Barry Wright

A critical assessment of botanical indicators as historic markers in wooded landscapes.

A thesis submitted in fulfilment of the requirements of

Sheffield Hallam University

for the degree of Doctor of Philosophy

May 2016

1. Abstract

Extensive critical review of literature and stakeholder interrogation provided key research questions and paradigms. They are explained in the introductory chapters. Approaches to the understanding and assessment of woods and of hedgerows (as linear 'woodlands') were developed and tested through intensive and extensive field-based case studies.

This research investigated and critically assessed the role and value of using botanical indicators as historic markers in wooded landscapes that comprise woodlands and hedgerows. These are linked by social history and ecology. In both habitat types, there have been recent attempts to determine their age and origins based on current floras. Ancient woodlands (i.e. present pre-1600) are determined by reference to regional ancient woodland indicator species (AWI) lists. Hedgerows have been dated by counting the number of woody species in sections (the Hooper Rule) to provide an estimate of hedgerow age. In this study, both the derivation of ancient woodland indicator species and the dating of hedgerows using the 'Hooper Rule' were questioned. In particular, the survey methods applied in these situations were critically analysed. For woodlands, there has been only limited emphasis on recording the local variations in flora within woodland. The woody species counting for hedgerows took little account of the species involved.

Stakeholder opinion was canvassed using a series of four woodland workshops where the role of AWI was discussed. This generated questions the outcomes of which agreed with this research that new methods of data collection and interpretation were needed. Furthermore, the current patterns of the use of ancient woodland indicator species at regional or county level were considered and assessed. The need for a new approach to surveying woodlands and hedgerows to collect data relevant to historic interpretation was addressed. Appropriate methodologies were proposed and tested.

A novel approach to interpretation was developed that considered the nature of a species used as an historic marker: where it was, how abundant it was and if there were any other associated species in combination. This intelligent interrogation process is a radical departure from current approaches to using only the presence of botanical species as historic markers.

The overall conclusion of this research is that botanical species are valuable and powerful historic markers if their presence is considered carefully and intelligently based on adequately detailed surveys. This original approach has added to scientific knowledge and the understanding of botanical species as historic markers. New practitioner and researcher toolkits were developed and tested, and novel approaches to the evaluation of woods and hedgerows using cross-disciplinary methods were proposed.

CONTENTS

GENERAL NOTES ON READING THIS THESIS

Table and figure referencing

For ease of navigation, figures and tables are referenced using the page number followed by the Figure/ Table number.

Conventionally, figures and tables are numbered sequentially through the document from say 1 to 10 without any indication of the page in which each occurs. In this thesis, to make it easier for the reader to locate a figure mentioned on other pages, these are prefixed by the page number e.g., Figure 112.4 is the fourth figure in the thesis, which is situated on page 112. If there are two figures on the same page these are referenced as Figure 112.4 and 112.5 etc.

Species nomenclature

The scientific and common names of plants are taken from Stace (1997). Scientific names are in italics and not within brackets and the common name formats follow the Stace conventions of initial capitals for each word and his convention on hyphenation, e.g., Wood Anemone, Opposite-leaved Golden-saxifrage and Herb-Paris and Herb-Robert (where the word after the hyphen is a proper noun or a name). For consistency, this general concept of using initial capitals for the elements of common names is also used for the common names of other organisms referred to in the text e.g., Water Vole, Brown Long-eared Bat and Orange-tip (butterfly).

Appendices

Owing to the size of the technical appendices and the inclusion of the complete report on the Dunnington hedgerows, some are only provided as electronic files (Adobe© Acrobat PDF format) on a DVD included with the hard copy of the thesis (this thesis is also included as a PDF on the DVD). Appendices 1-10 are included as hard copy in Volume 2. As the appendices are not part of the main thesis each has independent page numbers.

NB This version differs from the two volume printed copy in having map copyright information on every map or on every page with maps and is a continuous document including all appendices rather than being split into two volumes that included only appendices 1-10 in volume 2. The Dunnington hedgerows report with its annexes (referred to in the thesis) is available on the DVD.

2. Glossary and abbreviations

Abiotic factors - non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems.

Ancient tree - A specimen tree in the later stages and declining period of its life. Different species have different natural lifespans and become ancient at different times. It is apocryphally said that 'An oak tree grows for 300 years, rests for 300 years and then spends the next 300 years gracefully expiring'. Other species complete their lifespans in less than 300 years, e.g., Birch *Betula* sp. have a normal lifespan of 80-140 years.

Ancient woodland - An area of land where trees or shrubs create a degree of shading to allow the development of a shade-tolerant ground flora that has essentially persisted since at least 1600. It may be a closed canopy or be more open with clearings and glades or be a shadow or ghost wood

Archaeology of the woods - linked to the historic uses of that woodland, including charcoal hearths, wood-banks, worked trees etc.

Archaeology in the woods - covers all archaeology not directly linked to the woodland and its uses, for example agricultural remains from historic periods when the woodland was largely cleared of trees.

Assarting - The process of clearing blocks of woodland to create fields.

AHI - Ancient Hedgerow Indicator

AW - Ancient Woodland

AWI - Ancient Woodland Indicator

Biotic factors - A biotic factor is a living organism that affects another organism in its ecosystem.

Botanical indicator - a plant that can inform about the growing conditions, management or historic origins.

Candidate species - Species that could potentially be present at a location based on records from the New Atlas of the British and Irish Flora and/ or are likely to be found at the local level based on the precise growing conditions, e.g., a wet area or a dry calcareous slope.

Climax vegetation - The final stage of vegetation succession that has achieved a steady state, e.g., mature woodland.

Coaxial field system - A prehistoric division of land bounded by walls, ditches and possibly hedgerows that extend, in parallel, for long distances, sometimes for many kilometres across the landscape.

Coppice ring - Rings of trunks that mark out the circumference of what is a lapsed coppice stool where the stool central stump has rotted away leaving separated coppice poles arranged in a ring.

Defra - Department for the Environment and Rural Affairs

End effect - The atypical flora in hedgerows that can occur where one hedgerow joins one, or more others (or where a hedgerow may have joined in the past, but is now missing). The atypical flora can result from a number of causes, including:

- Slow colonisation of species along a new hedge from a joining older hedge.
- The preference of some bird species to frequent junctions and potentially drop seeds.

EUNIS - EUropean Nature Information System

Ghost wood - May or may not contain small veteran or worked trees but will have a ground flora associated with ancient woodland (Handley and Rotherham 2013).

Hedge - The shrub component of a Hedgerow.

Hedgeline - The line of a former hedgerow that lacks any of the shrubs or shade-tolerant ground flora associated with a hedgerow.

Hedgerow - Includes the complex of hedge, hedgerow trees, ground flora and the shade affected verge. The definition for this research is wide as it needed to capture everything from a classic intact hedge down to a single Hawthorn *Crataegus monogyna* or Bluebell *Hyacinthoides non-scripta*.

Hedgerow tree - Woody species that normally exceed 7m at maturity that usually have a single main trunk (although coppicing can create many trunks).

HR - Hedgerows Regulations (HMSO 1997)

HSH - Hedgerow Survey Handbook (Defra 2007)

Indicator species - An organism that can be used to indicate the environmental conditions, management or historic origins

Macro-habitat - The large-scale, gross habitat such as woodland. This can contain a number of other habitats at different scales from, for example large sections of rock, through medium outcrops to small boulders.

Meso-habitat - A habitat at medium-scale. This may be a feature that can be at different scales such as a cliff that can be anything from a few metres across to a cliff of several kilometres. But in context of the reference the cliff component is medium in scale and is a Meso-habitat.

Micro-habitat - A small-scale habitat. This may be a feature that can be at different scales such as rock that can be a cliff from a few metres across to a cliff of several tens of metres, but could also be a small boulder or other Micro-habitat.

Native - A plant that has naturally arrived.

Non-native - A non-native species has been anthropogenically introduced and is regarded as either an archaeophyte (introduced before 1500) or a neophyte (introduced after 1500) (Hill, Preston and Roy 2004)

Photocline - An adaption of the term ecocline referring to the change in flora associated with woods and hedgerows that are due to the change in light level from open sky to the ground influenced by the canopy shade formed by the trees and shrubs. This gradual shift from light to shade can support a different flora in the photocline. These are often species that have intermediate Ellenberg (Hill 2004) values of [L]. An example would be Red Campion *Silene dioica* with an [L] value of 5 that is unusual to find in full sun or deep shade and is characteristic of woodland edge and hedge bottoms.

Propagule - Seeds, spores or vegetative components of plants (Gemmae, rhizomes, branch cutting etc.) that can establish a new colony at a new location if conditions are suitable.

RW - Recent woodland

Saproxylic - Inhabiting or dependent on dead wood (Cowan 2003). Includes fungi and wood-boring insects etc.

Shadow wood - an area which may contain ground flora associated with ancient woodland and/ or a scattered distribution of small veteran or worked trees (Handley and Rotherham 2013).

Shrub - Woody species normally <7m at maturity that may be multi-stemmed or single stemmed.

Sere -A recognisable stage in vegetation succession, e.g., scrub is a sere in the succession of grassland into woodland.

SPACES (Species, Position, Abundance and Combination Evaluation System) - A novel approach used in this thesis to take account of:

- **SPECIES** - Are there any species present in the woodland or hedgerow that can inform about the history?
- **POSITION** - Does the position of the species in the landscape, in the woodland or hedgerow inform about history and origins?
- **ABUNDANCE** - Does the abundance of the species in the landscape, in the woodland or hedgerow inform about history and origins?
- **COMBINATION** - Does the combination of species in the wood or hedgerow inform about history?

Each element can be considered independently or in combinations. The ideal being a species [S] that informs about history that is found at specific positions [P] and at similar levels of abundance [A] and in combination [C] with a number of species [SPAC]

Succession - The development of vegetation over time at a location where the vegetation changes based on natural processes such as the encroachment of scrub onto grassland that eventually progresses into woodland.

Tree - Woody plants normally >7m in height at maturity, usually on a single main stem, free-standing, in a wood or along a hedgerow (but may be multi-stemmed e.g., a coppice).

Veteran tree - A specimen tree that shows a loss of vigour leading to the dieback and loss of limbs usually with evidence of rotting by fungi. This is normally associated with aged specimens, but can occur at any life-stage (see ancient tree).

Wind-still - Conditions inside a habitat, like woodland, or on the lea-side of a hedgerow, where the vegetation has a wind-calming effect that will cause spores and light wind-blown seeds, such as those shed by orchids, to fall out of the airstream.

Wooded Landscape - landscapes in which what is commonly regarded as woodland and hedgerows are a key component. More open ghost and shadow woods and parkland type woodlands are also part of a wooded landscape.

Woodland - An area of land where trees or shrubs create a degree of shading to allow the development of a shade-tolerant ground flora. It may form a closed canopy or be more open with clearings and glades or be a shadow or ghost wood.

Woodlander/ woodland species - species that are adapted to shaded conditions by:

- Evading the full effects of shade by having their main growth period early in the year before the leaf canopy develops or
- Have an ability to grow under the reduced light conditions created during the summer in a deciduous woodland

3. Introduction

This research was driven by questions regarding the principles behind using botanical species in support of, and as surrogates for, historical information to indicate the origins and histories of deciduous broad-leaved woodlands and hedgerows in the United Kingdom. These are both parts of 'wooded landscapes'. Although a primary aim is to better understand how botanical indicators have been used, and can be used, to determine if woodland qualifies as being 'ancient' and hedgerows can be dated to their creation, the research is not limited to these aspects. It seeks to regard botanical species as having the potential to inform about the past in support of, or in the absence of, any historical information.

This thesis critically assesses botanical indicators - primarily vascular plants - in wooded landscapes, comprising the common interpretation of what constitutes woodland and hedgerows in relation to what they can inform about their origins and histories.

The 'Oxford English Dictionary' (2014) definitions are:

1. Woodland - Land covered with wood, i.e. with trees; a wooded region or piece of ground.
2. Hedgerow - A row of bushes forming a hedge, with the trees, etc. growing in it; a line of hedge.

Other definitions exist that are, in some cases, helpful, and in others may add to confusion. For woodland Rackham (1986, 1994) defines a number of types.

1. "Woodland - Land on which trees have arisen naturally. They are managed by the art of *woodmanship* to yield successive crops of produce in a perpetual succession. When cut down, the trees replace themselves by natural regrowth.
2. Wood-pasture - Land-use involving grazing animals and trees.
3. Non-woodland - Trees in hedgerow and field.
4. Orchards.
5. Trees of gardens and streets.
6. Plantation - Here the trees are not naturally regenerated. Plantations are usually of just one or two species, often conifers or other exotic trees. They usually die when felled and are replaced by a new plantation. This is the basis of modern forestry."

Rotherham, in Handley and Rotherham (2013) refers to 'shadow' and 'ghost' woods (see Glossary, Section 2) that are vestiges of what may have been a more densely wooded area or may have only ever been sparsely covered with trees, many of which are now old and gnarled 'veterans' and are also 'ancient' (see Glossary, Section 2).

With hedgerows a modern definition comes from the *Hedgerow Survey Handbook* (Defra 2007).

> "A **hedgerow** is defined as any boundary line of trees or shrubs over 20m long and less than 5m wide at the base, provided that at one time the trees or shrubs were more or less continuous. It includes an earth bank or wall only where such a feature occurs in association with a line of trees or shrubs. This includes 'classic' shrubby hedgerows, lines of trees, shrubby hedgerows with trees and very gappy hedgerows (where each shrubby section may be less than 20m long, but the gaps are less than 20m)".

There are public perceptions of what is regarded as woodland. It is generally accepted that it is not just trees growing close together as shown at Figure 7.1.

Figure 7.1 - An area 'Land covered with wood, i.e. with trees' on a golf course where a combination of mowing and insufficient shade (Birch casts light shade and the canopy is lifted, letting light in from the sides) do not provide conditions to induce a shade-tolerant and typical woodland ground flora.

A hedgerow is perceived as a linear row of shrubs, with or without standard trees, managed to create a boundary or barrier.

These definitions and perceptions are explored in this thesis, in particular the definitions of woodland and ancient woodland.

Trees and/ or shrubs contribute biotic[1] factors to the abiotic[2] conditions of soils, climate, geology, pH, moisture, topography and drainage etc.:

1. The trees/shrubs cast shade to varying degrees and affect the light regime that creates conditions for shade-tolerant shrubs and ground flora species, often referred to as woodland species or woodlanders.
2. The conditions created by any canopy has additional influences on any species below by providing shelter, making woodlands particularly essentially 'wind still', and being more sheltered on the lea side of hedgerows.
3. The lower wind speeds and reduced evapotranspiration combine to increase air humidity within woodland and under a hedgerow.
4. The soil conditions are affected by the leaf fall and natural recycling of nutrients from leaves and dead wood.
5. The water and nutrient draw by the canopy species impacts on the availability of these resources to the understory flora.

The research described in this thesis assesses how the trees, shrubs, ground flora species and individual plant specimens are used as historic markers in these habitats and considers how they might be better used in the future. It develops new approaches to enable current knowledge to be used more effectively and proposes novel methods for data collection and analysis for the future. A general perception is that there is a need to use botanical indicators to assist in determining the origins of wooded landscape features in support of any historical information. This may be whether the wood was present before a pre-determined date or when the hedgerow was planted. Other historic marker events are considered in this research: such as the historical management changes that are the result of human intervention in the natural processes that shape the species composition and character of woods and hedgerows.

3.1. Wooded Landscapes

There are two elements of wooded landscapes considered in this research - woodland and hedgerows, as defined above. The species they contain now have adapted through time and are the product of dynamic changes throughout their history. They are a significant part of our cultural heritage providing a range of services and products used and harvested by the local community. The social and economic demands of wooded landscapes have created and retained them, and have shaped and influenced their current nature and the plants they now contain. They have importance as ecologically valuable wildlife habitats and as fundamental components of our social history. They

1 A living thing, animal or plant, that influences or affects an ecosystem i.e., the presence of a plant influences the environmental conditions that can impact on other species.

2 The non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems.

are only here today because our ancestors needed them and this makes the research a study of human historical development and our impact upon the ecology of woodlands and hedgerows.

The use of botanical indicators as historic markers in these landscape features originated in research that proposes botanical indicators can be used to inform about origins and histories by authors such as Peterken (1974) and Rose (1999) (for woodlands) and Pollard, Hooper and Moore (1974) and Barnes and Williamson (2006) (for hedgerows).

Ancient woodlands and historic hedgerows generally have different origins. Ancient woodlands developed as vegetation re-colonised across the land bridge from the continent after the last glaciation (Jones 2009). These developed a flora that initially was unaffected by humans, but has been impacted by human activity since their arrival to the present day. Hedgerows are human creations, either formed from woodland as relicts or deliberately planted. Hedgerows are dependent on human management or they would revert to linear woodland. Woodlands can develop and persist without intervention, but, historically, most have been altered significantly by human intervention.

Both elements of our wooded landscapes are intimately linked to human use through time. These are two permanent landscape elements that are retained partly because they are difficult to remove, but mainly because they provide food and timber. Their preservation and management links back to at least medieval times with such legislation as the Statute of Merton - The Act of Commons 1235 (in Rotherham 2011). This effectively set the boundaries for land that could be enclosed for 'woods', common fields, heaths and commons, parks, fens, bogs and forests and other features that became fixed in place and accounted for. Prior to that, the landscape would have been more fluid and 'scruffy' with productive areas and timber producing areas being informally arranged. It is possible that some of these scruffy areas may still be detectable today, particularly in the uplands where Rotherham (2011 and Handley and Rotherham 2013) is researching 'shadow' and 'ghost' woods. Once woodland areas were defined they could be enclosed and field systems developed, bounded by hedgerows or walls.

These two features are linked in this research because they are historically significant woody habitats casting shade onto any ground-flora present, and their histories and changes through time are linked to human activity. The result is that both contain species now that reflect their past and this can be interpreted to understand former land use and the evolution of the countryside. In addition, some hedgerows can have a ground-flora of woodland species regarded as ancient woodland indicator species (Campagne *et al.* 2009a, b) and so form part of the scruffy landscape that could provide propagules to colonise recent woodland.

3.1.1. Woodland Origins

Unmodified natural woodlands are the ‘wildwoods’ referred to by Rackham (2006) that existed before humans returned across the land bridge from the continent and began using woods and clearing them for agriculture. Rackham believes that none of these relicts exists today as all woods have had some human influence and can no longer be regarded as truly wild. The nature of these woods at this time cannot be determined. Proposals by Vera (2000) suggest an open and almost savannah-like landscape with patches of trees interspersed with areas of open grassland maintained by large herbivores. This contrasts with current public perceptions that woodlands have a closed canopy that creates constant shade.

Rackham differentiates 'wildwoods' from what we now regard as 'ancient woods'; the latter being man-modified from the 'wildwoods'. Woodlands retaining the flora that developed in the wildwoods are potentially the most valuable as their trees, shrubs, ground flora and soils have persisted under woodland conditions for the great length of time (Day 1993).

Woods as currently expected, i.e., a defined area with trees, came into being with the Statue of Merton in 1235 (Rotherham 2011). Prior to that woodlands were not clearly defined. Rackham (2003) refers to two main types from the medieval period, *Silva minuta* and *Silva pastilis*, the former being coppiced woods to harvest 'underwood' and the latter being used as pasture, for grazing and pannage.[3]

Although the ‘ancient woods’ are modified by human influence, the ground they occupy has probably been relatively undisturbed and under some form of canopy (potentially a fluid and mobile canopy following the Vera (2000) theory and including coppice woods) for a long period. With this long-term continuity (Wulf 2003) it is assumed that some of the ground flora and woody species present from the post-glacial colonisation (Cain, Damman and Muir 1998) are still present today.

Two principles form the basis of using botanical indicators as historic makers in woodlands:

---

[3] The practice of taking pigs into woodland to feed on 'mast' (acorns and other seeds, especially Beech mast) to fatten them up.

1. Persistence through time resulting from continuity of suitable conditions.
2. A reduced capacity of species to colonise newly created woodlands on previously cleared and un-wooded sites.

Woodlands in the landscape that are not regarded as ancient are the result of re-wooding of land cleared historically that has either been allowed to re-colonise naturally or was planted. These are secondary or recent woodlands (Birch 1936, Peterken 1993, Rackham 2008). Planted woods will have a range of trees and shrubs dictated by the needs of the landowners. Naturally-regenerated woods will re-colonise with species from propagules of local provenance. Such species must be able to survive and grow under the local conditions whether they are native to the locale, or not. The two types are likely to have different characters because of their origins.

Many authors (Peterken 1993, Rackham 2003) have defined dates before when there is little evidence of woodland having been planted and suggest that any woodlands present before then are likely to have been wooded from times more ancient. The most widely adopted date is 1600 (Jones 2009, Peterken 1993) although Rackham (2003) favours 1700.

3.1.2. Hedgerow Origins

Hedgerows are anthropogenic in origin and have been created from the early times (Baudry, Bunce and Burel 2000, Muir and Muir 1987, Pollard, Hooper and Moore 1974) when our ancestors began primitive agriculture and used hedges to define boundaries of land ownership, retain stock and provide shelter (Muir and Muir 1987). They also provided other resources such as fruits, berries, medicines and materials for making dyes etc. (Chapman 2001).

Rackham (1994) suggests that some hedge boundaries may have originally been strips of woody vegetation left during assarting. Having cleared one block, the next block would have left a strip of woodland that formed the 'new' hedge (Pollard, Hooper and Moore 1974). Muir and Muir (1987) point out that a wood of the time would have comprised a random mix of existing large trees, saplings and smaller trees which questions this concept. These are likely to have been difficult to align into a linear feature and thus create a hedgerow. Clearing woods and creating new hedgerows may explain why some of our oldest hedgerows have a typical woodland ground-flora. This could have survived until the 'new' canopy of hedge shrubs established and be still present today because of the continuity of shade from the hedge.

According to Rackham (1993), there are three ways to create a hedge:

1. They can be deliberately planted with species of shrubs.
2. They can arise spontaneously from natural colonisation from nearby woodland or shrubby vegetation.
3. From a relict 'ghost' of former woodland, left as strips following assarting into woodlands to create fields.

There is considerable evidence that hedgerows were being deliberately planted prior to the accepted date for determining a woodland to be ancient viz. 1600 (Rackham 2003). There is evidence for planting in medieval times to enclose parts of the classic open field systems adopted in many parts of the country (Aston 1985).

Earlier hedge plantings would most likely have been from locally collected stock as recounted by Muir and Muir (1987) from an earlier document by Fitzherbert in "*The book of Husbandry*" (1534):

- "Gette thy quicksettes in the woode countrye and let thym be of whyte thorne and crabtree for they be beste, holye and hasell be good. And if thou dwell in the playne countrey, then mayste thou gete both ash, oke and elm, for those wyll encrease moche woode in shorte space".

Hedges that are more recent have used purpose grown commercial nursery stock. Again Muir and Muir (1987) recount from an earlier document by Thomas Tusser (Tusser 1573)

- "Buy quicksets at market, newly gather'd and small,
  buy bushes or willows, to fence it with".

Nurseries became established during the Parliamentary Enclosure period (approximately 1750 - 1850) to supply the quantities of stock needed to plant large numbers of hedges. Muir and Muir (1987) (page 45) quote an estimate from a William Pendar in 1766 to supply 4,000 quicksets to Lord Bruce of Tottenham at a cost of five shillings.

The current method of determining the origins of hedgerows is based on a premise from the work of Hooper (in Pollard, Hooper and Moore 1974). This was that old hedges were originally planted with only one species and have become colonised by an increasing number of shrub species through time. The oldest contain the greatest number of species recorded today. This is referred to as the Hooper Rule. This rule applies a formula that approximately one new species is recruited into a hedge every 100 years as detected by sampling one or more 30 yard section(s).

3.1.3. Linkage Between Woodlands and Hedgerows

It is important in this research to consider the interaction between woodlands and hedgerows, as historically some of the shrubs used to populate hedges will have come from woodlands (McCollin *et al.* 2000). As such the species in woods and hedges are linked. Hedges would have been planted with species present in the landscape at the time of their creation.

The ground flora of hedgerows is generally given little consideration with regard to assessing their histories and origins in current literature and approaches to assessment. Some hedgerows created following woodland clearance may have trapped some typical woodland ground-flora species or woodlanders that were able to tolerate the unfavourable conditions until the new canopy of shrubs established.

Our ancestors retained, created and managed both habitats as part of their overall landscape use and obtained benefits from both in the forms of food, timber and other resources as well as the benefits of forming boundaries in the case of hedgerows. These features were maintained following the dictates of lords of the manor, then individual landowners and tenants, and in the case of hedgerows, the enforced creation by Act of Parliament in many parts of the country.

3.1.4. The Importance of Woodlands and Hedgerows

Wooded landscapes are valued historical and ecological features (Blakesley and Buckley 2010, Rotherham and Wright 2008) with intrinsic and social significance. They can be ancient, having been purposefully retained or deliberately created. Over much of England, this landscape is based on the medieval system of manors and townships or vils (Rackham 1986). Within this system, the use of woods and the division of land units by hedgerows was controlled and regulated by the lords of manors, with penalties meted out where individuals damaged these features or removed timber or other products (Muir and Muir 1987). This medieval re-organisation, and in particular the 'Statute of Merton - Act of Commons' (1235), set a baseline for woods and hedgerows that were defined and protected then and can still be present (Rotherham 2011, Rotherham *et al.* 2013a). Since the medieval period, the uses for woodlands and hedgerows have changed to fulfil changing needs.

Woodland

The importance of identifying and retaining ancient woodlands is acknowledged and they are regarded as a material consideration under the National Planning Policy Framework (HMSO 2012). Paragraph 118 states that:

- "planning permission should be refused for development resulting in the loss or deterioration of irreplaceable habitats, including **ancient woodland** and the loss of aged or veteran trees found outside ancient woodland …".

In determining their status, botanical indicators have been used when dealing with planning applications that involve the potential damage or destruction of woodland.

Ancient woodlands are regarded as being irreplaceable habitats – they cannot be re-created to replay the sequence of events since the end of the last glaciation. As such they are important to the general public who are now increasingly aware of their value through the promotion work of organisations like Natural England, Woodland Trust and local wildlife groups.

Hedgerows

Hedgerows were regarded as part of the productive landscape (Rackham 1986). This was because they were a source of timber and other produce like Hazel *Corylus avellana* nuts for food (Pollard, Hooper and Moore 1974, Rackham 1986), Holly *Ilex aquifolium* probably used for winter forage (Jones 2012), and shrubs like Willow *Salix* spp., used to make hurdles (Rackham 1986) and for winter fuel (Brooks and Agate 1998). In the nineteenth century, these products would have had less value and hedgerows were retained mainly as boundary and stock retention features (Dowdswell 1987). More recently, they became regarded as being of low agricultural value and impeded the use of large modern machinery and many have been removed (Brooks and Agate 1998, Dowdswell 1987).

The value of hedgerows in the landscape has been recognised by the legal protection of 'important' hedgerows under the Hedgerows Regulations (HMSO 1997). This legislation uses a count of the number of woody species, amongst other criteria, to assess the value of a hedgerow with emphasis on its historic context (a legacy from the Hooper Rule, see 3.1.2). Such assessments are used to prevent landowners from removing important hedgerows. Under planning legislation and guidance, any hedgerows proposed for removal that are assessed as being important should be retained.

Hedgerows are also a resource that the general public values. Many public rights-of-way follow hedgerows and this adds interest for walkers, cyclists and horse riders. The lowland rural landscape is characterised by its hedged fields forming an intricate patchwork, which are valued by the public who regard them as an integral part of the rural scene and are likely to object to and oppose their removal.

Organisations like Hedgelink (http://www.hedgelink.org.uk) promote hedgerows for their contribution to wildlife and the landscape (Barr, Britt and Sparks 1995, Barr and Petit 2001, Bates 1937, Aude, Tybirk and Bruus Pederson 2003, Aude *et al.* 2004). In recent times, hedgerows have had a resurgence in their appreciation as a local resource with the publication of a number of books encouraging foraging for food, medicines and remedies (Chambers 2012, Lewis-Stempel 2012, Nozedar 2012, Popescu 2008, 2011, Wright 2010). One of the earlier publications accompanied a television series from the BBC: Discovering Hedgerows broadcast in April 1982 (Streeter and Richardson 1982).

3.2. Botanical Indicators as Historic Markers

The primary aim of the current research is to critically assess the basis on which botanical indicators are used to interpret the historic origins of woodlands and hedgerows in the landscape.

Botanical indicators can indicate many features found in the landscape from the physical growing conditions of soils, their pH and moisture to the influences of shade casting trees and shrubs on the ground flora below.

Using botanical indicators as historic markers means that a species present today in a wood or hedgerow can inform about the origins, history or past management of the feature.

For woodlands this generally means it has persisted from ancient times. Ancient woodland indicator species (AWIs) are those species found most often in datable ancient woods (pre-1600) and therefore a wood that lacks these species is likely to have a more recent origin. AWIs are used to assert if a woodland is likely to pre-date 1600.

In hedgerows it is currently presumed that species have colonised into the hedgerow in the past and the number present today is used to estimate the planting period. This is based on research done by Max Hooper (see Pollard, Hooper and Moore 1974) that suggested a hedgerow, originally planted with a single species, acquires one new species approximately every century. This is used to provide an age estimate to the nearest century.

The current concepts and processes of assigning botanical indicators as historic markers has raised questions that this research intends to address. How and why can a species found in a woodland be categorised as being an indicator of ancient woodland? Does the number of species in a hedgerow increase over time at a fixed rate as per the Hooper Rule?

The stimulus for this research concerns the way botanical species are used to interpret history in both woodlands and hedgerows. The aim is to gain a better understanding of why species can be used, how, and to consider developing better methods.

This research aims to review what botanical indicators are in the context of being historic markers in wooded landscapes and intends to develop a better understanding and propose new methods of data acquisition and interpretation.

Although a primary aim is to determine the reliability of using botanical species to indicate origins, pre-1600 for woodlands or planting dates for hedgerows, any use of species or specimens as historic markers of any historical event is to be considered in this research.

3.3. Summary

This chapter set the scene by describing what is meant by woodland and hedgerows and how they form part of a wooded landscape, what their origins are, and why they are important. It indicates how the two features are linked historically and culturally. There is a description of what botanical indicators used as historic markers are and what they indicate.

Wooded landscapes were chosen as there is much documented evidence suggesting that both woodlands and hedgerows can be 'dated' using the species of plants they currently contain. These two features in the landscape are linked not only by their shade casting components of trees and shrubs, but more importantly by their permanence in the landscape driven by human needs and uses for both. Following the Statute of Merton the landscape became essentially fixed in terms of the allocation of land for different uses. Woods were enclosed and fields created, bounded by hedges formed from a likely combination of retained fragments of woodland and new planting derived from the surrounding scruffy landscape that probably contributed to the botanical content that is still present today. If a hedge was planted on land that had recently been cleared of trees the resilience of the woodland ground flora may have persisted until the hedge shrubs re-established the shade removed by the woodland felling.

This research asks the questions: Can botanical species indicate the histories of woodlands and hedgerows in the widest sense? Can species or ancient specimens indicate antiquity?

4. Research Questions

4.1. Introduction

The basic questioning of the current uses are now formalised into a set of Research Questions that address the aims and objectives listed below. These review the methods of using botanical indicators and consider new methods for use in the future, the output of which add to academic understanding and provide new practitioner tools.

4.2. Aims

1. To gain a better understanding of the role of Botanical Indicators for informing about woodland and hedgerow origins and management histories.
2. To determine the value they have and the reliability of their use as Historic Markers in the absence of supporting historic evidence.
3. To identify the needs for such approaches and to develop better methods of survey and interpretation.

4.3. Objectives

In order to achieve the aims, there are a number of identifiable objectives that form the structure of the methods used (see Chapter 6 - Methods on page 59).

1. Review current literature on survey, analysis and interpretation methods to identify shortcomings and the need for better methods for using existing Botanical Indicators.
2. Gather stakeholder opinion on the value of using Botanical Indicators as surrogates for an absence of supporting historical data.
3. To improve on the methods of using current Botanical Indicator data.
4. Propose and test novel survey methods to provide better data on which to base interpretation.
5. Develop a toolbox to provide a better system for the assessment and interpretation of the Botanical Indicators as Historic Markers.

The following research questions are addressed:

4.4. Research Questions

RQ-01a - Are botanical indicators a reliable and robust means of informing about the origins and history of a woodland or hedgerow?

From this a supplemental question is:

RQ-01b - Can they be used in the absence of historic data?

Which leads to the question:

RQ-01c - If so, how?

The requirement of a botanical indicator used as a historic marker is to provide independent evidence that a woodland or hedgerow has a defined history and origin or evidence of management history based on its current presence. It should ideally be absent, or at least less likely to be found, in more recently established woods and hedgerows. Alternatively, its absence should be explainable by the historic management of the feature.

It is desirable to identify and establish the status of the older examples of woodlands and hedgerows. Identifying recent historic markers is also important for interpreting recent history.

The autecologies of Historic Marker species and their individual attributes are likely to lead to a degree of overlap of their fidelity to either ancient or recent woodland or hedgerows. Consideration is given in this thesis to investigating this continuum to provide degrees of confidence based on the number and characteristics of species and species combinations.

In hedgerows, there are natural dynamics processes and significant human influences, including active management that can affect which species are present today. Disentangling the changes from the original planting mixture and the subsequent anthropogenic and natural processes of colonisation, spread, decline and extinction are key questions addressed.

An important part of this research is to determine if it is possible, once calibrated against features of known antiquity, to use the botanical evidence alone where there is an absence of supporting historic evidence. If this is possible, how could it be done?

RQ-02 - What is the basis for using botanical indicators as historic markers?

Based on the concept of RQ-01 that botanical species can be used as indicators of history, the basic premise is that their presence confirms that a wood or hedgerow is old or ancient, being absent from more recent examples. This alludes to the lack of ability of species to colonise new woods and hedgerows from nearby habitats - other woods, hedgerows or shrubby habitats that may also have shade-tolerant ground flora (Petit *et al.* 2004).

RQ-03 - What do Botanical Indicators used as Historic Markers indicate?

For woodlands, botanical indicators generally assume a continuity of tree/ shrub cover and a persistence of sun demanding species from ancient times. Most authors concern themselves with shade tolerant species (Bierzychudek 1982), and tree and shrub species (Peterken 2000) and do not consider species found within the bounds of an ancient wood that are sun lovers or 'open sky' species. The Woodland Trust (2003) included all species within a woodland boundary in their recent survey of woodlands in Northern

Ireland. Botanical surveys of areas defined on maps as woodland are frequently going to include areas of a more open nature where sun-loving species will be recorded.

A specific aspect of autecology to be investigated, is the degree of shade-tolerance of species used as ancient woodland indicators. Oliveira *et al*. (2011) refers to this attribute in relation to bryophytes. Species are: sun species, generalists or shade species. Adopting a purist approach, only shade species, i.e. dependent upon the continuity of canopy (see also Burch 2008), should be included in lists as the presence of sun-lovers is not diagnostic or preferential to woodland.

The species used as indicators in hedgerows are generally not considered in any detail. The current method is to count the number of woody species (trees and shrubs) to indicate age (Pollard, Hooper and Moore 1974). The Hedgerows Regulations uses certain rare species of tree, such as Black Poplar *Populus nigra* ssp. *betulifolia* and a selected list of woodland ground flora species like Bluebell *Hyacinthoides non-scripta* to indicate a hedgerow as being 'important'.

RQ-04 - How were they derived?

Although there are ancient woodland indicator species that are more or less nationally agreed to be indicators in woodlands there are regional lists in use that are drawn up from a number of sources. One readily available compilation is in Rose (2006). Recent research and a questionnaire in Glaves *et al*. (2009a) asked the question 'Do you know anything about how the list was produced?'. Many lists are based on expert opinion, others on detailed surveys and comparisons, and some adopt and adapt lists from nearby regions. This question was asked to determine how reliable the list may be, based on how they were derived.

The origins of these regional variants (see also De Frenne *et al.* 2001) and the way they are used is assessed and novel alternative approaches developed. The origin of the species count approach for hedgerows is from the research by Max Hooper (Pollard, Hooper and Moore 1974).

RQ-05 - How are they used?

Woodland indicators are used in the National Planning Policy Framework or NPPF (HMSO 2012) to identify ancient woodlands and support any historic data to allow the Local Planning Authority to make a considered judgement about the value (see Nature Conservancy Council 1989) of a woodland subject to potential damage or destruction.

They are also used to identify woodland sites as candidates for designation as local wildlife sites - often referred to as Biological Heritage Sites or Sites of Importance for Nature Conservation).

Hedgerow data are used to protect 'Important' hedgerows under the Hedgerows Regulations (HMSO 1997) and to identify hedgerows that are of historic value for wildlife organisations and local history groups.

RQ-06 - Are current methods adequate?

The current research is driven by questioning current methods. In the words, commonly attributed to Albert Einstein (no precise reference found), that 'everything should be made as simple as possible, but not simpler'. The overriding impression is that the approach for assigning woods as ancient and for dating hedgerows are more simple than they should be and that the methods for using botanical species as indicators is also in need of critical review. They are prescriptive and inflexible, relying on targets and thresholds. This could lead to the mis-identification of a woodland or hedgerow as being ancient when it is recent in origin or the converse.

RQ-07 - What are the shortcomings?

The main shortcomings identified that this current research seeks to address are:

Regional distinctiveness

The current basis of regional lists for AWIs normally focuses on administrative boundaries. This is, in part, due to administration organisation of councils and local county wildlife groups as well as the historical use of vice-counties as a means of dividing the country into definable and manageable areas for collecting biological records (Dandy 1969). Some lists were also based on the regions covered by the Nature Conservancy Council offices of the time South Region - Hants, Wilts, Oxon, Bucks and Berks (Rose 1999). These are purely administrative divisions and are not related to ecologically distinct regions based on geology and landscape character driven by centuries of agriculture and forestry.

Weighting of species

Few authors currently deal with the issue of whether a species can be regarded as being a reliable indicator or one that occurs in other situations. Peterken (2000) lists species based on their percentage fidelity to either ancient woodland or recent woods. Is a weighting system appropriate to provide a probability of a woodland being ancient based on a combination of 'good' - High level - and 'poor' - Low level - indicators? The ideal (or perfect) indicator would be a species that can be conclusively asserted to only ever be found in ancient woodland and never in examples that are more recent. A phrase, attributed to Aristotle, that one swallow does not a summer make would allude to whether a single keystone species could potentially give a 100% diagnostic certainty of ancientness.

For hedgerows, the current methods take no account of the identity of the species, nor do they apply any weighting for species that may be more reliable at interpreting hedgerow origins and histories.

Variations within and between woodlands and hedgerows

Many woodlands contain a range of different sub-habitats like streams, springs or wet areas. Subtle variations in slope can also influence the range of species that can potentially occur in woodlands

Within the macro-habitat of woodland, meso-habitats and even micro-habitats can exist that support particular AWI species that have specific requirements. For example, Opposite-leaved Golden-saxifrage *Chysosplenium oppositifolium* is more commonly found in damp parts such as stream sides and wet hollows. If this meso-habitat is absent, this species is likely to be missing from the survey list. Woods with more meso-habitats have the potential to have longer lists of AWIs than those that are more homogeneous in nature.

Entire woodlands may also be fundamentally rich in AWIs compared with others. The range of species expected in woodlands on base-rich soils is generally greater than in those on acidic substrates. This fundamental difference makes it difficult to assign thresholds, or give woodlands on the different substrates an equable evaluation for their observed range of AWIs.

Little account is taken of the species composition of hedges and different combinations of species on different geologies, for example. Two hedges may each have five species, but be on different geologies and have few or even no species in common. Variation within the hedgerow receives even less emphasis. Most current survey methods take no account for any difference in the species mix either for the whole hedge or for parts that may differ from the norm. For example, the Hedgerows Regulations (HMSO 1997) specify a sample of a maximum of 3 x 30m sections and averages the species counts regardless of what the species are. There may be a total of 10 species in the three sections, but the average may be calculated to five.

Accounting for both shade tolerators and shade evaders

Lists drawn up for woodlands often encompass both shaded and unshaded areas. As such some lists contain species that are sun lovers. The method of dealing with such species is addressed in this research. These species may be indicators of ancient woodland based on the Vera (2000) concept that the ancient wooded landscape was a mix of shaded habitat interspersed with open areas.

In addition to species at the extremes of shade tolerance there are species that exist in what can be called the photocline. This is the zone where shade intensity increases moving into the wood. The width of this zone will vary dependent on the tree canopy and density and if there are any shrubs or a hedge around the wood. This makes photocline a more meaningful word than phototone that may imply a sharp change between the two biomes. Within the photocline there are often species that are absent from the extremes of deep shade and open sky (Peterken and Francis 1999).

The Hedgerows Regulations do account for 'woodlanders' being an associated feature that can elevate a low shrub count hedge and classify it as being 'important'. There is account made for shade tolerators under the regulations based on my assertion (as part of the steering group drafting up the regulations) that hedges with woodland ground floras were almost certainly populated by these because of a retention of these species.

The Hedgerow Survey Handbook or HSH (Defra 2007) records the hedge-bottom flora, but only to identify either a favourable[4] flora or unsuitable vegetation like weeds or even bare ground cause by too much shade or herbicides.

RQ-08 - Can current survey and analysis methods to identify ancient woodlands and hedgerows be improved?

Based on the premise that existing methods are inadequate this research proposes to develop novel approaches to improve on the current methods and provide a clear process for collecting and processing data to give increased confidence that historic woodlands and hedgerows are correctly identified using botanical evidence.

RQ-09 - How can they be improved?

Having identified and acknowledged that there are shortcomings with existing methods, this research proposes to develop a number of methods to review the current status of

[4] The HSH is almost entirely aimed at recording hedgerows to assess if they are in favourable condition based on targets set by the steering group for the UK Biodiversity Action Plan for Hedgerows. There is only one reference to age at Appendix 7 (section 13) that asks how many hedgerows are pre-1845 in origin.

Botanical Indicators as Historic Markers and identify areas where improvements can be made.

The conceptual framework for this research is illustrated on the diagram at Figure 24.2.

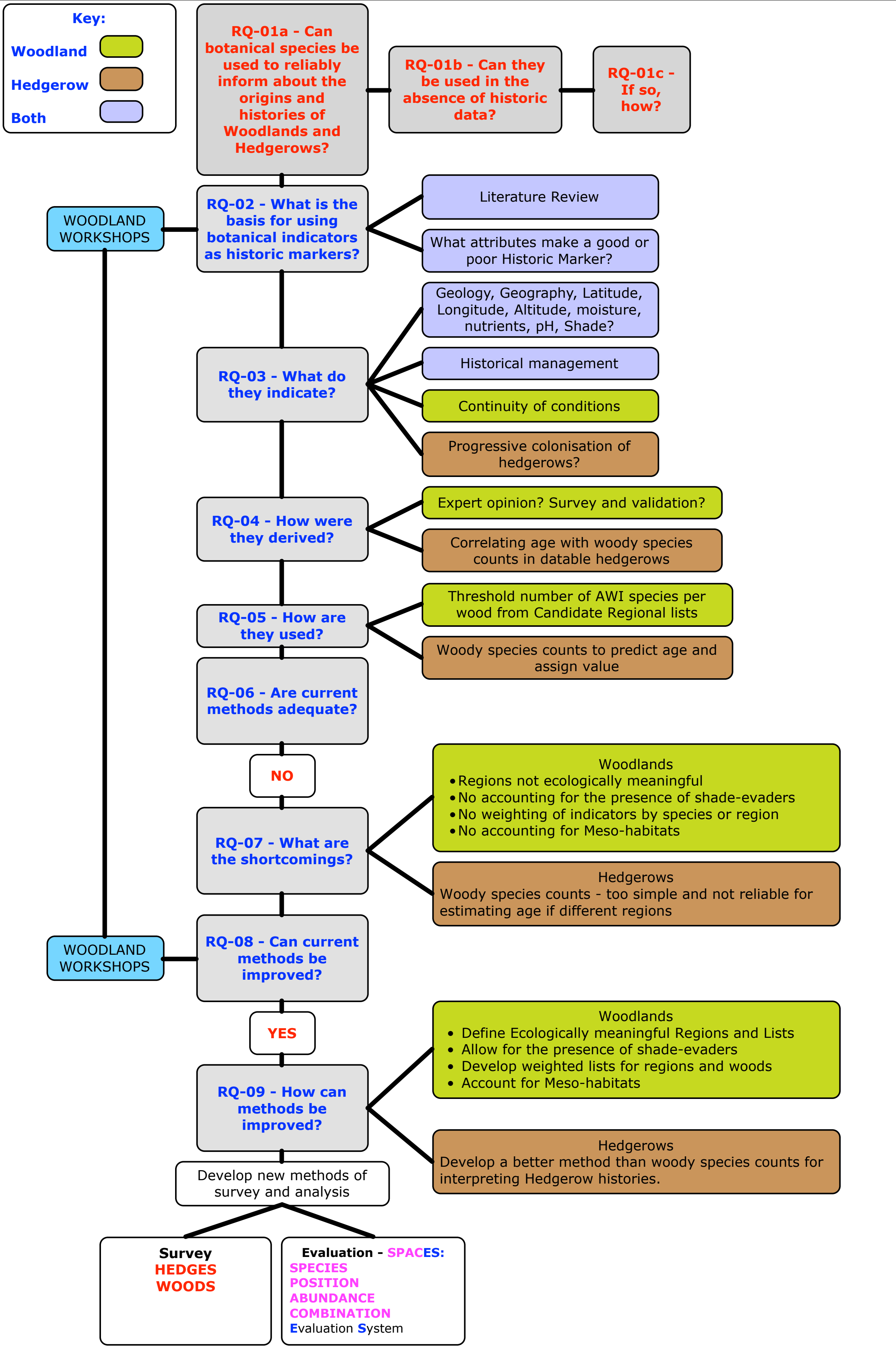


Figure 24.2 - Conceptual framework for the process of addressing the Research Questions.

4.5. Summary

This section sets out the research aims and objectives that will critically assess and question the current use of botanical indicators. There are identified shortcomings that the current research aims to address, including the use of regional lists, applying a weighting to species and accounting for both shade tolerators and sun lovers on current lists for woodlands. For hedgerows there are concerns over the use of current methods of recording and interpreting using the Hooper Rule of counting the number of species per 30m and using that to estimate the age. The lack of consideration of the identity of the species found in hedgerows is also a concern. Research questions are posed and in answering these, novel methods of both field survey and data analysis are proposed. These take fresh approaches to using Botanical Indicators in a more focussed, reliable and informative way.

Academically the work aims to gain a better understanding of the use of indicators and determine if there is a sound basis for interpreting the status of species as indicators by evaluating the attributes of species that are regarded as AWIs.

At a practitioner level, it proposes to provide a toolbox to aid the surveying of woodland and hedgerow vegetation and the evaluation of both existing data and data obtained by adopting the novel survey methods proposed.

The overall aim is to critically assess the use of botanical indicators and provide guidance on their use in the future.

5. Literature Review

5.1. Introduction

This chapter critically reviews relevant literature, focussing on current approaches to using botanical indicators, specifically as historic markers in wooded landscapes, to identify shortcomings and provide information to pose, address and answer the research questions.

Authors generally treat the common attributes of woodlands and hedgerows differently. Both have a canopy that casts shade and they provide shelter and humidity, affecting flora. How these are accounted for and are dealt with differ. In woodlands the main focus is the role of shade-tolerant ground flora species, whereas in hedgerows these only receive minor consideration (associated features under the Hedgerows Regulations 1997). Some authors have reported on the role of hedgerows as refuges and corridors for woodland ground flora species (Davies and Pullin 2007, Roy and De Blois 2006, 2008, Sitzia 2006). It is the hedgerow's shrubs (the canopy) that form the focus of attention and the canopy element in woodlands receives less emphasis. There is an ecocline[5] element to both. In woods the degree of shading is less for a zone around the perimeter and the shading influence of a hedgerow declines moving away and varies with compass alignment (north-facing hedgerows extending their shade zone compared with south-facing).

The current research draws together common elements and focuses on their differing characteristics and current methods of data collection, assessment and the use of information for each.

5.2. Indicator species

The prime concept of biological indicators is based on the requirements of species being able to inform about the conditions at that location and, for the current research, specifically about origins and history. For plants this encompasses both abiotic factors: soil (Wilson, Moffat and Nortcliff 1997), pH (Sciama *et al*. 2009), moisture, nutrients (Falkengren-Grerup and Schöttelndreier 2004), temperature - altitude, latitude - slope, aspect etc., and biotic factors: shade (Blackman and Rutter 1946), competition (Grime, Hodgson and Hunt 2007), humidity (Morecroft, Taylor, and Oliver 1998), humus build up (Gorham 1953) etc. These combine to produce plant combinations (communities)

[5] From a woodland edge the degree of shading grades towards darker moving into the wood and the influence of shade moving away from the hedge canopy also grades. Hence ecocline is a more appropriate description than ecotone that implies an abrupt change in biome.

that are specific to a location and its growing conditions. Summaries of many of these factors are presented in *Plantatt* (Hill, Preston and Roy 2004) and *Comparative Plant Ecology* (Grime, Hodgson and Hunt 2007).

These systems are also time driven, with many communities progressing through a succession of combinations before reaching a stable condition, e.g., the progression from open grassland through scrub to woodland. The concept of succession has been the subject of study of many authors, including Cameron (1980a, b), Hester, Gimingham and Miles (1991), Matlack (1994), Patino, Werner and Gonzalez-Mancebo (2010), Stehlik and Holderegger (2000), Vickers, Rotherham and Rose (2000), Watt (1934). Species can therefore indicate a sere within a succession towards a climax vegetation.

5.3. Botanical Indicators

Botanical indicators are species or individual specimens that can be used as markers to inform about the environment (Cantarello and Newton 2008), management and/ or the landscape in which they grow (Diekman 2003, Ellenberg 1950, 1974, 1992a, 1992b). This includes determining plants as markers of landscape history (Wulf 1997).

5.3.1. Indicators of Abiotic Factors.

Botanical species are used in various ways as indicators, including giving an indication of abiotic factors in the environment. This includes indicators of soil condition e.g. Nettles as indicators of high levels of nitrogen (Rackham 1993); and indicators of pollution, e.g. lichens as indicators of air quality (James 1982).

Some species have narrowly defined requirements or preferences and their occurrence indicates exacting conditions for that species or community. These are 'good' botanical indicators. Other species have wider ecological amplitudes and cannot be used as ‘diagnostic indicators’ of specific conditions.

Fundamental requirements for either high or low pH are recognised in community classifications systems like the National Vegetation Classification system (NVC) (Rodwell 1991) where grasslands, for example, are defined floristically but are classified into groups of acidic, mesotrophic and calcareous with a range of characteristic indicator species used to define community types (see also Bunce 1982, 1989). The list of species found in each community type contains some species that are preferential or diagnostic in defining the community. Other species are more catholic and not diagnostic, occurring in several, often unrelated communities because they have such a wide ecological tolerance. Hill, Preston and Roy (2004) uses Ellenberg (1950, 1974, 1992a, 1992b) values for the attributes of Light [L[6]], Moisture [F], Reaction/pH [R], Nitrogen [N] and Salt tolerance [S] to provide information on the abiotic environment for most of the British Flora. Ellenberg (1950, 1974, 1992a, 1992b) assigned values to the attributes listed above in relation to the point on a scale (1-9 or 1-12 for moisture) where species showed a preference. These are largely descriptive scales with a degree of overlap as described in the class descriptions. An example for light is scale point 2 that is described as "Between 1 and 3 …". With 1 being a "plant of deep shade …" and 3 being a "Shade plant, mostly less than 5% relative illumination, seldom more than 30% illumination when trees are in full leaf …" (from Hill, Preston and Dines 2004).

These are mainly abiotic factors. Light is normally determined by shade being cast by other plants (or in some cases by cliffs and in caves etc.) and is usually regarded as being a biotic factor.

Ellenberg values are presented as single figure on a scale, presumed to be the central value. There is no indication of a spread of values to suggest the range, or ecological amplitude. The original work by Ellenberg considered continental material but Hill, Preston and Roy (2004) adapted some of the values to reflect UK conditions.

Accounts of the ecological amplitude for attributes of commonly occurring plant species are described in *Comparative Plant Ecology* (Grime, Hodgson and Hunt 2007). For example, they indicate for pH the percentage of their samples that were recorded at actual pH values. Such as: *Oxalis acetosella* is found mainly in the range of pH 3-5 and less frequently where the pH >5.

5.3.2. Indicators of Biotic factors

In addition to plants only being able to grow at a location if the abiotic factors are equable, the interaction with other plants can influence species presence in the landscape. The example explored in this thesis is primarily that of biotic shade cast by trees and shrubs on the tolerant ground flora adapted to those conditions especially in woodlands, but also in hedgerows to a lesser extent. Other biotic influences from trees and shrubs in wooded landscapes include the effects on soils and soil structure by the creation of leaf litter, shelter and humidity.

[6] Ellenberg values for light range from 1 = deep shade to 9 = full sun.

Some woodland species can tolerate a wide range of levels of shade intensity in woodlands. Ellenberg (1950, 1974, 1992a, 1992b) described the ecological preferences of a large number of European species in terms of light attribute, [L] value (see also Kirby, Pyatt, and Rodwell 2012).

The best species to use as indicators are those with very restricted requirements and low ecological amplitude as these can be used with greater confidence to assert that those conditions are present.

5.3.3. Indicators of Management

The nature of past woodland management can also have a significant impact on the range of species present and changes in their abundance (Asouti 2003). For example, it is well documented that in coppiced woods there is a cycle of harvesting and regrowth that changes the light environment significantly. At harvesting, the canopy is removed and light allowed in. Over the following years, the shrubs re-grow and re-establish a canopy. This has been shown to cause a change in abundance of species like violets *Viola* spp., Primrose *Primula vulgaris* and Bluebell *Hyacinthoides non-scripta* that grow and flower more profusely for the first years after coppicing (Rackham 2006). This also illustrated ecological amplitude as these species are always present, but are able take opportunity of increased light to grow more vigorously. To refer back to the earlier cited example of Bluebell, the quoted Ellenberg value of 5 suggests a core preference of 'semi-shade, rarely in full sunlight, but generally with more than 10% relative illumination when trees are in leaf' (Hill, Preston and Roy 2004). Following harvest Bluebell can tolerate full sun exposure, at least until the re-establishment of canopy. This species would be unlikely to survive indefinitely in the open although it can persist for many years following woodland clearance. In hedgerows particularly, the past and current management will have played a part in the current species content and mix as people will have actively encouraged and planted desired species, or discouraged other species. Examples include Elder *Sambucus nigra*, regarded by farmers as being of little or no value (Brooks and Agate 1998) or, in the case of Barberry *Berberis vulgaris*, damaging to crops. This latter species is the host of a rust fungus disease of wheat (Barnes and Williamson 2006) and was actively removed from hedgerows in the eighteenth century.

A negative management marker in woodland could be the absence of a species caused by for example, local extinction due to turf removal for charcoal production (Ardron and Rotherham 1999). This could result in the destruction of an established slow colonising species like Wood Anemone *Anemone nemorosa,* and the establishment of a rapid colonist like Bluebell *Hyacinthoides non-scripta*.

5.3.4. Indicators of Anthropogenic Intervention

Our ancestors have planted hedgerow species that may not have naturally colonised a particular location post-glaciation. They may be biologically capable of growing there, e.g., Privet *Ligustrum vulgare* is not naturalised in the north of England, but it can be introduced and will grow at higher latitudes. In addition, some species that may naturally prefer high pH may survive and grow in lower pH soils if planted e.g. Spindle *Euonymus europeaus*. This is normally a species of base rich soils (Hill, Preston and Roy 2004), but will grow in neutral to more acidic conditions if planted.

5.3.5. Indicators of Multiple Factors

The presence of a species today at a precise location is driven by one or more factors. For example, an alpine species is primarily restricted to either high altitude or to lower altitudes at polar latitudes, with temperature being the determining factor. Other factors also come into play, such as moisture and pH. An example would be Spring Gentian *Gentiana verna*, that requires Dry [F] = 4 and calcareous conditions [R] = 8 (Hill, Preston and Roy 2004) as well as the fundamental alpine temperature constraint (Preston, Pearman and Dines 2002) with a minimum recorded altitude of 370m in Teesdale (although it is found at sea level in the Burren in Ireland).

A concept that needs consideration in interpreting the usefulness of botanical indicators is:

> "All indicators are equal, but some are more equal than others" (adapted from Orwell 1969)

This investigation is developed within the scope of the thesis. It essentially provides a means of weighting species based on their fidelity or faithfulness to the conditions prevalent at their current locations and their use as diagnostic species. This has bearing when considering the lists of species than can potentially be used as indicators in different parts of the country and on different geologies. Candidate species lists are discussed further in the section dealing with regional distinctiveness (6.3.1).

5.4. Botanical Indicators as Historic Markers

Botanical indicators are used differently when assigning age and origins to woodlands and hedgerows. Both are threshold-based. In woodlands, the number of species needs to exceed thresholds to assert that a woodland **is**, or is **not**, ancient in origin.

Shrub counts from hedgerows are used as a surrogates for estimating the age of hedgerows (Frudd undated, Pollard Hooper and Moore 1974). Allen (1971) proposed Bramble as a promising approach to dating hedgerows in support of the Hooper theory.

Both are used in the planning process to afford some protection from development for ancient woodlands and important hedgerows. Woodlands are a material consideration under the National Planning Policy Framework (HMSO 2012) and hedgerows are normally assessed as part of the Hedgerows Regulations (HMSO 1997) when developers provide evidence in the planning process.

Botanical species used as historical markers in woodlands and hedgerows have a convergence when considering the shade-tolerant ground flora component (Defra 2007, HMSO 1997).

For woodlands, there is an increased emphasis on the woodland ground flora (Peterken 1974, 2000, Rose 1999, Spencer 1990) whilst hedgerows use the woody species component (Hooper in Pollard 1974, Defra 2007, HMSO 1997)

5.4.1. Historic Markers in Ancient Woodland

Assigning a particular age to woodland has been a subject of research and debate (Peterken 1974, Rose 1999, Spencer 1990), the focus being to determine if species were present historically and have persisted through time.

Analysis so far indicates that there are few vascular plant species that are found exclusively in ancient woodland. A number occur more frequently in ancient woodlands and are less common in recent woodland (Colebourne 1989). Peterken (2000) tabulates species in relation to their frequency of occurrence in identified ancient woods and recent woods. An example of a species exclusive to ancient woodlands from Peterken's research in Lincolnshire is Common Cow-wheat *Melampyrum pratense*. This species was found in 14 (out of 89) ancient woods and not in any of the 273 recent woods surveyed, a fidelity to ancient woods of 100%. This contrasts with Dog's Mercury *Mercurialis perennis* that was found in 62 ancient woods and 53 recent woods having a fidelity to ancient woods of 54%.

Many local authorities regard woodland as ancient woodland if it contains a threshold number of Ancient Woodland Indicator (AWI) species, e.g., the Sheffield Ecology Unit (Sheffield City Council 2012). They specify in their document 'Criteria for selection of woodland Local Wildlife Sites in the Sheffield Context' that a wood should be regarded as having ancient origins if it contains 10, or more, AWIs. This is from a list supplied at

Appendix 3 in that document. This list and recommendation came from Professor Mel Jones based on his extensive research in the Sheffield area. The list of candidate species and the threshold are an expert opinion.

Peterken (1974 *en seq*.) suggested a number of possible reasons why a species might be more common in ancient than in recent woods, these include:

1. Slow colonists - Ancient Woodland Indicator species have poor dispersal abilities and take many years to colonise new woodlands.
2. Intolerant of non-woodland conditions - that they cannot survive in the dryer and more exposed conditions found outside woodlands.
3. Habitat isolation - Ancient Woodland Indicator species were formerly more widespread but have become isolated by fragmentation and have difficulty spreading into new woods unless these are directly linked.
4. Climatic relics – species that historically could survive and disperse into non-woodland habitats but climate change means that they are no longer able to move beyond woodlands.
5. Recent woods do not contain suitable environmental conditions – i.e. specialised niches may take many years to evolve, e.g. veteran trees, specialised woodland micro-habitats etc.

Recent woods have different soils or other physical conditions. The soil microbiology may not be suitable in new woodlands – for example recent plantations may be established on land which was previously used as farmland and their soils have been modified by such land uses and are unsuitable for ancient woodland indicator plants to grow. In reality, different factors in combination, may account for why some species tend to be more frequently found in ancient woodlands.

Woodland is a community of plants where trees cast shade and create humidity that influences the underlying shrub and field layers of the flora. These conditions create the woodland habitat. The species that normally cast shade are trees, but shrubs and Bracken *Pteridium aquilinum* or Bramble *Rubus fruticosus* also create woodland shade conditions under their canopies. Modern perceptions of woodland are that this is a relatively uniform block of close-canopy trees with an understory of some shrubs or Bramble and a typical woodland ground flora including species like Bluebell *Hyacinthoides non-scripta*, Wood Anemone *Anemone nemorosa* and Dog's Mercury *Mercurialis perennis*. This differs from some current views on the nature of our woodlands in the past as suggested by Frans Vera (Vera 2000, see also Mitchell 2005). He proposed a more dynamic and open woodland more closely resembling a savannah with more scattered trees maintained by native herbivores.

In woodlands, the main basis of using species as historic markers relates to the continued presence of shade-tolerant ground flora species, with less emphasis on the species of trees and shrubs. Trees cast shade in varying amounts depending on the species and their density. Shade-tolerant ground flora is likely to be present in current woods because a shade-creating canopy has persisted through time providing a continuity (Coppins and Coppins 2002). This is driven by the concept that indicators of historic woodlands are low dispersal species. They may take many centuries to re-colonise a shaded habitat if there has been an unfavourable phase.

The concept of Ancient Woodland Indicator (AWI) species has developed over the past 30 years (Peterken 1974 *en seq*). There are lists of AWI species, which are used to determine which woodlands can be regarded as ancient in origin (Glaves *et al.* 2009a, Rose 1999). Most have been derived from a total species list for a defined area of woodland (Woodland Trust 2003, 2007) and are often interpreted by expert opinion rather than from a comparison with the historical evidence.

Historical research is needed initially in order to determine which species can be used as reliable indicators or historic markers and to calibrate the model.

There are issues regarding the use of ancient woodland vascular plant species across the United Kingdom. A number of regional lists have been made available over the past three decades (Rose 2006, Glaves *et al.* 2009a)) and these are used to refine the decisions about whether or not woodlands, in the local context, can be regarded as having ancient, or more recent origins. These regional lists are investigated based on current species distribution in the *New Atlas of the British and Irish Flora* (Preston, Pearman and Dines 2002).

One of the most readily available sources of regional lists is Rose (2006). Research by Hallam Environmental Consultants and Sheffield Hallam University for the Woodland Trust (Glaves *et al*. 2009a) extended this with a questionnaire to local authorities asking for details of any AWI lists they used when determining planning or designation wildlife sites.

There is evidence that some hedgerows may have been derived from woodland in the past (Rackham 1986) and share some common ground-flora species. A range of ground-flora species is used in woodland and features in lists used to evaluate the historic origins of hedgerows. The probability that shade-tolerant ground-flora present in hedgerows may have originated because the hedgerows were in close proximity to, or formed part of woodland, is investigated, along with the presupposition that our landscapes were historically 'scruffy' and had a number of other shaded areas to offer sources of shade tolerant ground-flora species.

5.4.2. Historic Markers for Hedgerows

Hooper (in Pollard, Hooper and Moore 1974) proposed the hypothesis that hedgerows were originally planted with a single species and acquired new species through time. From this their age can be estimated using a formula that roughly equated to the colonization of one new woody species every hundred years (in a measured 30-yd (metre) section). This is the so called 'Hooper Rule'. The identity of the species was not regarded as critical; it was the number of species that indicated age. This simplistic approach stimulated interest in aging hedgerows and has passed down into many hedgerow survey methods, most significantly the *Hedgerow Survey Handbook* (Defra 2007) and the Hedgerows Regulations (HMSO 1997), both of which the author of this thesis was involved with (the editor of the former and as part of the steering group for the latter).

Under the Regulations, counting the number of woody species in up to three objectively selected 30m assessment sections is fundamental to the assessment. A threshold of seven species in the south of the country and six in the north is used. Account is taken of the woodland-type ground flora under hedges using a list of 57 species derived from Ancient Woodland Indicator lists. The presence of three, or more, species (at any point along the assessed hedgerow length) from this list is an ‘associated feature’. This can elevate hedgerows that fail to qualify as important based on the average number of species recorded per 30m section. A hedgerow with only five species in the north would still qualify if it had three associated features (including three or more woodland ground flora species).

The recommendations made by the Hedgerows Regulations (HMSO 1997) steering group for including the whole length of hedgerow could not be incorporated as they could not be written into legally defendable prescriptions. The regulations adopted the accepted survey method of the time, the 30m section. This was formalised to require a minimum of one section to a maximum of three sections[7] dependent upon the length of the hedgerow. These are evenly spaced along the hedgerow to ensure that the ends of the hedge are not sampled. This restriction further stimulated the need to consider the whole hedgerow as part of the current research.

---

[7] A hedgerow<100m = 1x 30m section, 100-200m = 2x sections, >200m = 3x sections.

Initial concerns about the Hooper rule that stimulated this research were:

1. Why, out of all the useful shrubs in the scruffy medieval landscape, would our ancestors choose only one species to plant?
2. Where did the species come from to get into the ageing hedges? Other hedges, parts of the scruffy landscape or woodlands?
3. If the theory holds true, is there a sequence of colonisation with bird dispersed (avichorous) species coming in first, followed by wind dispersed (anemochorous) species?

The null hypothesis for this research is contrary to Hooper, proposing that the earliest hedges will have been planted with many species and also that subsequent hedge plantings will have included those species our ancestors regarded as useful, both as a physical barrier/ boundary and for their produce in the forms of food, medicines and wood products - firewood and twigs for basket making etc.

5.5. Species as Historic Event Markers

Some species now present can be used as indicators of one, or more, historic 'events'. These 'event markers' can indicate changes in fashion or changes in need. A classic example is the historic encouragement to plant Oak trees to supply naval shipyards in the seventeenth century with John Evelyn championing the planting of oak in his book *Sylva* (Evelyn 1908, originally published in 1664), with other notable figures endorsing this need during the mid-seventeenth century.

5.6. Specimens as Historic Management Markers

Both woodlands and hedgerows have frequently been subject to significant human intervention. This may have been responsible for their creation and for the way in which they have developed their current floras. The characteristics of the specimens of trees and shrubs found can reflect their past management and be evident as coppiced or pollarded trees and shrubs in woodlands and hedgerows, and laying in hedgerows. Research by Rotherham (2011) suggests that some individual coppiced trees may be more than 500 years old and hence date to before 1600. Individual trees may also be traced to historic persons or events like the tale of Charles II hiding in the Boscobel Oak in 1651 following the battle of Worcester.

The age of specimens can also add to the historic interpretation. The presence of ancient trees and shrubs (in both woodlands and hedgerows), large coppice stools and coppice rings and large and ancient pollards can also contribute to historic interpretation. It is often difficult to age ancient trees or hedgerow shrubs, as their cores are often too rotten to dendro-core and obtain an age estimate.

5.7. Non-botanical Indicators

Indicator species are not confined to vegetation and many authors have used animals and other organisms as indicators for a number of purposes. Groups included as indicators are listed below. These have either direct or indirect relevance to the vascular plants being considered as indicators in the current research.

1. Birds
2. Bryophytes
3. Fungi
4. Invertebrates
5. Lichens
6. Mammals

5.7.1. Birds

The use of birds as indicators is to assess the quality of the habitat in which they are found (Abate 1992, Fuller *et al*. 2001, Hansson 1997, 2000a, b, Hinsley and Bellamy 2000). Other authors (Emmerich and Vohs 1982, Sweeney *et al.* 2010) use birds as indicators for comparing habitats. This group cannot directly be used as indicators of antiquity or history, but they contribute to the movement of plant species within and between woodlands and along hedgerows. Evans and Barkham (1992) point out that birds are more likely to find and ingest fleshy fruits that occur in open areas, rides and gaps[8] (from Thompson and Willson 1978). Their primary impact on woodland ecology is the contribution they make to both seed dispersal and seed predation. Similarly, birds are not indicators of hedgerow age or management history but affect the development of hedgerows through time in their contribution to seed dispersal and predation. The movement and colonisation of shrubs along a hedgerow is proposed as an area for further research.

5.7.2. Bryophytes

Bryophytes are important indicators (Callaghan and Ashton 2008a, b) for continuity of shade and have value as AWIs. Their presence is significantly affected by the enhanced humidity within a wood (Ariyanti *et al.* 2008), and the richer bryophyte floras are found towards the western parts of the country that are generally wetter than the east. The attributes for bryophytes are treated similarly to vascular plants, in *Bryoatt* (Hill, Preston and Bosanquet 2007), the companion volume to *Plantatt* (Hill, Preston and Roy 2004). *Bryoatt* included the Ellenberg tables for light [**L**] and moisture [**F**] as well as

[8] Many species of plant tend to show a depressed seed production under shaded conditions.

data from the EUNIS (**EU**ropean **N**ature **I**nformation **S**ystem) habitat classification (Davies 2004, Strachan 2015). Candidate bryophyte indicator species of 'woodland' can be identified considering the attributes of shade tolerance and affinity for other conditions found in woodland [G1] and hedgerows [FA].

Bryoatt also take into consideration what this thesis refers to as micro-habitats (Virtanen and Oksanen 2007). As an example, there is a category [EW] for epiphytes growing on the bark of living trees. This affects some recognised AWI vascular plant species like ferns in the genus *Polypodium*. These are frequent epiphytes in the damper woodlands in the western parts of the country and the presence or absence of this micro-habitat can make a difference to the candidate list for a wood. The other common micro-habitats for this species are moist drystone walls, cliffs and, less commonly, steep earth banks. If these features are not present in the wood or hedgerow, this reduces the candidate list by one.

The colonization of bryophytes into new woodlands or, to a lesser extent, new hedgerows is impeded by the dispersal mechanism for the spores. Being wind-blown this affects the penetration into the 'wind-still' environment of a woodland. As an analogy, Bremer (2007) studying fern colonisation of new woodlands on land reclaimed from the sea in Holland discovered that there was there was little movement of spores laterally, within the woodland. Spores that established were traced by DNA analysis to plants in the UK. They had been carried by the wind from Scotland across the North Sea and precipitated down to the woodland floor in rain.

5.7.3. Fungi

Fungi as indicators are independent of the shading aspects created by woodlands and hedgerows and are fundamentally regarded as indicators of long-term continuity being associated with dead wood that is more frequent in longer standing and less intensively managed woodlands and older hedgerows. Not all are saprophytes, some are mycorrhizal and do not require dead wood. In addition, some are pathogenic and attack live wood.

Woods that have historically contained a continuous supply of rotting timbers will have provided the conditions suitable for fungal colonisation for a protracted period and could potentially have rich saproxylic fungal complements to support the probability that the woodland is ancient.

Fungi, in common with ferns and bryophytes (and also minute-seeding orchids) have airborne spores and theoretically can colonise new woodland freely (See Bremmer 2007). Their value as indicators lies in their presence as a consequence of the time taken for favourable conditions to develop in a woodland or hedgerow. As discussed later the propagules may get to the feature, but the conditions for their establishment and spread may not be present and may take many centuries to develop. Hence, their presence now can be taken that those conditions have been present for a period and can indicate long-term continuity. The same applies for uncommon grassland waxcap fungi. The constant rain of spores will not lead to colonisation until the soil conditions become favourable.

Fungi are also an important part of the functioning of woodland and hedgerow soil and nutrient recycling systems (Merryweather and Fitter 1998, Mulder and de Zwart 2003, Humphrey *et al*. 2002, Odor *et al*. 2006).

5.7.4. Invertebrates

As with indicators generally, authors have used invertebrate indicators for identifying environmental and management effects as well as indicating origin and age (Allen 1998, Braendle and Brandl 2001, 2003, Crisp *et al.* 1998, Charrier, Petit and Burel 1997 Gunther and Assman 2004). Crisp *et al.* (1998) determined a correlation between native plant diversity and the diversity of carabid beetles in a number of habitats including Gorse *Ulex europaeus*, 'bush' (native forest remnants) and scrub. She also found that Gorse scrub contained a wide range of beetles, but was of low botanical diversity. This deviation from the normal observed trend of increasing botanical diversity mirrored by increased beetle diversity has conservation implications. This could be relevant when contrasting invertebrate assemblages in UK woods and hedgerows where recent examples may be species-poor botanically and could potentially be species-rich in their invertebrate faunas. Although some individual species are highlighted, Crisp makes her main focus the numerical differences in species from each habitat with little discussion about the species mix in each assemblage. Potentially two habitats may have 50 species each, but only 25 in common.

The use of invertebrates as indicators of old hedgerows and ancient woodland alludes to the lack of movement of species from ancient sites to new woods and hedgerows. This mirrors the assumptions for the slow colonisation of recent woodlands by plants from ancient examples nearby (Aubin, Messier and Bouchard 2008). Buse (2012) affirms this with the example of flightless weevils. These will clearly have difficulty in colonising new woodlands if the network has become too fragmented to facilitate movement. This aspect is also addressed by Abensperg-Traun and Smith (1999) in looking at the persistence of arthropods in fragments of woodland of different sizes. Although there was a correlation between the size of the wood and the number of relict species, there were no significant differences to indicate that the isolation affected species present in the remaining fragments. This is likely to be because the study focused on persistence rather than the effectiveness of colonising new areas of suitable habitat.

Assmann (1999) studied this issue and recorded a greater number of species in ancient woodlands as well as noting species like *Carabus glabratus* and *Abax paralellus* showed a 'distinct focus in ancient woodlands'.

Cameron (1981) found that older hedgerows contained more mollusc species than more recent examples and there were a number of species he believed were key indicators, e.g., *Acanthinula aculeata*, *Aegopinella pura* and *Discus rotundatus* being 'good' indicators in Huntingdon and Warwickshire. Clements and Alexander (2009) found a similar result whereby old hedgerows contained species regarded as indicators of ancient woodland or 'old growth'. They concluded that hedgerows were an 'important habitat resource for ancient woodland invertebrates, and invertebrates dependent on old growth, as well as saproxylic invertebrates in general'.

Various other authors have developed the concept that certain groups of invertebrates may be reliable indicators of the age of woods and hedgerows (Matern *et al*. 2011, Maudsley 2000, Poole, Gormally and Sheehy Skeffington 2003, Sroka and Finch 2006, Stubbs 1982, Terrell-Nield 1990).

An important issue for the current research is that some invertebrates, notably ants, are important seed vectors. Ness and Morin (2008) found that ant-dispersed plants were affected by proximity to a woodland edge. They suggest that the reduced occurrence of the plant species at the edge may be due, in part, to the lower population of ants, especially *Aphaenogaster rudris* that was more commonly recovered from bait stations >100m from the woodland edge. Unfortunately, they did not take consideration of the effects on the plant species of the growing conditions in the photocline. The lower abundance could be the result of factors other than the correlation observed.

Ness and Morin (2008) also highlighted that not all ant species are vectors or 'rescuers' of seeds from rodent predation. Some deposit them in unfavourable situations such as arboreally (*Camptonotus* species) rather that the more desirable location in 'shallow, nutrient-rich nests where germination is likely'.

5.7.5. Lichens

Much of the value of lichens as indicators (Ask and Nilsson 2004) follows the comment for bryophytes and fungi. As with bryophytes, lichens have a requirement for light and are not found in heavily shaded parts of woodlands. Their use and value as indicators is also affected by pollution that could reduce the range of lichens in a wood. Juriado *et al*. (2011) considered the dispersal ecology of woodland lichens.

Lichens are frequently found on hedge shrubs, but little account is taken of lichens in this situation.

5.7.6. Mammals

As with the value of birds as seed dispersal vectors, mammals also have the capacity to facilitate the movement of seeds within and between woodlands and along hedgerows. They are also proved to have a negative impact by acting as seed predators (Ness and Morin 2008). They found that seed predation was greatest within 50m of the woodland edge. The reason was not fully explored, but appeared to relate to increased ant predation towards the centre and a consequent reduced predation at the edge (again no postulated reason) leading to a degree of competition, and suggests that this could explain why the species predated were consequently less common at the woodland edge. As with the comments above (5.7.4), on the treatment of ant dispersal and the same woodland edge effect there is no sound justification that either a lack of ant vectors or an increased predation is the cause of the low plant density at the edge. Both correlations imply causation, but this was not demonstrated conclusively by the research.

Authors, such as Fitzgibbon (1997) discuss the effect of isolation of woodland fragments on the number of small mammals in woodlands at different times of year. A key result was that populations rose significantly in small and isolated woods during the summer indicating that seed predation could be a significant factor under these conditions. In addition, woods connected by hedgerows contained higher populations. The implication here is that this scenario would favour seed dispersal as well as consequential seed predation.

Schaumann and Heiken (2002) studied the endozoochorus seed dispersal by martens *Martes foina* and *M. martes* in Germany. This research identified species commonly dispersed endochorously and the germination responses following ingestion. In most cases (10 out of 12 species), the seeds germinated normally, but for *Rubus idaeus*, *R. caesius* and *Vaccinium myrtillus* there was enhanced germination following passage through the gut. This has implications for the success of establishment of such species into new woods.

Mammal vectors are a significant consideration, as a fundamental issue regarding AWIs is that they are poor colonists, partly because they have limited dispersal capability. A poor AWI would be an endozoochorus species where mammal dispersal was readily achieved.

Using live and dummy sheep to assess the long-distance dispersal by mammals, seed dispersal externally (epizoochory) was investigated by Mouisse, Lengkeek and Van Diggelen (2005). They discovered that seeds other than those with a means of attachment (hooks, burrs or sticky substances) could attach to fur, sheep fur being better at catching seeds with no specific adaptation for this mode of dispersal. Although some of their study area contained woodland, the vegetation they studied was grassland and heath. In these, eleven species were observed in grassland and six in heathland. Seeds adapted for epizoochory remained attached for longer and had the potential to travel greater distances to new sites, but they were more difficult to detach. They extrapolated their findings to model how small mammals like Wood Mouse *Apodemus sylvaticus* might perform as animal vectors, but concluded that seeds carried on this species would 'not be transported beyond 12m'.

The contribution of anthropochory is largely absent from the current literature searches. Zwaenepoel, Roovers and Hermy (2006) introduced anthropochory specifically with respect of motor vehicles as vector. They found that thirty-three species were 'car-borne'. Their identity was checked together with their germination by collecting the seeds and sowing them onto composts and growing them on to identify them. Railways are also an important dispersal vector for some species like Oxford Ragwort *Senecio squalidous* that increased its range after it escaped from Oxford botanical garden and reached Oxford rail station in the 1830s (Mabey 1996). That lack of consideration of humans as vectors in the literature is concerning. Assuming that the majority of recent woodlands were planted from 1600 onwards (Rackham 2003) this allows 400 years of humans moving between ancient woods and recent ones carrying propagules on their clothing, in the mud on their boots as well as endo-anthropochorously in the case of fruits like Gooseberry *Ribes uva-crispa*. The study by Zwaenepoel, Roovers and Hermy (2006) highlighted soil or mud as a key element in dispersal on vehicles. In addition to humans carrying seeds themselves, their animals (horses, mules, dogs) would also have transported propagules as well as the vehicles they used. Wichmann *et al* (2009) also demonstrated that humans had the capability of transporting seed considerable distances of 5km or more.

The same concept of dispersal by humans, domestic animals and vehicles also applies to hedgerows that have been trafficked since planting anything from a few years ago to several centuries.

This aspect itself could merit a PhD study.

5.8. Ancient Woodland Vascular Plant Indicators

Some of the earliest published works, identifying that the origins of woodlands could be proposed by looking at the species they contain, were by Peterken (1974). For a vascular plant species to be an Ancient Woodland Indicator (AWI), there need to be reasons that restrict them to that habitat. These will include the growing conditions in ancient woods and the ability of species to colonise new woods (see also Peterken and Game 1984).

Peterken (1974) is dismissive of species that are not shade tolerators. He discounted 75 species regarding them as 'rare casuals that just happened to be in ancient woods'. Most studies of AWIs focus on the ground flora element, with some consideration of the trees and shrubs (Pigott 1969).

The general principle that identifies a species as an AWI is their limited ability to colonise new woods. To quote Rackham (2006) he suggests (*italics* - additional comments):

1. They lack seed production (or do not provide suitable vegetative material for translocation).
2. They lack seed dispersal (*they cannot reach new woods*).
3. The environment of new woods is unsuitable for them (the soils and existing vegetation conditions are not suitable for colonisation).
4. The environment of new woods is more suitable for competing species (rapid colonists establish and maintain a cover into which AWIs have difficulty in colonising)'.

Item 1 above is of low significance as even low propagule production will lead to some early colonisation providing items 2-4 are not restrictions. The crucial limiters on colonisation are dispersal and establishment (with subsequent spread).

5.9. Ancient Hedgerow Vascular Plant Indicators

The Ancient Hedgerow Indicator (AHI) concept devotes more emphasis on the shrub and tree component (Hooper, in Pollard, Hooper and Moore 1974, HMSO 1997, Defra 2007; Clements and Tofts 1992a, 1992b, Whitney and Foster 1988, Willmot 1980).

Woodland species in the ground flora of hedgerows are important (Wehling and Diekmann 2009), as acknowledged by their consideration as associated features when assessing hedgerows under the Hedgerows Regulations (HMSO 1997). Other authors consider hedgerows as refuges or corridors for shade-adapted woodland species (Corbit, Marks and Gardescu 1999, Roy and de Blois 2008, Smart, Bunce and Stuart 2001). In general, there is little acknowledgement of any linkage between the indicator species of the two features. Rackham (2006) places a negative linkage in his book *Woodlands* on page 321 where he alleges that: 'A shortcut is to ask, "What species occur in ancient woodland but not in ancient hedges?" Especially in an Ancient Countryside with many ancient hedges, hedgerow species can normally be excluded as ancient-woodland indicators'.

The influence of adjoining woodlands on the flora of hedgerows is cause for concern for many authors studying hedgerows. Most current survey methods for hedgerows advocate avoiding the first/last 30 metres (HMSO 1997, Defra. 2007), especially where the hedgerow adjoins woodland. This section of hedgerow is predicted to be influenced by the proximity of the woodland or other factors (Dover, Butt and Pearson 1998) and is regarded as being atypical. This issue is addressed by the current research. A paper by Wright and Rotherham (2011b) advocates including the ends **because** they can be atypical and provide important and critical information to aid interpretation, especially when considering the hedgerows they join - the End Effect.

5.10. Regional Ancient Woodland Species Lists

There have been attempts to define candidate lists for regions (Glaves *et al*. 2009a, Gulliver 1995). There is no evidence of a co-ordinated approach to deriving and assigning these lists and inconsistencies exist:

1. Some regions are large, e.g., the east (Rose 2006) encompasses the counties of Essex, Suffolk, Norfolk, Cambridgeshire, parts of Middlesex and part of Hertfordshire.
2. There are large differences in the numbers of species on the lists. The range is 18 (Leicestershire and Rutland) to 154 (the eastern counties).
3. The total number of species on the lists for adjoining regions varied, e.g., west Wales 37 species, south Wales 103.
4. The range of species on the lists differ in adjoining regions, e.g., species on the list for south Wales, but missing from west Wales include *Allium ursinum*, *Arum maculatum*, *Blechnum spicant*, *Chrysosplenium oppositifolium* and *C. alternifolium*, *Dryopteris carthusiana*, *Gymnocarpium dryopteris, Lamiastrum galeobdolon, Lathraea squamaria*, *Lysimachia nemorum*, *Mercurialis perennis*, *Paris quadrifolia* and *Viola reichenbachiana*. These are frequent inclusions on many other lists.

5. Only one region, North Yorkshire attempted to divide their region ecologically into acidic, neutral to calcareous and wet.
6. Many regions had no list, or adapted other lists.

Drawing up candidate lists stems from an initial concept suggested by Peterken (1974 page 244) where he suggested looking at *the Atlas of the British Flora* (Perring and Walters 1976) (currently *New Atlas of the British and Irish Flora* (Preston, Pearman and Dines 2002)) to look up the species for the 10km square in which the study wood was located. From this list, consider only woodland species. Then refine this by identifying which are indicative of recent woodland and the remainder will be the candidate ancient woodland indicator list for that wood. Hill (2003) used the ecologically meaningful 'region' of the Malvern Hills and Teme Valley Natural Area (NA) (NA57 - English Nature 1997). This is currently split into National Character Areas (NCAs) 102 Teme Valley (Natural England 2104b) and 103 Malvern Hills (Natural England 2015).

National Character Areas are:

> "… areas that share similar landscape characteristics, and which follow natural lines in the landscape rather than administrative boundaries, making them a good decision-making framework for the natural environment"' (Natural England 2014a, 2015).

Even within a NA or NCA there will be differences in the candidate list for a given wood based of local conditions of pH, soils, climate, aspect and slope as well as the range and number of meso-habitats a wood contains. It is important to take as full account of these issues as any attempt to set thresholds or compare lists obtained from two or more woods could mis-identify ancient woods.

5.11. Autecologies

Autecology is the study of the interactions between species and their environment. A fundamental basis for defining a plant as being an AWI is that authors agree that the environmental interactions of such species limit their ability to move from ancient woods and establish themselves in recent woods (Bossuyt, Hermy and Deckers 1999). The converse is suggested for hedgerows as they were proposed by Hooper as a habitat that becomes regularly colonised by new species (in Pollard, Hooper and Moore 1974). Therefore, an AWI has passed down through history and has not recently colonised, whereas Ancient Hedgerow Indicator (AHI) shrub species are suggested to have positive dispersal and colonisation abilities to invade hedgerow over time.

These concepts are developed in this thesis by considering the autecologies of species to determine why they are used and what autecological attributes support their use as AWIs and AHIs (Bierzychudek 1982, Taylor 1997a, 1997a, 1999). Many authors deal with autecology (Corney *et al.* 2004) of plants and the autecologies of AWIs (Mukerji 1936). These are discussed in this chapter in relation to those attributes that the current research will address.

Facets of autecology relevant to AWIs and AHIs are:

1. The requirements of the species - are the conditions suitable?
2. The effectiveness of the species' reproductive strategy.
3. The ability for dispersal and establishment into new woodlands and hedgerows.
4. The persistence under management stresses such as clear felling and coppicing (physical damage as well as exposure to light) or grazing pressures.

5.11.1. Geography, Climate, Altitude

Plants are often limited in their distribution by climatic factors; mean winter and summer temperatures and continentality where species are classed from Arctic-montane to Mediterranean (Hill, Preston and Roy *et al*. 2004, Preston 2007). Many species are limited in their tolerance of climatic conditions. This is reflected in the distribution of species as indicted on the botanical atlas maps (Preston, Pearman and Dines 2002), some species appearing with a southern (*Euphorbia amygdaloides*) or western (*Hymenophyllum wilsonii* and *H. tunbridgense*) distribution, others being restricted to northern climes and upland areas (*Phegopteris connectilis* and *Gymnocarpium dryopteris*) (Pearman and Corner 2004).

5.11.2. Soil type - Geology

The substrate that AWIs grow in can vary and many authors identify that soil type is an important factor in determining whether certain species can be 'candidates' in given situations (Rodwell 1991). National Character Areas incorporate geology, e.g. Southern Magnesian Limestone NCA (No 30) (Natural England 2013b) that straddles the A1 between Thirsk in the north and Nottingham to the south and crosses three county boundaries. Limestone soils are generally able to support a wider range of plant species than are some of the acidic and impoverished types as found in the Derbyshire and Yorkshire Coalfield NCA (No 38) Natural England (2014a). The National Vegetation Classification identifies certain woodlands as confined to particular geologies and soil types (Rodwell 1991), e.g., W8 (*Fraxinus excelsior-Acer campestre-Mercurialis perennis*) is described as "a community of calcareous mull soils …" and W4 (*Betula* *pubescens-Molinia caerulea*) as "a community of moist, moderately acid, though not necessarily highly oligotrophic, peat soils in a variety of mire types".

5.11.3. Light/ Shade

Fundamental to the treatment of AWIs is the role shade plays on limiting the range of species present (see Blackman and Rutter 1946, Dzwonko 2001, Evans 1956, Madgwick and Brumfield 1969). This is also reflected in hedgerows where 'woodland ground flora species' are accommodated in the assessment as associated features for the Hedgerows Regulations (HMSO 1997). Many authors have considered the light environment in woods. (Anderson 1964a 1964b, Blackman and Rutter 1946, Grubb and Whitmore 1967, Harris 1972, Hutchinson 1967, Sparks *et al.* 1996), including papers on the methods for measuring light levels (Dowdeswell and Humby 1953, Evans and Coombe 1959, Roxburgh and Kelly 1995, Evans 1956). The light interception of hedgerows has also been considered (Friday and Fownes 2001). In woodlands particularly, it is not merely the amount of light, but also the quality and its direction that authors like Evans (1956) regard as important in determining the survival and growth of species. He emphasised the importance of sun flecks in addition to 'shade light' noting that, at midday the contribution of sun flecks to the total light reaching the ground could be as high as 70%. He also cites earlier work by Lundegardh (1922) that for some species 'sunflecks might represent the only periods during the day when a particular plant (*Oxalis acetosella*) received light above the compensation point'.

Overarching on top of the light levels at full canopy expansion, in deciduous woods the effects of seasonal leaf growth also has an impact. It is well known even to non-specialists that the species of tree creating the canopy can create different intensities of shade. For example, under a Beech *Fagus sylvaticus* canopy the shade is so intense that very few vascular plants can survive. Some bryophytes show tolerance and vascular species like Bird's-nest Orchid *Neottia nidus-avis* is able to grow as it is a chlorophyll-less saprophyte not requiring light.

The critical issues of light in a woodland include:

1. The timing of canopy expansion
2. Canopy duration
3. The intensity of shade and the availability of sunflecks to facilitate the survival of some species.
4. The general level of shade light through the day and across the growing season.

5. The quality of the light in terms of the photo-active spectrum that reaches the understory plants. This is influenced by the absorption and reflection of light by leaves and branches etc.

5.11.4. pH

The pH of the substrate influences the species present. Many authors agree that calcareous substrates support a greater range of species. (Jones 2009, Rotherham 2013b) (Ellenberg [R]) Grime, Hodgson and Hunt 2007). Using the examples from 5.11.2 the number of species per sampled stand is 17 for the acidic W4 and 25 for the calcareous W8.

5.11.5. Moisture

Moisture has a profound impact on species (Buckland *et al.* 1997). Entire woods may be either wet or dry and topographically variable woods may have local variations in moisture such as streams and flushes etc. Hedgerows may also cross wet or dry ground and this can impact on the range of species that were either planted originally, or colonised since (Ellenberg value [F] in Hill, Preston and Roy 2004, see also Grime, Hodgson and Hunt 2007).

5.11.6. Nutrients

Differences in soil fertility can encourage or limit species (Chazdon 1986, Duncan *et al* 2008, Tsiouris and Marshall 1998). Those with high nutrient requirements (Ellenberg [N] (Hill, Preston and Roy 2004)) are more likely to colonise woods and hedgerows that were formed recently on land that was previously cultivated and fertilised (Kennedy and Pitman 2004). Recent woodlands are likely to be planted onto either arable or productive agricultural grassland with an elevated nutrient status. This will disfavour woodland species unable to utilise the high nutrient status or may affect AWI species that may be incapable of competing with species that are able to utilise high nutrients. Ancient woodlands will have developed in the absence of significant artificial nutrient enrichment (nutrients from grazing animals in woods will provide some nutrient recycling) and there will be a relatively stable recycling on nutrients.

5.11.7. Topography - Aspect, Slope

(Grime, Hodgson and Hunt 2007, Beatty 1984) The topography at the precise station for a plant can have a significant impact on which species are advantaged and disadvantaged. Woodlands vary in terms of the slope and aspects within their confines. Topography is considered as a meso-habitat. Topography influences flora at all scales. Beatty (1984) considered small-scale variations in topography linked to canopy cover and determined there were species that showed an affinity for mounds (eight species) and pits (five species). Personal observation confirmed by Grime, Hodgson and Hunt (2007) shows that the presence and abundance of some species, particularly ferns, has topography as a significant determinant. *Athyrium filix-femina*, *Dryopteris dilatata*, *D. filix-mas* can grow on level ground, but are more frequent on moderate slopes (Grime, Hodgeson and Hunt 2007). Moreover, at the extreme the so-called 'wall' ferns like *Cystopteris fragilis*, *Asplenium trichomanes* and *A. ruta-muraria* are often confined to vertical or near-vertical surfaces - even an overhang in the form of cave roofs for Killarney Fern *Trichomanes speciosum*.

Topography affects soil moisture, depth and pH (leaching), nutrient status, leaf litter depth and, depending on aspect, frost heave (Beatty 1984) and steep-sided valleys increase atmospheric humidity (Page 1997).

5.11.8. Pollution

Although less well reported by authors, pollution can restrict the ability of species to colonise new sites or persist under unfavourable conditions in ancient sites. Much of the work looking at the impacts of pollution have focussed on bryophytes and lichens as these are groups sensitive to atmospheric pollution (Bignal, Ashmore and Headley 2008, James 1982). Hansen *et al.* (2007) showed annual ring decreases in areas subject to pollution looking at three species of forest tree (Norway Spruce *Picea abies*, Sitka Spruce *P. sitchensis* and Beech *Fagus sylvatica*) in Denmark.

5.11.9. Shelter and Atmospheric Humidity

Some AWI species are intolerant of desiccation. Filmy ferns - *Hymenophyllum wilsonii* and *H. tunbridgense* and *Trichomanes speciosum* - are all species with thin-textured leaves prone to desiccation. These species are typically found on sheltered and often north facing slopes along stream sides, protected from drying out by rocks, trees, shrubs etc. (Page 1997).

5.11.10. Ecological Amplitude

The ecological amplitude exhibited by some species makes them poor or good indicators (Packham and Willis 1976). Aspects of the ecological amplitude of species are covered in *Comparative Plant Ecology* (Grime, Hodgeson and Hunt 2007) where they present the data on how frequently a species is found growing under particular conditions of pH, slope and moisture etc. In woodlands, a good indicator would be one that is tolerant of deep shade, is less frequent and/ or abundant if the canopy was, or became, more open and may become extinct if the canopy is removed for too long. A poor indicator would be able to survive even indefinitely in situations that are more open. Species growing under a coppice regime are generally assumed to have wide ecological amplitudes (Ash and Barkham 1976, Van Calster *et al.* 2008) to tolerate the post-coppicing periods when plants are exposed to high light levels. Similar exposure will follow hedgerow coppicing or laying. Meier, Bratton and Duffy *et al.* (1995) identified that, following logging, the typical ground flora species do not recover well, partly because 'Less common species may also have more specific environmental requirements and may be less able to tolerate microclimatic changes initiated by logging'.

Packham and Willis (1976) considered the ecological amplitude for two woodland herbs Yellow Archangel *Lamiastrum galeobdolon* and Wood Sorrel *Oxalis acetosella*. They highlighted the issue that species may be constrained by different conditions to different extents. For example, Wood Sorrel showed a wider tolerance of pH than Yellow Archangel, but was less tolerant of drier soils and is largely absent from the drier, eastern parts of the country. This disparity will be explored in the later sections of this thesis. They considered the effect of shade on these species in their paper, Packham and Willis (1982), showing that plants adapt to higher levels of shade by producing larger leaves and more chlorophyll. This research highlighted another aspect, which is that plants in very deep shade tend to produce fewer flowers, with implications for reproductive spread and colonisation.

5.11.11. Reproductive Success

How well do species propagate and reproduce? Seed producing plants have been cited as having low seed set, because of poor pollination success or low seed production (Croxton and Summers 2004), as well as low viability of seeds (Shirreffs 1985). Spore-bearing species and plants with air-borne seeds will be affected by the relative wind-stillness of woodlands and the sheltering effects of hedgerows.

5.11.12. Pollination

In both woodlands and hedgerows, pollination success is driven by the conditions that facilitate either wind or insect pollination. The sheltering effect of both habitats could potentially limit wind pollination and the characteristics of the environment can either encourage or discourage insect pollinators (Diaz and Kite 2002), wind pollinated and insect pollinated species.

Corbet (1998) investigated a number of aspects of pollination and seed set in Bluebell *Hyacinthoides non-scripta*. This research highlights features that can impact on the ability of species to set viable seed that can then move within and between woodlands and hedgerows to colonise new habitats. Although cross-pollination is commonly assumed, species like Bluebell also self-pollinate. Corbet found that self-pollination produced fewer mature seeds than cross-pollination. Some AWI species have mechanisms to ensure cross-pollination. Endels *et al*. (2002) investigated if an imbalance in the ratios of pin and thrum-eyed morphs[9] of Primrose *Primula vulgaris* could lead to local extinctions if only one morph was present. This study showed that sexual reproduction in this species could happen with pin-pin crosses and that imbalances in the ratios did not indicate any probability of local extinction.

The importance of pollinators in a fragmented landscape was researched by Aguirre and Dirzo (2008) and Bailey (2007). This has relevance to UK woodlands that are increasingly fragmented. They found that pollinator abundance was negatively affected by fragmentation, with a 4.2-fold average difference between small (<35 ha) and large (114–700 ha) fragments.

5.11.13. Dispersal

As a general consideration it is assumed that dispersal is normally by seed or spores by wind or animal vectors, birds, mammals and, possibly to a lesser extent, invertebrates - hairy insect species like bees carrying very small seed, from plants such as orchids, or other invertebrates carrying adhesive seeds (Sarlöv Herlin and Fry 2000).

Some seeds with elaiosomes have evolved specifically to be distributed by insects such as wasps and ants. In the U.K., ants disperse the seeds of many woodland plants, including Common Cow-wheat or *Melampyrum pratense*, violets (*Viola* sp.) and Wood Anemone (*Anemone nemorosa*).

Water dispersal, along streams and rivers and in areas of flooding, is also a possibility (Flinn *et al.* 2010).

With regard to the colonisation of woods and hedgerows, this normally requires dispersal over distance (Baeten, Hermy and Verheyen 2009, Clark *et al* 1999, Chmura and Sierka 2007, Dawson *et al.* 2004, Verheyen *et al.* 2003). Depending on the density

[9] In pin-eyed plants the anthers are short and the stigma long; in thrum-eyed this is reversed. Pollen collected by a bee from the low down stamens of a pin-eyed plant should only be deposited onto the low down stigma of a thrum-eyed. This normally makes self-pollination impossible.

and proximity of the donor habitat, the distance a species is capable of crossing is key to its ability to colonise new areas.

Wehling and Diekmann (2010) emphasised the differences between species in terms of their ease of colonisation based on their dispersal strategies 'Furthermore, plants with wind or animal dispersal were found to be better colonizers of hedgerows than species with other means of dispersal'. Roy and De Blois (2008) found in their study that colonisation along hedgerows was more commonly via vegetative spread than by sexual reproductive means.

The value of considering birds in the context of this research is the contribution they make to seed dispersal in woodlands and along hedgerows (Levey *et al*. 2005). Woodlands and hedgerows that are able to support a greater number, and number of individuals, of bird species will provide enhanced capacity for the colonisation and movement of seeds in wooded landscapes (Hansson 1997, 2000b, Lack and Venables 1939, Vanhinsburgh *et al.* 2002). Research in the tropics by Wunderle (1997) emphasised the site traits being significant in the success of colonisation at degraded sites. Receptor sites that offered some existing food (e.g. fruits) and suitable perching opportunities had a greater chance of attracting birds and receiving seeds.

5.11.14. Seed/ Spore Production and Establishment

Seed production (Sparks and Martin 1999) and the viability of seeds and spores can significantly affect colonisation and spread of species. The study by Corbet (1998) showed that fewer seeds were set when plants were self-pollinated and the size of seeds and their weight is reduced. This is a potential issue when considering the available propagule recourse of a species.

As discussed under hybrids some crosses are sterile and others fertile.

5.11.15. Hybrids

In the literature, there is little evidence of the importance hybrids can add to the interpretation of ancient woodland indicator species (Dines 2002). An example would be the ferns Hard Shield-fern *Polystichum aculeatum* and Soft Shield-fern *P. setiferum*. Both species are cited on many AWI lists (Glaves *et al.* 2009a) and yet the hybrid (*P*. x *bicknellii*) is not[10]. Clearly, if the hybrid is present, and if the wood now contains one

[10] This combination is also important as it suggests the present of two meso-habitats as *Polystichum aculeatum* prefers calcareous soil and *P. setiferum* acid substrates.

parent plus the hybrid, it is logical to assume that both parents were present at some time. Other cases of hybrids also have ecological significance in term of the value as AWIs. Two papers by Page (1988 and 2007) describe occurrences of hybrids between *Equisetum sylvaticum* x *E. pratense*, *E. sylvaticum* x *E. telmateia* (Page 1988) and *E. pratense* x *E. fluviatile*. The *E. sylvaticum* x *E. telmateia* hybrid confirms the presence of both damp acidic and damp flushed calcareous conditions to support both parental requirements. Hybrid occurrence as a marker is referred to later in this thesis under the Hackfall Wood case study.

In some cases the hybrids formed between two AWI species are fertile, e.g., *Geum rivale* and *G. urbanum* (*G.* x *intermedium*). If the ecological amplitude of the hybrid is wider than the parent it could conceivably colonise different parts of the wood and again persist following the extinction of a parent during an unfavourable period.

5.11.16. Seed/ Spore Viability

The viability of propagules can vary from highly viable seed (*Geum* x *intermedium*) to completely or, in some cases, mainly sterile (*Polystichum* x *bicknellii*) hybrid material. Shirreffs (1985) found that seeds of Wood Anemone *Anemone nemorosa* had high viability, but that germination was affected by temperature, increasing with cold treatment and decreasing at higher temperatures.

5.11.17. Germination

To establish in a new wood or hedgerow a species must be able to germinate at the arrival location (Jescke and Kiehl 2008, Thompson and Grime 1983, Grime *et al.* 1981) reviewed a wide range of species and experimented with different treatments to determine which factors may inhibit germination. One of their conclusions for woodland species was that the range of temperature conducive for the germination of woodland species was narrower than for grassland species. This implies a lack of tolerance of widely fluctuating temperatures and that the expected temperature range in woodland is likely to be low owing to the stable nature of the shade environment making the internal climate more equable.

5.11.18. Establishment

The establishment of a new species in a woodland or hedgerow is the first stage of many that the plant will have to go through to become a part of the woodland or hedgerow community. Authors have detailed many reasons for success and failure at this stage. This is discussed by (Grime, Hodgson and Hunt 2007) in relation to the competitive strategies of woodland species, competitive and stress tolerating species being more likely to establish than those with a ruderal trait.

5.11.19. Colonisation/ Extinction

Colonisation is an important consideration for AWIs (Singleton *et al.* 2001) Once established a species can potentially colonise the whole woodland or hedgerow. This can be by further seeding or by vegetative spread. Brunet and Von Oheimb (1998), Brunet, Von Oheimb and Diekmann (2000), Brunet (2007), Buckley, Howell and Anderson (1997), Davie, Akeroyd and Thompson (1998), Webster and Kirby (1988) have done extensive work on the rates at which species can migrate across from ancient woods into attached new plantings. These are a combination of seed 'leap-frogging' and slow vegetative movement.

5.11.20. Dormancy

To be a good AWI a species should be able to remain dormant for relatively short periods. Long dormancy seeds may persist long enough to span the gap between woodland clearance and a re-planting. Dougall and Dodds (1997) referred to work by Brown and Oosterhuis (1981) suggesting that woodland plants "have not needed to acquire the adaption of seed dormancy" as they should be able to rely on being shed into already favourable conditions. Buckley, Howell and Anderson (1997) affirmed that some AWI species have short dormancies, e.g., Bluebell *Hyacinthoides non-scripta*, Common Dog-violet *Viola riviniana*, Enchanter's Nightshade *Circaea lutetiana*, Yellow Archangel *Lamiastrum galeobdolon* and Wood False-brome *Brachypodium sylvaticun*. Stehlik and Holdregger (2000) also quote that Wood Anemone *Anemone nemorosa* "does not build persistent soil seed banks".

5.11.21. Competition

Added to the problems some species may have in germination at new sites, some species are less able to establish and compete with existing flora and may fail to compete. Competition also relates to the ability of species to spread once established. This can be either vegetatively or by sexual reproduction (Grime, Hodgson and Hunt 2007, Holderegger, Stehlik and Schneller 1998, Holmes 2005).

5.11.22. Stress Tolerance

Many species found in woodlands are regarded as stress tolerators once established (Grime, Hodgson and Hunt 2007), i.e., they can persist under the dual constraining factors of shade and competition for resources.

5.11.23. Management

Management can significantly affect the current condition of AWIs and AHIs (Croxton *et al.* 2004, Croxton and Sparks 2002, Vickers and Rotherham 2000).

AWIs can be severely depleted following clear felling and may not recover from coppicing (Bridge, Hibbert and Rackham 1986) operations especially if significant damage is done during extraction.

Historically hedgerows may have been subject to active species removal in the case of Barberry *Berberis vulgaris* and Elder *Sambucus nigra*. The former because it was discovered to be the secondary host of a wheat rust in the eighteenth century and the latter because most farmers regard Elder as a hedgerow weed and actively remove it during management.

The impact on flora of charcoal production and the soil stripping has been suggested to have led to the removal of ground flora species like Bluebell *Hyacinthoides non-scripta*. This was recognised by Rotherham and Doram (1992) and Rotherham, Ardron and Percy (2001)

The impact of both historic and current grazing (Chatter and Sanderson 1994, Putman 1994, Pratt *et al.* 1986) has been shown to adversely impact on floral diversity (Adams 1975, Bugalho *et al.* 2011), with sensitive species being more significantly affected (Meier, Bratton and Duffy 1995). It also affects regeneration. Peterken and Tubbs (1965) reported that, in the New Forest, grazing pressure up to 0.3 feeding units/ acre still allowed regeneration.

Grazing can physically damage ground flora, but the movement of animals can facilitate dispersal within and between woods.

5.12. Current Woodland and Hedgerow Field Survey methods

5.12.1. Critical Review of Current Woodland Survey Techniques

A comprehensive publication by Kirby (1988) details and discusses the merits and de-merits of various methods of survey for woodlands. These fall into three major categories:

- Walkover surveys
- Quadrats
- Mapping

The degree of rigor in applying these methods is flexible and guidance is given on suitable levels of survey effort in order to obtain valuable data from each technique. The work done by Keith Kirby in his publication *A Woodland Survey Handbook* (Kirby, 1988) describes the different techniques and details the various shortcomings that each has. The purpose of the WOODS survey method is not to classify the vegetation, but to study it in detail, to gather information to answer questions on historic origins, value and importance.

One of the main problems of a walkover survey or transect is ensuring adequate coverage of the entire area of the woodland. This type of survey generally does not differentiate between any of the internal variations in habitat found within most woodlands. Indeed, they commonly cross boundaries without changing the recording form or considering producing any separate listing as their aim is to produce a list 'for the wood'. The use of quadrats is often flawed by the choice of scale; larger quadrats encompass internal variations in vegetation and smaller quadrats require large numbers in order to characterise the flora. As Kirby points out (p.33 of Kirby 1988), rare species are often missed completely by a quadrat technique.

Most woodland surveys have no indication of the abundance of species, nor is any account taken of where the species is located within the wood. WOODS redresses this by looking in detail at the species composition within woodlands in what is being termed ‘meso-habitats’ and ‘micro-habitats’. These can range from streams, springs, steeply sloping banks, cliffs, to individual trees or stumps supporting small colonies of epiphytes etc.

Walkover Survey

The simplest and most basic survey technique is the walkover survey - to follow a fixed path that encompasses the range of variation within the woodland, or focus on particular areas and make a route that follows what appears to be a homogeneous area. This general method has the advantage in that it is relatively quick and has the potential to encompass a wide range of variation in vegetation within a woodland block. Although this method has the potential for recording abundance values this is rarely adopted.

Quadrat Survey

Quadrat survey methods, such as National Vegetation Classification (NVC) survey method in Rodwell (1991) rely on placing appropriate sized quadrats throughout the woodland at a density to encompass the majority of variation found within. This method is more focussed and collects significantly more detailed information. Nevertheless, generally, it has the limitation of inadequately sampling the vegetation and has the potential for missing significant areas within the woodland.

Mapping Survey

The site chosen for one of the case studies at Ecclesall Woods in Sheffield has an active volunteer group that has done a considerable amount of survey of most of the wood for woodland ground flora. They have produced maps of some of the species like Bluebell *Hyacinthoides non-scripta*. These maps also include an abundance assessment and are a valuable resource for interpreting the woodland ground flora. Kirby (1988) uses mapping to define the limits of woodland types or stands within a wood.

5.12.2. Critical Review of Current Hedgerow Survey Techniques

The methods of surveying hedgerows are mainly based on the original Hooper hypothesis protocol of counting the number of woody species in measured 30m sections of hedgerow (Winchester 2008). This method was adopted for the Hedgerows Regulations (HMSO 1997) and Hedgerow Survey Handbook (Defra 2006). These systems often apply a minimum survey effort of at least one section per survey length. There is encouragement to increase the number of sample lengths up to the maximum of the surveyed section. Current standard methods also frequently take other measurements from the entire hedgerow length, including the recording of ground-flora woodland indicator species (Clements and Tofts 1992b, Rich *et al.* 2000).

As already mentioned the author was part of the steering group for devising the ecological criteria for the Hedgerows Regulations (see also Churchward *et al.* 1996), and also the editor for the 2nd edition of the Hedgerow Survey Handbook (Defra 2006). As editor there was limited scope to propose new methods as the steering group was focussed on an objective recording scheme based on the standard 30m sections. The persistence in adopting this method called for a review that this current research addresses.

It is unfortunate that the correlation observed by Hooper that older hedgerows are generally more species-rich than newer ones has led to the widespread adoption of his rule, that he himself urged caution in using. Since the publication of the Hooper hypothesis the historical interpretation of hedgerows using botanical indicators has not advanced until now, despite there being a number of challenges proposed by authors like Muir (1996), Muir and Muir (1987) and Barnes and Williamson (2006). Even as recently as 2006 Barnes and Williamson (2006) were still using the 30m rule (despite their challenge to the Hooper Rule) when they did their surveys of Norfolk hedgerows. They did set a minimum number of sections as three. They did accept (on page 70) that:

> "Nevertheless, the sheer size of the body of data collected, combined with the particular ways we have analysed and interrogated it, give some confidence in the results presented here".

Current approaches to hedgerow survey and analysis are too generalised, omit significant amounts of data and are not critically detailed enough to assess hedgerows adequately in their historical context. There are also a number of very significant issues raised by the approach adopted by current survey and evaluation systems that follow the generalised Hooper theory (in Pollard, Hooper and Moore 1974).

Many survey techniques advocate ignoring the beginning and end sections of a hedgerow that join up with other hedgerows or a woodland, alleging that these are atypical, i.e., they contain species that don't conform to the generality of the main hedgerow. In other words, they ignore important information these 'ends' contain. Dover, Butt and Pearson (1998) studied these end effects and reported increased plant species-richness of grasses, herbaceous plants and hedge canopy species at 'nodes' (within 5m of the junction with other hedgerows).

Along with the shortcomings of a hedgerow sampling strategy, there are other areas where a lack of data collection may impede analysis.

1. There is a lack of emphasis on the significance of the species present
2. Where the species are in the landscape.
3. The pattern of abundance along the hedgerows is not normally recorded.
4. They omit certain species of shrubs and climbers with little or no justification.
5. They focus on the shrub and tree species only and generally take little account of the ground flora.

These are addressed by HEDGES (Hedgerow Ecological Description, Grading and Evaluation System) described in the methods chapter.

5.13. Summary

Botanical species, including bryophytes, lichens and fungi along with some animal species have been recorded in the literature as indicating the continuity of conditions that are associated with ancient woodlands and hedgerows. The literature review focussed on vascular plants as indicators and how they have been treated and considered as indicators.

Individual species are frequently indicators of multiple factors, with shade tolerance being fundamental with regard to ancient woodland indicator species with associated factors like moisture and slope combining to create the meso-habitat requirements of the species. References in the literature to the attributes of species that may impact on their ability to reproduce, disperse and establish in new woods are reviewed.

In hedgerows, the tree and shrub indicators are more often the product of the original planting, with some natural colonisation and extinction running in parallel through time with man-made changes in keeping with needs or fashion.

The current research will build on the published information and aims to provide a new approach that significantly advances scientific understanding of the relationships of species in a historical context. Current methods are applicable to the purpose for which they were designed. The requirements of ecological historians need to be addressed and methods tailored that are fit for purpose and not a compromise as a consequence of using an inherited and inappropriate method.

6. Methods

6.1. Introduction

This section details the mixed methods used to address the research questions by a combination of literature review, stakeholder participation, desk studies and field survey as shown in the diagram at Figure 60.3. Leading on from the reviews of current methods in the literature review the novel approaches for this research are set out. During the early part of the current research various existing survey methods were considered and failed to provide information that was of value for the interpretation needed to assess the role of botanical indicators in woodlands and hedgerows. For woodlands a more focussed combination of transects and quadrats was adopted. Hedgerows were more radically reviewed as the low level of detail offered by current survey methods was significantly below what was judged necessary to gather sufficient information.

There are a number of threads to the methods: the exploration of regional distinctiveness; consideration of autecologies and the proposed novel survey and interpretation methods. The survey methods included in HEDGES (Hedgerow Ecological Description, Grading and Evaluation System) (Appendix 09) and WOODS (Woodland Overview and Objective Description System) (Appendix 08) have evolved through the research and are still being refined. These are now regarded as being workable methods in their current forms to achieve the aims of historical research using botanical indicators in woods and hedgerows. These are all developed through the results section and reviewed in the discussion chapter.

The common analytical method SPACES (Species, Position, Abundance and Combination Evaluation System) (Appendix 10) is a novel approach that provides a framework for considering species that aids scientific understanding of the complexities of the role botanical indicators play in the interpretation of historic wooded landscapes. This was driven by concerns that some analytical methods were too mechanistic and would provide an answer, but that this might not be sufficient to provide the guidance needed to interpret the data. It was also becoming increasingly clear that the habitats involved were highly human modified and did not readily conform to following normal ecological pathways to get to the present day and their current botanical content. Attempts to detect planting patterns from the known enclosure dates for the hedgerows at Dunnington are a primary example.

Of particular concern was the omission by the Woodland Trust (2007) of rare species in their analysis and the discounting of the ends of hedgerows that joined other hedgerows

HMSO 1997, Defra 2006). This was regarded as scientifically unacceptable to discard potentially informative data. It may have been done to achieve statistically sound data or to avoid anomalous data, but the purpose of using botanical indicators as historic markers is to use all available data and interpret it intelligently to provide confidence that the species are indicating something about their past - origins and management.

The literature review has already reported on this at Section 5. This addresses Objective 1 (at Section 4.3). The other objectives are addressed in the methods developed in this section:

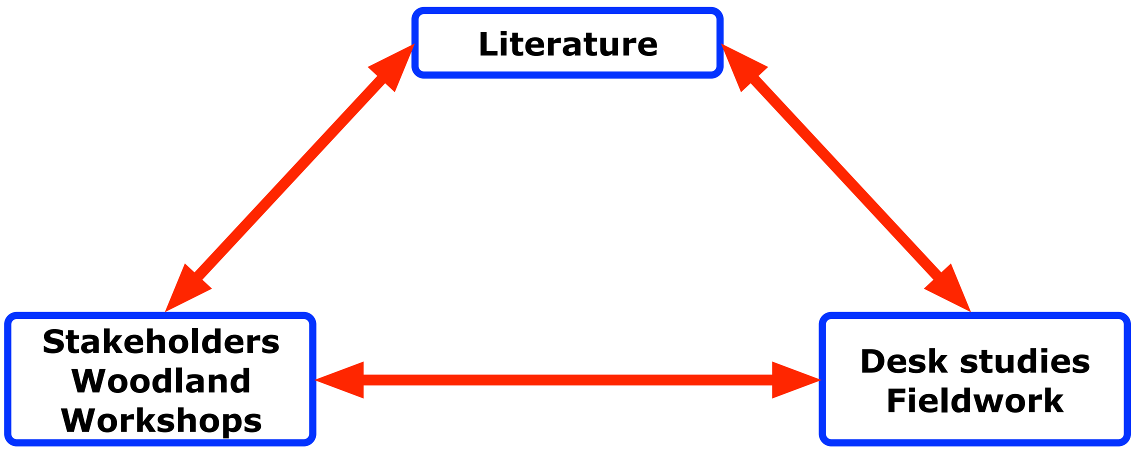


Figure 60.3 - Triangulation diagram showing the mixed methods approach used in this research.

There are a number of major components of the method used in this research.

1. Woodland Workshops – stakeholder involvement (Objective 2)
2. Desk Studies – Regional distinctiveness and autecologies (Objective 3)
3. Woodland and Hedgerow Field Survey methods (Objective 4)
4. Case studies (Objective 4)
5. SPACES interpretation method (Objective 4 and 5)

6.2. Woodland Workshops – Stakeholder - Method

A key method of this research was a series of Woodlands Workshops to elicit expert opinion on AWIs in the woodland element of wooded landscapes. These were facilitated by Sheffield Hallam University in association with the *Biodiversity and Landscape History Research Institute* (BaLHRI) and the British Ecological Society, the Forestry Commission, Natural England, and the Woodland Trust. This is a novel approach as no evidence can be found to suggest that such a meeting of experts has ever been coordinated to canvas opinions. Invited stakeholders attended a series of four workshops to discuss the origins and uses of AWIs.

- W1 - 14 May 2008
- W2 - 22 October 2008
- W3 - 20 May 2009

- W4 - 23 September 2009

It was a valuable exercise to critically assess the status of botanical indicator perceptions and uses, and direct the current research as well as seeking confirmation of the approaches being developed to add to the academic understanding of the role of AWIs in woodlands. In addition to achieving the academic aims of this part of the research, it was also important to consider the practitioner aspects of who will use the outputs of the research. One of the aims was to provide a toolbox for both amateurs and professionals to use to make a robust assessment of the status of a woodland based on its botanical content.

The workshops were designed to explored the origins of existing lists in terms of how they were derived, e.g., from field survey or expert opinion and reviewed how practitioners used lists, either existing, or newly acquired, to add confidence to the prediction that a woodland has a truly ancient origin (this included discussion about the definition of what constitutes an ancient woodland). These workshops drew upon existing studies ranging from the rigorous data analysis and historical research conducted by the Woodland Trust in Northern Ireland to the less rigorous surveys done in various parts of England Wales and Scotland (Castle, Latham and Mileto 2008, Crawford 2006, 2009). Many lists have been derived from the circulation of candidate species to panels of experts (Glaves *et al.* 2009a).

There are three elements to this method;

1. Assessing the current data. How were they collected and are they valid and robust for use in historic interpretation?
2. Can these data be used in a more objective and informative way?
3. Proposing and testing new methods of data collection and interpretation to provide a more robust system of survey and analysis as the outcome.

These mirror the aims of the current research (see 4.2).

A key element of the current research involves stakeholder involvement in the discussion regarding which species can be used as indicators as well as how they can be applied in practice. The main focus of these workshops was to review the current lists to determine how they were derived and their coverage across England, Wales and Scotland. They also highlighted the need to review how woodlands were surveyed to obtain lists and if there were better methods that could be applied to the specific aims of this thesis that seeks to use such lists for historic interpretation rather than woodland classification. Of particular concern was that most lists appeared to have been derived from walkover surveys that did not target or take account of internal variation. This was a focus for the development of a more informative survey method originally referred to as the Woodland Survey System (WSS), now WOODS (Woodland Overview and Objective Description System) (Appendix 08).

6.3. Desk studies

6.3.1. Regional Distinctiveness.

Regional Distinctiveness addresses Objective 3 at 4.3. The results of the Woodland Workshops stimulated the updating of the status of regional lists using a questionnaire circulated to practitioners using them across the country. Although there was agreement from the workshops that lists need to be focussed on regional areas there was no proposal as to how this might be achieved.

The novel approach in this research aims to both improve academic understanding of the regional status of indicator species and provide a practical method for stakeholders to base their decisions on objective data for the status of species in their regions using evidence based desk research and the result from field surveys.

The proposal for this part of the research is to start with the list of species collated by Glaves *et al*. (2009a), that includes those already published and in use. This can be regarded as the most up to date and comprehensive total candidate list of ancient woodland indicator species currently regarded by at least one author or respondent to the questionnaire, as well as those species on already published lists. A map of regions where the lists are currently available is at Figure 63.4. From this it is clear there are gaps that need to be filled. The method suggested here provides a way of creating a candidate list for any area in the country and also a better basis for defining a 'region'.

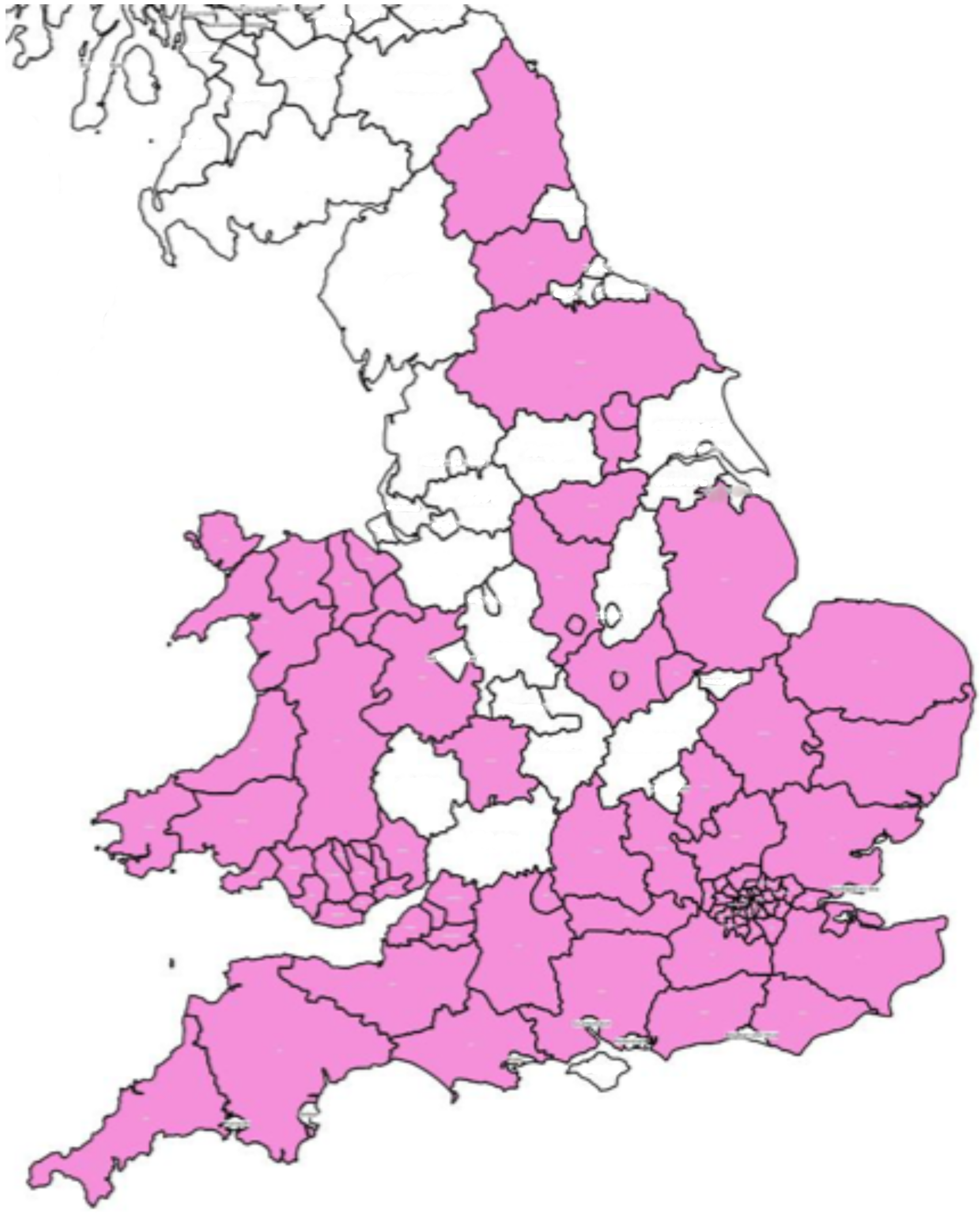


Figure 63.4 - Map showing the areas from published lists and questionnaire respondents of regions that currently have and use lists of AWIs. (The coloured regions are those with existing lists or responded. Uncoloured regions did not respond or do not have lists.)

A starting point was to determine where each species on the total candidate list are found across the country. The BRC (Biological Records Centre) database was interrogated for these species and returned the data for the number and locations of the 10km records. These are roughly equivalent to data from the *New Atlas of the British and Irish Flora* (Preston, Pearman and Dines 2002). These will be considered in relation to National Character Areas (NCAs) for England as designated by Natural England. From these the number and percentage of candidate 10km grid squares in that NCA will give a measure of the likelihood of having that species in the woodland or hedgerow under consideration (Appendix 05). For example, if there were 100 squares in the NCA and the species chosen occurred in 50 of those from the atlas, that would indicate a reasonable chance of recording it, or that it may already have been recorded if existing data for the habitat is being re-assessed. This will remove some of the often subjective decisions to include species on regional lists. Even if they are known to grow in a 'region' there are cases where species have been omitted without justification.

Figure 266.115 shows where a species Pendulous Sedge Carex pendula) is found in two regions (Northumberland and Durham), but is only on the list for Northumberland.

The ethos is that candidate lists should be drawn up based on data that regards a species to be an indicator - either a good one or a low confidence one. If the species is regarded as being an ancient woodland indicator, and it occurs in a particular NCA, then it should be on that list, possibly with the caveat that it might be a low confidence indicator or it may be present historically in the records for the NCA and 10km square but not very common as it is at, or near to the edge of its natural range. This will affect its weighting and is also likely to be affected by climate changes in the future.

The regional distinctiveness method will draw up a candidate list for the feature (woodland or hedgerow). This is not an exclusive statement. If a survey is done and a species found that has not previously been recorded for the NCA, then it will be added to the candidate list.

The weighting from the candidate list will be combined with the results of the autecological assessment to provide a weighting for species in NCAs. It is predicted that candidate lists will vary between NCAs. Out of the total list of 270 species, one NCA may only host 50 species based on the atlas records while another may have 100. The makeup of which species are involved in both scenarios will be covered by reference to the autecologies and meso-habitats elements of the weighting process.

Regions have differing amounts of woodland cover and differing proportions that have been regarded as ancient under the Inventory. An example of these quantities is taken from NCA37 (reported on later as part of the WOODS (Woodland Overview and Objective Description System) survey for Gillfield, Ecclesall and Church woods).

> The NCA contains 6,335 ha of woodland (11 per cent of the total area), of which 2,547 ha is ancient woodland. South Yorkshire Forest Partnership Community Forest, one of twelve Community Forests established to demonstrate the

contribution of environmental improvement to economic and social regeneration, covers 5,236 ha of this NCA, which is 9 per cent of the NCA.

These data do not indicate the sizes of each woodland or their pattern of distribution across the NCA. These are shown graphically on the maps at Figure 67.6 and Figure 68.7. These add detail to that statistic as they show where the ancient woodland is in relation to other woodland and the size of ancient woodlands and their proximity to other ancient woodland that has a potential impact on the colonisation capacity of AWIs in the landscape.

In some cases, the distribution of certain AWIs will be affected by the distribution of woodland across an NCA. If the NCA has few woodlands and even fewer ancient woods there are likely to be few records of woodland specialist species on the BRC dataset. Looking at Figure 67.6 and NCA51, there is an area at the centre that lacks woodland and ancient woodland. It would be expected that any 10km square in this area should lack records of AWIs. Less specialised woodland species found in other semi-shaded habitats like hedgerows will be more widely recorded on the BRC database records for the NCA.

As the NCA boundaries are not clear-cut interfaces and grade from one to another there will be consideration that a wood or hedgerow on a boundary should refer to the candidate lists for all nearby NCAs. A good example is Gillfield Wood used in this research. As can be seen from Figure 66.5 Gillfield wood is on the boundary of NCAs 37, 50 and 51.

One of the proposed outputs from this research is a practitioner toolbox for assessing the status and importance of ancient woods and hedgerows. It is hoped to produce an 'App' for use on smart phones and tablet devices that will take the GPS location and generate a candidate species list for that location. As the location changed during a survey there will be the capability built in to the App to update and change that list.

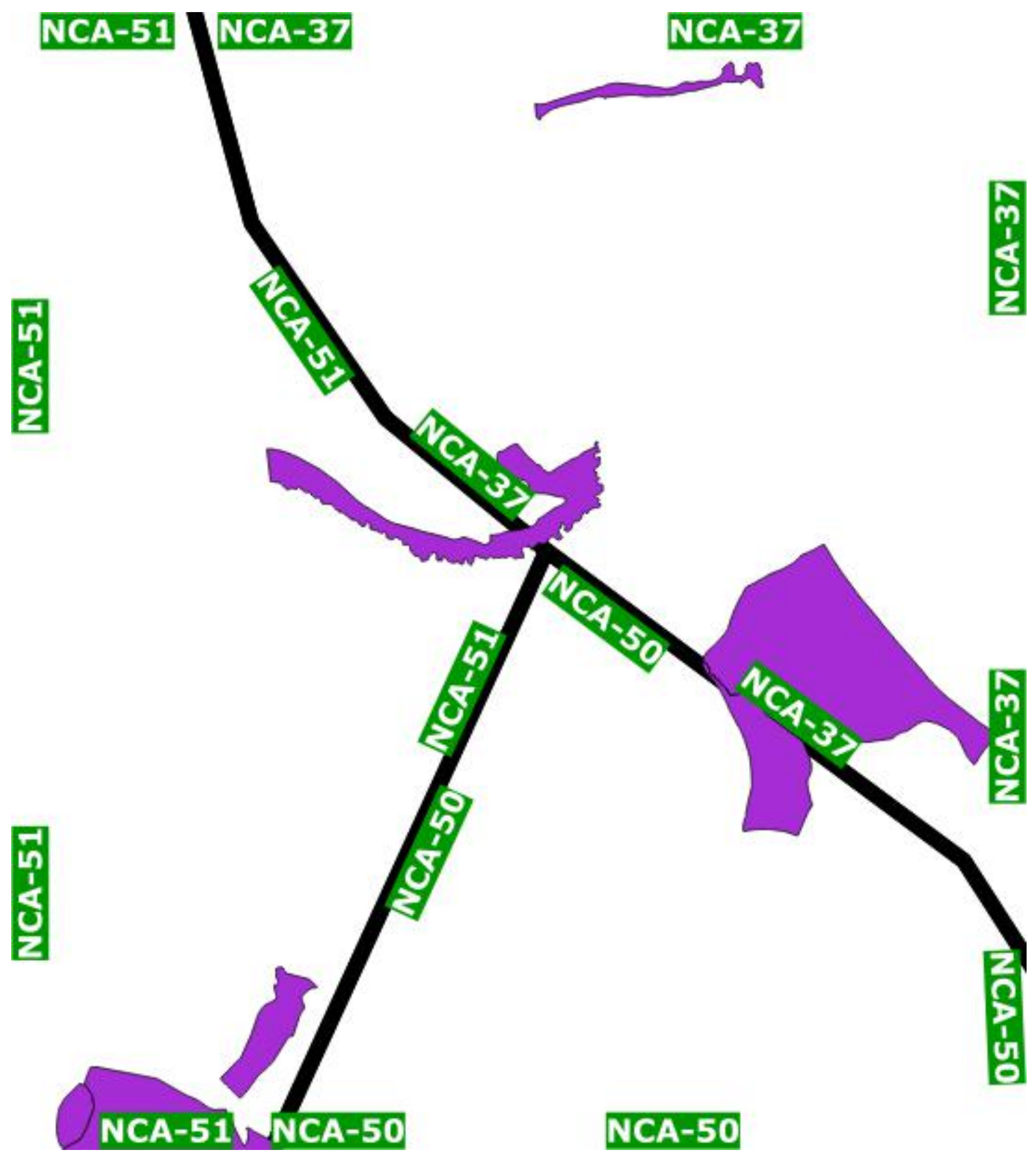


Figure 66.5 - Extract showing Gillfield Wood spanning the boundary between NCA37 and NCA51 and almost into NCA50.

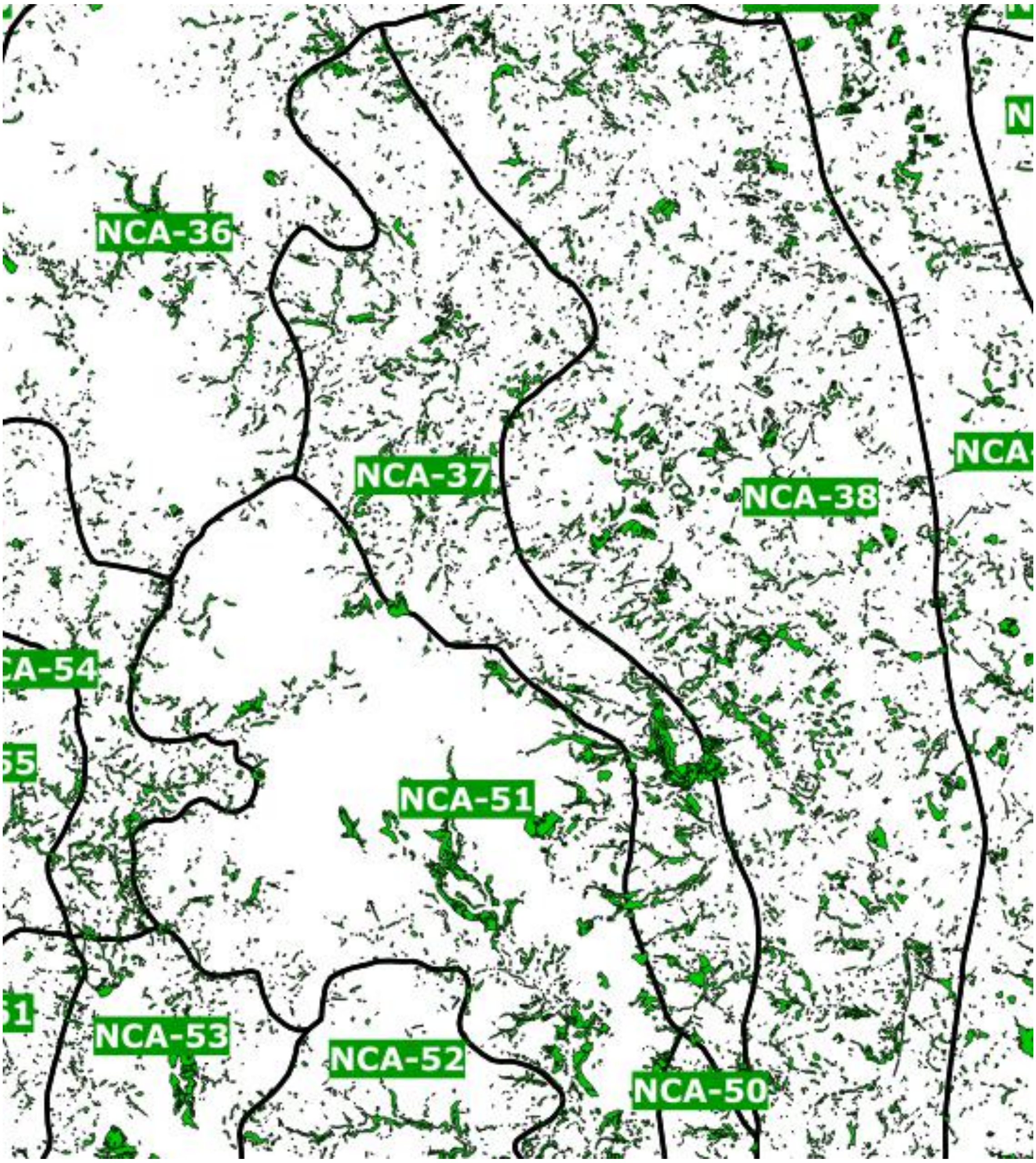


Figure 67.6 - Map of NCA37 showing the area indicated as wooded on the National Forest Inventory.

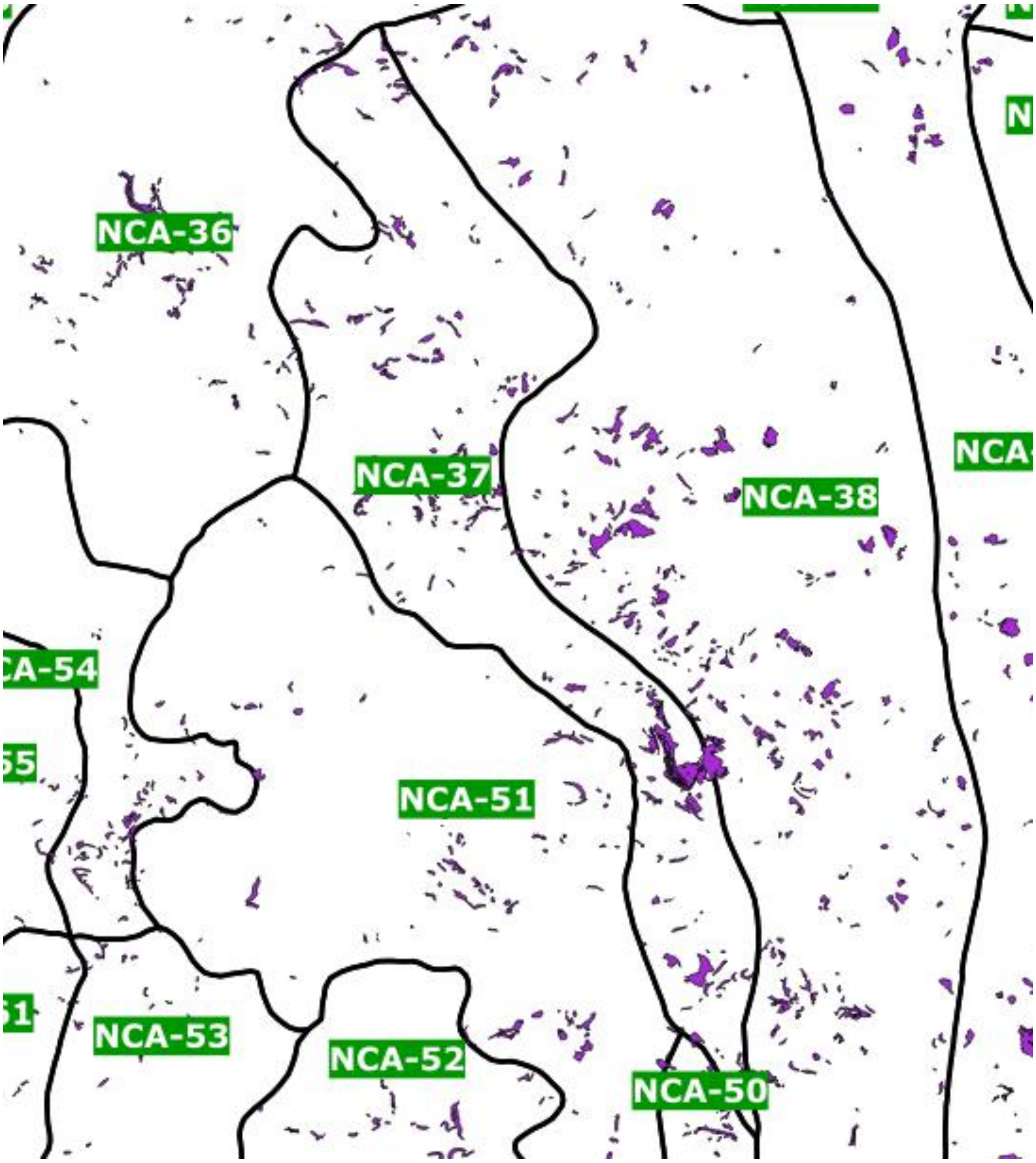


Figure 68.7 - Map of NCA37 showing the area indicated as wooded on the Ancient Woodland Inventory.

There are no regional lists for hedgerow species. The only indication of this consideration is in the Hedgerows Regulations (HMSO 1997) that reduces the number of species needed to qualify a hedgerow as being important by one in northern counties. This acknowledges that the conditions and climate in the south tends to support a greater range of species than further north. As hedgerows are more likely to be deliberately planted the probability that they may receive any suitable shrub that is capable of growing at that location is high. As an example, a generic planting list may include species that do not normally occur in the north as they have not colonised there naturally, but the may be able to grow there if planted.

6.3.2. Autecologies

Autecologies answer Objective 3 at 4.3. A review of the autecologies of AWIs will identify species that are more, or less, likely to disperse and successfully colonise new woodland and hedgerows by both natural processes and human intervention. Those with poor dispersal mechanisms are predicted to be confined to ancient woodland and should therefore be regarded as ancient woodland indicator species. Any that show evidence of easy transfer are likely to colonise recent woods and are less reliable as indicators of continuity of ancient woodland conditions. This draws extensively on *Plantatt* (Hill, Preston and Roy 2004), and *Comparative Plant Ecology* (Grime, Hodgson and Hunt 2007). This is used, along with other relevant sources, to determine the potential for a species to comply with the perceived primary reason why an AWI is an indicator of ancient woodland viz a poor colonist with limited dispersal abilities and poor establishment and spread characteristics.

The elements considered in this will be mainly the method of dispersal, with animal vectors and wind being the most likely means of species moving from ancient woodland to recent woodland. Other aspects need consideration, including the requirements of the species, whether it is likely to establish at a new site, and its ability to compete and spread. In some cases, the species may have restricted growing requirements and the parts of a new woodland it finds suitable may be limited. As such, the likelihood of seeds getting to such potentially small target areas will also limit colonisation. For example, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* has a favoured position in woodland of stream sides, flushes and other damp to wet areas. If the new wood has few places where this meso-habitat exists, then any seed arriving has not only to get to the wood, but also to get to one of these limited positions within it. This could mean that even species with seeds that could be readily moved, e.g., Herb-Paris *Paris quadrifolia* may still have limited dispersal ability as the probability of arriving at a suitable position in the new wood may be limiting.

This research also draws on existing surveys that are evidence based, comparing species found in ancient woodland and species found in recent woodlands. Species that have a fidelity for ancient woodland and are rarely found in recent woodland will be candidates for being classed as ancient woodland indicator species. This evidence is derived from the combined effects of dispersability and colonisation ability with the meso-habitat context incorporated. The species themselves are informing us whether they are capable of moving to new sites.

This method highlights and focusses on species that may have restricted growing conditions, e.g., preferentially grows in calcareous flushes and springs. This will be used to define the weighting for species within woods that have that feature and those that may not.

6.4. Woodland and Hedgerow Survey Methods

Novel methods of data collection for woodlands and hedgerows are developed to answer Objective 4 at 4.3 on page 17 above.

There are a number of common elements for both the survey method and interpretation for each habitat. These general items are described here and habitat specifics are under the relevant sections.

6.4.1. Phase 1.5

The Phase 1.5 Habitat system (Preliminary Habitat Assessment Survey and Evaluation System) has developed alongside the current research by the author. The aim is to record the vegetation at different scales as it is not appropriate to describe a species as growing 'in woodland' since there is variation inside many woodlands that can influence the range of species that grow at a particular point within. Phase 1.5 is summarised here with more detail at Appendix 01.

This system includes ecological attributes, which have a relationship with autecologies in that the growing conditions of an individual species, or the conditions where a small combination of species exists, can be described using Phase 1.5 coding. When conducting a survey of a woodland or hedgerow, the area being surveyed can be described using a combination of Phase 1.5 codes that provide a hierarchical description of the conditions within the area of survey. If there are any specialist species, or areas where combinations of specialist species occur, these can be further refined using additional codes from the Phase 1.5 categories. This provides a toolbox to enable the details of species present at particular locations within habitats to be described and considered. This is a practitioner tool to provide a better understanding of the nature of habitats.

This system provides an ecological profile for either an individual species or a combination of species growing in a particular set of conditions, and works with the SPACES (Species, Position, Abundance and Combination Evaluation System) analysis process. The purpose of SPACES is to identify patterns of species distribution across the landscape and within habitats and also to identify where combinations of species are associated with particular locations. Once it is acknowledged that a particular species or combination grows at a particular location, application of the Phase 1.5 species profile will further inform about the nature of the species within the landscape, woodland or hedgerow.

As an example the SPACES signature may identify a species as occurring in woodlands in particular positions and the [P] can be described as on relatively steep sloping ground but does not take account that the soils are on calcareous substrates. The Phase 1.5 ecological profile describes the conditions that are prevalent at a location.

Under the SPACES system (see Appendix 10) *Polystichum aculeatum* would be regarded as having a signature of [SPaa][W]. That is, it has precise positions [P] within a woodland [W] and is always at low frequency and abundance [aa]. Applying the Phase 1.5 profile for this species it would be described using the following codes.

- BWD - Broadleaved Woodland
- WGF - Part of a general woodland ground flora
- BCL - On a basic inland cliff
- EAT - Topography - on steep slopes
  (scale: eat = level; Eat = gentle; EAt = moderate; EAT = steep to vertical).
- Eas - Moderate shade tolerance
  (scale: [eas] = open; [Eas] light shading; [EAs] = moderate shading; [EAS] = dense shade)
- EAP - High pH
  (scale: [eap] = acid; [Eap] = Neutral; [EAP] = calcareous)
- Eam - Moist conditions
  (scale; [eam] = dry; [Eam] = Moist; [EAm] wet; [EAM] = under/ in water
- EAA-270 = aspect, west facing.

6.4.2. Abundance Recording.

One of the key concerns about existing survey methods for both features is a general lack of recording the abundance of species and also a lack of responding to the two aspects of abundance, frequency - how many plants - and abundance - how much ground it covers or length of hedge in spans. This was addressed by adopting a double DAFOR or DDAFOR (Kent and Coker 1992). Using the codes D = Dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare, once to reflect frequency and once for cover or 'presence', e.g., OA = occasional patches of the species, but abundant where found) approach initially. Later the SACFOR (S = Superabundant; A= Abundant; C = Common; F = Frequent; O = Occasional; R = Rare) (Hiscock 1990) scale was adopted that explains better the way that the words used can be applied to frequency and cover (see Appendix 02).

6.4.3. Record Point and Linear Survey Referencing.

For both methods a hand-held GPS is desirable to record transects in woodlands and hedgerow sections and individual plants along hedgerows. As GPS devices only record up to 999 records a unique identifier is needed to account for the reuse of a device or the use of multiple devices. This is achieved by maintaining a prefix of two letters that are attached to the device until it is reset and the next label added. For example the device may be labelled [CR], making its records [CR001] to [CR999]. When its data are downloaded and the memory cleared it may get the label [CT] and work can continue. Unique identifier codes like [CR456] can then be used in both woodland and hedgerow surveys to note the start and end points of transects or hedge sections and individual locations of quadrats or species. Linear survey sections - transects or hedge sections are uniquely identified using the start and end nodes e.g., [CR456-CT345]. In this example the transect linked nodes from two nodes with different prefixes indicating multiple devices were in use and one end of the survey had already been given a waypoint by a different surveyor. In all cases, to standardise, such references are always presented in strict alpha-numerical order e.g., even if the survey was from [CT345-CR456] the reference is reversed to [CR456-CT345].

6.4.4. Woodland Survey Method

This is described at Appendix 08 (see also Wright and Rotherham 2011a, Rotherham, Wright and Smith 2008). In summary it adopts a flexible approach as its purpose is to locate and record AWIs, not to classify the woodland and builds on the work done by Glaves *et al.* (2009b). The aim is to actively seek out areas where AWIs may be growing. To do this an additive system is proposed whereby a recognisance survey is done to determine the likely complexity of the wood followed by further surveys to explore areas in more detail. Existing methods either sample using quadrats or a walked transect that is either random or regular.

There are three elements that draw on both transect and quadrat methods. The three components, to repeat, are:

1. **Transect** - corresponding to sections of a walked route through the woodland. The number of transects and their direction and length can either be pre-determined or can vary depending on local conditions. If the wood has public access the paths and track would be walked first, followed by 'off piste' transects to explore areas not covered by following paths. Paths can be

anomalous as they may have alien flora on them e.g., the garden escape variegated from of Yellow Archangel *Lamiastrum galeobdolon*, the form ssp *argentatum*. They may also be subject to eutrophication from dog walking as well as possibly being more open in the case of some wide paths, especially if they follow rides or clearings. In most cases the perimeter of the wood should be walked as this will pick up species in the photocline.

2. **Standing Quadrat** - this is a rough area surrounding the observer that can comfortably be surveyed, ideally without moving from the observation point - approximately 2m radius - placing a marker or object at the observation point will allow the observer to move around within the defined quadrat area. The canopy within a 10m radius is also assessed and an azimuth photograph should be taken along with a nadir view of the vegetation to assist in interpretation.
3. **Point Record** - where very localised conditions exist a point record can be made of one, or more, species found at that location using a GPS reference, e.g., *Polypodium vulgare* growing epiphytically on a branch of a single tree, or a single spike of Bird's-nest Orchid *Neottia nidus-avis*. Photographs are an assistance in the interpretation.

To cover a block of woodland adequately the three elements are applied proportionately to ensure full coverage in order to obtain reliable data on which to base an assessment of the origins of the wood. This is a novel approach to woodland survey.

The transects are intended to be of variable length. Again, this survey method is not intended to provide statistical information or collect standard data. A transect ends when the observer judges a different vegetation character is encountered. For example, the transect may pass into Beech *Fagus sylvatica* woodland and the ground flora will change from a cover of woodland ground-flora species to essentially bare ground and leaf litter.

These changes require a new recording form, as would making a diversion to follow a woodland stream or ditch. These meso-habitats are recorded on side 'b' of the AF7 recording form (see Appendix 08, Figure 5.2) using the Phase 1.5 codes described at Appendix 01.

At any point along a transect a point record can be made, even deviating to record a notable species where necessary. As the transect data are based on the DDAFOR/ SSACFOR (see Appendix 02) frequency/ cover scale, this adds value to the data. It is used as a single letter code to collect 'standing quadrat' information. It is subject to judgement or guidance as to where and when to do a standing quadrat and how many. Sampling is not a purpose of these surveys and no rigorous distances between quadrats should be used. Typical and atypical areas can be selected. If more standing quadrats are used they can, with the addition of an abundance related transect line thickness, provide as a form of mapping as shown on the examples described at the Appendices for this thesis and on page 109 of Wright and Rotherham (2011a). Examples of two standing quadrats from the Ecclesall Woods surveys are shown at Figure 74.8 to Figure 76.11. The quadrat at Figure 74.8 and Figure 75.9 was under a Beech *Fagus sylvatica* canopy and was species poor.

Figure 74.8 - An example standing quadrat from Ecclesall Woods under a Beech *Fagus sylvatica* dominated part showing the low frequency and abundance of Bluebell (Phase 1.5 code [R1] - low frequency and low cover) *Hyacinthoides non-scripta* and abundant leaf litter [LTR-S6 - superabundant in frequency and high cover].

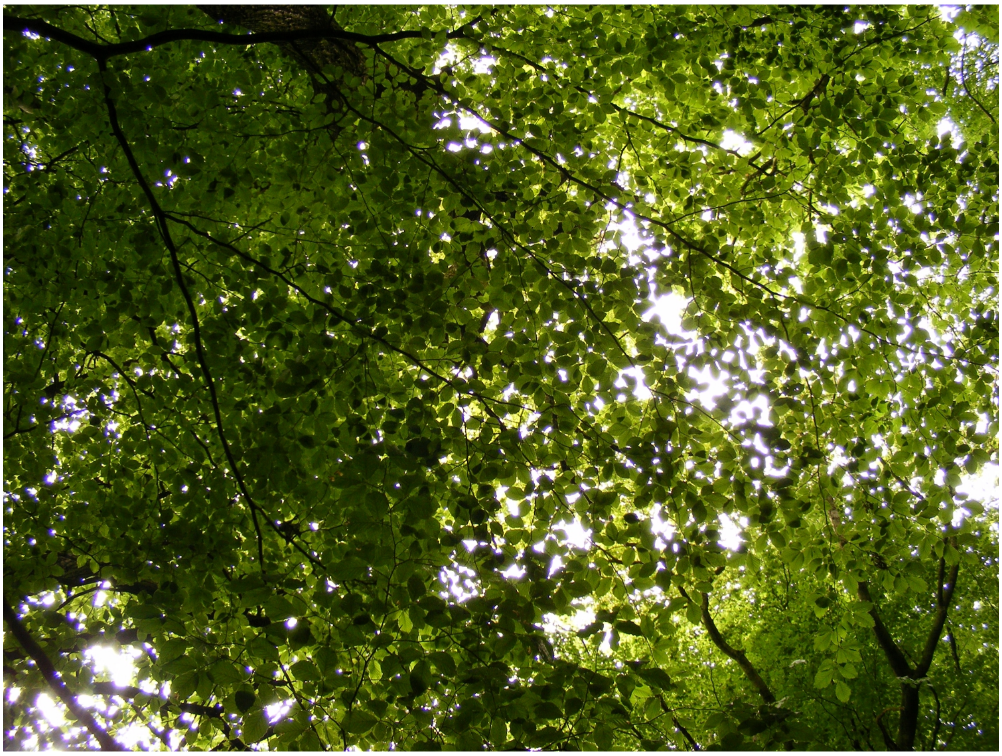


Figure 75.9 - Azimuth shot of the Beech canopy over the standing quadrat shown at Figure 74.8.

By contrast a quadrat under a less dense canopy of Sweet Chestnut *Castanea sativa* and on a meso-habitat stream side is shown at Figure 75.10 and Figure 76.11.

Figure 75.10 - An example standing quadrat from Ecclesall Woods under a more mixed tree canopy showing full cover of woodland ground-flora species [WGF-S6], including Bluebell *Hyacinthoides non-scripta* (Phase 1.5 [R1]) and Creeping soft-grass *Holcus mollis* [A5] along with ferns.

Figure 76.11 - Azimuth shot of the less dense mixed tree canopy of Sweet Chestnut *Castanea sativa* over the standing quadrat at Figure 75.10.

As a general guide a wood may have a number of paths or tracks running through. These would be the best transects to take in the initial stages of the survey. These may be anomalous as there can be a significant presence of introduced species like Indian Balsam *Impatiens glandulifera*, the variegated form of Yellow Archangel *Lamiastrum galeobdolon* ssp *argentatum*, non-native Bluebells and other domestic discards like Ground Elder *Aegopodium podagraria*. There may also be eutrophication from the faeces of dogs being walked. In some cases paths may be wide and under reduced canopy cover equivalent to a woodland edge or ride. This will influence the range of species found. Any standing quadrats along paths should go 'off piste' to a typical area if the path is regarded as atypical in the sense that it doesn't have any ancient woodland indicator species. It could still be sampled by a quadrat to typify the nature of the transect.

Once the easy routes have been surveyed (and an impression gained of the nature of the woodland) or whilst they are being surveyed, additional transects can be used to target and survey areas likely to yield ancient woodland indicator species. These will include following streams, investigating cliffs, looking for wet areas etc. A final assessment of the areas covered will identify gaps where further transects can be done.

A basic assistant for surveys in woodlands is a GPS device that can track a transect and also report on the location to cross-reference to a grid imposed map as shown at

Figure 77.12. At intervals along the transect the GPS is read and a waypoint set. The 10m square is identified and the waypoint number entered. The example at Figure 77.12 was an early survey 'path plotting' that shows wide tracks suitable for vehicles or horses (motorways) as triple lines, paths wide enough for two people to pass as double lines (A roads) and single file paths as single lines (Country lanes).

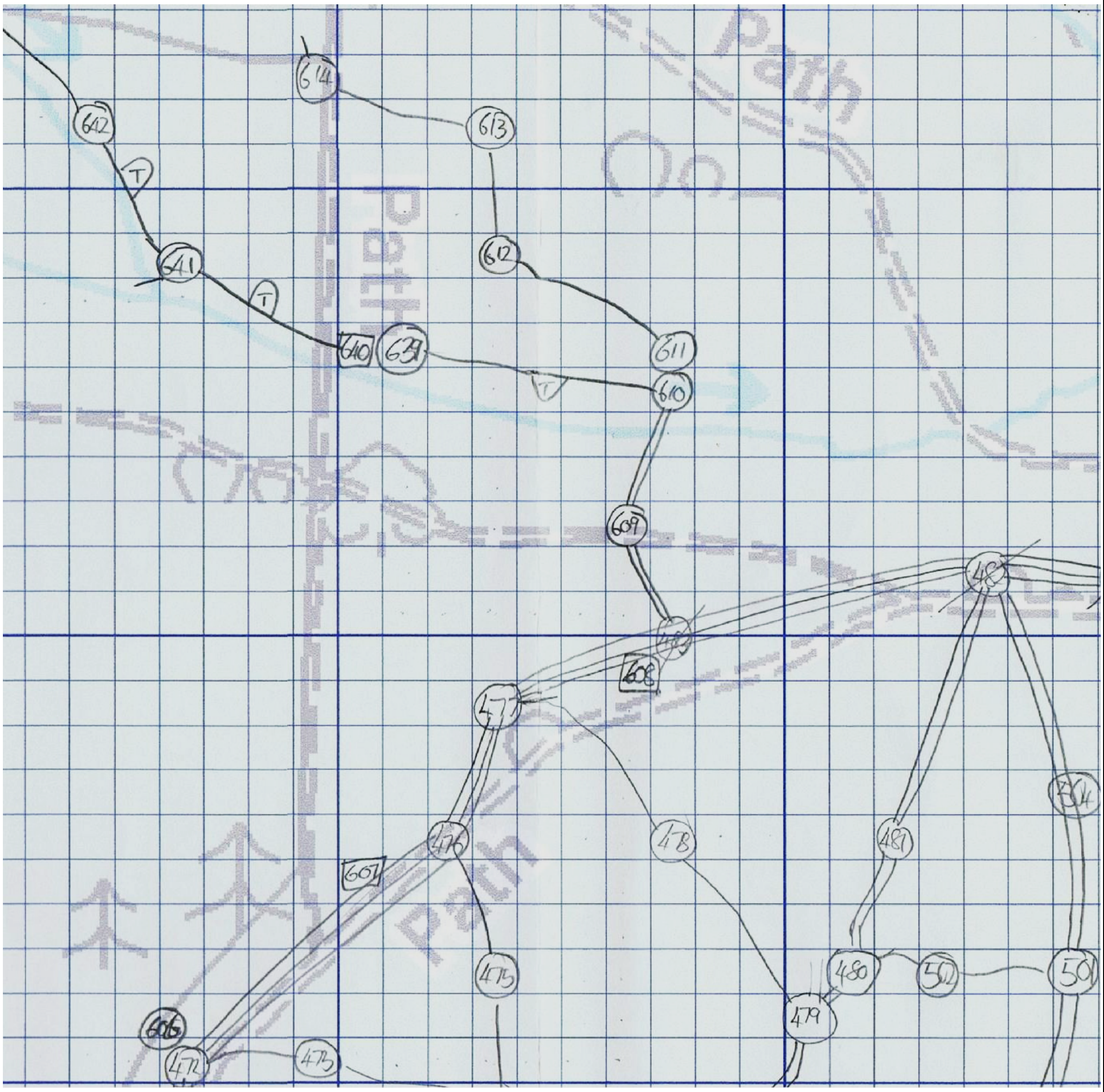


Figure 77.12 - An example field map for Ecclesall Woods with waypoint numbers showing how the 10m grid was used in conjunction with a GPS to plot onto the field maps where the recorder was and where the transects were, along with quadrat locations etc. Square boxes = standing quadrats, circle = waypoint. Triple lines = track, double = wide path, single = single file path. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

6.4.5. Hedgerow Survey Method

Shortcomings in existing systems and identifying the need for a fresh approach to look at the botanical composition of hedgerows to interpret their history has led to the development of HEDGES (Hedgerow Ecological Description Grading and Evaluation System) as described by Wright and Rotherham (2011b) and Wright *et al.* (2012a, b). This is described is some detail at Appendix 09.

The HEDGES method is part of the Phase 1.5 Habitat Survey System (Preliminary Habitat Assessment, Survey and Evaluation system) developed by the author to collect better data than standard JNCC Phase 1 (Joint Nature Conservancy Council 1990). There are 3 levels of survey:

Level 1 – The most basic level, equivalent to doing an assessment as proposed by Hooper and adopted by the Hedgerows Regulations (HMSO 1997) and the Hedgerow Survey Handbook (Defra 2007). This involves assessing one, or more 30m sections, but Level 1 of HEDGES adds the facility to record other parameters like the abundance of species and the structure of the hedge and any evident earthworks. Not recommended and included only to comply with existing methods.

Level 2 – A rapid survey method looking at the entire length of a hedgerow – between recognisable points like hedgerows joining at each end. This level records the abundance of all species along the defined length and identifies the exact locations of the rarer species using a GPS, e.g., [CR567] (see above). All trees, and their positions are recorded along with their size and character – Coppice, Pollard etc. The method also records the structural parameters of the hedgerow, banks, ditches, evidence of laying etc. (DDAFOR/ SSACFOR scale, see Appendix 02). The output is a line that is thicker with increasing frequency and a darker shade of green with increasing abundance/ presence. Individual records are either dots for shrubs or diameter-scaled tree symbols.

Level 3 – This looks at the species visible every 4m (five 'normal' paces) along the length (these are Record Points RPs) and assigns an abundance to each on an abbreviated - vowel free - DAFOR, three-point scale; D = Dominant; F = Frequent; R = Rare. It also records trees and the structural hedgerow features. This produces an output consisting of dots for each Record Point (RP), varying in size dependent on the species abundance, indicating exactly where each species is present or absent. Each Record Point represents a 4m section of hedgerow and is numbered using the GPS waypoint number for the start of the section, the GPS waypoint for the end of the section and a sequential number for the 4m section as described above e.g., [CR456-CT345-01] [CR456-CT345-02] [CR456-CT345-03] [CR456-CT345-04]. This provides a unique identifier for any 4m RP section surveyed as part of a Level 3 survey.

The shortcoming of existing methods referred to in the Literature review at 5.12.2 are addressed by HEDGES:

1. The species are critically looked at to detect patterns of the position in the landscape, along medieval township boundaries for instance.
2. Their frequency at the landscape scale and
3. Their abundance and distribution in hedgerows is considered.
4. All likely relevant species are considered, not just the restricted lists proposed by Hooper (Pollard, Hooper and Moore 1974). HEDGES includes Bramble, Bracken, Ivy and both White and Black Bryony.
5. Any significant ground flora is recorded - mainly woodland or shade-tolerant species.

The primary outputs of HEDGES are species maps showing the location, distribution and abundance of species across the landscape.

The surveys done for this research were at Level 2 and Level 3. Examples of both are at Figure 80.13 and Figure 81.14. Only on the northern hedgerows were individual plants point recorded. Elsewhere the species was common enough to make waypointing individual plants tedious and of limited value when considering the time that would be required.

Figure 80.13 - An example Level 2 hedgerow survey maps from Rushy Leasowes. Yellow lines = surveyed hedgerows. Thickness of green line = frequency, and darkness of green = abundance. All other hedgerows marked are either missing or are now fences. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

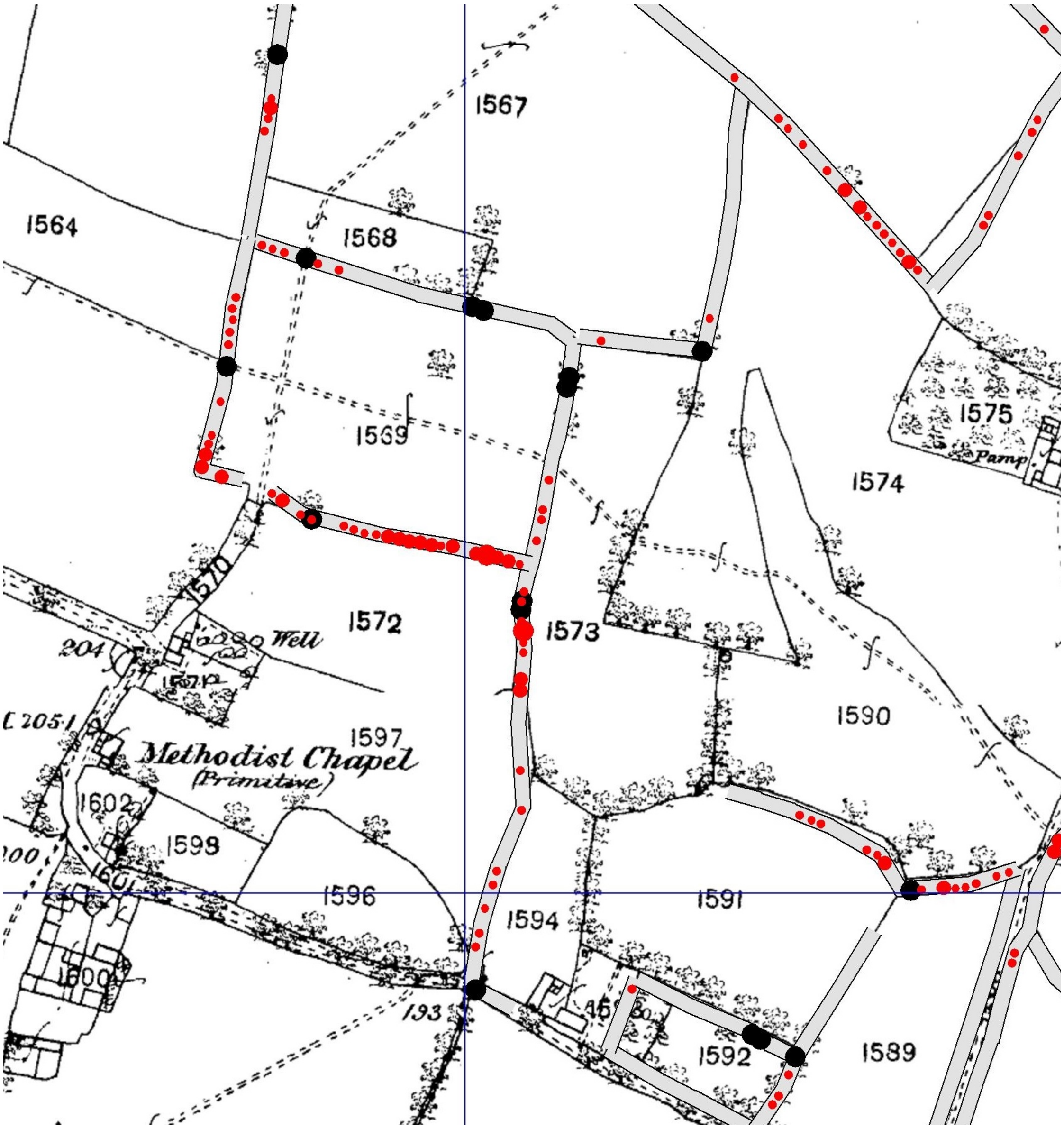


Figure 81.14 - An example Level 3 survey map survey map. Grey lines = surveyed hedgerows. Black dots = gaps, red dots 4m Record Point record (larger dots, more abundant). All other hedgerows marked are either missing or are now fences.

The level of detail recorded by the two methods can easily be seen. The former is more rapid and the latter more thorough but time consuming. HEDGES advocates using judgement and mixing the two levels where appropriate. For example there is little merit in sampling a near-monoculture Hawthorn *Crataegus monogyna* hedge to Level 3. This would be more appropriately surveyed to Level 2, but a more diverse hedgerow would benefit from being surveyed at Level 3. This is why the recording form is designed to switch to any level by completing the boxes differently.

6.5. Case Studies

For both woodlands and hedgerows, the case study approach has been adopted for the following reasons.

6.5.1. Woodlands - Case Study Rationale

The current research does not aim to devise a classification system to provide a key to ancient woodlands or hedgerow type along the lines of the NVC (National Vegetation Classification). Rackham (2003) lists an ancient woodland classification system from a combination of systems and authors (NVC, Peterken and Rackham) on his table 31.1 on page 480 of *Ancient Woodland* (Rackham 2003). These are defined by canopy species dominants and factors such as geographical location and soil conditions. There is no integration with the ground flora. Rackham (2003), supported by Peterken (1993) considers that there is often a poor relationship between the canopy species in woodlands and the ground floras beneath. I concur. Peterken advocates surveying each component discretely - trees and shrubs, ground flora and epiphytes. This is fundamental in the WOODS method.

Rackham (2003) also supports a key element of this research by acknowledging the variations in ground floras in woodlands due to often-subtle differences in growing conditions. He quotes a woodland planted on former ridge and furrow arable where

- "Bluebell and mercury grow on the better drained ridges and primrose and *Deschampsia cespitosa* in the furrows where water accumulates …".

As the approach of this research is to test the proposed novel methods, the use of case studies of woodlands and hedgerows with documented histories is the most appropriate method. By adopting a case study approach, examples of woodlands were selected that were different in character and provided a range of data collection opportunities to test the robustness of the survey methods. The main ethos behind this research is a questioning of classifying woods and setting thresholds that seem arbitrary and meaningless. Choosing to assess woodlands that are either similar or different in character or have potential elements to enhance scientific understanding is in keeping with the research aims. It is also important to investigate woods that have been researched so that historical information is available to inform the interpretation. The woods reported on in this thesis are those selected from a range of woods surveyed and represent those that were judged to provide data that would inform about the use of indicator species. The surveys were limited to selected woods in Yorkshire, but the principles of the survey and interpretation methods will be applicable to other parts of the country. The findings and results from other surveys are mentioned where they add to the scientific understanding of the processes, but the full data from these are not included. Also, some isolated observations are included where they add to the knowledgebase.

Consideration was driven by concerns over random or systematic sampling and methods used for classification. These provide statistically analysable data but having worked in woodlands and used NVC previously, this was discounted. It has severe limitations when trying to assess the detailed composition of woodlands for the current research purposes. The approach in woodlands is to better record the vegetation, to identify areas where AWIs grow and interpret the overall range of species and the local distribution and abundance.

6.5.2. Hedgerows - Case Study Rationale

Current surveys often only sample hedgerows within a given area, say a 1km square. The Hedgerow Survey Handbook (Bickmore 2002, Defra, 2007) recommends a minimum sample size of 9 hedgerows/1km grid square. In many parts of Britain, there was a considerable increase in the number of hedgerows planted during the Parliamentary Enclosure period (approximately 1750 - 1850). Potentially as many as 80% or more of the hedgerows present today could have been added during that period. Sampling only nine out of say 100 hedgerows in a 1km grid square could potentially only capture one or two of the older stock, pre-enclosure. To study hedgerow history this method is of no value as it is very unlikely to provide data to allow detailed historical interpretation. Even increasing the sampling still omits information in an uncontrolled manner. It is the purpose of this research to obtain robust data at a level of detail and coverage to make defendable statements about hedgerow history. Consequently, sampling is discounted. Individual hedgerows were only surveyed where there was learning potential and historical data to support any conclusions.

The critical analysis of the history of hedgerows in a landscape needs to consider all sources of evidence and information that have influenced the positioning of hedgerows in the landscape and their species composition. The primary aims of the surveys done for this research deal with hedgerows at the landscape scale based on land management units. In England, these are the medieval townships. Although many of these are identical (conterminous) to the current civil parishes, there may be differences and these need to be addressed for a proposed 'township survey', as was done at the civil parish of Dunnington (comprising 3 or 4 townships).

Within a township or any large unit of survey like a whole farm holding there is a palimpsest of hedgerows reflecting history. Some hedgerows will be datable with varying degrees of confidence to a particular planting era like a Parliamentary Enclosure Award. The issue addressed later, is that areas may be recorded as inclosed[11] by Enclosure Award, but there may be no documentary evidence to confirm that the layout of the hedgerows did not take account of any pre-existing hedgerows. Certainly the medieval township and open field boundaries are likely to have been retained, but others may also have been. Taking the case studies approach at large scales and recording all extant hedgerows is more likely to detect this phenomenon and interpret anomalous data from hedgerows that cannot be identified as having a known origin. Sampling, as advocated by the *Hedgerow Survey Handbook* (Defra 2007) is prone to collecting data in a statistically valid way, but is likely to include a disproportionate amount of data from recent (parliamentary enclosure award) hedgerows, and miss recording the more historically significant hedgerows that will be in the minority.

6.5.3. Woodland - Case Studies

Case study sites were selected to include woods for which there was historical information and evidence that they were different in character and would form a basis of comparison using the novel data collection and interpretation methods of this research. They currently focus on the NE of England being the author's location. Further work in other parts of the country will add to the knowledge base presented in this thesis.

1. Boston Spa, River Wharf Wood (including an area called Deep Dale), Boston Spa. This is next to the river Wharfe that has cut through Magnesian limestone. There is a range of soils and conditions. To the west is an area that was unwooded in the early 1900s when the first edition OS maps were drawn. The riverside woodland is recorded as AW in the Ancient Woodland Inventory. Deep Dale is recorded as Plantation on an Ancient Woodland Site (PAWS).
2. Church Wood, Birstall - A small and varied wood near Leeds studied by the South Leeds Archaeology Group that is less than 2ha and, as such, was not recorded as AW in the Ancient Woodland Inventory
3. Ecclesall Woods, Sheffield - a well-documented woodland with a significant history of human intervention and a varied topography that had a range of meso-habitats within. Recorded as AW in the Ancient Woodland Inventory. The area selected was the Bird Sanctuary. This was not surveyed by the friends of Ecclesall Woods and contained two meso-habitats and there is evidence of settlement to the west including Romano-British field

[11] The convention is that land was 'inclosed' by an 'enclosure' award.

systems indicating that the area was unwooded at that time. This section of wood was deliberately selected as it had no previous records, had been unwooded prior to 1600 and may be showing evidence of regeneration and also because it had a stream as a meso-habitat.

4. Gillfield Wood, Sheffield - an ancient wood near Sheffield with steep valleys and streams the subject of study by the Friends of Gillfield Wood. It straddles a major land division boundary. The stream separates Totley parish to the north and Dronfield to the south. Recorded as Plantation on an Ancient Woodland Site in the Ancient Woodland Inventory with sections to the south excluded.
5. Gunter Wood, Wetherby - An apparently homogeneous wood on level ground near Boston Spa, West Yorkshire. This wood was part of an archaeological investigation by the Boston Spa Archaeology and Heritage Group and was chosen because it was mostly on level ground and appeared to have a species-poor and even ground flora. Not recorded as AW in the Ancient Woodland Inventory
6. Hackfall Wood, Grewelthorpe - an ancient woodland with a wide range of soil conditions. This wood was used to trial the method to a workshop the author ran for the local branch of the Chartered Institute of Ecology and Environmental Management (CIEEM). Recorded as AW in the Ancient Woodland Inventory

6.5.4. Hedgerow - Case Studies

As already discussed, the critical basic unit for hedgerow survey to interpret history is a medieval township. Several townships east of York were studied as part of this research and at the invitation of the Friends of Hagg Wood. Of these, the civil parish of Dunnington was selected for a detailed survey. A similar survey was done earlier at the neighbouring *Scoreby* that is referred to for its significant discoveries.

The other case studies involving smaller areas were selected because they had traceable histories or had been identified as unusual or anomalous and worth investigation to understand their status and context:

1. Dunnington, York - The whole of the civil parish of Dunnington was selected that comprised the medieval townships of Dunnington, *Grimston* and an undocumented *Ianulfstorpe* and a postulated fourth unrecorded township. This was chosen, as a collaborator on the project was Stephen Moorhouse, who researched the landscape development of these townships and provided data on the likely phases of hedgerow creation in each township. This was done at Level 2, with a small part done to Level 3.
2. Clifford Boundary, Clifford - A medieval township boundary near Wetherby. The unusual species-richness of this hedgerow was identified during a 'beating the bounds' led by the Clifford Local History Society. This hedgerow, along with a number of others on the medieval township boundary between Clifford and Bramham were of known age and were investigate to look for patterns that could be interpreted by SPACES (Species, Position, Abundance and Combination Evaluation System). This hedgerow was used to trial the survey and interpretation methods to workshops the author ran for the local branch of the Chartered Institute of

Ecology and Environmental Management (CIEEM); once in summer and again in winter. This was surveyed at Level 3.

3. Manor farm, Leppington - A chance observation of anomalous woodland ground flora on some of the hedgerows prompted this study which was done to Level 3 in 2008.
4. Rushy Leasowes, Shrewsbury. This was a whole farm survey that was used for a series of hedgerow survey courses tutored by the author for the Field Studies Council at Preston Montford Field Centre near Shrewsbury (for four years between 2008 and 2012). This farm was surveyed at two levels - Level 2 and Level 3 (2008 and 2009 respectively). It was also chosen because it has been researched by local historians to provide interpretation data. Surveys were done to each level in different years to compare the value of data collected at the two levels of detail and to investigate if increasing the intensity of survey from Level 2 to Level 3 provided significantly more accurate and complete survey data.

6.6. SPACES Interpretation Method

This section proposes novel methods for the interpretation of data for woodlands and hedgerows (Objective 5 and 6 at 4.3).

The current interpretation methods record the number of species found in a woodland that appear on the nearest appropriate regional list, often citing a threshold based on expert opinion. This is flawed in its concept, as it requires all woods to be homogeneous and have the same potential number of candidate species. Setting an arbitrary threshold of 10 species could misclassify woodland that has a naturally poor ground flora of AWIs because it may be on nutrient poor soils or in an upland location.

The SPACES (Species, Position, Abundance and Combination Evaluation System) method (see Appendix 10) is a tool that takes data collected using the WOODS and HEDGES methods and considers species in their context within a woodland or hedgerow to identify patterns that can inform the historic interpretation of the habitat. It accommodates the wide range of scale from macro-habitats to micro-habitats within habitats and between habitats in the landscape. Using the four elements of Species, Position, Abundance, and Combination an original and radical novel analysis approach has been developed. This method is used to provide a better scientific understanding of the processes involved in determining why species are where they are, at particular abundances and in association with other species in combinations.

To aid the interpretation of the data it is important in woodlands to consider species in relation to their location within the wood, and their abundance both within the wood overall and in any isolated areas where these species may occur.

The woodland and hedgerow survey and analysis methods have evolved together developing into a novel method of SPACES analysis. This innovative method contributes to academic understanding by providing intelligent interpretation and a systematic method for assessing botanical indicators as historic markers. It considers the 'spaces' that species occupy at the landscape and local level (woodland or hedgerow) and also the species combinations at both levels. Considering these elements identifies patterns that can explain the history and pose questions for investigation to determine the reasons for the observations. This method is described in detail at Appendix 10 and in summary here.

SPACES interrogates data to determine:

1. Is that species where it is now because it has been there from ancient times or at least a dateable period?
2. Are a range of species in a combination there for the same reason, i.e., they are historic markers?

The SPACES approach works for both habitats at all scales from individual woods or wood fragments to woods at the landscape scale. Similarly, the approach can be applied to parts of hedgerows through whole hedgerow lengths and whole hedgerows in the landscape. It also accounts for woods and hedgerows of different lengths, and, for different levels of survey effort. It does not require a fixed number of quadrats, length of hedgerow, a defined transect pattern or a set survey time. The method uses all information available from the amount of effort and resources available. If more information is needed and collected this adds to the confidence of the interpretation.

The system looks at the four core elements of:

1. [S]pecies
2. [P]osition
3. [A]bundance
4. [C]ombination

to interpret the significance of the botanical content of woodlands and hedgerows. It also considers both

1. [T]ime (history)
2. [M]anagement

and scale;

1. [L]andscape
2. [H]edgerow
3. [W]ood

Time [T] - A purpose of hedgerow and woodland surveys is to analyse the species present today using SPACES to indicate ecological history. This requires the consideration of time in the analysis. This indication may be evident from considering particular elements from SPACES. An example from a hedgerow would be Purging Buckthorn *Rhamnus cathartica* that is a [S]pecies that, in the current research area of Yorkshire, is nearly always at specific [P]ositions, on township boundaries [SP], at low [A]bundance [Sa], associated with other species [C]ombinations [SC] (with Spindle *Euonymus europaeus* and Guelder-rose *Viburnum opulus*). This would be classed as a [SPAC] species indicating it encompasses [SP], [SA] and [SC]; [SPAC]. The SPACES status of a species normally uses the greatest number of elements that can be combined (see the hierarchy at Appendix 10, Figure 2.2). Having determined that the species is indicative of medieval origins and that the associations are at the landscape level this species this would add the [T] prefix and [L] suffix - [T][SPAC][L].

Management [M] - If the species was indicating management a further prefix would be added [TM][SPAC][L] (see Appendix 10). This would be relevant if a set of hedgerows were found to have been laid in the past or coppiced etc, or a woodland may have been coppiced.

Consideration of the element combinations leads to a signature being identified. In some cases a species may have a number of signatures. As an example, English Elm *Ulmus procera* had a number of signatures from the Dunnington case study:

1. **[T][SPa][L]** - The [S]pecies occurs infrequently [a] on confirmed medieval [T] township and field boundaries [P] in the landscape [L].
2. **[T][SaA][H]** - In some hedgerows [H] the [S]pecies is infrequent [a] but [A]bundant [A] but at no precise [P]ositions.
3. **[T][SAA][H]** - On some of the historic [T] boundaries the [S]pecies is frequent [A] and [A]bundant [AA] along the whole hedgerow - no precise [P]osition.
4. **[T][SPaA][H]** - There are indications that it is slowly colonising along hedgerows that have recently been created leading off an older hedgerow [T], at low frequency [a] (one end) but high abundance and at precise [P]ositions (the end).

The core SPACES elements are:

Species [S]: What can the species inform about the historic origins of individual woodlands and hedgerows and about the overall history of the landscape? This element is normally in-combination with the other elements. The species [S] may be present in the study area as a result of historic planting, in which case it will be found on specific woods or hedgerows [SP][L] associated with time and will therefore have the SPACES signature of [T][SP][L]. Also a species may be typical of wet areas in the landscape regardless of historic planting and would therefore be [SP][L].

Position [P]: where individual species are located both within the landscape and within habitats.

Abundance [A]: how abundant species are within the landscape and within individual features. Abundance incorporates the elements of frequency or density (at the landscape level and habitat level – hedgerow or woodland) as well as the cover or amount of species at the habitat level (See Appendix 01 and Appendix 02), and can be differentiated in the signature. The abundance part of a SPACES signature can be that the species is at High frequency/ abundance [A] or low frequency/ abundance [a]. For abundances in species combinations, some species may be at high frequency/ abundance and others at low as part of the signature. This cannot be incorporated into the SPACES code. When considering individual species, if the frequency **and** abundance are not the same a refined code can be used, [aA] = low frequency/ high abundance to [Aa] high frequency/ low abundance etc.

Combination [C]: How are species combined into groups in habitats? The species and combination elements can each be considered with the position and abundance elements to create seven combinations. By combining species or combination with position and abundance patterns, the combined elements can be investigated. Combination is used rather than community to reflect the anthropogenic influences and nature of woods and hedgerows. Although natural colonisations and extinctions occur in both, the combination of species present today is relatively un-natural as it reflects the needs of our ancestors who created or modified and managed these features. Therefore, community is inappropriate as this generally implies a natural community developed over time. It is inappropriate in woodlands where past management has a significant influence on the current combinations in areas such as charcoal hearths or along earthworks, and inappropriate for hedgerows as these are almost entirely the product of human creation and management with relatively few natural processes at work.

For Dunnington there were defined phases of hedgerow creation that it was predicted could exhibit a systematic planting in response to enclosure award prescriptions. A method was tested to see if this was the case. This built on the work of Kent and Coker (Kent and Coker 1992) who collated data based on sorting quadrat data into groups with similar mixes of species or communities. They focussed on what they refer to as differential species. These are shown at Figure 91.15. These show the combinations of differential species as referred to by Kent and Coker (1992). These are the species that fall between the ubiquitous and the rarities i.e., it ignores species like Hawthorn that is present in virtually every hedgerow and also species like Lilac that are probably only chance seedling escapes from a garden. Such species are likely to inform about the histories and management of hedgerows.

These tables are ordered with the differential species to the left, the pale blue columns (around 50% presence), that have been moved to the left of the table to make it easier to look for patterns in the data. Where all four differential species are present these are coloured darker green and reflected in the differential counts. Less constant species are below in increasingly paler shades of green where constancy decreases to 3, 2, 1 and 0.

The dark pink cells show the concordance with some historic marker species indicating a correlation between high constancy of the differential species and their combination with historic marker species. Paler pink are less diagnostic or are species of historic significance.

To the left, the columns summarise which species are present in the combinations where 3, 2 or 1 of the differential species are present. For example if there are three differential species along a particular hedgerow there are four ways that these could be represented. For [DU-2] the species could be:

1. Blackthorn, Crab Apple, Hazel
2. Blackthorn, Crab Apple, Field Maple
3. Blackthorn, Hazel, Field Maple
4. Crab Apple, Hazel, Field Maple

These are summarised in the olive coloured columns. Dark olive are the combinants as above. Column A (QRS) shows where the 3 combinants are Blackthorn, Crab Apple and Hazel. Where three of the four differential species are present the mix shows no defined pattern. The data indicated that where all four species are present these hedgerows tend to be richer overall and have the rarer species that are historic markers, like Guelder-rose *Viburnum opulus*, Purging Buckthorn *Rhamnus cathartica* and Spindle *Euonymus europaeus* .

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
1																	DUNNINGTON - PHASE 2																																		
2	Q R S	Q R T	Q S T	R S T	Q R	Q S	Q T	R S	R T	S T	Q	R	S	T	Differential sp. Count	ID	BLACKTHORN	CRAB APPLE	HAZEL	FIELD MAPLE	HAWTHORN	ELDER	BRAMBLE	DOG ROSE	ASH	ENGLISH ELM	HOLLY	GREY WILLOW	SYCAMORE	PEDUNCULATE OAK	GUELDER-ROSE	DOGWOOD	IVY	DOMESTIC APPLE	PRIVET	PURGING BUCKTHORN	WYCH ELM	ALDER	ASPEN	CHERRY	FIELD ROSE	GOOSEBERRY	GORSE	ROWAN	SILVER BIRCH	SPINDLE	WEEPING WILLOW	YEW	Total count	Differential sp. count
3															4	BH219-BH224	33	11	34	23	22	11	12	12	11			25	11	12	12					11													13	4
4															4	BV152-BV174	22	11	11	11	33	22	22	22	11						11				11														10	4
5															4	BW201-BW240	22	11	33	44	33	22	22	33	11	33																				11			10	4
6															4	BW240-BW258	22	11	33	22	33	33	22	22		22			44			11																	10	4
7	3														4	BS345-BS387	35	11	11	11	45	11	11							11		22																	8	4
8	3														3	BH227-BH229	45	11	23		45	11	11	22				11			11																		8	3
9	3														3	BS345-BS388	34	22	11		45	11		11	11				11	11																			8	3
10	3														3	BW258-BW269	33	11	44		55		22	33																									5	3
11	3														3	CE465-CE486	22	11	11		55	33																											4	3
12	3														3	BU001-BU120	22	11	22		45	22	11	11	22	11			11			11					22												11	3
13		3													3	BV054-BW169	22	11		22	45	22	11		22												11												7	3
14			3												3	BT180-BU256	22		11	44	55	11	11	11	11				11			11																	9	3
15			3												3	BS119-BU256	11		22	11	55	11	33	11	33		11		22																				9	3
16			3												3	BW443-BW465	11		44	44	44		22	11	44	55																							7	3
17					2										2	BS388-BW086	35	11			45		22																										3	2
18					2										2	BV036-BV054	33	35			44	33	33	22					11																				6	2
19					2										2	BS162-BV036	22	22			45	33	11		11		22		11						14														8	2
20						2									2	BG759-BX470	45		23		45	23	23				23	55					55															11	8	2
21						2									2	BH210-BL2026	33		22		44	11	33	33	11	44	11			11	11					11													11	2
22						2									2	CE486-CE508	22		22		55	22	22					11													44								6	2
23								2							2	BV141-BV152		11	11		44	11	22	11		11																							7	2
24									2						2	BW465-BW484		22		44	44		33	11	44																								6	2
25										2					2	BH212-BH219			23	23	45	22	11	22	11		24	22	11	11	23	12	24							35		11					12		17	2
26										2					2	BS755-BS760			11	11	11			11	11	55																							6	2
27											1				1	BG766-BX470	44				55	22	22	22									11																5	1
28											1				1	CF431-CF526	22				33	11		22																					22				4	1
29											1				1	BW433-BW442	11				22			11		45																							3	1
30											1				1	BG751-BG757	44				44	23	22																										3	1
31											1				1	BG757-BG758	55				11			22					33																				3	1
32											1				1	CE684-CE687	11																																0	1
33												1			1	CH337-CH364		22			45			22	11	22	11	22		33				11					22										10	1
34												1			1	CF526-CF654		22			22	22	33	22	22			11		11								55											9	1
35												1			1	CH364-CH404		44			44					22		22	11	33				33									11						8	1
36												1			1	CH314-CH337		33					22	22			22	11		22																			6	1
37												1			1	CF387-CF413		11			35	33	44	11			22																						6	1
38												1			1	CE687-CE713		11				11	11																										3	1
39													1		1	CH843-CH850			45			11					25																						3	1
40														1	1	BV175-BV186				11	45	11	22	11	33																								6	1
41														1	1	BW169-BW201				33	45	22	22	11	22																								6	1
42														1	1	BV141-BW484				22	44		11		22						44																		5	1
43															0	BH348-BH354					44				11		22			11																			4	0
44															0	BV186-BV203					11	11			11	55																							4	0
45															0	CF413-CF431					11	22					11																	11					4	0
46															0	CH309-CH313					44		22				11	22																					4	0
47															0	BV203-BV229						11				22																							2	0
48															0	BH224-BH227												33																					1	0
49															0	BS387-BS654						11																											1	0
50																Total	26	22	20	15	40	32	31	27	21	12	12	11	11	10	6	5	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1		
51																Percent	55%	47%	43%	32%	85%	68%	66%	57%	45%	26%	26%	23%	23%	21%	13%	11%	6%	4%	4%	4%	4%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%		

Figure 91.15 - Combination table for Dunnington Phase 2

6.7. Summary

The methods proposed for this research are tailored to answer the questions posed and achieve the objectives set. This has necessitated the development of novel field survey, desk study and interpretive analysis methods. Existing methods were considered to be inadequate and inappropriate, but have been considered and elements incorporated into the methods used in this research. The starting point of selecting methods is to define the outcomes and ensure that the inputs will meet those needs.

For the WOODS survey method is was decided that the objective was not to sample the flora nor to classify the stands. The sole purpose of the survey was to elicit as much information on the botanical content of the wood as possible in a usable and structured way. This method does not pre-set minimum standards as it is designed to be additive subject to resources. It is in the judgement of the organiser to determine when sufficient surveys have been done such that it is unlikely that further work will add significantly to the data.

Current hedgerow survey methods are at best unhelpful and at worst dangerous. They systematically avoid collecting historically significant data and apply very little in the way of intelligence in the analysis of the data. This research developed a multi-level survey method that can acquire data of sufficiently high quality that a hedgerow can be replicated virtually plant for plant at a new location as the author has done on a farm near Tockwith as described in Wright and Rotherham (2015). Even in a relatively rapid survey at Level 2 a large amount of usable data is collected for interpretation. This novel approach adds significantly to scientific understanding by setting out a framework for data collection.

As the proposed survey methods for WOODS (Woodland Overview and Objective Description System) and HEDGES (Hedgerow Ecological Description, Grading and Evaluation System) are novel, a similarly novel analytical process was required. This is SPACES (Species, Position, Abundance and Combination Evaluation System). A single unifying method of looking at botanical data from both aspects of the wooded landscape research into woodlands and hedgerows. Because both woods and hedgerows are relatively unnatural their content now shows significant differences that are difficult to classify satisfactorily. Barnes and Williamson (2015) recognise that human use of woods effectively makes each one unique. Moreover, their internal divisions and plot uses need to be interpreted historically and cannot just be sampled and classified using statistically significant methods. Statistics can be made to classify woodlands, but this research does not seek to classify, only to interpret what is there in terms of what the species are contributing to informing about the woodland or hedgerow history.

7. Results

7.1. Introduction

The results of both the desk study methods and field survey and analysis methods are presented in this chapter. The detailed field data are available as technical appendices. Relevant data are brought into this chapter or reference made to key results from the appendices.

One of the major methods of this research were the stakeholder workshops that were related to woodlands. These canvassed expert opinion and discussed many aspects of how ancient woodland indicator species were derived, how they are used and current perceived shortcomings.

The main bulk of the field survey case studies results are species maps and species lists that are extensive and can be studied at the appendices and in the annexed Dunnington hedgerows report to provide a more detailed understanding of the data.

The novel analytical approach SPACES (Species, Position, Abundance and Combination Evaluation System) is described as it applies to the data collected. This new way of thinking about botanical indicators increases scientific understanding of the processes at work that have arrived at the species composition of our woods and hedgerows.

7.2. Woodland workshops

A number of key issues were debated and discussed during the series of four woodland workshops held between 2008 and 2009. These covered a wide range of subjects and left many issues unresolved that are the subject of the current research. Details of the workshops and the sessions are available at Appendix 11. This section summarises the key discussion points and results. There were a number of important elements discussed. These are dealt with in turn.

7.2.1. What is ancient woodland?

One of the key questions was, "what is ancient woodland?". The main focus of this debate was to discuss whether ancient woodland encompassed more than just closed canopy high forest trees with an understory and ground flora. It was agreed that there are many places in the wider landscape that contain typical woodland ground flora species including those that are regarded as ancient woodland indicator species that are present today in the absence of significant tree canopy cover. These are referred to as ghost woods or shadow woods (Handley and Rotherham 2013, Rotherham 2007b). The supposition is that the former are relics and vestiges left over from centuries of progressive woodland clearance from a more ancient and potentially denser canopy of trees. The latter are apparently survivors of Domesday wood pastures or wooded commons (Ian Rotherham pers. comm.).

The other debate was at what date in history is a cut-off point for determining a woodland as being ancient. The consensus was that the date of 1600 was widely accepted. Prior to this date, there are few records to indicate that woodlands were deliberately planted. Evidence exists that any woodlands predating the year 1600 are more likely to have been in existence for a considerable period, potentially going back to what is regarded as the wildwood that developed following the retreat of the glaciers after the last ice age. At one point during the workshops, it was suggested that the date of the Parliamentary Enclosure awards may be appropriate.

7.2.2. What is recent woodland?

The converse of the above is, "what is recent woodland?". Recent woodland was regarded as an area of trees planted on land that had previously been under agricultural cultivation, or at least not regarded as wooded in any sense. This generated a debate as to how long a period of non-wooded conditions would constitute a break likely to have removed any ancient woodland indicator ground flora species and therefore a new plantation would be on non-woodland soil with no residual woodland species. There was some evidence from Keith Kirby that suggested a period exceeding 40 years and potentially in excess of 100 years to assign any degree of certainty that there has been a breaking canopy.

There are a number of issues regarding recent woodland. It is presumed that recent woodland has been planted on previously un-wooded land and therefore there were no typical shade-adapted woodland type species present at planting. It is also assumed that there has been little or no colonisation since that period by ancient woodland indicators. The fact that many recent woodlands do contain species regarded as ancient woodland indicators e.g., Church Wood and Gunter Wood would suggest that one or both of these assumptions are, in part, false. It is likely that recent woods planted within an environment that included areas of shaded habitat could potentially have harboured residual elements of shade adapted ground flora that may now be spreading across the woodland. This could include areas of scrub, hedgerows and tree-lined stream sides. In addition, was already stated in the workshops, there are a number of species that are normally shade-adapted and regarded as woodland plants that occur in other habitats including open sky environments. Species such as these that have wide ecological amplitudes may be able to "wait out" the unfavourable period until a new woodland canopy is established. For example, the Forest of Gunnerside in Swaledale was clear-felled in the 1700s and yet Wood Anemone *Anemone nemorosa* is still abundant in the grassland today.

It is also very likely that, since creation, a number of dispersal opportunities have been effective in colonising these recent woodlands. There seems to be an assumption that colonisation is by natural vectors such as animals or birds. There is insufficient consideration that human activity may be a factor in moving ancient woodland indicator species into recent woodlands. Woodlands have generally been actively managed throughout history. Foresters have moved freely between ancient and recent woodlands for over 400 years since the year 1600. In this period, it would be perverse to suspect that no transfer of seeds has happened because of human activity - this includes the transfer of seed on beasts of burden such as horses as well as on the wheels of carts and motorised vehicles.

An important consideration from the workshops is the importance of recording the location and abundance of ancient woodland indicator species if found in recent woodlands. Patches of ancient woodland indicators could indicate colonisation and spread or could possibly represent retraction and decline. This requires intelligent interpretation (Rotherham 2011) as advocated in the workshop discussions.

7.2.3. What is the nature of ancient woodland?

There was considerable discussion and debate as to how to recognise ancient woodland now based on its current botanical and other characteristics. It was agreed that ancient woodlands have been effectively managed, more or less intensively, for a very long period. The nature of this management has changed with many woods going through phases of effectively industrial production of charcoal (Crossley 1993) and exploitation for their timber products. In recent times this emphasis has changed and many woodlands that were formerly coppice woodlands have now reverted to high canopy plantations for the removal of mature timbers for construction and other purposes.

On this basis the nature and character of the flora beneath the canopy is likely to have changed over time. It was generally regarded that the typical ground flora that exists where the woodland is coppiced is different from that that would be expected under a continuous closed canopy. Under a coppice regime the amount of light varies throughout the harvesting cycle and it is likely that some species may be disadvantaged by this regime and be absent from areas of coppicing. These would be the significant shade-adapted species with the lowest values for light on the Ellenberg scale.

7.2.4. What are ancient woodland indicators?

This generated significant debate as the consensus was that these are any species that are found most often in woodland dated to being present before 1600. This will include trees, shrubs and ground flora. It is assumed that the species in question have persisted from before that date, i.e., there has been continuous shade for the shade-adapted species and areas of open glades to allow the associated woodland species to persist. Other species from non-woodland habitats will also be present within defined ancient woodland boundaries and dealing with these species is an issue.

One of the main assumptions about ancient woodland indicator species is that they are found more exclusively in ancient woodlands than in recent woodlands because they have limited abilities to colonise new sites. A number of factors may influence this ability including low pollination, low seed viability and barriers to dispersal e.g. heavy seeds that are not easily transported. The majority of ancient woodland indicators acknowledged by experts are those that are shade-adapted.

Botanical species can indicate many facets of the environment in which they live, including pH, moisture levels, altitude, latitude etc. The main consideration of these workshops was whether shade was a critical element in the determination of which species are ancient woodland indicators. In many cases, authors only referenced ancient woodland indicators as those that are shade-adapted (shade-evaders that grow, flower, set seed and die down before full canopy cover, or shade-tolerant species that can persist under the full canopy once developed). Surveys often include all species that are found within the confines of a mappable area that is regarded as a candidate for ancient woodland.

7.2.5. The inclusion of light demanding species

These sun-lovers or open-sky species posed a significant problem when considering ancient woodland indicators. The general consensus was that woodlands historically were more open with clearings, glades and rides and that these encouraged a number of open sky species to persist. It was agreed that open-sky species can be regarded as ancient woodland indicators but are also indicators of unshaded habitats and cannot be regarded, on their own, as providing indication of ancient woodland status.

7.2.6. How were ancient woodland indicator species lists created?

Ancient woodland indicator species lists were generated from:

1. Expert opinion
2. Survey and interpretation

A combination of both may also be adopted. Some of the earliest work done by Peterken (1974) fell into the category of survey and interpretation. The majority of ancient woodland indicator species were by expert opinion. This led to circular arguments with respect to the Ancient Woodland Inventory (Westaway, Grose and McKernan 2007). The inventory was created using archival data and information and collected information on the species content of the ancient woodlands identified. This created species lists that were then applied back to other woodlands that did not appear on the inventory.

The number of candidate species on each regional lists varied from tens, to over 100. Hornby and Rose (1996) deliberately standardised to 100 species for each of the three southern NCC regions for convenience.

7.2.7. Survey methods.

Relatively few of the ancient woodland indicator species lists have been derived from rigorous survey backed up by documentary and archival research. The Woodland Trust in Northern Ireland (Woodland Trust 2007) has done one of the most significant recent surveys. This was reported on in the workshops.

There were presentations during the workshops on the various methods of surveying woodlands for their floras. Although most techniques were intended for a general species assessment, they are equally applicable if the intention is to look for ancient woodland indicators.

At several points it was emphasised that using vascular plants as indicators would require surveying more than once during the survey season. Although many of the recorded ancient woodland indicator species are shade-evaders in that they tend to grow, flower, set seed and die back before the tree canopy becomes too dense, other species only emerge during the mid and late summer and are shaded-tolerators.

There was considerable debate as to which method of survey was the most desirable. The two methods currently advocated are:

1. A walked transect
2. Quadrats

The various merits of both were discussed. It was agreed that intensive walked transects are most likely to detect rare ancient woodland indicators compared with quadrats, even if placed at high density. The main advantage of quadrats was that statistically valid information could be gathered and that in doing quadrats there was a concentration of effort that is more likely to ensure complete coverage of the flora present.

One of the issues raised was that currently the ancient woodland inventory did not survey any woodlands that were less than 2 ha in size and also that it completely ignored what the workshops agreed were valid wooded habitats in the form of shadow woodlands.

The method proposed by the present author for his research was a combination of both systems. This was questioned by Keith Kirby of Natural England who felt that both systems had a place but that it would be difficult to combine and reconcile both to enable a statistically acceptable and realistic assessment to be made.

This was countered by the proposal to use a novel method of analysis that did not rely on statistical applications and was an intelligent interpretation method. There is no intention to make the method repeatable or statistically sound. A thorough search would be done to ensure a confident belief that most, if not all critical species have been found and their [P]osition and [A]bundance recorded.

It was agreed that whatever method was adopted it should be simple to use - reliable, repeatable and provide sufficient data on which to formulate a decision as to the nature of the woodland surveyed.

7.2.8. The use of ancient woodland indicator species.

During a number of the workshops, there was discussion on the way ancient woodland indicators should be used. One of the main uses was in planning applications where potential ancient woodland sites were under threat. Where there was inconclusive or documentary evidence ancient woodland indicator species were called into play as evidence to suggest that the woodland in question was ancient. There was further discussion on the quality of surveys in terms of detecting enough woodland indicator species to allow the woodland to qualify as being regarded as ancient. The general consensus was that some form of threshold or index needs to be devised.

Many local authorities and some of the experts involved in devising ancient woodland indicator lists also had recommended thresholds for the number of species required to provide sufficient indication that the woodlands were ancient. The number of species required to qualify varied from region to region and in some cases from woodlands on one type of soil to woodlands on other types of soils where the numbers are expected to differ. The intrinsic flaw in this approach is that if the target is 25 species and the woodland in question has 24 it would be regarded as recent whereas if it had 25, it would be regarded as ancient. Such an arbitrary cut-off is undesirable. It was more desirable to consider an index or a weighting system to allow for some flexibility and an intelligent interpretation that gave increasing confidence to the assertion that the woodland is ancient rather than a black-and-white yes/no.

Debate covered how to deal with both continuous ancient woodland sites and plantations on ancient woodland sites. Was it appropriate to use the same thresholds for both or, should a different threshold be used for a plantation on an ancient woodland site?

7.2.9. Can indicators be used where historical records are absent?

The primary aim of using ancient woodland indicators is that they can support documentary evidence if available or can be used as the sole source of evidence, if such documentation is not available. It was generally felt that the botanical data was not definitive, only indicative, and was no substitute for documentary evidence.

It is desirable to be able to confirm ancient woodland status where documentary evidence is lacking. There was debate about whether this was achievable.

7.2.10. Are vascular plants the only usable indicators?

At several points during the workshops, there was mention of other taxonomic groups being potentially used as indicators. In many cases, it is likely that such groups would be more difficult to survey systematically than the relatively simple process of recording vegetation. No proposals were made to extend the consideration of other groups.

7.3. Regional Distinctiveness

The status of current regional lists was canvassed by Glaves *et al*. (2009a). Existing data and new data from respondents were combined to draw up a map of where lists are available at present. This is shown at Figure 63.4. There are gaps where there appear to be no regional lists. As Glaves *et al*. (2009a) reported, some regions adopted an adjacent region's lists. The purpose of regional lists is to add a local dimension to deciding which species are regarded as being ancient woodland indicators. As some of the 'regions' are small and others large the range of species considered was also large.

7.3.1. National Character Areas.

The result of this part of the desk study analysis focusses on National Character Areas as Ann Hill advocated in her PhD in the Malvern Hills and Teme Valley Natural Area (Hill 2003) (Natural England 2014b, 2015a and English Nature 1997). These relate to ecological and landscape factors and are more meaningful than administrative boundaries that can cover many different soil types and topographies etc. The NCAs considered in the current analysis are 22, 30, 37 and 51 (Natural England 2013a, 2013b, 2013c, 2015b respectively), being those that include the woodland case study sites. The concordance between county boundaries and all of the NCAs occurring in Yorkshire is shown at Figure 101.16. Large counties like North Yorkshire contain 12 NCAs, at least in part. North Yorkshire was the only county respondent that indicated that it varied its lists by crude geology. They supplied lists for North Yorkshire - neutral to calcareous and North Yorkshire - acid as well as North Yorkshire - wet. In addition, an original list for the north-east of Yorkshire related to the North York Moors that is mainly upland acidic with some calcareous areas.

Figure 101.16 - Concordance between the County boundaries in Yorkshire and the NCAs (RED = NCAs, GREEN = County boundaries).

Spatial data from the Biological Records Centre was entered into the Geographic Information System computer program of Quantum GIS or QGIS. The dataset requested was from the list of 270 species from the questionnaire used by Glaves *et al*. (2009a).

This is shown at Appendix 05, omitting some of the very rare species. This table shows the number of 10km squares that fall at least partly within the four NCAs that contained the case study woodlands discussed later. These values are the RED column headings. The Relevant NCA's are 22, 30, 37 and 51 (Natural England 2013a, 2013b, 2013c, 2015b respectively) and the number of squares each is recorded from in each NCA under the NCA headings of Appendix 05. The grey columns are the percentage occurrences of each species; 100% = recorded from every 10km square etc. The table is in descending order of the cumulative percentage occurrence in all four NCAs. This is a measure of the frequency that adds the percentage of 10km squares from which a species is recorded in each of the four NCAs to give the cumulative % column where the data ranges from 400% (100% presence in all four NCAs) to 3% where *Orobanche hederae* was only found in 1 square (3% presence) of only one of the NCAs (NCA30) (cumulative presence 3%).

This list includes species from both Scottish and Welsh lists and is used as a 'catch-all' to consider all candidate species that have been regarded as AWIs by authors or local authorities etc. One of the rare species referred to later is Killarney Fern *Trichomanes speciosum*. This is an important species as its distribution records have increased significantly following the discovery of its persistent gametophyte phase (without visible fronds) published in Watsonia in 1998 (Rumsey, Jermy and Sheffield 1998). A more up-to-date map than the data provided by the BRC showing its distribution from the BSBI atlas website is at:
http://www.brc.ac.uk/plantatlas/index.php?q=plant/unmatched-species-name-216
(last accessed 22-03-2016) is shown at Figure 103.17.

The typical meso-habitat where it is found, and what the sporophyte and the gametophyte look like, are at Figure 103.18 to Figure 104.21.

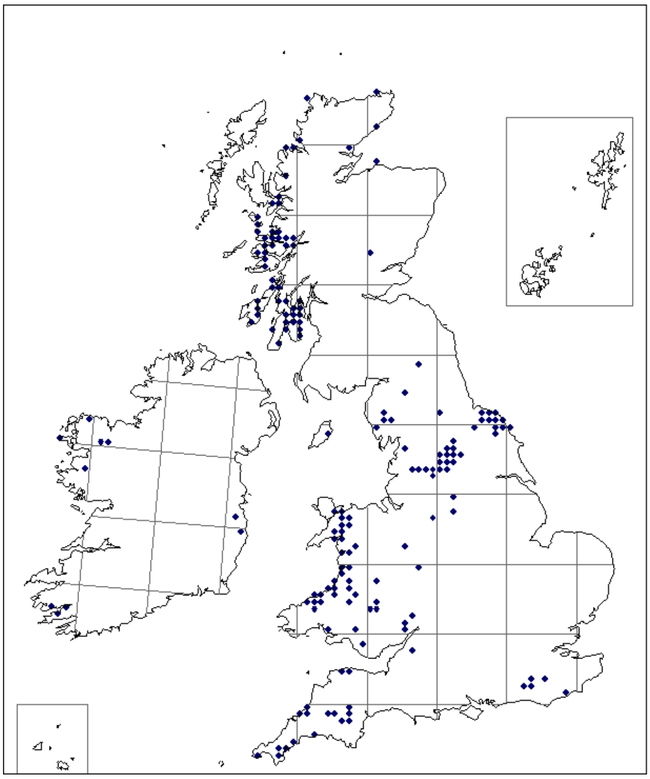


Figure 103.17 - Current distribution of Killarney Fern *Trichomanes speciosum* as gametophyte.

Figure 103.18 -Typical habitat for *Trichomanes speciosum.*

Figure 103.19 - Sporophyte of *Trichomanes speciosum.*

Figure 104.20 - Gametophyte mat (green fuzz) of *Trichomanes speciosum*. Superficially like a moss protonema.

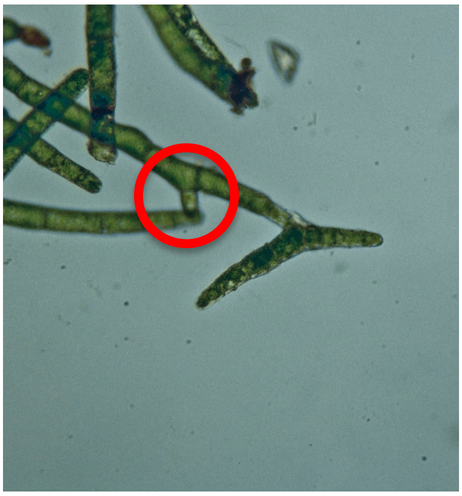


Figure 104.21 - Microscope slide of the vegetative gemma on the persistent prothallus mat of *Trichomanes speciosum*.

The individual data from respondents and the other sources used to derive the lists is in the appendices at Appendix 03 in alphabetical order and Appendix 04 in descending order of the number of lists on which each species appears. Out of the 37 lists, no species appeared on all lists. The species most frequently on lists was Hairy Wood-rush *Luzula pilosa* that was on 35 lists.

There are many inconsistencies in the treatment of existing data on lists could be regarded as ancient woodland indicators. A good example is Orpine *Sedum telephium*. This is a species regarded by Peterken in 2000 as having a 100% fidelity for ancient woodland. Considering its status in Yorkshire it is not included on any of the lists obtained by Glaves *et al*. (2009a). Even though it is found within the county and within the NCAs referred to later in this thesis (NCAs 22, 30, 37 and 51), it has a cumulative constancy of 54% out of a potential 400%, being recorded from 1, 2, 1 and 7 10km squares in these NCAs respectively. The species is not regarded in *Comparative Plant Ecology* as being a woodland species (occurrence = 1) as it is a species of outcrops (occurrence = 5) and has a significant presence in skeletal habitats (occurrence = 5). Inconsistencies like this are difficult to understand. In this instance it may appear that expert opinion has determined that it is not a species that is sufficiently abundant that it can be regarded as an ancient woodland indicator species. For the purpose of this research, it should be considered a candidate species for an area if it is recorded from any 10km squares within the NCA, even if it is not currently on that region's lists, or it is rare in the region. Orpine is a species that does occur on a number of lists, notably Bedfordshire, East, South, South-east, South-west, Suffolk, Wales - All, Wales - North-east, Worcestershire. This largely accords with the national distribution as shown at Figure 105.22.

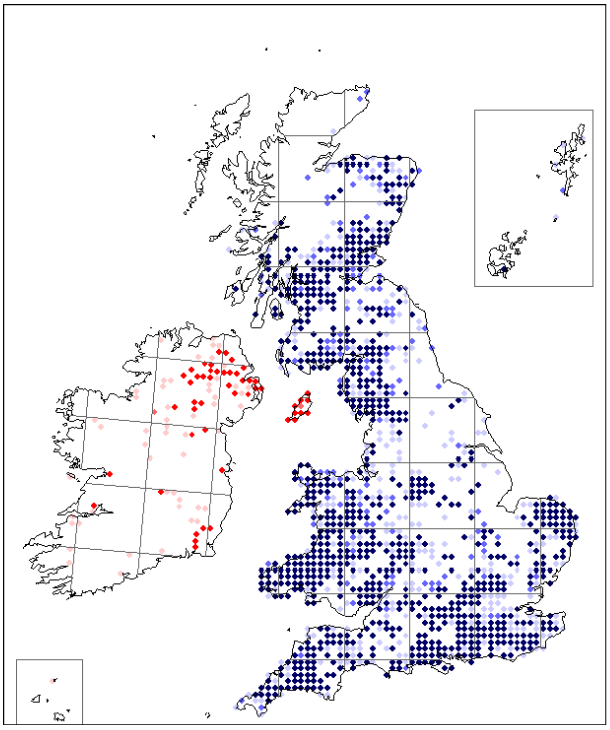


Figure 105.22 - National distribution of Orpine *Sedum telephium* from the *New Atlas of the British and Irish flora* (Preston, Pearman and Dines 2002).

The areas covered by the lists varied greatly as most were derived for administrative counties, sometimes for more than one. As such the number of species on each list also varied with the most species on a list being 154 on the list for the 'East' region and the least being 18 for Leicestershire and Rutland. 68 of the species were only on one list. As a catch all, these are considered in this research, although the presence of Bramble *Rubus fruticosus* on one list (Vickers 2001 as a 60% fidelity) may be questionable to include. As it was not rated as having a fidelity for ancient woodland by the authors referred to later it is included as a possible for consideration.

Other Data used in the analysis include:

1. The National Forest Inventory England 2014 taken from the Forestry Commission website at http://www.forestry.gov.uk/forestry/infd-8g5bya (accessed 2013-03-05). This is a data layer that shows the registered boundaries of all woodland over 0.5ha in England.
2. The Natural England data for the Ancient Woodland Inventory.
3. National Character Areas. The boundaries are used in the analysis and the printed descriptions are used to provide summaries and add to the interpretation.

The distribution of woodlands from the National Forest Inventory has already been shown at Figure 67.6 for NCA37 and the distribution of ancient woodlands at Figure 68.7. These show how much woodland is in the NCA and how many are ancient. The pattern of agreement between the amount of woodland in the NCA and the number that are ancient. There are more areas of woodland towards the south and few in the north and this is mirrored by the concentrations of ancient woods. The adjacent NCA 51 shows an almost lack of both woodlands and ancient woodland at its centre. The density of woodlands of both types is likely to have an influence on the rate of colonisation of recent woodland by ancient woodland indicator species. Few woodlands, widely spaced and few ancient woodlands to provide a source of propagules are likely to adversely affect colonisation rates. But there will still be refugia of ancient woodland indicator species in other parts of the landscape that are still scruffy or in hedgerows, scrub, Bracken and Brambles that have entrapped and retained shade tolerant woodland species.

The primary aim of this part of the study was to demonstrate that NCAs are a more appropriate area to consider and how this should be accounted for. Applying atlas data to NCAs defines candidate lists. Consideration of the distributions of woodlands and ancient woodlands will provide guidance on the likely colonisation sources locally.

7.4. Woodland Autecologies

The autecological method is designed to provide guidance as to which species can be regarded at ancient woodland indicators based on their ecological requirements and also their ability to colonise new sites. One of the main reasons for determining that a species is an indicator of ancient woodland is that it is relatively incapable of moving freely into newly planted areas. This is on the assumption that formerly woodland, or at least shrubby cover, was more or less continuous across the landscape and species slowly moved around as the vegetation shifted from shade-casting trees and shrubs to open sky as predicted by Vera (2000). Following human clearances of woodlands for agriculture the landscape became 'tidied up'. Woods became isolated, making the movement of species more difficult if their reproductive strategy was for relatively short distance movement e.g., a flower stalk of *Allium ursinum* of some 25cm tall falling over an depositing its seed (a spread of 25cm). In parts of the country there may be more woodlands in close proximity that could facilitate easier transfer of propagules from ancient to recent woodlands. There are still 'scruffy' areas in our countryside, including ancient hedgerows, with woodland ground flora species, that can hold ancient woodland indicator species and be close to a new wood and hence facilitate colonisation.

Aspects of this study include:

1. Is the autecology of a species in a woodland confirmation that the woodland has ancient origins?
2. Are there characteristics of the species that make it a poor colonist?
3. Does it persist from ancient times despite any management that may have potentially impacted on its survival (coppicing, charcoal turf stripping, clear felling etc.)?
4. How confident is this determination?

To address the first point, evidence needs to be collated that can indicate that a species has low colonisation ability and is therefore most likely to be present in the woodland because of continuity rather than colonisation. The fourth point is important as there needs to be a level of confidence given for the determination date a species is indicating.

There are two approaches to answering these questions as discussed in the methods section.

1. Comparative studies - To consider what species currently occur in what can be demonstrated from documentary evidence as ancient woodland compared with the species present in recent woodland, i.e., is the species presence or absence informing about its ability to colonise recent woodland?
2. Autecological attributes - Consider the ecological characteristics of the species and make a determination as to the likelihood of it being an easy colonist of new woodlands.

7.4.1. Comparative Woodland Studies

The comparative study approach (comparing lists from documented ancient sites with those known to post-date 1600) is one that has been frequently adopted (Woodland Trust 2007, Vickers 2001, Peterken 1974 and 2000 and Thompson *et al*. 2003). It is evidence-based as species that are confined to ancient woodlands are probably poor colonisers of recent plantations even if they potentially have a dispersal mechanism that facilitates colonisation e.g., animal dispersal by ingestion. They will also not establish if a suitable meso-habitat is either absent from the new wood, or the conditions have not developed sufficiently to facilitate establishment and spread.

These authors listed above have applied comparative and statistical methods in order to determine the fidelity a species has for ancient woodland compared with associations it may have with recent woodlands. This led them to produce lists with an index or percentage likelihood of the species occurring in ancient rather than recent woodlands.

The Woodland Trust used statistics to differentiate between ancient woods and long-established woods (evidenced as have a clear felled period between 1600 and 1830. There are 32 species in common with the list compiled by Glaves *et al*. (2009a). Peterken in 1974 grouped species into those with definite association with ancient woods down to those that are also found in recent woods. This used a scale from 1-6 where 1 was a strong affinity for ancient woods and he identified 45 species.

The Peterken 1974 list places the species in a group as follows: this

- Group 1 = Confined to primary woodland
- Group 2 = Almost confined to primary woodland. All localities outside primary woods explicable by survival on site, or (rarely) by planting.
- Group 3 = Almost confined to primary woodland. May colonise secondary woodlands very rarely.
- Group 4 = Most localities in primary woodlands. Clear evidence of colonisation can occur, but rarely.
- Group 5 = Most localities in primary woodlands, but also occur in other long-established habitats. No evidence of colonisation ability in either habitat.
- Group 6 = Native trees and shrubs confined to primary woods and ancient, mixed hedges, except where (rarely) planted.

He later (2000) produced a list of 79 species where he compared their percentage frequency in ancient versus recent woods and provided a list in descending percentage order ranging from 100% to 53%. Thompson produced a similar list for Somerset of 47 species with an index than can convert to percentage frequency and ranged from 100% to 43%.

These data are shown at Appendix 06. The Woodland Trust list just indicates that the species has been found to be statistically associated with AW and these were given a fidelity rating of 100%.

The lists from Thompson and Peterken 2000 use a percent fidelity value (Thompson converted from an index 0.0 - 1.0 to percentages).

A weighting has been derived from the author who applied the highest fidelity value to the species. In many cases authors who considered the species judged it to have a 100% fidelity, but there were cases where they differed and lower values were applied. To partly accommodate this the average percentage fidelity is also present at Appendix 06 and is used in the case study evaluation tables. For the purpose of this analysis the best case scenario is taken and the highest fidelity value is considered.

7.4.2. Woodland Species Autecologies

The data from *Plantatt* (Hill, Preston and Roy (2004) and *Comparative Plant Ecology* (Grime, Hodgson and Hunt 2007) are used, in conjunction with the information on regional distinctiveness, to consider if there is framework for applying an objective and intelligent method to determine the status of species in a wood and hence the status of the wood.

The autecological attributes of species are set out in *Plantatt* (Hill, Preston and Roy (2004) and *Comparative Plant Ecology* (Grime, Hodgson and Hunt 2007). The latter includes a determination of the dispersal mechanism for the species it considers. *Comparative Plant Ecology* only deals with common species and only includes 182 species from the total list of species from Glaves *et al*. (2009a).

Which species are woodland species?

There are 44 species that *Comparative Plant Ecology* list as having woodland as their 'Commonest terminal habitat' as listed at Table 109.1. This table also includes the assessment of the core pH requirement with an indication of the range spread with 'a' being a tightly defined range with an interquartile range of ≤1 pH unit and 'c' being >2 pH units.

Table 109.1 - Species listed by CPE as having woodland as their commonest terminal habitat and also the abundance of the species in other primary habitats as well as their pH range requirements.

Species	Abundance in primary habitat 1-5 = rare to common								Commonest Terminal Habitat a = acid l - limestone le = limestone wood edge	pH. Core + Range a = narrow c = wide
	Aquatic	Mire	Skeletal	Arable	Pasture	Spoil	Waste	Woodland		
Adoxa moschatellina	1	3	3	1	1	1	2	5	WOODa	6.0B
Carpinus betulus	1	3	1	1	1	1	1	5	WOODa	5
Ceratocapnos claviculata	1	1	1	1	2	1	3	5	WOODa	3.5a
Galanthus nivalis	1	1	2	1	1	2	2	5	WOODa	6.5c
Holcus mollis	1	3	2	1	3	2	3	3	WOODa	5.0c
Ilex aquifolium	1	1	2	1	2	1	1	5	WOODa	4.5c
Luzula sylvatica	1	1	4	1	2	1	1	5	WOODa	5.0b
Melampyrum pratense	1	1	3	1	2	1	1	5	WOODa	7.0a
Narcissus pseudonarcissus	1	1	1	1	1	1	3	5	WOODa	4.0c
Prunus avium	1	1	1	1	2	1	1	5	WOODa	6.0c
Quercus petraea	1	1	1	1	2	1	3	5	WOODa	4
Sorbus aucuparia	1	1	2	1	2	1	2	4	WOODa	4.0c
Allium ursinum	1	2	1	1	2	1	2	5	WOODl	6.5B
Anemone nemorosa	1	1	1	1	3	1	1	5	WOODl	6.5B
Aquilegia vulgaris	1	2	3	1	3	2	3	4	WOODl	7.0a
Arum maculatum	1	1	1	1	2	1	1	5	WOODl	7.0a
Brachypodium sylvaticum	1	1	3	1	3	2	1	4	WOODl	7.0a
Bromopsis ramosa	1	1	3	1	2	2	3	4	WOODl	7.0b
Campanula latifolia	1	1	1	1	1	1	2	5	WOODl	7.0a

Table 109.1 - Species listed by CPE as having woodland as their commonest terminal habitat and also the abundance of the species in other primary habitats as well as their pH range requirements.

Species	Abundance in primary habitat 1-5 = rare to common								Commonest Terminal Habitat a = acid l - limestone le = limestone wood edge	pH. Core + Range a = narrow c = wide
	Aquatic	Mire	Skeletal	Arable	Pasture	Spoil	Waste	Woodland		
Campanula trachelium	1	1	4	1	1	3	2	5	WOODl	7.0a
Daphne laureola	1	1	3	1	1	1	1	5	WOODl	7.0a
Elymus caninus	1	1	4	1	2	1	2	4	WOODl	6.5a
Geum urbanum	1	1	3	1	2	1	2	5	WOODl	6.5a
Hedera helix	1	1	3	1	2	1	1	4	WOODl	7.0b
Iris foetidissima	1	1	1	1	1	1	1	5	WOODl	5.5
Lamiastrum galeobdolon	1	2	1	1	2	1	1	5	WOODl	6.5b
Lathraea squamaria	1	1	1	1	3	1	1	5	WOODl	6.0b
Lonicera periclymenum	1	2	1	1	2	1	1	5	WOODl	4.0b
Melica uniflora	1	1	3	1	2	1	1	5	WOODl	7.0a
Mercurialis perennis	1	1	2	1	2	1	2	5	WOODl	7.0a
Moehringia trinervia	1	1	3	1	2	1	1	5	WOODl	6.5c
Myosotis sylvatica	1	1	3	1	1	2	3	4	WOODl	7.0a
Neottia nidus-avis	1	1	1	1	1	1	1	5	WOODl	6.5c
Paris quadrifolia	1	1	1	1	1	1	3	5	WOODl	7.0a
Ranunculus auricomus	1	1	1	1	4	2	4	5	WOODl	7.0a
Ribes uva-crispa	1	1	1	1	2	1	1	5	WOODl	6.0c
Ruscus aculeatus	1	1	1	1	1	1	1	5	WOODl	6.5a
Sanicula europaea	1	1	1	1	2	1	1	5	WOODl	6.5b
Taxus baccata	1	1	5	1	1	1	1	1	WOODl	7.0a
Ulmus glabra	1	2	2	1	2	1	1	5	WOODl	7.0b
Viburnum opulus	1	3	1	1	2	1	1	5	WOODl	7.0b
Viola reichenbachiana	1	1	3	1	1	1	1	5	WOODl	7.0a
Lithospermum officinale	1	1	3	1	1	1	3	5	WOODle	7.0b
Pimpinella major	1	1	2	1	1	3	4	4	WOODle	7.0a

Studying this list, the 'Abundance in primary habitat' columns in some cases are indicating meso-habitat attributes. For example the Mires column picks out woodland species that favour wet conditions, e.g., Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* and the category of Skeletal picks out topographic species (the [EAS] ecological attribute of Phase 1.5, see Appendix 01) like Hard Shield-fern *Polystichum aculeatum* and Oak Fern *Gymnocarpium dryopteris*. Although not clearly defined, the former is a high pH species of 7.0a in CPE and an Ellenberg value of 7 from *Plantatt,* whereas the latter is a low pH species 4.5a in *Comparative Plant Ecology* and Ellenberg 4. These are crude measures of habitat preference. Phase 1.5 is more refined and accounts for combinations of attributes that contribute to describing the macro-, meso- and micro-habitat conditions a species may require.

Given the Skeletal attribute there is a likely indication that Hard Shield-fern will not colonise new woods unless there are places with high pH and with sloping topography, even though it is dispersed by spores in the wind. Woods can be relatively wind still, although spores can be washed down vertically in rain as suggested by Bremer (2007). There are no major impediments to spores of these two species getting into new woods certainly within the last 400 years.

The data at Table 109.1 lists only the species from *Comparative Plant Ecology* that have their commonest terminal habitat as woodland. The degree of amplitude of some species can be seen from the affinity with other habitats in the 'Abundance in primary habitats' columns. Most species are rarely found outside their core habitat of woodland. Unfortunately the authors of *Comparative Plant Ecology* do not have hedgerow as an alternative habit. If it did, it is likely that many of the woodland species would also be found in that habitat.

In general there is concordance with the pH of the woods as shown by the 'a' or 'l' suffix, but odd cases of a species supposedly in acid woods with an alkaline pH preference, e.g., *Melampyrum pratense* that is supposed to be an acid woodland species but has a pH preference of 7.0. Or *Iris foetidisimma,* a limestone wood species and a pH preference of 5.5. This crude measure confirms an affinity for woodland and suggests a target pH range for species. Most acid woodland species prefer pHs of 4-6 and limestone wood species 6-7.

What are the dispersal mechanism for ancient woodland indicator species?

The other facet of *Comparative Plant Ecology* is that many species are listed as having agencies of dispersal (see Table 115.2). For the purpose of plants moving into recent woods the most likely methods are expected to be by animals, either adhesive or ingested seeds, and wind dispersal (with the caveat that woods are relatively wind still). Aquatic mechanisms are less likely. The result of the *Comparative Plant Ecology* interrogation indicates that 65 of the species, for which there are accounts, are primarily animal dispersed (12 - adhesive; 5 - burrs; 14 elaiosomes; 29 - ingested; 2 - mucilage; 1 - nut). The UNSP group have unknown dispersal mechanisms or none that are evident but are regarded as being unlikely to be effectively dispersed more than short distances by wind.

The AQAT group can disperse from ancient to recent woods where streams pass from one to the other, or during flooding events (personal observation of Crab Apple *Malus sylvestris* on a flood strand line).

WIND dispersed species total 43 (11 - capsule; 8 capsule/ minute; 16 - minute; 12 - plume; 1 - plumed/ winged; 4 winged).

In the literature review a large number of possible autecological factors were considered that could make a species either a good or poor ancient woodland indicator based on attributes that a species may have that allow it propagate itself and get to a wood, get to the right part, establish and thrive. A good ancient woodland indicator will be one that has difficulty at one, or more, or these stages. A poor ancient woodland indicator would be one that would easily deal with all of these stages and be expected to more easily colonise a new wood. To do so it:

1. Needs to be in the right place geographically and altitudinally.
2. Must be on a suitable soil type/ geology.
3. Can tolerate the level of shade at the new site.
4. Should find the pH equable.
5. Receives the right level of moisture throughout the year.
6. Is able to cope with the possibly high nutrient status at a new site that may have been under arable prior to being planted.
7. Will be able to grow on suitable sloping ground if that is what it needs to be competitive.
8. Needs to be able to tolerate any level of pollution in the current environment.
9. Must find the shelter and atmospheric humidity acceptable.
10. Is able to accommodate the ecological amplitudes that it may experience in term of attributes like changes in light levels or moisture etc.
11. Should have an efficient method of reproduction.
12. Requires a successful pollination mechanism.
13. Would have a suitable dispersal method.
14. Needs to be able to establish new colonies easily - germination, establishment, spread.
15. Should be able to compete with any existing flora.
16. Is able to cope with the stresses of being in a woodland environment.
17. Needs to be able to accommodate any woodland management practices.

A good ancient woodland indicator has difficulty getting from wood A to wood B. Good ancient woodland indicator species are those that are likely to fail on item 13 and may have limited abilities to succeed with items 11, 12, 14, and 15. To persist in an ancient wood a good ancient woodland indicator needs to have items 1-5 and 7-10 acceptable to the species. These need to be available in the new wood as a species may be able to disperse into a new wood, but not establish until conditions become favourable, e.g., weedy grasses die out and the nutrient status falls and competition is reduced. Items 9 and 10 are also relevant if an ancient woodland indicator is to persist during potentially unfavourable periods.

Many ancient woodland indicator species have specific meso-habitat requirements. In some cases more than one. Four of the most important ecological attributes of a meso-habitat are those used in Phase 1.5, viz, Topography [EAT], Shade [EAS], pH [EAP] and moisture [EAM] for items 7, 3, 4 (and 2) and 5 respectively. These are used to create species profiles to define the meso-habitat that a species needs. If that is in the wood, it should be predicted that the species could be present. A typical multi-attribute profile would apply to a species like Oak Fern *Gymnocarpium dryopteris*. In Hackfall Wood and most other places where the author has found it, it is on moderately to steep sloping ground [Eat] to [EAT], in moderate shade [Eas] on acid soils [eap] and free draining [eam]. Combined with the Phase 1.5 habitat codes it would have an profile of

- [BWD] [WGF] [AFL] - [EAT] [Eas] [eap] [eam].

Contrasting with Great Horsetail *Equisetum telmateia* that has a profile of:

- [BWD] [WGF] [BFL] - [eat] [Eas] [EAP] [EAM]

In broadleaved woodland associated with a woodland ground-flora, in a calcareous flush, on gentle slopes, under moderate shade, calcareous conditions and wet soils.

A number of species may have a similar profile and form a SPACES (Species, Position, Abundance and Combination Evaluation System) combination. A damp streamside may have Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Moschatel *Adoxa moschatellina,* Hairy Wood-rush *Luzula pilosa,* Lesser Celandine *Ranunculus ficaria,* Ramsons *Allium ursinum,* and Wood Anemone *Anemone nemorosa*. Such a combination would have a SPACES signature of [SPC], Species, Position and Combination or [SPAC] if the species were at identifiable abundances.

There are basically two groups of ancient woodland indicator species, the *generalists* that are species with wide tolerances and are able to colonise most parts of a wood and the *specialists* or species with more defined autecological requirements. The aim of this part of the research is to consider applying a weighting to a species based on any attributes that create a difficulty in the species getting from donor site A[12] to wood B. Some of the aspects listed 1-17 above have published information that can be used to categorise a species as, say producing only small amounts of low viability seed (Items 11 and 12) or have seeds that do not have an effective dispersal mechanism over the distances likely to be involved in getting to wood B (Item 13).

Conceptually, within the time frame of the last 400 year limiter to the cut-off date of 1600 each item can be either a major significant or a minor impediment. Assuming that, over that period, a plant produces some seeds or spores then it is likely that the

[12] Bearing in mind that 'A' might not be an ancient wood but a scruffy part of landscape that has the donor species still present.

impeding parts are the dispersal and establishment phases. The most likely impediment is the ability to disperse, with the caveat that it may not be possible to determine if the conditions at the new wood are favourable i.e., the soil micro-flora and nutrient status may not have had time to develop to a point where ancient woodland indicator species find conditions acceptable.

The table at Table 115.2 lists the dispersal methods adopted by the woodland species from the Glaves *et al.* (2009a) list. Many species unfortunately have an unspecified method. The two main methods for consideration are animal and wind.

Unless there is water movement between A and B then the species with Aquatic (AQUAT) as their mode of dispersal are likely to have dispersal as a major impediment and could potentially be regarded as very good ancient woodland indicators.

Considering the ANIM group of species there may be subtle differences between the animal vector, whether it is a bird or mammal, how big, which species etc., but essentially any form of ANIM (burr, adhesive or ingested) is likely to offer successful dispersal when considering probability over the last 400 years (see Moussie, Lengkeek and Van Diggelen 2005). The only mode less likely to be successful are the ANIMe group that rely on ants and should only be able to move short distances. This would make these good ancient woodland indicators.

Within the WIND group the most likely mode would be the minute form as they will potentially cover large distances. When they arrive at the new wood their penetration will be retarded by the shelter woods offer and the drop in wind speed into the centre (see Bremer 2007).

Table 115.2 - List of ancient woodland species from the list by Glaves *et al.* (2009a) that have entries in *Comparative Plant Ecology* for their mode of dispersal.	
ANIM +: a = adhesive: b = Burr: c = Capsule: e = Elaiosomes: i = Ingested: ie = ingested/ elaiosomes: m = Mucilage: n = Nut: WIND +: c = capsule; m = minute: p = plume; pw = plumed/ winged; w = winged. UNSP: unlikely to be wind dispersed AQUAT: aquatic	
Taxon name	Agency of dispersal
Agrimonia procera	ANIMb
Ajuga reptans	ANIMe
Anemone nemorosa	ANIMa
Arctium minus	ANIMb
Arum maculatum	ANIMi
Brachypodium sylvaticum	ANIMa
Bromopsis ramosa	ANIMa
Ceratocapnos claviculata	ANIMe
Circaea lutetiana	ANIMb
Cornus sanguinea	ANIMi
Corylus avellana	ANIMn
Daphne laureola	ANIMi
Deschampsia flexuosa	ANIMa
Elymus caninus	ANIMa
Euonymus europaeus	ANIMie
Festuca gigantea	ANIMa
Fragaria vesca	ANIMi
Galium odoratum	ANIMb
Geranium robertianum	ANIMa
Geum rivale	ANIMa
Geum urbanum	ANIMa
Hedera helix	ANIMi
Holcus mollis	ANIMa
Hypericum androsaemum	ANIMi
Ilex aquifolium	ANIMi
Lamiastrum galeobdolon	ANIMe
Ligustrum vulgare	ANIMi
Lonicera periclymenum	ANIMi
Luzula pilosa	ANIMe
Luzula sylvatica	ANIMe
Malus sylvestris sens. lat.	ANIMi
Melampyrum pratense	ANIMe
Melica uniflora	ANIMe
Mercurialis perennis	ANIMe
Oxalis acetosella	ANIMm
Paris quadrifolia	ANIMi
Primula vulgaris	ANIMe
Prunus avium	ANIMi
Prunus padus	ANIMi
Quercus petraea	ANIMm
Ranunculus ficaria	ANIMe
Rhamnus cathartica	ANIMi

Table 115.2 - List of ancient woodland species from the list by Glaves *et al.* (2009a) that have entries in *Comparative Plant Ecology* for their mode of dispersal.	
ANIM +: a = adhesive: b = Burr: c = Capsule: e = Elaiosomes: i = Ingested: ie = ingested/ elaiosomes: m = Mucilage: n = Nut: WIND +: c = capsule; m = minute: p = plume; pw = plumed/ winged; w = winged. UNSP: unlikely to be wind dispersed AQUAT: aquatic	
Taxon name	Agency of dispersal
Ribes nigrum	ANIMi
Ribes rubrum	ANIMi
Ribes uva-crispa	ANIMi
Rosa arvensis	ANIMi
Rosa caesia	ANIMi
Rubus fruticosus agg.	ANIMi
Rubus idaeus	ANIMi
Rubus saxatilis	ANIMi
Ruscus aculeatus	ANIMi
Sanicula europaea	ANIMb
Sorbus aucuparia	ANIMi
Stachys sylvatica	ANIMa
Tamus communis	ANIMi
Taxus baccata	ANIMi
Vaccinium myrtillus	ANIMi
Viburnum opulus	ANIMi
Viola odorata	ANIMe
Viola palustris	ANIMe
Viola reichenbachiana	ANIMe
Viola riviniana	ANIMe
Adoxa moschatellina	WINDw
Athyrium filix-femina	WINDm
Blechnum spicant	WINDm
Calamagrostis canescens	WINDp
Calamagrostis epigejos	WINDp
Calluna vulgaris	WINDcm
Campanula latifolia	WINDc
Campanula trachelium	WINDc
Carpinus betulus	WINDw
Cirsium heterophyllum	WINDp
Clematis vitalba	WINDp
Dactylorhiza fuchsii	WINDcm
Dryopteris affinis	WINDm
Dryopteris filix-mas	WINDm
Epilobium montanum	WINDp
Epilobium obscurum	WINDp
Epipactis helleborine	WINDcm
Equisetum fluviatile	WINDm
Equisetum sylvaticum	WINDm
Equisetum telmateia	WINDm
Erica tetralix	WINDcm
Eupatorium cannabinum	WINDp

Table 115.2 - List of ancient woodland species from the list by Glaves *et al.* (2009a) that have entries in *Comparative Plant Ecology* for their mode of dispersal.	
ANIM +: a = adhesive: b = Burr: c = Capsule: e = Elaiosomes: i = Ingested: ie = ingested/ elaiosomes: m = Mucilage: n = Nut: WIND +: c = capsule; m = minute: p = plume; pw = plumed/ winged; w = winged. UNSP: unlikely to be wind dispersed AQUAT: aquatic	
Taxon name	Agency of dispersal
Gnaphalium sylvaticum	WINDp
Gymnocarpium dryopteris	WINDm
Humulus lupulus	WINDw
Hypericum hirsutum	WINDc
Hypericum maculatum	WINDc
Hypericum perforatum	WINDc
Hypericum pulchrum	WINDc
Hypericum tetrapterum	WINDc
Listera ovata	WINDcm
Lychnis flos-cuculi	WINDc
Neottia nidus-avis	WINDcm
Ophioglossum vulgatum	WINDm
Orchis mascula	WINDcm
Oreopteris limbosperma	WINDm
Osmunda regalis	WINDm
Phegopteris connectilis	WINDm
Phyllitis scolopendrium	WINDm
Polypodium vulgare	WINDm
Polystichum aculeatum	WINDm
Polystichum setiferum	WINDm
Populus tremula	WINDp
Salix cinerea	WINDp
Scrophularia nodosa	WINDc
Sedum telephium	WINDcm
Senecio aquaticus	WINDp
Serratula tinctoria	WINDp
Silene dioica	WINDc
Solidago virgaurea	WINDp
Trollius europaeus	WINDc
Ulmus glabra	WINDw
Valeriana officinalis	WINDpw
Allium ursinum	UNSP
Aquilegia vulgaris	UNSP
Cardamine amara	UNSP
Carex binervis	UNSP
Carex nigra	UNSP
Carex pallescens	UNSP
Carex pendula	UNSP
Carex sylvatica	UNSP
Chrysosplenium alternifolium	UNSP
Chrysosplenium oppositifolium	UNSP
Conopodium majus	UNSP

Table 115.2 - List of ancient woodland species from the list by Glaves *et al.* (2009a) that have entries in *Comparative Plant Ecology* for their mode of dispersal.	
ANIM +: a = adhesive: b = Burr: c = Capsule: e = Elaiosomes: i = Ingested: ie = ingested/ elaiosomes: m = Mucilage: n = Nut: WIND +: c = capsule; m = minute: p = plume; pw = plumed/ winged; w = winged. UNSP: unlikely to be wind dispersed AQUAT: aquatic	
Taxon name	Agency of dispersal
Galanthus nivalis	UNSPc
Glechoma hederacea	UNSP
Hyacinthoides non-scripta	UNSP
Hypericum humifusum	UNSPc
Iris foetidissima	UNSP
Lathraea squamaria	UNSP
Lathyrus linifolius	UNSP
Lithospermum officinale	UNSP
Lysimachia nemorum	UNSPc
Lysimachia nummularia	UNSPc
Lythrum portula	UNSPc
Milium effusum	UNSP
Moehringia trinervia	UNSPc
Molinia caerulea	UNSP
Myosotis scorpioides	UNSP
Myosotis secunda	UNSP
Myosotis sylvatica	UNSP
Narcissus pseudonarcissus	UNSPc
Pimpinella major	UNSP
Poa nemoralis	UNSP
Potentilla sterilis	UNSP
Ranunculus auricomus	UNSP
Rumex sanguineus	UNSP
Stachys officinalis	UNSP
Stellaria holostea	UNSPc
Stellaria neglecta	UNSPc
Stellaria uliginosa	UNSPc
Teucrium scorodonia	UNSP
Thalictrum flavum	UNSPc
Trientalis europaea	UNSP
Veronica chamaedrys	UNSPcw
Veronica montana	UNSPcw
Veronica officinalis	UNSPcw
Vicia sepium	UNSP
Wahlenbergia hederacea	UNSPc
Apium nodiflorum	AQUAT
Berula erecta	AQUAT
Caltha palustris	AQUAT
Carex acuta	AQUAT
Carex acutiformis	AQUAT
Carex elata	AQUAT
Carex laevigata	AQUAT

Table 115.2 - List of ancient woodland species from the list by Glaves *et al.* (2009a) that have entries in *Comparative Plant Ecology* for their mode of dispersal.	
ANIM +: a = adhesive: b = Burr: c = Capsule: e = Elaiosomes: i = Ingested: ie = ingested/ elaiosomes: m = Mucilage: n = Nut: WIND +: c = capsule; m = minute: p = plume; pw = plumed/ winged; w = winged. UNSP: unlikely to be wind dispersed AQUAT: aquatic	
Taxon name	Agency of dispersal
Carex paniculata	AQUAT
Carex pseudocyperus	AQUAT
Carex remota	AQUAT
Carex riparia	AQUAT
Iris pseudacorus	AQUAT
Lycopus europaeus	AQ/AN
Lysimachia vulgaris	AQUATc
Myosotis laxa	AQUAT
Oenanthe crocata	AQUAT
Ranunculus flammula	AQUAT
Rorippa palustris	AQUAT

The light environment

The light environment of a woodland can produce conditions where flowering and seeding is suppressed. It is well documented that Bluebell *Hyacinthoides non-scripta* has a flush of growth and flowers extensively following coppice harvesting and there is a decline as the coppice re-grows and establishes a shading canopy again. Bluebell does flower under canopy expansion, but this evidence suggests it has a tendency to be more shade intolerant than other species, such as Dog's Mercury *Mercurialis perennis*. This species is more shade tolerant and will flower during tree canopy expansion and show no obvious suppression. A phenological study was done in two woods, taking frequent panoramas for a year to record the timing of ground flora emergence and decline and the development of the overbearing tree canopy (see also Salisbury 1916). Two woods were selected, Scalibar Wood and Tickhill Wood between Little Ribston and Knaresborough. The former in on the Ancient Woodland Inventory and the latter is not (see Figure 121.23).

The two woods are different in their ground floras. Scalibar Wood is dominated by Ramsons *Allium ursinum* and Tickhill contains a more typical mixed woodland ground flora of Dog's Mercury *Mercurialis perennis*, Wood Avens *Geum urbanum* Remote Sedge *Carex remota* Wood False-brome *Brachypodium sylvaticum*, Bluebell *Hyacinthoides non-scripta*, Wood Melick *Melica uniflora*, Bugle *Ajuga repens*, Wood Millet *Milium effusum*, Wood speedwell *Veronica montana* and Common dog-violet

Viola riviniana. Both woods have similar canopies that cast moderate shade, comprising Sycamore *Acer pseudoplatanus* and Ash *Fraxinus excelsior*. The trees are even aged, implying a single planting or regeneration probably in the case of Tickhill Wood.

The photography created a series of images that can be stitched together to make panoramas. The method is described at Appendix 07 along with the example panoramas (Appendix 07, Figure 4.3 and Figure 5.4) and photographs for Sites 1 and 3 (Appendix 07, Figure 6.5 to Figure 14.38), Site 1 being part of Scalibar Wood (Site 2 is in Scalibar wood some 20m from Site 1 where Ramsons were slightly more dense) and Site 3 is in Tickhill Wood. No rigorous survey or assessment was made apart from recording each panorama location as a standing quadrat using the WOODS (Woodland Overview and Objective Description System) method. There was no obvious difference in the intensity of canopy cover at the two sites from the azimuth photographs and there are no obvious differences in woodland conditions to explain the gross difference in floras. The MAGIC map indicates that Tickhill wood is coniferous. This is not correct. It has a few remaining European Larch *Larix kaemferi* in the canopy, but it is essentially a deciduous woodland at present. The levels of shading are similar, but the floras are different. Both are on the same soil series, although there must be some local effects of the overlying drift at Tickhill, but Scalibar is level and wet and Tickhill, level and relatively dry. An initial impression would favour classing Tickhill as the ancient wood and Scalibar as recent.

Although the light environment can impact on flora this exercise demonstrated that other factors control the species beneath essentially identical light environments. Both woods would have different Phase 1.5 profiles for their meso-habitat content (red are the significantly different elements of the profiles). See Appendix 01 for codes and Appendix 02 (Figure 5.2) for SSACFOR values

1. Scalibar - [BWD-S6] [SSC-F3] [BSC-O2] [WGF-A5] [BRY-A1] [BGRA1][- [eat-Ø] [Eas-Ø] [Eap-Ø] [**EAM-Ø**]
2. Tickhill - [BWD-S6] [SSC-F2] [BSC-A1] [WGF-A5] [BRY-A1] [BGR-A1] - [eat-Ø] [Eas-Ø] [Eap-Ø] [**eam-Ø**]

The survey data from the woodland surveys noted the percentage of total canopy cover, and the components, how much tree canopy was conifer and broadleaved cover and the shrub and field layer covers. Where relevant these are referred to in the appropriate section. Shading has an important impact on the flora beneath. The impact of shading is considered further in the discussion section.

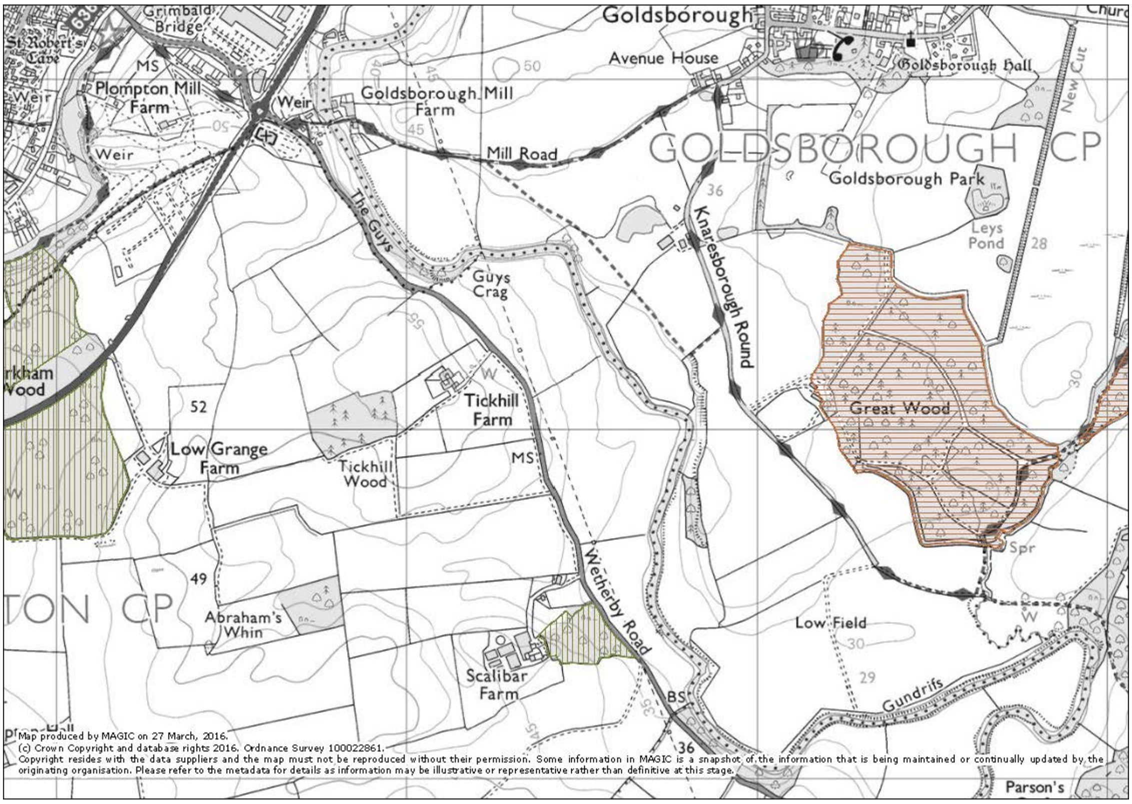


Figure 121.23 - MAGIC map of Scalibar and Tickhill woods. The former being regarded as ancient woodland, being on the Ancient Woodland Inventory from which the latter is omitted.

7.5. Hedgerow Autecologies

With hedgerows the main autecological characteristics of concern are:

1. Can the shrub species easily colonise new hedgerows as suggested by the Hooper rule?
2. Are the species robust enough to persist and compete in an established hedge?
3. What are the characteristics of the woodland ground-flora species of significance which determine their presence, persistence and spread?

Table 123.3 shows the autecological attributes for the hedgerow species from the Hedgerows Regulations (HMSO 1997) indicating their mode of seed/ spore dispersal and their vegetative spread method if one exists. The Ellenberg values are also included. Other species included in surveys for this research are Bramble *Rubus fruticosus*, Bracken *Pteridium aquilinum*, Ivy *Hedera helix*, Black (*Tamus communis*) and White Bryony (*Bryonia dioica*).

The expectation from these data is that animal dispersed seeds are most likely to result in colonisation compared with wind or the short-range possible by elaiosomes - ant dispersed. Once established, vegetative spread is likely to be a reliable if slow process. Additional seeding may continue.

The establishment of species in hedgerows is not well documented. Shrubs are likely to favour establishing in gaps and woodland ground-flora species will require shade establishment. Evidence from this research suggests that a primary colonist of gaps is Bramble *Rubus fruticosus* and some other berry-bearing species like Elder *Sambucus nigra* (See section E1 from the Clifford boundary results section (Appendix 18, Figure 57.57).

Table 123.3 - Hedgerow species autecology table for both shrubs and ground-flora using the eligible species from the Hedgerows Regulations (HMSO 1997).

Seed type is from *Comparative Plant Ecology* and Clonality and Ellenberg values from *Plantatt*.

			Ellenberg values			
Taxon name	Seed	Clonality	Light	Moisture	pH	Nitrogen
Acer campestre	Wind - winged		5	5	7	6
Acer pseudoplatanus	Wind - winged		4	5	6	6
Adoxa moschatellina	Animal - ingested	Rhizome - short	4	5	6	5
Ajuga reptans	Animal - elaiosome	Stolon - long	5	7	5	5
Alnus glutinosa	Wind - winged		5	8	6	6
Anemone nemorosa	Animal - Awn	Rhizome - short	5	6	5	4
Arum maculatum	Animal - ingested	Rhizome - short	4	5	7	7
Athyrium filix-femina	Wind - minute		5	7	5	6
Betula pendula	Wind - winged		7	5	4	4
Betula pubescens	Wind - winged		7	7	4	4
Blechnum spicant	Wind - minute		5	6	3	3
Brachypodium sylvaticum	Animal - Awn	Tussock forming	6	5	6	5
Bromopsis ramosa	Animal - Awn	Tussock forming	4	6	7	7
Bryonia dioica	Animal - ingested		7	5	7	7
Buxus sempervirens			4	4	8	5
Campanula latifolia	Wind - small seed		4	5	7	6
Campanula trachelium	Wind - small seed		4	5	7	6
Carex sylvatica	Unspecified	Tussock forming	4	5	6	5
Carpinus betulus	Wind - winged		4	5	5	6
Circaea lutetiana	Animal - burr	Rhizome - long	4	6	7	6
Conopodium majus	Unspecified		6	5	5	5
Cornus sanguinea	Animal - elaiosome	Suckering from root	7	5	7	6
Corylus avellana	Animal - nut		4	5	6	6
Crataegus laevigata	Animal - ingested		5	5	7	5
Crataegus monogyna	Animal - ingested		6	5	7	6
Cytisus scoparius	Animal - elaiosome		8	5	4	4
Daphne laureola	Animal - ingested		4	5	7	5
Daphne mezereum	Animal - ingested		4	5	7	6
Dryopteris affinis	Wind - minute		5	6	5	5
Dryopteris carthusiana	Wind - minute	Rhizome - short	6	8	5	4
Dryopteris dilatata	Wind - minute		5	6	4	5
Dryopteris filix-mas	Wind - minute		5	6	5	5
Epipactis helleborine	Wind - minute		4	5	7	4
Equisetum sylvaticum	Wind - minute	Rhizome - long	5	8	5	5
Euonymus europaeus	Animal - ingested	Suckering from root	5	5	8	5
Euphorbia amygdaloides	Animal - elaiosome		4	5	6	6
Fagus sylvatica	Animal - nut		3	5	5	5
Festuca gigantea	Animal - Awn	Tussock forming	5	6	7	7
Fragaria vesca	Animal - ingested	Stolon - long	6	5	6	4
Frangula alnus			6	8	5	5
Fraxinus excelsior	Wind - winged		5	6	7	6
Galium odoratum	Animal - burr	Rhizome - long	3	5	7	6
Galium saxatile	Unspecified	Creeping	6	6	3	3

Table 123.3 - Hedgerow species autecology table for both shrubs and ground-flora using the eligible species from the Hedgerows Regulations (HMSO 1997).

Seed type is from *Comparative Plant Ecology* and Clonality and Ellenberg values from *Plantatt*.

			Ellenberg values			
Taxon name	Seed	Clonality	Light	Moisture	pH	Nitrogen
Geranium robertianum	Animal - Awn		5	6	6	6
Geum urbanum	Animal - Awn		4	6	7	7
Hedera helix	Animal - ingested	Creeping stems	4	5	7	6
Hippophae rhamnoides	Animal - ingested	Suckering from root	8	5	7	5
Hyacinthoides non-scripta	Unspecified - capsule	Tuberous	5	5	5	6
Ilex aquifolium	Animal - ingested	Suckering from root	5	5	5	5
Juglans regia	Animal - nut		6	4	8	7
Juniperus communis	Animal - ingested		8	5	5	3
Lamiastrum galeobdolon	Animal - elaiosome	Stolon - long	4	5	7	6
Lathraea squamaria	Unspecified		3	6	7	6
Luzula pilosa	Animal - elaiosome	Tussock forming	5	5	5	3
Luzula sylvatica	Animal - elaiosome	Rhizome - short	5	5	4	4
Malus sylvestris sens.lat.	Animal - ingested		7	5	6	6
Malus sylvestris sens.str.	Animal - ingested		7	5	6	6
Melampyrum pratense	Animal - elaiosome		5	5	2	3
Melampyrum sylvaticum	Animal - elaiosome		4	5	2	2
Melica uniflora	Animal - elaiosome	Rhizome - short	4	5	7	5
Mercurialis perennis	Animal - elaiosome	Rhizome - long	3	6	7	7
Milium effusum	Unspecified	Tussock forming	4	5	6	5
Orchis mascula	Wind - minute		6	5	7	4
Oxalis acetosella	Animal - adhesive mucilage	Rhizome - short	4	6	4	4
Paris quadrifolia	Animal - ingested	Rhizome - long	3	6	7	6
Phyllitis scolopendrium	Wind - minute		4	5	7	5
Poa nemoralis	Unspecified	Tussock forming	4	5	6	5
Polypodium vulgare	Wind - minute	Rhizome - short	5	5	4	3
Polypodium vulgare sens.lat.	Wind - minute	Rhizome - short	5	5	5	3
Polystichum aculeatum	Wind - minute		5	5	7	5
Polystichum setiferum	Wind - minute		4	5	5	6
Populus alba x tremula (P. x canescens)	Wind - plumed	Suckering from root	6	6	6	5
Populus nigra sens.lat.	Wind - plumed	Suckering from root	6	8	7	7
Populus tremula	Wind - plumed	Suckering from root	6	5	5	6
Potentilla erecta	Unspecified		7	7	3	2
Potentilla sterilis	Unspecified	Stolon - short	5	5	5	5
Primula elatior	Animal - elaiosome		4	5	7	6
Primula vulgaris	Animal - elaiosome		5	5	6	4
Prunus avium	Animal - ingested	Suckering from root	4	5	6	6
Prunus padus	Animal - ingested		5	6	6	7
Prunus spinosa	Animal - ingested	Suckering from root	6	5	7	6
Pteridium aquilinum	Wind - minute	Rhizome - long	6	5	3	3
Pyrus communis sens.lat.	Animal - ingested	Suckering from root	7	5	6	7
Pyrus communis sens.str.	Animal - ingested	Suckering from root	7	5	6	7
Pyrus cordata	Animal - ingested	Suckering from root	6	5	5	4
Quercus petraea	Animal - nut		6	6	3	4

Table 123.3 - Hedgerow species autecology table for both shrubs and ground-flora using the eligible species from the Hedgerows Regulations (HMSO 1997).

Seed type is from *Comparative Plant Ecology* and Clonality and Ellenberg values from *Plantatt*.

			Ellenberg values			
Taxon name	Seed	Clonality	Light	Moisture	pH	Nitrogen
Ranunculus auricomus	Unspecified		6	7	6	5
Rhamnus cathartica	Animal - ingested		7	5	7	6
Ribes alpinum	Animal - ingested		5	5	8	6
Ribes spicatum	Animal - ingested		4	6	7	6
Ribes uva-crispa	Animal - ingested		5	5	7	6
Rosa arvensis	Animal - ingested		6	4	7	5
Rosa canina agg.	Animal - ingested		6	5	7	6
Rosa canina sens.str.	Animal - ingested		6	5	7	6
Ruscus aculeatus	Animal - ingested	Rhizome - short	4	5	4	4
Salix caprea	Wind - plumed		7	7	7	7
Salix cinerea	Wind - plumed		7	8	6	5
Salix fragilis	Wind - plumed		6	8	7	7
Sambucus nigra	Animal - ingested		6	5	7	7
Sanicula europaea	Animal - burr	Rhizome - short	4	5	7	5
Sorbus aria agg.	Animal - ingested		6	5	7	4
Sorbus aucuparia	Animal - ingested		6	6	3	4
Sorbus torminalis	Animal - ingested	Suckering from root	4	5	6	5
Tamus communis	Animal - ingested		6	5	7	6
Taxus baccata	Animal - ingested		4	4	7	5
Teucrium scorodonia	Unspecified	Rhizome - long	6	4	4	3
Tilia cordata			5	5	6	5
Tilia platyphyllos			4	5	7	6
Ulex europaeus	Animal - elaiosome		7	5	5	3
Ulex gallii	Animal - elaiosome		7	6	3	2
Ulex minor	Animal - elaiosome		8	6	1	2
Ulmus glabra	Wind - winged		4	5	7	6
Ulmus procera	Wind - winged	Suckering from root	5	5	8	6
Veronica montana	Unspecified - winged	Creeping	4	6	6	6
Viburnum lantana	Animal - ingested		7	5	7	5
Viburnum opulus	Animal - ingested		6	7	6	6
Viola odorata	Animal - elaiosome	Stolon - long	5	5	7	7
Viola reichenbachiana	Animal - elaiosome		4	6	7	5
Viola riviniana	Animal - elaiosome	Suckering from root	6	5	5	4

This table (Table 123.3), along with personal observations from doing hundreds of hedgerow surveys, gives an indication of the status of both hedging shrubs and woodlander ground-flora. Holly *Ilex aquifolium* has had its entry on Table 123.3 altered as it is a species *Plantatt* did not indicate as spreading vegetatively from suckers. A paper by Stokes (2014) describes the invasion of Pacific Northwest forest by this species, including describing its capacity for vegetative spread. This capacity is presented in the hedgerows results section and discussed. The importance of Holly as fodder in the Sheffield area has been reported on by Spray and Smith (1977) and reference to its presence in hedges in Spray (1981). For the case studies, other species were recorded and considered as historic markers in hedgerows, notably:

1. Bramble *Rubus fruticosus*- Animal dispersed ingested seed and tip rooting shoots normally omitted form surveys but considered for this research.
2. Ivy *Hedera helix* - Ingested seed and creeping stems that only flower when growing up through vegetation or other support. Considered in this research.
3. Bracken *Pteridium aquilinum* - a rhizomatous and wind - (minute spores) - spread species that probably has an association with former heathland in a scruffy landscape (see the section on the Clifford Boundary hedge survey Appendix 18, Figure 31.31, 39.39 and 42.42)
4. Black and White Bryony *Tamus communis* and *Bryonia dioica* - ingested berry herbaceous species often found in older hedgerows and requiring further investigation.

7.6. Woodland Survey Results

The woodland survey results are species maps and data tables in the technical appendices. The pertinent findings are referred to in the text. The technical appendices for each woodland case study are:

1. Boston Spa Wood - Appendix 12
2. Church Wood - Appendix 13
3. Ecclesall Woods - Appendix 14
4. Gillfield Wood - Appendix 15
5. Gunter Wood - Appendix 16
6. Hackfall Wood - Appendix 17

Description and Context maps

Context maps are included that show the area surveyed and the node and transect numbers. The lines are labelled with the transect identifier e.g., [BL234-BL257] indicating it runs from node [BL234] to [BL257]

Magic Maps

Extracts from the MAGIC website indicate the extent of any blocks of woodland that are recorded on the Ancient Woodland Inventory.

http://magic.defra.gov.uk/MagicMap.aspx

Meso-Habitats

Phase 1.5 habitat/ feature codes are used to describe the range of meso-habitats and ecologically significant attributes present in each wood surveyed. This adopts the simplified Level 1 that presents an overall assessment for the entire area of woodland surveyed to provide an insight into its character. The current version of the codes is shown at Appendix 01. A more detailed level uses the Phase 1.5 box on the recording form at Appendix 08, Figure 5.2.

Species Maps show:

1. The transect routes – single colour lines fixed line width
2. Quadrat locations – black squares
3. Point record positions – circles
4. Transect Species frequency (one of five line widths) and cover/ abundance (one of five darkness shades of green).
5. Quadrat cover/ abundance combined (one of five red square sizes).

Species data tables in the appendices show:

1. Species recorded using the size-coded binomial abbreviated names. **ACE-CAM** = Field Maple *Acer campestre* as a tree and **Ace-Cam** as a shrub with **ace-cam** representing a seedling.
2. Species recorded along transects – using DDAFOR scale converted to numeric values (1 = Rare, 2 = Occasional, 3 = Frequent, 4 = Abundant, 5 = Dominant). Values of 22 = Occasional plants/ patches and low cover, and 24 would be Occasional plants/ patches and high cover. A transect is defined by the start and end waypoints used during the survey. As many surveys were done, and GPS devices can only record waypoints up to 999, a two-letter sequential prefix was used to provide a unique code for each waypoint.
3. Species recorded from quadrats using cover/ abundance combined (1 = Rare, 2 = Occasional, 3 = Frequent, 4 = Abundant, 5 = Dominant). These use the same unique waypoint numbering system described above.
4. Point records = 9. These use the same unique waypoint numbering system described above.
5. The presence of ecologically significant attributes of BARE ground, BRYOphytes and LITTER.

Botanical data

The key results from the survey data are presented in terms of any relevant SPACES elements they exhibit. For example if a species or a combination is specific to a precise part of the wood (a meso-habitat) at similar levels of abundance this will be described under [SPAC] [S]pecies [P]osition [A]bundance [C]ombination. If it is a species that was confined to precise locations or meso-habitats with no systematic abundance and no discernible association with other species combination, it would be a [SP] species only. If there is no discernible combination of SPACE elements there is no entry.

Evaluation

An evaluation table is included. This takes the species present that are on the Glaves *et al.* (2009a) list (Appendix 03) and uses the converted weighting for fidelity (see Appendix 06) to provide a scoring system for each wood or the meso-habitats within each. This is a percentage fidelity value for ancient woodlands. The sources of these evaluations are Woodland Trust - Northern Ireland (2007), Vickers (2001), Thompson (2003) and Peterken (1974, 2000).

If a species is regarded by at least one author to have a fidelity to ancient woodlands that value, or the highest value (if more than one author regarded the species as an ancient woodland indicator) is used as a weighting for that species. For example, from Appendix 06 Moschatel *Adoxa moschatellina* is regarded as an ancient woodland indicator by Vickers (2001) and Peterken (1974 and 2000) at percentage fidelities of !00%, 70% and 55% respectively. Of these the value of 100% is used. Appendix 06 also includes an average of the values where more than one author is involved. This brings the value for Moschatel down to 75%. Appendix 06 shows some wide ranges of fidelities reported by the different authors. But the fundamental issue is that they have been shown to have an affinity for ancient woodlands. The significance is dealt with in the discussion section. The case study approach has surveyed woods of different sizes and with varying numbers of meso-habitats within them.

The percentage fidelity a species has for ancient woodland is converted to an index value by dividing by 10 (1 = 10% 10 = 100%). Each species is given a score and these are added together to reach the cumulative scores presented. The scores shown at Table 299.20 indicate the cumulative scores for each meso habitat as well as the overall score for the entire woodland. The weighted values when summed are often widely different between woodlands.

The species on the Glaves *et al.* (2009a) list that the four authors do not include are still regarded by at least one respondent to the questionnaire to be an ancient woodland indicator species.

7.6.1. Boston Spa Woodlands.

Description

Boston Spa Wood is north of Boston Spa on the banks of the river Wharfe (see Figure 130.24). They are owned by the local Parish Council and are, in part, on the Ancient Woodland Inventory as shown on the MAGIC map for the Ancient Woodland Inventory records (Figure 131.25). The section at Deep Dale is regarded as Plantation on an Ancient Woodland Site (PAWS). Part of the area to the north of the path down into Deep Dale was not mapped as woodland in 1849. It was partly wooded in 1891, marked as wooded in 1963 and again unwooded to 1991, as shown on the regression at Figure 133.26 to Figure 133.29. The area is currently fully wooded as at Figure 133.28. Transect [CA258-CA289] (Appendix 12, Figure 1.1) was done within the area that has been unwooded in the recent past (Deep Dale north).

This woodland is on a steep-sided bank of the river Wharfe north of Boston Spa at SE425460 (see Figure 130.24). The river has cut through a section of Magnesian Limestone and there are limestone cliffs in places and limestone quarries.

Figure 130.24 - OS location map for Boston Spa Wood (Gunter Wood to the west). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

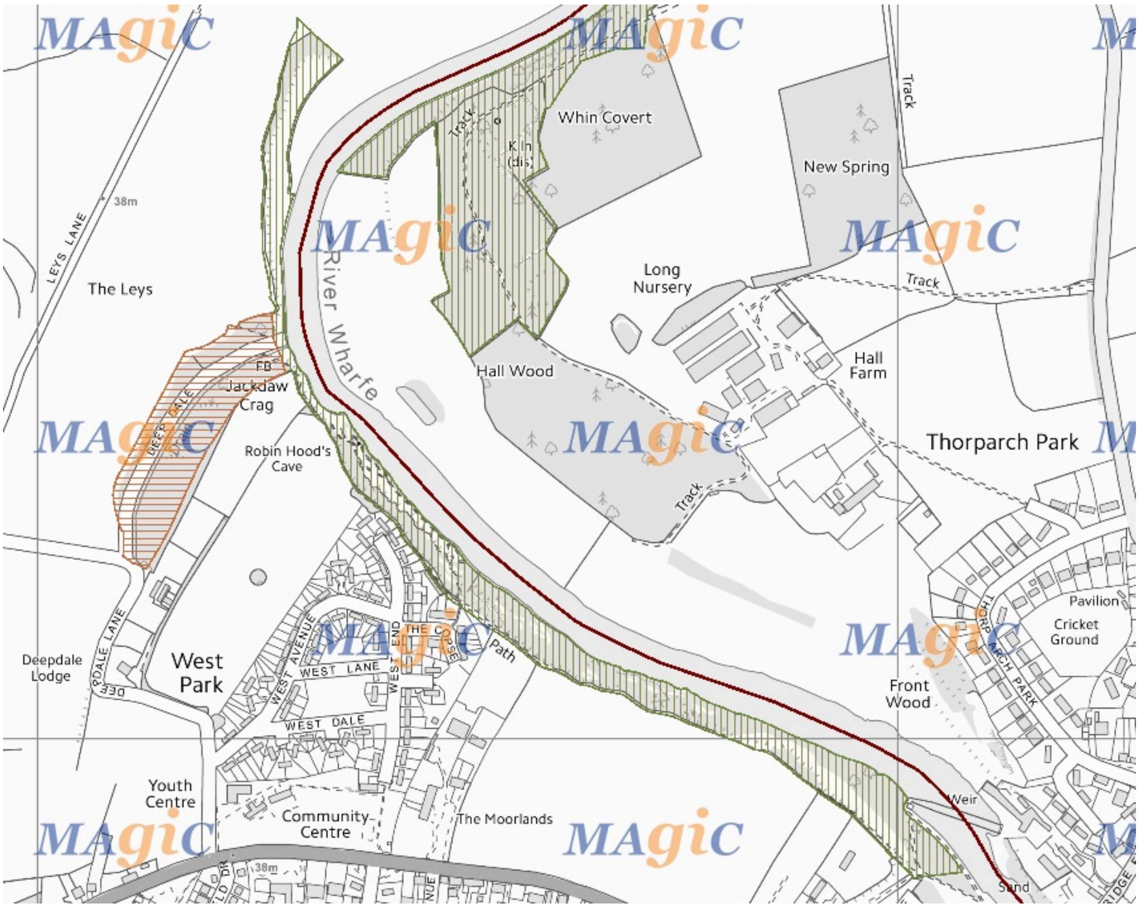


Figure 131.25 - MAGIC website map showing the areas of woodland on the Ancient Woodland Inventory - green vertical hatching = AW and brown horizontal hatching = Plantation on an Ancient Woodland Site (PAWS).

Meso-habitats

The range of meso-habitats in the Boston Spa woodland complex as a whole is shown at Table 132.4 using average values for the entire woodland. See Appendix 01 for codings. and Appendix 02, Figure 5.2 for SSACFOR values.

Table 132.4 - Phase 1.5 codes for Boston Spa Woodlands.		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **Woo****DL**and	**WDL**	S-6
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	S-6
A.2. **SCR**ub	**SCR**	C-2
A.2.1. **S**hrubby **SC**rub	**SSC**	C-2
A.2.2. **B**ramble **SC**rub	**BSC**	O-3
A.6. **W**oodland **G**round **F**lora	**WGF**	A-5
E. Mire		
E.2. **S**pring/ **FL**ush - Sm-Md-Lg: F-S-L	**SFL**	
E.2.2. **B**asic **FL**ush	**BFL**	S-F-0
G. Open water		
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	0-0-F
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	F-0-0
I. Rock exposure and waste		
I.1. Natural		
I.1.1. **I**nland **CL**iff - Sm-Md-Lg: F-S-L	**ICL**	
I.1.1.2. **B**asic Inland **CL**iff	**BCL**	S-F-0
I.2. Artificial		
I.2.1. **QU**arr**Y**	**QRY**	O-1
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	A-2
J.5. Other habitat/ feature		
J.5.3. Leaf **L**i**t**T**e**R/ leaf mould	**LTR**	A-3
J.5.6. **BRY**ophytes	**BRY**	C-3
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	1-3-6
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	1-8-1
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	3-7-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	2-7-1
K.5. **EA** - **A**spect - Compass degrees (270º)	**EAA**	

The majority of this woodland was homogeneous in that it was mainly on relatively sloping ground [EAt-1-3-6] (i.e., 10% gentle or level, 30% moderate and 60% steep). There were a varying number of cliffs [BCL-S-F-0] (some small, a few medium and no large) including the former limestone quarries in various locations.

The remainder of the wood has topographic variations at a small scale that produces a matrix of meso- and micro-habitats having differences in vegetation.

Three main areas were surveyed because of their varying conditions and status. These were Deep Dale north that was un-wooded in recent times, Deep Dale south that is regarded as being a Plantation on an Ancient Woodland Site (PAWS) and the main wood. These are shown on the overview map at Figure 134.30.

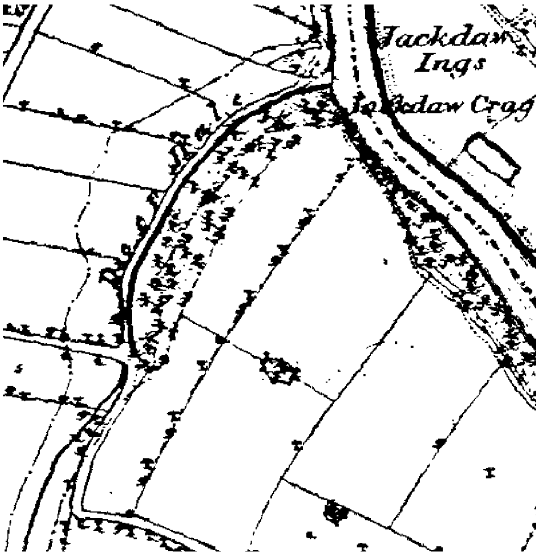


Figure 133.26 - Deep Dale north unwooded in 1849. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1849).

Figure 133.27 - Deep Dale north part wooded in 1891. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1891).

Figure 133.28 - Deep Dale north fully wooded in 1963. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1963).

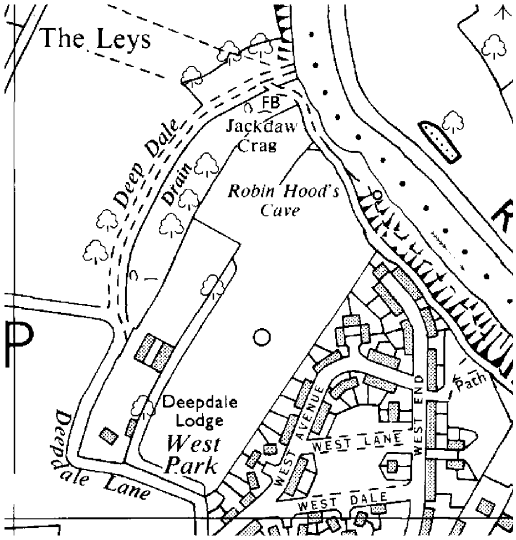


Figure 133.29 - Deep Dale north part wooded in 1991. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1991).

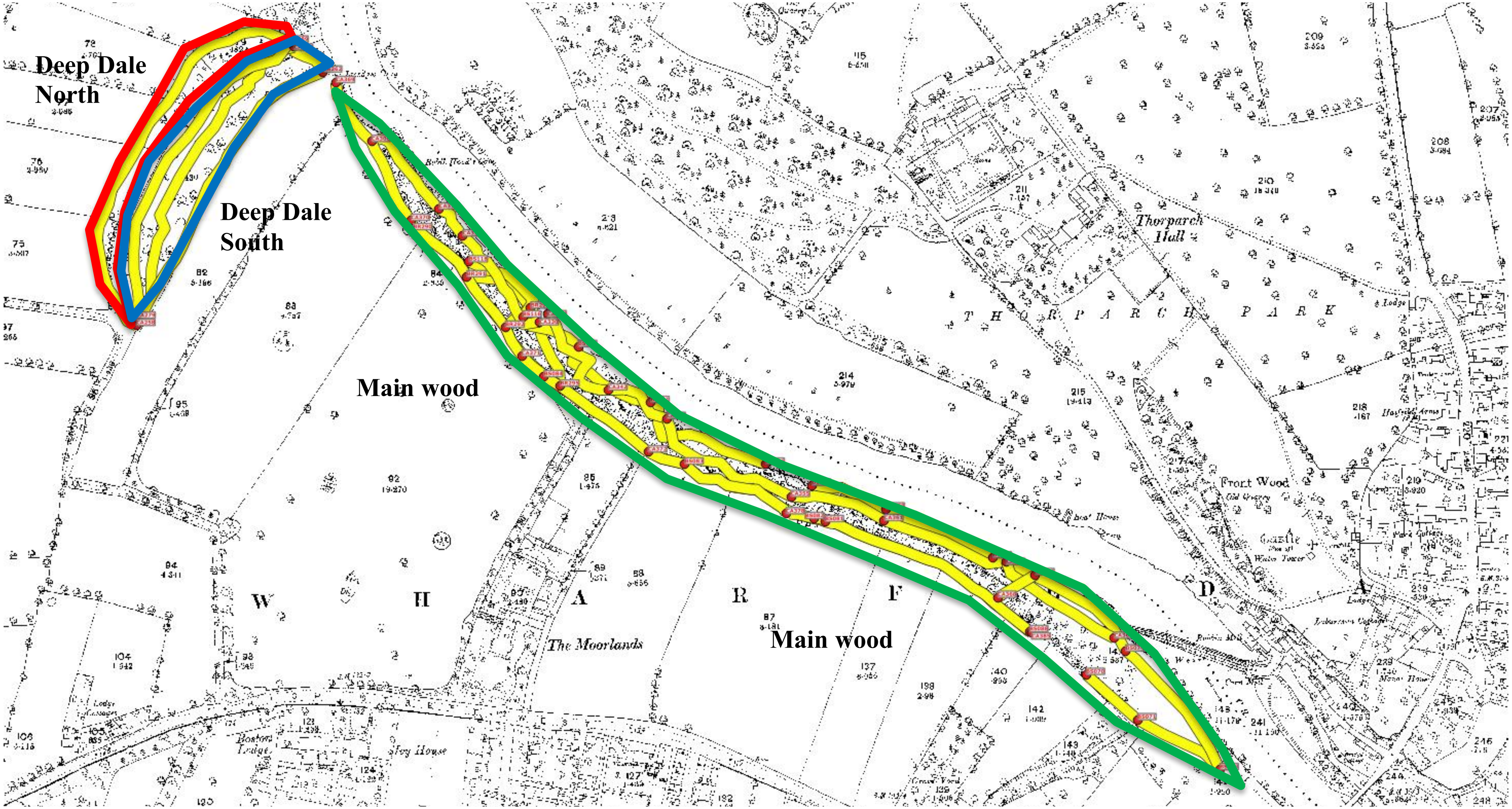


Figure 134.30 - Boston Spa woods showing the transects (yellow) and nodes (red), Deep Dale north area (red outline), Deep Dale south area (Blue outline) and Main wood area (green outline).

Botanical survey results

The species maps are at Appendix 12 and the data are from Appendix 12, Table 52.1.

[S]pecies

These woods contain two local rarities, Baneberry *Actea spicata* and Fingered Sedge *Carex digitata* as shown on the maps at Appendix 12, Figure 4.4 and Appendix 12, Figure 11.11 respectively. Other uncommon and specialist species are Lily-of-the-valley *Convallaria majalis* and Bird's-nest Orchid *Neottia nidus-avis* as shown at Appendix 12, Figure 14.14 and Appendix 12, Figure 31.31 respectively.

[T]ime + [M]anagement

A significant difference is predicted in the vegetation based on the Ancient Woodland Inventory map which indicated that Deep Dale is a Plantation on an Ancient Woodland Site (PAWS). The most northerly transect is along a section which covered an area that was not marked as woodland on early maps.

[S]pecies + [P]osition + [A]bundance

The botanical data supports this as there is a complete lack of Bluebell *Hyacinthoides non-scripta* in Deep Dale North area and although Wood Anemone *Anemone nemorosa* is included it was only recorded as three small patches, each of which was waypointed on the map. Ramsons *Allium ursinum* was similarly present but only as isolated clumps. The lack of other woodland indicator species in any quantity supports the fact that this area was unwooded for periods during the last 100 years. The remainder of Deep Dale woodland, by contrast, has evidence of an ancient woodland ground flora that again supports it being regarded as Planted on an Ancient Woodland Site. Some species have presumably been retained.

The rare species like Lily-of-the-valley *Convallaria majalis*, Fingered Sedge *Carex digitata* and Bird's-nest Orchid *Neottia nidus-avis* are infrequent at the site and are also at low abundance [SPaa][W]. *Neottia nidus-avis* had the Phase 1.5 profile of :

- [BWD-S6] [BGR-A5] - [eat] [EAS] [EAP] [eam]

being found only at the SE end under dense Beech *Fagus sylvaticus* trees. Fingered Sedge *Carex digitata* and Lily-of-the-valley *Convallaria majalis* had profiles of:

- *Carex digitata* [BWD-S6] [WGF-A5] - [EAT] [Eas] [EAP] [eam]
- *Convallaria majalis* [BWD-S6] [WGF-A5] - [eat] [Eas] [EAP] [eam].

The many steep slopes, cliffs and former quarry faces support topographic species like Hart's-tongue Fern *Phyllitis scolopendrium* and Hard Shield-fern *Polystichum aculeatum*, with a Phase 1.5 species profile of:

- [BWD-S6] [WGF-A5] - [EAT] [Eas] [EAP] [Eam]

[S]pecies + [P]osition + [A]bundance + [C]ombination

There are species like Ramsons *Allium ursinum*, Wood Anemone *Anemone nemorosa*, Wood Melick *Melica uniflora*, Wood Meadow-grass *Poa nemoralis*, *Hyacinthoides non-scripta*, *Mercurialis perennis*, Sanicle *Sanicula europaea*, Sweet Violet *Viola odorata* and Common Dog-violet *V. riviniana.* All these are at moderate frequency and abundance.

Evaluation

The summary and evaluation results for Boston Spa woodlands is at Table 137.5. The main area of woodland was undulating, and gently to steeply sloping on Magnesian limestone.

- [BWD] [WGF] [BFL] [RWA] [RWS] [BCL] [BGR] [BRY] - [EAt] [Eas] [EAP] [Eam] [EAA-90].

Although there were local topographic variations and some cliffs [BCL] and quarries [QRY], the whole area was generally similar in character. The two areas that differed were at the northern end which has the area that has had a period of being un-wooded in the last 100 years, and the main part of Deep Dale that is recorded on the ancient woodland inventory as being Planted on an Ancient Woodland Site. These three separate areas are dealt with on the summary table at Table 137.5. These data show that the previously unwooded area contained 13 species regarded as ancient woodland indicators and having a combined weighted score of 110. The remainder of Deep Dale had a total of 21 ancient woodland indicator species and a combined weighted score of 177. The majority of the woodland contained 37 ancient woodland indicator species and these gave a combined weighted score of 334. The entire wood complex has 53 ancient woodland indicator species and an overall total score of 454 (see page 127 section 7.6 Evaluation for an explanation of these scores)

Table 137.5 - Evaluation summary for Boston Spa Wood.

			DD North		Deep Dale South					Main wood																																			
Species	Max % weighting	Average % weighting	CA258-CA289	Score	CA258-CA262	CA263-CA279	CA279-CA289	Count	Score	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118	CA006-CA386	CA262-CA263	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385	Count	Score
Actea spicata	100	100						0								11																												1	10
Ajuga reptans	100	88						0										11																	11									2	10
Allium ursinum	100	79	22	10	11	33		2	10				11	11	22	33	22	44	44						11		33				22	11			22	44	22			11		11	44	17	10
Anemone nemorosa	100	91	33	10	11	33		2	10				11				11		22								33	44	11					11	11		11				11	22		11	10
Arum maculatum	100	84	22	10	11		11	2	10	22		11	11	11	11	22		22		22		22	11	11	22	11	22	22	11	22	33	22	22	11	11		11					11	22	25	10
Brachypodium sylvaticum	100	86	22	10				0		22	22	22	22			22	33		22	33	33		11				11									22		22						13	10
Bromopsis ramosa	83	73						0								11	22																											2	8
Carex digitata	100	100						0																										11										1	10
Carex sylvatica	100	82						0														11																						1	10
Circaea lutetiana	85	85						0						22	22	33	22	33																		11								6	9
Conopodium majus	100	93	11	10				0																													11					11		2	10
Corylus avellana	100	81						0																11	11										11			22				22		5	10
Cornus sanguinea	75	73	11	8			11	1	8																				11									11			11	11		4	8
Dryopteris filix-mas	79	79					11	1	8			11	11	11				11					11	22	11	11					22	22	11		11									12	8
Euonymus europaeus	100	81						0																																			11	1	10

Table 137.5 - Evaluation summary for Boston Spa Wood.

			DD North		Deep Dale South					Main wood																																			
Species	Max % weighting	Average % weighting	CA258-CA289	Score	CA258-CA262	CA263-CA279	CA279-CA289	Count	Score	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118	CA006-CA386	CA262-CA263	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385	Count	Score
Geranium robertianum	100	92						0			11																22								11			33		22				5	10
Geum urbanum	81	81	11	8	11	11	11	3	8	22	33	11	22		22	33	22	22		33	44	33			11		22				22					11		44	33	33	33	33		20	8
Glechoma hederacea	63	63			11			1	6									11									11																	2	6
Hedera helix	65	65	33	7	11	44	44	3	7	33	44	44	44	33	44	44	44	44	44	44	44	44	22	33	44	33		33	44	44	33	22	22	33	33	33	22	33	44	33	33	44	33	33	7
Holcus mollis	69	68						0						22		22																												2	7
Hyacinthoides non-scripta	100	80			11	22	11	3	10	11		22	22									22			11	22	33	22		11	22	11					11	11		11		11	11	16	10
Ilex aquifolium	100	76	11	10	11		22	2	10	22	22	22	22										11	22		22	22	11	11	33	22		22	22	11	22	11	22	22	11	22	22		22	10
Lamiastrum galeobdolon	95	89						0																	11	11						11			11			11						5	10
Lonicera periclymenum	100	93						0																					11															1	10
Malus sylvestris sens.lat.	78	73						0																																	11			1	8
Melica uniflora	90	90	22	9			11	1	9		22		22							44		44	11				22			11							22	44	33	22	22	33		13	9
Mercurialis perennis	77	66	33	8	11	33	33	3	8	33	22	33	22	33	22		11	22	33	44		44	22	22	22		44	33	33	33	22	22	22	22	22	22	22	33	33	22	33	33	22	31	8
Neottia nidus-avis	100	93						0													11																					11		2	10
Oxalis acetosella	100	89						0																11																				1	10

Table 137.5 - Evaluation summary for Boston Spa Wood.

			DD North		Deep Dale South					Main wood																																			
Species	Max % weighting	Average % weighting	CA258-CA289	Score	CA258-CA262	CA263-CA279	CA279-CA289	Count	Score	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118	CA006-CA386	CA262-CA263	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385	Count	Score
Phyllitis scolopendrium	100	100						0				11											11	11						11	11	11		11										7	10
Poa nemoralis	80	70	22	8			11	1	8											44	44	44	22	22								11						33	33	33	33	33		11	8
Polystichum aculeatum	100	100						0											11				11	11								11		11	11									6	10
Primula vulgaris	100	87	11	10				0																																				0	
Ranunculus auricomus	80	77	11	8				0																																				0	
Ranunculus ficaria	100	85			11	33		2	10																		33	22			22			11									33	5	10
Ribes uva-crispa	100	100						0					11														11	11																3	10
Rosa arvensis	79	68						0																										11								11		2	8
Rubus fruticosus agg.	60	60	11	6	11	11	11	3	6	22	22	22	11										22	22	22	33	22		11		22	22	22			22	11	33	11		22		33	19	6
Rubus idaeus	80	80						0																											11									1	8
Sanicula europaea	100	79					22	1	10			11	11					11	11	22	33									11				11			11	22			11	22		12	10
Scirpus sylvaticus	0							0										11	11																	11								3	0
Silene dioica	77	77			11			1	8																										11			22						2	8
Sorbus aucuparia	82	82						0					11													11									11									3	8
Stachys sylvatica	83	83						0			11						11																											2	8

Table 137.5 - Evaluation summary for Boston Spa Wood.

			DD North		Deep Dale South					Main wood																																			
Species	Max % weighting	Average % weighting	CA258-CA289	Score	CA258-CA262	CA263-CA279	CA279-CA289	Count	Score	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118	CA006-CA386	CA262-CA263	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385	Count	Score
Stellaria holostea	100	86						0												11																								1	10
Tamus communis	70	64						0																	11					11	11							11						4	7
Viola odorata	70	70	22	7	11	22		2	7																11		22	11			11								11			11		6	7
Viola riviniana	100	90					11	1	10			11	22	11				11	11		22	11	11	11																11				10	10
Total count	48		16					19																																				46	
Total score		420		138					162																																				402

7.6.2. Church Wood

Description

The OS location map for Church Wood is at Figure 141.31. It is SW of Leeds, between Birstall and Gomersal at SE214262.

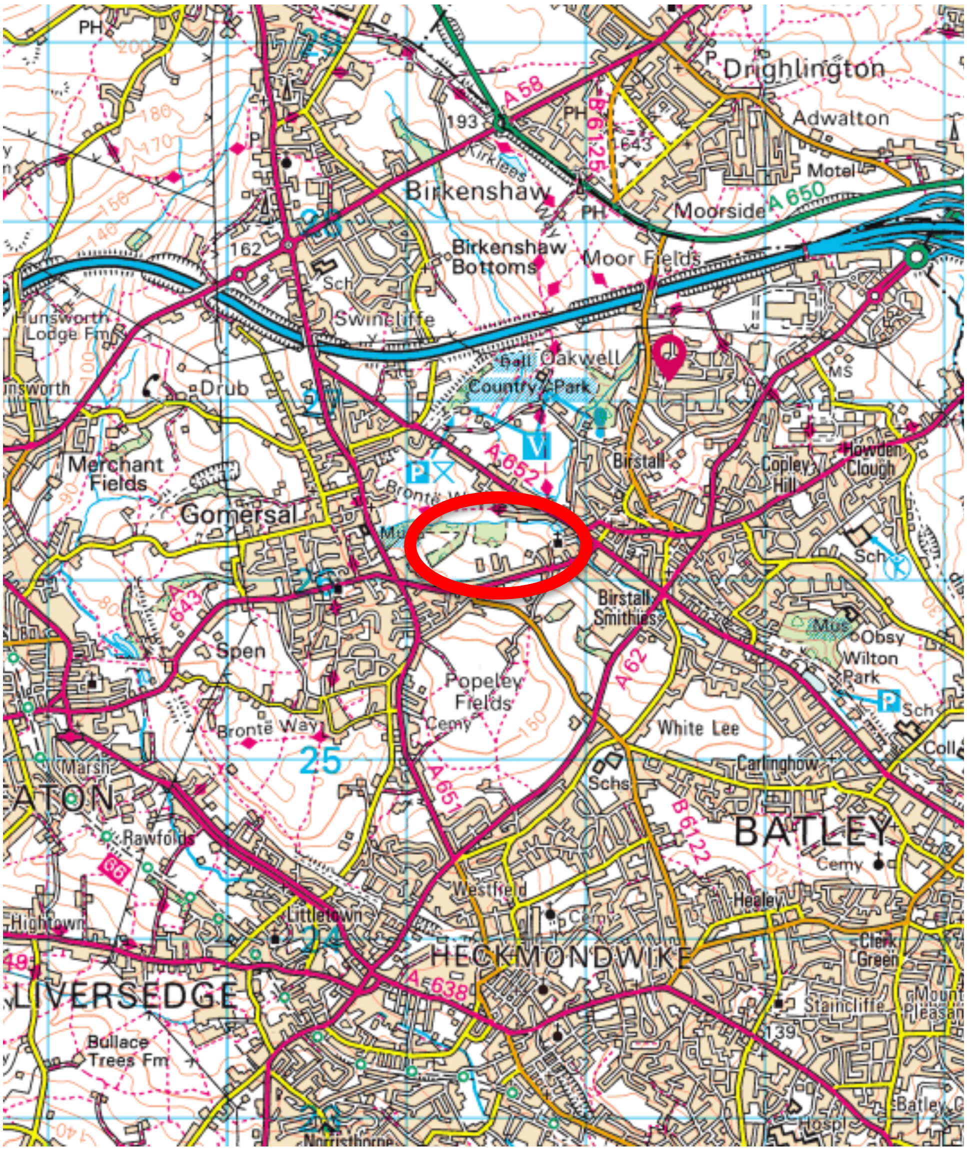


Figure 141.31 - OS location maps for Church Wood (SE214262). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The transects for Church Wood are shown at Figure 142.32. Seven transects were used and nine standing quadrats were surveyed. This wood was studied because it was less than 2Ha and was not considered for the Ancient Woodland Inventory.

This is a small deciduous wood with a generally sloping and undulating topography [CL674-CL678] that becomes a steep slope to the north where it falls away to the Church Beck below where it levels out onto wetter ground than the rest of the wood

[CL669-CL671]. There are two seasonal streams, one to the west [CL671-CL673] and one to the east [CL666-CL668].

Meso-habitats

The range of meso-habitats in Church Wood as a whole are shown at Table 143.6 using average values for the entire woodland.

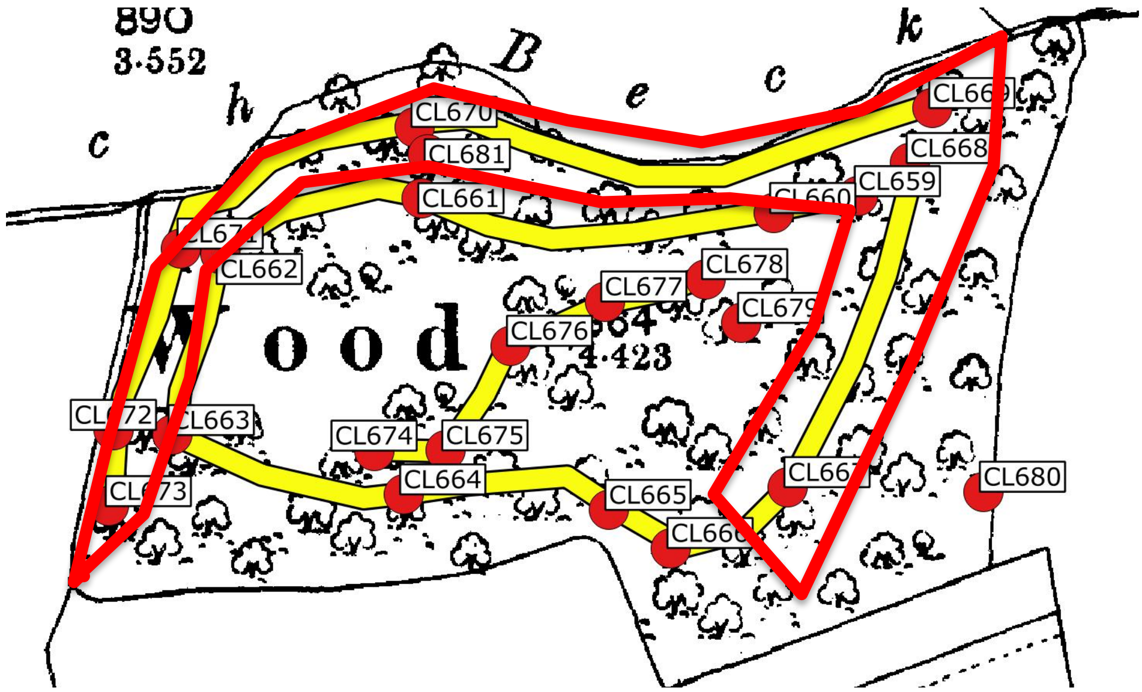


Figure 142.32 – Map of Church Wood showing the transect lines (yellow) quadrat locations (black squares) and transect nodes (red circles). Red outline = wet transects [EAM], rest of the wood drier [eam]. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Table 143.6 - Meso-Habitats for Church Wood, Birstall.		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **Woo**D**L**and	**WDL**	S-6
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	S-6
A.2. **SCR**ub	**SCR**	O-3
A.2.1. **S**hrubby **SC**rub	**SSC**	O-3
A.6. **W**oodland **G**round **F**lora	**WGF**	A-5
G. Open water		
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	0-0-F
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	F-0-0
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	O-2
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	O-2
J.5.6. **BRY**ophytes	**BRY**	O-2
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	5-2-3
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	1-9-0
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	0-10-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	2-6-2

Botanical survey results

The species maps are in Appendix 13 and the data in Appendix 13, Table 15.1. The summary data from the transects from both of these significant meso-habitats is at Table 145.7. This indicates that there were 14 species in the dry habitat [eam] and 22 species in the wet habitat [EAM]. When the weighted scores are applied the total score for the 14 [eam] species is 124 (average 8.86/species) and for the 22 species in the [EAM] areas 193 (average 8.77/species).

[S]pecies + [P]osition

There were a number of high scoring species in the wet [EAM] area that were missing from the dry [eam] transects, notably Wood Melick *Melica uniflora* and Wood Millet *Milium effusum* both score 9 each. Of the 22 species found in the wet [EAM] areas there were eight species that were absent from the dry [eam] transects and there was only one species that was found on the dry [eam] transects that was missing from the wet [EAM] areas, Wood Dock *Rumex sanguinea*.

Of the transects in the wet [EAM] areas, the western valley contains the greatest number of ancient woodland indicator species. This was deeper than the eastern one and had the capacity to have running water on occasions [RWS]. In addition to a number of individual species having a SPACES signature of [SPaA][W], being found is specific parts of the wood at low frequency and high abundance, a number of the species complied with expected Phase 1.5 profiles, notably Wood Melick *Melica uniflora* occurred on the gently sloping banks of the valleys to the west and east that are generally wet in the bottom, but drier on the sides, complying with Oliver Rackham's assertion that this is a wood-bank species. Ramsons *Allium ursinum* favoured damper areas particularly along the main stream side to the north of the wood.

The single record of Gooseberry *Ribes uva-crispa* to the west, near the edge suggests bird dropped seed. A number of respondents to the Glaves *et al.* (2009a) questionnaire discounted species like Gooseberry from their lists unless the plants were found in the middle of the wood, implying that birds are more likely to deposit seeds at the woodland edges. This was also found at Gunter Wood.

Evaluation

There were two meso-habitats surveyed. The expectation that the valleys and the land near the stream would be more species-rich and contain a different range of species proved to be correct.

Table 145.7 - Ancient Woodland Indicator species recorded from Church Wood.

Transects from the dry parts [eam] on the left and the damp seasonal streams and main stream to the right [EAM] with summaries for both meso-habitats based on their weighted scores. Red figures are where the species is present in one meso-habitat but absent elsewhere.

	Dry - [eam] transects									Wet - [EAM] transects				
Species	CL659-CL661	CL661-CL663	CL661-Cl664	CL664-CL666	CL674-CL678	[eam] count	[eam] score	Max % weighting	Average % weighting	[EAM] score	[EAM] count	CL669-CL671	CL671-CL673	CL666-CL668
Allium ursinum	14	22				2	10	100	79	10	3	35	55	22
Anemone nemorosa		11				1	10	100	91	10	2	11		25
Arum maculatum				24		1	10	100	84	10	1			24
Athyrium filix-femina						0		96	96	10	2	22		11
Carex remota	11					1	10	100	86	10	2	11		11
Carex sylvatica						0		100	82	10	1			11
Dryopteris filix-mas					11	1	8	79	79	8	1		11	
Geum urbanum	11	22	22	22		4	8	81	81	8	1			22
Hedera helix					11	1	7	65	65	7	1	24		
Holcus mollis	34	44		44	24	4	7	69	68	7	1			34
Hyacinthoides non-scripta	22	44	33	44	33	5	10	100	80	10	3	34	33	34
Ilex aquifolium	33			22		2	10	100	76	810	3	33	22	22
Lamiastrum galeobdolon		24				1	10	95	89	10	1		24	
Melica uniflora						0		90	90	9	2		14	11
Mercurialis perennis						0		77	66	8	1	24		
Milium effusum						0		100	91	10	1		11	
Oxalis acetosella	11	24	24			3	10	100	89	10	2		24	24
Polystichum setiferum						0		58	58	6	1			11
Prunus avium						0		73	65	7	1		11	
Ranunculus ficaria						0		100	85	10	1			24
Rubus fruticosus agg.	22	22		22	24	4	6	60	60	6	3	22	33	22
Rumex sanguinea		22				1	10	100	100		0			
Stachys sylvatica						0		83	83	8	1		11	
Total count						14					22			
Total Score							124			193				

There were a number of high scoring species in this wood that may suggest parts were probably more wooded in the past even if the whole area was not.

7.6.3. Ecclesall Woods

Description

The location map for Ecclesall Woods is at Figure 147.33. The wood lies to the SW of Sheffield, north of Totley. An overview of the area surveyed and the transects used is at Figure 149.35. Detailed views showing the transect lines (yellow) quadrat locations (black squares) and transect nodes (red circles) are at Appendix 14.

The main focus was the bird sanctuary area that was lacking previous data from the Friends of Ecclesall Woods. An additional transect ran along the Limb Brook. This was to gather additional data to compare with that already collected for the streams that crossed the bird sanctuary area which are a significant meso-habitat within the woods. This is to the south Figure 149.35, in detail as [CB671-CB674] at Appendix 14, Figure 2.2.

There has been extensive work done on the archaeology **in** the wood - human artefacts like former enclosure boundaries, as well as archaeology **of** the wood (Beswick and Rotherham 1999, Clayton 2000, Rotherham 2011) - elements which are there because of the wood, e.g., pit platforms and charcoal hearths.

Figure 147.33 - OS location maps for Ecclesall Woods (SK323824). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The MAGIC map extract showing that the whole of Ecclesall Woods are on the Ancient Woodland Inventory is at Figure 148.34 below.

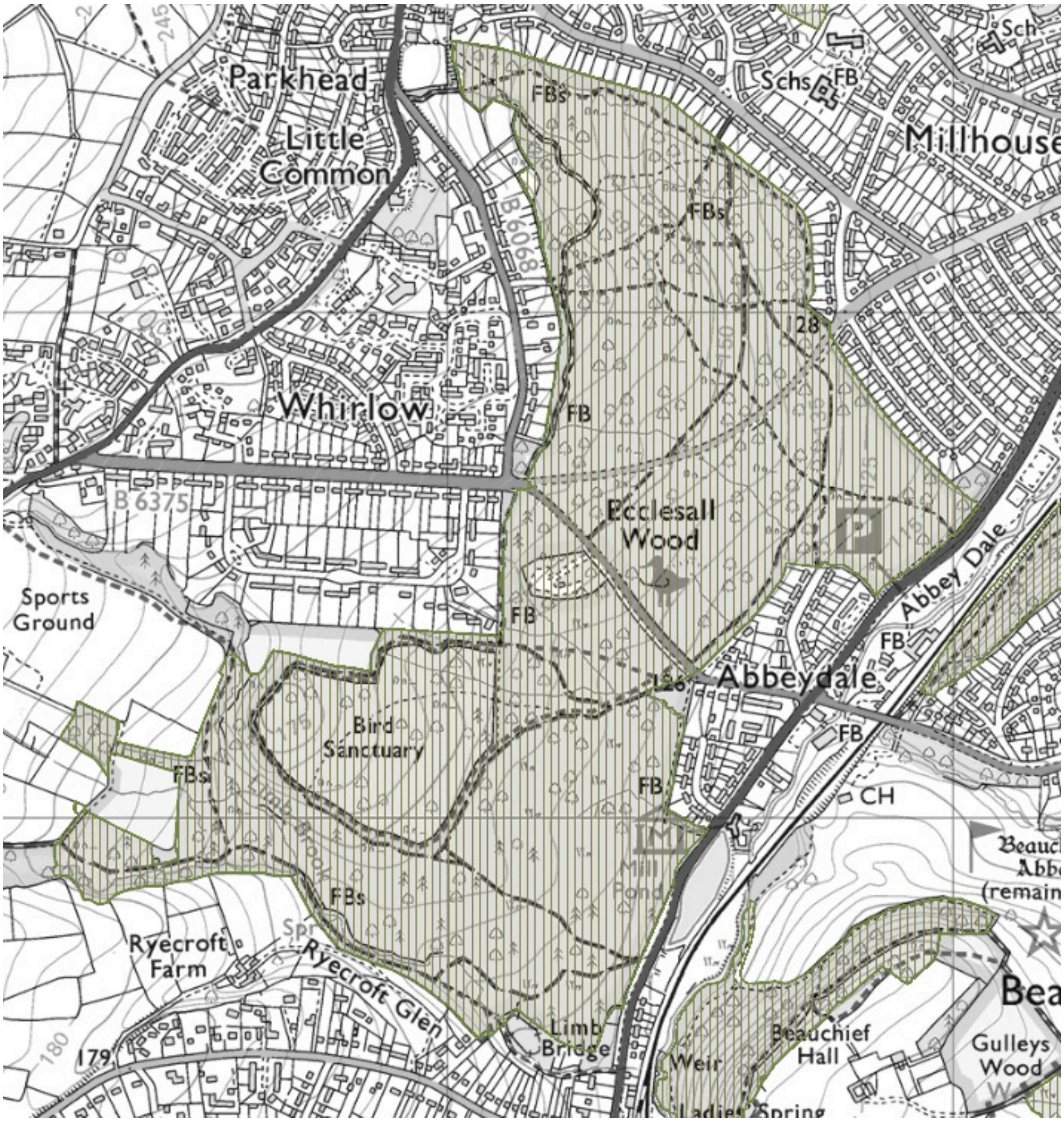


Figure 148.34 - MAGIC map showing that Ecclesall Woods are on the Ancient Woodland Inventory. Note the location of the bird sanctuary area that was surveyed.

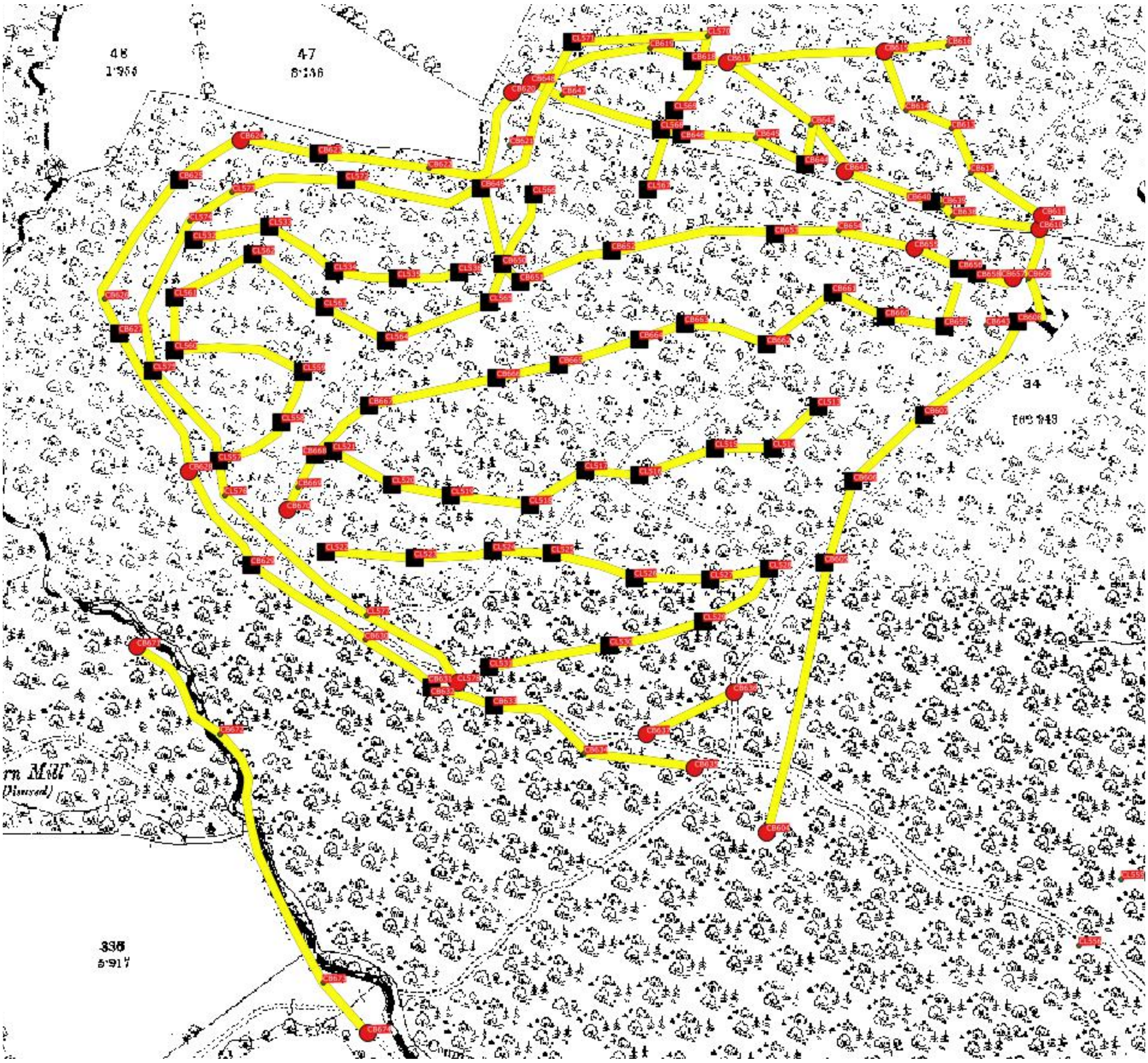


Figure 149.35 - Map of the 'Bird Sanctuary' of Ecclesall Woods showing the pattern of transects (yellow lines) and quadrat locations (black squares) used in the survey. Red lines wet areas [EAM] the rest are drier [eam]. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Meso-habitats

The range of meso-habitats in the Bird Sanctuary area of Ecclesall Woods as a whole are shown at Table 150.8 using Level 1 detail i.e., average values for the entire survey area.

Table 150.8 - Meso-Habitats/ Ecological Attributes for Ecclesall Woods.		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **Woo**D**L**and	**WDL**	A-5
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	A-5
A.2. **SCR**ub	**SCR**	F-2
A.2.1. **S**hrubby **SC**rub	**SSC**	F-2
A.2.2. **B**ramble **SC**rub	**BSC**	O-2
G. Open water		
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	0-F-0
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	F-0-0
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	F-2
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	C-2
J.5.6. **BRY**ophytes	**BRY**	F-2
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	6-3-1
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	2-7-1
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	3-7-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	7-2-1

The survey transects are shown in overview at Appendix 14, Figure 1.1 and in detail at Appendix 14, Figure 2.2 onwards.

Botanical Survey results

The species maps for the Ecclesall Woods surveys are in Appendix 14, and the data in Appendix 14, Table 51.1 onwards. The summary evaluation data are in Table 154.9. These data show that there is a difference between the wet areas surveyed and the drier areas. Within the wetter parts of the wood, there was a total of 40 ancient woodland indicator species with a cumulative weighted score of 359. In the dryer area, there were only 36 ancient woodland indicator species giving a total evaluation score of 311.

[S]pecies + [P]osition

As predicted, there were a number of species that were found in the wetter areas that were not found in the drier parts, notably Ramsons *Allium ursinum,* Wood False-brome *Brachypodium sylvaticum, Cardamine amara,* Pendulous Sedge *Carex pendula,* Giant Fescue *Festuca gigantea,* Yellow Pimpernel *Lysimachia nemorum,* Wood Melick *Melica uniflora,* Dog's Mercury *Mercurialis perennis,* Lesser Celandine *Ranunculus ficaria,* Marsh Valerian *Valeriana officinalis,* Wood Speedwell *Veronica montana* and Common Dog-violet *Viola riviniana.* This Combination [SPAC] represents a richer ancient woodland indicator flora in these areas compared with the general and drier parts of the wood.

[S]pecies + [P]osition + [C]ombination

To emphasise this point, the maps in Figure 151.36 to Figure 153.39 are useful. These show that, not only do the streams have more ancient woodland indicator species on them (Figure 151.36), but also more of the species regarded as having a high fidelity for ancient woodland (Figure 153.39). The thick parallel line round the western side is partly the result of this transect being longer than most and also it crossed some damp areas and picked up some of the species in this combination.

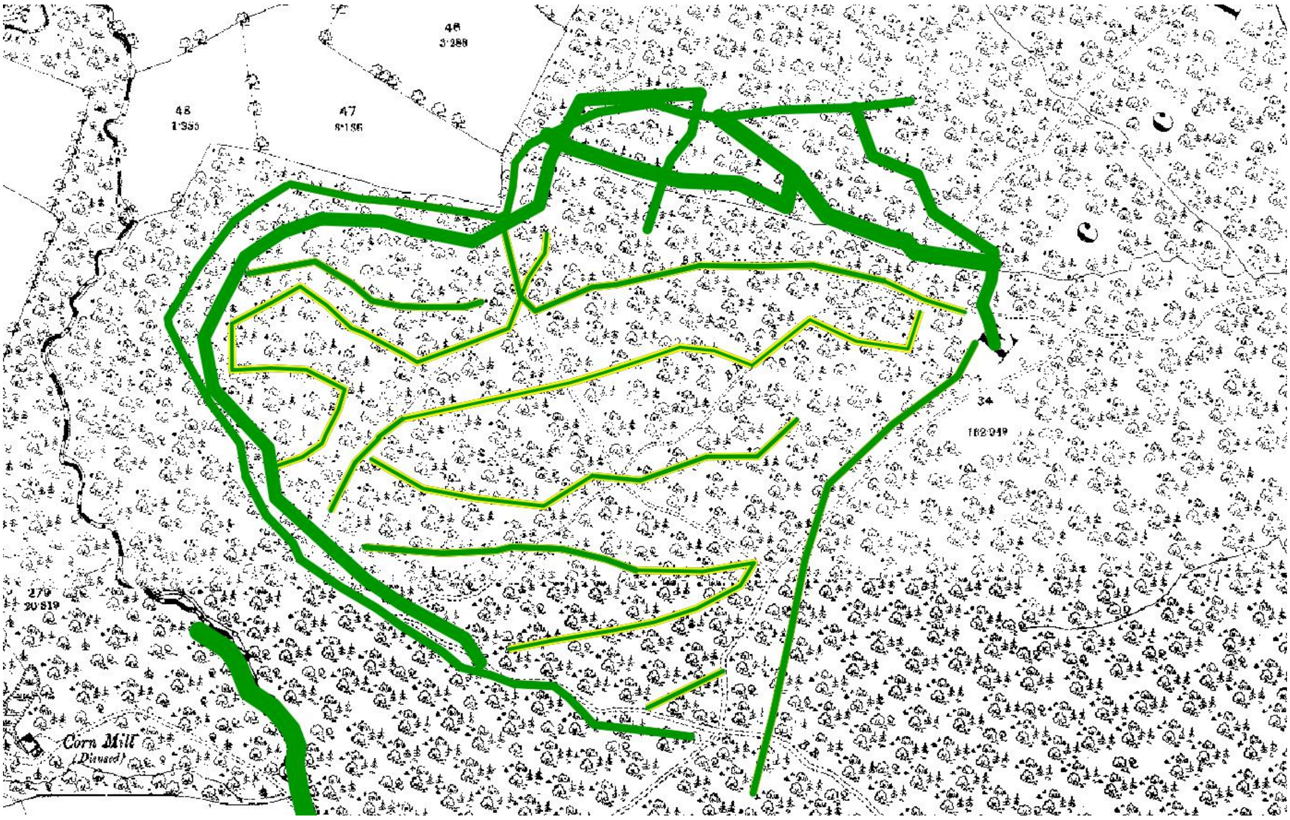


Figure 151.36 - Ecclesall Woods survey area showing transects where the line thickness indicates the total number of ancient woodland species recorded. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

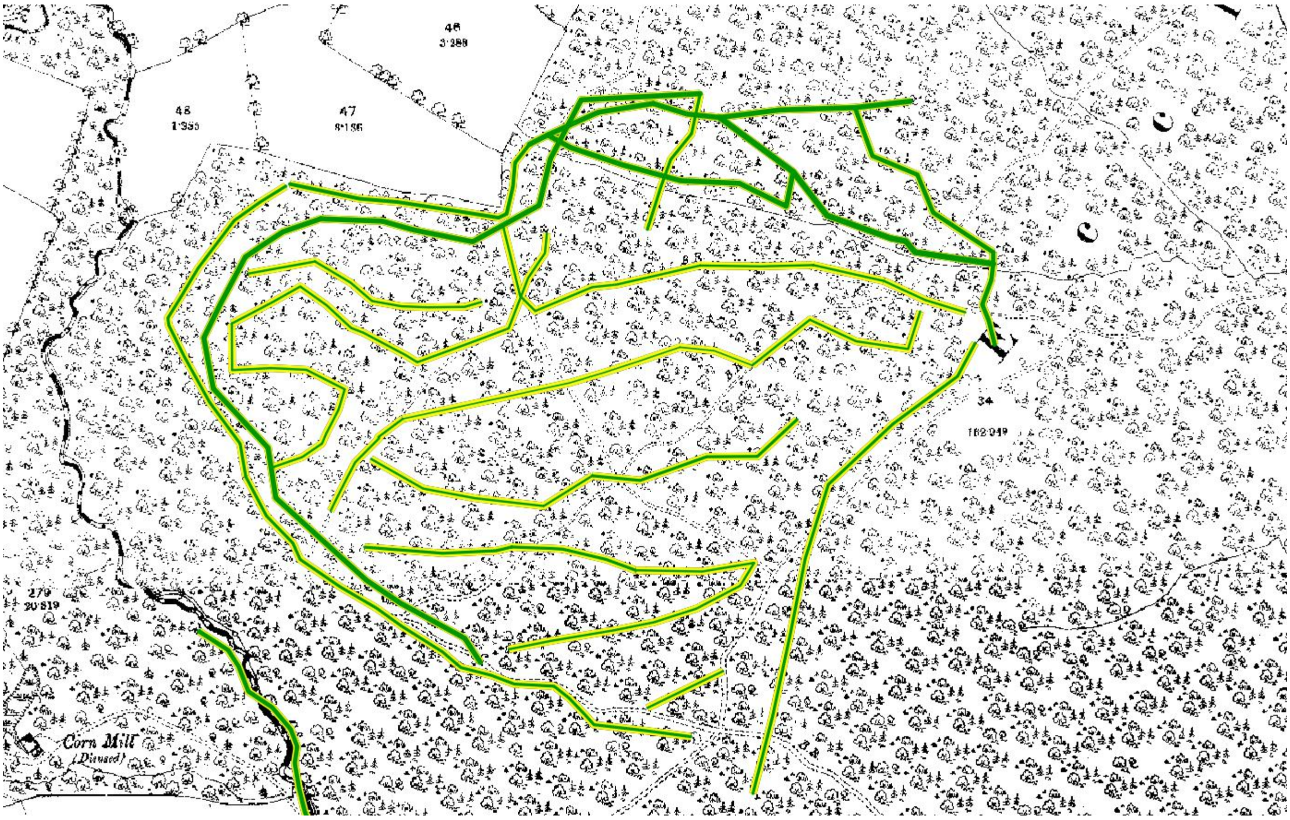


Figure 152.37 - Ecclesall Woods survey area showing transects where the line thickness indicates the number of low fidelity ancient woodland species recorded. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

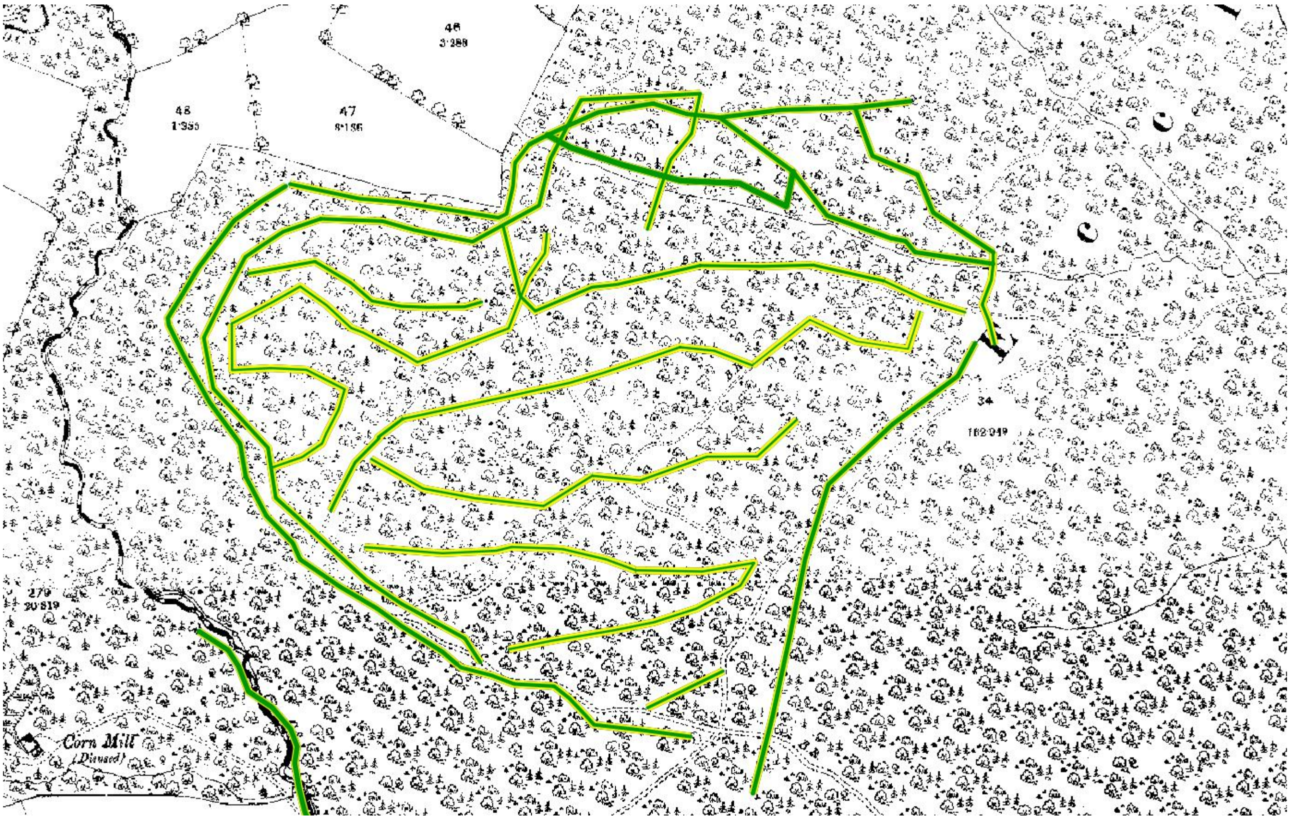


Figure 152.38 - Ecclesall Woods survey area showing transects where the line thickness indicates the number of medium fidelity ancient woodland species recorded. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

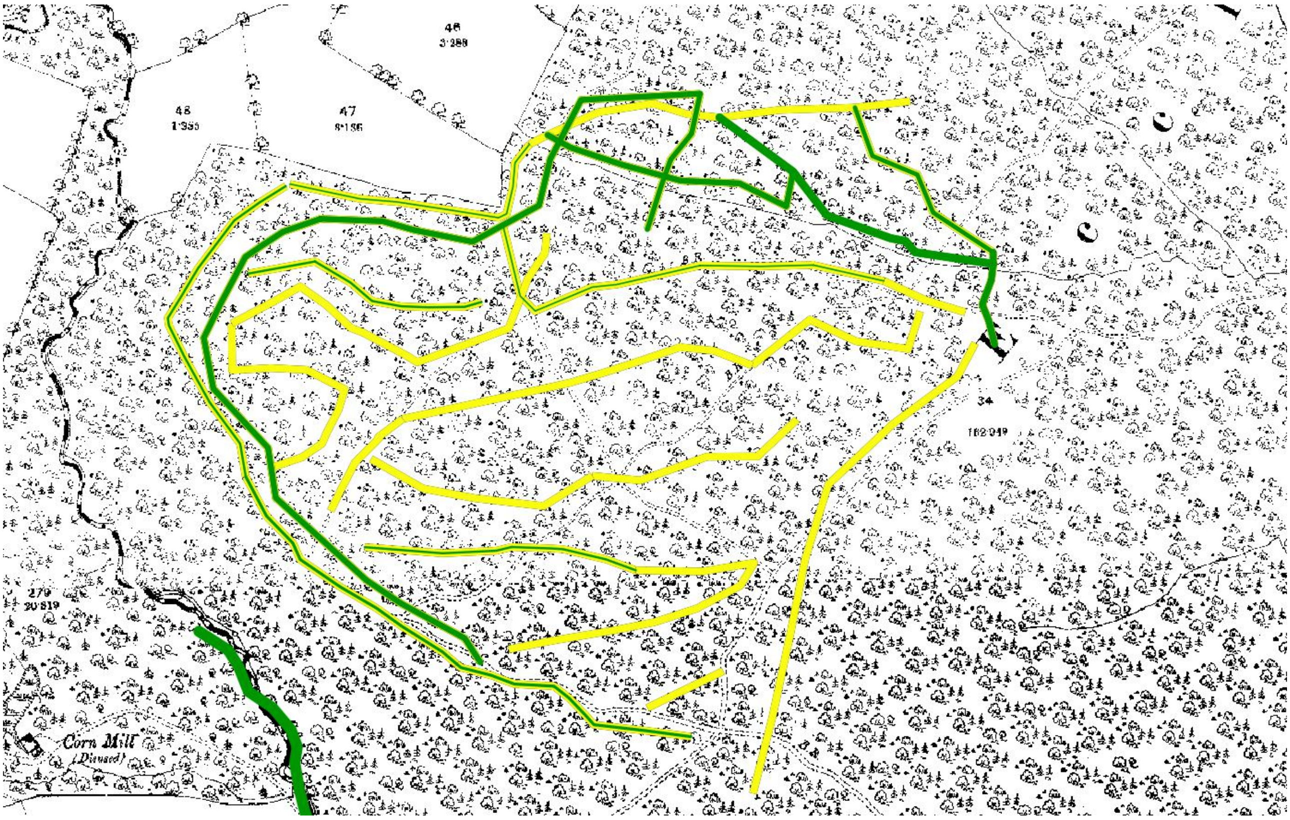


Figure 153.39 - Ecclesall Woods survey area showing transects where the line thickness indicates the number of high fidelity ancient woodland species recorded. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Evaluation

The evaluation table for Ecclesall Woods is at Table 154.9. This shows that the wet areas had 40 qualifying species giving a cumulative total score of 359 with the drier area having 36 species and a score of 311. The range of species in each was predictably different with wetland specialists like *Cardamine amara* and *Carex pendula* restricted to this meso-habitat.

Table 154.9 - Evaluation data for Ecclesall Woods

Red figures are where the species is present in one meso-habitat but absent elsewhere.

			Wet - [EAM] transects					Dry - [eam] transects																								
Species	Max % weighting	Ave % weighting	CB671-CB674	CB610-CB617	CB641-CB648	Count	Weighed score	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667	Count	Weighted score
Allium ursinum	100	79	14			**1**	10																								0	
Anemone nemorosa	100	91	24	22		2	10		11																						1	10
Athyrium filix-femina	96	96	22	22	33	3	10		11	11																					2	10
Blechnum spicant	100	84	11			**1**	10																								0	
Brachypodium sylvaticum	100	86	11		22	**2**	10																								0	
Cardamine amara	100	100	11			**1**	10																								0	
Carex pendula	100	87	14			**1**	10																								0	
Carex remota	100	86	14	22	22	3	10	11	11		11																				3	10
Ceratocapnos claviculata	85	85				0												11													**1**	9
Chrysosplenium oppositifolium	100	81	23	44	33	3	10		11		11																				2	10
Circaea lutetiana	85	85		22	22	2	9	24		11		11		11	11	24	11														7	9
Corylus avellana	100	81		22		1	10	22				11																			2	10
Deschampsia flexuosa	82	82	23			1	8	24		11			11	35				14													5	8
Dryopteris affinis	100	100	11			1	10	22																							1	10
Dryopteris carthusiana	0			11		1	0												11	11											2	0

Table 154.9 - Evaluation data for Ecclesall Woods																																
Red figures are where the species is present in one meso-habitat but absent elsewhere.																																
			Wet - [EAM] transects					Dry - [eam] transects																								
Species	Max % weighting	Ave % weighting	CB671-CB674	CB610-CB617	CB641-CB648	Count	Weighed score	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667	Count	Weighted score
Dryopteris filix-mas	79	79		22	44	2	8	22		22	11	11	11			22	11		14	11											9	8
Epilobium montanum	100	100		11		1	10					11																			1	10
Festuca gigantea	75	75			11	**1**	8																								0	
Geranium robertianum	100	92	11	23	22	3	10	11		11		11				33		15					14								6	10
Geum urbanum	81	81	11	11	11	3	8	11	22	11		11	11	11	11		22		11				11								10	8
Hedera helix	65	65	11			1	7	12							33					11					11		13				5	7
Holcus mollis	69	68	24	34	45	3	7	25	45	33	23	11	11	33	22	44	55	24	24	11	55	44	35	44	22	25	45	35	35	22	23	7
Hyacinthoides non-scripta	100	80	24	33	45	3	10	25	22	22	25	11	11	33	22	45	22	33	13		22	33	34	22	11	23	35	34		33	21	10
Ilex aquifolium	100	76				0		12	11	22	11	11		11	22	11	22	12		33	22	11	11	11	11	13	24	24	33	22	**21**	10
Lamiastrum galeobdolon	95	89	22	33	25	3	10		11		11																				2	10
Lonicera periclymenum	100	93	11			1	10		22	33		11	11	33	22		22			11	22	33									10	10
Luzula pilosa	100	92		22		1	10		11				11																		2	10
Luzula sylvatica	100	96	24			1	10	11					11	24																	3	10
Lysimachia nemorum	100	89			14	**1**	10																								0	
Melica uniflora	90	90	22			**1**	9																								0	
Mercurialis perennis	77	66			12	**1**	8																								0	
Milium effusum	100	91	22	11		2	10	13		11	11				11	11															5	10
Oxalis acetosella	100	89	24	22	34	3	10	14	11	11	11				11																5	10

Table 154.9 - Evaluation data for Ecclesall Woods

Red figures are where the species is present in one meso-habitat but absent elsewhere.

			Wet - [EAM] transects					Dry - [eam] transects																								
Species	Max % weighting	Ave % weighting	CB671-CB674	CB610-CB617	CB641-CB648	Count	Weighed score	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667	Count	Weighted score
Poa nemoralis	80	70		11	22	2	8	14	11	11					11				11												5	8
Ranunculus ficaria	100	85		11		**1**	10																								0	
Rubus fruticosus agg.	60	60	33	22	23	3	6	25	22	33		11	11	33	44	11	33	22	24	33	22	33	33	11	11	35	34	34	33		21	6
Rubus idaeus	80	80				0						11																			**1**	8
Silene dioica	77	77		22	22	2	8		11	11	11							4													3	8
Sorbus aucuparia	82	82	11			1	8	11	11	22		11	11	11		11	11	12	11	22		11			11	12	11	11	22		17	8
Sorbus aucuparia	82	82				0		11			12							12		22			23		11			11			**7**	8
Stachys sylvatica	83	83				0		11				11																			**2**	8
Stellaria holostea	100	86	24	33	24	3	10	14	11																						2	10
Taxus baccata	89	83				0				11						11								11					11		**4**	9
Teucrium scorodonia	82	82				0							11	22																	**2**	8
Ulmus glabra	63	63				0			11							11															**2**	6
Valeriana officinalis	100	88			22	**1**	10																								0	
Veronica montana	100	85	11			**1**	10																								0	
Vicia sepium	92	71				0																	11		11						2	9
Viola riviniana	100	90	11			**1**	10																								0	
Total score							359																									311
Total count						40																									36	

BW PhD - 2016-12-14 - 209.docx

S18

7.6.4. Gillfield Wood

Description

Gillfield Wood is located west of Dronfield and south of Totley. Gillfield Wood was surveyed in collaboration with the friends of Gillfield Wood. This is woodland along a valley with the county boundary between South Yorkshire and Derbyshire, with the Totley Brook down the middle at SK306788. As part of this collaboration, Little Wood to the north was also surveyed. This is not on the Ancient Woodland Inventory.

Only the northern side of the brook on the South Yorkshire side has been mapped as Plantation on an Ancient Woodland Site (PAWS) for the Inventory as shown at Figure 159.41. To the south of the brook there is no inventory designation. There were three areas that were south of the stream, in Derbyshire, that were surveyed as part of this research. The omission of these areas from the ancient woodland inventory was curious and therefore the results of this survey would be of great value in determining whether or not this area should have been included in the inventory or not.

Within the woodland as a whole there was a wide range of meso-habitats present. As the woodland was on a stream valley there were large areas of moderate sloping ground and a number of small seasonally wet streams entered the permanent stream in the bottom of the valley. Adjacent to the main stream there were areas of level ground that were wet in nature. The projection of woodland to the north east of the site was relatively level ground with a small stream running through it. The woodland is essentially deciduous and closed canopy offering moderate amounts of shade over much of the area. The ground flora was typically of a woodland type.

Figure 158.40 - OS location map for Gillfield Wood (SK306788) and Little wood (north of the 7 in 79). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

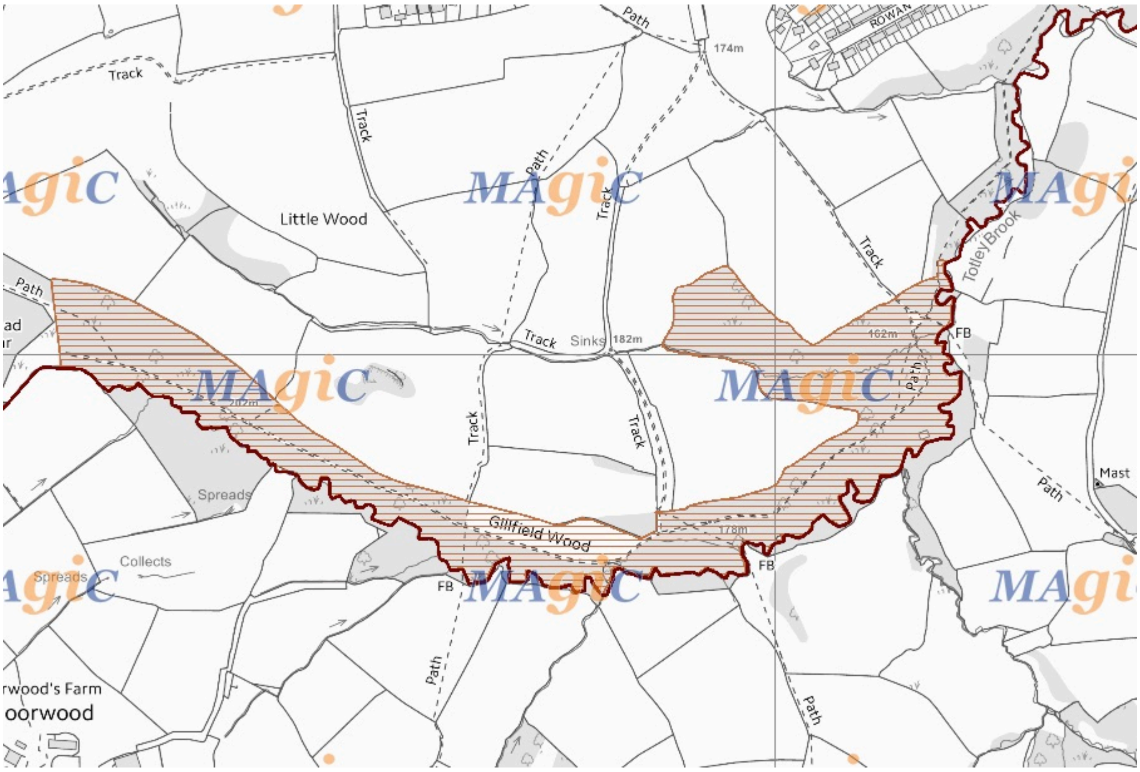


Figure 159.41 - Map extract from MAGIC showing the area of woodland regarded as planted on an ancient woodland site (PAWS) that is indicated as only within the county of South Yorkshire. Little Wood to the NW is not on the Inventory.

Table 159.10 - Meso-habitats/ Ecological Attributes for Gillfield wood.

FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **WooDL**and	**WDL**	A-5
A.1.1. **B**road-leaved **WooD**land	**BWD**	A-5
A.2. **SCR**ub	**SCR**	O-2
A.2.1. **S**hrubby **SC**rub	**SSC**	O-2
A.2.2. **B**ramble **SC**rub	**BSC**	O-2
A.6. **W**oodland **G**round **F**lora	**WGF**	A-4
G. Open water		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	0-F-0
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	F-0-0
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	F-2
J.5. Other habitat/ feature		
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	C-2
J.5.6. **BRY**ophytes	**BRY**	F-2
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	2-7-1
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	1-8-1
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	2-8-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	3-6-1

Little Wood.

Little Wood is a small wood on a west-facing moderate slope that was not regarded as ancient on the Ancient Woodland Inventory. It is south of Totley at SK303791.

This woodland was relatively homogeneous in its ground flora being carpeted almost exclusively by Bluebell *Hyacinthoides non-scripta*. Only on the lower slopes next to the stream was there any significant variation in the ground flora. The western transect followed this meso-habitat.

Table 161.11 - Meso-habitats/ Ecological Attributes for Little Wood.		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **W**oo**DL**and	**WDL**	A-5
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	A-5
A.2. **SCR**ub	**SCR**	O-2
A.2.1. **S**hrubby **SC**rub	**SSC**	O-2
A.2.2. **B**ramble **SC**rub	**BSC**	O-2
A.6. **W**oodland **G**round **F**lora	**WGF**	A-3
G. Open water		
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	0-F-0
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	F-2
J.5. Other habitat/ feature		
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	C-2
J.5.6. **BRY**ophytes	**BRY**	C-1
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	1-8-1
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	2-8-0
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	2-8-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	1-8-1
K.5. **EA** - **A**spect - Compass degrees (270°)	**EAA**	260°

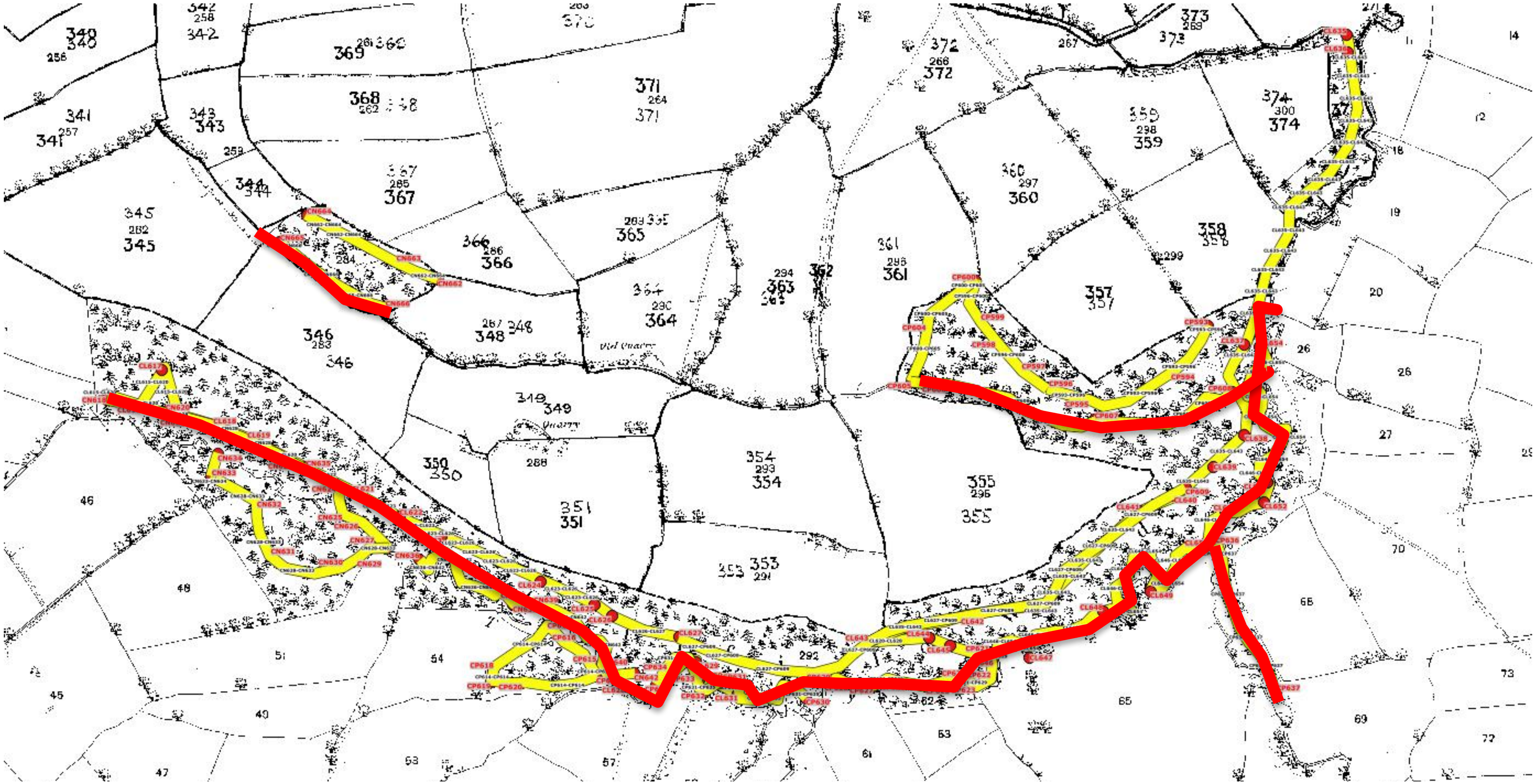


Figure 162.42 – Map of Gillfield and Little Woods showing the layout of the transects and the transect nodes. Red line = wet areas [EAM] the rest were drier areas [eam].

Botanical survey results

The species maps for Gillfield Wood and Little Wood are in Appendix 15, and the data in Appendix 15 from Table 60.1. The data from Gillfield Wood and Little Wood show a less clear difference between the wetter parts and the drier parts in terms of the species compositions.

Gillfield Wood

[S]pecies + [P]osition

The main notable differentiating species that occur in the wetter part, but which do not occur in the drier parts, are Moschatel *Adoxa moschatellina,* Marsh Marigold *Caltha palustris* and Great Hairy Woodrush *Luzula sylvatica.*

There were a number of meso-habitats within Gillfield Wood that contained significant ancient woodland indicator species. One of these was two small wet acidic flush areas down by the stream that supported colonies of the high level indicator

- *Equisetum sylvaticum* [BWD] [WGF] [AFL] - [eat] [EAs] [eap] [EAM].

As this habitat was rare within the woodland the occurrence of this species was also rare and the survey method adopted was able to identify what were probably the only areas of this habitat and species within the woodland complex.

Other species that showed an affinity for a precise meso-habitat preference along the edges of the stream were Sweet Woodruff *Galium odoratum* and Moschatel *Adoxa moschatellina*. These two species were found in irregular patches along the edges of the stream and were often in combinations together.

- [BWD] [WGF] [RWA] - [eat] [EAs] [EAM].

Two fern species which were found in predicted meso-habitats were Hard Fern *Blechnum spicant* and Soft Shield-fern *Polystichum setiferum.*

- [BWD] [WGF] [RWA+S] - [EAt] [EAs] [eap] [Eam].

These were found very rarely, and on the steep sides of the ditches and streams and other near-vertical situations.

Gooseberry *Ribes uva-crispa* was predictably found near the woodland edge (see Appendix 15, figure 47.47) in keeping with other records made by the author and data presented in this thesis.

It was also interesting to note that the stream is an administrative boundary. This meant the northern part was assessed by the local ecologists devising the Ancient Woodland Inventory as being ancient woodland but the southern side was regarded as such from the Derbyshire research into its history. The data obtained during the surveys indicates that the north and south sides of the stream are of similar character and both contain a wide range of ancient woodland indicators. There is no botanical reason to suspect that the woodland to the south is in any way different in origins from the area to the north. An example is shown on the map for Sweet Woodruff *Galium odoratum* (see Figure 164.43) that was found on both sides of the stream, although it is absent from drier and more level ground.

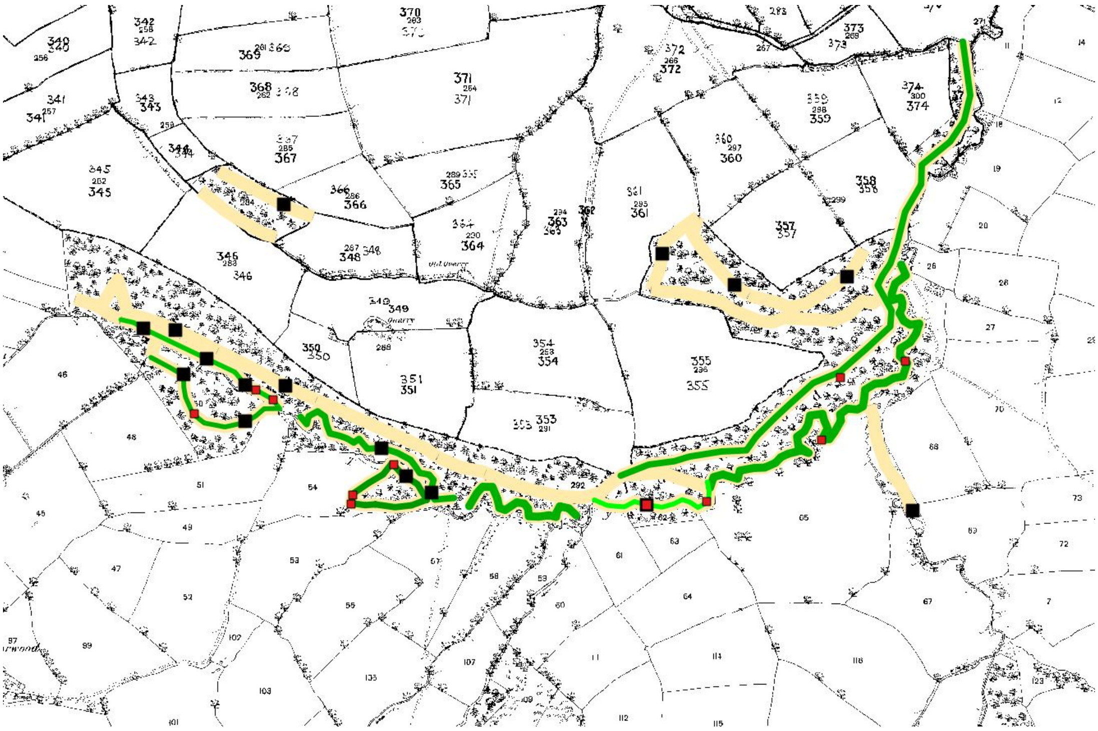


Figure 164.43 - Map of Gillfield Wood showing the distribution of Sweet Woodruff *Galium odoratum* on both sides of the Brook, but largely missing from the drier parts to the north and from the extension west (towards the north) that was on relatively level ground. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Little wood

Other features of note in these data are that the two transects that were in Little Wood were predictably very poor in the number of ancient woodland indicator species. There were only five and six species along each of the transects. This compares with the general level of species found on transects which tended to be in the mid to late teens and into the mid-twenties. As this wood is not on the ancient woodland inventory the botanical data supports the supposition that this wood is likely to be recent in origin.

[S]pecies + [P]osition

In terms of the species that Little Wood contained, the transect next to the stream [CN665–CN666] contained more species with a high fidelity for ancient woodland than the transect [CN662-CN664] that ran across the upper and drier part of the steep slope within this woodland. Of particular note, were Remote Sedge *Carex remota* and Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* that were not only better quality indicators but they also indicated the damp conditions along this transect. Potentially the streamside may have been wooded or shrub covered historically.

[S]pecies + [A]bundance

The dominant species across the main wooded slope was Bluebell *Hyacinthoides non-scripta* [A-5]

Evaluation

The evaluation table for Gillfield Wood is at Table 167.13. The total number of woodland indicators are also comparable with 47 species being found in the drier parts with a cumulative weighted score of 431 and 46 species in the wetter parts with accumulative score of 418.

Little Wood was very species-poor, but was assessed. The Eastern, dry transect at the top of the slope had only 5 qualifying species and the wet transect by the stream 6 species. The cumulative score for the dry transect was 43 and for the wet transect 56 with an overall total for the wood of 10 qualifying species and a total score of 89. The presence of Remote Sedge *Carex remota* and Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* are indications of either former wooded streamsides or a relict scruffy landscape.

Table 166.12 - Evaluation table for Little Wood.				
Species	Wet [EAM] transect	Score	Dry [eam] transect	Score
Brachypodium sylvaticum			1	10
Carex remota	1	10		
Chrysosplenium oppositifolium	1	10		
Corylus avellana	1	10		
Dryopteris filix-mas	1	8		
Holcus mollis			1	8
Hyacinthoides non-scripta	1	10	1	10
Ilex aquifolium			1	10
Rubus fruticosus			1	6
Stachys sylvatica	1	8		
Total	6	56	5	43

Table 167.13 - Evaluation table for Gillfield Wood																													
			Dry - [eam] transects																		Wet - [EAM] transects								
	Max % weighting	Ave % weighting	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CN618-CN620	CN620-CN628	CN633-CN634	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	Count	Evaluation	CL646-CL654	CN628-CN633	CN636-CN642	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637	Count	Evaluation
Adoxa moschatellina	100	75																	0					11		24		2	10
Anemone nemorosa	100	91	22	22	11	33	33	44	22	25	34				45	11	23	33	13	10	44	24	45	33	44	33	44	7	10
Arum maculatum	100	84																11	1	10								0	
Athyrium filix-femina	96	96						23	22		12							11	4	10	33		11		11	22	33	5	10
Blechnum spicant	100	84							11										1	10					11	11		2	10
Brachypodium sylvaticum	100	86						33					11						2	10	33			11		11		3	10
Caltha palustris	75	75																	0						11			1	8
Cardamine amara	100	100									24							11	2	10	33				11	34		3	10
Carex pendula	100	87								12									1	10					11	11	11	3	10
Carex remota	100	86		11				23						12					3	10					11	11		2	10
Carex sylvatica	100	82	11					23	11										3	10						22		1	10
Chrysosplenium oppositifolium	100	81									25	11		12					3	10	22				11	33		3	10
Circaea lutetiana	85	85	23					24								14			3	9	11					22		2	9
Convallaria majalis	100	86		11															1	10							22	1	10
Corylus avellana	100	81					22	11			11			11	33	22	33		7	10	22	11	11	33			33	5	10
Dryopteris affinis	100	100									11								1	10					11	11		2	10
Dryopteris carthusiana	0							11	11										2	0						11		1	0
Dryopteris filix-mas	79	79	11			11			11		11			11			11	22	7	8				22				1	8

Table 167.13 - Evaluation table for Gillfield Wood

			Dry - [eam] transects																		Wet - [EAM] transects								
	Max % weighting	Ave % weighting	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CN618-CN620	CN620-CN628	CN633-CN634	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	Count	Evaluation	CL646-CL654	CN628-CN633	CN636-CN642	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637	Count	Evaluation
Equisetum sylvaticum	100	100	11								11								2	10					11			1	10
Galium odoratum	100	95						24			12								2	10	33	13	24	23	11	33		6	10
Geranium robertianum	100	92						11		25	24							11	4	10		34	22	11		33		4	10
Geum urbanum	81	81	22	11	11		22	33		11					22	11		11	9	8			11			22	11	3	8
Hedera helix	65	65	33	33			33	33	33	13		11			33	22	33		10	7		25	22		11		22	4	7
Holcus mollis	69	68	33	44	22		44	44	22	23	24	23	22		11	55	44	33	14	7		45	24	22	11	33	22	6	7
Hyacinthoides non-scripta	100	80	44	44	44	33	44	35	33	35	24	34	55	25	45	33	44	44	16	10	35	45	35	33	11	45	44	7	10
Ilex aquifolium	100	76	22	11	11		22	25	22	22	11		11		22	22	22		12	10	33	11	11	22	11	11	22	7	10
Lamiastrum galeobdolon	95	89	11	22	11			33	33	34	34				22		24	23	10	10	33	22	23	22		33	22	6	10
Lonicera periclymenum	100	93	22	33	33	33	22	22	33		11					11	11	22	11	10	22	1	11			22	22	5	10
Luzula pilosa	100	92										12							1	10						11		1	10
Luzula sylvatica	100	96																	0		24		23			11		3	10
Lysimachia nemorum	100	89	14	24				14											3	10	22				11		11	3	10
Melica uniflora	90	90													13	11		22	3	9	11			11		11		3	9
Mercurialis perennis	77	66		11				35	22		25	34			45	11	22		8	8	24	23	13	33	11	22	22	7	8
Milium effusum	100	91															22	22	2	10						11		1	10
Oxalis acetosella	100	89	23	23				24	22	24	22	14					11	11	9	10	24	13	14	23	11	34	33	7	10
Phyllitis scolopendrium	100	100									11								1	10								0	
Poa nemoralis	80	70														11			1	8								0	
Polystichum setiferum	58	58																	0						11	11		2	6
Ranunculus ficaria	100	85	25		11			24	24	24	25				45	11		33	9	10	25	25	14	24	11	22	33	7	10
Rosa arvensis	79	68	22					33				11			22		11	22	6	8								0	

Table 167.13 - Evaluation table for Gillfield Wood

			Dry - [eam] transects																		Wet - [EAM] transects								
	Max % weighting	Ave % weighting	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CN618-CN620	CN620-CN628	CN633-CN634	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	Count	Evaluation	CL646-CL654	CN628-CN633	CN636-CN642	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637	Count	Evaluation
Ribes nigrum	100	100																11	1	10								0	
Ribes uva-crispa	100	100															11		1	10								0	
Rubus fruticosus agg.	60	60	33	22	22	22		22	22	22	11		11		22	22	11	11	13	6		11		22	11	22	22	5	6
Rubus saxatilis	100	100		11							11								2	10						11		1	10
Sanicula europaea	100	79						14		22									2	10	23			11	11	11		4	10
Sorbus aucuparia	82	82																	0		22			22			11	3	8
Sorbus aucuparia	82	82	11	11				22	11		11					22	11		7	8	22			11				2	8
Stachys sylvatica	83	83	11											11			11		3	8		11						1	8
Stellaria holostea	100	86	11		11				33	23	24				24			33	7	10	33	23				33	22	4	10
Valeriana officinalis	100	88																	0		11							1	10
Veronica montana	100	85	11	22				22	33						24	11		33	7	10	33		12	14	11	33	22	6	10
Vicia sepium	92	71						11								11			2	9								0	
Viola riviniana	100	90		11				11											2	10					11		11	2	10
Total score	483																			431									418
Total count	53																		47									46	

7.6.5. Gunter Wood

Description

Gunter Wood lies off the A1 between Wetherby and Boston Spa (see Figure 171.44). The opportunity was taken to study a uniform woodland on essentially level ground with a low number of meso-habitats as part of the botanical studies done to support the Boston Spa Archaeology and Heritage Group's work. Although it was on generally level ground there are some meso-habitats within, in the form of earth banks as indicated at Table 172.14 ([EBK-F-F-0] few small - few medium - no large). A significant bank runs down the eastern edge of the wood, inside the boundary wall, and was part of a wood bank complex. The other is a slight undulation that marks out a former track through the wood as confirmed by the archaeologists. It was along this transect that the plants of Early-purple Orchid *Orchis mascula* were found. This track was deliberately followed as the ethos of WOODS is to look for and record any meso-habitat that could contain species that differ from the norm and may have historic marker species to inform about the past ecology and management. This track is marked by the records for this species at Appendix 16, Figure 20.20.

Figure 171.44 - OS location map for Gunter Wood. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Table 172.14 - Meso-Habitats for Gunter Wood		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **W**oo**DL**and	**WDL**	A-5
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	A-5
A.2. **SCR**ub	**SCR**	O-2
A.2.1. **S**hrubby **SC**rub	**SSC**	O-2
A.2.2. **B**ramble **SC**rub	**BSC**	O-1
A.6. **W**oodland **G**round **F**lora	**WGF**	A-4
J. Miscellaneous		
J.2.8. **E**arth **B**an**K**/ ridge/ earthwork	**EBK**	F-F-0
J.4. **B**are **GR**ound - Soil	**BGR**	O-2
J.5. Other habitat/ feature		
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	O-2
J.5.6. **BRY**ophytes	**BRY**	F-2
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	0-10-0
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	3-7-0
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	0-10-0
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	8-2-0

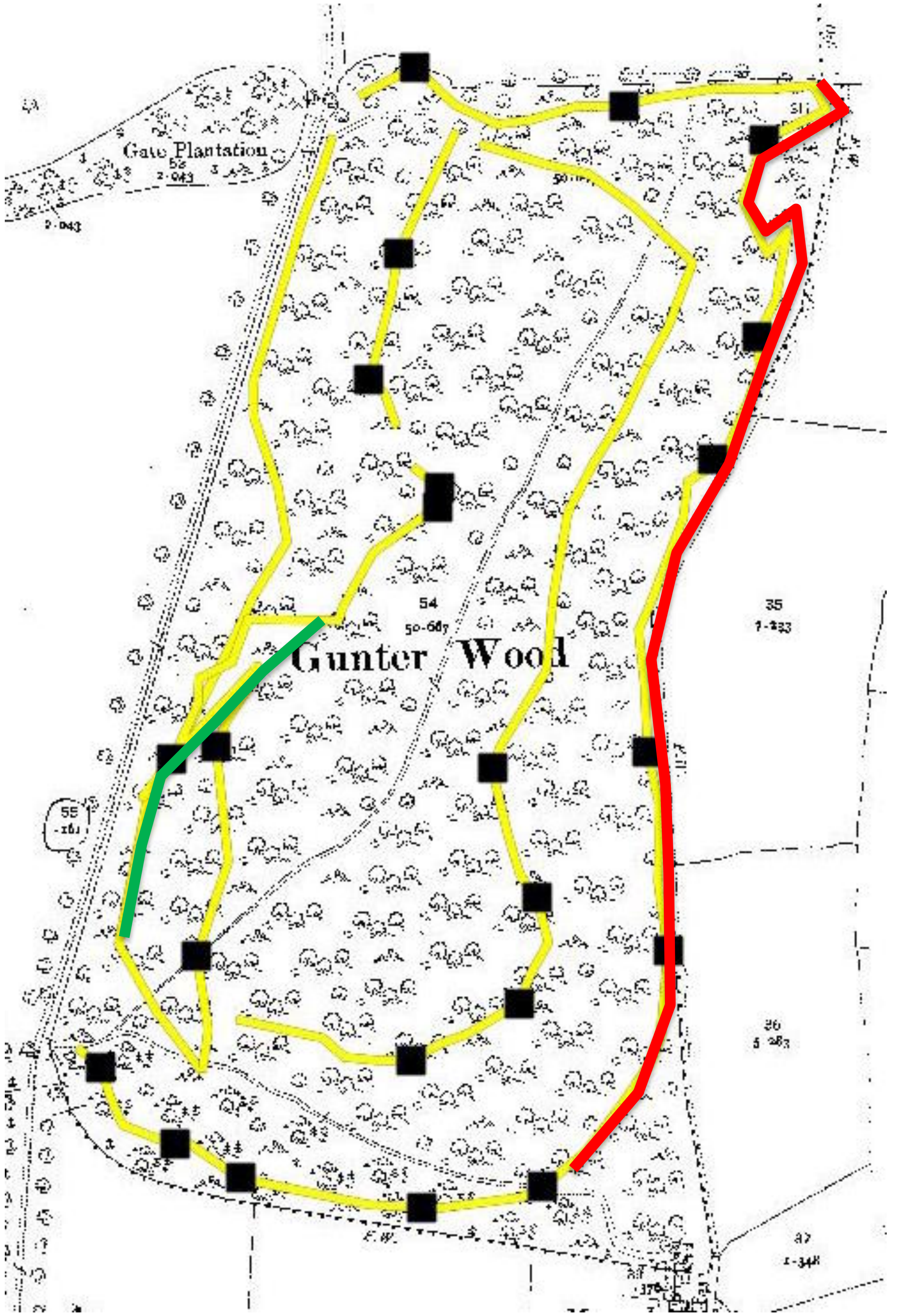


Figure 173.45 – Map of Gunter Wood showing layout of transects and quadrat locations. Green line = old routeway, Red = earthworks transect, the rest = main wood, level and moist. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Botanical survey results

The species maps for Gunter wood are at Appendix 16 and the data at Appendix 16 from Table 30.1.

[S]pecies + [A]bundance

The woodland ground flora in Gunter Wood was relatively uniform and even, comprising an intimate mix of Wood Anemone *Anemone nemorosa*, Bluebell *Hyacinthoides non-scripta* and Dog's Mercury *Mercurialis perennis* with some areas having a good presence of Ramsons *Allium ursinum*.

[S]pecies + [P]osition + [A]bundance

The old routeway was of particular significance as this had the Early Purple Orchid *Orchis mascula* on it and it was also the only location for Wood-sorrel *Oxalis acetosella*.

The earth bank down the eastern side had a range of other species typical of the meso-habitat in the light shade of the photocline on a bank. This was the area where Primrose was recorded, and also the Black Currant *Ribes nigrum* and Gooseberry *Ribes uva-crispa*. This may be related to the proximity of the farmstead which is east of Gunter Wood, seed having been brought there from the garden associated with the farm.

[S]pecies + [P]osition + [A]bundance + [C]ombination

Along the old routeway there was a combination of Scaly Male-fern *Dryopteris affinis*, Wood Sedge *Carex sylvatica*, Wood-sorrel *Oxalis acetosella* and Wood Speedwell *Veronica montana*. This combination was not found elsewhere. The routeway was particularly rich in ancient woodland indicator species.

Evaluation

The evaluation table for Gunter Wood is at Table 175.15. The main wood had 21 qualifying species and a total score of 193 with the eastern transect having 15 species and a score of 142. The route-way transect score of 134 was augmented by the presence of high-scoring species like Early-purple Orchid *Orchis mascula* and Wood Sorrel *Oxalis acetosa*. The presence of such species casts doubt on the origins of this wood. It is likely that it is, at least in part, a Plantation on an Ancient Woodland Site (PAWS).

Table 175.15 - Evaluation table for Gunter wood

			Route-way		Eastern transects				Main woodland							
	Max % weighting	Ave % weighting	CN582-CN598	Evaluation	CN541-CN554	CN554-CN563	Count	Evaluation	CN538-CN541	CN563-CN570	CN572-CN582	CN598-CN603	CN604-CN607	CN607-CN616	Count	Evaluation
Ajuga reptans	100	88					0				11				1	10
Allium ursinum	100	79				24	1	10	25	22	23	35	35	11	6	10
Anemone nemorosa	100	91	35	10	35	24	2	10	35	25	35	23	11	35	6	10
Arctium minus	60	60				11	1	6	11	11					2	6
Arum maculatum	100	84	23	10	22	22	2	10	23	22	22	12		22	5	10
Brachypodium sylvaticum	100	86			11	11	2	10			22				1	10
Carex sylvatica	100	82	12	10	11		1	10			11	11			2	10
Circaea lutetiana	85	85					0					11		12	2	9
Convallaria majalis	100	86					0				13	11			2	10
Corylus avellana	100	81				11	1	10							0	
Dryopteris affinis	100	100	11	10			0								0	
Dryopteris filix-mas	79	79	11	8			0				11	11		11	3	8
Geranium robertianum	100	92	11	10			0				11				1	10
Geum urbanum	81	81	11	8	11	22	2	8				12		11	2	8
Hyacinthoides non-scripta	100	80	13	10	24	44	2	10	23	23	23	13	23	23	6	10
Ilex aquifolium	100	76					0		11			11			2	10
Mercurialis perennis	77	66	13	8	55	34	2	8	35	13	35	35	24	23	6	8
Orchis mascula	100	89	11	10			0								0	
Oxalis acetosella	100	89	11	10			0								0	
Primula vulgaris	100	87			11	11	2	10							0	
Ranunculus ficaria	100	85	11	10	22	22	2	10	11	12	11	11	11	11	6	10
Ribes nigrum	100	100				14	1	10					11		1	10
Ribes uva-crispa	100	100			11	11	2	10							0	
Rubus fruticosus agg.	60	60					0				11	11			2	6
Stachys sylvatica	83	83					0							11	1	8
Veronica montana	100	85	11	10			0					11			1	10
Viola riviniana	100	90	11	10		13	1	10		12	13			11	3	10
Total score				134				142								193
Total count			14				15								21	

7.6.6. Hackfall Wood.

Description

Hackfall wood is located south of Masham in North Yorkshire (see Figure 176.46).

Hackfall Wood is a Woodland Trust woodland Near Grewelthorpe in North Yorkshire at SE235771. This was chosen at it has a wide range of meso-habitats (see Table 178.16) associated with streams and calcareous springs.

The NCA (22) describes the area as:

- The NCA contains 8,390 ha of woodland (nearly 10 per cent of the total area), of which 1,861 ha is ancient woodland. The area is relatively well-wooded which contrasts with the open landscapes to the east and west. Some lower-lying arable areas in the north-east of the area have lower levels of tree cover. There has been a significant uptake of Woodland Grant Scheme agreements for management and specifically restocking within the character area. About 27 per cent of the woodland cover is on ancient woodland sites.

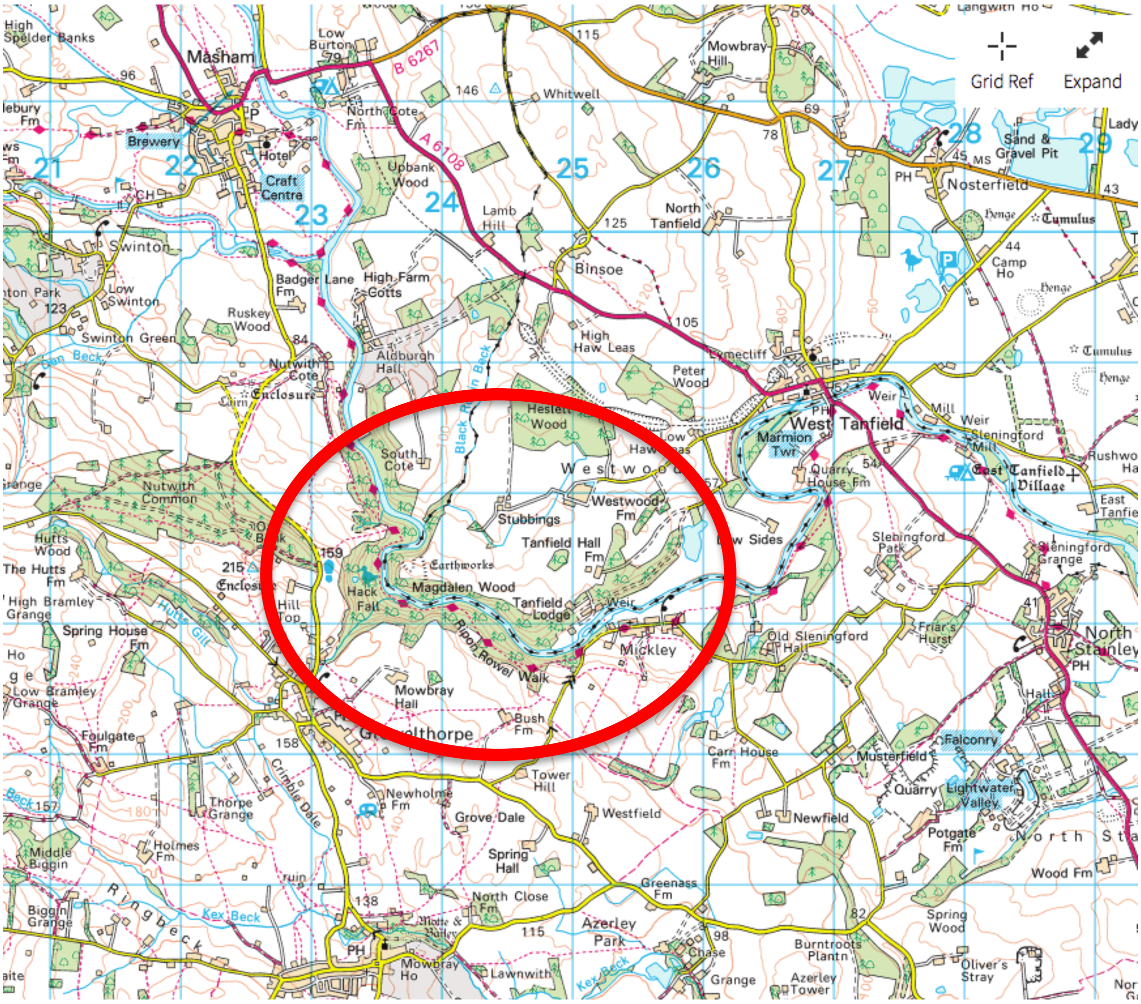


Figure 176.46 - OS location map for Hackfall Wood (SE237770). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The extract from the MAGIC website shows that all of Hackfall Wood is on the inventory, but part is regarded as Plantation on an Ancient Woodland Site (PAWS) (see Figure 177.47.

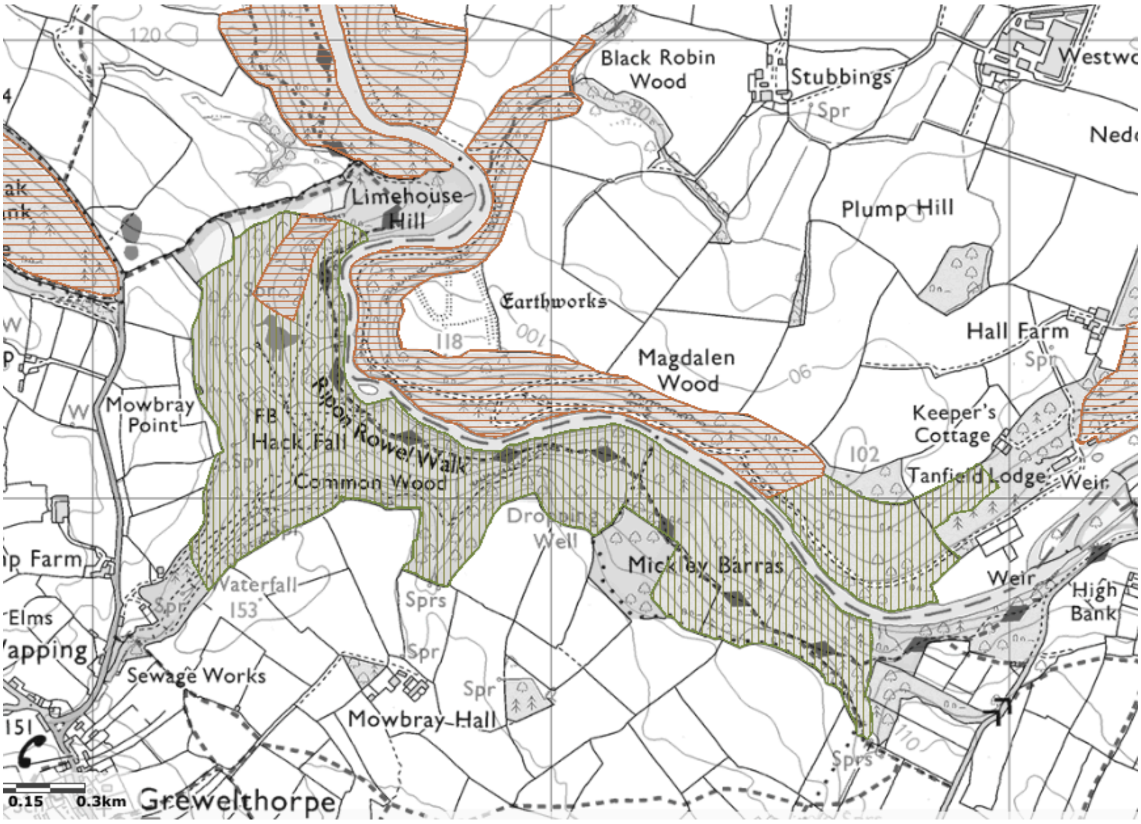


Figure 177.47 - MAGIC map extract showing that Hackfall Wood is all on the ancient Woodland Inventory.

Table 178.16 - Meso-habitats for Hackfall Wood.		
FEATURE Letter = SACFOR frequency Number = SACFOR abundance	**P1.5**	**VALUE**
A. Woodland and Scrub		
A.1. **W**oo**DL**and	**WDL**	A-5
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	A-5
A.2. **SCR**ub	**SCR**	O-2
A.2.1. **S**hrubby **SC**rub	**SSC**	O-2
A.2.2. **B**ramble **SC**rub	**BSC**	R-1
A.6. **W**oodland **G**round **F**lora	**WGF**	A-5
E.2.2. **B**asic **FL**ush	**BFL**	O-1
G. Open water		
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	F-F-F
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	F-0-0
I. Rock exposure and waste		
I.1. Natural		
I.1.1. **I**nland **CL**iff - Sm-Md-Lg: F-S-L	**ICL**	O-2
I.1.1.1. **A**cid/Neutral Inland **CL**iff	**ACL**	O-1
I.1.1.2. **B**asic Inland **CL**iff	**BCL**	O-1
J. Miscellaneous		
J.4. **B**are **GR**ound - Soil	**BGR**	O-1
J.5. Other habitat/ feature		
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	O-2
J.5.6. **BRY**ophytes	**BRY**	O-2
K. Ecological Attributes - % 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	1-8-1
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	1-9-0
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	3-4-3
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	2-7-1

Botanical Survey data

The northern transects on the overview map at Figure 179.48 are on neutral to calcareous soils with wet areas and calcareous streams. To the east, the geology is more acidic and there are significant cliff faces. The main stream valley running SW-NE has a mixture of pHs and the valley sides are mainly steep. This wood was a pleasure ground historically and contains follies and an alum spring that has been modified using tufa to create an ornamental feature with a viewing seat opposite.

The species maps for Hackfall Wood are at Appendix 17 and the data sheets at Appendix 17, Table 69.1 (transects) and Appendix 17, Table 73.2 (Quadrats, point records).

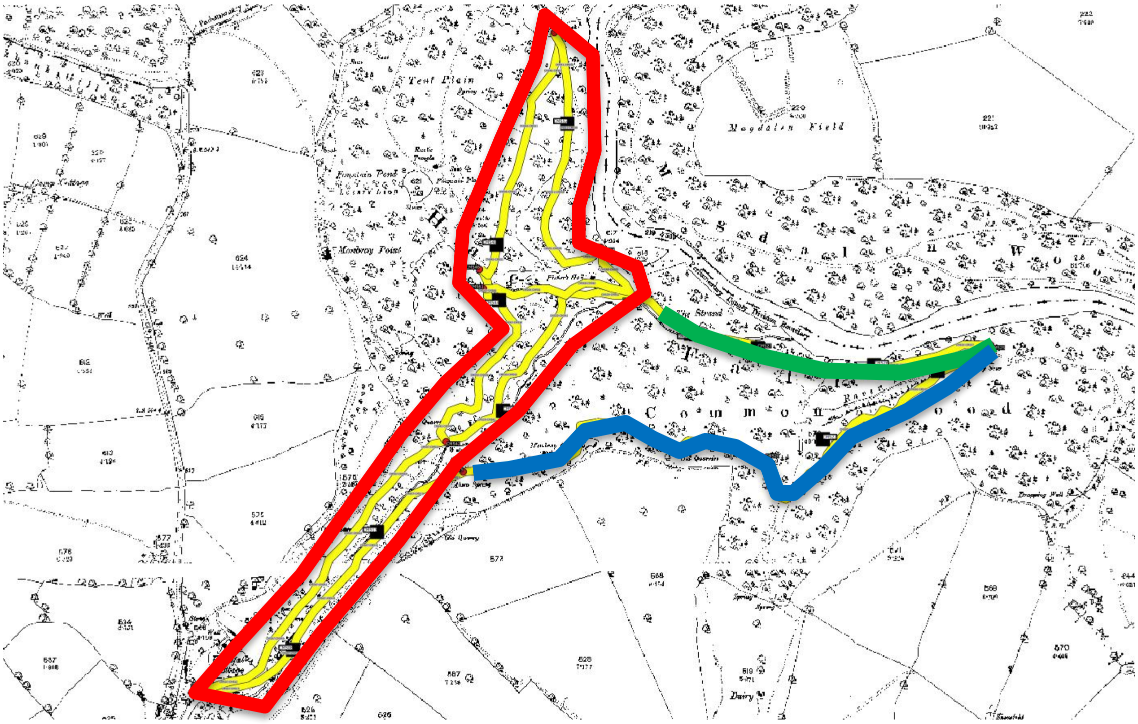


Figure 179.48 – Map of Hackfall Wood showing the layout of the transects and quadrats. Red = Calcareous area transects, Green = Trichomanes transect, Blue = Acidic transect. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

[S]pecies + [P]osition

Species of significance include the rare fern Killarney Fern *Trichomanes speciosum* recorded using a previous record from November 2010 on transect [CM525-CM527] on the acid rocks at the foot of the cliffs near to the river. This was discovered during earlier surveys for ferns by the Yorkshire Fern Group (YFG) (part of the British Pteridological Society). It is present from at least one boulder cluster between blocks of rock as the gametophyte only. Another species recorded higher up on the slopes but not on the survey transect was Oak Fern *Gymnocarpium dryopteris* in several places on the steep slopes [EAt] under acid conditions [eap].

Another venture done by the YFG was a survey for the hybrid fern *Polystichum* x *bicknellii* (*P. aculeatum* x *P. setiferum*) as both species occur in the wood. *P. aculeatum* is a species of mainly calcareous substrates and *P. setiferum* prefers acidic soils. As both substrates and species are in the wood the potential for hybrids existed. The curiosity was to determine where they were and how many. This was reported on in the 2011 society bulletin (Wright 2011). The location map is at Figure 180.49. Local variations in topography and pH have resulted in both species being present in the areas indicated by the white dots. To the W and SE where there are no hybrids, there are only *P. setiferum* plants as these are acidic areas.

Figure 180.49 - Air photograph of Hackfall Wood showing the locations of *Polystichum* x *bicknellii.*

From the evaluation table there were large numbers of ancient woodland indicator species found within this wood and also a number of high fidelity species including Killarney Fern *Trichomanes speciosum* and Herb-Paris *Paris quadrifolia*.

[S]pecies + [P]osition + [C]ombination

The gross differences in pH within the woodland recorded a number of specialists on certain transects. The acidic transect had the combination of Heather *Calluna vulgaris*, Bilberry *Vaccinium myrtillus* and Common Polypody *Polypodium vulgare* of note indicating the acid conditions, along with Wavy Hair-grass *Deschampsia flexuosa*.

The calcareous area was marked by species like Great Horsetail *Equisetum telmateia* that formed dominant stands in some of the flushes and stream sides on the lower slopes approaching the river.

The majority of the western side north of the stream is acidic and this grades into calcareous towards the bottom and influences the flora. Of particular interest is the incidence of the hybrid between the acid loving Soft Shield-fern *Polystichum setiferum* and the limestone loving Hard Shield-fern *Polystichum aculeatum*.

Of some note was the presence of both the Alternate-leaved *Chrysosplenium alternifolium* and Opposite-leaved Golden-saxifrage *C. oppositifolium* close to the river, growing side-by-side on a small stream along the Trichomanes transect. These favour different pHs, with the Alternate-leaved preferring limey conditions (Ellenberg [6] and the Opposite-leaved preferring acid conditions. These were growing within 1 m of each other on this streamside.

The local topography and pH variations led to the creation of a number of extensive and often dense patches of both Oak Fern *Gymnocarpium dryopteris* and Beech Fern *Phegopteris connectilis*. Both are acid loving species, but were found in lime rich areas where it is presumed acidic conditions were prevalent caused by leaf litter build-up or other soil characteristic adaptations.

Another species of note was Toothwort growing associated with both Wych Elm trees and Hazel bushes in a number of different parts of the woodland, especially towards the south.

This woodland has been significantly modified as it was a pleasure ground for the estate. There are a number of constructed follies and, in particular, a modified Alum spring that incorporated blocks of tufa to create a decorative feature that can be observed from a purpose-built viewing seat on the opposite side of the stream.

There is significant micro-topography within this woodland that influences the ground flora in various parts.

Evaluation

The evaluation table for Hackfall Wood is in Table 183.17. The species maps are in Appendix 17 and the data in Appendix 17 from Table 69.1. This rich complex of meso-habitats and micro-habitats contribute to Hackfall Wood having the largest number of qualifying ancient woodland indicator species and 82 the highest cumulative weighted score at 711.

Table 183.17 - Evaluation table for Hackfall wood

			Trichomanes transect		Acid transect		Calcareous transects				Main wood transects								
Species	Max % weighting	Ave % weighting	CM525-CM527	Evaluation	CM520-CM525	Evaluation	CM546-CM551	CM551-CM558	Count	Evaluation	CM527-CM529	CM507-CM515	CM507-CM542	CM515-CM520	CM529-CM542	CM542-CM546	CM568-CM561	Count	Evaluation
Ajuga reptans	100	88	14	10			11	22	2	10	14		22	22		11	11	5	10
Allium ursinum	100	79	11	10			11	23	2	10	11	22	11	22	33	11	11	7	10
Anemone nemorosa	100	91							0		11	22	22	11	22		11	6	10
Arctium minus	60	60							0			24		11				2	6
Arum maculatum	100	84	11	10					0		11							1	10
Athyrium filix-femina	96	96	22	10	22	10	22	22	2	10	33	34	33	23	33	22	11	7	10
Blechnum spicant	100	84	11	10	22	10		22	1	10	13	13			11	13	11	5	10
Brachypodium sylvaticum	100	86					22	22	2	10	22	22				22		3	10
Bromopsis ramosa	83	73						11	1	8								0	
Calluna vulgaris	79	79			13	8			0									0	
Campanula latifolia	80	68					11		1	8	11							1	8
Cardamine amara	100	100							0									0	
Carex pendula	100	87	11	10			11	24	2	10		13	23	11	11			4	10
Carex remota	100	86	11	10	11	10		14	1	10	11	34		22	22	11	11	6	10
Carex sylvatica	100	82	11	10			22		1	10		14	11	11	22		11	5	10
Chrysosplenium alternifolium	100	100							0		24							1	10
Chrysosplenium oppositifolium	100	81	24	10					0		14	14	24	14		24		5	10
Circaea lutetiana	85	85	11	9	11	9	33		1	9	33	22	11	22	33	11	33	7	9
Corylus avellana	100	81	22	10	22	10	11	11	2	10	22		34	22	33		22	5	10
Deschampsia flexuosa	82	82			24	8			0									0	

Table 183.17 - Evaluation table for Hackfall wood

			Trichomanes transect		Acid transect		Calcareous transects				Main wood transects								
Species	Max % weighting	Ave % weighting	CM525-CM527	Evaluation	CM520-CM525	Evaluation	CM546-CM551	CM551-CM558	Count	Evaluation	CM527-CM529	CM507-CM515	CM507-CM542	CM515-CM520	CM529-CM542	CM542-CM546	CM568-CM561	Count	Evaluation
Dryopteris affinis	100	100	22	10	22	10	22	22	2	10		34	22	33	11	22	11	6	10
Dryopteris carthusiana	0								0									0	
Dryopteris filix-mas	79	79	22	8	33	8	22	33	2	8	22	22	33	22	33	22	22	7	8
Epilobium montanum	100	100							0									0	
Equisetum telmateia	100	100					15	11	2	10								0	
Festuca gigantea	75	75							0									0	
Fragaria vesca	70	68					11	11	2	7								0	
Galium odoratum	100	95					24	14	2	10	14				34	14	24	4	10
Geranium robertianum	100	92	11	10	22	10	44	23	2	10	33	22	33	33	33	33	22	7	10
Geum urbanum	81	81	11	8			34	44	2	8	22	22	23	22	33	45	33	7	8
Glechoma hederacea	63	63	11	6	11	6	11		1	6	22	22		11				3	6
Gnaphalium sylvaticum	0		11	0					0									0	
Hedera helix	65	65	33	7	24	7	33	33	2	7	24		22	24	33		33	5	7
Holcus mollis	69	68							0					11				1	7
Hyacinthoides non-scripta	100	80	11	10	23	10	22	34	2	10		23	33	22		22		4	10
Ilex aquifolium	100	76	22	10	24	10	22	44	2	10	22	34	33	24	22	22	22	7	10
Lamiastrum galeobdolon	95	89							0									0	
Lathraea squamaria	100	100							0		11							1	10
Listera ovata	0							11	1	0								0	
Lonicera periclymenum	100	93	11	10				22	1	10		11		11	11		22	4	10

Table 183.17 - Evaluation table for Hackfall wood																			
			Trichomanes transect		Acid transect		Calcareous transects				Main wood transects								
Species	Max % weighting	Ave % weighting	CM525-CM527	Evaluation	CM520-CM525	Evaluation	CM546-CM551	CM551-CM558	Count	Evaluation	CM527-CM529	CM507-CM515	CM507-CM542	CM515-CM520	CM529-CM542	CM542-CM546	CM568-CM561	Count	Evaluation
Luzula pilosa	100	92							0									0	
Luzula sylvatica	100	96	13	10	24	10		24	1	10		24		24	24		22	4	10
Lysimachia nemorum	100	89	11	10	11	10	11	22	2	10	12	11	24	11				4	10
Melica uniflora	90	90	11	9					0			23		22	22	11		4	9
Mercurialis perennis	77	66	14	8	24	8	35	24	2	8	24	24		25	33	24	44	6	8
Milium effusum	100	91							0									0	
Orchis mascula	100	89						11	1	10								0	
Oxalis acetosella	100	89	23	10	11	10	22	22	2	10	13	22	24	22	13	14	23	7	10
Paris quadrifolia	100	100						13	1	10								0	
Phegopteris connectilis	100	100							0						14			1	10
Phyllitis scolopendrium	100	100					11		1	10	11		22	14	22		11	5	10
Poa nemoralis	80	70					22		1	8	22	11						2	8
Polystichum aculeatum	100	100					11		1	10								0	
Polypodium vulgare	100	100					11		1	10								0	
Polystichum setiferum	58	58	34	6			11	11	2	6	33	22	11	22	34	33	22	7	6
Potentilla sterilis	100	94					11		1	10								0	
Polypodium interjectum	100	100							0						11			1	10
Polypodium vulgare	100	100			13	10	12		1	10					14		11	2	10
Primula vulgaris	100	87						11	1	10								0	
Prunus avium	73	65	11	7				11	1	7	11			11		33	11	4	7

Table 183.17 - Evaluation table for Hackfall wood

			Trichomanes transect		Acid transect		Calcareous transects				Main wood transects								
Species	Max % weighting	Ave % weighting	CM525-CM527	Evaluation	CM520-CM525	Evaluation	CM546-CM551	CM551-CM558	Count	Evaluation	CM527-CM529	CM507-CM515	CM507-CM542	CM515-CM520	CM529-CM542	CM542-CM546	CM568-CM561	Count	Evaluation
Ranunculus ficaria	100	85							0									0	
Ribes nigrum	100	100					11	11	2	10								0	
Ribes uva-crispa	100	100	11	10					0					11				1	10
Rosa arvensis	79	68	11	8					0									0	
Rubus fruticosus agg.	60	60	22	6	22	6	33	33	2	6	22	22	33	33	33	33	22	7	6
Rubus idaeus	80	80					11	11	2	8		11	11					2	8
Rubus saxatilis	100	100							0			11		11				2	10
Sanicula europaea	100	79	13	10			13		1	10					13	13	11	3	10
Silene dioica	77	77							0		23	11		11				3	8
Sorbus aucuparia	82	82			11	8		22	1	8	11						22	2	8
Sorbus aucuparia	82	82			22	8		11	1	8	22	11		11			11	4	8
Stachys sylvatica	83	83					22	11	2	8		11	22	11				3	8
Stellaria holostea	100	86							0									0	
Taxus baccata	89	83							0			11						1	9
Teucrium scorodonia	82	82			22	8			0					11				1	8
Trichomanes speciosum	0	0	11	0					0									0	
Ulmus glabra	63	63	22	6	11	6	33	22	2	6	22	11	33	11	35	44	22	7	6
Vaccinium myrtillus	100	98			15	10			0									0	
Valeriana officinalis	100	88							0									0	
Veronica montana	100	85	12	10	11	10			0		22	22	24	11	22	33	11	7	10
Vicia sepium	92	71							0									0	

Table 183.17 - Evaluation table for Hackfall wood

			Trichomanes transect		Acid transect		Calcareous transects				Main wood transects								
Species	Max % weighting	Ave % weighting	CM525-CM527	Evaluation	CM520-CM525	Evaluation	CM546-CM551	CM551-CM558	Count	Evaluation	CM527-CM529	CM507-CM515	CM507-CM542	CM515-CM520	CM529-CM542	CM542-CM546	CM568-CM561	Count	Evaluation
Viola riviniana	100	90	22	10	11	10	11	11	2	10				11				1	10
Total score				307		240				434									485
Total count			36		27				49									54	

7.7. Hedgerow Survey Results

7.7.1. Dunnington

The Dunnington survey was a major collaboration with a local historian, Stephen Moorhouse, who determined probable hedgerow creation eras and epochs on the hedgerows within a current civil parish that was potentially four former townships – Dunnington, *Ianulfestorpe, Grimston* and an unrecorded township not mentioned at Domesday. The results of this survey are available as a set of technical annexes on DVD only owing to its size at nearly 1,000 pages (Annex 1 is 465 pages).

References in this section of the thesis to annexes are to the annexes in the Dunnington report (this assumption avoids repeating that they are part of that report rather than annexes to this thesis as there are no annexes in the current thesis, only technical appendices). The form of reference is either [A1] to refer to Annex 1 or [A1-4] to relate to Annex 1 page 4, hence [A1-4] to [A1-34] to refer to a range of pages. The hedgerow references are the standard approach of the GPS references that form the nodes at the start and end of each section surveyed. these are presented in strict alphabetical/ numerical order; even if the direction of survey was [BX117- BX092] it is referenced as [BX092-BX117]

This survey was done mainly to Level 2 of HEDGES with a separate commission from the Friends of Hagg Wood to look at Intake Lane at Level 3 (these data being incorporated into the overall dataset for the Level 2 survey).

Only the key results from this survey relevant to the significance of botanical indicators as historic markers are brought into this thesis. Some issues the survey raised that are not a core element of this research are the subject of further research and will be discussed later.

Figure 199.54 shows the layout of the recorded medieval fields for the combined township of Dunnington (encompassing Dunnington, *Grimston*, *Ianulfestorpe* and an un-recorded additional township). The layout of the total predicted townships, including the township of *Scoreby* referred to in the Dunnington report and this thesis is at Figure 198.53). The village of Dunnington lies on a glacial moraine that runs approximately SW to NE. The southern part of the township extends onto an area of level ground called Dunnington Common.

This was a major survey that was used to test the field survey and data analysis methods. A number of important discoveries were made that have contributed to academic understanding of hedgerows. The advantage at this case study was the historical data contributed by Stephen Moorhouse. This was an essential calibration for the observed differences in botanical content of the hedgerow complex. This study revealed a number of important SPACES signatures. These were at both the species and community levels. Figure 190.50 shows the hedgerows that fall within the areas that Stephen Moorhouse has indicated as being hedges during specific phases, the descriptions of which follow.

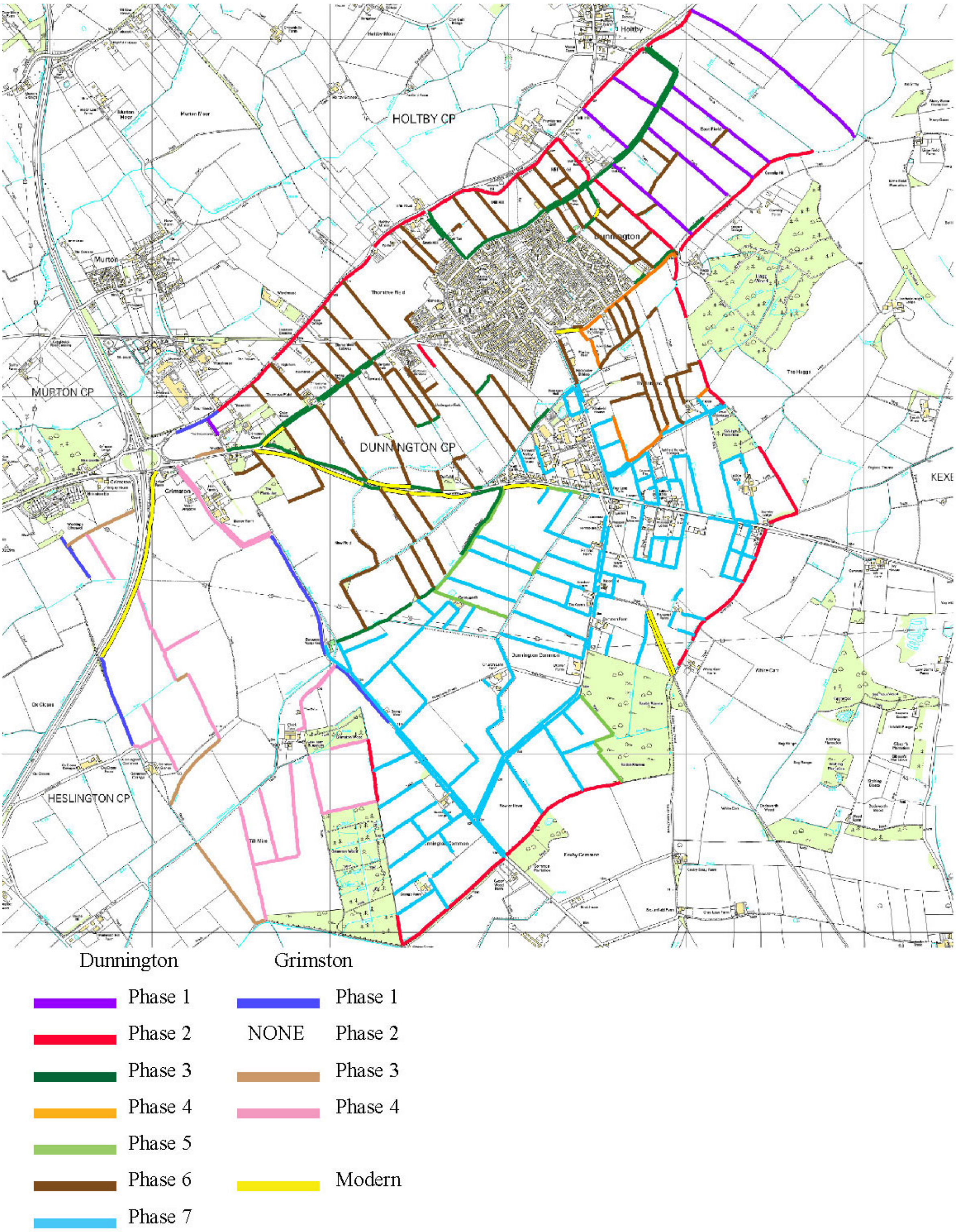


Figure 190.50 - Map of study area with Phases indicated. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The Phases as determined by Stephen Moorhouse are:

Dunnington Township

Phase 1 - Purple [DU-1]

These are interpreted as being possible continuations of use for pre-historic coaxial fields.

Phase 1a - Early roads with a farming landscape of coaxial fields that were possibly hedged. Possible survivors are :

- The north hedge of Intake Lane and
- Coney Garth Lane (the early route)
- The east hedge of East Field on the township boundary
- Dunnington/Grimston township boundary down to Coney Garth lane

Phase 1b -Three Roman roads could have been hedged and the coaxial field system would still be in use.

[DU-1] has 13 hedgerows ranging from 23m to 662m. This group of hedgerows contains a number of species that have been given the term "medieval species". This is because there is a strong tendency for them to occur on medieval, or earlier, boundaries. These species include - Dogwood *Cornus sanguinea*, Guelder-rose *Viburnum opulus* Spindle *Euonymus europaeus*. Of these, the rarest is Spindle. This species was only recorded in total on five hedgerows across the study area. On three occasions they were on the historic hedgerows from [DU-1] to [DU-3]. It was also recorded from the [DU-6] area. This was on a linear hedgerow that is speculated to have been of more historical origin than the 1772 enclosure of Dunnington common [A1-411]. The record for [DU-7] was a newly planted specimen on a hedgerow on [A1-410] Dunnington common.

Phase 2 - Red [DU-2]

The Red phase represent the fundamental medieval township boundaries. The early Medieval Township boundaries of *Ianulfestorpe*, Dunnington and the unnamed township with their associated open fields were located between the existing roads (see Annex [A5-1]).

The northern boundary of Dunnington has a significant shift at the junction between Holtby and Murton. Stephen Moorhouse believes the former township of *Ianulfestorpe* also joined making it a 'cross-roads' of four townships (see Figure 192.51).

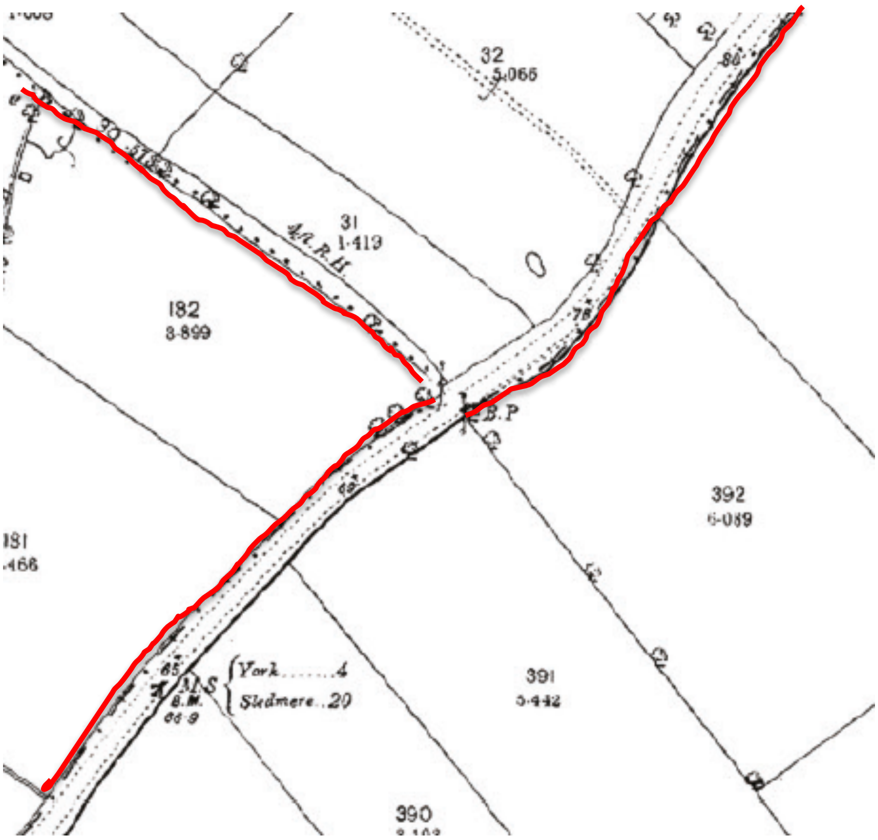


Figure 192.51 - Map showing the shift at the Vengeance Lane 'crossroads' where the township boundary with the current Dunnington changes from north of the A166 to the west (Murton) to the south (Holtby). © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

West of the Holtby/ Murton junction the Dunnington township boundary runs along the north side of the A166 and the northern roadside-hedge is the responsibility of Murton, with the southern road-side hedgerows being the responsibility of Dunnington. East of the junction the Dunnington township boundary moves to the south side of the A166 and this hedgerow is the responsibility of Dunnington (see Figure 193.52). This means that the whole of the hedging along the southern side of the A166 is the responsibility of Dunnington.

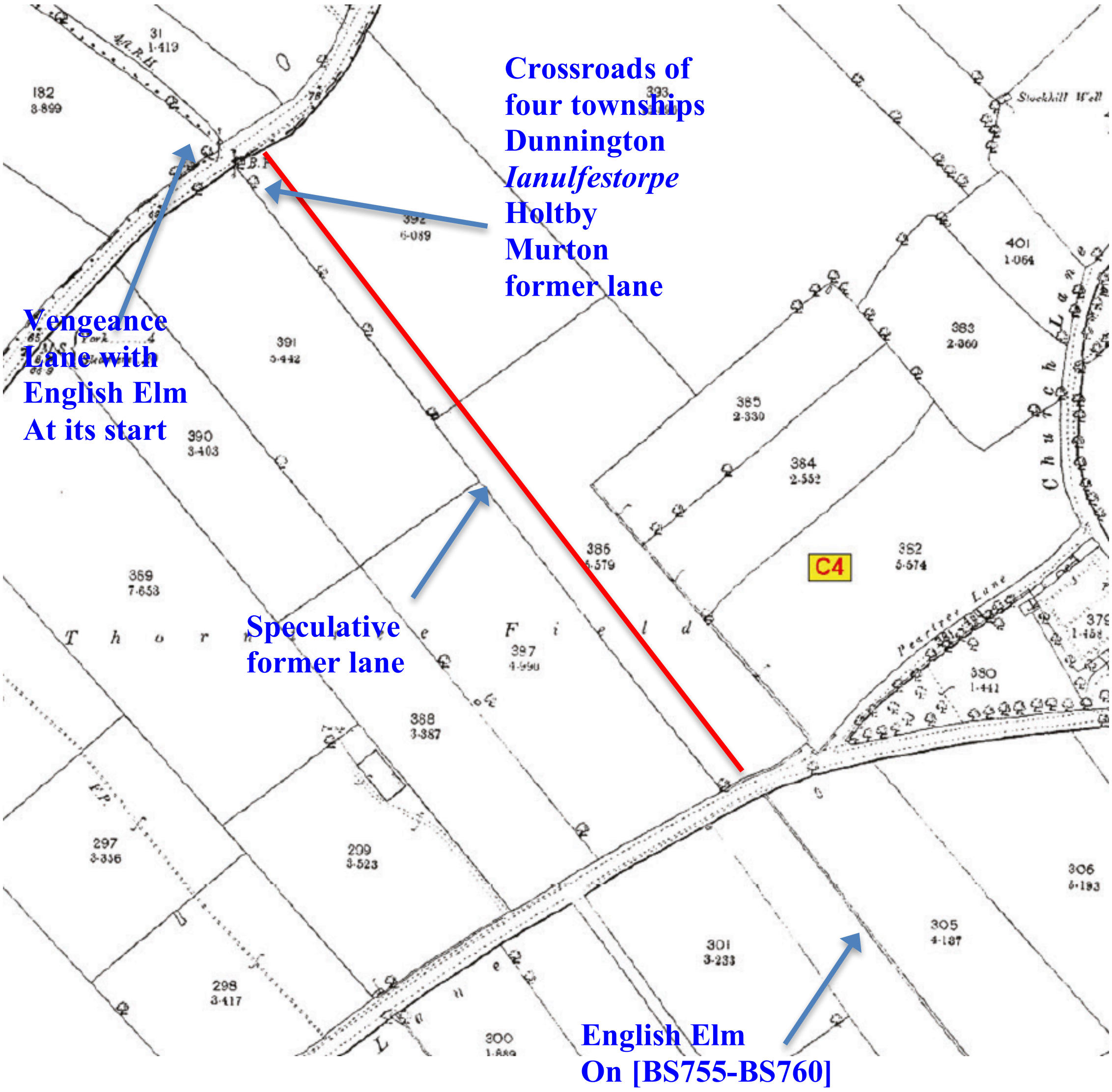


Figure 193.52 - Map showing speculative township boundary lane between Dunnington to the east and *Ianulfestorpe* to the west and the four-township crossroads. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

In the medieval period, the eastern section of hedgerow would have been created to protect Thorntree Field and Mill Field. Similarly, it is likely that the Holtby side of the road would have been hedged to protect their field. On the western section on the southern side of the A166 in Dunnington, this township would have needed to plant a hedgerow along their side of the road to protect their field.

The botanical evidence supports the presumption that the entire set of hedgerows along the southern side of the A166 are of the same origin historically. They have English Elm and the same general combination of species although lacking species like Guelder-rose and Dogwood.

During this phase the backbone structure was created that included the perimeter boundaries of the townships and also the internal boundaries between the open fields. Inside of this boundary field system the subsequent fields were set out each with their own bordering hedgerows.

All 47 extant hedgerows dated to this phase were surveyed. This was the main period of hedgerow creation during the medieval period (see Annex 5). The general mix of species shows evidence of those that are typical of the era in which this phase of hedgerow creation was implemented. In particular, there is a significant representation of English Elm *Ulmus procera*, Hazel *Corylus avellana* and Field Maple *Acer campestre* (see [A7-11]). During this phase Crab Apple *Malus sylvestris* becomes common being found in 22/47 hedgerows, representing 47%. Blackthorn *Prunus spinosa* is also another major component being found in 27 out of the 47, 57%.

The species found in each phase are presented and summarised at Annex 7.

Phase 3 - Dark Green [DU-3]

The Dark Green areas on the map shows the internal medieval open field system. This includes the double hedging of York Road and Eastfield Lane as well as the remnant fragmentary appearance of the hedge that once separated Undergate Field from The Ings that was probably formerly a double hedged lane.

Ianulfestorpe and the unnamed township were consumed into Dunnington and new open fields created. During this phase the roadways between the open fields became hedged. This included the hedgerows either side of York Road and Eastfield Lane, also the older hedgerows along the A1079. As shown on the plan at [A5-1] the recent re-alignment has taken out several sections of the older stock and replaced it with relatively modern plantings. In this phase there were 51 surveyable hedgerows.

Phase 4 - Orange [DU-4]

The Orange hedgerows represent the surrounding enclosure of The Intakes in the late 17c that involved hedging the southern side of Intake Lane and the northern side of Hagg Lane as well as the connecting hedgerow that links the two that parallels Common Lane. The infilled hedgerows were from the 1709 enclosure period [DU-6].

Only 14 hedgerows could be found and attributed to this phase

Phase 5 - Light Green [DU-5]

The Light Green boundaries were around the Rabbit Warrens that have been difficult to date, with the presumption that Coneygarth is probably medieval and the 'Rabbit Warren' is likely to be much later. Only 13 hedgerows were available within this phase of hedgerow creation. There were relatively few hedgerows in this phase that contained English Elm, but in those that did contain this species it was recorded as being abundant and dominant [AA].

Phase 6 - Dark Brown [DU-6]

The Dark Brown boundaries are all in the area enclosed after the1709 enclosure act. But that is not to say that they may not have already had a hedge in them at the time they were awarded their enclosure. This may have been left, or could have been replanted to comply with the rules for enclosure.

There were 86 hedgerows in this phase that were surveyed. During this phase Blackthorn *Prunus spinosa* was a prominent species being recorded from 69% of hedgerows and was dominant in one. This phase also saw the return of Hazel *Corylus avellana* as a prominent element in the flora with it being found in 58% of hedgerows, compared with only 15% in the previous phase [DU-5].

If it can be assumed that most of the hedgerows in this phase were actually planted from 1709, then it is likely to comprehensively disprove the Hooper theory as there are far too many hedgerows in this phase that are multi-species which would cause the Hooper rule to assess them as being more than the 300 years old that they actually are.

Phase 7 - Light Blue [DU-7]

The next set of enclosures dates from 1772 and are coded with the Light Blue colour. Again, some of these may have already been hedged and simply incorporated into the enclosure plans.

This second phase of planned enclosure hedgerow creation produced 155 surveyable hedgerows. Blackthorn was slightly less evident in this phase being recorded from only 43% of the hedgerows. As with the previous phase [DU-6], Crab Apple *Malus sylvestris* was also a prominent feature. Hazel *Corylus avellana* was considerably less evident being found in only 25% of the [DU-7] hedgerows compared with the previous [DU-6] frequency of 58%.

Modern - Yellow [DU-M]

The final phase is the modern set, coloured Yellow. These are cases where there are clear indications that the hedgerows have been formed in the last 100 years and include the hedges on the A1079 where the road has been straightened and new hedges planted.

It also includes the hedgerows along the now disused railway line and other fragments that are clearly composed of new plants.

The modern hedgerows in Dunnington only yielded ten hedgerows that could be surveyed. Even though they were dominated by Hawthorn, there was still some species diversity in a number of hedgerows created in this phase.

Grimston Township

There are fewer identifiable phases in *Grimston*. Stephen Moorhouse has suggested a chronology.

Phase 1 - Dark Blue [GR-1]

Early roads with coaxial fields: possible survivors are *Grimston*/Dunnington township boundary and the township boundary between *Grimston* and Heslington north of the early route.

Very few hedgerows were created in this phase and only five survived to be surveyed in this case study. Because of the low number of hedgerows, it is difficult to detect any pattern that could be ascribed to the history of the hedgerows in this phase.

Phase 3 - Light Brown [GR-3]

Early township boundary and planned three-row village with associated arable field and 3b expansion infill. Again, only seven hedgerows were surveyed from this phase. No clear patterns seem to have emerged.

Phase 4 - Pink [GR-4]

Pre 1680 enclosure.

There were 25 remaining surveyable hedgerows from this phase. It is obvious that rapid colonisers like Bramble *Rubus fruticosus* can become established in these later phase developments.

Modern - Yellow [GR-M]

This is basically the hedgerow that forms the eastern boundary of the A64 dual carriageway that is clearly of modern origin.

Species mapping

One of the primary outputs of the survey was the mapping of species along all of the surveyed hedgerows. This included plotting the location of any trees and indicating their size by an increase in diameter of a tree symbol. An example of a map for Ash *Fraxinus excelsior* across the entire case study area is at Figure 200.55. This shows the surveyed hedgerows marked as yellow lines, any significant gaps marked as black sections and the presence of the species as a hedge component as red lines. The un-scaled trees are indicated as green dots. More detailed maps are included in the report that show frequency by variation in line thickness and abundance by varying intensity of green shading (the components of DDAFOR - now SSACFOR). It is these that indicate trunk size by the diameter of the tree symbol.

An example of these detailed maps is at Figure 201.56. These are based on 1km OS grid squares. Each square has been given an identifier of a letter and number code, e.g. in this case D5.

A map showing the different phases of proposed actual creation is at Figure 190.50. It is important to note that these areas can only reflect parcels of land that were potentially un-hedged before they were defined and enclosed and new hedgerows installed. As these results show that this is not necessarily the case. There is evidence that areas that were proposed as having been enclosed in say 1709 already contained hedgerows that pre-dated this epoch.

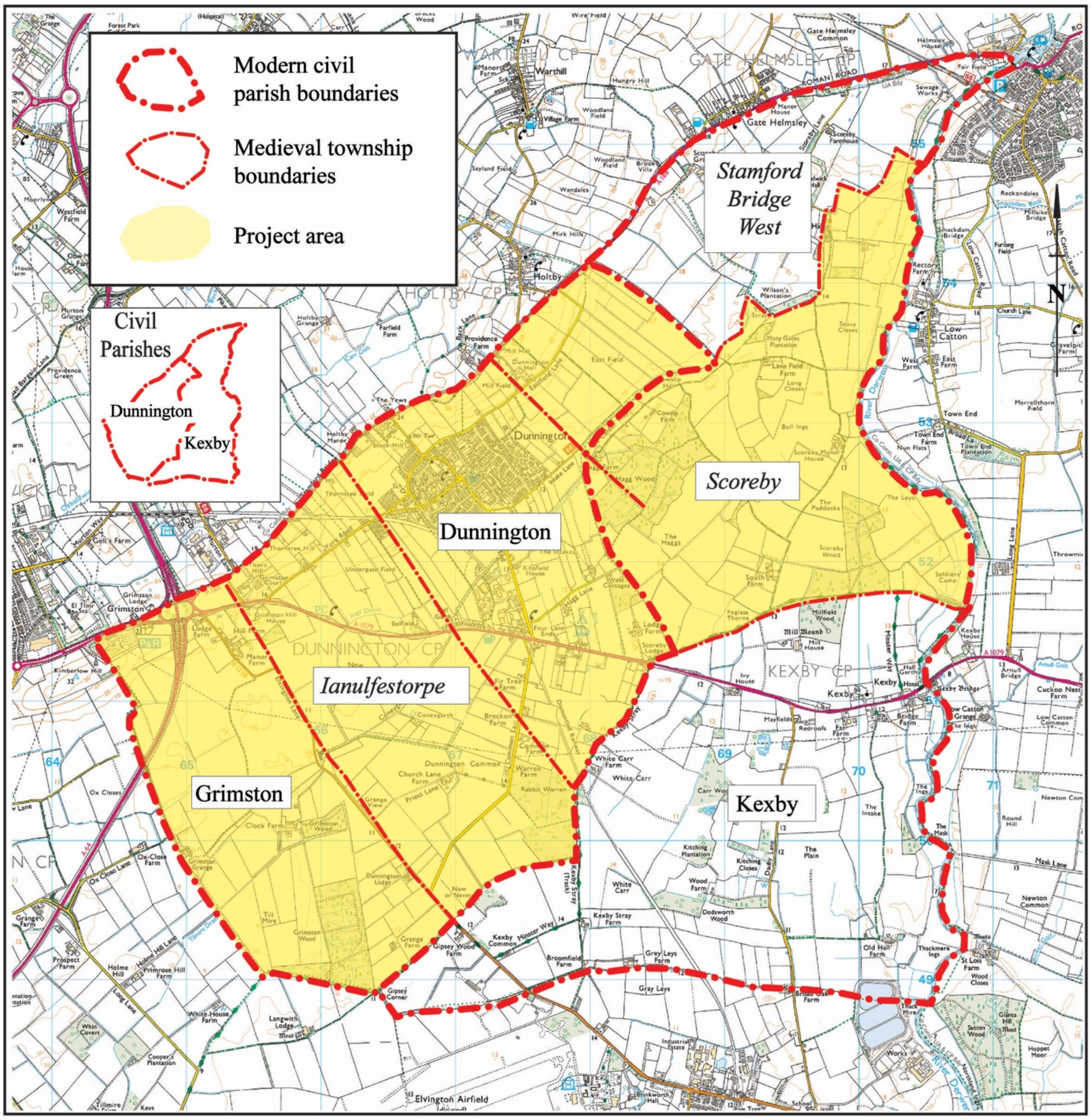


Figure 198.53 - Map of the overall study area, including the nearby medieval township of *Scoreby* (not reported on here) that is part of a separate study and the location of the medieval township of *Stamford Bridge West*. An overview of the current civil parishes is also shown (inset). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

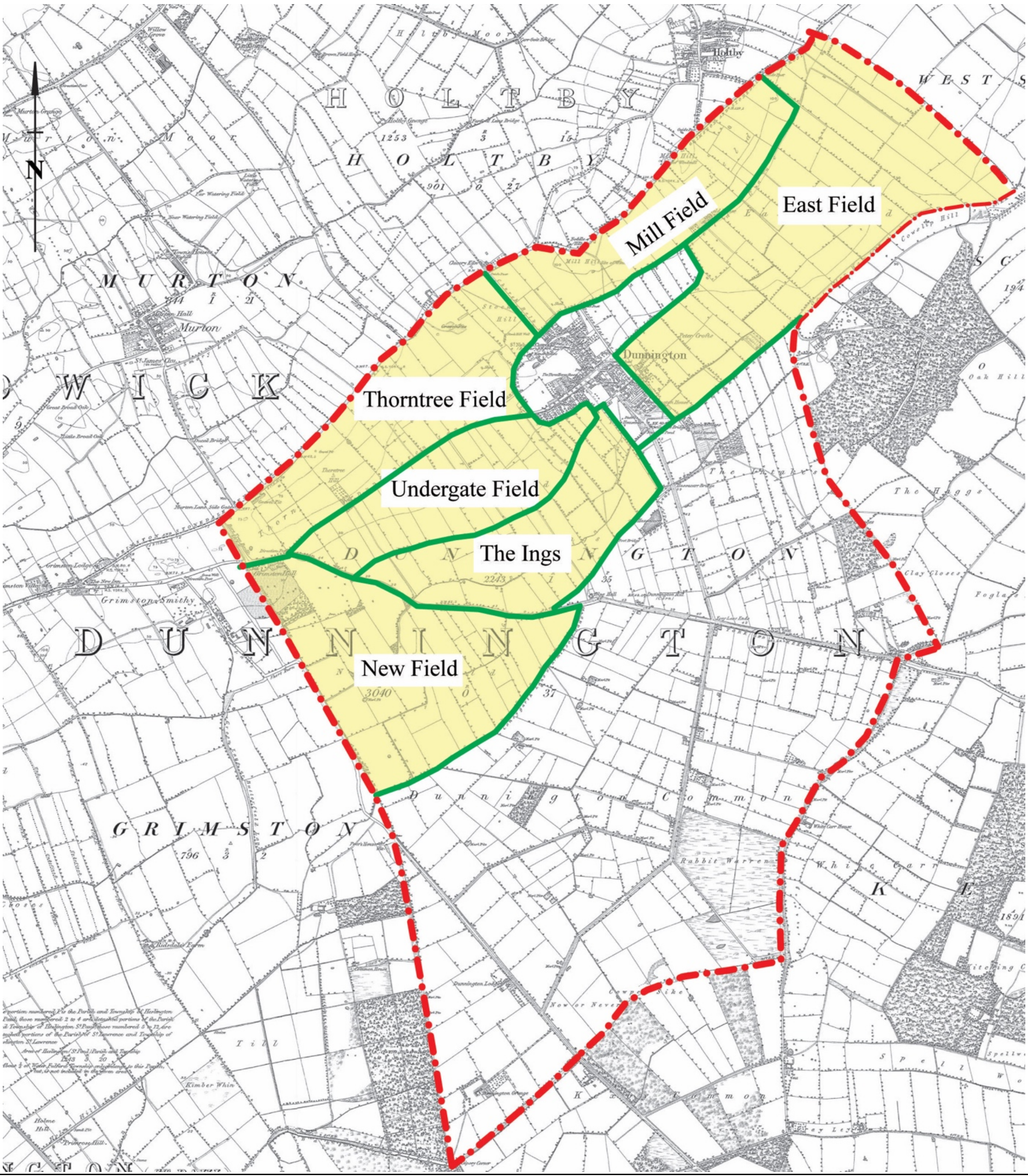


Figure 199.54 – The layout of the medieval open fields for Dunnington, the uncoloured area being the common that was enclosed from 1772. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

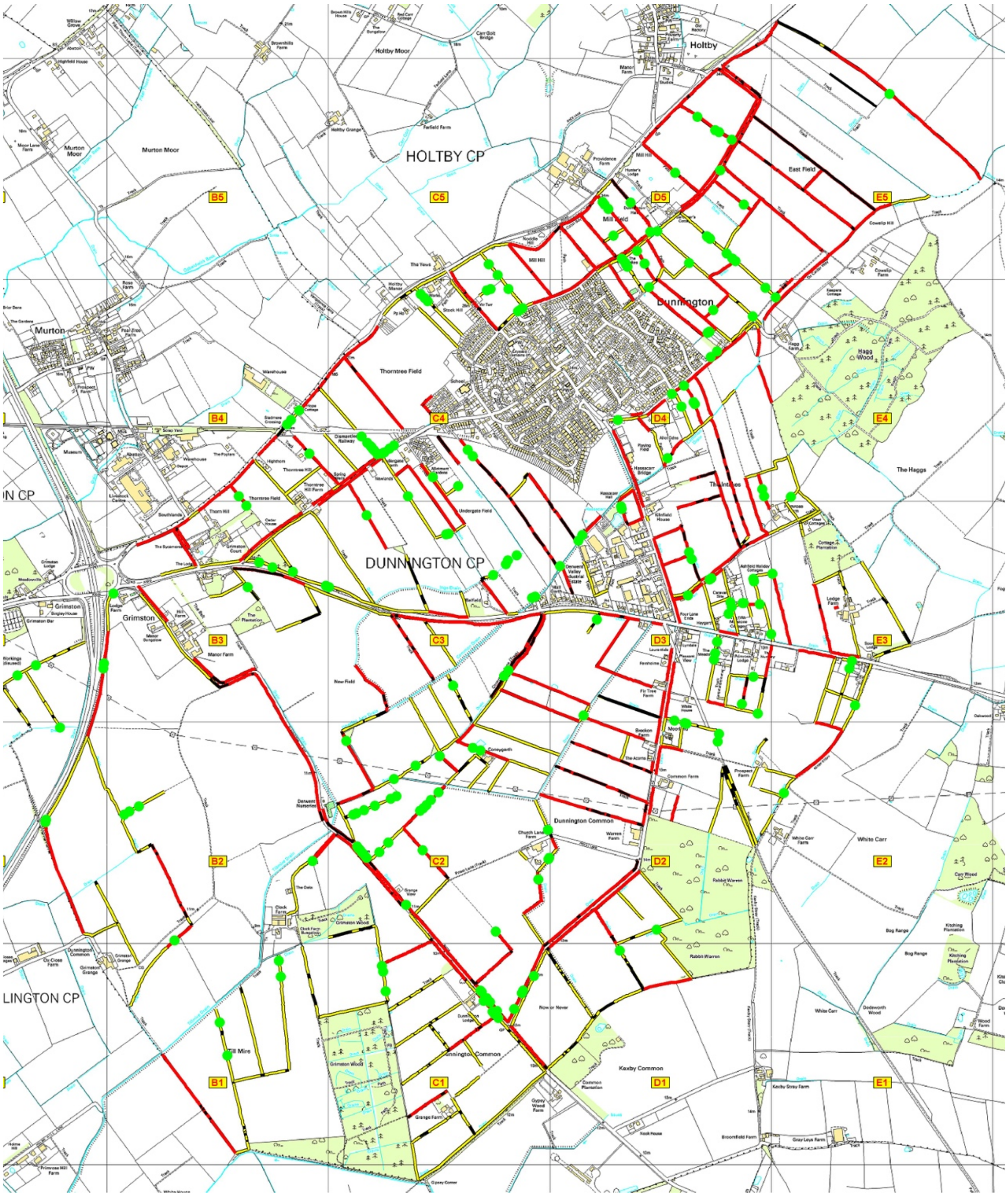


Figure 200.55 – An example map showing the distribution of Ash as a hedge component and as a hedgerow tree across the whole study area. Red lines = present; Yellow = absent; Black = gap/ hedge missing; Green dot = Ash as a tree. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

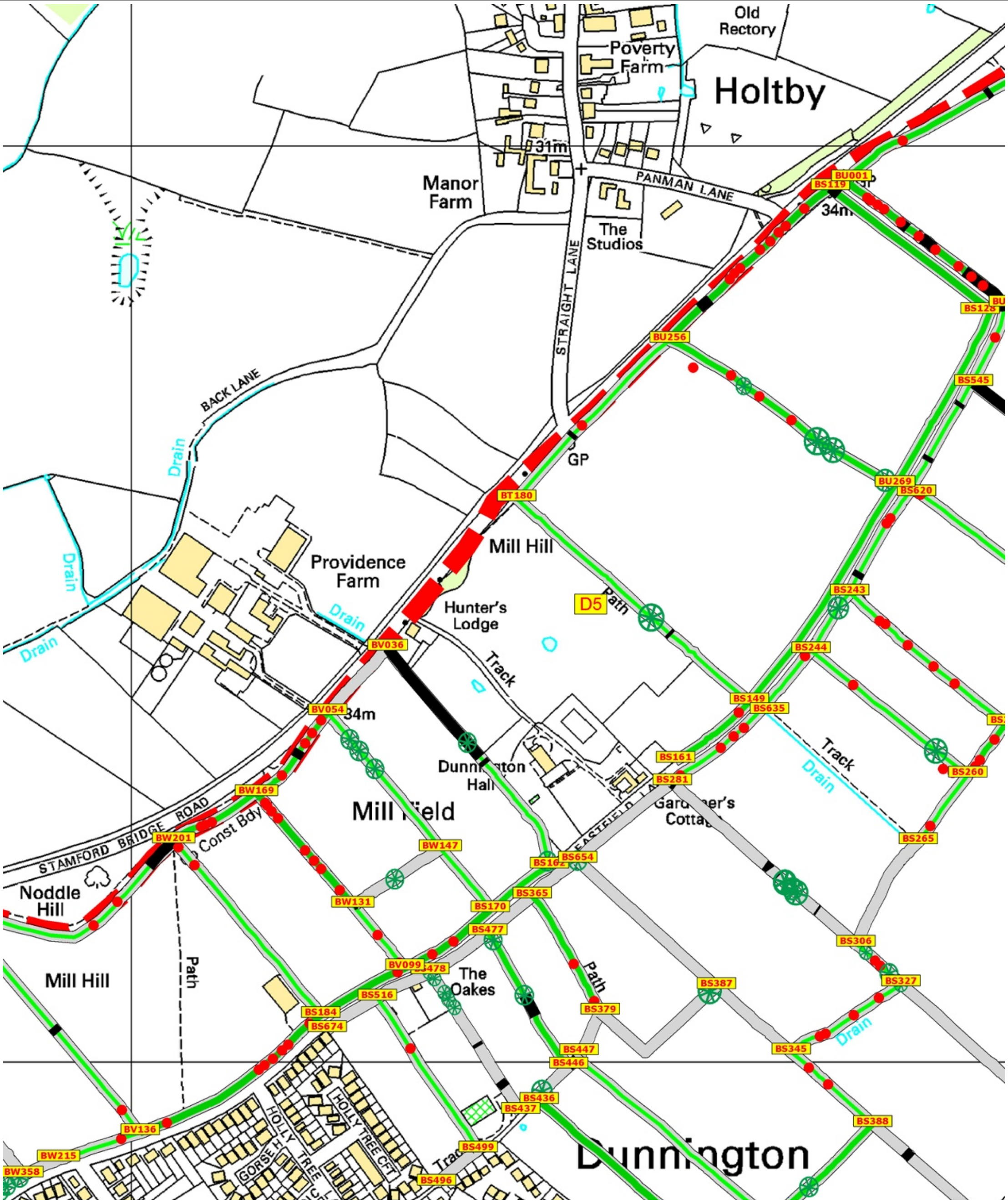


Figure 201.56 – An example map showing the distribution of Ash in [D5]. Green line = present (frequency = increasing width and abundance = darkening colour) Red dot = Ash as a shrub in the hedge; Green cartwheel = Ash tree (diameter = size of trunk); Grey line = surveyed hedgerow, but Ash not present; Black line = gap/ hedge missing. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Total list of species

From the total list of species Hawthorn *Crataegus monogyna* was predictably the most frequent species across the whole study area being found on 404 of the 430 hedgerows (94%). Of the major structural shrubs Blackthorn *Prunus spinosa* (55%), Elder *Sambucus nigra* (53%), Ash *Fraxinus excelsior* (46%) and Hazel *Corylus avellana* (38%) were also well represented across the study area. Some of the berry-bearing climbers like Bramble *Rubus fruticosus* (70%) and Dog Rose *Rosa canina* (50%) were also very frequent across the landscape.

A graphical representation of the abundance in terms of percent frequency in the case study hedgerows is at Figure 202.57. This gives a visual indication of which species are most frequently found across the entire study area and also those that are in relatively low frequencies or the 1st decile species. The table at Table 205.19 shows the percentage occurrences of each species over the whole study area for each phase.

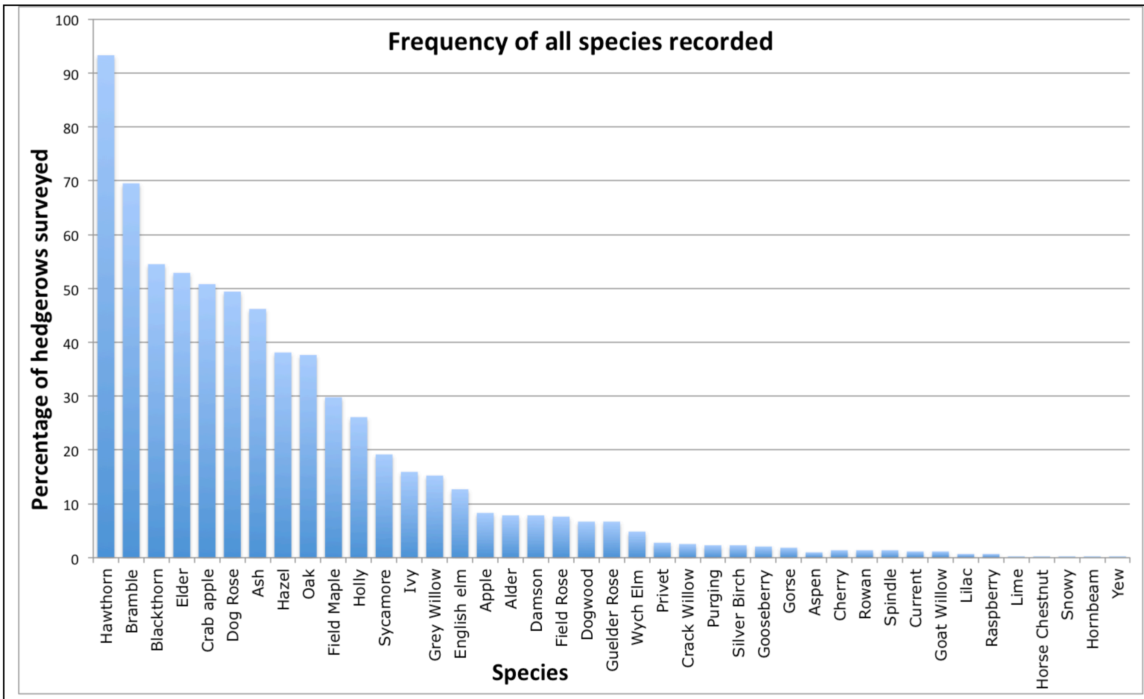


Figure 202.57 - The percentage frequency of each species over the whole study area

The maximum number of species along any hedgerow was 17 with an average of 7.

The overall abundances of each species across the entire site broken down by their DDAFOR values is at Annex [A7-7]. This also summarises the DDAFOR data for each phase [A7-9] to [A7-34].

The frequency of some species at the hedgerow level were variable and predictable, with Hawthorn *Crataegus monogyna* being found to be more often abundant or dominant and less often rare in most hedgerows, and Blackthorn *Prunus spinosa* was almost opposite -

Hawthorn - D=27% - A=48% - F=14% - O=6% - R=5%
Blackthorn - D=2% - A=18% - F=19% - O=31% - R=31%.

Many of the 1st decile species overall were also tending towards low amounts in individual hedgerows. One anomalous species was English Elm *Ulmus procera*. This was found at - D=13% A=23% F=9% O=20% R=36%. The large number of hedgerows with it present and abundant or dominant is a reflection of the potential aggressive nature of this suckering species.

Species by Phase

The primary aim of this research was to determine any correlation between the documented phases of landscape development. Both sets of data are available with the caveat that there is no certainty that an area of land identified as belonging to a given phase will have been devoid of all hedgerows before that time or that all of the hedgerows we see today were created in that area during that phase. Also it cannot be determined that all of the hedgerows attributable to a given phase:

- Were planted with the same mix
- Have followed the same pattern of dynamic development up to the present day. The original landowners and those that followed may have made different modifications to the mix over time.

Overall species by phase

One of the basic considerations that has been adopted by the Hooper (Pollard, Hooper and Moore 1974) rule is the number of species per 30m section of hedgerow. This is taken to indicate the age of a hedgerow in years based on a pure numerical count. The data from Dunnington are presented at Table 204.18. The overall trend of species-richness across time did not support the theory that older hedgerows had more species. This study did not follow the rules of the Hooper method of using 30m sections, but the whole hedgerow averages obtained are likely to give a fair reflection of the species-richness. Only [DU-1] appeared to be elevated. Even the enclosure phases of [DU-6] and [DU-7] were comparable in species compared with medieval hedgerows in [DU-2] (see Table 204.18). Table 204.18, in keeping with the treatment by Hooper (Pollard, Hooper and Moore 1974) does not differentiate which species are involved in the average species counts. It is likely that certain species may be preferential to a particular phase of landscape development. Species may be present in early hedgerows and absent from later ones reflecting changes in planting policy or changes in the availability of stock plants. Conversely, species may be absent in early periods and may be introduced in later phases. These scenarios are dealt with earlier and are illustrated by Abundance-o-grams as shown at Figure 311.132 and Figure 312.133.

As hedgerows develop through time the species present can either increase or decrease in frequency and/or abundance. These scenarios are illustrated by Abundance-o-grams. This section deals with the changes in species occurrence across the different phases of hedgerow development.

Phase	Minimum No of species	Maximum No of species	Average No of species
DU-1 - Coaxial fields and early routes	3	16	10
DU-2 - Medieval Township boundaries	1	17	7
DU-3 - Internal medieval field boundaries	1	12	8
DU-4 - The intakes	2	11	8
DU-5 - Rabbit Warrens	1	8	5
DU-6 - 1709 enclosure	1	13	8
DU-7 - 1772 enclosure	1	13	7
DU-M - Modern	1	12	6
GR-1 - Coaxial early fields	3	10	7
GR-3 - Medieval township boundaries	3	8	5
GR-4 - 1680 enclosure	1	11	6
GR-M - Modern	3	5	4

Table 204.18 - Summary of the species richness of each historic phase.

Species in each phase

Consideration of the species present in each phase is an important aspect of this research. There are two elements to this component:

- The range of species present
- The abundance of each species present

In terms of the frequency (range) of each species in each of the phases, these are shown at Table 205.19. This table shows that there are a number of phases where certain species are absent. It is also worth bearing in mind that the number of hedgerows in some phases are very low and that the percentage frequencies are artificially high. For example, at Grimston phase 1 there are only five hedgerows, hence a species in a single hedgerow represents 20%. In reality this is only one hedgerow out of the five in that phase. This table still indicates which species are present in each of the phases. The total at the end indicates how many species occur overall in each phase.

Phase	ALDER	ASH	ASPEN	BLACK CURRENT	BLACKTHORN	BRAMBLE	CRAB APPLE	DAMSON	DOG ROSE	DOGWOOD	DOMESTIC APPLE	ELDER	ENGLISH ELM	FIELD MAPLE	FIELD ROSE	GOAT WILLOW	GOOSEBERRY	GORSE	GREY WILLOW	GUELDER-ROSE	HAWTHORN	HAZEL	HOLLY	HORNBEAM	HORSE CHESTNUT	IVY	LILAC	LIME	PEDUNCULATE OAK	PRIVET	PURGING BUCKTHORN	ROWAN	SILVER BIRCH	SNOWY MESPILUS	SPINDLE	SYCAMORE	WEEPING WILLOW	WYCH ELM	YEW	Total
	Species																																							
DU-1		69		8	100	85	54	15	85	46		92		62	38					8	92	54	31			8			62		8				8	8				20
DU-2	2	45	2		55	66	47		57	11	4	68	26	32	2		2	2	23	13	85	43	26			6			21	4	4	2	2		2	23	2	4	2	31
DU-3		51		4	65	75	49	8	57	10		65	18	61	8		6		2	8	94	43	20	2		39	2	2	29	8	2				2	27	4	8		29
DU-4		57			71	79	57		29	14		36	21	43					7		93	79	50			64	7		43	14										17
DU-5	31	46			8	62	23	15	38		8	23	15	8					23	8	69	15	8						38				8			8	8			20
DU-6	2	51			69	67	58	5	56	13	7	58	12	57	5		3		9	9	99	58	37		1	23			37	1		1			1	12	3	9		28
DU-7	17	45	2	1	43	71	59	14	43		16	43	11	8	8	3	1	4	23	5	97	25	26			8	2	1	46	1	3	3	4	1	1	19	1	4		35
DU-M		20	20		40	60	40		30		10	50		10	10			10	20		100	10	10			20			40		10		10			30	10			21
GR-1		80			60	40	40		60			60	20	20	20				20	20	100	40				20			40							40				16
GR-3		29			86	71	29		43			57		14							100	29	14						29							14				12
GR-4	4	24			56	80	12		52		4	52	4	12	20					4	88	36	16					4	32	4	4					40	4			21

Table 205.19 - Summary of percentage frequencies for each species in each phase.

SPACES deals with the evidence from changes in species presence, frequency and abundance in order to detect any systematic differences that can be attributed to the phase of hedgerow creation.

An example of the differences in abundance of Hazel *Corylus avellana* in each phase is at Figure 205.58. This shows that in the earlier phases Hazel was found to be more frequent/ abundant on hedgerows compared with its occurrence on later hedgerows. This could equate to an evening out over time whereby a few original plants have slowly colonised and extended their range, or it could equally be that, at the time of planting, Hazel was preferentially added into the mixture and has maintained a high presence up to the present day.

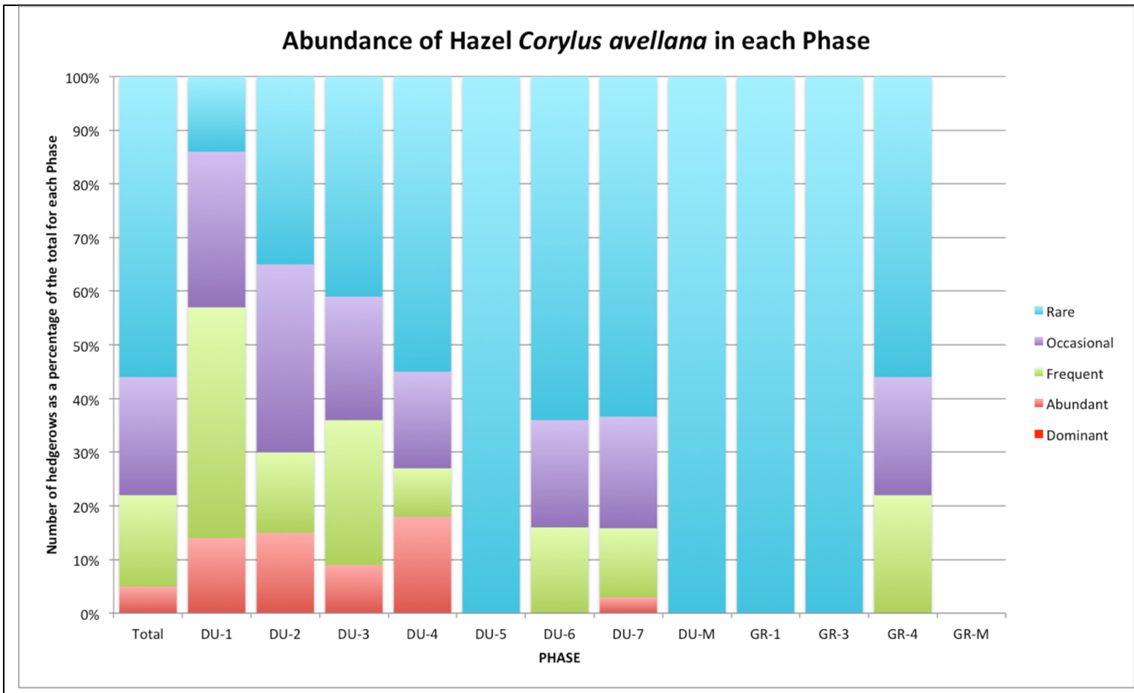


Figure 205.58 - An example chart showing the differences in species frequency/ abundance along hedgerows in each Phase for Hazel *Corylus avellana*.

Species results of SPACES

From the species perspective of SPACES there were a number that had one, or more, signatures that informed about history. Species of relevance are presented here with the full account being in the report itself. Of these, English Elm *Ulmus procera* is perhaps the most revealing. The suckering nature of this species means that it rarely achieves a stature that makes it susceptible to invasion by the beetle responsible for transmitting and spreading Dutch Elm disease.

English Elm *Ulmus procera*

[S]pecies + [P]osition

[T][SP][L]

See [A6-45] and [A1-193]-[A1-206].

Township boundaries

Looking at the pattern of distribution across Dunnington and *Grimston* medieval townships there are clear indications that this species is associated with some of the more ancient boundaries and routeways within that landscape [T][SP][L] it is preferential for township boundaries and the roads that separated the internal medieval fields. It also has [T][SPA][H] attributes as it has differences in abundance when found. On some hedgerows it is super-abundant [AA] and on others it may only be as scattered single plants [aa].

The northern boundary of Dunnington is a good example of English Elm on a township boundary (Dunnington Phase 2). Several hedgerows along the southern side of this road have English Elm present (see [A1-194], [A1-195], [A1-198], [A1-199], [A1-200], [A1-204] and Figure 207.59).

This species is also along the Dunnington/ Kexby boundary (Dunnington Phase 2) as seen on [A1-205] and [A1-206], and on the Dunnington/ Grimston boundary (*Grimston* Phase 1) [A1-193] [A1-194] [A1-196] on the Grimston side of the Elvington Lane (except on [A1-197] where it is also on the hedgerow that passes east of Derwent Nurseries). This alignment parallels what could be fragments of a coaxial field system to the east and west. To the west is hedgerow [A1-193] [CE145-CE174] and to the east is hedgerow [A1-197] [BX060-BX073]. Supporting evidence comes from the presence of Guelder-rose on [A1-247] [CE099-CE117] and Spindle on [A1-411] [BX092-BX117].

It is also present on the Dunnington/ *Scoreby* boundary at [A1-203] [BH210-BL2026].

Open field boundaries

It occurs on many of the Dunnington Phase 3 - between open field hedgerows – such as along York Road leading from York to the village (see [A1-199] and Figure 207.60). It is on both sides of the lane which Stephen Moorhouse regards as a lane separating two medieval open fields, Thorntree Field and Undergate Field.

This alignment also leads through the village to be picked up on Peter Croft Lane at [A1-203] that separates East Field from the area of croft and tofts east of the medieval core of Dunnington.

It also occurs on the hedgerows both sides of Intake Lane and borders East Field again at [A1-203] where it is super-abundant (Phase 3). It is at both the western and eastern ends on the southern boundary at [A1-203] [BL2046-BX286] and [A1-203] [BL2027-BL2032] to [BL2026-BL2027] respectively. These are presumed by Stephen Moorhouse to be Phase 4. The speculation would be that both hedgerows along Intake lane were either contemporary with Phase 3 or pre-dated Phase 3 and were part of a pre-medieval routeway and that they have been extensively re-planted leaving the fragments at both ends on both sides.

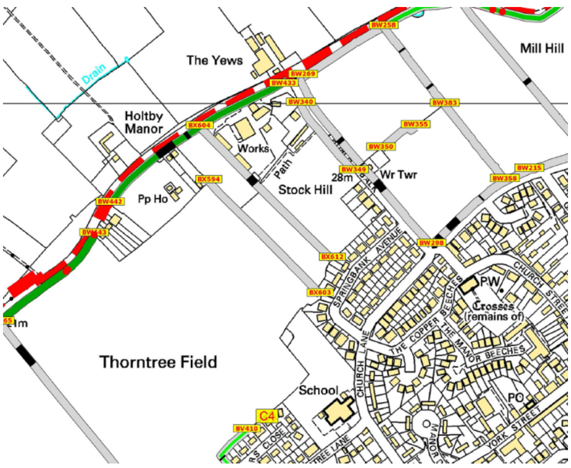


Figure 207.59 – A section of the northern boundary of Dunnington showing the incidence of English Elm in the hedgerows. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

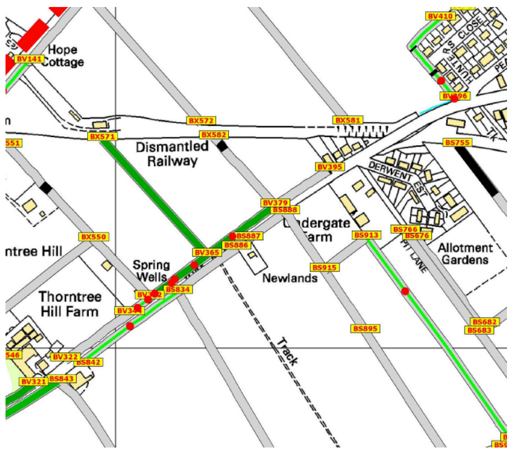


Figure 207.60 – English Elm on both sides of York Road and also on what was possibly a pre-medieval NW-SE alignment. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

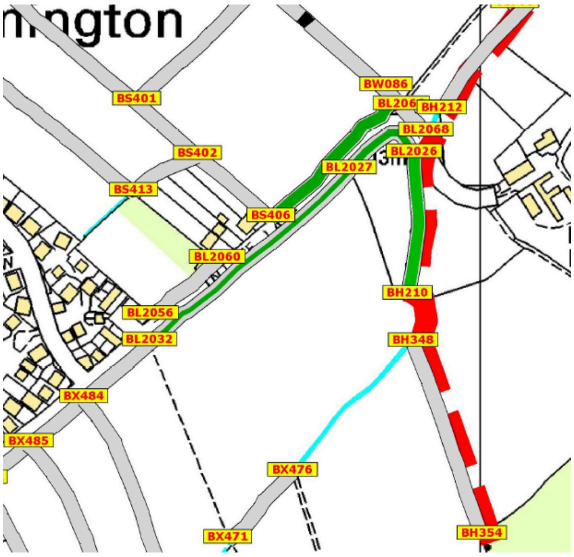


Figure 208.61 – The northern end of Intake Lane that was double-hedged with English Elm that has been retained historically while the rest of the Lane was re-planted more recently. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

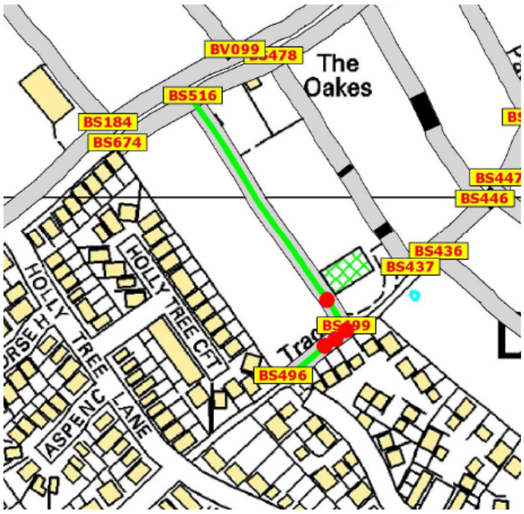


Figure 208.62 – English Elm along the north side of Peter Croft lane and also on [BS499-BS516], but only at the southern end where it has colonised along from Peter Croft Lane. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Roads, lanes and tracks.

In addition to Elvington Lane, York Road, Peter Croft Lane, the A166 and Intake Lane having English Elm hedgerows, the main road to Hull, the A1079, also had English Elm on both sides at various points within the study area.

Former road alignment?

Another curious occurrence of English Elm is on what could potentially be a re-alignment of the A1079 as shown on Figure 209.63 where the hedgerow [A1-202][CH176-CH198] retains two plants of English Elm (see Figure 210.64).

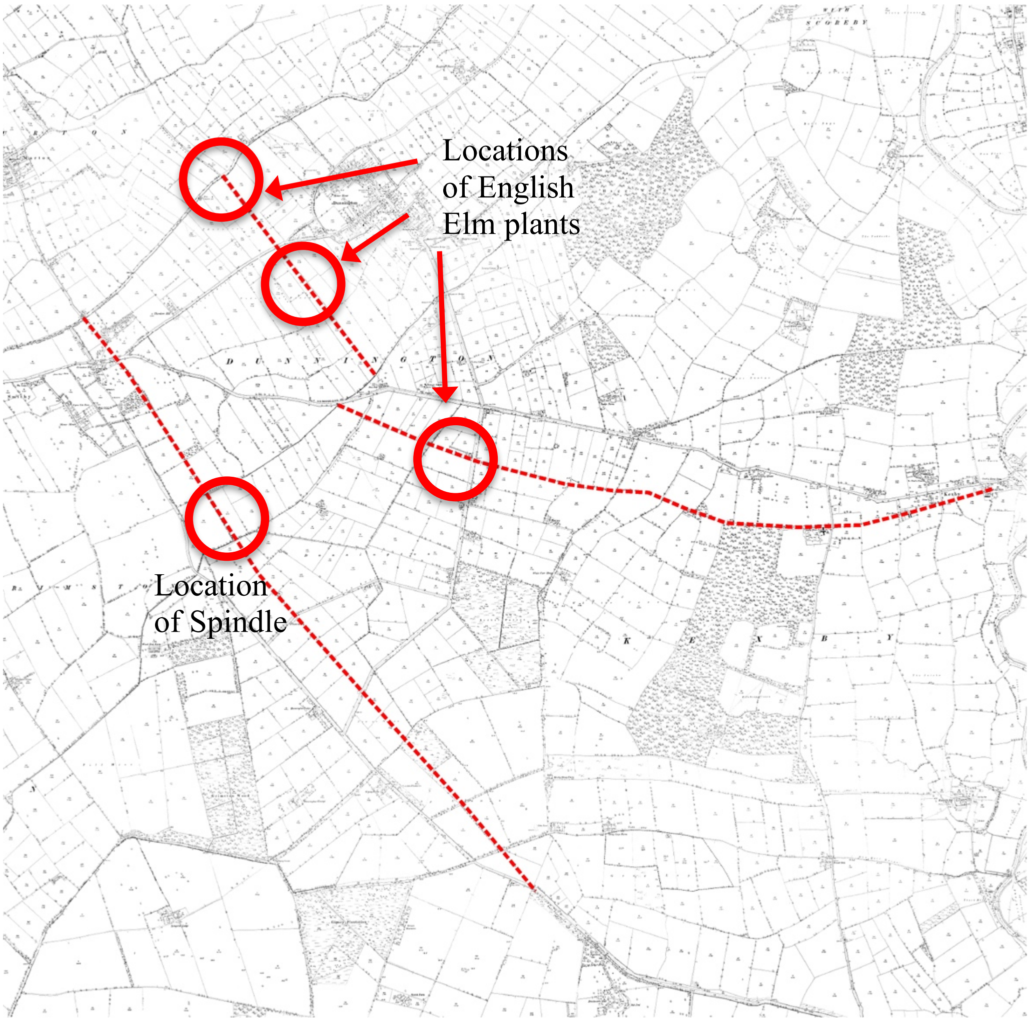


Figure 209.63 – Speculative former road alignments that have supporting hedgerow botanical data corroboration. The northern ones contain English Elm as a probable marker. The southern one has Wych Elm and Spindle as markers.

This may be part of a coaxial field system, as there are a number of other hedgerows to the south that have the same ‘grain’ running NW-SE, at a more E-W bearing than the coaxials that cross the Dunnington moraine which are on a more N-S bearing.

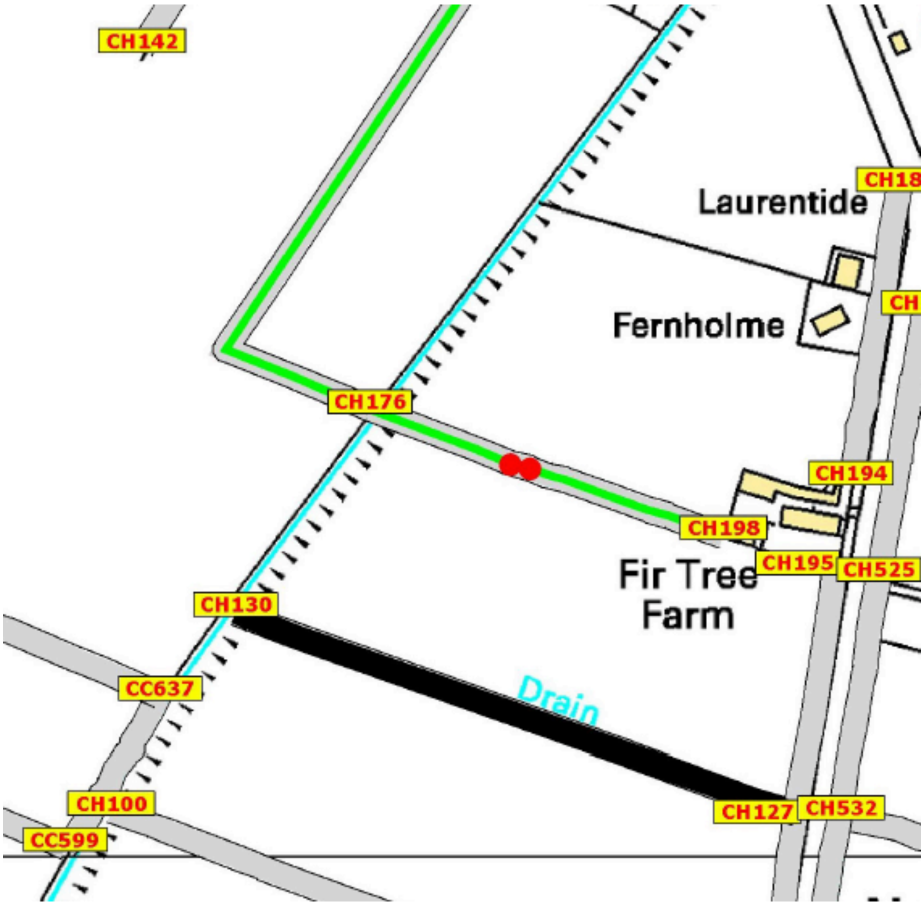


Figure 210.64 – The presence of English Elm on what is speculated could be an earlier alignment of the A1079 [A1-202]. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Coaxial alignments

Potential remnants of coaxial alignments are where English Elm is abundant to dominant on hedgerows that have an alignment that goes over the Moraine at right-angles i.e., NW-SE. Two examples are near Dunnington on York Road [A1-199] [BV365-BX571], and [A1-199] [BS755-BS760] and running north and south of the lane (see Figure 211.65 and Figure 211.66). And also at [A1-195] [BV486-BX521].

The latter ([BS755-BS760]) was investigated further as the 1st ed. OS map shows a hedgerow running NW to meet up with Vengeance Lane across the A166 (see [A5-11] and [A1-199]). There is the possibility that [BS755-BS760] was the eastern hedgerow of a lane that continued with a now missing hedgerow across Thornhill Field forming the western hedgerow at that point (see Figure 209.63). This hedgerow appears to have crossed the A166, as a single extant English Elm bush is found where the blue circle is on [A1-199]. In the area of this crossing there were some plants of English Elm on the southern side of the A166. But the road curves at this point and the English Elm at the start of Vengeance Lane is north of what would have been the northern side hedgerow of the A166, making it more likely that the English Elm on Vengeance Lane was not part of the A166 northern side hedgerow.

Unfortunately, the Vengeance Lane hedgerow is severely degraded and no more English Elm occurs north of the location on the A166 junction. The presence of English Elm part way along hedgerow [A1-199] [BV396-BV410] suggests another parallel coaxial hedgerow. Precisely aligning the gaps in these hedgerows is difficult and there is no certainty as to which joined with Vengeance Lane and which side of a possible track they were. All we can see is a number of parallel hedgerows south of Thorntree Field and a probable link to Vengeance Lane north of the A166.

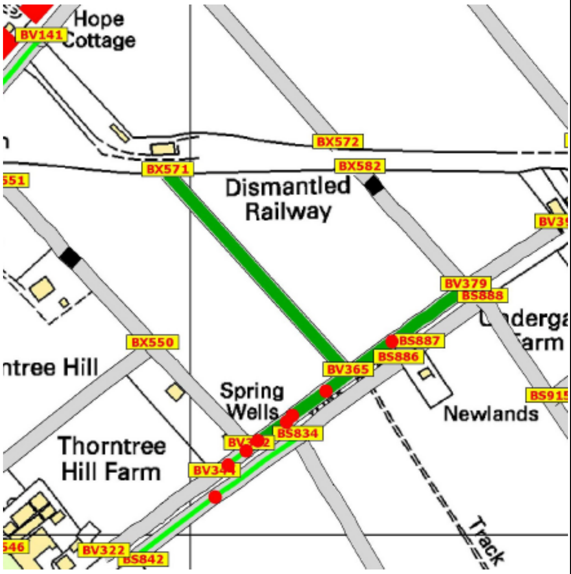


Figure 211.65 – An English Elm dominated hedgerow running northwest from York Road [C4][BV365-BX571] on [A1-199]. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

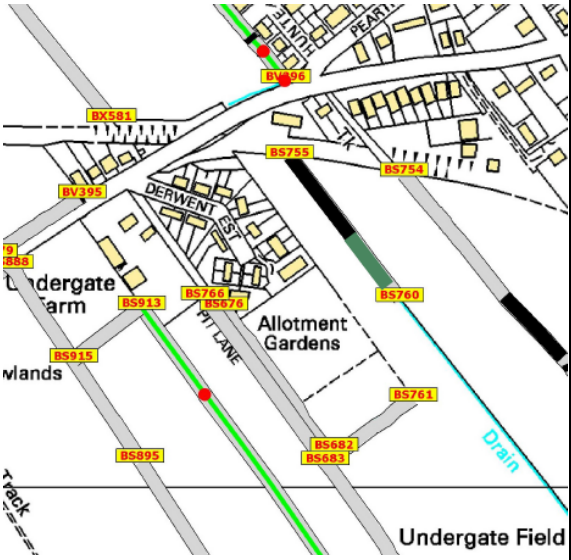


Figure 211.66 – Several NW-SE Aligned hedgerows with English Elm. [C4][BS755-BS760] was dominated by the species (see [A1-199]). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Another set of potential coaxials is on The Intakes as identified by Stephen Moorhouse. Hedgerows relating to this phase are in orange on [A5-1] and comprise the block of land shown on Figure 212.67.

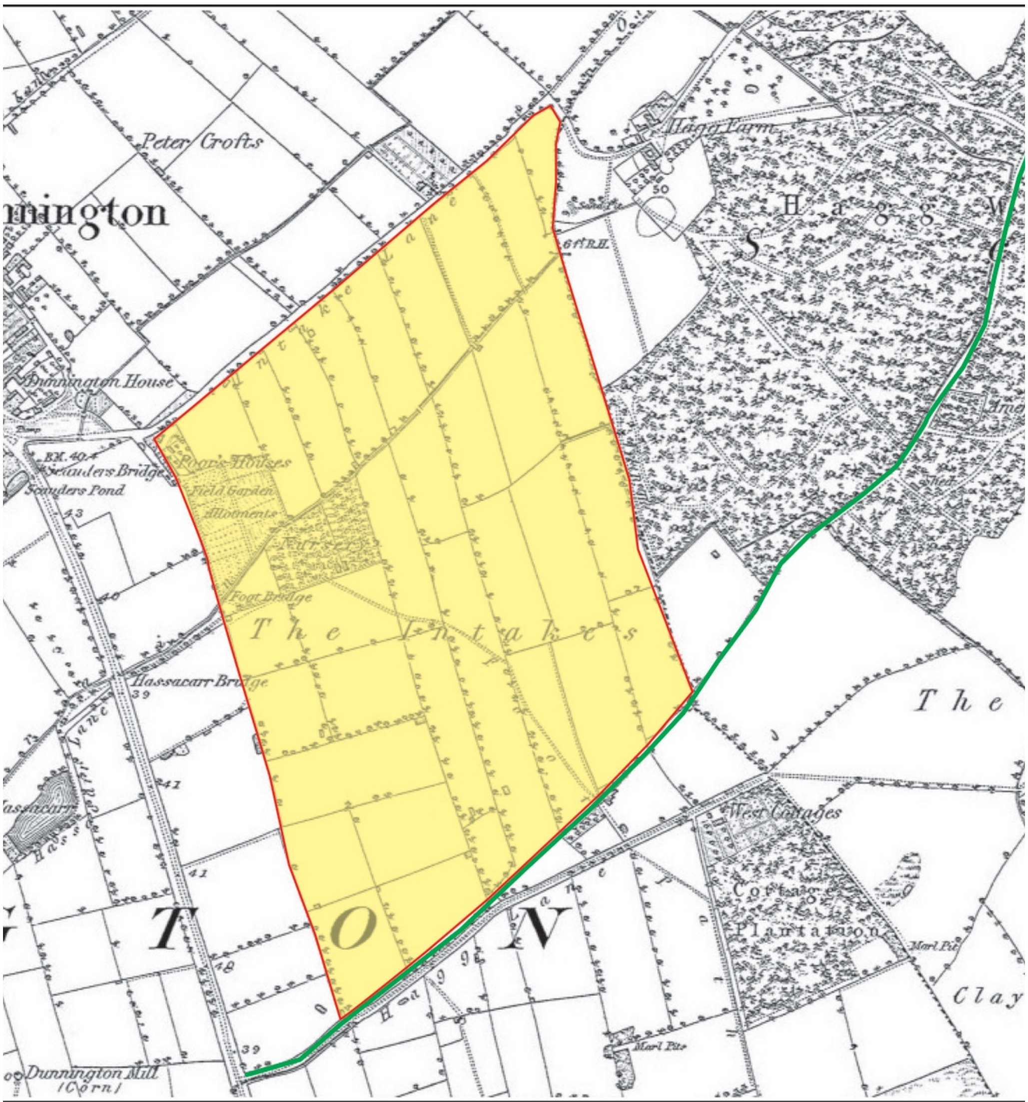


Figure 212.67 – The area of land believed to have been surrounded by hedgerows as part of Dunnington phase 4 in the late 17c. The internal hedgerows were then planted in the 1709 enclosure. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

There is a curious cluster of hedgerows in the eastern part of Dunnington township split between the Dunnington Intakes and the northern part of Dunnington Common. English Elm occurs in [A1-202] [BX315-BX361] north of Hagg Lane, but it also seems to occur in [CH774-CH778], [CH746-CH755-CH734-CH762-CH765] and [A1-206][CH629-CH666] and in septum hedgerows at [A1-202][BX322-BX337] and [A1-202][CH728-CH734]. Were these part of an earlier field system that Phase 4 and Phase 6 retained when they were enclosed and hedged? See Figure 213.68.

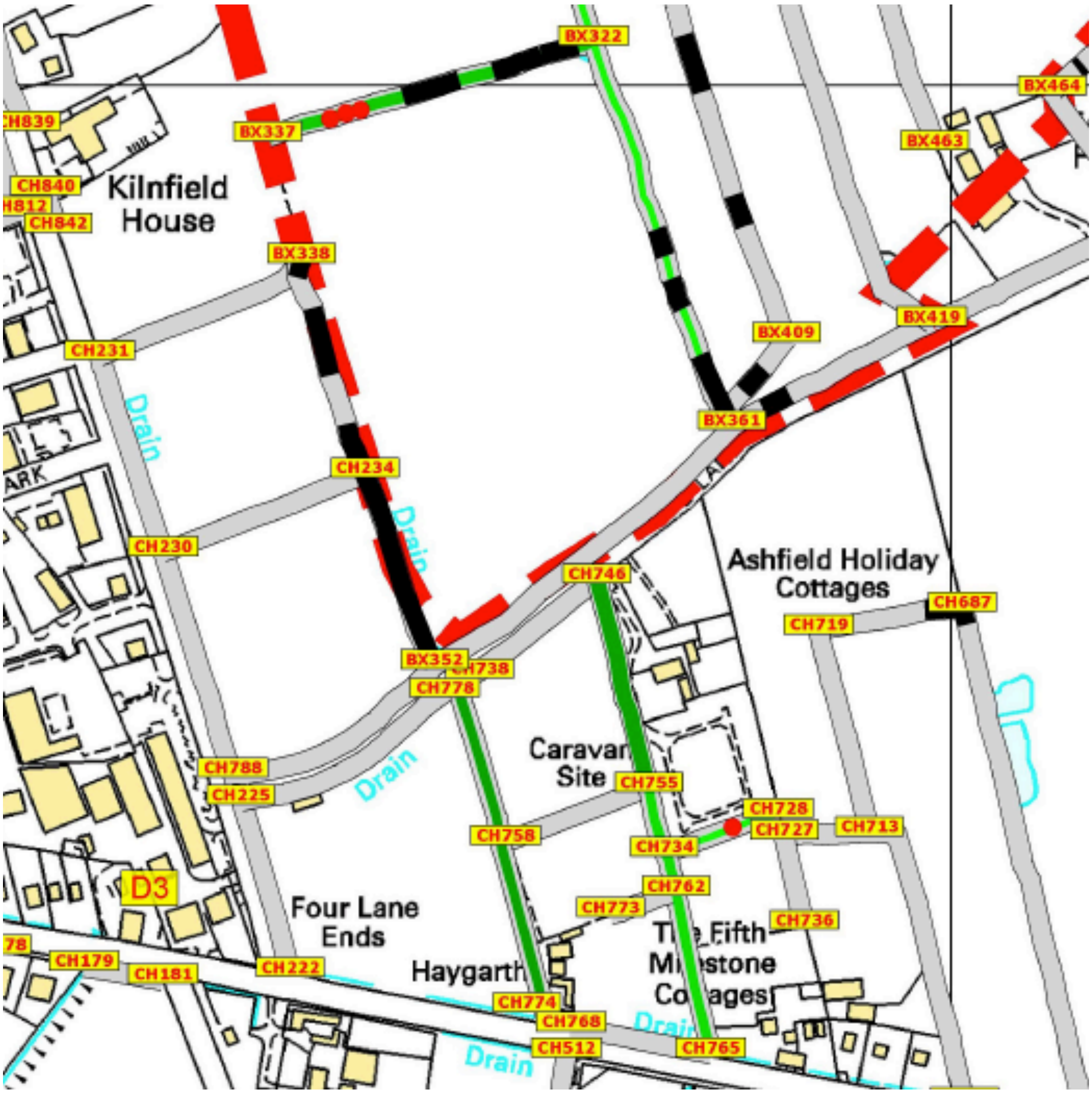


Figure 213.68 – The 'grain' and cross-septum hedgerows in, and to the south, of The Intakes either side of Hagg Lane. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

[T]ime + [S]pecies + [P]osition + [H]edge

There are a number of places in the landscape where evidence suggests that English Elm is colonising along relatively recently formed hedgerows from an initial inoculant derived from an historic hedgerow containing the species. Two good examples are at [A1-199] [BV396-BV410] north of York Road where the species is recorded, but only towards the lane and at Peter Crofts Lane on [A1-203] [BS499-BS516] where it may have only progressed a short distance from the lane. This hedgerow is suggested by Stephen Moorhouse to be Phase 6 (1709). This is likely as the alignment would not suggest it is part of an earlier coaxial system as might be the case for some of the hedgerows running NW-SE across the moraine through East Field.

[S]pecies + [A]bundance

[S]pecies + [A]bundance + [L]andscape

At the landscape level this species is generally rare.

[S]pecies + [A]bundance + [H]edgerow

The abundance data for this species differs from the norm of a tendency to be towards the rare end of the spectrum. There were 7 hedgerows where it was dominant and 13 where it was abundant. This accords with the data from *Scoreby* where three hedgerows datable to the medieval period are all now dominated by English Elm. Either this species was planted at this density or the species has aggressively become more dominant naturally over the last 800-1000 years. The vegetative suckering of English Elm will give it an advantage over seed dispersed species when gaps open up next to English Elm plants as they will be able to immediately move into the gap supported by the food resources of the main plant.

At the landscape level it is relatively uncommon, being recorded from 56 out of 430 or 13% of hedgerows in the study area. It is rarer in Grimston (three hedgerows only) than in Dunnington (53 hedgerows).

[S]pecies + [P]osition + [A]bundance

[T]ime + [S]pecies + [P]osition + [A]bundance + [L]andscape

Maps showing the *Scoreby* evidence for English Elm being a medieval or pre-medieval species are shown in Figure 215.69 and Figure 216.70. The first two of these figures show the overview of the landscape and the curved boundaries centred on the manor of *Scoreby* on the modern 1:10000 OS base to show the trace of what was there and what is left now. The second shows the presence of English Elm on two of the curved concentric rings and down a 'spoke' between two rings. This is a [T][SPA][L] signature with the abundance at the hedgerow level being [T][SPAA][H]. These were the only three hedgerows where English Elm was found in *Scoreby* apart from on the medieval township boundary with Dunnington. This gives English Elm potentially two [T][SPA][L] signatures, one where [T] = medieval and one where [T] = pre-medieval coaxial

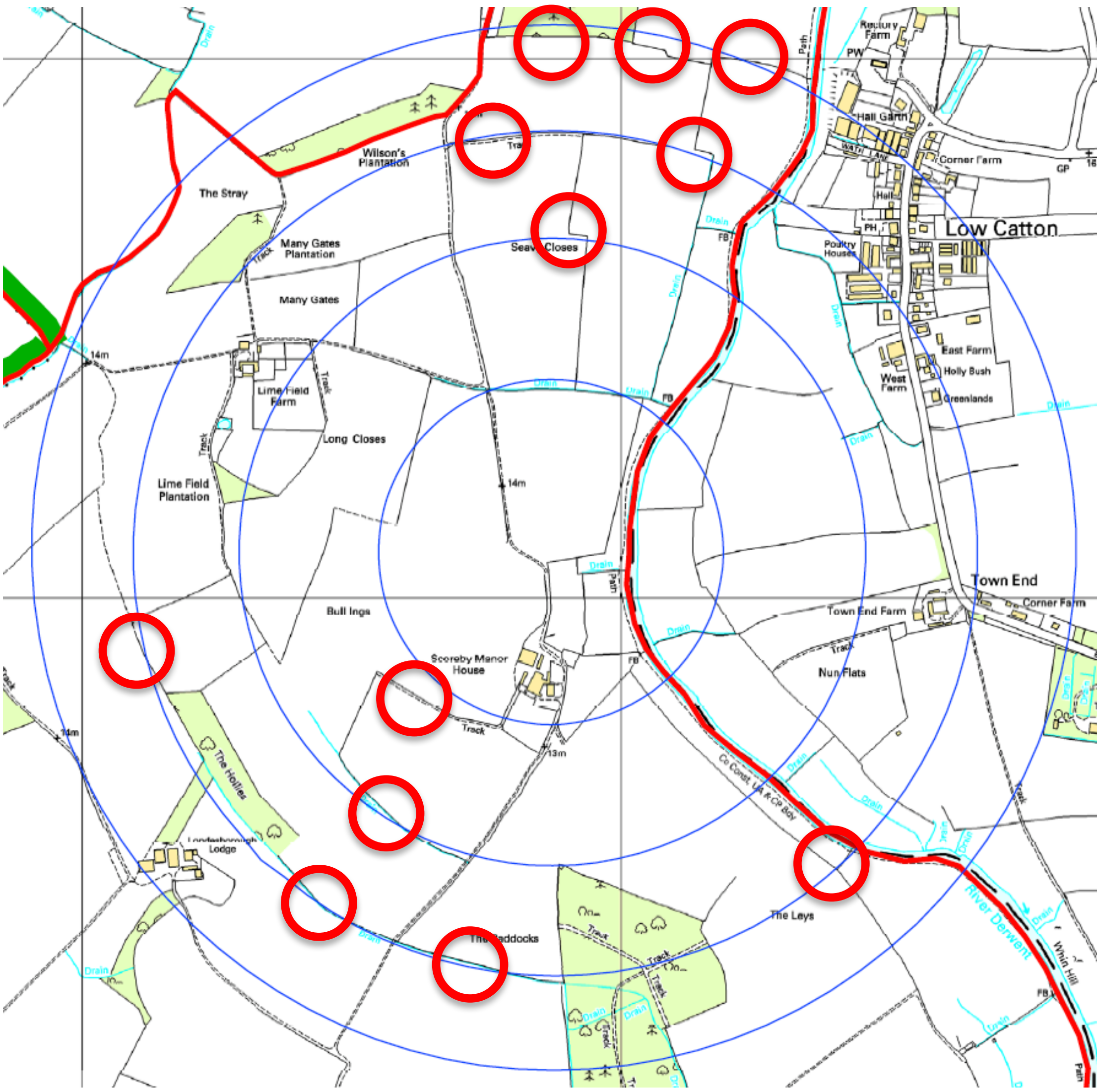


Figure 215.69 - The concentric medieval or pre-medieval ring field system at Scoreby on a modern base centred on the former medieval Scoreby Manor. Showing critical confirmatory fragments where the rings connect with current hedgerows. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

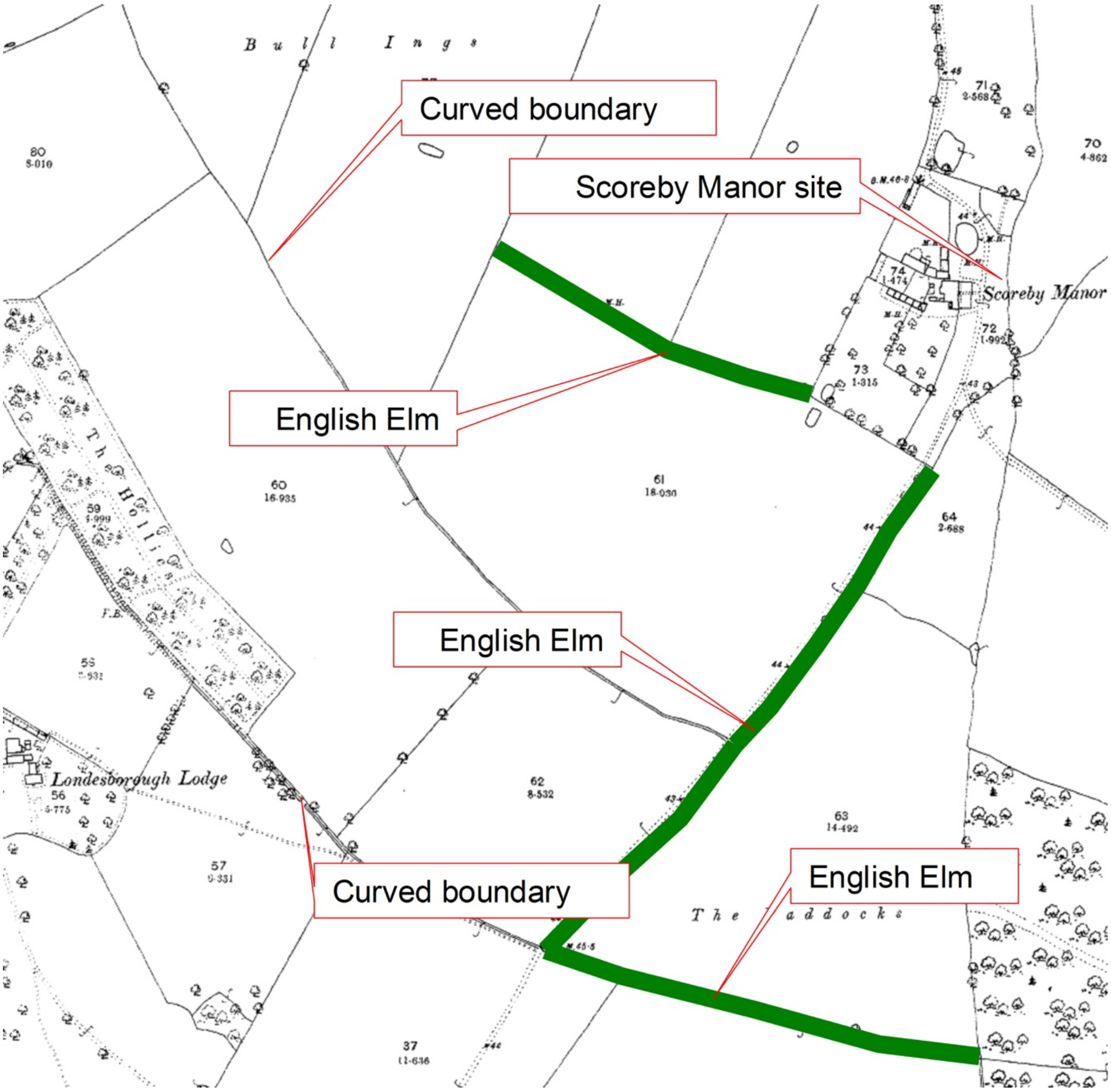


Figure 216.70- Close-up of the middle of the concentric fields at Scoreby showing which hedgerows are English Elm dominant. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

As part of observations made during the surveys for this research, the phenomenon of English Elm *Ulmus procera* tracing medieval roads and lanes has been recorded from a number of locations that confirm medieval, or earlier origins, including:

- The village of Long Marston, in the village and on the way to Tockwith, near York in North Yorkshire and on a possible coaxial alignment that runs in a straight line over the moraine of Bilton Bream (see Figure 217.71).

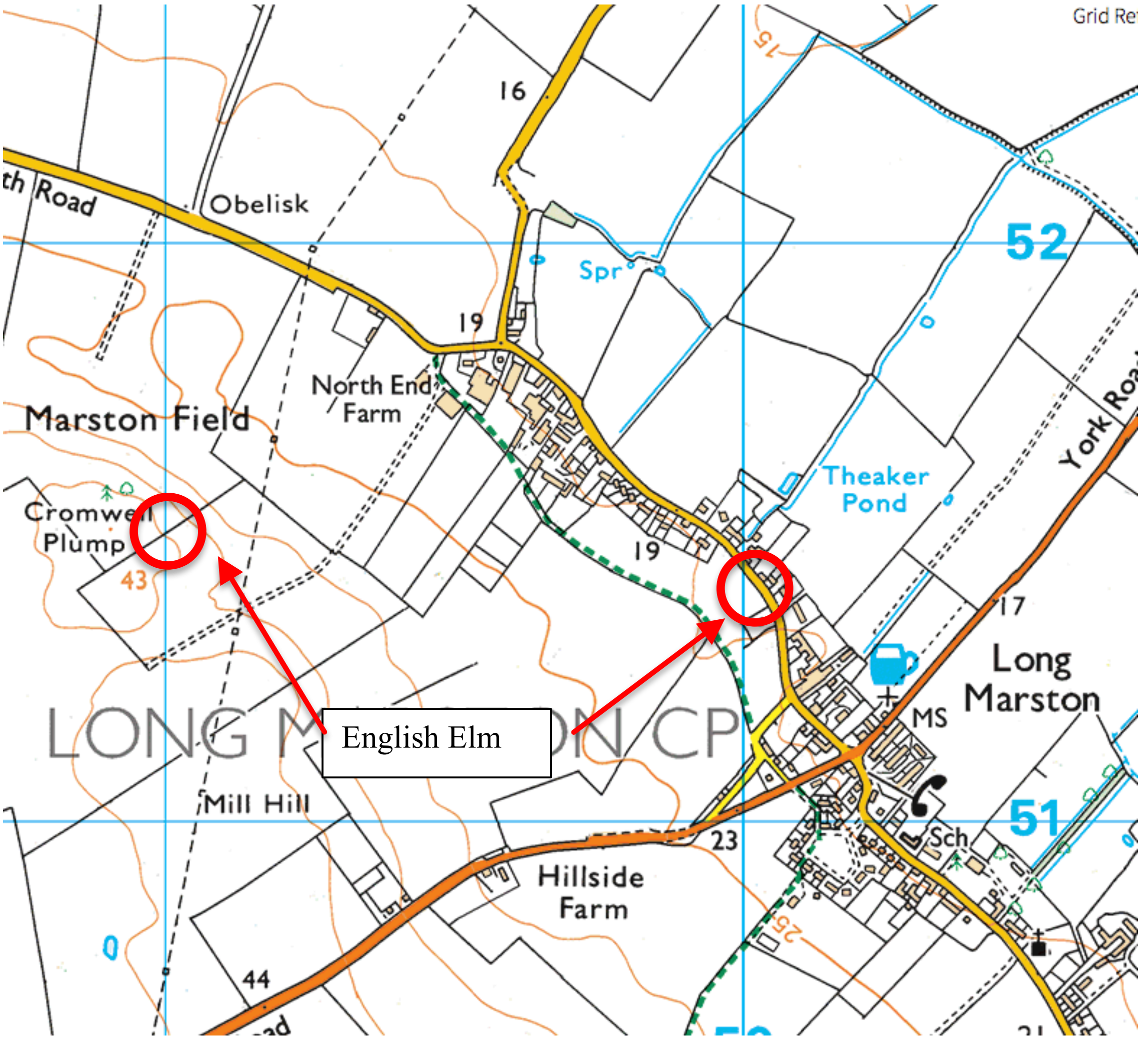


Figure 217.71 - Map of Long Marston showing the location of two instances of English Elm. One on the medieval road through the village (east) and one perpendicular to the moraine on a straight alignment as recorded at Dunnington (west). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

- On the B1224 east of Long Marston it is on both sides of this medieval major road between Wetherby and York. On the western side of the village it does not occur along the B1224, but runs along what is presumed to be a former route to Healaugh Priory along what it now just a bridleway (see Figure 218.72).

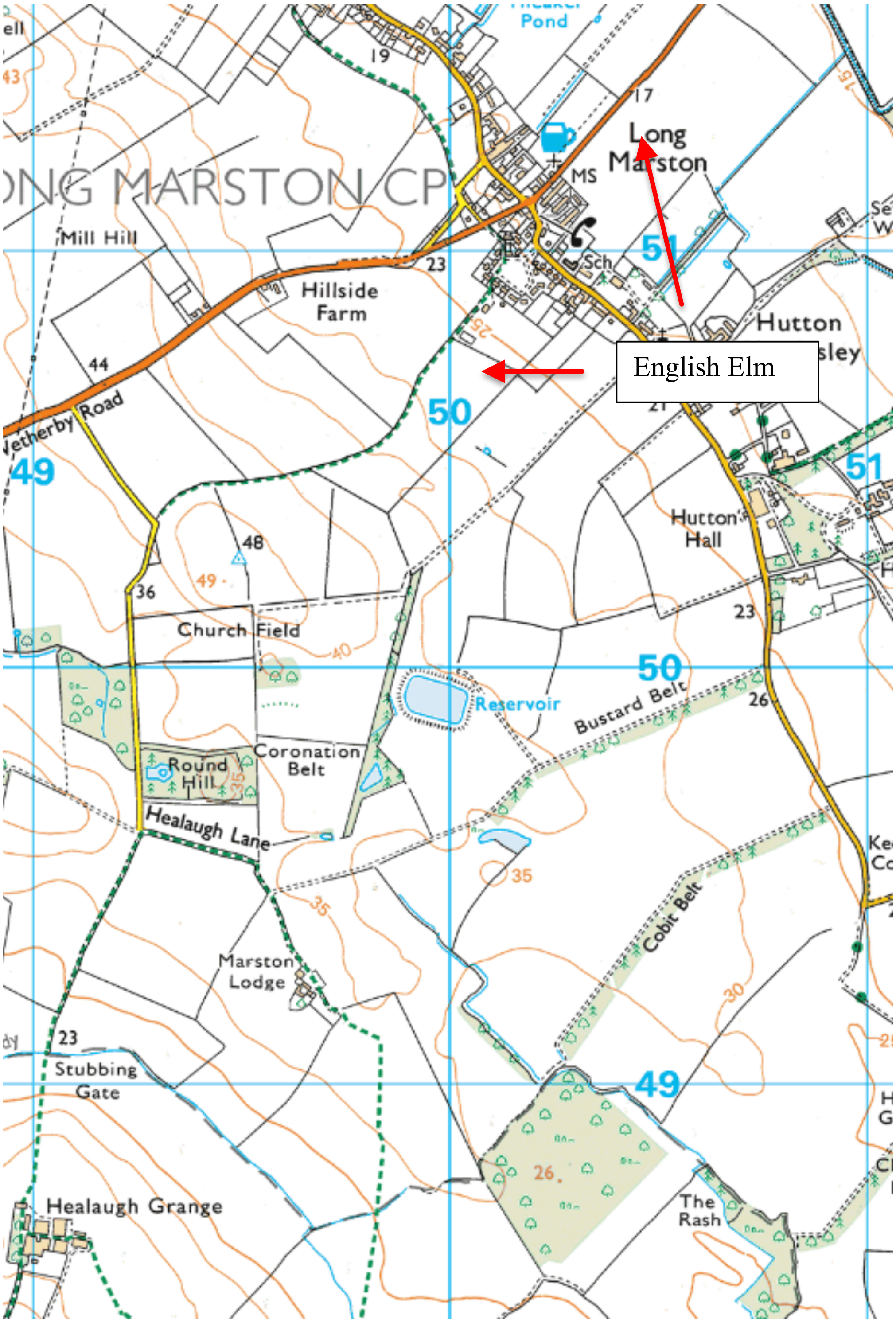


Figure 218.72 - Map of Long Marston showing the probable route to Healaugh Grange (Priory) where English Elm is dominant on the Wetherby Road east of the village and on the bridleway west of the village. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

- On two of the medieval entry and exit roads to Goldsborough, near Knaresborough in North Yorkshire (see Figure 219.73).

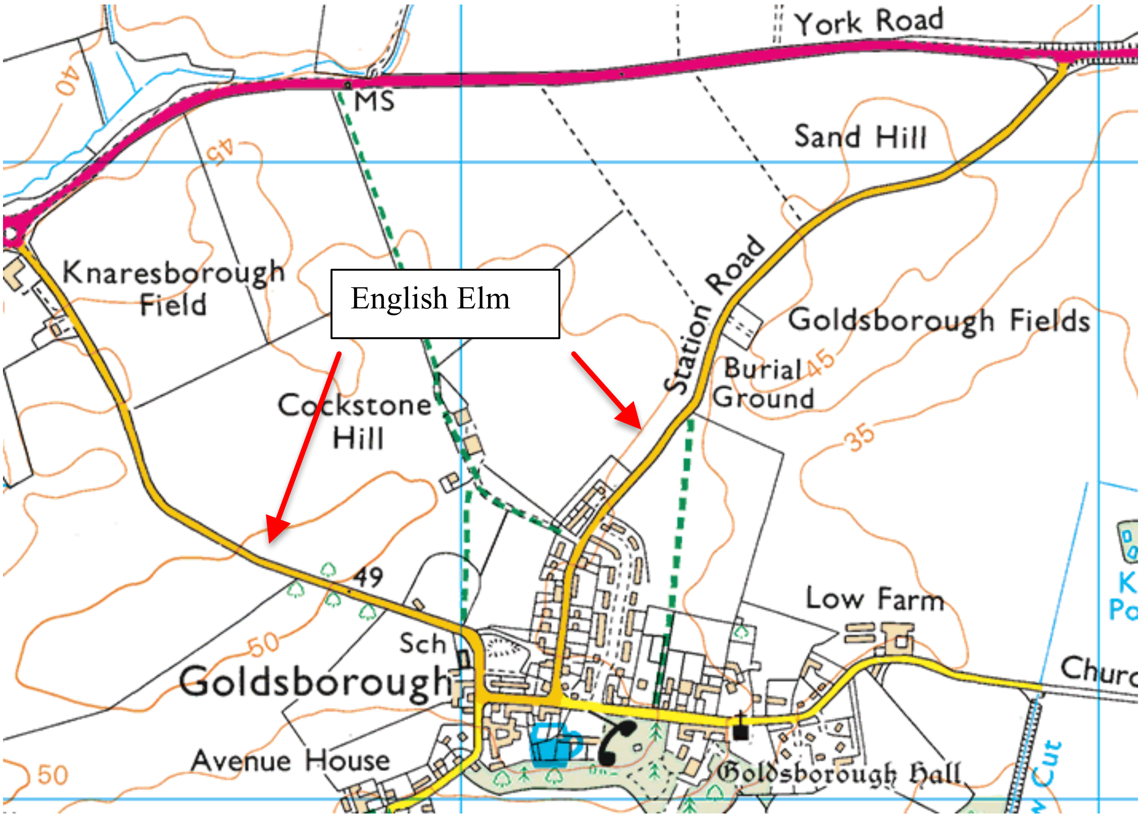


Figure 219.73 - Map of Goldsborough showing the location of English Elm on hedgerows leading into the village. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Anthropophyllous species

Two species were identified as having close affinity to places of human habitation. There were Black Currant *Ribes nigrum* and Gooseberry *Ribes uva-crispa*. These are both domestically useful species and were found in the Dunnington survey and also they have been found elsewhere in my studies, close to villages or manors and farmsteads.

Black Currant *Ribes nigrum*

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

See [A6-29] and [A1-145]-[A1-147]

At least two of the locations on Eastfield Lane, near to Dunnington Hall on [A1-146] indicate local domestic escapes from the gardens of the Hall. The other records on [A6-29] show no such affinity.

[S]pecies + [A]bundance

[S]pecies + [a]bundance + [L]andscape

Rare in the landscape.

[S]pecies + [a]bundance + [H]edgerow

Normally as single plants scattered along a hedgerow, or the only plant where found.

[S]pecies + [P]osition + [A]bundance

[S]pecies + [P]osition + [a]bundance + [L]andscape

There are very few records of domestic currants. These were identified as Black Currant during the surveys, and they were assumed to be of domestic origin.

This species was found in only a scattering of locations across Dunnington and Dunnington Common. The locations on Eastfield Lane in [A1-146] [BS365-BS654] and [BS281-BS654] were the only ones that showed an association with habitation (see Figure 221.74). As this species is dispersed by birds, this apparent random scatter of plants is easily understood.

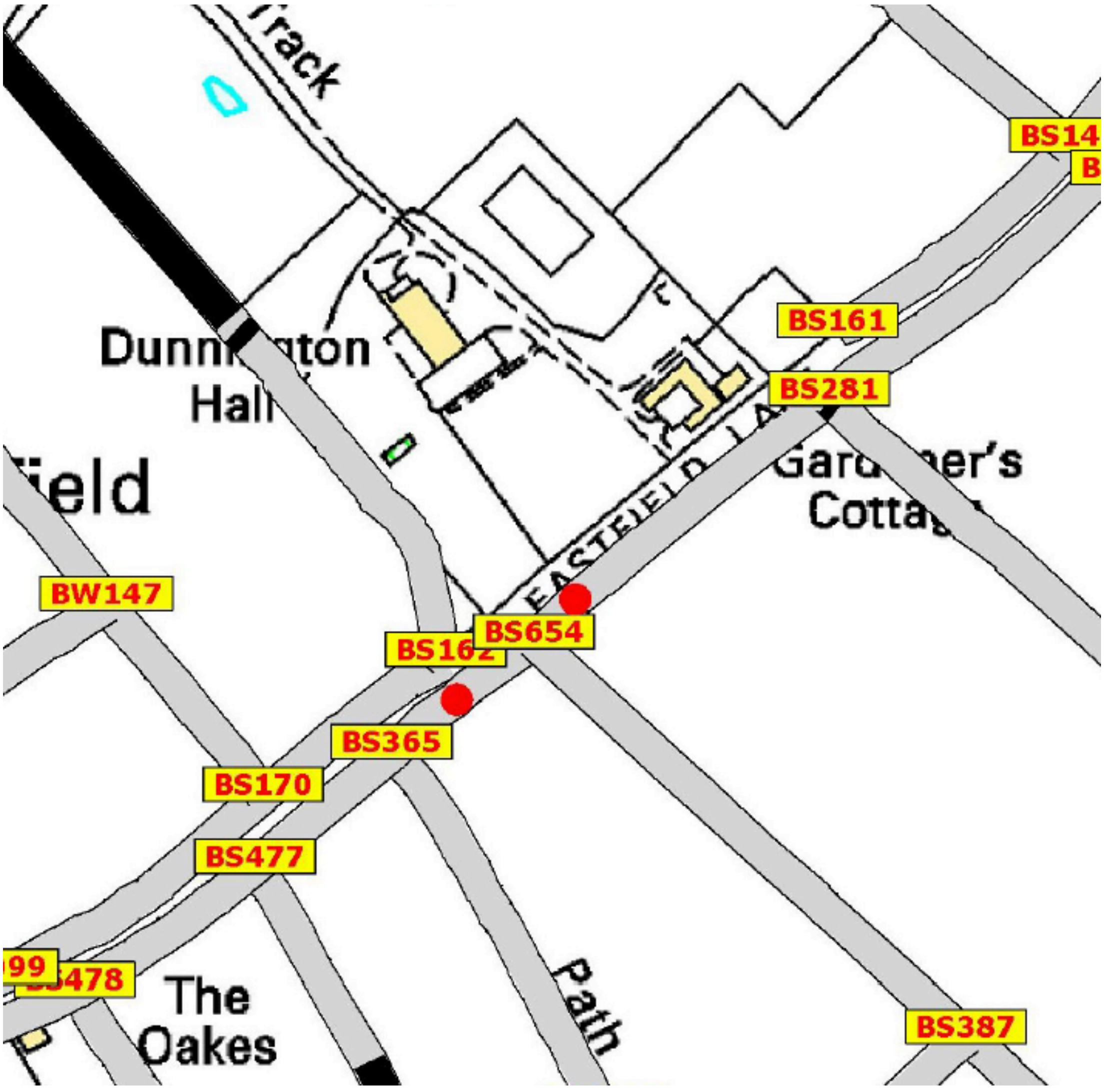


Figure 221.74 – The locations of two plants of Blackcurrant on Eastfield Lane near Dunnington Hall implying a domestic origin. These are in the [DU-3] Phase but could have colonised at any time from then onwards.

Gooseberry *Ribes uva-crispa*

[S]pecies + [P]osition

See [A6-30] and [A1-236]-[A1-242]. This species is anomalous as it has low vigour and does not compete well, nor does it generally achieve significant size. It is often only visible from one side of the hedgerow, even if the hedge is small to medium in size. Hence it can be, and was at Dunnington, overlooked. On Figure 224.75, the plant is on the west side of the hedgerow, but an original survey was along the eastern side and the species was missed. On a subsequent visit the west side was walked and the species recorded as labelled 'A' on Figure 224.75.

[S]pecies + [P]osition + [L]andscape

The overview at [A6-30] shows mainly positions near to the village of Dunnington (see Figure 224.75.

This association becomes more evident looking at [A1-240] where it is on the eastern boundary of the tofts and crofts that lie east of the village and next to Dunnington Hall (that has already been shown to have Black Currant as an escapee into nearby hedgerows next to the Hall). It also occurs along Eastfield Lane and for short distances north down the hedgerows leading to the A166.

[S]pecies + [A]bundance

This species is always recorded as single plants that are often difficult to spot as they are never vigorous growers in hedgerows. They are rare at both landscape [SA][L] and hedgerow scales [SA][H].

[S]pecies + [P]osition + [A]bundance

[S]pecies + [P]osition + [A]bundance + [L]andscape

The distribution of this species across the civil parish strongly suggests that it has slowly, over time, colonised some of the hedgerows close to the village of Dunnington and also next to Dunnington Hall on Eastfield Lane. There are other scattered records across the two medieval townships. These may be also indications of former domestic occupation in the area, but, as the Gooseberry is easily transported by birds, it could also be example of avichory.

Other examples of where this species has been studied and observed to be associated with habitation are:

- On the edge of the village of Tockwith along Southfield Lane next to the modern primary school (associated with Dog's Mercury *Mercurialis perennis* and Field Maple *Acer campestre*) at SE 46673 52003.
- 300m outside the village of Cattal on the way towards Hunsingore at SE 44305 53895 and
- 300m outside of the village of Hunsingore on the way to Cattal at SE 43153 53691.
- Adjacent to the croft of Greenbogue north of Dumfries at NY 01657 79334 and absent further afield in the surrounding hedgerow network.

There are also records associating this species with streams crossed by hedgerows. Possible explanations could be that farm workers discarded the fruits whilst taking a meal break near a stream (or deposited seeds during the performance of biologically essential actions). Or birds visiting streams to drink after feeding on the berries may also have had similar biological needs. This will be the subject of further research.

This gives this species a management signature as well [M][SPa][L] and is a novel discovery that adds to academic understanding of the anthropological context of species presence in the landscape.

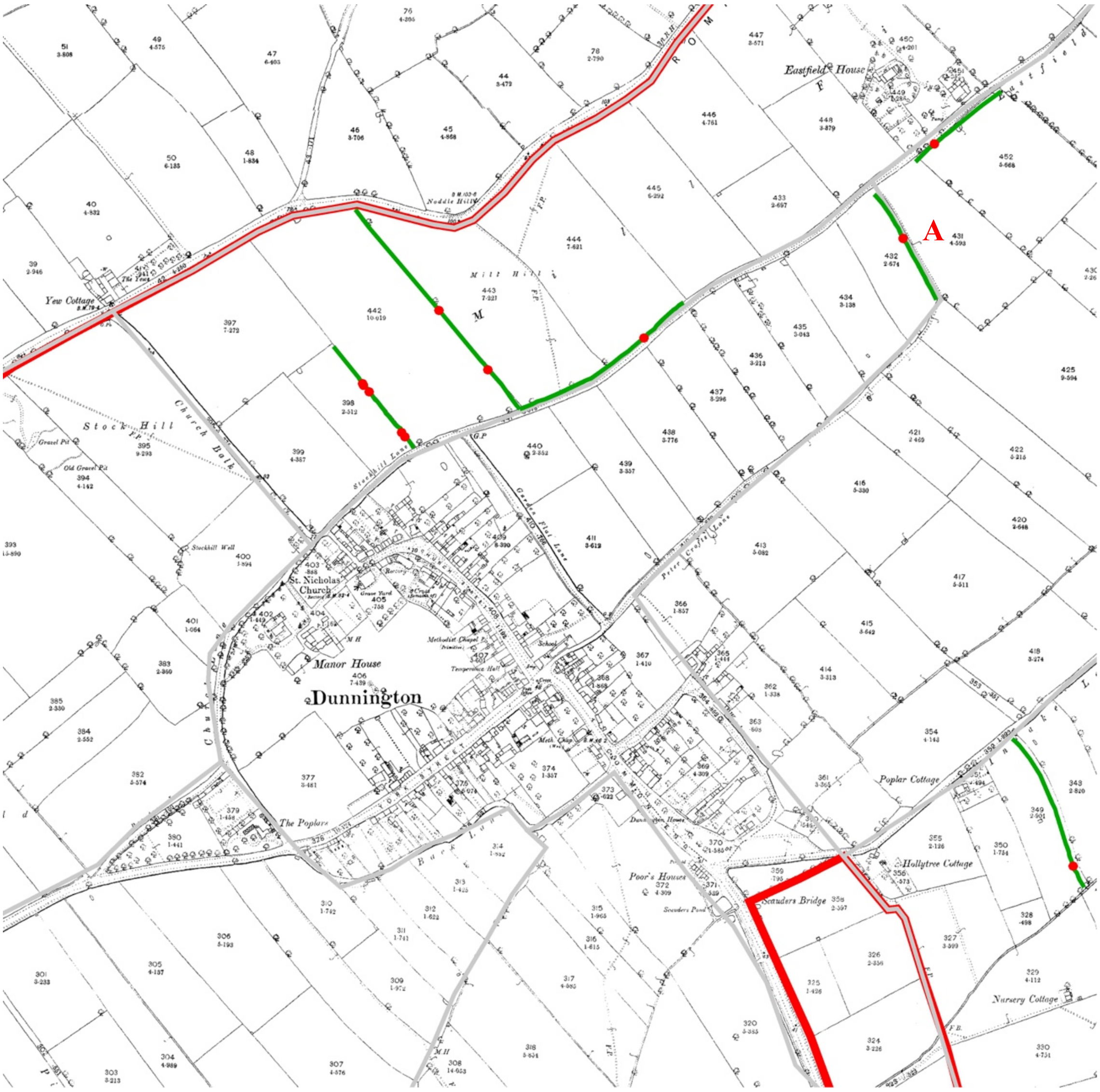


Figure 224.75 - Species map for Gooseberry *Ribes uva-crispa* on the 1909 OS base showing the proximity of records to the 'old' village of Dunnington, and to the north next to Dunnington Hall on Eastfield Lane. Red lines = medieval boundaries. Green line = Gooseberry present and red dots mark individual plant locations. A = where Gooseberry is only visible from the western side of the hedgerow. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

Apples

During the surveys at Dunnington it became apparent that the hedgerows contained not only the expected Crab Apple *Malus sylvestris* but also a large number of plants that produced larger and sweeter fruits which also had characteristically paler and less glossy leaves than Crab Apple. These were grouped as Domestic Apple *Malus domestica*. This difference and the distinction of the difference between the two made the data incomplete. This will form a subject of further research. For the current research a cautionary interpretation of the data is used. The data shown at Annex 1 separates the groups (Crab Apple *Malus sylvestris* being from [A1-37]-[A1-56] and Domestic Apple *Malus domestica* [A1-57]-[A1-65] and also presents data for 'all apples' [A1-17]-[A1-36] (see also [A6-19]).

Crab Apple *Malus sylvestris*

Crab Apple was an important resource for the Townships being found overall on 220 out of 430 (51%) hedgerows surveyed.

It occurs in all phases and was significantly planted during enclosures in [DU-6] (50 out of 86 (58%) hedgerows planted) and [DU-7] (92 out of 155 (59%) hedgerows planted). This level of planting is unlikely to be the result of colonisation as suggested by Hooper (on the Hooper presumption that they were originally planted as a pure Hawthorn *Crataegus monogyna* at enclosure).

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

See [A6-20] and [A1-37]-[A1-56].
Apples were generally ubiquitous across the study area with the exception of parts of Grimston where there was a distinct absence on most hedgerows, with hedgerow [A1-29] [CE384-CE425] being the exception (see Figure 226.76). It was also remarkably absent from the township boundary between Dunnington and Stamford Bridge West [A1-56] and also sections of Ox Calder Way [A1-55], and the township boundary between Dunnington and Scoreby [A1-55]. This suggests that Crab Apple was not a significant species to plant on the boundaries of townships, possibly because this area was not inhabited and therefore there was no requirement to obtain the fruits for domestic use.

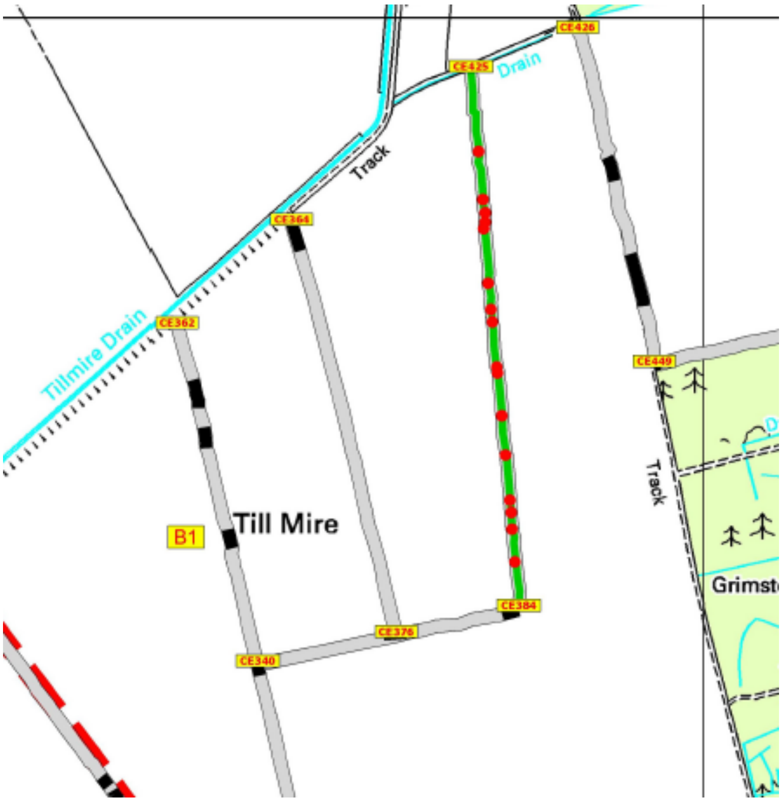


Figure 226.76 – Grimston Till Mire showing the distribution of Crab Apple indicating a deliberate planting by the enclosure allotee. Green line = Crab Apple present and red dots mark individual plant locations. Grey lines = surveyed hedgerows with Crab Apple absent and black sections are gaps. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

[S]pecies + [A]bundance

[S]pecies + [A]bundance + [H]edgerow

Within the project area there are variable quantities of apples occurring in the hedgerows. This species is often rare or occasional, with some records at frequent or above, especially in the [DU-6] and [DU-7] phases. In [DU-7] it was a frequent component in 24 hedgerows or 26% of the 92 hedgerows in which it was recorded for that Phase.

[S]pecies + [P]osition + [A]bundance

[S]pecies + [P]osition + [A]bundance + [H]edgerow

The occurrence of all types of apples is likely to show trends of deliberate planting either as part of enclosure or individual landowner's preferences. This seems to be the case for [A1-39] [CE384-CE425] where there were frequent plants along the length of the hedgerow, implying planting (see Figure 226.76).

Elsewhere across the study area Crab Apple varied in its distribution at the hedge level [SPA][H] often having short sections of hedgerow with a number of plants, implying natural local dispersal. Examples are at [A1-51] [BS413-BS436] and [A1-43] [CE735-CE763] (see Figure 227.77 and Figure 227.78).

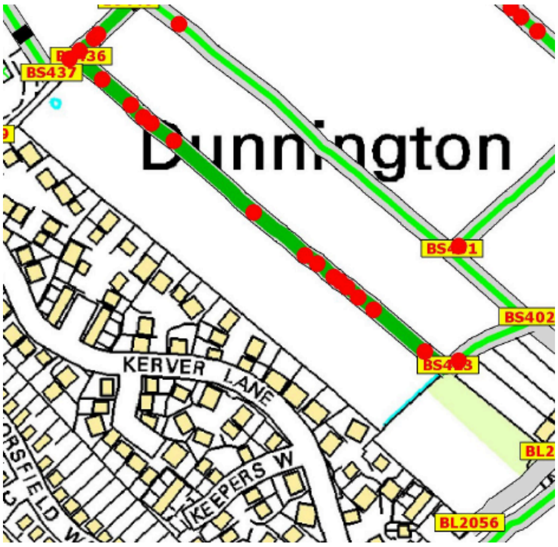


Figure 227.77 – Clumping of Crab Apple along [A1-51][BS413-BS436]. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

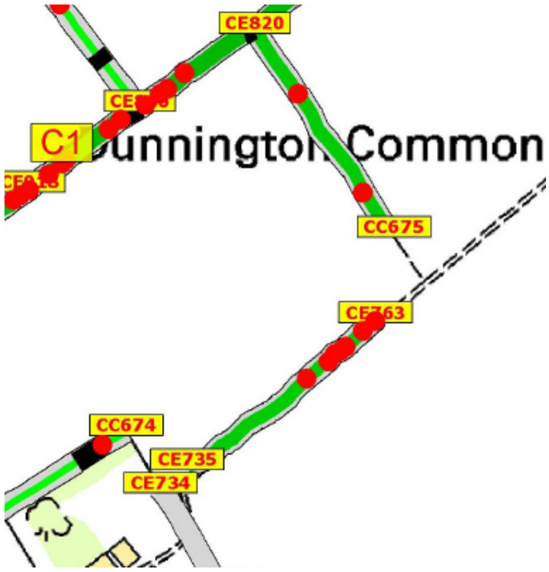


Figure 227.78 – Clumping of Crab Apple along [A1-43][CE735-CE763]. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Domestic Apple *Malus domestica*

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

See [A6-18] and [A1-57]-[A1-65].

Domestic Apples were more reliably recorded in 2009 but show no pattern for their position in the landscape [SP][L].

[S]pecies + [A]bundance

[S]pecies + [A]bundance + [H]edgerow

Domestic apple is nearly always rare to occasional in hedgerows. Unlike Crab Apple that was often found at levels of occasional or above (frequent).

[S]pecies + [P]osition + [A]bundance

[T]ime + [S]pecies + [P]osition + [a]bundance + [L]andscape

The presence of Domestic Apple in hedgerows is a major feature of the enclosure of the landscape (1709 [DU-6] and 1772 [DU-7]). This indicates deliberate planting as it is unlikely to have occurred as chance colonisation as might be suggested by the Hooper rule. Especially there are a variety of different forms and no indication of their presence elsewhere in the landscape to offer inocula for such colonisations. To have colonised to the extent that it has, the seedlings discarded by people and spread by birds would have been in competition with the existing hedgerow. Of the two scenarios and based on the size of some of the apple trees it is judged more plausible that planting has occurred. This will be the subject of further research.

Other species

Dogwood *Cornus sanguinea*

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

See [A6-9] and [A1-163]-[A1-172]

At the landscape level [SP][L] it is completely absent from Grimston and also from [DU-7].

[T]ime + [S]pecies + [P]osition + [L]andscape

It clearly has an association with the older hedgerows even taking into account the relatively low number of records.

There is an association with ancient boundaries as it occurs at several places along the northern township boundary of Dunnington [A1-167] and [A1-170]. It is also on the internal open field boundary hedgerows of York Road [A1-166], Intake Lane [A1-169] and Eastfield Lane [A1-170], and on the township boundary between Dunnington and *Scoreby* at [A1-171] and between Dunnington and *Stamford Bridge West* [A1-172].

The remaining records largely follow the 'grain' and support other species as historic markers in combination, especially across Mill Field and East Field, but also across Undergate Field and Thorntree Field. It showed a tendency to occur more frequently in hedgerows east of Dunnington (see [A1-170]).

Dogwood also supports English Elm at [A1-163][BX146-BX155] and [BS869-BX180] as a combination of historic markers.

[S]pecies + [A]bundance

[S]pecies + [A]bundance + [L]andscape

At the landscape level [SA][L] this species was a relatively frequent component of [DU-1] to [DU-4]. For [DU-1] it was found in 6 out of the 13 hedgerows or 46%.

This species was only recorded in 29 hedges representing 7% of those surveyed. Within this group of 29 it was most frequently recorded as a rare component at 16 (55% of 29) and was only recorded as abundant on one occasion.

[S]pecies + [a]bundance + [H]edgerow

At the hedgerow level it was generally rare to frequent, with only one record where it was judged to be abundant.

[S]pecies + [P]osition + [A]bundance + [L]andscape

[T]ime + [S]pecies + [P]osition + [L]andscape

The chart at Figure 229.79 shows the bias towards the earlier phase hedgerows in Dunnington and an absence from Grimston.

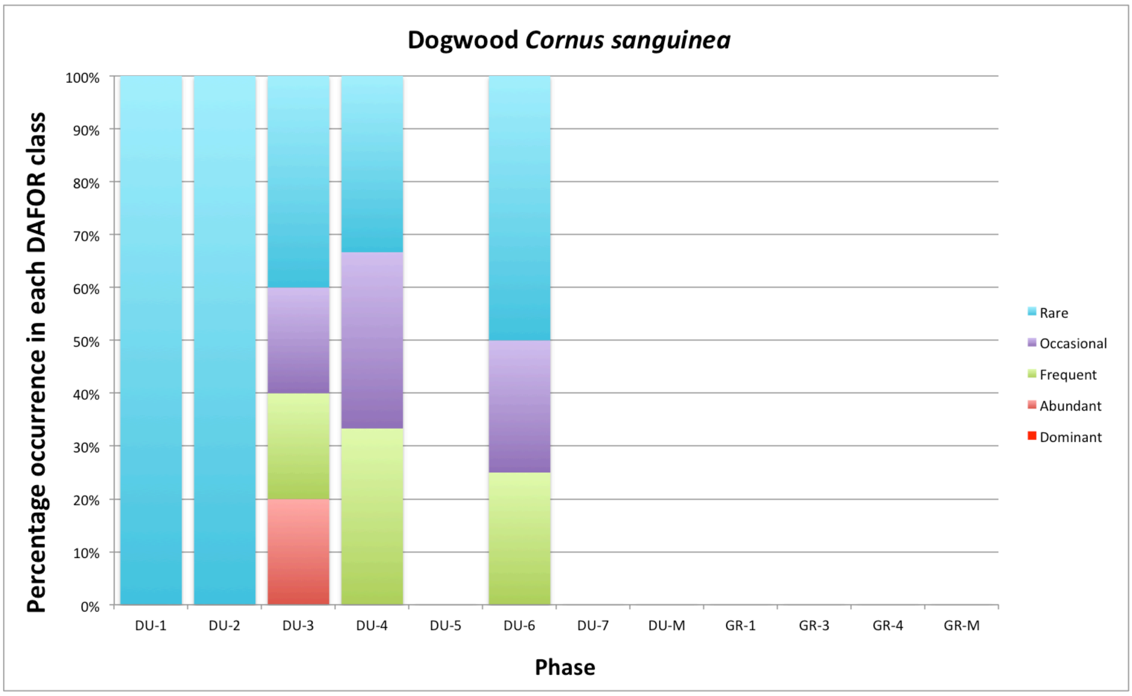


Figure 229.79 - Chart of the percentage frequency in each DAFOR class in each phase for Dogwood *Cornus sanguinea* - [T][SPA][L]

It should be noted that it is also frequently planted into new hedgerows and as a component of hedges that are gapped-up.

Dogwood appears to have a relatively weak species-location preference for township boundaries and medieval hedgerows [T][SPA][L]. It does have an association with the older phases of development although it curiously appears frequently in [DU-6].

Because this species is dispersed by berries carried by birds, it is likely that some of the records relate to this method of spread across the landscape.

Guelder-rose *Viburnum opulus*

[S]pecies + [P]osition

[T]ime + [S]pecies + [P]osition + [L]andscape

[A6-46] shows Guelder-rose located on many historic hedgerows. On the northern Dunnington township boundary [A1-249] where it supports English Elm; the interface between Dunnington and Dunnington Common [A1-251], Hagg Lane - [A1-255], Eastfield Lane [A1-257] (adding support to Dogwood) and the township boundary between Dunnington and *Scoreby* [A1-259] where it supports English Elm and Dogwood.

The records on [A1-250] relate to recent re-planting and new planting using Guelder-rose as a biodiversity gain species.

[S]pecies + [A]bundance

[S]pecies + [a]bundance + [L]andscape

Guelder-rose is mainly a rare component of hedgerows

[S]pecies + [P]osition + [A]bundance

[T]ime + [S]pecies + [P]osition + [a]bundance + [L]andscape

The rarity of this species and its slight preference for older hedgerows makes this a sensitive marker species. It is probably a poor competitor in hedgerows and may not establish well into any gaps that form.

Purging Buckthorn *Rhamnus cathartica*

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

In Dunnington, there are a number of ancient boundaries on which it occurs, such as the township boundary between Dunnington and *Scoreby* as shown at Figure 231.80 and Figure 231.81. Figure 231.80 also shows its presence along the north side of Intake Lane. At both locations on this figure, it is in combination with English Elm.

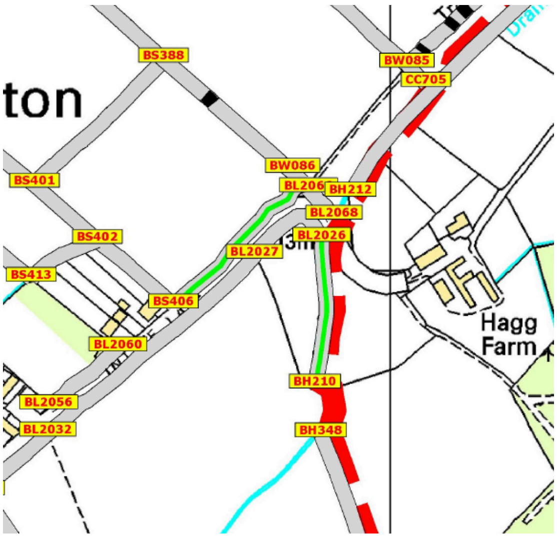


Figure 231.80 – Purging Buckthorn along Intake Lane and the township boundary between Dunnington and *Scoreby*. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

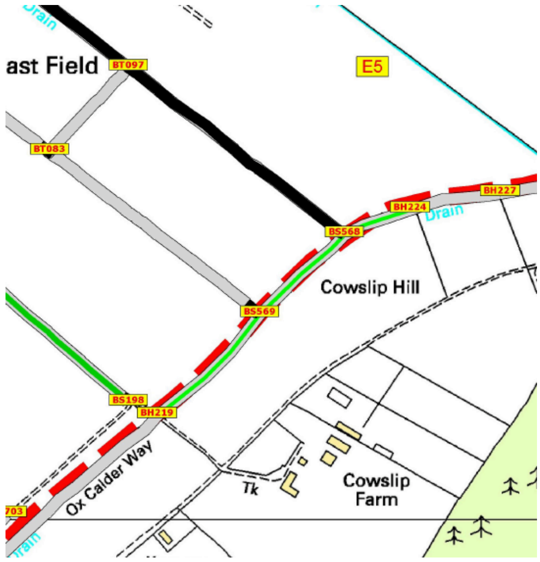


Figure 231.81 – Purging Buckthorn along Ox Calder Way - the township boundary between Dunnington and *Scoreby*. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Other records are clearly of more recent plantings/seedlings like the one along the disused railway line at [A1-367] [CH287-CH300] and [A1-366] [CE486-CE578] and [CE786-CE836] as well as [A1-365] [CE384-CE425] and [A1-368] [CH172-CH176].

The record at the southern end of Common Road, near the junction with the A1079 is likely to be an historic instance.

Hedgerow [A1-370]-[A1-371] [BS198-BS243] is suggested as an unrecognised township boundary. Stephen Moorhouse suggested the alignment of this at Figure 198.53. Nothing botanically supports this, whereas there is botanical evidence for the suggested alignment above from the presence of Purging Buckthorn, supported in combination with Dogwood *Cornus sanguinea* and Guelder-rose *Viburnum opulus*.

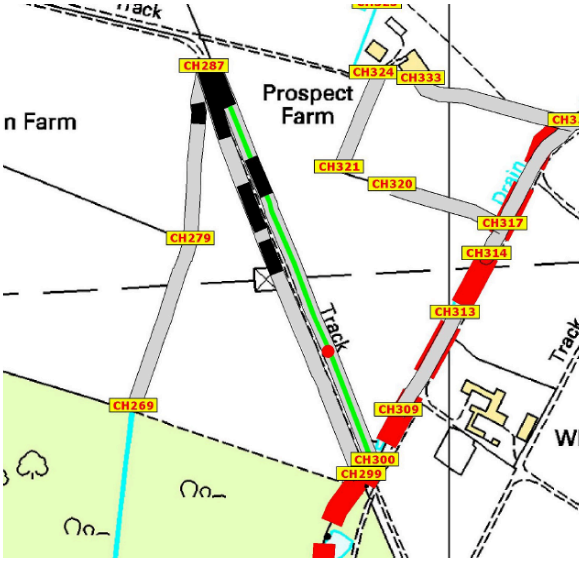


Figure 232.82 – Probable recent introduction or colonisation by Purging Buckthorn along the disused railway line. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

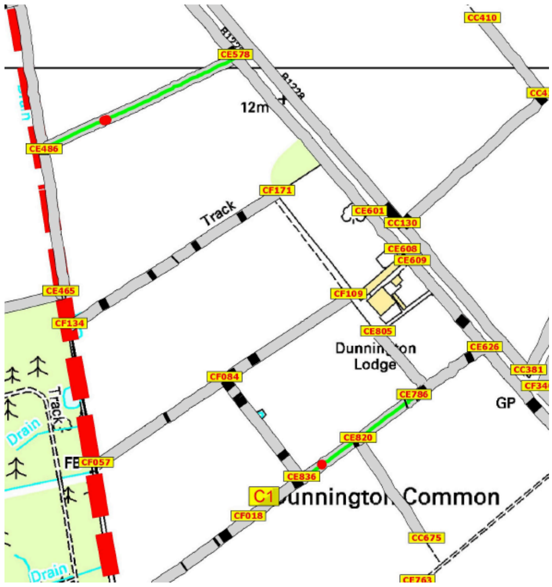


Figure 232.83 – Purging Buckthorn has probably been recently introduced on these hedgerows. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

[S]pecies + [A]bundance

[S]pecies + [a]bundance + [L]andscape

This species is nearly always present as scattered plants across the landscape and also as a rarity on hedgerows where it occurs.

[S]pecies + [P]osition + [A]bundance

[S]pecies + [P]osition + [a]bundance + [L]andscape

Purging Buckthorn *Rhamnus cathartica* is primarily a [SPA] species being confined to township boundary and other medieval hedgerows.

Spindle *Euonymus europaeus*

[S]pecies + [P]osition

[S]pecies + [P]osition + [L]andscape

This is a very rare species in the study area (four locations) at a number of critical locations as seen at [A6-12] and [A1-410]-[A1-414]. It is frequently added to modern planting schemes to add biodiversity and its presence needs careful consideration in context to confirm whether the species is a recent introduction or persistent from more ancient times.

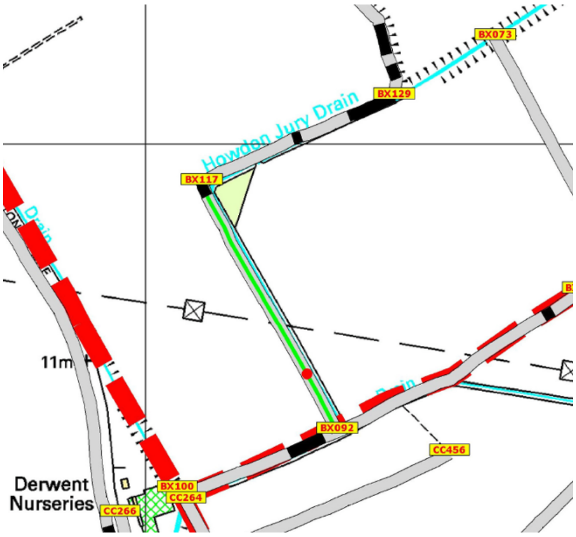


Figure 233.84 – Modern map showing the Spindle plant on hedgerow [BX095-BX117]. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

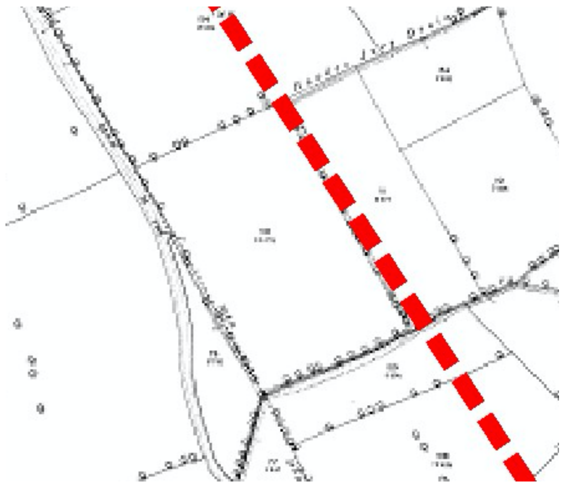


Figure 233.85 – The first edition OS map showing similar view as Figure 233.84with the dashed line of the speculative road alignment. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

This former alignment is attractive as it lines up with the main road entering Murton. The current road joins the A1079 to the west.

[S]pecies + [A]bundance

[S]pecies + [a]bundance + [L]andscape

Rare across the landscape.

[S]pecies + [a]bundance + [H]edgerow

Always as single or scattered plants in hedgerows.

Species + Position + Abundance [SPA]

This species has a definite [SPA] relationship. It is always at low frequency in precise locations that have a known or strongly speculative historic context and is therefore a [T][SPa][L] in the landscape of Dunnington.

It occurs on township boundaries at [A1-414] [BU131-BU148], [A1-412] [BW201-BW240] and on the medieval Eastfield Lane at [A1-413] [BS365-BS654]. This strongly indicates this is a historic marker 'medieval species'. From this, the other two locations need explanation.

[A1-410] [CF134-CF171] is a new planting into a gappy hedgerow.

The linear hedgerow at [A1-411] [BX095-BX117] was a mystery until the 1st edition OS map was studied which suggests a strong possibility that this hedgerow follows the line of an earlier alignment of Elvington Lane or was part of a coaxial field system as suggested by Barnes and Williamson (2015). This uses the principle that two records are documented to be on medieval hedgerows and there are no other records for the species except the known recent planting and this record on hedgerow [A1-411] [BX095-BX117]. On this presumption a possible medieval or pre-medieval connection needs to be considered as follows:

The speculative road alignment suggested at Figure 209.63 shows the suspected alignment as the dashed red line to the west. This alignment is also parallel to the northern dotted line that is the speculative township boundary between Dunnington and *Ianulfestorpe* leading onto Vengeance Lane north of the A166 where English Elm betrays a possible coaxial continuation from Dunnington. The coaxial evidence combined with the [T][SPa][L] and [T][SPa][H] signature of Spindle gives credence to the speculation that it is a historic marker for medieval hedgerows.

7.7.2. Clifford Township Boundary

The Clifford township boundary hedgerow was studied following a local history group's 'beating the bounds' walk. The southern boundary had a very rare species for Yorkshire, Barberry *Berberis vulgaris*. This species was actively removed during the 17c when it was discovered to be the secondary host for a rust fungus infecting wheat (specimens present today are probably those that were overlooked). Some of the other boundaries were unusually species-rich with evidence of woodland species in the ground-flora. This stimulated further study of those that were still hedged.

Maps showing the hedgerows surveyed and the node numbers are in Appendix 18, Figure 2.2 onwards (NB there are different node numbers for the same hedgerows as they relate to different surveys, summer or winter). Appendix 18, Figure 1.1 shows the layout of the hedgerows straddling The A1 road. This figure uses a 1909 OS 1:2500 base to show the former layout of other hedgerows in the locality.

Appendix 18, Figure 2.2 shows the hedgerows to the east and the node numbers for the CL surveys and CM (Appendix 18, Figure 3.3). The survey nodes for the west, CL, CM and CS are in Appendix 18, Figure 4.4 to Appendix 18, Figure 6.6. To the west, between W2 and W3 there is a change in hedgerow alignment relative to the township boundary and also a township boundary running off to the north. These are shown on the close-up map in Appendix 18, Figure 7.7.

The species maps for this survey are at Appendix 18, Figure 8.8 onwards. This survey was done to Level 3 in spring to record the ground flora and summer to record the shrubs. Both are included in this appendix. The data from the late winter and spring surveys are at Appendix 18, Table 115.1 and Appendix 18, Table 125.2 onwards respectively.

These are all set on the 1909 OS 1:2500 base that shows the A1 before it became a motorway and explains why the eastern hedgerow E1 starts at [CM675] that is east of the 1909 'Great North Road'.

These surveys were carried out between 2011 and 2015.

Ground flora and Ivy surveys - spring

These were done to link and support the data from the summer surveys. As the HEDGES method evolved it became clear that Ivy *Hedera helix* may be significant in interpreting hedgerows history using botanical indicators. As the earliest survey at Clifford omitted this species during spring surveys, hedgerow W1 was re-surveyed in 2015 to redress this change in survey requirements.

E1

This hedgerow was in poor condition for its shrubs, but has retained a good ground-flora of species like Bluebell *Hyacinthoides non-scripta* (Appendix 18, Figure 12.12) and Dog's Mercury *Mercurialis perennis* (Appendix 18, Figure 13.13) with the former occupying mainly the central section and the latter, the ends.

Ivy *Hedera helix* was a major constituent both terrestrially (Appendix 18, Figure 11.11) and arboreally (Appendix 18, Figure 10.10).

This was the only section where Sweet Violet *Viola odorata* was recorded (Appendix 18, Figure 17.17) as a single patch.

E2

The two main ground-flora species Bluebell *Hyacinthoides non-scripta* and Dog's Mercury *Mercurialis perennis* were again well represented with the former (Appendix 18, Figure 22.22) being relatively subordinate to the latter (Appendix 18, Figure 23.23).

W1

One of the reasons for re-surveying W1 in 2015 was the realization, during a CIEEM training workshop at this hedgerow, that there seemed to be a lack of Ivy *Hedera helix* on this hedgerow compared with others in the case study. This proved correct as there were few records either terrestrially (Appendix 18, Figure 21.21) or arboreally (Appendix 18, Figure 20.20).

This section had a similar combination signature [SPAC][H] to E2 with regard to Bluebell *Hyacinthoides non-scripta* (Appendix 18, Figure 29.29) and Dog's Mercury *Mercurialis perennis* (Appendix 18, Figure 30.30) with the former being less abundant [SPa] than the latter [SPA].

A species almost absent from the east was Bracken *Pteridium aquilinum* (except for one small patch on E1 (Appendix 18, Figure 14.14). On W1 as one patch towards the east and as a stand and scattered shoots to the western end (Appendix 18, Figure 31.31).

W2

A species unique to this section was Ramsons *Allium ursinum*. This was as a small patch immediately to the west of the dense Holly *Ilex aquifolium* on this hedgerow (see Figure 237.86 and Figure 237.87), in combination with the only patch of Dog's Mercury *Mercurialis perennis* on this section. Bracken *Pteridium aquilinum* (Appendix 18, Figure 39.39) was also a feature on this section, especially along the stand of Holly *Ilex aquifolium.*

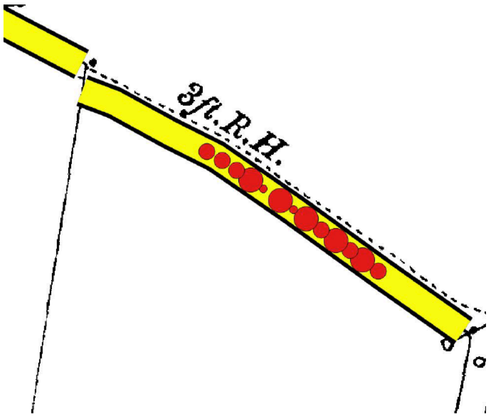
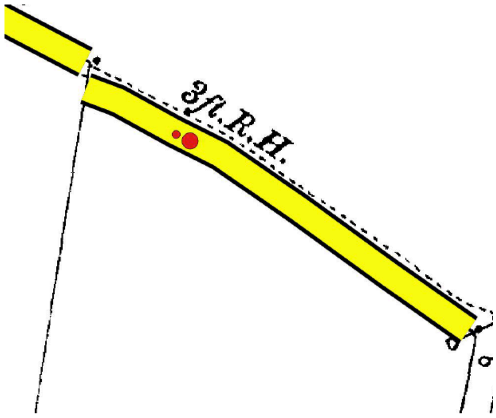
	

Figure 237.86 - Holly on W2. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).	Figure 237.87 - Ramsons on W2. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

W3

There was an almost complete lack of woodland ground-flora along this section in stark contrast with all other sections in the case study. A few patches of low cover Lords-and-ladies *Arum maculatum* were towards the western end [SPAa][H] (Appendix 18, Figure 40.40) along with some Bracken *Pteridium aquilinum* [SPaA][H] (Appendix 18, Figure 42.42).

Shrub and herbaceous species - Summer

One of the stimuli for undertaking this case study was the unexpected discovery of Barberry *Berberis vulgaris* at only one position along the southern township boundary. This is shown in Appendix 18, Figure 81.81 as a dominant species for 3 record points only (12m) [SPaa][L] and [SPaA][H] with the abundance being low frequency and high abundance [aA]. Another species, Spurge Laurel *Daphne laureola* is also a rare species in Yorkshire hedgerows and was at only one localised position as shown in Appendix 18, Figure 66.66 [aa][L] and [aa][H].

In addition to summer being best to record shrubs, it is also best to record herbaceous species like Black and White Bryony *Tamus communis* and *Bryonia dioica* (respectively) and Bracken *Pteridium aquilinum*.

Other species were also at low frequency and also low abundance [aa], e.g., Purging Buckthorn *Rhamnus cathartica*, Spindle *Euonymus europaeus* and Guelder-rose *Viburnum opulus*. These were at low frequency and low abundance [aa] at both the landscape and hedgerow levels [SPaa][L] and [SPaa][H].

The general nature of the five surveyed hedgerows was that they are species-rich, have a number of notable rare species and the species are mixed in their relative abundances and distributions. There is generally no one species that over-dominates.

E1

E1 was exceptional in that it was almost dominated by Elder *Sambucus nigra* (Figure 238.88) for much of its length with 'normal' shrubs like Hawthorn *Crataegus monogyna* being subordinate (Appendix 18, Figure 47.47). E1 also had one of the rarest species, Purging Buckthorn *Rhamnus cathartica* as a single specimen (Figure 238.89) and four patches of the rare Spindle *Euonymus europaeus* (Figure 239.90). This hedgerow was in generally poor condition indicating neglect that the Elder had capitalised upon.

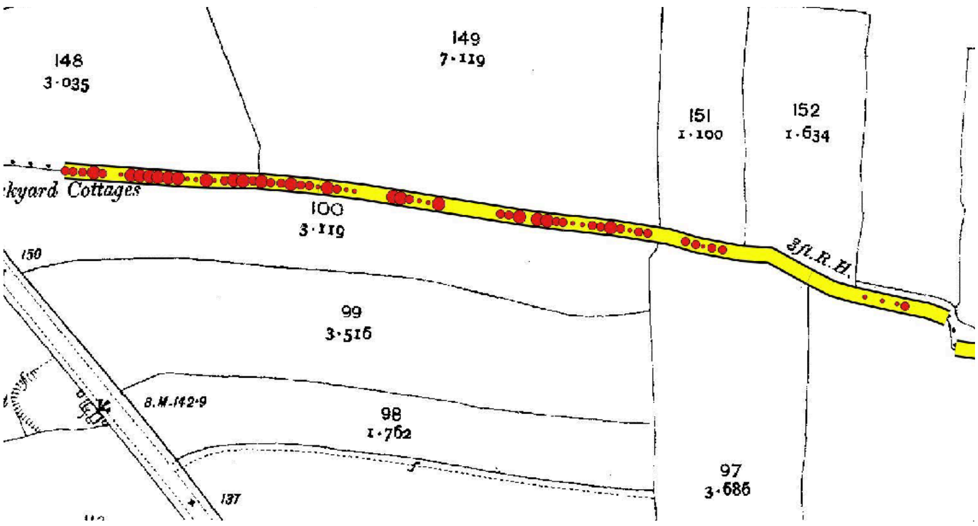


Figure 238.88 - Elder *Sambucus nigra* domination of E1. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

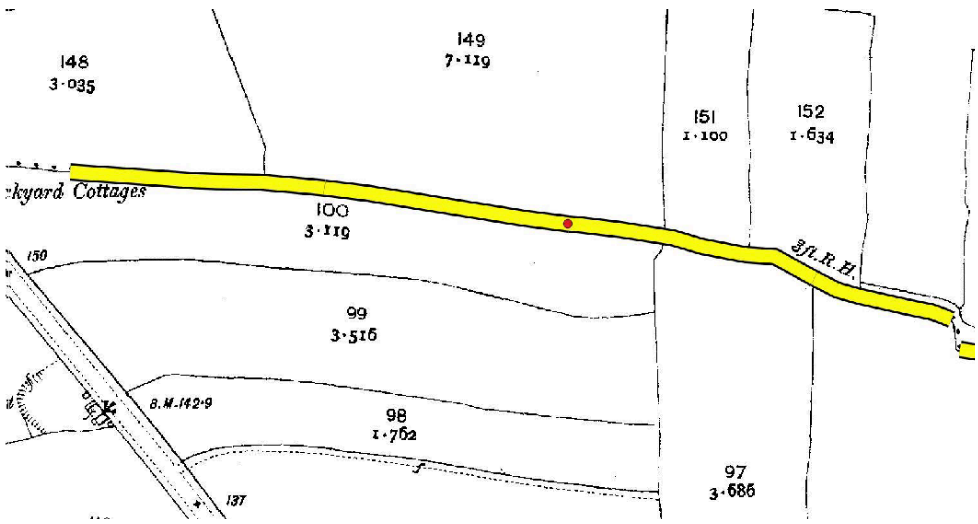


Figure 238.89 - Buckthorn *Rhamnus cathartica* on E1. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

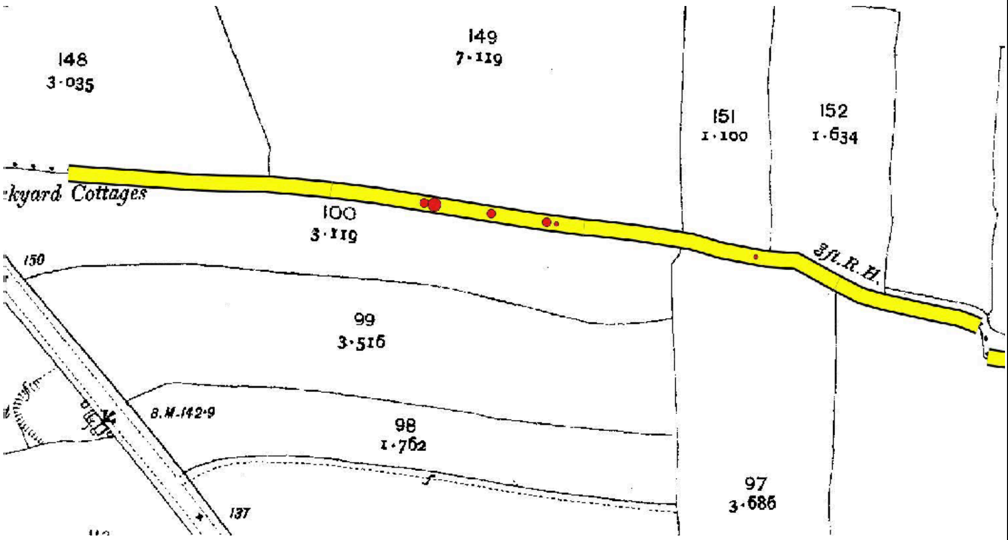


Figure 239.90 - Spindle *Euonymus europaeus* on E1. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

E2

This had one of the rarest species at its western end, Spurge Laurel *Daphne laureola* (Appendix 18, Figure 66.66). This hedgerow was in better condition and had a more even mix of species distributed along its length. Hazel *Corylus avellana* was a significant component (Appendix 18, Figure 63.63) along with Dogwood *Cornus sanguinea* (Appendix 18, Figure 64.64) and moderate amounts of the two main hedgerow species, Hawthorn *Crataegus monogyna* (Appendix 18, Figure 65.65) and Blackthorn *Prunus spinosa* (Appendix 18, Figure 70.70). This section also had two other rarities, Spindle *Euonymus europaeus* (Appendix 18, Figure 67.67) and Guelder-rose *Viburnum opulus* (Appendix 18, Figure 79.79).

W1

This was one of the most diverse and species-rich hedgerows with no one species dominating except in certain parts of the hedgerow where species like Holly *Ilex aquifolium* (Appendix 18, Figure 87.87) and Dogwood *Cornus sanguinea* (Appendix 18, Figure 83.83) had colonised and aggressively developed.

In addition to the Barberry *Berberis vulgaris* there were also three rarities along this section - Spindle *Euonymus europaeus* (Appendix 18, Figure 85.85), Purging Buckthorn *Rhamnus* cathartica (Appendix 18, Figure 91.91) and Guelder-rose *Viburnum opulus* (Appendix 18, Figure 96.96)

W2

An unusual hedgerow with a probable re-planted eastern section dominated by Hawthorn *Crataegus monogyna* (Appendix 18, Figure 100.100) and a large section of Holly *Ilex aquifolium* (Appendix 18, Figure 102.102).

W3

Despite this being on the correct alignment for the township boundary it was very species poor, indicating a recent planting or replanting. There can be no guarantees that lines drawn on OS maps were hedgerows, except at township boundaries. In this case the township boundary is indicated as 4ft RH (see Appendix 18, Figure 7.7) and as such there was a hedge along this alignment in 1909. This does not mean it was this hedge with these species. This hedgerow was almost completely dominated by Hawthorn *Crataegus monogyna* (Appendix 18, Figure 110.110) with only Elder *Sambucus nigra* forming a significant combination (Appendix 18, Figure 113.113). Small amounts of Hazel *Corylus avellana* appear to have colonised in from the west (Appendix 18, Figure 109.109).

7.7.3. Manor Farm, Leppington

The Leppington survey was done in response to a chance observation about the presence of Bluebell *Hyacinthoides non-scripta* and Dog's Mercury *Mercurialis perennis* along two short sections of hedgerow that were on 'dog-legs' in an E-W aligned hedgerow. Discussions with the farmer revealed that the main axis of hedgerow alignment in the area was changed from N-S to E-W in the early 1700s. This made it a likely possibility that the woodland species were at the intersection of the former alignments. This proved to be true and further evidence of different historic origins were made during the Level 3 survey that was done.

A map showing the farm and the hedgerows surveyed is at Figure 241.91. Close up sections, in five parts, showing the node numbers are at Figure 241.92 to Figure 242.93.

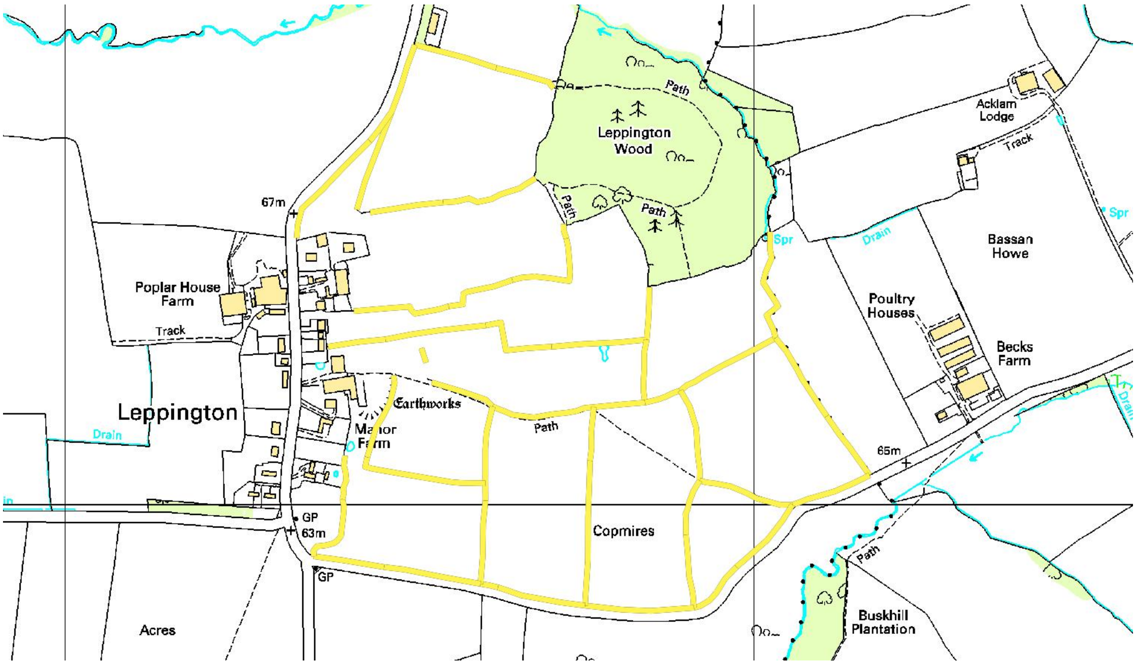


Figure 241.91 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

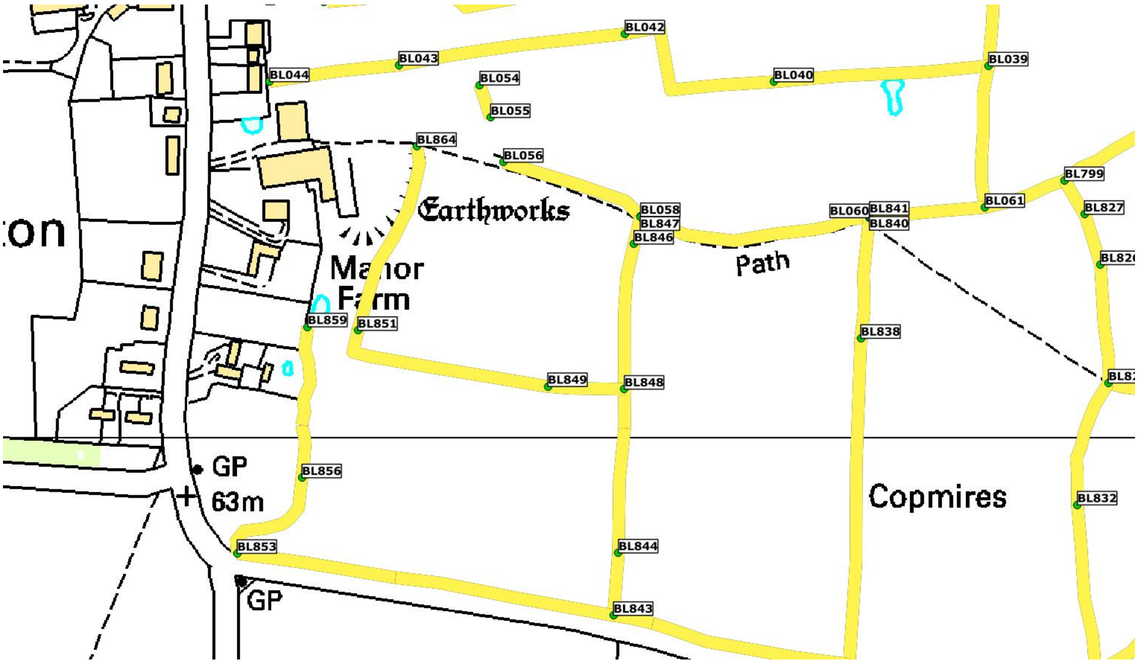


Figure 241.92 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow) and node numbers - part 1. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

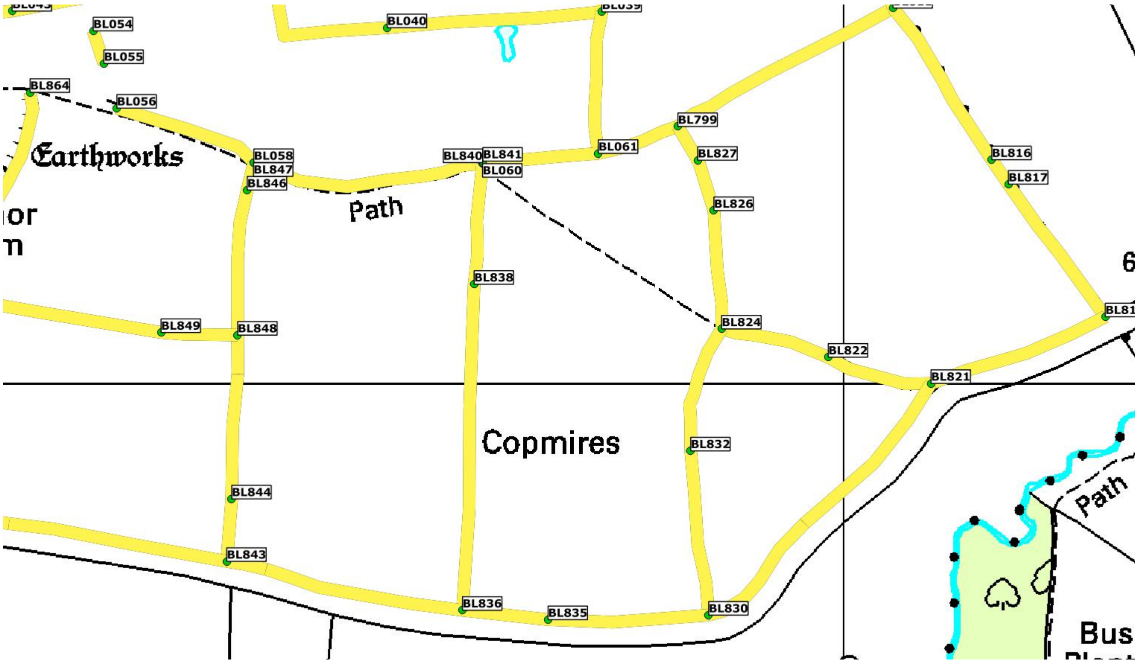


Figure 242.93 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow) and node numbers - part 2. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

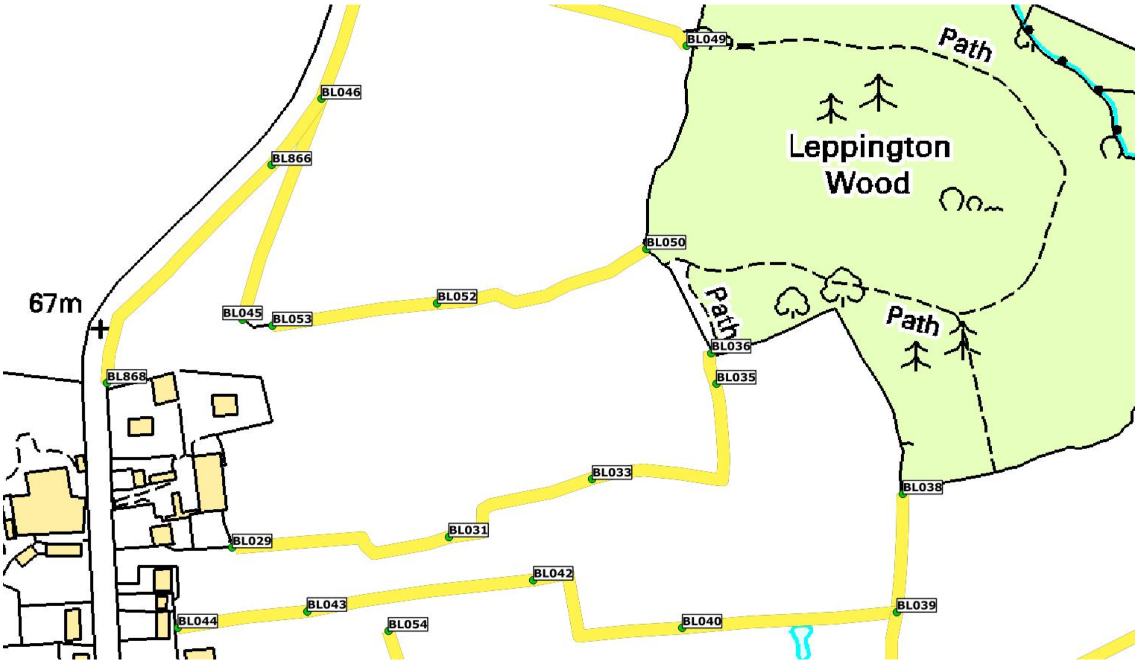


Figure 242.94 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow) and node numbers - part 3. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

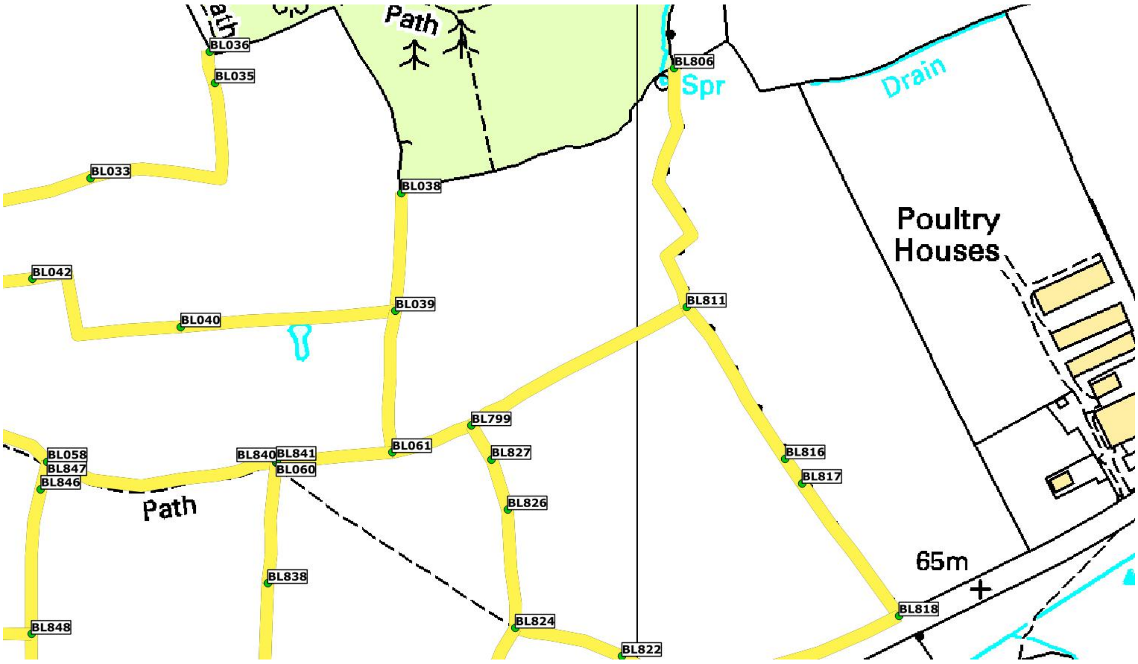


Figure 243.95 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow) and node numbers - part 4. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

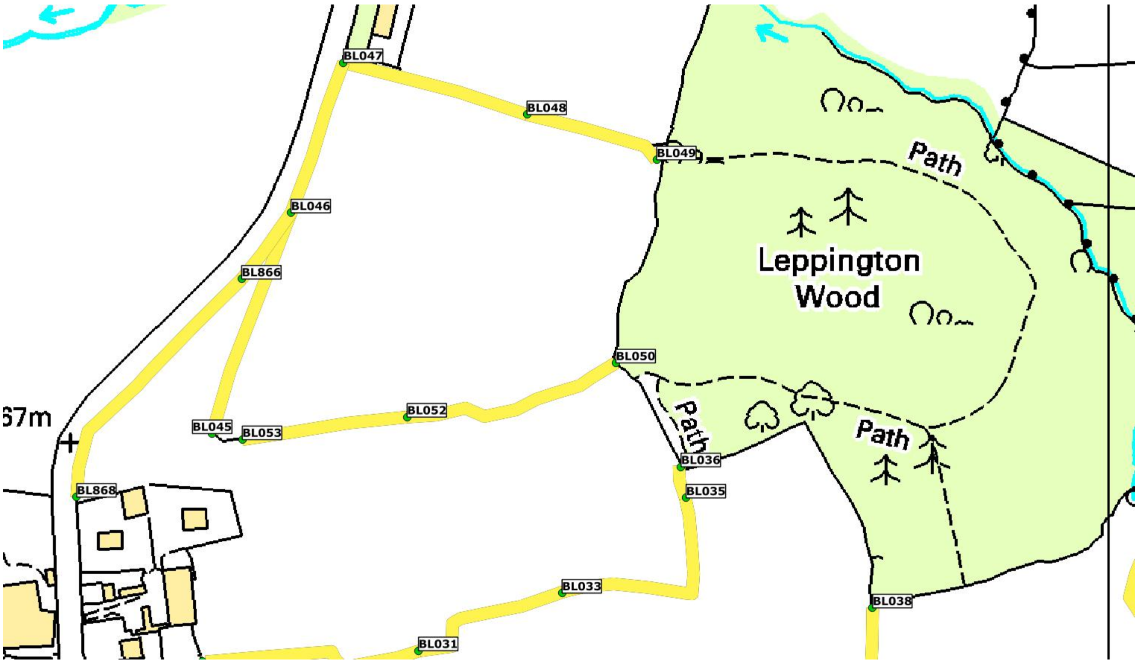


Figure 243.96 - Map showing Manor Farm, Leppington and the hedgerows surveyed (yellow) and node numbers - part 5. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The 1909 1st edition OS map at 1:2500 scale showing fragments of the N-S field boundary alignment is at Figure 244.97. The botanical evidence is the presence of Bluebell *Hyacinthoides non-scripta* and Dog's Mercury *Mercurialis perennis* both at the dog-legs and at points on the hedgerow to the south that extrapolate the former N-S hedgerow alignment.

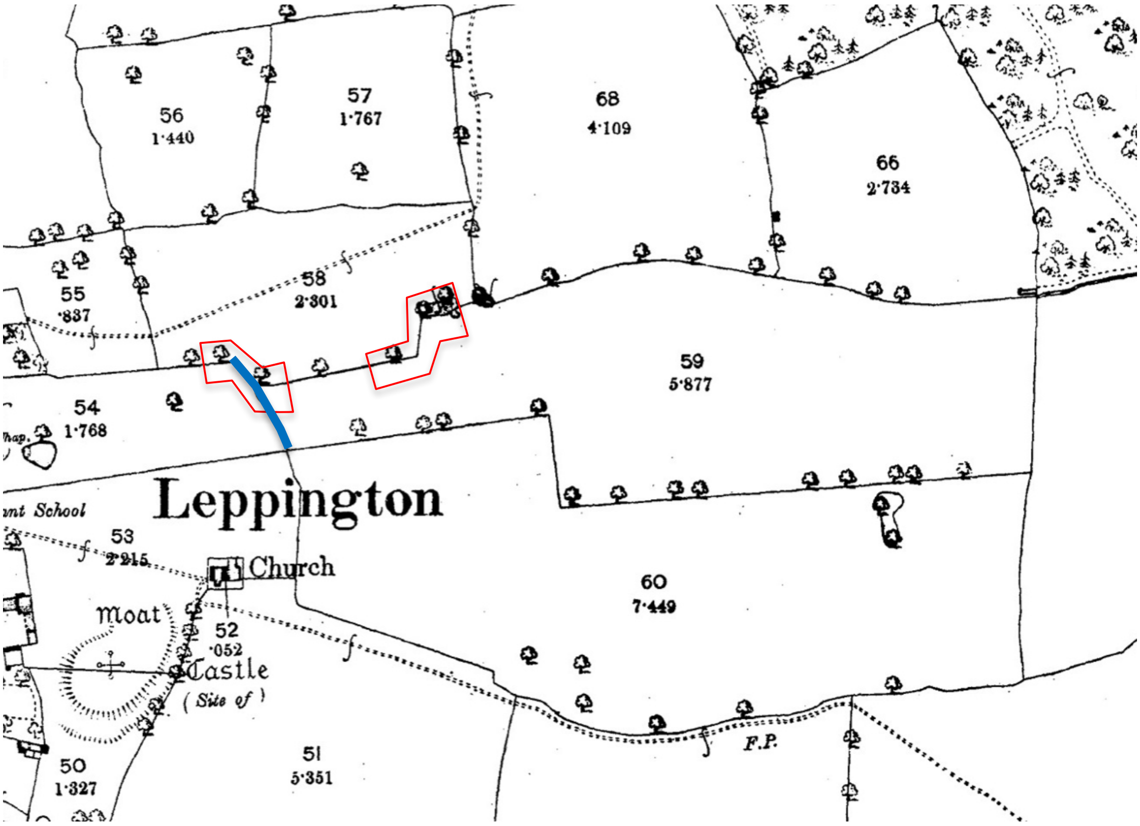


Figure 244.97 - Manor Farm Leppington showing 'dog legs' where woodland species were restricted (red polygons) to and a remnant of the former N-S field alignment (blue line). © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

These are shown on the maps in Appendix 19, Figure 10.10 and Appendix 19, Figure 14.14 and in close-up in Figure 245.98 and Figure 245.99.

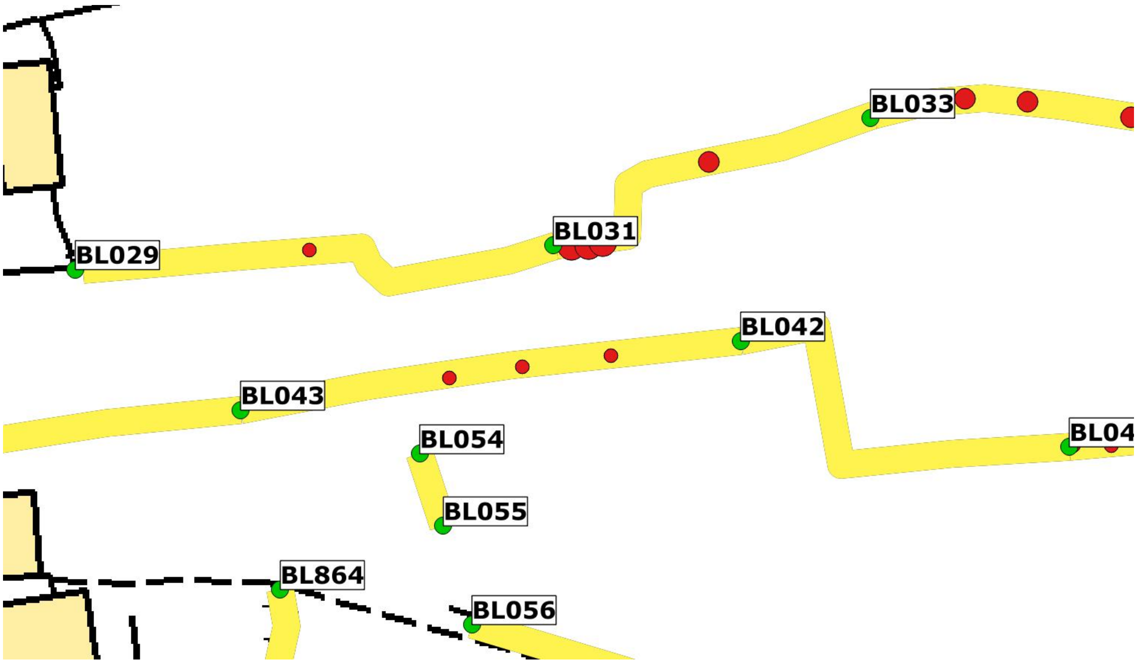


Figure 245.98 - Locations of Bluebell *Hyacinthoides non-scripta* on the dog-leg of hedgerow BL029-BL033 and a corresponding presence on the extrapolation to the hedgerow to the south (BL042-BL043). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

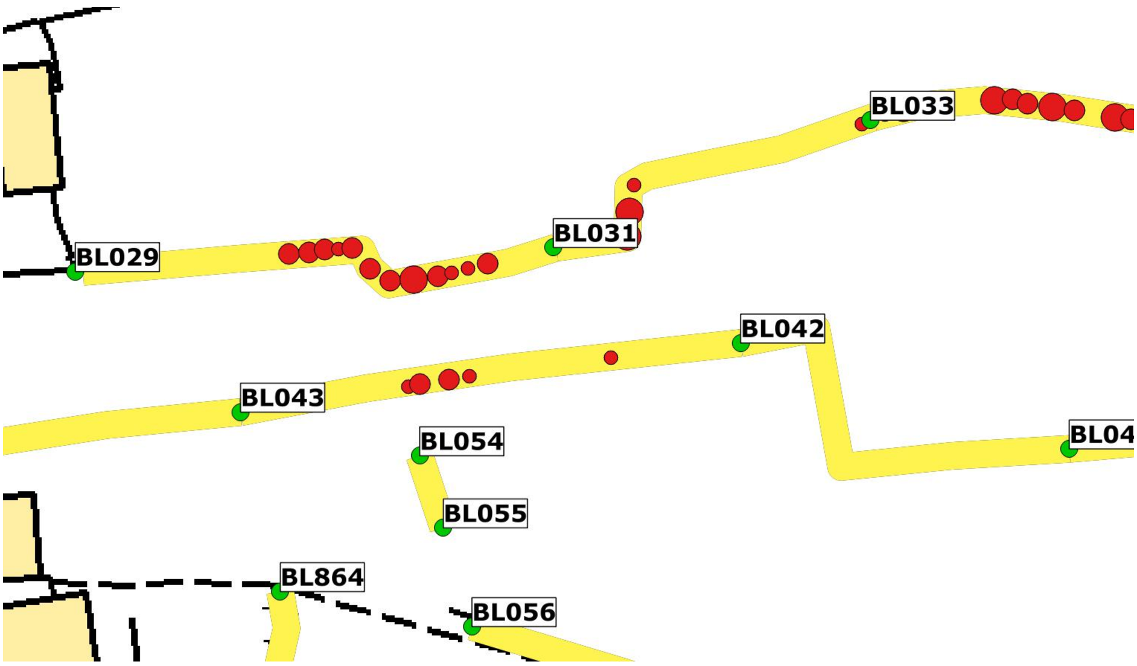


Figure 245.99 - Locations of Dog's Mercury *Mercurialis perennis* on the dog-leg of hedgerow BL029-BL033 and a corresponding presence on the extrapolation to the hedgerow to the south (BL042-BL043) and showing the E-W colonisation from the former N-S hedgerow. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

One of the issues identified at Leppington was the presence of shrubs that resembled Blackthorn *Prunus spinosa*, but had larger fruits and more oval leaves often with two glands at the base of leaf/ petiole junction as can be seen in Figure 246.100.

Figure 246.100 - Putative Damson/ Blackthorn hybrid with broad oval leaves characteristic of a Damson/ Bullace including typical glands at the leaf base petiole junction.

This this has been observed at other locations and is in need of further investigation. As the fruit and leaves are intermediate between Damson/ Bullace *Prunus insititia* and Blackthorn it is likely these could be a hybrid, in which case, this has significant historical importance. The location of these indeterminate specimens is shown in Appendix 19, Figure 15.15. The specimens at [BL843-BL848] were more like Damson/ Bullace.

There is some evidence that this species is associated with the potentially older N-S aligned hedgerows, including the farm's eastern boundary that is also the township boundary (see Appendix 19, Figure 15.15 and [BL811-BL818] at Figure 242.93). It is also associated with the East-West aligned hedgerows at [BL848-BL851]) and [BL058-BL060] (see Appendix 19, Figure 15.15 and Figure 241.92) It also occurs on E-W hedgerows that run off a N-S hedgerow at [BL042-BL043] (see Appendix 19, Figure 15.15 and Figure 241.92).

The general nature of the hedgerows at Leppington was that they were relatively poor in terms of the variety of shrub species. Many of the hedges were dominated by one of two species, either Hawthorn *Crataegus monogyna* or Blackthorn *Prunus spinosa*; rarely with both species in combination. These can be compared in Appendix 19, Figure 6.6 and Appendix 19, Figure 16.16 respectively. Examples of hedgerows with Hawthorn *Crataegus monogyna* dominant, with Blackthorn *Prunus spinosa* absent, or nearly so, are [BL806-BL811] along the township boundary, [BL799-BL811], [BL047-BL049] and [BL836-BL840]. Blackthorn-rich hedgerows were [BL038-BL061], [BL050-BL053] and the segments between the dog-legs on [BL029-BL033] (and the corresponding segment on the hedgerow to the south at [BL042-BL043].

Gooseberry *Ribes uva-crispa* has an essentially domestication signature as observed at Dunnington and other personal observation where it is rare to find it >300m from historic habitation (villages, farms of manors etc.). Apart from one record, it is in hedgerows just east of the village at [BL029-BL031] and [Bl042-BL044] (see Appendix 19, Figure 20.20. These are also the two hedgerows that have Holly *Ilex aquifolium* (see Appendix 19, Figure 11.11).

Species like Elder *Sambucus nigra*, Dog Rose *Rosa canina* and Bramble *Rubus fruticosus* do not appear to have any detectable localisations and are essentially ubiquitous across the landscape [SA]. They are also found at both low and high frequencies and abundances with no obvious patterns.

The woodland ground-flora at Manor Farm was of significance. The presence of three species meriting interpretation; Bluebell *Hyacinthoides non-scripta*, Dog’s Mercury *Mercurialis perennis* and Ramsons *Allium ursinum*. These are plotted in Appendix 19, Figure 10.10 Appendix 19, Figure 14.14 Appendix 19, Figure 3.3 respectively. The rarest of the three is Ramsons (see Figure 248.101). This is normally a rare species to find in hedgerows in Yorkshire and also in many other parts of the country (personal observations). At Manor Farm it is found in combination with Bluebell and, to a lesser degree Dog's Mercury. This constitutes a SPACES signature of [SPAC] (Species, Position, Abundance and Combination). This is also likely to be of historic significance [T][SPAC] as the presence and location of the Ramsons is most probably a historic relict retained rather than a new colonisation.

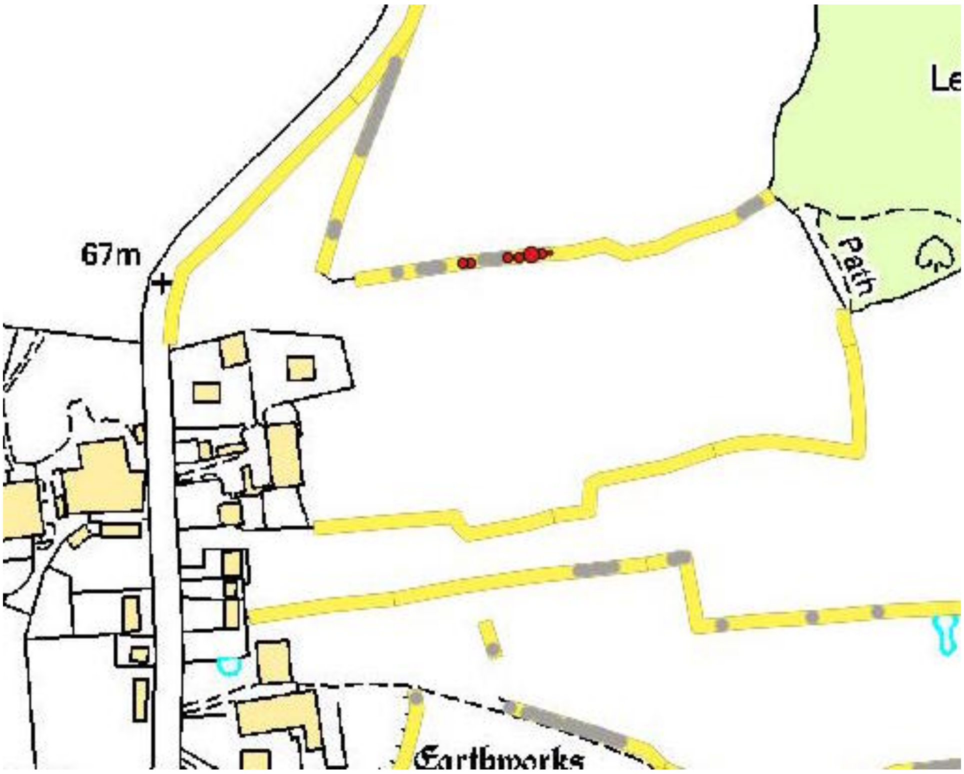


Figure 248.101 - The only hedgerow at Manor farm with Ramsons *Allium ursinum*. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Generally, Bluebell *Hyacinthoides non-scripta* is more frequent and abundant at the landscape level [SA][L] than Dog's Mercury *Mercurialis perennis* [Sa]. The former having a [SPA][H] signature, being frequent and abundant along specific hedgerows like [BL811-BL818] (the township boundary) and [BL050-BL053] [SPA] in the near absence of Dog's Mercury *Mercurialis perennis,* and [BL033-BL036] in combination with frequent and abundant Dog's Mercury *Mercurialis perennis* [SPAC][H].

In other places Bluebell *Hyacinthoides non-scripta* is found alone, e.g., [BL848-BL851] and [BL799-BL811] with a low abundance signature [SPa]. There are other instances of where Dog's Mercury *Mercurialis perennis* was found, in the absence of Bluebell *Hyacinthoides non-scripta,* such as at [BL836-BL840] and the western and southern farm boundary hedgerows of [BL047]-[BL868] and [BL818-BL853] respectively (although at low frequency/ abundance [SPa]).

7.7.4. Rushy Leasowes, Shrewsbury.

Surveyed as part of the development of the research hedgerow survey training courses which were run by the author at the Field Studies Council's centre at Preston Montford near Shrewsbury. The venue offered for use as a teaching resource was at Rushy Leasowes Farm near Pentre SJ361182. This had been studied historically and some of the boundaries had been dated, notably the township boundary between the current parishes of Kinnerley and Great Ness (Kinnerley Parish Council 2007).

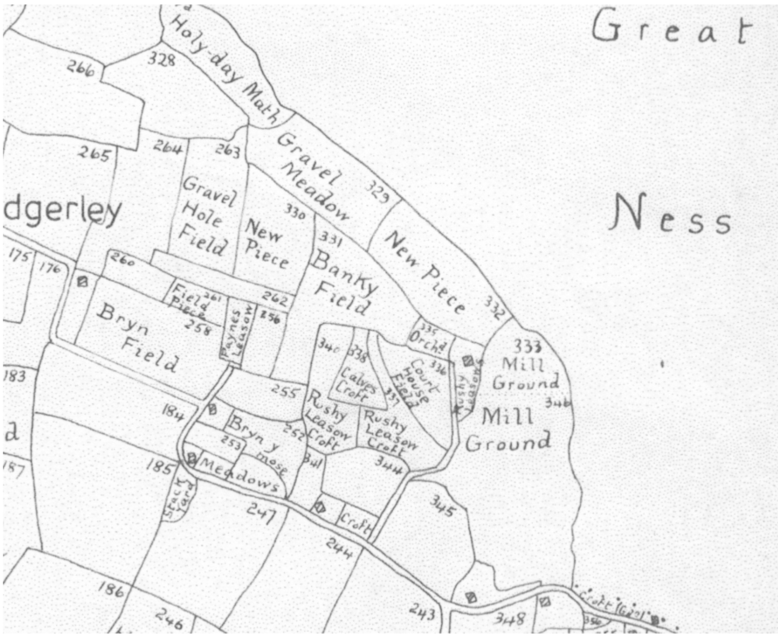


Figure 249.102 - Map of Rushy Leasowes showing the eastern boundary forming the township boundary with Great Ness.

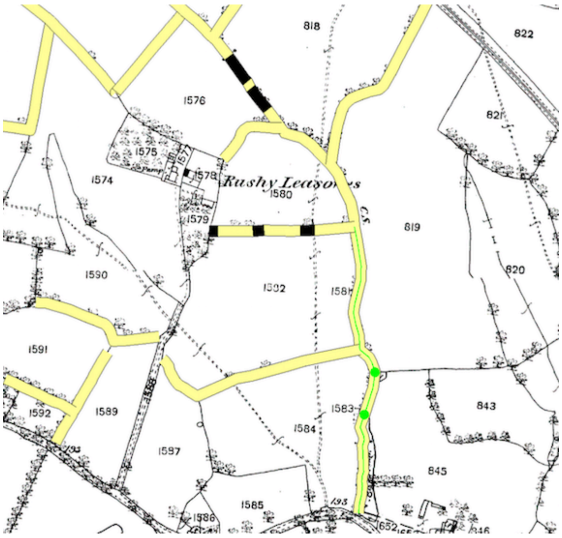


Figure 250.103 - Section of Rushy Leasowes showing the locations of Spindle *Euonymus europaeus* plants only on the township boundary (Level 2 survey data). © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

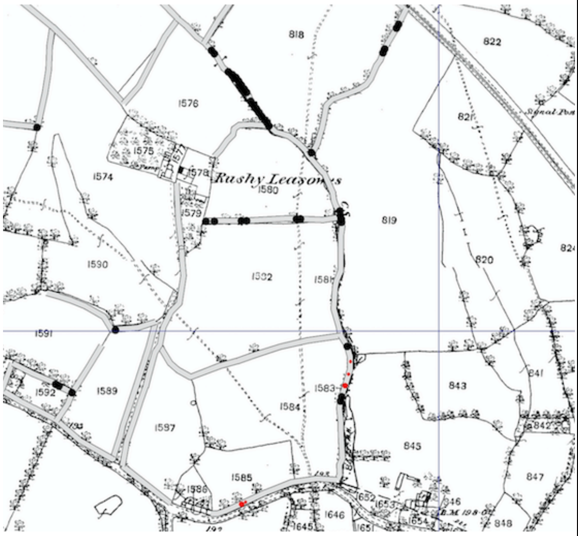


Figure 250.104 - Section of Rushy Leasowes showing the locations of Spindle *Euonymus europaeus* plants on the township boundary (Level 3 survey data) and medieval road into the village. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

These data provided further corroboration that Spindle *Euonymus europaeus* had a signature for medieval boundaries [T][SPA][L]. At Rushy Leasowes it was found on the township boundary and also on the old medieval road into the village as shown at Figure 250.103 and Figure 250.104. These two figures show the results from the Level 2 and Level 3 surveys done as part of the teaching element of the surveys. Both levels of survey were done in successive years to illustrate the differences in outputs from the two levels. The Spindle on the road side was not overlooked. This hedgerow was not surveyed in the first year when the Level 2 surveys were done owing to time constraints. The intention being to use the Level 3 data to re-construct Level 2 data for teaching purposes.

At Level 2 there is a risk of missing rare species as this is a slow walked survey compared with the standing observation every 4m for Level 3. Level 3 is less likely to miss rare species than Level 2. A further note of caution was learned from the Clifford boundary hedgerow surveys that were initially done only in winter when Purging Buckthorn *Rhamnus cathartica* was missed. Winter surveys are not as likely to provide reliable shrub survey data compared with summer, especially if there is a need to differentiate between types of apple, or the Damson/ Bullace/ Blackthorn/ hybrid scenario.

Further supporting evidence of the age of this boundary is the presence of Dog's Mercury *Mercurialis perennis* in the ground flora. This species was more frequent and abundant in the township boundary as shown at Figure 252.107. Further north this hedgerow also supported the only records for Common Dog-violet *Viola riviniana*, along with some Dogwood *Cornus sanguinea.* This combination confirms the historic signature of this boundary.

The other combination signature that betrays a probable historic origin is the hedgerow north of field 1591 that was the other location for abundant Dog's Mercury *Mercurialis perennis*. This was in combination with Dogwood *Cornus sanguinea* Primrose *Primula vulgaris* and Field Maple *Acer campestre*.

Figure 251.105 - Hedgerow north of 1591 with Dog's Mercury *Mercurialis perennis*. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

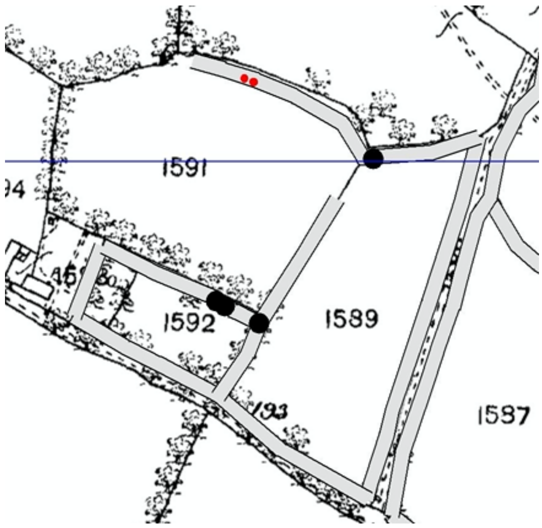


Figure 251.106 -Hedgerow north of 1591 with Dogwood *Cornus sanguinea*. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

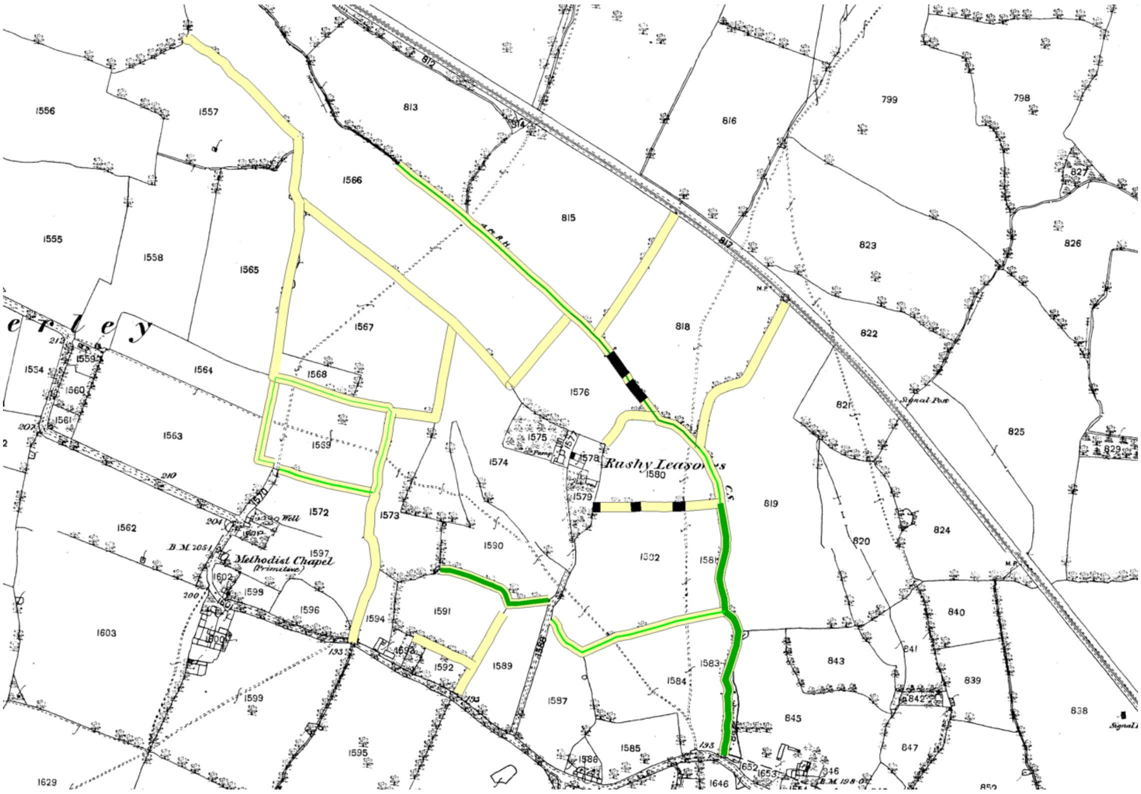


Figure 252.107 - Map of the distribution of Dog's Mercury *Mercurialis perennis* at Rushy Leasowes from the Level 2 survey. © Crown Copyright and Landmark Information Group Limited (2016). All rights reserved (1892).

7.7.5. Species Combinations

As the data from Dunnington was collected in close liaison with local historian Stephen Moorhouse a probable hedgerow creation sequence of phases could be investigated to look for systematic planting patterns. Some phases contained too few hedgerows and there were no detectable differential species. Phases 6 and 7 (see Figure 254.108 onwards) provided good examples to investigate the [C]ombination part of SPACES. From the methods section, these tables are ordered with the differential species to the left, the pale blue columns (around 50% presence), that have been moved to the left of the table to make it easier to look for patterns in the data. Where all 4 differential species are present these are coloured darker green and reflected in the differential counts. Less constant species are below in increasingly paler shades of green where constancy decreases to 3, 2, 1 and 0.

The dark pink cells show the concordance with some historic marker species indicating a correlation between high constancy of the differential species and their combination with historic marker species. Paler pink are less diagnostic or are species of historic significance.

To the left, the columns summarise which species are present in the combinations where 3, 2 or 1 of the differential species are present. For example if there are three differential species along a particular hedgerow there are four ways that these could be represented. For [DU-6] and [DU-7] the differential species were Blackthorn *Prunus spinosa* Crab Apple *Malus sylvestris*, Hazel *Corylus avellana* and Field Maple *Acer campestre*.

There was no clear planting plan revealed that suggests all hedgerows in each phase were planted to a set mixture. In [DU-6] there were a number of hedgerows with all four species compared with [DU-7] where there were only two hedgerows with all four species. At the three species level there was no definable trend for either set. At two species there was a no definable mix for [DU-6], but in [DU-7] there was a distinct combination of Blackthorn *Prunus spinosa* and Crab Apple *Malus sylvestris*.

The palimpsest of hedgerow creations makes it difficult to detect patterns even where there is allegedly a known planting date and presumably a defined planting mix. There are differences between these two example sets. In [DU-6] there are more hedgerows with four and three species and few with only two or one. [DU-7] has few hedgerows with four and three species and many with two and even one. The suggestion is that [DU-7] may have been planted with a lower variety of species than [DU-6].

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
1																	DUNNINGTON - PHASE 6																														
2	**Q R S**	**Q R T**	**Q S T**	**R S T**	**Q R**	**Q S**	**Q T**	**R S**	**R T**	**S T**	**Q**	**R**	**S**	**T**	**Differential sp. Count**	ID	**BLACKTHORN**	**CRAB APPLE**	**HAZEL**	**FIELD MAPLE**	HAWTHORN	BRAMBLE	ELDER	DOG ROSE	ASH	HOLLY	PEDUNCULATE OAK	IVY	DOGWOOD	ENGLISH ELM	SYCAMORE	GREY WILLOW	GUELDER-ROSE	WYCH ELM	DOMESTIC APPLE	DAMSON	FIELD ROSE	GOOSEBERRY	WEEPING WILLOW	ALDER	CHERRY	HORSE CHESTNUT	PRIVET	ROWAN	SPINDLE	Total count	Differential sp. Count
3															**4**	BX092-BX117	**45**	**11**	**11**	**11**	45	22	22		11	22		11						11		22									11	13	4
4															**4**	BS402-BS447	**45**	**11**	**11**	**33**	33	22	33	22	11		22						11		11											12	4
5															**4**	BX377-BX409	**45**	**11**	**11**	**33**	35	22	11	11	11		44				11	11														12	4
6															**4**	BX129-BX144	**45**	**11**	**11**	**11**	35	11	22		11						11		11	11												11	4
7															**4**	BX047-BX055	**44**	**11**	**33**	**22**	44	11	11	11			11	22							11											11	4
8															**4**	BX439-BX453	**11**	**11**	**33**	**11**	44	11	11	11			11	33																		10	4
9															**4**	BW465-BX581	**35**	**11**	**33**	**33**	35	11	11		22	11	11																			10	4
10															**4**	BS682-BS761	**22**	**11**	**33**	**33**	44	22	22			22	11	11																		10	4
11															**4**	BS823-BS834	**22**	**11**	**11**	**11**	45	11	11	11	11																					9	4
12															**4**	BV175-BX546	**22**	**22**	**11**	**22**	45	11	11			33																11				9	4
13															**4**	BX322-BX361	**35**	**22**	**11**	**11**	35	22		33	35	11	22	15		11																12	4
14															**4**	BX060-BX073	**45**	**33**	**11**	**11**	25	11		11			11			22	11			11					11							12	4
15															**4**	BX419-BX439	**11**	**11**	**11**	**22**	45		11		11	22	11					11														10	4
16															**4**	BX322-BX337	**11**	**11**	**22**	**22**	33		22		11		11			33	22															10	4
17															**4**	BS388-BS401	**22**	**11**	**22**	**22**	45		22		22	11	11		33																	10	4
18															**4**	BS777-BS793	**33**	**11**	**33**	**33**	33	11		11	22		24						11													10	4
19															**4**	BS904-BS913	**35**	**22**	**22**	**22**	45				11					11				11												8	4
20															**4**	BX025-BX045	**11**	**22**	**24**	**11**	44			11				11																		7	4
21	**3**														**3**	BS683-BS766	**22**	**22**	**33**		33	22	22	22	33				33				11				22									11	3
22	**3**														**3**	BS733-BS754	**11**	**11**	**11**		33	11	11		33		22	11																		9	3
23	**3**														**3**	BW258-BW383	**22**	**11**	**11**		44	33	44	11		11																				8	3
24	**3**														**3**	BX307-BX478	**11**	**11**	**11**		33	33		11		22	33	33					11													10	3
25	**3**														**3**	BT083-BT097	**33**	**33**	**22**		22	11		11	11		11																			8	3
26	**3**														**3**	BX197-BX223	**33**	**11**	**33**		33			11	11		33					11														8	3
27	**3**														**3**	BS446-BS477	**22**	**33**	**22**		45			22	22	11						11														8	3
28	**3**														**3**	BS437-BS478	**44**	**11**	**11**		44																									4	3
29		**3**													**3**	BS413-BS436	**22**	**44**		**11**	45	22	11	22	33	11									22					35						11	3
30		**3**													**3**	BS683-BS690	**35**	**11**		**11**	55	22	11	11	11		11												11							10	3
31		**3**													**3**	BS260-BS266	**11**	**22**		**33**	44	11	33	11	22												11									9	3
32		**3**													**3**	BX594-BX603	**33**	**11**		**22**	55	33	11	11		11																				8	3
33		**3**													**3**	BW131-BW169	**22**	**22**		**11**	45	33	33	33	33																					8	3
34		**3**													**3**	BX478-BX484	**45**	**22**		**11**	45	33		11	11		33								11											9	3
35		**3**													**3**	BX485-BX499	**45**	**11**		**11**	45			22	33		22		11			11	11					11								11	3
36		**3**													**3**	BS402-BS413	**22**	**11**		**22**	45						22	33															22			7	3
37			**3**												**3**	BS244-BS260	**35**		**11**	**11**	45	11	11	11	11	11		11	11		11						11									13	3
38			**3**												**3**	BV352-BX551	**45**		**22**	**11**	45	22	11		11	22																				8	3
39			**3**												**3**	BS327-BS345	**22**		**11**	**22**	44	22		22	11	22	22		35					22												11	3
40			**3**												**3**	BV396-BV410	**11**		**11**	**11**	22	11		11	11	11				11																9	3
41			**3**												**3**	BL2054-BL2055	**11**		**14**	**11**	55	11		11	11	11		33																		9	3
42			**3**												**3**	BX315-BX322	**22**		**11**	**11**	45	22			11			11		11																8	3
43			**3**												**3**	BS260-BS265	**45**		**11**	**22**	45		22	22	11		11																			8	3
44			**3**												**3**	BS402-BS406	**22**		**11**	**11**	45	22						11				11														7	3
45			**3**												**3**	BV379-BX582	**33**		**22**	**33**	35		33			11										22										7	3
46			**3**												**3**	BX300-BX307	**22**		**11**	**22**	33				11		22				11															7	3
47			**3**												**3**	BW484-BX572	**33**		**22**	**22**	44						11		22																	6	3
48				**3**											**3**	BS499-BS516		**11**	**11**	**11**	45	22	11	11	11		11			11						11										11	3
49				**3**											**3**	BS184-BW201		**11**	**11**	**22**	55	11	33	33	11	11									11											10	3
50				**3**											**3**	BX471-BX476		**11**	**11**	**11**	33	11	11	11			11					11														9	3
51				**3**											**3**	BS676-BS682		**22**	**11**	**22**	45		22			11			11								22									8	3
52				**3**											**3**	BS818-BS850		**11**	**22**	**22**	45						22				44															6	3
53					**2**										**2**	BV136-BW240	**11**	**11**			45	11	45	33	11	11												11								9	2
54					**2**										**2**	BW358-BW383	**22**	**11**			44	33	44	33		11												11								8	2
55					**2**										**2**	BW131-BW147	**11**	**44**			45	22	11	11																						6	2
56					**2**										**2**	BX604-BX612	**25**	**11**			55	33		11				44																		6	2
57					**2**										**2**	BS265-BS306	**45**	**22**			45		33	22									11													6	2

Figure 254.108 - Combination table for Dunnington Phase 6 - part 1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
1																	DUNNINGTON - PHASE 6																														
2	Q R S	Q R T	Q S T	R S T	Q R	Q S	Q T	R S	R T	S T	Q	R	S	T	Differential sp. Count	ID	BLACKTHORN	CRAB APPLE	HAZEL	FIELD MAPLE	HAWTHORN	BRAMBLE	ELDER	DOG ROSE	ASH	HOLLY	PEDUNCULATE OAK	IVY	DOGWOOD	ENGLISH ELM	SYCAMORE	GREY WILLOW	GUELDER-ROSE	WYCH ELM	DOMESTIC APPLE	DAMSON	FIELD ROSE	GOOSEBERRY	WEEPING WILLOW	ALDER	CHERRY	HORSE CHESTNUT	PRIVET	ROWAN	SPINDLE	Total count	Differential sp. Count
58						2									2	BX308-BX315	22		11		35	11			11																					5	2
59						2									2	BS800-BS822	45		15		35		11																							4	2
60						2									2	BS800-BS803	44		11		44																				11					4	2
61							2								2	BL2066-BL2068	55			11	22	44				24																				5	2
62								2							2	BX146-BX155		11	11		45	11	33	11				11	11	11				11												10	2
63								2							2	BV099-BW131		11	15		45	22	11	22	11																					7	2
64								2							2	BX224-BX239		33	11		55	11		11			33						11													7	2
65									2						2	BS379-BS387		11		11	44			22					11											33						6	2
66										2					2	BS715-BS733			11	44	44	22		22	11		22		11			11		22												10	2
67										2					2	BS694-BS708			33	11	55	11			11		22																			6	2
68											1				1	CH822-CH829	35				45	22	11	22	22			22							11	11								11		10	1
69											1				1	BS170-BV054	22				33	11	33	11	11	22					33															8	1
70											1				1	BX117-BX129	25				45	33	11								11								11							6	1
71											1				1	BV186-BX521	45				34		33		11					44	11															6	1
72											1				1	BS895-BS897	33				44		22						22																	4	1
73												1			1	BX500-BX511		11			11	11	22	22		11		44																		7	1
74												1			1	CH829-CH833		11			45	44			11	11																				5	1
75														1	1	BS694-BS699				33	44	22	22																							4	1
76														1	1	BS807-BS814				11	45		11					11																		4	1
77														1	1	BS869-BS874				11	55	22					11																			4	1
78															0	BX547-BX550					45	44	44	11		11	11																			6	0
79															0	BX169-BX171					55	44	44	22		11																				5	0
80															0	BV365-BX571						44	11	22				44		45																5	0
81															0	BW350-BW355					22	22	11																							3	0
82															0	BX454-BX463					45	33		11	22	11		11						11												7	0
83															0	BS888-BS895					45		33	11		11																				4	0
84															0	BX169-BX173					55		44			11																				3	0
85															0	BX155-BX158					55	11																								2	0
86															0	BS913-BS915					55				11																					2	0
87															0	BX162-BX169					55					11																				2	0
88															0	BS843-BS850					45																									1	0
89																Total	59	50	50	49	85	58	50	48	44	32	32	20	11	10	10	8	8	8	6	4	4	3	3	2	1	1	1	1	1		
90																Percent	69%	58%	58%	57%	99%	67%	58%	56%	51%	37%	37%	23%	13%	12%	12%	9%	9%	9%	7%	5%	5%	3%	3%	2%	1%	1%	1%	1%	1%		

Figure 255.109 - Combination table for Dunnington Phase 6 - part 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
1																	DUNNINGTON - PHASE 7																																			
2	Q R S	Q R T	Q S T	R S T	Q R	Q S	Q T	R S	R T	S T	Q	R	S	T	Differential sp. Count	ID	CRAB APPLE	BLACKTHORN	HAZEL	FIELD MAPLE	HAWTHORN	BRAMBLE	PEDUNCULATE OAK	ASH	DOG ROSE	ELDER	HOLLY	GREY WILLOW	SYCAMORE	ALDER	DOMESTIC APPLE	DAMSON	ENGLISH ELM	IVY	FIELD ROSE	GUELDER-ROSE	GORSE	SILVER BIRCH	WYCH ELM	GOAT WILLOW	PURGING BUCKTHORN	ROWAN	ASPEN	LILAC	BLACK CURRENT	PRIVET	WEEPING WILLOW	GOOSEBERRY	LIME	SNOWY MESPILUS	SPINDLE	Total count
3															4	CH100-CH123	11	22	11	11	33	11		11		11	11		22	11	33	11																						13
4															4	CH043-CH069	22	22	11	11	44	22	11	22			11					11		22																				11
5	3														3	CC409-CC471	44	22	45		33	22	22	11			11	11		11					22		35			11														13
6	3														3	CC381-CC409	11	22	11		55	22	11	11	11	11		11		33	11																							12
7	3														3	CF292-CF600	22	22	11		44	33	33	11	33					33							11					11	44											12
8	3														3	CF340-CF387	11	11	22		44	11	11	11	22												33			11														10
9	3														3	CC580-CC596	11	11	11		44	11	11		33			11										22																9
10	3														3	CC457-CC503	22	33	35		35		33	11											33					11														8
11		3													3	CC130-CC155	22	33		11	45	33	22	22	33			11		22																								10
12		3													3	CC192-CC214	44	11		11	44	22	11	11	33	33																												9
13		3													3	CH536-CH568	11	22		11	55	11					11		11		11		33																					9
14			3												3	CH654-CH666	33		11	22	45	22	22	11	11								11																					9
15			3												3	CC543-CC546	33		11	11	44	33									11																							6
16				3											3	CE486-CE578		44	11	44	55	33	11	11	33	22										11		33			11													12
17				3											3	CH124-CH127		33	22	11	44	22	11	22			11		33	22																								10
18				3											3	CE786-CE805		22	33	33	55		11		33											33													22					8
19					2										2	CH687-CH707	11	22			55	11	11	11	11	11	11	11															11		11									12
20					2										2	CC626-CC637	33	22			44	11	33	22	11	11		33	11							11																		11
21					2										2	CC155-CC233	22	45			45	33	11	33	11	33	11	11																										10
22					2										2	CC167-CC192	11	11			44	33	22	11	33	22		11		22																								10
23					2										2	CE786-CE836	44	22			55	11	11	11	22	22									11						11													10
24					2										2	CH182-CH194	33	11			45	11	11	11		11	11					11														11								10
25					2										2	BX419-CH610	11	11			55	11			11	11	11				11			11																				9
26					2										2	CF551-CF600	22	22			33	33	33	22	33			11		44																								9
27					2										2	CH230-CH231	33	11			45	33		11	11				11			11		33																				9
28					2										2	CH269-CH279	33	11			45	22	33		11			33	11														11											9
29					2										2	CH438-CH475	22	11			35	22		22		22				11			35						11															9
30					2										2	CH151-CH163	33	11			44	33	22					22			22														11									8
31					2										2	CH333-CH337	11	45			45	44	22		11	33	11																											8
32					2										2	CH513-CH525	33	33			55	22	22	11			22		11																									8
33					2										2	CH708-CH713	11	22			44	22			22	33						22												11										8
34					2										2	CC130-CC381	22	11			55	22		11	22	22																												7
35					2										2	CC192-CC233	33	22			45	22			22	22					22																							7
36					2										2	CC409-CC503	11	22			45	33				33		11		33																								7
37					2										2	CE626-CE786	11	11			44		33	33	11			11																										7
38					2										2	CE651-CE684	33	44			55	11			22	22												11																7
39					2										2	CF134-CF171	11	33			55	22				33						11																				11	7
40					2										2	CH504-CH512	33	22			44	11			11				11			33																						7
41					2										2	CH809-CH814	11	22			45			22			11		11					33																				7
42					2										2	CC262-CC456	22	11			55	22				33					22																							6
43					2										2	CF292-CF340	22	11			55	22			22	44																												6
44					2										2	CH713-CH719	33	35			45				11	11								11																				6
45					2										2	CH713-CH727	22	45			33	11		11	11																													6
46					2										2	CE564-CE578	11	22			33							11							22																			5
47					2										2	CE836-CF084	11	22			55	22				33																												5
48					2										2	CH163-CH167	22	11			33					11																		33										5
49					2										2	CH479-CH489	11	11			22					11					11																							5
50					2										2	CF057-CF084	22	44			55					44																												4
51						2									2	CH833-CH839	11		11		33	22	11	33		11	11		11			22		11																				11
52						2									2	CC410-CC420	33		11		44		22	22	11			11		11									11															9
53						2									2	BX352-CH788	11		11		33	33				22	35				11	33																						8
54						2									2	CE836-CF056	44		11		55	22	11			33		11							11																			8
55						2									2	CC467-CC470	11		11		55			11			11				11				11																			7
56						2									2	CE735-CE763	33		33		44	44							33						33							11												7
57						2									2	CF648-CF703	44		33		22	11	44	33				22																										7
58						2									2	CH551-CH579	11		11						11		11		33			11	44																					7
59								2							2	CH230-CH234		11	11			22	22	11	22	11	45	11	11		11			44																				12
60								2							2	CH525-CH532		22	22		55		22	11	22		22	11		11																								9
61								2							2	CH260-CH268		24	22		55			22	22		22	11				11																						8
62								2							2	CH774-CH778		45	22		45	22				22		22		35			25																					8
63								2							2	CH036-CH070		33	22		44		22	22	22		11																											7

Figure 256.110 - Combination table for Dunnington Phase 7 - part 1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
1																	DUNNINGTON - PHASE 7																																			
2	Q R S	Q R T	Q S T	R S T	Q R	Q S	Q T	R S	R T	S T	Q	R	S	T	Differential sp. Count	ID	CRAB APPLE	BLACKTHORN	HAZEL	FIELD MAPLE	HAWTHORN	BRAMBLE	PEDUNCULATE OAK	ASH	DOG ROSE	ELDER	HOLLY	GREY WILLOW	SYCAMORE	ALDER	DOMESTIC APPLE	DAMSON	ENGLISH ELM	IVY	FIELD ROSE	GUELDER-ROSE	GORSE	SILVER BIRCH	WYCH ELM	GOAT WILLOW	PURGING BUCKTHORN	ROWAN	ASPEN	LILAC	BLACK CURRENT	PRIVET	WEEPING WILLOW	GOOSEBERRY	LIME	SNOWY MESPILUS	SPINDLE	Total count
64								2							2	CH536-CH547		11	11		45	22			22	11	22																									7
65								2							2	CF084-CF109		33	11		55						11									11																5
66									2						2	CH127-CH130		11		11		11	11				11										11					11										7
67										2					2	CH088-CH110			11	33	22	33			22	22				44																						7
68											1				1	CH176-CH198	11				45	22	11	11		33	11	11		11			11						11													11
69											1				1	CH489-CH504	11				44	22		11	22			22	11	11	11	33								11												11
70											1				1	CH629-CH666	44				45	22	22	11	11			11	11				22	22				22														11
71											1				1	CH251-CH259	22				55	33	22	22	33	22	22		11		33																					10
72											1				1	CC599-CC610	33				55	33	11	11	33	22		11														11										9
73											1				1	CF551-CF650	11				33	22	22		11	11		22		33	11																					9
74											1				1	CH083-CH099	11				44	33	22	11		22	11		44	11																						9
75											1				1	CH424-CH435	22				45	22	22	11	22						22	22	45																			9
76											1				1	CE578-CE601	22				22	11	11	44	22	11							55																			8
77											1				1	CH225-CH230	11				45	11	11	22	22		11					33																				8
78											1				1	CH647-CH654	11				44	11			11	11	11		11					11																		8
79											1				1	CC652-CC674	11				44	22		22		11				33	22																					7
80											1				1	CH083-CH208	11				45	22	11	11						33		11																				7
81											1				1	CH364-CH371	33				45		22	22			22	44												33												7
82											1				1	CH552-CH555	22					11		22	11	22			11							11																7
83											1				1	CH552-CH594	33				55	22		33	22							11							11													7
84											1				1	CH629-CH632	11				22	11	22			11			11									33														7
85											1				1	CH755-CH765	22				45	22	22			22							22															11				7
86											1				1	CC457-CC467	11				45	11	11											22	11																	6
87											1				1	CE688-CE717	11				33	22	33			11									11																	6
88											1				1	CF600-CF703	22				33		44	55	44			22																								6
89											1				1	CH225-CH778	33				45	22		33			11									11																6
90											1				1	CH632-CH643	11				45	22	11		11									25																		6
91											1				1	CH746-CH755	33				45	22						11					45													11						6
92											1				1	CC155-CC167	44				44	33			22	22																										5
93											1				1	CC257-CC264	22				55	22				11							11																			5
94											1				1	CC527-CC529	11				45	11				11				11																						5
95											1				1	CC538-CC541	44				45	22		11	22																											5
96											1				1	CC675-CE820	33				44	22	33							33																						5
97											1				1	CH143-CH150	33				44	22	11	22																												5
98											1				1	CH453-CH489	22				44	22				22						11																				5
99											1				1	CC541-CC542	33				55	22			22																											4
100											1				1	CC560-CC562	33				55	11			11																											4
101											1				1	CH179-CH181	11				44	22		11																												4
102											1				1	CH453-CH465	11				44			22								11																				4
103											1				1	CH728-CH734	11				55	22											11																			4
104											1				1	CH411-CH415	11				55										11																					3
105											1				1	CH415-CH419	33				44		22																													3
106											1				1	CH644-CH646	11				44			11																												3
107												1			1	CF292-CF431		22			45	33	11		22	33				15																	11					8
108												1			1	CH172-CH176		44			44	33	11	11									11						11		11											8
109												1			1	CC470-CC537		44			44	33	11		33			11							22																	7
110												1			1	CH036-CH043		11			44	22	22	33	22				33																							7
111												1			1	CH222-CH225		11			44	22		11		22															11											6
112												1			1	CH325-CH329		15			45		33		11			22			22																					6
113												1			1	CE626-CE651		11			11					22									22																	4
114												1			1	CF526-CF551		33			44	33				22																										4
115												1			1	CH727-CH736		22			44	22			22																											4
116												1			1	CH755-CH758		11			45	11				11																										4
117												1			1	CH840-CH842		22			45								22		22																					4
118												1			1	CH465-CH479		44			33																															2
119													1		1	CC130-CC420			33		44	33	33	44	22			22										22	11													9
120													1		1	CE609-CE626			11		33	11	11	55	11								33		11																	8
121													1		1	BX361-BX419			11		55	11	11	11		11																										6
122													1		1	CE688-CE713			22		55	23				34						11				11																6
123													1		1	CH438-CH448			11		44	22	11					22			11																					6
124													1		1	BG759-CH610			11		55	22					11				11																					5

Figure 257.111 - Combination table for Dunnington Phase 7 - part 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ
1																	DUNNINGTON - PHASE 7																																			
2	Q R S	Q R T	Q S T	R S T	Q R	Q S	Q T	R S	R T	S T	Q	R	S	T	Differential sp. Count	ID	CRAB APPLE	BLACKTHORN	HAZEL	FIELD MAPLE	HAWTHORN	BRAMBLE	PEDUNCULATE OAK	ASH	DOG ROSE	ELDER	HOLLY	GREY WILLOW	SYCAMORE	ALDER	DOMESTIC APPLE	DAMSON	ENGLISH ELM	IVY	FIELD ROSE	GUELDER-ROSE	GORSE	SILVER BIRCH	WYCH ELM	GOAT WILLOW	PURGING BUCKTHORN	ROWAN	ASPEN	LILAC	BLACK CURRENT	PRIVET	WEEPING WILLOW	GOOSEBERRY	LIME	SNOWY MESPILUS	SPINDLE	Total count
125													1		1	CH568-CH572			11		44		11				22			11																						5
126													1		1	CH621-CH627			22		55					22					11													11								5
127													1		1	CH532-CH578			11		11						45																									3
128													1		1	CH380-CH405			11		55																															2
129														1	1	CE601-CE608				11	11																															2
130															0	CH127-CH195					35	11	11	22	22					33																	11					7
131															0	CH765-CH768					45	22		33	11	11	11							11																		7
132															0	CH321-CH324					45	33			11	33	11																							11		6
133															0	BX464-CH610					55	33				11	11										55															5
134															0	CC233-CC265					55			33		11			11				11																			5
135															0	CH371-CH424					55		11					11				11					11															5
136															0	CH438-CH465					11		11		11	11							55																			5
137															0	CH547-CH551					22	11				11	55		11																							5
138															0	CH738-CH746					55	22	33	11	22																											5
139															0	CH809-CH812					35	11		45					11					11																		5
140															0	BX338-CH231					55	11		33					11																							4
141															0	CC546-CC549					44	11									11	11																				4
142															0	CH317-CH320					44	11			11	11																										4
143															0	CH532-CH536					45	11					33		11																							4
144															0	CH687-CH719					55	22					11				22																					4
145															0	CC265-CC266					55			11					22																							3
146															0	CE688-CE734					22	22				33																										3
147															0	CF703-CH218							22					11		44																						3
148															0	CH137-CH142					11	11				11																										3
149															0	CH279-CH287					22		22					11																								3
150															0	CH448-CH453					45		44									11																				3
151															0	CH627-CH628					33		11				44																									3
152															0	CH812-CH814					44			33					11																							3
153															0	CC541-CC549					55																															1
154															0	CH382-CH384					55																															1
155															0	CH382-CH411					55																															1
156															0	CH762-CH773					22																															1
157															0	CH820-CH821					55																															1
158																Total	**92**	**66**	**39**	**13**	150	110	71	69	66	66	40	36	29	26	25	22	17	13	12	7	6	6	6	5	4	4	3	3	2	2	2	1	1	1	1	
159																Percent	**59%**	**43%**	**25%**	**8%**	97%	71%	46%	45%	43%	43%	26%	23%	19%	17%	16%	14%	11%	8%	8%	5%	4%	4%	4%	3%	3%	3%	2%	2%	1%	1%	1%	1%	1%	1%	1%	

Figure 258.112 - Combination table for Dunnington Phase 7 - part 3

7.8. Summary

The results for both the desk studies and field surveys are presented. The desk studies include the Woodland Workshops method, Regional distinctiveness and autecologies. The field studies include the results for both the woodlands and hedgerow case studies.

The woodland workshops re-affirmed many of the concerns that stimulated the current research, that there was uncertainty as to the reliability of ancient woodland indicator species at confirming ancient woodland status. There was also much debate as to whether it is also important to use ancient woodland indicator species to assign value to different woodlands.

It was generally felt that the most reliable way to identify an ancient woodland indicator was to do comparative analysis looking at the floras of ancient woodlands and recent woodlands. Species found preferentially in ancient woods and at lower frequency or absent from recent woodland should provide guidance on the fidelity of ancient woodland indicator species to ancient woods.

Data from the woodland case study surveys has shown that the original concept of this research, that ancient woodland indicator species are not uniformly spread across the woodland floor, has been vindicated. Many species occupy specialist meso-habitats in woodland and the more, and more varied, these are will elevate the total species count.

The hedgerow data showed clear evidence that the HEDGES method was detecting species that were historic markers for hedgerows of known origins and led on to tantalising questions that will lead to further research that will add to the finding of these studies.

8. Discussion

8.1. Introduction

The results of the research into all aspects are discussed in relation to achieving the aims and objectives of this research. It also poses questions that the current research cannot answer and suggests the need for further research. These areas are considered in more detail at chapter 10.

The main areas for discussion are:

1. Stakeholder woodland workshops
2. Regional distinctiveness
3. Autecologies
4. Woodland case study results
5. Hedgerow case study results

This chapter draws together the findings and critically assesses the concept of botanical indicators being a valuable tool in the interpretation of our wooded landscapes.

8.2. Woodland Workshops

The value of the woodland workshops was the opportunity to discuss issues with experts and practitioners familiar with ancient woods and canvas their views on any shortcomings that could be addressed in the current research.

8.2.1. What is ancient woodland?

There is still an issue about what we are trying to identify. The phrase ancient woodland is used but discussion centred on what that should look like. Is the expectation that it will be a closed canopy woodland with an abundant ground flora of shade tolerant indicator species, or could it be a remnant scatter of ancient trees in a shadow woodland on an exposed moor? Also, should ancient woodland include rides, glades and other open sky components? Ancient woodland implies a block of habitat with trees as a dominant component. Following the concepts described by Vera (2000) and Rotherham (2013a) it is suggested that a more open form of woodland existed historically, and that sparse and fragmented areas containing trees in the uplands are the remnants or ghosts of ancient woodland. Even individual trees can cast shade to support shade tolerant ground-flora species that may have persisted for many centuries. It is essential that these wooded components of our landscape are taken into consideration, especially as they represent vestiges of the scruffy landscape that can provide the refugia and inocula for shade tolerant ancient woodland indicator species to migrate into new 'woods' if and when created.

The ethos of the current research is to examine all available evidence, from all sources and not to discount anything, no matter how insignificant it might seem, until it can be discounted as of no value in the interpretation of landscape history. The definition of ancient woodland should encompass everything from a single tree on a moor to an established full canopied wood.

It was agreed that ancient woodlands should be regarded as a continuum of characteristics from open wood pasture and ghost woodlands to typical modern closed canopy examples.

8.2.2. What are ancient woodland indicators?

One of the major discussion points of the workshops was what the ancient woodland indicator species are indicating. Are they indicating ancient woodland, or are they just indicating continuity of woodland canopy? The shade tolerant species are indicating that there is shade and that they can tolerate the conditions and probable lack of competition from more light demanding species. How the species came to be there is the subject of an intelligent interpretation process. This needs to answers the questions:

1. Has the species been there from early times e.g., pre-1600 for woodlands and potentially since creation for hedgerows that could be medieval or earlier?
2. Has it arrived there in relatively recent times?

Using the Aristotle one swallow does not a summer make argument, are there species that are so incapable of getting to the location that the presence of one species can be sufficient to confirm that it has always been there and it is not a new arrival?

The main discussions revolved around the cut-off date for regarding woodland as being ancient. There was general agreement that 1600 was reasonable. Ancient woodland indicators should be those species that have a high fidelity for these ancient, rather than recent, woodlands. The species to consider were those that supported continuity of conditions from 1600. Sun lovers should also be considered (see below).

8.2.3. How were ancient woodland indicator species lists created?

The lists in current use were from either expert opinion or comparative data looking at the fidelity of species for documented ancient woodlands.

8.2.4. The inclusion of light demanding species

Many surveys have, in the past, included open sky areas and attempted to include these in the evaluation. The author presented a discussion paper for Woodland Workshop 3 that demonstrated that there were species on regional lists that had relatively high Ellenberg values for light [L]. It was suggested that 'woodland specialists' could be expected to have [L] values on average around 5.2, with other woodland species around 6.2 and any non-woodland species at 7.6. The general agreement was that ancient woodlands are probably more likely to have been dynamic with areas of clearings and parts where dense shade was cast and that the species that developed encompassed the range for this mix of light environments, so shade-evaders need to be considered as ancient woodland indicator species in the broad sense. It was still the main consensus that ancient woodland indicator species were mainly the shade-evading, shade demanding or shade-tolerant ground flora species. Very few trees and shrubs are considered to be ancient woodland indicator species, with some lists having none on them e.g., Borders and Lothian, Dorset, Northern Ireland, Leicestershire and Rutland. Rotherham (2011) advocates using all historical evidence including the information that can be obtained from individual trees like ancient coppices that can pre-date 1600 that are often overlooked. Also, some stand-alone trees in shadow woods may also exceed the 1600 cut-off point for asserting that a woodland is ancient.

Using the list of indicators and their fidelities for ancient woods at Appendix 06, the majority of species are at the shaded end of the Ellenberg scale. Descriptions up to Ellenberg [6] relate to woodlands where there is dense to light shade and for [7] above the species is showing a preference for more open positions. Form the Glaves list there are 173 species at [6] or less ([2] = 2, [3] = 9, [4] = 47, [5] = 57, [6] = 58). There are still 72 species that are [7] and above ([7] = 56, [8] = 16). Comments already suggest that the Ellenberg values should not be treated as narrowly defined conditions under which plants will grow. The wide amplitude of some species will account for some species growing in darker positions than their Ellenberg value suggests and others in lighter conditions. The issue still remains that a light demanding species would have been present in the more open woodlands of the past. This colonisability of open or lightly shaded areas in a recent woodland are the same as for the shaded meso-habitat of a recent wood. The species must generate propagules that are capable of being moved the distances necessary to reach the new wood. Then they need to arrive in the right part where conditions are favourable and establish into any existing sward. The only likely difference with respect to the colonisability of shade tolerators is that shade tolerators may not only come from ancient woods, but could arrived from shaded scruffy parts of the landscape that are closer. Shaded areas in the landscape will be less common than more open habitats and therefore the possible sources of light demanding species will be greater and the speed of colonisation by this group would be expected to be faster. This differential colonisability would form the subject of further research.

Shade evaders are an important part of ancient woodland. The ecological amplitude of species and the light environment in woods mean that there will always be less shaded parts, around the edges and in natural clearings. These will be colonised by species suited to more open conditions and may still be present in the 'wooded' area but have been lost from the 'tidy' landscape outside.

8.2.5. Survey methods

The discussions regarding survey methods expressed concerns about ensuring adequate coverage to detect all ancient woodland indicator species in a wood. Transects and quadrats were considered. The proposal from the current research was to take the best elements from both and devise a targeted survey protocol to maximise the chances of detecting most, if not all, ancient woodland indicator species in a wood. This method WOODS (Woodland Overview and Objective Description System) also advocated targeting transects to survey areas of internal variation - called meso-habitats - separately as a means of better describing the range of species in terms of their autecologies.

8.2.6. The use of ancient woodland indicator species

The current use of ancient woodland indicator species is in support of any historical data and is often used during planning to determine the status of woodland. The norm is to use a threshold number of species taken from a candidate regional list. This was a subject of concern as there was no accounting for differences in woodland character, acid vs calcareous woods, homogeneous woods vs woods with a range of meso-habitat etc. A weighing system was recommended with better regional lists.

8.2.7. Can indicators be used where historical records are absent?

An important aspect discussed was whether or not the determination of an ancient woodland should rely on historic and documentary evidence only without any supporting botanical information. It was generally agreed that historical evidence and documentary evidence should take precedence over botanical evidence (Rotherham 2011) although the latter should be brought into play in support of any historical information that may be available. It is still likely that there may be a small pockets and fragments of ancient woodland across the countryside for which there is no documentary evidence. The only method of determining if this is the case will be to consider any botanical evidence they may contain to support a supposition of a continuity of canopy cover from pre-1600. It is unlikely that botanical evidence can provide a definitive answer where historical data is missing, but it can provide an 'indication' that should be a consideration is cases like planning applications or conservation strategies.

8.2.8. Are we trying to identify ancient woods or assign value?

Another significant discussion point raised during the workshops was whether or not we were attempting to only identify ancient woodlands or whether we were trying to assign value. This was driven largely by the requirement under planning policy to consider ancient woodlands as irreplaceable to refuse permission for development if it can be asserted that the woodland is regarded as ancient. To an extent, determining whether a woodland is ancient or not is a black and white decision. But the decision may need to consider comparing different ancient woodlands to determine if one is more valuable than the other and planning policies may allow development in the lower grade woodland compared with the higher grade. This has significant implications as the general impression is that, almost regardless of the size of the woodland, it is the range of internal variation that can elevate the number of ancient woodland indicators and therefore satisfy any defined threshold number of species. This is why this research considers if it is practicable to create a level 'playing field' that can be used in planning policy and conservation strategies.

8.3. Regional Distinctiveness

Current regions encompass whole counties or more than one county in some cases. The standard BRC records are for 10km OS grid squares. This means that a record relating to a grid square could be anything from a single record for the species in the square to many hundreds, or even thousands of records across the area. Using atlases for species distributions which use 10km resolution is likely to give a false impression frequency. Compared with data at the tetrad (2x2 km), or even monad (1km) resolution the frequency would appear to be lower. An extract from the *Butterflies of Yorkshire* (Frost 2005) for the Orange Tip butterfly *Anthocaris cardamines* (see Figure 265.113 and Figure 265.113) shows that it is found in almost every 10km square, but there are many areas where it is absent or at low frequency within a 10km square when considering the tetrad map. For example, the 10km square at the extreme north has two tetrads only where there are records of 1 and 2-9 records respectively and the same at 10km resolution gives at best a false impression of the distribution of this species. This mapping does account for the number of records either in the 10km square or tetrad by varying the symbol size and colour.

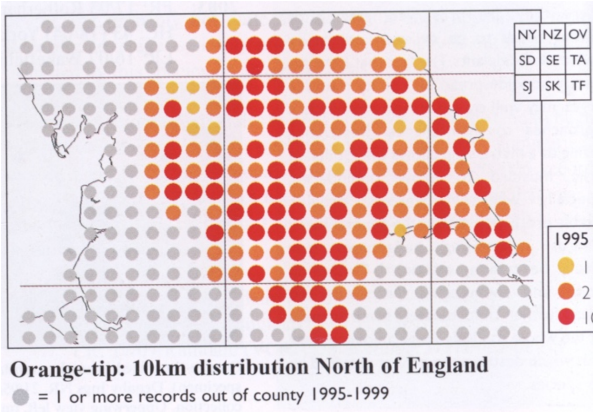


Figure 265.113 - Species map for Orange Tip butterfly *Anthocaris cardamines* showing the pattern at 10Km resolution records.

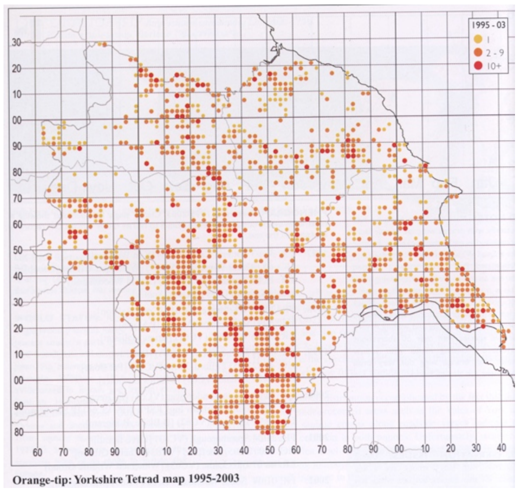


Figure 265.114 - Species map for Orange Tip butterfly *Anthocaris cardamines* showing the pattern at 2x2Km resolution records.

There is still a trend that more 10km record equates to more records. In a NCA with 100 10km squares a species recorded in 5 could be as few as 5 specimens. A species recorded from 50 squares could be hundreds of colonies, not just 50, etc. The general basis for this part of the analysis is that the number of 10kms that a species has been recorded from is taken as a measure of the likelihood that the species could be encountered in woodland in that NCA. This should form the basis for generating candidate lists, in conjunction with the use of lists of species that have been shown from comparative study to have a distinct fidelity for ancient woods. The uses of candidate lists for NCA are:

They take a more objective view of the species that should be considered for lists. Currently there are counties where a species is missing, but is found on adjacent county lists with no obvious reason for the omission, e.g., the absence of Pendulous Sedge *Carex pendula* on the list from CO Durham (

1. Figure 266.115).
2. To focus attention on species likely to be encountered that are known to be found in woods in the NCA.
3. To account in the interpretation for any differences in the candidate lists from adjacent NCAs. For example, between an NCA with calcareous soils next to one that is more neutral to acidic, the expectation is that a) the former might have more species on the list and b) the range and identity of species will differ, reflecting the pH differences.

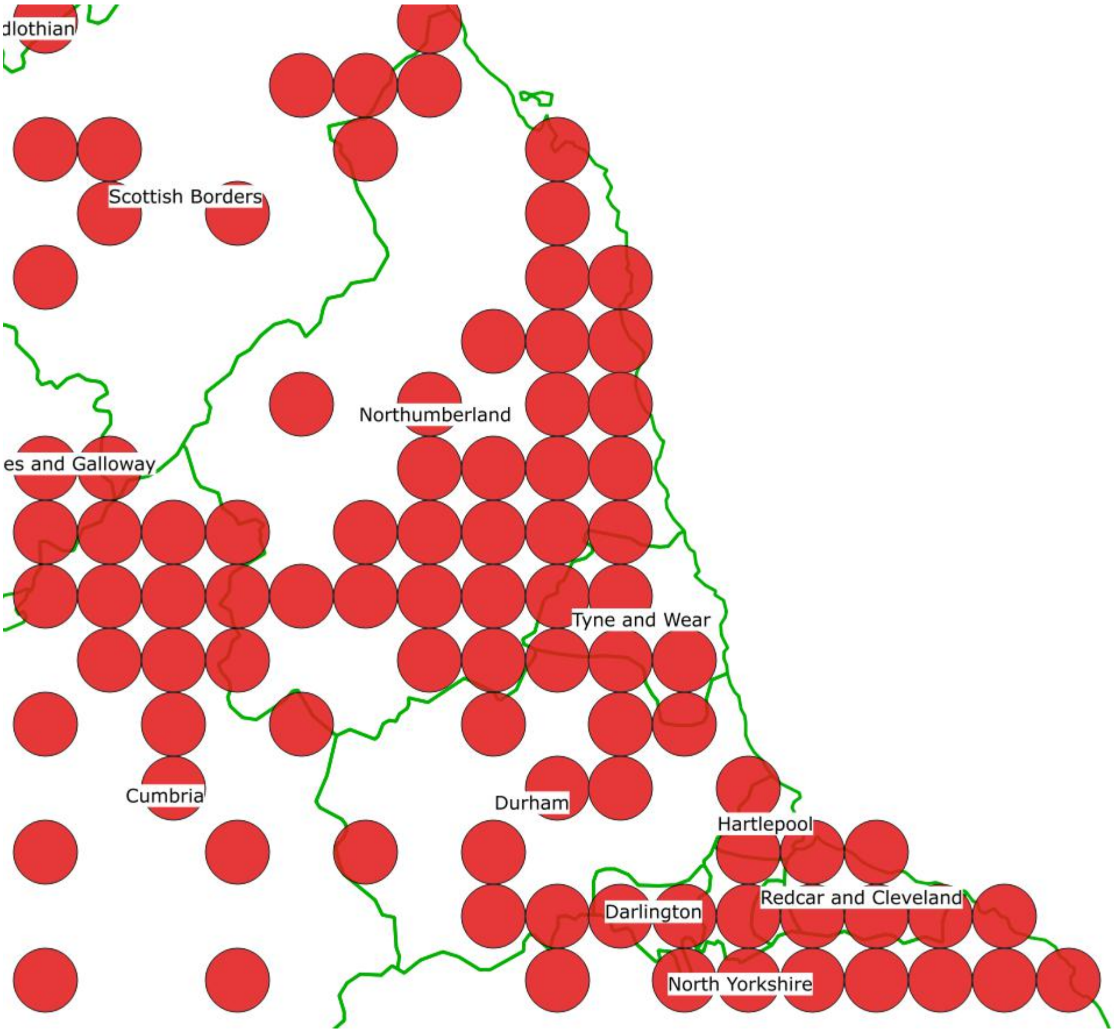


Figure 266.115 - Extract form the BRC records showing 10km records for Pendulous Sedge *Carex pendula* that appears on the Northumberland list, but not on the Durham list despite it being in 13 10km squares in the county.

Because it is not known from the 10km BRC data where in the square the records are it cannot be confirmed that a record in a 10km square is actually in the NCA if the square straddles the NCA boundary as shown for NCA30 at Figure 267.116. Future data needs to look at occurrence at a finer scale. The tetrad is often used (2 x 2 1km grid squares) but there is no reason, with current technology, not to move to 10m with hand-held GPS and smartphones.

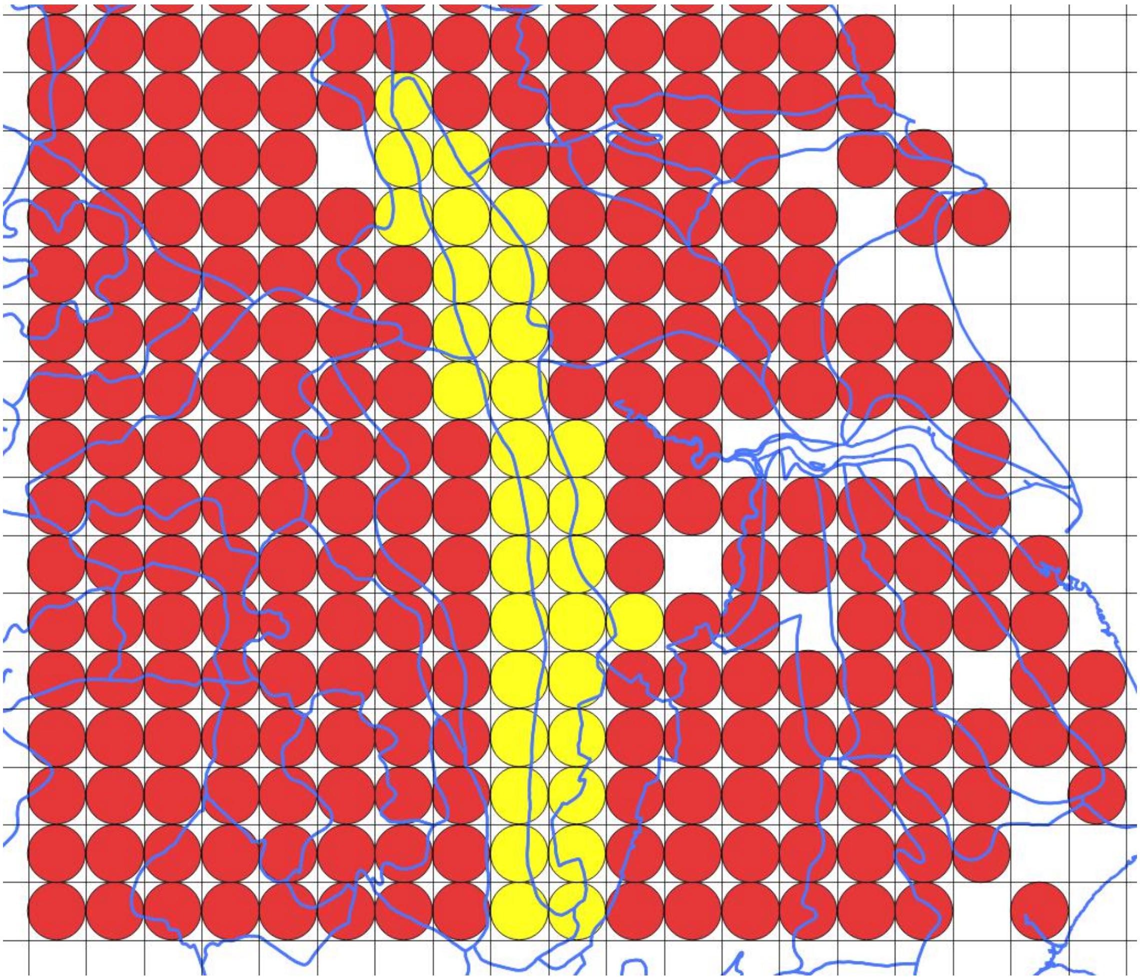


Figure 267.116 - Extract for NCA 30 for Wood Anemone *Anemone nemorosa* showing how many of the 31, 10km grid squares (marked with yellow circles) are fully or only partly inside the NCA boundary (blue line)

In this case, (see Figure 267.116), the chances are, as Wood Anemone is such a common species, that there will be a spread of records across the 10km square and it is most likely that this species has a valid place in the candidate list analysis for this NCA.

As the NCA boundaries themselves are not clear cut and definitive the adoption of a record that could potentially be outside the NCA is not an issue and again acts as a 'catch all' to account for the maximum number of candidate species for the NCA.

An example of where species occurrence can change at NCA boundaries is at NCA 30 for Wood Horsetail *Equisetum sylvaticum*. Figure 268.117 shows how the records for this species with an acidic preference are to the west of the calcareous magnesian limestone in of NCA 30 only partly into NCA30 and not to the east where acid conditions are not present. The blue circles are 10km squares that are at least partly in the NCA, but where Wood Horsetail is not recorded.

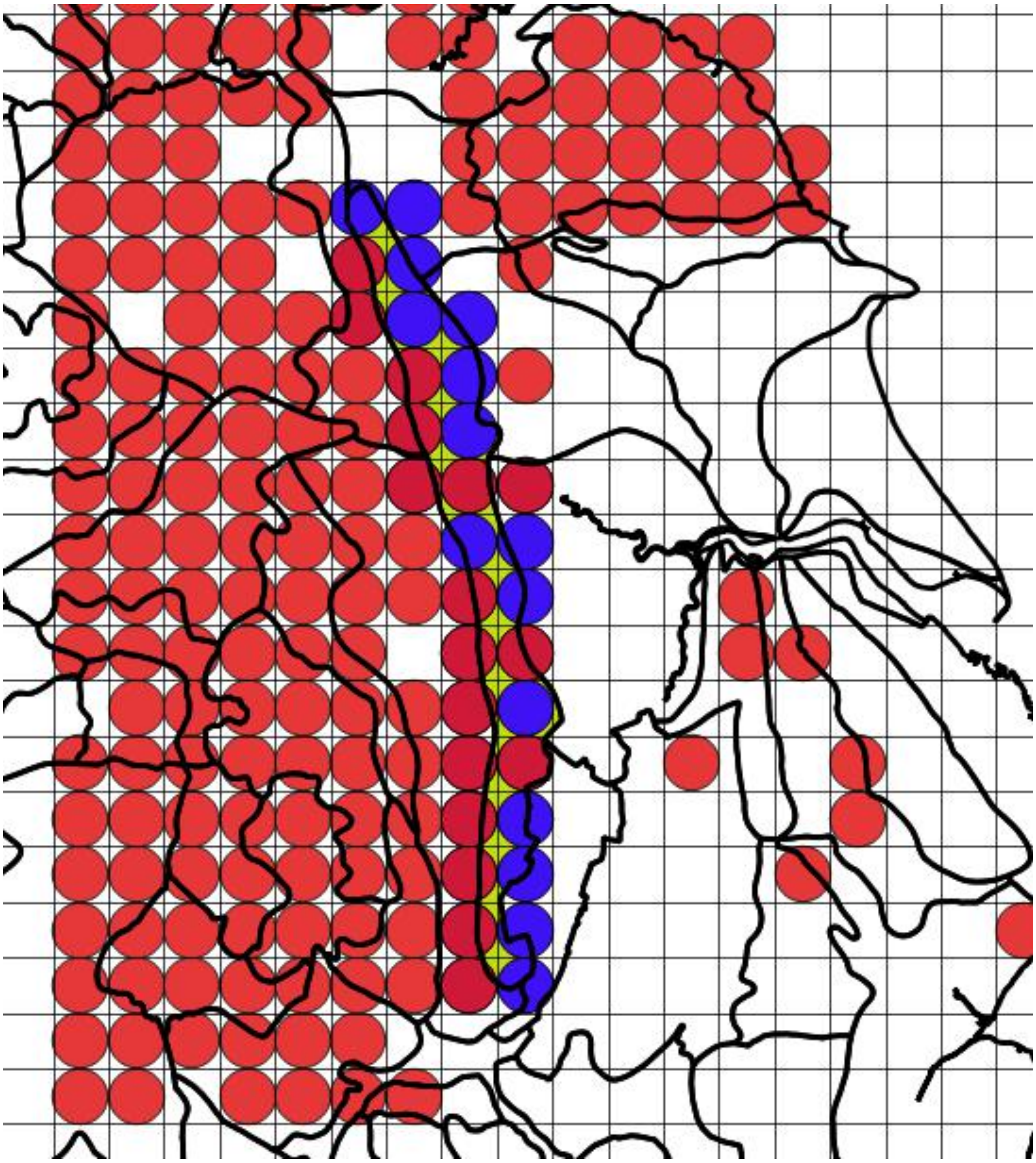


Figure 268.117 - BRC record map for Wood Horsetail *Equisetum sylvaticum* at NCA 30 and adjacent NCAs showing how abruptly the species disappears from records passing west to east from the neutral/ acidic NCAs to the west and across the magnesian limestone of NCA30 to calcareous NCAs to the east(Red = present, blue = absent within the NCA, white absent.

The use of NCAs in England will focus future regional lists onto ecologically meaningful areas and, in conjunction with BRC data and a list of high fidelity species, realistic candidate lists can be drawn up for counties where no list currently exists. Existing counties can adopt the NCA approach and develop a set of lists relevant to their administrative area.

The concept of applying a weighting by NCA has been evaluated. For species that are rare it could provide information in cases where the species was on the edge of its range, but if it is just that the species is rare in the NCA and it is recorded on a survey it is more important that the species is on the candidate list than giving it an enhanced score. The best way to devise candidate lists for NCAs is to determine if there are any records for the species in the NCA and use that to draw up a candidate list. The fundamental requirement of assessing whether a woodland is ancient is whether there are species present that have a fidelity for ancient woodland. There is little merit in uprating a species like Killarney Fern *Trichomanes speciosum* just because it is rare. It does not make the wood more likely to be ancient than any other high fidelity species. It should be regarded as a high fidelity species and weighted under that consideration, not because it is rare. As a species that is restricted to deep, dark crevices and probably has not produced quantities of spores for centuries it is likely to be one of the best indicators of continuity of shade.

Knowing how many 10km squares from which the species is recorded is only of value in suggesting how likely it is that it will be encountered. The best way to use the number of records for a NCA is in assigning value to the wood. If there are two ancient woods being assessed and one has a species rare in the NCA it should be uprated in an evaluation.

The density of woodlands in the NCA and the density of ancient woodland may impact on the likely rate of colonisation of recent woodlands with ancient woodland indicator species. In many cases recent woodlands i.e., those on the Forestry Commission Woodland Inventory that are not in the Ancient Woodland Inventory, are close to or even joined onto ancient woodlands. Where there are short distances between the two types there may be a likelihood that the recent woodlands will become colonised with AWIs more quickly than if the two types are more distantly separated. The proximity of an ancient woodland to a recent woodland may elevate the list of AWIs and this needs to be accounted for to avoid wrongly classifying a recent woodland as ancient woodland. This needs to be done on a site-by-site basis. There may be a less than clear cut differentiation of the two types of woodland where AWI colonisation of a recent woodland has taken place.

A benefit of the WOODS survey and SPACES analysis is that they are likely to detect where a wood is becoming colonised by AWIs, rather than having an existing population, by considering the presence of species and their abundance in different parts of the wood. In the case of Wray Wood referred to at 5.11.19, the area north of the earthworks was dominated by Bluebell *Hyacinthoides non-scripta* and had only four small patches of Wood Anemone *Anemone nemorosa.* This indicated that the area was disturbed or un-wooded and has rapidly re-colonised with Bluebell and is beginning to colonise with Wood Anemone.

Hedgerow assessments normally take little account of regional differences, except for the Hedgerows Regulations (HMSO 1997) that acknowledges a north-south divide by decreasing the number of qualifying shrub species by one for northern counties.

8.4. Woodland Autecologies

There are two major components of autecologies in relation to colonisation ability:

1. Can the species get to the wood - produce seed that can disperse to new woods over the likely distance involved today?
2. Will it grow there - are the seeds viable and are the abiotic and biotic conditions suitable?

Item 1 relates to the reproductive strategy of the species and Item 2 largely deals with the abiotic and biotic conditions at the new wood.

From the autecological results the synthesis is that there are many attributes that affect the ability of a species to colonise a new wood from a donor site. The shortcut approach is to look at the evidence for which species have a high fidelity occurrence in ancient woods compared with recent woods (comparative studies). This is likely confirmation that the autecology of species makes them good ancient woodland indicators without needing to know which attributes are involved. This is discussed in the next section. The more detailed approach would be to consider the autecological attribute and determine which are limiting for a given species.

8.4.1. Comparative Studies

The comparative studies method compiled a table starting with the list of species regarded as being ancient woodland indicator species by at least one author from the survey by Glaves *et al.* (2009a). Each species was given a weighting based on the degree of fidelity observed from 5 studies by:

1. The Woodland Trust (2007) - Northern Ireland
2. Adrian Vickers (2001) - South Yorkshire
3. Thompson (2003) - Somerset
4. Peterken 1974 - Lincolnshire
5. Peterken 2000 - Lincolnshire

Adrian Vickers (Vickers 2001) presented data from 107 ancient woods in south Yorkshire contrasted with 46 recent woods and 24 that were planted after WW2. The latter two groups were combined to represent data from post 1600 woodland. These data were converted to percentage fidelities for the two types of woodland. As an example Lady-fern *Athyrium filix-femina* was recorded from 26 woods, 25 in ancient and 1 in recent. This represents a 96% affinity for ancient woodlands and 4% in recent etc.

Thompson also present data as a percentage fidelity.

Peterken 1974 assigned a grade for groups of specie (see 7.4.1). All groups were regarded as being indicative of ancient woodland but some species did occur in recent woods if rarely. These were converted by the author of this thesis into percentages as shown at Appendix 06.

The Peterken 2000 lists are presented as percentage fidelities.

The list from Glaves *et al.* (2009a) is a generous list that errs on the cautious, catch-all principle. Similarly the maximum percentage score takes the highest score from any author as the value (Cross 1987) in the assessment. There is often a range of scores from the authors, with frequent cases where at least one author found 100% fidelity but another treated the same species as only 50% restricted to ancient woodlands, so an evening out is also presented at Appendix 06. This averages out the percentage data for a species that at least one author has assessed. An example would be *Carex remota* that was recorded by all authors at 100%, 100%, 59%, 90% and 82%, average 86%.

The list at Appendix 06 emphasises the lack of consistency in regarding species as having an affinity to ancient woodlands. There is variation across the country.

Work of this nature detects and presents a correlation between species presence in identified ancient and recent woodlands, but does not explain the cause, nor the reason why there is an overlap with many recent woods having the same AWIs as ancient ones. This is likely to be the result of a number of factors including the presence of ancient woodland indicator species in the 'scruffy landscape' that recent woods were planted into, and the anthropogenic impact of humans carrying propagules from ancient woods to recent woods as an accelerated dispersal vector.

This is why the WOODS method was developed, as a species in a wood may be anything from one plant to an entire carpet and would normally be recorded as present by current survey methods. WOODS not only assigns abundance but also identities the position(s) in the wood where the species was found. Using intelligent interrogation the status of the species can be assessed and determined if it is likely to have been present for a protracted period and has colonised and spread to its predicted limits, or if it is only in isolated patches suggesting recent colonisation that has not fully developed the potential extent for the species. Also, if the species has specialist requirements and that meso-habitat is rare, then the species may be in all suitable situations in an ancient wood, but may only be in one such position, out of many possibles, in a recent wood. An example would be Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* that may be in every damp part of an ancient wood, but only in one such meso-habitat in a recent wood, and that could be near the edge or next to a ride where human or other vectors could have deposited seed. This species is regarded by two authors as having an affinity for ancient woods of 57% and 60% (Somerset and Lincolnshire) indicating a significant present in recent woods.

8.4.2. Woodland Species Autecologies

From Table 109.1 relatively few AWIs have woodland as their common terminal habitat. These should perhaps be regarded as the Rackham - Woodland Specialists. Even some of these have alternatives in which they occur frequently. This facet cannot be relied upon to identify AWIs.

The main principle cited by authors as the reason for species being confined to ancient wood is that they are poor colonisers of recent woodland. Taking this concept, a good ancient wood indicator would be one with autecological attributes that made it difficult for the species to colonise newly planted woods. They would be expected to:

1. Produce low amounts or low viability dispersible propagules.
2. Have a poor mechanism to for dispersal to recent woodlands.
3. Find conditions unsuitable in a recent woodland because of such factors as competition, lack of suitable meso-habitat and nutrient status.

These relate to colonisation ability, with Item 3 incorporating the attributes a species needs to be able to grow under the conditions of light, soil, pH, moisture, slope etc.

As already referred to in the results section, there should have been enough time elapsed since 1600 for even low propagule-yielding species to have produced enough seed over the years to colonise into woods planted after 1600. Items 2 and 3 are more likely to be the constraining facets. Of these, Item 2, the difficulty of getting to a new wood may be the more limiting. The data on dispersal is shown at Table 115.2. In this list there are many species with an unspecified method of dispersal. This limits the use of this attribute in determining which species to be given higher weighting that others because of their difficulty in dispersal. Several critical species like Bluebell *Hyacinthoides non-scripta* are listed as unspecified. Although this attribute may be useful as a guide for species that are listed with a dispersal method it cannot be used universally as a method of weighting. From this list there are also a number of species regarded as have 100%

fidelity to ancient woodland that are dispersed by animals. These would be expected to be species likely to colonise new woods readily, so why are they regarded as high fidelity AWIs? This attribute cannot be used without caution to predict that a species is a good AWI.

One of the aspects of considering which ancient woodland indicator species are likely to colonise is that some species regarded as ancient woodland indicator species are also found in other habitats. For example, Common Spotted-orchid *Dactylorhiza fuchsii* is found in a wide range of habitats, including woodland, as well as unshaded habitats such as meadows and waste ground. It is also relatively widespread in the countryside and has minute, wind-dispersed seeds. On this basis, it is highly likely that seeds from the species will be present in the atmosphere adjacent to any recent woodland that has been newly planted and where the canopy has developed. This species is also a generalist and has no particular ecological requirements and should, in theory be regarded as a good colonist and yet it is also regarded as an ancient woodland indicator by many authors.

It is often presumed that ancient woodland indicator species get into new woodlands from other ancient woodland habitat, rather than from other suitable habitats. Although this may be the case for many species it is not applicable to all ancient woodland indicators. It would be tempting to consider that ancient woodland indicators can only come from that habitat. This is not the case, and this needs to be taken into consideration when determining candidate species for consideration as being poor colonists of recent woodland.

Many recent woods will have been planted onto agricultural land with a high nutrient status. This relates to Item 3 (above) and could significantly affect colonisation as ancient woodland indicator species (Brenchley and Adam 1915) are generally not nutrient demanding and other, more demanding species will be competitive and restrict the establishment and growth of ancient woodland indicator species.

It is clear that many species regarded as ancient woodland indicators have a wide amplitude of conditions they can tolerate. As an example, there are five species listed below that can be found growing in the same place in a wood, under the same level of shading but have different quoted values for 'L' as follows:

- Dog's Mercury *Mercurialis perennis* = 3
- Herb-Paris *Paris quadrifolia* = 3
- Ramsons *Allium ursinum* = 4

- Wood Anemone *Anemone nemorosa* = 5
- Bluebell *Hyacinthoides non-scripta* = 5
- Early-purple Orchid *Orchis mascula* = 6

Ecologically it is likely that the light levels at that location are core to one or more, species, but marginal to others. So if the light level in the wood corresponds with the description for the Ellenberg value of 4[13], then the list above suggests that Dog's Mercury *Mercurialis perennis* and Herb-Paris *Paris quadrifolia* are growing under conditions where they are tolerating more light than would normally be ideal. Wood Anemone *Anemone nemorosa,* Bluebell *Hyacinthoides non-scripta* and Early-purple Orchid *Orchis mascula* are in deeper shade than their core preference suggests. Yet all co-exist with no indication that any is in decline caused by unfavourable conditions. In coppiced woodlands, the shade environment changes dramatically when the coppicing is done and light is allowed in. Species with a wide ecological tolerance for light will be favoured by this regime and those only able to tolerate deep shade will be disadvantaged, possibly to the point of extinction during the 'open sky' period.

This is partly the reason why some species typical of open situations are included on AWI lists. Other reasons include the dynamics of the shading that allows areas of light shading or no shade to develop and persist, and which provide the conditions for open-sky species to colonise. The converse can also apply, as already stated, in that species normally associated with shaded environments can persist for considerable periods in the absence of shade.

Personal observation of a hillside off the A59 near Skipton at SE 08201 52753 (see Figure 275.118) has recorded an area carpeted in flowering Bluebells every year for at least the last 12 years (presumably in an area of former woodland) with no indications of any decline in numbers.

[13] Between 3 and 5 - 3 being <5% illumination at full leaf canopy and 5 being >10% illumination

Figure 275.118 - Observation of an area of Bluebell on a hillside off the A59 near Skipton at SE0820152753 presumed to have been previously and area of woodland (Google earth image©)

It can also persist under Bracken as shown at Figure 276.119, and also Bramble *Rubus fruticosus* as well as other shaded locations such as in the grykes of limestone pavements.

Figure 276.119 - An example of where Bluebell *Hyacinthoides non-scripta* grows under the canopy of Bracken *Pteridium aquilinum* in grassland near Kendal (taken 03-06-2013 as the Bracken fronds are unfurling and the old fronds can be seen).

This raises the question posed by Keith Kirby as to how long a species might persist between periods of tree cover. If an area is clear felled, how long can some of the species persist before a second canopy of woodland can be established? It is also important to bear in mind that this persistence can be from the actual plants persisting or because of a long-term seed-bank, or other vegetative persistence.

The concept that a species could be characterised as having autecological attributes that indicate it to be an ancient woodland indicator was an original research aim. This would require data to be available for all important aspects of a plant's autecology.

1. How is it pollinated?
2. Is pollination successful, if so how successfully?
3. How much seed is set?
4. Is it all viable?
5. What are its germination requirements?
6. Are all of the growing conditions at the new site suitable?
7. How competitive is it at a new site?
8. Can it thrive and spread at a new site?

Data is not available for all relevant species for all of the above. This research has developed a system of describing the conditions under which a species grows and a species can be given a coding for the suite of attributes that apply in the Phase 1.5

profiles. The Phase 1.5 codes (see Appendix 01 and 6.4.1 on page 70) can either be generated from any information available from *Plantatt* or *Comparative Plant Ecology* to predict a species occurrence, or from observation of the conditions that species is growing under. As an example, Hairy Woodrush *Luzula pilosa* would have an ecological attributes profile from *Plantatt* and *Comparative Plant Ecology* of: [Eat] - gentle to moderate slope (*Comparative* Plant *Ecology*), [EAs] - moderate shade (*Plantatt* [L] = 5), [eap] - low pH (*Plantatt* [R] = 5 and *Comparative Plant Ecology*) and [EAm] - a species of damp site (*Plantatt* [F] = 5). These combined with observation of where the species grows would give a profile of:

- [BWD] [WGF] - [Eat] [EAs] [eap] [EAm].

This profile could have equally been created from an observation of where the plant was growing. An advantage of defining a profile from actual growing conditions is that a species may be growing in a sub-optimal position and the predictive method may fail to suggest that possibility. For example *Comparative Plant Ecology* lists Hairy Woodrush as being recorded occasionally in soligenous mires.

Autecological requirements of species can inform if a recent woodland has suitable conditions for colonisation. If there is a species that matches those conditions but does not appear to colonise that niche easily, it is likely that the dispersal mechanism is the limiting factor. Knowing the growing requirements of a species is unlikely to form the basis for a weighting system.

The original research proposals suggesting that a weighted scoring system should be developed has been critically assessed and there is no simple and clear answer. The variability in woodlands is too great to provide a simple numerical value that says 'This wood is ancient' and 'This wood is recent'. The intelligent interrogation proposed by Rotherham (2011) offers an assessment method that includes all available sources of information from ecological to historical, pedological and archaeological. It is suggested that the ecological component could include thresholds but would refer to key species and rarities. He also states (page 177) that "There is a danger that the use of indicators becomes too formulaic and users expect a definitive numerical answer of indicator occurrence and worth". The current research confirms this approach and, in addition to asserting that there is no answer of '42'[14], also believes that rarities need to

[14] 'The answer to the great question … of life, the universe and everything … is … is … forty-two' - Douglas Adams (1979).

be accounted for, especially if assessing Plantations on Ancient Woodland Sites (PAWS). These may currently contain very few ancient woodland indicator species. Another personal observation in a PAWS near Tockwith - Wilstrop Wood (SE490539) - found a small colony of Broad-leaved Helleborine *Epipactis helleborine* at its centre on a former ride and one plant of Soft Shield-fern *Polystichum setiferum* on a seasonal ditch bank (see Figure 279.120). Both were almost certain relics from before the wood was converted to conifers, confirming its ancient origin. To reverse Aristotle: one swallow *can* make a summer.

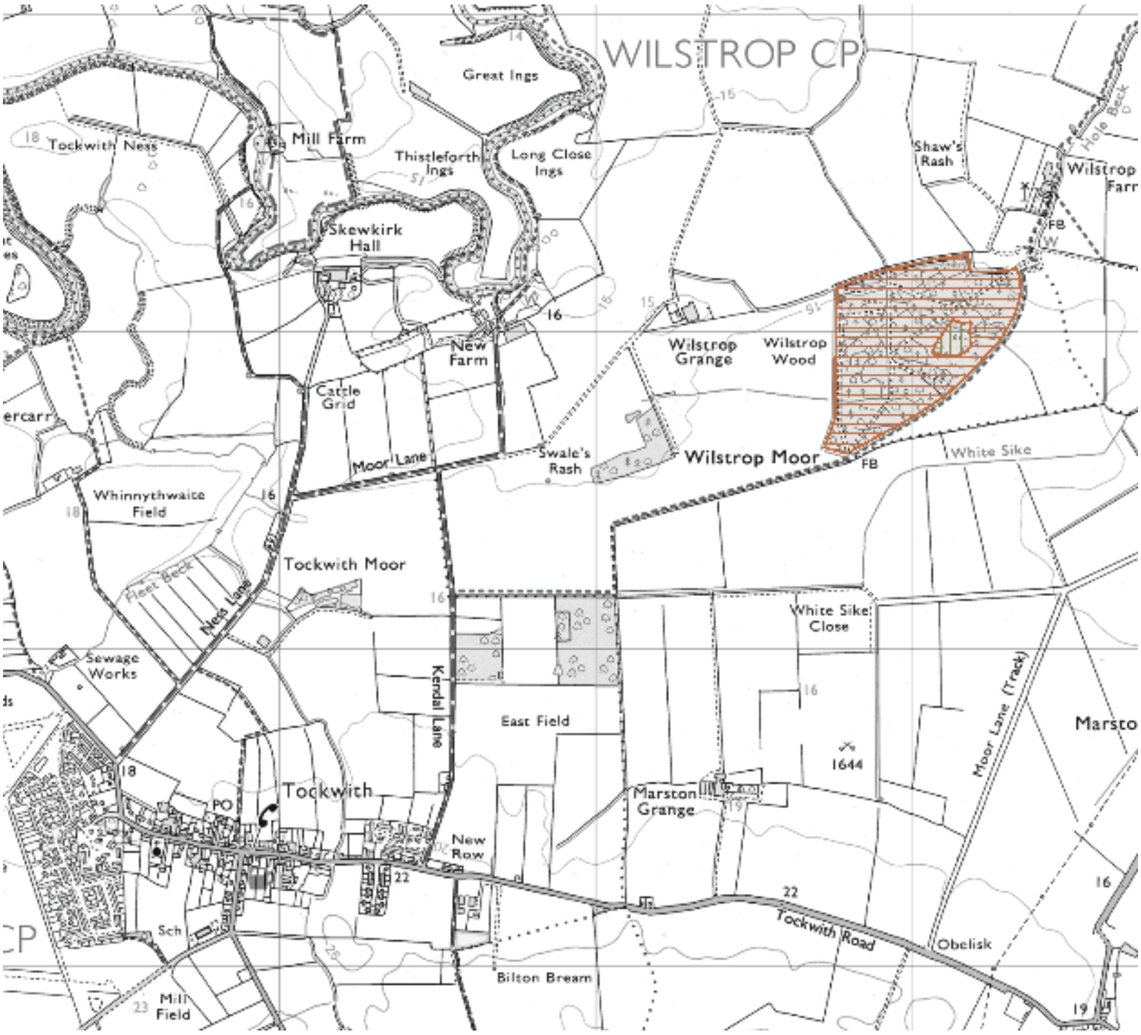


Figure 279.120 - The MAGIC location map of Wilstrop Wood, a Planted Wood on an Ancient Woodland Site that hosts two rarities still present under the conifers, *Epipactis helleborine* and *Polystichum setiferum.*

An example of the dynamics of species advancing and potentially retreating dependent on management is at Wray Wood near Boston Spa (see Figure 280.121). This wood was not studied in detail for this thesis, but the following observations are relevant.

Figure 280.121 - OS location map for Wray Wood SE421470. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Here, an ancient woodland fragment also had an earthwork on which there was a concentration of ancient woodland indicator species, including *Melica uniflora*, *Conopodium majus* and *Mercurialis perennis.* The latter species showed evidence that it was slowly colonising/ re-colonising part of the wood as shown at Figure 281.122 and Figure 282.123. The shape of the colony of Dog's Mercury strongly suggests colonisation from the 'L'-shaped earthwork. The right angle alignment and the fact that they are straight lines is suggestive that these may not be wood boundaries (these are more often sinuous or curved) and could potentially be Romano-British and an undocumented fragment of centuriation in Yorkshire similar to the Kent A Cadastre (Peterson 2002). The southern two compartments hold a full range of ancient woodland indicator species, including Yellow Archangel *Lamiastrum galeobdolon* and Wood Anemone *Anemone nemorosa*, both of which are absent, or nearly so in the case of

Wood Anemone (present as only 4 small patches NE of the red line), in the northern compartment.

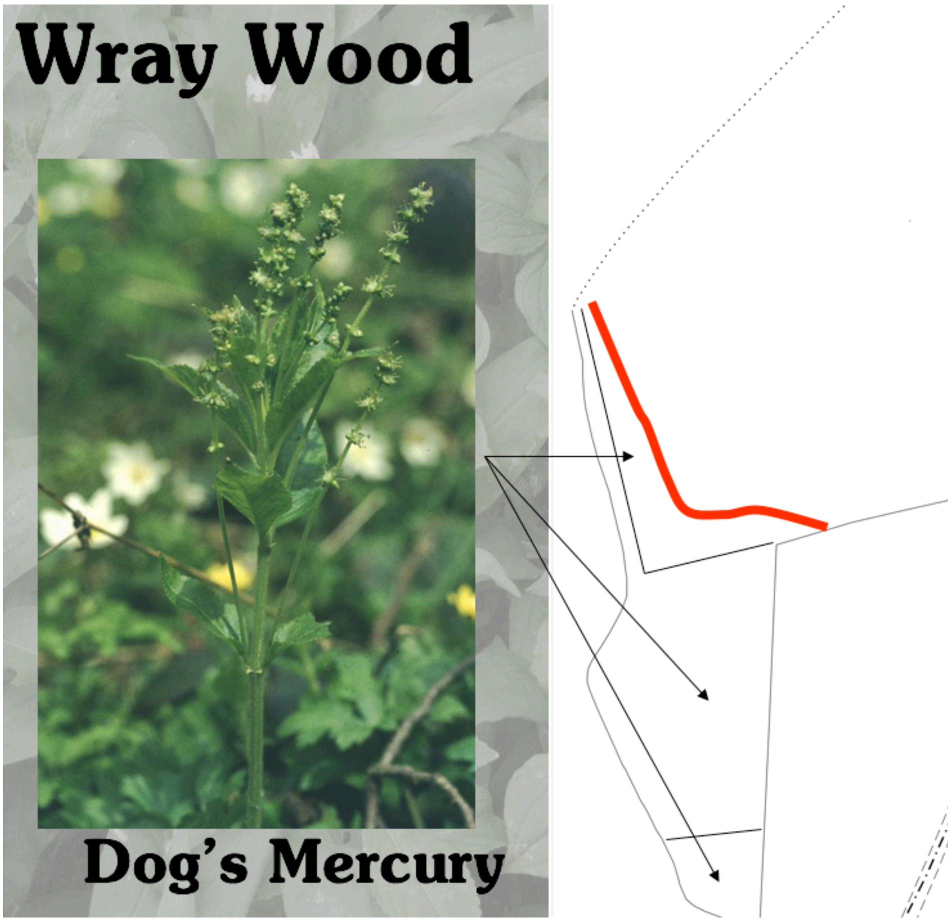


Figure 281.122 - An extract from a PowerPoint presentation showing the extent of Dog's Mercury *Mercurialis perennis* in Wray Wood, Boston Spa in relation to an 'L'-shaped earthwork and its constant presence in areas to the south, but absent NE of the red line, which is almost entirely dominated by Bluebell *Hyacinthoides non-scripta*.

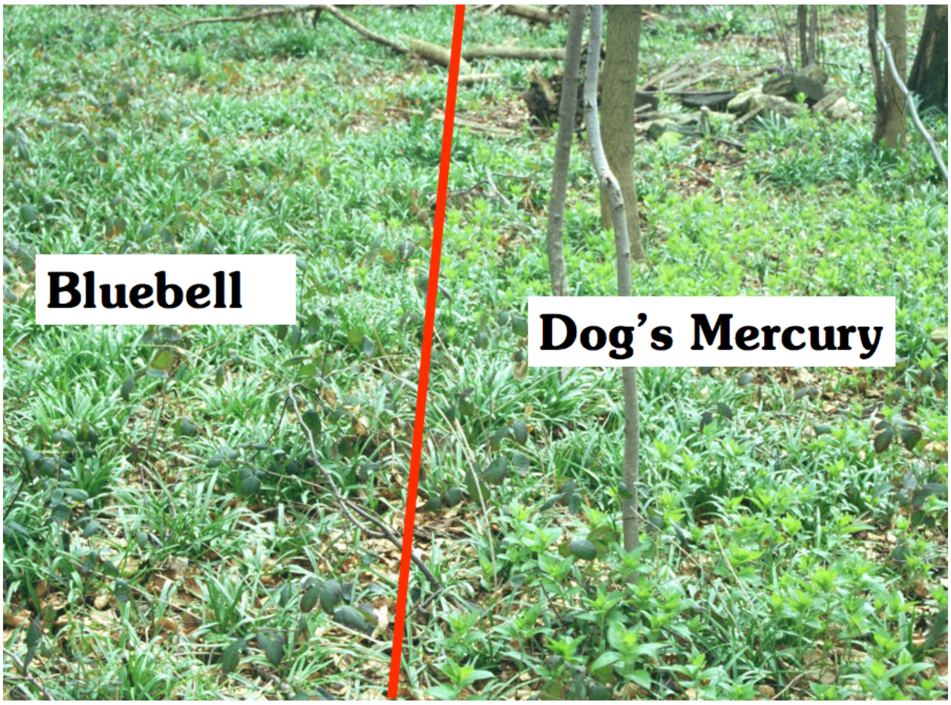


Figure 282.123 - Photo showing the interface between the Bluebell dominated main wood and the probable advancing front of the Dog's Mercury

For the purpose of this research the comparative method of using species with percentage fidelities to ancient woodlands is used, as these species have been determined as having demonstrated a significantly high affinity for ancient woodlands. The certainty and weighting become unsound as the fidelity approaches 50%, but values of 60% or more are providing a degree of confidence and many values are 100% and can be taken as a reasonable certainty that their autecologies are sufficiently restricting to make them a 'good' ancient woodland indicator species.

The SPACES approach combined with assessing species based on their autecologies as recorded by their Phase 1.5 profiles provides a more intelligent method for using botanical indicators as historic markers in woodlands.

Once the species in meso-habitats have been recorded their significance can be assessed to understand the finding in terms of the likelihood that a wood is ancient. This approached is done for the woodland case studies in the evaluation tables and discussions.

8.5. Hedgerow Autecologies

Hedgerows are dynamic. Species can potentially come and go frequently through history both through natural methods and by being either added or removed as part of human management See 8.9.7 and Figure 311.132). Trees and shrubs in hedgerows will normally reach maturity and die, opening up new colonisation opportunities that certain species are likely to be able to capitalise on more than others e.g., berry bearing species as opposed to wind dispersed species. Such deaths may be of only single bushes and rapid colonising species will be favoured. Sometimes the death can be more extensive, for example following a fire as demonstrated at Figure 284.124, or due to drainage failure and death from waterlogging. This may allow slower and less competitive species a chance to establish.

An example of persistence under unfavourable conditions in hedgerows is a species like Dog's Mercury *Mercurialis perennis* that shows a distinct affinity for the hedge base and normally ventures away from the shade cast by the hedge by as little as 50cm to a metre (personal observation[15]). It can persist, but will dwindle in gaps. An example is along a hedgerow near Cattal in North Yorkshire where a fire removed 30+m of hedge in the early 1970s. The Dog's Mercury is abundant under the extant hedgerow untouched by the fire, but less abundant in the burnt areas that are now dominated by open sky tall grasses (see Figure 284.124). There are two scenarios proposed to account for this:

1. The Dog's Mercury may have been severely damaged by the fire and is only now showing signs of recovery
2. Dog's Mercury under a hedge, where it is shaded, will not be subject to competition from open sky species like grasses. This species may tolerate the open conditions, but be less competitive against the better adapted open sky grasses. It may persist for many decades as demonstrated here, but may eventually become extinct. Such persistence has implications when considering whether a woodland planted on an area believed to have been previously un-wooded may have retained such species in scruffy areas during an unfavourable period.

Of the two, the most plausible is suggested to be number 2. It was relatively undamaged by the fire but has not regained its former abundance because of lack of shade or competition.

[15] This can extend further for tall hedges, where the hedge is on the top of a north-facing bank or where Bramble or Bracken provides a continuation of the shaded conditions.

Figure 284.124 - Photograph of persistent Dog's Mercury *Mercurialis perennis* on a hedgerow damaged by a fire in the 1970s.

The vegetative aggression of some species is an important consideration. Holly *Ilex aquifolium* is an evergreen with the apparent ability to gradually extend along hedgerows by seeding and suckering. English Elm *Ulmus procera* has a similar propensity based on the case studies at Dunnington. As this species rarely sets seed in this country under our current climate it is present now through vegetative suckering. This also means that the plants here today are the **same** plants as originally planted or colonised. Other species like Dogwood *Cornus sanguinea* and Blackthorn *Prunus spinosa* can bypass extant sections of hedgerows by seeding and suckering next to the hedge, moving along the front and entering gaps to establish. Further research may be needed, but many hedgerows surveyed as part of this research have stretches of these two species that can occupy 20-30m of hedge and be the dominant or exclusive species.

Knowing the characteristics of certain species can assist in explaining their current status in hedgerows. The supposition from this research is that English Elm *Ulmus procera* is a persistent vegetative spreading species that has been present in some hedgerows since the medieval period and has successfully dominated a number of hedgerows, pushing other species like Hawthorn *Crataegus monogyna* into a subordinate abundance.

The autecological attributes tabulated in the results section at Table 123.3 show the method of seed dispersal and the clonality, but this does not greatly assist in determining which species are most likely to colonise gaps or out-compete less aggressive species and which ground-flora species are likely to establish, spread or persist in hedgerows.

Species like Spindle *Euonymus europaeus* have animal ingested seeds and sucker from the base, but it is a species that does not normally appear as anything above rare in frequency terms although it can achieve high abundance as at Clifford Boundary W1. Compare this with English Elm *Ulmus procera* that also suckers, but appears to be much more aggressive. Hedgerow species autecologies are of some assistance in determining the species composition of hedgerows but they cannot be used to predict that a species will be a good colonist or an early colonist. There is scant information on the competitiveness of hedgerows species.

Throughout all of the hedgerows the author has studied in Yorkshire and elsewhere there is normally a restricted range of ground-flora species - Lords-and-ladies *Arum maculatum*, Bluebell *Hyacinthoides non-scripta* and Dog's Mercury *Mercurialis perennis* being the most frequently encountered with Wood Anemone *Anemone nemorosa* more rarely seen and usually in ancient boundaries like township or medieval open field hedgerows. Colonisation, expansion and extinction is discussed further at 8.9.7

8.6. Woodland Surveys.

Initial concerns at the start of this research revolved around devising a better method of field survey to answer Research Question 08 (see 4.4) and Objective 04 (see 4.3) to gather the information necessary to assist in determining the historic context of a woodland. This led to the development of the WOODS survey method (see Appendix 08) that adopts a flexible approach to obtaining data from woodlands. As many of the existing techniques were restrictive, or had the capacity to under-record essential and often rare species within woodlands, a novel approach was essential. Although the individual survey methods are not novel, the way in which they are combined has added to scientific understanding by providing a framework for data collection.

During the woodland workshops, Keith Kirby expressed concern that it would be difficult to develop a technique that effectively drew upon the best of both worlds of a walkover survey and quadrat. The technique adopted with WOODS uses both methods effectively and includes the capacity for recording individual species of interest using point records.

The other aspect that was of some concern regarding surveying was that it was desirable to provide some sort of visual mapping of the areas containing ancient woodland indicator species. Examples provided by the Friends of Ecclesall Woods were impressive, but would have involved a considerable effort to recreate them for other woodlands (see Figure 290.125 in 8.6.3). They provided maps on which they colour-coded the abundance of a number of key species like Bluebell *Hyacinthoides non-scripta* and Wood Anemone *Anemone nemorosa*. The effort in defining these boundaries and making the abundance determination was admirable but not justified for the purpose of identifying crucial areas of woodland containing ancient woodland indicator species.

The method advocated in the WOODS process involves colour-coding transect routes with a line thickness that varies with frequency and a line colour that varies with abundance (increasingly darker green). This provides a visual overview of the areas where a species is found and its frequency/ abundance (see Figure 292.127). This can also emphasise transects that follow meso-habitats like streams of earthworks.

As an increasing number of transects are completed within a block of woodland, an increased visual impression is gained as to the distribution of species along the transects done within its boundaries. In addition, a number of standing quadrats are surveyed in order to further characterise the nature of the vegetation. Depending on the number of these, their frequency, distribution etc., again a further visual mapping element is added to the surveys.

The other important facet of the WOODS Survey method is that it is not a random, regular or systematic method of survey. The sole purpose of the method is to specifically target and identify areas that are likely to hold ancient woodland indicators and to do transects and standing quadrats in these areas. This means it is possible to obtain sufficient data without expending considerable effort sampling areas that are homogeneous and yield little new information for the survey effort expended. Techniques involving regularly spaced quadrats are likely to sample the same vegetation repeatedly to no added gain in terms of obtaining valuable data. With the WOODS method any homogeneous areas will receive relatively few standing quadrats, only enough to provide information at a local level on the nature and character of the ancient woodland indicators at key locations, both typical and atypical. Examples would be where a transect covered parts of the wood that varied in shading but not to the extent that a separate transect was triggered (or the changes were at a small scale and transition from light to dense shade occurred every few metres). Standing quadrats would be made under both the light shaded areas and darker areas to consider the effects upon the species in each situation.

The other significant advantage that the WOODS method offers is that it provides an objective overview and description of the woodland by adopting the process of identifying any internal variation or meso-habitats within its confines. This builds on the methods adopted by the author to characterise vegetation in habitats as part of what he refers to as Phase 1.5. This process crucially incorporates ecological attributes as well as the normal habitat descriptions of grassland, woodland etc. This was driven to a large extent by personal observations that certain species were confined within woodlands to very precise locations and growing conditions. For example, Oak Fern *Gymnocarpium dryopteris* was observed to be a frequent component on relatively steep sloping valley sides and was very rarely seen on level, or near-level ground. Such differences in conditions were felt to be important considerations for determining whether certain species are likely to be found within woodlands.

The significant outputs of a WOODS Survey are the botanical records in terms of species lists and abundances, the mapping of their pattern of occurrence within the woodland and the characterisation of the woodland using the meso-habitats.

8.6.1. Boston Spa Wood

In Boston spa woodlands at the northern end, in Deep Dale, there are differences in management history. North of the track running down the middle of the valley was not wooded for periods in recent times. The other portion south of the track is recorded on the ancient woodland inventory as plantation on ancient woodland. The surveys done have confirmed historic markers in both of these areas. In the area to the north of the track, that was not wooded, there is a low level presence of ancient woodland indicators. Although some ancient woodland indicator species were recorded these were at very low frequency and abundance. This indicates the start of a colonisation process or it may be what the author calls the result of a 'scruffy landscape' with patches of scrub or shade creating habitat sufficient to allow shade tolerators to persist, but not under anything that appears on maps as woodland. These small habitats carried enough shade and allowed the persistence of these species until the current canopy provided a permanent suitable situation for them to survive and potentially spread.

Taking the list without considering [P]osition and [A]bundance would give a false impression of the status. This part is not ancient woodland or even Plantation on an Ancient Woodland Site (PAWS) based on the survey data.

The other part of Deep Dale woodland is the area regarded as a plantation on an ancient woodland site. This area contained a number of ancient woodland indicator species (21 with a weighted score of 177) indicating that this is a likely scenario.

The remaining portions of this woodland had small-scale variations in topography, pH and moisture that supported a wide range of ancient woodland indicator species. There were a number of specialists found in very specific and isolated locations, notably Lily-of-the-valley *Convallaria majalis* and Bird's-nest Orchid *Neottia nidus-avis* along with the very rare Fingered Sedge *Carex digitata*. The latter was found on only one small cliff face

- [BWD-S6] [WGF-A5] [BCL] - [EAT] [EAs] [EAP] [Eam]

close to the river. One of the species of note that was characterised by meso-habitat was the expected location of the Birds-nest Orchid *Neottia nidus-avis* under the dense canopy of a Beech *Fagus sylvatica* trees

- [BWD-S6] [BGR-A5] [LTR-O2] - [eat] [EAS] [EAP] [eam]

at various locations along the woodland.

8.6.2. Church Wood

Church Wood is not recorded as ancient on the ancient woodland inventory. The survey of this woodland revealed a number of ancient woodland indicators to be present. Of these, there were number that had relatively high fidelity scores for ancient woodland using the weighted scoring system, particularly species like Wood Anemone *Anemone nemorosa*, Remote Sedge *Carex remota*, Yellow Archangel *Lamiastrum galeobdolon*, Wood Melick *Melica uniflora*, and Wood Sorrel *Oxalis acetosella*. Each of these species has a fidelity of greater than 80% using the NI/ Vickers/ Thompson/ Peterken assessments.

The transects through the wetter portions of this woodland yielded 22 ancient woodland indicator species and a cumulative weighted score of 193. The dryer parts of the remaining woodland recorded 14 ancient woodland indicator species and total cumulative score of 124. There was a combination of species specific to this meso-habitat that included Dog's Mercury *Mercurialis perennis*, Wood Millet *Milium* *effusum*, Wood Sedge *Carex sylvatica*, and Lady Fern *Athyrium filix-femina*. These species were absent from the drier transects.

As this woodland is relatively isolated from other potential ancient woodland sites, the presence of the ancient woodland indicators within this woodland is strongly suggestive that this wood is, at least in part, a relict fragment of ancient woodland.

These results question the use of thresholds as the wood had 23 possible qualifying species. This could be reduced by taking a harsher view of the Glaves list. But there are indications of ancient woodland retention in the current flora.

8.6.3. Ecclesall Woods

Ecclesall Woods is a complex of mainly acid woodlands that have been subjected to significant industrial use and exploitation in their past. The area chosen for the survey encompassed the Bird Sanctuary within which there were two significant meso-habitats: the general area of undulating ground on drier soils, and the wetter areas bordering streams and valley sides. In addition to surveying the streams in the Bird Sanctuary, an additional stream was surveyed to obtain further data on the nature of ancient woodland indicators associated with streams within woodlands. The data confirmed what has been observed at other locations in that wetter areas such as stream sides tend to have greater numbers of ancient woodland indicators and also that the species themselves have highest affinities and fidelity with ancient woodlands using the weighted scoring system adopted by this research. This was demonstrated graphically on diagrams at Figure 151.36 onwards. The evidence that wet areas tend to have more, and more high scoring AWI species might suggest that these are older than drier parts with fewer, and lower fidelity species. This raises the question about using a single score when the wood contains a number of meso-habitats. To obtain a level playing field these disparities need to be addressed.

The Friends of Ecclesall Woods (FEW) have done a number of surveys in the woods (Smyllie 2005) and have produced a number of maps of species of interest, notably Bluebell *Hyacinthoides non-scripta*. Note, the bird sanctuary area is blank because it was not surveyed. These are reproduced at Figure 290.125 to Figure 292.128. Figure 292.127 shows the map from the WOODS survey to compare the visual appearance with the conventional mapping produced by the Fiends of Ecclesall Woods. These emphasise the differences in detail from using different mapping methods including dot maps as discussed at 8.3 and shown at Figure 265.113 and Figure 265.114. Dot maps are of value if a small enough scale is used. The FEW also produced the more valuable detailed map showing boundaries of different densities for the species at Figure 291.126.

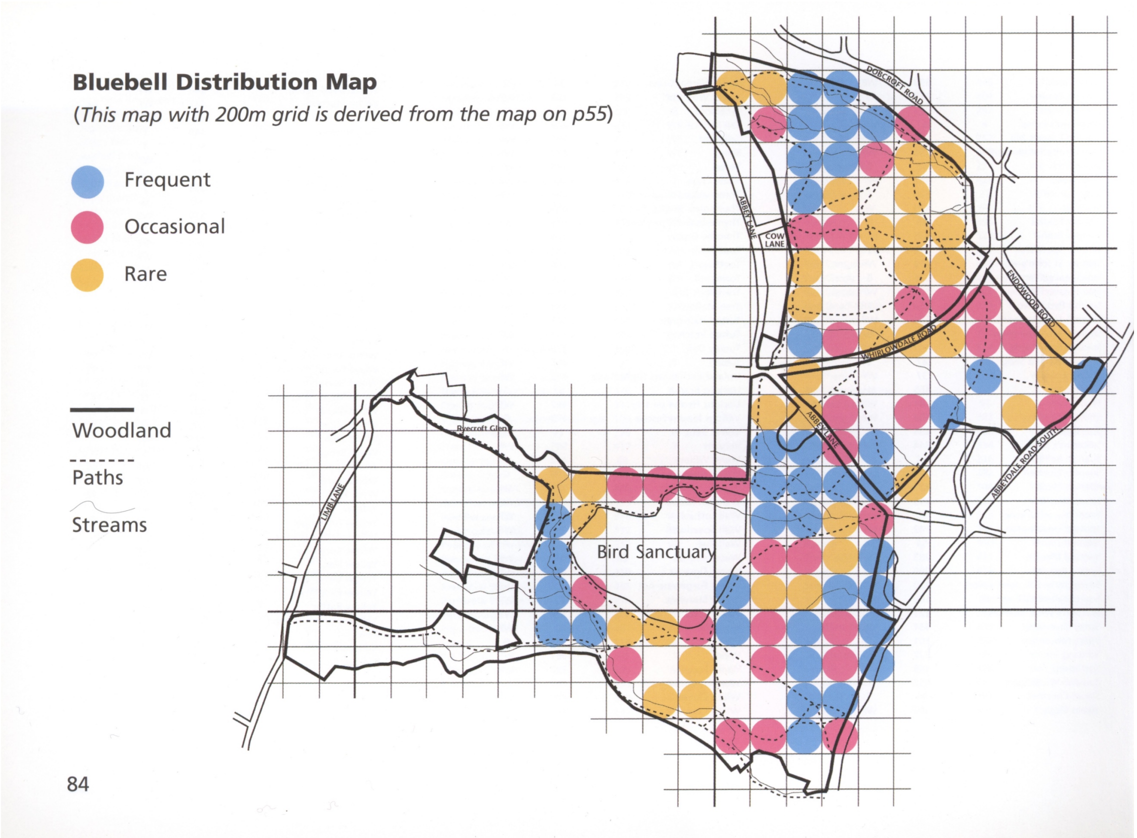


Figure 290.125 - Map of Ecclesall Woods, from the Friends of Ecclesall Woods booklet, showing the dot map version of the Bluebell map.

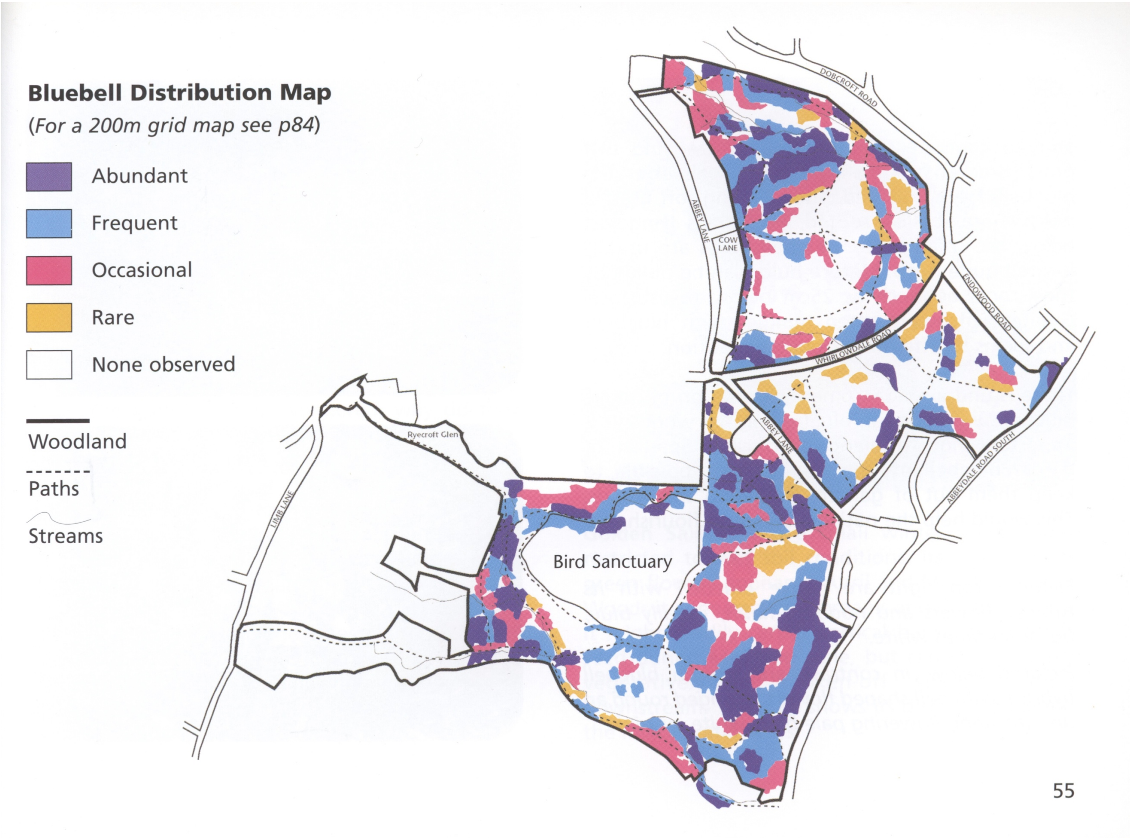


Figure 291.126 - Map of Ecclesall Woods, from the Friends of Ecclesall Woods booklet, showing the area mapped version of the Bluebell map.

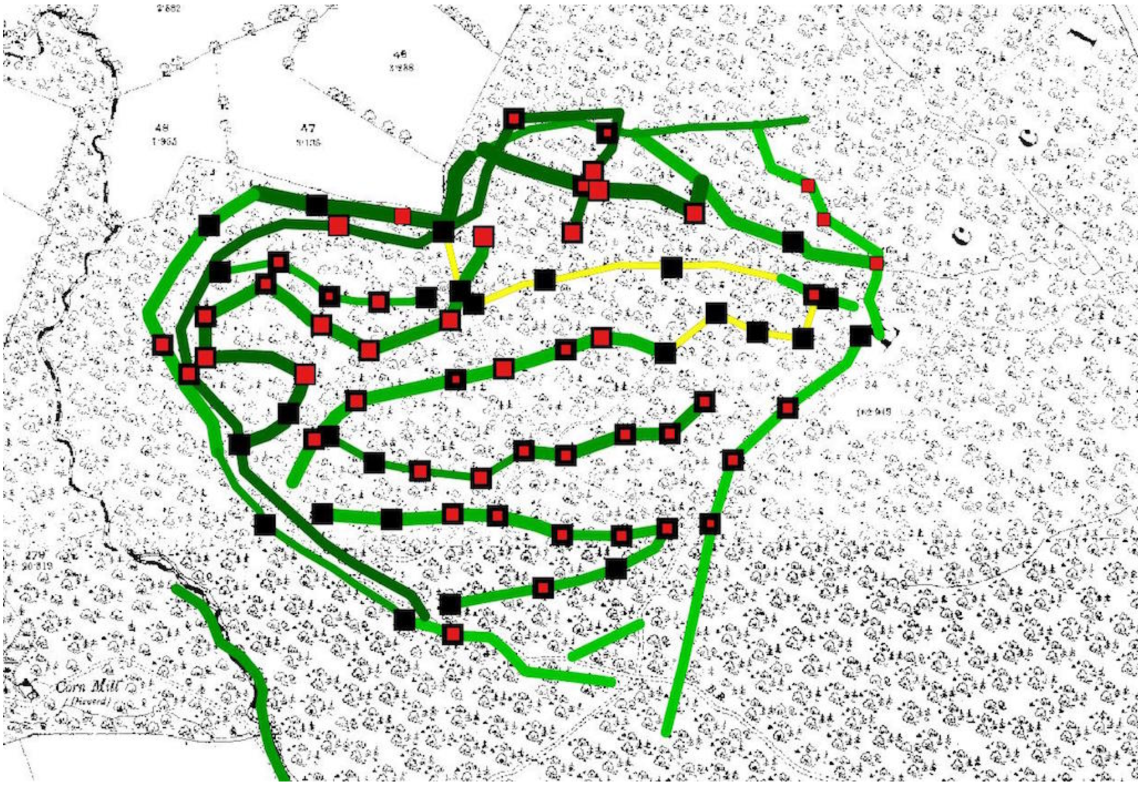


Figure 292.127 - Map of Ecclesall Woods showing the data from the WOODS survey for Bluebell in the Bird Sanctuary area. Thick green lines = high frequency; dark green lines = high cover; larger red squares on black = high frequency/ abundance in standing quadrats. Black squares - standing quadrat locations.

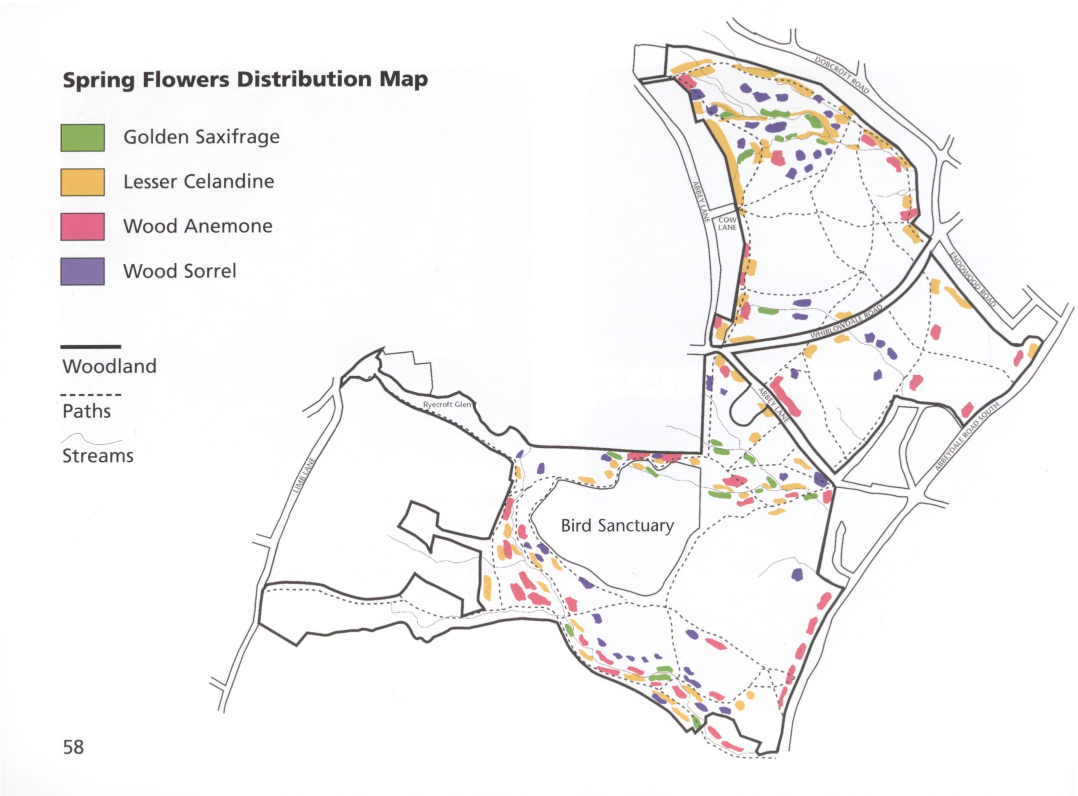


Figure 292.128 - Map of Ecclesall Woods, from the Friends of Ecclesall Woods booklet, showing the mapped distribution of other spring flowers.

Within the general matrix of the drier parts of the woodlands that were generally on gently sloping or level ground, there were some differences in the tree canopy cover with some areas being dominated by densely shading Beech *Fagus sylvatica* and having virtually no ground flora remaining, and other areas being more open and having an abundant woodland ground flora growth and also, in certain places, abundant bramble growth in areas where the shade was particularly light.

There is a cautionary note on these data in that one of the transects was longer than the others as it skirted round the edge of the Bird Sanctuary area and appeared homogeneous for a considerable distance. The consequence of this was that, as in the classic island biogeography theory of MacArthur and Wilson (1969) - the bigger the island the more species will be found - the longer the transect the more species. Although the WOODS method does not advocate regularising transect lengths it still should be a consideration when interpreting the results. The WOODS method does not advocate the simple counting of woodland species but recording the nature of the species and what they are informing about their presence there as historic markers using the SPACES approach. The archaeological evidence from studies in this part of the wood by Ardron (2001) trace land use back to the iron age and indicate Romano-British fields as well as later pits, platforms and quarry areas. All of these can have influenced the current flora, and have probably contributed to the relatively species-poor flora of today. Evidence suggests that re-colonisation is slow following the most recent management practice of turf stripping in this area. The main species present in the central portion of the bird sanctuary area is Bluebell *Hyacinthoides non-scripta*. The other species normally expected on relatively free drained level ground would be Dog's Mercury *Mercurialis perennis*. This species is a rarity and confined to the stream area to the north of the bird sanctuary area (see Appendix 14, Figure 36.36).

Ecclesall Woods are ancient by documentary evidence and they contain a modified flora of good quality ancient woodland indicator species in the refuge areas by the streams in the bird sanctuary area and along the Limb Brook.

8.6.4. Gillfield Wood and Little Wood

There are a number of interesting facets to Gillfield Wood. The main one of concern is that the northern part of the woodland is in South Yorkshire and is on the ancient woodland inventory as and the land south of the dividing stream is in Derbyshire and that part is not registered as being ancient woodland on the ancient woodland inventory.

The data obtained from surveys suggests that the characteristics of the flora on both sides of the stream are similar enough to justify the assertions that both sides of the stream are ancient woodlands. This is the sort of inconsistency in which botanical information may assist in providing guidance as to whether or not a piece of woodland has been wrongly omitted from the ancient woodland inventory, or where a woodland that falls below the 2ha threshold for assessment is in fact a small fragment of ancient woodland that has gone unrecognised.

The issue with identifying areas of woodland less than 2ha links to the observation of many authors that there is a relationship between the number of species recorded and the size of woodland. This is partly the result of larger woodlands frequently having more meso-habitats than relatively small woods that contain few meso-habitats and have fewer ancient woodland indicators.

Having asserted that Gillfield Wood, in its entirety, is likely to be ancient woodland, within its confines there are a number of significant meso-habitats that support a range of relatively high scoring ancient woodland indicator species. Some of these patches are very small. For example, some of the locations for Moschatel *Adoxa moschatellina* were no more than one or two square metres across. Other rare records were of single plants of Hard Fern *Blechnum spicant* and Soft Shield-fern *Polystichum setiferum* on topographic micro-habits of steep stream banks or ditch banks [EAT].

- [BWD] [WGF] [RWA+RWS] - [EAT] [Eas] [Eap] [EAm].

This woodland was apparently clear felled and replanted after the Second World War and has therefore suffered a degree of disturbance. This may account, in part, for some of the areas being relatively species-poor in terms of ancient woodland indicators and often being dominated by a single species, normally Bluebell. The entire wood, on both sides of stream is judged to have the same origin. This inconsistency makes critical ancient woodland indicator research important.

8.6.5. Gunter Wood

The scenario at Gunter Wood confirms Early-purple Orchid *Orchis mascula* is a historic marker species. It has a position preference within the woodland along what archaeologists regard as an old route way through the wood that is now not in use. The reason why this species is present at that location has a number of possible scenarios.

1. The species is present because it is still on an original earthwork that was under a woodland or shaded conditions.

2. As the wood is not on the ancient woodland inventory and this is a correct assessment, it would indicate that this wood was clear felled and originated in its current form after 1600. In this case the orchid has either persisted under unfavourable conditions between the pre-1600 felling and the replanting, or has colonised only that meso-habitat recently.
3. The species has colonised since the woodland canopy has developed, but only along the route way because of potentially locally specific conditions.
4. The survey was only done in one year. The species may have been more prevalent across the woodland but there were relatively few flower spikes produced in the year of survey. Another survey in another year may record a more widespread distribution.

If it is assumed that the species has colonised recently, then the options are that either conditions are not favourable anywhere else in the woodland, or, as already stated it is present in the wood but it did not flower in the year of survey. This species, along with others, like Wood Anemone *Anemone nemorosa* and Bluebell *Hyacinthoides non-scripta* are found in other habitats, either because they have a wide ecological amplitude or because they have a high degree of persistence in the absence of a woodland canopy. It is possible that Early-purple Orchid may have been a grassland plant and was consumed by the woodland when the latter was planted.

If it can be assumed that the species has been present for at least some time, the reason why it has not spread is unclear, since the elevation of the track banks is only some 15cm above general ground level.

The fact remains that this species is a historic marker within the woodland and the more tempting explanation is that it is a relict species from a time when the area was wooded or hedged and that the species has remained where it is, but has not been able to colonise further afield and has persisted during an un-wooded phase. This species, along with other high scoring species casts doubt on the omission of this wood on the Ancient Woodland Inventory.

This is part of the critical assessment by which this research aims to enlighten and inform the scientific community regarding the nature of historic markers, how they can be identified and how the information can be used potentially to extrapolate to other scenarios.

8.6.6. Hackfall Wood

Hackfall Wood is a very rich and diverse woodland compared with the other woodlands that were surveyed during these case studies. It was deliberately chosen for this reason as it is known that it contains a wide variety of meso-habitats. The nature of the geology produces both acidic and calcareous slopes and cliffs and many calcareous springs and streams. There is evidence of tufa formation in some of these. A number of significant ecologically significant observations were made during the surveys.

One of the significant species recorded that is worthy of discussion is Killarney Fern *Trichomanes speciosum*. This is a species that, historically, has been under-recorded as it currently very rarely produces fronds in this country. It is well documented that this species was frequently collected in the Victorian times by fern collectors when it was in frond. Possible recent changes in air quality and climate have produced conditions whereby the species rarely produces fronds particularly in the northern parts of the country. Recent research by Rumsey, Jermy and Sheffield (1998) alerted botanists to the presence of the gametophyte of the species that is present and visible all year round in suitable situations. This has led to the collecting of significantly larger numbers of records of this species as shown at Figure 103.17. Many of the northern sites were added by the late Ken Trewren of Egton Bridge in the North York Moors. He was tireless in his pursuit of new records for the species and on many occasions beckoned the author to peer into a deep dark hole with a torch to marvel at the splendour of a small patch of green fuzz that is the diagnostic for the species. Any acidic rock, boulder or overhang in a wood, especially on north-facing slopes was a challenge to find the gametophyte, and one he rarely failed at.

As this species was omitted from all but one list it is likely this was done because of the rarity of the species and the low likelihood of it being recorded in a given ancient woodland survey. This needs to be redressed as this is seems likely to be a 100% ancient woodland indicator species since it is highly unlikely to establish in any other set of ecologically circumstances.

Personal observation of sensitive shade-demanding and moisture-demanding species of fern such as Wilson's Filmy-fern *Hymenophyllum wilsonii* confirms that they can persist in different habitats from the expected sheltered shaded and humid woodland conditions. It occurs in an overhanging small cave in open grassland on a stream bank on Skiddaw Fell in Cumbria. This is a north-facing slope and the shade, shelter and humidity are sufficient to allow this species to have colonised the area or to persist in this overhang since a former ancient woodland was clear felled.

The issue this raises regarding regional lists is that all current up-to-date survey information on candidate species needs to be collated in order to draw up a meaningful list of species. This should be considered for each indicator species in order to provide a regional weighting based on the knowledge of its characteristics in terms of its likelihood of occurrence in any particular ancient woodland being surveyed.

8.7. Woodland Assessment

The process of woodland assessment was to attempts to create a 'level' playing field for determining if a woodland had sufficient botanical evidence to confirm that it had an ancient origin. Significant issues raised during the research are:

1. How to accommodate woodlands of different sizes,
2. in different parts of the country,
3. on different soils and geology is as well as
4. accounting for the internal variations within woodlands that create a range of different meso-habitats each supporting a different suite of ancient woodland indicators.

The objective of creating a system that accounts for all of these variables is probably unattainable with the current level of knowledge and information. Using the case study woodlands as an example these were different and deliberately chosen to determine whether the differences could be accounted for in an evaluation and assessment strategy.

The objective of any assessment is to agree that a woodland is ancient. As the workshops alluded to, perhaps the best that can be offered is a probability of a woodland being ancient.

Data from the case studies show that woodlands acknowledged as ancient from the ancient woodland inventory, notably Boston Spa Wood, Ecclesall Woods, Gillfield Wood and Hackfall Wood, contain large numbers of qualifying species compared with the two woodlands that are not on the ancient woodland inventory, notably Church Wood and Gunter Wood. The latter two woodlands only had 23 and 27 qualifying species with cumulative weighted scores of 230 and 253. These values are considerably lower than those of the other woodlands surveyed that are on the ancient woodland inventory. These ranged from 49 species in Ecclesall Woods to 82 species in Hackfall Wood. The cumulative weighted scores ranged from 434 in Ecclesall Woods to 711 in Hackfall Wood.

Even though there may be similar numbers of species in wet and dry transect areas the identity of the species varies, with a core list of species common to both, but with the wet and dry specialists differentiating the two meso-habitats.

One of the differences shown at Hackfall Wood was the relatively low count and score for the acidic transects compared with the calcareous and main wood transects with the acid transect having 27 species with a score of 240, the calcareous transects having 49 species and a score of 434 and the main wood having 54 species and a score of 485.

Making the assumption that Church Wood and Gunter Wood are not ancient woodland sites and the remaining woodlands are, then, a threshold it would lie somewhere between 253 (Gunter Wood) and 434 (Ecclesall Woods), using these data. This would be artificial and of little value as the two woods do contain what authors agree are species with a high fidelity for ancient woods.

From the data presented at Table 299.20 there is a sliding scale of evaluation scores with a temptation to set a threshold between 253 and 434. The data provide an index only. The interpretation needs to account for both size of wood and the number of meso-habitats. Degraded woods need consideration. A relatively rich recent wood may have the same score as a degraded ancient one, but the species mix and their abundance may differentiate the two.

It is beyond the scope of this research to offer a detailed guide to interpreting data as the aim was to critically assess the way botanical species are used to interpret woodland and hedgerow histories. It has provided the critical assessment and developed new tools for surveys and methods to interrogate the results. It has also highlighted that the origin of a woodland or hedgerow is not the only event which can be indicated by historic marker species. Other events are defined by species presence and also the dynamics of change over time can also be understood.

Table 299.20 - Summary of the weighted evaluations of the case study woodlands, for the whole wood (green rows) and the transects through meso-habitats.

	No of species	Cumulative max weighted score
Boston Spa Wood	48	420
North Deep Dale	16	138
South Deep Dale	19	162
Main wood	46	402
Church wood	23	230
Dry areas	14	124
Wet areas	22	193
Ecclesall Woods	49	434
Dry areas	36	311
Wet areas	40	359
Gillfield Wood	53	483
Dry areas	47	431
Wet areas	46	418
Little Wood	10	89
Dry transect	5	43
Wet transect	6	56
Gunter Wood	27	253
Routeway transect	14	134
Earthworks transect	15	142
Main wood	21	193
Hackfall Wood	82	711
Trichomanes transect	36	307
Acidic transect	27	240
Calcareous transects	49	434
Main wood	54	485

8.8. Hedgerow Surveys

8.8.1. Dunnington Surveys

The surveys at Dunnington have greatly added to academic understanding by identifying species in hedgerows that corroborate the historical research, and also generates new questions that this research has made attempts to answer, in particular, the unexpected occurrences of English Elm *Ulmus procera*. This species has been strongly associated with history. In *Flora Britannica* (Mabey 1996), there is reference to it being used in prehistoric times for animal and human forage and that it was widely planted as a tree and encouraged to sucker sideways in hedgerows.

The importance of English Elm in the Dunnington landscape was evidenced by its appearance on both datable and non-datable hedgerows. The results showed that there was a distinct preference for this species to be found on both the medieval field boundaries and on the medieval township boundaries. The other instances where it occurred required explanation. There is little evidence to suggest that these are recent plantings, particularly as the nature of the abundance and frequency of this species suggests that it has been present in these hedgerows for a considerable period. The most plausible conclusion is that these hedgerows were created either around the same time as the medieval hedgerows, or potentially previous to that period. The reasoning behind the proposal that it pre-dates the medieval is that the unexplained locations are on straight line, linear hedgerows and the township and field boundary hedgerows are sinuous in nature. This implies different origins.

Based on evidence obtained from other studies, notably Barnes and Williamson (2015), there is a strong possibility that the linear arrangement of these English Elm-rich hedgerows are part of a pre-medieval coaxial field system. The alignment of these unexplained elm-rich hedgerows is parallel to each other and perpendicular to the slope of the moraine on which Dunnington stands. In addition to these forming the parallel sides of potential coaxial fields there is also evidence that, on one of these alignments, there was an ancient routeway that linked to Vengeance Lane that was hedged with English Elm.

In addition to this possibility there is also a suggestion that the botanical evidence may support a realignment of roads in the past. Consulting the first edition ordnance survey maps indicates that there are linear alignments of hedgerows that run parallel to the A1079 and the ancient route way of Elvington Lane. If the latter alignment is traced it would join up with the main road leading through the village of Murton. The current alignment brings the Elvington Lane west of this junction. Although Stephen Moorhouse asserts that it was quite common for lanes to meet at offset junctions it is also possible that offset junctions of this nature are the result of realignments. Road systems in historical times were not as well maintained as they are currently and if an alignment becomes unusable because of flooding or other reasons then it is likely that a realignment would take place. Such realignments are likely to have occurred after the Roman period when it is expected that the local populace were less able to maintain rural road systems following the departure of the Roman occupying forces.

English Elm was also present on some hedgerows where it was only located within the first few metres. These cases are where such hedges meet other hedgerows on which

English Elm was established. The likely explanation is that the species has begun to colonise down a newer hedge from an older medieval hedge with English Elm in it.

8.8.2. Clifford Boundary

The importance of the survey done at the Clifford Township boundary was that the ancient nature of this hedgerow was reflected in both the shrub species and ground flora. It demonstrated that both aspects of the vegetation should be considered as botanical indicators and historic markers.

For the shrub species, there were clear indications that there were species that were both rare in frequency terms, and also uncommon or rare in terms of their abundance at both the hedgerow and landscape scales. These are the same species that were also regarded as 1st decile species in the Dunnington survey, namely Purging Buckthorn *Rhamnus cathartica* , Spindle *Euonymus europaeus*, Guelder-rose *Viburnum opulus* and, at Clifford boundary, Spurge Laurel *Daphne laureola* .

An important feature observed on E1 at Clifford was that the hedge had obviously been neglected and, although there were some 1st decile species present, the condition and richness of this hedge was severely degraded. The ground flora gave supporting evidence to confirm that this hedgerow is likely to be of the same origin as the remaining hedgerows on the township boundary.

To the west of the A1 the hedgerow section W2 was highly dominated by Holly. This was also the only location where Ramsons was recorded. This is normally a species associated with documented ancient hedgerows and would act as further confirmation that this hedgerow is ancient in origin.

By contrast, the last section on the western side, W3, although it was on the correct alignment to be on the Township boundary, was entirely dominated by Hawthorn *Crataegus monogyna* and had none of the predicted supporting ground flora of Bluebell *Hyacinthoides non-scripta*, Dog's Mercury *Mercurialis perennis* and Lords-and-ladies *Arum maculatum* as found on the remaining hedgerows in this complex.

8.8.3. Manor Farm, Leppington

Further confirmation of the importance of ground flora was obtained during the surveys of hedgerows at Manor farm, Leppington. On this farm there were a number of hedgerows that contained ground flora elements. Of particular note was the incidence of Dog's Mercury *Mercurialis perennis* and Bluebell *Hyacinthoides non-scripta* at two specific locations on a particular hedgerow. On interrogation, the farmer said that there had been a major realignment of the field system in the 1700s. Hedges were previously aligned with their long axes North – South and that in the early 1700s the hedgerows were realigned with their long axes predominantly East – West. This offered a plausible explanation for the localised occurrence of the ground flora species. They were associated with fragments of what were probably the remains of the North – South aligned hedgerows with some subsequent colonisation East and West from these north-south fragments. Further confirmation of this supposition was obtained by looking at the hedgerow to the south which also ran in an east – west direction. At the extrapolated corresponding points on this hedgerow there were also the woodland ground flora species indicating that these are likely relics from when the hedgerows extended south and crossed the current east – west boundary features. This is an example of where botanical species are historic markers of events after hedgerow creation and reflecting changes in land use and management.

In addition, Manor farm at Leppington was also one of the few locations where the author has recorded Ramsons growing in a hedgerow. It was growing in an East – West hedgerow along with other woodland ground flora species at low frequency and low abundance. This confirms that this is likely to be an ancient hedgerow. The other significant hedgerows with woodland ground flora present were the township boundary to the east, and other remaining North – South hedgerows presumably left in place when the hedgerows were realigned.

8.8.4. Rushy Leasowes

The surveys done at Rushy Leasowes provided further confirmation of the significance of township boundaries as the location of species-rich hedgerows with associated 1st decile species and significant elements of ground flora. Spindle was recorded in one such township boundary hedgerow on this farm and was at the predicted pattern of low frequency and low abundance. The whole length of this boundary hedgerow had a well-represented ground flora including abundant Dog's Mercury as well as violets and other typical species.

8.9. Hedgerow assessment

The Hooper method for the survey and assessing hedgerows is not supported by the current research. It does not provide the answers to the questions asked about hedgerow origins and histories. The dating of hedgerows requires the same multi-disciplinary approach that was done at Dunnington and which is advocated for woodland interpretation. All available historical data needs to be used against which to start calibrating the botanical survey data. The starting point is the medieval township boundaries followed by the detection of the open field boundaries and any roads or tracks that could have had historic use. These will form the basic building blocks to which archival research can add to if it is available.

Data collected to HEDGES Level 2 or Level 3 can be studied and plotted to look for these patterns within the framework of the SPACES analysis. What are the species? Where are they? How much is there? Are there any detectable species combinations?

8.9.1. HEDGES Survey Method

The HEDGES method is a flexible system that has the capacity to collect data sufficient to replicate a hedgerow at a new location. During the development of HEDGES a number of methods were trialled and discarded until the final version of HEDGES was produced. It is based on different levels of survey effort from Level 1 to Level 3. The intermediate level, Level 2 is designed to provide a rapid survey with relatively little effort that is capable of being done by volunteers as well as professionals. As a guide, more than 3km of hedgerow can be surveyed in a day at this level. By contrast, the more detailed Level 3 survey is only likely to achieve 1.5 to 2km per day. Also, Level 2 is more of a "walk in the countryside" compared with the intense recording required at Level 3 and is more likely to appeal to volunteers, with Level 3 being more appropriate for professionals.

The advantages of Level 2 and Level 3 methods were tested, particularly at Rushy Leasowes where the entire farm was surveyed at both levels as a means of providing a teaching resource to identify any differences in adopting the different levels of survey. The main advantage of Level 3 is that, as the attention is focused on a 4m section of hedgerow, it is less likely to miss important species at low presence (frequency or size of plant). The Level 2 survey is intended to account for rare species in hedgerows by recording, using a GPS, a waypoint for any uncommon or rare species. This Level 2 method was adopted in the extensive survey at Dunnington and provided useful information on the precise location of the 1st decile species (species present at <10% frequency), such as Purging Buckthorn *Rhamnus cathartica* and Guelder-rose *Viburnum opulus*.

As with the WOODS survey method, HEDGES was designed to provide a visual impression on resulting maps of the presence of a species across the landscape. This adopted a similar technique to WOODS in that the frequency of a species along a hedgerow length was indicated by an increasing thickness of line and the abundance of the species was indicated by an increasingly darker colour of green. Any individual species records of note were plotted as red dots to indicate their location. The development of this process has added to the scientific and academic understanding by creating a method for data collection that is a significant and major improvement on existing methods.

One advantage of HEDGES is that it considers in critical detail the significance of individual species and individual plants in the historical interpretation of the species as historic markers.

This novel approach has added significantly to academic understanding of the dynamics and processes involved in hedgerows that have combined to produce the range and abundance of species we see today.

The other major element of the HEDGES method is that it has identified that in some cases a single species or specimen can be a historic marker, providing the information needed to develop a model for identifying similar occurrences in other locations.

8.9.2. Hedgerow Sampling and Survey Methods

As was the case with woodlands, at the outset of this current research there were significant concerns about the survey methods and the way in which botanical information from hedgerows was interpreted to determine historical context. The current adopted methods of hedgerow survey were regarded by the author as inadequate to the point of being dangerous in terms of misleading interpretation of the historical context of the hedgerows. What limited surveys the author had done, cast very significant doubts about whether a hedgerow could be dated using the Hooper rule by counting the number of woody species in one or more randomly chosen 30yard lengths. As this did not seem to work, an alternative was required.

The Hooper method is inadequate as it does not fully account for the species present. There is no clear guidance as to how many sections of 30 yards were required to be surveyed to enable the Hooper rule to be applied, the assumption was a minimum of one section up to a maximum of every contiguous 30m section along the entire hedgerow length. As an exercise this was done at the Clifford boundary hedgerow for teaching purposes. The section already referred to as W1 was surveyed to Level 3 of the HEDGES method. As this recorded all of the shrubs every 4m it was possible to do retro-surveys on any and every 30m section (technically approximately 28m - 7 x 4) of the hedgerow (if necessary) as if it has been done using a standard 30m sections. This was also done to see what would be recorded had a Hedgerows Regulations survey been done or one according to the Hedgerow Survey Handbook. The lengths that would have been done for these methods are shown at Figure 305.129 and Figure 305.130.

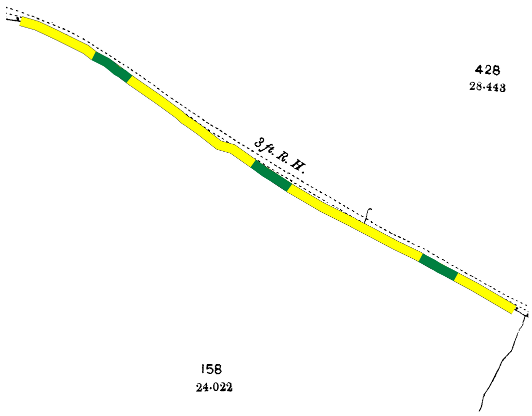


Figure 305.129 - Clifford boundary hedgerow showing how much would be surveyed for a Hedgerows Regulation assessment. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

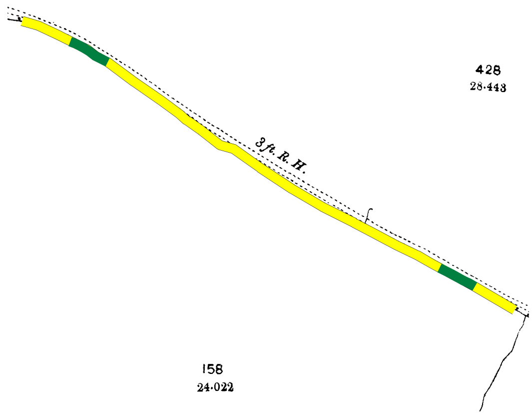


Figure 305.130 - Clifford boundary hedgerow showing how much would be surveyed for a Hedgerow Survey Handbook assessment (NB only one of the green sections would be done). © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

The comparative data for all three methods is at Figure 306.131. This shows that there is a total of 12 species along the length. If all sections were used for the Hooper assessment, then all 12 species would have been recorded and a maximum number of species in any one 30 m section would have been eight and the minimum would have been five with an average of 6.2. Had the hedgerow been surveyed for the Hedgerow Survey Handbook then only one section would have been done starting 30 along from whichever end the survey chose. In either case six species out of the known population of 12 would have been recorded. If the hedgerow was required to be surveyed for the Hedgerows Regulations then three sections would have been sampled yielding a minimum of five species, a maximum of six species and average of 5.6. This level of under-recording is regarded as being unacceptable when attempting to make scientific interpretation of the botanical evidence in an attempt to place a hedgerow in its historical context.

359	ID	ace-cam	ace-pse	ber-vul	cor-ave	cor-san	cra-mon	dap-lau	euo-eur	fra-exc	ile-aqu	mal-syl	pru-spi	ros-spp	sal-cin	sam-nig	ulm-gla	vib-opu		
Hooper	81																			
6.2	1	0	0	3	7	0	6	0	2	0	2	0	0	3	0	2	0	0	7	
	2	0	0	0	5	0	7	0	0	0	0	0	5	1	0	4	0	1	6	
	3	0	0	0	6	0	7	0	0	0	0	0	7	4	0	1	0	1	6	
	4	0	0	0	6	4	7	0	2	1	0	0	7	2	0	3	0	0	8	Max
	5	0	0	0	4	7	1	0	0	1	0	0	3	2	0	0	0	0	6	
	6	1	0	0	4	3	6	0	0	0	0	0	3	4	0	0	0	0	6	
	7	1	0	0	4	4	3	0	2	0	0	0	6	0	0	0	0	0	6	
	8	1	0	0	6	4	2	0	0	0	1	0	3	0	0	0	0	0	6	
	9	0	0	0	7	4	4	0	0	0	2	0	2	0	0	0	0	0	5	Min
	10	0	0	0	3	0	5	0	0	2	4	0	4	1	0	0	0	0	6	
		6	0	1	56	33	53	0	7	7	11	0	50	22	0	12	0	4	12	Total
	Percentage	7	0	1	69	41	65	0	9	9	14	0	62	27	0	15	0	5		
HSH																				
A		0	0	0	5	0	7	0	0	0	0	0	5	1	0	4	0	1	6	Max
B		0	0	0	6	0	5	0	0	2	3	0	5	2	0	0	0	0	6	Min
		0	0	0	8	0	7	0	0	3	4	0	7	4	0	1	0	1	8	Total
HR																				
1		0	0	0	6	0	7	0	0	0	0	0	6	3	0	3	0	2	6	Max
2		1	0	0	4	3	6	0	0	0	0	0	3	4	0	0	0	0	6	
3		0	0	0	3	0	5	0	0	2	5	0	3	0	0	0	0	0	5	Min
5.6		2	0	0	10	4	14	0	0	3	6	0	9	6	0	1	0	1	10	Total

Figure 306.131 - Comparative results for using three different survey methods on the same section of hedgerow on the Clifford Boundary hedgerow W1 (Hooper, Hedgerows Regulation [HR] and Hedgerow Survey Handbook [HSH]).

8.9.3. Avoidance of Terminal 30m Sections

The two main methods of surveying hedgerows both avoid sampling the first and last 30m sections of any hedgerow, the allegation being that these areas are atypical and should not be included. Observations during this research indicates that this is unacceptable if the objective is to record the botanical information to an adequate level to interpret the historical context. Survey evidence confirms that in some circumstances critical species will be missed if these areas are omitted. In particular, the survey done at Clifford Boundary would have missed completely the only three plants of Barberry *Berberis vulgaris*. Also preliminary surveys done in the township of *Scoreby* identified only three plants of Purging Buckthorn *Rhamnus cathartica* and each one was within 30m of a hedge junction and would have been systematically discounted from surveys done under the Hedgerows Regulations or Hedgerow Survey Handbook. At Dunnington there were instances where the advance of English Elm *Ulmus procera* was less than 30m along the new hedgerow from the old. For the purposes of conducting historical research into hedgerows using the HEDGES method, avoidance of the first 30m will not be done.

8.9.4. Gooseberry

Other flagship species were identified as significant historic markers with a human context, such as Gooseberry *Ribes uva-crispa*. Although this species has a frequent association with habitation is has also been found at unexpectedly high abundance along the hedgerows bordering both sides of the B6275 south of Piercebridge and the farm at Long Leases (east of Aldborough St John) at NZ214109. Here there are several possible cultivars and natural varieties ranging from plants with small, green, hairy fruits to those with medium-sized red fruits with few hairs. The density is a bush every 10-30m along both sides of the road for at least 1km. It is unlikely that this species is present because of eutrophication from the road as it is present at low frequency on other roads with similar traffic flows. This will be a subject of further research (see 10.2.7).

Gooseberry can often be only visible from one side of the hedge. Most shrubs are observable regardless of which side of the hedge the survey was done. Gooseberry can be restricted to showing its presence on only one side of a relatively modest hedge. It is desirable to survey each hedge from both sides to ensure that species are not missed. In practical terms this is unlikely to be done owing to resource implications. It must however, be borne in mind that failing to record species like Gooseberry is a risk. At Dunnington, one of the records of Gooseberry was missed initially as a hedgerow was surveyed from the east side. Later in the survey the west side was walked and the Gooseberry was discovered.

8.9.5. Ivy

The status of Ivy *Hedera helix* in hedgerows may be of relevance to the historical interpretation. A number of observations make this a candidate species for further research (see 10.2.6).

1. It tends to only fruit once it become arboreal and therefore its long-distance dispersal and spread is affected by this strategy.
2. Although it is normally internal within the hedge volume, it can eventually emerge and in some case become dominant arboreally and give the appearance of an 'Ivy hedge'. This may suppress other hedgerow shrubs.
3. Rigorous trimming seems to accelerate point 2 (above) as light can penetrate the hedge and provide more light to favour Ivy.

8.9.6. Ground Flora

One of the driving forces behind the current research into hedgerows was an observation that certain hedgerows appear to have woodland ground floras whereas others did not. This became apparent when doing a farm survey for conservation purposes and there were hedgerows bordering a track that had abundant Dog's Mercury *Mercurialis perennis* and Bluebell *Hyacinthoides non-scripta* in them, but when the track turned into a road these species were absent. When a local ecologist and historian was asked for a reason the two words she replied with were 'enclosure award'. The hedgerows on either side of the track were created before the enclosure award of 1785 and the road was hedged after that period. The Dog's Mercury has not colonised the recent hedges by any significant amount in the intervening two hundred years (approximately 15m). This stimulated interest in considering the role played by ground-flora in informing about hedgerow origins and history.

The studies undertaken by the current research have included surveying a number of hedgerows where ground flora was present and also a number where it is absent. There is a notable absence of ground-flora in the hedgerows at Dunnington compared with the hedgerows on the Clifford boundary hedges.

8.9.7. Colonisation by Shrubs - Hooper theory

In addition to the Hooper theory there are a number of other authors that have interpreted species presence in hedgerows in their historical context. In the literature there are statements made with regards to the ageing of hedgerows that are difficult to understand. The following was made by Chapman (2001).

- "Spindle needs an even thicker hedge for its seedlings, so a hedge will have to be 600 years old before spindle occurs".

This is curious as it proposes that Spindle can only establish under the canopy of a thick hedge and is sufficiently competitive to do so.

Another publication by the Field Studies Council, in a leaflet on hedgerows (Crane *et al*. 2009a) suggests that:

- "Some species take longer to move in, for instance spindle won't usually thrive until at least five species are already present".

This almost implies that Spindle can count! Both of these statements imply that in the medieval period hedgerows were devoid of Spindle and that they were colonised either after 600 years or when at least five other species were already present. The current research has not found Spindle outside hedgerows that can either be confidently dated to the medieval, or have another plausible explanation for containing it. The evidence suggests that it is more likely that, at Dunnington, Spindle is in medieval hedgerows because it was present at the time of creation, and not that it has more recently colonised hedgerows once they achieved the status of being 600 years old, or containing five species as suggested by these authors.

The HEDGES method is capable of providing acceptable data on which to base interpretation and assessment at Level 2 and Level 3 (Level 1 is only included for completeness and to comply with the current less rigorous methods that may be specified by planners commissioning hedgerow surveys).

The author of this thesis also believes that the Hooper theory is based on a correlation with a causation that is fundamentally flawed. Hooper alleges that hedgerows were planted as a single species historically and that they have acquired new species at the rate of approximately one every century since that time. The concern raised from the current research is that some of the species currently in the more ancient hedgerows are not found anywhere else in the landscape. To take an example of Purging Buckthorn *Rhamnus cathartica* at *Scoreby*. If it is present in a hedgerow now the two possible scenarios are that:

1. It has been there since the hedgerow was created, or
2. It has colonised since then.

If scenario one prevails, then why has this species not migrated into other, more recent hedgerows in the last 800 years as proposed by Hooper? This species is a berry-bearing shrub and therefore there is no logical impediment to its dispersal and spread. If it was in medieval hedges it should have moved into at least one hedge created since then.

If scenario two applies, then where has the species come from in the landscape? It does not occur on any of the current hedgerow stock and it is also not present in any of the surrounding woodlands to the best of the author's knowledge.

It has already been suggested that species like this are poor competitors and are unlikely to achieve dominance or possibly even maintain populations over prolonged periods. On this basis the more likely scenario is that this species has always been there and that it may have been more abundant historically and has significantly declined over time as it is unable to maintain a population with competition from the other species in these hedgerows.

If the species under consideration was Spindle, then using earlier arguments, by now the hedge is greater than 600 years old, so it must have six species, so Spindle should be there. These are the ill thought out arguments that the current research has comprehensively countered.

Hooper did not propose any mechanism to support his theory of systematic colonisation at a regular rate through time. It is recognised that there is a correlation that, in general, older hedgerows do tend to have more species but the more likely scenario is that they always had more species. There is even some evidence to suggest that some of the species that may have been more abundant historically have declined and may even have become extinct from certain hedgerows because they are not as competitive within the dynamic context of hedgerow ecology.

Hedgerows are dynamic, both anthropogenically and naturally, and species can be present or absent at different periods through time. The diagram at Figure 311.132 shows a time chart where species can be either present or absent at an arbitrary time interval. These are labelled T0 to T4 and could be any period from decades to centuries. Two start points are possible, and the species is either present (green circle in the lower diagram) or absent (red circle in the upper diagram) at creation. At each time reference point T1 - T4 this can change as illustrated with the thick coloured lines that pick out some of the possible permutations from always absent (red circles down the left of the diagram) to always present (green circle down the right of the diagram). The Hooper theory would suggest that the an additional new species would be absent at T0 and then come in at T1 and still be present at T4 and that the intervals are approximately 100 years apart. After this species comes in at T1, the next species will enter at T2 and also stay to T4 etc. In reality, colonisation may be transient with a species colonising at T1 and then becoming extinct and still absent at T4. Or, as illustrated on the diagrams, the species may colonise and become extinct at intervals through history.

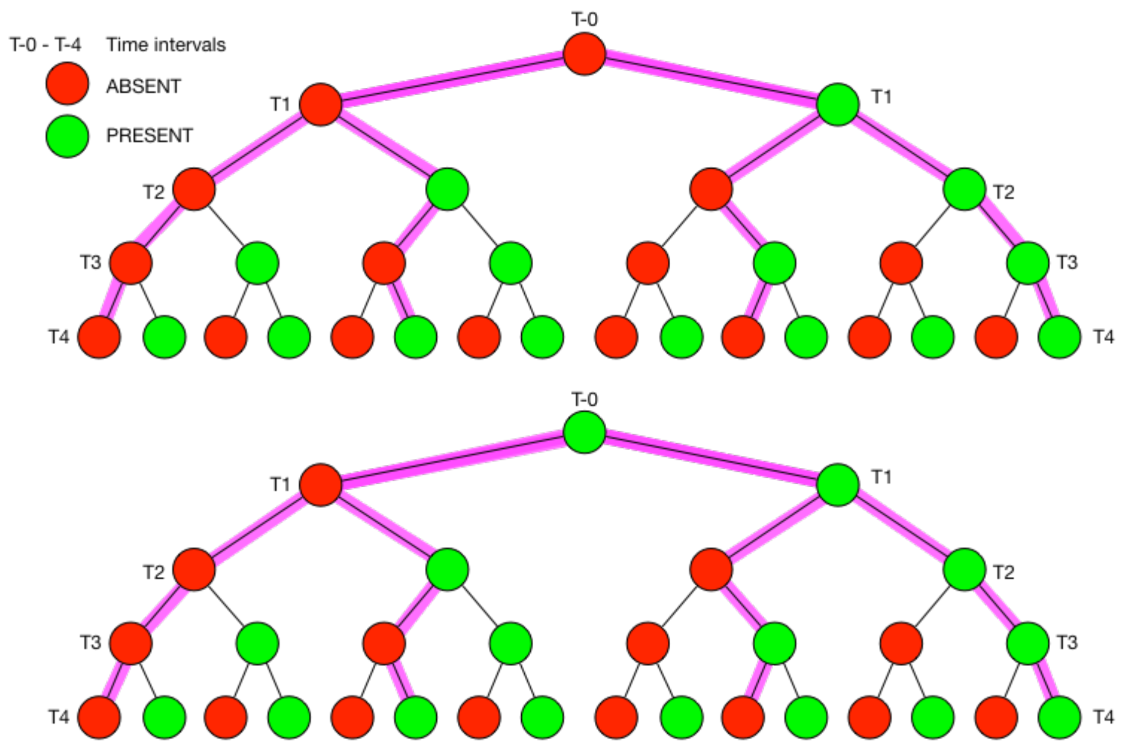


Figure 311.132 - A diagram that shows the wide range of possibilities for species to colonise a hedgerow or be removed possibly in a dynamic way. Two scenarios, one where the species was originally absent and one where it was part of the original mix. The time intervals are not fixed, but could be around 100years as a guide. The purple lines show speculative paths for a species from always absent or lost to always present or gained.

In addition to species either colonising a hedgerow or becoming extinct from it, there are the other dynamics to consider:

1. Position - Has the species moved into new positions or has it been lost from one or more over time?
2. Frequency - Over time has the number of bushes increased or decreased either systematically in one direction or dynamically i.e., has it increased in frequency or decreased consistently over time, or has it waxed and waned?
3. Abundance - Linked to frequency, has the amount or presence of the species increased, decreased or stayed roughly the same over time.

The diagram at Figure 312.133 shows a range of possible scenarios for species changing frequency or abundance in hedgerows (point 2 and 3 above). The likelihood is that some species will become more frequent/ abundant, others less so, and some may stay the same (the rightmost path). The green colour indicates a species either increases in frequency or abundance, blue indicates it stays the same and red indicates that it becomes less frequent or abundant.

A similar diagram could be drawn to illustrate point 1 (above) showing that some species stay in the same location over time and others move position as gaps open up and as specimens die.

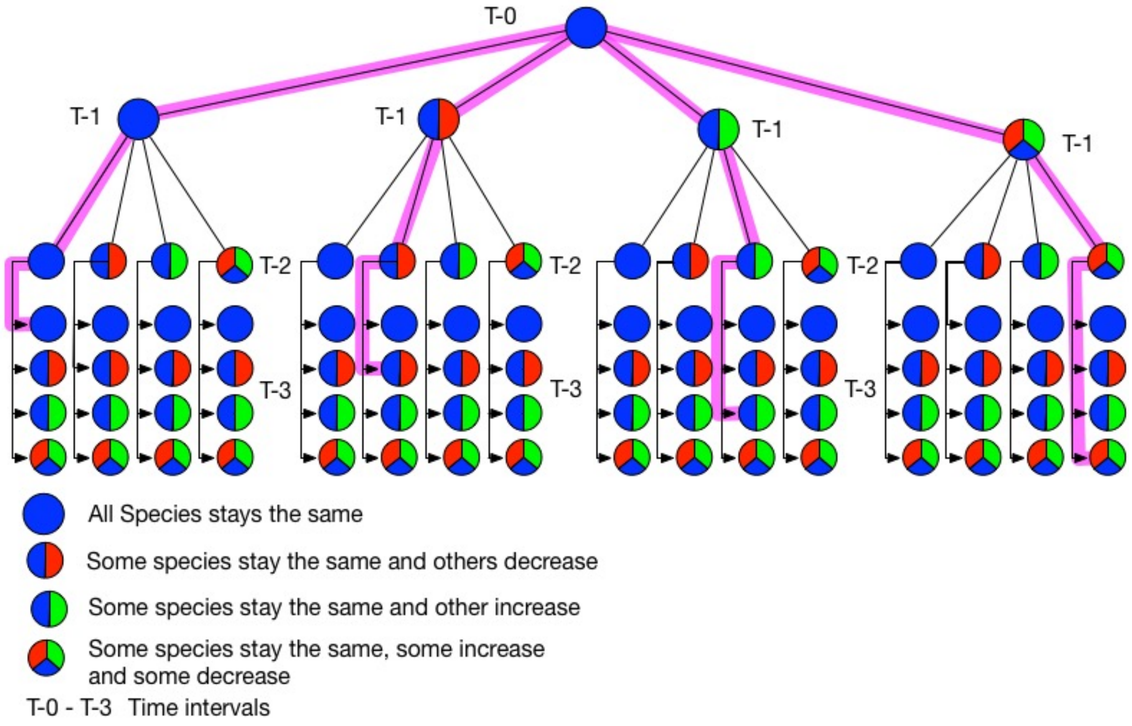


Figure 312.133 - An illustrative diagram to show how either the species frequency or species abundance could change over time. The four thick coloured lines trace various speculative scenarios where: all species stay the same (Left); some species stay the same whilst others decrease (2nd left); some species stay the same and others increase (3rd left); and the where some species stay the same, some decrease and some increase (right).

The reality for many hedgerows is that the dynamic options are more likely. For English Elm *Ulmus procera* there were three identified SPACES signatures [T][SPAA] and two forms of [T][SPaa], one where the species occurred as occasional plants mid-length and one where there were a few plants at the end of a hedgerow where it joined another with the same species in it, indicating colonisation. The nature of the autecology for this species would suggest a mechanism that allowed the former scenario of progressive and aggressive colonisation over time until the present when the hedgerow is virtually a mono-species. The other scenario to produce [T][SPaa] could involve active removal or some other, natural, process, or it could be, as suggested, new colonisation along a more recently planted hedgerow.

The evidence for some of the 1st decile species like Purging Buckthorn *Rhamnus cathartica*, Spindle *Euonymus europaeus* and Guelder-rose *Viburnum opulus* is that they are in progressive decline, contrary to Hooper (Pollard, Hooper and Moore 1974) and Chapman (2001). The field survey evidence suggest that these species are not good colonists of established and new hedgerows. If this is because they cannot self-propagate with the level of competition then it is likely that they will decline over time to the point of becoming extinct. This links to the missing species conundrum for

Combination. If Purging Buckthorn *Rhamnus cathartica* and Spindle *Euonymus europaeus* are present now and Guelder-rose *Viburnum opulus* is not, is that because it was never there or Guelder-rose has been lost through time?

The initial concerns about the Hooper rule voiced in the introduction have been vindicated by the current research and reflect similar concerns by other authors (Muir 1996). The survey method of using 30m sections is only of value if the entire hedgerow is surveyed with contiguous sections as shown at Figure 306.131. The research done by the author of this thesis as part of a review of the Hedgerows Regulations confirmed that, in general, sampling hedgerows to the requirements of the regulations picked up approximately 50% of the total species in a given length. This figure was also confirmed at the Field Studies Centre courses tutored by the author of this thesis, where the different methods were tested on the same hedgerows where 50% of the total was also a general finding.

8.9.8. SPACES Analysis Method

As a consequence of developing the two novel survey methods it became clear that a fresh approach to analysis was also required. This was developed into SPACES. During one of the woodland workshops Richard Smithers announced that, in his opinion 'The devil is in the details'. For the purposes of this research the converse is adopted that 'God is in the details' (Ludwig Mies van der Rohe 1886-1969). Many existing analytical methods for looking at woodlands and hedgerows use what can best be described as a 'broad brush' approach. It also became clear at an early stage that the nature of both woodlands and hedgerows did not lend themselves adequately to be analysed statistically when considering interpreting their botanical content for use as historic markers. The concept that every wood is different is supported by Barnes and Williamson (2015) and the same applies to hedgerows. Each hedgerow has had a different past and should be treated as such.

The initial research revealed that both of these habitats have been very significantly influenced by human activity and the impact of natural processes was in some cases very limited. This was particularly the case with hedgerows that were entirely created and maintained by humans. Their species composition and management was dictated by human desires and needs. Overlaid on top of this is that natural processes continue and certain species can either be removed from the hedgerow or can attain dominance without human intervention. This is particularly the case where natural gaps can form and become colonised by relatively aggressive species like Dogwood *Cornus sanguinea* and Elder *Sambucus nigra*.

The basic elements of SPACES consider what the species in itself is contributing to informing about its historical context. In woodlands very often the presence of certain species are indicating local growing conditions such as wet areas or sloping ground etc. With hedgerows, the presence of a particular species in the landscape can be the result of deliberate and conscious planting. For example, at Dunnington the high frequency and abundance of Crab Apple *Malus sylvestris* in hedgerows enclosed in 1709 and 1772 is unlikely to be the result of natural colonisation as it is unlikely that seedlings would effectively establish in an existing hedgerow that would probable cast too much shade.

Having considered what the species themselves might be contributing to informing about historic context it is then crucial to record where in the woodland, hedgerow or landscape these species occur. This forms the position part of the analysis.
In addition, many of the current woodland and hedgerow survey methods take either no account, or little account of the abundance of the species they record. For the purposes of this research this was regarded as a serious omission addressed in the development of both the WOODS and HEDGES methods.

The complexities and dynamics of hedgerows made the use of the [C]ombination element difficult. It was used at Dunnington and also at Clifford boundary where a number of species were grouped into 'medieval' indicators. Attempts to refine the combination element gave indications of patterns, for example at Dunnington [DU-6] and [DU-7]. More detailed interrogation using tithe maps and enclosure award allocations would be needed. The process can illustrate where patterns emerge. The main advantage is that it displays the data in such a way that the researcher can visualise it and look for patterns rather than put data into a computer and try and interpret the output.

8.10. Abundance Recording

The woodland workshops brought into question the methods of assessing abundance. Keith Kirby emphasised that one of the main systems used is the DAFOR scale where the individual letters referred to dominant, abundant, frequent, occasional and rare. He considered that these words conveyed elements of both frequency and cover or abundance. In general use with the DAFOR scale a species may be frequent across the study area [F] but there may be places where it is locally common or even locally abundant. These qualifying letters (lc or la) are added to the DAFOR letter code to indicate this variation (F(lc) etc.). During this research consideration was given to separating the elements of frequency and abundance or quantity and adopting a double lettering code system to reflect both aspects of abundance. This developed into what was regarded as double DAFOR or DDAFOR. This was later regarded as having some limitations and an alternative system was adopted that drew on marine ecology where they had a mechanism for separating the frequency of species recorded on shorelines compared with the amount of rock surface they covered. This SACFOR (Super-abundant, Abundant, Common, Frequent, Occasional and Rare) scale is the standard recommended for incorporation into the future survey methods. As with the DDAFOR System adopted earlier, the system also adopts the use of two letters, one indicating frequency and the other indicating abundance. The system is referred to as double SACFOR or SSACFOR.

The final element of SPACES is combination. Again, as both woodlands and hedgerows have been very significantly impacted and influenced by human activities; there are natural processes at work, but these may be subordinate to the activities of human intervention. As such it was felt that there were limitations to the use of any statistical classification approach to describe differences between ancient woodlands and hedgerows and recent ones. It should also be emphasised that the whole ethos of this research was not to repeat what has already been done by other authors in attempting to classify woodland and in particular ancient woodland. The object was to identify species that contribute to a determination that a woodland or hedgerow has an ancient origin or history or that have evidence of historical changes marked by the species present today. To this end, consideration of combinations of species needs to be assessed with a different approach.

One of the major concerns that became apparent when considering hedgerows was that even though a number of hedgerows at Dunnington were supposed to have been planted during the two enclosure award eras beginning in 1709 and 1772 respectively, there was little evidence to show any systematic planting during these two periods. Multivariate and statistical analysis could have been applied to classify and identify patterns but the value of this was regarded as limited when considering the objective of identifying species as historic markers in the landscape.

Being able to calibrate the species content of hedgerows at Dunnington provided essential background information to incorporate into the SPACES analysis. Of particular relevance was the focus on boundaries that could be confidently dated to the medieval period. This included the township boundaries themselves along with a number of internal boundaries separating the open fields created during this period. The individual species found on these boundaries were studied to consider if any were more or less confined to this era of hedgerow creation. The evidence pointed to a number of species having SPACES signatures that confirmed they were favoured during the medieval because they were either not present at all, or were only present sporadically, in more recently created hedgerows. Having determined that a number of species had this 'medieval' signature, consideration of any combinations of these was done. The difficulty encountered was that many of these species were very rare in the landscape and also rare in individual hedgerows. In some cases there was only one plant of a species in an entire length. One possible explanation for this rarity is that the species involved have difficulty maintaining populations within a relatively dense and competitive hedgerow and that they are in a slow decline from when they were more abundant at their creation, or were encouraged in their early history. If this is the case, then it is possible that some hedgerows may have actually lost some of these rare species. Accounting for lost species is a difficult task. Chao and Shen (2003) attempted to do this in their paper looking at predicting lost species from those still present. At Dunnington there was a suite of rare species that individually indicated potential medieval origins. Along individual datable medieval hedgerows it was normal for only a proportion of these candidates species to be recorded. For example, if there were five species that indicated medieval origins, one hedgerow might have three of these and another might have four but also, the identity of the three and four species might be different in both cases with only two species in common. As a consequence the element of combination in SPACES considers that combinations of different species may have the same origin. This consideration would not be identified using a more mechanistic approach such as classifying hedgerows according to multivariate or TWINSPAN (Hill 1979) type analysis. It is likely is that these hedgerows would be placed into different end groups because of the differences between the species mixes of the combinations in the different hedgerows.

The current accepted methods for hedgerow survey focus very heavily on the shrub component and often give little credence to any shade-tolerant ground flora. As the presence of Bluebell in pre-enclosure award hedgerows was an initial stimulus for this research, further development of this concept has been dealt with in the surveys conducted on hedgerows for this thesis.

The results from these case studies strongly indicate that a shade-tolerant ground flora can be a significant historic marker for certain hedgerows. Although there are exceptions to the rule, the general principle is that older hedgerows (although not necessarily hedges - see below) are much more likely to contain shade-tolerant ground flora than more recent examples. The principle that is likely to be at work is again the ‘scruffy landscape’ concept in that, during the early history of hedgerow creation from the medieval period onwards it is likely that some shade-tolerant species like Bluebell, Dog's Mercury and Lords-and-ladies are likely to have been in shaded enclaves in parts of the landscape at the time hedgerows were created and moved into, or were incorporated into these hedgerows.

One of the species that is going to be the subject of further research is the incidence of Ramsons in hedgerows. This species has been recorded on a number of occasions in linear hedgerows often oriented East-West or North-South. If these hedges are old, as the species suggests, this is at variance to most ancient hedgerows that tend to be medieval in origin and very often curved or sinuous on the ground. If it is a fair assumption that these are ancient hedgerows this would beg the question as to whether or not they were linked to historic periods such as when coaxial fields were being laid out, or Roman centuriation was taking place. Both of these events would tend to create straight-line linear hedgerows as observed now that contain Ramsons.

The data obtained from Clifford boundary hedgerows shows a consistent confirmation that shade-tolerant ground flora presence is a significant historic marker on a township boundary.

The value of considering the ground flora at Clifford was that the hedgerow to the east of the A1, Hedgerow E1, had been severely degraded in terms of its hedge shrub component, but yet it retained a flora of similar character to the remaining hedgerows, particularly those to the West, W1.

Another personal observation of the importance of ground flora in determining the historic context of a hedgerow is on the A59 between Skipton and Clitheroe. Just past the roundabout on the north side of the road there is a hedgerow on the right-hand side at SD 92601 50481 that is very clearly newly planted monoculture Hawthorn and yet the ground flora is dominated by Dog's Mercury for some several hundred metres. It is highly unlikely that this can have colonised in recent times and the most likely explanation is that there was a former ancient hedgerow along this line and the old shrubs have been removed and replaced recently with a more vigorous new planting of Hawthorn.

It is an important consideration for both woods and hedges that all available information from these habitats, in whatever condition they are in, is taken into full account as part of the survey and interpretation methods. Regarding hedgerows, the ethos behind HEDGES is to provide a survey method that is independent of rules about conforming to fixed length sample sections. The concept is that a hedgerow can comprise anything from a full length of shrubs with shade-tolerant ground flora, down to a single Bluebell or a single Hawthorn bush, yet both are regarded as hedgerows and can be surveyed using the HEDGES method. To use a colloquialism 'you should never throw out the baby with the bathwater'. In other words, you should never discard data until you know it is of little value. HEDGES was designed to collect all data thought to be relevant to hedgerow interpretation. This includes collecting data on the physical nature of the hedgerows.

The HEDGES method records a profile of the hedgerow indicating whether or not it is on a bank, associated with a ditch or some other form of earthworks, for example a kest (typically found in Cumbria and also in Wales).

Of particular relevance is the section on the HEDGES form where a plan view is drawn showing the arrangement of the stems of the hedging shrubs.

It is likely that there are probably two methods by which new species can become established in hedgerows:

1. They establish in gaps formed either naturally or by active removal by human intervention.
2. They become appended to the outside of a hedgerow and eventually grow, compete and become consumed within its confines.

The latter concept (2 above) has been observed as a potential method of colonisation, particularly on the Clifford boundary hedge. On the hedgerow W1 there are large stretches of hedgerow that are dominated by Dogwood. It is likely that this species may have colonised a natural gap of some considerable distance being such an aggressive, suckering and seeding species. But it is also evident that this species occurs 'in the foreground' as seedlings and suckers in front of the current drip line of the hedgerow. (Other species like Blackthorn and Ash have a similar propensity). It is likely that this situation if left unchecked is likely to result in competitive growth of the Dogwood that could eventually become a managed component of the hedge. The evidence of this occurring would be from the vertical plan view sketches drawn using the HEDGES method. At Clifford boundary this would be represented by a linear arrangement of the ancient hedging trunks with a spread of smaller seedlings to one side of the hedge where the seeding and suckering of Dogwood was taking place.

Consideration of the ground flora as an historic marker exists within the Hedgerows Regulations (HMSO 1997). When the author was part of the steering group devising the legislation it was at his suggestion that the inclusion of woodland ground flora species should form part of the regulations. This was accepted and became an associated feature whereby a hedgerow would be more likely to be regarded as having importance under the regulations if it contained at least three species of woodland ground flora from a list of 57 candidate species. Although the Hedgerow Survey Handbook advocates sampling the ground flora using rectangular quadrats, its primary purpose is to identify whether or not the ground flora is in favourable condition. It was more concerned about weeds being in the ground flora than woodland indicators.

As was demonstrated in the illustration at Figure 284.124, the ground flora can persist for many decades in the absence of shade cover and would only require replanting of the hedgerow shrubs to return favourable conditions for these species.

One of the elements considered regarding hedgerows and autecology was the nature of the shrubs themselves and their possible character as aggressive species or colonisers to explain some of the differences in abundance recorded on individual hedgerows. It was observed that there are two basic types of shrub normally included in hedgerow planting schemes:

1. Trunk-formers - these are species like Hawthorn, Field Maple, Elder, Ash, Purging Buckthorn, etc., that, left to grow naturally, are likely to form a single trunk with side branches and could eventually achieve small tree stature.
2. Thicket-formers - this is a group of species that are self-coppicing or produce many thin stems rather than a single thick trunk. This group includes Hazel, Blackthorn and Barberry.

The ecology of Holly was considered to be a problem that the current research may be incapable of solving. There was evidence from a number of hedgerow surveys including those done at Dunnington and Clifford boundary where there were considerable stretches of hedgerow with Holly dominant. As this species is evergreen it is likely to have a significant competitive advantage over its deciduous neighbours. The evidence at Clifford boundary for hedgerow W2 strongly suggests that the current weak shoots of species like Hawthorn and Hazel that erupt from the Holly thicket are likely to have been consumed by the Holly and are basically 'hanging on' under unfavourable conditions. Further research will focus on trying to understand the potential of this species to colonise and aggressively outcompete deciduous species through time. It may be possible to calibrate and determine that a spread occurs at a reasonably fixed rate over the decades or centuries.

Other autecological issues revolve around the method of dispersal and colonisation of hedgerows by certain shrub species. Species with seeds that are dispersed by animals, notably birds, are more likely to colonise any gaps formed in receptor hedgerows than species that rely on wind for their dispersal, e.g. Ash, Field Maple and Sycamore. Species like Oak and Hazel that are also transported by small mammals will have some mobility in the landscape.

One concept that will form further research is that there was an impression at Dunnington of what has been referred to by the author as 'bird bum theory'. This is where he has observed the presence of berry-bearing shrubs underneath extant hedgerow trees (as well as potentially next to where trees were historically as shown on the 1st Ed OS maps) the implication being that birds have transported seeds to these areas and by perching in the trees deposited seeds immediately beneath. A range of species may illustrate this theory, notably Holly, Gooseberry and Crab Apple.

Another curiosity observed during the hedgerow surveys at Leys Lane, Boston Spa (not reported on in this thesis) was that there were some unusual hedgerows along the lane that were dominated by fairly even mixtures of Wych Elm and Sycamore. These hedgerows were almost completely devoid of any other species of shrub, especially those that were berry-bearing, even Bramble. It is postulated that this could be because the Elm and Sycamore are not attractive to berry-eating birds and that these species have no reason to visit hedgerows without berries during the period of berry production elsewhere in the landscape to deposit seed for germination into new plants.

8.11. Research Aims, Objectives and Questions.

The following relates to the original aims, objectives and questions and discusses whether these have been met or if further work is needed.

8.11.1. Aims

Aim 1 - To gain a better understanding of the role of Botanical Indicators for informing about woodland and hedgerow origins and management histories.

Previous attempts to simplify the use of historic marker species to counts of qualifying species do not consider the detail that this research has shown to be needed to adequately interpret the wooded landscapes in terms of their origin and histories.

The aim for woodlands was to develop a reliable and objective system to provide a scoring for woodlands that would both determine a degree of certainty that a wood qualifies as ancient based on its flora and also to provide a weighted evaluation that accounts for variations across the country and within woods. A better understanding has been achieved that confirms that woodlands are individual, and that any attempt to classify them using simple thresholds is too simple and does not account for the differences. A more informed scientific understanding is proposed by this research that requires intelligent interpretation. This includes taking full account of all available information even if, as at Gunter Wood, it is only one species in a specific location. The interpretation may not be clear, but the association should be acknowledged and considered and not ignored because it is a 'rare species'.

For hedgerows, the research has critically reviewed both the survey methods and interpretation and has developed novel approaches that provide both deeper scientific understanding of the interaction of botanical indicators as historic markers and offers a practitioner toolkit to enable new data to be collected and processed. Once adopted as a preferred method it will continue to add to the scientific knowledge base and improve the understanding of hedgerows across the country.

Aim 2 - To determine the value they have and the reliability of their use as Historic Markers in the absence of supporting historic evidence.

Guidance is given in this research on how to calibrate botanical evidence and then extrapolate to other situations. Botanical species are regarded as reliable indicators if their presence has been fully considered in relation to likely pathways that could lead to a species or combination being present where it is today.

Aim 3 - To identify the needs and develop better methods of survey and interpretation.

The need for better methods was identified and developed in this research. New methods are proposed, and tested, for field surveys of woods and hedgerows. Both are targeted at providing sufficient information to allow intelligent interpretation to answer questions about the development of both habitats through time. They have taken elements from existing methods and refined and targeted them into a specific procedure rather than continuing to accept current methods that the current research has clearly demonstrated are not fit for purpose as a means of gathering data for the interpretation of species as historic markers. The development of the methods was addressed by setting and achieving the objective at 4.3.

8.11.2. Objectives

In order to achieve the aims, there are a number of identifiable objectives that form the structure of the methods used (see Chapter 6 - Methods on page 59).

Objective 1 - Review current literature on survey, analysis and interpretation methods to identify shortcomings and the need for better methods for using existing Botanical Indicators.

The literature was reviewed to consider current survey methods, the use of botanical indicators and whether there was scope for improving these. There were clear shortcomings and these were addressed during the research.

Objective 2 - Gather stakeholder opinion on the value of using Botanical Indicators as surrogates in an absence of supporting historical data.

Stakeholder involvement was done in a series of Woodland Workshops and these confirmed a number of issues that the current research addressed.

Objective 3 - To improve on the methods of using current Botanical Indicator data.

Current data can be used more effectively to devise candidate list for regions that do not have lists currently. The adoption of National Character Areas (NCA) as a 'Region' is proposed as these are based on physical and social areas of similarity. Using these and data from the Biological Records Centres will allow focussed regional candidate lists to be created.

Objective 4 - Propose and test novel survey methods to provide better data on which to base interpretation.

The major shortcomings of current field survey methods were addressed in the development of the WOODS and HEDGES methods with the support of a novel analysis process - SPACES, and with the adoption of elements of the Phase 1.5 coding system. These were developed by the author of this thesis, to create meso-habitat and species profiles that refine descriptions of growing conditions at precise locations and consider the role of the species, its position and abundance to offer the tools to interpret botanical data.

Objective 5 - Develop a toolbox to provide a better system for the assessment and interpretation of the Botanical Indicators as Historic Markers.

The development of SPACES has provided a framework that analyses botanical data to gain both a better scientific understanding of the role they play as historic markers and the ways data should be interrogated intelligently by practitioners.

The use of SPACES in woods identifies areas of meso-habitat that can be used to make intelligent comparisons with other woods. Hedgerow SPACES analysis has identified significant historic markers, some that confirm documentary evidence and others that pose further questions and stimulate the need for further research and interpretation.

8.11.3. Research Questions.

The purpose of this section is to determine if the aims (see 4.2) and objectives (see 4.3) have been achieved and that the research questions (see 4.4) have been answered. If not, what is the way forward to achieve a successful outcome of the investigations into ancient woodland indicator species and hedgerow indicator species?

RQ-01a - Are botanical indicators a reliable and robust means of informing about the origins and history of a woodland or hedgerow?

This is the fundamental question of the current research. The evidence gathered from the triangulation approach of the research looking at the literature, desk studies and field surveys have confirmed that botanical indicators can be reliable historic markers providing they are interpreted correctly. There will always be anomalous cases where a species regarded as a classic ancient woodland indicator has appeared in a woodland that is known to be of more recent origin. The issue is that new woods do not necessarily get their complement of ancient woodland indicator species from ancient woods that could be many kilometres away, but from nearby scruffy parts of the landscape hosting ancient woodland indicator species.

The research into hedgerows has clearly pointed to certain species, and some combinations, being historic markers both in respect of determining the origins and also reflecting changes in management through time.

RQ-01b - Can they be used in the absence of historic data?.

Ideally it would be desirable to use botanical indicators as historic markers in situations where there is poor, or no historical data available. If it is possible to calibrate species against history then it is possible that they can be used where historical information is absent. As shown at Dunnington for the hedgerows, there are possibilities that the botany can lead the debate as to whether a species is a historic marker rather than act in support. English Elm in some Yorkshire hedgerows is offering guidance as to where historic hedgerows exist for which there is not documentary evidence to explain their presence in the landscape.

RQ-01c - If so, how?

The method adopted for the Dunnington hedgerow survey provides a framework which develops a process of calibrating which species, or combinations of species, (SPACES analysis) can be used as historic markers in the absence of documentary evidence. This may need to be done at a very local level as individual differences between the ways woods and hedges were managed historically may influence the reliability of botanical indicators in different situations. The HEDGES method provides a framework on which to base judgements as to whether or not certain species can be used in the absence of historic data.

RQ-02 - What is the basis for using botanical indicators as historic markers?

The basis for using botanical indicators as historic markers in woodland is that they are indicating continuity of conditions. This applies to both shade-tolerators and light-demanding species. The classic assumption that woodland indicators are indicating continuously shaded conditions is the aspect that achieves greatest consideration by authors. The likely interpretation of any light-demanding species is that historically woodlands were generally more open and allowed open sky areas to develop. Within these a rich mixture of species would have colonised and developed as a component within the overall woodland boundaries. Any such areas will confirm that these are also indicating continuity and persistence of these species in the open sky parts of the area enclosed by a defined ancient woodland boundary.

The basis of the number of species per 30m length of a hedgerow is questioned and evidence that hedgerows were originally planted as single species and have gained extra species at a fixed rate was not obtained from the current research. The converse was indicated that species-rich hedgerows today are a legacy from times past when the landscape was scruffy and contained a wider range of species suitable as hedging plants and these were incorporated either coincidentally or deliberately at creation points through time. There was also strong evidence of multi-species hedge planting as recently as 1772 following the enclosure award.

RQ-03 - What do Botanical Indicators indicate when used as Historic Markers?

Leading on from Research Question 02 the majority of historic markers in woodland are indicating continuity of conditions, both shaded and unshaded.

For hedgerows, botanical indicators mark out historic events and preferences in terms of species mixtures selected to deliver products and benefits for the local community. Considering the number of species only, this can provide a rough estimation of the age of most hedgerows based on a correlation that older hedgerows are normally more species-rich than more recent examples. This research has confirmed that there needs to be extreme caution exerted in the application of the Hooper rule in any locations other than where it was developed by Max Hooper himself. The significant work done at Dunnington did not detect an adherence to the Hooper rule, more a complete opposite to his theory in that hedgerows were more likely multi-species and have probably actually lost species over time more.

The focus with hedgerows is normally on the shrubs with some consideration of the ground-flora in the Hedgerows Regulations and Hedgerow survey Handbook, but not in the detail necessary to complete the interpretation of the botanical data hedgerows contain. 'A hedgerow is an open history book waiting to be read. We just need to understand the language' (Barry Wright).

RQ-04 - How were they derived?

Woodland indicator species were derived from either field survey, expert opinion, or a combination of both. The general use of ancient woodland indicators adopted the approach of determining which species were recorded within well documented woodlands that predated the cut-off period of 1600 compared with woodlands that could be confidently dated to have been planted on previously un-wooded land since 1600.

Using this approach authors have confirmed that there is a significant overlap of species from the two types of woodland. There are relatively few species that are 100% exclusively found in ancient woodlands and are totally absent from recent woodlands. Even if one author finds a 100% fidelity in their studies, another author may find only a 60% fidelity.

The main element of using botanical indicators as historic markers in hedgerows is less well founded. It relies heavily on the work done by Max Hooper, who derived his theory from field survey. The correlation he studied worked for the hedgerows he surveyed using the 30m sections approach.

RQ-05 - How are they used?

The main use of botanical indicators as historic markers in woodlands is to support any documentary evidence and provide additional confidence that woodland is ancient based on its botanical content.

If botanical indicators are used they are normally applied by defining a threshold number of species to set a benchmark. These are normally applied with reference to regional lists based on counties or larger blocks (several adjoining counties). The origin of the lists varies. A questionnaire reported on by Glaves *et al.* (2009a) had a mixed response with some respondents saying that they used their neighbour's list. The use by county is purely for planning and administrative purposes and does not take account of the occurrences of woodland and hedgerow species based on ecologically meaningful areas like National Character Areas.

Although some attempts are made to allow for differences in conditions at the landscape scale, for instance there are different lists in North Yorkshire for acidic, basic and wet conditions (Glaves *et al*. 2009a). Woodlands are frequently different in terms of the number of candidate species expected. This is because many species need specialised conditions for their survival and persistence. These are referred to as meso-habitats and different woodlands are likely to have different meso-habitats and range of species is likely to be different in a woodland that has few of these compared with a different woodland that has many more and offers more opportunities for a wider range of species. The main reason for adopting thresholds is to support local planning authority applications whereby they determined that if their threshold is ten species, a woodland should be regarded as non-ancient if it only has nine, and as ancient if it has ten or more species. Such arbitrary cut-offs are potentially dangerous and may lead to the loss of potentially valuable woodlands. There is no justification for assigning thresholds other than to advise planners. An intelligent interrogation approach will provide guidance on what the indicators are indicating.

Although certain critical species are a consideration for hedgerow determinations of value under the Hedgerows Regulations, the main consideration is again using the Hooper theory - how many species does the hedgerow contain within a 30m section? The main use of botanical indicators in hedgerows is to determine whether or not they are regarded as important and should be protected under the Hedgerows Regulations. The Hedgerow Survey Handbook is concerned with using botanical indicators to assist in determining the condition of hedgerows.

RQ-06 - Are current methods adequate?

The main driving force behind the current research is questions regarding the field survey and interpretation methods for woodlands and hedgerows when attempting to interpret their botanical content in providing historic markers to understand the history of the landscape. Current interpretation methods that use of thresholds in woodlands and species counts in hedgerows, were regarded as inadequate.

RQ-07 - What are the shortcomings?

Field surveys

There were significant concerns regarding the field survey methods for both habitats. The main shortcomings of the woodland field survey methods are that they are not sufficiently focused on detecting ancient woodland indicators, more on describing and classifying the woodlands, and even attempting to classify what an ancient woodland is. In woodlands the two options of walked transects and quadrats were accepted techniques. The use of quadrats is unacceptable as a means of detecting the full range of ancient woodland indicator species within a woodland. Sampling using quadrats is of little value for the effort expended. The use of walked transects was more likely to encompass the full range of potential locations where ancient woodland indicator species may be located. Many walked transects methods advocate a grid or zigzag pattern. Many of these patterns would have crossed internal meso-habitat boundaries and this aspect was not well considered in current methods.

The current methods for hedgerow surveys were regarded as unacceptable for the purpose of interpreting history based on botanical indicators. The only partly acceptable method would be to adopt the Hooper process but sample every 30m section rather than one or a limited number, but this would not approach the advantages of even a Level 2 HEDGES survey.

Interpretation

The approach to interpreting botanical data for Woodlands adopts a threshold system. This is inherently flawed as it takes no account of differences based on the characteristics of the woodlands being assessed. The more intelligent interpretation of all sources of data proposed by this research is preferred.

The threshold number of species approach for hedgerows to interpret history is a significant shortcoming as it does not apply equally across the country and there are errors in using it anywhere other than where Max Hooper developed the method. The

SPACES approach to hedgerows provides a basis and framework to make a better informed interpretation of what the species and combinations are informing about the origins and history of this habitat.

RQ-08 - Can current survey and analysis methods to identify ancient woodlands and hedgerows be improved?

Yes to both.

RQ-09 - How can they be improved?

The driving force behind the current research is that there are questions over the current survey and interpretation methods for woodlands and hedgerows. It has been identified that there are shortcomings and these are identified. From this the research has developed novel methods for both survey and interpretation for both habitats. For woodlands this is the WOODS method and for hedgerows it is the HEDGES method. Both of these adopt the novel approach of SPACES analysis in order to focus attention on the species recorded in these habitats and undertake an intelligent interrogation and interpretation of these data.

The WOODS method adopts a hybrid system of transects and standing quadrats supplemented by any individual localised point records of significant species or combinations. This method encompasses the consideration of meso-habitats within the woodland. Any recognisable and distinct meso-habitats are surveyed with separate transects. At intervals along these transects standing quadrats are also surveyed. Such quadrats are focused on recording any typical or atypical areas along the transect to refine the characterisation of the vegetation on that meso-habitat.

This system adopts the author's development of a habitat and ecological attribute recording system to produce a system of refining the habitat requirements of species using combinations of modified Phase 1 habitat classification codes (Phase 1.5). These codes are also used in WOODS to characterise and provide an overview of the nature and characteristics of the woodlands being surveyed.

The HEDGES method adopts a flexible approach to surveying hedgerows at different levels of detail. At Level 1 there is an acceptance that existing methods may need to be used and provides instruction and guidance on how to perform this level of survey. The Level 2 survey is more detailed, but is less rigorous than the Level 3. At Level 3 observations are made every 4m along the hedgerow (five paces) in order to record in detail the shrub and ground flora species. Ideally the surveys are done at least twice during the year, on the first occasion to record the structure of the hedge itself and the ground flora and is timed for late winter when most of the important species are visible and recordable. The second occasion is ideally targeted around late summer when any fruiting shrub species have recognisable fruits.

The analysis of woodland data focuses on a reassessment of regional distinctiveness in England, where a system of land classification called National Character Areas (NCAs) is available. This system is a landscape level assessment of areas of similar character in terms of the underlying geology that has shaped the landscape-scale vegetation and the cultural developments within the areas. It is proposed that new regional boundaries use National Character Areas rather than the more traditional county boundaries. With modern technology there is no reason why county boundaries should be the unit of consideration.

The radical novel approach for hedgerows concentrates on the nature of the species present, their position in the landscape and hedgerow, their frequency and abundance and on any apparent combinations of species that can be traced to historic events, mainly their possible period of creation. This makes use of the SPACES analysis in creating signatures for species based on the 'space' they occupy in the hedged landscape.

8.12. Summary

The results of both the desk studies and field surveys are discussed along with general comments of methods and outcomes, e.g., the SPACES method. Reference is made to the original research Aims, Objectives and Research Questions to discuss how far these have been addressed. Some of the expectations were determined as being unachievable within the scope of the current research but may be achieved with further work. The main area where there was no clear way forward was the attempt to provide a reliable and repeatable numerical score that took account of all the variables in a woodland. Also, with hedgerows, there was no magic formula that would age a hedge or inform about its history.

9. Conclusions

9.1. Introduction

This section concludes the consideration of the aims, objectives and research questions.

The main area of research that can be included in the conclusion chapter are:

1. Woodland Workshops
2. Regional Distinctiveness
3. Autecologies
4. Woodland Survey case studies
5. Hedgerow survey case studies

9.2. Woodland Workshops

The conclusions from the woodland workshops were:

1. **What is ancient and recent woodland and what is the nature of ancient woodland?** - Ancient woodland should be regarded as being characterised by shade-casting species, normally trees, but can include shade cast by other species, shrubs, Bracken *Pteridium aquilinum* and Bramble *Rubus fruticosus*. The nature of ancient woodlands should encompass everything from a closed canopy block of woodlands though more natural and open woods to the severely fragmented examples of ghost or shadow woodlands. Recent woodland is presumed to have been planted onto land devoid of typical ancient woodland species but that scruffy areas incorporated, or nearby, may contribute to the inclusion of ancient woodland indicator species in a current survey.
2. **What are ancient woodland indicators?** - These are species that have a fidelity for ancient woods as defined by the cut-off date of 1600 and confirm continuity of conditions. Consideration of the requirements and species traits is needed in order to determine which are the more reliable species having the greatest affinity with ancient woodland and have relatively poor colonisation abilities into more recent plantations.
3. **The inclusion of light demanding species** - Leading on from the point above the presence of light demanding species in woodlands and woodland survey species lists are to be regarded as part of the continuity of conditions where they can be shown to have a fidelity for ancient woodlands as defined above. There needs to be clear guidance on how to account for species that are on lists that are light-demanders or open sky species
4. **Survey methods** - New survey methods were required and these were developed as part of this research. Clear guidance needs to be provided as to how lists should be created from surveys. The abundance of species both within the whole wood and in any meso-habitats should be considered. This will either elevate or depress the likely number of species recorded from a woodland. There is a need to consider how to deal with the different sizes of woodlands, especially what to do with the woods <2Ha that were not included on the Ancient Woodland Inventory. Guidance needs to be provided on the method and minimum survey effort required to obtain future species lists for use in historical interpretation.
5. **The use of ancient woodland indicator species** - It was agreed that a simple threshold was not desirable and that better regional lists should be derived. A robust, reliable and defensible list of ancient woodland indicators needs to be available. There should be weighting for species. In particular,

an accounting for rare species that many authors ignore or discount because they cannot be validated statistically.

6. **Can indicators be used where historical records are absent?** - The use of indicators where historical data is absent can be reliably applied with the caveat that they are only indicating and not confirming. Using threshold numbers of species has been the main method for attempting to place a wood as either ancient or not. The conclusion of this research is that woods are too variable in gross habitat terms (being on say acid or basic rocks and soils) and internally that a 'level playing field' using numbers of species is not practicable. Intelligent interpretation needs to be used and account made for woods having different potentials.
7. **What do botanical indicators identify?** - Botanical indicators are identifying continuity of woodland in the broad sense as defined above, i.e., a continuity of cover for the shade tolerators and a continuity of open habitat for the light demanders.
8. **Regional distinctiveness** - A more objective system is needed. Lists should be based on regions, ideally biologically significant rather than arbitrarily administrative. National Character Areas are more appropriate for defining and developing regional lists. These were created by comparative survey and analysis or expert opinion. The nature of these regions requires addressing.

9.3. Regional Distinctiveness.

Leading on from the discussions of regional distinctiveness above, the method for deriving lists in the future is that they should be based on National Character Areas (for England) and can be created for parts of the country lacking a regional list by combining data on species that have high fidelity for ancient woodland and their occurrence within the NCA in question.

The hierarchy should be:

1. Is the species regarded as an ancient woodland indicator species as determined by comparative study?
2. Does it occur in any 10km square at least partly within the NCA and could therefore be within the NCA?

If the answer is yes to both then the species should be on the candidate list.

With regard to weighting, this should come in to play when assigning a value to a wood. A wood with rare species should have an elevated value applied. But otherwise the identity and nature of the species should be intelligently interpreted in determining confidence that the wood is ancient.

Up-to-date information on rare species like Killarney Fern *Trichomanes speciosum* and the consideration of hybrids on regional lists need to be included in the future.

Information about the distribution of woodland as reported by the forestry commission on their Woodland Inventory and the Ancient Woodland Inventory is not of assistance in weighting species on regional lists in most cases. There are normally recent woods close to, or even joining ancient woods. This makes transfer of seed to recent woods likely. Knowledge of the distribution of woodland and ancient woodland is of use in assessing the likelihood that recent woodland may be colonised by AWIs, but there are also other sources of AWIs in the landscape to consider as well.

9.4. Woodland Autecologies

The studies of the autecologies of ancient woodland indicator species have shown that there is no simple correlation between various autecological attributes and the designation of a species as an ancient woodland indicator species. A fundamental issue is whether an ancient woodland indicator species can move readily into a recent wood. Many species with apparently good dispersal mechanisms are still regarded as high fidelity ancient woodland indicator species. Too many variables are at work that affect colonisation ability and it is beyond the scope of this research to address the issues. A shortcut approach has been adopted by taking the results of a number of comparative surveys of both ancient and recent woodlands and assigning a weighting based on percentage fidelity for ancient woodlands. Applying weighted scores to the species in a wood, and in surveyed meso-habitats within a wood, provides the information necessary to intelligently interrogate the data and draw conclusions of the probability that a wood is ancient, or at least parts for which there is supportive data. The knowledge that a species is absent from recent woodland or less likely to be there is evidence that there is/ are autecological reason(s). There is little merit in trying to determine which attribute, or attributes are involved.

The basic premise initially investigated that a species can be weighted based on its ecological attribute has not proved practicable and reliable. The best method of using autecology is to follow the comparative study route as species with a high fidelity for ancient woodland are demonstrating their autecology by their presence in ancient woodland rather than recent woodland.

Collating more comparative data and more careful analysis of the regional differences in the results offers the best method of weighting of species as good AWIs.

9.5. Hedgerow Autecologies

Some species are good colonists of gaps in hedgerows, such as Elder *Sambucus nigra*, Dogwood *Cornus sanguinea* and Blackthorn *Prunus spinosa*. Others, like Holly *Ilex aquifolium* and English Elm *Ulmus procera* are aggressive competitors. Conversely, species like Buckthorn *Rhamnus cathartica*, Spindle *Euonymus europaeus*, and

Guelder-rose *Viburnum opulus* appear to be poor competitors and may have been lost from hedgerows they occupied during the medieval period. Knowing the autecology of a species can inform about its performance as a colonist of hedgerows or its competitiveness etc. As with woodlands, studying which species are in ancient hedgerows compared with recent ones is a better method of comparison but is complicated by being highly influenced by human management and intervention. Comparative analysis and calibration as was done at Dunnington is the best approach to the historical interpretation of hedgerows. As more such surveys are done a better model will emerge that can be used with increasing confidence to interpret woodland and hedgerow histories in the absence of historical data.

9.6. Woodland Sampling and Survey Method

The strategy for woodland survey (WOODS) has provided the level of detail needed to identify areas rich in AWIs as well as places that have depauperate floras because of past management. Recording to this level of precision would guide a development where, for example, a pipeline, or power line must cross the wood. The WOODS level of survey would inform about the least damaging route.

9.7. Woodland Case Studies

Boston Spa Wood was mainly ancient woodland on the inventory with Deep Dale being Plantation on an Ancient Woodland Site (PAWS) with the area north of the path down into the wood was marked as un-wooded on earlier OS maps. The wood contained some rare species and some uncommon specialists like Bird's-nest Orchid *Neottia nidus-avis* , Fingered Sedge *Carex digitata* and Lily-of-the-valley *Convallaria majalis*. This is concluded to indicate that the botanical data supports the ancient woodland status of this part.

Deep Dale North was concluded to be most probably a severely degraded site that is beginning to be colonised and it is not ancient woodland or Plantation on an Ancient Woodland Site (PAWS).

Deep Dale South is recorded as Plantation on an Ancient Woodland Site (PAWS) and the conclusion is that it complies with that definition.

The overall conclusion was that using the WOODS method correctly identified the different elements within this wood complex instead of producing a single species list created for the whole wood.

Church Wood was less than 2ha in size and would not have been considered for the inventory, contained two meso-habitats - a general dry area with two shallow valleys, and a stream to the north with low-lying level wet ground. There were a number of 100% fidelity species in the wet meso-habitats leading to the conclusion is that the main wood is probably recent but the valleys and streamside area have elements of ancient woodland ground-flora. This suggest at least an inheritance from a scruffy landscape or a re-colonisation from when the 'wet' areas were part of an ancient woodland that may have been felled, leaving the valleys part wooded, retaining the ancient woodland indicator species.

The bird sanctuary area of Ecclesall Woods contained two meso-habitats, a general dry and mostly level part, and wet valleys. The data recorded confirm the conclusion that the richest areas are the wet valleys and stream sides and that these also contain more of the high scoring species. The fact that the wet meso-habitat was so rich flagged up the probability that the dry area was degraded. The conclusion from this is that wet meso-habitats elevate species counts and scores and comparing Ecclesall Woods with another wood using a threshold scoring system is confounded by the inequality of comparing woods possessing a different range of meso-habitats. Threshold based assessment can be applied, but only if the meso-habitats are factored in.

The other conclusion for Ecclesall Woods is that the dry areas are relatively species-poor in ancient woodland indicator species with the indication that the effects of turf-stripping have not been redressed. Another conclusion was that a Beech *Fagus sylvatica* canopy causes a depauperate AWI flora and that this has implications for interpretation as the reduced flora will impact on the assessment of status.

Gillfield Wood and Little Wood confirmed some of the conclusions about Church Wood. Little Wood has several high scoring species by the stream including Remote Sedge *Carex remota* and Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, leading to the conclusion that the stream has retained a few ancient woodland indicator species either from former woodland or from a scruffy historical landscape.

Gillfield wood has the issue of the land south of the brook being excluded from the inventory and the land to the north is Plantation on an Ancient Woodland Site (PAWS). The data confirm the conclusion that there is no significant difference between the two and that both parts should be regarded as Plantation on an Ancient Woodland Site (PAWS).

Gunter Wood demonstrated the conclusion that a species like Early-purple Orchid *Orchis mascula* could be the 'one swallow making the summer', indicating an ancient origin to this wood in combination with other species found throughout the wood that were high fidelity species.

Hackfall Wood was the richest in ancient woodland indicator species of all the case study woodlands. There is no doubt that this wood would qualify as ancient using botanical indicators.

The presence of Killarney Fern *Trichomanes speciosum* confirms the conclusion of the need for proper survey and training of surveyors to ensure that critical species like this are not missed.

Hackfall Wood also contained the hybrid *Polystichum* x *bicknellii* (*P. aculeatum* x *P. setiferum*). The conclusion is that hybrids of ancient woodland indicator species need to be added to future candidate lists.

The acid transect was low in species and confirms the general conclusion that acid woodlands are less rich in ancient woodland indicator species.

9.8. Hedgerow Sampling and Survey Method

The current sampling and survey methods are not appropriate for the collection of meaningful data for historic interpretation. The original thinking behind the HEDGES method and its implementation, linked to the novel SPACES analysis approach, provides the means to interrogate the data and investigate patterns of species presence in the landscape and within individual hedgerows. It describes where a species or combination is in the landscape or along a hedgerow and directs investigations into the cause.

The survey data has confirmed that avoiding the ends of hedgerows can omit important information and the overall strategy of HEDGES is to record entire sections and encourage large-scale surveys based on historic administrative boundaries like medieval townships.

The Hooper rule does not generally work. At the Clifford boundary the Hooper age would be 600 years old. The documentary evidence is for medieval status i.e. at least 200 years older.

9.9. Hedgerow Case Studies

The thorough, intensive and extensive survey done for this case study came to several conclusions, primarily being that these hedgerows could not be dated using the simplified Hooper Rule. A number of species and combination came out as being significant historic markers. Mainly these confirmed existing historic data, but there were instances where species and combinations occurred that could not be defined from the documentary evidence available to date. Using the calibrated species that correlate with the documentary evidence led to speculation about their significance and what they might be indicating.

A major conclusion was that English Elm *Ulmus procera* was a species favoured at least in the medieval period. This opened up the possibility that its occurrence at undocumented locations could be medieval, or even earlier, possibly dating back to former coaxial field systems. Its occurrence also may possibly mark out hedgerows that bordered former road alignments.

The main conclusion from this work supported the analytical method of SPACES (Species, Position, Abundance and Combination Evaluation System). It is critical to take adequate records and make use of every fragment of information to reveal what the species are telling about hedgerow history.

It was also concluded that the combinations of species is important, and there is a need to adopt a more intelligent approach and consider combinations of historically defined 1st decile species like Purging Buckthorn *Rhamnus cathartica*, Spindle *Euonymus europaeus*, Guelder-rose *Viburnum opulus* and Dogwood *Cornus sanguinea*. If two, three or all four are present this adds confidence that the hedgerow is medieval in origin. These do not need to be in the same combination on different hedgerows. The conclusion is that all four were probably present when the hedgerows were first formed in the medieval but that time and competition have caused one, or more, to be lost.

The main conclusion from the Clifford Boundary study is that all of the hedgerows surveyed corroborate their origin as being mainly medieval. An exception was W3 that was a recent planting of Hawthorn *Crataegus monogyna*, although it was on the correct alignment for the township boundary.

Although hedgerow E1 was degraded in shrub species, comprising mainly Elder *Sambucus nigra* it was concluded to be of the same historic origins as the other hedgerows in this case study as it had the same rich ground-flora and rare species like Buckthorn *Rhamnus cathartica* and Spindle *Euonymus europaeus* in the shrub component.

Hedgerow W2 was largely a Holly *Ilex aquifolium* dominated hedgerow leading to the conclusion that this species has overwhelmed other shrubs, which appear as occasional shoots emerging out of the Holly. Significantly, here there is a patch of Ramsons *Allium ursinum* and some Dog's Mercury *Mercurialis perennis* west of the block of Holly. East of the Holly was a recent planting of Hawthorn *Crataegus monogyna*. The conclusion was that the west was undisturbed and typical and to the east there had been a loss of shrubs and a degrading of a woodland ground-flora.

Manor Farm offered the opportunities to relate ground-flora to hedgerows and the main conclusion was that the ground-flora confirmed the historic re-alignment of the field system as reported by the farmer. Formerly the long axes ran N-S and now run E-W. Traces of the N-S alignment are picked up by woodland ground-flora species like Dog's Mercury *Mercurialis perennis*, Bluebell *Hyacinthoides non-scripta* and Lords-and-ladies *Arum maculatum* that appear at the N-S kinks of a hedgerow and repeat on a parallel hedgerow to the immediate south.

There was also evidence of intermediate *Prunus* species with a conclusion that these were hybrids between Blackthorn *Prunus spinosa* and Damson/ Bullace *Prunus insititia*.

9.10. Overall Conclusions

Woodlands and hedgerows are individual. Simple measures of classification and evaluation are not appropriate and could be misleading.

This research has critically assessed the role of botanical species as historic markers and concludes that some species and combinations can reliably inform about the past. A preoccupation with surveying and only working with data that exceeds statistically analysable limits is not supported in the thinking developed , but the application needs to use detailed data collection, historical research and intelligent interpretation.

This research has demonstrated original thinking about ancient woodland indicator species and hedgerow indicator species. They are two parts of our wooded landscape, which is complex, dynamic and essentially human driven.

To inform and add to scientific understanding this research has used original thinking about botanical indicators and as a consequence has developed new methods to better inform the interpretation of botanical data.

SPACES applied to both habitats directs investigation to interpret what the species are indicating by their presence, position and abundance in the landscape and feature. In woodland it identifies signatures which can define Phase 1.5 meso-habitats. The species within the meso-habitats can then be considered and evaluated to determine both the likely age of the wood and indicate any other changes through time. Hedgerows can have more than one SPACES signature that can each have a different explanation. It is critical to record abundance (SSACFOR) and the locations of 1st decile species either by GPS waypoints for Level 2 or use a Level 3 survey as these are the species most likely to inform about the histories of the hedgerows being studied.

To use three quotations (actual or attributed):

1. Things should be as simple as possible and not simpler. Attributed to Albert Einstein
2. "The answer to the great question … of life, the universe and everything … is … is … forty-two" - Douglas Adams (1979).
3. One swallow does not a summer make. Attributed to Aristotle

Quote 1 - the first consideration is that this research has concluded that the current simplification to the level of assigning threshold numbers of species for woodlands to qualify as being ancient is too simple and can be misleading.

Quote 2 - From the second quote it is also unlikely that a definitive answer can be given that provides confirmation that a woodland was in existence before 1600.

Quote 3 - The third quote urges that even small pieces of evidence can inform about history. Severely degraded woodland may contain a depauperate flora of ancient woodland indicator species as at the bird sanctuary in Ecclesall Woods. It is known that this area was not wooded in the Romano-British period and it has suffered damage to the ground-flora during charcoal production but it is still on land that was wooded pre-1600 and thus qualifies as ancient woodland.

With hedgerows the same applies.

Quote 1 - Counting species and applying a formula is too simple and does not take account of the influences of humans and natural processes on the dynamics of the botanical composition of hedgerows.

Quote 2 - There is no answer of 42 for hedgerows. They need to be assessed intelligently using historic data for initial calibration as was done at Dunnington, then extrapolating to other areas and stimulating new questions about whether or not hedgerow systems are based on medieval, pre-medieval coaxials or more recent creation eras.

Quote 3 - Evidence from Dunnington suggests that Spindle *Euonymus europaeus* as a single specimen may be marking out a former road alignment. Other rare species occurrences may also act as 'single swallows'.

9.11. Research Novelty and Contribution to Science

This research has critically assessed the current use of botanical indicators as historic markers in wooded landscapes and has identified and addressed a number of shortcomings, and has presented its findings. The results of this research have provided a new approach to considering botanical species as historic markers. Critical original study has added to scientific and academic knowledge and understanding. The research has created and developed a number of novel approaches to field survey and data collection and methods of interrogation and interpretation. The key contributions are:

The research has developed the original concept of the ‘scruffy landscape’ as a mechanism for species continuity in an area of site over long periods. This is important in helping to inform and understand the nature of ‘ancient woods’.

A contribution of the study has been the integrated approach of landscape history and science to help inform understanding of ancient woods and hedgerows. For ancient woodlands, a triangulated approach with diverse information sources rather than merely species counts is advocated. Furthermore, the idea and concept of ‘intelligent interrogation’ as suggested by Rotherham (2011), is supported.

The investigation has brought together the previously separate fields of woodlands and hedgerows to provide a unified approach to landscape ecological history.

The study has demonstrated the value of integrated ecological and historical research underpinned by meticulous fieldwork, in approaching the paradigms of ancient woods and hedgerows

The research has developed a number of practitioner and researcher toolkits:

WOODS - Woodland Overview and Objective Description System: This is an original concept for a researcher and practitioner toolbox for the collection of data relevant to the specific requirements of surveying to maximise the opportunities for recording most, if not all, the relevant species data. This targets surveying within areas where there is internal variation or meso-habitats.

HEDGES - Hedgerow Ecological Description, Grading and Evaluation System: This is a research-based, practical method of surveying hedgerows from original thinking about how to record in sufficient detail that the data can be more intelligently interrogated.

SPACES - Species, Position, Abundance and Combination Evaluation System: This is an original conceptual approach to looking for patterns in the presence of species at locations in the landscape and hedgerow and taking account of their abundance and any species associations or combinations. This produces signatures to aid and guide interpretation.

Phase 1.5: This is an original concept based on JNCC Phase 1 survey methods that takes a novel approach to habitat definition and recognition. Its purpose is to identify (not classify) the range of internal variation in a wood that forms the basis for recording species by meso-habitat. The internal variations at small scales are describable using a combination of existing Phase 1 codes and new codes, including consideration of ecologically significant attributes like slope, shading, pH, moisture and aspect to create a profile for both the species requirements and the meso-habitat where it is found. A Phase 1.5 profile can be recorded in the field, based on the situation in which a species is found. It can also be generated from the known autecology of the species. Knowing a meso-habitat exists e.g., a wet calcareous flush leads to an expectation that certain species may be present.

SACFOR - Superabundant, Abundant, Common, Frequent, Occasional, Rare: This is a practical and original conceptual method for accounting independently for species presence in woods and hedgerows in terms of the frequency of plants/ patches or lengths of hedgerow and the cover or abundance where it occurs. A double code is used, SSACFOR (called double SACFOR).

Application of woodland indicator lists to NCAs - National Character Areas: In England, National Character Areas provide an ecologically meaningful region on which to base a regionally distinctive list of candidate ancient woodland indicator species. Current regional lists are usually based on counties and do not cover the whole country. This research urges using a combination of interrogating the Biological Record Centre, in combination with a global candidate list of species, reported by current regions to be ancient woodland indicator species, to devise a set of lists for a county that have a meaningful basis. These lists can then be further refined.

The key outcome of the research is that woods and hedgerows are variable and do not lend themselves to classification and dating with the precision that is currently attempted. This research has shown that it is not defensible to use a threshold number of ancient woodland indicator species to define woodland as ancient, and the number of species of shrub in a 30m section to give the age of a hedgerow.

For woodlands, recent blocks may have incorporated some ancient woodland indicator species from other habitats or have become colonised relatively quickly. A continuum of the number of ancient woodland species (and their degree of fidelity to ancient woodlands) in recent woodlands currently exists and is dependent on location and internal variations. Setting thresholds where woods have such variability should not be attempted. The research has considered issues of biogeography and spatial variation in both species occurrences, and in the application of indicators species lists.

Hedgerows can have numerical values calculated or derived, but in practice, these are to apply value and cannot be used to assess age in a mechanical way that reliably reflects their history.

To better understand the history and ecology of woods and hedgerows a more individual approach is required to particular sites. This research helps provide a basis for studies through more intelligent interpretation and interrogation systems.

10. Further Research

10.1. Woodland

10.1.1. Regional Distinctiveness

Continue the comparative woodland approach of Peterken etc. and survey woods in all NCAs that are known to be ancient and compare with those known to be recent to finalise the calibration for each NCA,

10.1.2. The Light Environment

More detailed work on the light environment to determine how ancient woodland indicator species respond to medium and long-term changes to light levels. For how long do unfavourable conditions have to persist before species become extinct under open sky conditions? Are all shade tolerant species equally intolerant of open sky conditions and decline and die out at the same rates?

More work on the effects on species of medium to long term changes in the light environment that could cause the extinction of indicator species if conditions stay too light, or too dark for too long.

The differential colonisability of shade demanding and light demanding species in a woodland flora. As discussed the rate at which recent woods become colonised by species is dependent partly on the proximity of the donor habitat. In the case of shade demanders this would need to be either another wood - an ancient one - or a scruffy element (or an open one that has retained a shade tolerant species) that has the species. These features are likely to be less common in the countryside than more open habitats that could form the refugia for the light demanding species recorded as ancient woodland indicator species by authors. The theory is that new woods (with suitable open sky areas) are likely to be colonised with light demanding ancient woodland indicator species faster than the main body of the wood will become colonised by shade evaders.

Research into whether the open areas have entrapped ancient 'open sky' species, i.e., have they historically been hosts to species typical of open situations and are now the only refuge for such species as the surrounding landscape has been made unsuitable by 'tidying'?

10.1.3. Autecologies

Work to refine the Ellenberg values to incorporate a range of ecological amplitude. Some species will have a narrow range and be incapable of tolerating clear felling and replanting or coppicing.

Expand the knowledgebase of the autecologies to fill gaps in Comparative Plant Ecology.

10.1.4. Dispersal

The impact of the shelter inside woodlands on the penetration of wind dispersed species into recent woodlands on the basis that woods are relatively wind still towards their centres (see also Bremer 2007)

10.2. Hedgerows

10.2.1. Autecologies

Does the presence of stretches of species like Dogwood and Blackthorn confirm their aggressive attribute in that they are dominating because they have rapidly colonized a gap, or because they are naturally aggressive and have outcompeted other species?

10.2.2. Dispersal

Aspects of dispersal could support the assertion about how readily some species can colonise new woods and hedgerows. The confusion about how some species regarded as being AWIs seem to occur relatively frequently in recent woodlands could be explained by recent anthropochory (Zwaenepoel, Roovers and Hermy 2006) accelerating the colonisation (see also Wunderle 1997).

Anecdotal evidence collected by the author suggests there may be an association as described in Wunderle (1997) that suitable perching in hedgerow trees may explain a suspicion that birds perching here are transmitting seeds collected from fruit-bearing trees and shrubs elsewhere. It is an observation of an association that it is more than random chance that under trees like Oak *Quercus* sp. and Ash *Fraxinus excelsior* in hedgerows; Holly *Ilex aquifolium*, Gooseberry *Ribes uva-crispa*, Crab Apple *Malus sylvestris*, Elder *Sambucus nigra* and even Guelder-rose *Viburnum opulus* are frequently found. It is also possible that such species are still present even though the 'perch' tree has long since gone (this could be validated by consulting the tree positions on the 1st ed OS maps). This is further suggested at hedgerows near Boston Spa. Here the hedgerows are dominated by Wych Elm *Ulmus glabra* and Sycamore *Acer pseudoplatanus*, neither of which would be attractive to seed eating birds and the lack of seed-bearing trees and shrubs in the hedgerows might be a plausible cause in need of confirmatory investigation.

Two species that are not normally considered as historic markers in wooded landscapes are White Bryony *Bryonia dioica* and Black Bryony *Tamus communis*. Both are herbaceous species that produce berries and use the hedge or shrubs to support them as they grow. A general impression is that both of these species tend to occur in older hedgerows and occasionally in various parts of woodlands. The significance of these occurrences has not been investigated and will form part of further work. This has linkage to the dispersal aspect in that, how can this information on bird dispersal be used to add information to hedgerows survey results in a historical context?

Another issue that became apparent during the field surveys was that there seems to be a miss-match between the incidence of species like Alder, Field Maple, Ash and Sycamore and the nearest available trees from which seed may have been shed to arrive in the hedgerows. This was particularly relevant at Dunnington where there were a good number of hedgerows that contained Field Maple and yet there were very few Field Maple trees within the landscape. This would tend to suggest that Field Maple was deliberately planted and maintained as a hedging shrub, since managed Field Maple in a hedgerow rarely fruits. During historic management it is likely that hedgerows were certainly more bushy than they are currently and that there may have been flowering and seed set in these large Field Maple bushes and the seeds could have migrated along hedgerows, entered gaps, germinated and produced new hedging Field Maple plants.

The dispersal of seed by wind is relying on random chance that seeds land in the favourable situations. Even if trees or shrubs shed seed, and the wind speeds were sufficiently strong to blow, them the probability of them landing in gaps and germinating is probably low.

As was shown at Dunnington there are a number of hedgerows that have trees in them that cast wind-dispersed seed and yet the hedgerows beneath do not contain the species.

The proposal for further research is to attempt to match existing shrub locations for wind-dispersed tree species and any potential nearby trees as well as the next nearest location for other bushes of the same species.

10.2.3. Apples

The work done at Dunnington has suggested that the hedgerows there have had some degree of systematic planting of both Crab Apple *Malus sylvestris* and Domestic Apple

Malus domestica. Hedgerows are in existence because of the needs and requirements of humans and it is likely that apples formed an important component of the diet of our ancestors and that they introduced and maintained apple trees in the hedged landscape for their produce.

Although some records and determinations were made on the locations of the two different types of apple no rigorous investigation was done into the precise positions of each type within the landscape. The other aspect that will need to be investigated is whether or not the varieties of domestic apples are definable varieties suggesting deliberate planting of known cultivars or whether they are indeterminate and would suggest that they are the result of seedlings establishing within the hedged network. Attention will need to be paid to the plants themselves to make an estimation as to whether or not they may have been part of the original planting, of some 200 years previous, or whether they may have seeded in or been introduced since that period.

10.2.4. Damson/Sloe

Evidence collected from Manor Farm Leppington and also from Dunnington, along with anecdotal observations by the author, suggest that there may be hybridisation between Blackthorn *Prunus spinosa* and Damson *P. insititia*. On a number of occasions when surveys were done during the fruiting period there have been observations of spherical fruits that were larger than sloes and had a less sour and astringent taste. In these cases, both parent plants were in the landscape and this is a likely possibility. Investigating the potential for this occurrence should inform about the histories of these two species in a landscape context.

10.2.5. Holly

The apparent aggressive spread of this species along hedgerows needs further work. Can plants be dated by calculating their rate of movement?

10.2.6. Ivy

During a number of surveys Ivy was recorded. Its position and abundance was recorded but no interpretation was done as to the reasons why it was more prevalent in certain hedgerows compared with others. This is a species that is predicted to establish and thrive under an existing canopy. Once established it can often form large dense carpets underneath the hedge shrubs but only when it starts to climb through the hedging shrubs does it begin to flower and set seed. It was important during the HEDGES surveys to record whether or not the Ivy was purely terrestrial or whether it was growing in amongst the hedging shrubs. This has a fundamental bearing on the likelihood of seed been produced to allow the species to spread to other hedgerows.

As Ivy is a bird-dispersed species the role it plays as an historic marker is likely to be important and is worth further investigation to determine whether or not it can be used as a botanical indicator in hedged landscapes.

10.2.7. Gooseberry

Gooseberry along the B6275 Piercebridge road. The observation from the current research is that Gooseberry tends to have a SPACES signature of being associated with habitation [T][SPaa], but there are also places in the landscape where it is more abundant and remote from areas of human occupation [T][SPAA]. This was found particularly on the B6275 road from Scotch Corner to Piercebridge. Along here there were a number of varieties of Gooseberry at regular intervals for a prolonged distance. As this is essentially a domesticated species the reason for this occurrence is unclear.

Further research into the archives may reveal information to suggest how this species has a second SPACES signature in certain parts of the countryside

11. References and further reading

Items with the first author underlined are referencing from the text, others are background reading consulted during the review and as part of the general reading for this research

ABATE, T. (1992). Which bird is the better indicator for old-growth forest? *Bioscience*, **42** (1), 8-9.

ABENSPERG-TRAUN, M. and SMITH, G. T. (1999). How small is too small for small animals? Four terrestrial arthropod species in different-sized remnant woodlands in agricultural western Australia. *Biodiversity and Conservation*, **8,** 709-726.

ADAMS, D. (1979). *The hitch-hikers guide to the galaxy*. Pan Books Ltd, London.

ADAMS, S. N. (1975). Sheep and cattle in forests – a review. *Journal of Applied Ecology*. **12,** 143-152.

ADAMSON, R. S. (1922). 5. The oak hazel woods (*Quercetum roboris* modified.). *Journal of Ecology*, **9**, 179-219.

AGUIRRE, A. and DIRZO, R. (2008). Effects of fragmentation on pollinator abundance and fruit set of an abundant understory palm in a Mexican tropical forest. *Biological Conservation*, **141**, 375-384.

ALLEN, A. A. (1998). Notable beetles of Oxleas wood. *Urban Nature Magazine,* No1, spring 1998, 25-27.

ALLEN, D. E. (1971). Bramble dating: a promising approach. in Standing conference for local history. *Hedges and local history.* 30-36. Bedford Square Press, London.

ANDERSON, M. C. (1964a). Studies of the woodland light climate: I. the photographic computation of light conditions. *Journal of Ecology*, **52**, 7-41.

ANDERSON, M. C. (1964b). Studies of the woodland light climate: II. seasonal variation in the light climate, *Journal of Ecology,* **52**, 643-663.

ARDRON, P (2001). Archaeological Survey and GIS Mapping of Ecclesall Woods. Sheffield Hallam University. Unpublished.

ARDRON, P. A. and ROTHERHAM, I. D. (1999). Types of charcoal hearth and the impact of charcoal and whitecoal production on woodland vegetation. *The Peak District Journal of Natural History and Archaeology*, **1**, 35-47.

ARIYANTI, N. S., BOS, M. M., KARTAWINATA, K., TJITROSOEDIRDJO, S. S., GUHARDJA, E, and GRADSTEIN, S. R. (2008). Bryophytes on tree trunks in natural forests, selectively logged forests and cacao agroforests in Central Sulawesi, Indonesia. *Biological Conservation*, **141**, 2516-2527.

ASBERY, E. (undated). A study of factors affecting species distribution and colonization in woodlands. Dissertation for Unit LFM/1352 School of leisure and food management, Sheffield Hallam University, supervisor I. D. Rotherham.

ASH, J. E. and BARKHAM, J. P. (1976). Changes and Variability in the Field Layer of a Coppiced Woodland in Norfolk, England. *Journal of Ecology*, **64** (2), 697-712.

ASK, P. and NILSSON, S. G., (2004). Stand characteristics in colour-infrared aerial photographs as indicators of epiphytic lichens. *Biodiversity and Conservation*, **13,** 529–542.

ASOUTI, E. (2003). Woodland vegetation and fuel exploitation at the prehistoric campsite of Pinarbasi, south-central Anatolia, Turkey: the evidence from the wood charcoal macro-remains. *Journal of Archaeological science*, **30**, 1185-1201.

ASSMANN, T. (1999). The ground beetle fauna of ancient and recent woodlands in the lowlands of north-west Germany (coleoptera, carabidae), *Biodiversity and Conservation,* **8** (11), 1499-1517.

ASTON, M. (1985). *Interpreting the landscape - Landscape archaeology and local history*. Routledge, London.

ATHERTON, M. A. and BUTLIN, R. A. (eds) (NO DATE). *Woodlands in the landscape: Past and future perspectives*. York, Leeds University Press.

ATHERTON, M. A. (1999). The vegetation history of Yorkshire: A bog-trotters guide to god's own county. *Naturalist,* **124**, 137-155.

ATKINSON, P. M., FOODY, G. M., GETHING, P. W., MATHUR, A. and KELLY, C. K. (2007). Investigating spatial structure in specific tree species in ancient semi-natural woodland Using remote sensing and marked point pattern analysis. *Ecography*, **30**, 88-104.

AUBIN, I., MESSIER, C. and BOUCHARD, A. (2008). Can plantations develop understory biological and physical attributes of naturally regenerated forests? *Biological Conservation*, **141**, 2461-2476

AUDE, E., TYBIRK, K. and BRUUS PEDERSEN, M. (2003) Vegetation diversity of conventional and organic hedgerows in Denmark, *Agriculture, Ecosystems and Environment,* **99**, 135-147.

AUDE, E., TYBIRK, K., MICHELSON, A., EJRNAES, R., HALD, A. B. and MARK, S. (2004) Conservation value of the herbaceous vegetation in hedgerows - does organic farming make a difference, *Biological Conservation,* **118**, 467-478.

BADENOCH, C. (1993). Woodland origins and the loss of native woodland in the Tweed valley. In ASHMOLE, P. (ed) *Restoring borders woodland*. Peebleshire Environment Concern 11-26.

BAETEN, L., HERMY, M. and VERHEYEN, K. (2009). Environmental limitation contributes to the differential colonization capacity of two forest herbs. *Journal of Vegetation Science*, **20**, 209-223.

BAILEY, N., LEE, J. T. and THOMPSON S. (2006). Maximising the natural capital benefits of habitat creation: Spatially targeting native woodland using GIS. *Landscape and Urban Planning*, **75**, 227–243..

BAILEY, S. (2007). Increasing connectivity in fragmented landscapes: An investigation of evidence for biodiversity gain in woodlands. *Forest Ecology and Management*, **238**, 7–23

BAKKER, E. G., van DAM, B. C., van ECK, H. J. and JACOBSEN, E. (2001). The Description of Clones of *Quercus robur* L. and *Q. petraea* (Matt.) Liebl. with Microsatellites and AFLP in an Ancient Woodland. *Plant biol*ogy, **3**, 616-621.

BANNISTER, N. (1996). *Woodland archaeology in Surrey*. Kingston upon Thames, Surrey County Council.

BARNES, G. and WILLIAMSON, T. (2006). *Hedgerow history.* Windgather Press, Bollington.

BARNES, G. and WILLIAMSON, T. (2015). *Rethinking ancient woodland*. University of Hertfordshire Press, Hatfield.

BARR, C. J., BRITT, C. P. and SPARKS, T. H. (1995) *Hedgerow Management and Wildlife.* ADAS/ITE contract report to MAFF.

BARR, C. J. and GILLESPIE, M. K. (2000) Estimating hedgerow length and pattern characteristics in great Britain using countryside survey data, *Journal of Environmental Management,* **60**, 23-32.

BARR, C. J. and PETIT, S. (2001) *Hedgerows of the world: Their ecology functions in different landscapes,* IALE UK.

BATES, G. H. (1937). The vegetation of wayside and hedgerow. *Journal of Ecology*, **25** (2), 469-481.

BAUDRY, J., BUNCE, R. G. H. and BUREL, F. (2000). Hedgerows: An international perspective on their origin, function and management, *Journal of Environmental Management,* **60**, 7-22.

BEATTY, S. W. (1984). Influence of microtopography and canopy species on spatial patterns of forest understory plants. *Ecology* 1406-1419.

BESWICK, P. and ROTHERHAM, I. D. (1999). *Ancient woodlands: Their archaeology and ecology, a coincidence of interest.* Sheffield, Wildtrack publishing.

BICKMORE, C. J. (2002). *Hedgerow survey handbook.* Wales, Countryside Council.

BIERZYCHUDEK, P. (1982). Life histories and demography of shade tolerant temperate forest herbs: A Review. *New Phytologist*, **90**, 757-776.

BIGNAL, K. L., ASHMORE, M. R. and HEADLEY A. D. (2008). Effects of air pollution from road transport on growth and physiology of six transplanted bryophyte species. *Environmental Pollution* **156**, 332-340.

BIRCH, T. W. (1936). The afforestation of Britain. *Economic Geography*, **12** (1), 1-26.

BLACKMAN, G. E. and RUTTER, A. J. (1946). Physiological and ecological studies in the analysis of plant environment: 1. light factors and the distribution of bluebell (*Scilla non-scripta)* in woodland communities, *Annals of Botany,* **10** (40), 361-390.

BLAKESLEY, D and BUCKLEY, P. (2010). *Managing your woodland for wildlife*. Newbury, Pisces publications.

BOATMAN, D. J. (1980). Mixed hedges of the former East Riding of Yorkshire. *Naturalist*, **106**, 41-44.

BOOTH, T. C. (1967). Plantations on medieval rigg and furr cultivation strips – A study in Scoreby Wood York East Forest. Forestry Commission: *Forest Reco*rd No 62.

BOSSUYT, B., HERMY, M. and DECKERS, J. (1999). Migration of herbaceous plant species across ancient-recent forest ecotones in central Belgium, *Journal of Ecology,* **87** (4), 628-638.

BOUTIN, C., JOBIN, B., BÉLANGER, L. and CHOINIÈRE, L. (2002). Plant diversity in three types of hedgerows adjacent to cropfields. *Biodiversity and Conservation*, **11,** 1–25.

BOYD, J. M. (1993). Sycamore - A review of its status in conservation in Great Britain, *Biologist,* **39** (1), 29-31.

BRADSHAW, A. D. (1971). The significance of Hawthorns. In Standing conference for local history. *Hedges and local history.* 20-29. London, Bedford square press,.

BRAENDLE, M. and BRANDL, R. (2001). Species richness of insects and mites on trees: expanding Southwood. *Journal of Animal Ecology*, **70**, 491-504.

BRAENDLE, M. and BRANDL, R. (2003). Species richness on trees: A comparison of parasitic fungi and insects, *Evolutionary Ecology Research,* **5** (6), 941-952.

BRANDON, P. F. (1969). Medieval clearances in the East Sussex Weald. *Transactions of the Institute of British Geographers*, **48**, 135-153.

BRAUN-BLANQUET, J. (1964): *Pflanzensoziologie, Grundzüge der Vegetationskunde. (3. Auflage*). Springer Verlag, Wien, 865 pages.

BREMER, P. (2007). The colonization of a former sea-floor by ferns. Published PhD thesis, Wageningen University, The Netherlands.

BRENCHLEY, W. E. and ADAM, H. (1915). Recolonisation of cultivated land allowed to revert to natural conditions. *Journal of Ecology*, **3** (4), 193-210.

BRIDGE, M. C., HIBBERT, F. A. and RACKHAM, O. (1986). Effects of Coppicing on the Growth of Oak Timber Trees in the Bradfield Woods, Suffolk. *Journal of Ecology*, **74** (4), 1095-1102.

BROOKS, A and AGATE, E. (1998). *Hedging – A practical handbook* (revised edition). BTCV. Oxford

BROWN, A. D. (2010). Pollen analysis and planted ancient woodland restoration strategies: a case study from the Wentwood, southeast Wales, UK. *Vegetation History Archaeobotany*, **19**, 79–90.

BROWN, A. H. F. and OOSTERHUIS, L. (1981). The role of buried seed in coppicewoods. *Biological Conservation*, **21**, 19-38.

BRUDVIG, L. A. and DAMSCHEN, E. I. (2011). Land-use history, historical connectivity, and land management interact to determine longleaf pine woodland understory richness and composition. *Ecography*, **34**, 257-266.

BRUNET, J. and VON OHEIMB, G. (1998). Migration of vascular plants to secondary woodlands in southern Sweden, *Journal of Ecology,* **86** (3), 429-438.

BRUNET, J., VON OHEIMB, G. and DIEKMANN, M. (2000). Factors influencing vegetation gradients across ancient-recent woodland borderlines in southern Sweden. *Journal of Vegetation Science*, **11**, 515-524.

BRUNET, J. (2007). Plant colonization in heterogeneous landscapes: an 80-year perspective on restoration of broadleaved forest vegetation. *Journal of Applied Ecology*, **44**, 563–572.

BUCKLAND, S. M., GRIME, J. P., HODGSON, J. G. and THOMPSON, K. (1997). A comparison of plant responses to the extreme drought of 1995 in northern England. *Journal of Ecology*, **85**, 875-882.

BUCKLEY, G. P., HOWELL, R. and ANDERSON, M. A. (1997). Vegetation succession following ride edge management in lowland plantations and woods. 2. the seed bank resource. *Biological Conservation,* **82** (3), 305-316.

BUGALHO, M. N., LECOMTE, X., GONCALVES, M., CALDEIRA, M. C. and BRANCO, M. (2011). Establishing grazing and grazing-excluded patches increases plant and invertebrate diversity in a Mediterranean oak woodland. *Forest Ecology and Management*, **261**, 2133–2139.

BUNCE, R. G. H. (1982). *A field key for classifying British woodland vegetation – part 1.* Institute of Terrestrial Ecology, Cambridge.

BUNCE, R. G. H. (1989). *A field key for classifying British woodland vegetation – part 2.* HMSO, London.

BURCH, J. (2008). The relationship of bryophyte regeneration to heather canopy height following moorland burning on the North York Moors. *Journal of Bryology*, **30**, 208-216.

BURGESS, J. (1994). Woods must become no-go. *Countryside*, July/August 1994, 7.

BURNSIDE, N. G, METCALFE, D. J., SMITH, R. F. and WAITE, S. (2006). Ghyll woodlands of the Weald/ characterisation and conservation. *Biodiversity and Conservation*, **15**, 1319–1338.

BUSE, J. (2012). 'Ghosts of the past': flightless saproxylic weevils (Coleoptera: Curculionidae) are relict species in ancient woodlands. *Journal of Insect Conservation*, **16**, 93–102.

BUTLER, J. (2005). Trees in historic landscapes. Crisis and continuum in the shaping of landscapes, *Landscape Archaeology and Ecology,* **5**, 16-18.

CAIN, M. L., DAMMAN, H. and MUIR, A. (1998). Seed Dispersal and the Holocene Migration of Woodland Herbs. *Ecological Monographs*, **68** (3), 325-347.

CALLAGHAN, D. A. and ASHTON, P. A. (2008a). Knowledge gaps in bryophyte distribution and prediction of species-richness. *Journal of Bryology*, **30**, 147-158.

CALLAGHAN, D. A. and ASHTON, P. A. (2008b). Attribution of rarity in a regional bryophyte assemblage. *Journal of bryology*, **30**, 101-107.

CAMERON, R. A. D. (1980a). Stand structure, species composition and succession in some Shropshire woods. *Field Studies*, **5**, 283-306.

CAMERON, R. A. D. (1980b). Hedgerow shrubs and landscape history: some Shropshire examples. *Field Studies*, **5**, 177-194.

CAMERON, R. A. D. (1981). Snails, hedges and history. *Countryside*, spring 1981, 108-109.

CAMPAGNE P., AFFRE L., BAUMEL A., ROCHE P. and TATONI T. (2009a). Fine-scale response to landscape structure in Primula vulgaris Huds./ does hedgerow network connectedness ensure connectivity through gene flow? *Popul Ecol* **51**, 209–219.

CAMPAGNE, P., BAUMEL, A., AFFRE, L., JUIN, M., DUONG, N., ROCHE, P. and TATONI, T. (2009b). Genetic signs of connectivity in *Primula vulgaris* (Primulaceae) in a hedgerow network landscape. *C. R. Biologies*, **332**, 652–661.

CANTARELLO, E. and NEWTON, A. C. (2008). Identifying cost-effective indicators to assess the conservation status of forested habitats in Natura 2000 sites. *Forest Ecology and Management*, **256**, 815–826.

CARLETON, T. J., MAYCOCK, P. F., ARNUP, R. and GORDON, A. M (1996). The situ regeneration of *Pinus strobus* and *P. resinosa* in the Great Lakes forest communities of Canada. *Journal of Vegetation Science*, **7**, 431-444.

CASTLE, G., LATHAM, J. and MILETO, R. (2008). Identifying ancient woodland in Wales – The role of the ancient woodland inventory, historical maps and indicator species. Countryside Council for Wales contract report No 819. CCW.

CHAMBERS, P. (2012). *Foraging*. Remember When (Pen & sword books Ltd.), Barnsley.

CHAO, A and SHEN, T-J. (2003). Nonparametric estimation of Shannon's index if diversity when there are unseen species in sample. *Environmental and Ecological Statistics,* **10**, 429-443

CHARRIER, S., PETIT, S. and BUREL, F. (1997). Movements of *Abax parallelepipedus* (Coleoptera, Carabidae) in woody habitats of a hedgerow network landscape: a radio-tracing study. *Agriculture Ecosystems and Environment*, **61**, 133-144.

CHAPMAN, L. (2001). *The living history of our hedgerows: A guide to dating hedgerows,* Revised edition, Orchard publication, Chudleigh.

CHATTER, C. and SANDERSON, N. (1994) Grazing lowland pasture woods, *British Wildlife,* **6**, (2), 78-88.

CHAZDON, R. L. (1986). Light Variation and Carbon Gain in Rain Forest Understorey Palms. *Journal of Ecology*, **74**, (4), 995-1012.

CHMURA**,** D. and SIERKA, E. (2007). The invasibility of deciduous forest communities after disturbance: A case study of *Carex brizoides* and *Impatiens parviflora* invasion. *Forest Ecology and Management*, 242, 487–495.

CHURCHWARD, J., BRITT, C. P., McLEISH, A., DAVIS, M. and WRIGHT, B. (1996). *The hedgerow evaluation system: a system for identifying important hedgerows*, Department of the environment contract report, ADAS.

CLARK, J. S., SILMAN, M., KERN, R., MACKLIN, E. and HILLERISLAMBERS, J. (1999). Seed Dispersal near and Far: Patterns across Temperate and Tropical Forests. *Ecology*, **80**, (5), 1475-1494.

CLAYTON, C. (2000). An archaeological survey of Parkbank Wood, Sheffield. *The Peak District Journal of Natural History and Archaeology*, **2**, 31-41.

CLEMENTS, D. K. and TOFTS, R. J. (1992a). *Hedgerow evaluation and grading system (HEGS).* Countryside planning and management.

CLEMENTS, D. K. and TOFTS, R. J. (1992b) Hedges make the grade: A look at the wildlife value of hedges, *British Wildlife,* **4** (2), 87-95.

CLEMENTS, D. K. and ALEXANDER, N. A. (2009). A comparative study of invertebrate faunas of hedgerows of differing ages, with particular reference to indicators of ancient woodland and 'old growth'. *Journal of Practical Ecology and Conservation* **8** (2), 42-62.

CLIFFE, P. (1993). Cannock 'designs' to counter conflict. *British Timber*, **22**, 28-32.

COLAK, A. H., ROTHERHAM, I. D. and CALIKOGLU, M. (2003). Combining 'naturalness concepts' with close-to-nature silviculture. *Forestw Cbl.* **22**, 421-431

COLEBOURNE, P. H. (1989). Discovering ancient woodland, *British Wildlife,* **1** (2), 61-75.

COPPINS, A. M. and COPPINS, B. J. (2002). *Indices of ecological continuity for woodland epiphytic lichen habitats in the British Isles*. British Lichen Society. London.

CORBET, S. A. (1998). Fruit and seed production in relation to pollination and resources in bluebell, *Hyacinthoides non-scripta*, *Oegologia,* **114**, 349-360.

CORBIT, M, MARKS, P. I. and GARDESCU, S. (1999). Hedgerows as Habitat Corridors for Forest Herbs in Central New York, USA. *Journal of Ecology*, **87**, (2), 220-232

CORNEY, P. M., LE DUC, M. G., SMART, S. M., KIRBY, K. J., BUNCE, R. G. H. and MARRS, R. H. (2004). The effect of landscape-scale environmental drivers on the vegetation composition of British woodlands, *Biological Conservation,* **120**, (4), 491-505.

COUSINS, S. A. O. and AGGEMYRA, E. (2008). The influence of field shape, area and surrounding landscape on plant species richness in grazed ex-fields. *Biological Conservation*, **141**, 126–135.

COWAN, A. (2003). *Decaying wood – recycling within arboreal ecosystems*. A and E Arborecology. West Whickham, Kent.

COWAN, A. (2004). *Protecting our ancestors legacy for the generations of the future*. A & E Arborecology. West Whickham, Kent.

CRACKLES, E. (1985). Why are they not there? *Yorkshire Naturalists Union Bulletin*, No. 4, 12-14.

CRANE, G., ROBERTS, C., LANGMAN, M and SHIELDS. C. (2009). *A guide to hedgerows*. Field Studies Council AIDGAP leaflet OP134. Field Studies Council, Shrewsbury.

CRAWFORD, C. (1985). Ancient woodlands in Castle Morpeth district, Northumberland. University College London, MSc dissertation.

CRAWFORD, C. L. (2006): A provisional ancient woodland indicator plant list for Scotland. Native Woodlands Discussion Group Newsletter. **31** (2). Autumn 2006. NWDG.

CRAWFORD, C. L. (2009). Ancient woodland indicator plants in Scotland. *Scottish Forestry*, **63** (1), 6-19.

CRISP, P. N., DICKINSON, K. J. M. and GIBBS, G. W. (1998). Does native invertebrate diversity reflect plant diversity? A case study from New Zealand and implications for conservation. *Biological Conservation*, **83** (2), 209-220.

CROSS, J. (1987). Status and value of native broadleaved woodland. *Journal of the Society of Irish Foresters*, **44** (2), 81-88.

CROSS, J. R. (1992). The distribution, character and conservation of woodlands on esker ridges in Ireland. *Proceedings of the Royal Irish Academy*, **92B**, 1-19.

CROSSLEY, D., (1993). White coal and charcoal in the Woodlands of North Derbyshire and the Sheffield Area. In: Beswick, P., Rotherham, I. D. (Eds.), Proceedings of the National Conference on Ancient Woodlands: their archaeology and ecology—a coincidence of interest, Sheffield 1992. *Landsc. Archaeol. Ecol*. **1**, 67.

CROXTON, P. J., FRANSSEN, W., MYHILL, D. G. and SPARKS, T. H. (2004). The restoration of neglected hedgerows: A comparison of management treatments, *Biological Conservation,* **117**, 19-23.

CROXTON, P. J. and SPARKS, T. H. (2002). A farm-scale evaluation of the influences of hedgerow cutting frequency on hawthorn (*Crataegus monogyna*) berry yields, *Agriculture, Ecosystems and Environment,* **93**, 437-439.

CROXTON, P. J. and SUMMERS, R. W. (2004). Timing of berry depletion rates of three common hedgerow shrubs, *Agriculture, Ecosystems and Environment,* **104**, 663-666.

CUMMINS, R., FRENCH, D., BUNCE, B., HOWARD, D. and BARR, C. J. (1992), *Diversity in British Hedgerows*, ITE.

DANDY, J. E. (1969). *Watsonian vice-counties of Great Britain*. The Ray Society, London.

DARBY, H. C. (1950). Domesday woodland. *The Economic History Review*, New series, **3**, (1), 21-43.

DAVIE, J. H., AKEROYD, J. R. and THOMPSON, D. H. (1998). Progressive plant invasion and colonization of an area adjacent to ancient woodland at Edford wood, Somerset, England, *Botanical Journal of the Linnean Society,* **128**, no. 1, 87-98.

DAVIES, C. E., MOSS, D. and HILL, M. O. (2004). EUNIS Habitat Classification Revised 2004. Paris, European Topic Centre on Nature Protection and Biodiversity.

DAVIES, Z. G., and PULLIN, A. S. (2007). Are hedgerows effective corridors between fragments of woodland habitat? An evidence-based approach. *Landscape Ecology*, **22**, 333–351.

DAWSON, T. P., BERRY, P. M., HARRISON, P. A. and PEARSON, R. G. (2004). Modelling long-distance seed dispersal across fragmented landscapes. *Landscape Ecology of Trees and Forests.* IALE (UK), 43-49.

DAY, S. P. (1993). Woodland origin and ancient woodland indicators': a case-study from Sidlings Copse, Oxfordshire, UK. *The Holocene*, **3**, 45-53.

de BLOIS, S., DOMON, G. and BOUCHARD, A. (2002). Factors affecting plant species distribution in hedgerows of southern Quebec. *Biological Conservation* **105,** 355–367.

DE FRENNE, P., BAETEN, L., GRAAE, B. J., BRUNET, J., WULF, M., ORCZEWSKA, A., KOLB, A., JANSEN, I., JAMONEAU, A., JACQUEMYN, H., HERMY, M., DIEKMANN, M., De SCHRIJVER, A., De SANCTIS M., DECOCQ, G., COUSINS, S. A. O., and VERHEYEN, K. (2001). Interregional variation in the floristic recovery of post-agricultural forests. *Journal of Ecology*, **99**, 600–609.

De KEERSMAEKER, L., MARTENS, L., VERHEYEN, K., HERMY, M., De SCHRIJVER, A. and LUST, N. (2004). Impact of soil fertility and insolation on diversity of herbaceous woodland species colonizing afforestations in Muizen forest (Belgium), *Forest Ecology and Management,* **188**, (1-3), 291-304.

DECKERS, B., HERMY, M. and MUYS, B. (2004). Factors affecting plant species composition of hedgerows: Relative importance and hierarchy, *Acta Oecologia,* **26**, 23-27.

DECKERS, B., VERHEYEN, K., HOWELL, R. and MUYS, B. (2004). Differential environmental response of plant functional types in hedgerow habitats, *Basic and Applied Ecology,* **5**, 551-566.

DEFRA. (2007). *Hedgerow Survey Handbook,* Second edition, Defra, London.

De SANCTIS, M., ALFO, M., ATTORRE, F., FRANCESCONI, F. and BRUNO, F. (2010). Effects of habitat configuration and quality on species richness and distribution in fragmented forest patches near Rome. *Journal of Vegetation Science*, **21**, 55–65.

DIAZ, A. and KITE, G. C. (2002). A comparison of the pollination ecology of *Arum maculatum* and *Arum italicum* in England, *Watsonia*, **24**, 171-181.

DIEKMANN, M. (2003). Species indicator values as an important tool in applied plant ecology – a review. *Basic Applied Ecology*, **4**, 493–506.

DINES, T. D. (2002). A new hybrid horsetail, *Equisetum arvense* x *E. telmateia* (*E.* x *robertsii*) in Britain. *Watsonia*, **24**, 145-157

DONALD, P. F., HAYCOCK, P and FULLER, R. J. (1997). Winter bird communities in forest plantations in western England and their response to vegetation growth stage and grazing. *Bird Study*, **44**, 206-219.

DONOHUE, K., FOSTER, D. R. and MOZKIN, G. (2000). Effects of the Past and the Present on Species Distribution: Land-Use History and Demography of Wintergreen. *Journal of Ecology*, **88**, (2), 303-316.

DONY, J. G. and DENHOLM, I. (1985). Some comparative methods of assessing the conservation value of ecologically similar sites. *Journal of Applied Ecology*, **22**, 229-238.

DOUGALL, T. A. G. and DODD, J. C. (1997). A study of species richness and diversity in seed banks and its use for the environmental mitigation of a proposed holiday village development in a coniferized woodland in south east England. *Biodiversity and Conservation*, **6**, 1413-1428.

DOVER, J. W., BUTT, K. and PEARSON, D. (1998). Nodes and linear sections of field boundaries: plant species richness, soil nutrients and boundary width. In *Key concepts in Landscape Ecology*. IALE(UK), Preston.

DOVER, J. and SPARKS, T. (2000). A review of the ecology of butterflies in British hedgerows. *Journal of Environmental Management*, **60**, 51-63.

DOWDESWELL, W. H. and HUMBY, S. R. (1953). A photovoltaic light meter for school use. School science review, **35** 64-70.

DOWDESWELL, W. H. (1987). *Hedgerows and verges*. Allen and Unwin, London.

DUMORTIER, M., BUTAYE, J., JACQUEMYN, H., van CAMP, >, LUST, N. and HERMY, M. (2002). Predicting vascular plant species richness of fragmented forests in agricultural landscapes in central Belgium. *Forest ecology & management*, **158**, 85-102.

DUPRE, C. and EHRLEN, J. (2002). Habitat Configuration, Species Traits and Plant Distributions. *Journal of ecology*, **90**, No. 5, 796-805.

DUSHYANTHA, K., WIJESINGHE and HUTCHINGS, M. J (1997). The effects of spatial scale of environmental heterogeneity on the growth of a clonal plant: an experimental study with *Glechoma hederacea*. *Journal of Ecology*, **85**, 17-28.

DUNCAN, D. H., DORROUGH, J., WHITE, M. and MOXHAM, C. (2008). Blowing in the wind? Nutrient enrichment of remnant woodlands in an agricultural landscape. *Landscape Ecology*, **23**, 107–119.

DZWONKO, Z. and LOSTER, S. (1988). Species richness of small woodlands on the western Carpathian foothills, *Vegetatio,* **76**, (1-2), 15-27.

DZWONKO, Z. and LOSTER, S. (1989). Distribution of vascular plant species in small woodlands on the western Carpathian foothills, *Oikos,* **56**, (1), 77-86.

DZWONKO, Z. and LOSTER, S. (1992). Species richness and seed dispersal to secondary woods in southern Poland, *Journal of Biogeography,* **19**, (2), 195-204.

DZWONKO, Z. and GAWRONSKI, S. (1994). The role of woodland fragments, soil types, and dominant species in secondary succession on the western Carpathian foothills, *Vegetatio,* **111**, no. 2, 149-160.

DZWONKO, Z. and LOSTER, S. (1997). Effects of dominant trees and anthropogenic disturbances on species richness and floristic composition of secondary communities in southern Poland. *Journal of Applied Ecology,* **34**, (4), 861-870.

DZWONKO, Z. (2001) Assessment of light and soil conditions in ancient and recent woodlands by Ellenberg indicator values, *Journal of Applied Ecology,* **38**, (5), 942-951.

DZWONKO, Z. (2001) effect of proximity to ancient deciduous woodland on restoration of the field layer vegetation in a pine plantation, *Ecography,* **24**, no. 2, 198-204.

EDWARDS, K. (2005). Crisis? Recovery? Management? Landscapes of contrast in Viking age Iceland and the Faroe Islands. Crisis and continuum in the shaping of landscapes, *Landscape Archaeology and Ecology,* **5**, 19-20.

EDWARDS, K. (2006). Hedgerows and the historic landscape, *British Wildlife,* **17**, (4), 260-269.

EDWARDS, M. E. (1986). Disturbance histories of four Snowdonian woodlands and their relation to atlantic bryophyte distributions. *Biological Conservation*, **37**, 301-320.

ELLENBERG H (1950).1Ackerunkraut-Gemeinschaften als Bodenzeiger. Landwirtschaftlicher Zentraldienst (Stuttgart- Hohenheim), Merkblatt 1950: 1–14.

ELLENBERG H (1974). Zeigerwerte der Gefäßpflanzen Mitteleuropas. Scripta Geobotanica **9**: 1–97.

ELLENBERG H (1992a). Zeigerwerte der Gefäßpflanzen (ohne ubus). 2nd ed. Scripta Geobotanica **18**: 9–166.

ELLENBERG H, WEBER HE, DÜll R, WIRTH V, WERNER W, PAULISSEN D (1992b). Zeigerwerte von Pflanzen in Mitteleuropa. 2nd ed. Scripta Geobotanica **18**: 1–248.

ELLIS, C. J. and COPPINS, B. J. (2007). Changing climate and historic-woodland structure interact to control species diversity of the 'Lobarion' epiphyte community in Scotland. *Journal of Vegetation Science*, **18**, 725-734.

ELKINGTON, J. (1978). A treeless Britain? *New Scientist* 13 April 1978, 72-74.

EMMERICH, J. M. and VOHS, P. A. (1982). Comparative use of four woodlands habitats by birds. *Journal of Wildlife Management*, **46**, No. 1, 43-49

ENDELS, P., JACQUEMYN, H., BRYS, R. and HERMY, M. (2002). Changes in pin-thrum ratios in populations of the heterostyle *Primula vulgaris* Huds. Does imbalance affect population persistence? *Flora*, **197**, 326-331.

ENGLISH NATURE (1997). Malvern Hills and Teme Valley Natural Area. Natural Area NA57. Ledbury, English Nature.

ERICSSON, T. S., BERGLUND, H. and OSTLUND, L. (2005). History and forest biodiversity of woodland key habitats in south boreal Sweden. *Biological Conservation*, **122**, 289-303.

ERNOULT, A. and ALARD, D. (2011). Species richness of hedgerow habitats in changing agricultural landscapes: are α and γ diversity shaped by the same factors. *Landscape Ecology*, **26**, 683–696.

EVANS, G. C. (1956). Area Survey Method of Investigating the Distribution of Light Intensity in Woodlands, with Particular Reference to Sunflecks. *Journal of Ecology*, **44**, (2), 391-428.

EVANS, G. C. and COOMBE, D. E. (1959). Hemispherical and Woodland Canopy Photography and the Light Climate. *Journal of Ecology*, **47**, (1), 103-113.

EVANS, M. N. and BARKHAM, J. P. (1992). Coppicing and natural disturbance in temperate woodlands – a review. In Buckley, G. P. (ed.) *Ecology and Management of Coppice Woodlands*. London, Chapman and Hall. 79-98.

EVELYN, J (1908). *Sylva or a Discource of Forest Trees*. 4th edition. London: Arthur Doubleday and Company Limited.

FACELLI, J. M. (1994). Multiple Indirect Effects of Plant Litter Affect the Establishment of Woody Seedlings in Old Fields. *Ecology*, **75**, (6), 1727-1735.

FAHY, O. and GORMALLY, M. (1998). A comparison of plant and carabid beetle communities in an Irish oak woodland with a nearby conifer plantation and clearfelled site. *Forest Ecology and Management*, **110**, 263-273.

FALKENGREN-GRERUP, U. and SCHÖTTELNDREIER, M. (2004). Vascular plants as indicators of nitrogen enrichment in soils. *Plant Ecology*, **172**, 51–62.

FARLEY, R. A. and FITTER, A. H. (1999) Temporal and spatial variation in soil resources in a deciduous woodland, *Journal of Ecology,* **87**, 688-696.

FARLEY, R. A. and FITTER, A. H. (1999). The response of seven co-occurring woodland herbaceous perennials to localized nutrient-rich patches, *Journal of Applied Ecology,* **87**, 849-859.

FENTON, N. J. and FREGO, K. A. (2005). Bryophyte (moss and liverwort) conservation under remnant canopy in managed forests. *Biological Conservation* **122,** 417–430.

FITZHERBERT (1534). *The book of Husbandry.* SKEAT, W. M. reprinted in 1882 by the English dialect society, London.

FITZGIBBON, C. D. (1997). Small mammals in farm woodlands: the effects of habitat, isolation and surrounding land-use patterns. *Journal of Applied Ecology*, **34**, 530-539.

FLEURY, A. M. and BROWN, R. D. (1997). A framework for the design of wildlife conservation corridors With specific application to southwestern Ontario. *Landscape & Urban Planning*, **37**, 163-186.

FLINN, K. M., GOUHLER, T. C., LECHOWICZ, M. J. and WATERWAY, M. (2010). The role of dispersal in shaping plant community composition of wetlands within an old-growth forest. *Journal of Ecology*, **98**, 1292-1299.

FOODY, G. M., ATKINSON, P. M., GETHING, P. W., RAVENHILL, N. A. and KELLY, C. K. (2005). Identification of Specific Tree Species in Ancient Semi-Natural Woodland from Digital Aerial Sensor Imagery. *Ecological Applications*, **15**, (4), 1233-1244

FORMAN, R. T. T. and BAUDRY, J. (1984). Hedgerows and hedgerow networks in landscape ecology, *Environmental Management,* **8**, (6), 495-510.

FOWKES, D. (1992). Excavation of whitecoal pits at hag wood, Barlow, 1986-1987, *Derbyshire Miscellany,* **13**, (1), 2-9.

FOX, H. S. A. (1975). The Chronology of Enclosure and Economic Development in Medieval Devon. *The economic history review,* New series, **28**, (2), 181-202

FREGO, K. A. (2007). Bryophytes as potential indicators of forest integrity. *Forest Ecology and Management* **242** 65–75.

FRELICH, L. E. and LORIMER, C. G. (1985). Current and predicted long-term effects of deer browsing in hemlock forests in Michigan, USA. *Biological Conservation*, **34**, 99-120.

FRIDAY, J. B. and FOWNES. J. H. (2001). A simulation model for hedgerow light interception and growth. *Agricultural and Forest Meteorology* **108**, 29–43.

FRITZ, O., GUSTAFSSON, L. and LARSON, K. (2008). Does forest continuity matter in conservation? – A study of epiphytic lichens and bryophytes in beech forests of southern Sweden. *Biological Conservation*, **141**, 655-668.

FROST, H. M (2005). *The butterflies of Yorkshire*. Butterfly Conservation Yorkshire, Wareham

FRY, G. and SARLOEV-HERLIN, I. (1997) The ecological and amenity functions of woodland edges in the agricultural landscape; a basis for design and management, *Landscape Urban Planning,* **37**, (1-2), 45-55.

FRUDD, I. (undated 1987?). The relationship between the hedgerow flora and the age, structure and management of hedges on a North Yorkshire farm. University of Durham environmental management certificate project report. University of Durham.

FULLER, R. J., CHAMBERLAIN, D. E., BURTON, N. H. K. and GOUGH, S. J. (2001). Distributions of birds in lowland agricultural landscapes of England and Wales: How distinctive are bird communities of hedgerow and woodland? *Agricultural ecosystems and environment*, **84**, 79-92.

FYFE, R. M., BRUCK, J., JOHNSTON, R., LEWIS, H., ROLAND, T. P. and WICKSTEAD, H. (2008). Historical context and chronology of Bronze Age land enclosure on Dartmoor, UK. Journal of Archaeological Science **35** 2250-2261.

GAME, M. and PETERKEN, G. F. (1984). Nature reserve selection strategies in the woodlands of central Lincolnshire, *Biological Conservation,* **29**, 157-181.

GARBUTT, R. A. and SPARKS, T. H. (2002). Changes in the botanical diversity of a species rich ancient hedgerow between two surveys (1971-1998), *Biological Conservation,* **106**, (2), 273-278.

GEARY, B. R., CHARMAN, D. J. and KENT, M. (2000). Palaeoecological evidence for the prehistoric settlement of Bodmin Moor, Cornwall, south-west England. Part 1: the status of woodland and early human impacts. *Journal of Archaeological Science*, **27,** 423-438.

GILBERT, O. L. (1984). Some effects of disturbance on the lichen flora of oceanic hazel woodland, *Lichenologist,* **16**, (1), 21-30.

GILL, D. S. and MARKS, P. L. (1991). Tree and Shrub Seedling Colonization of Old Fields in Central New York. *Ecological Monographs*, **61**, (2), 183-205.

GKARAVELI, A., GOOD, J. E. G. and WILLIAMS, J. H. (2004). Determining priority areas for native woodland expansion and restoration in Snowdonia national park, Wales, *Biological Conservation,* **115**, (3), 395-402.

GLAVES, P., ROTHERHAM, I. D., WRIGHT, B., HANDLEY, C., and BIRBECK, J. (2009a). A survey of the coverage , use and application of ancient woodland indicator lists in the UK. Unpublished report to the Woodland Trust. Hallam Environmental Consultants and Sheffield Hallam University. Sheffield.

GLAVES, P, ROTHERHAM, I. D., WRIGHT, B., HANDLEY, C. and BIRBECK, J (2009b). *Field surveys for ancient woodlands: issues and approaches*. Report to the Woodland Trust. Hallam Environmental Consultant and Sheffield Hallam University.

GODEFROID, S., PHARTYAL, S. S. and KOEDAM, N. (2006). Depth distribution and composition of seed banks under different tree layers in a managed temperate forest ecosystem. *Acta Oecologica*, **29**, 283–292

GODEFROID, S. and KOEDAM, N. (2003). RESEARCH PAPER: How important are large vs. small forest remnants for the conservation of the woodland flora in an urban context?. *Global Ecology and Biogeography,* **12**, (4), 287-298.

GOLDBERG, E., KIRBY, K., HALL, J. and LATHAM J. (2007). The ancient woodland concept as a practical conservation tool in Great Britain. *Journal for Nature Conservation*, **15**, 109-119.

GOLDSMITH, F. B., HARRISON, C. M. and MORTON, A. J. (1986). *Description and analysis of vegetation*. In Moore, P. D. and Chapman, S. B. (eds) 1986). *Methods in Plant Ecology*. Blackwell scientific publishing. London?, 437-524.

GOOD, J. E. G., CRAIGIE, I., LAST, F. T. and MUNRO, R. C. (1978). Conservation of amenity trees in the Lothian region of Scotland. *Biological Conservation*, **13**, 247-272.

GOODFELLOW, S. and PETERKEN, G. F. (1981). A method for survey and assessment of woodland for nature conservation using maps and species lists: The example of Norfolk woodlands. *Biological Conservation,* **21**, 177-195.

GORHAM, E. (1953). The Development of the Humus Layer in Some Woodlands of the English Lake District. *Journal of Ecology*, **41**, (1), 123-152.

GRABHAM, P. W. and PACKHAM, J. R. (1983). A comparative study of bluebell *Hyacinthoides non-scripta* (L.) Chouard in two different woodland situations in the west midlands, England, *Biological Conservation,* **26**, 105-126.

GRAINGER, A. (1981). The shape of woods to come. *New Scientist* 2 April 1981, 26-28.

GREEN, P. and PETERKEN, G. F. (1997). Variation in the amount of dead wood in the woodlands of the Wye valley, UK in relation to the intensity of management. *Forest Ecology and Management*, **98**, 229-238.

GRIME, J. P. and BLYTHE, G. M. (1969). An Investigation of the Relationships between Snails and Vegetation at the Winnats Pass. *Journal of Ecology*, **57**, (1), 45-66.

GRIME, J. P. and HUNT, R. (1975). Relative Growth-Rate: Its Range and Adaptive Significance in a Local Flora. *Journal of Ecology*, **63**, (2), 393-422.

GRIME, J. P., MASON, G., CURTIS, A. V., RODMAN, J. and BAND, S. R. (1981). A Comparative Study of Germination Characteristics in a Local Flora. *Journal of Ecology*, **69**, (3), 1017-1059.

GRIME, J. P. and MOWFORTH, M. A. (1982). Variation in genome size – an ecological interpretation. *Nature*, **299**, 151-153.

GRIME, J. P., HODGSON, J. G. and HUNT, R. (2007). *Comparative plant ecology: A functional approach to common British species,* (2nd ed), Castelpoint press, Colvend .

GRUBB, P. and WHITMORE, T. C. (1967). A Comparison of Montane and Lowland Forest in Ecuador: III. The Light Reaching the Ground Vegetation. *Journal of Ecology*, **55**, (1), 33-57.

GULLIVER, R. (1995). Woodland history and plant indicator species in north-east Yorkshire, England, In BUTLIN, R. and ROBERTS, N. (eds) *Ecological Relations in Historic Time*. Blackwell, Oxford, 169-189.

GULLIVER, R. L. (2011). Prelude to management: an introduction to 'Ecological Site Classification' and related techniques using Ellenberg indicator values. *Aspects of Applied Biology*, **108**, 239-245.

GUNTHER, J. and ASSMAN, T. (2004). Fluctuations of carabid populations inhabiting an ancient woodland (Coleoptera, Carabidae). *Pedobiologia,* **48**, 159-164.

GURNEY, M., PRESTON, C. D., BARRETT, J. and BRIGGS, D. (2007). Hybridisation between oxlip *Primula elatior* (L.) Hill and primrose *Primula vulgaris* Hudson, and the identification of their variable hybrid *P.* x *digenea* A. Kerner. *Watsonia*, **26**, 239-251.

GUSTAFSSON, L., De JONG, J. and NOREN, M. (1999). Evaluation of Swedish woodland key habitats using red-listed bryophytes and lichens, *Biodiversity and Conservation,* **8**, (8), 1101-1114.

GUSTAFSSON, L. and HALLINGBAECK, T. (1988). Bryophyte flora and vegetation of managed and virgin coniferous forests in south-west Sweden, *Biological Conservation,* **44**, (4), 283-300.

GUSTAFSSON, L., FISKESJOE, A., HALLINGBAECK, T., INGELOEG, T. and PETTERSSON, B. (1992) Semi-natural deciduous broadleaved woods in southern Sweden - habitat factors of importance to some bryophyte species, *Biological Conservation,* **59**, No. 2-3, 175-181.

GUSTAFSSON, L. (2000). Red-listed species as indicators: vascular plants in woodland key habitats and surrounding production forests in Sweden. *Biological Conservation*, **92**, 35-43.

HADFIELD, M. (1976). Trees and Their Periods: Some Notes on Arboricultural Planting in the British Isles. *Garden History*, **4**, (2), 23-29.

HALL, J. E., KIRBY, K. J. and WHITBREAD, A. M. (2001). *National vegetation classification – field guide to woodland*. Joint Nature Conservation Committee, Peterborough. Reprinted 2004.

HANDLEY, C and ROTHERHAM, I. D.(eds) (2013). *Shadow woods and ghosts: a survey guide*. Wildtrack publishing, Sheffield.

HANSEN, K., VESTERDAL, L., BASTRUP-BIRK, A. and BILLE-HANSEN, J. (2007). Are Indicators for Critical Load Exceedance Related to Forest Condition? *Water Air Soil Pollution*, **183**, 293–308.

HANSSON, L. (1997). Environmental determinants of plant and bird diversity in ancient oak-hazel woodland in Sweden. *Forestry and Ecology Management*, **91**, 137-143.

HANSSON, L. (2000a). Edge structures and edge effects on plants and birds in ancient oak-hazel woodlands. *Landscape and Urban Planning*, **46**, 203-207.

HANSSON, L. (2000b). Interactions by vascular plants and birds between isolated ancient oak-hazel woods and a matrix of conifer plantations, *Biological Conservation,* **95**, (2), 191-196.

HANSSON, L. (2001). Traditional management of forests: plant and bird community responses to alternative restoration of oak–hazel woodland in Sweden. *Biodiversity and Conservation*, **10**, 1865–1873.

HARMER, R., PETERKEN, G., KERR, G. and HOULTON, P. (2001). Vegetation changes during 100 years of development of two secondary woodlands on abandoned arable land, *Biological Conservation,* **101**, (3), 291-304.

HARRIS, G. P. (1972). The Ecology of Corticolous Lichens: III. A Simulation Model of Productivity as a Function of Light Intensity and Water Availability. *Journal of Ecology*, **60**, (1), 19-40.

HART, C.R., (1993). The Ancient Woodland of Ecclesall Woods, Sheffield. In: Beswick, P., Rotherham, I. D. (Eds.), Proceedings of the National Conference on Ancient Woodlands: their archaeology and ecology - a coincidence of interest, Sheffield 1992. *Landsc. Archaeol. Ecol.*, **1,** 49–66.

HARVEY, N. (1976). *Fields, hedges and ditches*. Shire publications, Ayelsbury.

HAZEL, P. and GUSTAFSSON, L. (1999). Retention of trees at final harvest - valuation of a conservation technique using epiphytic bryophyte and lichen transplants, *Biological Conservation,* **90**, (2), 133-142.

HEY, D. (2003). Woodland transport: the evidence for Derbyshire and the West Riding of Yorkshire. Working and walking in the footsteps of ghosts conference proceeding May 2003, 4-9.

HELLIWELL, D. R. (1978). Survey and evaluation of wildlife on farmland in Britain: an indicator species approach. *Biological Conservation*, **13** (1) 63-73.

HERMY, M., HONNAY, O., FIRBANK, L., grashof-Bokdam, C. and LAWESSON, J. E. (1999). An ecological comparison between ancient and other forest plant species of Europe, and the implications for forest conservation. *Biological conservation*, **91**, 9-22.

HERSPERGER, A. M. and FORMAN, R. T. T. (2003). Adjacency arrangement effects on plant diversity and composition in woodland patches. *Oikos*, **101**, 279–290.

HESTER, A. J., GIMINGHAM, C. H. and MILES, J. (1991). Succession from Heather Moorland to Birch Woodland. III. Seed Availability, Germination and Early Growth. *Journal of Ecology*, **79**, (2), 329-344.

HEYLEN, O., HERMY, M. and SCHREVENS. E. (2005). Determinants of cryptogamic epiphyte diversity in a river valley (Flanders). *Biological conservation*, **126**, 371-382.

HIETALA-KOIVU, R., JÄRVENPÄÄ, T. and HELENIUS, J. (2004). Value of semi-natural areas as biodiversity indicators in agricultural landscapes. *Agriculture, Ecosystems and Environment*, **101**, 9–19.

HILL, A. (2003). Plant species as indicators of ancient woodland in the Malvern Hills and Teme Valley natural area, Unpublished PhD thesis. University of Coventry.

HILL, M.O. (1979). *TWINSPAN – A FORTRAN program for arranging multivariate data in an ordered two way table by classification of individuals & attributes*. Cornell University, New York.

HILL, M. O. (1980). The changing flora of aging plantations of sitka spruce and other conifers. Proceedings of the weed control in forestry conference 1980, 34-53.

HILL, M. O., BUNCE, R. G. H. and SHAW, M. W. (1975). Indicator Species Analysis, A Divisive Polythetic Method of Classification, and its Application to a Survey of Native Pinewoods in Scotland. *Journal of Ecology*, **63**, No. 2, 597-613

HILL, M. O., PRESTON, C. D., BOSANQUET, S. D. S. and ROY, D. B (2007). *Bryoatt: attributes of British and Irish mosses, liverworts and hornworts*. Abbots Ripton, Centre for Ecology and Hydrology.

HILL, M. O., PRESTON, C. D. and ROY, D. B. (2004). *Plantatt: Attributes of British and Irish plants: Status, size, life history, geography and habitats,* 1st ed, Centre for ecology and hydrology, Huntingdon.

HINSLEY, S. A. and BELLAMY, P. E. (2000). The influence of hedge structure, management and landscape context on the value of hedgerows to birds: A review, *Journal of Environmental Management,* **60**, 33-49. P

HISCOCK, K. (1990). Marine Nature Conservation Review: methods. Joint Nature Conservation Committee, Peterborough, Nature Conservancy Council, CSD Report, No. 1072. (Marine Nature Conservation Review Report, No. MNCR/OR/5.).

HODGSON, J. G. (1986a). Commonness and rarity in plants with special reference to the Sheffield flora part I: The identity, distribution and habitat characteristics of the common and rare species, *Biological Conservation,* **36**, (3), 199-252.

HODGSON, J. G. (1986b). Commonness and rarity in plants with special reference to the Sheffield flora part II: The relative importance of climate, soils and land use, *Biological Conservation,* **36**, (3), 253-274.

HODGSON, J. G. (1986c). Commonness and rarity in plants with special reference to the Sheffield flora part III: Taxonomic and evolutionary aspects, *Biological Conservation,* **36**, (3), 275-296.

HODGSON, J. G. (1986d). Commonness and rarity in plants with special reference to the Sheffield flora part IV: A European context with particular reference to endemism, *Biological Conservation,* **36**, (3), 297-314.

HOELSCHER, L. (1963). Improvements in Fencing and Drainage in Mid-19th century England. *Agricultural History*, **37**, (2), 75-79.

HOLDEREGGER, R., STEHLIK, I. and SCHNELLER, J. J. (1998). Estimation of the relative importance of sexual and vegetative reproduction in the clonal woodland herb *Anemone nemorosa*. *Oecologia*, **117**, 105-107

HOLMES, D. S. (2005). Sexual reproduction in populations of *Adoxa moschatellina* L. *Watsonia*, **25**, 265-273.

HMSO (1997). The Hedgerows Regulations 1997, Statutory Instrument no 1160. HMSO, London.

HMSO (2012). National Planning Policy Framework. Department for Communities and Local Government, London.

HONNAY, O. ,HERMY, M. and COPPIN, P. (1999). Effects of area, age and diversity off forest patches in Belgium on plant species richness, and implications for conservation and reforestation. *Biological Conservation*, **87**, 73-84

HONNAY, O., BOSSUYT, B., VERHEYEN, K., BUTAYE, J., JACQUEMYN, H. and HERMY, M. (2002). Ecological perspectives for the restoration of plant communities in European temperate forests, *Biodiversity and Conservation,* **11**, (2), 213-242.

HONNAY, O., VERHEYEN, K., BUTAYE, J., JACQUEMYN, H., BOSSUYT, B. and HERMY, M. (2002). Possible effects of habitat fragmentation and climate change on the range of forest plant species, *Ecology Letters,* **5**, (4), 525-530.

HONNAY, O., JACQUEMYN, H., BOSSUYT, B. and HERMY, M. (2005). Forest fragmentation effects on patch occupancy and population viability of herbaceous plant species. *New Phytologist*, **166**, 723–736

HOOPER, M. D. and HOLGATE, M. W. (eds) (1968). Hedge and hedgerow trees. Proceedings of a symposium No 4 held on 25-26 November 1968 at monks wood Experimental Station, Abbots Ripton, Huntingdon.

HOOPER, M. D. (1971). Hedges and local history. In Standing conference for local history. *Hedges and Local History.* Bedford square press, London.

HORNBY, R. J. and ROSE, F. (1986). The use of plants in evaluation of ancient woodlands for nature conservation in southern England. Internal report. Nature Conservancy Council.

HOSKINS, W. G. (1971). Historical sources for hedge dating. In Standing conference for local history. *Hedges and Local History.* Bedford square press, London.

HOWARD, C. (communicated 1832). East Riding of Yorkshire - Farming at Scoreby on the Estate of Ottiwell Wood Esq. Chapter 8 page 5. In Society for the diffusion of useful knowledge (1840). *British husbandry exhibiting the farming practices in various parts of the United Kingdom*. Volume 3. Society for the diffusion of useful knowledge, London

HOWES, C. A. (2003). Hedging our bets: an introduction to hedgerows surveys in the Doncaster region, Unpublished.

HUDSON, R. (undated). *Take a closer look at Bentham Boundaries*. Hudson History, Settle.

HULL, S. K. (1991). A study undertaken in southern Britain to investigate the late-flushing of hedgerow Ash in spring 1987. *Forestry*, **64**, (2), 189-197.

HUMPHREY, J. W., DAVEY, S., PEACE, A. J., FERRIS, R. and HARDING, R., (2002). Lichens and bryophyte communities of planted and semi-natural forests in Britain: the influence of site type, stand structure and deadwood. *Biological Conservation*, **107**, 165–180.

HUTCHINGS, M. J. and BARKHAM, J. P. (1976). An Investigation of Shoot Interactions in *Mercurialis Perennis* L., A Rhizomatous Perennial Herb. *Journal of Ecology*, **64**, (2), 723-743.

HUTCHINGS, M. J. and PRICE, E. A. C. (1999). Biological flora of the British isles: *Glechoma hederacea* L. (*nepeta glechoma* benth., *N. hederacea* (L.) trev.), *Journal of Ecology,* **87**, 347-364.

HUTCHINSON, T. C. (1967). Comparative Studies of the Ability of Species to Withstand Prolonged Periods of Darkness. *Journal of Ecology*, **55**, (2), 291-299.

JACQUEMYN, H., BRYS, R., HOONAY, O. and HERMY, M. (2008). Effects of coppicing on demographic structure, fruit and seed set in *Orchis mascula*. *Basic and Applied Ecology*, **9**, 392-400.

JACQUEMYN, H., BUTAYE, J. and HERMY, M. (2001). Forest plant species richness in small, fragmented mixed deciduous forest patches: the role of area, time and dispersal limitation. *Journal of Biogeography*, **28**, 801–812.

JACKSON, G. and SHELDON, J. (1949). The vegetation of magnesian limestone cliffs at Markham Grips near Sheffield. *Journal of Ecology*, **37**, (1), 38-50.

JAMES, P. (1982). *Lichens and air pollution*. London, British museum (Natural History).

JANSSON, N., BERGMAN, K-O. JONSELL, Mats. and MILBERG, P. (2009). An indicator system for identification of sites of high conservation value for saproxylic oak (Quercus sp.) beetles in southern Sweden. *Journal of Insect Conservation*, **13**, 399–412.

JESCKE, J. and KIEHL, K. (2008). Effects of a dense moss layer on germination and establishment of vascular plants in newly created calcareous grasslands. *Flora*, **203**, 557-566.

JOINT NATURE CONSERVANCY COUNCIL (1990). *Handbook for phase 1 habitat survey – A technique for environmental audit.* Nature Conservancy Council, Peterborough.

JOINT NATURE CONSERVANCY COUNCIL (2004) *Common standards monitoring guidance for woodland habitats,* JNCC, Peterborough.

JONES, J. (undated). Hedgerows. *A world of trees*, **19**, 22-23

JONES, M. (1986) Coppice woodland management in the eighteenth century: An example from county Wicklow, *Journal of the Society of Irish Foresters,* **43**, (1), 5-30.

JONES, M. (1984). Woodland origins in a south Yorkshire parish, *The local historian,* **16**, (2), 73-82.

JONES, M. (2009). *Sheffield's woodland heritage* (fourth edition). Sheffield, Wildtrack publishing.

JONES, M. (2012). *Gapping, raddling and snagging*. Sheffield, Wildtrack publishing.

JONSSON, B. G. and JONSELL, M. (1999). Exploring potential biodiversity indicators in boreal forests, *Biodiversity and Conservation,* **8**, 1417-1433.

JONSSON, M. T., and JONSSON, B. G. (2007). Assessing coarse woody debris in Swedish woodland key habitats: Implications for conservation and management. *Forest Ecology and Management*, **242**, 363–373.

JUKES, M. R., PEACE, A. J. and FERRIS, R. (2001). Carabid beetle communities associated with coniferous plantations in Britain: the influence of site, ground vegetation and stand structure. *Forest Ecology and Management*, **148**, 271-286.

JURIADO, I., LIIRA, J., CSENCSICS, D., WIDMER, I., ADOLF, C., KOHV, K. and SCHEIDEGGER, C. (2011). Dispersal ecology of the endangered woodland lichen Lobaria pulmonaria in managed hemiboreal forest landscape. *Biodiversity Conservation*, **20**, 1803–1819.

KANTELHARDT, J., OSINSKI, E and HEISSENHUBER, A. (2003). Is there a reliable correlation between hedgerow density and agricultural site conditions? *Agricultural Ecosystems and Environment*, **98**, 517-527.

KELLY, D. L. (1981). The native forest vegetation of Killarney, south-west Ireland: an ecological account. *Journal of Ecology*, **69**, 437-472.

KENNEDY, C. E. J. and Southwood, T. R. E. (1984). The number of species of insect associated with British trees: a re-analysis. *Journal of Animal Ecology*, **53**, 455-478.

KENNEDY, F. and PITMAN, R. (2004) Factors affecting the nitrogen status of soils and ground flora in beech woodlands, *Forest Ecology and Management,* **198**, No. 1-3, 1-14.

KENWARD, H. (2006). The visibility of past trees and woodland: testing the value of insect remains. *Journal of Archaeological Science*, **XX**, 1-13.

KENT, M. and COKER, P. (1992). *Vegetation description and analysis - a practical approach*. John Wiley & sons. Chichester.

KERRIDGE, E. (1951). Ridge and Furrow and Agrarian History. *The Economic History Review*, **4**, No. 1, 14-36.

KINNERLEY PARISH COUNCIL (2007). *Design statement and landscape character assessment - The parish of Kinnerley*. Kinnerley parish council, Kinnerley.

KIRBY, K. J., PYATT, D. G. and RODWELL, J. (2012). Characterization of the woodland flora and woodland communities in Britain using Ellenberg Values and Functional Analysis. In Working and Walking in the Footsteps of Ghosts: volume 1, the wooded landscape', edited by I D Rotherham, M Jones, C Handley, Wildtrack Publishing, Sheffield, 66-86.

KIRBY, K. J. (1984), A comparison of two methods for classifying British broadleaved woodland, *Field Studies,* **6**, 103-116.

KIRBY. K. J., PETERKEN, G. F., SPENCER, J. W. and WALKER, G. J. (1984). Inventories of ancient semi-natural woodland. NCC report No. 6. NCC, Shrewsbury.

KIRBY, K. J., BINES, T., BURN, A., MACINTOSH, J., PITKIN, P. and SMITH, I. (1986). Seasonal and observer differences in vascular plant records from British woodlands, *Journal of Ecology,* **74**, 123-131.

KIRBY, K. J., THOMAS, R. C., KEY, R. S., McLEAN, I. F. G. and HODGETTS, N. (1995). Pasture-woodland and its conservation in Britain, *Biological Journal of the Linnean Society [BIOL.J.LINN.SOC.],* **A**, no. Supplement A.

KIRBY, K. J. (1988). *A woodland survey handbook*, NCC, Peterborough.

KIRBY, K. J., REID, C. M., THOMAS, R. C. and GOLDSMITH, F. B. (1998). Preliminary estimates of fallen dead wood and standing dead trees in managed and unmanaged forests in Britain. *Journal of Applied Ecology*, **35**, 148-155.

KIRBY, K. J. and WOODELL, S. R. J. (1998). The distribution and growth of bramble (*Rubus fruticosus)* in British semi-natural woodlands and the implications for nature conservation, *Journal of Practical Ecology and Conservation,* **1**, (2), 31-41.

KIRBY, K. J. (1999). The conservation of woodland within agricultural landscapes [Homepage of English Nature], [Online]. Available: www.nmw.ac.uk/ite/econet/kirby.html.

KIRBY, K. J. and THOMAS, R. C. (2000). Changes in the ground flora in Wytham Woods, southern England from 1974 to 1991 – implications for nature conservation. *Journal of Vegetation Science*, **11**, 871-880.

KIRBY K (2008) Woodland indicators – some experiences from Natural England, Proceedings of a Woodland Indicator Workshop Held on 14 May 2008, Sheffield

KNIGHT, G. H. (1964) Some factors affecting the distribution of *Endymion non-scriptus* (L.) Garcke in Warwickshire woods. *Journal of Ecology*, **52**, (2), 405-421.

KOHN, D. D., HULMEA, P E., HOLLINGSWORTH, P. M. and BUTLER, A. (2009). Are native bluebells (*Hyacinthoides non-scripta*) at risk from alien congenerics? Evidence from distributions and co-occurrence in Scotland. *Biological Conservation*, **142**, 61–74.

KREYER, D. and ZERBE, S. (2006). Short-Lived Tree Species and Their Role as Indicators for Plant Diversity in the Restoration of Natural Forests. *Restoration Ecology*, **14**, (1), 137–147.

KULL, T. (1958). Biological flora of the British Isles – *Cypripedium calceolus* L. *Journal of Ecology*, **87**, 913-924.

KUUSELA, K. (1994). *Forest resources in Europe 1950-1990*. European forest institute, Cambridge

LACK, D. and VENABLES, L. S. V. (1939). The Habitat Distribution of British Woodland Birds. *Journal of Animal Ecology*, **8**, (1), 39-71

LEUSCHNER, C. (2002). Air humidity as an ecological factor for woodland herbs: Leaf water status, nutrient uptake, leaf anatomy, and productivity in eight species grown at low and high vpd levels, *Flora,* **197**, 262-274.

LEACH, W. (1925). Two Relict Upland Oak Woods in Cumberland. *Journal of Ecology*, **13**, (2), 289-300.

LEVEY, D. J., BOLKER, B. M., TEWKSBURY, J. J., SARGENT, S. and HADDAD, N. M. (2005). Effects of landscape corridors on seed dispersal by birds. *Science (Washington),* **309**, (5731), 146-148.

LE VIOL, I., JULLIARD, R., KERBIRIOU, C., DE REDON, L., CARNINO, N., MACHON, N. and PORCHER, E. (2008). Plant and spider communities benefit differently from the presence of planted hedgerows in highway verges. *Biological Conservation*, **141**, 1581–1590.

LEWIS-STEMPEL, J. (2012). *Foraging - the essential guide to free wild food*. Right Way (Constable & Robinson), London.

LISEWSKI, V. and ELLIS, C. J. (2011). Lichen epiphyte abundance controlled by the nested effect of woodland composition along macroclimatic gradients. *Fungal Ecology*, **4**, 241-249.

LITTLEMORE, J. and BARKER, S. (2001). The ecological response of forest ground flora and soils to experimental trampling in British urban woodlands. *Urban Ecosystems*, **5**, 257–276.

LOWENTHAL, D. and PRINCE, H. C. (1964). The English Landscape. *Geographical review*, **54**, (3), 309-346.

LUNDEGARDH, H. (1922). Zur Physiologie und Okologie der Kohlensaureassimilation. *Biol. Zbl*., **42**, 337-58.

MABEY, R. (1996). *Flora Britannica*. Sinclair-Stevenson, London.

MADGWICK, H. A. I. and BRUMFIELD, G. L. (1969). The Use of Hemispherical Photographs to Assess Light Climate in the Forest. *Journal of ecology*, **57**, (2), 537-542.

MARCHETTI, M (ed) (2004). Monitoring and Indicators of Forest Biodiversity in Europe – From Ideas to Operational. *EFI Proceedings* No. 51. European Forest Institute, Joensuu, Finland.

MARINOVA, E. and THIEBAULT, S. (2008). Anthracological analysis from Kovacevo, southwest Bulgaria: woodland vegetation and its use during the earliest stages of the European Neolithic. *Vegetation History Archaeobotany*, **17**, 223–231.

MARON, M. and LILL, A. (2005). The influence of livestock grazing and weed invasion on habitat used by birds in grassy woodland remnants. *Biological Conservation*, **124**, 439-450.

MARSHALL. (1796). *The rural economy of Yorkshire*. London, G Nichol.

MATERN. A., DREES, C., HÄRDTLE, W., VON OHEIMB, G, and ASSMANN, T. (2011). Historical ecology meets conservation and evolutionary genetics: a secondary contact zone between *Carabus violaceus* (Coleoptera, Carabidae) populations inhabiting ancient and recent woodlands in north-western Germany. In: KOTZE, D. J., ASSMANN, T., NOORDIJK, J., TURIN, H. and VERMEULEN, R. (Eds) *Carabid*

Beetles as Bioindicators: Biogeographical, Ecological and Environmental Studies. *ZooKeys* **100**, 545–563.

MARTIN, M. H. (1968). Conditions Affecting the Distribution of *Mercurialis Perennis* L. in Certain Cambridgeshire Woodlands. *Journal of Ecology*, **56**, (3), 777-793.

MATLACK, G. R. (1994). Plant species migration in a mixed-history forest landscape in eastern North America. *Ecology*, **75**, (5), 1491-1502.

MATLACK, G. R. (1994). Vegetation dynamics of forest edge - trends in space and successional time. *Journal of Ecology,* **82**, 113-123.

MAUDSLEY, M. J. (2000). A review of the ecology and conservation of hedgerow invertebrates in Britain. *Journal of Environmental Management,* **60**, 65-76.

MAUREMOOTO, J. R., WRATT, S.D., WORNER, S. P and FRY, G. L. A. (1995). Permeability of hedgerows to predatory carabid beetles. *Agriculture Ecosystems and& Environment*. 52, 141-148.

MacARTHUR, R.H. and WILSON, E.O. (1967). *The theory of island biogeography*. Princeton University Press, Princeton.

McCOLLIN, D. (2000). Editorial: Hedgerows policy and protection – changing paradigms and the conservation ethic. *Journal of Environmental Management,* **60**, (1), 3-6.

McCOLLIN, D., JACKSON, J., BUNCE, R., BARR, C. J. and STUART, R. (2000). Hedgerows as habitat for woodland plants, *Journal of Environmental Management,* **60**, (1), 77-90.

McEVOY, P. M., FLEXEN, M. and McADAM J. H. (2006). The effects of livestock grazing on ground flora in broadleaf woodlands in Northern Ireland. *Forest Ecology and Management*, **225**, 39–50.

MEAD, W. R. (1954). Ridge and Furrow in Buckinghamshire. *The Geographical Journal*, **120**, (1), 34-42.

MEIER, A. J., BRATTON, S. P. and DUFFY, D. C. (1995). Possible Ecological Mechanisms for Loss of Vernal-Herb Diversity in Logged Eastern Deciduous Forests. *Ecological Applications*, **5**, (4), 935-946.

MERRYWEATHER, J. and FITTER, A. H. (1998). The arbuscular mycorrhizal fungi of *Hyacinthoides non-scripta*. *New Phytologist,* **138**, 131-142.

MILES, J. and MILES, A. (1997). Plant indicators of long-established woodland: a preliminary test in NE Scotland. In Smout T.C. (ed) *Scottish Woodland Histo*ry. Scottish Cultural Press. Edinburgh.

MITCHELL, F. J. G. (1988). The Vegetational History of the Killarney Oakwoods, SW Ireland: Evidence from Fine Spatial Resolution Pollen Analysis. *Journal of Ecology*, **76**, (2), 415-436.

MITCHELL, F. J. G. and KIRBY, K. J. (1990). The impact of large herbivores on the conservation of semi-natural woods in the British uplands, *Forestry,* **63**, (4), 333-353.

MITCHELL, F. J. G. (2005). How open were European primeval forests? Hypothesis testing using palaeoecological data. *Journal of Ecology*, **93**, 168–177.

MOFFATT, C., MORTON, A. J. and McNEILL, S. (2008). Plantations in Milton Keynes, United Kingdom, Resulted in More Woodland-Like Insect Assemblages? *Restoration Ecology*, **16**, (1), 50–58.

MORECROFT, M. D., TAYLOR, M. E. and OLIVER, H. R. (1998). Air and soil microclimates of deciduous woodland compared to an open site. *Agricultural and Forest Meteorology*, **90**, 141-156.

MOUISSIE, A. M., LENGKEEK, W. and VAN DIGGELEN, R. (2005). Estimating adhesive seed-dispersal distances: Field experiments and correlated random walks, *Functional Ecology,* **19**, (3), 478-486.

MUIR, R. (1995). Hedgerow ecology and the landscape historian. *Naturalist*, **120**, 115-118.

MUIR, R. (1996). Hedgerow dating: A critique, *Naturalist,* **121**, 59-64.

MUIR, R. (1989). *Portraits of the past : The British landscape through the ages*. London, Michael Joseph.

MUIR, R. (1993). *Reading the landscape*. London Michael Joseph.

MUIR, R. (2000a). *The new reading the landscape*. Exeter, University of Exeter press.

MUIR, R. (2000b). Pollards in Nidderdale: A landscape history. *Rural History*, **11**, 95-111.

MUIR, R. (2001). *Landscape detective: discovering a countryside*. Macclesfield, Windgatherer.

MUIR, R. (2005). *Ancient Trees Living Landscapes*. Stroud Tempus Publishing Ltd..

MUIR, R. and MUIR, N. (1987). Hedgerows - their history and wildlife. London, Michael Joseph.

MULDER C., and DE ZWART, D. (2003). Assessing fungal species sensitivity to environmental gradients by the Ellenberg indicator values of above-ground vegetation. *Basic Applied Ecology*, **4**, 557–568.

MUKERJI, S. K. (1936). Contributions to the Autecology of *Mercurialis Perennis* L. *Journal of Ecology*, **24**, (1), 38-81.

MÜLLER, N., SCHNELLER, J. J. and HOLDEREGGER, R. (2000). Variation in breeding system among populations of the common woodland herb *Anemone nemorosa* (Ranunculeae). *Plant Systematics and Evolution*, **221**, 69-76.

NASH, A. (1982). The Medieval Fields of Strettington, West Sussex, and the Evolution of Land Division. *Geografiska Annaler*. Series B, *Human Geography*, **64**, (1), 41-49.

NATURAL ENGLAND (2013a). National Character Area 22 Pennine Dales Fringe. National Character Areas,

http://publications.naturalengland.org.uk/publication/5619375490990080?category=587130

Peterborough, Natural England (Accessed 15-03-2016).

NATURAL ENGLAND (2013b). National Character Area 30 Southern Magnesian Limestone. National Character Areas,

http://publications.naturalengland.org.uk/publication/5733629942562816. Peterborough, Natural England (Accessed 28-08-2015).

NATURAL ENGLAND (2013c). National Character Area 37 Yorkshire southern Pennine Fringe. National Character Areas,

http://publications.naturalengland.org.uk/publication/5459581769613312?category=587130

Peterborough, Natural England (Accessed 28-08-2015).

NATURAL ENGLAND (2014a). National Character Area 38 Nottinghamshire, Derbyshire and Yorkshire Coalfield. National Character Areas,

http://publications.naturalengland.org.uk/publication/4743624?category=587130

Peterborough, Natural England (accessed 28-08-2015).

NATURAL ENGLAND (2014b). National Character Area 102 Teme Valley. National Character Areas,

http://publications.naturalengland.org.uk/publication/4947777108836352?category=587130,

Peterborough, Natural England (accessed 28-08-2015).

NATURAL ENGLAND (2015a). National Character Area 103 Malvern Hills. National Character Areas,

http://publications.naturalengland.org.uk/publication/3039205?category=587130, Peterborough, Natural England (accessed 28-08-2015).

NATURAL ENGLAND (2015b). National Character Area 51 Dark Peak. National Character Areas,

http://publications.naturalengland.org.uk/publication/3684793?category=587130

Peterborough, Natural England (accessed 28-08-2015).

NATURE CONSERVANCY COUNCIL (1989). *Guidelines for selection of biological SSSIs.* Peterborough, NCC.

NESS, J. H. and MORIN, D. F. (2008). Forest edges and landscape history shape interactions between plants, seed-dispersing ants and seed predators. *Biological Conservation*, **141**, 838-847.

NEWTON, I., DALE, L. and ROTHERBY, P. (1997). Apparent lack of impact of sparrowhawks on the breeding densities of some woodland songbirds. *Bird Study*, **44**, 129-135.

NORDÉN, B., GÖTMARK, F., TÖNNBERG, M. and RYBERG, M. (2004). Dead wood in semi-natural temperate broadleaved woodland: contribution of course and fine dead wood, attached dead wood and stumps. *Forest Ecology and Management*, **194**, 235-248.

NOZEDAR, A. (2012). *The hedgerow handbook - recipes, remedies and rituals*. London, Square peg.

ODOR, P., HEILMANN-CLAUSEN, J., CHRISTENSEN, M., AUDE, E., VAN DORT, K. W., PILTAVER, A., SILLER, I., VEERCAMP, M. T., WALLEYN, R., STANDOVAR, T., VAN HEES, A. F. M., KOSEC, J., MATOCEC, N. KRAIGHER, H. and GREBENC, T. (2006). Diversity of dead wood inhabiting fungi and bryophytes in semi-natural beech forests in Europe. *Biological Conservation*, **131**, 58-71.

OLIVEIRA, J. R. P. M., PORTO, K. C. and SILVA, M. P. P. (2011). Richness preservation in a fragmented landscape: a study of epiphytic bryophytes in an Atlantic forest remnant in Northeast Brazil. *Journal of Bryology,* **33** (2), 279-290.

OOSTHUZEN, S. (2006). Priceless landscapes, *British Archaeology,* May June, 26-31.

ORCZEWSKA, A. (2009). The impact of former agriculture on habitat conditions and distribution patterns of ancient woodland plant species in recent black alder (*Alnus* *glutinosa* (L.) Gaertn.) woods in south-western Poland. *Forest Ecology & Management*, **258**, 794–803.

ORESZCZYN, S. (2000). A systems approach to the research of people's relationship with English hedgerows. *Landscape and Urban Planning,* **50**, 107-117.

ORESZCZYN, S. and LANE, A. (2000). The meaning of hedgerows in the English landscape: Different stakeholder perspectives and the implications for future hedge management. *Journal of Environmental Management,* **60**, 111-118.

ORLOWSKI, G. (2008). Roadside hedgerows and trees as factors increasing road mortality of birds: Implications for management of roadside vegetation in rural landscapes. *Landscape and Urban Planning*, **86**, 153–161.

ORWELL, G. (1969). *Animal farm*. London, Penguin books.

OSBORNE, P. (1984). Bird numbers and habitat characteristics in farmland hedgerows. *Journal of Applied Ecology*, **21**, 63-82.

OUIN, A. and BUREL, F. (2002). Influence of herbaceous elements on butterfly diversity in hedgerow agricultural landscapes. *Agriculture Ecosystems and Environment*, **93**, 45-53.

OSEI, W. Y. (1993). Woodfuel and deforestation – answer for a sustainable environment. *Journal of Environmental Management*, **37**, (1) 51-62.

OXFORD ENGLISH DICTIONARY (2014). Oxford, Oxford University Press.

PACKHAM, J. R. and WILLIS, A. J. (1976). Aspects of the ecological amplitude of two woodland herbs, *Oxalis acetosella* L. and *Galeobdolon luteum* Huds. *Journal of Ecology,* **64**, 485-510.

PACKHAM, J. R. and WILLIS, A. J. (1982). The influence of shading and of soil type on the growth of *Galeobdolon luteum*. *Journal of Ecology*, **70**, (2), 491-512.

PACKHAM, J. R., HARDING, D. J. L., HILTON, G. M. and STUTTARD, R. A. (1992). *Functional ecology of woodlands and forests*. London, Chapman and Hall.

PAGE, C. N. (1988). Two hybrids of *Equisetum sylvaticum* L. new to the British flora. *Watsonia*, **17**, 273-277.

PAGE, C. N. (1997). *The ferns of Britain and Ireland*. (2nd ed). Cambridge, Cambridge University Press.

PAGE, C. N. (2007). A new far northern hybrid horsetail from Scotland: *Equisetum* x *mchaffieae* L. C. N. Page (*Equisetum fluviatile* L. x *E. pratense* Ehrh.). *Watsonia*, **26**, 339-345.

PAQUET, J-Y., VANDEVYVRE, X., DALAHAYE, L. and RONDEAUX, J. (2006). Bird assemblages in a mixed woodland-farmland landscape: The conservation value of silviculture-dependent open areas in plantation forest. *Forest Ecology and Management*, **227**, 59-70.

PARLANE, S., SUMMERS, R. W., COWIE, N. R. and VAN GARDINGEN, P. R. (2006). Management proposals for bilberry in Scots pine woodland. *Forest Ecology and Management*, **222**, 272-278

PATINO, J., WERNER, O. and GONZALEZ-MANCEBO, J. M. (2010). The impact of forest disturbance on the genetic diversity and population structure of a late-successional moss. *Journal of Bryology*, **32**, 220-231.

PEARMAN, D. A. and CORNER, R. W. M. (2004). *Altitudinal limits of British and Irish vascular plants*. Botanical Society of the British Isles. London.

PEARMAN, D. A. (2007). ‘Far from any house’ – assessing the status of doubtful native species in the flora of the British Isles. *Watsonia*, **26**, 271-190.

PEARSALL, W. H. (1938). The Soil Complex in Relation to Plant Communities: II. Characteristic Woodland Soils. *Journal of Ecology*, **26**, (1), 194-209.

PEARSALL, W. H. (1950). *Mountains and Moorland*. Collins, New Naturalist. London.

PEARSALL, W. H. and PENNINGTON, W. (1973). *The Lake District*. Collins, New Naturalist. London.

PERRIN, P. M., MITCHELL, F. J. G. and KELLY, D. L. (2011). Long-term deer exclusion in yew-wood and oakwood habitats in southwest Ireland: Changes in ground flora and species diversity. *Forest Ecology and Management*, **262**, 2328–2337.

PERRING, F. H. and WALTERS, S. M (1976). *Atlas of the British Flora*. Third edition (1982) Botanical Society of the British Isles. EP Publishing, Wakefield.

PETERKEN, G. F. (1966). Mortality of holly (*Ilex aquifolium*) seedlings in relation to natural regeneration in the New Forest. *Journal of Ecology*, **54**, (2), 259-269.

PETERKEN, G. F. (1974). A method for assessing woodland flora for conservation using indicator species, *Biological Conservation,* **6**, (4), 239-245.

PETERKEN, G. F. (1993). *Woodland Conservation and Management*. 2nd edition. Chapman and Hall, London.

PETERKEN, G. F. (1976). Long-Term Changes in the Woodlands of Rockingham Forest and Other Areas. *Journal of Ecology*, **64**, (1), 123-146.

PETERKEN, G. F. (1977). Habitat conservation priorities in British and European woodlands, *Biological Conservation,* **11**, 223-236.

PETERKEN, G. F. (1997). Woodland origin as a factor in the distribution of native trees and shrubs in central Lincolnshire, *The Lincolnshire Naturalist,* **24**, (2), 162-179.

PETERKEN, G. (2000). Identifying ancient woodland using vascular plant indicators. *British Wildlife,* **11** (3), 153-158.

PETERKEN, G. F. and FRANCIS, J. L. (1999). Open spaces as habitats for vascular ground flora species in the woods of central Lincolnshire, UK. *Biological Conservation,* **91**, (1), 55-72.

PETERKEN, G. F. and GAME, M. (1981). Historical factors affecting the distribution of *Mercurialis perennis* in central Lincolnshire, *Journal of Ecology,* **69**, 781-796.

PETERKEN, G. F. and GAME, M. (1984). Historical factors affecting the number and distribution of vascular plant species in the woodlands of central Lincolnshire, *Journal of Ecology,* **72**, (1), 155-182.

PETERKEN, G. F. and JONES, E. W. (1987). Forty years of change in lady park wood: The old-growth stands, *Journal of Ecology,* **75**, (2), 477-512.

PETERKEN, G. F. and JONES, E. W. (1989). Forty years of change in lady park wood: The young-growth stands, *Journal of Ecology,* **77**, (2), 401-429.

PETERKEN, G. F. and LLOYD, P. S. (1967). Biological flora of the British Isles – *Ilex aquifolium* L. *Journal of Ecology*, **56**, 841-858.

PETERKEN, G. F. and MOUNTFORD, E. P. (1998). Long-term change in an unmanaged population of wych elm subjected to Dutch elm disease. *Journal of Ecology,* **86**, 205-218.

PETERKEN, G. F. and TUBBS, C. R. (1965). Woodland regeneration in the New Forest, Hampshire, since 1650, *Journal of Applied Ecology,* **2,** 159-170.

PETERSEN, P. M. (1994). Flora, vegetation, and soil in broadleaved ancient and planted woodland, and scrub on Rosnaes, Denmark. *Nordic Journal of Botany,* **14**, (6), 693-709.

PETERSON, J. W. M (2002). Published in French as Peterson, J. W. M. 2002. Le réseau centurié "Kent A". In Atlas Historique des cadastres d'Europe. 2. edited by Clavel-Lévêque, M. and Orejas, A. Dossier 8. Office for Official Publications of the European Community, Luxembourg. Available in English from https://archive.uea.ac.uk/~jwmp/KentAEnglish.pdf

PETIT, S. and BUREL, F. (1998). Effects of landscape dynamics on the metapopulation of a ground beetle (Coleoptera, Carabidae) in a hedgerow network. *Agricultural Ecosystems and Environment*, **69**, 243-252.

PETIT, S., GRIFFITHS, L., SMART, S. S., SMITH, G. M., STUART, R. C. and WRIGHT, S. M. (2004). Effects of area and isolation of woodland patches on herbaceous plant species richness across Great Britain. *Landscape Ecology,* **19**, (5), 463-471.

PICOZZI, N., CATT, D. C. and MOSS, R. (1992). Evaluation of capercaillie habitat. *Journal of Applied Ecology,* **29** 751-762.

PIGOTT, C. D. (1983?) The vegetation of Upper Teesdale in the North Pennines. *Journal of Ecology*, **44**, 545-586.

PIGOTT, C. D. and TAYLOR, K. (1964). The Distribution of Some Woodland Herbs in Relation to the Supply of Nitrogen and Phosphorus in the Soil. *The Journal of Animal Ecology*, **33**, British Ecological Society Jubilee Symposium, 175-185.

PIGOTT, C. D. (1969). The status of *Tilia cordata* and *T. platyphyllos* on the Derbyshire limestone. *Journal of Ecology*, **57** 491-504.

PIGOTT, C. D. (1975). Natural regeneration of *Tilia cordata* in relation to forest-structure in the forest of Bialowieza, Poland. *Philosophical Transactions of the Royal Society of London*, **270**, (904), 151-179.

PIGOTT, C. D. (1983). Regeneration of oak-birch woodland following the exclusion of sheep. *Journal of Ecology*, **71**, 629-646.

PIGOTT, D. (1988). First conserve the woodlands. *The National Trust Magazine, autumn 1998*, 17-19.

PIGOTT, C.D. (1993) The History and Ecology of Ancient Woodlands. *Landscape Archaeology and Ecology*, **1**, 1-11.

PIGOTT, C. D. (1990). The influence of evergreen coniferous nurse-crop on the field layer in two woodland communities. *Journal of Applied Ecology*, **27**, 448-459.

PITCAIRN, C. E. R., LEITH, I. D., SHEPPARD, L. J., SUTTON, M. A., FOWLER, D., MUNRO, R. C., TANG, S. ad WALTON, D. (1998). The relationship between nitrogen deposition, species composition and foliar concentrations in woodland flora in the vicinity of livestock farm. *Environmental Pollution*, **102**, 41-48.

POLLARD. E. (1973). Hedges – VII woodland relic hedges in Huntingdon and Peterborough. *Journal of Ecology*, **61**, (2), 343-352.

POLLARD, E., HOOPER, M. D. and MOORE, N. W. (1974). *Hedges*. London, Collins.

POLLARD, E., WOIWOD, I. P., GREATOREX-DAVIES, J. N., YATES, T. J. and WELCH, R. C. (1998). The spread of coarse grasses and changes in the number of Lepidoptera in a woodland nature reserve. *Biological Conservation*, **84**, 17-24.

POPESCU, C. (2008). *Wild food, garden food - gather and cook through the year*. Upavon, Cavalier paperback.

POPESCU, C. (2011). *Fruits of the hedgerow and unusual garden fruits - gather them, cook them, eat them*. Upavon, Cavalier paperback.

POOLE, A., GORMALLY, M. and SHEEHY SKEFFINGTON, M. (2003). The flora and carabid beetle fauna of a mature and regenerating semi-natural oak woodland in south-east Ireland. *Forest and Ecology Management*, **177**, 207-220.

PRATT, R. M., PUTMAN, R. J., EKINS, J. R. and EDWARDS, P. J. (1986). Use of habitat by free-ranging cattle and ponies in the new forest, southern England. *Journal of Applied Ecology*, **23**, 538-557.

PRESTON, C. D. (2007). Which vascular plants are found at the northern or southern edges of their European range in the British Isles? *Watsonia*, **26**, 253-269.

PRESTON, C. D., PEARMAN, D. A. and DINES, T. D. (Eds) (2002). *New atlas of the British and Irish flora*. Oxford, Oxford University Press.

PRICE, L. W. (1993). Hedges and Shelterbelts on the Canterbury Plains, New Zealand: Transformation of an Antipodean Landscape. *Annals of the Association of American Geographers*, **83**, (1), 119-140.

PUTMAN, R.J. (1994) Effects of grazing and browsing by mammals on woodlands. *British Wildlife,* **5**, (4), 205-213.

PUTMAN, R. J., EDWARDS, P. J., MANN, J. C. E., HOW, R. C. and HILL, S. D. (1989). Vegetation and faunal changes in an area of heavily grazed woodland following relief of grazing. *Biological Conservation,* **47**, 13-32.

PUTMAN, R.J., PRATT, R. M., EKINS, J. R. and EDWARDS, P. J. (1987). Food and feeding behaviour of cattle and ponies in the New Forest, Hampshire. *Journal of Applied Ecology*, **24**, 369-380.

QUINE, C. P. and WATTS, K. (2009). Successful de-fragmentation of woodland by planting in an agricultural landscape? An assessment based on landscape indicators. *Journal of Environmental Management*, **90** 251-259.

RACKHAM, O. (1993). *Trees and woodland in the British landscape*. First revised paperback edition., London, J. M. Dent.

RACKHAM, O. (1986). *The history of the countryside*. Reprint, London, J. M. Dent & sons Ltd, 1990.

RACKHAM, O. (1994). *The illustrated history of the countryside*. London, Weidenfeld and Nicholson.

RACKHAM, O. (1997). Where is Beech native? *Tree news*, 8-14.

RACKHAM, O. (2003). *Ancient Woodland – its history, vegetation and uses in England*. Colvend, Castlepoint Press.

RACKHAM, O. (2006). *Woodlands*. Collins, London, New Naturalist series.

RADFORD, J. Q., BENNETT, A. F. and CHEERS, G. J (2005). Landscape-level thresholds of habitat cover for woodland-dependent birds. *Biological Conservation*, **124**, 317-337.

RANIUS, T. and JONSSON, M. (2007). Theoretical expectations for thresholds in the relationship between number of wood-living species and amount of coarse woody debris: A study case in spruce forests. *Journal for Nature Conservation*, **15**, 120-130.

REED, T. M. (1983). The role of species-area relationships in reserve choice: A British example, *Biological Conservation,* **25**, 263-271.

REYNOLDS, L. A. and McLETCHIE, D. N. (2011). Short distances between extreme microhabitats do not result in ecotypes in *Syntrichia caninervis*. *Journal of Bryology*, **33**, 148-153.

RICH, T. C. G., CLEMENTS, D. K., LEWIS, J. and MOORE, L. (2000). A comparison of four methods used to survey hedgerows: The Cardiff hedgerow survey 1998. *Journal of Environmental Management,* **60**, 91-100.

ROBERTS, B. K. (2001). Woodlands in England: An Appreciation of Hilda Annie Wilcox. *The Geographical Journal*, **167**, (2), 163-173.

RODWELL, J. S. (Ed) (1991). *British plant communities - Vol. 1 - Woodlands and scrub*. CUP. Cambridge.

ROLSTAD, J., GJERDE, I., GUNDERSSEN, V. S. and SAETERSDAL, M. (2002). Use of indicator species to assess forest continuity: a critique. *Conservation Biology,* **16**, (1), 253-257.

ROSE, F. (1976). Lichenological indicators of age and environmental continuity in woodlands. In: *Lichenology*: Progress and problems (Systematics Special Volume 8) (Eds. D. H. Brown, D. L. Hawksworth and R. H. Bailey) 297-307. Academic Press, London.

ROSE, F. (1999). Indicators of ancient woodland: The use of vascular plants in evaluating ancient woods for nature conservation, *British Wildlife*, **10** (4), 241-251.

ROSE, F. (2006). *The wildflower key,* Warne, London.

ROTHERHAM, I. D. (1996). The sustainable management of urban-fringe woodland for amenity and conservation objectives, *Aspects of Applied Biology,* **44**, 33-38.

ROTHERHAM, I. D. (undated). Introducing the orchard and the fruit tree. *A world of trees*, **19**, 18-20.

ROTHERHAM, I. D. (undated). Mixed management and multi-function use of traditional orchards. *A World of Trees*, **20**, 18-20.

ROTHERHAM, I. D.(ed) (2005). Crisis and continuum in the shaping of landscapes. In Rotherham, I. D. and Handley, C. 2003, Working and walking in the footsteps of ghosts. *Landscape Archaeology and Ecology,* **5**.

ROTHERHAM, I. D. (2007a). Cultural severance – causes and consequences. In Cultural landscapes – Changing landscapes. Delegate handbook, the International Association for Vegetation Science: 50th annual symposium, Swansea University, 43-44, 22-27 July 2007, 1-16.

ROTHERHAM, I. D. (2007b). The ghosts in the woodlands past. In Cultural landscapes – Changing landscapes. Delegate handbook, the International Association for

Vegetation Science: 50th annual symposium, Swansea University, 22-27 July 2007, 1-16.

ROTHERHAM, I. D. (2007c). The implications of perception and cultural knowledge loss for the management of wooded landscapes: a UK case-study. *Forest Ecology and Management*, **249**, 100–115.

ROTHERHAM, I. D. (2011). A landscape history approach to the assessment of ancient woodlands. In WALLACE, E. B. *Woodlands, Ecology Management and conservation*. 161-184. Hauppauge, USA, Nova Science publishers.

ROTHERHAM, I. D. (2013a). Searching for Shadows and ghosts. In ROTHERHAM, I. D., HANDLEY, C., AGNOLETTI, M. and SAMOJLIK, T. (eds) (2013). *Trees beyond the wood*. Revised edition. 1-16. Wildtrack publishing, Sheffield.

ROTHERHAM, I. D. (2013b). *Ancient woodland*. Oxford, Shire publications.

ROTHERHAM, I. D., ARDRON, P. A. and PERCY, C. (2001). The archaeology and ecology of managed ancient woodlands: understanding the coincidence of interest. European Society for Environmental History conference 1st international conference 5-8 September 2001, University of St Andrew's, Scotland. Environmental history: problems and potential.

ROTHERHAM, I. D. and AVISON, C. (1997). Sustainable woodlands for people and nature – the relevance of landscape history to a vision of forest management. Woodland in the landscape: past, present and future perspectives conference, York – October 1997, 1-14.

ROTHERHAM, I. D. and DORAM, G. P. (1992). A preliminary study of the vegetation of Ecclesall Woods in relation to former management. *Sorby Record*, **29**, 60-70.

ROTHERHAM, I. D., GLAVES, P. and WRIGHT, B. (undated). Evidencing ancient woodlands. *A World of Trees*, **20**, 42-44.

ROTHERHAM, I. D. and JONES, M. (1997). The natural history of Ecclesall woods, *The Peak Park Journal of Natural History and Archaeology,* No. 1.

ROTHERHAM, I. D. and JONES, M. (2000). The impact of economic, social and political factors on the ecology of small English Woodlands: a case study of the Ancient Woods in South Yorkshire, England. In: Agnoletti, M., Anderson, S. (Eds.), Forest History: International Studies in Socio-economic and Forest ecosystem change. CAB International, Wallingford, Oxford, 397–410.

ROTHERHAM, I. D. and WRIGHT, B. (2008). Searching for ghosts - how a forester reads the woodland landscape. *A World of Trees*, **16**, 40-41.

ROTHERHAM, I. D., WRIGHT, B and SMITH, L. (2008). Ancient woodland botanical indicators - a survey guide. in Rotherham, I. D., Jones, M. and Smith, L, Handley, C (Eds). *The woodland heritage manual - a guide to investigating wooded landscapes*. 142-146. Wildtrack publishing. Sheffield.

ROXBURGH, J. R. and KELLY, D. (1995). Uses and limitations of hemisherical photography for estimating forest light environments, *New Zealand Journal of Ecology,* **19**, (2), 213-217.

ROY. V, and DE BLOIS, S. (2006). Using functional traits to assess the role of hedgerow corridors as environmental filters for forest herbs. *Biological Conservation*, **130**, 592–603.

ROY, V and DE BLOIS, S. (2008). Evaluating hedgerow corridors for the conservation of native forest herb diversity. *Biological Conservation*, **130**, 298–307.

RUMSEY, F. J, JERMY, A. C. and SHEFFIELD, E. (1998) The independent gametophytic stage of Trichmanes speciosum Willd. (Hymenophyllaceae), the Killarney Fern and its distribution in the British Isles. *Watsonia* **22** 1-19.

RYAN, P. A., and BLACKFORD, J. J. (2010). Late Mesolithic environmental change at Black Heath, south Pennines, UK: a test of Mesolithic woodland management models using pollen, charcoal and non-pollen palynomorph data. *Vegetation History Archaeobotany*, **19**, 545–558.

RYNDOCK, J. A., STRATTON, G. E., BREWER, J. S. and HOLLAND, M. M. (2012). Differences in Spider Community Composition among Adjacent Sites during Initial Stages of Oak Woodland Restoration. *Restoration Ecology*, **20**, (1), 24–32.

SAGE, R. B., LODOLF, C. and ROBERTSON, P. A. (2005) The ground-flora of ancient semi-natural woodland in pheasant release pens in England, *Biological Conservation,* **122**, 243-252.

SAGE, R. B., WOODBURN, M. I. A., DRAYCOTT, R. A. H., HOODLESS, A. N., and CLARKE, S. (2009). The flora and structure of farmland hedges and hedgebanks near to pheasant release pens compared with other hedges. *Biological Conservation*, **142**, 1362–1369.

SALISBURY, E. J. (1916). The Emergence of the Aerial Organs in Woodland Plants. *Journal of Ecology*, **4**, (3/4), 121-128.

SALTER, B. R. (1998). Urban forestry: UK experience in practice. *Arboricultural Journal*, **22**, 11-23.

SANTOS, B. A., PERES, C. A., OLIVEIRA, M. A., GRILLO, A., ALVES-COSTA, C. P. and TABARELLI, M. (2008). Drastic erosion in functional attributes of tree assemblages in Atlantic forest fragments of northeastern Brazil. *Biological Conservation*, **141**, 249-260.

SARLÖV HERLIN, I. L. and FRY, G. L. A. (2000). Dispersal of woody plants in forest edges and hedgerows in a Southern Swedish agricultural area/ the role of site and landscape structure. *Landscape Ecology*, **15**, 229–242.

SCHAUMANN, F. and HEINKEN, T. (2002) Endozoochorus seed dispersal by martens (*Martes foina*, *M. martes)* in two woodland habitats, *Flora,* **197**, 370-378.

SCHMUCKI, R., DE BLOIS, S., BOUCHARD, A. and DOMON, G. (2002). Spatial and temporal dynamics of hedgerows in three agricultural landscapes of southern Quebec, Canada. *Environmental Management*, **30**, (5), 651–664.

SCHNITTLER, M. and GUNTER, K-F. (1999). Central European plants requiring priority conservation measures from national red lists and distribution maps. *Biodiversity and Conservation*, **8**, 891-925.

SCIAMA, D., AUGUSTO, L., DUPOUEY, J-L., GONZALEZ, M., and DOMINGUEZ C. M. (2009). Floristic and ecological differences between recent and ancient forests growing on non-acidic soils. *Forest Ecology and Management*, **258**, 600–608.

SCHOFIELD, J. E. and EDWARDS, K. J. (2011). Grazing impacts and woodland management in Eriksfjord: Betula, coprophilous fungi and the Norse settlement of Greenland. *Vegetation History Archaeobotany*, **20**, 181–197.

SCHMITZ, M. F., SANCHEZ, I. A. and DE ARANZABAL, I. (2007). Influence of management regimes of adjacent land uses on the woody plant richness of hedgerows in Spanish cultural landscapes. *Biological Conservation*, **135**, 542–554.

SCHMIDTLEIN, S. (2005). Imaging spectroscopy as a tool for mapping Ellenberg indicator values. *Journal of Applied Ecology*, **42**, 966–974.

SCHUSTER, B. and DIEKMANN, M. (2005). Species richness and environmental correlates in deciduous forests of Northwest Germany. *Forest Ecology and Management*, **206**, 197–205.

SHEFFIELD CITY COUNCIL (2012). Criteria for selection of woodland Local Wildlife Sites in the Sheffield Context. PDF document taken form web site accessed 11-04-2015 (https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCQQFjAA&url=https%3A%2F%2Fwww.sheffield.gov.uk%2Fdms%2Fscc%2Fmanagement%2Fcorporate-communications%2Fdocuments%2Fleisure-culture%2Fparks-gardens%2Fecology%2Flocal-wildlife-sites%2FCriteria-for-the-selection-of-Woodland-LWS%2FCriteria%2520for%2520the%2520selection%2520of%2520Woodland%2520LWS.pdf&ei=1fIoVYO8MYTzUISQgMAF&usg=AFQjCNEp_YkcrU_ONT6cxYAOe7I-BGP4dA&sig2=iiPNxHIEiB8GDbPrUdf4Hw&bvm=bv.90491159,d.d24). (Sheffield City Council. Sheffield

SILVA, M. P. P. and PORTO, K. C. (2010). Spatial structure of bryophyte communities along an edge-interior gradient in an Atlantic Forest remnant in northeast Brazil. *Journal of Bryology*, **32**, 101-112.

SHIRREFFS, D.A. (1985). Biological flora of the British Isles: *Anemone nemorosa* L. *Journal of Ecology,* **73**, 1005-1020.

SIMBERLOFF, D. (1998). Flagships, umbrellas, and keystones: is single-species management passe in the landscape era? *Biological Conservation*, **83**, 247-257.

SINGLETON, R., GARDESCU, S., MARKS, P. L. and GEBER, M. A. (2001). Forest Herb Colonization of Postagricultural Forests in Central New York State, USA. *Journal of Ecology*, **89**, (3), 325-338.

SIPPOLA, A-L., MONKKONEN, M. and RENVALL, P. (2005). Polypore diversity in the herb-rich woodland key habitats of Koli National Park in eastern Finland. *Biological Conservation*, **126**, 260-269.

SITZIA, T. (2006). Hedgerows as corridors for woodland plants: a test on the Po Plain, northern Italy. *Plant Ecology*, **188**, 235–252.

SKLENICKA, P., MOLNAROVA, K., BRABEC, E., KUMBLE, P., PITTNEROVA, B., PIXOVA, K. and SALEK, M., (2009). Remnants of medieval field patterns in the Czech Republic: Analysis of driving forces behind their disappearance with special attention to the role of hedgerows. *Agriculture, Ecosystems and Environment*, **129**, 465–473.

SMART, S. M., BUNCE. R. G. H., BLACK, H. J., RAY. N., BUNCE, F., KIRBY, K., WATSON, R. and SINGLETON, D. (2001). Measuring long-term ecological change in British woodlands (1997-2000). English Nature research report Number 461. English Nature, Peterborough.

SMART, S. M.; BUNCE, R. G. H. and STUART, R. C. (2001). An assessment of the potential of British hedges to act as refuges for Ancient Woodland Indicator plants. In: C. Barr and S. Petit (Eds.) *Hedgerows of the World*. IALE(UK), Preston. 137-146.

SMART, S. M. and ANDREW, S. W. (2004). Bias in Ellenberg indicator values – problems with detection of the effect of vegetation type. *Journal of Vegetation Science*, **15**, 843-846.

SMITH, K. W. (1997). Nest site selection of the Great Spotted Woodpecker *Dendrocopus major* in two oak woods in southern England and its implications for woodland management. *Biological Conservation*, **80**, 283-288.

SMITHERS, R. 2004, *Landscape ecology of trees and forests*, IALE UK, Grantham.

SMYLLIE, B. (2005). *Ecclesall Woods, Sheffield: A flora.* Friends of Ecclesall Woods, Sheffield.

SOEDERSTROEM, L., HALLINGBACK, T., GUSTAFSSON, L., CRONBERG, N. and HEDENAES, L. (1992). Bryophyte conservation for the future, *Biological Conservation,* **59**, (2-3), 265-270.

SPARKS, T. H., GREATOREX, J. N., MOUNTFORD, J. O., HALL, M. L. and MARRS, R. H. (1996). The effect of shade on the plant communities of rides in plantation woodland and implication for butterfly conservation. *Forest Ecology and Management,* **80**, 197-207.

SPARKS, T. H. and MARTIN, T. (1999). Yields of Hawthorn *Crataegus monogyna* berries under different hedgerow management. *Agriculture, Ecosystems and Environment*, **72**, 107-110.

SPENCER, J. (1990). Indications of antiquity: Some observations on the nature of plants associated with ancient woodland, *British Wildlife,* **2**, (2), 90-102.

SPILSBURY, L. and SPILSBURY, R. (2005). *Hedgerows*. Heinemann, Oxford.

SPRAY, M. (1968). Molluscs of the Sheffield region. *Sorby Record*, (1), 3-7.

SPRAY, M. (1981). Holly as fodder in England. *Agricultural History Review*, **29**, 99-108.

SPRAY, M. and SMITH, D. J. (1977). The rise and fall of holly in the Sheffield region. *Transcations of the Hunter Archaeological Society*, **10,** 239-251.

SQUIRES, A. and JEEVES, M. (1994). *Leicestershire and Rutland woodlands past and present,* Kairos press, Newtown Linford.

SROKA, K. and FINCH, O-D. (2006). Ground beetle diversity in ancient woodland remnants in north-western Germany (Coleoptera, Carabidae). *Journal of Insect Conservation*, **10**, 335–350.

STEHLIK, I. and HOLDEREGGER, R. (2000). Spatial genetic structure and clonal diversity of *Anemone nemorosa* in late successional deciduous woodland in central Europe, *Journal of Ecology,* **88**, 424-435.

STEINBRENNER, E. C. (1951). Effects of grazing on floristic composition and soil properties of farm woodlands in southern Wisconsin. *Journal of Forestry*, 906-910.

STACE, C. (1997). *The New Flora of the British Isles*. Second edition. Cambridge University Press, Cambridge.

STRACHAN, I. M. (2015). Manual of terrestrial EUNIS habitats in Scotland. *Scottish National Heritage Commissioned Report No 766*. Inverness, Scottish Natural Heritage.

STREETER, D. and RICHARDSON, R. (1982). *Discovering hedgerows,* BBC, London.

STOKES, D. L. (2014). Pictures of an Invasion: English Holly (*Ilex aquifolium*) in a Semi-natural Pacific Northwest Forest. *Northwest Science* **88** (2) 75-93

STUBBS, A. E. (1982) Hoverflies as primary woodland indicators with reference to Wharncliff Wood. *Sorby Record*, **20**, 62-67.

SUMMERS, R.W., MAVOR, R.A., MacLENNAN, A.M. and REBECCA, G. W. (1999). The structure of ancient native pinewoods and other woodlands in the Highlands of Scotland. *Forest Ecology and Management*, **119**, 231-245.

SWEENEY, O. F. McD., WILSON, M. W., IRWIN, S., KELLY, T. C., and O'HALLORAN, J. (2010). Are bird density, species richness and community structure similar between native woodlands and non-native plantations in an area with a generalist bird fauna? *Biodiversity Conservation*, **19**, 2329–2342.

SYKES, J. M., HORRILL, A. D. and MOUNTFORD, M. D. (1983) The use of visual cover estimates a quantitative estimators of some British woodland taxa, *Journal of Ecology,* **71**, 437-450.

TALLIS, J. H. and SWTISUR, V. R. (1983). Forest and moorland in the south Pennine uplands in the mid-flandrian period. *Journal* of *Ecology*, **71**, 585-600

TAYLOR, K. (1980). The growth of *Rubus vestitus* in a mixed deciduous woodland. *Journal of Ecology*, **68**, 51-62.

TAYLOR, K. (1997a). Biological flora of the British Isles - *Geum rivale* L., *Journal of Ecology,* **85**, 721-731.

TAYLOR, K. (1997b). Biological flora of the British Isles - *Geum urbanum* L., *Journal of Ecology,* **85**, 705-720.

TAYLOR, K. (1999). Biological flora of the British Isles - *Galium aparine*, *Journal of Ecology,* **87**, 713-730.

TERRELL-NIELD, C. (1990). Is it possible to age woodlands on the basis of their carabid beetle diversity? *The Entomologist*, **109**, (3), 136-145

THOMAES, A., DE KEERSMAEKER, A. L., DE SCHRIJVER, A., VANDEKERKHOVE, K., VERSCHELDE, P. and VERHEYEN, K. (2011). Can tree species choice influence recruitment of ancient forest species in post-agricultural forest? *Plant Ecology*, **212**, 573–584.

THOMAS, R. C., KIRBY, K. J. and REID, C. M. (1997). The conservation of a fragmented ecosystem within a cultural landscape - the case of ancient woodland in England, *Biological Conservation,* **82**, 243-252.

THOMPSON, K., BAKKER, J. P., BEKKER, R. M. and HODGSON, J. G. (1998). Ecological correlates of seed persistence in the soil in north-west European flora, *Journal of Ecology,* **86**, 163-169.

THOMPSON, K., GASTON, K. J. and BAND, S. R. (1999). Range size, dispersal and niche breadth in the herbaceous flora of central England, *Journal of Ecology,* **87**, 150-155.

THOMPSON, K. and GRIME, J. P. (1983). A comparative study of germination responses to diurnally-fluctuating temperatures, *Journal of Applied Ecology,* **20**, 141-156.

THOMPSON, K., HODGSON, J. G. and GASTON, K. J. (1998). Abundance-range size relationships in the herbaceous flora of central England, *Journal of Ecology,* **86**, 439-448.

THOMPSON, J. N. and WILLSON, M. F. (1978). Disturbance and the dispersal of fleshy fruits. *Science*. **200**, 1161-1163

THOMPSON, R. J, BUTCHER, W. G., WILLIAMS, P. and WARREN, M. (2003). The use of vascular plants as indicators of ancient woodland in Somerset: the development of a count-specific list. *Somerset Archaeology and Natural History* 147 (2003) 247-256.

THOMSON, F. J., MOLES, A. T., AULD, T. D., RAMP, D., REN, S. and KINGSFORD, R. T. (2010). Chasing the unknown: predicting seed dispersal mechanisms from plant traits. *Journal of Ecology*, **98**, 1310-1318.

TORRAS, O., GIL-TENA, A. and SAURA S. (2012). Changes in biodiversity indicators in managed and unmanaged forests in NE Spain. *Journal of Forest Research*, **17**, 19–29.

TSIOURIS, S. and MARSHALL, E. J. P. (1998). Observations on patterns of granular fertiliser deposition beside hedges and its likely effects on the botanical composition of field margins, *Annals of Applied Biology,* **132**, 115-127.

TUSSER**,** T. (1573). *Five hundred points of good husbandry.* The English Dialect Society, London

UNWIN, T. (1983). Townships and early fields in north Nottinghamshire. *Journal of Historical Geography*, **9**, (4), 341-346.

URSIC, K. A., KENKEL, N. C. and LARSON, D. W. (1997). Regeneration dynamics of cliff faces in abandoned limestone quarries. Journal of applied ecology, **34**, 289-303.

USHER**,** M. B. (ed) (1986). *Wildlife Conservation Evaluation*. Chapman & Hall, London.

VALLET, J., DANIEL, H., BEAUJOUAN, V. and ROZE, F. (2008). Plant species response to urbanization: comparison of isolated woodland patches in two cities of North-Western France. *Landscape Ecolo*gy, **23**, 1205–1217.

VALLET, J., BEAUJOUAN, V., PITHON J., ROZE, F. and DANIEL, H. (2010). The effects of urban or rural landscape context and distance from the edge on native woodland plant communities. *Biodiversity Conservation*, **19**, 3375–3392.

VALVERDE, T. and SILVERTOWN, J. (1997). A metapopulation model for *Primula vulgaris*, a temperate forest understorey herb. *Journal of Ecology*, **85**, 193-210.

VALVERDE, T. and SILVERTOWN, J. (1998) Variation in the demography of a woodland understory herb (*Primula vulgaris*) along the forest regeneration cycle: Projection matrix analysis, *Journal of Ecology,* **86**, 545-562.

VANHINSBURGH, D., GOUGH, S., FULLER, R. and BRIERLEY, E. D. R. (2002). Summer and winter bird communities in recently established farm woodlands in lowland England. *Agriculture, Ecosystems and Environment*, **92**, 123-136.

VAN CALSTER, H., ENDELS, P., ANTONIO, K., VERHEYEN, K and HERMY, M. (2008). Coppice management effects on experimentally established populations of three herbaceous layer woodland species. *Biological Conservation*, **141**, 2641-2652.

VAN DER HORST, D. and GIMONA, A. (2005). Where new farm woodlands support biodiversity action plans: A spatial multi-criteria analysis. *Biological Conservation,* **123**, (4), 421-432.

VAN UYTVANCK, J., MAES, D., VANDENHAUTE, D. and HOFFMANN, M. (2008). Restoration of woodpasture on former agricultural land: The importance of safe sites and time gaps before grazing for tree seedlings. *Biological Conservation*, **141**, 78-88.

VERA, F. (2000). *Grazing Ecology and Forest History*. CABI Publishing, Oxon, UK.

VERHEYEN, K., BOSSUYT, B., HERMY, M. and TACK, G. (1999). The land use history (1278-1990) of a mixed hardwood forest in western Belgium and its relationship with chemical soil characteristics, *Journal of Biogeography,* **26**, (5), 1115-1128.

VERHEYEN, K., and HERMY, M. (2001). The relative importance of dispersal limitation of vascular plants in secondary forest succession in Muizen forest, Belgium. *Journal of Ecology*, **89**, (5), 829-840.

VERHEYEN, K., HONNAY, O., MOTZKIN, G., HERMY, M. and FOSTER D. R. (2003). Response of Forest Plant Species to Land-Use Change: A Life-History Trait-Based Approach. *Journal of Ecology*, **91**, (4), 563-577.

VERHEYEN, K., GUNTENSPERGEN, G. R., BIESBROUCK, B. and HERMY, M. (2003). An Integrated Analysis of the Effects of past Land Use on Forest Herb Colonization at the Landscape Scale. *Journal of Ecology*, **91**, (5), 731-742.

VICKERS, A. D. and PALMER, S. C. (2000). The influence of canopy cover and other factors upon the regeneration of Scots Pine and its associated ground flora within Gelen Tanar National Nature Reserve. *Forestry*, **73**, (1), 37-49.

VICKERS, A. D. (2001), The evaluation of woodland status by means of botanical indicator species, Unpublished PhD thesis, Sheffield Hallam University.

VICKERS, A. D. and ROTHERHAM, I. D. (2000). The response of bluebell (*Hyacinthoides non-scripta*) to seasonal differences between years and woodland management, *Aspects of Applied Biology,* **58**, 351-356.

VICKERS, A. D., ROTHERHAM, I. D. and ROSE, J. C. (2000). Vegetation succession and colonisation rates at the forest edge under different environmental conditions, *Aspects of Applied Biology,* **58**, 1-8.

VIRTANEN, R. and OKSANEN, J. (2007). The effects of habitat connectivity on cryptogam richness in boulder metacommunity. *Biological Conservation*, **135**, 415-422.

VITASSE, Y., DELZON, S., DUFRENE, E., PONTAILLER, J-Y., LOUVET, J-M., KREMER, A. and MICHALET, R. (2009). Leaf phenology sensitivity to temperature in European trees: Do within-species populations exhibit similar responses? *Agricultural and Forest Meteorology*, **149**, 735–744.

WALKER, K. J. (2007). The last thirty five years: recent changes in the flora of the British Isles. *Watsonia*, **26**, 291-302.

WALKER, K. J. (2009). Water-borne dispersal of *Cardamine bulbifera* (L.) Crantz (Brassicaceae) in mid-west Yorkshire (V.C. 64). *Watsonia*, **27**, 250-253.

WARDHAUGH, A. A. (1997). Terrestrial molluscan fauna of Wilton Wood, north-east Yorkshire. *Naturalist*, **122**, 19-23.

WARDLE, P. (1959). The Regeneration of *Fraxinus excelsior* in Woods with a Field Layer of *Mercurialis perennis*. *Journal of Ecology*, **47** (2), 483-497.

WALKER, M. P., DOVER, J. W., SPARKS, T. H. and HINSLEY, S. A. (2006). Hedges and green lanes/ vegetation composition and structure. *Biodiversity and Conservation*, **15**, 2595–2610.

WATKINS, C. (1985). Sources for the assessment of British woodland change in the twentieth century. *Applied Geography*, **5**, 151-166.

WATT, A. S. (1925). On the Ecology of British Beechwoods with Special Reference to Their Regeneration: Part II, Sections II and III. The Development and Structure of Beech Communities on the Sussex Downs. *Journal of Ecology*, **13** (1), 27-73.

WATT, A. S. (1934). The Vegetation of the Chiltern Hills, with Special Reference to the Beechwoods and their Seral Relationships. *Journal of Ecology*, **22** (2), 445-507.

WATTS, K. and HANDLEY, P. (2010). Developing a functional connectivity indicator to detect change in fragmented landscapes. *Ecological Indicators*, **10**, 552–557.

WEBSTER, S. D. and KIRBY, K. J. (1988). A comparison of the structure and composition of an ancient and an adjacent recent wood in Essex. *The London Naturalist,* **67**, 33-45.

WEHLING, S. and DIEKMANN, M. (2008). Factors influencing the spatial distribution of forest plant species in hedgerows of North-western Germany. *Biodiversity Conservation*, **17**, 2799–2813.

WEHLING, S. and DIEKMANN, M. (2009). Hedgerows as an environment for forest plants: a comparative case study of five species. *Plant Ecology*, **204**, 11–20.

WEHLING, S. and DIEKMANN, M. (2010). Prediction of changes in the occurrence of forest herbs in hedgerow networks along a climate gradient in north-western Europe. *Biodiversity Conservation*, **19**, 2537–2552.

WESCHE, S., KIRBY, K. and GHAZOUL, J. (2006). Plant assemblages in British beech woodlands within and beyond native range: Implications of future climate change for their conservation. *Forest Ecology and Management*, **236**, 385–392.

WESTAWAY, S., GROSE, M. and McKERNAN, P. (2007). A revision of the Ancient Woodland Inventory for Mid Sussex District, West Sussex. Report for Mid Sussex District Council. Weald ancient woodland survey, Flimwel.

WHITNEY, G. G. and FOSTER, D. R. (1988). Overstorey Composition and Age as Determinants of the Understorey Flora of Woods of Central New England. *Journal of Ecology*, **76** (3), 867-876.

WICHMANN, M. C, ALEXANDER, M. J., SOONS, M. B., GALSWORTY, S., DUNNE, L., GOULD, R., FAIRFAX, C., NIGGERMAN, M., HAILS, R. S. and BULLOCK, M. (2009). Human-mediated dispersal of seeds over long distances. *Proceeding of the Royal Society B* **276** 523-532

WIJESINGHE, D. K. and HUTCHINGS, M. J. (1997). The effects of spatial scale of environmental heterogeneity on the growth of a clonal plant: An experimental study with *Glechoma hederacea*. *Journal of Ecology,* **85**, 17-28.

WILLIAMSON, T. (2006). Back to roots, *British Archaeology,* May/June 2006, 33-37.

WILLIS, J. C., MOUNTFORD, J. O. and SPARKS, T. H. (2005). The modification of ancient woodland ground flora at arable edges. *Biodiversity and Conservation*, **14**, 3215–3233.

WILLMOT, A. (1980). The woody species of hedges with special reference to age in Church Broughton parish, Derbyshire. *Journal of Ecology,* **68**, 269-285.

WILLMOT, A. (1985). Population dynamics of woodland *Dryopteris* in Britain. *Proceedings of the Royal Society Edinburgh*, **86B**, 307-313.

WILSON, B. R., MOFFAT, A. J. and NORTCLIFF, S. (1997). The nature of three ancient woodland soils in southern England, *Journal of Biogeography,* **24** (5), 633-646.

WINCHESTER, A. J. L. (2008). *Discovering parish boundaries* (2nd ed). Shire publications. Oxford.

WOLSELEY, P. A. and PRYOR, K. V. (1999). The potential of epiphytic twig communities on *Quercus petraea* in a welsh woodland site (Tycanol) for evaluating environmental changes. *Lichenologist*, **31** (1), 41-61.

WOODLAND TRUST (2003). Woodland biodiversity: expanding our horizons. Woodland trust, Grantham.

WOODLAND TRUST (2007). Back on the Map. An inventory of Ancient and Long-established woodland for Northern Ireland. www.backonthemap.org.

WRIGHT, B. (2011). Meeting report - Hack Fall Wood, Grewelthorpe, North Yorkshire - 13 November. In Paul, A. M. (ed) (2011). The British Pteridological Society Bulletin **7**, (4), 348-349.

WRIGHT, B. and ROTHERHAM, I. D. (2011a). Assessing woodland history and management using vascular plant indicators. *Aspects of Applied Biology*, **108**, 105-112.

WRIGHT, B. and ROTHERHAM, I. D. (2011b). Surveying and assessing vascular plants in hedgerows to inform historic interpretation, planning decisions and conservation strategies. *Aspects of Applied Biology*, **108**. 123-131.

WRIGHT, B., ROTHERHAM, I. D., DARWIN, N. A. and HALL, R. (2012a). A new approach to practical survey and interpretation of hedgerows: An introduction to the “Hedgerow Ecological Description Grading and Evaluation System” (HEDGES). *Arboricultural Journal*, **34** (3), 134-150.

WRIGHT, B., ROTHERHAM, I. D., DARWIN, N. M. A. and HALL, R. (2012b). HEDGES - Hedgerow Ecological Description Grading and Evaluation System - A new approach to surveying and interpreting hedgerows. In Dover, J. W. (ed.) Hedgerow futures - Proceedings of the first international Hedgelink conference held at Staffordshire University, Stoke-on-Trent, UK 3-5 September 2012. Hedgelink, Stoke-on-Trent.

WRIGHT, B and ROTHERHAM, I. D. (2015). Creating replica historical hedgerows. *Conservation Land Management*, **13**, (2), 4-8.

WRIGHT. J. (2010). *Hedgerow*. Bloomsbury, London

WUNDERLE, J. M. (1997). The role of animal seed dispersal in accelerating native forest regeneration on degraded tropical lands. *Forest Ecology and Management*, **99**, 223-235.

WULF, M. (1997). Plant species as indicators of ancient woodland in northwestern Germany, *Journal of Vegetation Science,* **8**, 635-642.

WULF, M. (2003) Preference of plant species for woodlands with differing habitat continuities. *Flora,* **198**, 444-460.

WULF, M. (2004). Plant species richness of afforestations with different former use and habitat continuity. *Forest Ecology and Management*, **195**, 191–204.

ZERBE, S. (2002). Restoration of natural broad-leaved woodland in central Europe on sites with coniferous forest plantations, *Forest Ecology and Management,* **167**, 27-42.

ZIEGENHAGEN, B., BIALOZYT, R., KUHLENKAMP, V., SCHULZE, I., ULRICH, A. and WULF, M. (2003). Spatial patterns of maternal lineages and clones of *Galium odoratum* in a large ancient woodland: Inferences about seedling recruitment. *Journal of Ecology,* **91** (4), 578-586.

ZWAENEPOEL, A., ROOVERS, P. and HERMY, M. (2006). Motor vehicles as vectors of plant species from road verges in a suburban environment. *Basic and Applied Ecology*, **7**, 83-93.

Word count 86594

Appendix 01 – Phase 1.5 Habitat system.

The Phase 1.5 Habitat system has developed alongside the current research by the author. The aim is to record the vegetation at different scales as it is not appropriate to describe a species as growing 'in woodland' since there is variation inside many woodlands that can influence the range of species that grow at a particular point within. Phase 1.5 is summarised here.

This has developed to include ecological attributes, which have a relationship with autecologies in that the growing conditions of an individual species, or the conditions where a small combination of species exists, can be described using Phase 1.5 coding (see Table 5.3). When conducting a survey of a woodland or hedgerow, the area being surveyed can be described using a combination of Phase 1.5 codes that provide a hierarchical description of the conditions within the area of survey. If there are any specialist species, or areas where combinations of specialist species occur, these can be further refined using additional codes from the Phase 1.5 categories. This provides a toolbox to enable the details of species present at particular locations within habitats to be described and considered. This is a practitioner tool to provide a better understanding of the nature of habitats.

This system provides an ecological profile for either an individual species or a combination of species growing in a particular set of conditions. This system works with the SPACES (Species, Position, Abundance and Combination Evaluation System) analysis process. The purpose of SPACES is to identify patterns of species distribution across the landscape and within habitats and also to identify where combinations of species are associated with particular locations. Once it is acknowledged that a particular species or combination grows at a particular location, application of the Phase 1.5 species profile will further inform about the nature of the species within the landscape, woodland or hedgerow.
As an example the SPACES signature may identify a species as occurring in woodlands in particular positions and the [P] can be described as on relatively steep sloping ground but does not take account that the soils are on calcareous substrates. The Phase 1.5 ecological profile describes the conditions that are prevalent at a location.
Under the SPACES system (see Appendix 10) *Polystichum aculeatum* would be regarded as having a signature of [SPaa][W]. That is, it has precise positions [P] within a woodland [W] and is always at low frequency and abundance [aa]. Applying the Phase 1.5 profile for this species it would be described using the following codes.

- BWD - Broadleaved Woodland
- WGF - part of a general woodland ground flora

- BCL - on a basic inland cliff
- EAT - Topography - on steep slopes
  (scale: eat = level; Eat = gentle; EAt = moderate; EAT = steep to vertical).
- Eas - Moderate shade tolerance
  (scale: [eas] = open; [Eas] light shading; [Eas] = moderate shading; [EAS] = dense shade)
- EAP - High pH
  (scale: [eap] = acid; [Eap] = Neutral; [EAP] = calcareous)
- Eam - Moist conditions
  (scale; [eam] = dry; [Eam] = Moist; [EAm] wet; [EAM] = under/ in water
- EAA-270 = aspect, west facing.

SPACES informs that the species is found in specific places at particular abundances and Phase 1.5 describes the conditions at those locations. This records information to explain why the species is where it is.

The use of a standard triple-letter code makes each entry the same number of characters, unlike the JNCC phase 1 that uses 'I' for improved grassland and 'SI' for poor semi-improved grassland to 'SNG' for semi-improved neutral grassland.

Where necessary the three letters are either capitalised or colour-coded to add information. For example hedgerows can be coded for their size by capitalisation in the absence of a colour-pen or to allow monochrome copying;

1. hdg - Small - 1.5m x 1.5m
2. Hdg - Medium 2 x 2m
3. HDG - Large >3m x 3m

or by colour-coded pens

1. HDG - Small - 1.5m x 1.5m
2. HDG - Medium 2 x 2m
3. HDG - Large >3m x 3m

or for species-richness

1. hdg or HDG - Species poor - 1-3 species
2. Hdg or HDG - moderately species-rich - 4-7 species (Within Hedgerows Regulations requirements)
3. HDG or HDG - Species-rich - ≥ 8species

or both (see Table 3.1)

Appendix 01 – Phase 1.5 Habitat system.

Table 3.1 - An example using hedgerows of coding for size and species richness in a single three-letter code.			
	Size		
Species-richness	Small	Medium	Large
Poor	hdg	Hdg	HDG
Moderate	hdg	Hdg	HDG
Rich	hdg	Hdg	HDG

Both colour-coding and capitalisation allow for 4 levels of additional information:

1. Capitalisation - [hdg] - [Hdg] - [HDg] - [HDG]
2. Colour - [HDG] - [HDG] - [HDG] - [HDG]

to make a two-attribute 4x4 matrix if necessary (see Table 3.2)

Table 3.2 - An example of how both colour and capitalisation can be used to incorporate into a code that has two attributes and 4 levels of assessment.				
	Attribute			
Attribute	1	2	3	4
A	aaa	Aaa	AAa	AAA
B	aaa	Aaa	AAa	AAA
C	aaa	Aaa	AAa	AAA
D	aaa	Aaa	AAa	AAA

These can be used in both field recording on maps and field forms using a four-colour pen and also in presenting the data summary. The capitalised and red letters emphsise the source of the abbreviated three-letter codes. The P1.5 and P1 columns show where there are differences in coding between Phase 1.5 and standard JNCC monchrome codes.

The presentation of data used the Phase 1.5 codes plus the SSACFOR abundance values.

e.g., [BWD-S-6] = Broadleaved woodland - super abundant in both frequency and cover.

Some habitats like flushes, runnin waterand inlnad cliffs are coded for how many there are and their size using FSL, Few - Some -lots. A wood with a some small basic flushes, a few medium basic flushes and no large ones would be coded [BFL-S-F-0]. Similarly if there were streams in the wood there may be just a few seasonalltwet streams or [RWS-F-0-0]. Cliffs have no vertical area to assign cover to, so, Phase 1.5 codes for face area. again an area with some small faces, a few medium ones would be coded [BCL-F-S-0].

The ecological attributes are coded to include how much of the wood the attribute applies to. For exanple if 10% was level, 30% on moderate slopes and 60% on steep slopes it would be coded [EAR-1-3-6]. The # symbol indicates presence at <5% cover and the single digit = an abbreviated 10% interval (1=5% to 15%). Aspect is also inlcuded as this may be relevant.

Appendix 01 – Phase 1.5 Habitat system.

Table 5.3 - Phase 1.5 codes and Phase 1 equivalents.		
RED = New code, BLUE = Modified code, GREEN = Same code		
PHASE-1.5 habitat/ feature codes		
HABITAT	**P1.5**	**P1**
A. Woodland and Scrub		
A.1. **W**oo**DL**and	**WDL**	
A.1.1. **B**road-leaved **W**oo**D**land	**BWD**	[P]BW
A.1.2. **C**oniferous **W**oo**D**land	**CWD**	[P]CW
A.1.3. Mixed – both codes and covers	**BWD**	[P]MW
	CWD	[P]MW
A.2. **SCR**ub	**SCR**	D/SS
A.2.1. **S**hrubby **SC**rub	**SSC**	-
A.2.2. **B**ramble **SC**rub	**BSC**	-
A.3. Scattered Trees **B**road-leaved **W**oo**D**land	**BWD**	SBW
A.3. Scattered Trees **C**oniferous **W**oo**D**land	**CWD**	SCW
A.4. **R**ecently **F**elled **W**oodland	**RFW**	
A.4.1. **R**ecently **F**elled **W**oodland Broad-leaved	**FBW**	FB
A.4.2. **R**ecently **F**elled **W**oodland Coniferous	**FCW**	FC
A.4.3. Mixed – each coded	**FBW**	FM
	FCW	FM
A.5. **L**ine **O**f **T**rees	**LOT**	Symb
A.6. **W**oodland **G**round **F**lora	**WGF**	-
A.7. **N**otable **TR**ee	**NTR**	-
A.8. **S**tanding Dead Wood	**SDW**	-
A.9. **F**allen **D**ead **W**ood	**FDW**	-
A.10. **STU**mp	**STU**	-
B. Grassland:		
Rushes coded (RSH3) R&F (RNF)		
B.1. **A**cidic **GR**assland	**AGR**	-
B.1.1. **U**nimproved **A**cidic **G**rassland	**UAG**	AG
B.1.2. **S**emi-improved **A**cidic **G**rassland	**SAG**	SAG
B.2. **N**eutral **GR**assland	**NGR**	-
B.2.1. **U**nimproved **N**eutral **G**rassland	**UNG**	NG
B.2.2. **S**emi-improved **N**eutral **G**rassland	**SNG**	SNG
B.2.3. **T**all, **R**ough **G**rassland	**TRG**	-
B.3. **C**alcareous **GR**assland	**CGR**	-
B.3.1. **U**nimproved **C**alcareous **G**rassland	**UCG**	CG
B.3.2. **S**emi-improved **C**alcareous **G**rassland	**SCG**	SCG
B.4. **I**mproved **GR**assland	**IGR**	I
B.5. **M**arshy **GR**assland	**MGR**	MG
B.6. **P**oor **S**emi-improved **G**rassland	**PSI**	SI
C. Tall Herb and fern		
C.1. **B**rac**K**e**N**	**BKN**	C/SB
C.3. Other		
C.3.1. **T**all **RU**deral	**TRU**	TR
C.3.2. **N**on-**RU**deral	**NRU**	NR
D. Heath - matrices	**HTH**	-
D.1. **D**ry **D**warf Shrub **H**eath	**DDH**	-
D.1.1. **A**cidic **D**warf **H**eath	**ADH**	ADH
D.1.2. **B**asic **D**warf **H**eath	**BDH**	BDH
D.2. **W**et Dwarf Shrub **H**ea**T**h	**WHT**	WH

Appendix 01 – Phase 1.5 Habitat system.

Table 5.3 - Phase 1.5 codes and Phase 1 equivalents.

RED = New code, BLUE = Modified code, GREEN = Same code

PHASE-1.5 habitat/ feature codes		
HABITAT	**P1.5**	**P1**
D.3. **L**ichen/**B**ryophyte **H**eath	**LBH**	LH
D.4. **M**ontane **H**ea**T**h/Dwarf Herb	**MHT**	MH
E. Mire		
E.1. Bog.		
E.1.6.1. **B**lanket **B**o**G**	**BBG**	BB
E.1.6.2. **R**aised **B**o**G**	**RBG**	RB
E.1.7. **W**et **M**odified **B**og	**WMB**	WB
E.1.8. **D**ry **M**odified **B**og	**DBG**	DB
E.2. **S**pring/ **FL**ush - Sm-Md-Lg: F-S-L	**SFL**	-
E.2.1. **A**cid/Neutral **FL**ush	**AFL**	AF
E.2.2. **B**asic **FL**ush	**BFL**	BF
E.2.3. **BR**yophyte dominated **F**lush	**BRF**	Note
E.3. Fen		
E.3.1. **V**alley **MI**re	**VMI**	VM[B]
E.3.2. **B**asin **MI**re	**BMI**	BM[B]
E.3.3. **F**lood-**P**lain **M**ire	**FPM**	FPM
E.4. **B**are **P**ea**T**	**BPT**	P
F. Swamp/ marginal inundation		
F.1. **SW**am**P** – Reeds	**SWP**	SP
F.2. Marginal/Inundation		
F.2.1. **M**arginal **V**e**G**etation	**MVG**	MV
F.2.2. **I**nundation **V**e**G**etation	**IVG**	IV
G. Open water		
G.1. Standing Water - Sm-Md-Lg: F-S-L		
G.1.1. **S**tanding **W**ater wet **A**ll year	**SWA**	SW?
G.1.2. **S**tanding **W**ater wet **S**easonally	**SWS**	-
G.2. Running Water - Sm-Md-Lg: F-S-L		
G.2.1. **R**unning **W**ater wet **A**ll year	**RWA**	RW?
G.2.2. **R**unning **W**ater wet **S**easonally	**RWS**	-
G.3. Aquatic vegetation		
G.3.1. **S**ubmerged **A**quatic **V**egetation	**SAV**	-
G.3.2. **E**mergent **A**quatic **V**egetation	**EAV**	-
G.3.3. Free-**F**loating **A**quatic **V**egetation	**FAV**	-
G.3.4. Surface-**R**ooted **A**quatic **V**egetation	**RAV**	-
G.3.5 **ALG**ae	**ALG**	-
I. Rock exposure and waste		
I.1. Natural		
I.1.1. **I**nland **CL**iff - Sm-Md-Lg: F-S-L	**ICL**	
I.1.1.1. **A**cid/Neutral Inland **CL**iff	**ACL**	AC
I.1.1.2. **B**asic Inland **CL**iff	**BCL**	BC
I.1.2. Scree/ boulder fields		
I.1.2.1. **A**cid/Neutral **SC**ree	**ASC**	AS
I.1.2.2. **B**asic **SC**ree	**BSC**	BS
I.1.2.3. **A**cid/neutral **B**oul**D**ers	**ABD**	-
I.1.2.4. **B**asic **B**oul**D**ers	**BBD**	-
I.1.3. **L**imestone **PA**vement	**LPA**	LP
I.1.4. Other exposure		

Appendix 01 – Phase 1.5 Habitat system.

Table 5.3 - Phase 1.5 codes and Phase 1 equivalents.		
RED = New code, BLUE = Modified code, GREEN = Same code		
PHASE-1.5 habitat/ feature codes		
HABITAT	**P1.5**	**P1**
I.1.4.1. **A**cid/Neutral **R**oc**K**	**ARK**	AR
I.1.4.2. **B**asic **R**oc**K**	**BRK**	BR
I.1.5. **CAV**e	**CAV**	CA
I.2. Artificial		
I.2.1. **QU**arr**Y**	**QRY**	Q
I.2.2. **SP**oi**L**	**SPL**	S
I.2.3. **MIN**e	**MIN**	MI
I.2.4. **REF**use tip	**REF**	R
J. Miscellaneous		
J.1. Cultivated/disturbed land		
J.1.1. **ARA**ble	**ARA**	A
J.1.1.1. **A**rable **U**n-cropped/ **F**allow	**AUF**	-
J.1.1.2. **A**rable **U**n-cropped **M**argin	**AUM**	-
J.1.1.3. **A**rable **U**n-**S**prayed margin	**AUS**	-
J.1.1.4. **A**rable **C**onservation seed **M**ix	**ACM**	-
J.1.1.5. **A**rable **G**ame **C**over Crop	**AGC**	-
J.1.1.6. **H**o**RT**iculture	**HRT**	-
J.1.2. **A**menity **GR**assland	**AGR**	AM
J.1.3. **E**phem/**S**hort **P**erennial	**ESP**	ESP
J.1.4. **I**ntroduced **SH**rub	**ISH**	IS
J.1.5. **I**ntroduced **TR**ees	**ITR**	
J.1.6. **B**rown**F**ield **S**ite	**BFS**	-
J.1.7. **I**njurious **W**ee**D**s	**IWD**	-
J.2. Boundaries		
J.2.1. **H**e**DG**erow - Sm-Md-Lg: F-S-L	**HDG**	-
Intactness HDG # 1-9 Ø		
Richness 5HDG + intactness		
Size HDG, Hdg, hdg		
J.2.1.1. **R**ich **H**ed**G**e ≥4sp	**RHG**	RH
J.2.1.2. **P**oor **H**ed**G**e ≤3sp	**PHG**	PH
J.2.2.1. **R**ich **H**edge - defunct #	**-**	RH-
J.2.2.2. **P**oor **H**edge - defunct #	**-**	PH-
J.2.3. **H**ed**G**e with **T**rees	**HGT**	Symb
No of trees **TRE7**	**TRE**	-
J.2.3.1. **R**ich **H**edge with **T**rees	**RHT**	RHT
J.2.3.2. **P**oor **H**edge with **T**rees	**PHT**	PHT
J.2.4. Fe**NC**e	**FNC**	F
Height **FNC Fnc fnc**		
Wildlife permeability # 1-9 Ø		
J.2.4.1. **F**ence **P**ost & **W**ire	**FPW**	-
J.2.4.2. **F**ence **P**ost & **R**ail	**FPR**	-
J.2.4.3. **F**ence **P**ost & **N**etting	**FPN**	-
J.2.5. **WAL**l - Free-standing	**WAL**	W
J.2.5.1. **W**al**L** **S**tone wall	**WLS**	
J.2.5.1.1. **W**al**L** **D**ry**S**tone Wall	**WDS**	-
J.2.5.1.2. **W**all **M**ortared **S**tone wall	**WMS**	-
J.2.5.2. **W**all **B**rick/ **B**lock Wall	**WBB**	-
J.2.6. **W**al**L** - **R**etaining	**WLR**	
J.2.6.1. **W**all - **R**etaining - **S**tone	**WRS**	
J.2.6.1. **W**all - **R**etaining - **B**rick	**WRB**	

Appendix 01 – Phase 1.5 Habitat system.

Table 5.3 - Phase 1.5 codes and Phase 1 equivalents.		
RED = New code, BLUE = Modified code, GREEN = Same code		
PHASE-1.5 habitat/ feature codes		
HABITAT	**P1.5**	**P1**
J.2.6.1. **W**all - **R**etaining - **C**oncrete	**WRC**	
J.2.6.1. **W**all - **R**etaining - Concrete bloc**K**	**WRK**	
J.2.6.1. **W**all - **R**etaining - Stone **G**abion	**WRG**	
J.2.6. **D**ry **D**i**T**ch	**DDT**	DD
J.2.7. Boundary Removed	**XXX**	X
J.2.8. **E**arth **B**an**K**/ ridge/ earthwork	**EBK**	EB
J.2.9. **S**tone/earth **B**an**K**/ridge e.g., hedge Kest	**SBK**	-
J.3. Built-up areas		
J.3.4. **C**aravan **S**i**T**e	**CST**	CS
J.3.5. **S**ea **W**al**L**	**SWL**	SWALL
J.3.6. Buildings - **URB**an	**URB**	Black
J.3.6.1. **B**uildings **BR**ick	**BBR**	-
J.3.6.2. **B**uildings **ST**one	**BST**	-
J.3.6.3. **B**uildings **SL**ate	**BSL**	-
J.3.6.4. **B**uildings **AS**bestos	**BAS**	-
J.3.6.5. **B**uildings **W**oo**D**	**BWD**	-
J.3.6.6. **B**uildings **C**o**N**crete	**BCN**	-
J.3.6.7. **B**uildings **M**e**T**al	**BMT**	-
J.3.6.8. **GLA**ss - Greenhouses	**GLA**	-
J.3.7. Hard-standing		
J.3.7.1. **H**ard-**S**tanding - **T**armac	**HST**	-
J.3.7.2. **H**ard-**S**tanding - **C**oncrete	**HSC**	-
J.3.7.3. **H**ard-**S**tanding - **G**ravel	**HSG**	-
J.3.7.4. **H**ard-**S**tanding - **H**ard-core	**HSH**	-
J.3.7.5. **H**ard-standing - **G**rass-**C**rete	**HGC**	-
J.3.7.6. **W**ood - **D**ec**K**ing	**WDK**	-
J.4. **B**are **GR**ound - Soil	**BGR**	BG
J.5. Other habitat/ feature		
J.5.1. **M**etalled **R**oa**D**	**MRD**	-
J.5.2. **TR**ac**K** - Un-metalled	**TRK**	-
J.5.3. Leaf **L**it**T**e**R**/ leaf mould	**LTR**	-
J.5.4. **D**ead **V**e**G**etation	**DVG**	-
J.5.6. **BRY**ophytes	**BRY**	-
J.5.7. **G**ar**D**e**N**, Amenity planting	**GDN**	-
J.5.8. **R**ub**BL**e	**RBL**	-
K. Ecological Attributes - 1-7-2 etc (=10)		
K.1. **EA** - **T**opography - gentle>moderate>steep	**EAT**	-
[eat] level; [Eat] gentle; [EAt] moderate]; [EAT] steep		
K.2. **EA** - **S**hade [**L**] - light>moderate>dense	**EAS**	-
[eas] open; [Eas] light; [EAS] moderate; [EAS] dense		
K.3. **EA** - **P**H/ [**R**] - acid>neutral>basic	**EAP**	-
[eap] acid; [Eas] neutral; [EAS] basic		
K.4. **EA** - **M**oisture - dry>moist>wet	**EAM**	-
[eam] dry; [Eam] moist; [EAm] wet; [EAM] under/ in water		
K.5. **EA** - **A**spect - Compass degrees (270º)	**EAA**	
NB Shade-casting features (trees [BWD], shrubs [SSC], Bramble [BSC], Bracken BRK] etc.) coded **EAS** or coded for density of cover: [**BWD**] = Dense shade; [**Bwd**] = Medium; [**bwd**] = low		

Appendix 02 - The modified SACFOR scoring system

One of the key elements of recording that is generally lacking is a consistent method for applying abundance values to species in a simple and understandable manner. Kirby (1988) on page 33 highlights an issue regarding the DAFOR (see Kent and Coker 1992 p.45) scale (Dominant, Abundant, Frequent, Occasional, Rare) in that:

> 'These terms have no precise definition and observers vary in their use; both frequency and cover are combined (or confounded) in the one value and plant size and season affect the result'.

As Kirby states the words used can be interpreted as referring to both frequency (number of plants or density) and cover or abundance (vertical ground cover, or the volume or side face area of a hedge). Frequency refers to the distribution and number of plants (or in some cases leaves or shoots for vegetative rhizomatous species like Wood Anemone *Anemone nemorosa* or Bracken *Pteridium aquilinum).*

One alternative system is the ACFOR (see Kent and Coker 1992) (Abundant, Common, Frequent, Occasional, Rare). This avoid the Dominant class that is intended to indicate ubiquitous frequency and extremely abundant cover or presence.

A general perception of the DAFOR system is:

- Dominant = Cover, abundance measure - the species is ubiquitous in terms of both the number of plants or leaves etc., and is the most visually abundant species in terms of its cover/ presence.
- Abundant = Cover, abundance and/ or Frequency measure - Many plants, leaves etc, and occupying a significant amount of the ground or showing a significant presence.
- Frequent = Frequency measure - Moderate numbers of plants, spaced out and not covering large areas or implying many plants = significant cover.
- Occasional = Frequency measure - A few scattered plants with an implication that the species has a low total cover/ presence.
- Rare = Frequency measure - Very few plants and very low cover/ presence.

Added to these descriptions A**C**FOR includes:

- **Common** - Frequency measure - between frequent and abundant.

Sometimes lists are produced from surveys where the abundance is given as O-lc indicating Occasional and locally common (both frequencies). Does this mean there are say 20 places where the species occurs and it is locally common at each or it is only locally common at some, or one? 'O-lc' is more helpful than 'O', but 'locally common' implies frequency. The adoption of this refinement is inconsistently applied and only where the local frequency/ abundance differs from the general level.

Appendix 02 - The modified SACFOR scoring system

The DAFOR approach sometimes adopts an assessment of the abundance as expressed in percentage 'cover' for each scale point. One of the more widely accepted for DAFOR is to convert the Braun-Blanquet (Braun-Blanquet 1964) scale of 1-5 into the five letters (from Kent and Coker 1992);

- 76-100% - Dominant
- 51-75% - Abundant
- 26-50% - Frequent
- 6-25% - Occasional
- 1-5% - Rare

Rodwell (1991) asserts that DAFOR cannot be converted for use in the NVC, unless, presumably, it can be established that the Braun-Blanquet cover estimates were applied during data collection. There are others in literature that use different cut-off points for the percentage band.

An alternative adopted during the early part of this research was a modification of DAFOR that used two DAFOR codes, one assessing frequency and one assessing local cover abundance. This is referred to as double DAFOR or DDAFOR. Thus a species was considered for the number of times a bush was found and given a DAFOR code. Then, if the local abundance was greater the second letter was an elevated DAFOR given to reflect the dominance of the species at the places where it occurred. A species that was infrequently found like Holly *Ilex aquifolium* was very often a dominant component and was coded OD or FD.

This is now refined into a form of SACFOR (Hiscock 1990), called double SCAFOR or SSACFOR which is described here as the future for abundance coding. It relates to the data presented here. Two codes differ between DDAFOR and SSACFOR. This research used the DAFOR code [D] and the new code is [A] and the DAFOR code [A] is now the SSACFOR code [C]. The SACFOR super-abundant [S] relates to an overwhelming dominance of a species equivalent to the upper extreme of [D] in the DAFOR scale.

SACFOR is used in marine ecology encompassing a percentage cover estimate and frequency density of species like in limpets on littoral rocks in a single code (see Figure 3.1). As SACFOR acknowledges and uses both a frequency/ density and cover/ abundance element, SSACFOR adopts the use both attributes and assigns two codes. The letters accounts for frequency – how many plants, patches or occurrences and the numbers assess the cover/ abundance – how much there is at each location. It also applies a density that takes account of the sizes of the organisms being assessed i.e., the numbers/10cm^2 of small limpets will potentially be more dense than the density of larger ones. For small limpets <1cm super-abundance would be >80% cover and a density of >10,000/m^2, but for limpets 3-5cm the density of animals regarded as superabundant would be 100-999/m^2.

Figure 3.1 - Synopsis of the SACFOR coding system for marine and littoral surveys

Growth form	Size of individuals/ colonies							
% cover	Crust/ meadow	Massive/ Turf	<1cm	1-3 cm	3-15 cm	>15 cm	Density	
>80%	S		S				>1/0.001m^2 (1 x 1 cm)	>10,000/m^2
40-79%	A	S	A	S			1-9/0.001m^2 (3.16 x 3.16cm)	1000-9999/m^2
20-39%	C	A	C	A	S		1-9/0.01 m^2 (10 x 10 cm)	100-999/m^2
10-19%	F	C	F	C	A	S	1-9/0.1 m^2 (31.6 x 31.6cm)	10-99/m^2
5-9%	O	F	O	F	C	A	1-9/m^2	
1-5% or density	R	O	R	O	F	C	1-9/10m^2 (3.16 x 3.16 m)	
<1% or density		R		R	O	F	1-9/100 m^2 (10 x 10 m)	
					R	O	1-9/1000 m^2 (31.6 x 31.6 m)	
						R	<1/1000 m^2 (31.6 x 31.6 m)	

This equates with HEDGES in the consideration of the frequency or density of shrubs.

In hedgerows a species might be only scattered plants - DAFOR/ ACFOR Occasional or O - along a hedge, but where it occurs it may be obvious and occupy a long section of hedgerow - Braun-Blanquet 4 or 5. Using SSACFOR this would be coded O-4 or O-5 to signify Occasional plants - locally high or very high % cover.

This system uses all combinations of R-1 to A-5. Illustrations at Figure 5.2 and Figure 6.3 show examples of species recorded in both area and linear habitats. The Superabundant category is reserved for cases where the species is unmistakably the primary species in the woodland or along the hedgerow and there is no separation between large numbers of plants and large cover or presence.

The example of A-1 would be where a species is common in a wood or along a hedgerow length, but is only present as individual sprigs or single plants at each location. The SSACFOR system interprets the linear feature frequency in terms of how far it might be between plants for both shrubs and ground flora, in this case one plant every 5m for a shrub or every 1m for ground flora. These are arbitrary suggestions that generally work well. The same approach to [A]bundant in a wood would be 50 trees/Ha, 100shrubs/Ha and 100 ground flora plants/1m^2.

The diagrams at Figure 5.2 and Figure 6.3 show that a pattern can exist in nature where a species is found almost ubiquitously across the woodland floor, or along a length of hedgerow but only as individual plants or sprigs of woody growth. In reality, both in woods and along hedgerows, there will be many species that fit this pattern. In a hedgerow Bramble *Rubus fruticosus* can range from O-1 or O-2 to being present every metre or so, but only as small sprigs and could be coded C-1 or A1.

By recording the frequency/ abundance in this way a more comprehensive indication of the species presence is obtained. Recording Holly *Ilex aquifolium* as SSACFOR O-6 (Occasional and >80% presence) in a hedge is more informative than recording it as DAFOR 'O' and considerably more valuable than just recording it as present, which would be all that is required by other survey methods (Pollard, Hooper and Moore 1974, Defra 2006). Species like Bramble *Rubus fruticosus* may occur regularly along a hedgerow but only as small shoots and would be coded C-1 or A-1 etc.

For either area features or linear features there may larger patches or longer continuous lengths of some species. These may require a field note. In a woodland it would be preferable to make separate lists for areas where a species has clearly different abundances, e.g., one list where Bluebell may be dominant and another for an area where it is less dominant and intermixed with other species. Such clumping may be biologically relevant. For example, Herb-Paris *Paris quadrifolia* often occurs in shallow damp calcareous depressions in woods. These colonies could either be coded as R-3 taking the sample area as the wood, or F-3 if recording the area with Herb Paris as a sub-plot.

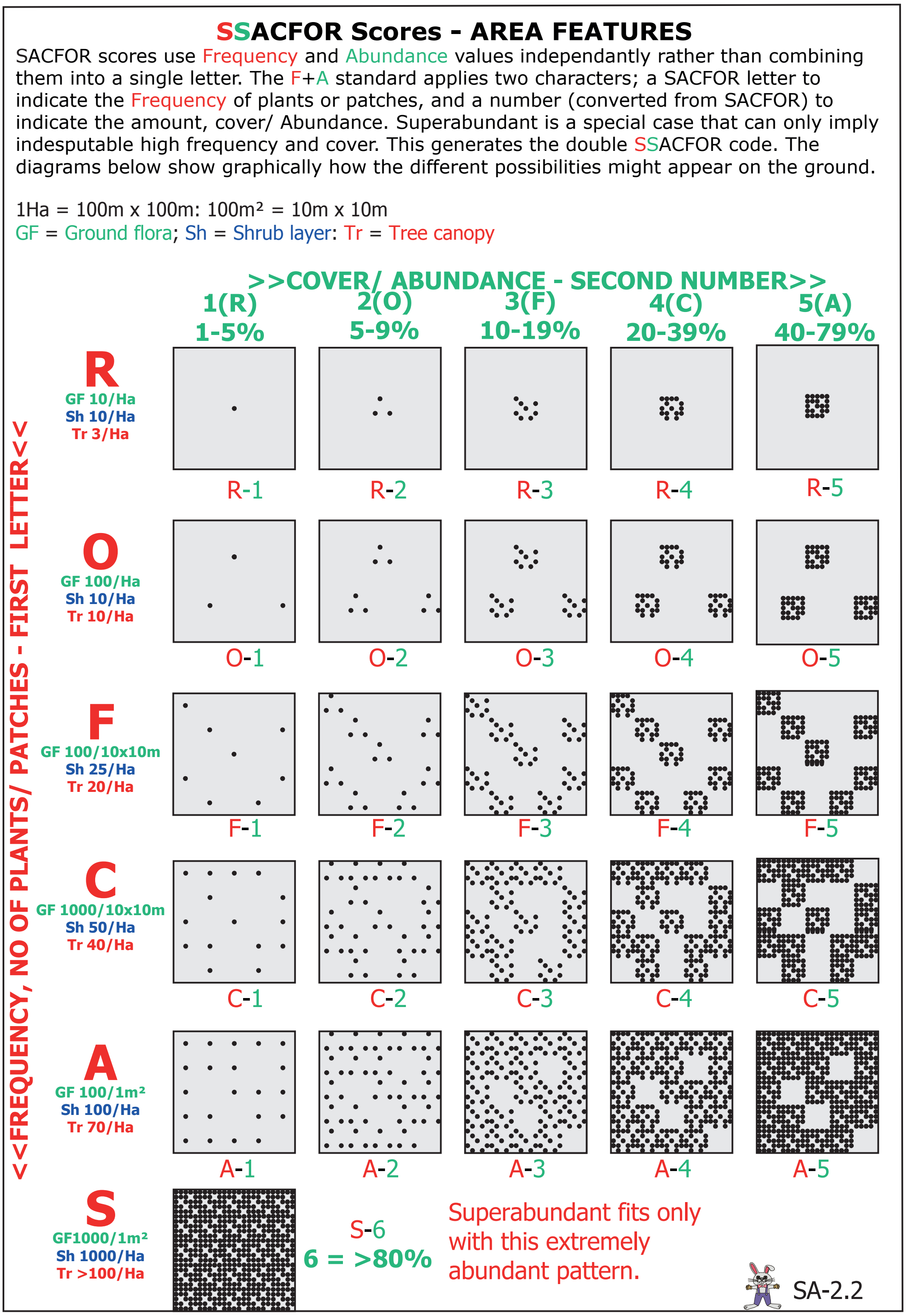


Figure 5.2 - Diagram illustrating the SACFOR interpretations for area habitats.

Appendix 02 - The modified SACFOR scoring system

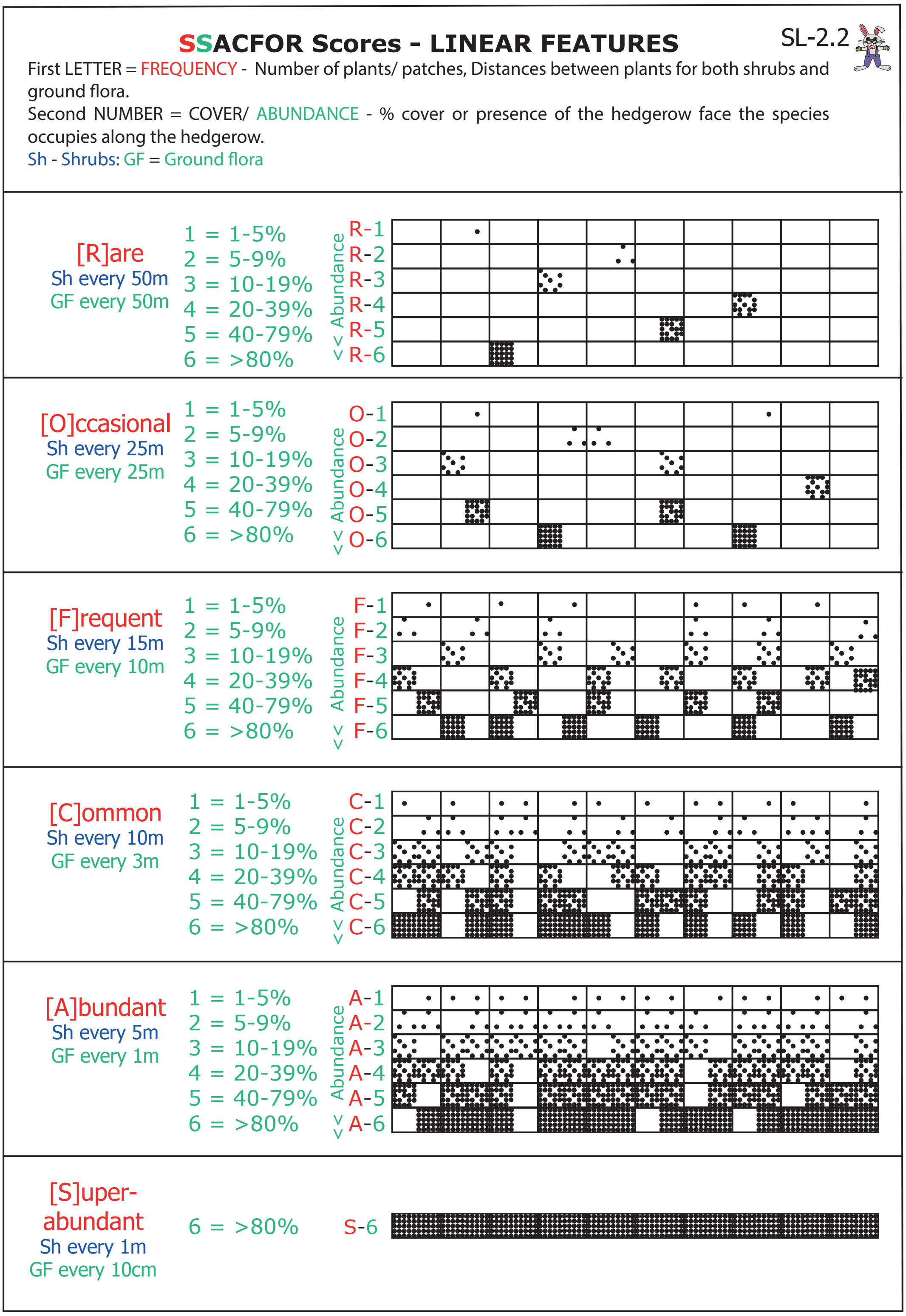


Figure 6.3 - Diagram illustrating the SSACFOR interpretations for linear habitats.

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																			
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Adoxa moschatellina	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	1		1		1	1		1		1				1	
Agrimonia procera													1																								
Agropyron caninum				1		1	1																														
Ajuga reptans	1	1											1								1			1					1								
Alchemilla filicaulis	1																																				
Allium ursinum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1			1						1	
Anagallis minima							1																														
Anemone nemorosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1		1	1	1		1
Apium nodiflorum															1				1																		
Aquilegia vulgaris	1	1	1	1	1	1	1	1	1		1	1						1							1							1					
Arctium nemorosum		1																																			
Arum maculatum	1		1					1		1										1		1							1							1	
Athyrium filix-femina	1				1				1				1		1		1		1												1						
Berula erecta																			1																		
Blechnum spicant	1	1	1	1	1	1	1	1	1	1		1	1	1		1													1					1			

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																			
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Brachypodium sylvaticum	1	1													1					1	1	1	1						1								
Bromopsis benekenii										1					1								1		1												
Bromopsis ramosa	1	1	1	1	1	1	1	1		1	1	1		1		1				1	1	1	1				1	1									
Calamagrostis canescens	1								1								1		1					1													
Calamagrostis epigejos	1	1	1	1	1	1	1		1			1																									
Calluna vulgaris			1					1						1																				1			
Caltha palustris																			1																		
Campanula latifolia	1	1	1		1				1	1	1	1	1		1	1	1	1	1	1	1	1										1				1	
Campanula patula					1																																
Campanula trachelium	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1							1						1							
Cardamine amara	1	1	1	1			1					1				1			1																		
Cardamine impatiens		1			1																1		1														
Carex acuta																			1																		
Carex acutiformis									1										1																		
Carex binervis																																		1			

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Carex digitata		1																																			
Carex elata																			1																		
Carex elongata					1																																
Carex laevigata	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1	1			1	1	1	1							1		
Carex montana	1	1		1	1	1	1		1																1						1						
Carex nigra																			1																		
Carex pallescens	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1		1		1		1	1	1		1			1						
Carex paniculata	1			1	1	1	1		1										1	1					1		1					1					
Carex pendula	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1	1				1	1			1	1
Carex pseudocyperus													1																								
Carex remota	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	1	1		1	1			1		
Carex riparia																			1																		
Carex strigosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1							1		1	1		1							1
Carex sylvatica	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1		1	1	1	1	1	1			1		
Carpinus betulus	1			1			1						1																								
Cephalanthera damasonium					1																				1												
Cephalanthera longifolia				1	1										1																						

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Ceratocapnos claviculata	1	1	1	1		1		1	1														1					1						1			
Chrysosplenium alternifolium	1	1	1		1			1	1	1	1	1	1	1	1	1		1	1	1	1	1					1					1	1				
Chrysosplenium oppositifolium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1				1				1		1	1					1
Circaea intermedia		1													1						1	1	1														
Circaea lutetiana	1		1								1		1		1								1						1							1	
Cirsium heterophyllum		1																																			
Clematis vitalba	1												1																								
Colchicum autumnale				1	1	1																											1				
Conopodium majus	1	1	1	1	1	1	1	1	1		1		1	1	1	1								1					1	1	1					1	
Convallaria majalis	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1					1	1			1			1		1		1			
Cornus sanguinea	1								1	1			1					1																			
Corydalis claviculata				1		1								1												1											
Corylus avellana	1								1						1	1	1												1					1	1		
Crataegus laevigata	1	1		1	1		1						1				1							1													

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Crepis paludosa																			1																		
Dactylorhiza fuchsii	1								1				1		1	1																					
Daphne laureola	1	1	1	1	1	1	1	1		1		1	1	1				1								1				1							
Daphne mezereum		1	1					1						1																							
Deshampsia flexuosa			1					1						1																							
Dipsacus pilosus	1	1	1	1	1	1	1		1	1		1	1																								
Dryopteris aemula	1		1	1		1	1	1			1			1									1				1	1							1		
Dryopteris affinis	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1									1	1								
Dryopteris carthusiana	1	1	1	1	1	1	1	1	1	1		1			1	1			1																1		
Dryopteris filix-mas	1																																				
Elymus caninus	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1			1	1	1						1									
Epilobium montanum															1						1																
Epilobium obscurum									1																												
Epipactis helleborine	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		1		1			1				
Epipactis muelleri				1																					1												

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Epipactis phyllanthes			1							1		1													1												
Epipactis purpurata	1			1	1		1			1			1				1								1												
Epipactus leptochila				1						1															1												
Equisetum fluviatile																			1																		
Equisetum hyemale		1																																			
Equisetum sylvaticum	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1	1		1		1		1									
Equisetum telmateia		1			1										1				1		1																
Erica tetralix																			1																		
Euonymus europaeus	1		1		1	1		1	1	1	1	1	1	1	1		1	1		1		1		1			1								1		
Eupatorium cannabinum									1										1																		
Euphorbia amygdaloides	1	1	1	1	1	1	1	1		1	1	1	1	1			1								1	1	1	1		1			1				
Festuca altissima		1	1		1					1	1	1			1			1		1	1	1	1												1		
Festuca gigantea	1	1	1	1		1	1	1		1	1	1		1	1	1				1	1	1	1				1	1		1						1	
Fragaria vesca	1								1	1			1		1	1								1											1		

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Frangula alnus	1	1	1	1	1	1	1	1	1		1	1	1	1				1	1							1								1			
Gagea lutea	1	1			1					1			1		1			1		1	1	1										1					
Galanthus nivalis																																	1				
Galium odoratum	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1
Geranium robertianum	1																												1		1						
Geranium sanguineum		1			1																																
Geranium sylvaticum					1					1								1																			
Geum rivale	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1					1								1					
Geum urbanum	1		1					1																					1								
Glechoma hederacea	1																																				
Gnaphalium sylvaticum	1				1					1																											
Goodyera repens																						1	1														
Gymnocarpium dryopteris			1		1			1				1		1	1					1	1	1	1				1							1			
Hedera helix	1																																				
Helleborus foetidus	1	1	1		1					1		1																									

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Helleborus viridis	1	1	1	1	1	1	1			1	1	1	1											1													
Holcus mollis		1	1	1		1	1	1			1	1				1																					
Hordelymus europaeus	1	1		1	1					1			1				1	1		1		1		1								1					
Humulus lupulus									1																												
Hyacinthoides non-scripta	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1					1					1	1	1	1
Hymenophyllum tunbrigense			1			1		1				1															1	1									
Hymenophyllum wilsonii			1					1				1									1						1	1									
Hypericum androsaemum	1		1	1	1	1	1	1		1	1	1		1		1										1		1		1			1				
Hypericum hirsutum	1		1						1		1		1		1	1	1							1													
Hypericum humifusum									1							1	1							1													
Hypericum maculatum																				1																	
hypericum perforatum																								1													
Hypericum pulchrum	1	1	1	1	1	1	1	1	1			1			1	1	1	1						1					1		1	1				1	
Hypericum tetrapterum									1															1													

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																			
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Ilex aquifolium	1	1	1	1		1	1	1		1	1				1	1																					
Iris foetidissima	1		1	1	1	1	1	1		1		1	1	1																							
Iris pseudacorus																			1																		
Juniperus communis																				1		1															
Lamiastrum galeobdolon	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1					1	1	1				1		1	1				1
Lathraea squamaria	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1		1	1	1	1	1	1	1	1			1		1	1				1
Lathyrus linifolius	1	1	1	1	1	1	1	1	1		1	1					1								1												
Lathyrus montanus		1		1		1	1																			1											
Lathyrus sylvestris	1	1	1	1	1	1	1			1	1						1								1												
Ligistrum vulgare	1																	1																			
Linnaea borealis																							1														
Listera ovata	1				1					1			1		1																1						
Lithospermum officinale	1												1																								
Lonicera periclymenum	1	1	1					1							1						1								1					1			
Luzula forsteri			1	1	1	1	1	1			1			1			1								1	1											
Luzula pilosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Luzula sylvatica	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1			1	1	1			1			1	1	1	1		1
Lychnis flos-cuculi	1								1										1																		
Lycopus europaeus																			1																		
Lysimachia nemorum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1			1	1	1			1			1
Lysimachia nummularia	1								1				1																								
Lysimachia thyrsiflora																			1																		
Lysimachia vulgaris					1				1																												
Lythrum portula	1																																				
Maianthemum bifolium	1								1																												
Malus sylvestris	1	1	1	1		1	1	1		1	1	1	1	1			1									1	1	1									
Melampyrum cristatum	1																1																				
Melampyrum pratense	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1			1		1	1	1			1	1		1	1			1	1	1	
Melampyrum sylvaticum															1			1														1					
Melica nutans	1	1	1		1					1	1	1			1			1		1	1	1															

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Melica uniflora	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1		1	1		1	1	1
Melittis melissophyllum			1			1		1						1				1							1		1	1									
Mercurialis perennis	1	1	1		1			1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1							1					1	
Milium effusum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1			1			1	1
Moehringia trinervia	1	1	1	1		1	1	1		1	1			1		1	1				1		1				1										
Molinia caerulea																			1																		
Moneses uniflora																					1		1														
Monotropa hypopitys					1																				1												
Myosotis laxa spp caespitosa																			1																		
Myosotis scorpioides																			1																		
Myosotis secunda																			1																		
Myosotis sylvatica	1	1	1		1			1	1	1	1		1			1				1	1	1	1								1						
Narcissus pseudonarcissus	1	1	1	1	1	1	1			1	1		1				1									1											
Neottia nidus-avis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1		1	1	1	1					1				
Oenanthe crocata																			1																		

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Ophioglossum vulgatum	1								1																1												
Ophrys insectifera	1																1								1												
Orchis mascula	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			1			1					1	1		1					
Orchis purpurea							1																														
Oreopteris limbosperma	1	1	1	1	1	1	1	1		1		1																						1			
Orobanche hederae					1																																
Orthila secunda																							1														
Osmunda regalis																				1																	
Oxalis acetosella	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			1	1	1			1	1			1
Paris quadrifolia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1			1		1	1				1
Phegopteris connectilis			1			1		1							1	1				1	1	1	1								1			1	1		
Phyllitis scolopendrium		1	1	1	1	1	1				1	1				1		1																			
Pimpinella major	1				1		1						1				1																				
Platanthera chlorantha	1		1	1	1	1	1	1	1	1		1	1	1			1	1																			
Poa nemoralis	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1			1	1	1			1	1	1	1		1	1					1	

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Polygonatum multiflorum	1	1	1	1		1	1	1		1	1			1											1					1			1				
Polygonatum odoratum		1	1								1																										
Polygonatum verticillatum																							1														
Polypodium vulgare	1	1	1	1	1	1	1	1			1	1	1			1					1	1							1		1		1	1			
Polystichum aculeatum	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1		1	1	1	1			1			1		1		1		1		
Polystichum setiferum	1	1	1	1	1	1	1		1	1	1	1	1	1				1		1	1	1	1														
Populus tremula	1	1	1	1		1	1	1	1	1	1	1		1		1												1							1		
Potentilla sterilis	1	1	1	1		1	1	1	1	1			1	1	1	1								1		1			1		1						
Primula elatior	1												1				1																				
Primula vulgaris	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1							1						
Prunus avium	1	1	1	1	1	1	1	1	1		1	1	1			1										1											
Prunus cerasifera	1																																				
Prunus padus	1	1	1					1			1	1		1		1		1																			
Pulmonaria longifolia				1		1																															
Pulmonaria obscura	1																																				

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Pyrola minor		1																1																1		1	
Pyrus communis	1																																				
Pyrus pyraster	1																																				
Quercus petraea	1		1	1	1	1	1	1	1	1	1	1	1	1		1	1							1		1								1	1		1
Radiola linoides	1						1																														
Ranunculus auricomus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1			1				1			1				
Ranunculus ficaria	1																																				
Ranunculus flammula																			1																		
Rhamnus cathartica	1	1	1					1					1	1				1									1										
Ribes alpinum		1																																			
Ribes nigrum	1	1		1		1	1																1			1					1						
Ribes rubrum	1	1	1	1		1	1	1			1			1									1			1					1		1				
Ribes spicatum				1		1	1													1		1															
Ribes sylvestre				1		1	1																														
Ribes uva-crispa	1																						1														
Rorripa palustris																				1																	
Rorripa sylvestris																				1																	

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Rosa arvensis		1	1	1		1	1	1			1		1													1											
Rubus caesius	1	1																																			
Rubus fruticosus	1																																				
Rubus idaeus	1																																				
Rubus saxatilis		1																																			
Rumex sanguineus	1																																			1	
Ruscus aculeatus	1			1		1	1						1													1											
Salix aurita					1																													1			
Salix caprea	1		1					1																			1	1									
Salix cinerea	1																																				
Salix pentandra																				1																	
Sanicula europaea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1						1	1	1
Scirpus sylvaticus		1	1	1	1	1	1	1		1		1	1	1					1	1							1	1			1						
Scrophularia nodosa	1		1					1	1		1			1	1	1							1					1									
Scutellaria minor							1																														
Sedum telephium	1		1	1	1	1	1					1	1				1																				
Senecio aquaticus																													1								

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Serratula tinctoria		1		1			1																														
Sibthorpia europaea						1																															
Silene dioica	1																														1						
Solidago virgaurea		1	1	1	1	1	1	1		1	1	1														1					1						
Sorbus (microspecies)						1																				1											
Sorbus aria																	1																				
Sorbus aucuparia	1		1					1					1			1																					
Sorbus rupicola		1																																			
Sorbus torminalis	1	1	1	1	1	1	1	1	1	1	1	1	1	1										1	1	1	1	1		1		1	1				1
Stachys officinalis	1	1		1	1	1	1		1	1			1																								
Stachys sylvatica	1														1																1						
Stellaria alsine																			1																		
Stellaria holostea	1	1	1		1				1		1				1	1								1					1								
Stellaria neglecta	1	1	1					1					1	1					1																		
Stellaria nemorum		1	1					1			1			1	1	1			1	1	1	1	1									1					
Tamus communis	1	1	1	1		1	1	1			1	1																									
Taxus baccata			1					1		1	1			1						1						1											

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Teucrium scorodonia	1																																	1			
Thalictrum flavum																			1																		
Tilia cordata	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1				1		1		1	1	1		1		1	1				
Tilia platyphyllos		1			1					1																											
Trichomanes speciosum																							1														
Trientalis europaea																					1													1		1	
Trollius europaeus		1																																			
Ulmus glabra		1	1	1	1	1	1	1		1	1	1		1		1										1											
Vaccinium myrtillus		1	1	1	1	1	1	1						1																				1			
Valeriana dioica									1										1																		
Valeriana officinalis									1							1			1										1								
Veronica chamaedrys	1																																				
Veronica montana	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1	1	1						1		
Veronica officinalis									1																												
Viburnum lantana	1												1																								

Appendix 03 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire.

	Region																																				
Scientific Name	**East**	**Derbs**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**Shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**North & Central Europe ***	**Mid Lothian ***	**Bedfordshire**	**N York neutral to calcareous**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leicestershire & Rutland**
Viburnum opulus	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	1		1				1							1				
Vicia sepium	1	1	1	1		1	1	1			1	1				1								1							1						
Vicia sylvatica		1	1	1	1	1	1	1	1	1	1	1		1		1	1	1		1	1	1			1							1			1		
Viola odorata	1		1					1																													
Viola palustris		1		1		1	1												1																		
Viola reichenbachiana	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1								1	1					1	1				
Viola riviniana	1	1			1				1				1																1								
Wahlenbergia hederacea						1	1																														
Total for region	154	123	121	109	109	108	106	103	90	90	87	86	83	81	69	67	58	57	56	56	55	52	47	45	43	42	38	37	32	29	29	28	27	25	23	21	18

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Scientific Name	Region																																					
	Derbs	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Luzula pilosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	35
Galium odoratum	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	34
Melica uniflora	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1		1	1		1	1	1	33
Anemone nemorosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1		1	1	1		1	32
Milium effusum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1			1			1	1	31
Carex pendula	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1	1				1	1			1	1	30
Carex sylvatica	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1		1	1	1	1	1	1			1			30
Oxalis acetosella	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			1	1	1			1	1			1	30
Sanicula europaea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1						1	1	1	30
Carex remota	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	1	1		1	1			1			29
Lysimachia nemorum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1			1	1	1			1			1	29
Paris quadrifolia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1			1		1	1				1	29
Epipactis helleborine	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		1		1			1					28
Lathraea squamaria	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1		1	1	1	1	1	1	1	1			1		1	1				1	28
Veronica montana	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1	1	1						1			28
Adoxa moschatellina	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	1		1		1	1		1		1				1		27
Allium ursinum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1			1						1		27
Hyacinthoides non-scripta	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1					1					1	1	1	1	27
Luzula sylvatica	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1			1	1	1			1			1	1	1	1		1	27
Melampyrum pratense	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1			1		1	1	1			1	1		1	1			1	1	1		27

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Neottia nidus-avis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1		1	1	1	1					1					26
Poa nemoralis	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1			1	1	1			1	1	1	1		1	1					1		26
Chrysosplenium oppositifolium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1				1				1		1	1					1	25
Polystichum aculeatum	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1		1	1	1	1			1			1		1		1		1			25
Ranunculus auricomus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1			1				1			1					25
Carex laevigata	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1	1			1	1	1	1							1			24
Lamiastrum galeobdolon	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1					1	1	1				1		1	1				1	24
Tilia cordata	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1				1		1		1	1	1		1		1	1					24
Carex pallescens	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1		1		1		1	1	1		1			1							23
Sorbus torminalis	1	1	1	1	1	1	1	1	1	1	1	1	1	1										1	1	1	1	1		1		1	1				1	23
Convallaria majalis	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1					1	1			1			1		1		1				22
Equisetum sylvaticum	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1	1	1	1		1		1		1										22
Mercurialis perennis	1	1	1		1			1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1							1					1		22
Orchis mascula	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1			1			1					1	1		1						22
Primula vulgaris	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1							1							22
Carex strigosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1							1		1	1		1							1	21
Chrysosplenium alternifolium	1	1	1		1			1	1	1	1	1	1	1	1	1		1	1	1	1	1					1					1	1					21
Festuca gigantea	1	1	1	1		1	1	1		1	1	1		1	1	1				1	1	1	1				1	1		1						1		21
Vicia sylvatica	1		1	1	1	1	1	1	1	1	1	1		1		1	1	1		1	1	1			1							1			1			21

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Euphorbia amygdaloides	1	1	1	1	1	1	1	1		1	1	1	1	1			1								1	1	1	1		1			1					20
Quercus petraea		1	1	1	1	1	1	1	1	1	1	1	1	1		1	1							1		1								1	1		1	20
Viburnum opulus	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1			1	1		1				1							1					20
Viola reichenbachiana	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1								1	1					1	1					20
Bromopsis ramosa	1	1	1	1	1	1	1	1		1	1	1		1		1				1	1	1	1				1	1										19
Campanula latifolia	1	1	1		1				1	1	1	1	1		1	1	1	1	1	1	1	1										1				1		19
Conopodium majus	1	1	1	1	1	1	1	1	1		1		1	1	1	1								1					1	1	1					1		19
Dryopteris affinis	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1									1	1									19
Elymus caninus	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1			1	1	1						1										19
Euonymus europaeus		1	1		1	1		1	1	1	1	1	1	1	1		1	1		1		1		1			1								1			19
Geum rivale	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1					1								1						19
Hypericum pulchrum	1	1	1	1	1	1	1	1	1			1			1	1	1	1						1					1		1	1				1		19
Polypodium vulgare	1	1	1	1	1	1	1	1			1	1	1			1					1	1							1		1		1	1				18
Polystichum setiferum	1	1	1	1	1	1	1		1	1	1	1	1	1				1		1	1	1	1															18
Campanula trachelium	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1							1						1								17
Frangula alnus	1	1	1	1	1	1	1	1	1		1	1	1	1				1	1							1								1				17
Potentilla sterilis	1	1	1	1		1	1	1	1	1			1	1	1	1								1		1			1		1							17
Acer campestre	1	1	1	1	1	1	1	1		1	1	1		1			1	1		1		1																16
Blechnum spicant	1	1	1	1	1	1	1	1	1	1		1	1	1		1													1					1				16

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Hypericum androsaemum		1	1	1	1	1	1	1		1	1	1		1		1										1		1		1			1					16
Malus sylvestris	1	1	1	1		1	1	1		1	1	1	1	1			1									1	1	1										16
Scirpus sylvaticus	1		1	1	1	1	1	1		1		1	1	1					1	1							1	1			1							16
Daphne laureola	1	1	1	1	1	1	1	1		1		1	1	1				1								1				1								15
Dryopteris carthusiana	1	1	1	1	1	1	1	1	1	1		1			1	1			1																1			15
Moehringia trinervia	1	1	1	1		1	1	1		1	1			1		1	1				1		1				1											15
Myosotis sylvatica	1	1	1		1			1	1	1	1		1			1				1	1	1	1								1							15
Populus tremula	1	1	1	1		1	1	1	1	1	1	1		1		1												1							1			15
Aquilegia vulgaris	1	1	1	1	1	1	1	1	1		1	1						1							1							1						14
Platanthera chlorantha		1	1	1	1	1	1	1	1	1		1	1	1			1	1																				14
Prunus avium	1	1	1	1	1	1	1	1	1		1	1	1			1										1												14
Festuca altissima	1		1		1					1	1	1			1			1		1	1	1	1												1			13
Lathyrus linifolius	1	1	1	1	1	1	1	1	1		1	1					1								1													13
Polygonatum multiflorum	1	1	1	1		1	1	1		1	1			1											1					1			1					13
Ribes rubrum	1	1	1	1		1	1	1			1			1									1			1					1		1					13
Stellaria nemorum	1		1					1			1			1	1	1			1	1	1	1	1									1						13
Ulmus glabra	1		1	1	1	1	1	1		1	1	1		1		1										1												13
Dryopteris aemula		1	1	1		1	1	1			1			1									1				1	1							1			12
Gymnocarpium dryopteris			1		1			1				1		1	1					1	1	1	1				1							1				12

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Helleborus viridis	1	1	1	1	1	1	1			1	1	1	1											1														12
Hordelymus europaeus	1	1		1	1					1			1				1	1		1		1		1								1						12
Melica nutans	1	1	1		1					1	1	1			1			1		1	1	1																12
Narcissus pseudonarcissus	1	1	1	1	1	1	1			1	1		1				1									1												12
Phegopteris connectilis			1			1		1							1	1				1	1	1	1								1			1	1			12
Solidago virgaurea	1		1	1	1	1	1	1		1	1	1														1					1							12
Vicia sepium	1	1	1	1		1	1	1			1	1				1								1							1							12
Carex paniculata		1		1	1	1	1		1										1	1					1		1					1						11
Dipsacus pilosus	1	1	1	1	1	1	1		1	1		1	1																									11
Gagea lutea	1	1			1					1			1		1			1		1	1	1										1						11
Ilex aquifolium	1	1	1	1		1	1	1		1	1				1	1																						11
Iris foetidissima		1	1	1	1	1	1	1		1		1	1	1																								11
Lathyrus sylvestris	1	1	1	1	1	1	1			1	1						1								1													11
Luzula forsteri			1	1	1	1	1	1			1			1			1								1	1												11
Oreopteris limbosperma	1	1	1	1	1	1	1	1		1		1																						1				11
Ceratocapnos claviculata	1	1	1	1		1		1	1														1					1						1				10
Phyllitis scolopendrium	1		1	1	1	1	1				1	1				1		1																				10
Scrophularia nodosa		1	1					1	1		1			1	1	1							1					1										10
Stellaria holostea	1	1	1		1				1		1				1	1								1					1									10

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Calamagrostis epigejos	1	1	1	1	1	1	1		1			1																										9
Carex montana	1	1		1	1	1	1		1																1						1							9
Holcus mollis	1		1	1		1	1	1			1	1				1																						9
Hypericum hirsutum		1	1						1		1		1		1	1	1							1														9
Prunus padus	1	1	1					1			1	1		1		1		1																				9
Rosa arvensis	1		1	1		1	1	1			1		1													1												9
Sedum telephium		1	1	1	1	1	1					1	1				1																					9
Stachys officinalis	1	1		1	1	1	1		1	1			1																									9
Tamus communis	1	1	1	1		1	1	1			1	1																										9
Vaccinium myrtillus	1		1	1	1	1	1	1						1																				1				9
Arum maculatum		1	1					1		1										1		1							1							1		8
Athyrium filix-femina		1			1				1				1		1		1		1												1							8
Brachypodium sylvaticum	1	1													1					1	1	1	1						1									8
Cardamine amara	1	1	1	1			1					1				1			1																			8
Circaea lutetiana		1	1								1		1		1								1						1							1		8
Corylus avellana		1							1						1	1	1												1					1	1			8
Crataegus laevigata	1	1		1	1		1						1				1							1														8
Epipactis purpurata		1		1	1		1			1			1				1								1													8
Fragaria vesca		1							1	1			1		1	1								1											1			8
Lonicera periclymenum	1	1	1					1							1						1								1					1				8

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Melittis melissophyllum			1			1		1						1				1							1		1	1										8
Rhamnus cathartica	1	1	1					1					1	1				1									1											8
Ribes nigrum	1	1		1		1	1																1			1					1							8
Stellaria neglecta	1	1	1					1					1	1					1																			7
Taxus baccata			1					1		1	1			1						1						1												7
Ajuga reptans	1	1											1								1			1					1									6
Helleborus foetidus	1	1	1		1					1		1																										6
Hymenophyllum tunbrigense			1			1		1				1															1	1										6
Hymenophyllum wilsonii			1					1				1									1						1	1										6
Listera ovata		1			1					1			1		1																1							6
Ruscus aculeatus		1		1		1	1						1													1												6
Viola riviniana	1	1			1				1				1																1									6
Calamagrostis canescens		1							1								1		1					1														5
Circaea intermedia	1														1						1	1	1															5
Cornus sanguinea		1							1	1			1					1																				5
Dactylorhiza fuchsii		1							1				1		1	1																						5
Equisetum telmateia	1				1										1				1		1																	5
Lathyrus montanus	1			1		1	1																			1												5
Pimpinella major		1			1		1						1				1																					5
Ribes spicatum				1		1	1													1		1																5
Salix caprea		1	1					1																			1	1										5

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Sorbus aucuparia		1	1					1					1			1																						5
Viola palustris	1			1		1	1												1																			5
Bromopsis benekenii										1					1								1		1													4
Calluna vulgaris			1					1						1																				1				4
Cardamine impatiens	1				1																1		1															4
Carpinus betulus		1		1			1						1																									4
Colchicum autumnale				1	1	1																											1					4
Corydalis claviculata				1		1								1												1												4
Daphne mezereum	1		1					1						1																								4
Epipactis phyllanthes			1							1		1													1													4
Geum urbanum		1	1					1																					1									4
Hypericum humifusum									1							1	1							1														4
Pyrola minor	1																	1																1		1		4
Valeriana officinalis									1							1			1										1									4
Agropyron caninum				1		1	1																															3
Cephalanthera longifolia				1	1										1																							3
Deshampsia flexuosa			1					1						1																								3
Epipactus leptochila				1						1															1													3

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Geranium robertianum		1																											1		1							3
Geranium sylvaticum					1					1								1																				3
Gnaphalium sylvaticum		1			1					1																												3
Lychnis flos-cuculi		1							1										1																			3
Lysimachia nummularia		1							1				1																									3
Melampyrum sylvaticum															1			1														1						3
Ophioglossum vulgatum		1							1																1													3
Ophrys insectifera		1															1								1													3
Polygonatum odoratum	1		1								1																											3
Primula elatior		1											1				1																					3
Ribes sylvestre				1		1	1																															3
Serratula tinctoria	1			1			1																															3
Stachys sylvatica		1													1																1							3
Tilia platyphyllos	1				1					1																												3
Trientalis europaea																					1													1		1		3
Viola odorata		1	1					1																														3
Aconitum napellus					1	1																																2
Apium nodiflorum															1				1																			2
Carex acutiformis									1										1																			2

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																				
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Cephalanthera damasonium					1																				1													2
Clematis vitalba		1											1																									2
Epilobium montanum															1						1																	2
Epipactis muelleri				1																					1													2
Eupatorium cannabinum									1										1																			2
Geranium sanguineum	1				1																																	2
Goodyera repens																						1	1															2
Hypericum tetrapterum									1															1														2
Juniperus communis																				1		1																2
Ligistrum vulgare		1																1																				2
Lithospermum officinale		1											1																									2
Lysimachia vulgaris					1				1																													2
Maianthemum bifolium		1							1																													2
Melampyrum cristatum		1															1																					2
Moneses uniflora																					1		1															2
Monotropa hypopitys					1																				1													2

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Pulmonaria longifolia				1		1																																2
Radiola linoides		1					1																															2
Ribes uva-crispa		1																					1															2
Rubus caesius	1	1																																				2
Rumex sanguineus		1																																		1		2
Salix aurita					1																													1				2
Silene dioica		1																													1							2
Sorbus (microspecies)						1																				1												2
Teucrium scorodonia		1																																1				2
Valeriana dioica									1										1																			2
Viburnum lantana		1											1																									2
Wahlenbergia hederacea						1	1																															2
Actaea spicata																		1																				1
Agrimonia procera													1																									1
Alchemilla filicaulis		1																																				1
Anagallis minima							1																															1
Arctium nemorosum	1																																					1
Berula erecta																			1																			1
Caltha palustris																			1																			1
Campanula patula					1																																	1
Carex acuta																			1																			1

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Carex binervis																																		1				1
Carex digitata	1																																					1
Carex elata																			1																			1
Carex elongata					1																																	1
Carex nigra																			1																			1
Carex pseudocyperus													1																									1
Carex riparia																			1																			1
Cirsium heterophyllum	1																																					1
Crepis paludosa																			1																			1
Dryopteris filix-mas		1																																				1
Epilobium obscurum									1																													1
Equisetum fluviatile																			1																			1
Equisetum hyemale	1																																					1
Erica tetralix																			1																			1
Galanthus nivalis																																	1					1
Glechoma hederacea		1																																				1
Hedera helix		1																																				1
Humulus lupulus									1																													1
Hypericum maculatum																				1																		1

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																					
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
hypericum perforatum																								1														1
Iris pseudacorus																			1																			1
Linnaea borealis																							1															1
Lycopus europaeus																			1																			1
Lysimachia thyrsiflora																			1																			1
Lythrum portula		1																																				1
Molinia caerulea																			1																			1
Myosotis laxa spp caespitosa																			1																			1
Myosotis scorpioides																			1																			1
Myosotis secunda																			1																			1
Oenanthe crocata																			1																			1
Orchis purpurea							1																															1
Orobanche hederae					1																																	1
Orthila secunda																							1															1
Osmunda regalis																				1																		1
Polygonatum verticillatum																							1															1
Prunus cerasifera		1																																				1
Pulmonaria obscura		1																																				1
Pyrus commumis		1																																				1
Pyrus pyraster		1																																				1
Ranunculus ficaria		1																																				1

Appendix 04 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

Table 1.1 - Total list of AWI species for England, Wales and Scotland from published lists and respondents to a questionnaire in descending order of the frequency of species on the lists.

	Region																																				
Scientific Name	**Derbs**	**East**	**All Wales**	**South**	**Worcs**	**South west**	**South east**	**South Wales**	**Lincolnshire**	**shropshire**	**East Wales**	**North East Wales**	**Suffolk**	**S E Wales**	**N & Central Europe**	**Mid Lothian ***	**Bedfordshire**	**N York neutral to**	**N Yorks wet**	**Durham**	**Borders & Lothian ***	**Northumb**	**All Scotland ***	**South Yorkshire**	**Dorset**	**Devon**	**Carmarthen**	**West wales**	**Northern Ireland ***	**Avon NSom S Glos**	**Angus ***	**NE Yorks**	**Somerset**	**N Yorks acid**	**Isle of Man ***	**Lothian ***	**Leics & Rutland**	**Total No of lists**
Ranunculus flammula																			1																			1
Ribes alpinum	1																																					1
Rorripa palustris																				1																		1
Rorripa sylvestris																				1																		1
Rubus fruticosus		1																																				1
Rubus idaeus		1																																				1
Rubus saxatilis	1																																					1
Salix cinerea		1																																				1
Salix pentandra																				1																		1
Scutellaria minor							1																															1
Senecio aquaticus																													1									1
Sibthorpia europaea						1																																1
Sorbus aria																	1																					1
Sorbus rupicola	1																																					1
Stellaria alsine																			1																			1
Thalictrum flavum																			1																			1
Trichomanes speciosum																							1															1
Trollius europaeus	1																																					1
Veronica chamaedrys		1																																				1
Veronica officinalis									1																													1
Total	123	154	121	109	109	108	106	103	90	90	87	86	83	81	69	67	58	57	56	56	55	52	47	45	43	42	38	37	32	29	29	28	27	25	23	21	18	

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Caltha palustris	25	100	31	100	15	100	19	100	400	4
Corylus avellana	25	100	31	100	15	100	19	100	400	4
Dactylorhiza fuchsii	25	100	31	100	15	100	19	100	400	4
Dryopteris filix-mas	25	100	31	100	15	100	19	100	400	4
Epilobium montanum	25	100	31	100	15	100	19	100	400	4
Geranium robertianum	25	100	31	100	15	100	19	100	400	4
Hedera helix	25	100	31	100	15	100	19	100	400	4
Ilex aquifolium	25	100	31	100	15	100	19	100	400	4
Lonicera periclymenum	25	100	31	100	15	100	19	100	400	4
Oxalis acetosella	25	100	31	100	15	100	19	100	400	4
Ranunculus ficaria	25	100	31	100	15	100	19	100	400	4
Rubus fruticosus agg.	25	100	31	100	15	100	19	100	400	4
Rubus idaeus	25	100	31	100	15	100	19	100	400	4
Salix caprea	25	100	31	100	15	100	19	100	400	4
Scrophularia nodosa	25	100	31	100	15	100	19	100	400	4
Silene dioica	25	100	31	100	15	100	19	100	400	4
Sorbus aucuparia	25	100	31	100	15	100	19	100	400	4
Stachys sylvatica	25	100	31	100	15	100	19	100	400	4
Ulmus glabra	25	100	31	100	15	100	19	100	400	4
Veronica chamaedrys	25	100	31	100	15	100	19	100	400	4
Vicia sepium	25	100	31	100	15	100	19	100	400	4
Viola riviniana	25	100	31	100	15	100	19	100	400	4
Myosotis scorpioides	25	100	30	97	15	100	19	100	397	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Athyrium filix-femina	24	96	31	100	15	100	19	100	396	4
Fragaria vesca	24	96	31	100	15	100	19	100	396	4
Glechoma hederacea	24	96	31	100	15	100	19	100	396	4
Holcus mollis	24	96	31	100	15	100	19	100	396	4
Hyacinthoides non-scripta	24	96	31	100	15	100	19	100	396	4
Valeriana officinalis	24	96	31	100	15	100	19	100	396	4
Mercurialis perennis	25	100	31	100	15	100	18	95	395	4
Stellaria holostea	25	100	31	100	15	100	18	95	395	4
Veronica montana	25	100	31	100	15	100	18	95	395	4
Lathyrus linifolius	25	100	29	94	15	100	19	100	394	4
Lychnis flos-cuculi	25	100	29	94	15	100	19	100	394	4
Ranunculus flammula	24	96	30	97	15	100	19	100	393	4
Senecio aquaticus	25	100	30	97	15	100	18	95	392	4
Geum urbanum	24	96	31	100	15	100	18	95	391	4
Moehringia trinervia	24	96	31	100	15	100	18	95	391	4
Prunus avium	24	96	31	100	15	100	18	95	391	4
Stellaria uliginosa	25	100	28	90	15	100	19	100	390	4
Carex nigra	24	96	29	94	15	100	19	100	390	4
Lysimachia nemorum	24	96	29	94	15	100	19	100	390	4
Bromopsis ramosa	25	100	31	100	15	100	17	89	389	4
Circaea lutetiana	25	100	31	100	15	100	17	89	389	4
Hypericum tetrapterum	24	96	31	100	14	93	19	100	389	4
Carex remota	24	96	30	97	15	100	18	95	388	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Phyllitis scolopendrium	24	96	30	97	15	100	18	95	388	4
Deschampsia flexuosa	24	96	28	90	15	100	19	100	386	4
Quercus petraea	24	96	28	90	15	100	19	100	386	4
Stachys officinalis	25	100	30	97	15	100	17	89	386	4
Festuca gigantea	24	96	31	100	15	100	17	89	385	4
Iris pseudacorus	24	96	31	100	15	100	17	89	385	4
Taxus baccata	24	96	31	100	15	100	17	89	385	4
Myosotis sylvatica	25	100	28	90	15	100	18	95	385	4
Brachypodium sylvaticum	25	100	31	100	15	100	16	84	384	4
Viburnum opulus	24	96	31	100	14	93	18	95	384	4
Equisetum fluviatile	24	96	27	87	15	100	19	100	383	4
Ribes uva-crispa	25	100	31	100	14	93	17	89	383	4
Veronica officinalis	25	100	27	87	15	100	18	95	382	4
Potentilla sterilis	25	100	30	97	14	93	17	89	380	4
Teucrium scorodonia	23	92	27	87	15	100	19	100	379	4
Rumex sanguineus	24	96	31	100	14	93	17	89	379	4
Salix cinerea	21	84	29	94	15	100	19	100	378	4
Primula vulgaris	25	100	31	100	14	93	16	84	378	4
Melica uniflora	25	100	30	97	15	100	15	79	376	4
Malus sylvestris s.l.	24	96	30	97	14	93	17	89	376	4
Ajuga reptans	25	100	25	81	15	100	18	95	375	4
Allium ursinum	25	100	25	81	15	100	18	95	375	4
Conopodium majus	25	100	23	74	15	100	19	100	374	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.										
Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA										
SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Anemone nemorosa	24	96	24	77	15	100	19	100	373	4
Epilobium obscurum	23	92	27	87	14	93	19	100	372	4
Cardamine amara	24	96	25	81	14	93	19	100	370	4
Carex sylvatica	22	88	31	100	13	87	18	95	369	4
Populus tremula	21	84	30	97	14	93	18	95	369	4
Hypericum pulchrum	23	92	29	94	13	87	18	95	367	4
Arum maculatum	25	100	25	81	15	100	16	84	365	4
Hypericum perforatum	21	84	31	100	14	93	16	84	362	4
Calluna vulgaris	21	84	24	77	15	100	19	100	361	4
Galium odoratum	22	88	26	84	15	100	17	89	361	4
Chrysosplenium oppositifolium	23	92	23	74	14	93	19	100	360	4
Solidago virgaurea	21	84	23	74	15	100	19	100	358	4
Sorbus aria	18	72	28	90	15	100	18	95	357	4
Blechnum spicant	22	88	21	68	15	100	19	100	356	4
Rorippa palustris	16	64	30	97	15	100	18	95	356	4
Luzula pilosa	21	84	23	74	14	93	19	100	352	4
Prunus padus	23	92	22	71	14	93	18	95	351	4
Milium effusum	17	68	30	97	15	100	16	84	349	4
Campanula latifolia	25	100	31	100	11	73	14	74	347	4
Ligustrum vulgare	19	76	31	100	13	87	16	84	347	4
Viola palustris	25	100	16	52	14	93	19	100	345	4
Sanicula europaea	23	92	31	100	11	73	15	79	344	4
Ophioglossum vulgatum	20	80	25	81	14	93	17	89	343	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.										
Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA										
SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Rosa arvensis	12	48	31	100	15	100	18	95	343	4
Lysimachia vulgaris	20	80	26	84	14	93	16	84	341	4
Salix aurita	21	84	23	74	12	80	19	100	338	4
Luzula sylvatica	23	92	17	55	15	100	17	89	336	4
Molinia caerulea	20	80	21	68	14	93	18	95	336	4
Dryopteris affinis	21	84	16	52	14	93	19	100	329	4
Tamus communis	19	76	31	100	14	93	11	58	327	4
Equisetum sylvaticum	18	72	17	55	15	100	19	100	327	4
Ribes rubrum	22	88	30	97	11	73	13	68	327	4
Adoxa moschatellina	25	100	25	81	10	67	15	79	326	4
Epipactis helleborine	17	68	23	74	14	93	17	89	325	4
Geum rivale	24	96	27	87	10	67	14	74	323	4
Poa nemoralis	23	92	28	90	10	67	14	74	323	4
Lamiastrum galeobdolon	11	44	29	94	15	100	16	84	322	4
Vaccinium myrtillus	21	84	13	42	14	93	19	100	319	4
Elymus caninus	20	80	26	84	13	87	13	68	319	4
Valeriana dioica	24	96	25	81	9	60	15	79	316	4
Orchis mascula	21	84	27	87	10	67	14	74	311	4
Lysimachia nummularia	16	64	29	94	11	73	15	79	310	4
Viola odorata	21	84	30	97	9	60	13	68	309	4
Ribes nigrum	17	68	27	87	11	73	15	79	307	4
Carex acutiformis	24	96	30	97	6	40	14	74	306	4
Listera ovata	21	84	29	94	9	60	13	68	306	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Oreopteris limbosperma	17	68	10	32	15	100	19	100	300	4
Ranunculus auricomus	22	88	30	97	9	60	10	53	297	4
Apium nodiflorum	18	72	18	58	13	87	15	79	296	4
Galanthus nivalis	24	96	29	94	8	53	10	53	296	4
Crepis paludosa	25	100	15	48	10	67	15	79	294	4
Myosotis secunda	20	80	14	45	11	73	18	95	293	4
Salix pentandra	21	84	17	55	10	67	16	84	290	4
Cornus sanguinea	16	64	31	100	9	60	12	63	287	4
Humulus lupulus	14	56	30	97	12	80	10	53	285	4
Melampyrum pratense	18	72	13	42	13	87	16	84	285	4
Rorippa sylvestris	19	76	24	77	11	73	11	58	285	4
Carex pendula	16	64	18	58	13	87	14	74	282	4
Carpinus betulus	17	68	27	87	10	67	11	58	280	4
Hypericum humifusum	16	64	18	58	11	73	15	79	274	4
Hypericum hirsutum	22	88	29	94	6	40	10	53	274	4
Pimpinella major	18	72	30	97	7	47	11	58	273	4
Eupatorium cannabinum	15	60	29	94	7	47	13	68	269	4
Polystichum aculeatum	20	80	17	55	9	60	13	68	263	4
Lathraea squamaria	17	68	26	84	8	53	11	58	263	4
Euonymus europaeus	19	76	7	23	10	67	18	95	260	4
Lycopus europaeus	13	52	29	94	10	67	9	47	260	4
Equisetum telmateia	19	76	22	71	8	53	11	58	258	4
Carex binervis	15	60	8	26	11	73	17	89	249	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Dryopteris carthusiana	12	48	19	61	9	60	15	79	248	4
Viola reichenbachiana	21	84	28	90	5	33	7	37	244	4
Aquilegia vulgaris	13	52	13	42	12	80	12	63	237	4
Carex laevigata	10	40	4	13	14	93	17	89	236	4
Erica tetralix	14	56	26	84	6	40	10	53	233	4
Arctium minus subsp. nemorosum	23	92	23	74	1	7	11	58	231	4
Ceratocapnos claviculata	14	56	13	42	12	80	10	53	231	4
Carex pallescens	14	56	15	48	9	60	12	63	228	4
Carex paniculata	16	64	18	58	5	33	13	68	224	4
Berula erecta	14	56	22	71	6	40	10	53	220	4
Tilia cordata	14	56	21	68	7	47	9	47	218	4
Stellaria nemorum	23	92	15	48	4	27	6	32	199	4
Clematis vitalba	10	40	25	81	6	40	7	37	197	4
Rhamnus cathartica	12	48	25	81	4	27	7	37	192	4
Oenanthe crocata	9	36	21	68	10	67	4	21	191	4
Polygonatum multiflorum	12	48	17	55	6	40	9	47	190	4
Carex acuta	14	56	21	68	4	27	7	37	187	4
Chrysosplenium alternifolium	19	76	7	23	5	33	10	53	185	4
Hypericum androsaemum	12	48	15	48	5	33	10	53	182	4
Hypericum maculatum	9	36	12	39	7	47	11	58	179	4
Carex riparia	8	32	25	81	5	33	6	32	178	4
Crataegus laevigata	1	4	19	61	10	67	8	42	174	4
Hordelymus europaeus	11	44	12	39	6	40	8	42	165	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.										
Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA										
SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Scirpus sylvaticus	11	44	13	42	3	20	8	42	148	4
Prunus cerasifera	3	12	14	45	8	53	7	37	147	4
Geranium sylvaticum	22	88	6	19	2	13	5	26	147	4
Paris quadrifolia	15	60	20	65	1	7	3	16	147	4
Tilia platyphyllos	9	36	16	52	4	27	6	32	146	4
Ribes alpinum	11	44	12	39	3	20	8	42	145	4
Polypodium vulgare	6	24	4	13	5	33	14	74	144	4
Polystichum setiferum	8	32	8	26	5	33	10	53	144	4
Phegopteris connectilis	10	40	2	6	5	33	12	63	143	4
Gymnocarpium dryopteris	9	36	3	10	5	33	12	63	142	4
Convallaria majalis	5	20	19	61	5	33	5	26	141	4
Serratula tinctoria	6	24	16	52	5	33	6	32	141	4
Helleborus viridis	12	48	18	58	2	13	4	21	140	4
Thalictrum flavum	5	20	17	55	3	20	8	42	137	4
Narcissus pseudonarcissus	4	16	7	23	9	60	7	37	135	4
Cirsium heterophyllum	13	52	3	10	3	20	10	53	134	4
Lythrum portula	8	32	5	16	5	33	10	53	134	4
Frangula alnus	4	16	18	58	3	20	6	32	126	4
Stellaria neglecta	8	32	17	55	1	7	6	32	125	4
Calamagrostis epigejos	4	16	21	68	2	13	5	26	123	4
Gagea lutea	15	60	15	48	0		2	11	119	3
Daphne laureola	10	40	15	48	2	13	3	16	118	4
Helleborus foetidus	4	16	15	48	3	20	6	32	116	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.										
Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA										
SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Viburnum lantana	1	4	13	42	6	40	5	26	112	4
Trollius europaeus	11	44	3	10	4	27	6	32	112	4
Gnaphalium sylvaticum	13	52	8	26	1	7	4	21	106	4
Platanthera chlorantha	2	8	8	26	2	13	11	58	105	4
Lithospermum officinale	8	32	17	55	1	7	1	5	99	4
Melica nutans	7	28	9	29	2	13	5	26	97	4
Pyrus communis s.l.	3	12	14	45	5	33	1	5	96	4
Carex elata	9	36	16	52	1	7	0		94	3
Geranium sanguineum	4	16	11	35	2	13	5	26	91	4
Agrimonia procera	5	20	5	16	4	27	5	26	89	4
Campanula trachelium	1	4	10	32	3	20	6	32	88	4
Wahlenbergia hederacea	0		0		6	40	9	47	87	2
Colchicum autumnale	8	32	15	48	0		1	5	86	3
Myosotis laxa subsp. caespitosa	3	12	5	16	7	47	2	11	85	4
Scutellaria minor	2	8	2	6	3	20	9	47	82	4
Sorbus torminalis	1	4	13	42	3	20	3	16	82	4
Osmunda regalis	1	4	3	10	5	33	6	32	79	4
Pyrola minor	6	24	5	16	1	7	6	32	78	4
Ophrys insectifera	3	12	14	45	0		3	16	73	3
Neottia nidus-avis	4	16	11	35	0		4	21	73	3
Trientalis europaea	10	40	2	6	3	20	1	5	72	4
Rubus saxatilis	6	24	2	6	2	13	5	26	70	4
Carex strigosa	2	8	6	19	2	13	5	26	67	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA

SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Dipsacus pilosus	6	24	6	19	0		4	21	64	3
Circaea alpina x lutetiana (C. x intermedia)	0		0		4	27	7	37	64	2
Vicia sylvatica	6	24	2	6	1	7	5	26	63	4
Daphne mezereum	4	16	5	16	0		5	26	58	3
Sedum telephium	1	4	2	6	1	7	7	37	54	4
Calamagrostis canescens	4	16	10	32	0		1	5	54	3
Carex pseudocyperus	2	8	8	26	1	7	2	11	51	4
Juniperus communis	6	24	1	3	1	7	3	16	50	4
Monotropa hypopitys	2	8	4	13	1	7	4	21	49	4
Sorbus rupicola	4	16	3	10	0		4	21	47	3
Ruscus aculeatus	3	12	9	29	0		1	5	46	3
Carex digitata	3	12	7	23	0		2	11	45	3
Lathyrus sylvestris	2	8	4	13	2	13	2	11	45	4
Festuca altissima	4	16	1	3	1	7	3	16	42	4
Equisetum hyemale	4	16	4	13	1	7	1	5	41	4
Iris foetidissima	1	4	9	29	1	7	0		40	3
Rosa caesia	1	4	2	6	1	7	3	16	33	4
Cardamine impatiens	0		2	6	0		5	26	33	2
Ribes spicatum	7	28	1	3	0		0		31	2
Alchemilla filicaulis	1	4	1	3	1	7	3	16	30	4
Euphorbia amygdaloides	0		7	23	0		1	5	28	2
Epipactis phyllanthes	2	8	6	19	0		0		27	2
Bromopsis benekenii	2	8	2	6	1	7	1	5	26	4

Appendix 05 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.

Table 1.1 - List of species recorded for NCAs 22, 30, 37 and 51 showing how many from the 'total' list of candidate species are found in each.										
Red numbers are the numbers of 10km square at least partly within the NCA and the grey columns show the percentage of 10km squares for each NCA										
SPECIES	NCA22	25	NCA30	31	NCA37	15	NCA51	19	Cuml %	Count
Lysimachia thyrsiflora	0		2	6	2	13	1	5	25	3
Radiola linoides	2	8	4	13	0		0		21	2
Polygonatum odoratum	1	4	1	3	0		2	11	18	3
Hymenophyllum tunbrigense	1	4	0		1	7	1	5	16	3
Hymenophyllum wilsonii	1	4	0		1	7	1	5	16	3
Pyrus pyraster s.str.	0		1	3	1	7	1	5	15	3
Anagallis minima	0		0		1	7	1	5	12	2
Carex elongata	0		2	6	0		1	5	12	2
Epipactis leptochila	2	8	0		0		0		8	1
Campanula patula	0		2	6	0		0		6	1
Cephalanthera longifolia	0		2	6	0		0		6	1
Melampyrum sylvaticum	1	4	0		0		0		4	1
Carex montana	0		1	3	0		0		3	1
Cephalanthera damasonium	0		1	3	0		0		3	1
Epipactis purpurata	0		1	3	0		0		3	1
Orobanche hederae	0		1	3	0		0		3	1
Total for NCA	232		239		221		233			

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.								
NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.								
Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Adoxa moschatellina		100		70	55	3	100	75
Agrimonia procera						0	0	
Ajuga reptans	100	100	65			3	100	88
Alchemilla filicaulis						0	0	
Allium ursinum		100		70	68	3	100	79
Anagallis minima						0	0	
Anemone nemorosa	100	100		80	85	4	100	91
Apium nodiflorum		25				1	25	25
Aquilegia vulgaris		33		100	100	3	100	78
Arctium minus		60				1	60	60
Arum maculatum	100	67				2	100	84
Athyrium filix-femina		96				1	96	96
Berula erecta						0	0	
Blechnum spicant	100	94	58			3	100	84
Brachypodium sylvaticum	100	71				2	100	86
Bromopsis benekenii						0	0	
Bromopsis ramosa		83	63			2	83	73
Calamagrostis canescens		100		100	86	3	100	95
Calamagrostis epigejos		100				1	100	100
Caltha palustris		75				1	75	75
Calluna vulgaris		79				1	79	79
Campanula latifolia		80		70	53	3	80	68
Campanula patula						0	0	
Campanula trachelium		67		100	83	3	100	83
Carex acutiformis					67	1	67	67
Cardamine amara		100				1	100	100
Carpinus betulus		17				1	17	17
Carex binervis		100				1	100	100

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Carex digitata		100				1	100	100
Carex elata						0	0	
Carex elongata						0	0	
Cardamine impatiens						0	0	
Carex laevigata		100		100	100	3	100	100
Carex montana						0	0	
Carex nigra		100				1	100	100
Carex pallescens				100	97	2	100	99
Carex paniculata						0	0	
Carex pendula			61	100	100	3	100	87
Carex pseudocyperus						0	0	
Carex remota	100	100	59	90	82	5	100	86
Carex riparia						0	0	
Carex strigosa				100	100	2	100	100
Carex sylvatica	100	100	63		65	4	100	82
Carex acuta						0	0	
Cephalanthera damasonium						0	0	
Cephalanthera longifolia						0	0	
Ceratocapnos claviculata		85				1	85	85
Chrysosplenium alternifolium				100	100	2	100	100
Chrysosplenium oppositifolium	100	100	57	90	60	5	100	81
Cirsium heterophyllum		100				1	100	100
Circaea lutetiana		85				1	85	85
Circaea alpina x lutetiana (C. x intermedia)						0	0	
Clematis vitalba		33				1	33	33
Colchicum autumnale			80			1	80	80

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Conopodium majus	100	100		100	70	4	100	92
Convallaria majalis		100		80	79	3	100	86
Corylus avellana	100	89			55	3	100	81
Cornus sanguinea		75	75		68	3	1	73
Crataegus laevigata		100				1	100	100
Crepis paludosa		100				1	100	100
Dactylorhiza fuchsii		100			70	2	100	85
Daphne laureola		100	67			2	100	84
Daphne mezereum						0	0	
Deschampsia flexuosa		82				1	82	82
Dipsacus pilosus				70	90	2	90	80
Dryopteris affinis		100				1	100	100
Dryopteris carthusiana						0	0	
Dryopteris filix-mas		79				1	79	79
Elymus caninus				100	60	2	100	80
Epipactis helleborine		100	67		80	3	100	82
Epipactis leptochila						0	0	
Epilobium montanum		100				1	100	100
Epilobium obscurum		50			75	2	75	63
Epipactis phyllanthes						0	0	
Epipactis purpurata						0	0	
Equisetum fluviatile						0	0	
Equisetum hyemale						0	0	
Equisetum sylvaticum	100	100		100	100	4	100	100
Equisetum telmateia		100				1	100	100
Erica tetralix						0	0	
Euonymus europaeus		69	72	100	83	4	100	81
Euphorbia amygdaloides			77			1	77	77

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Eupatorium cannabinum					69	1	69	69
Festuca altissima						0	0	
Festuca gigantea		75				1	75	75
Frangula alnus		100			63	2	100	82
Fragaria vesca		67	70		67	3	70	68
Gagea lutea						0	0	
Galanthus nivalis						0	0	
Galium odoratum		100		90	94	3	100	95
Geranium robertianum	100	84				2	100	92
Geranium sanguineum		100				1	100	100
Geranium sylvaticum						0	0	
Geum rivale		100	75	100	68	4	100	85
Geum urbanum		81				1	81	81
Glechoma hederacea		63				1	63	63
Gnaphalium sylvaticum						0	0	
Gymnocarpium dryopteris		100				1	100	100
Hedera helix		65				1	65	65
Helleborus foetidus						0	0	
Helleborus viridis						0	0	
Holcus mollis		69	67			2	69	68
Hordelymus europaeus		25				1	25	25
Humulus lupulus					60	1	60	60
Hyacinthoides non-scripta	100	80			61	3	100	80
Hymenophyllum tunbrigense						0	0	
Hymenophyllum wilsonii						0	0	
Hypericum androsaemum			83			1	83	83
Hypericum hirsutum		89		80	71	3	89	80
Hypericum humifusum					69	1	69	69

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Hypericum maculatum						0	0	
Hypericum perforatum		50				1	50	50
Hypericum pulchrum	100	100	43		56	4	100	75
Hypericum tetrapterum		67			57	2	67	62
Ilex aquifolium	100	76	51			3	100	76
Iris foetidissima			50			1	50	50
Iris pseudacorus		33				1	33	33
Juniperus communis						0	0	
Lamiastrum galeobdolon		95		90	83	3	95	89
Lathyrus linifolius					100	1	100	100
Lathraea squamaria		100	100	100	100	4	100	100
Lathyrus sylvestris						0	0	
Ligustrum vulgare		68				1	68	68
Listera ovata						0	0	
Lithospermum officinale						0	0	
Lonicera periclymenum	100	85				2	100	93
Luzula pilosa		100		90	86	3	100	92
Luzula sylvatica	100	100		90	93	4	100	96
Lycopus europaeus		50				1	50	50
Lychnis flos-cuculi					79	1	79	79
Lysimachia nemorum	100	100	72	80	91	5	100	89
Lysimachia nummularia					69	1	69	69
Lysimachia thyrsiflora						0	0	
Lysimachia vulgaris					94	1	94	94
Lythrum portula						0	0	
Malus sylvestris sens.lat.		67	78			2	78	73
Melica nutans		100				1	100	100
Melampyrum pratense		100	67	100	100	4	100	92

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Melampyrum sylvaticum						0	0	
Melica uniflora		90		90	90	3	90	90
Mercurialis perennis		77			54	2	77	66
Milium effusum		81		100	91	3	100	91
Moehringia trinervia		77	50			2	77	64
Molinia caerulea		88				1	88	88
Monotropa hypopitys						0	0	
Myosotis laxa						0	0	
Myosotis scorpioides		100				1	100	100
Myosotis secunda						0	0	
Myosotis sylvatica		86				1	86	86
Narcissus pseudonarcissus		100	67			2	100	84
Neottia nidus-avis			80	100	100	3	100	93
Oenanthe crocata						0	0	
Ophrys insectifera						0	0	
Ophioglossum vulgatum					60	1	60	60
Orchis mascula	100	100	63	100	82	5	100	89
Oreopteris limbosperma		100				1	100	100
Orobanche hederae						0	0	
Osmunda regalis						0	0	
Oxalis acetosella	100	97	61	100	86	5	100	89
Paris quadrifolia				100	100	2	100	100
Phegopteris connectilis						0	100	
Phyllitis scolopendrium		100				1	100	100
Pimpinella major		100	56			2	100	78
Platanthera chlorantha			64	80	94	3	94	79
Poa nemoralis		80	56		75	3	80	70
Polystichum aculeatum		100		100		2	100	100

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Polygonatum multiflorum						0	0	
Polygonatum odoratum						0	0	
Polystichum setiferum			58			1	58	58
Polypodium vulgare	100	100				2	100	100
Populus tremula		83			71	2	83	77
Potentilla sterilis	100	100			82	3	100	94
Primula vulgaris	100	100	58	100	75	5	100	87
Prunus avium		73			57	2	73	65
Prunus cerasifera						0	0	
Prunus padus		100				1	100	100
Pyrus communis sens.lat.						0	0	
Pyrola minor						0	0	
Quercus petraea	100	69		100	72	4	100	85
Radiola linoides						0	0	
Ranunculus auricomus			75	80	75	3	80	77
Ranunculus ficaria	100	94	60			3	100	85
Ranunculus flammula	100	100				2	100	100
Rhamnus cathartica		100				1	100	100
Ribes alpinum		100				1	100	100
Ribes nigrum		100				1	100	100
Ribes rubrum		100				1	100	100
Ribes spicatum						0	0	
Ribes uva-crispa		100				1	100	100
Rorippa palustris						0	0	
Rorippa sylvestris						0	0	
Rosa arvensis		79	57			2	79	68
Rosa caesia						0	0	
Rubus fruticosus agg.		60				1	60	60
Rubus idaeus		80				1	80	80

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.

NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.

Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Rubus saxatilis		100				1	100	100
Rumex sanguineus		65				1	65	65
Ruscus aculeatus						0	0	
Salix aurita						0	0	
Salix caprea		67				1	67	67
Salix cinerea		51				1	51	51
Salix pentandra						0	0	
Sanicula europaea	100	90		70	56	4	100	79
Scirpus sylvaticus						0	0	
Scrophularia nodosa		25			72	2	72	49
Scutellaria minor						0	0	
Sedum telephium		100			100	2	100	100
Senecio aquaticus		50				1	50	50
Serratula tinctoria						0	0	
Silene dioica		77				1	77	77
Sorbus torminalis		100	100	100	86	4	100	97
Solidago virgaurea		100	67			2	100	84
Sorbus aria		38				1	38	38
Sorbus aucuparia		82				1	82	82
Sorbus rupicola		100				1	100	100
Stachys officinalis		100	43		66	3	100	70
Stachys sylvatica		83				1	83	83
Stellaria holostea	100	100			58	3	100	86
Stellaria neglecta		100				1	100	100
Stellaria nemorum		100			100	2	100	100
Stellaria uliginosa						0	0	
Tamus communis		70	58			2	70	64
Taxus baccata		77	89			2	89	83

Appendix 06 - List of species determined by four authors to be preferential for ancient woodlands.

Table 1.1 - List of species determined by four authors to be preferential for ancient woodlands.								
NI quoted species as statistically shown to be ancient woodland indicator species, therefore converted to 100%. Peterken (1974) scores 1-6 converted to %. 1 = 100%, 2 = 90%, 3 = 80%, 4 = 70%, 5 = 60% 6 = 100%. Highest fidelity by an author = Max % weighting. Average is an evening out of the differences between authors.								
Taxon name	WOODLAND TRUST NI 2007	VICKERS 2001	THOMPSON 2003	PETERKEN 1974	PETERKEN 2000	Count	Max % weighting	Average % weighting
Teucrium scorodonia		82				1	82	82
Thalictrum flavum						0	0	
Tilia cordata		50	67	100	85	4	100	76
Tilia platyphyllos		100				1	100	100
Trientalis europaea						0	0	
Trollius europaeus						0	0	
Ulmus glabra		63				1	63	63
Vaccinium myrtillus	100	96				2	100	98
Valeriana dioica					78	1	78	78
Valeriana officinalis		100			75	2	100	88
Veronica chamaedrys		76				1	76	76
Veronica montana	100	100		70	71	4	100	85
Veronica officinalis					59	1	59	59
Viburnum lantana			80			1	80	80
Viburnum opulus	100	93	71		60	4	100	81
Vicia sepium		92	50			2	92	71
Vicia sylvatica			67		100	2	100	84
Viola odorata		70				1	70	70
Viola palustris		100				1	100	100
Viola reichenbachiana				80	76	2	80	78
Viola riviniana	100	80				2	100	90
Wahlenbergia hederacea						0	0	

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

This method used a fixed point camera on a tripod to take successive images rotated through 360º horizontally and at four levels vertically plus the azimuth. The camera was a digital SLR (Canon 650D) with a wide-angle lens (Sigma 17-70 on an APS sensor = 27mm equivalent on a full frame of 35mm film camera at the 17mm zoom). The vertical level rotations were at -30º, 0º, 30º and 60º from horizontal in 30º increments. each rotation generating 12 images. The equipment was aligned to have the first image pointing north and retuning to north for a final image (No 13, not used). The north point was marked with a ski pole and the author's Scale Bear that was slung in the strap to identify the north pole. The bear is 10cm tall sitting down as on the pictures. A further pole was positioned south to act as an additional reference point in the panoramas. The arrangement of the equipment is shown at Figure 1.1 and a close-up of the panorama head at Figure 2.2.

Figure 1.1 - Panorama equipment setup in Tickhill Wood showing stump used as reference and Scale Bear at the north pole.

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

`

Figure 2.2 - Close-up of the panorama head with the rotating base used to index the vertical angles of each 360º rotation. A similar rotating base, off-shot at the bottom (on top of the tripod) indexes the 30º rotations for each shot.

The images were processed using the PTGui software (https://www.ptgui.com). Two types of panorama were generated a cylindrical version using each of the passes L1 and L2 (-30º and 0º). These can be printed and also viewed using a standard panorama viewer like Panini (available from https://sourceforge.net/projects/pvqt/). This allows panning and vertical tilting up and down as well as zooming in and out and used the jpg files generated by PTGui. The two-level pass panoramas allow enough vertical tilting to gain a good impression of the conditions within the wood. The other version of panorama uses all 4 levels of rotation passes and the azimuth to create a better than 180º x 360º panorama. Because of the tripod the nadir is not captured so a spherical panorama cannot be created. This is not essential as the -30º level is sufficient to study the ground flora close to the tripod and this is also the area that becomes damaged over time owing to the repeat trampling to rotate the panorama head on each visit.

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Example panoramas from Site 1 in Scalibar Wood and Site 3 in Tickhill Wood are at Figure 4.3 and Figure 5.4 respectively. The left and right edges are both north and the centre faces south.

A single north shot at -30º and the azimuth from each session for Site 1 and Site 3 are included from Figure 6.5 to Figure 14.38 indicating the date shot. The frequency of photography was aimed at recording the main period of ground flora development and tree leaf emergence. The decline in ground flora, post flowering and leaf shed were taken when it was judged appropriate.

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 4.3 - Scalibar wood - Site 1 - Winter and summer panorama examples. North to the left and right, south in the centre

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 5.4 - Tickhill woods - Site 3 - Winter and summer panorama examples. North to the left and right, south in the centre

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 6.5 -2015-02-03 - Site 1 - North

Figure 6.6 -2015-02-03 - Site 1 - Azimuth

Figure 6.7 -2015-02-15 - Site 1 - North

Figure 6.8 -2015-02-15 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 7.9 -2015-03-01 - Site 1 - North

Figure 7.10 -2015-03-01 - Site 1 - Azimuth

Figure 7.11 -2015-03-15 - Site 1 - North

Figure 7.12 -2015-03-15 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 8.13 - 2015-03-26 - Site 1 - Azimuth

Figure 8.14 - 2015-03-26 - Site 1 - Azimuth

Figure 8.15 -2015-04-05 - Site 1 - North

Figure 8.16 -2015-04-05 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

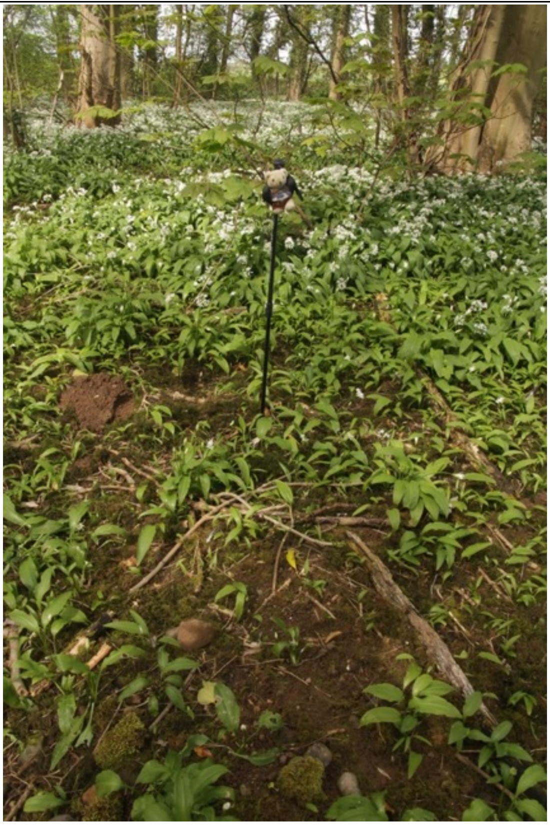
Figure 9.17 - 2015-04-18 - Site 1 - North

Figure 9.18 - 2015-04-18 - Site 1 - Azimuth

Figure 9.19 -2015-04-27 - Site 1 - North

Figure 9.20 -2015-04-27 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

 Figure 10.21 - 2015-05-04 - Site 1 - North	 Figure 10.22 - 2015-05-04 - Site 1 - Azimuth
 Figure 10.23 - 2015-05-10 - Site 1 - North	 Figure 10.24 - 2015-05-10 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

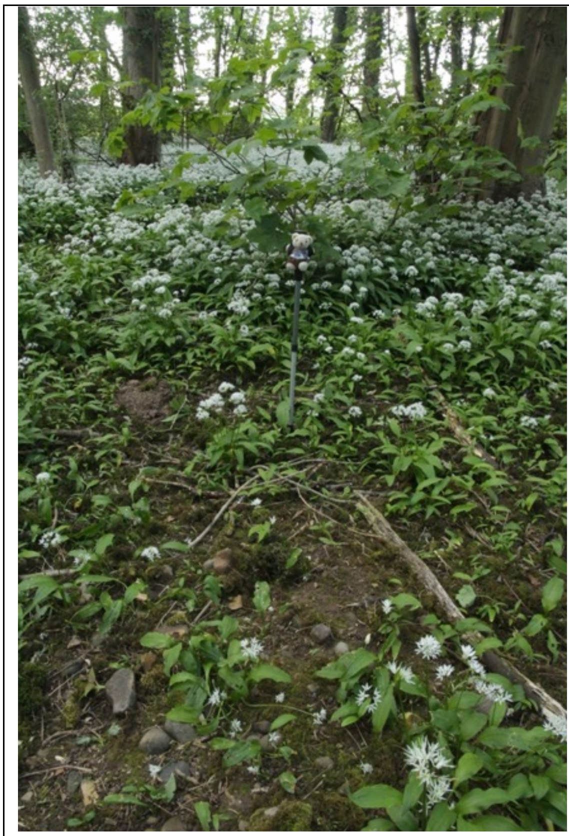


Figure 11.25 - 2015-05-16 - Site 1 - North

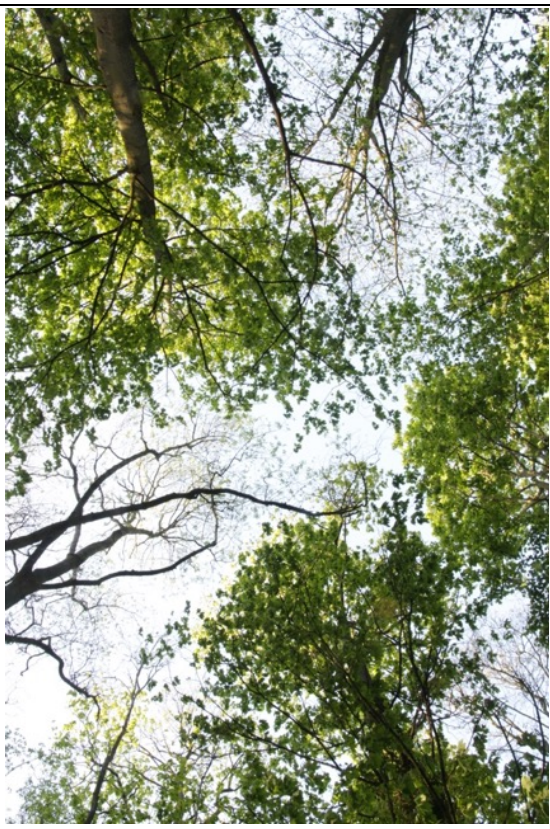


Figure 11.26 - 2015-05-16 - Site 1 - Azimuth

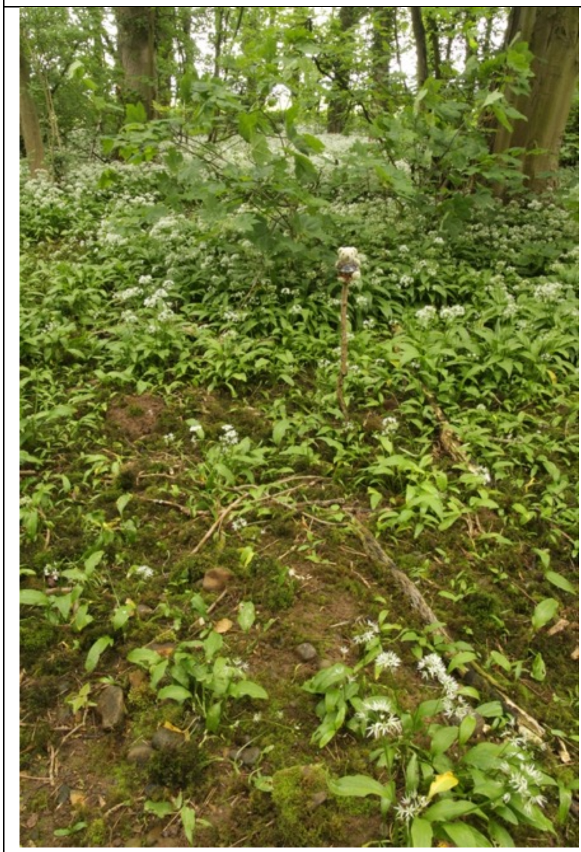


Figure 11.27 - 2015-05-24 - Site 1 - North

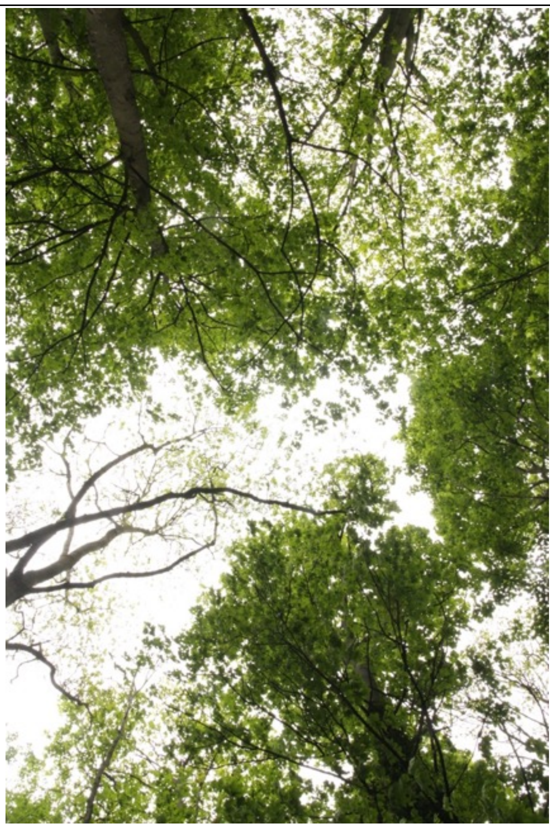


Figure 11.28 - 2015-05-24 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

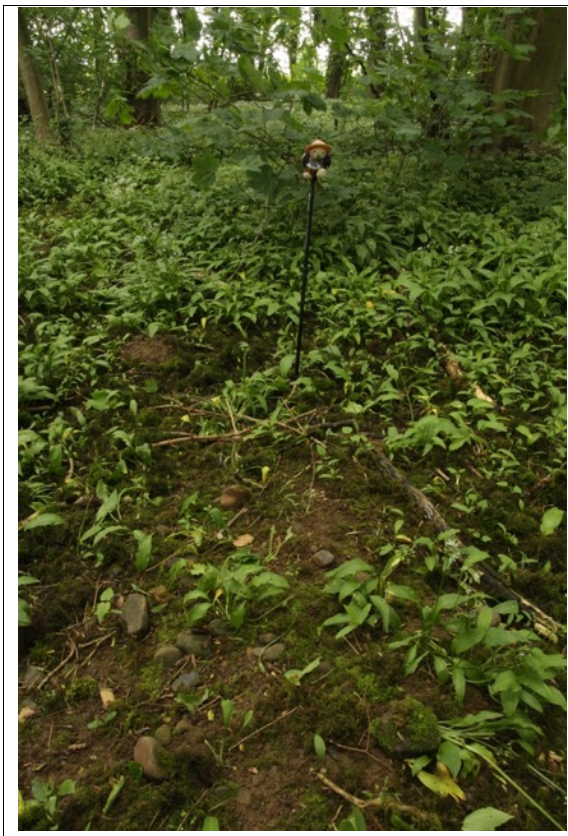


Figure 12.29 - 2015-05-31 - Site 1 - North

Figure 12.30 - 2015-05-31 - Site 1 - Azimuth

Figure 12.31 - 2015-07-11 - Site 1 - North

Figure 12.32 - 2015-07-11 - Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 13.33 - 2015-08-16 - Site 1 - North

Figure 13.34 - 2015-08-16 - Site 1 - Azimuth

Figure 13.35 - 2015-11-04 - Site 1 - North

Figure 13.36 - 2015-11-04- Site 1 - Azimuth

Appendix 07 - The Panorama method used to study the light environment at Scalibar and Tickhill Woods.

Figure 14.37 - 2016-01-11 - Site 1 - North

Figure 14.38 - 216-01-11 - Site 1 - Azimuth

Appendix 08 - WOODS survey method.

A system has been developed that is tailored to the needs of ecologists and landscape historians. The shortcomings and complexities of current survey techniques has identified the need for a simple and adaptable method of field survey. The survey approach of the WOODS (Woodland Overview and Objective Description System) method is presented here. The novel survey method has necessitated the need to develop alternative methods of analysing and applying the data to inform conservationists as well as planning authorities in their decision-making processes. This is referred to as SPACES (Species, Position, Abundance and Combination Evaluation System). This method is also applied to hedgerows as a novel method of assessing the 'spaces' that woodland and hedgerow species, and their combinations are positioned in the landscape and within the confines of each feature.

Current survey methods rely on either walkover surveys or studying quadrats in order to characterise the nature of the woodland flora - or, in the case of Ecclesall Woods, mapping the abundance of individual woodland species. Normally only a walkover survey **or** quadrats are adopted. Mapping is rarely done as it is difficult to define the limits of a species and even more difficult to map areas of abundance grading to areas of rarity. The Ecclesall Woods maps are expertly surveyed and drawn, but the effort of defining boundaries between abundance classes is presumed to be very high. The current research recognises that internal distribution and abundance is fundamental to the interpretation of the data and proposes a method of survey that encompasses all current methods - walkover, quadrats and mapping.

The current survey system is being developed and is produced as a WOODS module within an overall Phase 1.5 (Plant Habitat Assessment, Survey and Evaluation) habitat survey system developed by the author. The basic principle of the WOODS method is that it is an adaptable system designed to meet the needs of any project from an amateur assessment through to a detailed survey to record accurate detail to inform a planning authority or conservation strategy. The basis of the system is to allow the survey to be done at different levels of detail using a single recording form (see Figure 4.1 and Figure 5.2) where the cells and spaces are used differently depending on the level of survey being carried out (see also the HEDGES survey method Appendix 09).

This version of the forms uses the current expert view on the evaluation of woodland species in terms of their likely fidelity to ancient woodlands. It uses a colour-coded 5-point scale.

- GREEN-GREEN = Low fidelity
- BLUE-GREEN - Medium to Low
- BLUE-BLUE = Medium

- RED-BLUE = Medium to High
- RED-RED = High fidelity

This informs the recorder of the fidelity of the species found actually during the survey. It also uses the scale-dependant coding for the size of plant, for trees and shrubs:

- ace-cam = seedling
- Ace-Cam = sapling/ young tree
- ACE-CAM - mature tree

For ground flora:

- imp-gla = Indian Balsam as a seedling
- IMP-GLA = Indian Balsam as a mature canopy shade-casting plant
- tam-com = Black Bryony as a small plant
- TAM-COM = Black Bryony climbing through shrubs etc.
- hed-hel - Ivy on the ground
- Hed-Hel = Ivy growing to shrub level up trees
- HED-HEL - Ivy in the canopy of the trees (also for Clematis *Clematis vitalba*)

The overall strategy for the survey technique is to adopt a hybrid approach between walkover survey and using quadrats. The three elements are:

1. Transect - corresponding to sections of a walked route through the woodland. The number of transects and their direction and length can either be pre-determined or can vary depending on local conditions. If the wood has public access the paths and track would be walked first, followed by 'off piste' transects to explore areas not crossed by the paths. Paths can be anomalous as they may have alien flora on them e.g., the garden escape variegated from of Yellow Archangel *Lamiastrum galeobdolon*, the form ssp *argentatum*. They may also be subject to eutrophication from dog walking.
2. Standing Quadrat - this is a rough area surrounding the observer that can comfortably be surveyed, ideally without moving from the observation point - approximately 2m radius - however, placing a marker or object at the observation point will allow the observer to move around within the defined quadrat area. The canopy within a 10m radius is also assessed and an azimuth photograph should be taken along with a nadir view of the vegetation to assist in interpretation.
3. Point Record - where very localised conditions exist a point record can be made of one, or more, species found at that location using a GPS reference, e.g., *Polypodium vulgare* growing epiphytically on a branch of a single tree, or a single spike of Bird's-nest Orchid *Neottia nidus-avis*. Photographs are an assistance in the interpretation.

For each of these elements the level of detail of the botanical recording and associated items can vary depending on the needs of the survey. For example, a transect or standing quadrat could simply record the species surrounding the observer without any other information. With increasing levels of complexity, the abundance of each species could be estimated and information could be obtained on the nature and density of the woodland canopy as well as associated features such as the slope of the ground and other general characteristics of the meso-habitat. A basic survey would equate with a general walkover survey sufficient to characterise the nature of the woodland flora and potentially prepare for a higher level survey to be done at a later date. This would be regarded by Kirby (1988) as a Level 1 survey. He would then advocate follow up surveys to target areas and obtain more detail to inform the classification and assessment. Kirby *et al* (1986) detailed how the number of species and the proportion of the known total for a wood varied with the length of time spent on transects and how season affected the number of species recorded.

Defining how much time to spend recording per Hectare or limit a transect length based on the size of the wood is as limiting as using a finite number of quadrats based on woodland area alone. With WOODS the aim is to approach 100% of AWI species by not being bound by constraints and tailoring the survey to match the complexity of the vegetation. A simple, homogenous woodland of say 10Ha might be thoroughly surveyed by a 3 hour survey with 3 transects, 20 standing quadrats and 5 point records. A more complex woodland of the same size might require 20 hours of survey, 15 transects, 47 standing quadrats and 13 point records. The survey effort is increased proportionate to the complexity rather than size or the time allocated for a survey. Time-based surveys that are not targeted (random or regular walkover) and aim to continue recording until fewer and fewer new species are found can be flawed if species-rich areas are not targeted and included. A wood may have a relatively poor flora over most of its area and transects covering this may get to a point of recording few new species in a relatively short time. Switching attention to follow a stream could record many more species and a difference range. This is why WOODS advocates actively investigating areas where ancient woodland indicator species may be found.

Appendix 08 - WOODS survey method.

Fold 3 Fold 3

Woodland Overview and Objective Description System
AF7a Ver4.9

Final Ref		GPS	
Date	Surveyor	Survey Ref	Sta	End

	SPECIES	F	A	1	2	3	4	5	SPECIES	F	A	1	2	3	4	5	SPECIES	F	A	1	2	3	4	5	
Fold 2	Ace-Cam								fil-ulm								Rib-Uva								F 2
	ACE-CAM								Fra-Exc								Rub-Fru								
	Ace-Pse								FRA-EXC								Sam-Nig								
	ACE-PSE								fra-ves								san-eur								
	ado-mos								gal-apa								scr-nod								
	aeg-pod								gal-odo								sil-dio								
	aju-rep								ger-rob								Sor-Auc								
	all-pet								geu-urb								SOR-AUC								
	all-urs								gle-hed								ste-hol								
	ane-nem								hed-hel								teu-sco								
	ang-syl								hol-mol								Til-								
	ant-syl								hya-non								TIL-								
	arc-min								Ile-Aqu								Ulm-Gla								
	aru-mac								imp-gla								ULM-GLA								
	ath-fil								lam-gal								urt-dio								
	BARE								lap-com								ver-cha								
	Bet-Pen								Lar-Kae								ver-mon								
	BET-PEN								LAR-KAE								Vib-Opu								
	ble-spi								lat-squ								vio-odo								
	bra-syl								LITTER								vio-riv								
	bro-ram								lon-per																
	BRYO								luz-pil																
Fold 1	cam-lat								luz-syl																F 1
	car-pen								lys-nem																
	car-rem								mel-uni																
	car-syl								mer-per																
	Cas-Sat								mil-eff																
	CAS-SAT								moe-tri																
	cer-cla								oxa-ace																
	chr-opp								par-qua																
	cir-lut								Pin-Syl																
	cono-maj								PIN-SYL																
	conv-maj								poa-nem																
	Cor-Ave								poa-tri																
	Cor-San								pot-ste																
	Cra-Mon								pri-vul																
	des-fle								Pru-Spi																
	dry-aff								pte-aqu																
	dry-car								Que-																
	dry-dil								QUE-																
	dry-fil								ran-aur																
	epi-hir								ran-fic																
	epi-mon								Rho-Pon																
	Fag-Syl								Ros-Arv																
	FAG-SYL								Ros-Can																

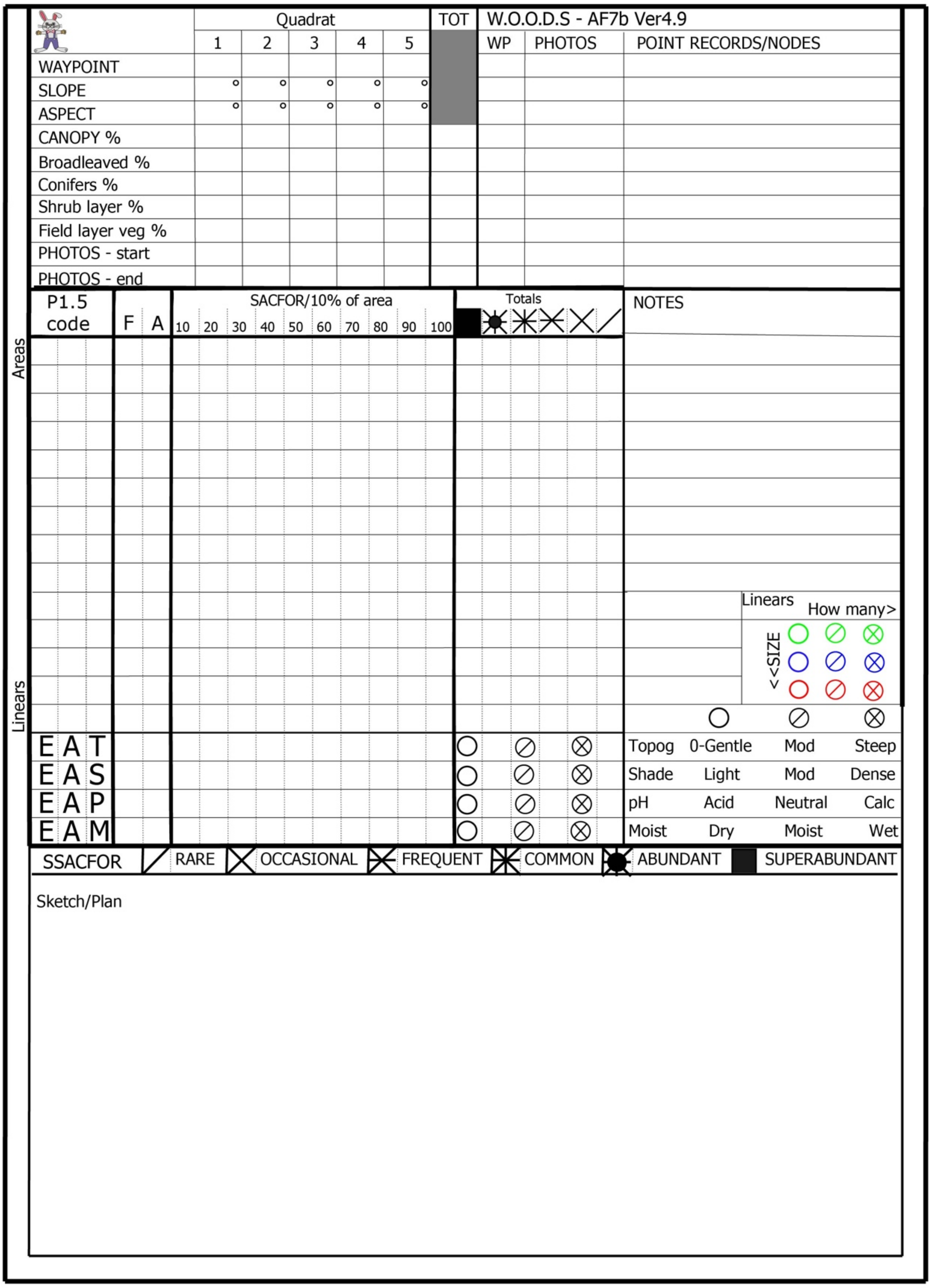
SSACFOR/SPIDERGRAMS RARE OCCASIONAL FREQUENT COMMON ABUNDANT SUPERABUNDANT

Species significances = RED-RED = High - RED-BLU = High/Med - BLU-BLU = Med - BLU-GRE = Med/Low - GRE-GRE = Low

F = Frequency along transect, A = Abundance : 1-5 standing quadrats : ACE-CAM = tree, Ace-Cam = sapling, ace-cam = seedling

Figure 4.1 - A blank WOODS recording form side A

Appendix 08 - WOODS survey method.



	Quadrat 1	2	3	4	5	TOT
WAYPOINT						
SLOPE	°	°	°	°	°	
ASPECT	°	°	°	°	°	
CANOPY %						
Broadleaved %						
Conifers %						
Shrub layer %						
Field layer veg %						
PHOTOS - start						
PHOTOS - end						

W.O.O.D.S - AF7b Ver4.9

WP | PHOTOS | POINT RECORDS/NODES

P1.5 code | F | A | SACFOR/10% of area 10 20 30 40 50 60 70 80 90 100 | Totals

NOTES

Areas

Linears

Linears How many>

<<SIZE

EAT	Topog	0-Gentle	Mod	Steep
EAS	Shade	Light	Mod	Dense
EAP	pH	Acid	Neutral	Calc
EAM	Moist	Dry	Moist	Wet

SSACFOR | RARE | OCCASIONAL | FREQUENT | COMMON | ABUNDANT | SUPERABUNDANT

Sketch/Plan

Figure 5.2 - A blank WOODS recording form side B

Side B of the recording form shows the SSACFOR recording panel. This allows for the recording of Meso-Habitats. This can be done for the whole wood, the area surveyed, a standing quadrat or the transect. Various levels of detail can be entered.

Appendix 08 - WOODS survey method.

An important part of WOODS is the overview summary describing the wood using the Phase 1.5. Figure 6.3 shows an example to show how a graphical impression of the wood can be gained from the symbols entered. This indicates:

1. Broadleaved woodland - Superabundant for 60%, common in 10%, frequent in 10%, occasional in 10% and rare in 10%.
2. Shrubby scrub - in 70% of the area at abundance levels frequent to rare.
3. Bramble scrub - 80% of the wood and generally occasional to rare in abundance.
4. Woodland ground flora - ranging from Superbundant to rare in parts.
5. Acid/ neutral flushes - occasional in 10% of the wood and rare in 10%.
6. Acid/ neutral cliffs - occasional in 20% and rare in 20%
7. Bare ground - frequent to rare across the whole wood
8. Litter - occasional to rare across the wood
9. Bryophytes - in 80% of the wood at occasional to rare abundance
10. Earth bank - in 3% of the wood, small and low numbers
11. Running water -seasonal - a few small in 20% of the wood and 1 few medium in 10%.
12. Running water - all year - some small in 10%, a few medium in 10% and a few medium in 10%
13. EA Topography - 40% level or gentle, 505 moderately sloping and 10% steeply sloping
14. EA Sahde20% light shade, 50% medium and 30% dense
15. EA pH - all neutral
16. EA Moisture - mostly moist with some dry and some wet areas.

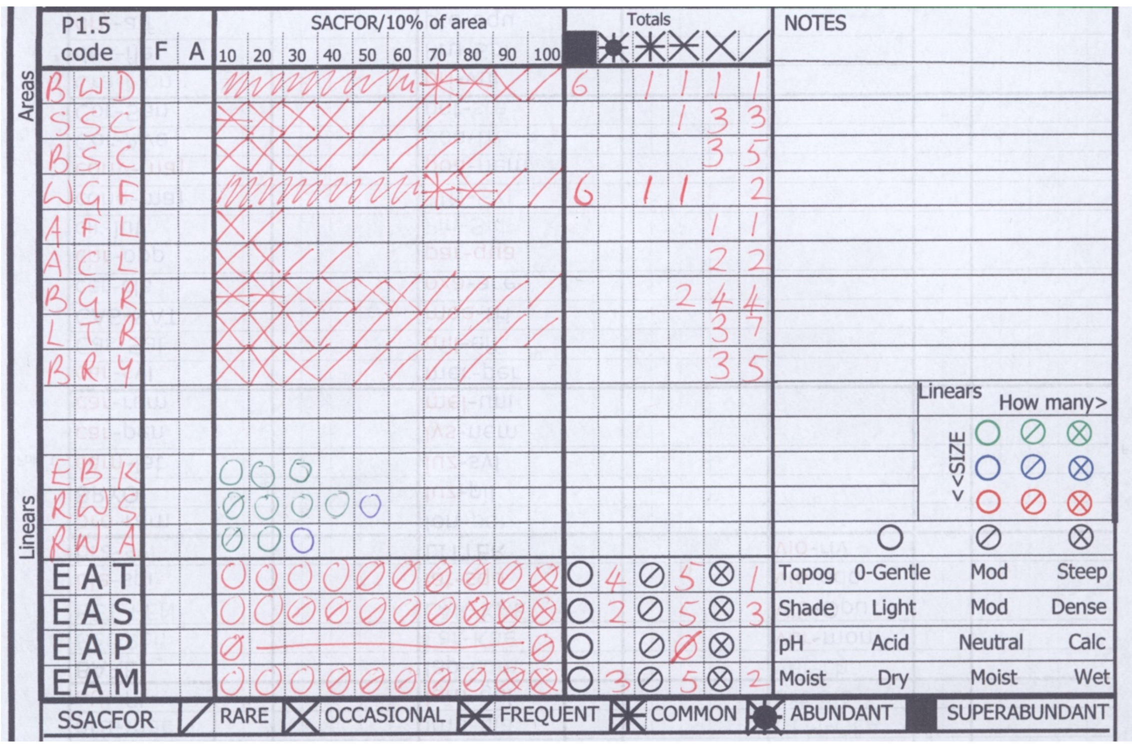


Figure 6.3 - A woodland overview panel from a speculative woodland survey.

Appendix 09 - HEDGES survey method.

1. Introduction

The novel survey method (part of HEDGES) records information from the entire length of any given hedgerow rather than existing methods of selecting one, or more, 30m sections, ignoring the beginning and end of any hedgerow (first and last 30m in the case of the Hedgerow Survey Handbook). It also records all potentially informative species of hedging shrub (including tree species managed as hedging shrubs), trees, climbers like Ivy *Hedera helix*, Honeysuckle *Lonicera periclymenum*, White Bryony *Bryonia dioica,* Black Bryony *Tamus communis* etc. and significant shade adapted ground flora (Bluebell *Hyacinthoides non-scripta*, Wood Anemone *Anemone nemorosa* etc.).

The HEDGES method is part of the Phase 1.5 Habitat Survey System developed by the author to collect better data than standard Phase 1 (JNCC 1990) There are 3 levels of survey:

Level 1 – The most basic level, equivalent to doing an assessment as proposed by Hooper and adopted by the Hedgerows Regulations (HMSO 1997) and the Hedgerow Survey Handbook (Defra 2007). This involves assessing one, or more 30m sections, but Level 1 of HEDGES adds the facility to record other parameters like the abundance of species and the structure of the hedge and any evident earthworks.

Level 2 – A rapid survey method looking at the entire length of a hedgerow – between recognisable points like hedgerows joining at each end. This level records the abundance of all species along the defined length and identifies the exact locations of the rarer species using a GPS. All trees, and their positions are recorded along with their size and character – Coppice, Pollard etc. The method also records the structural parameters of the hedgerow, banks, ditches, evidence of laying etc. This method was used at Dunnington.

Level 3 – This looks at the species visible every 4m along the length and assigns an abundance to each. It also records trees and the structural hedgerow features. This produces an output consisting of dots, varying in size dependant on the species abundance, indicating exactly where each species is present or absent. It also produces a 'hedge-o-gram' showing all species along the length and the abundance of each (See Table 2.1). Each Record Point represents a 4m section of hedgerow and is made up from the GPS waypoint number for the start of the hedgerow, the GPS waypoint for the end of the hedgerow and a sequential number for the 4m section. This provides a unique identifier for any 4m section surveyed as part of a Level 3 survey. In this example there were 27 record points making the hedgerow length approximately 108m long. Hawthorn *Crataegus monogyna* dominated (Blue) for the first

28m followed by a dominant block of 32m of Holly *Ilex aquifolium*. The paler blues are lower abundances for the species present within each 4m sampling section and the black/ grey indicate a gap with no shrubs present.

Table 2.1 - A typical short Hedge-o-gram from a Level 3 survey. Record points are every 4m.

Record Point	GAP	Hawthorn	Holly	Hazel	Ivy	Dogwood	Blackthorn	Elder	Dog Rose	Bracken	Hedge Garlic	Dog's Mercury	Ramsons
CL591-CL593-01													
CL591-CL593-02													
CL591-CL593-03													
CL591-CL593-04													
CL591-CL593-05													
CL591-CL593-06													
CL591-CL593-07													
CL591-CL593-08													
CL591-CL593-09													
CL591-CL593-10													
CL591-CL593-11													
CL591-CL593-12													
CL591-CL593-13													
CL591-CL593-14													
CL591-CL593-15													
CL591-CL593-16													
CL591-CL593-17													
CL591-CL593-18													
CL591-CL593-19													
CL591-CL593-20													
CL591-CL593-21													
CL591-CL593-22													
CL591-CL593-23													
CL591-CL593-24													
CL591-CL593-25													
CL591-CL593-26													
CL591-CL593-27													
Total	5	12	12	9	7	6	5	5	2	12	3	3	2

Black = GAP; Grey = Partial GAP; Pale Cyan = Low abundance; Mid-Cyan = Medium abundance; Blue = Abundant.

Appendix 09 - HEDGES survey method.

2. Species Recording

All shrubs and trees are recorded to species level where possible. Some species were difficult to confirm their identities, especially the apples and the Blackthorn/ Damson group. There sere clearly both Crab Apple *Malus sylvestris* and sweet Domestic Apple *Malus domestica*. The difference used was the size of leaf and the glossiness. Crab Apple being small-leaved and glossy and Domestic Apple being larger leaved and matt or dull. The identification was easier later in the season when there was the potential for fruit to be present, although not always.

The Blackthorn *Prunus spinosa* vs. Damson *Prunus inisititia* case was less likely to be resolved by fruiting and may need further work as leaf size was a variable character. Blackthorn should be small and narrow. Damson broad and larger. The latter species also seems to have two glands at the top of the leaf stalk in keeping with the character found on plums.

There are three types of botanical record.

1. Total hedge abundance values for each species
2. Individual shrub records
3. Individual tree records

The total hedge species abundance values used a simple modification of the widely used DAFOR system (a standard measure used by county recorders, researchers and ecological surveyors where abundance values are required), called the DDAFOR or double DAFOR. DDAFOR was an adapted system developed by the author to collect and present more detail on the often patchy and clumped distribution of species in both linear features like hedgerows and area features like woods. This has now been refined to double SACFOR or SSACFOR as described at Appendix 02. For field work for this thesis, the DDAFOR system was used. The only difference being that the SSAFOR value [S]uper-abundant equates to the DDAFOR value [D]ominant and the SSAFOR value [C]ommon = DAFOR [A]bundant. The original DDAFOR diagram used is at . The DAFOR scale uses familiar terms that attempt to indicate both frequency and abundance in one word (Dominant, Abundant, Frequent, Occasional, Rare).

As there are two elements to consider, frequency and abundance, with hedge plants the frequency would be the number of bushes, or stems for a climber, and the abundance would be the amount of leaf and twig area or volume the species occupied where it occurred.

Appendix 09 - HEDGES survey method.

DDAFOR separates the frequency and abundance assessments by assigning two letters; the first being the frequency – how many plants or occurrences and the second being the local abundance – how much there is at each location. A graphical representation of SSACFOR is shown at Appendix 02 Figure 6.3 with the original DDAFOR at Figure 5.1.

Appendix 09 - HEDGES survey method.

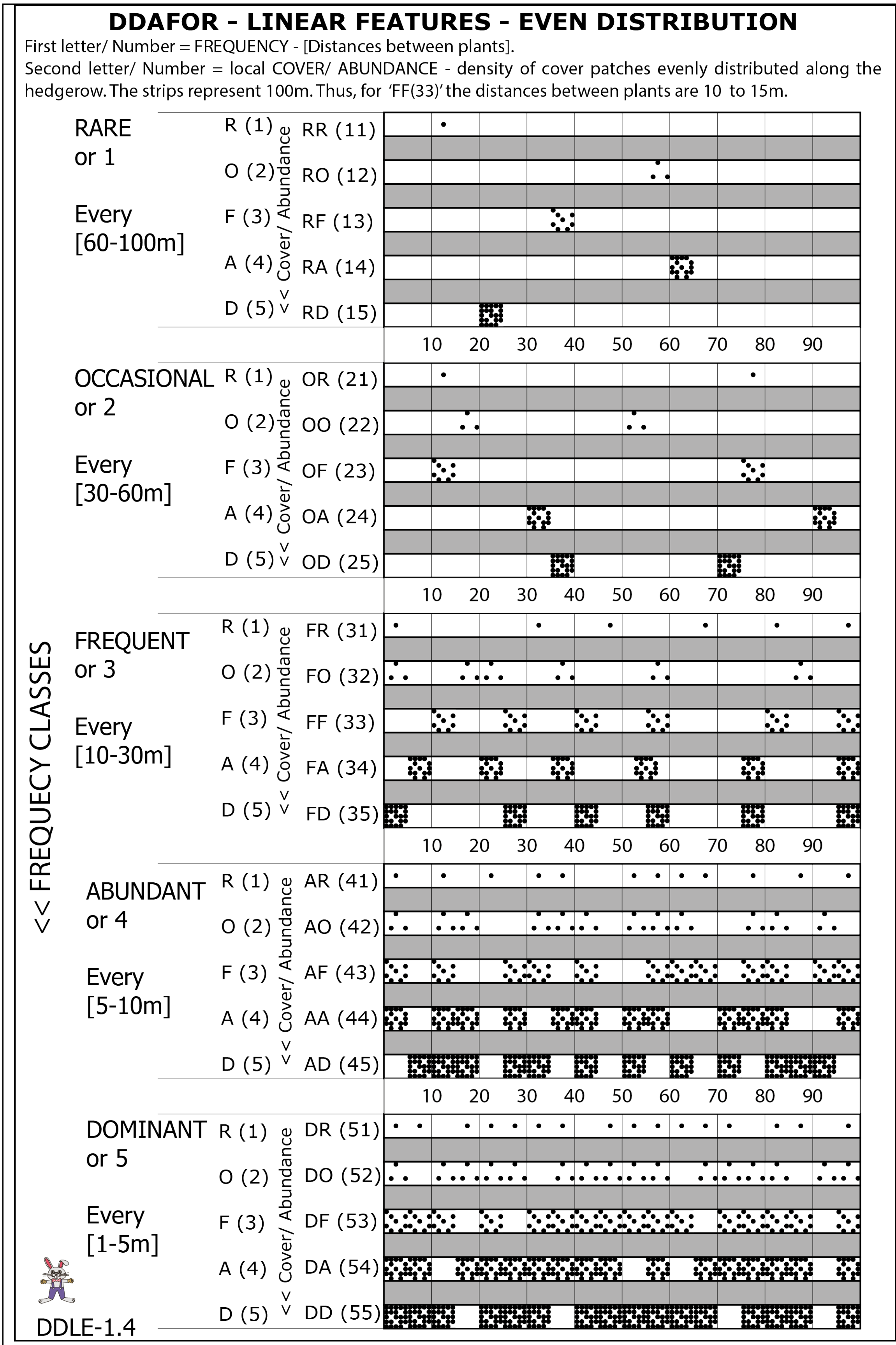


Figure 5.1 - Original DDAFOR diagram for hedgerows assuming plants relatively evenly distributed along the length.

Appendix 09 - HEDGES survey method.

In essence a species might be only scattered plants (Occasional) along a hedge, or across the landscape, but where it is found it may be obvious and Abundant or even Dominant. This would be coded OA or OD to signify Occasional-Abundant or Occasional-Dominant.

The illustrations are key. The nomenclature is merely a means to put this into words. This system also interprets the frequency in terms of how many metres could be between plants and also % estimates for each of the DAFOR letters to provide additional methods for recorders to comprehend what is intended by the assessment.

By recording the frequency/ abundance in this way a more comprehensive indication of the species presence is obtained. Knowing that Holly *Ilex aquifolium* is OD in a hedge is more informative than recording it as 'O' and even more valuable than just recording it as present, which is all that is required by the 'Hooper', and other survey methods.

The current survey technique identifies all species within the hedgerow, including those that are relatively uncommon – 1st decile species (<10% cover) - and, using modern GPS technology, records the exact location of these specimens. These are individual shrub records that supplement the abundance assessments for the whole hedgerow section. The advantage of this approach is that the pattern of 1st decile species can be informative and be used in the Position part of the SPACES analysis (see Appendix 10).

The use of GPS technology is also applied to recording the location of any existing hedgerow trees and stumps. These are the individual tree records. The species were recorded and their estimated girth/ diameter is used to identify any patterns to the age of hedgerow trees and the age of the hedgerows.

A blank field recording form is at Figure 8.2 for the 'a' side and Figure 9.3 for the 'b' side.

This version of the forms uses the current expert view on the evaluation of hedgerow species in terms of their likely indication that the hedgerow is old or ancient. It uses a colour-coded 5-point scale.

- GREEN-GREEN = low likelihood of the hedgerow being ancient
- BLUE-GREEN - Medium to Low
- BLUE-BLUE = Medium
- RED-BLUE = Medium to High
- RED-RED = High likelihood of the hedgerow being ancient.

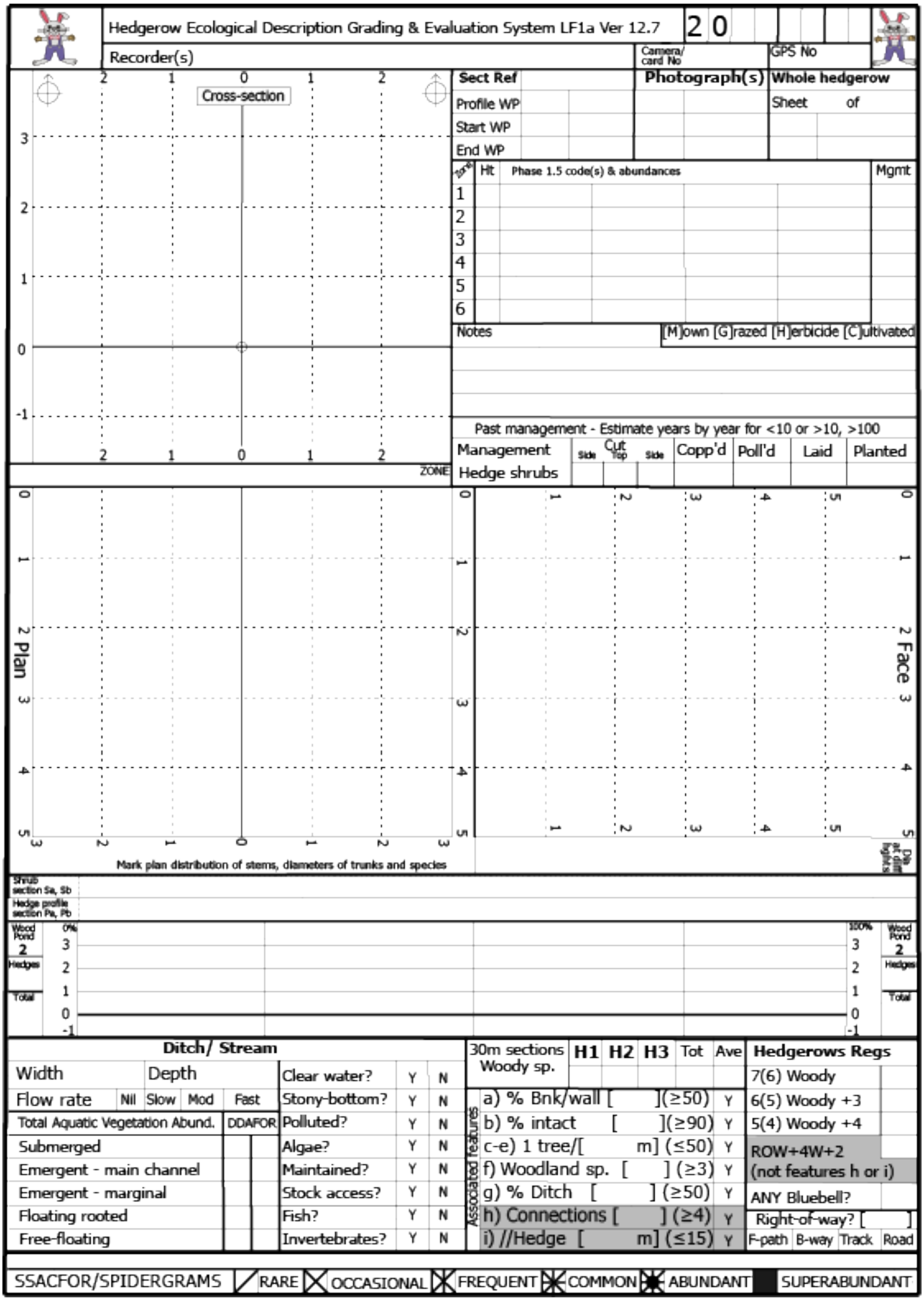
Appendix 09 - HEDGES survey method.

This informs the recorder of the fidelity of the species found actually during the survey.
It also uses the scale-dependant coding for the size of plant, for trees and shrubs:

- ace-cam = seedling
- Ace-Cam = sapling/ young tree
- ACE-CAM - mature tree

For ground flora:

- gal-apa = Cleavers as a seedling
- GAL-APA = Cleavers as a mature plant growing to the top of the shrubs.
- tam-com = Black Bryony as a small plant
- TAM-COM = Black Bryony climbing through shrubs etc.
- hed-hel - Ivy on the ground
- Hed-Hel = Ivy growing to shrub level internal.
- HED-HEL - Ivy in the hedge forming a visible and recordable presence on the outside of the hedge (also used for species like Clematis *Clematis vitalba*)



Hedgerow Ecological Description Grading & Evaluation System LF1a Ver 12.7 | 2 0

Recorder(s) | Camera/ card No | GPS No

Cross-section

Sect Ref | Photograph(s) | Whole hedgerow

Profile WP | Sheet of

Start WP

End WP

Ht	Phase 1.5 code(s) & abundances	Mgmt
1		
2		
3		
4		
5		
6		

Notes | [M]own [G]razed [H]erbicide [C]ultivated

Past management - Estimate years by year for <10 or >10, >100

Management	Side	Cut Top	Side	Copp'd	Poll'd	Laid	Planted
Hedge shrubs							

ZONE

Plan

Face

Mark plan distribution of stems, diameters of trunks and species

Dia at diff lights

Shrub section Sa, Sb

Hedge profile section Pa, Pb

Wood Pond 2 | Hedges | Total | 0% | 100%

Ditch/ Stream				
Width	Depth	Clear water?	Y	N
Flow rate: Nil, Slow, Mod, Fast		Stony-bottom?	Y	N
Total Aquatic Vegetation Abund.	DDAFOR	Polluted?	Y	N
Submerged		Algae?	Y	N
Emergent - main channel		Maintained?	Y	N
Emergent - marginal		Stock access?	Y	N
Floating rooted		Fish?	Y	N
Free-floating		Invertebrates?	Y	N

30m sections Woody sp.	H1	H2	H3	Tot	Ave

Associated features	
a) % Bnk/wall [ ](≥50)	Y
b) % intact [ ](≥90)	Y
c-e) 1 tree/[m] (≤50)	Y
f) Woodland sp. [ ] (≥3)	Y
g) % Ditch [ ] (≥50)	Y
h) Connections [ ] (≥4)	Y
i) //Hedge [m] (≤15)	Y

Hedgerows Regs	
7(6) Woody	
6(5) Woody +3	
5(4) Woody +4	
ROW+4W+2 (not features h or i)	
ANY Bluebell?	
Right-of-way? [ ]	
F-path, B-way, Track, Road	

SSACFOR/SPIDERGRAMS | RARE | OCCASIONAL | FREQUENT | COMMON | ABUNDANT | SUPERABUNDANT

Figure 8.2 – Blank Hedgerow survey form side A (LF1a)

Figure 9.3 – Blank hedgerow survey form side B (LF1b)

3. Species mapping

An example output map for Ash at Dunnington is at Figure 11.4. The length of gaps in the hedge are shown as black sections. Surveyed hedgerows are yellow lines. Where a species is recorded both in the hedge component (red lines) and as a specimen tree, the trees are included on the species maps (at this scale as green dots). This gives a visual impression of the distribution of trees across the study area.

In both Level 2 and Level 3 surveys, the abundance of the woody species and woodland ground-flora components is recorded. At Level 2, the SSACFOR system of abundance assessment described at Appendix 02 is used.

Appendix 09 - HEDGES survey method.

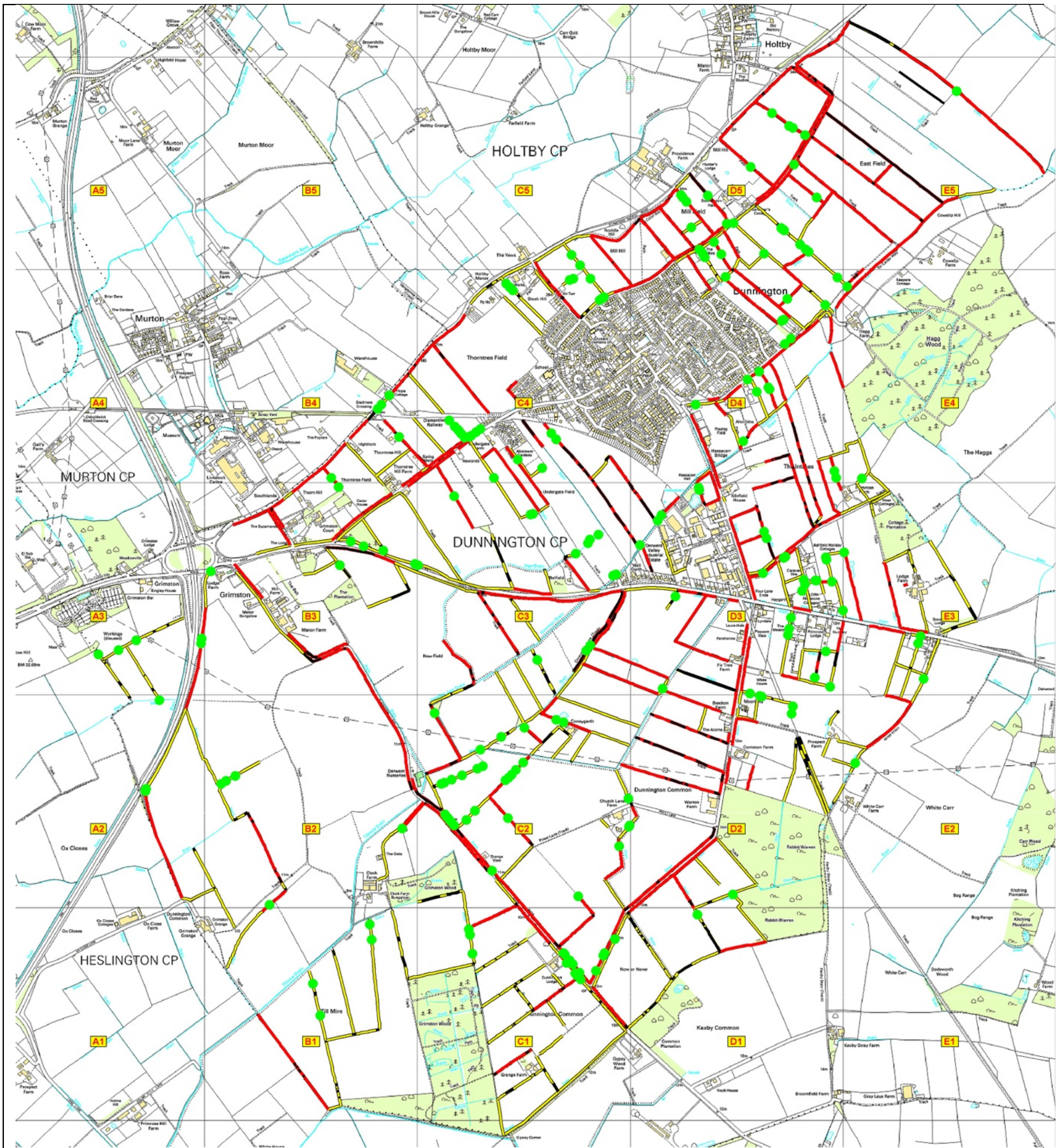


Figure 11.4 – An example map showing the distribution of Ash as a hedge component and as a hedgerow tree across the whole Dunnington study area. Red lines = present; Yellow = surveyed but absent; Black = gap/ hedge missing; Green dot = Ash as a tree. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

Appendix 10 - SPACES analysis method.

The main principle of SPACES analysis is that it adds to scientific understanding as it provides a framework for identifying patterns in the presence of species in the landscape, both individually and in combination with other species.

The basic elements of Spaces are:

1. [S]pecies - What do the species present inform about their context?
2. [P]osition - Are species or combinations at specific locations that can inform about history and management?
3. [A]bundance - Where they occur, do species have any patterns to their frequencies and abundances, both individually and within species combinations?
4. [C]ombination - Are there any detectable combinations of species that can inform about how, why and when these developed?

To these are added the elements of:

1. [T]ime (history) - are the observations linked to known or implied history?
2. [M]anagement - Are the species or combinations there currently because of past management?

As well as consideration of scale;

1. [L]andscape - Is the observation at the landscape scale?
1. [H]edgerow - Are the observations relevant within a hedgerow length?
2. [W]ood - Do certain species only occur in parts of a wood?

Observations from field surveys will identify species and combination signatures that can be explored and interpreted. These signatures will be combinations of the basic elements [SPAC] and any detected qualifying aspects related to time [T], management [M] and scale [L] [H] [W].

Many permutations of the SPACES elements are possible and can be used to interpret the data. A diagram at Figure 2.1 illustrates these and the text that follows describes the combination scenarios.

Appendix 10 - SPACES analysis method.

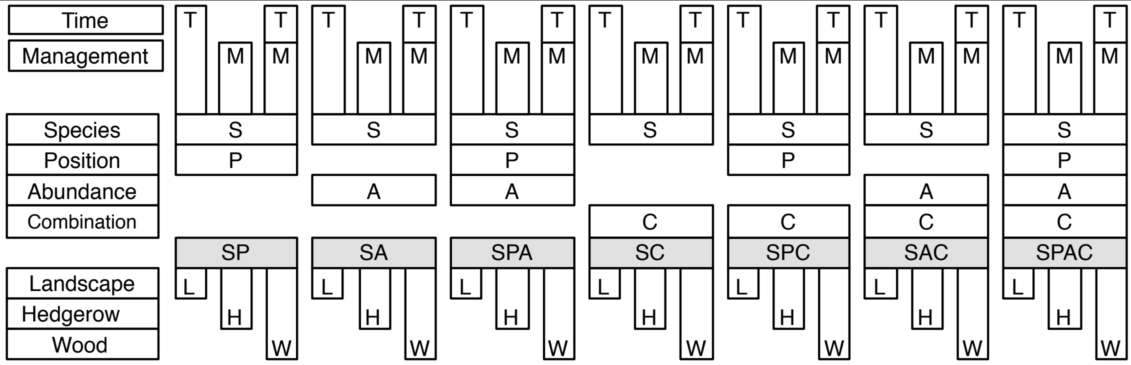


Figure 2.1 - SPACES diagram showing the makeup of the possible SPACES elements in relation to time [T], management [M] and scale [L] [W] or [H].

The basic seven possible combinations of core SPACES elements are shown in the shaded blocks at Figure 2.2 shows the hierarchy of these possible combinations of the SPACES elements.

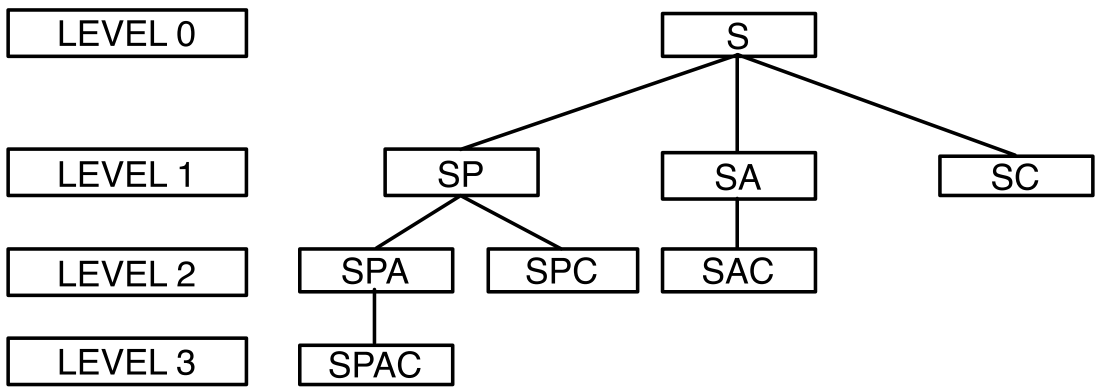


Figure 2.2 – Diagram showing hierarchy of combining elements of SPACES

At Level 1 there are associations of two of the SPACES elements:

[SP] - The [S]pecies is found at defined [P]ositions but shows no systematic [A]bundance or [C]ombination with other species

[SA] - A [S]pecies that has a particular [A]bundance but does not seem to be found at any specific [P]osition or in any [C]ombinations.

[SC] - [C]ombinations of [S]pecies that show no pattern for [P]osition or [A]bundance.

For Level 2 there can be three elements:

[SPA] - The [S]pecies is present at specific [P]ositions and at certain [A]bundances, but not in any [C]ombinations.

Appendix 10 - SPACES analysis method.

[SPC] - Certain [S]pecies [C]ombinations occurs in particular [P]ositions but at no recognisable [A]bundances.

[SAC] - There are [S]pecies [C]ombinations at certain [A]bundances but not in any pattern of [P]osition.

Level three associates all elements of SPACES:

[SPAC] - [S]pecies are found in certain [P]ositions, at defined [A]bundances and in recognisable [C]ombinations.

Scale

Scale [L] [H] [W] - The seven core SPACES element combinations can be considered at both the Landscape ([L]) and feature level ([H] [W]), e.g. a species may be abundant in the landscape, but rare at the wood/ hedgerow level and *vice versa*. These are added as qualifiers to the SPACES codes. Examples are:

[SPA][W] - A [SPA] species at the Woodland level where it occurs in particular parts of the woodland at predicable levels of abundance.

[SPA][L] - A [SPA] species at the landscape level being found at specific locations and at a particular abundance in parts or all of the landscape.

[SPA][H] - A [SPA] species at the Hedgerow level that is only at a predictable position in the hedgerow (e.g., at the end, or everywhere) and at a defined abundance level.

Combining the time/ management + the core SPAC elements and the scale [L] [H] [W] produces a range of 'signatures' that a species, or combination of species, may have. These signatures can be approached from the species perspective or the combination perspective as follows.

Species Analysis

From the Species perspective consideration of SPACES elements and permutations of elements are studied at both the landscape scale and habitat scale. The species in a hedgerow, woodland or in the landscape are evaluated to see if there are any species present that are characteristic of the study that show a pattern for position or have a particular abundance level.

The species may be present in the study area as a result of historic planting, in which case it will have positions on specific hedgerows in the landscape [SP][L] associated with time and will therefore have a time-species-position-landscape [T][SP][L] signature. Another species may be typical of wet areas in the landscape regardless of historic planting and would therefore be [SP][L]. The [S] code cannot be used without combining it with another element or elements except to comment on the characteristics of the species itself that may influence its occurrence in the study area.

SPACES analysis approach for Hedgerows

In relation to hedgerows possible scenarios for the permutations of SPACES elements are as follows:

Species + Position [SP] - Species can be located in specific parts or all parts of the landscape [SP][L], in localised sections or all parts of the hedgerow [SP][H] in conjunction with time [T] and management [M].

[SP][L] - A species associated with specific positions in the landscape at no particular abundance and not linked to history or management, e.g., a species favouring wet conditions e.g., some willows and Alder *Alnus glutinosa* or a species like Hawthorn *Crataegus monogyna* that occurs everywhere.

[SP][H] - A species and position association at the hedgerow level at no particular abundance and not linked to history or management, e.g., a species only found in a low-lying wet section of a hedgerow of any age.

[T][SP][L] - A species linked to history that is found in certain parts of the landscape, e.g., a species favoured during an enclosure award planting phase like Hazel *Corylus avellana*, Crab Apple *Malus sylvestris* etc.

[T][SP][H] - Historically a species found in certain parts of a hedgerow that can be assigned to a particular time or phase, e.g., a species like Pedunculate Oak that was reported by Mr Charles Howard (1832/1840) to have been planted every 7 yards in the township of *Scoreby*.

[M][SP][L] - As the result of specific management actions a species is found in certain parts of the landscape. e.g., there is evidence of laying, or the species is present as a tree and as a shrub in various places in the landscape with no apparent link to history. This may link to a time for such laying and would be [TM][SP][L]. The presence of trees could be the result of seeding into the hedge and 'getting away' or being actively avoided during trimming to create standards and may be a deliberate action to have the species in the hedgerow in both forms.

Appendix 10 - SPACES analysis method.

[M][SP][H] - Management at certain positions along the hedgerow has determined the species presence in the hedgerow e.g., laying a section of hedgerow to close a small gap or allowing a tree to develop into a standard.

Species + Abundance [SA] - species may occur at similar abundances across the study area, and within individual hedgerows with no apparent preferences for position. Again at both landscape and hedgerow scales [SA][L] and [SA][H].

[SA][L] - A species that is at a certain general level of frequency across the landscape regardless of other considerations, e.g., Bramble may occur in almost all hedgerows regardless of location or when the hedgerow was created or how it has been managed.

[SA][H] - A species that is at a certain general level of frequency or abundance in a hedgerow regardless of other considerations, e.g., Bramble *Rubus fruticosus* may be occasional to frequent in almost all hedgerows regardless of location or when the hedgerow was created.

[T][SA][L] - As a consequence of history a species has an abundance in the landscape. This may also link to position and such species will be [T][SP][L] or [T][SPA][L]. For example, Crab Apple *Malus sylvestris* was generally actively planted during the 1709 and 1772 enclosure planting at Dunnington. Other species may be less abundant in the landscape now that were actively discouraged, like Barberry (the host of a rust in wheat). Its abundance in the landscape can be linked to the prolonged period of removal (and probably also management [TM][SA][L]) when it was recognised as a problem species and became the target of active removal.

[M][SA][L] - A species may be actively encouraged by management over time (but not confined to a particular era or phase), or removed from hedgerows regardless of their time of creation or their histories, e.g., Elder has often been regarded as a weed and systematically removed from all hedgerows of any age and is ongoing.

[M][SA][H] - A species may be actively managed and encouraged into gaps in hedgerows at high frequency/ abundance, e.g., a monoculture of Hawthorn *Crataegus monogyna* may have been used to fill gaps in a more species rich old hedgerow, or conversely a species-rich mix can be used to fill the gap in a monoculture Hawthorn hedgerow.

Species + Position + Abundance [SPA] - some species may be located at particular parts of the landscape [SPA][L] or places along a hedgerow [SPA][H] and be at a predictable level of Abundance.

[SPA][L] - A species that is found in certain places in the landscape, e.g., on a number of hedgerows in the landscape, Hazel may be at an abundance of frequent but there is no indication that this is linked to history.

[SPA][H] - In hedgerows a species that is found at certain points (or is general throughout) at a particular abundance e.g., in a hedgerow that contains English Elm *Ulmus procera* it may be only at the ends, dominant at a point or dominant throughout.

[T][SPa][L] - Historically, in the landscape a species that is at certain locations and has a particular abundance e.g., Purging Buckthorn *Rhamnus cathartica* is usually found on medieval hedgerows [T] that are often on township boundaries [P] and [L] and the species is usually rare [a] when it occurs.

[T][SPA][H] - In a particular historical context a hedgerow species is at certain locations at a particular abundance, e.g., English Elm *Ulmus procera* may be dominant in hedgerow positions that are of medieval origins.

[M][SPA][L] - The management could relate to a position and the frequency of a species in hedgerows. Hedgerows in the landscape may have been managed by gapping up regardless of the age or history of the hedgerow, e.g., Guelder-rose *Viburnum opulus* may have been recently planted into gaps [P] in particular sections of hedgerow as a recent [T] enhancement. During the 1970s and to date many schemes encouraged farmer to restore and gap up hedgerows.

[M][SPA][H] - The consequence of [M][SPA][L] above could be the unexpected high frequency of Guelder-rose in gapped up sections of hedgerow.

Combination analysis

The principles behind the assessment of the combination of species in a hedgerow is derived partly from the standard phytosociology assessments where relevees (hedgerows or woodlands) are assigned to groups with similarities. This is the top-down approach. The bottom-up approach takes, for example in hedgerows, where say 5 species can be individually assigned as being likely indicators of medieval boundaries, a combination of 2, 3, 4 or all 5 are combinations that add confidence to the prediction.

With regard to hedgerows the top-down expectation is that there will be a number of deliberately planted and desired species such as Hawthorn and Blackthorn present in all hedgerows from a certain era (like an enclosure award period). Other species will be less frequent and less abundant all the way down to a single specimen of a species. There will be dominant constant species at one end and companions or associates at the other. In the middle are the preferential or differential species used by authors like Kent and Coker (1992) and Rodwell (1991). These are generally species that are present in approximately 50% (constancy 3 = 41-60%) of the habitat surveyed.

It is still vital that the rarer species, or 1st decile species are not ignored, but are fully included in the analysis in conjunction with combinations.

The concept considered is that hedgerows formed during specific phases were initially planted with the same mix of species and today these can still be recognised, assuming they have been subject to similar management during the intervening period. For example, it could be that 1709 enclosure hedgerows contained Hawthorn *Crataegus monogyna*, Blackthorn *Prunus spinosa* and Holly *Ilex aquifolium*. Whereas 1772 enclosure hedgerows contained Hawthorn, Blackthorn, Hazel *Corylus avellana*, Crab Apple *Malus sylvestris* and Elder *Sambucus nigra*. Here, Hazel, Crab Apple and Elder are missing from the earlier period and are added to the later enclosures. This concept is likely to be subject to variation in that, even though a specific planting mixture may have been recommended for a given enclosure award, there is no guarantee that individual farmers followed this mixture. It is therefore likely that a number of signatures for combination may be applicable to different areas of farm ownership within an enclosure award area.

The other concept is that bottom-up combinations of some of the 1st decile species may provide supporting and corroborating evidence of historic origins and management. This is based on a principle that certain species have been determined as indicating medieval origins (unless there is obvious evidence of recent planting). If certain individual species can be regarded as 'medieval species', then it follows that if several of these are combined that this will be supporting evidence that gives increased confidence to the assumption that the hedgerow is of a particular phase. An example would be if Spindle, Guelder-rose and English Elm are individually regarded as medieval species, if this combination was to occur on a hedgerow this is likely to further emphasise that this hedgerow is of mediaeval origin. From this concept of combination analysis any two or more species that are historic marker species will constitute a combination. Clearly, the more species added to the combination the greater will be the confidence of asserting that they are historic markers.

Similarly, it could be that hedgerows formed during two different phases may contain essentially the same combination of species, but they may be at different levels of abundance

[SAC]. This type of association may occur across the entire landscape, or that particular species abundance combination may be specific to particular allotees at the time of enclosure.

As with the species analysis approach above, the combination element of the species composition is considered with other SPACES elements.

Species + Combination [SC] - are certain combinations of species found where there is no apparent systematic position or abundance association?

[SC][L] - A particular combination of species is found across the study area without any historical reason or indications of systematic position or abundance. For example, the combination of Hawthorn, Blackthorn and Elder may be a common feature of some hedgerows in the landscape with no further indications about why these have that combination.

[SC][H] - A particular combination of species is found in certain parts of the hedgerows. For example, random sections of a rich mix of species along a hedgerow dominated by Hawthorn.

[T][SC][L] - Historically a specific combination of species is in hedgerows in the landscape. This may be linked to specific eras or phases if known, otherwise their positions should be noted and considered for determining a [T][SPC][L] signature. For example, does the combination of Hawthorn, Blackthorn, Hazel, Field Maple and Dogwood occur randomly or should it be considered in relation to position [P]?

[T][SC][H] - History is reflected in a specific combination of species in sections of hedgerows. This may be indicative of the recommendations at the time these hedgerows were gapped up. For example, does the combination of Hawthorn, Blackthorn, Hazel, Field Maple, Guelder-rose, Crab Apple, Holly and Dogwood indicate over-the-top species enhancement in a Hawthorn dominated hedgerow?

[M][SC][L] - The management affects the species combinations at the landscape level. At the landscape level it is unlikely that this permutation of elements has any meaningful contribution to the interpretation. Species combinations at the landscape scale will be a reflection of the combinations at the hedgerow scale and this combination of SPACES element is not a likely consideration.

[M][SC][H] - The management affects the species combinations at the hedgerow level. For example, a species combination is different in a hedgerow where the owner has systematically removed one, or more, species, or where they have deliberately added new species.

Species + position + Combination [SPC] - Particular combinations of species are found at specific positions in the landscape [SPC][L], or along hedgerow lengths at no particular level of abundance [SPC][H].

[SPC][L] - Certain parts of the landscape have specific species combinations that don't have an associated timeframe or management reason. As an example the combination of Hawthorn, Blackthorn and Elder may be a common feature of hedgerows from many different origins and may not be diagnostic for a specific phase [SPC][H]. There may be a systematic reason why particular hedgerows have certain combinations. For example, on an open cast coal restoration site where the restoration planting was of a standard mix. This is may possibly be datable [T][SPC][L].

[T][SPC][L] - Historically specific species combinations occur in certain parts of the landscape. For example, the planting of areas of restored land.

[T][SPC][H] - History explains why certain combinations are in particular sections of hedgerow. For example, where a pipeline crossed the landscape and the restoration planting was of a standard mix.

[M][SPC][L] - Management practices have produced the species combination at certain locations in the landscape. As an example, have some landowners either encouraged or removed species to result in the current combinations? These may also be linked to history [T].

[M][SPC][H] - Management practices have created the species combination at certain locations in the hedgerow. Some landowners either encouraged species into gaps or removed species from sections to result in the current combinations. Again these could have historical context as well [T].

Species + Abundance + Combination [SAC] - There are systematic levels of abundance associated with particular hedgerows, independent of their position [SAC][L] and [SAC][H].

[SAC][L] - The species abundances in combinations at the landscape scale is predictable. For a combination of say Hawthorn, Blackthorn, Hazel, Holly, Crab Apple, the abundances are approximately the same between hedgerows (Hawthorn - AD, Blackthorn - AD, Hazel - F, Holly - FA, Crab Apple – FF. But, there is no indication that this has any historical significance nor that there is a reason for these being at the positions at which they are found.

[SAC][H] - At the hedgerow scale the abundances of species in combinations are similar. Within a hedgerow where a combination occurs the species are in approximately the same abundance compared with the same combination group either elsewhere in the same hedgerow or in another hedgerow. For example, where a hedgerow is gapped up the same general species abundances were used, i.e., the species were mixed to maximise the diversity in each gap.

[T][SAC][L] - History determines the abundance of species in combinations. This would be determined by historical evidence, e.g., the mix can be assigned to a phase of planting such as an enclosure scheme where a particular mixture was specified.

[T][SAC][H] - History explains the abundances of species combinations in hedgerows. e.g., determined by historical evidence that some species like Hazel *Corylus avellana* are more abundant generally in older hedgerows.

[M][SAC][L] - Management has produced the frequency of combinations of species at the landscape level. Selective encouragement or removal has produced the level of frequency observed in the combinations at the landscape level, e.g., Elder is less abundant in some hedgerows in the landscape because of active removal by a certain farmer.

[M][SAC][H] - Management practices at the hedgerow level have moulded the abundances of species in combinations. Lack of gapping up may have allowed aggressive species like Dogwood *Cornus sanguinea* to colonise and dominate.

Species + Position + Abundance + Combination [SPAC] - Combinations occur at specific positions and at particular levels of abundance [SPAC][L] and [SPAC][H].

[SPAC][L] - There is a pattern of species at certain positions, in recognisable combinations at a defined frequency in the landscape. There is a pattern to the distribution of the combination of species and their abundance across the landscape, e.g., the combination Hawthorn *Crataegus monogyna*, Hazel *Corylus avellana*, Dogwood *Cornus sanguinea*, and Crab Apple *Malus sylvestris* is in a number of hedgerows across the landscape.

[SPAC][H] - There is a linkage between species at certain positions, at predictable abundances in recognisable combinations in the hedgerow. For example, Hawthorn *Crataegus monogyna*, Blackthorn *Prunus spinosa*, and Bramble *Rubus fruticosus* are universally found in a range of hedgerows across the landscape at similar abundance levels not related to history or subsequent management.

[T][SPAC][L] - There is an historical basis for the position of species at defined frequency in combinations they are in at the landscape level. This is a primary hope of surveys of this type as they aim to show that the composition of some hedgerows can be used as markers to indicate a common origin or development through time. For example, the combination English Elm *Ulmus procera*, Guelder-rose *Viburnum opulus* and Spindle *Euonymus europaeus* are frequently encountered on known mediaeval boundaries in the landscape.

[T][SPAC][H] - There are historical reasons for the position of species at defined abundances in the combinations they are at the hedgerow level. This is likely to detect fragments in hedgerows that may have been significantly replanted or modified, e.g., English Elm *Ulmus procera* may be moving along a recent hedgerow from a medieval one, in combination with other species from the earlier hedgerow, or there may have been a recent replanting of a gap at a certain location using a particular combination of species.

[M][SPAC][L] - Management has created the pattern of species, being in certain positions at defined abundances in the combinations they are recorded in at the landscape level. Owners may have added a number of tree species to their hedgerows at some unknown time. At Dunnington, Lime *Tilia* sp. and Field Maple *Acer* campestre appear to have been added at some point after the original plantings. If the combination of position, frequency and combination cannot be linked to time, then it may be explained by the management the hedgerow has received.

[M][SPAC][H] - Management has resulted in the pattern of species, being in certain positions at defined abundances in the combinations they are recorded in at the hedgerow level. With undatable origins, hedgerows can acquire or lose species naturally or by human intervention to create or remove combinations. Sections may have been added or removed with no indications of when.

SPACES analysis for Woodland

Taking the species perspective for woodlands there is a focus on species associated within woods [W] rather than in different woodlands across the landscape [L]. Some ancient woodland species may be common in woods across the landscape, other rare. This may be an instance where there are more recent woods lacking the species. Its relevance would relate to the likelihood that the species originated from the few ancient woodlands in the landscape being close enough to colonise the larger number of probable local recent woodlands. For woodlands the possible scenarios for the permutations of SPACES elements are:

Species + Position [SP] - Species can be located in specific parts or all parts of the landscape [SP][L] as indicated from the atlas locations or in localised sections or all parts of the wood [SP][W] in combination with time [T] and management [M].

[SP][L] - A species associated with specific positions in the landscape at no particular abundance and not linked to history or management, e.g., a species favouring wet woodlands or occurs everywhere.

[SP][W] - A species and position association at the wood level at no particular abundance and not linked to history or management, e.g., a species only found at the deepest shade in the middle of the wood or at the lighter edges.

[T][SP][L] - A species linked to history that is found in certain parts of the landscape, e.g., a species planted or found in recent woodlands.

[T][SP][W] - Historically a species found in certain parts of a woodland that can be assigned to a particular time or phase, e.g., Hazel *Corlylus avellana* planted for coppicing. This would also be the result of specific management actions and would be [TM][SP][L].

[M][SP][W] - Management at certain positions in the woodland have determined the species presence e.g., coppicing.

Species + Abundance [SA] - species may occur at similar abundances across the study area, and within individual hedgerows with no apparent preferences for Position. Again at both landscape and hedgerow scales [SA][L] (the number of 10km squares it is recorded from) and [SA][W] (field data abundance values from surveys).

[SA][L] - A species that is at a certain general level of frequency across the landscape regardless of other considerations, e.g., Dog's Mercury *Mercurialis perennis* in all, or most, 10km squares in the NCA and adjacent NCAs.

[SA][W] - A species that is at a certain general level of frequency or abundance in a woodland regardless of other considerations, e.g., Dog's Mercury *Mercurialis perennis* may be occasional to frequent in almost all woodlands regardless of location or when the wood was created i.e., abundant in both ancient and recent woodlands.

Appendix 10 - SPACES analysis method.

[T][SA][L] - As a consequence of history a species has an abundance in the landscape. This may also link to position and such species will be [T][SP][L] or [T][SPA][L]. For example, a species present in ancient woodlands either abundantly or as a rare species.

[M][SA][L] - A species may be actively encouraged by management over time, or removed from woodlands regardless of their time of creation or their histories, e.g., many ground flora species could have been removed by turf stripping for charcoal making over a prolonged period.

[M][SA][H] - A species may be actively managed like Hazel planted for coppicing.

Species + Position + Abundance [SPA] - some species may be located at particular parts of the landscape [SPA][L] or places in a woodland [SPA][W] and be at a predictable level of Abundance.

[SPA][L] - A species that is found in certain places in the landscape, e.g., in a number of woodlands in the landscape Ramsons *Allium ursinum* is at an abundance of frequent but there is no indication that this is linked to history.

[SPA][W] - In woodlands a species that is found at certain points (or is general throughout) at a particular abundance e.g., in a woodland that contains Ramsons *Allium ursinum* will be dominant in wetter parts.

[T][SPA][L] - Historically, in the landscape a species that is at certain locations and has a particular abundance e.g., a species like Sanicle *Sanicula europaea* may be found in certain woods across the landscape where there are places of base enrichment within them.

[T][SPA][W] - In a particular historical context a species is at certain locations at a particular abundance, e.g. Herb Paris *Paris quadrifolia* is regarded as a good AWI that is found in particular parts of a wood (calcareous flushes) at low abundance.

[M][SPA][L] - The management could relate to a position and the frequency of a species. Woodlands in the landscape may have been managed by replanting with little indication of the age or history, e.g., Some woods may have have different traditions for management and contain different species and be at different abundances. For example coppice woods in one place may have more Bluebell *Hyacinthoides non-scripta* than a nearby wood that has not been coppiced.

[M][SPA][W] - The consequence of [M][SPA][L] above could be the unexpected low frequency of Dog's Mercury *Mercurialis perennis* caused by past turf stripping for charcoal making.

Woodland Combination analysis

Consideration of the combination of species in a woodland differs from the approach with hedgerows. There has been considerable work done in woodlands to classify them based on their floras. This includes the shade-creating canopy of trees and shrubs to the shade-tolerant shrubs and ground flora. The most comprehensive treatment in recent times is part of the National Vegetation Classification (NVC) system (Rodwell 1991). Earlier classifications by Bunce (1982 and 1989) and Peterken (1991) have added to the debate of how to classify the complex vegetation within the confines of a variable 'habitat' called woodland that often encompasses areas of open ground in clearing and rides. And the interactions of subtle differences in shade caused by different tree species or temporal difference during a coppice cycle confound efforts to find homogenous and stable 'stands' at appropriate quadrat sample sizes (Peterken 1991). The current research again does not seek to classify woodland stand types, only to interrogate the species present to determine the origins and past management histories where possible. As with the hedgerow approach the aim is to identify any combinations of species in parts of the woodland that can inform the analysis and be of value in the interpretation.

Combination in the woodland context can relate to two, or more, AWI species being found on a transect through a wood, at a standing quadrat or as part of a point record where several AWIs are found in close proximity.

It is the nature of the mix of species that is key to understanding the status of the transect or location of the records. In parts of the woodland there may be several low level indicators and in other parts a few high level indicators growing as a combination. The SPACES analysis crystallises the importance of the differences in these different scenarios in the context of their significance as historic markers.

As with the species analysis approach above, the combination element of the species composition is considered with other SPACES elements.

As with the species perspective analysis, the combination analysis in woodlands is mainly focussed on the woodland scale [W] although some combinations may be found in several woodlands across the landscape scale [L].

Appendix 10 - SPACES analysis method.

Species + Combination [SC] - are certain combinations of species found where there is no apparent systematic position or abundance association?

[SC][L] - A particular combination of species is found in woodlands across the landscape without any historical reason or indications of systematic position, abundance e.g., a combination of common woodland species that are low level indicators found in both ancient woods and recent woods and therefore not diagnostic of history [T].

[SC][W] - A particular combination of species is found generally throughout the woodland. For example, a basic combination of Dog's Mercury *Mercurialis perennis*, Bluebell *Hyacinthoides non-scripta* and Enchanter's Nightshade *Circaea lutetiana*. As with [SC][L] not diagnostic for ancient woods and not at consistent abundances [A].

[T][SC][L] - Historically a specific combination of species in woodlands across the landscape indicating ancient woods that lends itself better to the [T][SPC][L] signature as these will nearly always be identifiable to specific woods.

[T][SC][W] - History reflects a specific combination of species in ancient woods. The total combination of species in a wood or parts of a woods betray its ancient past.

[M][SC][L] - The management affects the species combinations at the landscape level. At this level the woodlands may have a general character of being coppiced and contain species indicative of this management practice.

[M][SC][W] - The management affects the species combinations at the woodland level. For example, a species combination related to coppicing of the whole wood or where charcoal has resulted in turf stripping in all parts.

Species + Position + Combination [SPC] - are particular combinations of species found at specific positions in the landscape [SPC][L], or within a woodland [SPC][W] at no particular level of abundance?

[SPC][L] – Woodlands in certain parts of the landscape have specific species combinations that don't seem to have an associated timeframe or management reason e.g., woods on either valley sides or in valley bottoms.

[SPC][W] – Combinations occur in specific parts of the wood without any indication of history and at no defined abundance. The positional form of [SC][W].

[T][SPC][L] - Historically specific species combinations occur in certain parts of the landscape. For example, ancient woodland species combinations found in specific woods.

Appendix 10 - SPACES analysis method.

[T][SPC][W] - History explains why certain combinations are in particular parts of an ancient wood. For example, it occurs on a steep-sided ravine that is unlikely to have been felled or had its ground flora damaged by management and is therefore likely to support a good range and combination of AWIs.

[M][SPC][L] - Management practices have produced the species combination at certain locations in the landscape. As an example recent forestry plantations may have combinations of mainly low level indicators. This is also likely to be linked to history [T].

[M][SPC][W] - Management practices have created the species combination at certain locations in the woodland. For example a species combination related to coppicing of the parts of a wood or where charcoal has resulted in turf stripping in localised areas.

Species + Abundance + Combination [SAC] - There is a systematic level of abundance associated with particular woodlands, independent of their position [SAC][L] and [SAC][W].

[SAC][L] - The combination and its frequency at the landscape scale is predictable. For example, a combination of Dog's Mercury *Mercurialis perennis*, Bluebell *Hyacinthoides non-scripta* and Ramsons *Allium ursinum* are typical of all of the woods in an area.

[SAC][W] - At the woodland scale the abundances of species in combinations are similar. Within a woodland where a combination occurs the species are in approximately the same abundance compared with the same combination group either elsewhere in the same woodland or in another woodland. For example, the combination of of Dog's Mercury *Mercurialis perennis*, Bluebell *Hyacinthoides non-scripta* and Ramsons *Allium ursinum* in approximately the same abundances in this combination occurs frequently at non-specific locations through the wood.

[T][SAC][L] - History determines the abundance of species in combinations. This would be determined by historical evidence e.g. the mix can be assigned to a phase of planting.

[T][SAC][W] - History explains the abundances of species combinations in woodlands, e.g., determined by historical evidence a combination of significant woodland species supports the assumption that the woodland is ancient.

[M][SAC][L] - Management has produced the frequency of combinations of species at the landscape level. Selective encouragement or removal produced the level of frequency observed, e.g., Coppicing has created combinations of species that are repeated at other woods under similar management.

Appendix 10 - SPACES analysis method.

[M][SAC][H] - Management practices at the woodland level have moulded the abundances of species in combinations. Coppicing has created combinations and similar abundances of species that are repeated in other parts of the wood under similar management.

Species + Position + Abundance [SPAC] - Combinations occur at specific positions and at particular levels of frequency or abundance [SPAC][L] and [SPAC][W].

[SPAC][L] - There is a pattern of species at certain positions, at defined frequency in recognisable combinations in the landscape, e.g., a combination like Dog's Mercury *Mercurialis perennis*, Bluebell *Hyacinthoides non-scripta* and Ramsons *Allium ursinum* is frequently encountered in all woods.

[SPAC][W] - There are combinations at certain positions, at predictable abundances in the woodland. For example, Bluebell *Hyacinthoides non-scripta* may be abundant and Dog's Mercury *Mercurialis perennis* frequent in defined parts of the wood as a combination.

[T][SPAC][L] - There is an historical basis for the position of combinations at defined frequency at the landscape level. This is a primary hope of surveys of this type as they aim to show that the composition of some woodlands can be used as markers to indicate an ancient origin. Woods that contain combinations of 'good' AWIs are the aim of surveys.

[T][SPAC][W] - There are historical reasons for the position of species at defined abundances in the combinations they are in at the woodland level. This is likely to detect where parts of a current woodland may have been recently felled and replanted causing a loss of 'good' indicators and only now becoming colonised by less reliable species.

[M][SPAC][L] - Management has created the pattern of species combinations, being in certain positions in the landscape at defined frequency. If the combination of position, frequency and combination cannot be linked to time, then it may be explained by the management the woodland has received. An example would be a series of woods managed by a particular estate that had a similar combination of species in each by virtue of having been managed by the same practices over time.

[M][SPAC][W] - Management has resulted in the combinations of species, being in certain positions at defined abundances in a woodland. A depauperate flora of Bluebell *Hyacinthoides non-scripta* and sparse Dog's Mercury *Mercurialis perennis* may be the result of disturbance or other management that happened at some unknown time in the past.

Appendix 10 - SPACES analysis method.

The SPACES process

The process involves careful consideration of the species recorded in the context in which they are found at both the landscape and woodland/ hedgerow levels.

The SPACES approach for woodlands

The SPACES approach to woodland is slightly different from the approach for hedgerows. With woodland there is a predetermination as to which species are regarded as historic markers based on their autecologies. There is a candidate list of species that is weighted in order of confidence that they are restricted to the type of woodland classified as ancient. The determination of ancient woodland is effectively a determination of a continuity of woodland conditions sufficient to allow for the continued survival of shade-tolerant species and other species associated with the often open character of these historic features.

With woodlands the initial approach is from the species perspective, the presumption being that a survey has been done and that, at the very least, a species list for the entire woodland is available. In an ideal world new survey data gathered using the WOODS survey method advocated in this thesis should be adopted and the data from this survey used in the interpretation.

Any historic information on the woodland will be of value in the interpretation. However, in the absence of any such information it should be assumed that the current woodland boundary is equivalent to any historic one that may have existed in the past. In the case of plantation woodlands this may be obvious and also it may be obvious from studying the boundary of an ancient woodland that there are additions that are clearly of more recent origin. The main object of this analysis is to determine the range of ancient woodland indicator species within the woodland in order to acquire a confidence that the woodland block has an ancient origin.

The weighting system advocated by this research does not require a simple numerical count in order to make a determination as to whether the woodland qualifies as ancient or otherwise. It is evident from research done by others and during this research that the candidate number of probable species will vary from one woodland to the next and therefore a single numerical value is dangerous and invalid. The use by such as local authorities of indicator species thresholds in planning applications should be discouraged in favour of a more pragmatic and realistic approach such as is provided in this research.

Appendix 10 - SPACES analysis method.

Essentially the starting point for this part of the analysis is to consider the status of the species found within the woodland. As part of the other elements to this research these will have been assigned a significance and weighting based on their autecologies and their regional distinctiveness.

The autecology study will have identified those species that are more reliable indicators of ancient woodland than others based on their more restricted ability to colonise recent woodland. This part of the study will also have identified those species that are preferential to different meso-habitats within woodland. This will generate candidate lists for meso-habitats that will then be weighted for their level of fidelity as historic markers.

As an example, if there are 240 candidate ancient woodland indicator species as recognised by the work done by Glaves *et. al.* (2006) there could be as many as 150 of the species that are generalists with wide amplitudes that do not reflect any particular meso-habitats within woodland. Of the remainder, 50 might be found more exclusively in wet areas on streamsides, springs and flushes and the other 40 with some other specialisation.

The next stage is to find out for the wood in question how many of these species are likely to be present based on the distribution from the Atlas. It may transpire that out of the 150 generalist species only 100 have been recorded within the 10 km^2 of the study woodland. And that out of the 50 wetland species only 30 are known to have been recorded within the same 10 km^2. This will reduce the effective candidate list for that woodland from 200 to 130.

The next part of the process is to find which of the 100 generalists are critical historic markers and which of the 30 wetland species are also critical historic markers. This will form the basis of the intelligent creation of an evaluation as to the likelihood that the candidate woodland is likely to be ancient woodland in character.

The data is then interrogated to see how many high level indicators are present in the surveyed woodland. Assuming the data are pre-existing then a statement can be made as to how well the list provided accords with the supposition that the wood is ancient. From here it will be possible to evaluate other woods in the study area and compare.

The comparison poses difficulties as woodlands are intrinsically not homogenous and do not have the same histories (Barnes and Williamson 2015). Woodlands in an area are likely to vary in the internal variations in Meso-habitats. This will affect the candidate lists for two individual surveyed woodlands. One woodland may be on level ground with no significant

Meso-habitats and the other may be in a valley with streams, flushes and springs as well as inland cliffs, rock outcrops and boulder scree.

It would be very unlikely that a species list from these two woods will be identical and could be radically different, not only in the number of AWI species but also the range and identity of the species i.e., the second wood will have species associated with the wet parts that are not likely to be found in the first wood. Creating a 'level' playing field to even out such differences and also to deal with woodland being of different sizes is the aim of the SPACES analysis.

The SPACES approach for hedgerows

Any historical information available is used to aid the interpretation. At the very least it is likely that the township boundaries are available as a historical starting point for some of the interpretations. Information may also be available on the time of any parliamentary or other enclosures of the landscape.

As the process involves looking for patterns of species distribution in the landscape, it is not essential to have such historical information. What the process will do will be to identify areas where certain species occur that will stimulate the need to investigate the reasons behind these occurrences using any historical research available.

Another aspect of the process is that if a correlation between species, position, abundance and combination has been determined for a nearby township, it may be possible to extrapolate these data into the area of current study. As an example for the Dunnington study similar patterns of distribution were recorded in the adjoining township of *Scoreby* that could be transferred into the findings from the Dunnington survey.

In any survey it is likely that there will be a range of species that are very common or even ubiquitous across the entire study area. These are unlikely to be informative as historic markers. The only likely interpretation of these will be if such common species are absent from certain parts of the landscape. This could indicate a systematic planting that excluded certain species during, for example, an enclosure award planting.

The SPACES approach process essentially begins by looking at some of the rarer species in the landscape. In many cases these species are found in less than 10% of hedgerows in the study area (1st decile species). This is partly based on the fact that, in many landscapes, there were a very large number of hedgerows planted during various enclosure periods throughout history. This means that potentially up to as many as 80% or more of the current stock of hedgerows are of relatively recent origins and may have been planted with a restricted range of species compared with earlier established examples. It has become apparent from doing hedgerow surveys that it is often the rarer species that are more diagnostic as historic markers than the more common species.

It is likely that, historically, hedgerows were a more valued resource and were planted with a range of species that were of value to the community. Subsequent plantings are more likely to have been utilitarian in nature and were designed purely to create a stock proof barrier between fields. Therefore, the species included were largely irrelevant and were often chosen for their ease of acquisition or for reasons such as the suitability for a stock barrier by being thorny etc.

With, or without, supporting historical information, the analysis process begins by determining which of the rare species may be informing as historic markers. At this stage care should be taken as there will be a number of species that could confound or confuse the process without some knowledge of their likely historical origins. It will be a matter of local research that determines which species are credible historic markers compared with those that may have been introduced as ornamental plantings in relatively recent times. For example, it is unlikely that Lilac will have been a significant hedgerow component in the past and may just be a chance seedling from a local garden.

Determining which species are likely to be relevant is a difficult task that is likely to be aided by any historical knowledge available.

Once it has been established which are relevant species likely to inform as historic markers these need to be mapped to determine if there is any pattern to their distribution across the landscape that can be determined as indicating historic origins. For example, if a species was found to be restricted to the township boundaries (medieval) this would be a strong indication that this species was an historic marker.

If this species was also found within the survey area on a number of hedgerows that could not be categorically dated to the medieval period, this would not necessarily mean that they were not medieval species, it could be that they are species from the medieval but that there is no current evidence to support this status. Such evidence may become apparent later when further historical research is done.

Having established one or more species as being historic markers for the township boundaries (medieval) the next stage would be to consider the other species found within these hedgerows to determine if there were any combinations that were common to medieval township boundaries. These combinations could again be used to look for internal boundaries where similar combinations were found and support the evidence that it is likely that this combination is indicative of unrecorded medieval origins.

The whole process relies on identifying signatures from both the species and combination perspectives. There are a number of species that clearly mark historic creation times. Such species are also posing interesting questions as to why they occur on features that cannot be categorically dated. The example is English Elm *Ulmus procera* that has a strong affinity for township boundaries and medieval field boundaries but is also found on hedgerows, in quantity, where there is no historic confirmation of origin, suggesting historic origin that needs a tangible hypothesis to explain its presence.

Appendix 11 – Woodland workshops presentations and discussions.

A summary of the notes from each of the four woodland workshops follow. Each begins with a programme of the topics covered and relevant notes extracted from each of the presentations, along with notes that were made during the discussion sessions throughout the series of workshops. These are a combination of notes provided by speakers and transcripts from audio recording made of the presentations as well as summaries of my sessions taken from the PowerPoint presentations.

Appendix 11 – Woodland workshops presentations and discussions.

Woodland Workshop 1 - 14 May 2008.

Programme

1. **Dr Peter Glaves,** Biodiversity and Landscape History Research Institute – Introduction: Ancient Woodland Indicators and Introduction and Overview
2. **Dr Ian Rotherham,** Sheffield Hallam University - Woodlands in the landscape – what indicators might tell us.
3. **Keith Kirby**, Natural England - Woodland indicators – some experiences from Natural England.
4. **Richard Smithers**, Woodland Trust - Back on the Map - Using plants to help determine antiquity of woods in Northern Ireland for an inventory of ancient and long-established woodland.
5. **Barry Wright**, Sheffield Hallam University - Woodland Indicator Research
6. **Discussion Session**

Introduction

The 14 May 2008 Woodland Indicator Workshop was the first of a series of workshops looking at the use of biological indicators of ancient woodland. The Workshop considered the identification of ancient woodland sites using distinctive regional lists of vascular plants as indicators and had the following objectives:

1. To establish a network of experts to support a review of woodland indicators
2. To gather current 'expert' opinion on woodland indicators
3. To identify key regional experts/ champions
4. To review the regional coverage of indicators
5. To identify/ clarify the problems with the current approach to woodland indicators
6. To review and agree targets for research

Appendix 11 – Woodland workshops presentations and discussions.

W1 - 01 - Dr Peter Glaves

Ancient Woodland Indicators, an Introduction and Overview

An introduction to the Workshop objectives and format was given (see above). The use of biological indicators was reviewed. Biological indicators are species or communities whose characteristics show the presence of specific environmental conditions, often by their presence or absence, sometimes by their condition and behaviour.

Vascular plants have for a number of years been used as "*ancient woodland indicator species*" both in Britain and internationally; a range of indicator lists have been proposed and used to determine the 'ancientness' of woodlands. There are however some concerns regarding the use of such lists to identify ancient woodlands, including the lack of quantified data to support some lists and the fact that indicators vary in their specificity to ancient woodlands in different parts of the country, on different soils etc.

Ancient woodland indicator species are indicators of the ancientness of a woodland, i.e., the continuity of woodland conditions at that site for a considerable length of time. Their presence or absence does not prove the ancientness of a site but they are used to designate ancient sites and there is therefore a need for the development of a robust, reliable and testable approach to ancient woodland indicators which takes account of '*local or regional species*' and variations.

The objective of this series of workshops is therefore to develop a strategy for producing *'distinctive area or regional*' vascular plant indicator lists which can be applied with confidence and reliability. This first sought to explore the practicalities of developing such an approach and gain expert opinion on how to take the work forward.

A robust approach needs to take into account the ecology of the potential indicator species, i.e. their autecology drawing on the characteristics of ancient woodland indicators including: Ellenberg values and the Grime *et. al.* (2006) *Comparative Plant Ecology* typologies. There are however a number of indicator issues which need to be overcome including:

- continuity and comparability of sites and species across sites

- non-specificity of indicators, an ancient woodland indicator may be present or absent on a site for reasons beyond the sites ancientness, e.g. soil type
- indicator dynamics including seasonal and annual variation in species occurrence and abundance, and the influence of regional and local factors etc. on species occurrence, and therefore their suitability as indicators

These factors, amongst others, need to be considered if a robust and regional specific approach is to be developed.

Appendix 11 – Woodland workshops presentations and discussions.

W1 - 02 - Dr Ian Rotherham

Woodlands in the Landscape – What indicators might tell us

Why are ancient woodland indicators used? Reasons presented included the fact that ecological complexity combined with limited resources, often leads to sites under examination being difficult to fully assess or evaluate. Also, that time, resources and indeed competence are often restricted and therefore ecologists often rely on so-called *'indicator species'* to provide information on the nature and quality of a particular site.

This information may in turn be used to help inform an assessment for nature conservation evaluation. Indicators can also identify priority areas for management or protection, and can also be used for the purposes of site monitoring.

Indicator species are therefore key to reading the landscape, its current ecology and management, and its history. The underlying idea is that some animals and plants have their *occurrence* (distribution and abundance) restricted or facilitated by particular environmental factors or variables to a specific niche. It is presumed therefore that there are certain species whose distribution is limited to, or predominately found within, ancient woodlands. The analysis of a species *occurrence* or *absence* may therefore provide information about not only the individual species, but of a more general nature - about the communities of animals and plants - or about the environment in ancient woodlands.

In terms of indicators in woodland and forest there are two key considerations:

- The species habitat requirements and specificity to woodland/forest, and
- The habitat continuity/ antiquity of the forest/ woodland (i.e. its ancientness)
- Underlying the development of ancient woodland indicators are several objectives including:
- attempting to understand environmental change and its effects on woodlands and the broader landscape
- the need to set priorities for the conservation and management of woodland (amongst which age and continuity of a site are important conservation considerations)
- the attempt to unify the approaches by ecologists, historians and archaeologists when analysing and evaluating woodlands and forests

The current approach to the use of ancient woodland indicators is based on a number of interlinked ecological principles including:

- the ecological (or autecological) characteristics of ancient woodland indicator species

Appendix 11 – Woodland workshops presentations and discussions.

- Grime's comparative plant ecology approach
- the species autecology approach developed by Donald Pigott etc.
- Ellenberg's indicators
- the historic timelines for sites and regions - including continuity of the woodland and its environmental characteristics
- spatial and temporal issues - including changes in environment between and within woodlands
- the effect of woodland clearance and re-establishment on species/indicators, including:
- the rate at which species are lost
- species re-colonisation ability
- Changing perceptions of landscape and woodland history, in particular Frans Vera and his view of the dynamic nature of landscape and ecology.

Ancient woodland indicators have been used on their own to indicate the antiquity of a site but are best used as part of a broader approach which involves reading the landscape, understanding history of occurrence and relating it to other evidence.

A series of examples were presented to illustrate these issues, including the evidence used to determine old and ancient coppice woods. For example, what do ancient coppiced woodland indicators tell us about the pre-coppice wood history and how far back can they 'indicate'? Woodland history and usage have changed substantially over time; the type of high forest which we now associate with ancient woodland may have historically been quite different, perhaps woodland pasture with a more open canopy. Ancient woodland indicators may therefore be associated with environmental conditions associated with high forest (light, humidity etc.) and not the conditions found in that woodland at some points in the past. Human management practices, chance and catastrophic events can each affect the species found in a woodland. Indeed, there is a need to determine what we mean by a 'woodland' and define the environmental conditions associated with a woodland, for example does a 'wood' need to have trees, and if so how many trees and how far apart?

Maps and other historical evidence can help identify the age and continuity of a woodland and should be the starting point for any study of woodland history and archaeology. The ecology and landscape of a woodland and the surrounding broader landscape both directly and indirectly determine the species found in that woodland, by determining the niches available and by determining the land uses (which in turn modify the environment).

The archaeology of an ancient woodland can be divided into:

- The archaeology **of** the woods, linked to the historic uses of that woodland, including charcoal hearths, working trees etc.
- The archaeology **in** the woods which covers all archaeology not directly linked to the woodland and its uses, for example agricultural remains from historic periods when the woodland was cleared

Such woodland historical and archaeological features can modify the woodland environment/ecology and affect the species found, for example, different species found in sunken tracks and charcoal hearths. There is a need to relate such history/archaeology to the woodland ecology.

A key characteristic attributed to many ancient woodland indicator species is poor dispersal and colonization ability and therefore a poor ability to re-colonise after woodland clearance, but there is a need far data on colonization rates for new woodlands. Such rates vary between species and with climate and soils - but many 'indicator' species move 0.5m – 1.5m per year.

What can indicators tell us about the environment? Well, all plants, animals and fungi provide information about the environment, i.e. all species are *potentially indicators* of something. The main problem is knowing *what* they 'indicate', specifically what do ancient woodland indicators indicate?

There are some wider implications in the use of ancient woodland indicators including:

- Regional character and distinction in indicators, including what are the differences in specificity of species to ancient woodlands in upland and lowland areas, in the more continental climates in the south east and more oceanic north west etc.?
- What about indicators of broader historical landscape with trees (treescapes) and other types of wooded landscape including parks and heaths?
- What are the implications of the Vera hypothesis (and the contention that historically Britain was not covered in dense forest) for our assumptions regarding ancient woodland indicators?

What about woodland shadows in the landscape, i.e. the survival of woodland indicator species after woodlands are cleared?

There are preconceptions associated with the use of ancient woodland indicators, specifically the historical static image of an unchanging medieval coppice woodland needs to be revised and related to a more dynamic changing wooded landscape where changes in land use, climate etc. have modified the woodland and its surroundings. Many so-called ‘ancient woodland indicators’ seem to give good information on a medieval or early industrial coppice but can they tell us more than this and how do they relate to the more fluid vision of the landscape?

Appendix 11 – Woodland workshops presentations and discussions.

W1 - 03 - Keith Kirby

Woodland indicators – some experiences from Natural England

Keith Kirby presented a view of the use and interpretation of ancient woodland and the use of ancient woodland indicators from a conservation agency perspective, given that Natural England have probably had more experience of this than anyone else. The presentation considered what is not understood about ancient woodland indicators and the uncertainties in their use as well as what is or is not an indicator.

The origins of the concept of ancient woodland indicators (AWIs) can be dated back to the 1970s, specifically George Peterken's work in Lincolnshire in 1974 (published as Peterken, G. F. 1974 A method for assessing woodland flora for conservation using indicator species. *Biological Conservation* 6, 239-245). As George himself points out, prior to this people had noted that certain species tended to be associated with old woods, but his 1974 study in Lincolnshire was probably the first to assess this quantitatively using independent assessment of the history of the woodland and the species occurrences.

This study involved:

- An independent assessment of history and flora
- A study of an area where there were ecologically clear-cut division between woodland and non-woodland environments
- Where the woodland history was fairly unambiguous
- Where there was limited ground flora variation between woodlands

It is worth noting that this study was about simplifying survey methods by concentrating on key woodland species, not aiming to identify ancient woods on the basis of the species present as such.

During the 1980s ancient woodland went from being an obscure idea understood by a relatively few people to being an accepted designation in conservation circles, largely because of the Nature Conservancy Council's work in developing the ancient woodland inventories (of sites believed to have been wooded since 1600 and in Phase Two woodland surveys). As part of this work ancient woodland indicators were used as part of the identification process. The Lincolnshire list of ancient woodland indicators and one or two others that had developed in other areas were then taken and modified for use in different counties and countries.

There was a proliferation of ancient woodland indicator lists in the 1980s, many of which were simply more-or-less direct copies of those for the adjacent county; a few (such as those by Hornby and Rose) were based on extensive empirical survey data; even fewer had independent checking of the history of sites against species occurrence as the basis for determining indicator status. The recent work in Wales (hot off the press from CCW, and from Northern Ireland which is covered in the next talk are honourable exceptions to this). See also Spencer, J W and Kirby, K J (1992) An inventory of ancient woodland for England and Wales. *Biological Conservation,* 62, 77-94 and Rose, F. (1999) Indicators of ancient woodland. *British Wildlife,* 10, 241-251.

It is important to note that in the 1980s the use of indicators shifted from their occurrence being an indication of the value of the site, to them being an indicator of ancientness, and ancientness is the attribute valued. This distinction is rarely made, but becomes critical when, as is increasingly happening, we find sites that are not 'ancient' on the historical evidence but do have a strong suite of indicator species.

Despite the popularity of the concept, and increasing use of ancient woodland indicators, there has been relatively little work done either in the agencies or in the research community in developing understanding of why ancient woodland indicators behaved as they did, at least in the UK. Rather more has been done on the continent particularly by the group led by Martin Hermy at Leuven in Belgium.

We increasingly need a better understanding of the 'ancient woodland indicator' concept if we are to continue to use it in site evaluation and defence. Specifically, we need to go back to some basic questions and test our assumptions with respect to:

- Why is a particular species more common in ancient than in recent woods; what is it really 'indicating'?
- How much commoner does it have to be in an ancient woodland to be an indicator?
- What factors affect number of 'indicators' found?
- What is the process used to decide which species then go on the list?

Appendix 11 – Woodland workshops presentations and discussions.

If we are comparing woods either with each other, or against some notional standard, then we need to understand what is an ancient woodland indicator and what factors affect how many ancient woodland species might occur in a wood.

Peterken in his 1974 paper and subsequent writings suggested a number of possible reasons why a species might be more common in ancient than in recent woods. For example, see the number of ancient woodland indicators recorded along plotlines in Lincolnshire woodlands (Fig1). Since then a number of theories have been proposed, the most popular is that these are slow colonists; that they were formally more widespread, have become isolated by fragmentation and are now unable to spread into new woods unless these are directly linked. This implies that they simply take time to spread and support for this is seen in situations where ancient woodland indicators have crossed the boundaries into adjacent woods (e.g. Lincolnshire work, Hayley, Plegdon Wood). A problem with this alone is that the rates measured are generally too low to allow spread back to Britain after the last ice-age, so are we missing rare long-distance events. See also Webster, S D & Kirby, K J (1988) A comparison of the structure and composition of an ancient and an adjacent recent wood in Essex. *The London Naturalist* 67, 33-45.

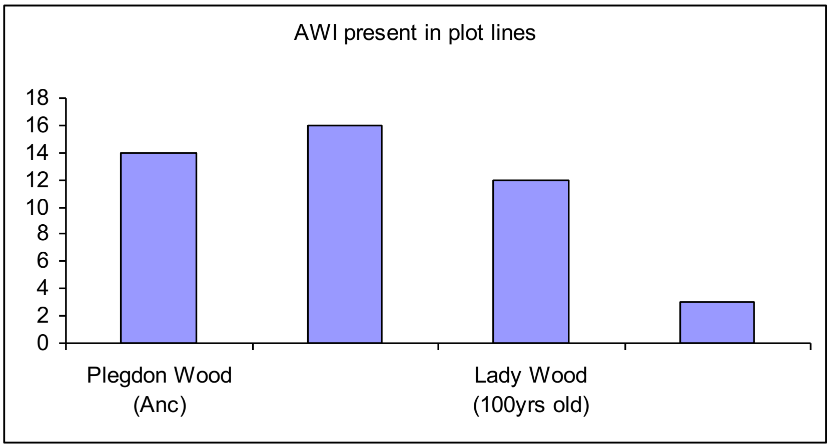


Figure 1 - Number of ancient woodland indicators in Lincolnshire Woods

A variant on the above assumes that part of the distinctiveness of ancient woodland is because they maintain a distinct moist microclimate not found in intervening ground and it is this rather than distance per se that limits spread – the occurrence of ancient woodland indicators in open ground in the west of England is often quoted as support for this idea.

There are alternative explanations. For example, we have to consider the possibility that species colonisation abilities have changed; for example that Lime spread to the north during a more favourable climatic period; that some insects might have become selected for low dispersal as the landscape became more fragmented.

By definition, recent woods could be up to 300 years old but in practice most are very much younger. It could be that for some species they have not been in existence long-enough for suitable conditions to have developed. This is more relevant to invertebrates and lichens than to higher plants, but still could be relevant. For example, it may take time for woodland soils to develop the sort of micro patterning of conditions that allow the co-existence of a range of different plant species, particularly relatively poor competitors.

Agricultural improvement in the 20th century may mean that soils under woods established since the 1930s may mean that colonisation will be slower than for woods at the same stage established on 19th century soils.

In practice there is unlikely to be a single mechanism common to all the species suggested as ancient woodland species, and in comparison of sets of ancient versus recent woods different elements may be operating.

Once we have identified, for whatever reason, that some species differ in their occurrence between ancient and recent woods, which do we include in a list? Too few species and most woods won't have any AWIs; too many and there will be many recent woods with substantial 'indicator' presence.

There is wide variation in the number of species and actual species used in AWI lists. For example, there are four different published versions of the Lincolnshire list from Peterken's work, containing 50, 55, 62 and 70 species on them. The lists produced by Dick Hornby and Francis Rose were deliberately standardised to 100 species for each of the three southern NCC regions for convenience. Other lists range from 25 to 95 ground flora species, so there will be different degrees of specificity in the list and species used.

Expert opinion has formed the basis of many lists. Statistical analysis provides a more objective approach to producing lists but if statistical tests are used to assess the significance of the difference in occurrence of species between ancient and recent woodland then whether a species shows significance may depend on the test used (chi-squared, mean abundance per site/area, binomial) and whether presence/ abundance is compared on an area or site number basis. In practice this may make little difference to the final outcome, but it has hardly been explored.

If the number of ancient woodland indicators present in a woodland is used to determine whether that site is classified as ancient or not, then there needs to be a clearer understanding of what affects AWI richness in an ancient wood. Peterken's 1974 paper showed a positive relationship between area and species richness, as have some other studies (e.g. Ann Hill's work in Hereford and Worcester Fig 2). The caveats are that this is typically a log-log or semi-log relationship such that the gains in species rapidly reduce per unit area increase as size goes up; and the relationship, though significant tends to have a low r-squared, i.e. area explains very little of the variance in indicator species number. This is highlighted particularly in Rose's list of the richest southern sites (Fig 3), which also highlights that very high numbers have been maintained in very small woods (less than 5 ha). Rackham similarly argues that individual wood size is not that critical for ancient woodland species richness; i.e. several small woods may be as rich as a single large one of the same area. Figures 2 and 3 show examples of such species area relationships, in some cases a clear size relationship can be seen; in others the relationship between woodland size and number of AWIs is unclear.

Appendix 11 – Woodland workshops presentations and discussions.

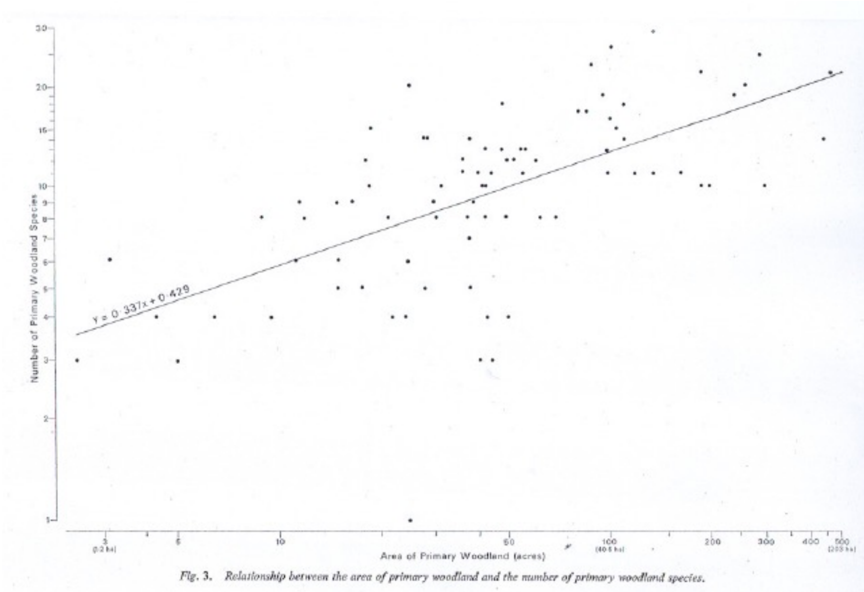


Figure 2

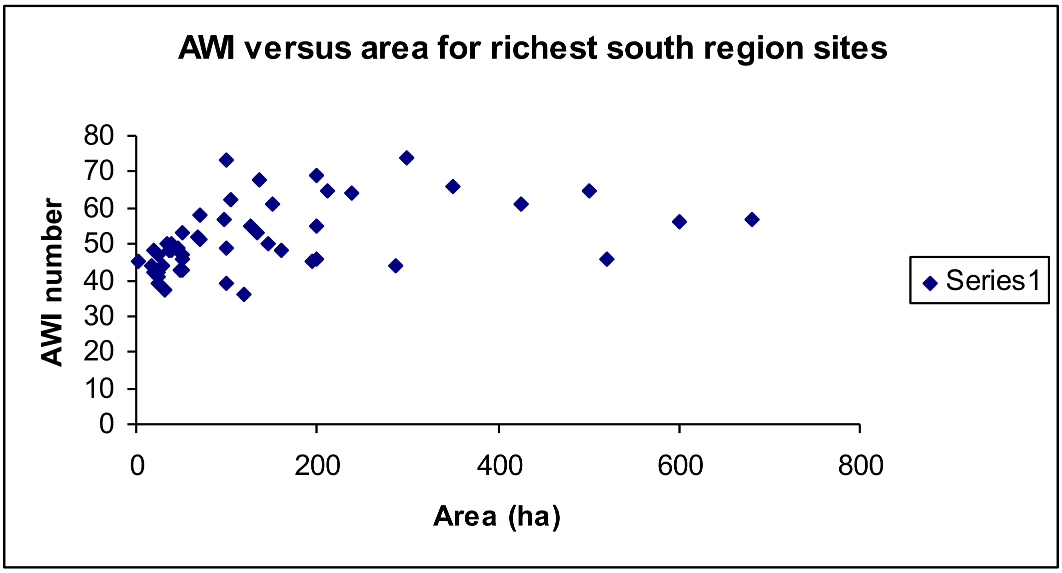


Figure 3

Type of woodland can also affect the number of species present (compare the two woodlands in Figure 4). Rose commented that the richest woods in his list spanned both acid and basic soils, but crucially notes that the acid woods usually also contained flushes or base-rich areas. There is a wider potential range of indicators in lowland base-rich communities than in upland acid ones (based on the NVC tables).

This is reflected in the actual lists from quadrats in different types, and in the lists from woods of similar sizes – mixed woods tend to be richer (hence the ridiculously high figures for some small woods in Rose's list). Similar conclusions have been found in the recent CCW work i.e. most potential indicators were for the more base-rich woods.

Structural diversity also affects number of indicators, particularly the presence of temporary gaps helps by bringing out some of the soil seed bank species, but also simply by increasing the abundance and hence detectability of other species.

Appendix 11 – Woodland workshops presentations and discussions.

Figure 4 - Comparison of Woodland Structure and Richness in Two Woodland Sites

No survey of a woodland is ever likely to cover the whole of the woodland except in the case of very small woods. When we are comparing numbers of indicators in woodlands therefore we are generally not comparing the total richness of AWIs, but a measure of that richness. Such measures of richness are affected by the survey approach used: the method used to survey a woodland, the levels of effort put into surveying a woodland and which parts of a woodland are surveyed will all affect the numbers of indicators identified. A range of methods can be used including: walk list or quadrats; equal effort across sites of different area, or proportional effort. There are arguments to make in favour of each of these different approaches depending on what you are trying to do. However, we need to be aware of the consequences when we are comparing surveys with different intensities and different observers. For example, almost any development site will be surveyed by objectors with a higher intensity per unit area than a typical phase two woodland survey in the past, so is likely to pick up more species, making the site look relatively better than perhaps it is. For a discussion of these factors see Kirby, K J, Bines, T, Burn, A, Mackintosh, J, Pitkin, P & Smith, I (1986) Seasonal and observer differences in vascular plant records from British woodlands. *Journal of Ecology* 74, 123-131.

As well as issues relating to how data is gathered there are issues relating to the interpretation of the findings in terms of numbers of AWIs, including does the richness in terms of AWIs equate to site value or are they just an indication of ancientness. In the 80s I was asked to comment on two woods being proposed for

SSSI status, both ancient, but one very much richer in ancient woodland indicators than the other, see details below:

Redhill Wood	16 ha,	6 stand types,	39 AWI
Enborne	9 ha,	3 stand types, but mainly lime,	20 AWI

The 'poorer' site in terms of AWIs however was a uniform stand of mature lime (hence its poor flora) compared to Redhill Wood which had a more varied, but generally widespread tree and shrub community.

Other issues relating to interpretation are illustrated by Four Acre Wood Bolnore; this is a small historically distinct wood on the edge of a much larger ancient woodland block (Fig 5). It was cleared and stumps largely removed in the 1950s and turned into a field for the next 30 years, whereupon it was let to go back to scrub. Surprisingly it appears to have retained a rich flora including c20 indicators. We had not included it on the 1989 ancient woodland inventory because the photographs used clearly show it as a field, but made the case it should be re-instated because in effect it had been behaving as a glade for 30 years. This raises the question as to how much of a break in woodland conditions can occur and still count the site as ancient. I think this was towards the limit.

Appendix 11 – Woodland workshops presentations and discussions.

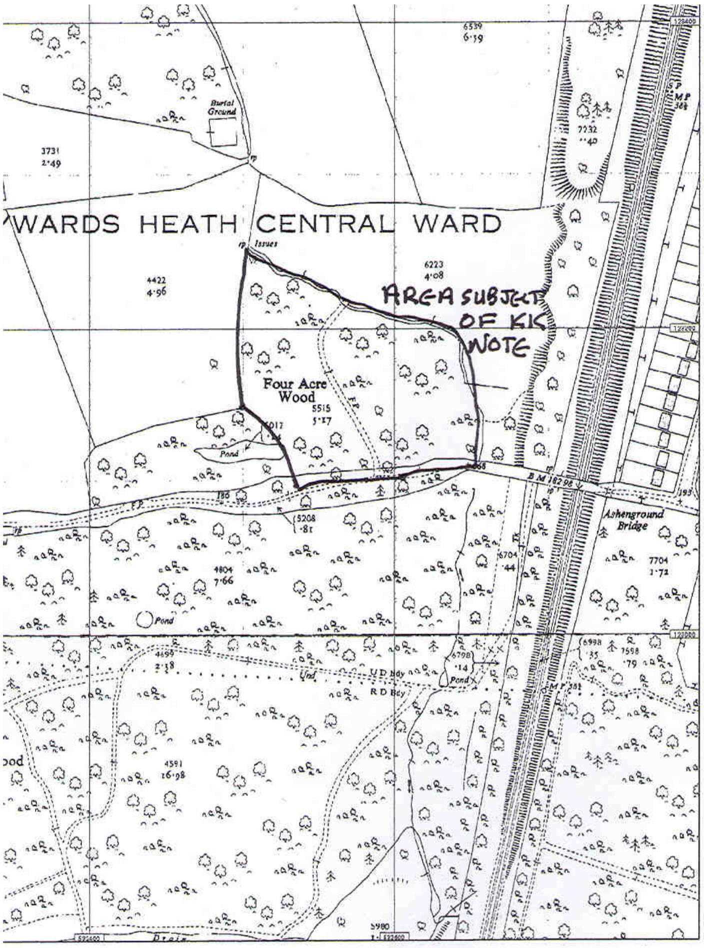


Fig 5 - Map showing location of Four Acre Wood

Another issue relates to the accuracy of species as ancient woodland indicators. For example, Herb Paris has always seemed to me to be the near perfect ancient woodland indicator, but The Wilderness in Berkshire seems to be the exception to the rule. From map evidence and an analysis of the structure of the woodland on the ground the woodland seems to have developed post c1830 on open ground and there is no adjacent ancient woodland. Yet Herb Paris is abundant throughout the site along with a reasonable range of other indicators, given that it is predominantly wet woodland which typically tends to have relatively few such species. So what is special about this situation that has allowed this invasion?

In conclusion therefore I begin to suspect that ancient woodland indicators are not strictly ancient woodland indicators. They perform this function because ancient woods tend to have characteristics, which may be only loosely linked to history individually, that collectively, make these species more common in ancient woods.

They do, as Hermy has shown for continental species and I have for British ones, tend to have a distinct set of characters: more shade tolerant; less competitive etc so that they are worth classing as woodland specialists. But this does then bring us back to the question of whether we are valuing such suites of species in their own right or because of what we thing they may in some circumstances indicate.

Appendix 11 – Woodland workshops presentations and discussions.

W1 - 04 - Richard Smithers

Back on the Map - using plants to help determine antiquity of woods in Northern Ireland for an inventory of ancient and long-established woodland

The presentation began by looking at the background to the Northern Ireland study. Great Britain inventories of ancient woodland indicators were created 20 years ago. These inventories are important for policy-makers and planners. Northern Ireland is the least wooded country in Europe, ancient woodlands in Northern Ireland are not recorded and their survival is in doubt. An inventory of ancient woodland indicators (AWIs) is therefore a vital first step to protection of such woodlands. The aim in the current study was to adopt a more rigorous approach to establishing an inventory of AWIs.

Ancient woodlands are defined as woodlands which have been continuously wooded since 1600. Another term 'long-established woodlands' is used to define woodlands which have continuously been present since the first edition of the six inch to a to mile Ordnance Survey (OS) maps which were produced between 1830-1844, but which have not been proven as ancient woodlands.

The starting point for the study was to establish a baseline of long established woodlands by comparing the first edition OS maps (1830-1844) with most recent 1:10,000 OS maps (1960s-70s) and intermediate maps (from the 1900s). All woodlands above 0.5 ha were considered including wood pasture, parkland and scrub. The woodland areas which have been continuously present since 1830-44 (i.e. long established woodlands) were mapped on a GIS. There were 2,617 woodland polygons covering 11,464ha. See Fig 1 and Table 1 for details)

Appendix 11 – Woodland workshops presentations and discussions.

Table 1 - Numbers of woodland polygons in size categories	
Woodland size range	**Percentage of polygons within size category (> 0.5 ha)**
< 2ha	60.5%
2-10 ha	30.4%
10-20 ha	5.6%
20-40 ha	2.5%
40-100 ha	0.7%
>100 ha	0.4%

Appendix 11 – Woodland workshops presentations and discussions.

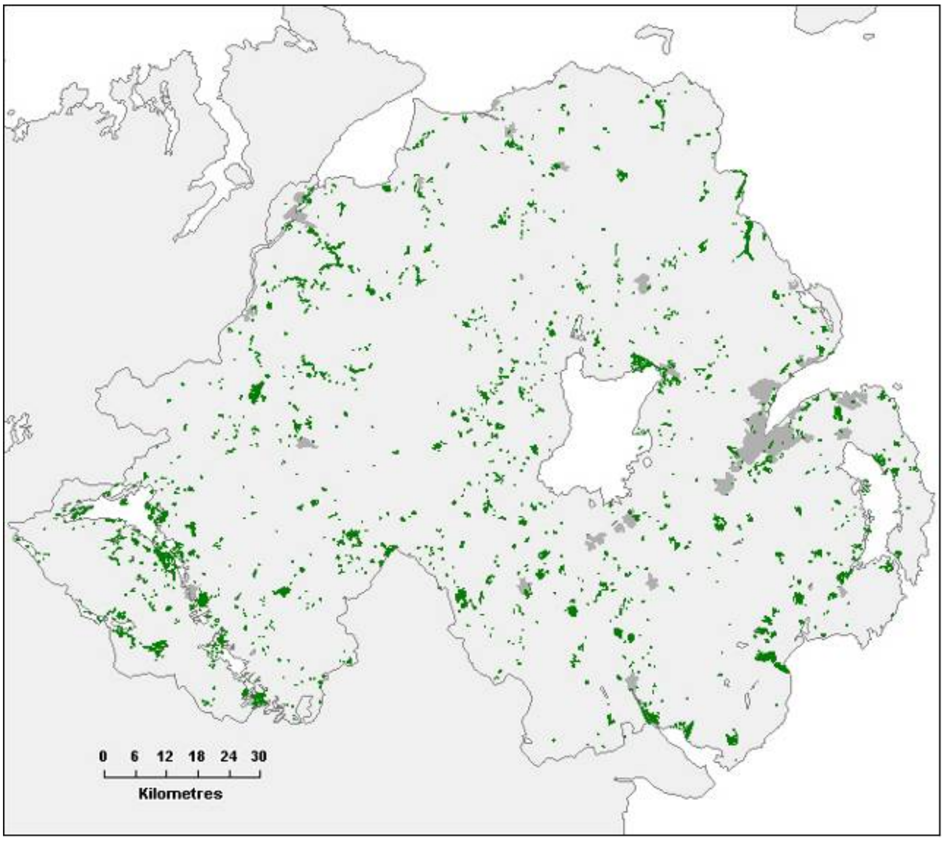


Fig 1 Map Showing Long Established Woodlands in Northern Ireland

There was extensive woodland clearance and planting in 17th -18th century in Northern Ireland. There is a need therefore to distinguish ancient woodland from long-established woodland, two approaches were used:

- Archive research
- Field survey

Historical Research of 17th century to 19th century sources confirmed the antiquity of 134 woods (with 69 being confirmed as ancient, and 65 as being long-established). The historical sources also provided much information about the remaining woodlands.

Field surveys of woodlands were undertaken between March and July in the years 2004 to 2006. A total of 2,205 woods were surveyed by two survey teams (made up of 24 surveyor groups). A range of factors were surveyed including: plants, bryophytes, ancient trees, banks and ditches, evidence of land use post-1600 and woodland type.

The aim of the analysis of the data collected was to produce a list of plants whose association with woods of known antiquity is statistically significant; the list to be used to supplement the historic research and classify all woods present since 1830. The analysis excluded species only recorded from less than five sites, any species only assigned to a genus and non-native species.

Chi-square Analysis was used to determine those species associated with ancient woodland as opposed to long-established and vice versa. The results showed that:

- no species were 100% faithful to ancient woodland or long-established woodland
- Four vascular plants were significantly associated with long-established woodland (no further analysis)
- 40 vascular plants and three bryophytes were significantly associated with ancient woodland

An analysis was undertaken into the effect of sample size on the findings. Chi-square test was applied to 120 random woodland data sets; a cumulative frequency curve was plotted for number of new species associated with ancient woodland and sample size (data sets) see Fig 2. The results showed the minimum sample size required to produce associates was 16 and the sample size at which the cumulative number of new associates levels off was 84.

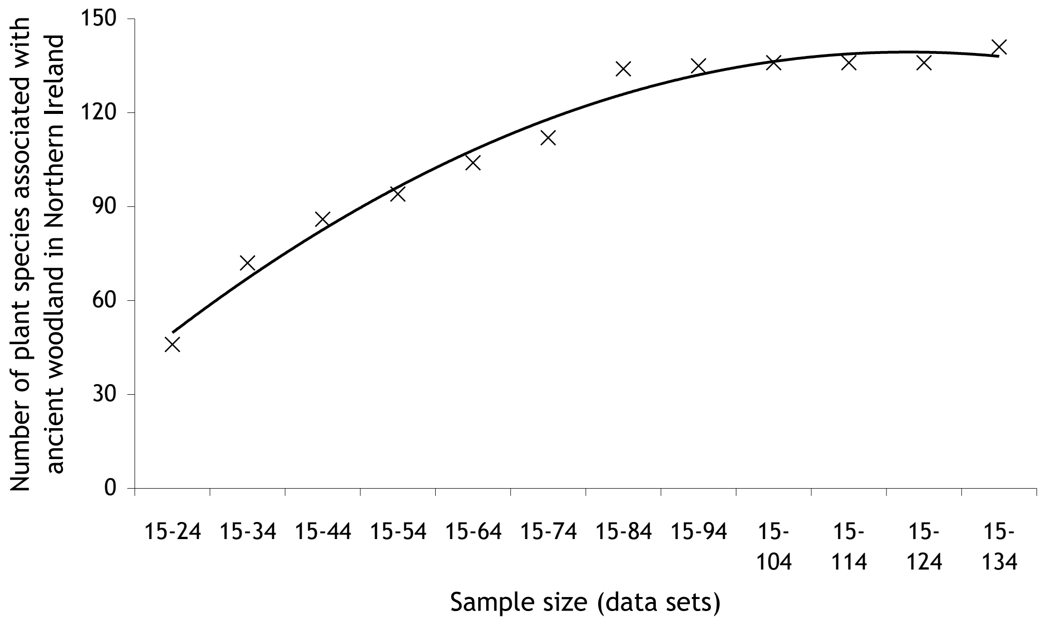


Figure 2 Correlation of number of new species associated with sample size

Appendix 11 – Woodland workshops presentations and discussions.

134 samples of the total survey were analysed in more detail. Spearman's rank-order correlations of relationship were undertaken between woodland size (original / present) and survey date, surveyor's group, geology, woodland type and number of observations. Significant association was found with survey date and there was a significant positive relationship with woodland size. For relationships see Figure 3

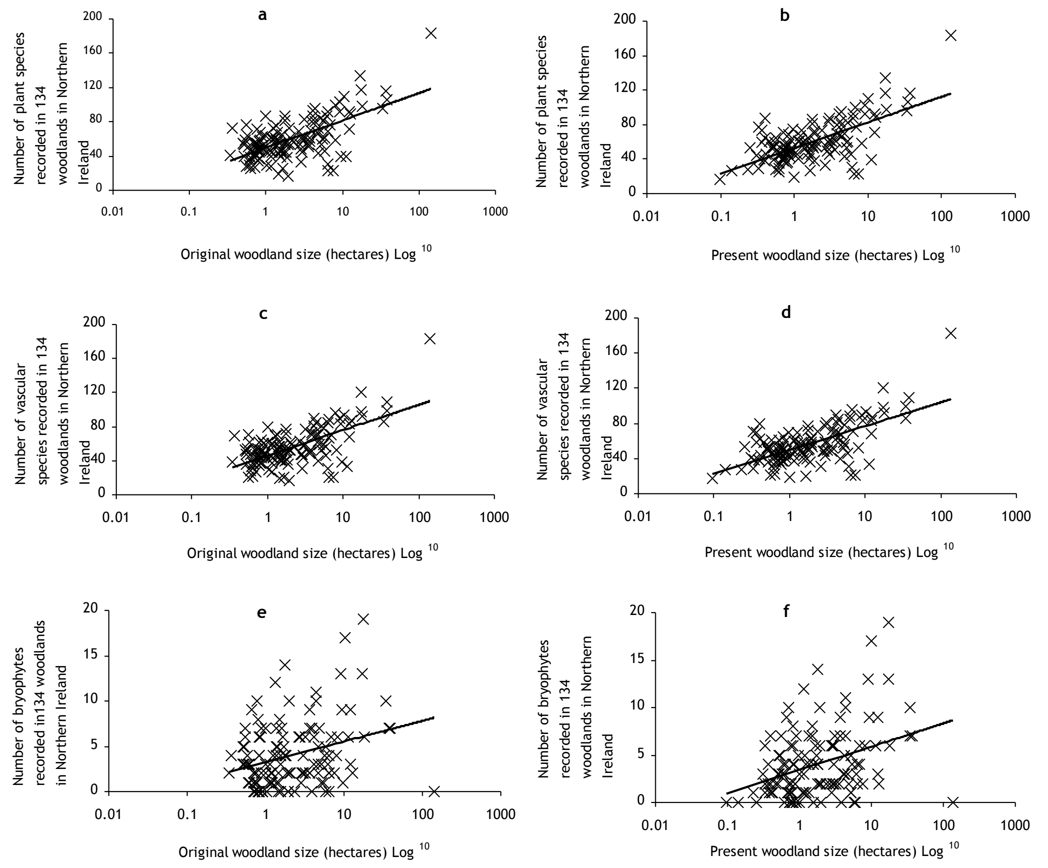


Figure 3 - Spearman's Rank Correlations

As shown above seasonal bias is a potentially important factor influencing the number of plants recorded in woodland. When the flowering period of species associated with ancient woodland were compared (Figure 4) the results showed that only 32 vascular species should be visible all year.

Appendix 11 – Woodland workshops presentations and discussions.

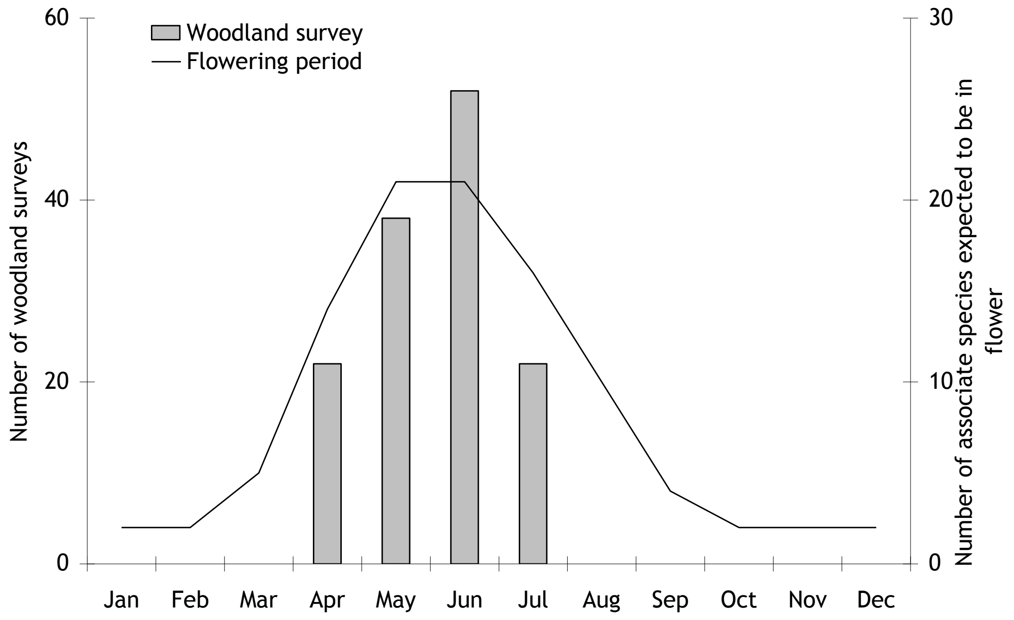


Figure 4 - Seasonality of woodland species

A Kruskal-Wallis test of variation was used to test for significant variation in observations between surveyor groups. No significant difference in the total number of plant species or vascular species was recorded between observers but a significant difference in bryophyte observations was recorded.

To overcome the issues raised by seasonality effects and observer errors, in May 2007 129 of the 134 woods of known antiquity were re-surveyed by a single surveyor. An analysis of the 2007 data showed that the average number of plant species recorded per site was higher in 2007 than in 2004-06 and that the frequency of observations of individual species also higher in 2007.

A Chi-square analysis of the 2007 data showed:

No species were 100% faithful to long-established woodland

Five vascular plants were significantly associated with long-established woodland:

- *Fagus sylvatic,*
- *Holcus lanatus*
- *Pinus sylvestris*
- *Poa annua*
- *Senecio jacobaea*

Appendix 11 – Woodland workshops presentations and discussions.

Five vascular plants were only found in ancient woodland (but there were however insufficient observations to prove 100% faithful to ancient woodlands)

- *Equisetum fluviatile*
- *Festuca gigantea*
- *Geum rivale*
- *Populus nigra subsp. betulifolia*
- *Succisa pratensis*

49 vascular plants and 14 bryophytes were significantly associated with ancient woodland.

Spearman's rank-order correlation was undertaken on the 2007 data to identify any factors affecting the results, specifically the relationship between woodland size (original/present), survey date, surveyor's group, geology, woodland type and no. of observations. The results shown in Table 2 showed a significant association with woodland size and also with woodland type.

2007 (129 data)	63 Total Associate Species			49 Vascular Associate Species		
	Correlation co-efficient	Significance (2-tailed)		Correlation co-efficient	Significance (2-tailed)	
Original woodland size	0.422	0.000	**	0.429	0.000	**
Present woodland size	0.451	0.000	**	0.448	0.000	**
Woodland type	-0.371	0.000	**	-0.383	0.000	**
Geology	-0.076	0.394	n.s.	-0.072	0.420	n.s.

Table 2 - Spearman's Rank correlation of the 2007 dataset

The relationship between plant species and woodland size were plotted (see Figure 5)

Appendix 11 – Woodland workshops presentations and discussions.

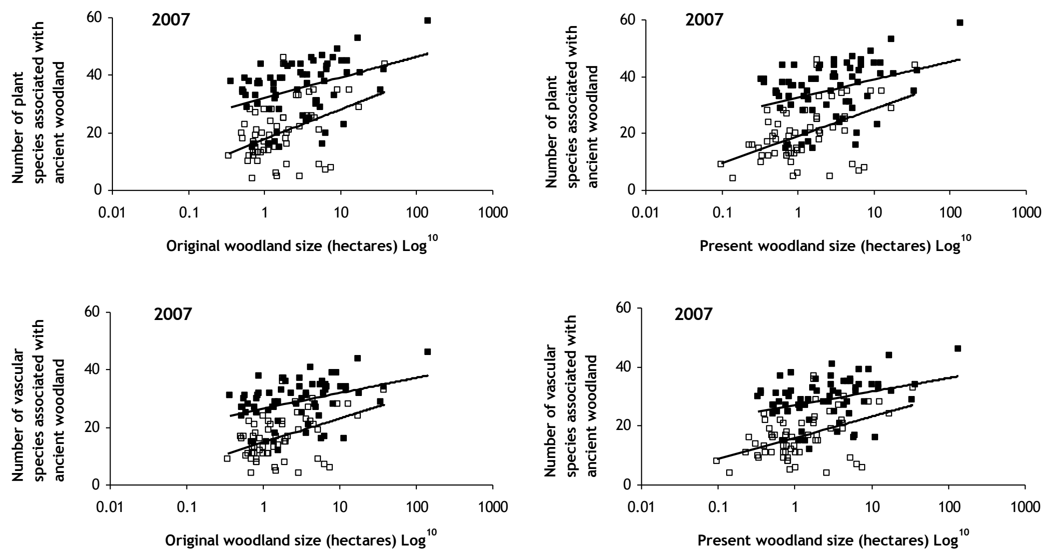


Figure 5 - Relationship between plant species and woodland size in the 2007 data

The findings of the study in terms of the antiquity of the woodlands in Northern Ireland are summarised in Table 4.

Table 4 - Antiquity of Woodlands in Northern Ireland

Classification	Number of sites	Percentage	Area (ha)	Area as % of total woodland identified for survey	Area as % of ancient and long-established woodland that remains
Long-established Woodland	1494	57.1%	5662	49.39%	56.82%
Possibly Ancient Woodland	699	26.7%	3269	28.52%	32.81%
Probably Ancient Woodland	145	5.5%	882	7.69%	8.85%

Ancient Woodland	6	0.2%	151	1.32%	1.52%
Completely lost since the 1960s-70s	273	10.4%	1500	13.08%	0%
Total	2617	100.0%	11464	100.00%	100.00%

The results of the analysis indicate that it is prudent to use the equation from 2007 data describing the relationship between total plant species associated with ancient woodland and original woodland size in consort with archive information to ascribing antiquity to woods where archive evidence alone is insufficient.

Further work is needed. This will include:

- The addition of further survey and historical data
- Where classification in doubt, sites should be re-surveyed on a case-by-case basis
- The inventory should remain provisional
- Continue to refine list of species associated with ancient woodland
- Further work on parkland and wood pasture

The findings of this study have wider implications. The list of species associated with ancient woodland in Northern Ireland should only be used within Northern Ireland but they are supportive of published lists largely determined from expert opinion across Europe with 31 vascular plants and 8 bryophytes cited on at least one national/European published list but the methods used here are robust and reproducible and should be considered for application elsewhere.

Appendix 11 – Woodland workshops presentations and discussions.

W1 - 05 - Barry Wright

Woodland Indicator Research

The research being undertaken by Barry Wright is not confined to the subject of these workshops, although a significant component is linked to the objectives of these workshops.

There are a number of research questions that will be addressed as part of the overall study being undertaken.

- Which species can be used as ‘Historic Markers’ to inform about landscape history?
- Can they be used at a small scale within woodland and at a large scale in a wooded (including hedged) landscape?
- How robust and reliable are they at interpreting past land use?
- How can/ should they be used?
- Can internal heterogeneity be accounted for?
- Is it possible to develop robust regional lists to aid the analysis?
- How should the boundaries be defined?
- Should species be weighted and analysed to provide a level of confidence that a wood, or part wood is ancient?
- What attributes of a species make it a more confident indicator than others?
- How persistent are species under unfavourable conditions?
- Which species are poor colonisers?

A significant emphasis of the research is to investigate species regarded as "Ancient Woodland Indicators" or "Historic Marker Species" within a wider landscape context. This 'bottom up' approach has a fundamental premise that the species regarded as 'Ancient Woodland Indicators' are essentially those species adapted to the shading within this habitat. Species with high light requirements that may coincidentally be included in a survey will be investigated in the context of considering less shaded wooded environments like parkland and hedgerows. A general concept proposed at present is to focus on species with Ellenberg values for light of 5 or less.

Appendix 11 – Woodland workshops presentations and discussions.

The studies include an assessment and evaluation of indicator species in woodlands and within hedgerow networks to attempt to establish links if present and suggest mechanisms for the current recorded presence of species in both environments.

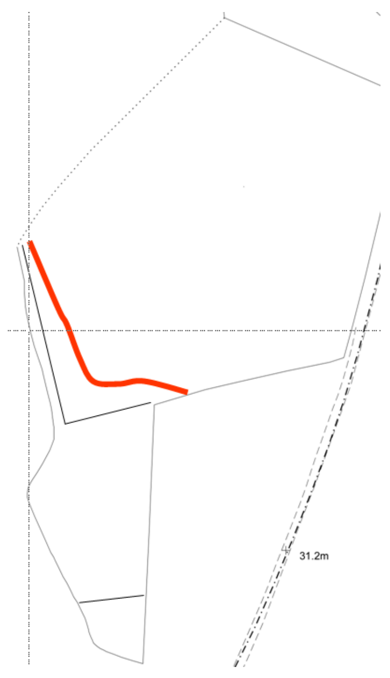
A further detailed inflection to the study is an investigation of the internal variation of species within woodland that can be attributed to meso-habitats that could be both natural, as in the case of woodland streams and ghylls, or artificial in the case of man-made artefacts within woodlands e.g. charcoal hearths, Q-pits and earthworks.

Initial case studies in Yorkshire have revealed patterns of species distribution within woodlands that indicate colonisation and retreat in response to historic changes in woodland management.

A particular case study at Wray Wood in Boston Spa, West Yorkshire, has shown that certain woodland species appear to be more rapid colonisers than others and that those less able to colonise rapidly are restricted to areas that were probably not disturbed during woodland management operations and are also associated with significant earthworks to be found within this woodland.

The botanical survey of this woodland showed that Dog's Mercury was re-colonising in the northern section of the woodland from a stronghold associated with an L-shaped earthwork as shown below at Figure 1.

Figure 1 - Plan showing the extent of dog's Mercury within Wray Wood. The thick red line indicating the current extent of an advancing migration from the L-shaped earthwork.



The survey also revealed that species like Wood Anemone and Yellow Archangel were restricted to the southern portion of this woodland and that Wood Melic had an even more restricted distribution being confined to three individual colonies all on the extreme western boundary of this woodland.

This has raised the issue of the survey techniques in obtaining species lists for determining the ancient woodland status based on overall lists that do not subdivide or segregate internal meso-habitats. Such lists may also include light-demanding species found on rides and open areas. Current survey methods will be investigated to attempt to devise a flexible system for obtaining biologically and statistically meaningful data on which to base the ancient woodland indicator species analysis.

The other significant branch of the research has been investigating the distribution of botanical indicator species in the hedgerow network. Current survey techniques do not adequately sample hedgerows in a way suitable for analysing at the landscape scale and concentrate on the use of woody species as a means of interpreting the age and antiquity of hedgerows.

A significant discovery during the research was on a study at a farm east of the village of Leppington between York and Malton.

During a survey it was observed that Dog's Mercury and Bluebell were present in association with kinks in a hedgerow running east-west. Owing to the alignment of these kinks, it was possible that the hedgerow network had been re-aligned from a north-south orientation to an east-west orientation and that the Dog's Mercury and Bluebell had been retained within the short sections of north-south hedge and were slowly colonising along the relatively recently established east-west hedges as shown at Figure 2.

Appendix 11 – Woodland workshops presentations and discussions.

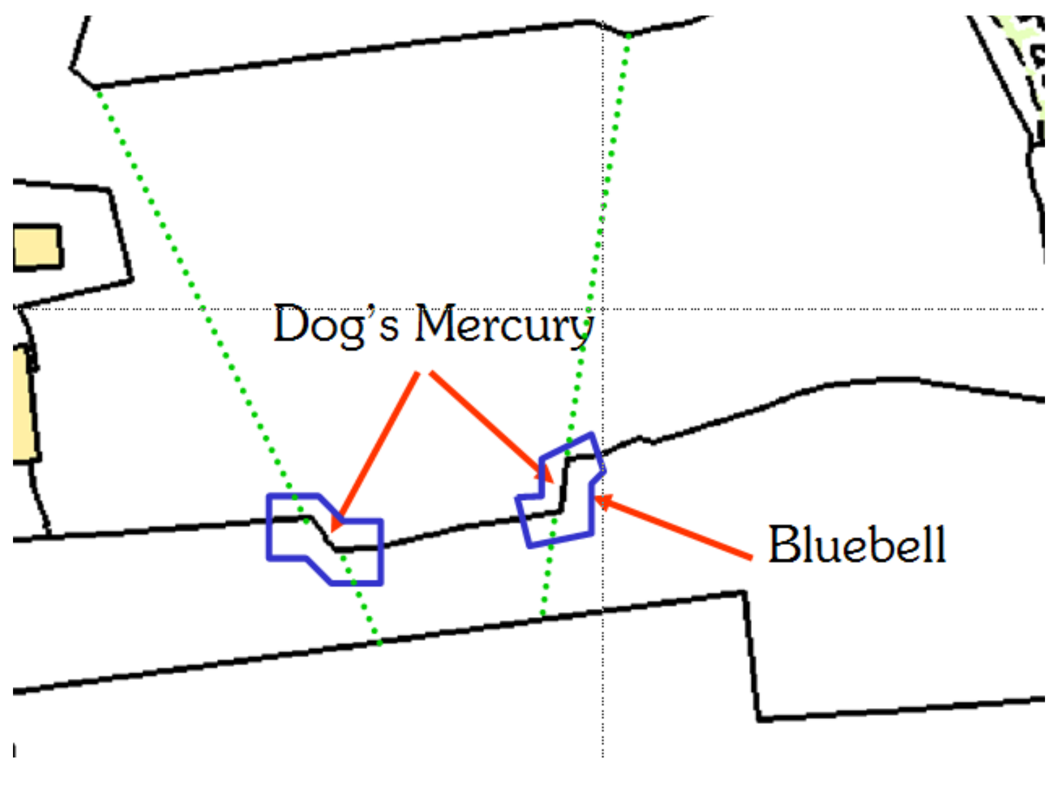


Figure 2 - Plan showing the recorded location of Dog's Mercury and Bluebell and the theoretical alignment of former North-South hedgerows no longer present in the landscape. © Crown Copyright and Database Right (2016). Ordnance Survey (Digimap Licence).

In order to confirm this theory the presence of woodland ground-flora species on the southern hedge, running east-west, was ascertained. The surveys showed that Dog's Mercury, Bluebell as well as Lord's-and-ladies were only found at points on the southern hedgerow as shown at Figure 3, close to, or at the predicted intersection points.

Appendix 11 – Woodland workshops presentations and discussions.

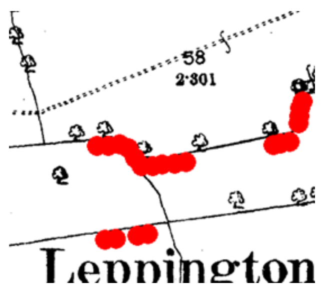
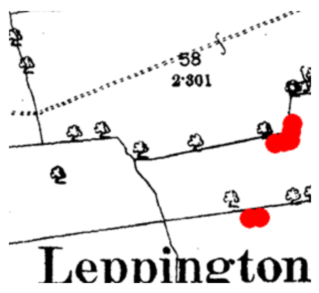
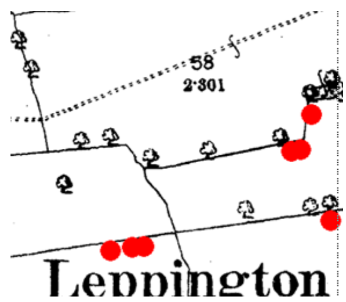
		
Dog's Mercury	Bluebell	Lord's-and-ladies

Figure 3 - Plan showing the distribution of three woodland indicator ground-flora species suggesting a former north-south alignment of the hedgerows.

Discussion with the farmer confirmed that in the 1700s the village was re-aligned and the resultant hedge boundary system rotated through 90° as confirmed by the botanical evidence.

A further hedgerow study into the landscape scale indicator species of Scoreby mediaeval township revealed a number of patterns that are currently being investigated. Of particular note and relevance to the development of a survey method was to be the rarity of Buckthorn (*Rhamnus cathartica*). In the entire hedgerow survey of the township only three individual plants were located. Each of these was on the township boundary and also was within 30m of a hedgerow intersection. Using any of the currently accepted hedgerow survey techniques, there would be a deliberate avoidance of this portion of hedgerow and therefore a systematic error in the recording. In order to address this issue, the novelty of approach for surveying hedgerows developed from the research will ensure that all species are recorded and ultimately analysed to determine the significance of their location, abundance and grouping.

A final study of hedgerows used an extension of a principal adopted by Max Hooper in the New Naturalist book on Hedges (Pollard et al 1974) and recorded the presence and abundance of all woody species every 4m along a section of hedgerow. The work has been done at Leys Lane near Boston Spa in support of the Boston Spa and District Community Archaeology Group. This revealed patterns in the landscape that will require careful analysis with appropriate reference to historical documentation such as inclosure awards and pre-enclosure mapping and accounts. The technique adopted also reinforces the need to accurately record sufficient data to enable the analysis to be done and, where necessary, inappropriate data can be filtered out. Current hedgerow survey approaches are not detailed enough and discard and discount data without justification. An example is the active dissuasion of recording the presence of climbing and scrambling species such as Bramble. The work at Leys Lane has indicated that these species are important components providing information about the past management and history of this hedgerow network.

Appendix 11 – Woodland workshops presentations and discussions.

W1- 06 - discussion section.

The discussion began with a reference back to the original definition of what constitutes ancient woodland. There was also reference to whether or not invertebrates should be regarded as ancient woodland indicators. Also what are ancient woodland indicators indicating? A general consensus was that they were indicating continuity of conditions found in woodlands.

There is a need for something that is quick and easy to implement that will give a reliable and robust result.

There was continued concern about regional distinctiveness and the fact that woods in different parts of the country could vary in the content of typical ancient woodland indicator species.

It was emphasised that there are significant gaps in coverage across the UK.

There was concern expressed about the way the ancient woodland inventory was formed and the use of ancient woodland indicators in that process.

There was some concern that reference to the archive was just a snapshot view of history. It is likely that some maps may show a woodland that is absent from earlier or recent maps but it still does not confirm a continuity between different editions.

Richard Smithers emphasised that there are places in Northern Ireland in particular where the documentary evidence is very sparse and that the only information they can gather from such woodlands is the botanical data that needs to be robust enough to substitute for archive information. Richard advocated the use of threshold number of species but, the threshold number could vary with woodland size. He was also concerned about referring to individual species as indicators relying on their approach which was to statistically analyse data collected from woodland surveys.

Ian Rotherham emphasised the issue regarding the presence of ancient woodland indicators in shaded situations suggesting that in some of these cases it could be that they are indicating woodland of a more extensive nature that is now essentially lost leaving small fragments of shaded habitat under which these shade-tolerant ancient woodland indicators can continue to exist.

Barry Wright emphasised the importance of the number of internal habitats that could enhance the overall species list count for a given woodland. Peter Glaves countered that by suggesting that an index was better than a threshold value of number of species.

For the Northern Ireland study Richard Smithers discounted species that were found in less than five sites as this would not get robust results. He also found that no species were 100% faithful to ancient woodland sites. In their study they confirmed ancient woodland status for 134 woodlands. The surveys in Northern Ireland were random walked transects throughout the woodland, not targeted as advocated by Barry Wright.

Mel Jones commented that historic mapping of woodlands may have ignored woodlands that had been recently coppiced as these may not have been mapped as woodland.

Appendix 11 – Woodland workshops presentations and discussions.

Woodland Workshop 2 - 22 October 2008

programme

1. **Dr Peter Glaves** – welcome and introduction: overview of workshop one and its outputs.
2. **Barry Wright** –Update on progress since the last workshop.
3. **Dr Ian Rotherham** – Landscape context and need for action.
4. **Dr Peter Glaves** - Discussion: options on approach and key priorities.
5. **Professor Mel Jones** – South Yorks woodlands: a multidisciplinary approach.
6. **Dr Keith Kirby** – Field survey approaches and needs.
7. **Dr Peter Glaves** – Discussion and morning roundup.
8. **Sian Atkinson** – Adapting the Northern Ireland approach to analysis.
9. **Dr Peter Glaves** – Approaches to analysis and interpretation.
10. **Barry Wright** – Approaches to improving local and regional lists.
11. **Dr Ian Rotherham** – Discussion: how to improve analysis and interpretation, summing up.

Appendix 11 – Woodland workshops presentations and discussions.

W2 - 01 - Dr Peter Glaves

Overview of workshop one and its outputs.

There is a lack of robust data. Peter also states that there is generally an uncritical use of current lists. He confirmed that the general impression was that ancient woodlands were a representation of a continuity of a woodland environment.

There is a need to refine regional lists and aim to discover if better coverage can be achieved.

There are inconsistencies in the acquisition of lists based on some being derived from expert opinion others from survey, and issues regarding the lists and their application to woodlands of different sizes.

What are the traits of indicators that make them suitable as historic markers for ancient woodland?

How much commoner does a species have to be in ancient woodland for it to be regarded as an historic marker?

What makes a good ancient woodland indicator?

How robust are indicators on their own without confirmatory documentary information? Woodland indicators are confirmation of documentary evidence and can only be regarded as indicators in the absence of any supporting documentation.

Appendix 11 – Woodland workshops presentations and discussions.

W2 - 02 - Barry Wright

Update on progress since the last workshop

Emphasised the variation in the number of species contained on different lists and the differences in sizes of regions used. There needs to be a discussion on the importance and significance of shade-casting, shade-bearing and sun-loving species in the ancient woodland lists so far created. He emphasised the potential critical need to account for rare species in the assessments as these may be fundamental to the determination of ancientness. There needs to be consideration of the shade tolerance of individual species to determine how faithful they would be under a closed canopy shaded environment. The Ellenberg values are variable. Species that live next to each other can have different L values. L values of 5 and below are probably reliably classed as shade-bearers.

Barry reviewed the number of species with different L values on the publish lists. Also discovered that a number of shade toleraters were not regarded as ancient woodland indicators on any lists. Emphasised that certain species may have a core value of five, but have ecological amplitude that will allow them to persist under different conditions either in the presence of more light, or less light.

He considered the treatment of rare species. Emphasised that in Northern Ireland they ignored any species that was found in less than five woods. But Francis Rose advocated treating rare species as special cases. Rose specifically acknowledged rare species and incorporated them in the overall evaluation process to determine if woodland was ancient or not.

Appendix 11 – Woodland workshops presentations and discussions.

W1 – 03 - Ian Rotherham

Landscape context and need for action

Ian stressed the dynamic nature of the landscape. Reviewed the role of ancient woodlands in landscapes referring to a number of other shaded environments rather than defined closed canopy woodland. He included parklands, wood-pasture and open commons. He emphasised placing the ancientness of woodland in the landscape of historical times for example the medieval landscape, Tudor landscape and to understand how woodlands would have been treated to encourage their persistence through these phases.

Ian also raised questions that some authors have about what is regarded as a tree and what is regarded to be a shrub. He stated that some authors believe Hazel to be a shrub whilst others call it a tree.

He also said that a number of ancient coppices may be overlooked. From his experience he has dated certain examples at between 400 and 600 years old.

He stated that we have a patchwork landscape with patches of variable sizes that have been subject to periods of intense management and abandonment throughout time.

One of the questions that is still in his mind is why certain species are where they are today, and why were they in that position historically? And also, why are certain species absent now where they should be expected?

He emphasised that the presence and distribution of woodlands today were determined by systems of government in the form of manorial constraints that imposed woodland management on this habitat.

He posed the question, “What are we asking?”
He advocated intelligent interrogation and referred to an example from Northern Ireland where Annual Meadow-grass appeared as a statistically significant ancient woodland indicator from their long-established woodland dataset.

Appendix 11 – Woodland workshops presentations and discussions.

W2 - 04 - Peter Glaves

Discussion - Options on approach and key priorities

Raised the question as to whether we want ancient woodland indicator species to indicate ancient woodlands or something else viz continuity.

A major factor affecting ancient woodlands is that they were intensively managed in our history involving the removal of materials and the intervention of human activity in various forms making the ancient woodlands essentially unnatural in context.

Mel Jones emphasised that you need to take each wood individually as the management within such woodlands is often unique to that particular woodland.

Peter Glaves even suggested that we should be looking for woodland exploitation species or indicators of disturbance.

There was also discussion on the use of vascular plants as ancient woodland indicators compared with the use of other taxonomic groups. There was some suggestion that certain taxonomic groups may be better indicators than vascular plants in certain circumstances. This was generally felt to be linked to the management of the woodlands and the availability of substrates and habitats to support the species.

The suggested cut-off date of the year 1600 for whether a woodland is ancient or not was questioned and discussed. Keith Kirby referenced his information which suggested that there is little evidence of any systematic planting of woodland before that date. It was agreed that some of the species encountered in woodlands that were planted after that period were derived from a generally untidy landscape where there were small fragments of shaded environment to allow the persistence of some of the species now regarded as ancient woodland indicators.

It was mentioned that in some fenced off areas within woodlands some of the ancient woodland indicator species suddenly appear. It was also noted that Hazel fails to fruit in woodlands where it does not receive enough sunlight.

There was also some discussion about the effect around the edges of woodland where there is significantly more light getting in than is encountered in the deepest darkest parts of a tall forest.

Appendix 11 – Woodland workshops presentations and discussions.

W2 - 05 – Mel Jones

South Yorks woodlands: a multidisciplinary approach

Mel Jones studied ancient woodlands in Sheffield and investigated the differences in ancient woodland indicators found in woods. He could clearly document as ancient a woodland that was ancient in part but had been extended in recent times, and more recent plantations. He identified and studied 80 ancient woodlands in the Sheffield area. This is based on work he did in 1984.

In particular, he referred to work done at the South Yorkshire parish of Tankersley where there are a number of woodlands of different origins.

He referred to differences in lists produced by the same authors in different years.

He discovered that ancient woodlands contained generally more species than attached recent woodland and recent plantations, but that the ancient woodlands only contained 11 or 12 species compared with eight species for the attached woodland running down to 4 or five species for the plantations, and only one in one of the isolated plantations in a deer park.

Mel Jones differentiates lists from different geologies and different altitudes including the acid coal measures, the lowland levels and the limestone areas.

He referred to species being particularly rare and found in only one or two woods within his study area. He also mentioned that historically botanists did not go out into the field with cameras, but trowels and that could be a contributory reason why there is no Lily-of-the-valley in any Sheffield woodlands.

He made reference to one particular species, Common Cow-wheat, quoting that this species is dispersed by ants as they recognise the seeds as being similar to their egg.

He emphasised there is a need to look at both ancient woodlands and recent woodlands as well as recent woodlands attached to ancient woodlands. It is important to know something about the previous land use on which the woodlands were planted in these recent woodlands.

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 06 – Keith Kirby

Field survey needs and approaches

At the previous meeting Keith discussed some of the issues that the agencies have encountered in trying to produce new indicator lists and his current view is probably that the idea of a precise indicator list is like the Holy Grail – never to be actually grasped, and probably not much use in practice because of inevitable trade-offs involved. Some of these trade-offs are to do with the nature of woods themselves but in instances they relate to survey methods. And it is the latter aspect that Keith was asked to talk on.

We talk about comparing areas in terms of the species occurrence, but what is the nature of the list from the site we are using?

Most studies have compared sites in terms of a list of species from the site – just presence or absence is enough to qualify. These lists are assured either to be more or less complete species list, or to at least be directly correlated with a complete list such that we are comparing comparable data.

Less often woods are compared in terms of lists from defined areas, e.g. quadrats. Even less often some account is taken of the abundance of different species (whether as frequency, and cover, or species density per unit area).

Different measures have different characteristics and this could therefore affect the interpretation of results.

Basically woodland lists are compiled in two ways, either from a general walk around the wood listing the species seen, with then perhaps a subjective estimate of abundance using a DAFOR scale. Or the species are listed in quadrats which may be distributed in a variety of different ways through a wood. There was quite a lot of work done in the 1980s on the effects of these different approaches on the range of species detected. While much of this was on general woodland species, there is no reason to consider that the effects are any different in nature for the detection of ancient woodland indicators.

Walked surveys - transects

Walks are a relatively efficient way of compiling a species list. They are:

- An efficient way to detect species

- likely to be related to overall site richness
- subjective abundance estimates, but still useful
- picks up small-spots of species (flushes, glades etc.)
- much more likely to detect rare species
- effort in part related to wood-size and complexity
- or can be standardised (fixed time/ length)
- species occurrence can be marked on a map
- related species occurrence to other elements of the wood (structure, archaeology etc.) qualitatively

But, have a number of limitations in terms of what is recorded.

- may cover areas of different origins
- combine areas of different vegetation types/ richness
- tendency to avoid difficult areas
- uncertainty as to area/ proportion covered, so difficult to do reliable statistical comparisons
- completeness variable

Quadrats

Quadrats are superficially a more objective way of collecting data, but for the purpose of comparing ancient woodland indicators may not be that efficient or effective.

- comparisons of known areas
- statistical analysis generally valid
- more intense recording, likely to pick up difficult species
- spatially precise so easy to link to other spatial data
- can either used fixed number, or vary according to wood size.
- potential for accurate change detection
- individual plots can be assigned to growth stage/vegetation type/origin

On the downside the results are affected by

- distribution
- randomness
- representativeness, even if stratified random, systematic
- number of plots
- size of plots
- very small percentage of wood sampled for time involved
- number detected not necessarily related to total number on site
- far fewer species detected
- small hotspots likely to be missed
- the standard error on numbers may be large, so statistical power low
- time spent walking between plots is wasted
- frequency of species affected by plot size.

In theory it would be possible to combine both approaches. However, this does not resolve the analysis problems because there is no formal way of combining results from two types of survey without making the basis of comparison even more uncertain. So the walk element and quadrat element would still have to be compared separately. The advantage though is that looking at the results from the two comparisons might give more insight than either alone.

In trying to link existing lists and new surveys it is likely that an analysis to identify ancient woodland indicators based on quadrat presence may not hold if used with a lists composed on walks and vice versa.

Species infrequent in recent woods in quadrat surveys may still be picked up on walks.

The best indicators for walks may be too infrequent for use in quadrat results.

Survey procedures do affect the ability to compare lists to determine site history. Sites need to be compared using lists produced in similar ways and species that are most useful in distinguishing ancient from recent will vary according to the method used. Basically scarce species are only likely to be detected by walks so little use in quadrat surveys; abundant species are likely to be present across the board, so only quadrats may pick up the necessary differences in abundance according to woodland origin.

Appendix 11 – Woodland workshops presentations and discussions.

Walk surveys are the most efficient at detecting species as a rule, so most likely to provide the range of species needed to draw conclusions. However, they are at least amenable to statistical interpretation because of uncertainties about how other factors affect the species detected on a walk. The lists need to be interpreted in the context of the other survey data collected for a wood.

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 07 – Dr Peter Glaves

Discussion and morning roundup

Need to learn more about the nature and origins of some of the more recent plantation woodlands and those that are potentially attached to more ancient features.

There was some discussion about the merits of using a single list for an entire woodland based on presence absence data only compared with using a variable and representative number of quadrats to gather data.

This led on to a discussion regarding the likelihood that a transect is likely to pick up the rare species more so than quadrats.

He also alluded to the penalties of allowing surveyors to walk transects in that people are more likely to follow easy paths rather than walk up and down steep slopes. This also emphasised a lack of knowledge whether or not a woodland was being over sampled or under sampled. Especially if areas surveyed concentrated on woodland rides and easy access parts.

NB they are advocating comparing woodlands by comparing the results from a number of samples from quadrats in the different areas of woodland. This is a sampling issue. Had the surveyors used the woodland survey technique Barry Wright recommends there would be little risk that any significant woodland species had been missed and therefore this is a more robust survey method as it does not sample and risk missing valuable and potentially rare and significant species.

Barry Wright introduced the concept of targeted walked transects, standing quadrats. Also the approach of following easy pass in the initial phases of the survey followed by transects which followed a zig-zag pattern to ensure more effective coverage. This also included an introduction to the necessity to obtain abundance data as part of the survey requirement. Including an introduction to the double coding system for frequency and abundance (NB *that is now SSACFOR*) that was originally DDAFOR. This separates the frequency of the species (first DAFOR letter) from the cover/abundance (second DAFOR letter) to produce OA = Occasional plants/ patches and abundant cover.

Referred to his WSS (Woodland Survey System) as a flexible interactive transect and standing quadrat system. He also emphasised the combination of data as a visual mapping exercise to indicate the total number of recognised ancient woodland indicators along each walked transect. This will be denoted by an increasingly thicker line based on an increasing number of ancient woodland indicators recorded. Emphasised that it was not necessary to have transects of fixed length and that transects should end where vegetation shifts from one type to another. Referred to the use of a GPS to follow progress on the map to ensure that there is no duplication of survey along transects and that there is a reasonable probability that adequate cover has been achieved. Emphasised the following of notable features within woodlands such as earthworks.

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 08 - Sian Atkinson

Adapting the Northern Ireland approach to analysis

Makes the distinction between woodlands of various ages considering those that are truly ancient. Ancient and long-established woodlands in Northern Ireland were a consideration. Long established are woodlands between 1600, and 1830. They had a complete dataset of 2500 woods. Conducted a uniform amount of archive research for all woodlands.

Selected woods from the archives that had the best records and could definitively say with 99% certainty that these were ancient or they were long established.

They then collected the botanical data and applied statistical analysis to it.

Developed a list of species that were closely associated with ancient woodland. They referred to species that are significantly associated with woodlands in a statistical sense.

Also considered the relationship between woodland size and species. The number of species did vary with woodland size. Developed a formula to obtain a threshold number of species depending on the size of the wood.

Referred to the work done by Carol Crawford in Scotland where she started with the established lists and deleted all of those species that didn't occur in Scotland.

NB *This is part of my ethos in that you should allocate a candidate set of species based on the location in which you are working.*

Carol circulated her provisional lists around experts within Scotland. This list was then refined by the expertise from the experts she consulted. Sian queried this in terms of the fact that it is largely a circular argument and that it could not stand up against the statistical scrutiny that is being adopted in Northern Ireland.

Sian reported that Carol has set an approximate threshold of 25 species to be indicative of a woodland being ancient.

Sian also agreed that this could be a dangerous precedent in that developers might take this as an absolute value and if the woodland only contained 24 species it would be regarded as suitable for development where as if it had 25 or 26 species it would be protected.

NB *This could lead to unscrupulous developers adjusting data to fall below any threshold!*

Emphasised that there should be a distinction between using woodland indicators to indicate value and using them to indicate ancientness. Knowing that a wood is ancient does not necessarily mean that it is valuable as an ecological resource.

Emphasise that in Northern Ireland they should have placed more emphasis on assessing the content of recent woodlands.

Also emphasised that there should be some sort of decision regarding how to define a region whether it is administrative, geological, altitudinal etc.

She was concerned about lack of clear guidance as to what constitutes an acceptable number of indicators citing that at a public inquiry it would be a case of an ecologist on one side of the argument trying to convince the other side of their case.

During the discussion it was again emphasised that there was no clear definition as to what a region should constitute. Nor, how the regional distinctiveness should be applied.

Ian Rotherham again emphasised that due consideration of the cultural context needs to be voiced as well.

Sian Atkinson emphasised that the Woodland trust position was that '**ancient woodlands are an irreplaceable habitat'.**

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 09 - Peter Glaves

Approaches to analysis and interpretation.

Multivariate analysis allows for the rapid identification of patterns in data. It is not a system that can be used by amateurs to quickly look at their data.

Multivariate data includes species data and abundance along with environmental data.

Data from 80 ancient sites was looked at. All data was collected in the same way.

Multivariate analysis is good at classifying data. The principle is to arrange all of the samples along an axis. There are two approaches, one where you start with the large dataset and repeatedly divide into smaller and smaller groups and the other is where you start with the individual species and create bigger and bigger groups.

The aim is to create groups and clusters that seem to be similar and to gather them together into like types of vegetation. Looking for closeness of plots to form natural groupings. Enables you to look for differences as well as similarities between woodlands.

Using the environmental data, it allows you to determine whether the differences are related to such items as altitude, geology, moisture etc.

Showed a plot showing that clusters of woodlands were associated with ancient, recent, and intermediate.

Twinspan takes all of the data and separates it into two groups - a positive and a negative, and continues to do this until you get down to relatively small groups. Peter indicated that Twinspan was good at differentiating the abundance value for species and would classify a pine woodland with sparse ground flora differently from a deciduous woodland with a more abundant ground flora. Again has to discount if species is found in <5 woods.

Peter only used the botanical data and not the environmental data in this analysis. Need to consider communities as well as individual species. Need also to consider the abundance of species within woodlands. Peter states that a rare species occurring rarely means that it's an indicator, or when it is frequent in a site whether it is ancient or not.

Also suggested that the dataset be divided into acid and calcareous before running the analysis.

Appendix 11 – Woodland workshops presentations and discussions.

Emphasised that the dataset he was working on was relatively small and recommends a dataset in excess of 100 samples to obtain robust data.

To adequately investigate ancient woodland dataset needs to comprise both ancient and recent woodlands to provide separation.

Also indicated that you should remove from the dataset anything which looks anomalous.

NB *is this throwing out the baby with the bathwater*?

During discussion Keith Kirby expressed concerns about the use of Ellenberg values for light in the analysis process.

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 10 – Barry Wright

Approaches to improving local and regional lists.

Advocates the acquisition of new regional lists and reassessment of existing ones.

Considers using the existing lists in a more positive fashion. Emphasised that the lists are not for the entire country. Is it possible to use the species from the current Atlas of the Flora to look for patterns and draw up new regional lines? A starting point would be Natural Areas. But having listened to Mel Jones it may be necessary to go down to the parish level or even the individual wood level. Also suggested that where a species is absent in the Atlas areas this can be regarded as negative evidence to reduce the candidate list.

Considered whether it was possible to use the distribution of single species to define new regional boundaries.

Questioned why certain species were on regional lists in some parts of the country but the species occurs in other parts but is not on their lists. Is it possible to fill the gaps and suggest that if it is agreed to be an ancient woodland species for Yorkshire but it also occurs in Cumbria or Kent, should it be added to those lists without further discussion?

Highlighted an issue of using the Atlas for a species that is present in the countryside both as a native plant and as an alien introduction. When can it be certain that the species in question is located in a native location rather than an introduced position.

Also suggested that there could be individual candidate lists for every 10 km² across the country based on the Atlas records. This could be applied to some sort of computer program linked to a GPS system so that when you crossed into a new 10 km² you would immediately have a different candidate list generated as potentials to look for in the woodlands you're surveying.

Introduced the concept of meso-habitats, looking at species in some communities within woodlands. This will involve the species profiling or what ecologists call autecologies. This will require investigating not only the main attributes of Ellenberg values, altitude etc., but also considering the attributes in the *Comparative Plant Ecology* volume. This volume gives an indication as to how frequently a species is found within a given habitat with higher values indicating a higher fidelity for that habitat, although this does not indicate ancient woodland, just woodland.

Unfortunately, *Comparative Plant Ecology* is limited in its coverage and a number of species that we are interested in as ancient woodland indicators are actually not covered.

Advocates two approaches - one is to look at the data top-down of dividing the data down, analysing it and deciding on which groups of species are ancient woodland indicators. The other approach is the bottom-up approach of consulting with expert opinion. This includes the species profiling (autecologies) and looking at the attributes that make species a woodland indicator and ideally an ancient woodland indicator.

A new Task 2 is to obtain better survey data. This could involve the combination of transects, standing quadrats, point records, abundance values and the use of meso-habitats. Also need to consider the seasonal differences in results owing to the nature of appearance and disappearance of woodland indicator ground flora.

Need to develop new methods of analysis. Also re-emphasised the issue regarding how any analysis copes with shade-creators, shade-evaders, and shade-toleraters.

Stressed the earlier comments about how to apply threshold, index or other weighting to the lists to ensure that adequate compensation is made for species that are more exclusively found in ancient woodland compared with those that are also found in recent woods. Also, take full account of topography etc.

Keith Kirby questioned the reliance on shade-tolerant species. Barry referred to the work of Frans Vera where he questioned whether or not the colonisation abilities of the shade-tolerant species was rapid enough to keep up with the movement of the shaded component in the Frans Vera landscape. Keith Kirby said that this was irrelevant as we were not looking for wildwood species.

Peter Glaves said that we should be looking for combination of traits that betray what is ancient woodland.

Appendix 11 – Woodland workshops presentations and discussions.

W2 – 11 - Ian Rotherham (chaired by Peter Glaves)

Discussion: how to improve analysis and interpretation, summing up.

Mentioned the Bassenthwaite dataset for ancient woodland.

Peter Glaves emphasised that woodlands in steep-sided valleys would be less able to be improved and modified and therefore are likely to have been left alone and potentially managed to a lesser extent than a woodland of a similar age on the flat that would have been accessible and could have been clear felled or managed in the past.

Ian Rotherham related an issue regarding the management of woodlands in Sheffield stating that a woodland on a steep slope had a relatively poor flora on the upper parts but an abundance of wood anemone on the lower slopes. This was alleged to be the result of nutrient down wash and other factors affecting the loss of wood anemone on the upper slopes. But Ian stated that if you went "round the corner" there was a wood bank and further round there was Wood Anemone up the entire slope. The explanation for this was that the species-poor area had been turf stripped for charcoal production in the past.

Appendix 11 – Woodland workshops presentations and discussions.

Woodland workshop 3 – 20 May 2009

Programme

1. **Dr Peter Glaves** – welcome, scene setting, overview of previous workshops.
2. **Fran Hitchinson** – Use of ancient woodland indicators in woodlands under threat.
3. **Barry Wright** – what makes a good ancient woodland indicator species
4. **Discussion**
5. **Dr Peter Glaves** – identifying ancient woodlands a decision tree.
6. **Discussion**
7. **Barry Wright** – regional ancient woodland indicator lists.
8. **Dr Ian Rotherham** – ancient woodland indicators in shadow woods.
9. **General discussion** – the way forward: partners, events, funding and outputs.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 01 - Peter Glaves

Welcome, scene setting, overview of previous workshops.

Remarked that, with regard to thresholds, a significant threshold is already adopted that is whether or not the woodland is on the ancient woodland inventory or not. If it is not on the ancient woodland inventory this did not necessarily mean it is not an ancient woodland. Merely that it has been omitted from inclusion. Also, it is important to recognise that the ancient woodland inventory has a lower limit of 2 ha.

Need to consider the practical application of ancient woodland indicators.

- How do you use them in the field?
- To identify entire woodland sites?
- How can you use those indicators to work out what has happened specifically in this part of the woodland?
- What is the underlying ecological theory behind ancient woodland indicators?
- Ancient woodland indicators are not just shade tolerant species.
- What are they actually telling us?

There is a need to consider management when creating lists. Woods are managed, affecting the flora and there is a need to account for woodland industries in the analysis.

Although the generally accepted cut-off date for ancient woodland is the year 1600, Peter suggested that a more relevant date might be the date of parliamentary enclosures in many parts of the country.

He also emphasised comments made by Ian Rotherham in the past that shadow woodlands may be ancient woodlands and the absence of trees should not be regarded as a negative feature if there is a present ancient woodland ground flora.

Peter also emphasised that non-flowering plants such as mosses, ferns and also invertebrates may also be important and could be used as better indicators.

He believes that the data analysis needs to make lists more robust and defensible.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 02 - Fran Hitchinson

Use of ancient woodland indicators in woodlands under threat.

The lists used by the Woodland Trust to assess woodlands for their ancient woodland character based on ancient woodland indicators uses the list by Peterken and Rose. These have been developed to detect ancientness and also to assign technological value.

The Woodland Trust's aim is to put pressure on statutory authorities to protect, and needs to use all means possible to effect that protection and defence.

An example is at Stansted where six ancient woodlands were destroyed and 20 others were adversely affected. These were generally of relatively poor quality and were less than 20 ha in size with only some ancient woodland indicators and was therefore judged to be of relatively low quality.

However, the Woodland Trust view is that **all ancient woodlands should be retained**.

The Woodland Trust accedes that there is a need to have some sort of threshold to assess a woodland, but also has difficulty in making proper assessments of woodlands that cannot be traced back historically to before the year 1600.

Another example is the Forest Pines golf course. This is a plantation on an ancient woodland site and not a native ancient woodland in its own right. It is somewhat degraded and there are areas of woodland on the golf course currently that are of better quality.

Another example is Lake Wood where 750 houses were scheduled to be installed in East Sussex. Here, Wood Anemone was patchy in a recent wood and constituted a large amount of cover being an ancient woodland. Bluebell was common in both but was not regarded as an indicator. These cases were difficult to assess as it is not clear whether species that are patchy are patchy because they are becoming more abundant, or because they are being systematically removed from areas and becoming patchy.

She emphasised the need for a method that needs to be simple, robust, replicable, easy to communicate and with clear guidance.

She also personally questioned the use of the year 1600 cut-off for determining ancient woodland status.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 03 - Barry Wright

What makes a good ancient woodland indicator species?

Barry began by listing the attributes he regarded as being indicative of a good ancient woodland indicator. These were:

- that it requires continuity of ancient woodland conditions to survive
- it usually occurs in relatively dense shade
- it is likely to be a stress tolerant species
- it does not persist for long outside of woodland
- and it should not regularly occur in non-shaded habitats
- and it has a limited ability to colonise new woodland.

He continued to propose a method of investigating ancient woodland indicators by using a species location abundance and grouping approach (SLAG). This considers what the species are and how many species there are, where they are in the woodland, how much of each there is, and what other species are growing with each other.

He also believes that 'all indicator species are equal, but some are more equal than others' (to paraphrase George Orwell).

Ancient woodland plants could be a mixture of shade casting species such as the trees and shrubs along with shade adapted species in the form of shrubs and ground flora species that are either shaded evaders or shade tolerant.

There are also a number of what he called consequential species that are found in more open situations such as along the woodland edge in glades and clearings. These are not shade tolerant but are part of what might be regarded as an ancient woodland environment if an assumption can be made that ancient woodland was more open in character historically.

He referred to work by Keith Kirby and Ellenberg values as well as *Comparative Plant Ecology* and National Vegetation Classification treatment of woodland indicators.

There are a number of types of indicator including what Keith refers to as woodland specialists, being those that are from ancient woodland indicator lists, and other woodland species that includes species recorded from National Vegetation

Appendix 11 – Woodland workshops presentations and discussions.

Classification scheme woodland classes that may not be on ancient woodland indicator species lists. Then there are non-woodland species typical of open habitats that are coincidently recorded in National Vegetation Classification woodland classes.

Using this basis, it is estimated that woodland specialists are likely to survive on the mean Ellensburg light values of 5.2 or less, be stress tolerant and have woodland as their main ecological habitat.

The other woodland species are likely to have a mean Ellenberg value for light of approximately 6.2 and be more competitive. Non-woodland species are likely to have Ellenberg light values of 7.6 or greater and be the most ruderal.

Barry went on to review how many of the species that are frequently used as indicators are also found in non-woodland habitats as well. Species like Wood Anemone are found in five other habitats as well as their normal habitat of woodland.

He showed a table for species like Wood Anemone showing how many other NVC classes this species was recorded from.

He emphasised that there was a degree of shade adaption that was, in his opinion, specific to woodland as were those species that had Ellenberg values of less than or equal to 5 and included Wood Anemone and Dog's Mercury, whereas less well adapted species would have Ellenberg value of greater or equal to 6, be found in woodland glades and include species like Hedge Wound-wort and Goldilocks Buttercup.

He emphasised that the Ellenberg value for light was a central value and it takes no account of ecological amplitude. Some species are likely to be able to tolerate significantly lighter or darker conditions. Although they may not thrive they would certainly survive for prolonged periods under slightly adverse light conditions.

On this basis he suggested a strategy for weighting that included elevating the score for high shade demanders, who are poor initial colonisers, species of low persistence under unfavourable conditions, and species normally missing from recent woodland sites. He also emphasised that species may be more common in the west where it is wetter and maybe rarer in the East and that this needs to be taken account of in the weighting as well.

A starting point for a potential method of weigting was published by George Peterken in British Wildlife magazine in 2000. In this article he listed species and provided a table showing the percentage fidelity each had for ancient woodland. Clearly those species that had a 100% fidelity for ancient woodland and were absent from recent woodland were the most reliable species to consider. From this list there are a range of species that did actually achieve the 100% fidelity, including Common Cow-wheat, Herb-Paris, Alternate-leaved Golden-saxifrage and Wood Horsetail.

Oliver Rackham in his book on Woodlands in 2006 quoted

- 'a shortcut is to ask 'what species occur in ancient woodland but not in ancient hedgerows?' Especially in an ancient countryside with many ancient hedges, hedgerow species can normally be excluded as ancient woodland species'.

Barry also recounted a quote from Gill Castle from her work in 2008 where she said that

- 'very few species are restricted to (or even mainly occur in) ancient woodland in Wales. The damp oceanic climate (particularly in West Wales) provides conditions in which a number of plants regarded as woodland species further east, thrive equally well on stream sides, open moorland, dunes and sheltered coastal cliffs, Bracken dominated hillsides, grassland and along hedgerows'.

Barry went on to consider attributes of plants that may make them good or bad indicators of ancient woodland. This included

- colonisation
- the initial establishment by seeds and propagules
- the dispersal mechanisms such as wind, water, animal and in particular human intervention

Then there were issues of germination, seed establishment and competition to consider. Once established, there were also issues about the spread of the species. If the species spread mainly vegetatively this could produce a relatively slow colonisation rate. If they were spread by seeds then there is likely to be a more rapid colonisation and spread across a newly created woodland.

From Gill Castle's work in 2008 she also included the quote

- 'the inclusion of rare species on lists was questioned because they make lists very long and will occur in few woods. However, where they occur, they might be important indicators'.

NB *This raises the question 'can one swallow make a summer?'.*

Barry went on to consider thresholds and weighting. How should thresholds be established? Should it be just a total number of species per woodland or should the number be adjusted for woodland size, geographic location, and the range of meso-habitats within the woodland?

Regarding the weighting of species. Should there be a weighting applied for high and low scoring species and should there be an accounting for the number of these in each of the meso-habitats recorded in the woodland?

He also repeated what others had already mentioned in that the ancient woodland inventory ignores woodlands less than 2 ha in size these could be important and should be fully accounted for.

Barry also quoted from a PhD thesis by Piet Bremmer in the Netherlands where he was mapping the colonisation of re-claimed land using ferns as indicators. His evidence suggested that there was relatively little lateral movement of ferns within these colonised areas suggesting that there is very minimal sideways movement of air to carry the spores from one part of the wood to another. His evidence from DNA analysis suggested that new specimens of ferns were coming vertically down in the rain rather than passing laterally from existing plants. This was based on detecting DNA from Scottish populations as a significant component of the established ferns in the Netherlands.

There is also a degree of concern about the location aspect of the analysis again, to quote Gill Castle from 2008

- "species which were observed on, or within 5 m, of the woodland boundary were noted separately but these were not included in the analysis since it was considered likely that even within recent woodland, the boundaries might support remnant ancient woodland'.

This impacts on the supposition that there are a number of species on ancient woodland lists that are sun demanders and would be expected within this 5 m zone that Gill refers to.

Regarding the abundance part of the analysis Barry felt that there was a need for some accounting for the fact that in a given woodland there may be relatively few high-scoring species compared with another woodland where there are a lot of low scoring species. Or should it be just that the number of species is taken as an increase in confidence? However, it is important to acknowledge the importance of specialist niche species such as Opposite-leaved Golden-saxifrage and Herb-Paris.

Consideration of the grouping aspect needs to consider whether the plants are scattered throughout the entire wood, whether certain plants are present as monocultures and how they are grouped. Are they grouped with other indicators? Or are they grouped by meso-habitat?

In his opinion, Barry felt that the way forward was to identify good indicator species looking at their strategies and attributes etc. There is a need to consider the initial colonisation capacity, their shade adaption and their stress tolerance and competitiveness.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 05 - Dr Peter Glaves

Identifying ancient woodlands - a decision tree.

Peter began by exploring why some ancient woodlands are where they are. He explained that many were on steep-sided valleys that were areas too difficult to cultivate. Therefore he concluded that many of our ancient woodlands on level sites had been destroyed as these were able to be cultivated and were on better drained soils.

Acknowledged that ancient woodland sites were those that had been continuously recorded since the year 1600.

Emphasised that under planning policy it is regarded that ancient land is irreplaceable. These also acknowledge a biodiversity value of this habitat.

Emphasised that local planning authorities should identify problems within their planning areas. These are under PPS9.

Peter quoted from PPS9

- 'ancient woodland is a valuable biodiversity resource both for its diversity of species and for its longevity as woodland. Once lost it cannot be replaced. Local planning authorities should identify any areas of ancient woodland in the areas that do not have statutory protection (e.g. as a SSSI). They should not grant planning permission for any development that would result in its loss or deterioration unless the need for, and benefits of, the development in that location outweigh the loss of the woodland habitat.)

Referred to a document handed out at the workshop on how to determine the ancientness of a woodland. This is divided into a section where the most robust evidence of ancient woodland and continuation of woodland cover are:

- the woodland is recorded on the ancient woodland infantry if it is more than 2 hectares in extent
- The site is shown as woodland on an early estate map, pre-1600 A.D

Peter referred then to additional supporting evidence for ancientness and continuity of cover.

He then went on to discuss supporting evidence for ancientness and continuity of woodland cover.

Appendix 11 – Woodland workshops presentations and discussions.

Referring to more recent maps there may be changes since the original series produced.

- Location towards parish boundaries is a good indicator. Woodlands are more likely to be ancient if they are in these locations
- Woodland topography. For example, if woodland is located on steep slopes, valley sides or along streams it is generally on land unsuitable for agriculture.
- Woodland shape, for example irregular or sinuous boundaries or which don't fit in with the 17th-century (or later) regular enclosure pattern of surrounding field boundaries
- Woodland has well-developed external boundary banks and ditches with old/ veteran trees growing on them and may have internal boundaries which are not straight
- Woodland contains archaeological features linked to traditional and management, for example charcoal hearths, old kilns
- Woodland contains features which are only associated with post-1600 A.D. non-woodland activities
- Woodland structure is typical of an ancient woodland type – old/ large coppice stools, veteran trees, old pollards, standing deadwood
- Contains ancient woodland indicator species (botanical fungi and invertebrates)
- Series of aerial photographs showing cover over the same area

Peter also emphasised regarding mapping evidence that maps were drawn for specific purposes and the absence of marked woodland is not evidence that the woodland was necessarily absent at the time of the mapping. If the object of the map was different from mapping everything, such items may have been omitted.

Peter emphasised that it is essential to many sources of evidence as possible to ensure a greater confidence of the ancientness of the woodland.

It was discussed that ancient woodland lists should be site specific and that thresholds should apply for the entire woodland. It was also acknowledged that there was a degree of confidence required based on the number of other forms of evidence available as part of the overall assessment. It was also important to ensure the quality of any evidence used.

Peter suggested a hierarchy of evidence beginning with the ordnance survey mapping data leading onto an archive research followed by field survey that included both archaeology and botany.

One possible approach he suggested was a decision tree.

This would produce effectively a key to "the answer". The decision tree would take a sequence of questions with a robustness of evidence grading those questions with strong evidence - green, moderate evidence - amber, and uncertain evidence - red.

This type of assessment is used by landscape architects. He cross-referenced an approach by Ratcliffe into assessing conservation value where a number of criteria were of primary importance such as size, diversity leading down to elements that were of lesser importance such as intrinsic appeal.

During the discussion Ian Rotherham pondered the situations where ancient woodlands were adjacent to heathland or parkland that all may have elements of ancient woodland ground floras. He suggested a triangulation of evidence that included historical records, archaeological discoveries and field surveys.

Further discussion revolved around confidence limits started by Peter Glaves and Fran Hitchinson who advocated that there needs to be a distinction between confidence of evidence versus what the evidence is showing.

W3 – 06 - Decision tree - Discussion

The discussion revolved around decision trees in that they were regarded as a possible use in ancient woodland situations as they not only provided an indication that a woodland was ancient they also added degree of confidence to that determination by using a combination of reliable forms of evidence and less reliable forms of evidence and making value judgement on the importance of each type in making the determination. Such primary sources of evidence included where map evidence from historic times confirms the same size and shape of boundary as is found today indicating a continuity from that period.

Peter Glaves suggested three possible mechanisms by which a decision tree may work. This first option was one already outlined in that you start with certain evidence indicating ancientness and gradually progress down a decision tree to less reliable evidence in support of any firm evidence that can be obtained at the early stages in the process.

The second approach is a simple cumulative listing. This uses a similar system but assigns an accumulation of points with each answer that is answered in the affirmative. For example, if it was on the ancient woodland inventory score one point at that stage. This would give something close to a percentage confidence estimate based on the number of positive answers given out of the candidate list of questions. However, if one of the questions was "has there been a period of un-wooded cover" this would negate any of the other arguments and questions.

There is also an issue regarding a weighting for each of the questions as some questions may be of lower value and confidence than others and yet they would each get one point.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 07 - Barry Wright

Regional ancient woodland indicator lists.

Barry began by reviewing the current status of regional ancient woodland indicator species lists. These are generally based on entire counties or part of counties. In some cases the counties are amalgamated into regions that often correspond with regions administered by the former Nature Conservancy Council.

Most of the lists are based on general survey data and the occurrence of species in ancient woodlands often as defined by the ancient woodland inventory. Many based on expert opinion only.

He showed a slide of the distribution of the current lists with large parts of England without any form of list at the present time.

The fundamental question was what should a region be? Should it be administrative or biological? If administrative, should it be country, county, Vice-county, district Council or parish?

If the decision was to develop biological boundaries these could be

- geological
- rainfall
- winter minimum temperature
- summer maximum temperature
- relative humidity
- number of frost days
- or any combination of these in a meaningful and scientific fashion

Much of this work has already been done in the development of natural areas of which there are currently 120 in England. These are now consumed under National Character Areas (159) that were formerly referred to as Joint Character Areas.

Another approach would be to use the attributes of the species themselves. Barry showed a series of slides where the distribution of species known to be of Arctic montane requirements were clearly distributed in Scotland and on the higher grounds of Cumbria and North Wales. As you consider species that require warmer climate the pattern of distribution moves further south and into the lowland for species conforming to that characteristic. Eventually the system is reversed whereby species that generally are found in the warmer parts of the Mediterranean are located in southern England and begin to become less frequent towards the middle of England and are generally absent from Scotland. This forms part of the basis of the autecological studies being undertaken as part of this research.

Barry showed an overlay of basic geological regions with the national character areas overlaid. It was easy to pick out a number of areas where geology and national area were coincident. This was taken as vindication that National Character Areas have at least some biological basis in their designation and use.

Barry also illustrated the characteristic mentioned earlier that sub-Mediterranean species have a general distribution towards the southern part of England this is mirrored by the distribution of Yellow Archangel indicating that Yellow Archangel should be regarded as a sub-Mediterranean species. By contrast, Wood Horsetail was of a general Northern and Upland distributional which corresponded very well with the distribution of boreo-montane species from the Atlas.

Barry further indicated the affinity for Yellow Archangel to the geology by overlaying natural character areas and the distribution of Yellow Archangel. In many cases the distribution of Yellow Archangel corresponded with and rarely exceeded the boundaries of many of the natural areas in which it was located. This indicates a value in this approach.

He also emphasised that some species that are naturally found in certain areas are omitted from the list without any reasonable indication as to why. He quoted an example of the two native filmy ferns in the United Kingdom the Tunbridge Filmy Fern is present on the list for the south-west region and it is recorded from the Atlas in this area. However, Wilson's Filmy Fern is also present in the south-west area based on the Atlas records but it is not included on the list for that region. Wilson's Filmy Fern is included on many other lists and is in reality of equal likely importance compared with the Tunbridge Filmy Fern therefore its absence from the south-west list is curious to say the least.

Barry went on to suggest a way forward.

He indicated that existing species recognised countrywide as ancient woodland indicators could be combined with Atlas records to refine these existing lists and ensure that species that are candidates for certain areas are actually included as likely species indicating ancientness.

It is important to develop lists based on biological boundaries.

Consideration of species in a low number of lists needs to be dealt with as some of these may be specific to areas or they may be coincidental species that do not require consideration. This leads on to considering the species strategies and how to treat what are regarded as consequential species that may not be definitive but are consequentially found in association with previously documented ancient woodlands.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 08 - Dr Ian Rotherham

Ancient woodland indicators in shadow woods.

Referred to work in Cumbria where there are sections of the countryside that contain ancient woodland indicator ground flora species in the absence of significant tree cover. Occasional trees may be present not the continuous cover expected of a normal woodland habitat. Raised the issue about what constitutes woodland in terms of the number of trees and how far apart they should be for the area still to qualify as woodland.

Identified that there was a clear understanding of what an ancient tree was but less clear was the understanding of what ancient woodland comprised.

Referred to primeval landscape and the more open nature of the landscape and referenced work done on lightning strikes on trees indicating that this may be a driver in the landscape we see today.

Emphasise that woodlands in our landscape are not natural, they are semi-natural. Especially as we are currently missing several species that would have been present in the natural woodlands, for example beaver.

What we have inherited is a patchy landscape.

Many of our lowland valley bottom woodlands have long since gone.

We now have a selection of mainly modified woodlands.

Ian said there are frequent references to individual trees of cultural significance that still occur in the landscape that were possibly former elements of an important environment historically.

Referred to a hedge bank near Norton that contained and retained the normally expected ancient woodland indicator species ground flora. Indicating that the term woodland is potentially misleading and the term wooded landscapes is more practical and meaningful.

Highlighted cases particularly in the uplands where there is an absence of closed canopy forest but fragments of shaded environment under which ancient woodland indicator ground flora species are able to survive and thrive.

Referred to Padley Gorge that was ring-fenced in the 1980s. Within 20 years there was a reappearance of woodland ground flora.

Other areas are more extreme and comprise contorted specimens scattered across the landscape under which are found the ancient woodland indicator species.

A species like Climbing Corydalis is a good indicator in the open areas for these shadow woodlands.

Ian quoted many examples where there were ancient woodland ground flora species under isolated and scattered trees and on areas where there were clearly wood banks that are now not associated with any woodland.

Peter Glaves re-emphasised Ian's point that many areas in the countryside that retain elements of ancient woodland ground flora are not mapped as woodland and therefore are not acknowledged as such and will not receive any protection as a consequence.

Appendix 11 – Woodland workshops presentations and discussions.

W3 – 09 - General discussion

Further discussion suggested that the use of invertebrates and both standing and fallen deadwood could be used as indicators of old-growth woodland implying ancient woodland. Peter Glaves suggested that forestry operations often tidy up dead timber therefore removing from such sites.

Fran Hitchinson said that the method for identifying antiquity needs vascular plants to be only part of the suite of options considered.

It was also discussed that the currently published woodland heritage manual needs to form part of a toolkit to assist in the assessment of ancient woodland status.

It was also agreed that the approach used in Northern Ireland was valid and should be used elsewhere in the country.

Ian Rotherham questioned the skills level of practitioners as an issue that would need to be addressed.

Peter Glaves emphasised that it would be important to begin the assessment with what he referred to as a Phase 1 visit to characterise the woodland followed by a Phase 2 visit to determine what else the woodland was telling about the history and management.

He also re-emphasised the critical need to make some assessment of the areas of woodland less than 2 ha that were omitted from the ancient woodland inventory.

Ian Rotherham stressed the need for robust evidence of ancient woodland status in order to convince a public inquiry that ancient woodland existed. It was also discussed how protection could be given to the shadow woods that would normally not be considered as woodland sites owing to a lack of tree cover.

Appendix 11 – Woodland workshops presentations and discussions.

Woodland workshop 4 – 23 September 2009

Programme

1. **Dr Ian Rotherham** – welcome, scene setting, overview and context.
2. **Dr Peter Glaves** – ancient woodland indicator list survey: overview
3. **Discussion** on issues raised by survey.
4. **Fran Hitchinson** – Forest Pines enquiry and planning issues arising.
5. **Discussion** on issues raised.
6. **Barry Wright** – review of methods for developing ancient woodland indicator lists.
7. **Christine Handley** – methods for assessing ancient woodlands.
8. **Dr Ian Rotherham** – ancient woodland decision-making matrices.
9. **Discussion** and way forward.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 01 - Dr Ian Rotherham.

Welcome, scene setting, overview and context.

Ian reviewed the earlier workshops and indicated that the sessions will be written up in a paper following the completion of this workshop.

He re-emphasised many of the issues such as the definition of woodland, what are the threats, what are the perceptions of a wood indicators and science supports the use of ancient woodland indicator species.

He referred to a woodland called Whitwell Wood. This is a large woodland in South Yorkshire that has an ancient history. There are areas with remnant old coppiced lime trees along with areas of more recent plantings including relatively recent forestry authority coniferous planting. Emphasised that the land surface goes back to the Domesday period.

His main concern was that the ground flora was under severe threat during operations and extraction vehicles have left deep ruts destroying and damaging the ground flora. Even the use of relatively low impact vehicles is also causing damage. The defence from the owners was that they were only doing one eighth of the area per year. This was a concern to Ian.

However, Ian emphasised that this woodland has always been a working woodland even from historic times. However, there is a difference in the way it was managed with these mediaeval workers having a relatively low impact compared with the mechanised operations that go on currently.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 02 - Dr Peter Glaves

Ancient woodland indicator list survey: overview

Peter summarised his presentation into the following:

1 Non-technical Summary

This report presents the results of a survey into the current use of ancient woodland indicator species lists in the UK. The idea of using species, particularly vascular plants, as indicators of ancient woodlands can be dated back to the 1970s and the work of Peterken, since then a wide number of ancient woodland indicators have been produced. Some based on expert opinions, some utilising field surveys, others from existing lists.

Recently developed lists, e.g. the lists for Scotland, Wales and Northern Ireland have been based on more robust reviews of existing lists, expert opinion and/or field surveys and statistical analysis. However, concerns have been expressed by workers in the field and these concerns appear to be supported by the uncritical use of indicator species in recent planning inquiries.

A survey was undertaken of relevant individuals working in biological record centres, local authorities and key agencies across the UK. The survey sought to identify what lists of ancient woodland indicators are currently in use, where possible to determine the methods used in developing these lists. The survey also sought to assess the awareness of ancient woodland lists amongst relevant decision makers/users and review the ways in which these were used.

A total of 419 questionnaires were sent out, a response rate of 11% was obtained. Follow up phone conversations were held with key individuals involved in developing ancient woodland indicator lists.

Responses were received from all counties excluding:

Buckinghamshire, Cheshire, Essex, Huntingdonshire, Middlesex, Northamptonshire, Staffordshire, Westmoreland, Wiltshire and Worcestershire.

In addition, the Lancashire respondent stated there was **no** AWI List for Lancashire.

The key findings of the survey were:

2 Introduction

2.1 Ancient Woodlands and the Evidence Used to Identify Them

Ancient woodlands in relation to planning are defined as:

woodlands which have been continuously wooded since 1600.

Appendix 11 – Woodland workshops presentations and discussions.

Ancient woodlands have been recognised as having ecological, historical, cultural and other values, the values being linked to the long continuity of woodland cover.

A range of methods have been used to identify the ancientness of woodlands and woodland continuity, this includes archive data (historical maps and documents etc.) and field surveys. (See Separate Reports for methodologies). The latter includes surveys of the species present in woodlands, in particular for species which are associated with or which indicate the ancientness of a woodland; the so called ancient woodland indicators (see below).

2.2 What is an Indicator?

Biological indicators are species or groups of species whose presence (or in some case their character, condition or behaviour) indicate the presence or absence of particular environmental conditions. Species have been used in various ways as indicators; this includes indicators of pollution (e.g. lichens as indicators of air quality), indicators of soil condition (e.g. nettles as indicators of high levels of nitrogen) and plants as indicators of woodland continuity/ancientness.

2.3 Ancient Woodland Indicator Species

Many species can be used to indicate that a site has had continuous woodland cover for a considerable length of time; this includes invertebrates (such as beetles associated with dead wood), mosses and lichens, and vascular plants (i.e. flowering plants and ferns). It is the latter group i.e. ancient woodland vascular plants (AWVPs) which are most often used.

Most ancient woodland indicator lists list species whose presence can be used to indicate ancientness. These are referred to as presence / absence indicators. Some lists are more detailed and take into account species abundance or likelihood of occurrence.

Analysis so far indicates that there are no vascular plant species that are exclusively found in ancient woodland, there are however a number of species which tend to occur in ancient woodlands and are less commonly found in more recent woodland (i.e., they tend to be associated with ancient woodlands).

Peterken, (1974 *en seq)* suggested a number of possible reasons why a species might be more common in ancient than in recent woods, these include:

- **Slow colonists** - that ancient woodland indicators have poor dispersal abilities and take many years to colonise new woodlands.
- **Intolerant of non-woodland conditions** - that they cannot survive in the dryer and more exposed conditions found outside woodlands.
- **Habitats isolation** - ancient woodland indicator species were formerly more widespread but have become isolated by fragmentation and are unable to spread into new woods unless these are directly linked.
- **Climatic relics** - species that historically could survive and disperse into non-

woodland habitats but climate change means that they are no longer able to move beyond woodlands.

- **Recent woods do not contain suitable environmental** conditions - i.e. specialised niches may take many years to evolve, e.g. veteran trees, specialised woodland micro-habitats etc.

- **Recent woodland have different soils or other physical conditions** - for example recent plantations may be established on land which was previously used as farmland and their soils have been modified by such land uses and are unsuitable for ancient woodland indicator plants to grow.

In reality different factors in combination may account for why some species tend to be more frequently found in ancient woodlands.

2.4 Ancient Woodland Indicator Lists

People have noticed for many years that some species tend to be found in ancient woodland more than others. However ,the origins of the concept of Ancient Woodland Indicators (AWIs) and lists of AWIs can be dated back to the 1970s, and George Peterken's work in Lincolnshire, as published as Peterken, G.F 1974 A method for assessing woodland flora for conservation using indicator species. *Biological Conservation* 6, 239-245)

During the 1980s the conservation importance of ancient woodland became widely recognised, this was associated with development of ancient woodland inventories (of sites believed to have been wooded since 1600) and the development of lists of ancient woodland indicators to help identify such sites.

Peterken's Lincolnshire list of Ancient Woodland Indicators and others developed in Kent etc. were adapted for use in other areas, leading to a proliferation of such lists in the 1980s.

Few such lists were based on extensive field surveys or cross relating archive data on site history to species occurrence. Recent lists developed in Wales, Scotland and Northern Ireland have sought to develop more robust verified lists,

2.6 Potential Concerns about Ancient Woodland Indicator Lists

There is wide variation in the number of species listed on different ancient woodland indicator lists (from 25 to over 100 species). There is also variation in the species included on such lists even on lists from neighbouring counties/areas. Few species are found on most lists.

In a number of lists local expert opinion and/or site surveys have been used to produce the lists, in other areas the origin of the lists is uncertain, and so it is therefore difficult to assess their robustness.

How ancient woodland species are used varies between lists. Some are just lists of species, others rank species in some way (for example separating out common ancient woodland species from rarer species). Some indicate threshold values (i.e. a. number of species above which a site can be considered to be ancient). Care needs to be taken in using numbers of indicator species to determine whether a site is ancient or not as a number of factors can affect the number of indicators found in a single woodland. These include:

- **Size of woodland** - generally the larger a woodland the more species found.
- **Soil type** - acid woodlands tend to contain fewer species than neutral or calcareous.
- **Altitude** - with generally fewer species and therefore indicators in upland woodlands.
- **Structural diversity** - with more species being found in woodlands with greater structural diversity (different ages of trees and gaps etc.).
- **Topographic and physical variations** - can also affect numbers of species found, as a number of indicators tend to be found in woodland microhabitats such as beside streams, on steep slopes or rocky areas etc.

3 Methodology

3.1 Rationale

Concern has been expressed regarding the robustness of some existing ancient woodland indicator lists and the uncritical way in which some users have been applying these; for example the perception that the indicators of ancientness are valuable in themselves rather than their value as indicators.

A range of anecdotal evidence has been collected but there has been no systematic wide ranging survey of the range of lists currently in use, how these lists were derived and how they are applied. Recent work on developing lists for Scotland and Wales has adopted a more systematic approach.

As indicated in previous sections other concerns regarding the use of such lists to identify ancient woodlands include the lack of quantified data to support some lists and the fact that indicators vary in their specificity to ancient woodlands in different parts of the country, on different soils etc.

3.2 Survey Approach

Key individuals who have been involved in the production of ancient woodland indicator lists or who may use ancient woodland lists in their work were surveyed using an e-mail questionnaire.

The questionnaire was sent out to 419 individuals from the following stakeholder groups/roles:

- Biological record centres
- Local Authority tree officers
- Local Authority ecologists (including members of the Association of Local Authority Ecologists)

- Regional and National Biodiversity Groups
- County Biodiversity Officers
- Natural England staff and equivalents in other organisations
- Individuals who work with veteran trees and ancient woodlands, including individuals who had attended previous conferences and workshops on the topic
- Individuals who were known to have been involved in developing ancient woodland indicator lists
- BSBI County Recorders
- Community Forest Groups

The key questions covered in the questionnaire were:

- Do you know of or use lists of ancient woodland indicators in your area?
- Can you provide a copy of the lists you use?
- Can you provide information regarding how the list was developed?
- How is the list applied - i.e. threshold values?
- Other comments on use.

Individuals were asked to pass on the questionnaire to other individuals. Follow up reminders were sent out to non-respondents.

In addition more in-depth phone or face to face interviews were held with key individuals who had developed or reviewed ancient woodland indicator lists.

3.3. Analysis

The returned questionnaires and interview responses were analysed using the following four themes:

1. Geographical coverage of ancient woodland indicators - gap analysis
2. Methods used to produced lists - if known (robustness analysis)
3. Use/application of lists
4. Content of the lists - species included in lists, thresholds and weightings

Appendix 11 – Woodland workshops presentations and discussions.

4 Initial Results

4.1 Coverage of Ancient Woodland Indicator Lists

The questionnaire survey and review of existing list has so far identified list for all UK counties except for the following:

Cheshire

Cumberland (list is in the process of being developed)

Gloucestershire (list for molluscs provided)

Herefordshire

Huntingdonshire

Lancashire (individuals have produced lists but no known standard list)

Northamptonshire

Staffordshire (outside the Peak District none noted)

Westmoreland

Several counties had two or three lists.

4.2 Methods used to Produce Lists

The following methods have been used, either on their own or in combination to produced list of ancient woodland indicators:

1 **Ecological surveys** - various surveys were indicated, but tended to form into the following categories:

- Specific surveys of known Ancient Woodlands, often by naturalist and wildlife groups or single individuals (one based on a degree project)
- Collation of surveys for a wide range of sites followed by analysis of records
- Phase I and Phase II survey data - adapted to produce AWI lists NVC based lists

Example responses:

Vascular plant data was provided by County Botanical Society which maintains an extensive database of plant records for the county, 420 000 so far. The records are obtained from surveys and individuals too numerous to mention plus data from historical records, archive material and herbarium specimens.

In most cases the number of sites surveyed to produce the lists was not indicated.

The responses showed an increasing use of lists of axiophytes and that many cases used expert opinion to modify the lists derived from field surveys, e.g.

Appendix 11 – Woodland workshops presentations and discussions.

Our axiophyte list is partly based on the number of tetrads within which species are located which excludes some species. Exceptionally some species such as Bluebell have been retained despite it being found in greater than 25% of tetrads in the county.

There were several references to NVC woodland community types and the species associated with these in developing ancient woodland indicator lists.

Archive based - less than a quarter of respondents referred to the use of archive evidence in developing lists

Example response: *surveys of documentary info & archives - All known records by recorders working in Shropshire in the past*

Expert opinion - expert opinion tended to be used in two ways i.e. use of a single expert or expert panel to develop the list. Experts/colleagues from within the region were used in most cases (draft lists being circulated for comment). In over a third of cases external experts were also used to either produce or refine a list. Experts included Botanical Recorders County Wildlife Site Panels:

Example responses: *Our SINC Panel, which includes local authority ecologists, representatives from Natural England, EC, EA, local WT, and importantly, also several local expert botanists, were all involved in defining the list.*

It was also noted that expert opinion was sometimes not used, e.g. *although following survey of ancient woodland inventory sites views were gathered on refining the list, this analysis was never completed but it would be a worthwhile exercise.*

Adaptation of existing lists, either for that county or list from other areas,

Example responses: *Based on the NCC Ancient Woodland Indicator List from the 1970s modified to fit Bedfordshire in consultation with BSBI recorder.*

Use the George Peterken list, rarest species removed, ferns added.

Yes - adaptation - didn't follow their lists exactly - disagreed with some of their findings

Specific reference was made to a number of key texts in developing lists including:

Peterken G.F (1993) Woodland Management and Conservation. London J.M Dent Rose, F. (1999) Indicators of Ancient Woodland: the use of vascular plants in evaluating ancient woods for nature conservation. British Wildlife 10:241-251.

Peterken, G., (2000) Identifying ancient woodland using vascular plant indicators. British Wildlife 11: 153-158

Kirby . K. (2004) list in Rose F (2006) The Wild Flower Key, Warne

The Botanical Society of British Isles axiophyte lists.

Over half the responders indicated that their Ancient Woodland Indicator Lists were derived from a combination of expert opinion and ecological surveys; with experts either developing a list or trialling a list produced by field work. For example:

The list was initially drawn up by the Vascular Plant County Recorder with a group of (university) students, and other leading members of the County Botanical Society. Revision was later led by the County Biodiversity Officer in conjunction with the County Botanical Society plus consultation with a wide range of botanists and ecologists working in the county including individuals at Natural England

Over a third of respondents who knew of and/or used lists were uncertain of how these lists were produced and therefore unable to comment on their robustness etc. For example:

Not sure - I imagine the County Council would have been involved when ancient woodlands in area initially designated

Few respondents indicated that their list (and in one case the wider Ancient Woodland selection criteria) were periodically reviewed. An interesting example of reviewing was:

We are currently reviewing our list as it is felt that there are too many species on the list (currently 90) and that many of these are too common to be true indicators. The list has been reduced and the threshold is suggested to be 5 instead of 10. These amendments are currently waiting to be approved by the County Wildlife Site selection panel.

4.3 Awareness of and Attitude Towards Ancient Woodland Indicator Lists

Most respondents were positive about the importance of Ancient Woodlands and the use of AWI lists, e.g.

Useful tool to aid understanding woodland history and identifying small areas of Ancient Woodland.

Appendix 11 – Woodland workshops presentations and discussions.

A few respondents questioned the relevance of Ancient Woodland Indicators and list of these, e.g.:

Given our cool wet climate many species often given as AWI species are found outside woodlands (in the county). Both Bluebell and Wood Anemone occur in grasslands (Upland Hay meadow) in Lancashire and also in Bracken Beds. Also Herb Paris occurs in a number of hedgerows.

AWIs become irrelevant in cool wet climates. Whilst certain rare species may only be found in AW, their rarity makes them valueless. It is often the association of species rather than the presence of individual species that characterise A W. This needs to be assessed with habitat and location. The lists given in the I of AW is populated with species frequently associated with other habitats.

I normally use magic map and the 1872 map

Some responders adopted an uncritical approach to Ancient Woodlands, e.g.:

Ancient woodlands are taken to be those which have been identified by Natural England

If we did use a list it would probably be from Natural England, in accordance with their Standing Advice.

Our list is split into BAP habitats and might not really identify true ancient woodland. We use the list to identify good quality woodland whatever the provenance. The best examples of course tend to be ancient woodland

I would make one (a AWI list) myself if I ever felt need for one.

The importance of Ancient Woodlands appeared to be questioned by some respondents:

We have criteria for selecting woodland SNCI's. There is a presumption to include ancient woodlands (as chosen in the county ancient woodland inventory, generated by EN originally). The more important point is whether they are diverse or hold rare spp now; so not all AWI woodlands have been selected

This county has little ancient woodland and what there is, is well known and almost all within reserves. Therefore we have little need of a AWI list. We do however have an Axiophyte list of species which in our opinion are of use in indicating habitats of high conservation value.

A few respondents applied indicators in a wider context:

We also tend to look at non woodland sites and take the presence of species such as Chickweed Wintergreen to indicate possible former woodland cover on unimproved land. This is sometimes used in part to justify woodland creation *schemes.*

4.4 Use of lists

Three interesting issues in relation to the use of AWI lists were raised:

Our stance is to try and protect sites which are of at least county value, so this will include ancient woodlands, but we don't separate these from other woodlands of high wildlife value.

AWI lists might be useful in developing criteria for Local Sites. A fundamental question is what area should AWI lists covers (e.g. Character Areas or Local Authority areas)

I'm the only member of staff who deals with this amongst a lot of other issues so there is no time for this kind of information. It would be great to be able to do this kind of stuff but isn't going to happen any time soon.

Few list used **threshold criteria.** Where used the threshold varied, e.g.

in Cardiff we use a threshold of 12 AWI spp

Woodlands with the characteristics of ancient woodland with a minimum species index score of 10 may qualify as Local Wildlife Sites.

Up to 4 species is poor, 4-8 is good, more than 8 is very good

In many cases a threshold value for indicators was just one of the criteria for determining a site e.g.

In order to determine if a site should be included as a County Wildlife Site having been initially identified through historic data, species lists and survey the following thresholds are used:

MINIMUM THRESHOLD

a) Ancient semi-natural woodlands included in Bedfordshire Inventory of Ancient Woodlands which retain over 25 % semi-natural cover.

b) Ancient woodlands which are over 75% replanted which contain either; ***I)***

more than 10 ancient woodland indicator species;

ii) more than 40 woodland plants.

c) Ancient semi-natural woods under 2 ha with one of the following:

i) more than 5 ancient woodland indicator species;

ii) more than 30 woodland plants:

Hi) good example of NVC W8 (ash-field maple-dog's mercury woodland);

iv) good example of NVC W10 (pedunculate oak-bracken-bramble woodland);

v) good example of NVC W16 (oak-birch-wavy hair-grass woodland).

The use of thresholds for Ancient Woodland Indicator species raised opposing opinions, e.g.

Positive responses included:

Not (currently used) but some species are less strongly indicative than others. This varies between the upland and lowland areas of this county, For example, Mercurialis perennis is strong in the upland west but much less so than in the lowland east.

Sites are not determined as ancient purely on the basis of presence (or absence) of particular species, it is a significant factor but can usually be combined with other archive data on mapped history, documentary evidence etc. to provide an assessment of site history

Negative responses included:

Would seem highly questionable practice to me, rather than basing on historical records and physical evidence, unless possibly i) separate thresholds were used for different NVC sub-communities, and ii) they were indicative guidelines of woods which have some biological attributes indicative of ancient woodland, rather than definitive opinion that woods above the threshold are ancient.

Less than a third of respondents used any sort of weighting in their lists:

Where weightings were used they related to either:
- Geographical factors - weighting of species in relation to different geology or natural area types
- Particular species given higher scores - but criteria not indicated

No respondent mentioned rarity of species as a factor to consider in weighting.

Some lists use a standard weighting:

Our woodland species list is weighted - plants shown in bold score 2, the rest score one each, and we have different thresholds relating to different Natural Areas etc.).

In other cases weighting was determined by surveyors

Our surveyors try and make a determination as to whether any of the AWI species might have been planted or are garden escapes, but this is not done in a scientific way.

One respondent made reference to the potential use of negative indicators:

Note that the absence of some plants (particularly ruderals) can also be indicative of the past history of a site

Only two respondents referred to the use of species other than non-vascular plants: fungi, hoverflies, molluscs and craneflies as indicators.

4.5 Species included in Ancient Woodland Indicator Lists

See separate list - list incomplete

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 04 - Fran Hitchinson

Forest Pines enquiry and planning issues arising.

Fran presented a case study on a site at Forest Pines in Lincolnshire. This was a golf course that wished to extend into an area of plantation on an ancient woodland site. The development was subject to a public inquiry. It was estimated that 33 ha would be lost and the remaining 48 ha damaged.

As part of the defence the area was surveyed but it was unclear which species could be used to confirm the ancient woodland status of this former ancient woodland site. The lists use included the one developed by George Peterken but Fran questioned whether this is the way these lists are supposed to be used.

Although the survey was done to a recognised standard it was not regarded as being competently executed and there were doubts as to how it was surveyed and mapped and issues regarding the numbering of samples and data.

The data could not be verified as the Woodland Trust were not allowed access. It was therefore difficult to determine whether or not any imposed threshold was valid.

Fran was also concerned that the list by Peterken was for South Lincolnshire and that the Forest Pines site was in North Lincolnshire and therefore was his list still valid?

She also questioned whether ancient woodland indicator lists were applicable to plantations on ancient woodland sites and even if they were, was it still appropriate to use the same thresholds?

She felt that in some cases ancient woodland indicators could be confused with species of individual importance.

The issue of abundance was again raised when Fran reported that Scabious was on a list of important species found in areas of ancient woodlands. But she was not sure about the significance of this as an individual species in terms of its presence and abundance on the site.

She also recounted that at the public enquiry the inspector referred to planning policy statements as being "**only guidance, I don't need to follow it**".

Appendix 11 – Woodland workshops presentations and discussions.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 05 - Discussion on issues raised.

There was some discussion that suggested that people use ancient woodland indicator species to learn something about the history not just to determine if the woodland is ancient or not.

None of the respondents to Peter Glaves survey said that they consulted historians in the determination of the ancient status of woodlands. He also commented that the question was not asked "how do you identify ancient woodland?". The questions related about the use of ancient woodland indicators to provide evidence for ancient woodland status.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 06 - Barry Wright

Review of methods for developing ancient woodland indicator lists.

Barry began by reviewing existing methods. this included existing field survey methods involving walkover surveys of the use of quadrats. The use of existing ancient woodland indicator lists and how they were obtained. Also, how future list should be obtained.

The objective was to obtain botanical data sufficient to inform a decision about the historic status of a woodland.

In reviewing the field survey methods he referred to the research and survey report number 11 by Keith Kirby in 1988 entitled 'a woodland survey Handbook' (see also W2 – 06).

The general considerations were to determine when surveys should be done, how many times they should be surveyed and what species should be included. With regard to the latter point, should recognised ancient woodland indicators be included and is there any need to include an abundance value?

Walkover survey.

Walkover surveys can be anything from a general walkover through the woodland - effectively a nature ramble. Structured surveys could include

- the use of a 'W' or zigzag pattern, following individual features
- walking the current woodland boundary
- walking a grid and if so how far apart should each leg be? How long should a transect be?
- Should it be based on distance or time?

The advantages of a walkover survey are that they

- provide good coverage
- are time/ cost-effective
- easy to do
- are likely to detect hotspots
- could potentially detect rarities

The disadvantages of walkover surveys include:

- encompassing areas of different origins
- there may be an avoidance of difficult areas
- these surveys are not repeatable or quantitative
- they may be difficult to use when comparing with other sites

Quadrats

The issues regarding the use of quadrat includes where to put them, how many, how big and what abundance value is used, e.g. DAFOR, Domin or percentage cover.

The advantages of quadrats are that:

- they are statistically comparable
- they can be randomised or made systematic
- they result in more intense observation that may pick up rare species but only within the quadrat surveyed

The disadvantages of quadrats are:

- their representativeness
- that usually only a small area of the wood is sampled, they are time/ cost expensive
- hotspots are missed
- low numbers of candidate species are likely to be recorded
- there is considerable time spent and wasted walking between quadrats

How were existing lists derived?

- Expert opinion based on often unknown survey data
- Ancient woodland inventory surveys
- Species details studies
- Sampling surveys
- Other published data

Survey methods used in surveys include:

George Peterken 1994 Lincolnshire

- Confined to shade-casters, shade-bearers and wood margin species
- Trees and shrubs omitted
- Species capable of growing in shade and in open areas were included
- Selected only 183 species of this type
- Transect – incorporating margins and special features, such as a stream
- Most sites visited on two, or more, occasions
- Recorded until a few new species added to the list **NB** *stopped before recording any potential rarities!*

Ann Hill 2003 Malvern Hills and Teme Valley.

- Woodlands less than 0.5 ha excluded
- Woodlands less than 20 m wide excluded
- Maximum of one sample/3 ha
- 50 m x 50 m 25 random sampling units
- Domin score for abundance
- Sampled April-September
- Visited twice in different seasons
- Vascular plants, lichens and bryophytes recorded
- Thorough walkover survey done as well

Gill Castle 2008 Wales.

- 2 ha plots
- All vascular plant species recorded
- Domin scale of abundance
- Species within 5 m of the woodland boundary recorded separately for woods not recorded in the ancient woodland inventory
- Survey to May–June
- One surveyor only

- Two hour fixed search time

Proposed field recording system for the future.

- Structured walk-through
- Standing quadrats
- Point records

The initial survey begins by following any existing footpaths or tracks throughout the woodland and plotting these onto maps. This forms the first part of the structured walk-through survey.

The species recorded include trees, shrubs and the ground flora.

The structured walk is equivalent to a transect and is designed to cover key areas throughout the entire woodland. These are intended to start and stop where vegetation changes and to deliberately follow features such as streams and earthworks where the vegetation may differ.

A number of standing quadrats are recorded on both typical and unusual areas of vegetation such as wet flushes, stream slides or charcoal hearths. As these are part of a transect that also records species, there is no 'wasted time' as suggested by Keith Kirby and Barry Wright in their earlier presentations.

Point records are made of individual plants or small patches of rare species such as Broad-leaved Helleborine.

Photographs are also useful to include in the survey documents general views of the woodland being of an advantage to refresh the memory on the characteristic of the woodland surveyed. Photographs showing the standing quadrats are useful to reinforce the nature of these parts of the recording. It is also of use to take a picture of the azimuth to indicate the canopy cover at the standing quadrant locations.

The outputs of the surveys are maps onto which the transects are overlaid. These are based on one map per species with a green line to indicate the presence of that species on a particular transect. The transect lines walked are normally coloured in white to indicate the route covered and the presence of the species indicated as green. The width of the green line indicates the abundance as estimated using the DDAFOR. The width of the line represents the frequency part of DDAFOR and the darkness of the colour green the cover/ abundance part.

Appendix 11 – Woodland workshops presentations and discussions.

This provides a visual impression of the extent of the species along the transects covered in the survey.

The next stage plots any standing quadrats along the transects (including any that may have been made away from the transects). These are normally indicated as red squares if the species in question was not recorded in that standing. The presence and abundance of species is indicated by a circle of green with the diameter varying relative to the quantity.

Any point records would also be indicated on the map.

Overall the impression given by the variable width transect coloration and the variable diameter quadrat circles and point record indications give a strong visual impression of the distribution of this species within the woodland.

This process is done for every individual species to allow for the study of their distributions. Once all other species have been plotted it is then desirable to perform a similar mapping exercise where the thickness of the transect line reflects the number of ancient woodland indicator species recorded on that leg of the transect. The same would apply for the standing quadrats, how many ancient woodland indicators were within a particular standing quadrat.

This provides an overview of the abundance and distribution of all ancient woodland indicator species throughout the woodland.

The next stage is to analyse the data using the SLAG approach referred to above.

Species

- What do the individual species inform about the history and management of the site?
- Are they poor colonisers?
- Can they persist in the absence of shade?
- Do they have specific habitat requirements, e.g. pH, moisture, shade intensity?
- Are all of the species equally indicative?

Location

- Are the ancient woodland indicator species only present in certain parts of the wood?
- Which part?
- Are they absent from parts?

- If so, which ?
- Why?

Abundance

- Are the ancient woodland indicator species evenly abundant?
- Are they only present as individual plants?
- Are they indistinct and dense clumps?
- Are they at an unexpectedly low abundance?

Grouping

- Are the ancient woodland indicator species grouped in certain areas?
- Is the grouping particular to the miso-habitat conditions e.g. calcareous flushes or stream sides?
- Does the grouping contain only weekly indicative species?

The detail of these processes will provide information that will give confidence of any decision regarding the historic nature of a woodland based on its ancient woodland ground flora.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 07 - Christine Handley

Methods for assessing ancient woodlands.

Christine reviewed the various methods used for assessing ancient woodlands including, in particular, the woodland heritage manual. The basic premise was that evidence needs to be collected that can demonstrate continuity of woodland from various documentary records in addition to any botanical information that may be available.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 08 - Ian Rotherham

Ancient woodland decision-making matrices.

Ian continued the theme discussed by Peter Glaves on methods of using decision trees in order to provide an answer as to whether or not an ancient woodland qualified to be ancient. He referred to a number of issues such as whether or not patches of Dog's Mercury in different parts of woodland were an indication of long establishment or was it evidence of recent colonisation.

Appendix 11 – Woodland workshops presentations and discussions.

W4 – 09 - Discussion and way forward.

Sufficient evidence for a planning authority or conservation organization.

Robust Guidelines needed.

With reference to thresholds Fran Hitchinson indicated that a value of eight species needs to be looked at in the context of the woodland management as it is not clear from that whether eight is a good number for that particular woodland or a bad number for that woodland.

There is a need to take a multi-disciplinary approach. Evidence from different sources needs to be combined into increasingly confident prediction as to the origins of given blocks of woodland. This includes historical, documentary, archaeology and botanical evidence each given the due weighting in order that it is fully taken account of. Does this require a minimum number of different sources?

An alternative approach to having the need to confirm ancient woodland is having to confirm that area is not ancient woodland. This may be the case at a public enquiry. This would require evidence proving that there had been a gap in canopy cover sufficient to cause a degradation in the ground flora that can now be observed with an absence of ancient woodland indicator species in the current flora.

In Wales the emphasis was that, if the woodland is on the ancient woodland inventory it is assumed to be ancient unless evidence is submitted to prove to the contrary.

Keith Kirby referred to instances where some of the ancient woodland features may potentially persist during an unfavourable and unwooded period. it was debated how much of a gap might be sufficient to change the decision about a woodland from ancient to recent.

Fran Hitchinson and said that in the Woodland trust they have a suite of four features that help to distinguish an ancient woodland but stated that some of these are also found outside of ancient woodland.

Peter Glaves questioned whether we can be scientific about history when history is not science?

Peter Glaves felt that providing information on the value and status of ancient woodlands needs to be tailored to the audience. He felt that it is acceptable to provide local authorities and conservation organisations with a numerical and weighted value but that local groups and amateurs would require a simple interpretation.

Peter also pondered whether or not there was a need for a minimum set of guidelines for future survey data to ensure that adequate lists are generated in the future.

The other issue that Peter raised was once somebody has acquired data how is it analysed to decide whether or not they have surveyed an ancient woodland or not? Ideally it should be some simple process like a crib sheet that will provide the confidence to add to any assertion that woodland is ancient.

Appendix 12 - Results for Boston Spa Wood

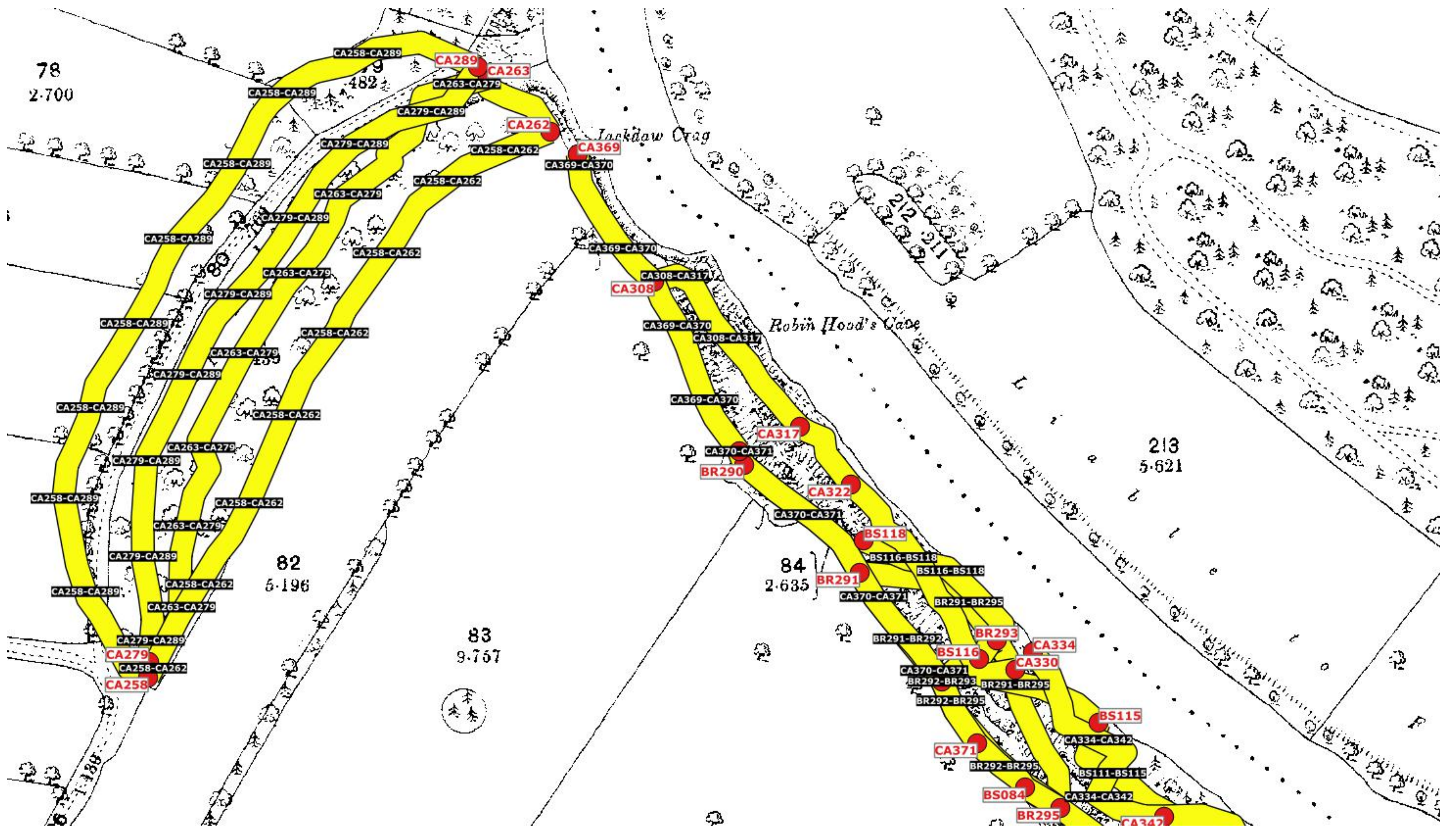


Figure 1.1 - Boston Spa woods - details of transects showing node and transect line identifiers. - part 01

Appendix 12 - Results for Boston Spa Wood

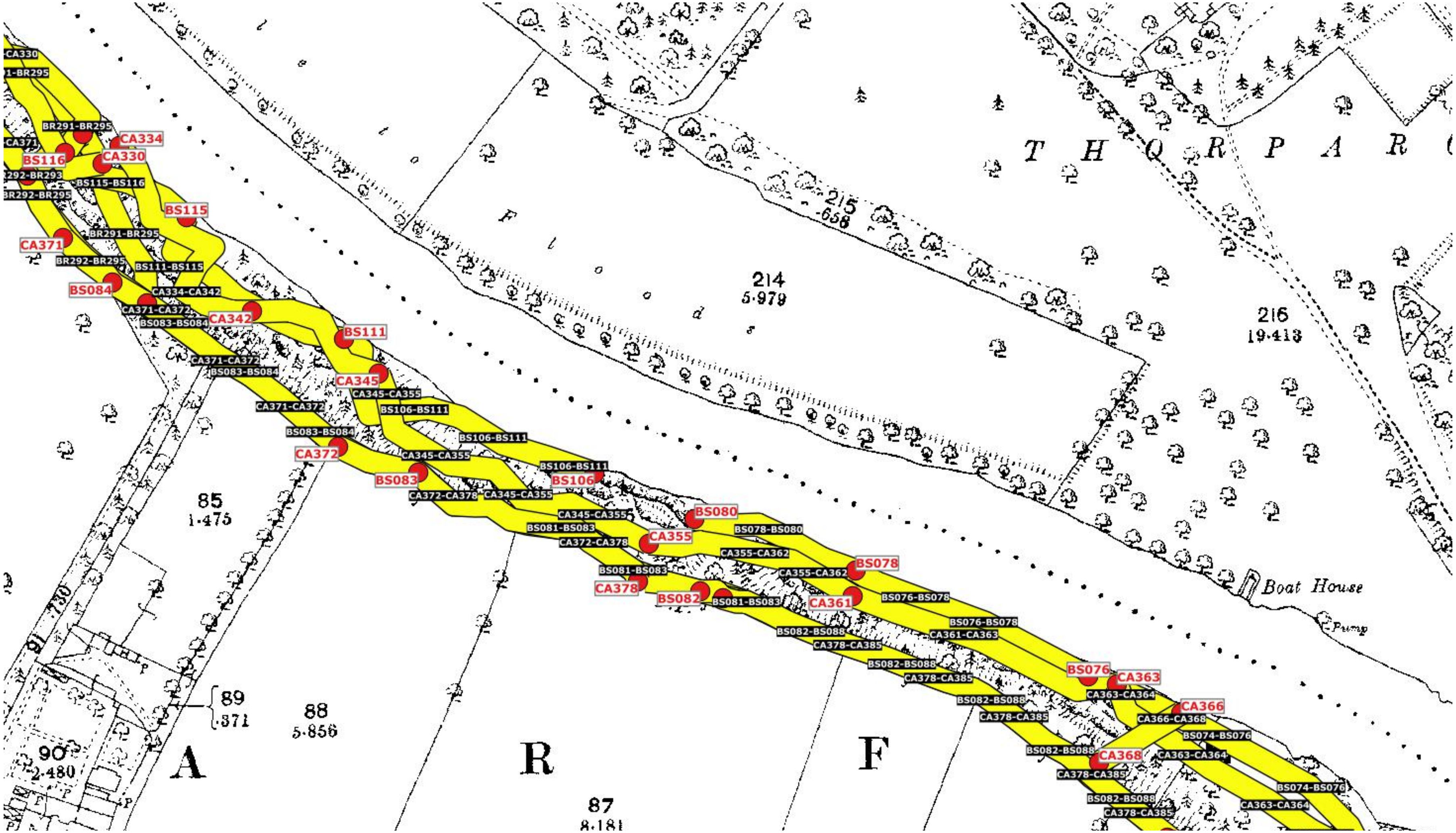


Figure 2.2 - Boston Spa woods - details of transects showing node and transect line identifiers. - part 02

Appendix 12 - Results for Boston Spa Wood

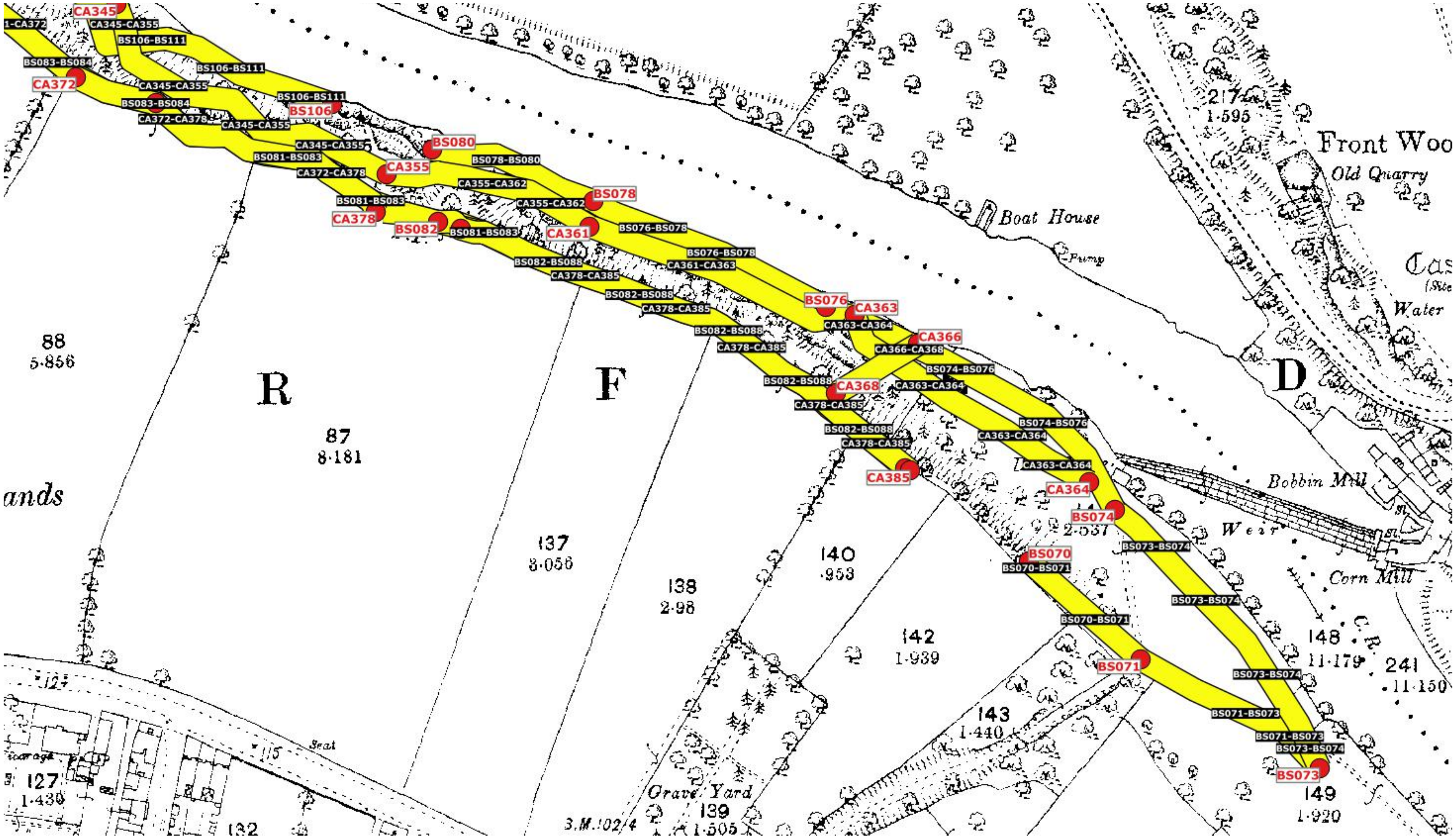


Figure 3.3 - Boston Spa woods - details of transects showing node and transect line identifiers. - part 03

Species maps for Boston Spa Wood

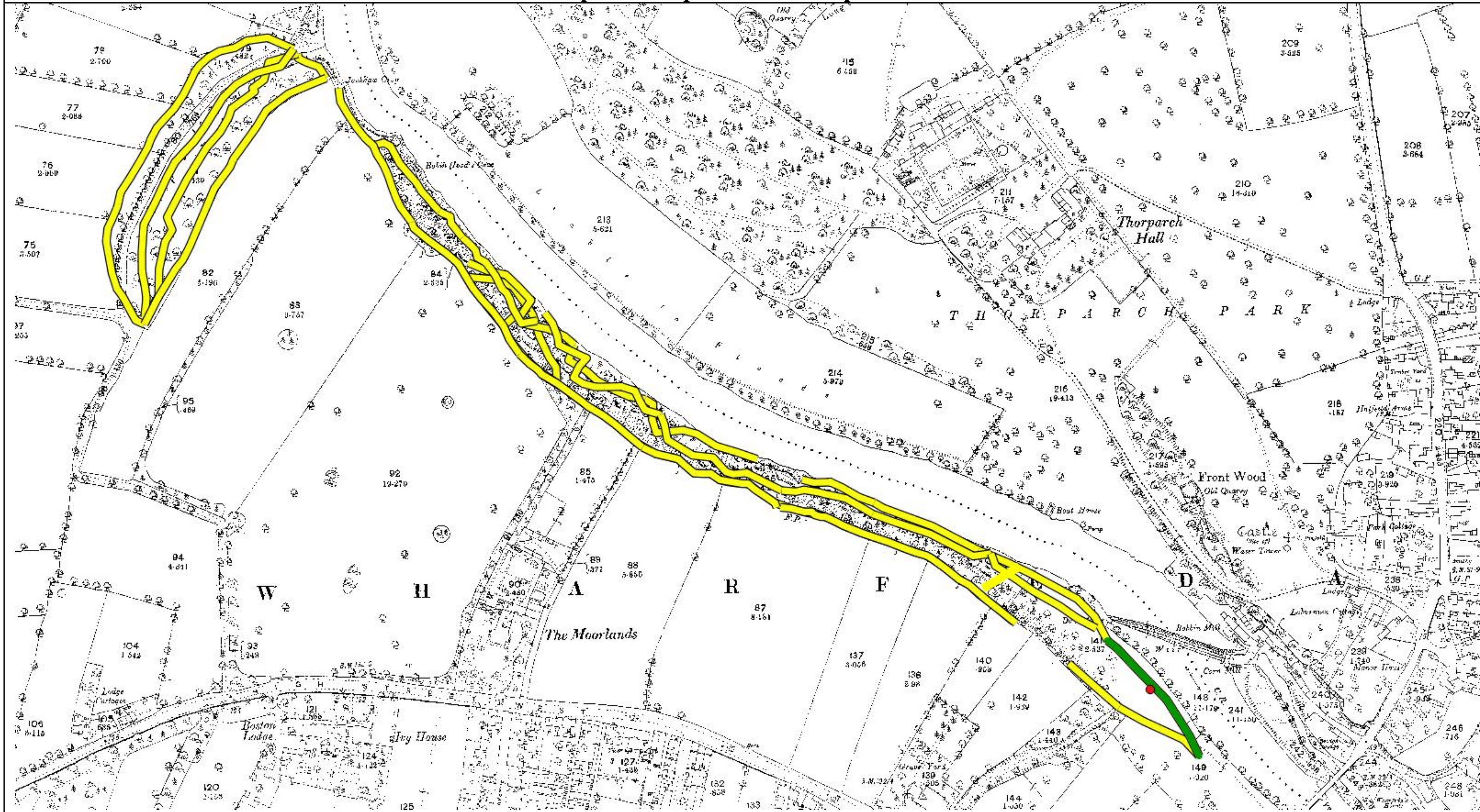


Figure 4.4 – *Actea spicata*

Species maps for Boston Spa Wood

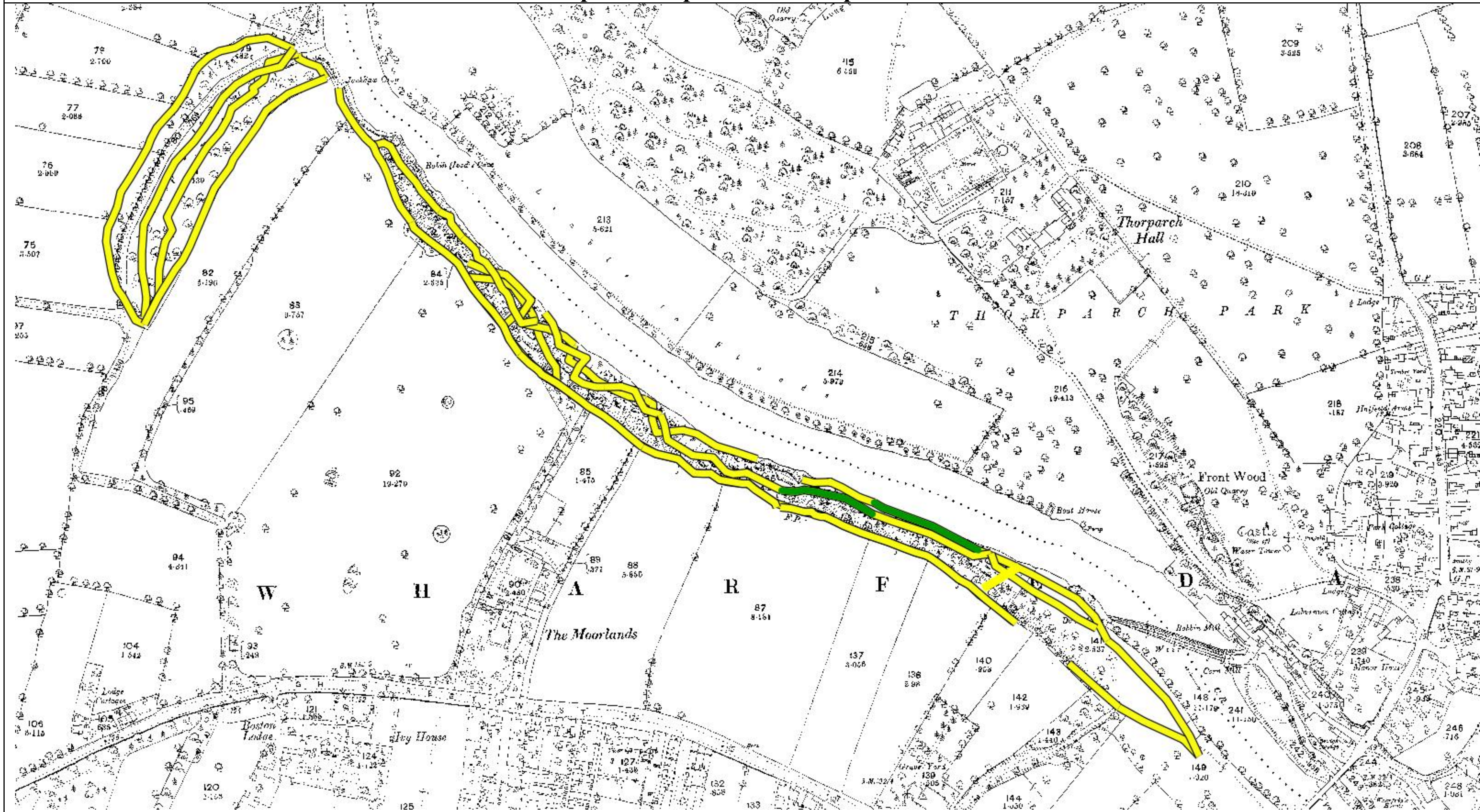


Figure 5.5 – *Ajuga reptans*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

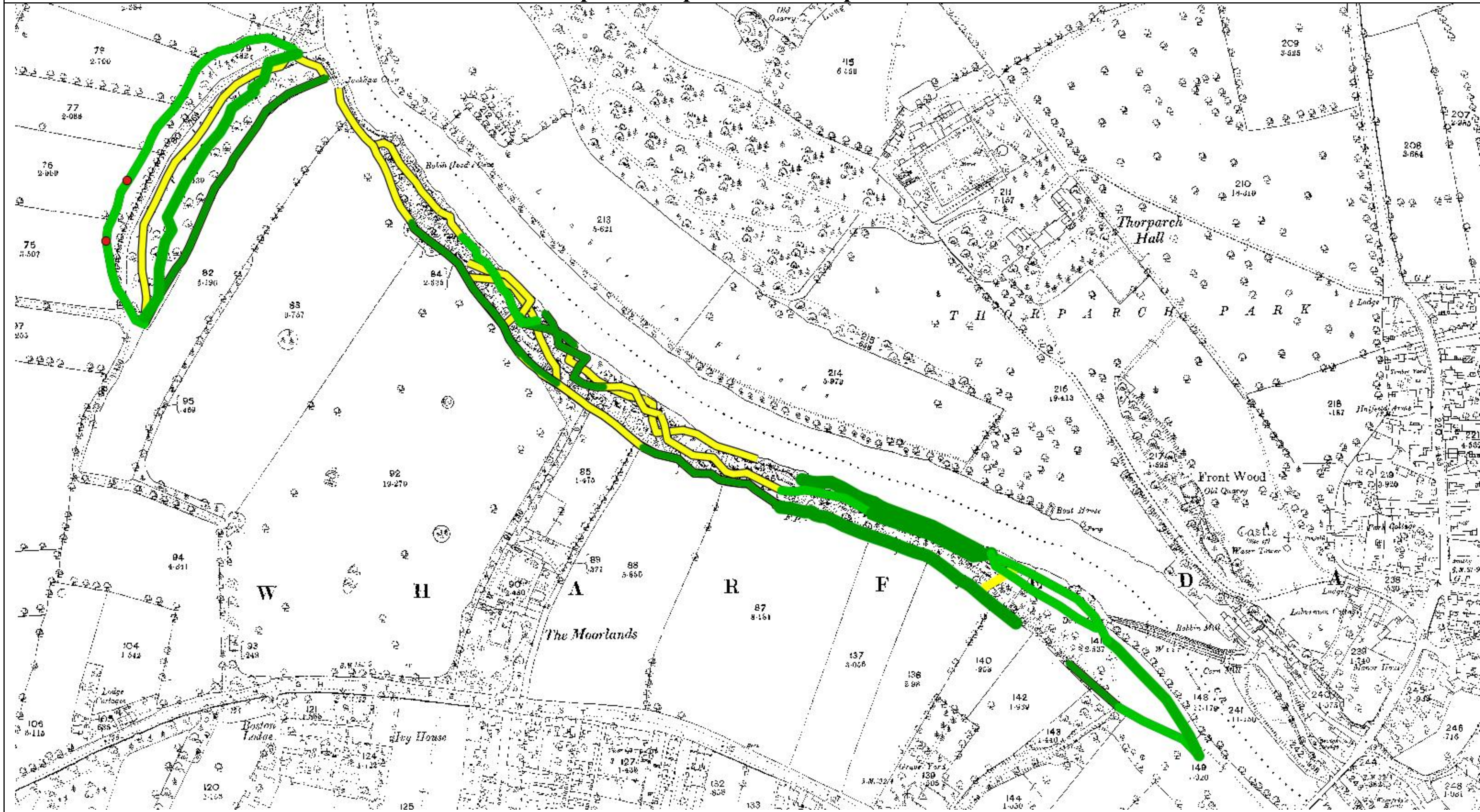


Figure 6.6 – *Allium ursinum*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

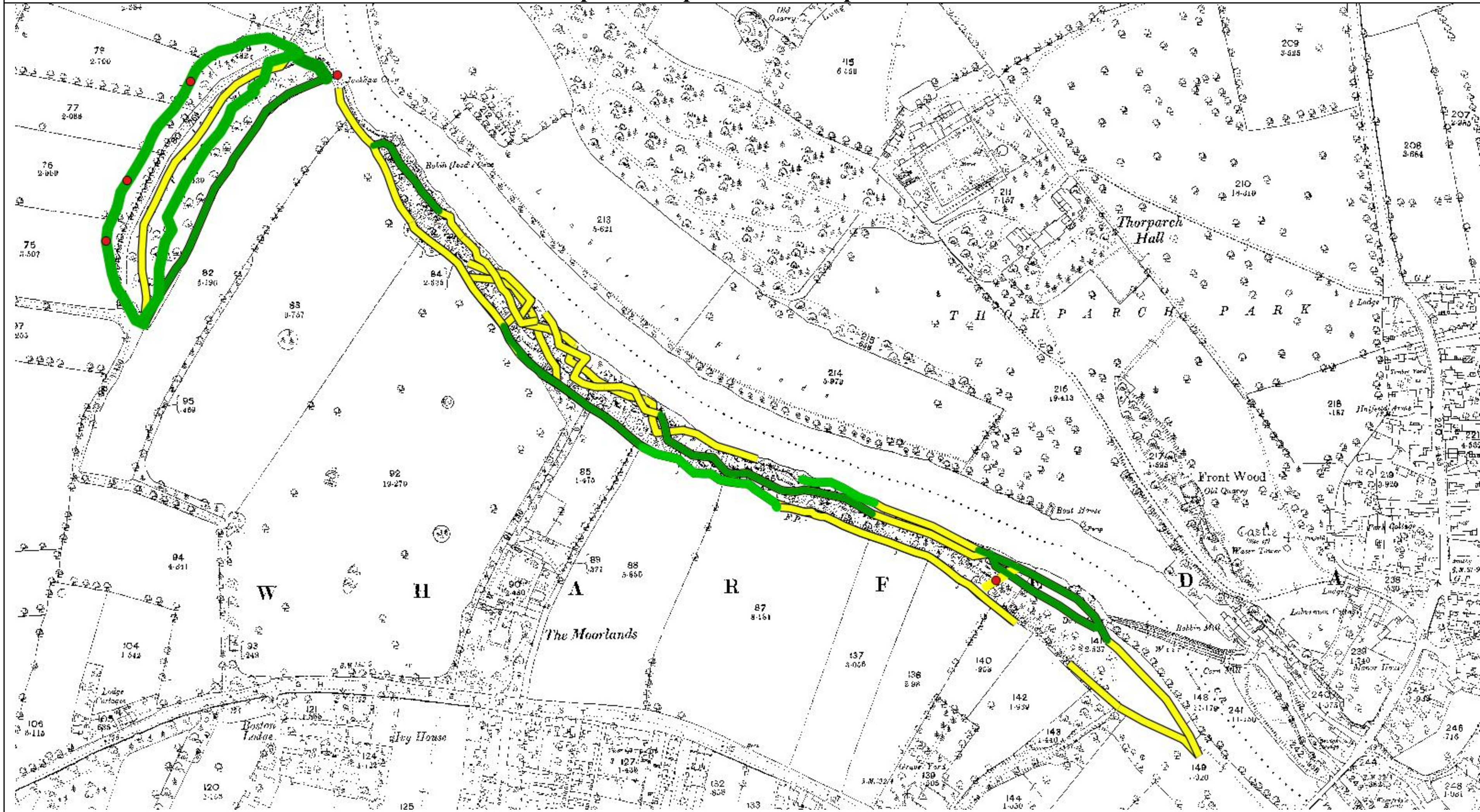


Figure 7.7 – *Anemone nemorosa*

Species maps for Boston Spa Wood

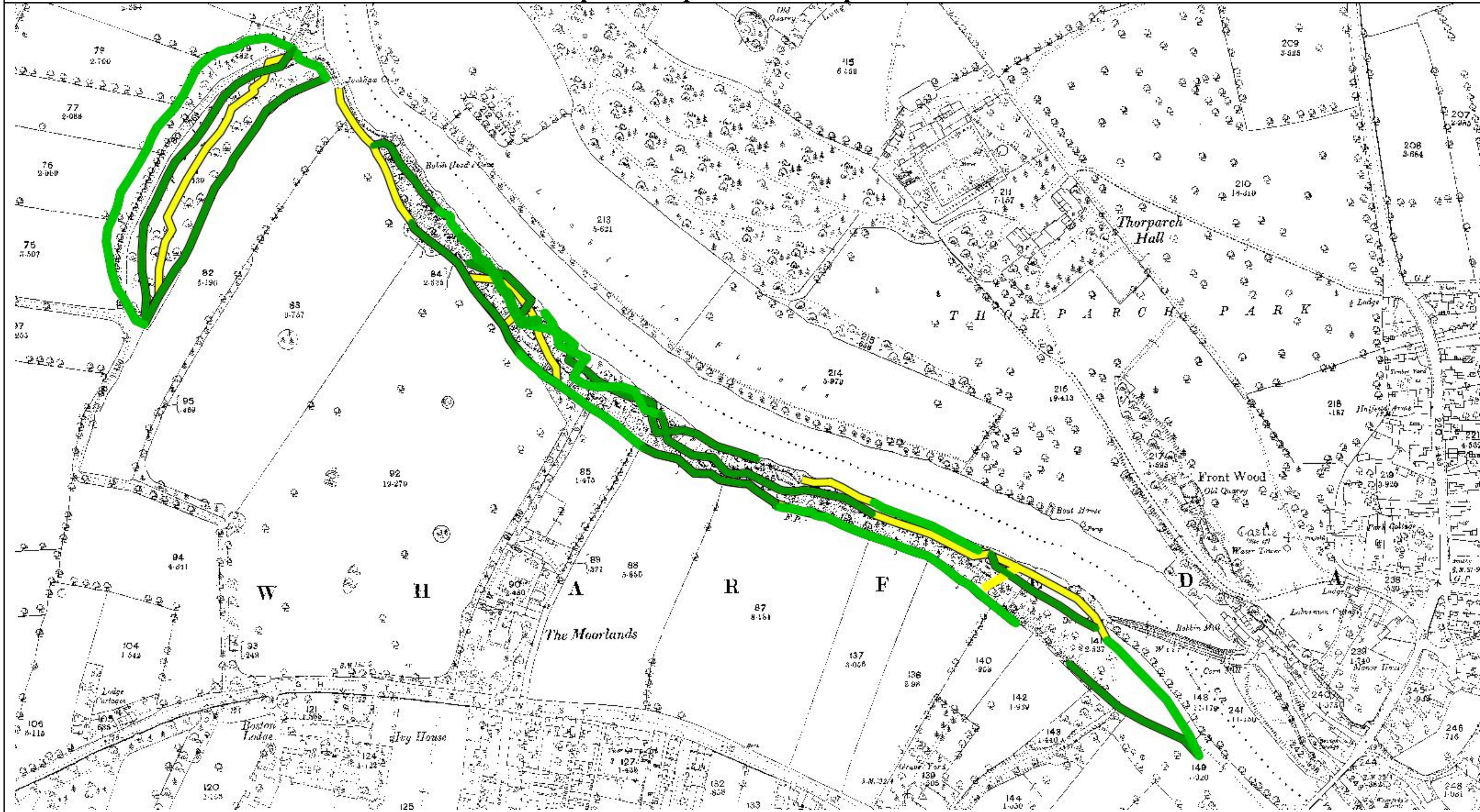


Figure 8.8 – *Arum maculatum*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

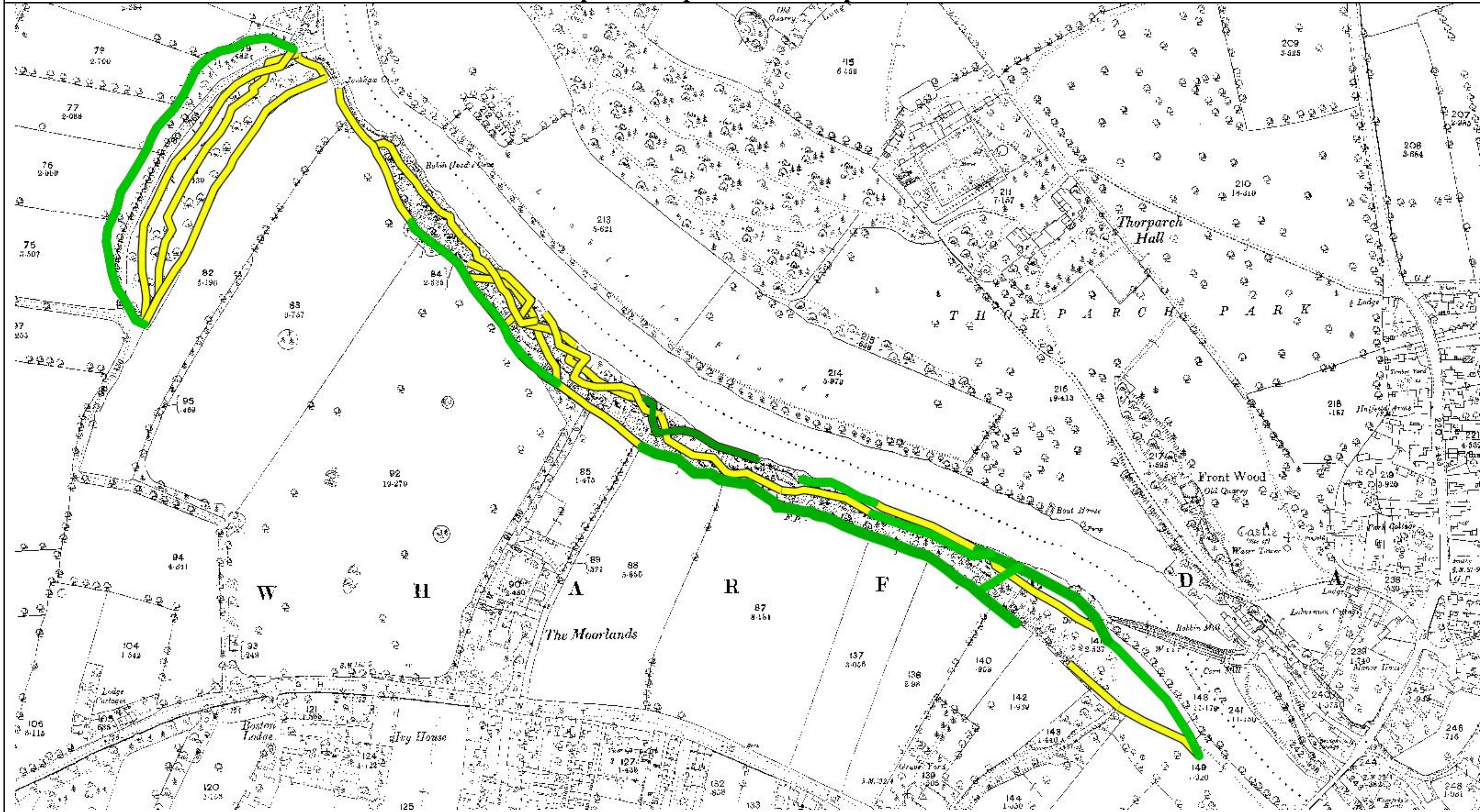


Figure 9.9 – *Brachypodium sylvaticum*

Species maps for Boston Spa Wood

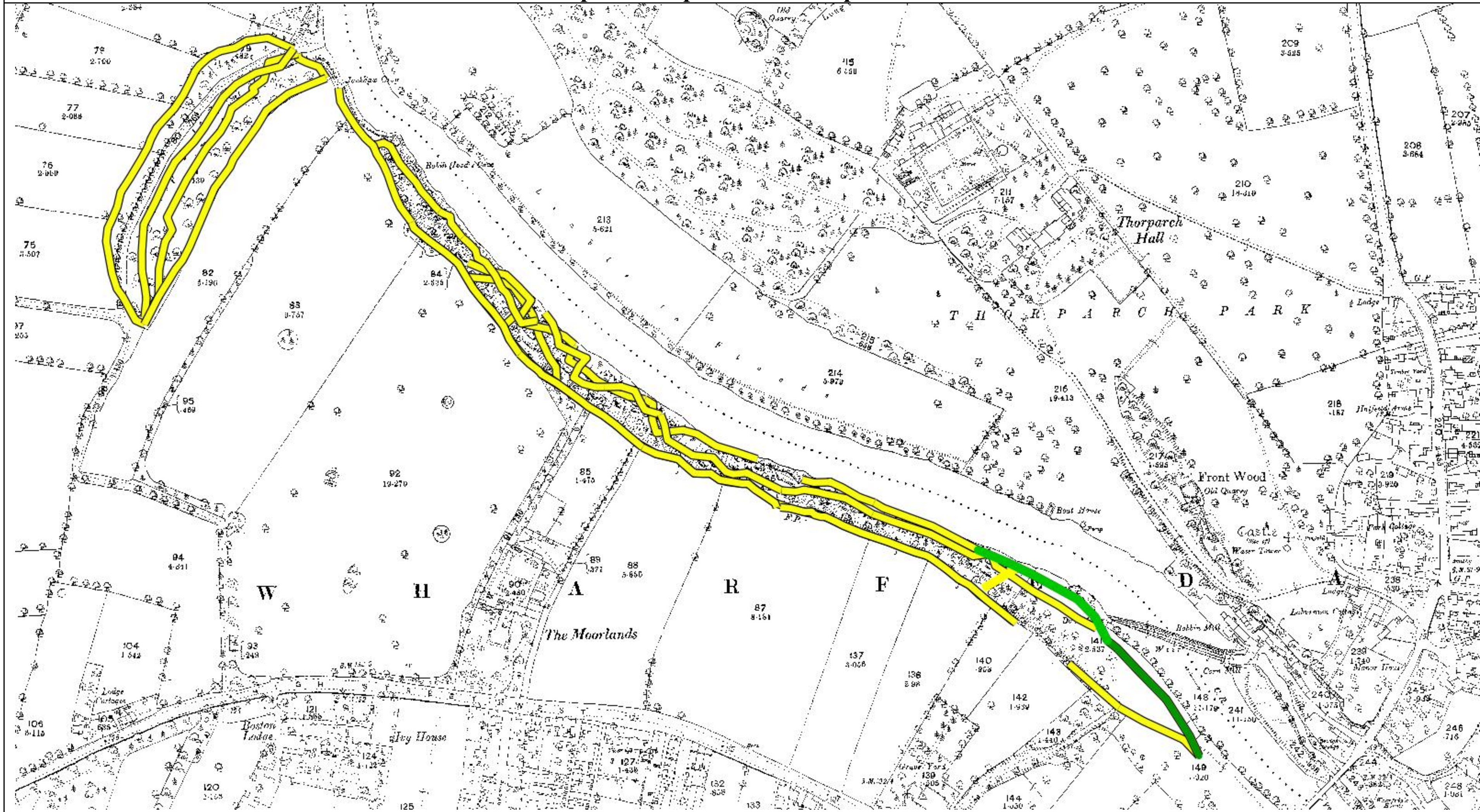


Figure 10.10– *Bromopsis ramosa*

Species maps for Boston Spa Wood

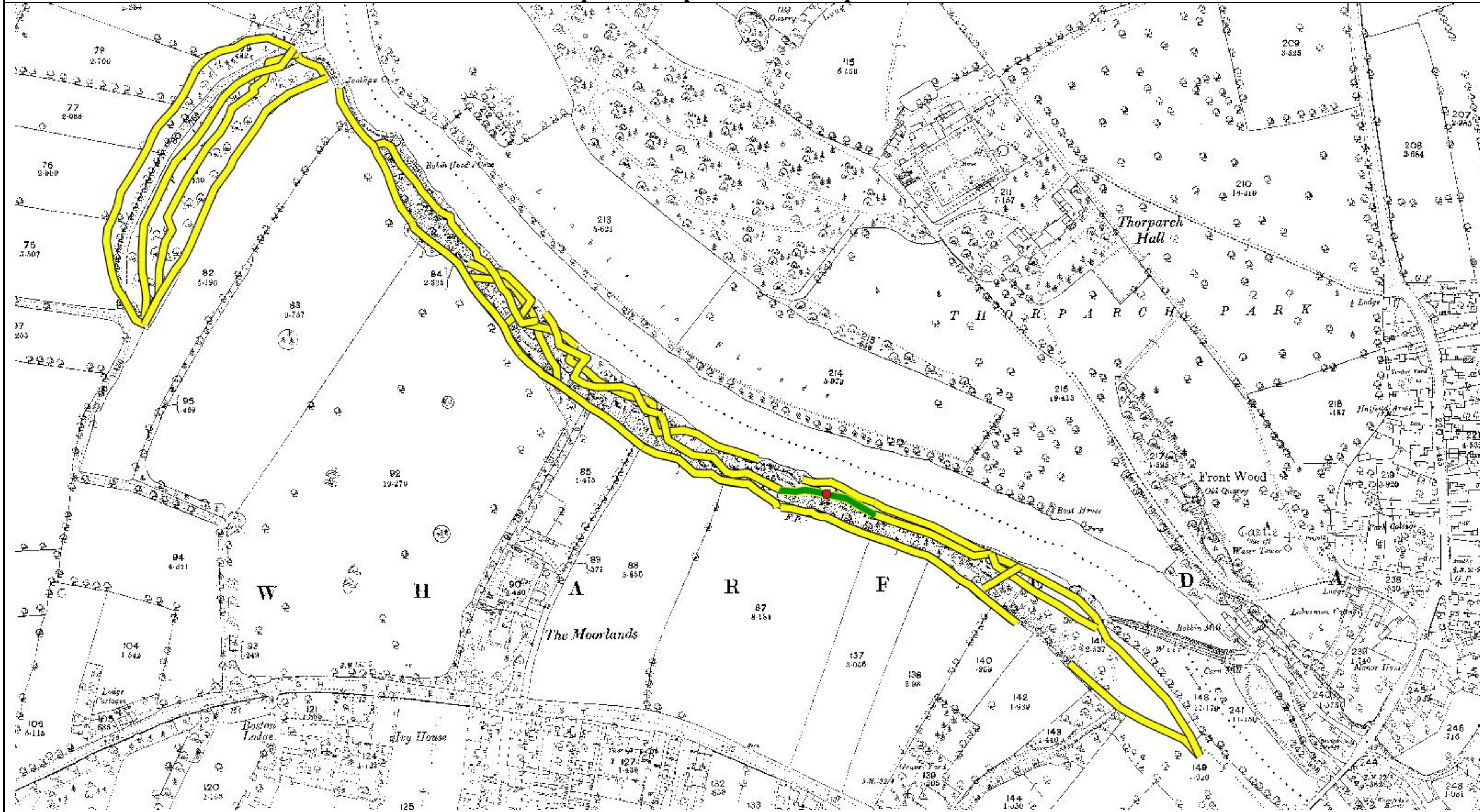


Figure 11.11 – *Carex digitata*

Species maps for Boston Spa Wood

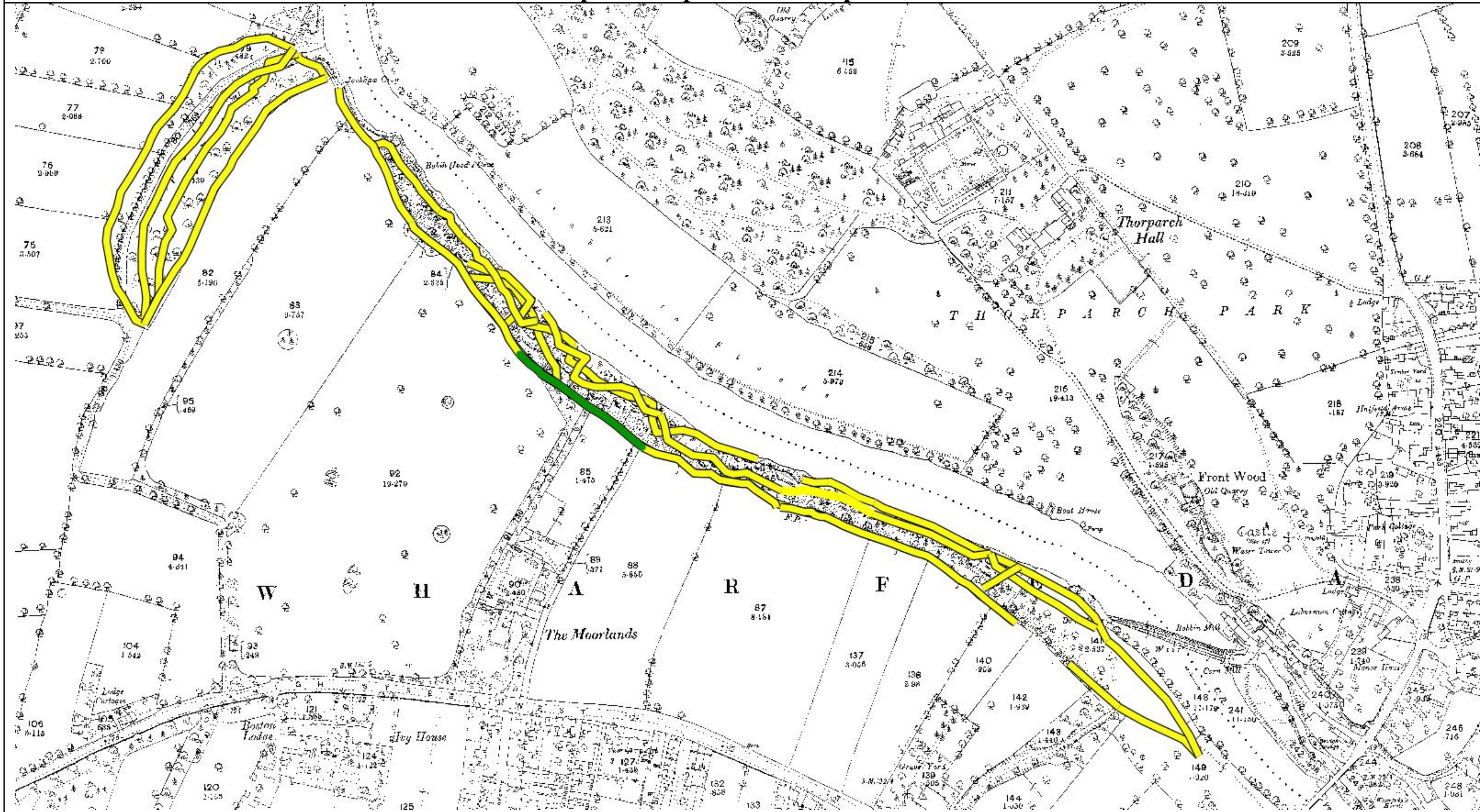


Figure 12.12 – *Carex sylvatica*

Species maps for Boston Spa Wood

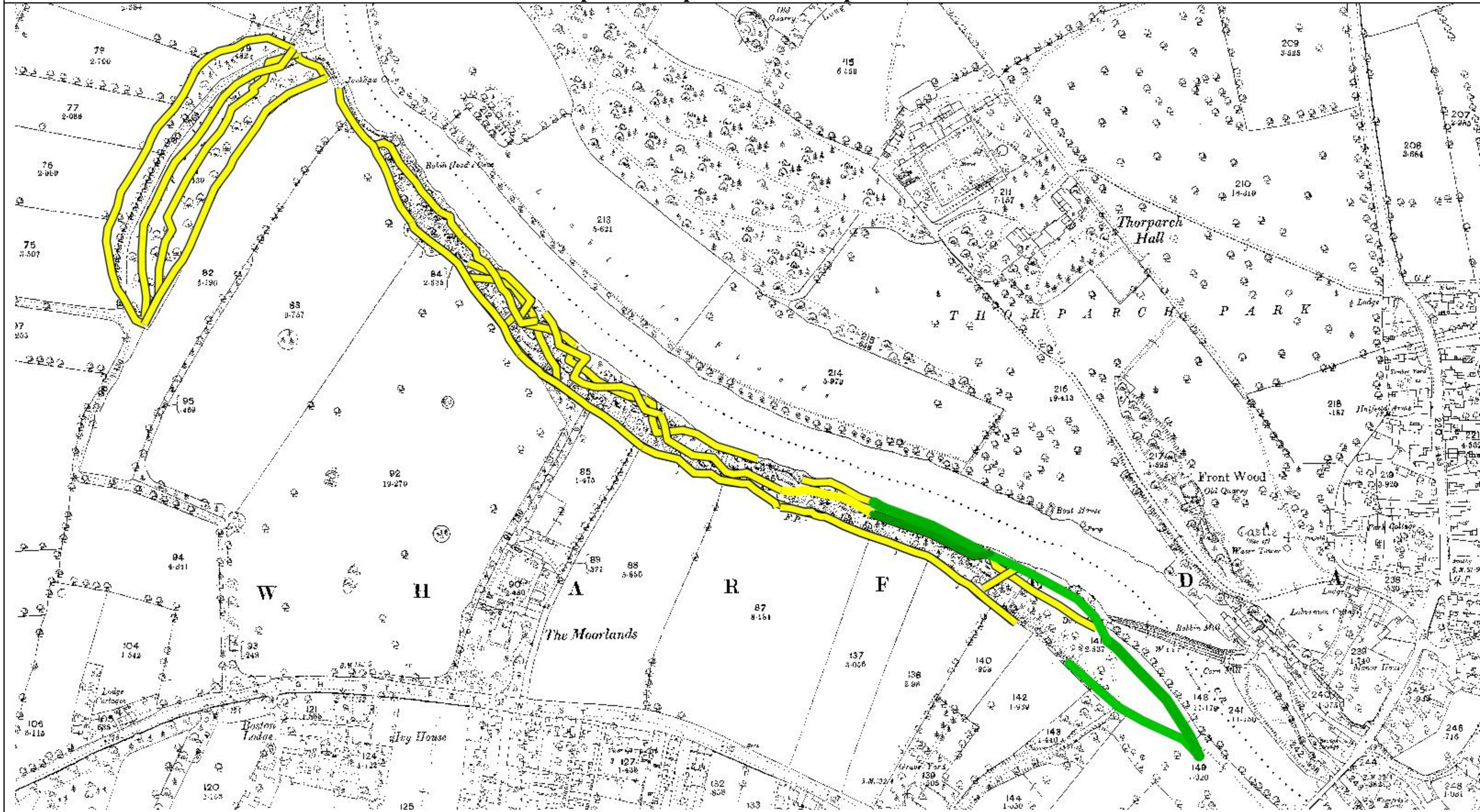


Figure 13.13 – *Circaea lutetiana*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

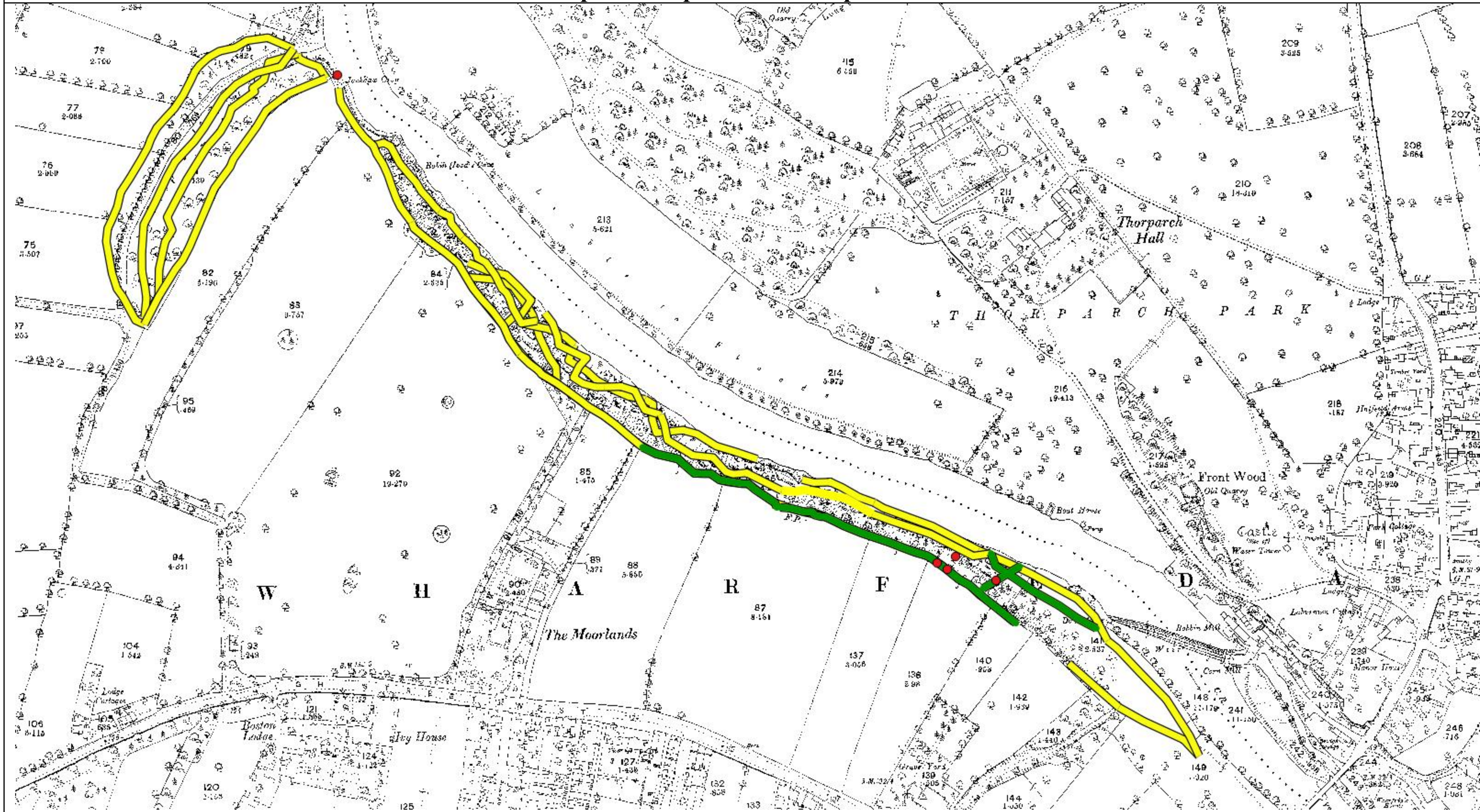


Figure 14.14 – *Convallaria majalis*

Species maps for Boston Spa Wood

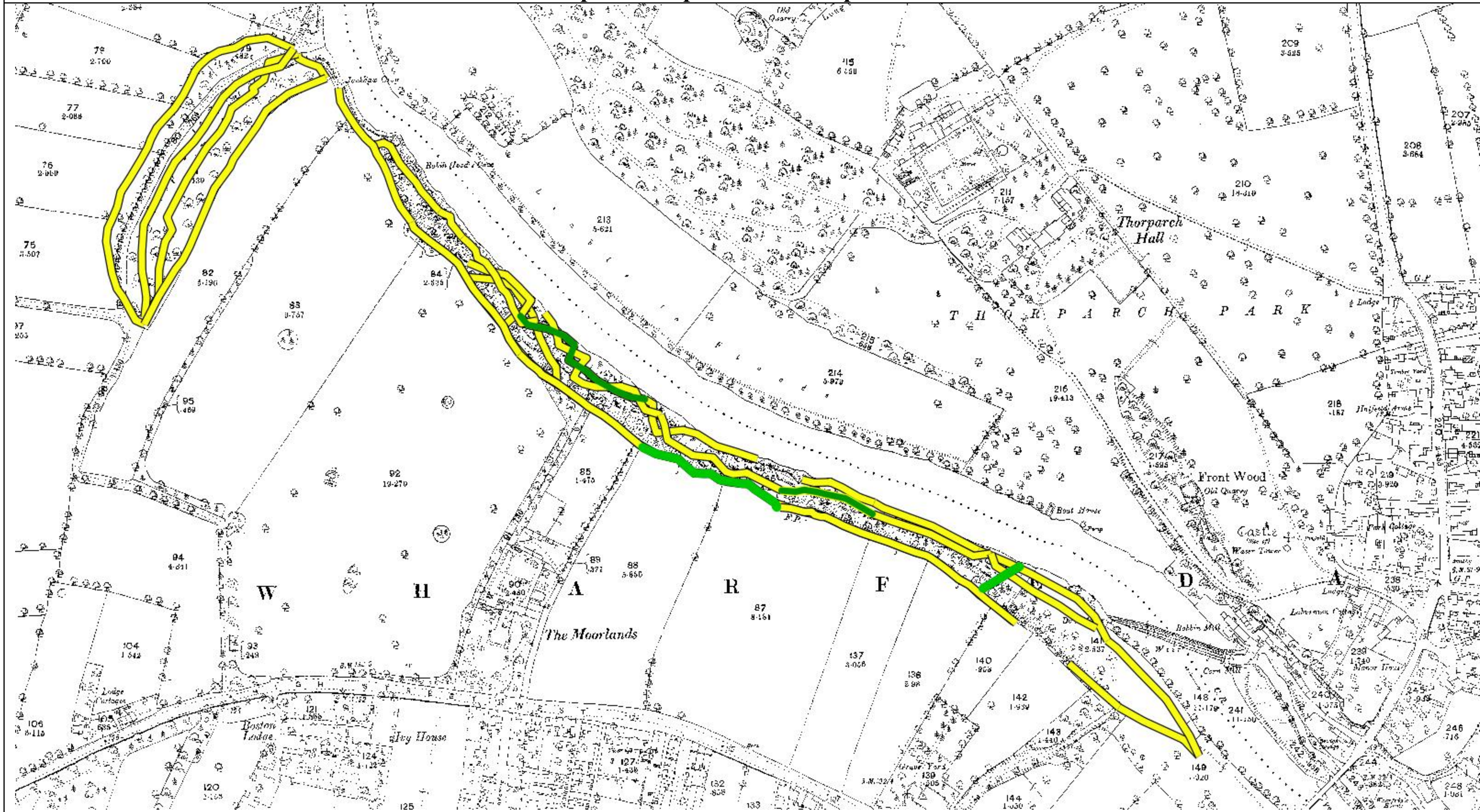


Figure 15.15 – *Corylus avellana*

Species maps for Boston Spa Wood

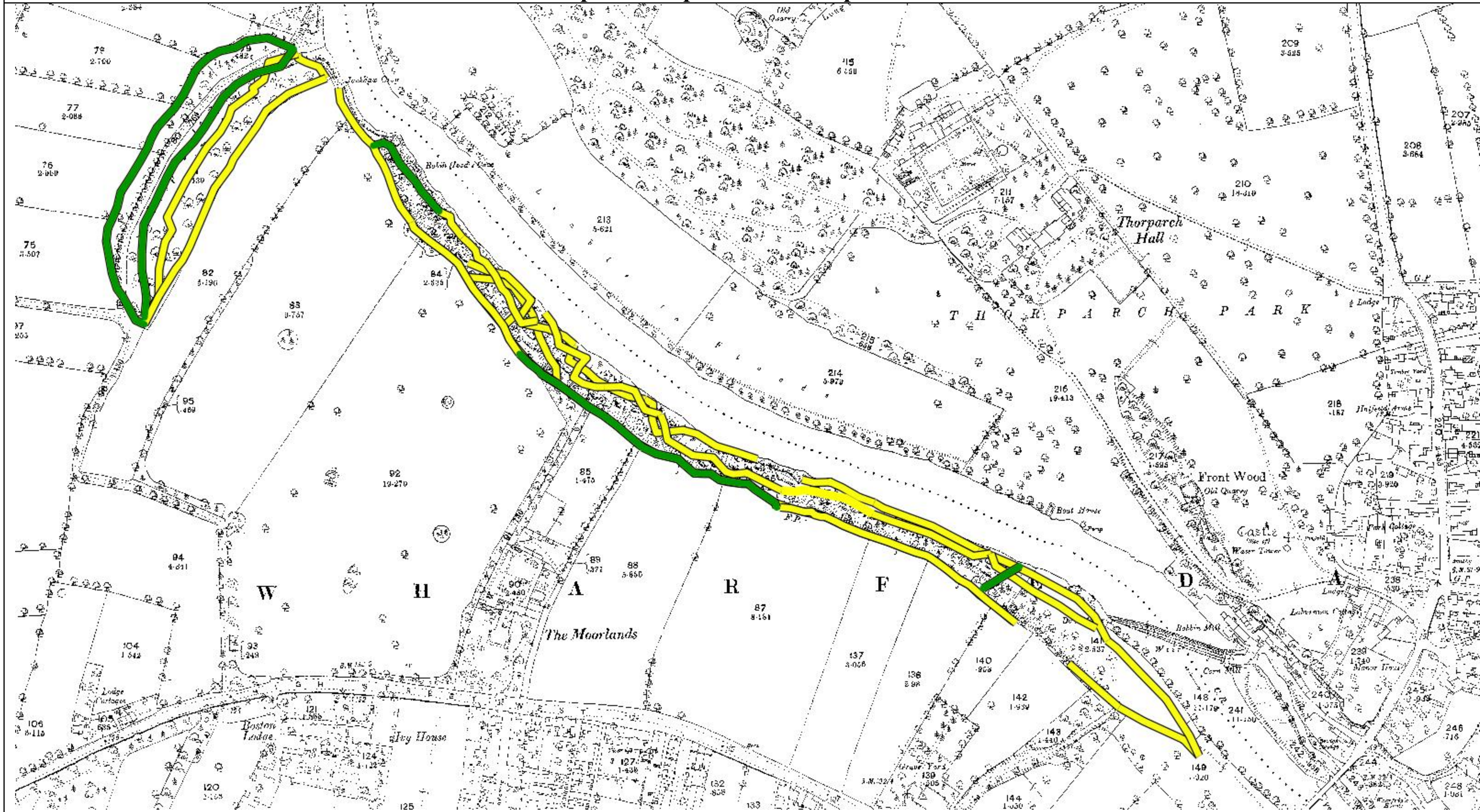


Figure 16.16 – *Cornus sanguinea*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

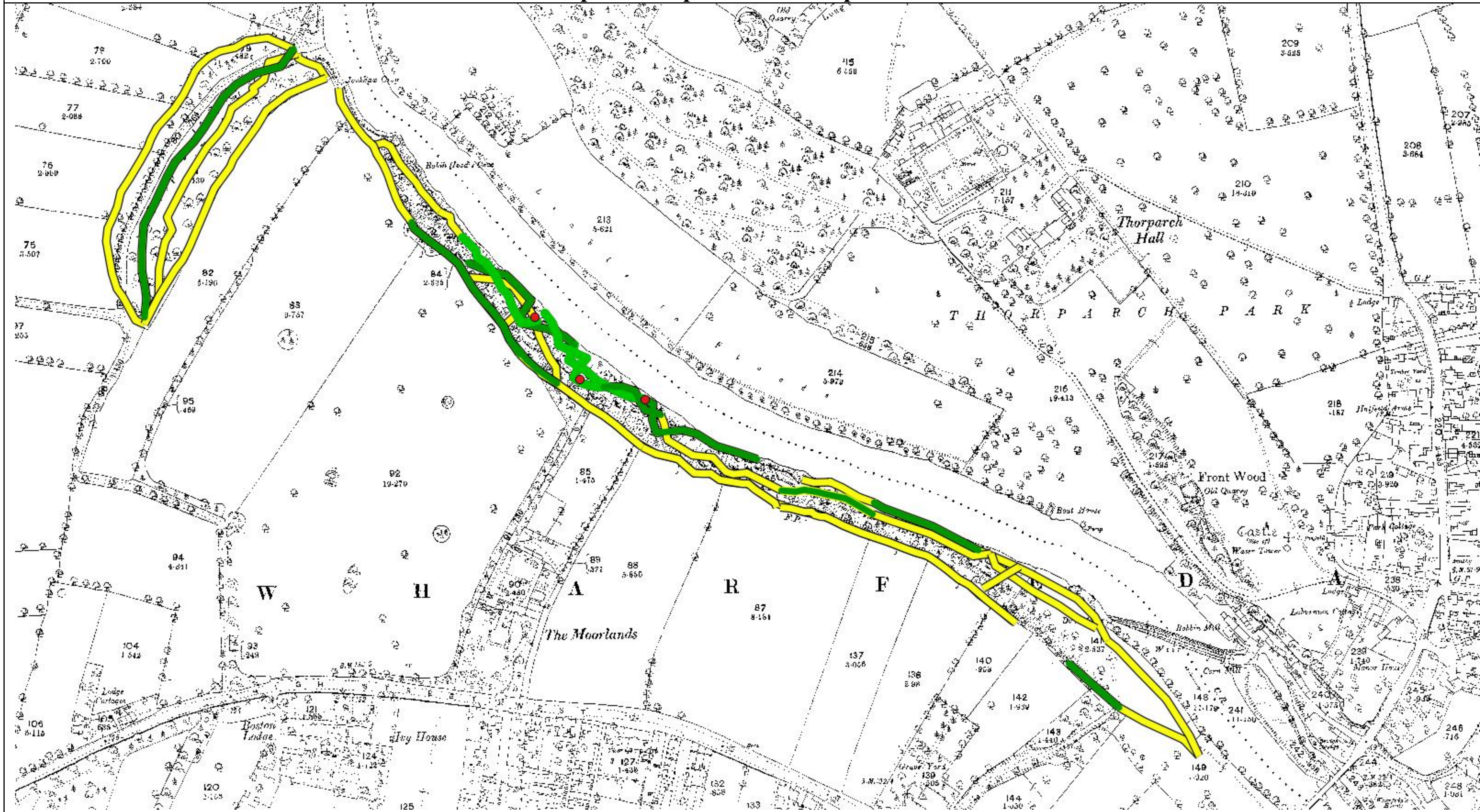


Figure 17.17 – *Dryopteris filix-mas*

Species maps for Boston Spa Wood

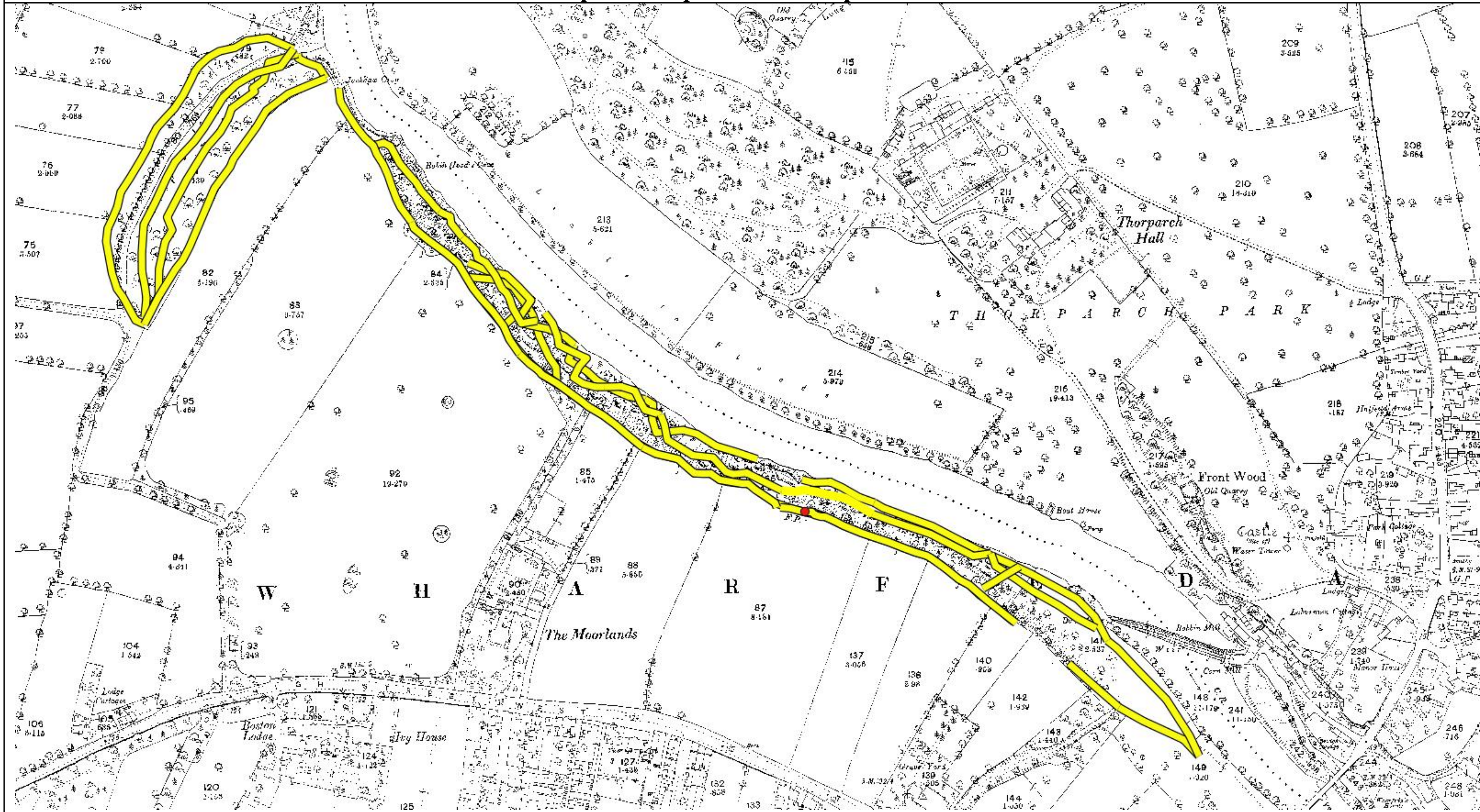


Figure 18.18 – *Euonymus europaeus*

Species maps for Boston Spa Wood

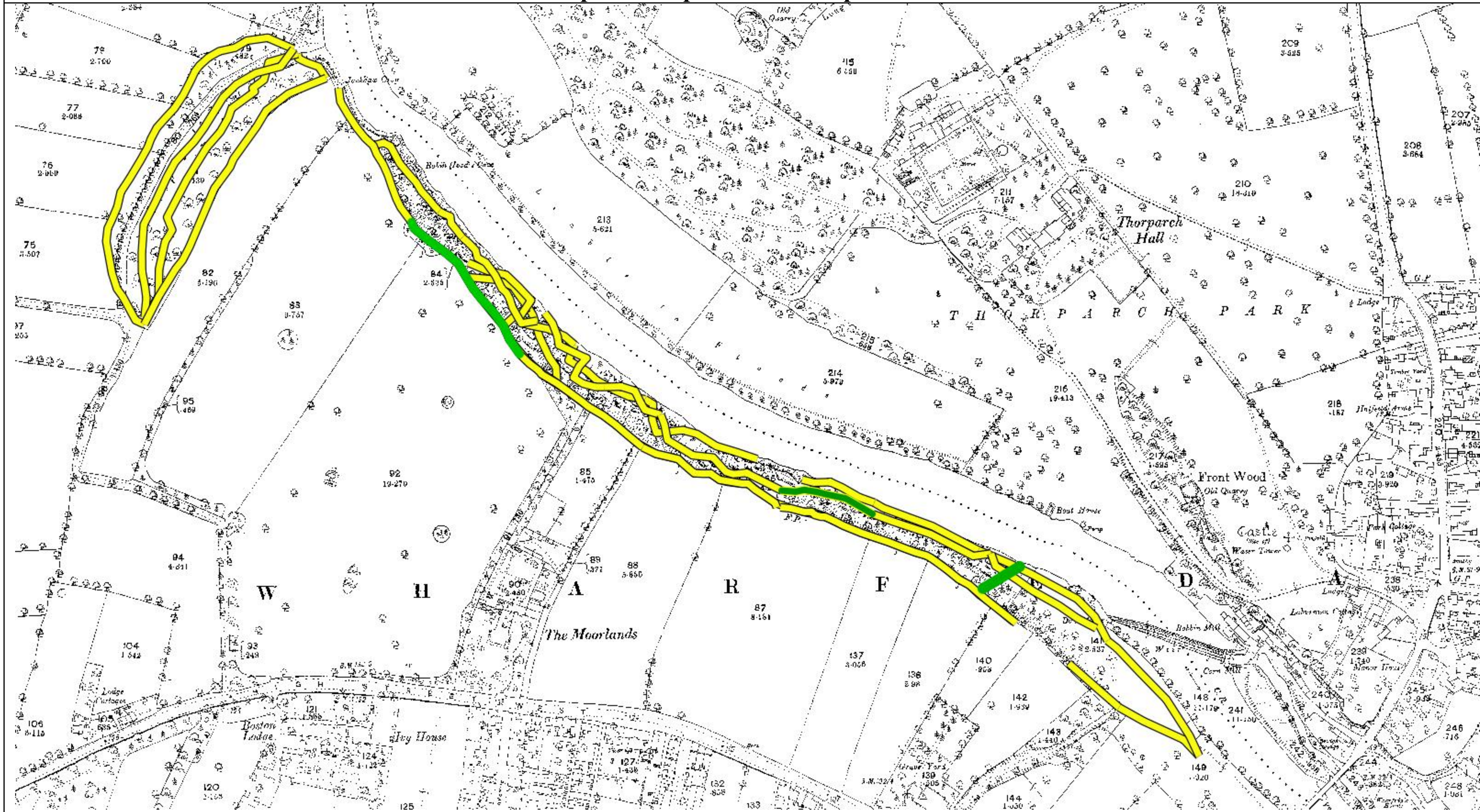


Figure 19.19 – *Geranium robertianum*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

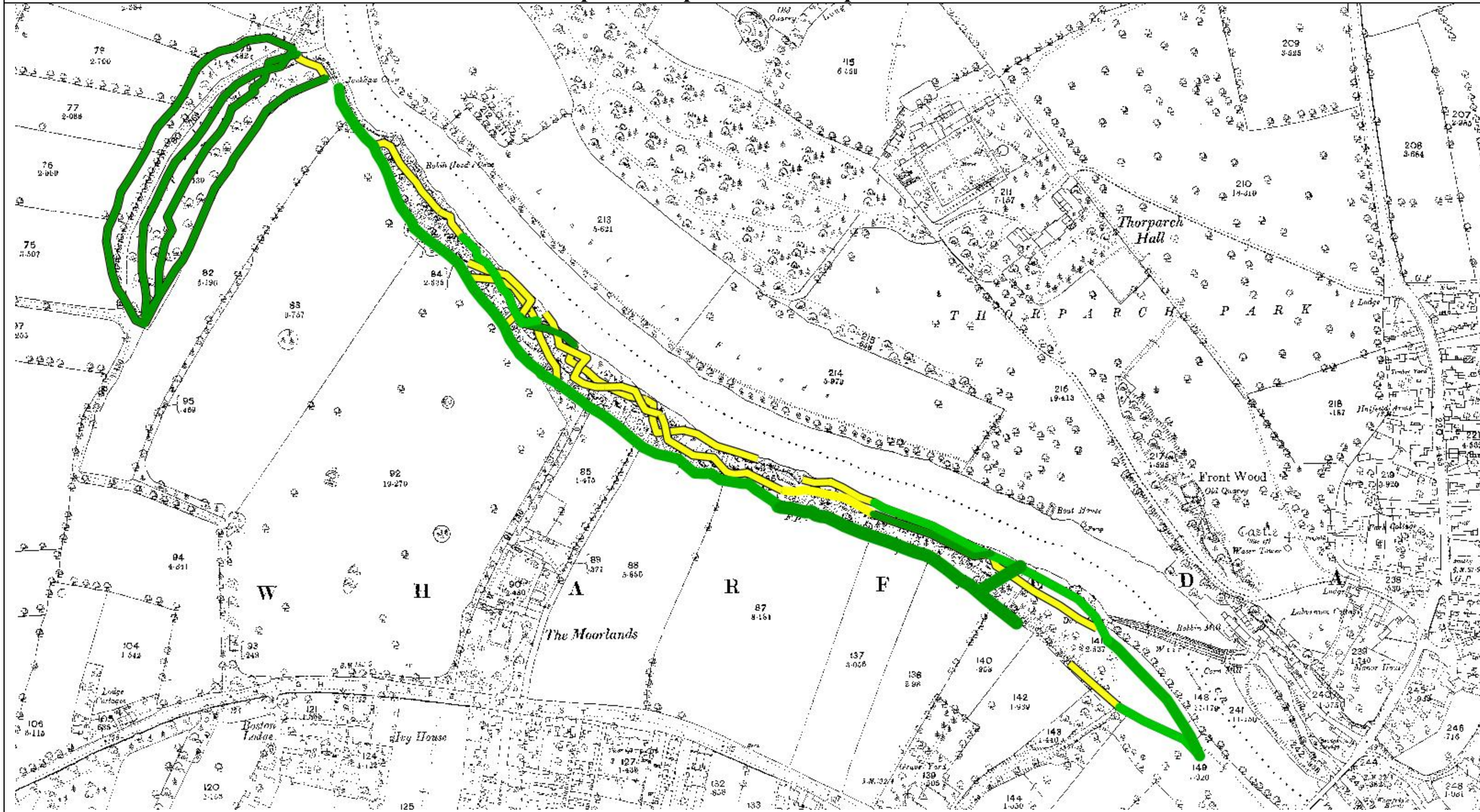


Figure 20.20 – *Geum urbanum*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

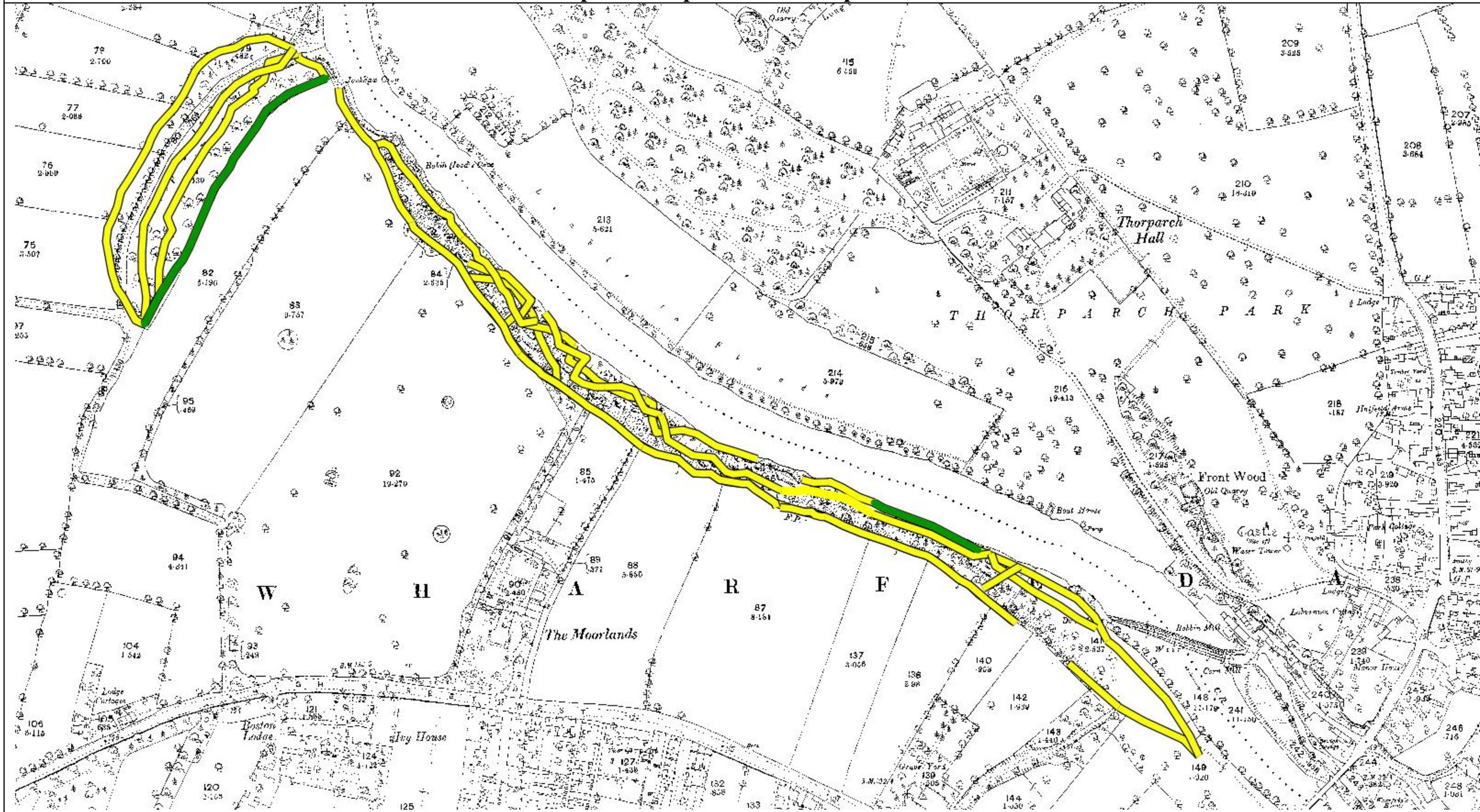


Figure 21.21 – *Glechoma hederacea*

Species maps for Boston Spa Wood

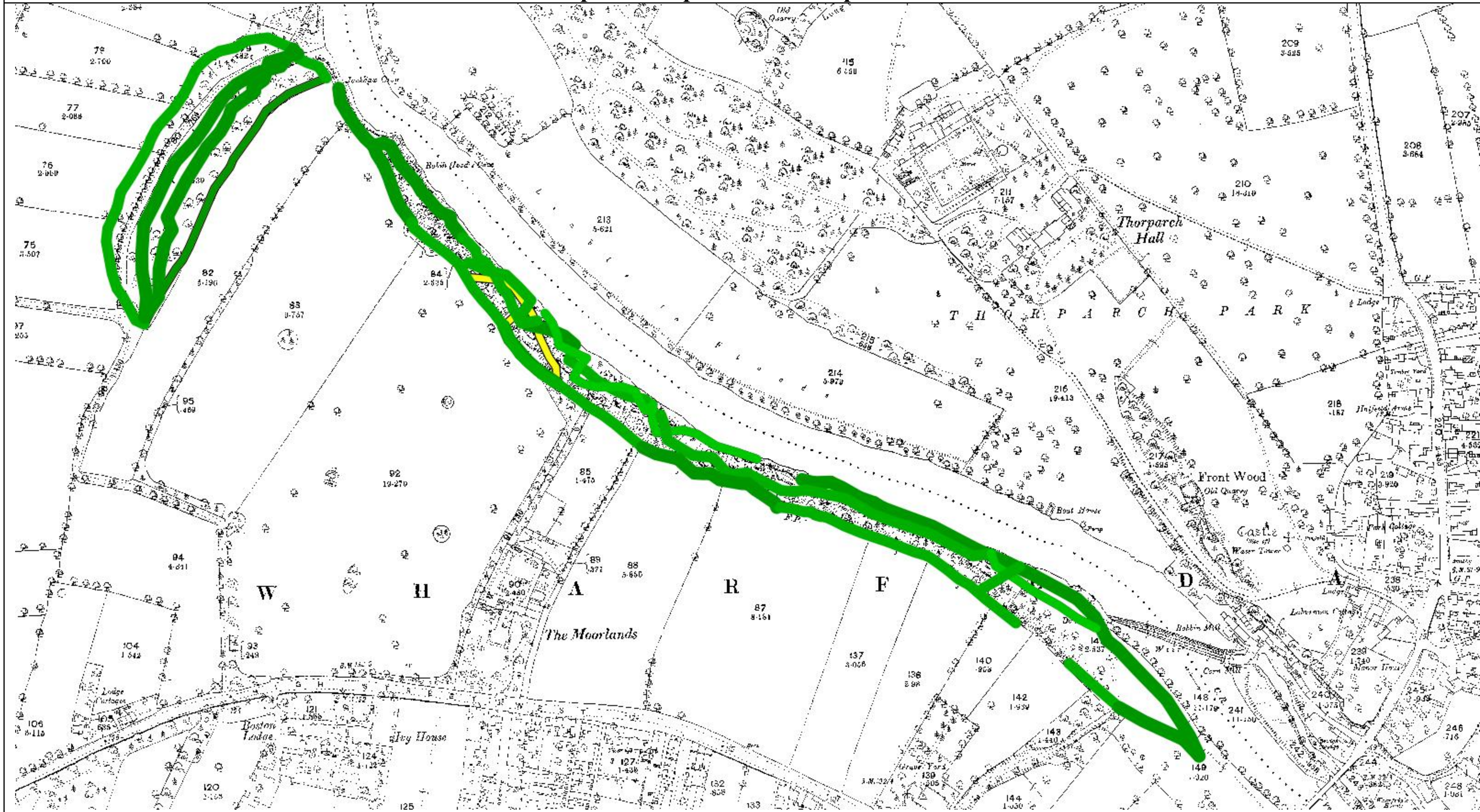


Figure 22.22 – *Hedera helix*

Species maps for Boston Spa Wood

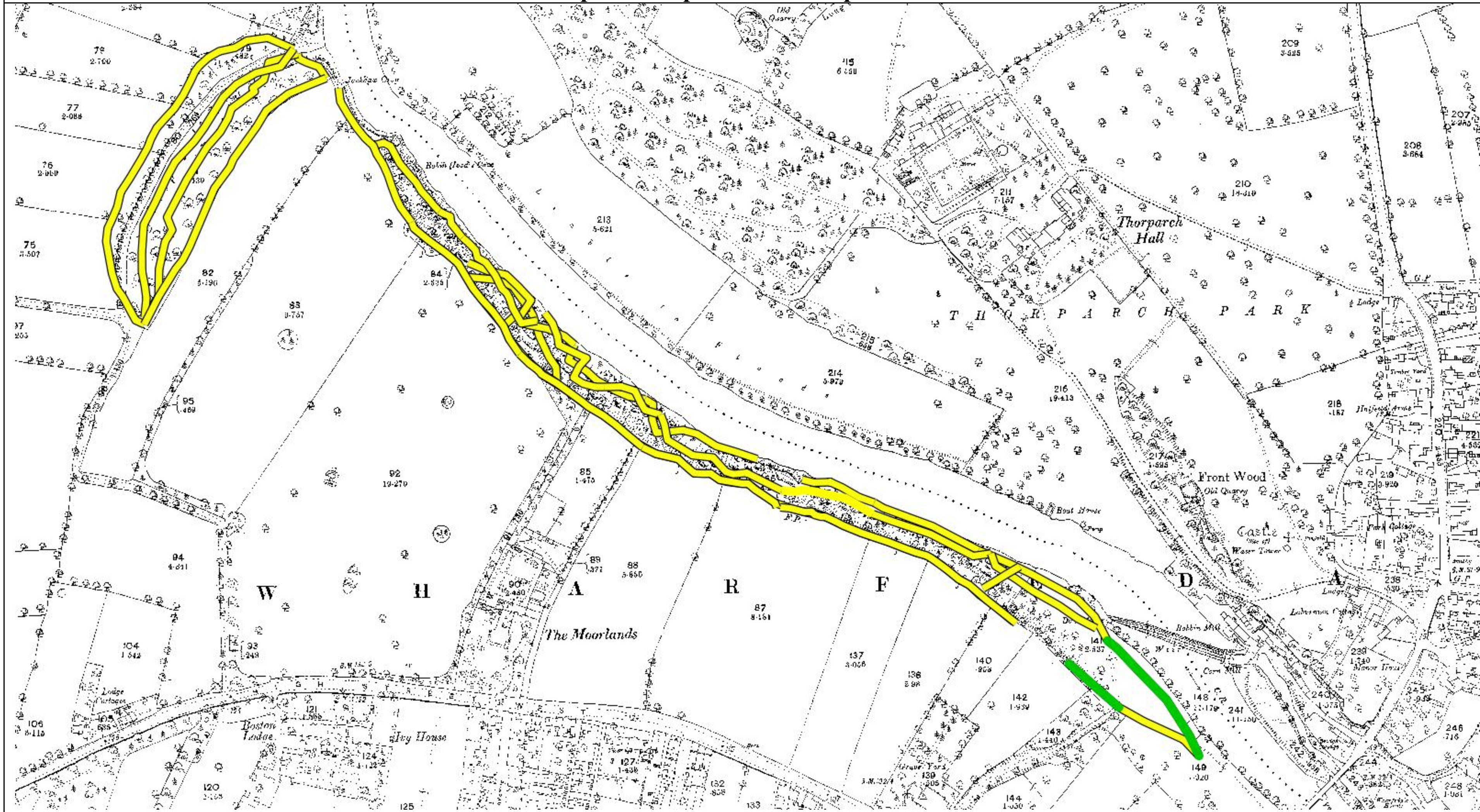


Figure 23.23 – *Holcus mollis*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

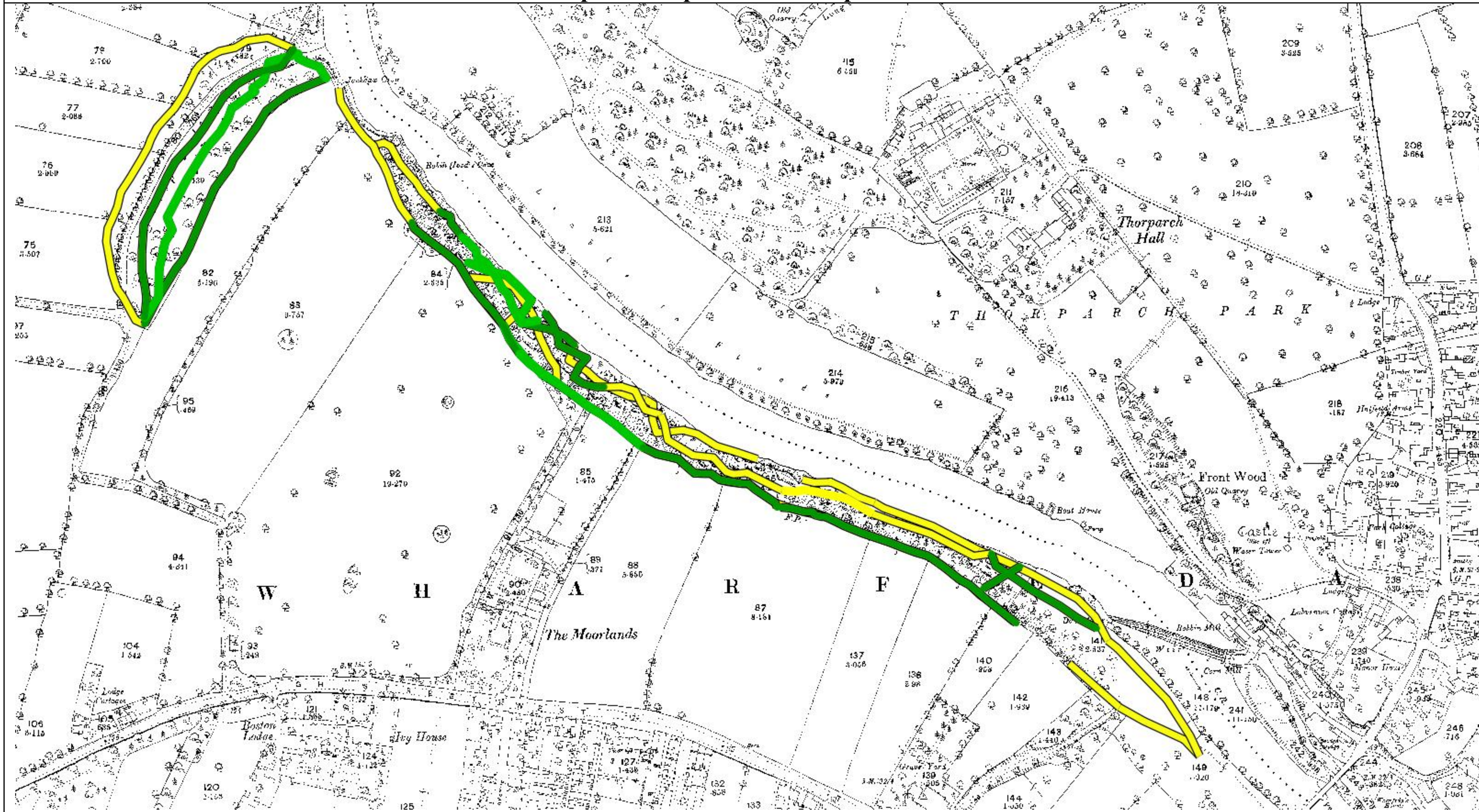


Figure 24.24 – *Hyacinthoides non-scripta*

Species maps for Boston Spa Wood

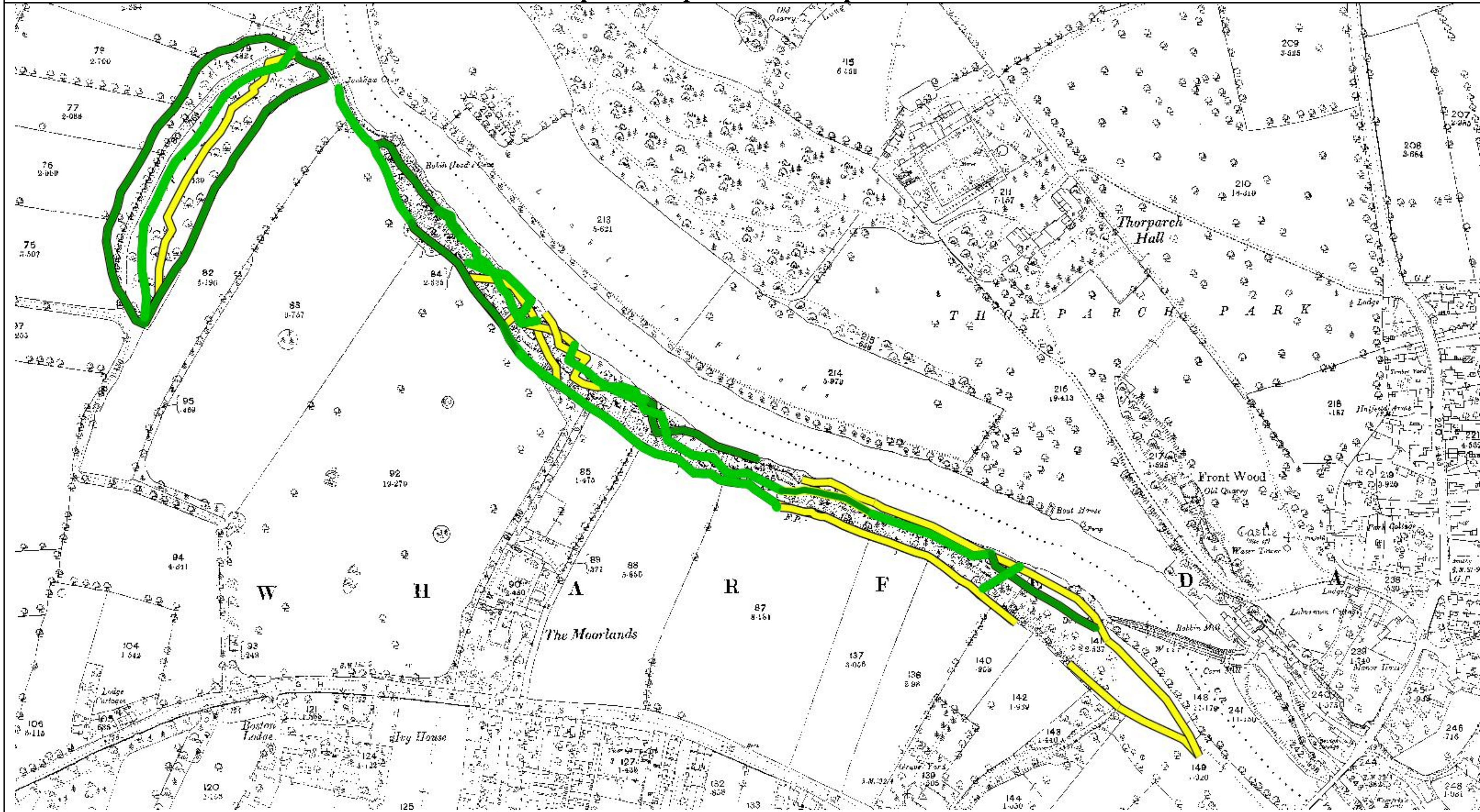


Figure 25.25 – *Ilex aquifolium*

Species maps for Boston Spa Wood

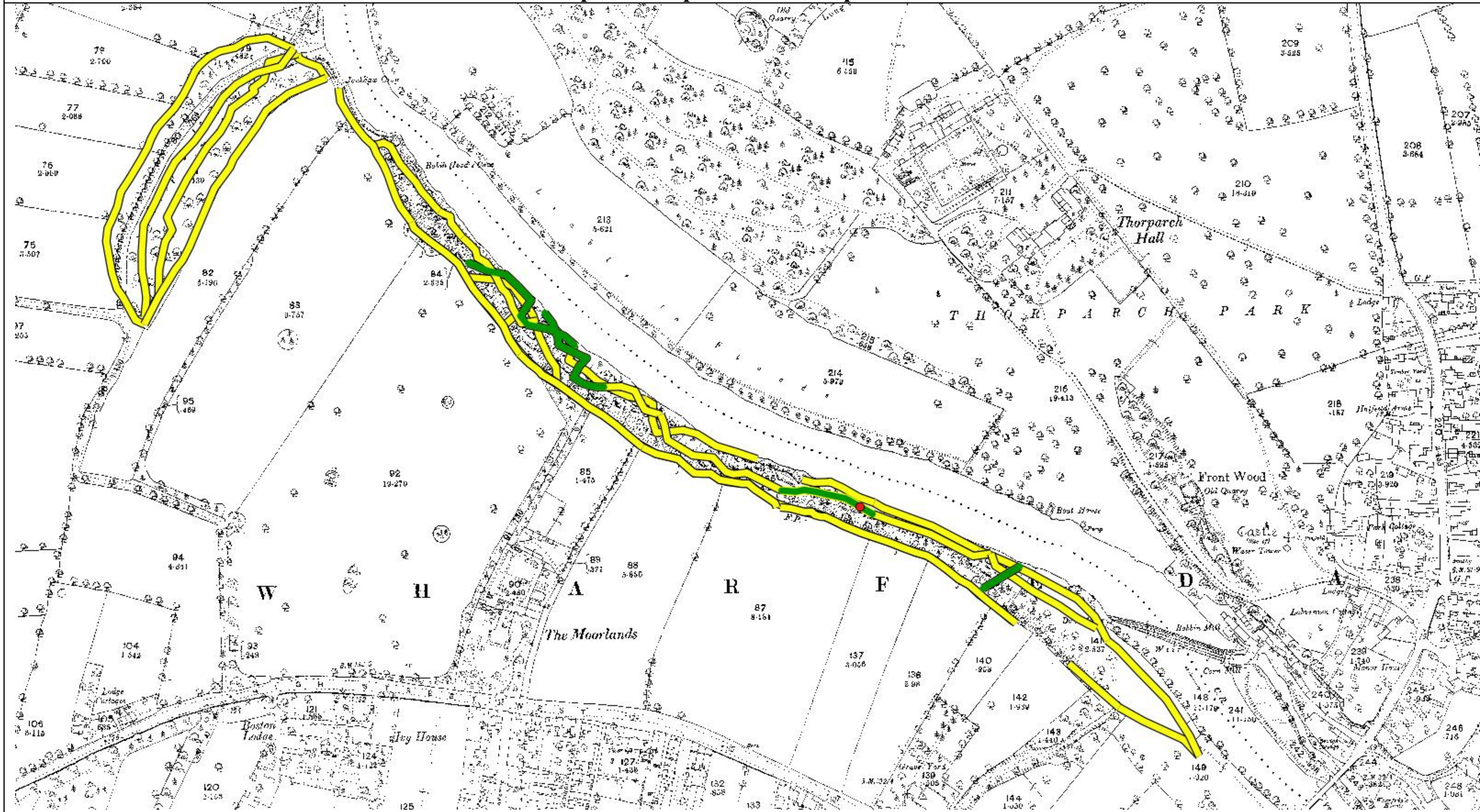


Figure 26.26 – *Lamiastrum galeobdolon*

Species maps for Boston Spa Wood

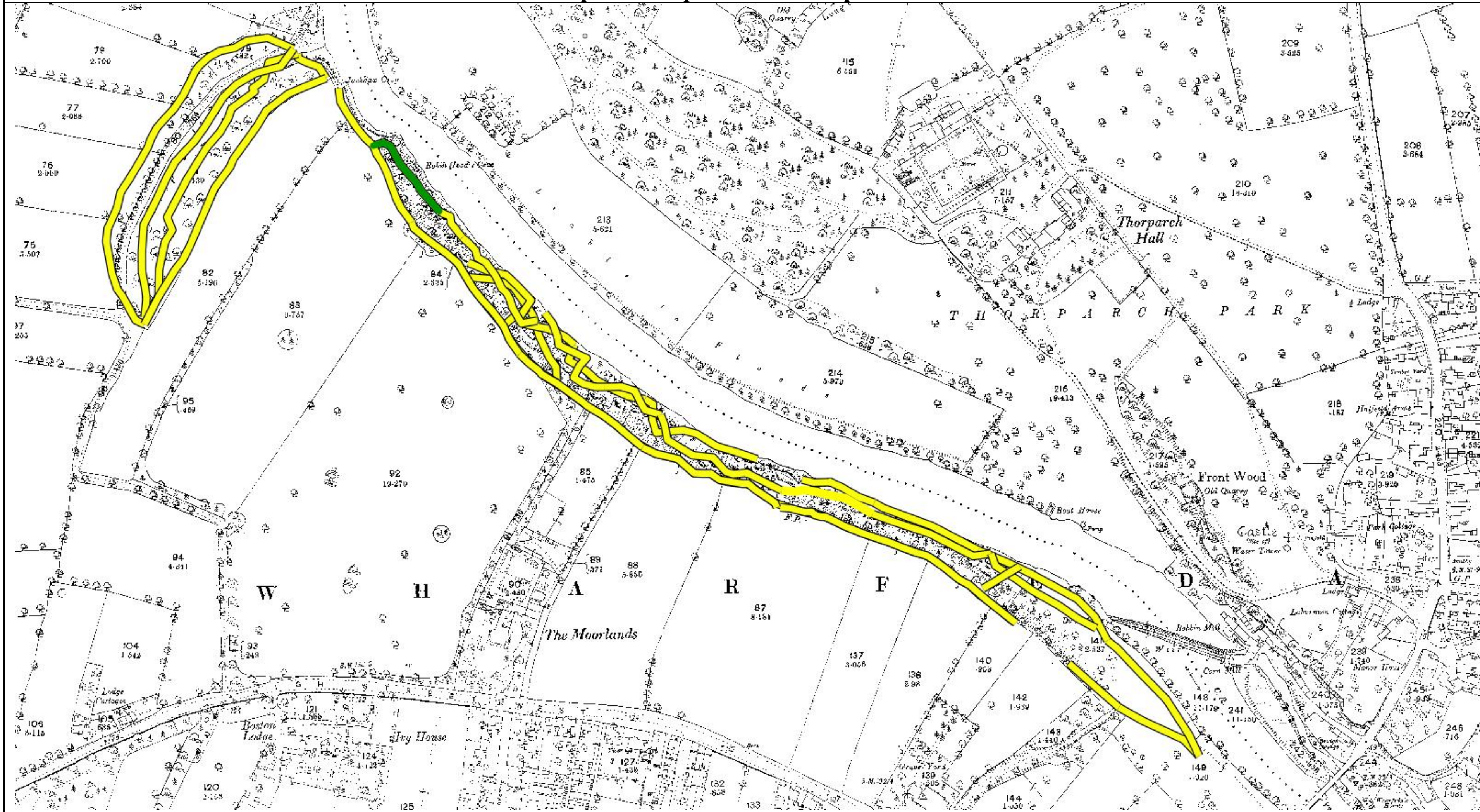


Figure 27.27 – *Lonicera periclymenum*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

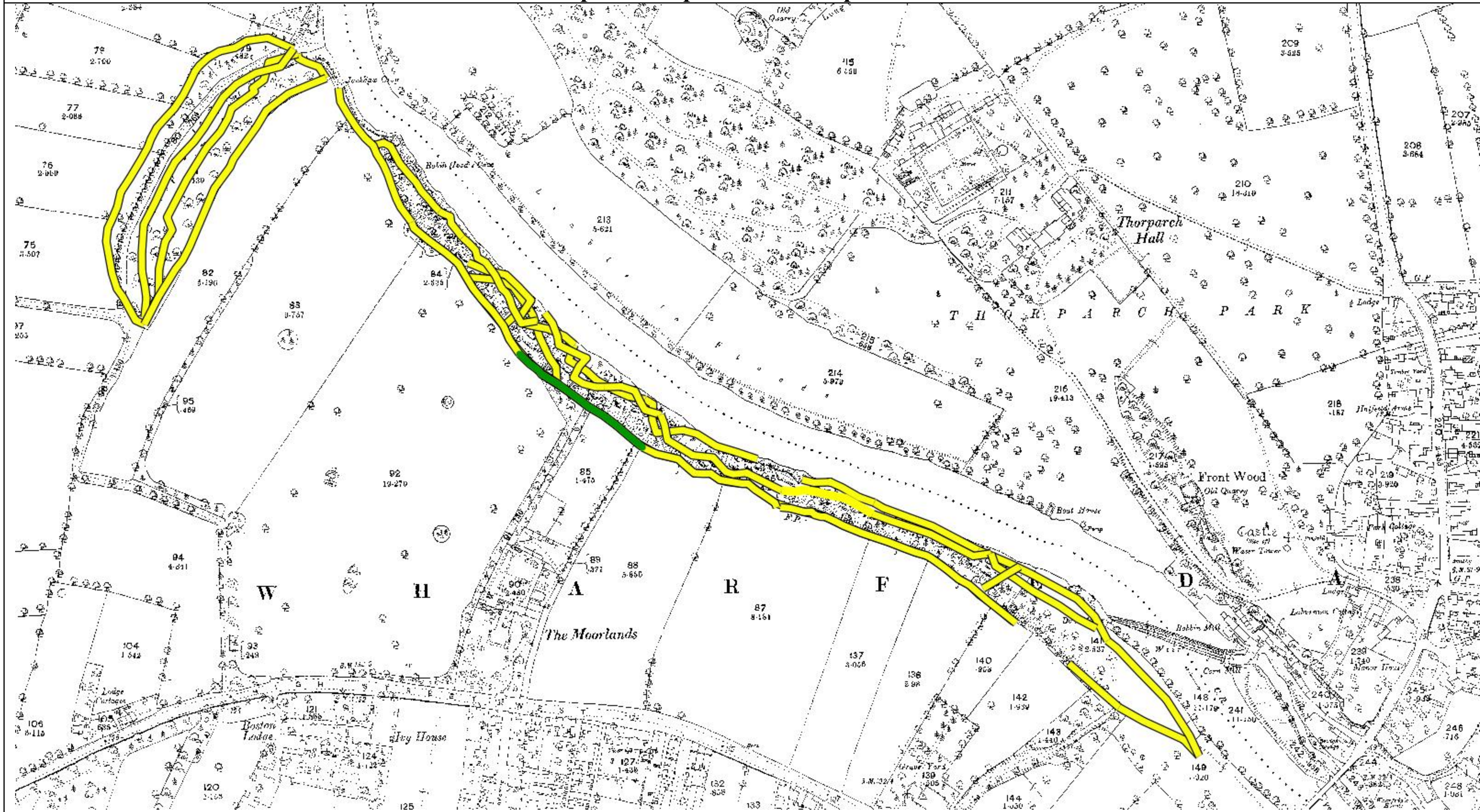


Figure 28.28 – *Malus sylvestris*

Species maps for Boston Spa Wood

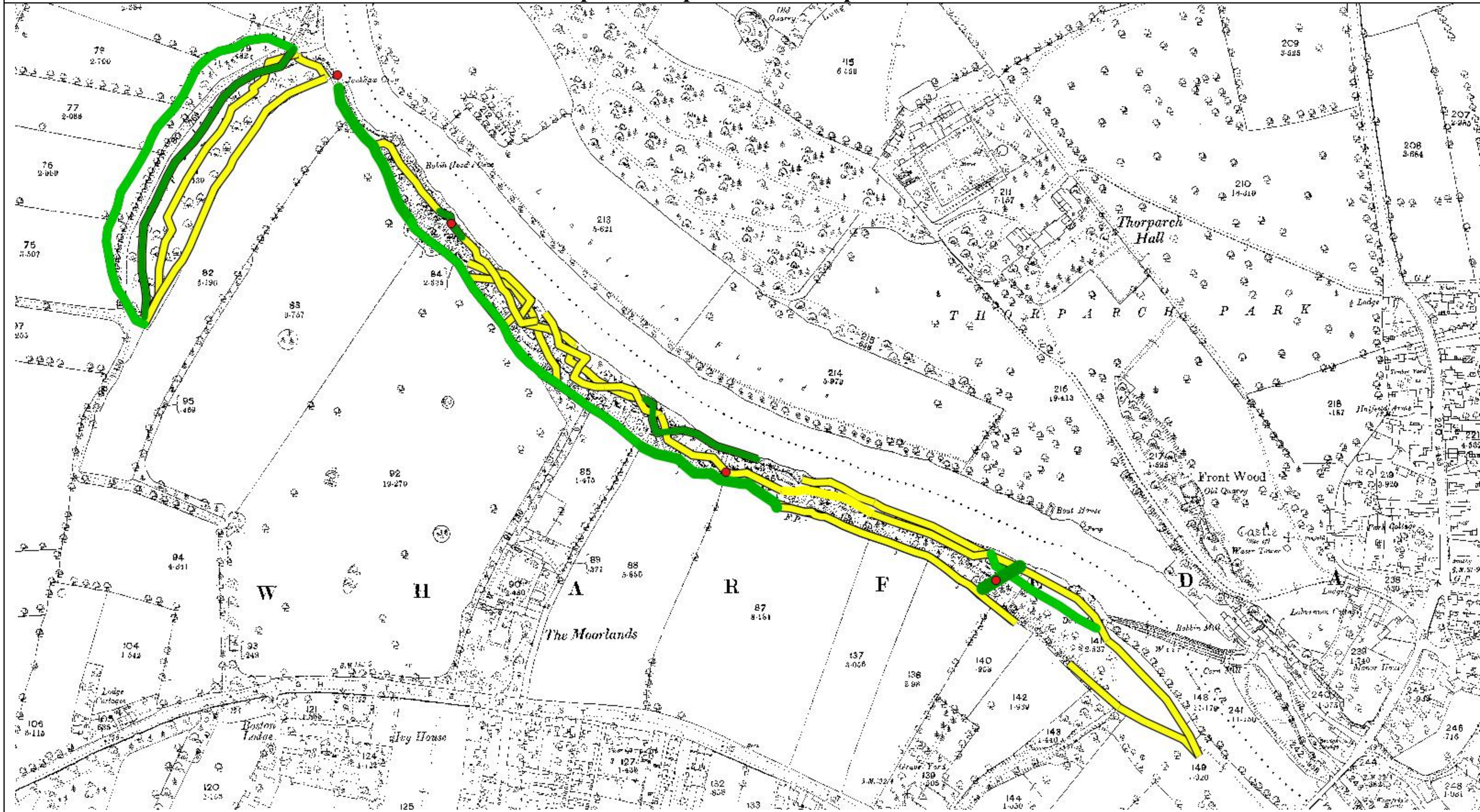


Figure 29.29– *Melica uniflora*

Species maps for Boston Spa Wood

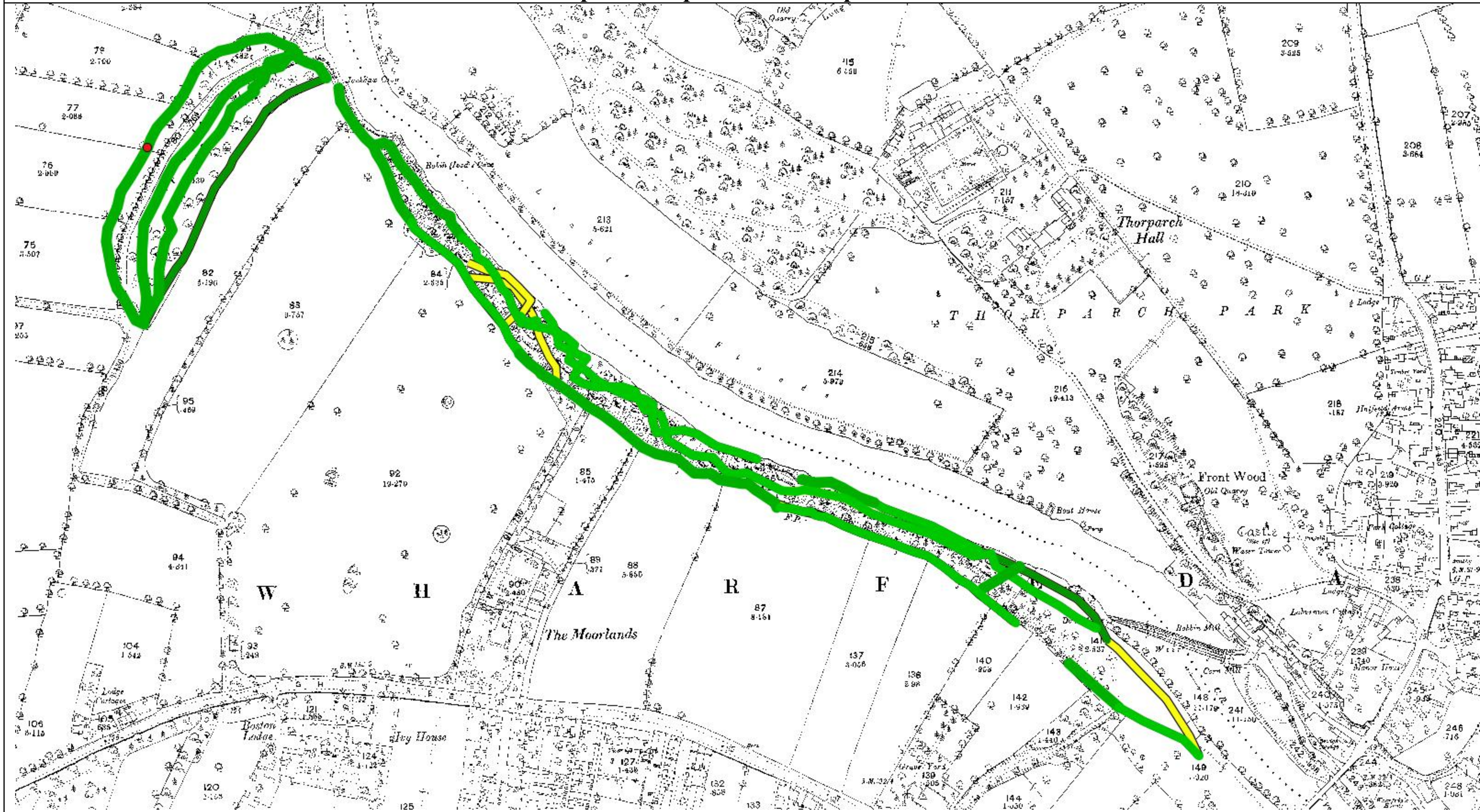


Figure 30.30– *Mercurialis perennis*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

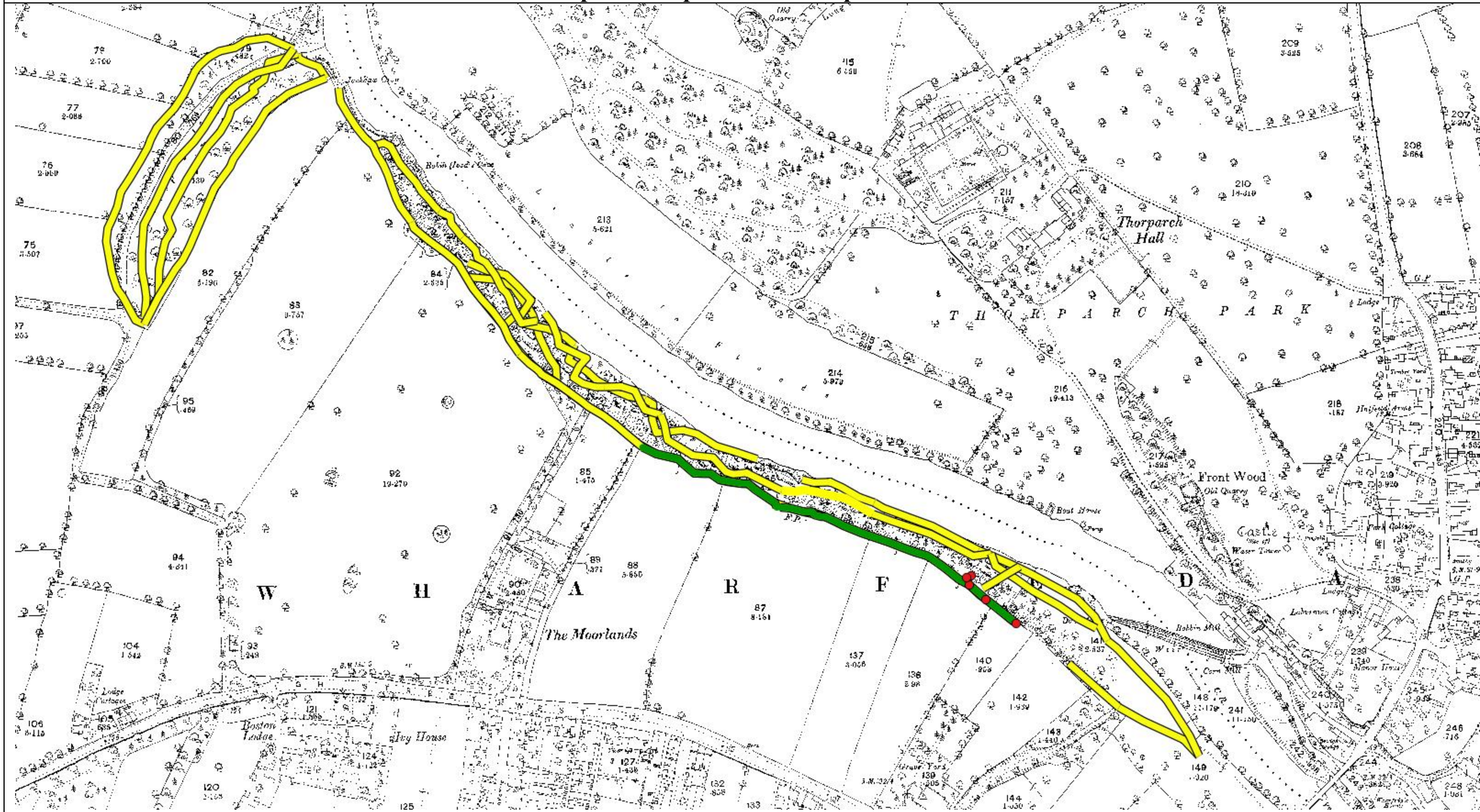


Figure 31.31 – *Neottia nidus-avis*

Species maps for Boston Spa Wood

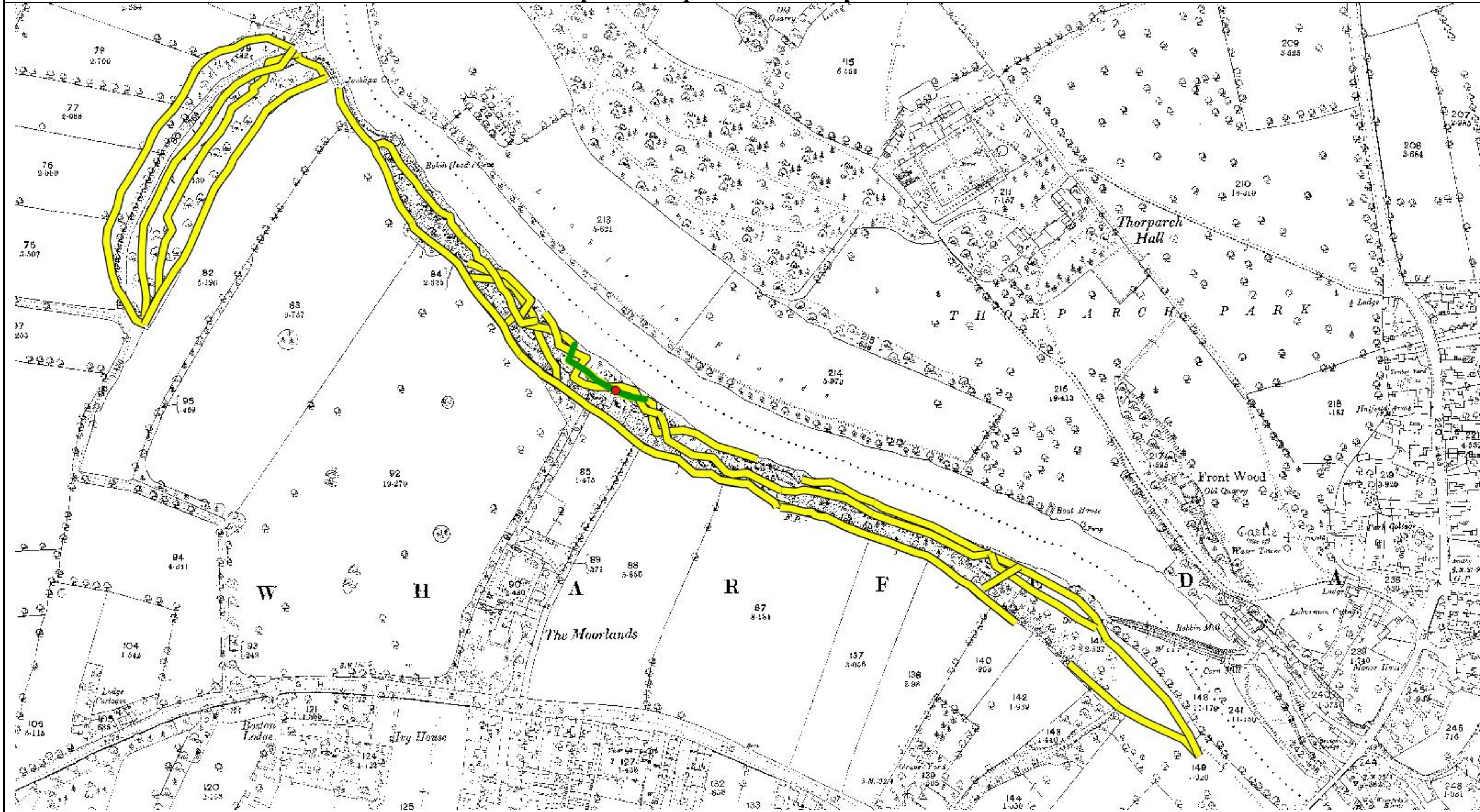


Figure 32.32 – *Oxalis acetosa*

Species maps for Boston Spa Wood

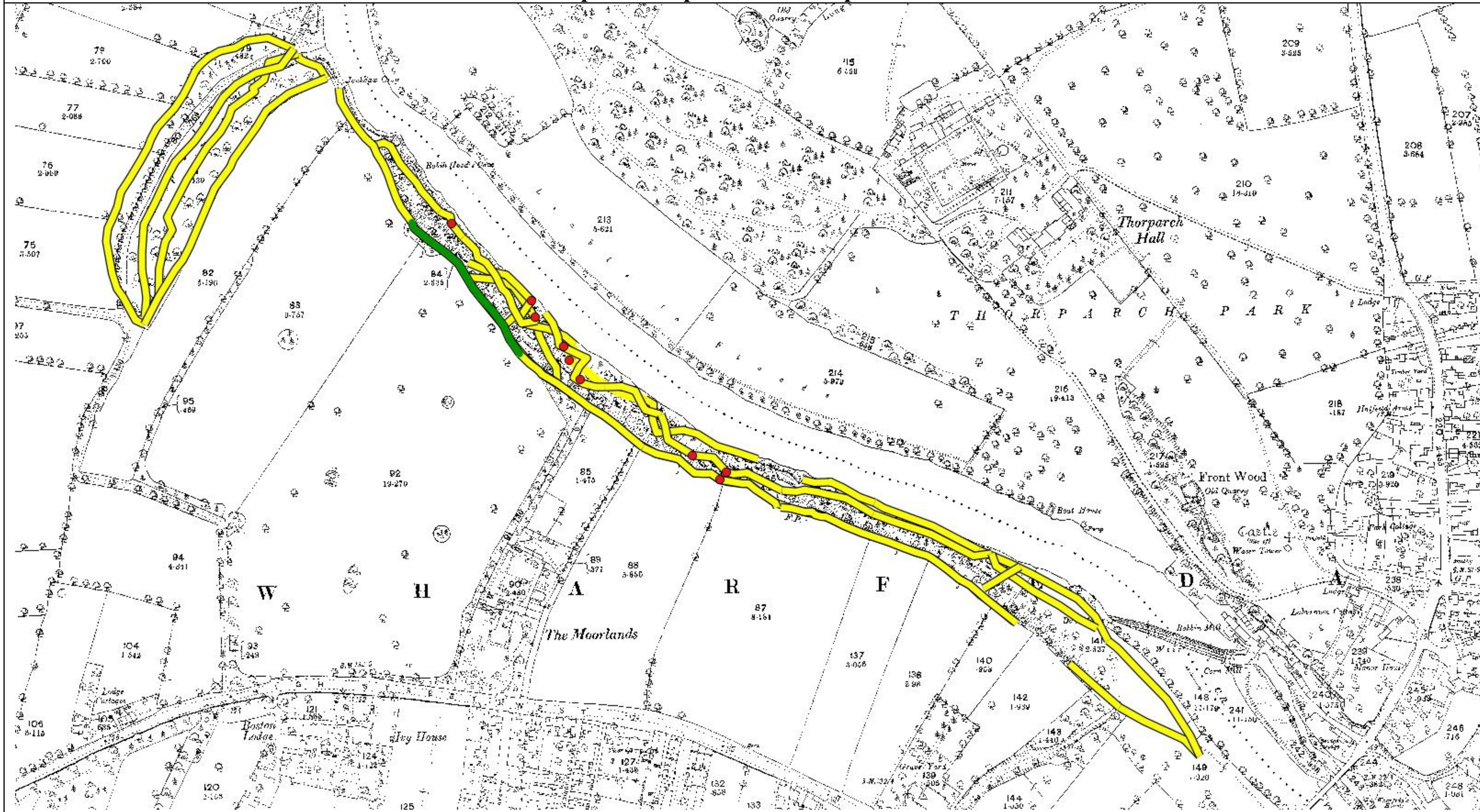


Figure 33.33 – *Phyllitis scolopendrium*

Species maps for Boston Spa Wood

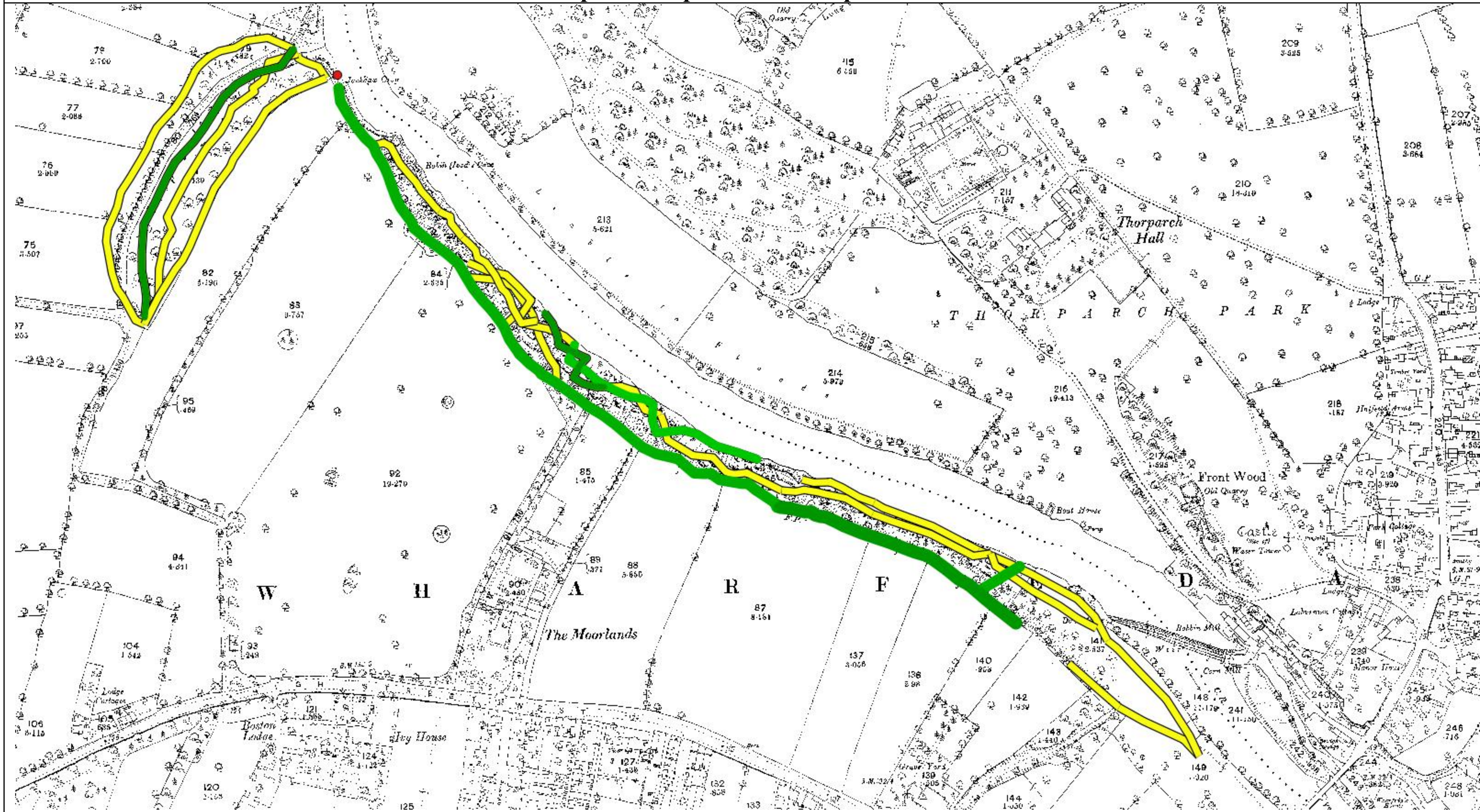


Figure 34.34 – *Poa nemoralis*

Species maps for Boston Spa Wood

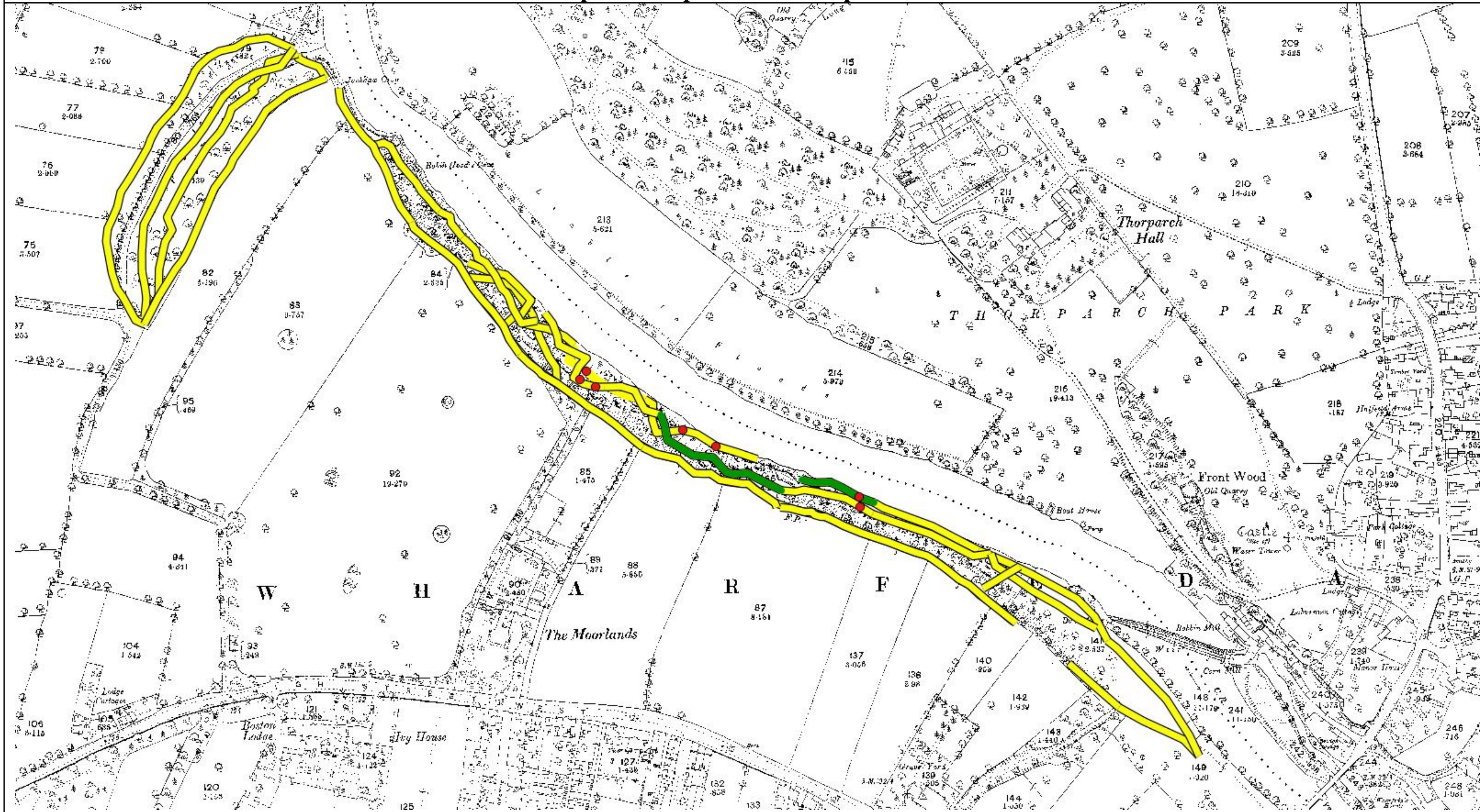


Figure 35.35 – *Polystichum aculeatum*

Species maps for Boston Spa Wood

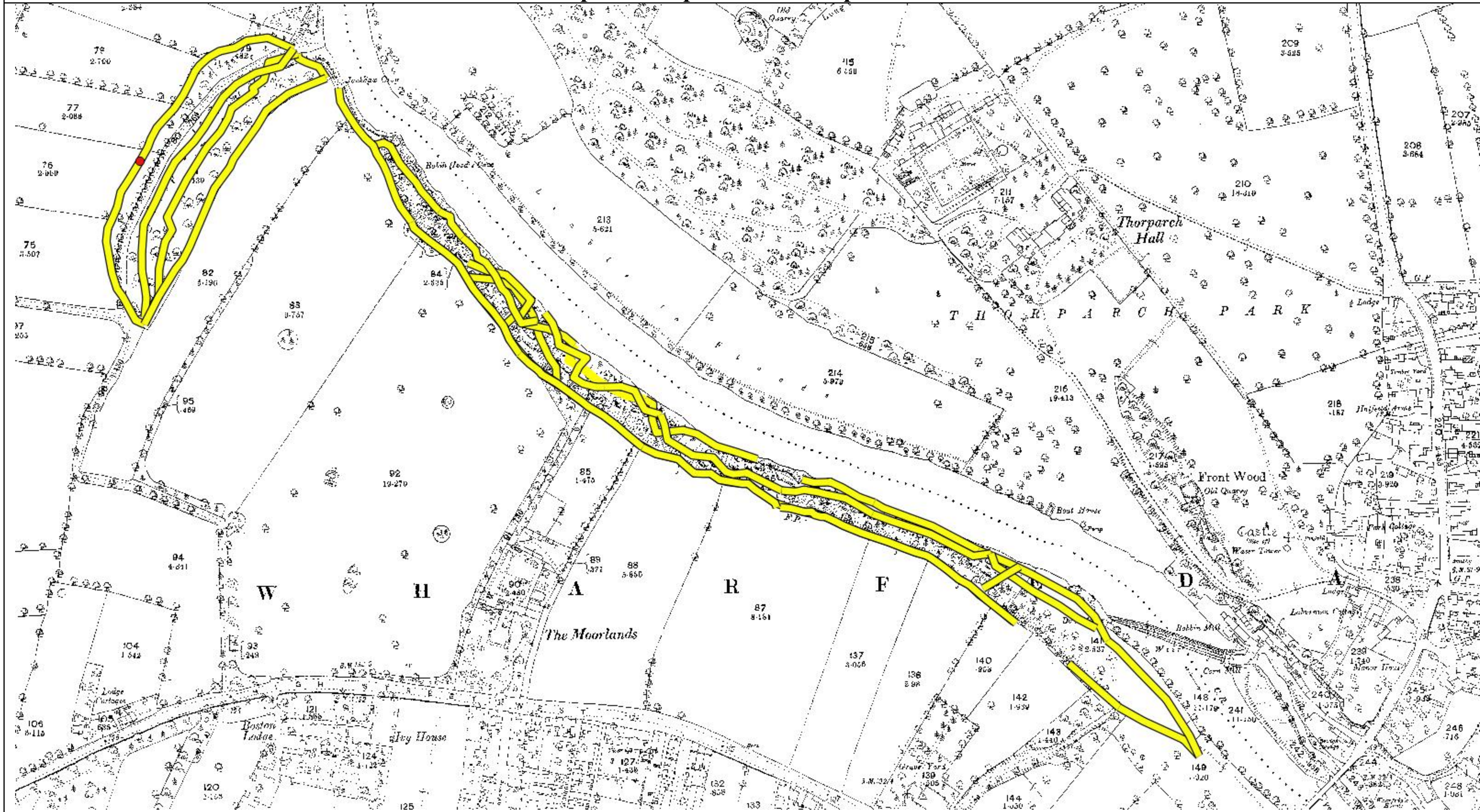


Figure 36.36 – *Primula vulgaris*

Species maps for Boston Spa Wood

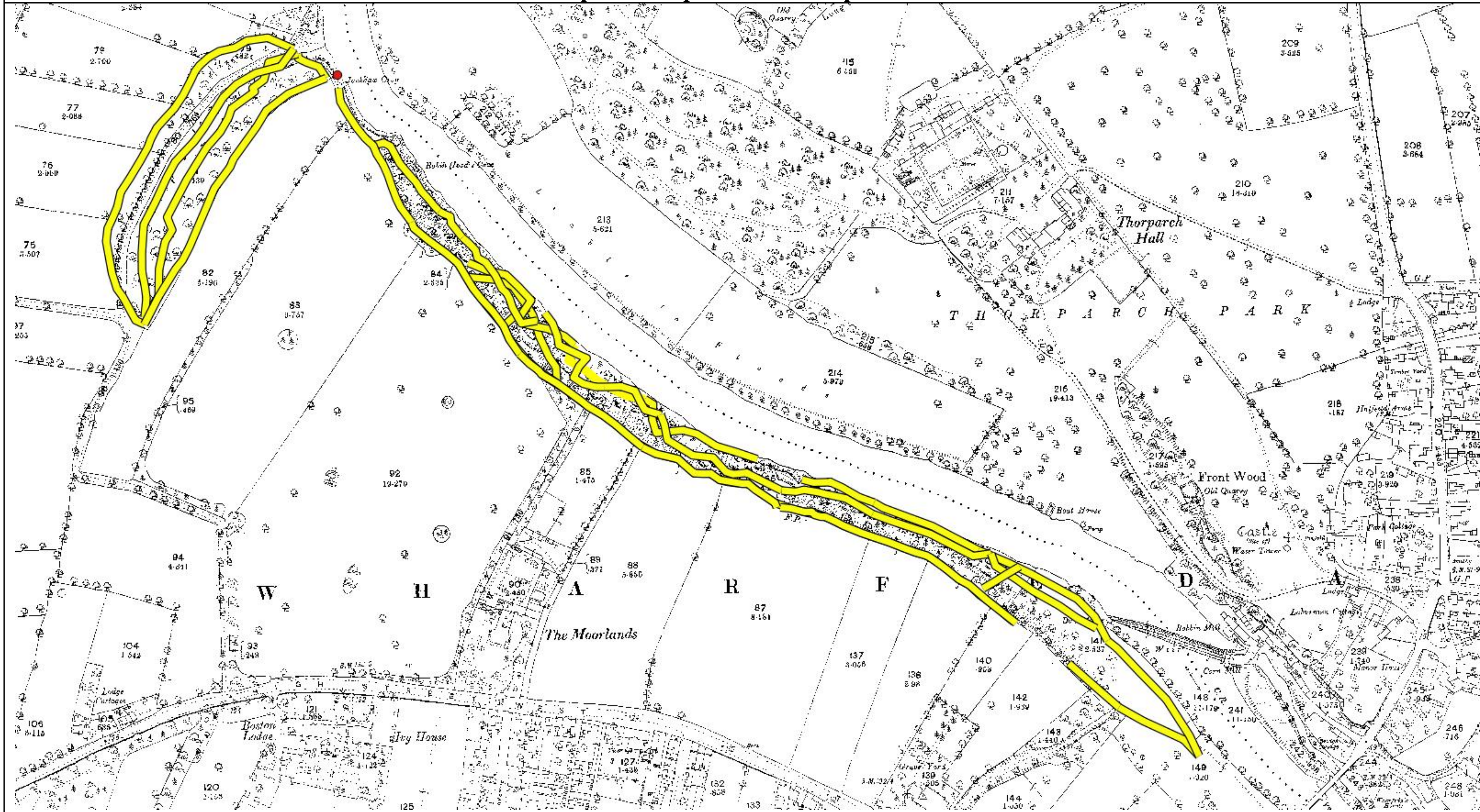


Figure 37.37 – *Ranunculus auricomis*

Species maps for Boston Spa Wood

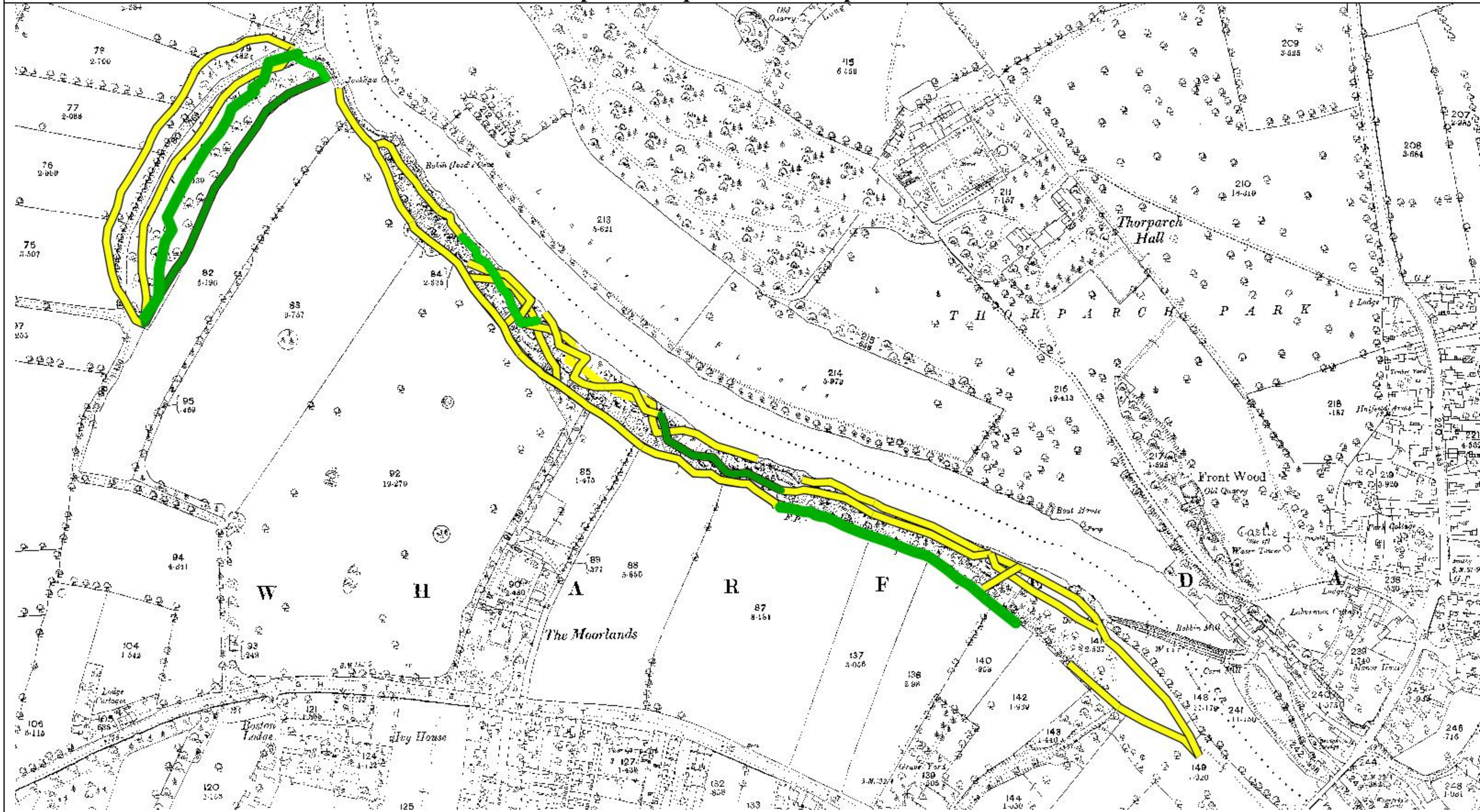


Figure 38.38 – *Ranunculus ficaria*

Species maps for Boston Spa Wood

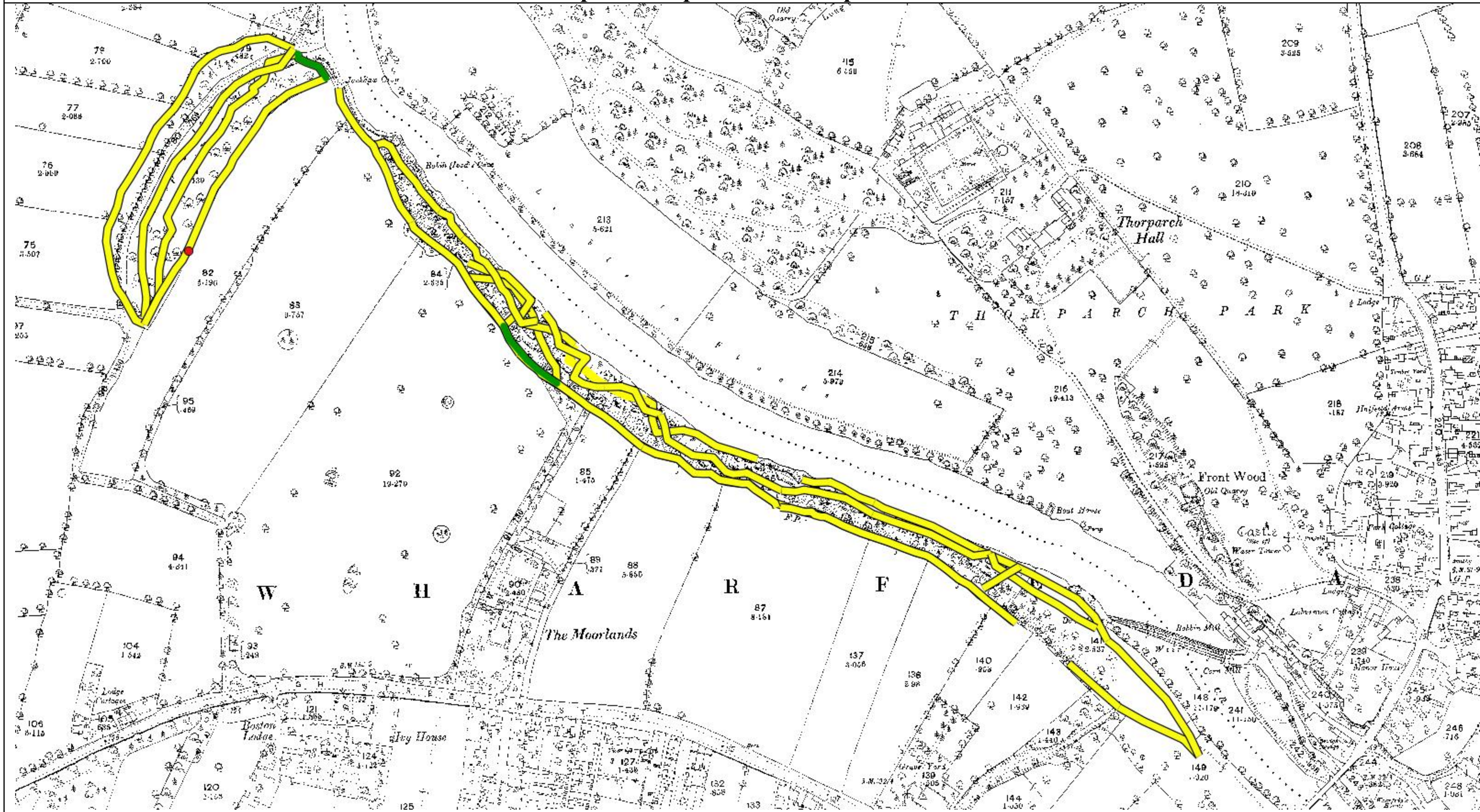


Figure 39.39 – *Ribes uva-crispa*

Species maps for Boston Spa Wood

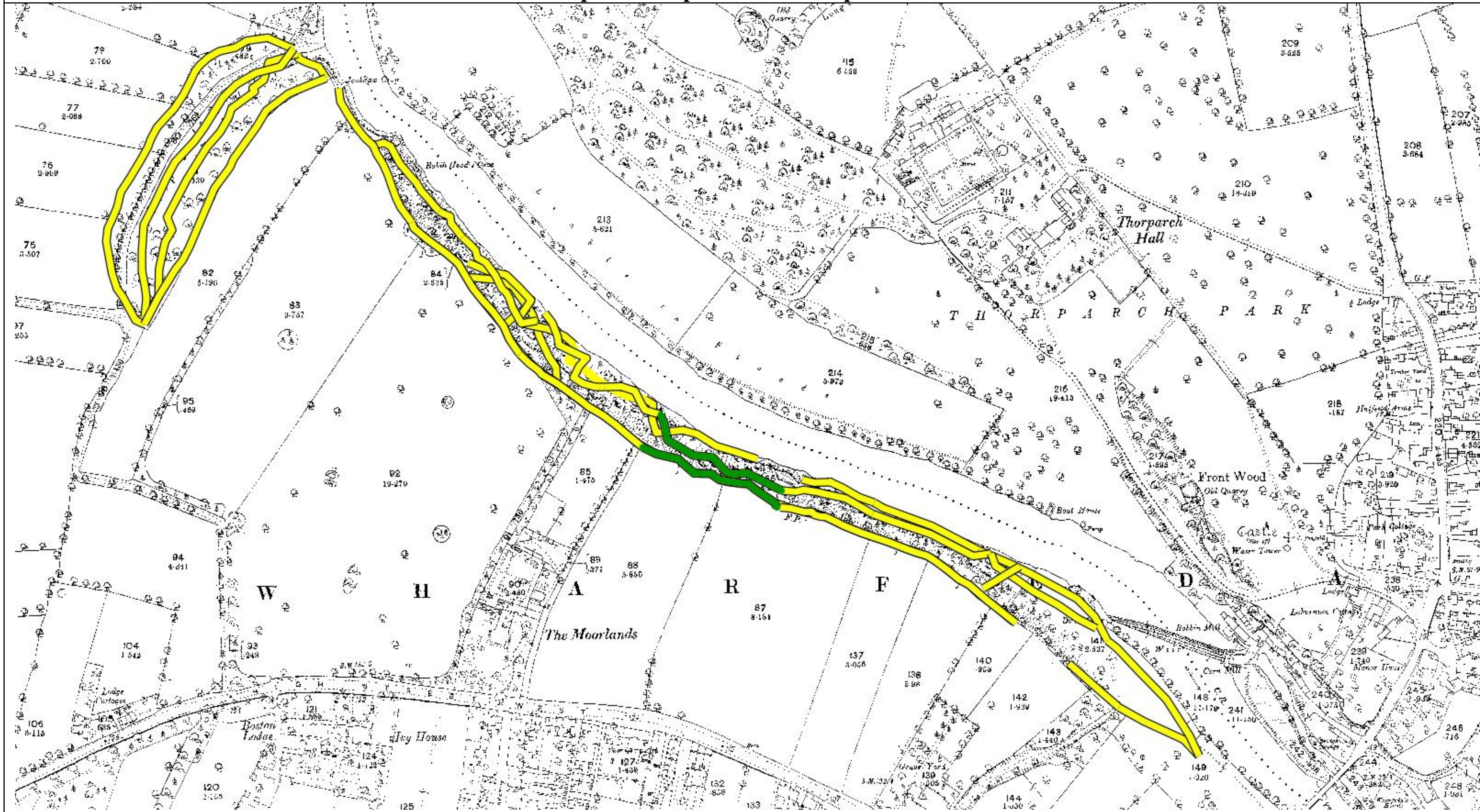


Figure 40.40 – *Rosa arvensis*

Species maps for Boston Spa Wood

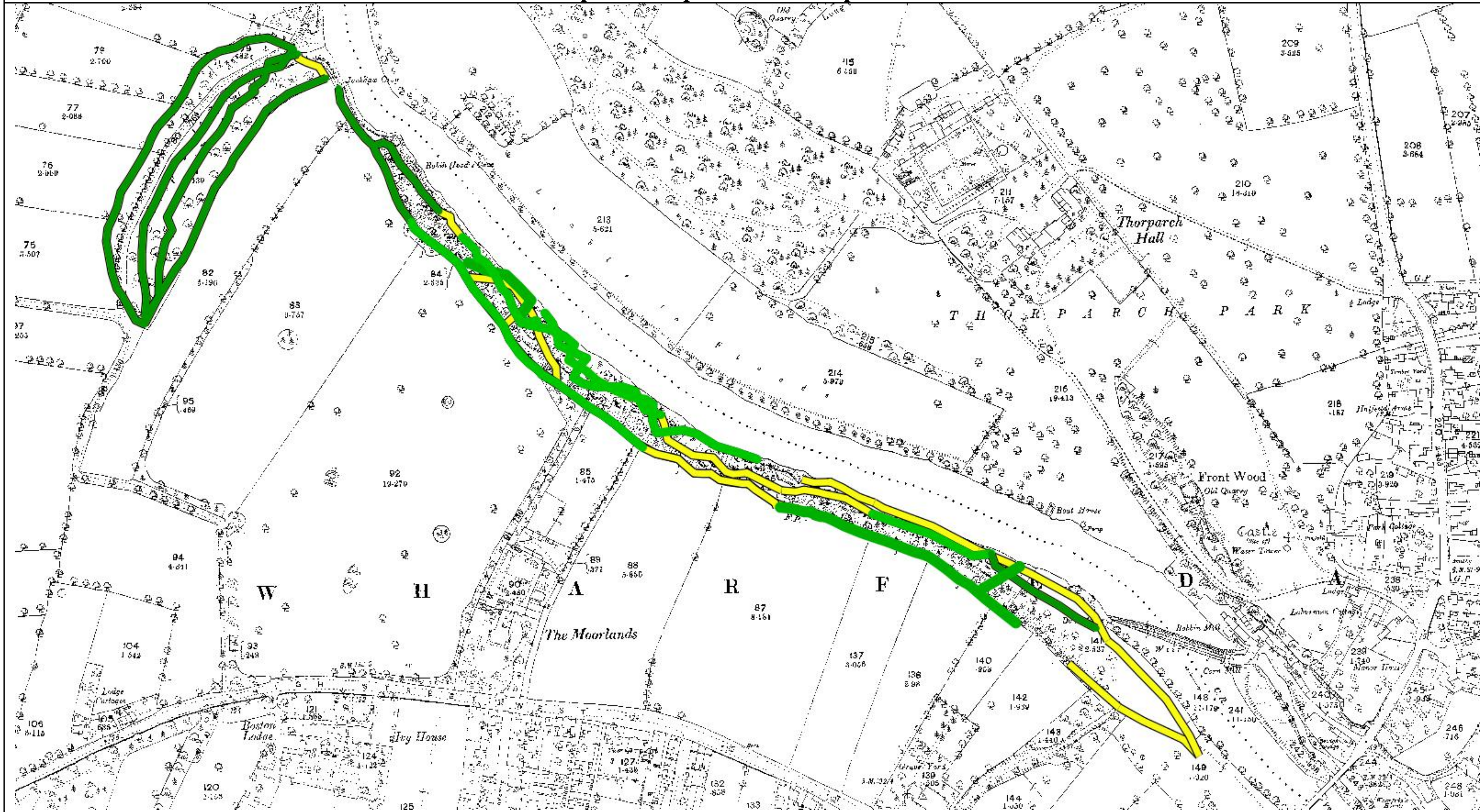


Figure 41.41 – *Rubus fruticosus*

Species maps for Boston Spa Wood

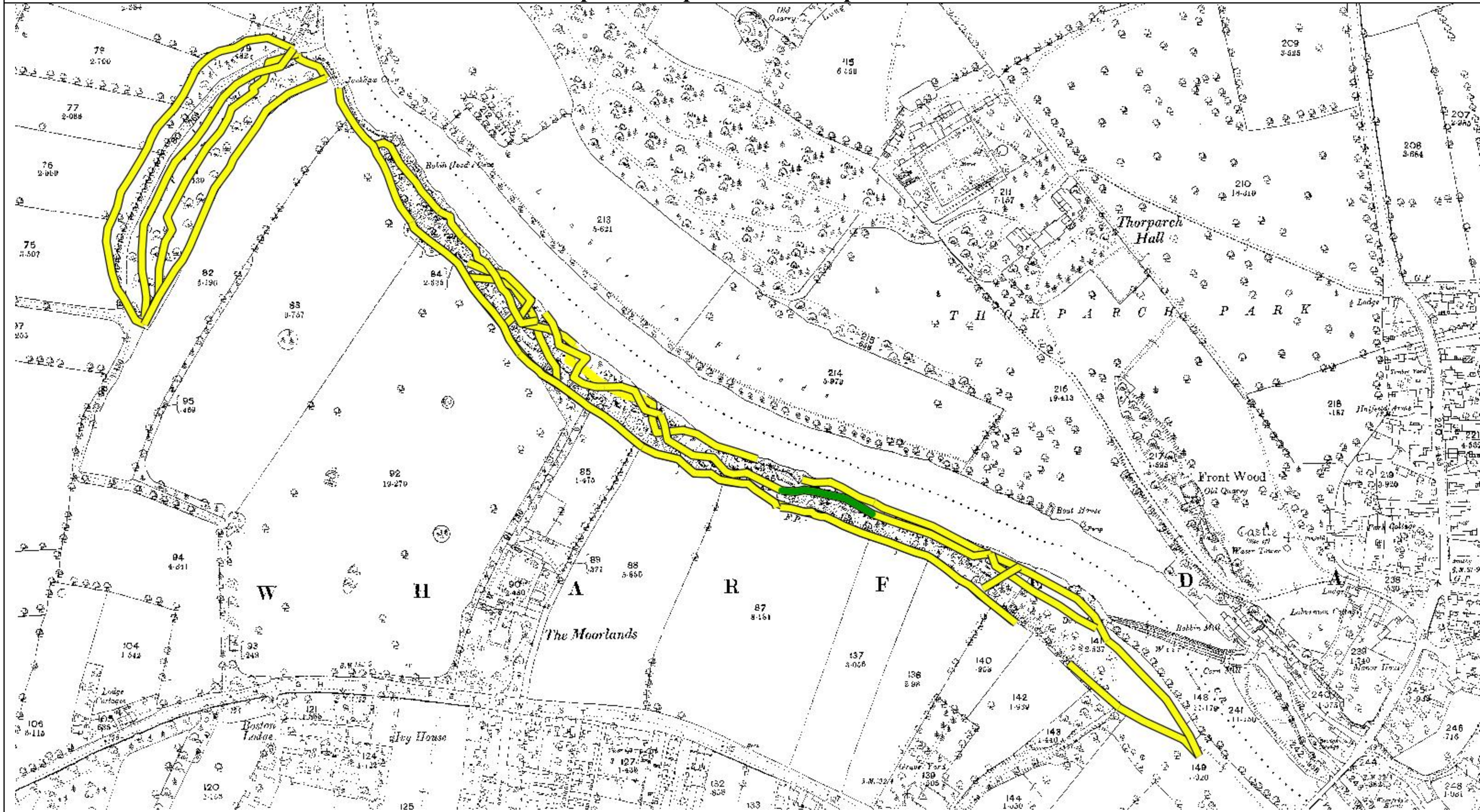


Figure 42.42 – *Rubus idaeus*

Species maps for Boston Spa Wood

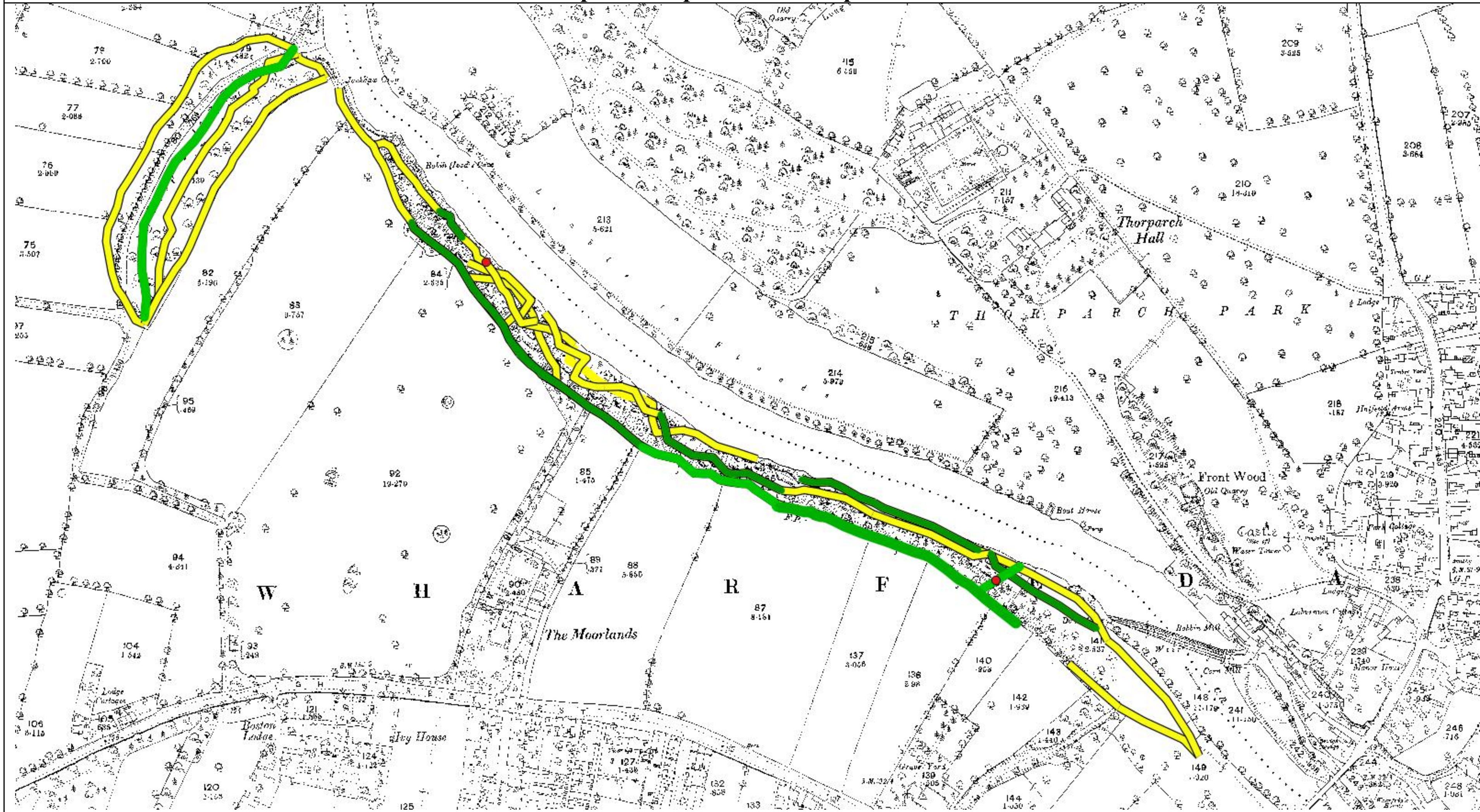


Figure 43.43 – *Sanicula europaea*

Species maps for Boston Spa Wood

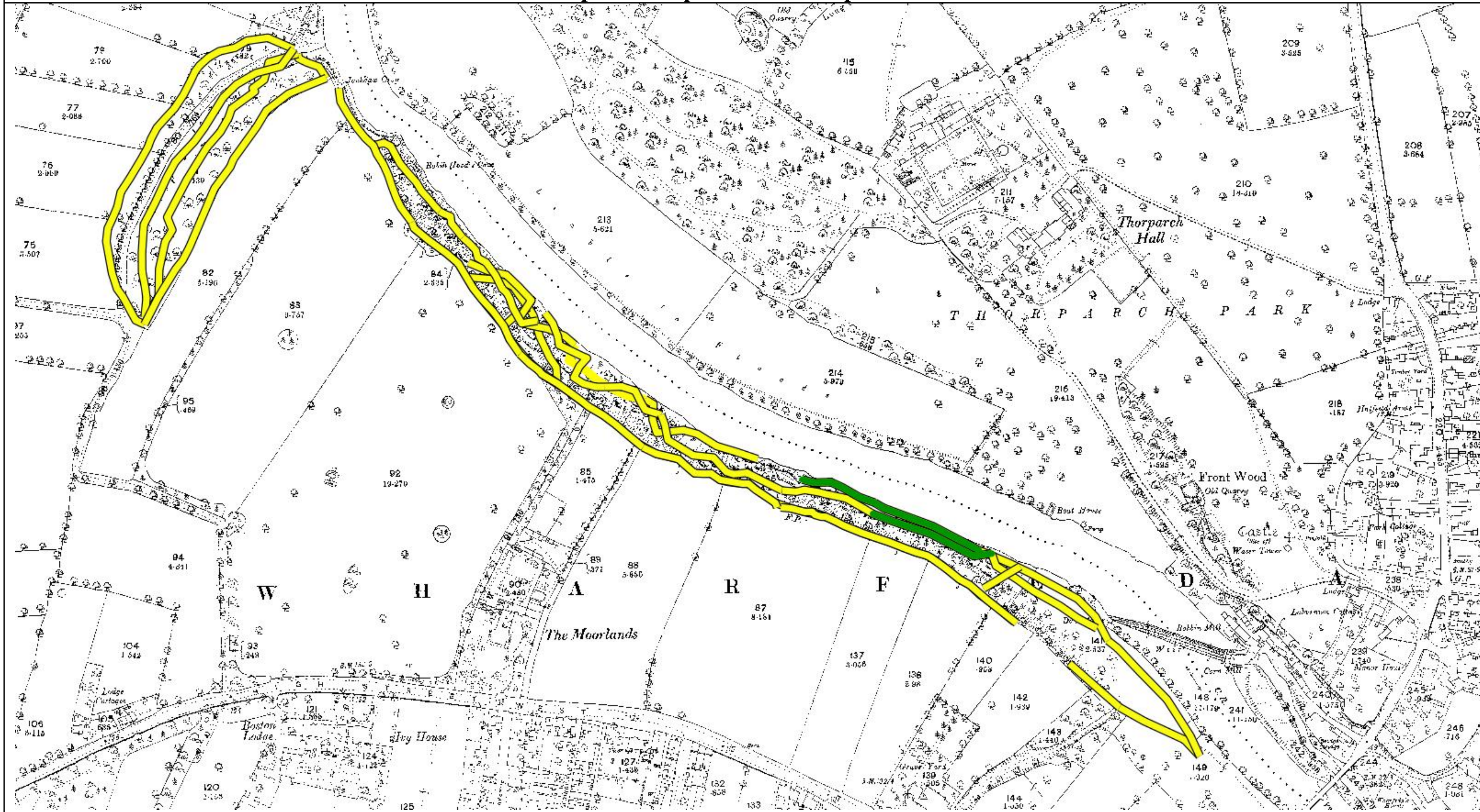


Figure 44.44 – *Scrophularia nodosa*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

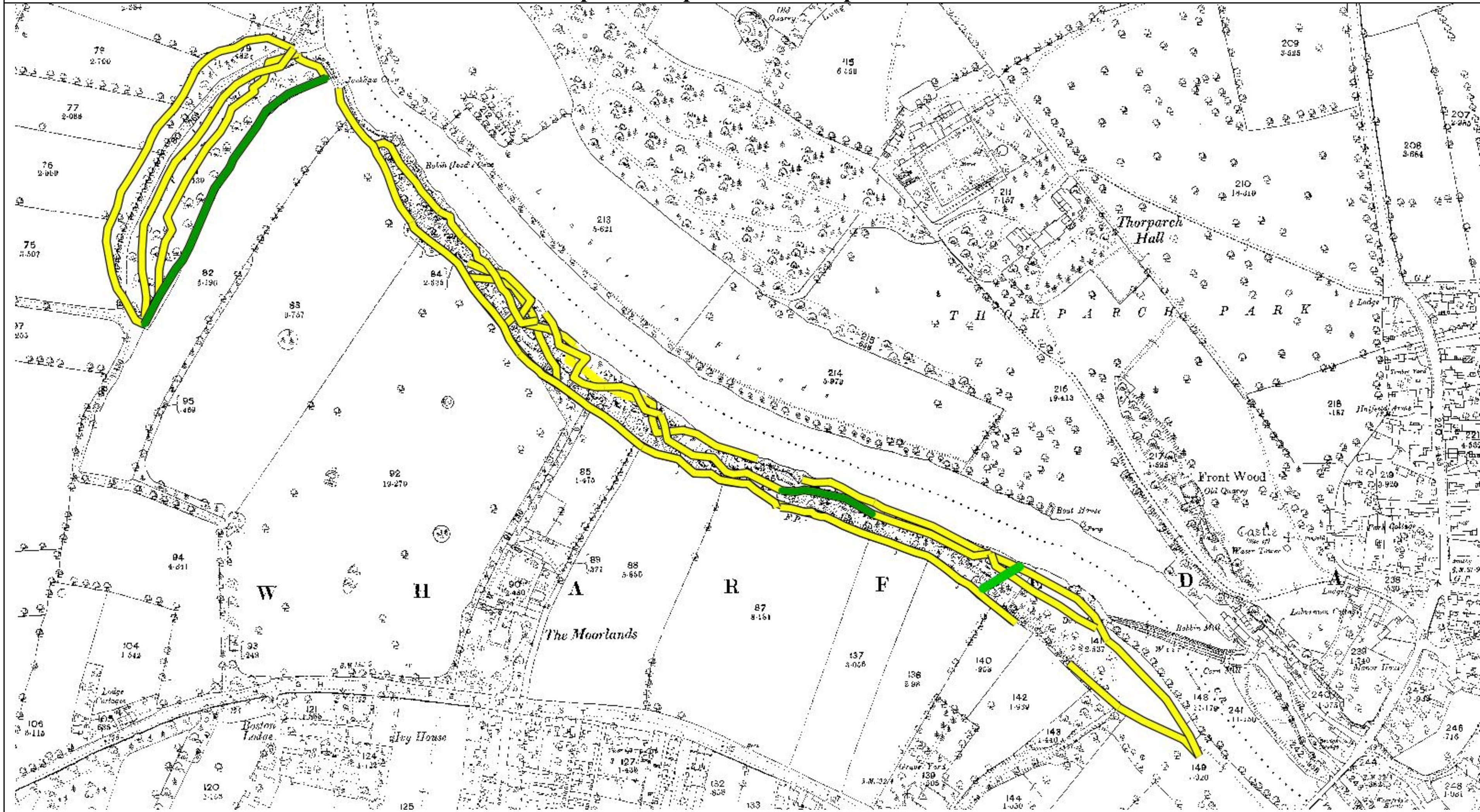


Figure 45.45– *Silene dioica*

Species maps for Boston Spa Wood

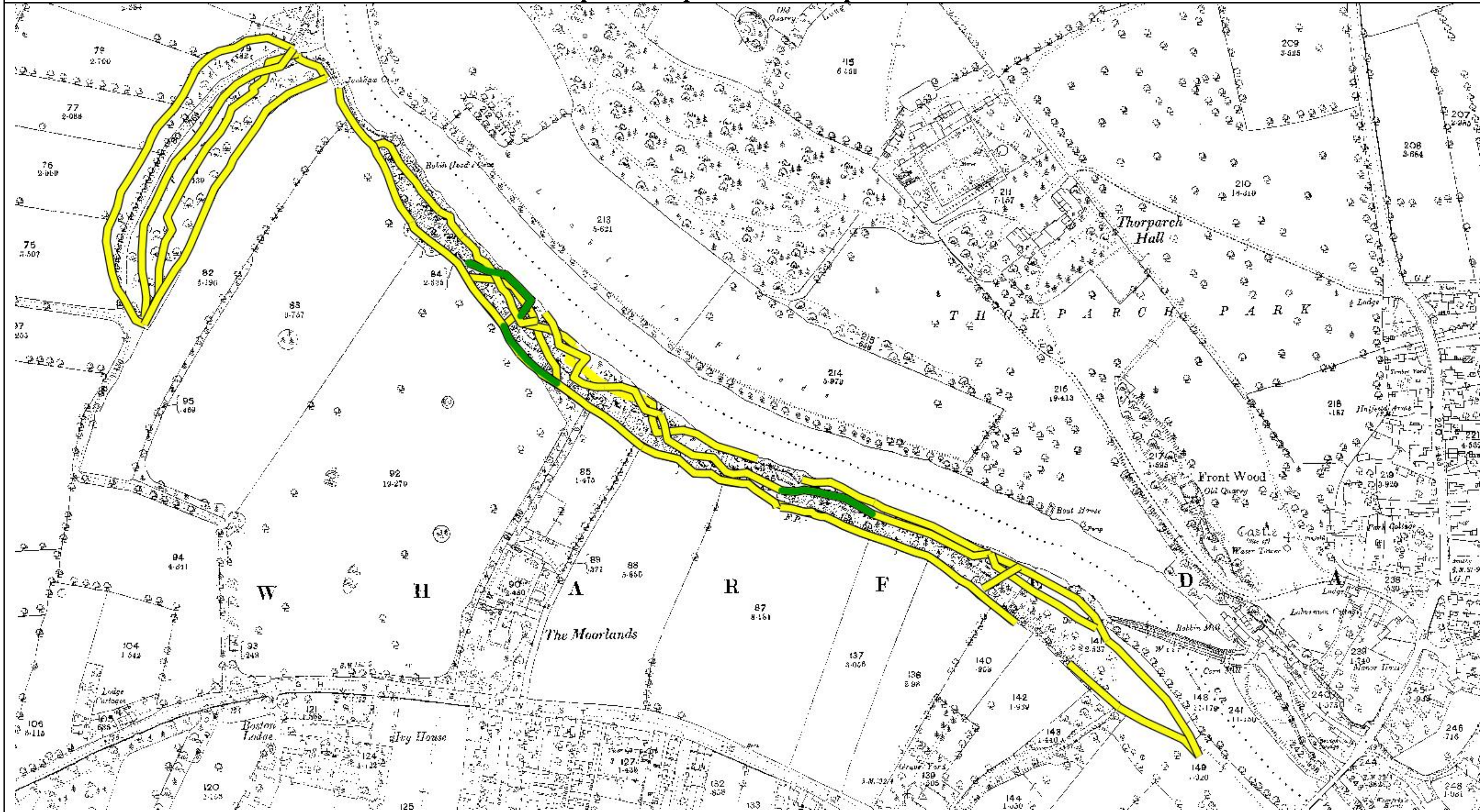


Figure 46.46 – *Sorbus aucuparia*

Species maps for Boston Spa Wood

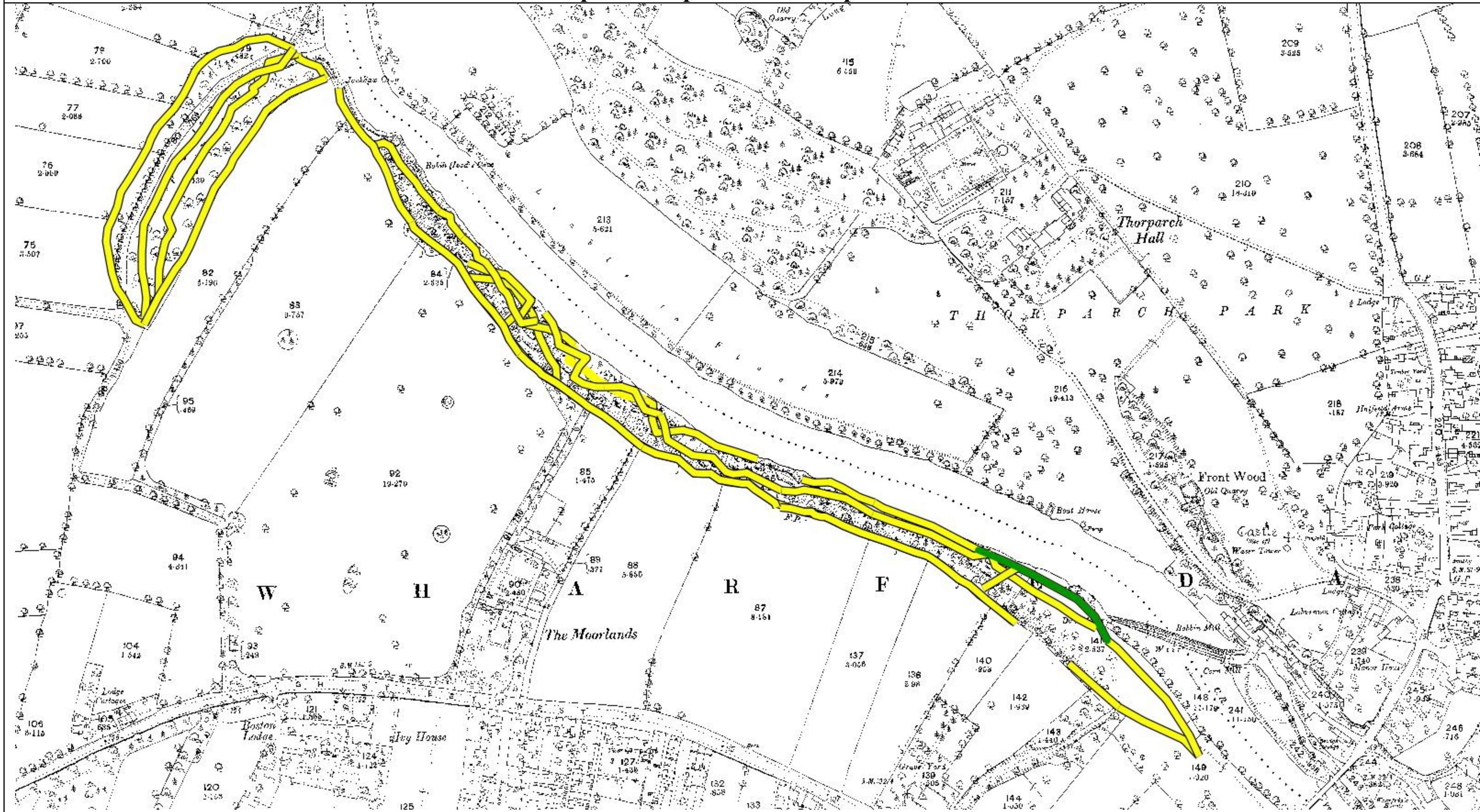


Figure 47.47 – *Stachys sylvatica*

Species maps for Boston Spa Wood

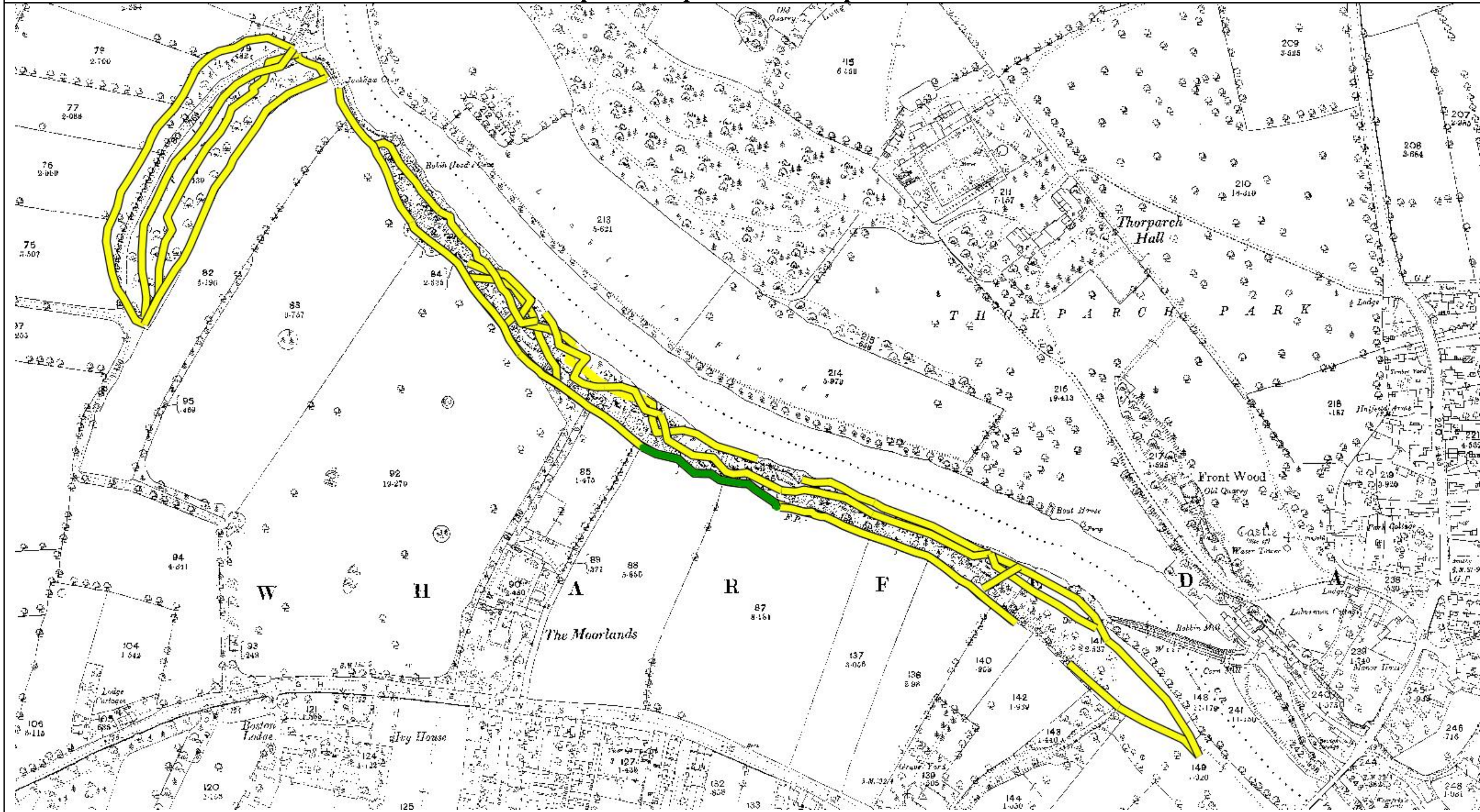


Figure 48.48 – *Stellaria holostea*

Species maps for Boston Spa Wood

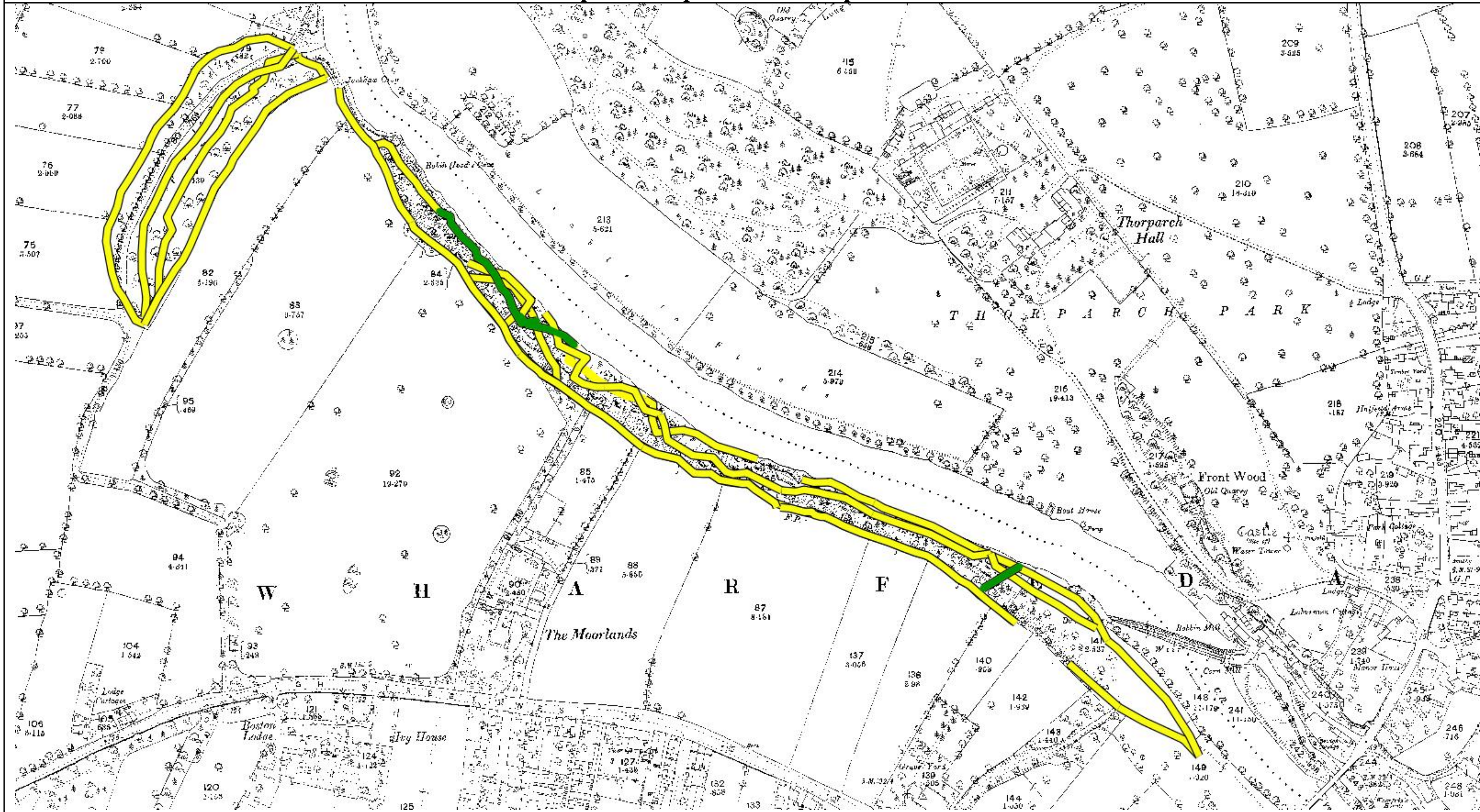


Figure 49.49 – *Tamus communis*

Appendix 12 - Results for Boston Spa Wood

Species maps for Boston Spa Wood

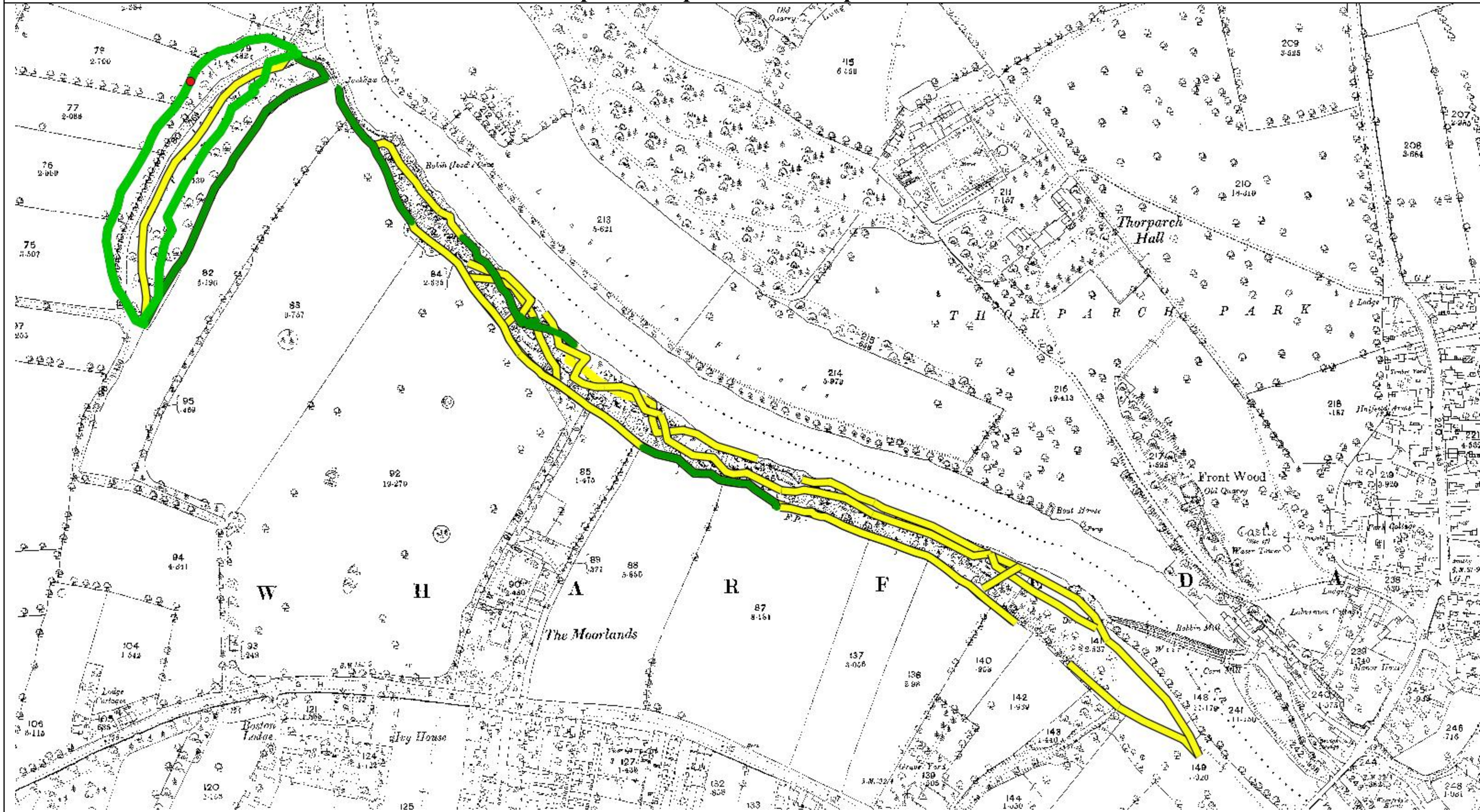


Figure 50.50 – *Viola odorata*

Species maps for Boston Spa Wood

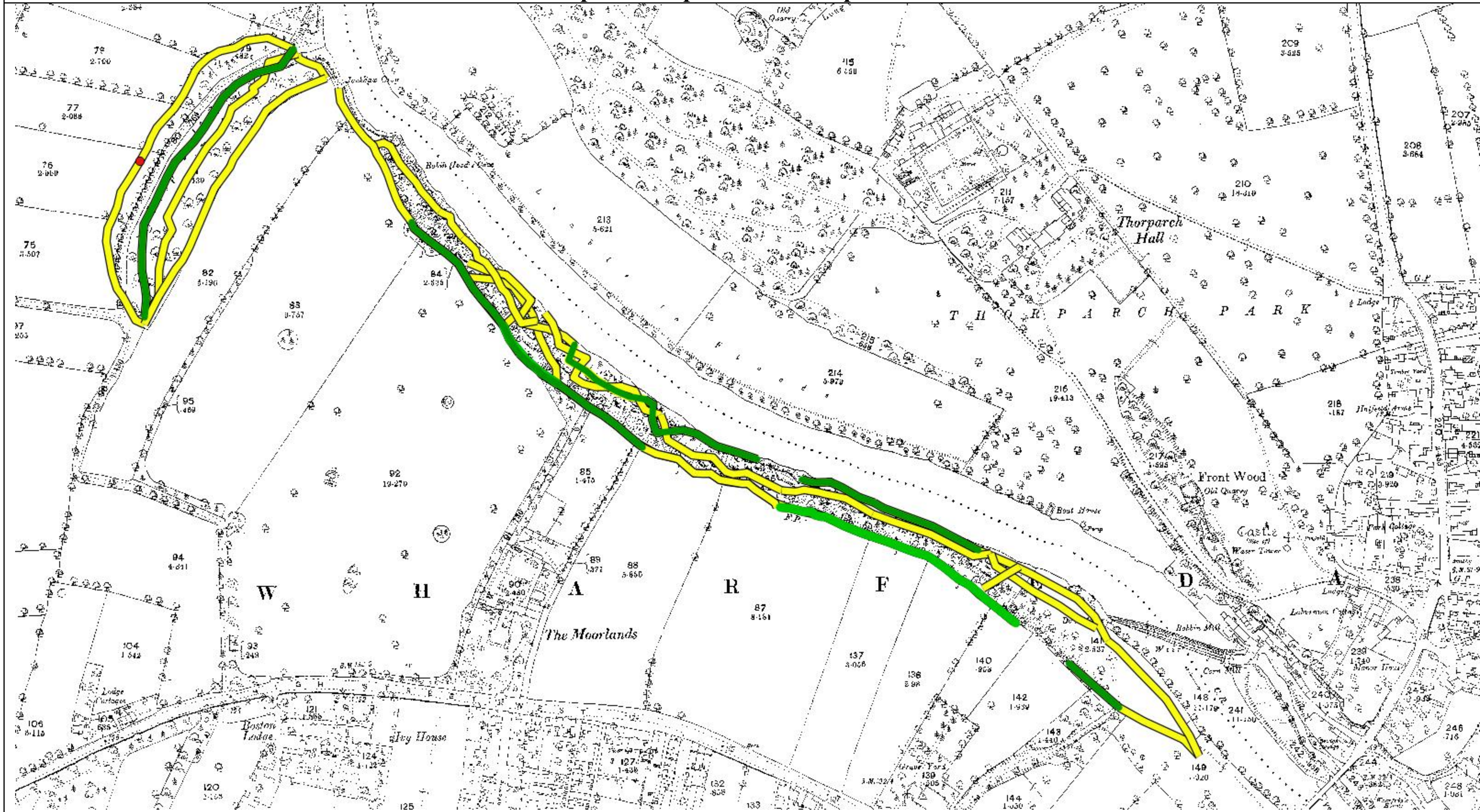


Figure 51.51 – *Viola riviniana*

Table 52.1 – Species data for Boston Spa Wood – Transects – part 1.																		
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																		
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																	
SPECIES	BR290-BR291	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118
ace-cam		11																
ace-pse	22	22	22	22	22										22	11	11	11
act-spi									11									
aeg-pod							22	22	22									
aes-hip																	11	
agr-cap		11	22		22													
aju-rep										11								
all-pet		11	22										11					
all-urs	11				11	11	22	33	22	44	44						11	
ane-nem					11				11		22							
ant-syl	22	33	22		22	11	22	22	11			22		22				
arc-min																	11	
aru-mac	11	22		11	11	11	11	22		22		22		22	11	11	22	11
BARE															55	44	44	33
bra-syl	11	22	22	22	22			22	33		22	33	33		11			
bro-ram								11	22									
BRYO															11	22		22
cam-lat			11															
car-dig																		
car-syl														11				

Table 52.1 – Species data for Boston Spa Wood – Transects – part 1.																		
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																		
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																	
SPECIES	BR290-BR291	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118
cir-lut						22	22	33	22	33								
con-maj																		
cor-ave																11	11	
cor-san																		
cra-mon	22	22	22	22	22										11	11		
dry-fil				11	11	11				11					11	22	11	11
euo-eur																		
fag-syl	11		22	22	22										22	11	11	11
fes-gig																		
fil-ulm									11									
fra-exc	11			22	22										11	11	11	11
gal-niv																		
ger-rob			11															
geu-urb	22	22	33	11	22		22	33	22	22		33	44	33			11	
gle-hed										11								
hed-hel	33	33	44	44	44	33	44	44	44	44	44	44	44	44	22	33	44	33
her-sph							11		22									
hol-mol						22		22										
hya-mas																		
hya-non		11		22	22									22			11	22
ile-aqu	11	22	22	22	22										11	22		22

Appendix 12 - Results for Boston Spa Wood

Table 52.1 – Species data for Boston Spa Wood – Transects – part 1.																		
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																		
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																	
SPECIES	BR290-BR291	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118
imp-gla								11	11	22	22				22	11	11	
lam-alb																		
lam-gal																	11	11
lap-com	11	22											11		11			11
LigVul																		
LITTER															22	22		22
lon-per																		
mal-syl																		
mel-uni	11		22		22							44		44	11			
mer-per	22	33	22	33	22	33	22		11	22	33	44		44	22	22	22	
myr-odo								11	11									
neo-nid													11					
oxa-ace																		
pet-hyb							11											
phy-sco				11														
poa-nem												44	44	44	22	22		
pol-acu											11							
Pru-Spi		11	11															
pri-vul																		
pru-spp																		
ran-aur																		

Appendix 12 - Results for Boston Spa Wood

Table 52.1 – Species data for Boston Spa Wood – Transects – part 1.																		
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																		
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																	
SPECIES	BR290-BR291	BR291-BR292	BR291-BR295	BR292-BR293	BR292-BR295	BS070-BS071	BS071-BS073	BS073-BS074	BS074-BS076	BS076-BS078	BS078-BS080	BS081-BS083	BS082-BS088	BS083-BS084	BS106-BS111	BS111-BS115	BS115-BS116	BS116-BS118
ran-fic																		
rib-uva					11													
ros-arv																		
ros-can																		
rub-fru	11	22	22	22	11										22	22	22	33
rub-ida																		
sam-nig	22	22	22		22										11	11		
san-eur				11	11					11	11	22	33					
sco-nod										11	11							
sil-dio																		
sor-auc					11													11
sta-syl			11						11									
ste-hol												11						
sym-alb																		
tam-com																	11	
tax-bac																		
til-eur	11		22	22	22										11			11
ulm-gla	22	11	22	22	22											11	11	
urt-dio								11	11	11					11		11	
vio-odo																	11	
vio-riv				11	22	11				11	11		22	11	11	11		

Table 56.2 – Species data for Boston Spa Wood – Transects –part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																			
SPECIES	CA258-CA262	CA258-CA289	CA262-CA263	CA263-CA279	CA279-CA289	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385
ace-cam							22										11			
ace-pse	33	33	33	33		22	11	11	11	22	22	11	11	11		22	11			
act-spi																				
aeg-pod				11									11							
aes-hip										11										
agr-cap																				22
aju-rep												11								
all-pet												11	22		22	22	22			
all-urs	11	22		33				22	11			22	44	22			11		11	44
ane-nem	11	33	44	33		11					11	11		11				11	22	
ant-syl		11		11									11		33	44	44	33	33	
arc-min																	11			
aru-mac	11	22	22		11	11	22	33	22	22	11	11		11					11	22
BARE	44	22	22		33			44	44	44	44	44			33	44	44	44	33	33
bra-syl		22											22		22					
bro-ram																				
BRYO								11												
cam-lat																				
car-dig											11									
car-syl																				
cir-lut													11							
con-maj														11					11	
cor-ave												11			22				22	

Appendix 12 - Results for Boston Spa Wood

Table 56.2 – Species data for Boston Spa Wood – Transects –part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																			
SPECIES	CA258-CA262	CA258-CA289	CA262-CA263	CA263-CA279	CA279-CA289	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385
cor-san		11			11	11									11			11	11	
cra-mon	22	22	22	22	22		22	22					11	11	33	11	11		33	
dry-fil					11			22	22	11		11								
euo-eur																				
fag-syl			22	11	44	44	22	22	33	22	22	22	22	11	11	11	11	11	22	
fes-gig																				
fil-ulm																				
fra-exc	11	33	33	33	11		33	33		22		11	22	11	11		11	22		
gal-niv																				
ger-rob												11			33		22			
geu-urb	11	11		11	11			22					11		44	33	33	33	33	
gle-hed	11																			
hed-hel	11	33	33	44	44	44	44	33	22	22	33	33	33	22	33	44	33	33	44	33
her-sph																				
hol-mol																				
hya-mas					11															11
hya-non	11		22	22	11		11	22	11					11	11		11		11	11
ile-aqu	11	11	11		22	11	33	22		22	22	11	22	11	22	22	11	22	22	
imp-gla											11	22								
lam-alb																				
lam-gal									11			11			11					
lap-com																				
LigVul																				

Table 56.2 – Species data for Boston Spa Wood – Transects –part 2																				
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																				
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																			
SPECIES	CA258-CA262	CA258-CA289	CA262-CA263	CA263-CA279	CA279-CA289	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385
LITTER		22	22					33	33	33	33	33			33		33	22	33	11
lon-per						11														
mal-syl																		11		
mel-uni		22			11		11							22	44	33	22	22	33	
mer-per	11	33	33	33	33	33	33	22	22	22	22	22	22	22	33	33	22	33	33	22
myr-odo													11							
neo-nid																			11	
oxa-ace																				
pet-hyb				11												11				
phy-sco																				
poa-nem		22			11				11						33	33	33	33	33	
pol-acu											11									
PRU-SPI																22	11	22		
pri-vul																				
pru-spp															11					
ran-aur																				
ran-fic	11		22	33				22			11									33
rib-uva			11																	
ros-arv											11								11	
ros-can		11			11										22			11	11	11
rub-fru	11	11		11	11	11		22	22	22			22	11	33	11		22		33
rub-ida												11								
sam-nig	11			11				22		11			11			11	22			

Table 56.2 – Species data for Boston Spa Wood – Transects –part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																			
SPECIES	CA258-CA262	CA258-CA289	CA262-CA263	CA263-CA279	CA279-CA289	CA308-CA317	CA317-CA322	CA322-CA330	CA334-CA342	CA342-CA345	CA345-CA355	CA355-CA361	CA361-CA363	CA363-CA364	CA366-CA368	CA369-CA370	CA370-CA371	CA371-CA372	CA372-CA378	CA378-CA385
san-eur					22		11				11			11	22			11	22	
sco-nod													11							
sil-dio	11											11			22					
sor-auc												11								
sta-syl																				
ste-hol																				
sym-alb												11	11							
tam-com							11	11							11					
tax-bac					11															
til-eur		11			22	22			11		11	11			11		11	11	11	
ulm-gla	22		22	22	11		11	22	22	22	11	11	11		11	11	11		11	
urt-dio																				11
vio-odo	11	22	11	22				11								11			11	
vio-riv					11												11			

Table 60.3 – Species data for Boston Spa Wood – Point records

Species use 3 + 3 abbreviated systematic names. 1 = point record of the species

Point record reference ID (Waypoint reference - device letter code and waypoint number)

SPECIES	BS072	BS079	BS086	BS087	BS105	BS107	BS108	BS111	BS112	BS113	BS114	BS117	CA259	CA294	CA298	CA299	CA300	CA304	CA307	CA320	CA324	CA330	CA331	CA332	CA335	CA338	CA340	CA349	CA351	CA358	CA360	CA365	CA367	CA380	CA382	CA383	CA384	CA385
act-spi																																1						
all-urs																	1	1																				
ane-nem														1			1	1	1														1					
car-dig																														1								
con-maj			1																1					1									1		1			
dry-fil								1														1				1												
euo-eur																																		1				
lam-alb																			1																			
lam-gal																															1							
Lig-Vul	1																																					
mel-uni																			1	1									1				1					
mer-per															1																							
neo-nid				1																			1													1	1	1
oxa-ace									1																													
phy-sco					1						1	1								1		1			1	1		1	1									
poa-nem																			1																			
pol-acu		1				1	1			1																1	1				1							
pri-vul																1																						
ran-aur																			1																			
rib-uva													1																									
san-eur																					1												1					
vio-odo														1																								

Appendix 13 - Results for Church Wood

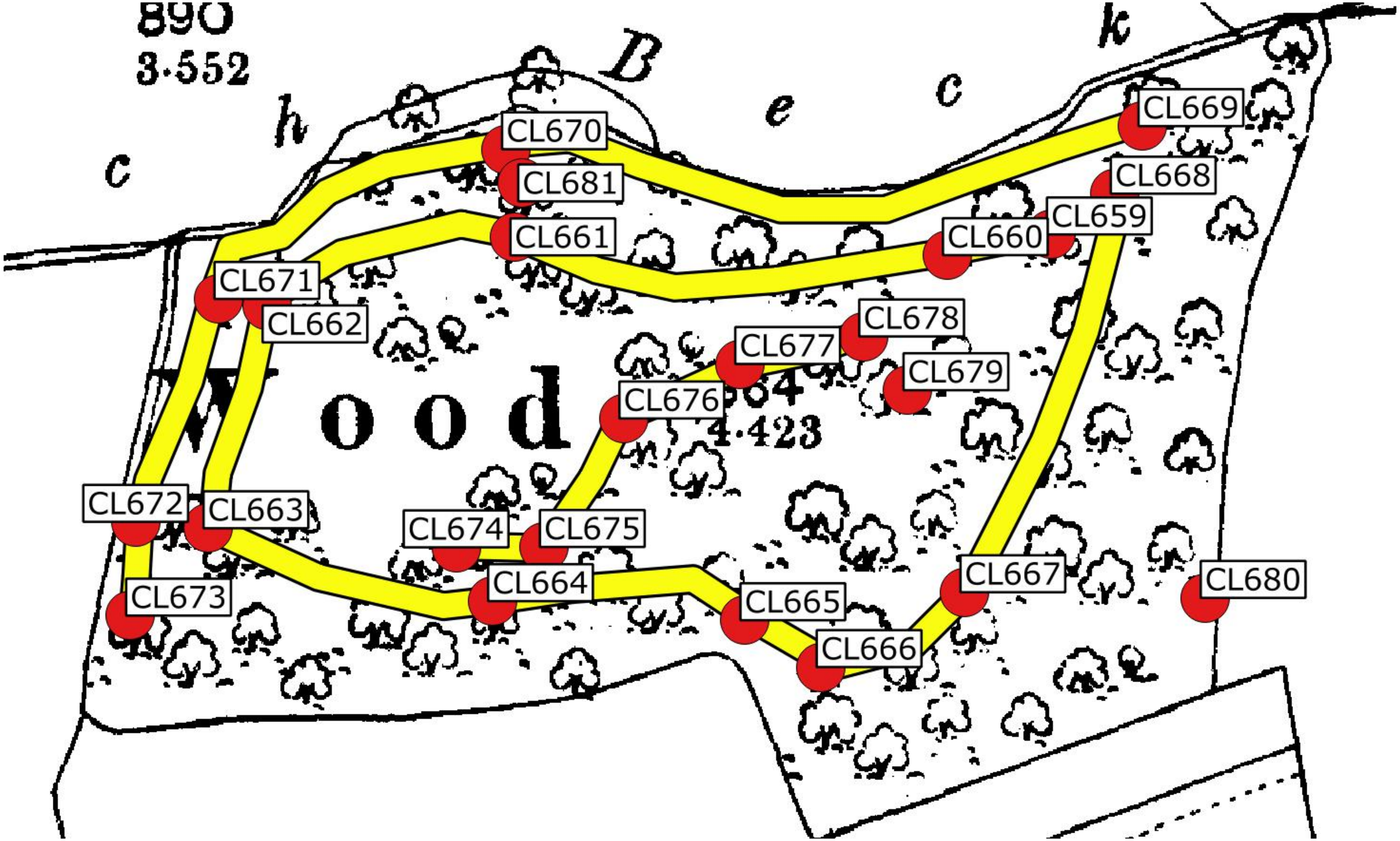
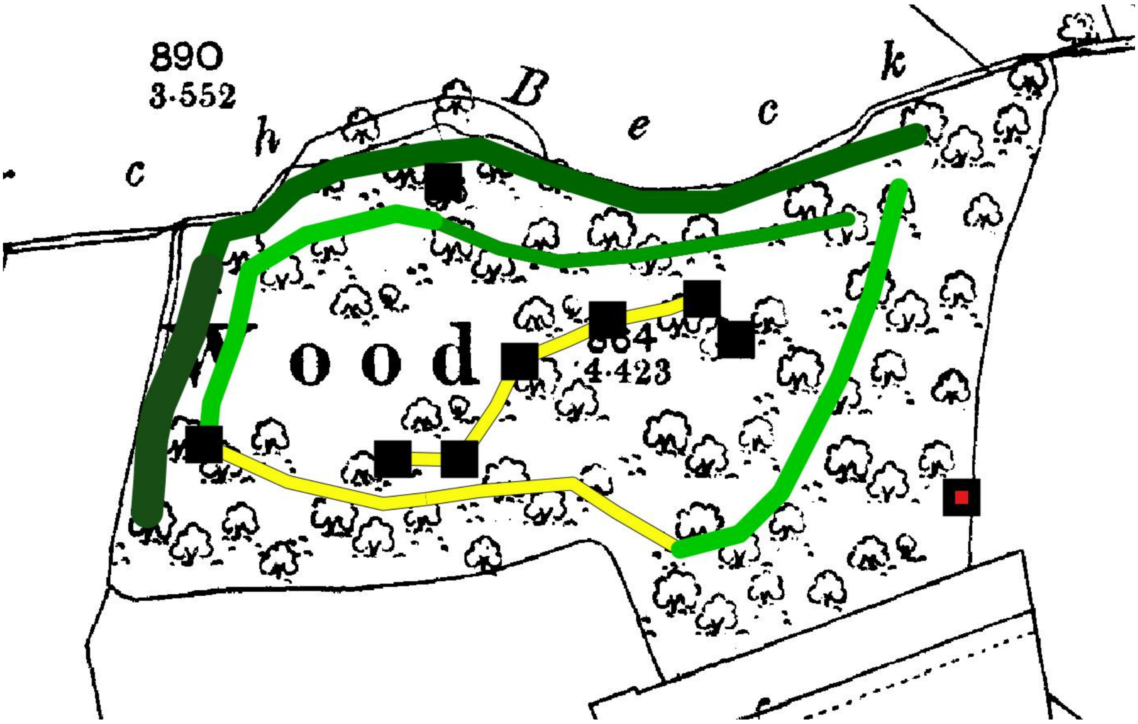
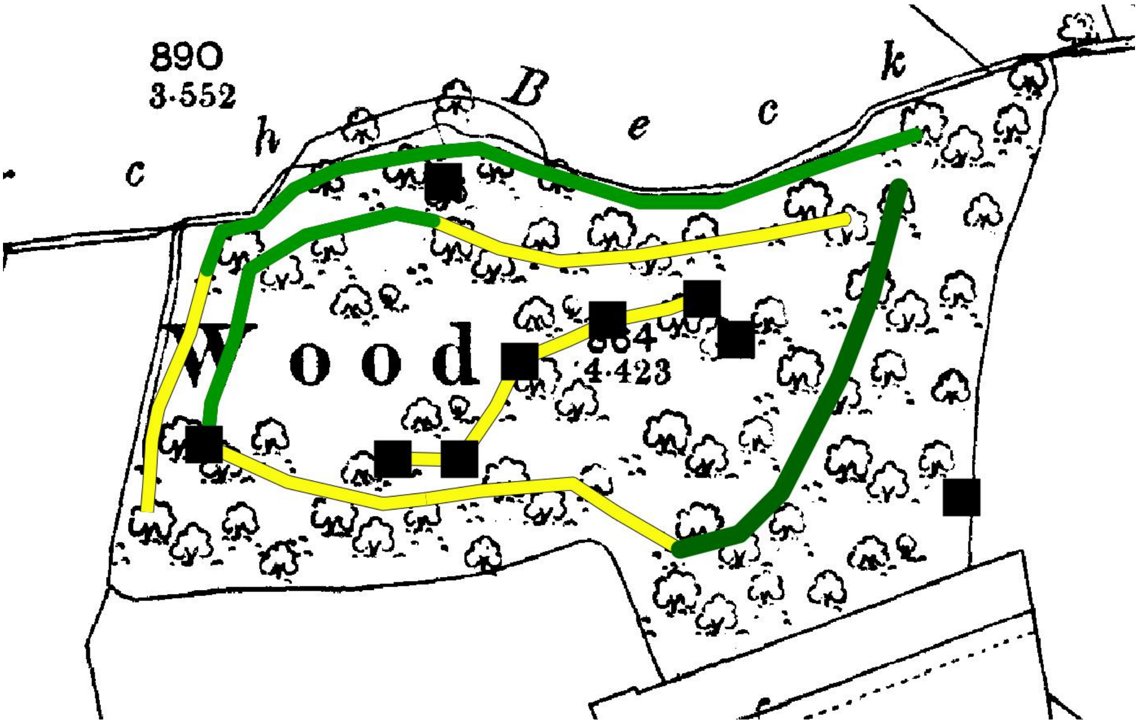
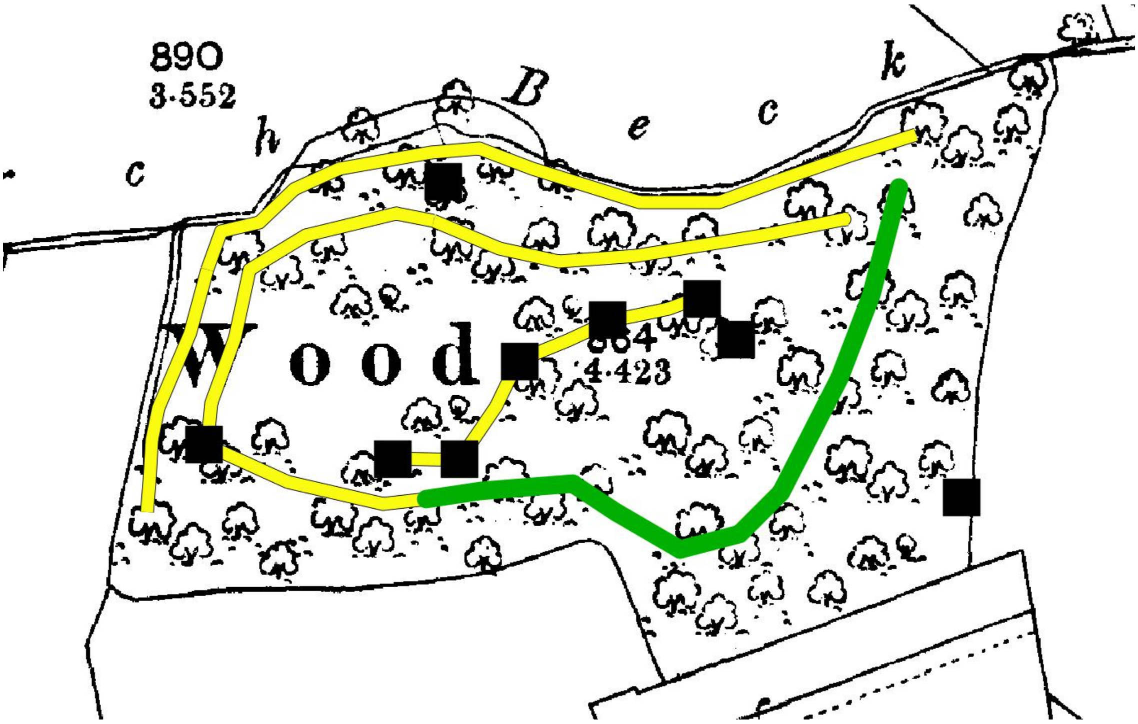
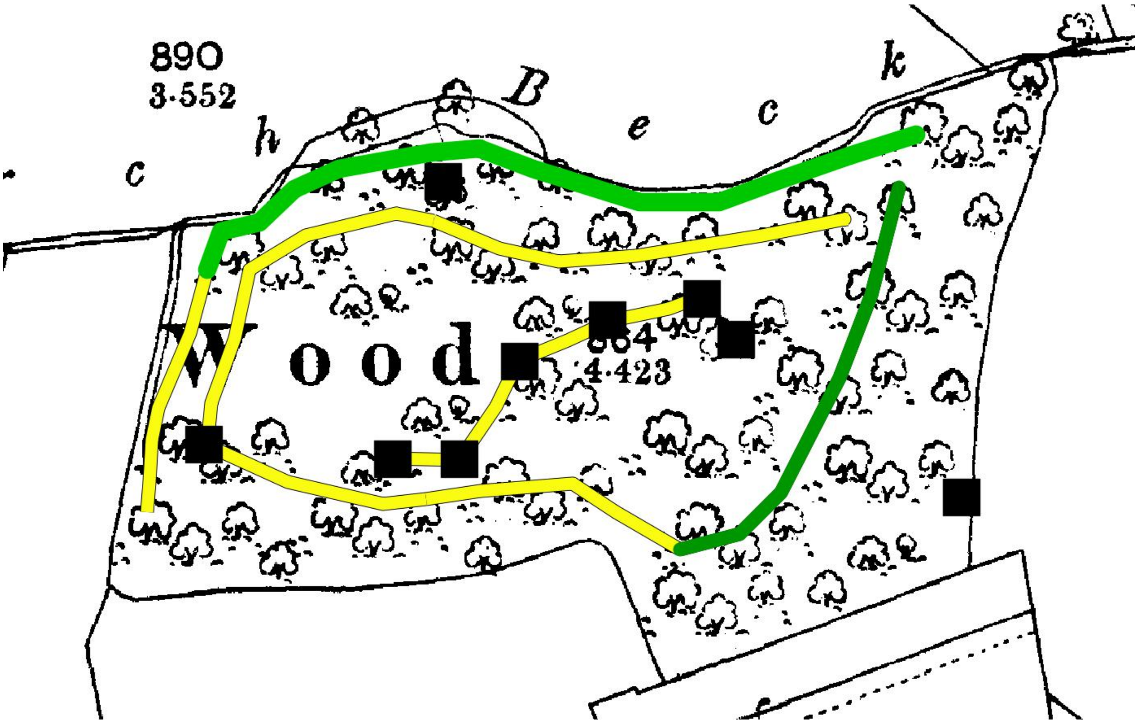


Figure 1.1 – Map of Church Wood showing the transect lines (yellow) quadrat locations (black squares) and transect nodes (red circles)

Species maps for Church Wood
Figure 2.2 – *Allium ursinum*
Figure 2.3 – *Anemone nemorosa*

Appendix 13 - Results for Church Wood

Species maps for Church Wood
 Figure 3.4 – *Arum maculatum*
 Figure 3.5 – *Athyrium filix-femina*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

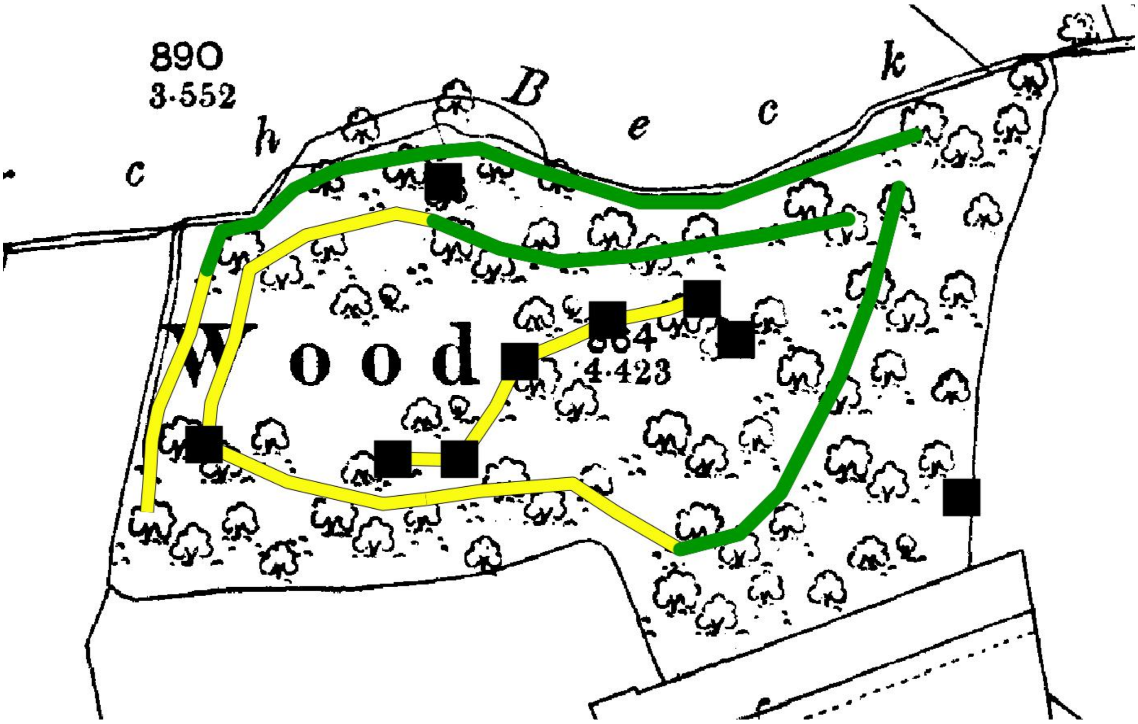


Figure 4.6 – *Carex remota*

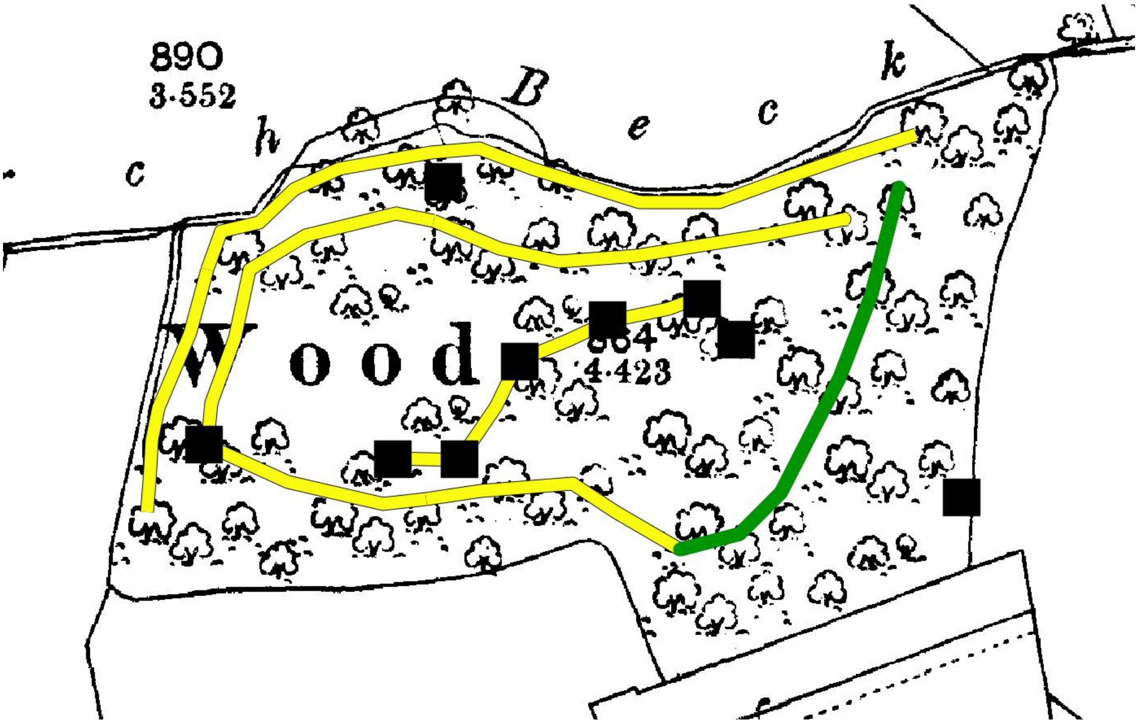


Figure 4.7 – *Carex sylvatica*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

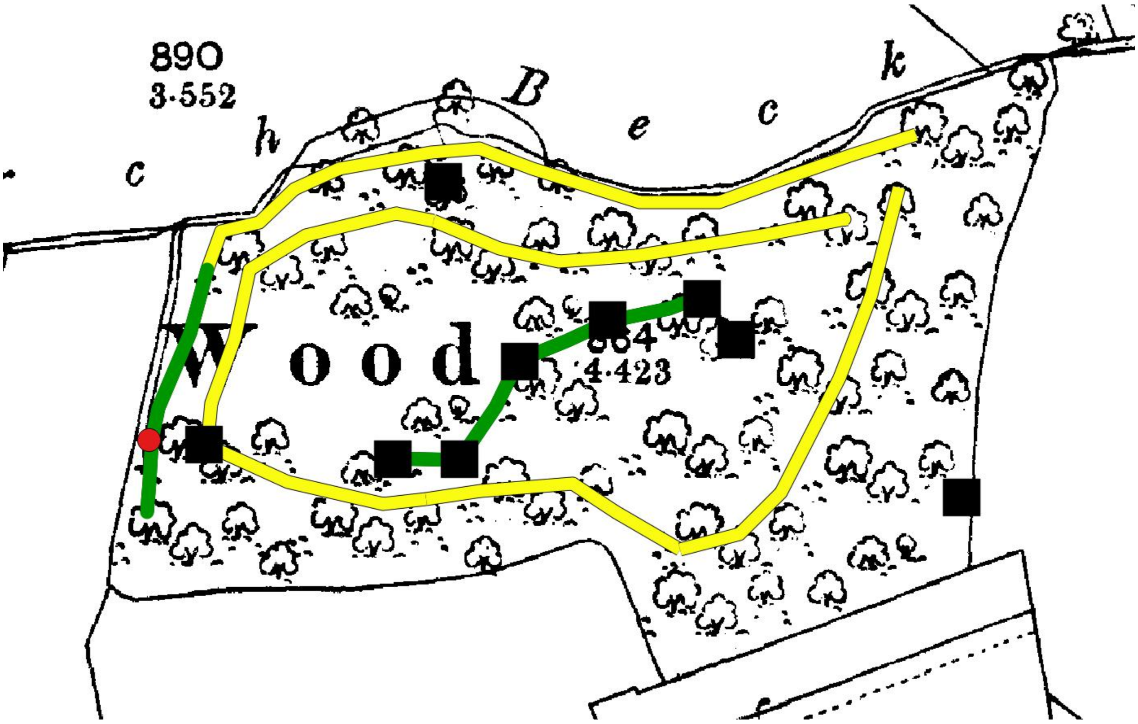


Figure 5.8 – *Dryopteris filix-mas*

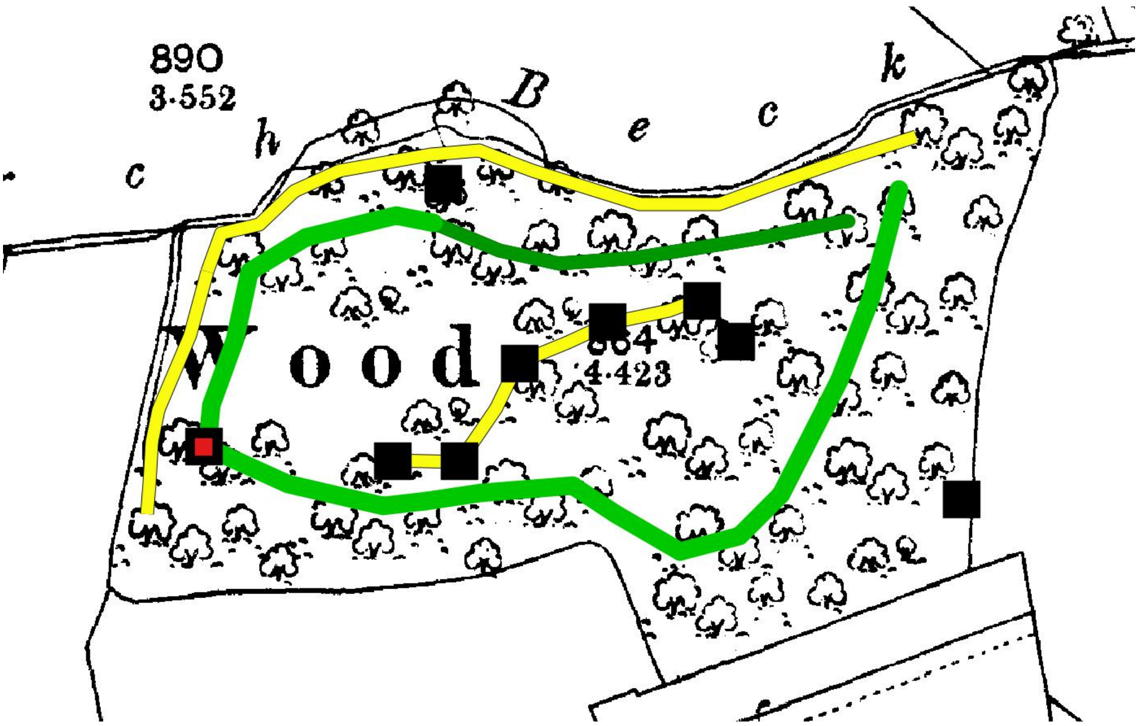


Figure 5.9 – *Geum urbanum*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

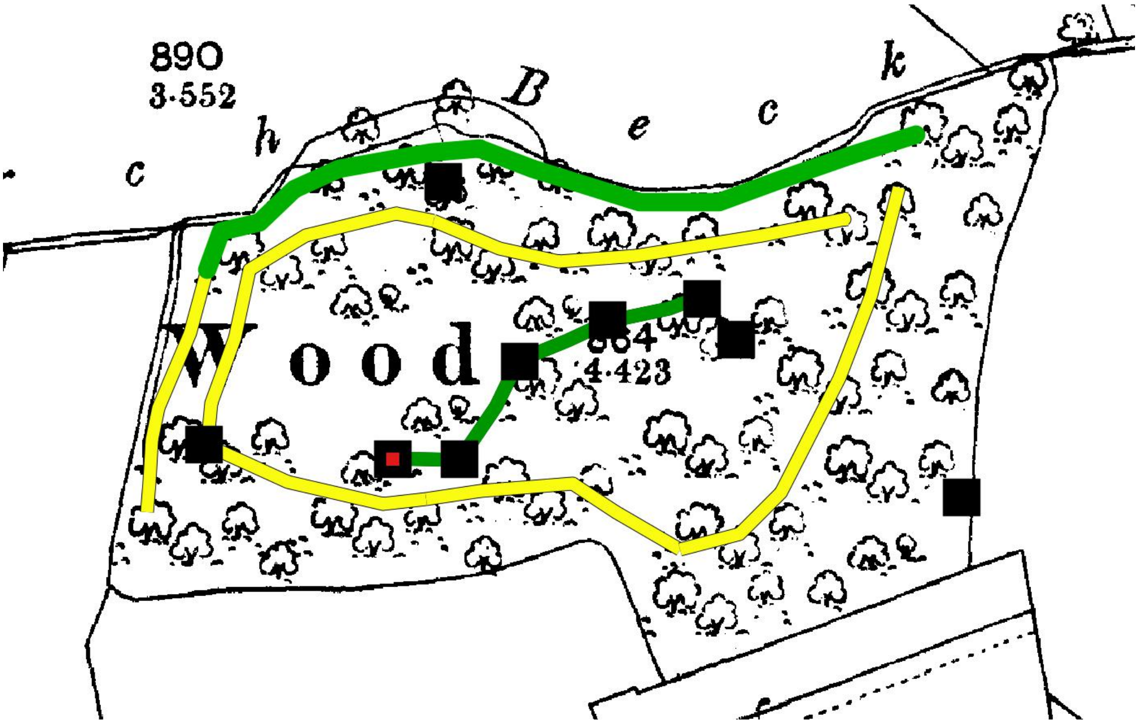


Figure 6.10 – *Hedera helix*

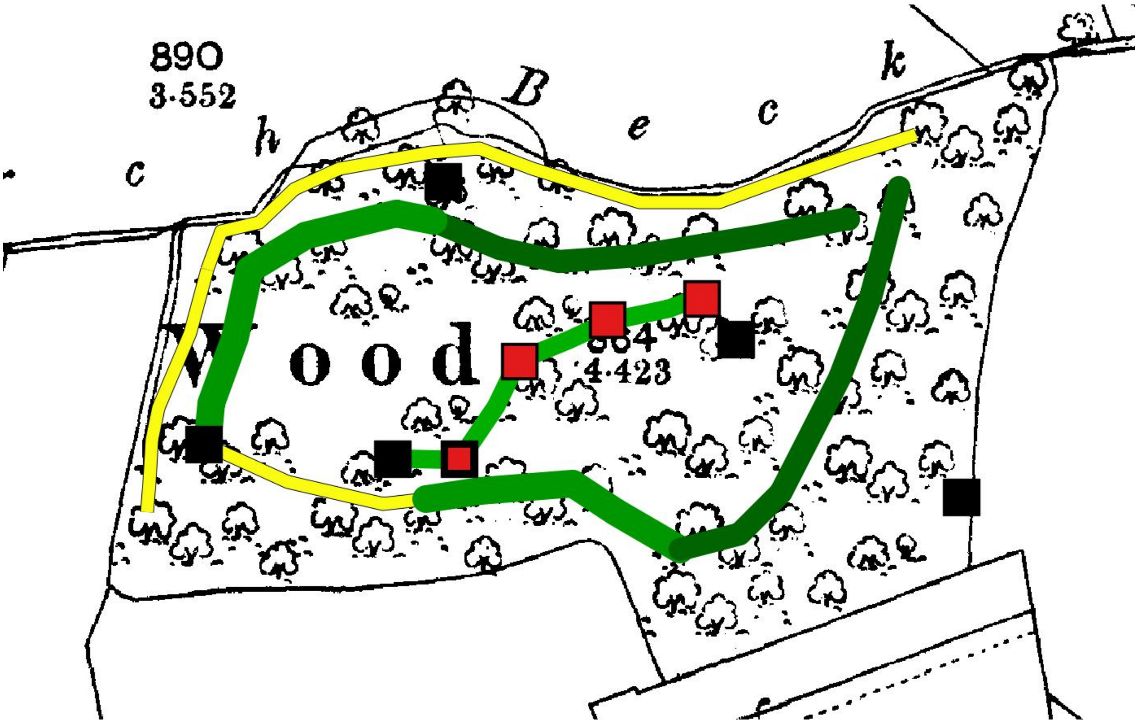


Figure 6.11 – *Holcus mollis*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

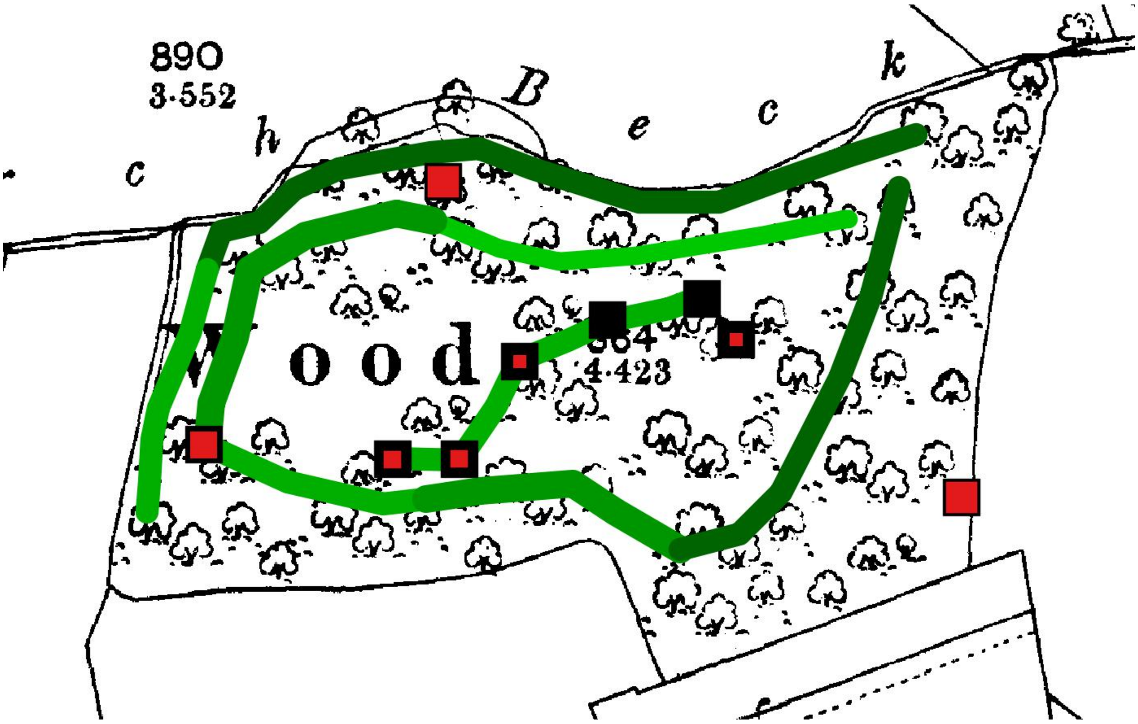


Figure 7.12– *Hyacinthoides non-scripta*

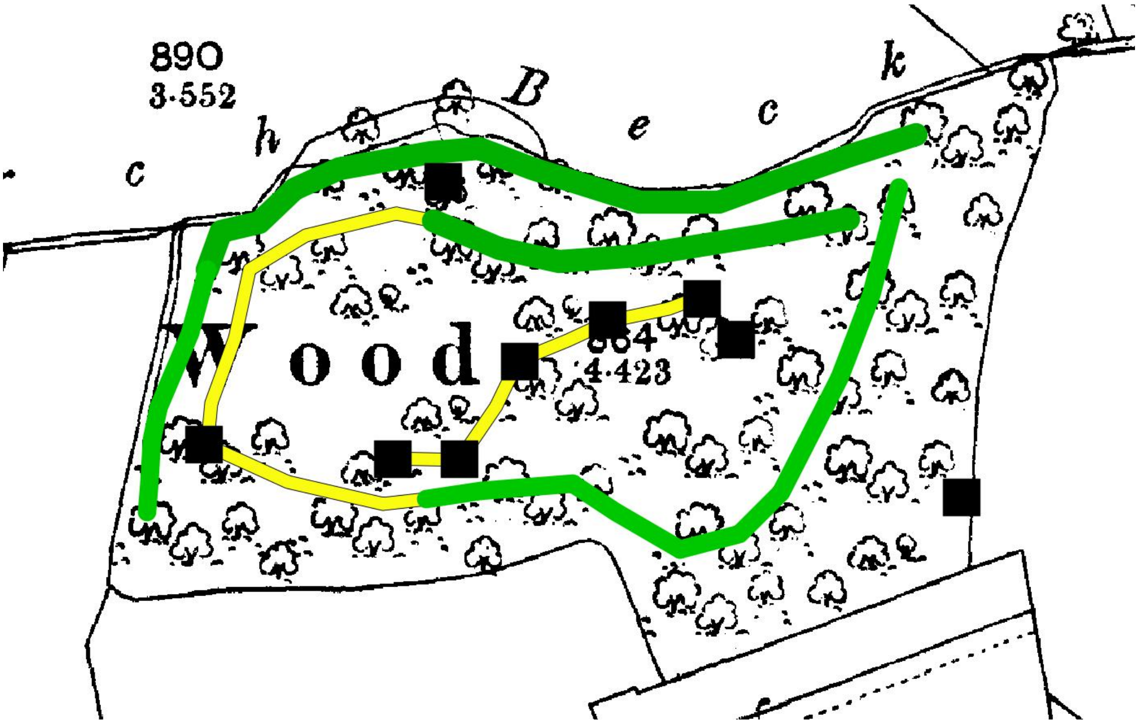


Figure 7.13 – *Ilex aquifolium*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

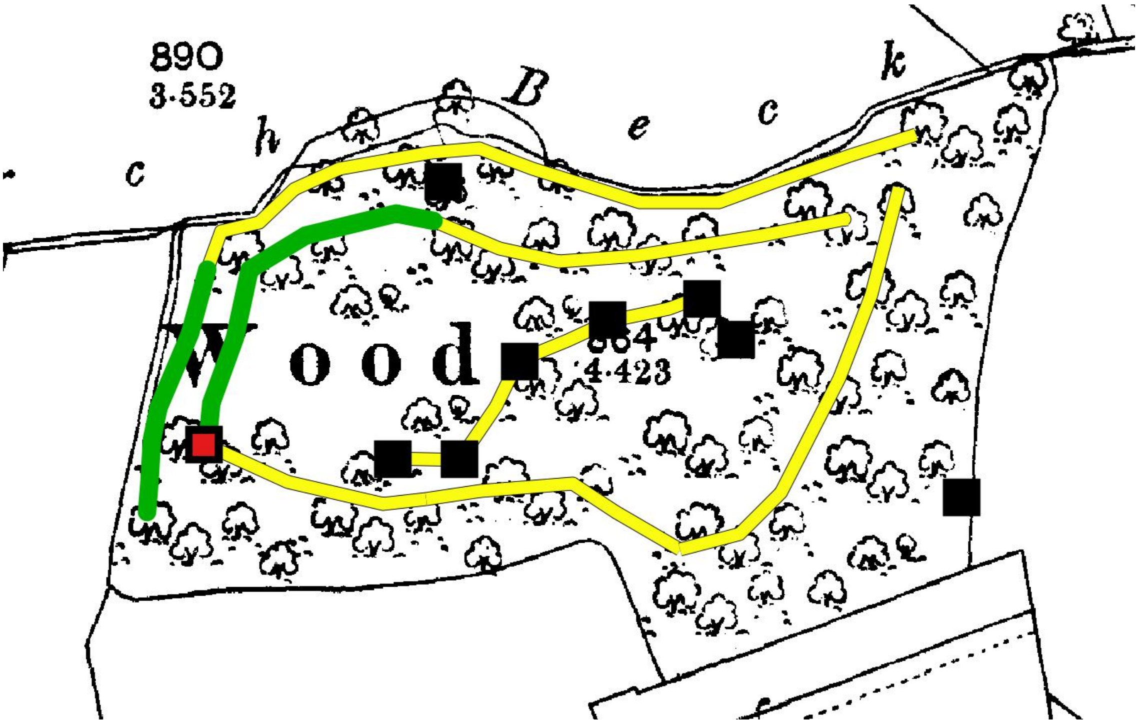


Figure 8.14 – *Lamiastrum galeobdolon*

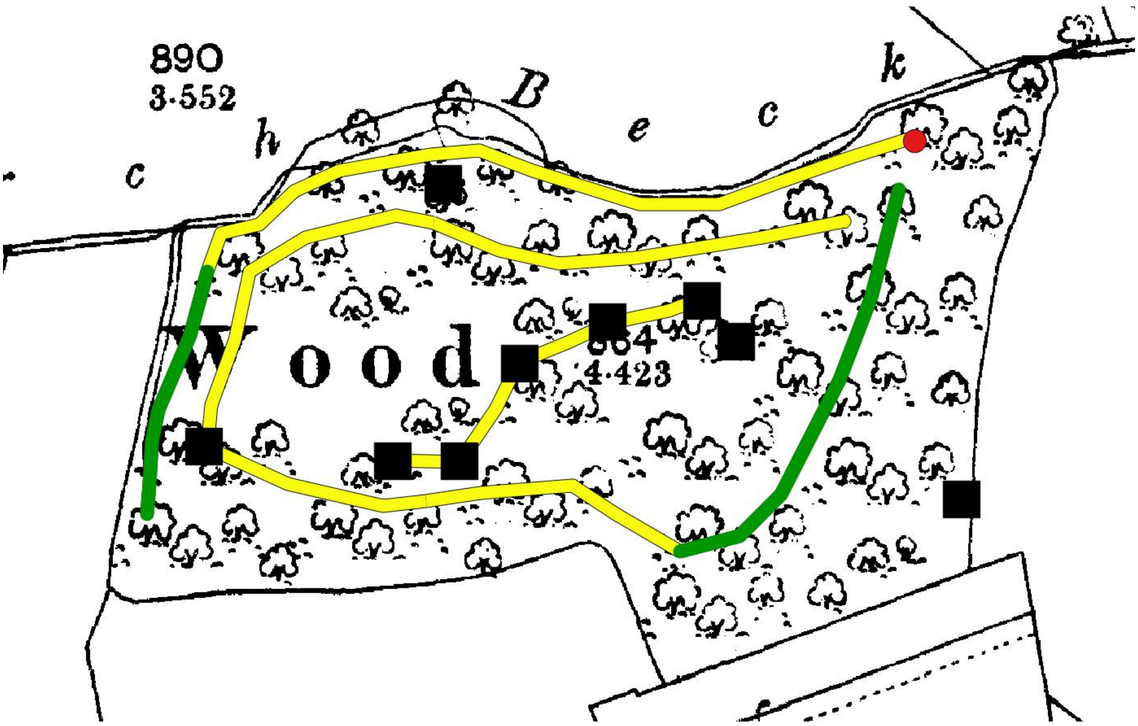
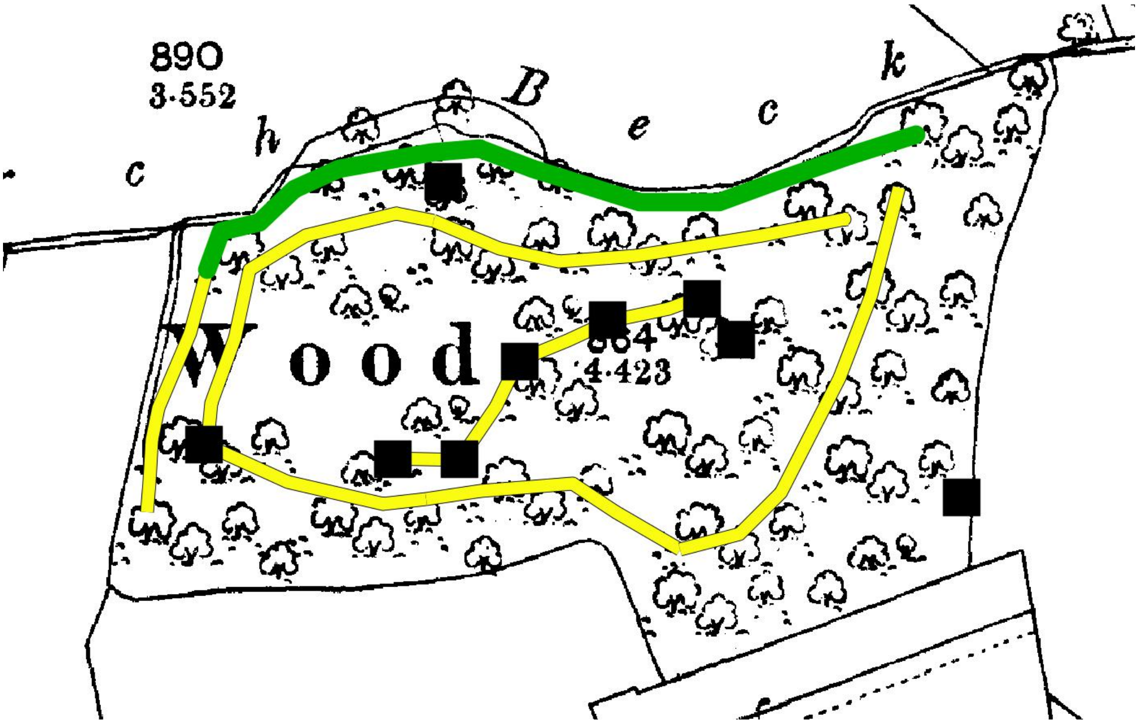
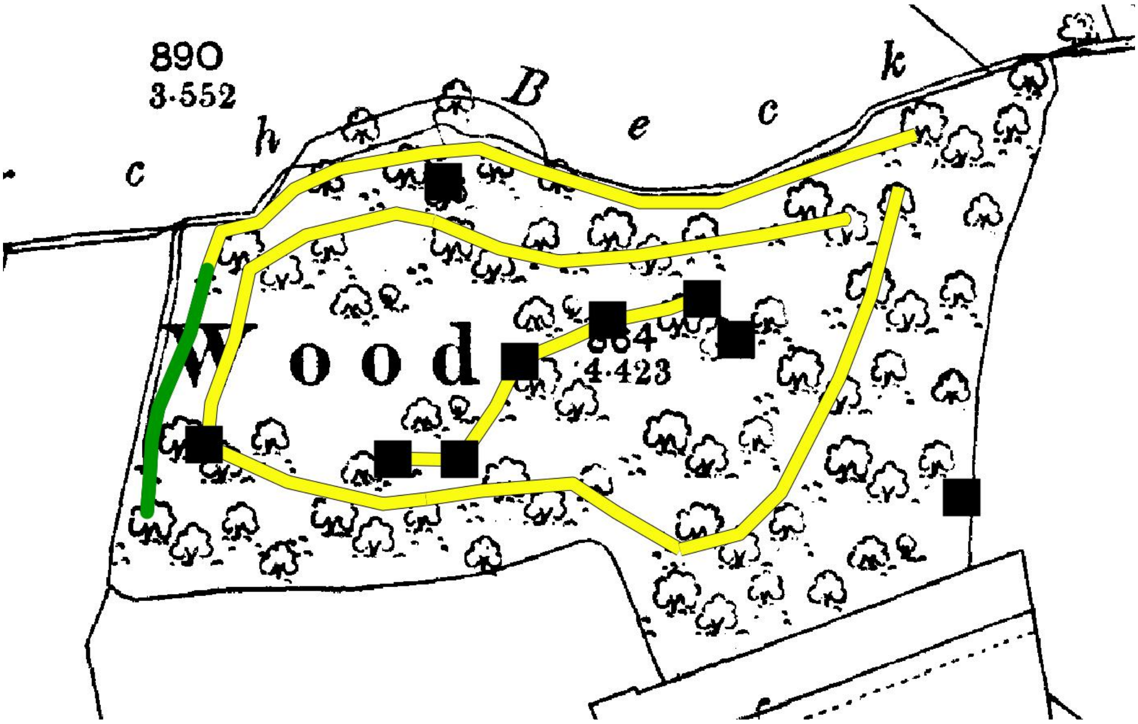


Figure 8.15 – *Melica uniflora*

Appendix 13 - Results for Church Wood

Species maps for Church Wood
 Figure 9.16 – *Mercurialis perennis*
 Figure 9.17 – *Milium effusum*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

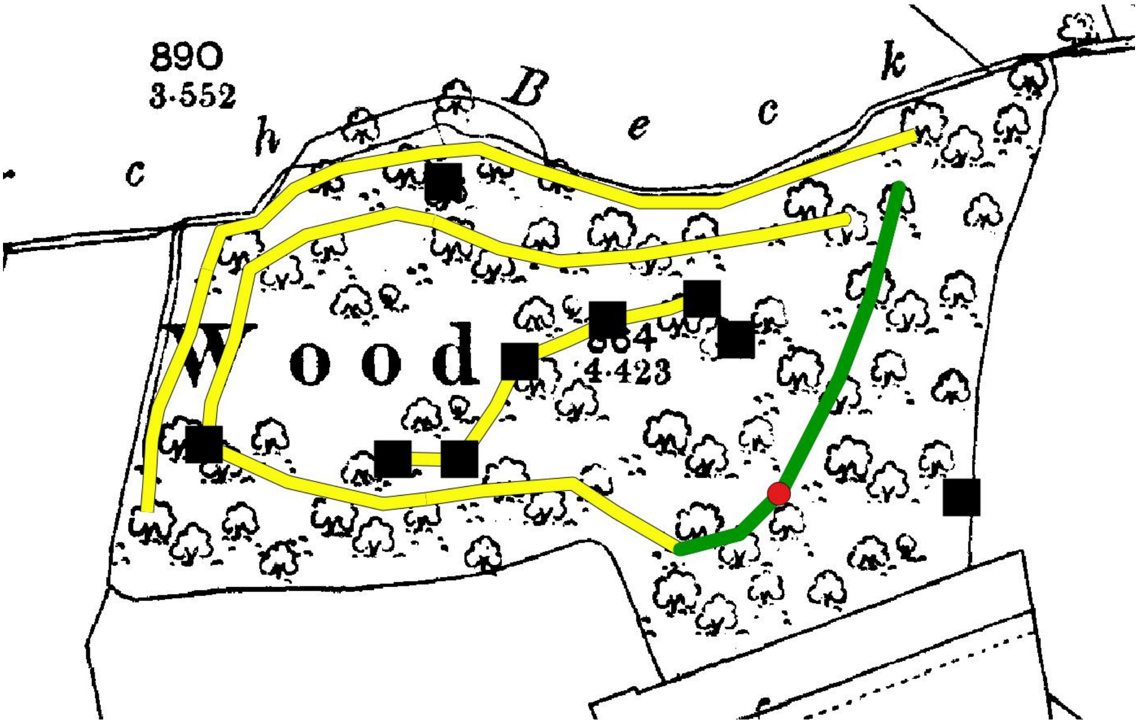


Figure 10.18– *Polystichum setiferum*

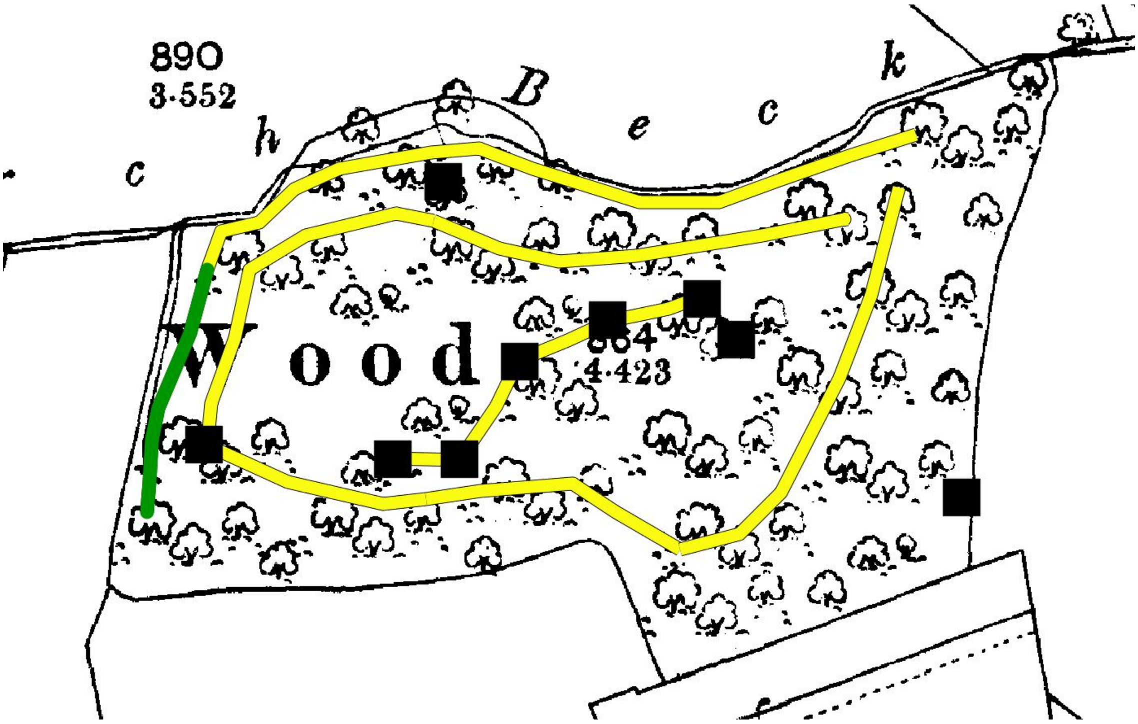


Figure 10.19 – *Prunus avium*

Appendix 13 - Results for Church Wood

Species maps for Church Wood

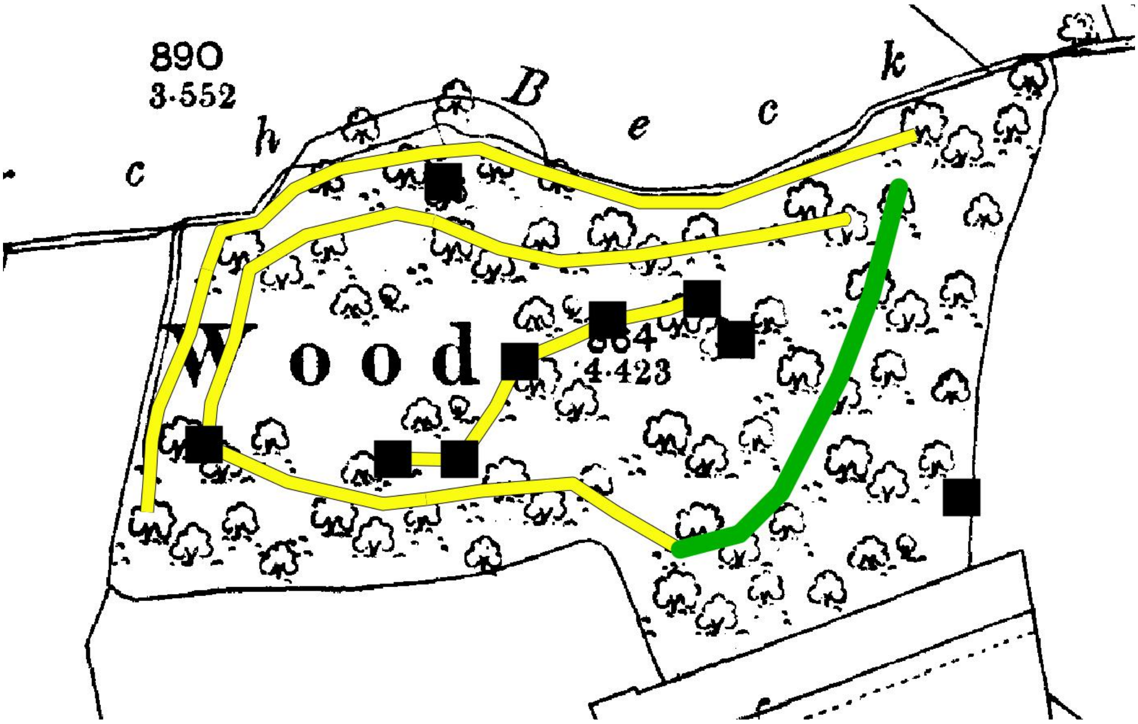


Figure 11.20 – *Ranunculus ficaria*

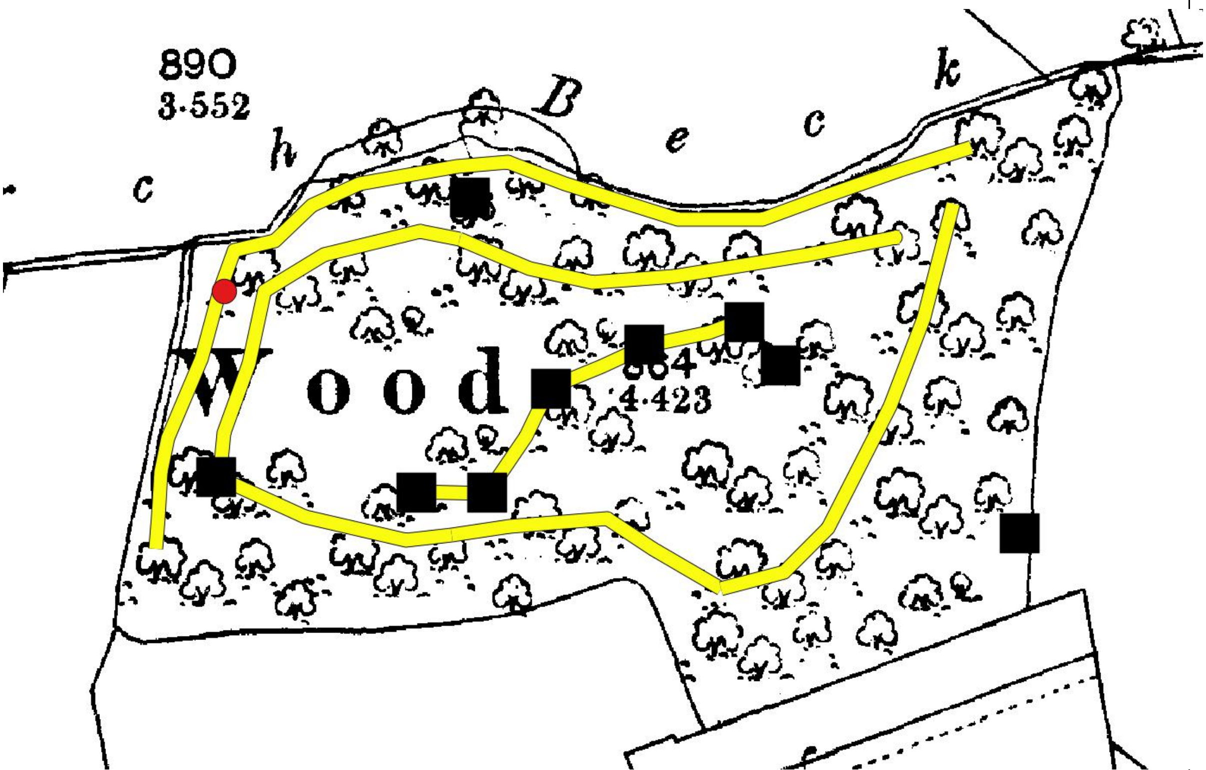
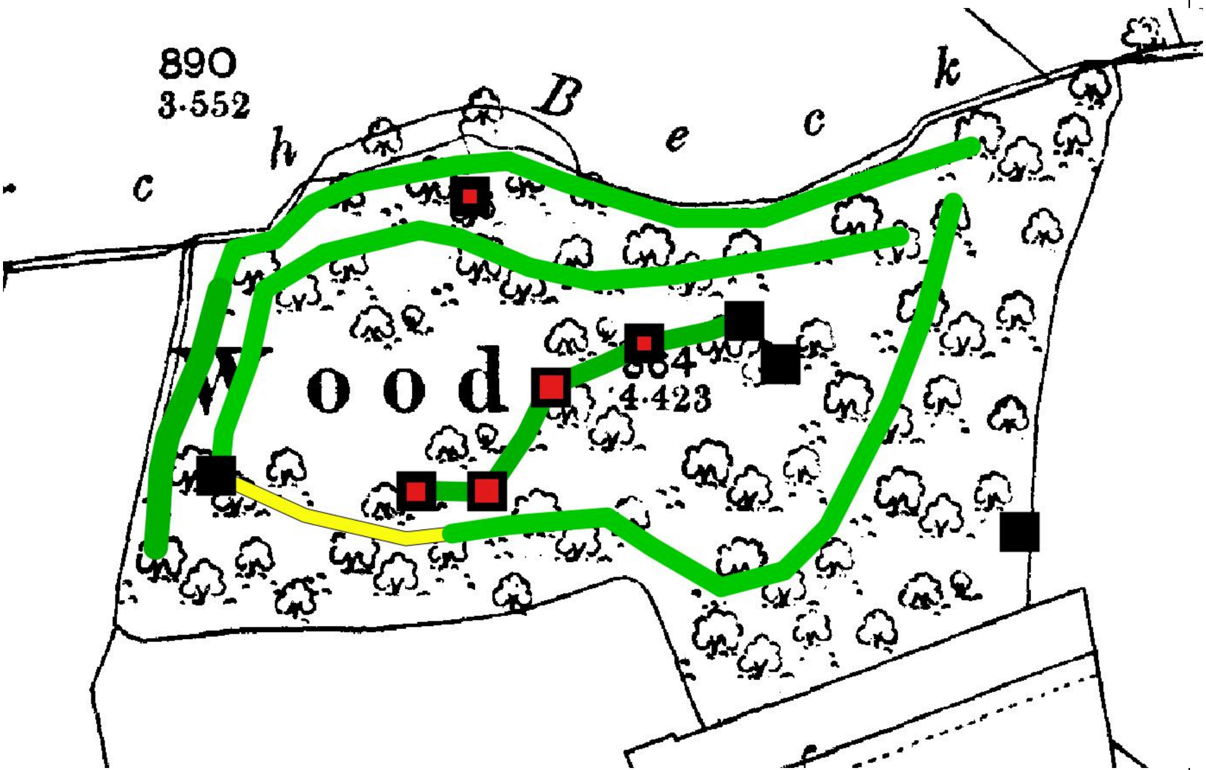
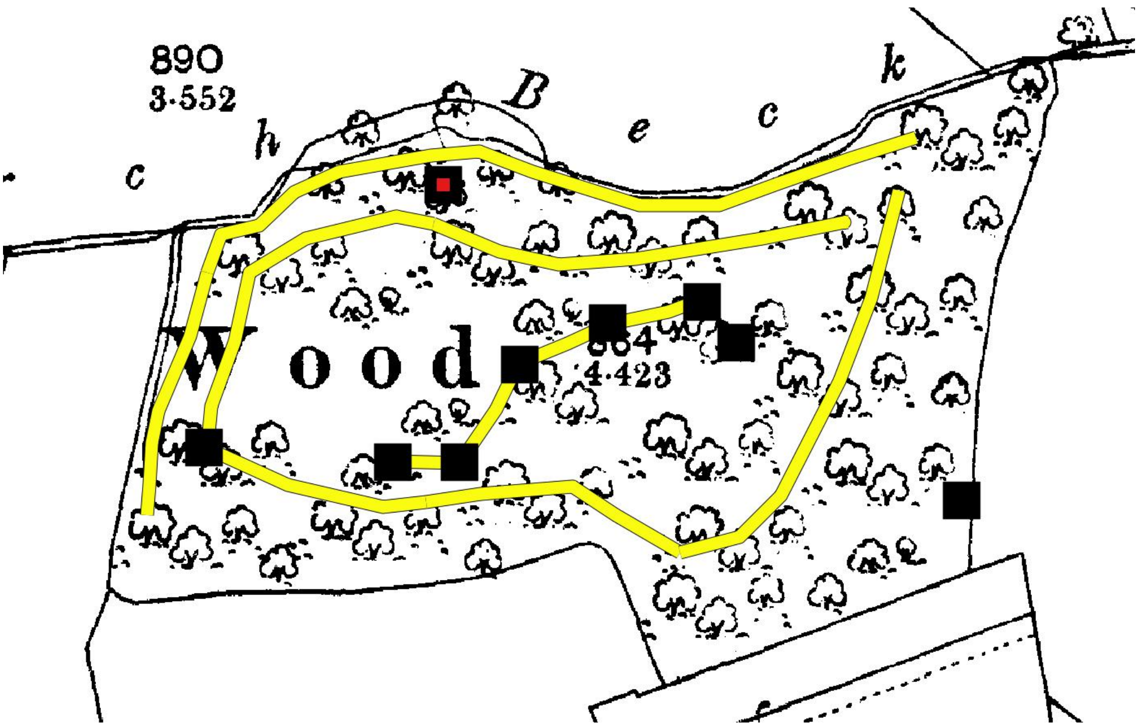
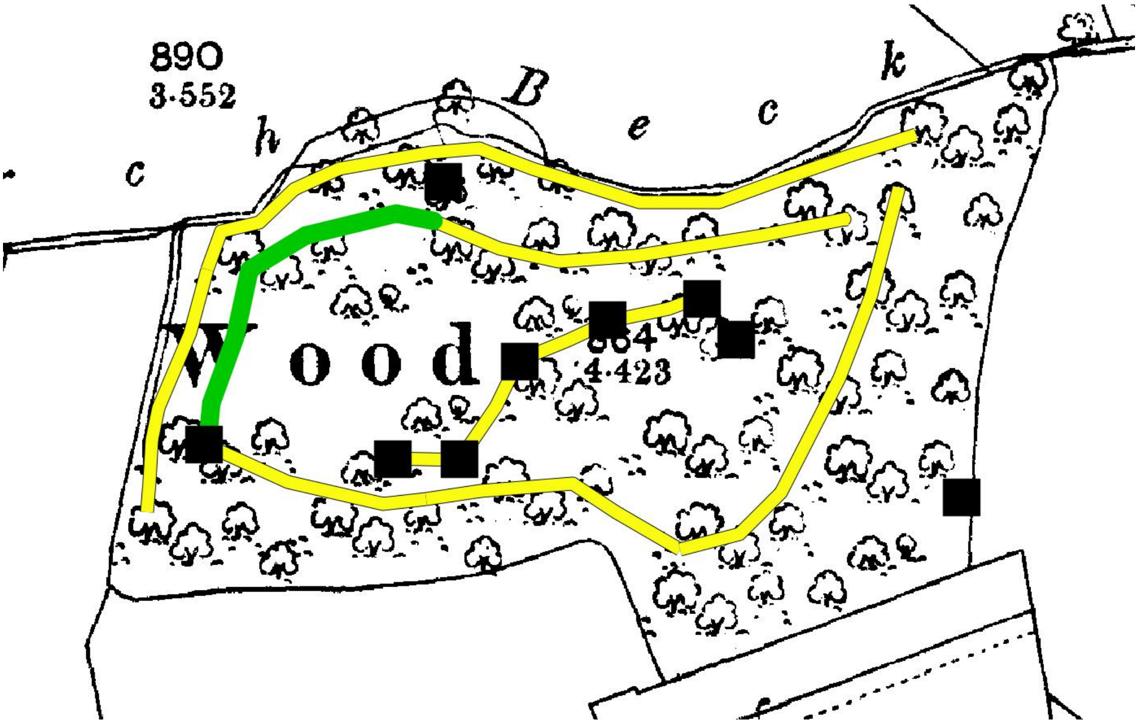
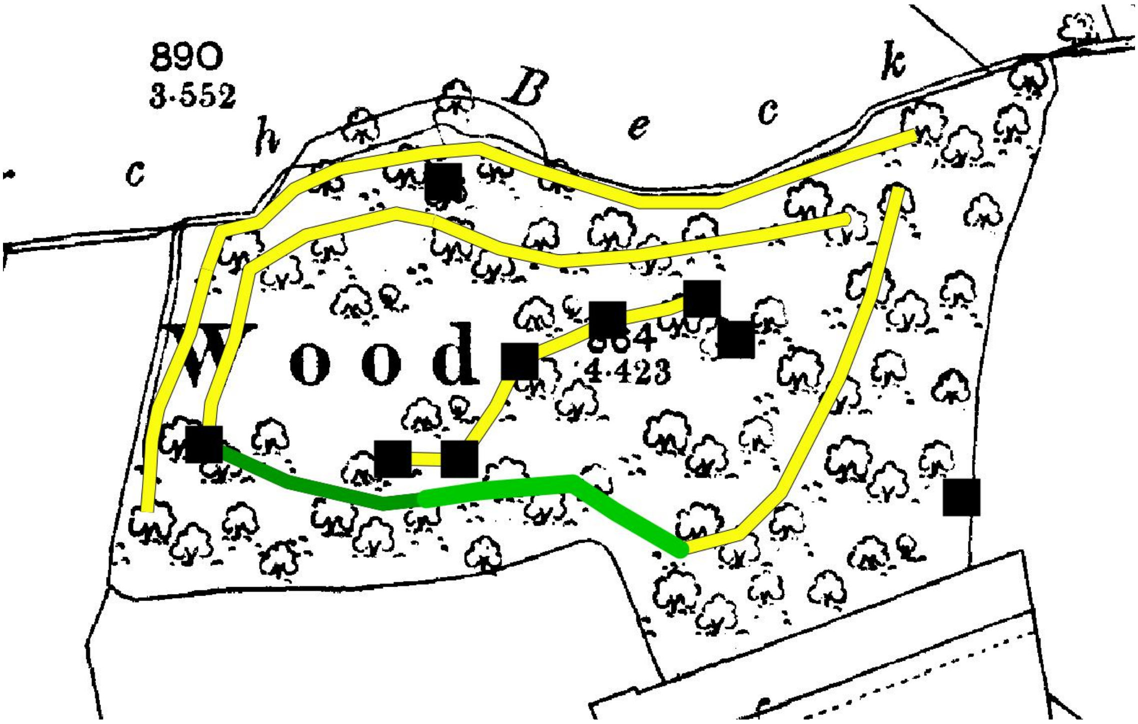


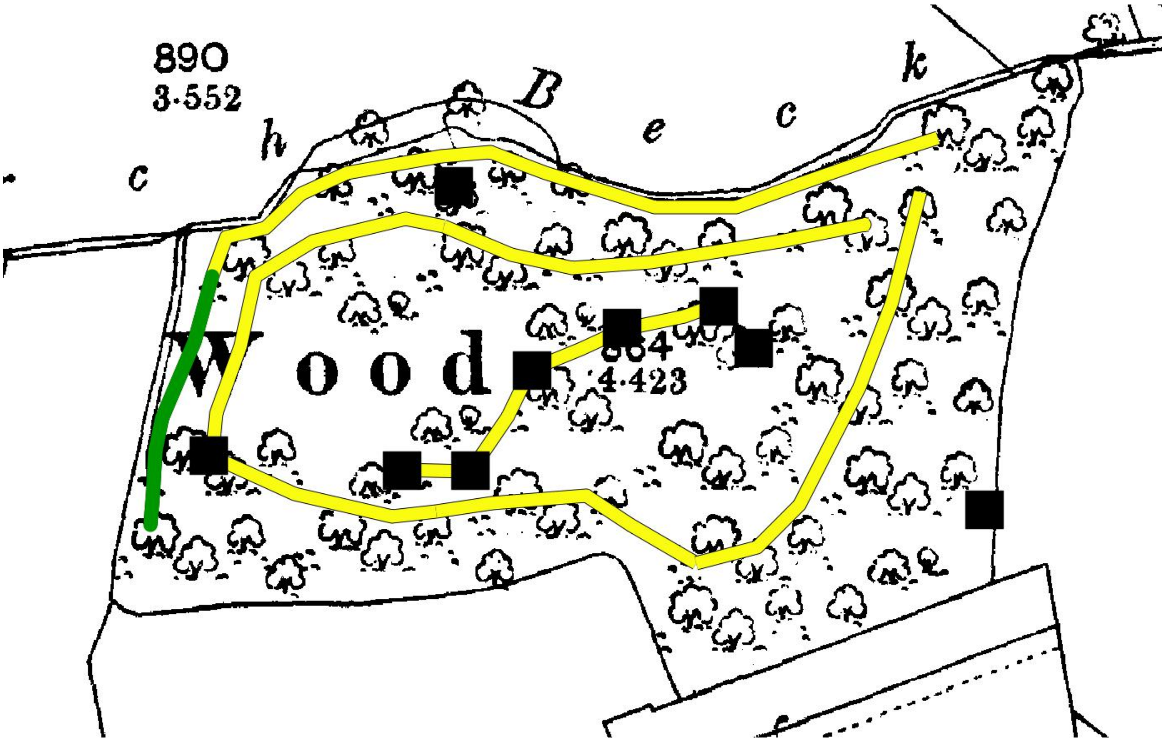
Figure 11.21 – *Ribes uva-crispa*

Appendix 13 - Results for Church Wood

Species maps for Church Wood
 Figure 12.22 – *Rubus fruticosus*
 Figure 12.23 – *Rubus idaeus*

Species maps for Church Wood
 Figure 13.24 – *Rumex sanguinea*
 Figure 13.25 – *Sorbus aucuparia*

Appendix 13 - Results for Church Wood

Species maps for Church Wood
 Figure 14.26 – *Stachys sylvatica*

Appendix 13 - Results for Church Wood

Table 15.1 - Species data for Church Wood, Birstall.

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - Transects; DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare). 1-5 = DAFOR (quadrat), 9 = point present.
Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number.
Quadrat/ Point record reference ID (Waypoint reference - device letter prefix and waypoint number).

	Transect								Quadrat/ Point Record																							
SPECIES	CL659-CL661	CL661-CL663	CL661-CL664	CL664-CL666	CL666-CL668	CL669-CL671	CL671-CL673	CL674-CL678	CL659	CL660	CL661	CL662	CL663	CL664	CL665	CL666	CL667	CL668	CL669	CL670	CL671	CL672	CL673	CL674	CL675	CL676	CL677	CL678	CL679	CL680	CL681	CL682
Ace-Cam					22																											
ACE-CAM					22																											
Ace-Pse	11	22	22		22	22	22																									
ACE-PSE	11	22	22		22	22	22																									
aes-hip					22																											
all-urs	14	22			22	35	55																							1		
ane-nem		11			25	11																										
aru-mac				24	24																											
ath-fil					11	22																										
BARE	34	33	33			35																										
BET-PEN					11	22																										
car-rem	11				11	11																										
car-syl					11																											
cha-ang		11			11																											
Cra-Mon		11	22	22		22	12						1																			
dac-glo		11	11										2																			
dry-dil	11	11		22	22	22	11	11																		1				1		

Appendix 13 - Results for Church Wood

Table 15.1 - Species data for Church Wood, Birstall.

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - Transects; DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare). 1-5 = DAFOR (quadrat), 9 = point present.
Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number.
Quadrat/ Point record reference ID (Waypoint reference - device letter prefix and waypoint number).

	Transect								Quadrat/ Point Record																							
SPECIES	CL659-CL661	CL661-CL663	CL661-CL664	CL664-CL666	CL666-CL668	CL669-CL671	CL671-CL673	CL674-CL678	CL659	CL660	CL661	CL662	CL663	CL664	CL665	CL666	CL667	CL668	CL669	CL670	CL671	CL672	CL673	CL674	CL675	CL676	CL677	CL678	CL679	CL680	CL681	CL682
dry-fil							11	11														9										
Fag-Syl		22					22																									
FAG-SYL							11																									
Fra-Exc	22	33	22		33	22																								1		
FRA-EXC			22			22																										
gal-apa					11		11																									
geu-urb	11	22	22	22	22								2																			
hed-hel						24		11																1								
her-sph		11					11																									
hol-mol	34	44		44	34			24																	3	5	5	5				
hya-non	22	44	33	44	34	34	33	33					4																1	5	5	
Ile-Aqu	33			22	22	33	22																									
imp-gla				22	22	11																										
lam-gal		24					24						3																			
LITTER	44	22						44																4	4	4	4	4	5	3	2	
mel-uni					11		14												9													
mer-per						24																										

Appendix 13 - Results for Church Wood

Table 15.1 - Species data for Church Wood, Birstall.

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - Transects; DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare). 1-5 = DAFOR (quadrat), 9 = point present.
Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number.
Quadrat/ Point record reference ID (Waypoint reference - device letter prefix and waypoint number).

	Transect								Quadrat/ Point Record																							
SPECIES	CL659-CL661	CL661-CL663	CL661-CL664	CL664-CL666	CL666-CL668	CL669-CL671	CL671-CL673	CL674-CL678	CL659	CL660	CL661	CL662	CL663	CL664	CL665	CL666	CL667	CL668	CL669	CL670	CL671	CL672	CL673	CL674	CL675	CL676	CL677	CL678	CL679	CL680	CL681	CL682
mil-eff							11																									
oxa-ace	11	24	24		24		24						4																			
pol-set					11												9															
Pru-Avi							11																									
pte-aqu			33		22																			5						1		
Que-Rob	33	22	22		22	22		22																								
QUE-ROB	55	55	55		55	44		44																	5	4	4					
ran-fic					24																											
ran-acr		11	11																													
ran-rep		11																														
Rib-Uva																					9											
rub-fru	22	22		22	22	22	33	24																2	3	3	1				1	
rum-san		22																														
Rub-Ide																															1	
Sam-Nig			11			22	11																									
Sor-Auc			11	22																												
sta-syl							11																									

Appendix 13 - Results for Church Wood

Table 15.1 - Species data for Church Wood, Birstall.

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - Transects; DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare). 1-5 = DAFOR (quadrat), 9 = point present.
Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number.
Quadrat/ Point record reference ID (Waypoint reference - device letter prefix and waypoint number).

	Transect								Quadrat/ Point Record																							
SPECIES	CL659-CL661	CL661-CL663	CL661-CL664	CL664-CL666	CL666-CL668	CL669-CL671	CL671-CL673	CL674-CL678	CL659	CL660	CL661	CL662	CL663	CL664	CL665	CL666	CL667	CL668	CL669	CL670	CL671	CL672	CL673	CL674	CL675	CL676	CL677	CL678	CL679	CL680	CL681	CL682
ste-med		24																														
TIL-SPP				11																												
Ulm-Gla			11		22	22	11																									
ULM-GLA				22		22																										
urt-dio		22			22		11																									

Appendix 14 - Results for Ecclesall Woods.

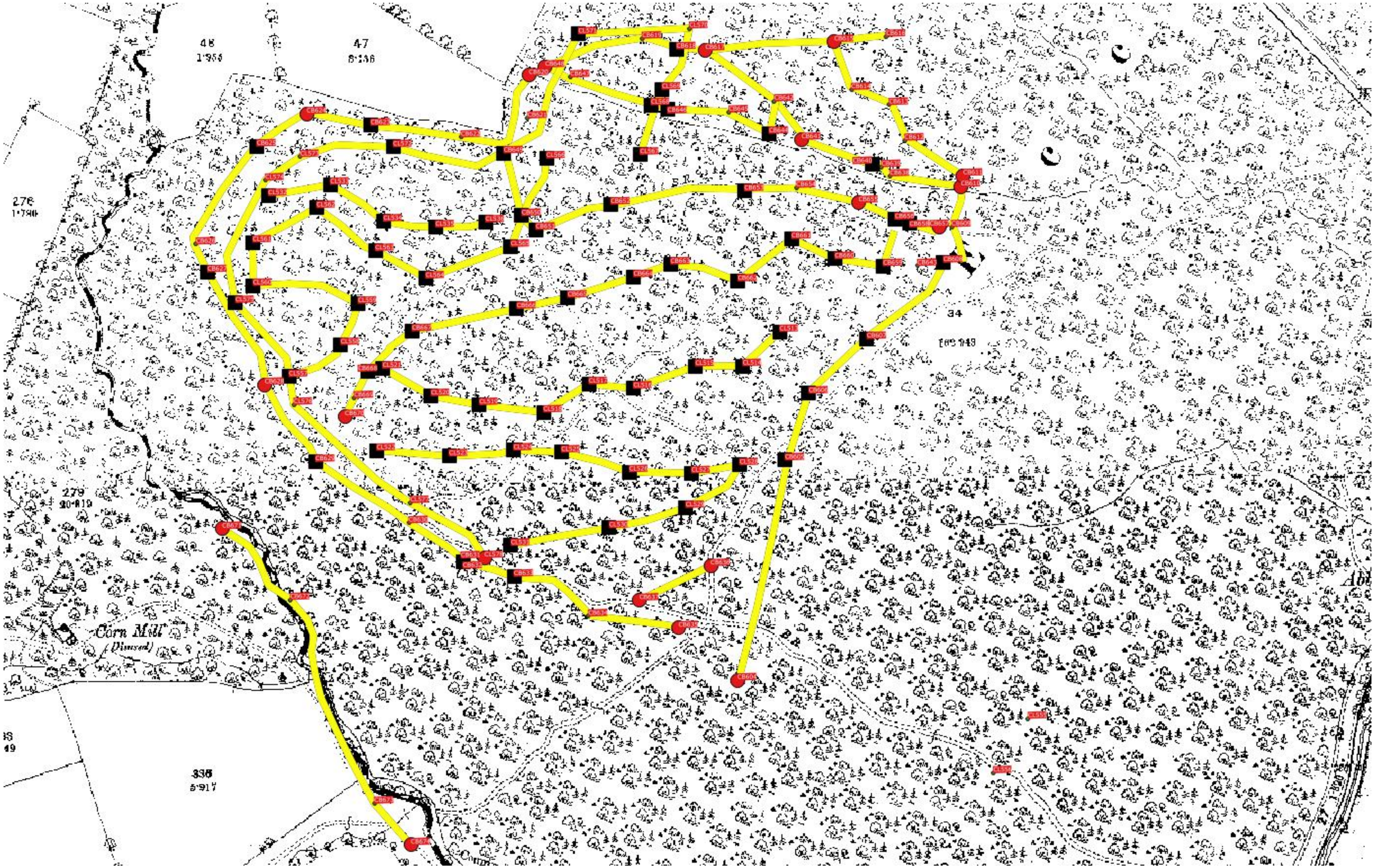


Figure 1.1 – Map of the 'Bird Sanctuary' of Ecclesall Woods showing the pattern of transects (yellow lines) and quadrat locations (black squares) used in the survey.

Appendix 14 - Results for Ecclesall Woods.

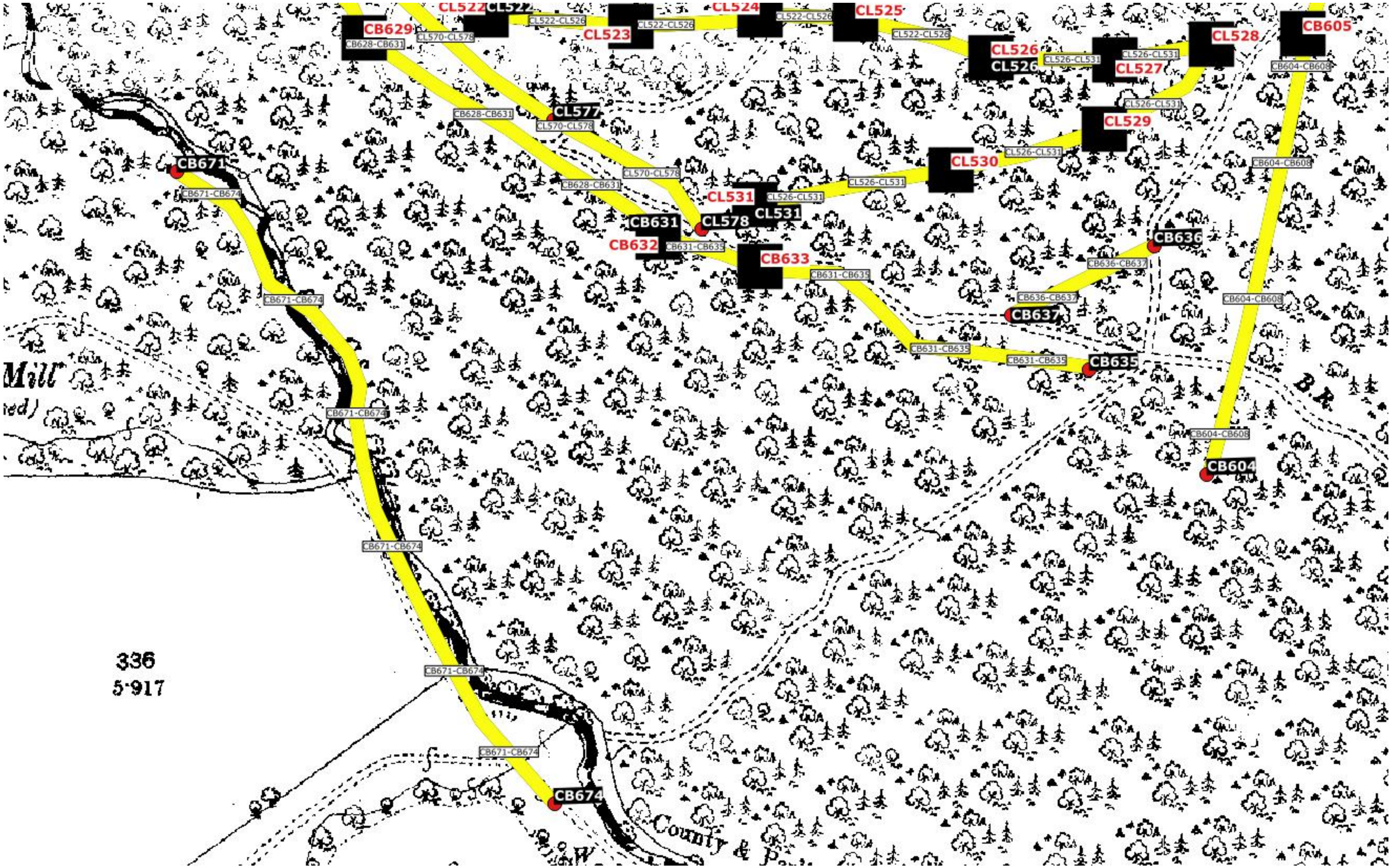


Figure 2.2 – Map of Ecclesall Woods - showing the transect lines (yellow) quadrat locations (black squares, red labels on white) and transect nodes (red circles, white labels on black) – part 01

Appendix 14 - Results for Ecclesall Woods.

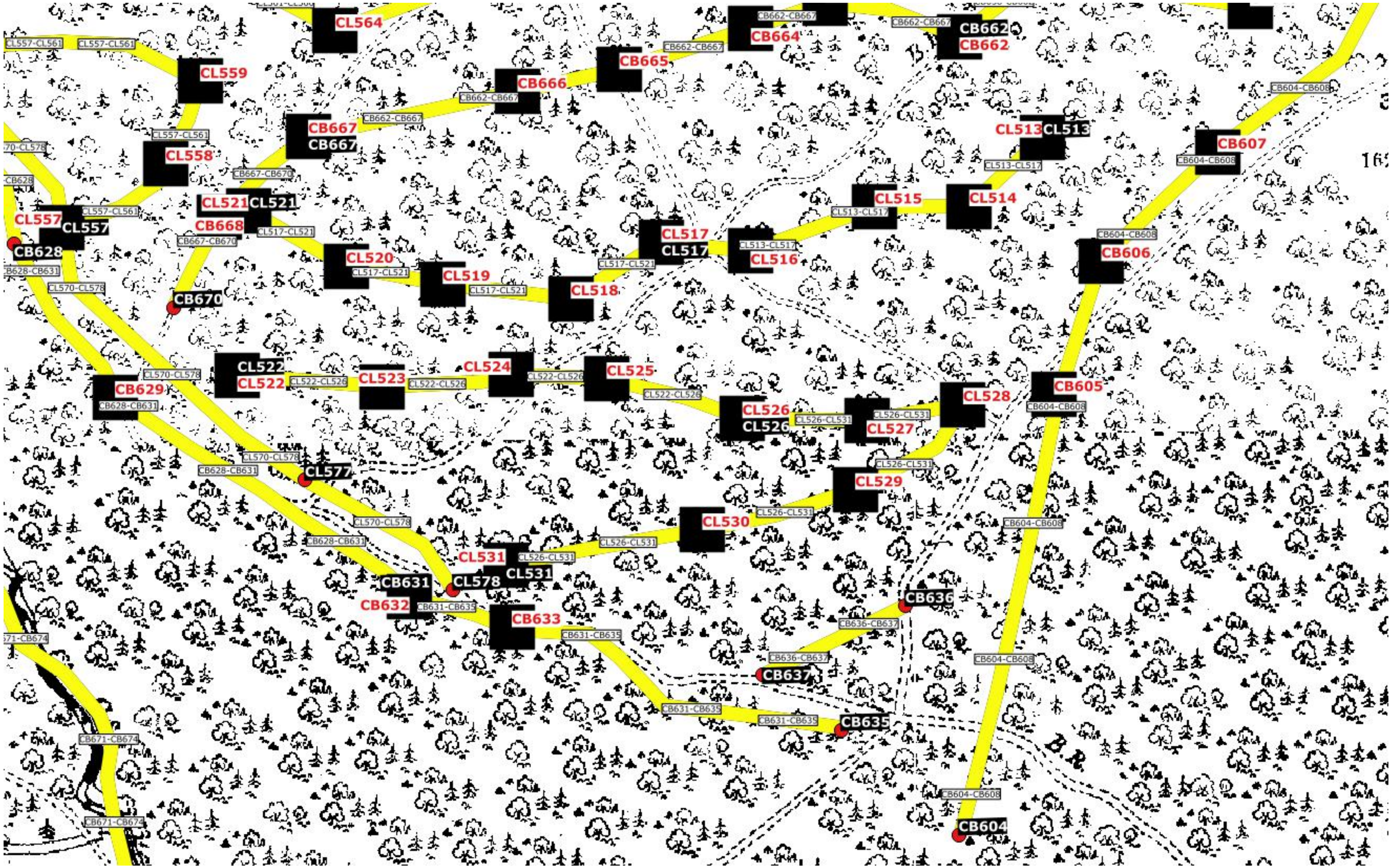


Figure 3.3 – Map of Ecclesall Woods - showing the transect lines (yellow) quadrat locations (black squares, red labels on white) and transect nodes (red circles, white labels on black) – part 02

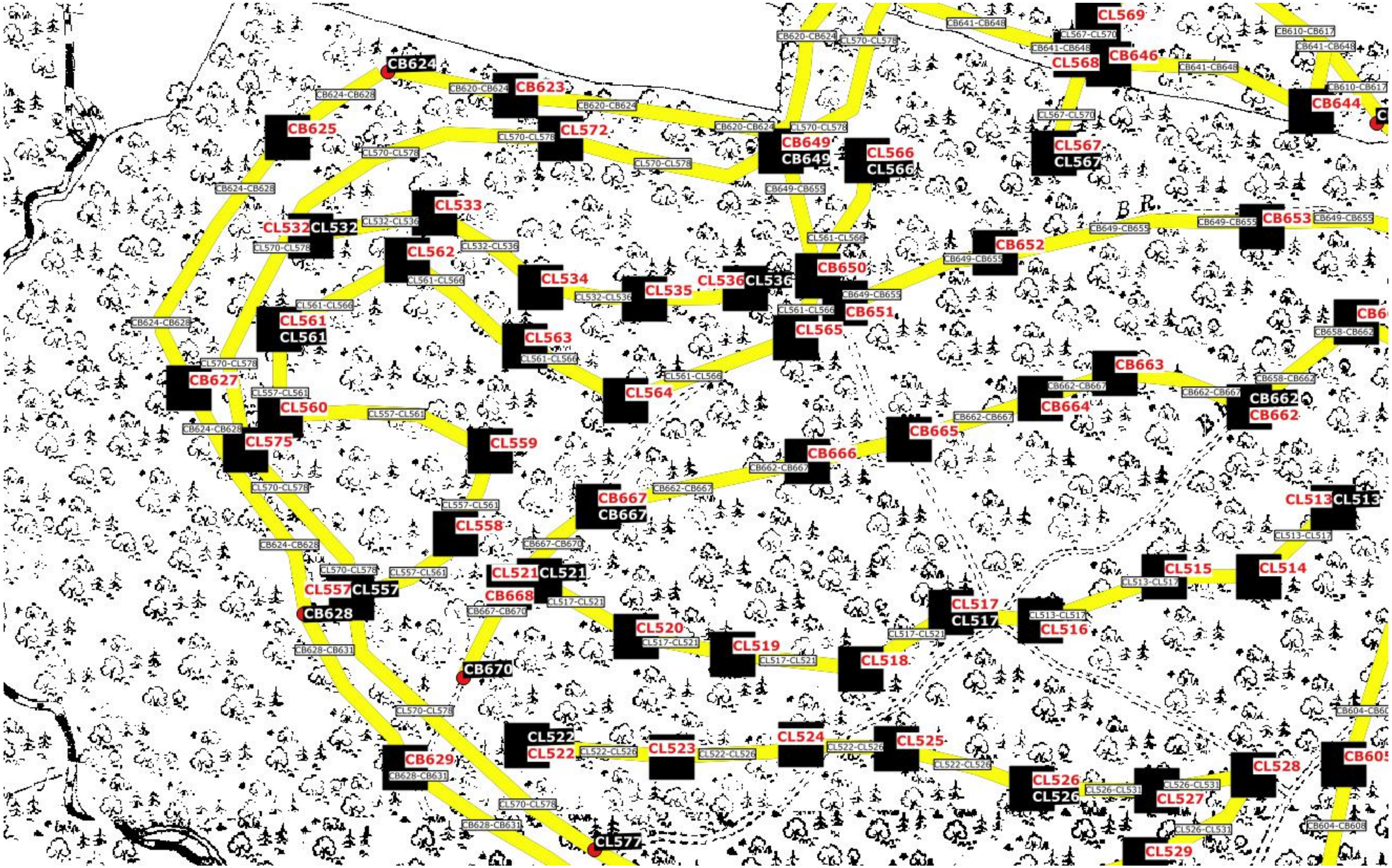


Figure 4.4 – Map of Ecclesall Woods - showing the transect lines (yellow) quadrat locations (black squares, red labels on white) and transect nodes (red circles, white labels on black) – part 03

Appendix 14 - Results for Ecclesall Woods.

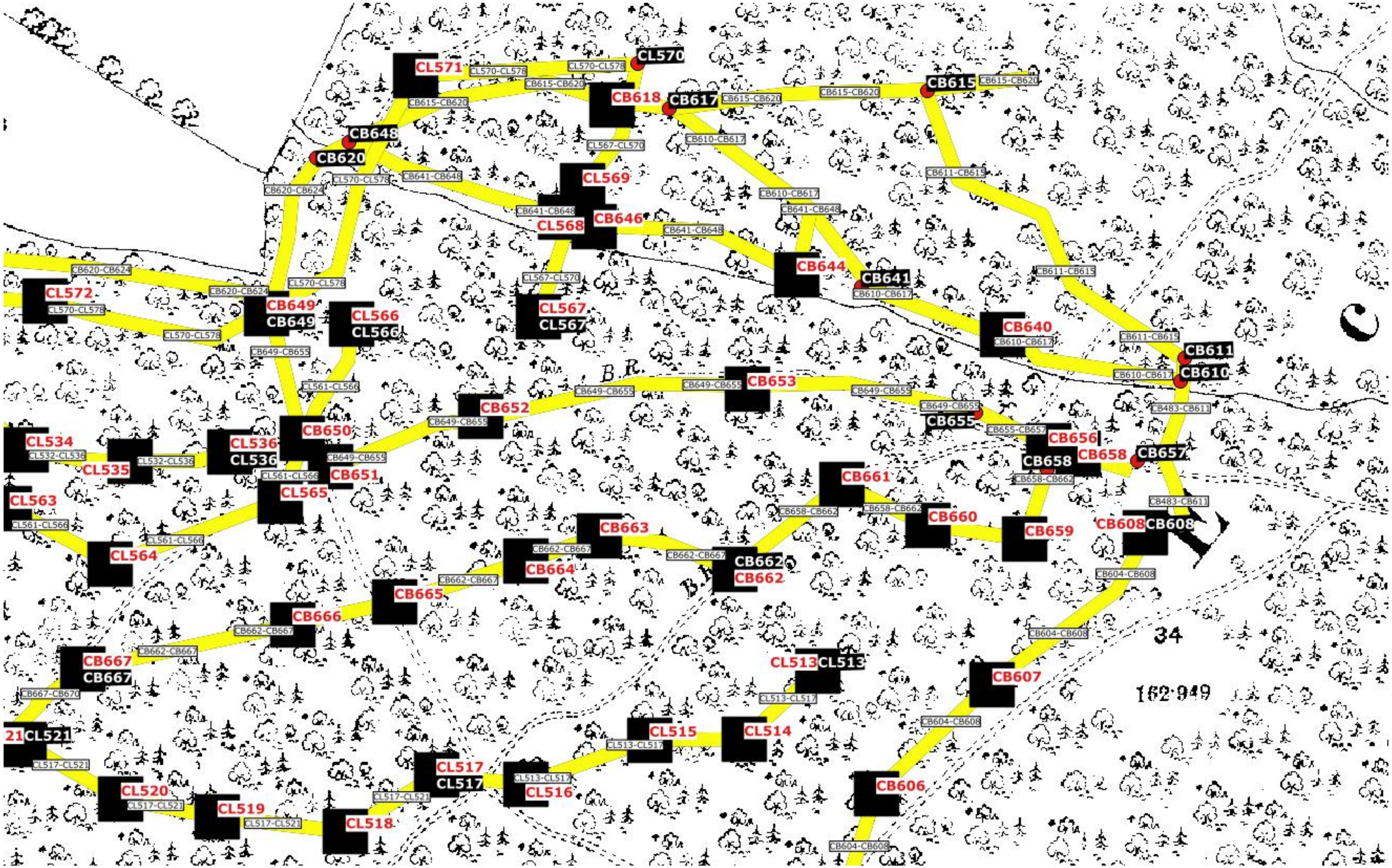


Figure 5.5 – Map of Ecclesall Woods - showing the transect lines (yellow) quadrat locations (black squares, red labels on white) and transect nodes (red circles, white labels on black) – part 04

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

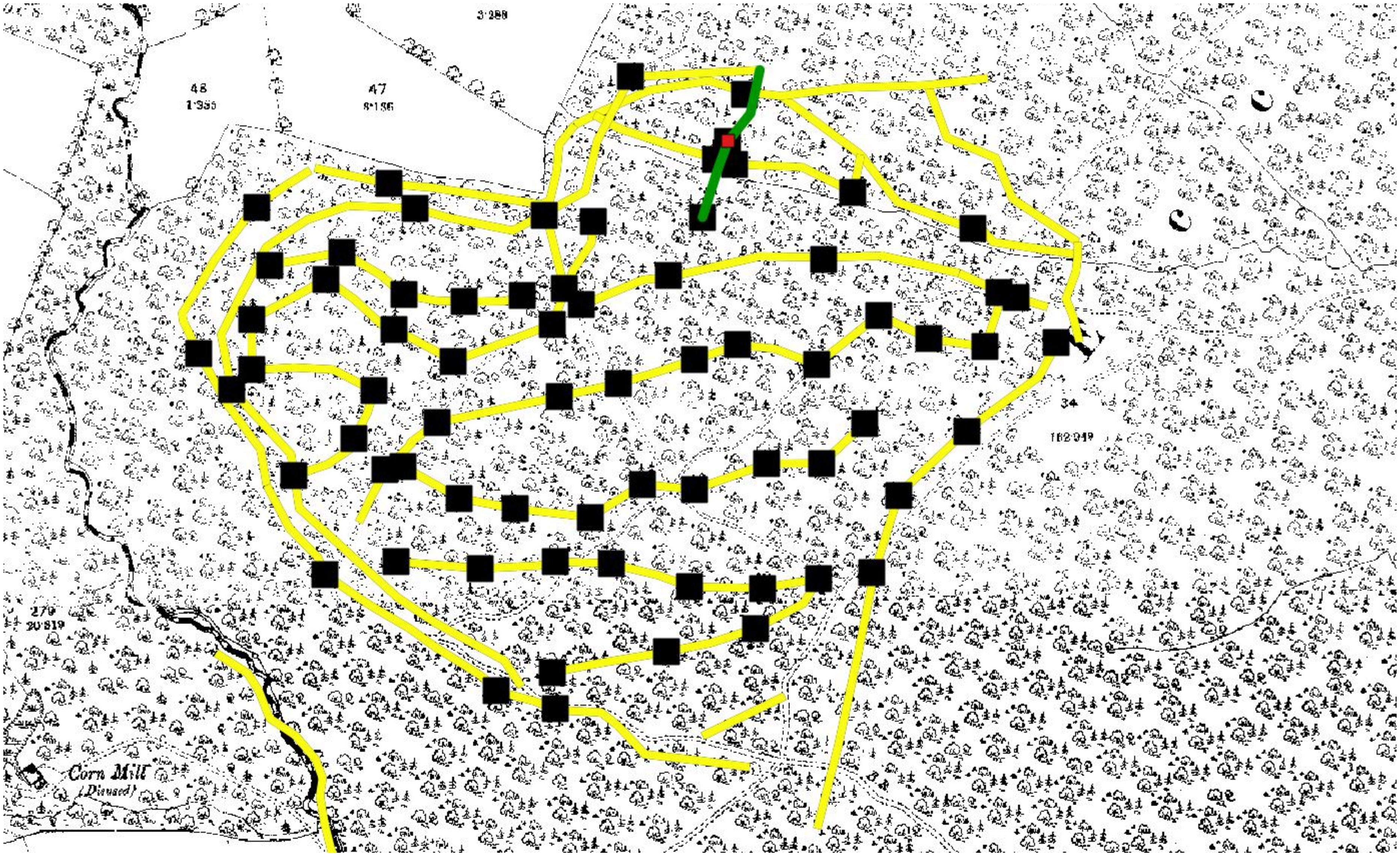


Figure 6.6 – *Ajuga reptans*

Species maps for Ecclesall Woods

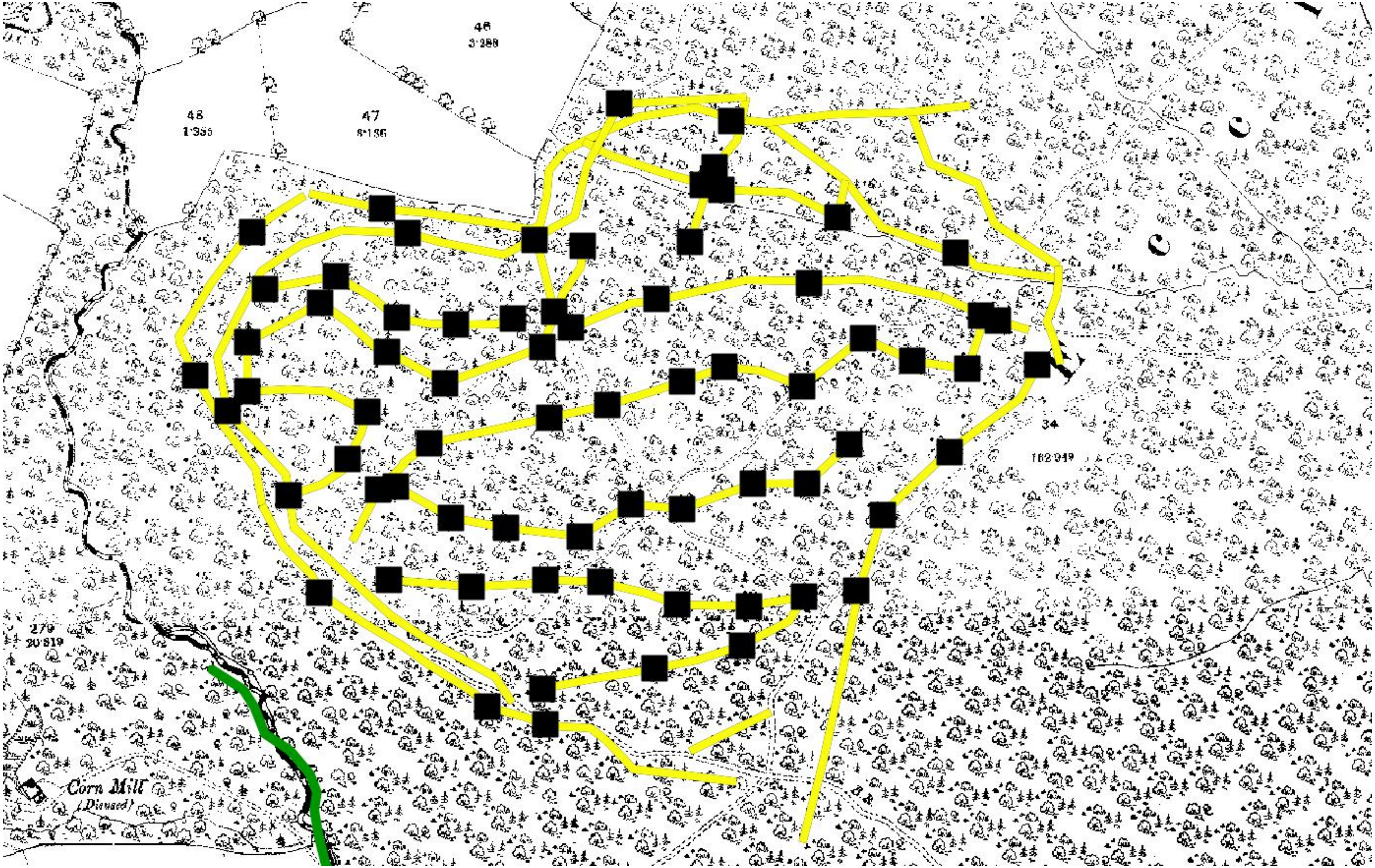


Figure 7.7 – *Allium ursinum*

Species maps for Ecclesall Woods

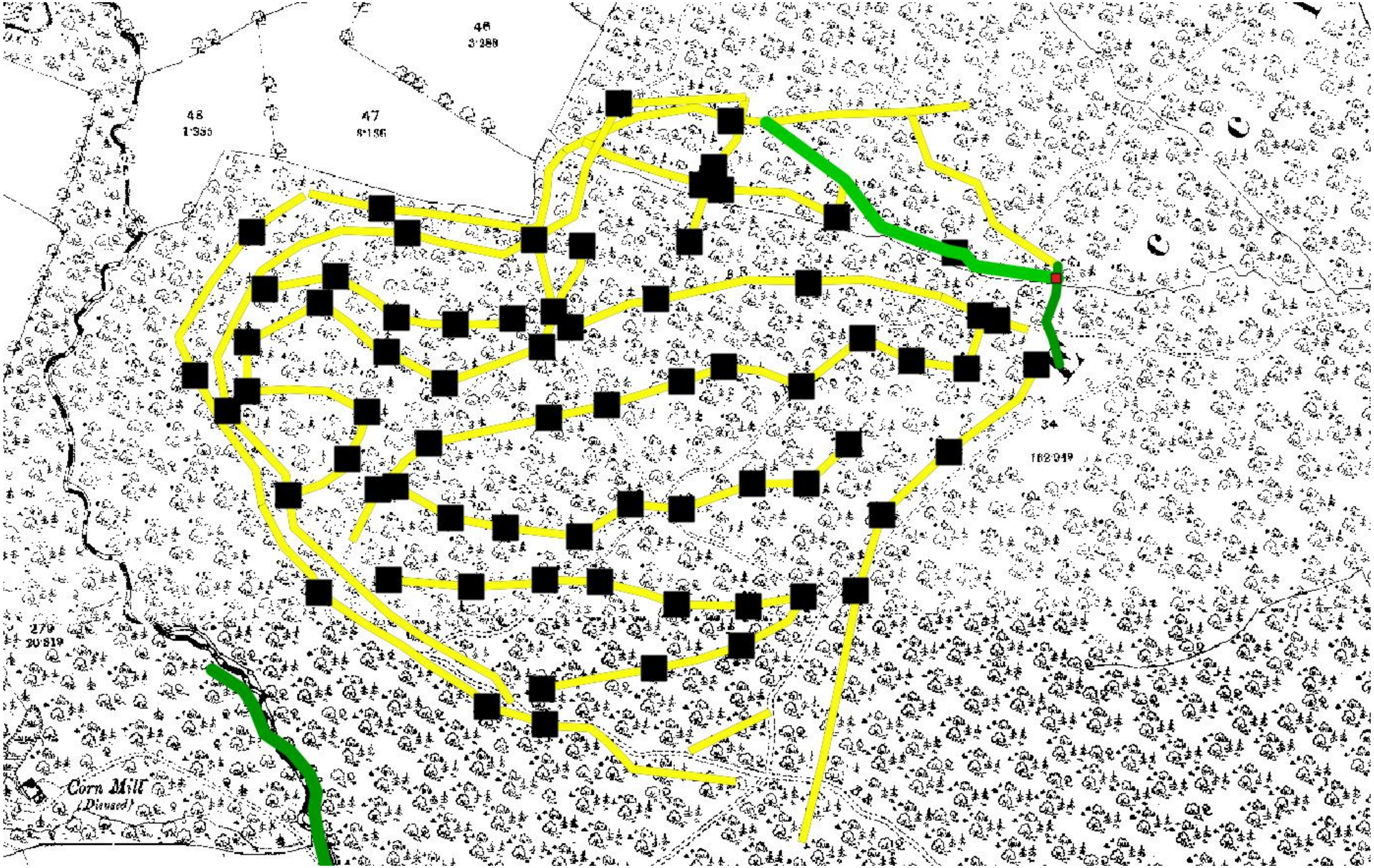


Figure 8.8 – *Anemone nemorosa*

Species maps for Ecclesall Woods

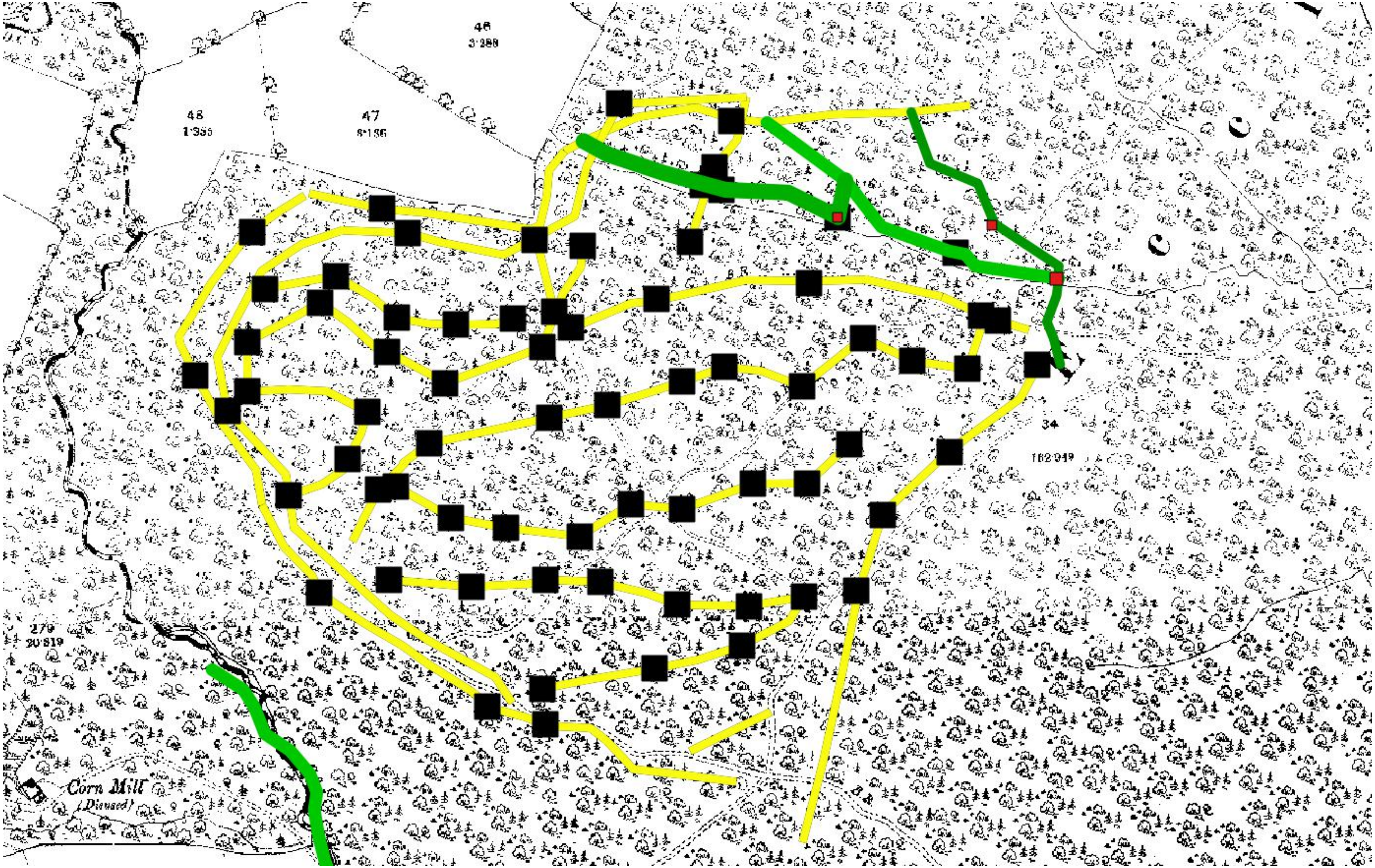


Figure 9.9 – *Athyrium filix-femina*

Species maps for Ecclesall Woods

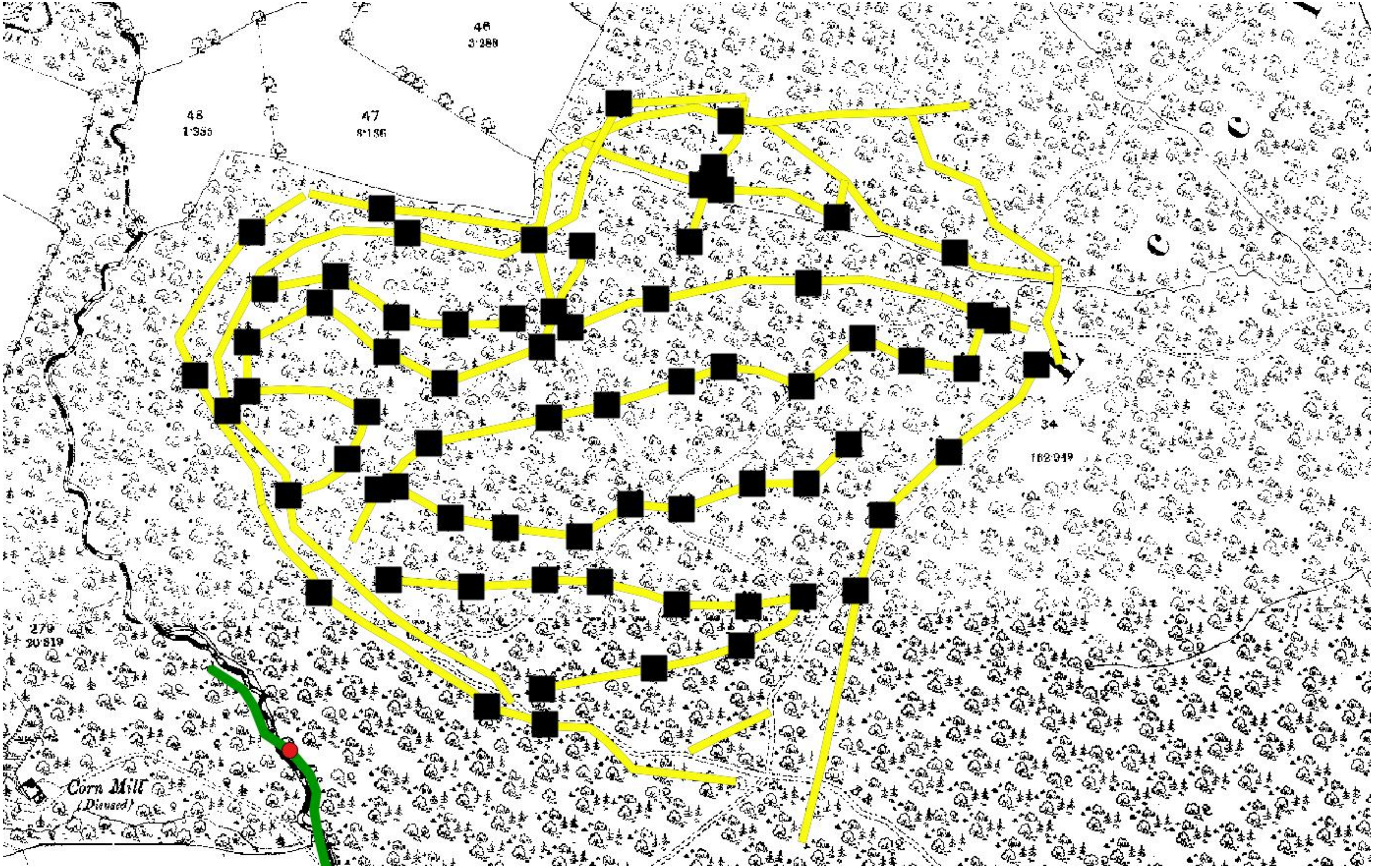


Figure 10.10 – *Blechnum spicant*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

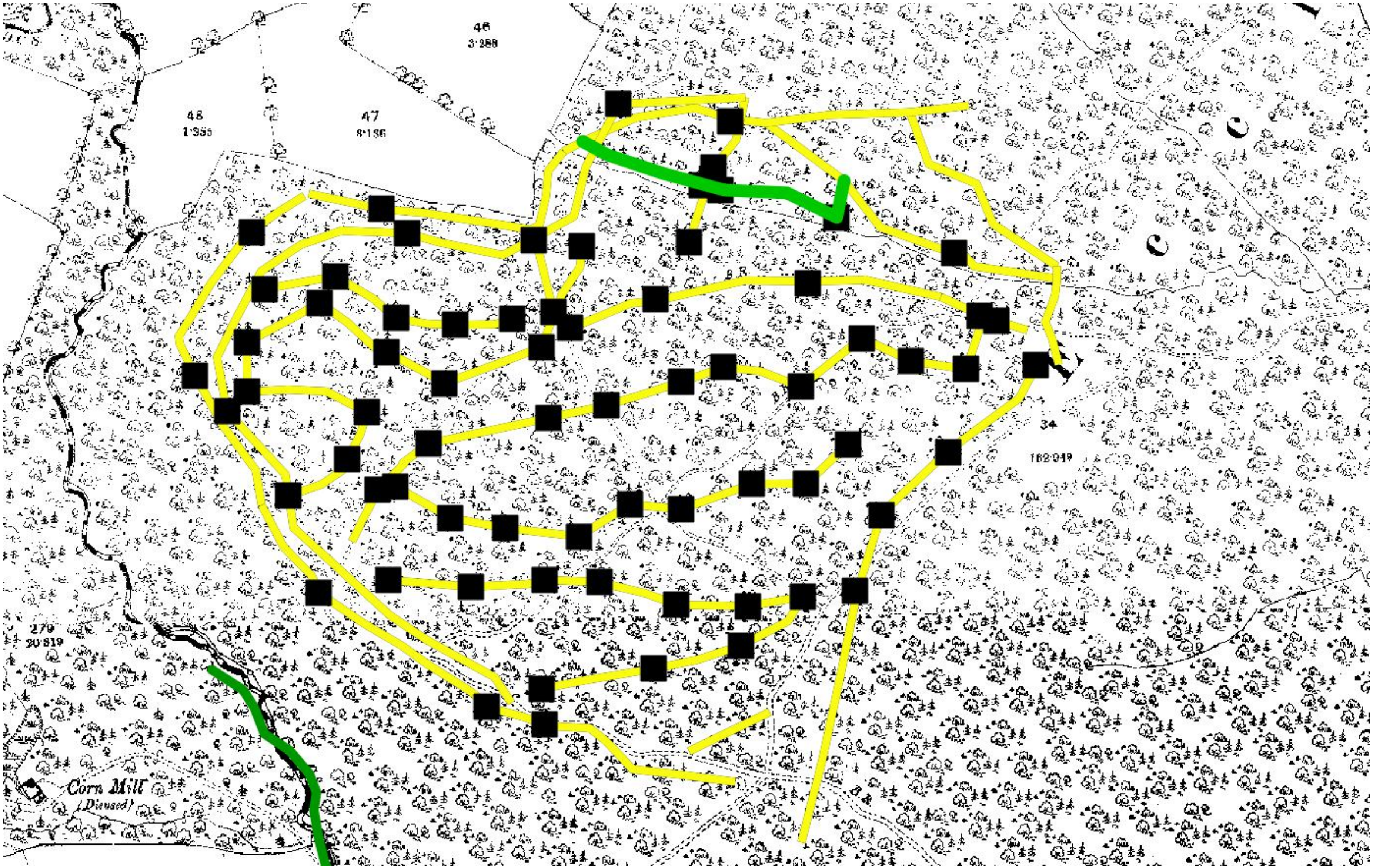


Figure 11.11 – *Brachypodium sylvaticum*

Species maps for Ecclesall Woods

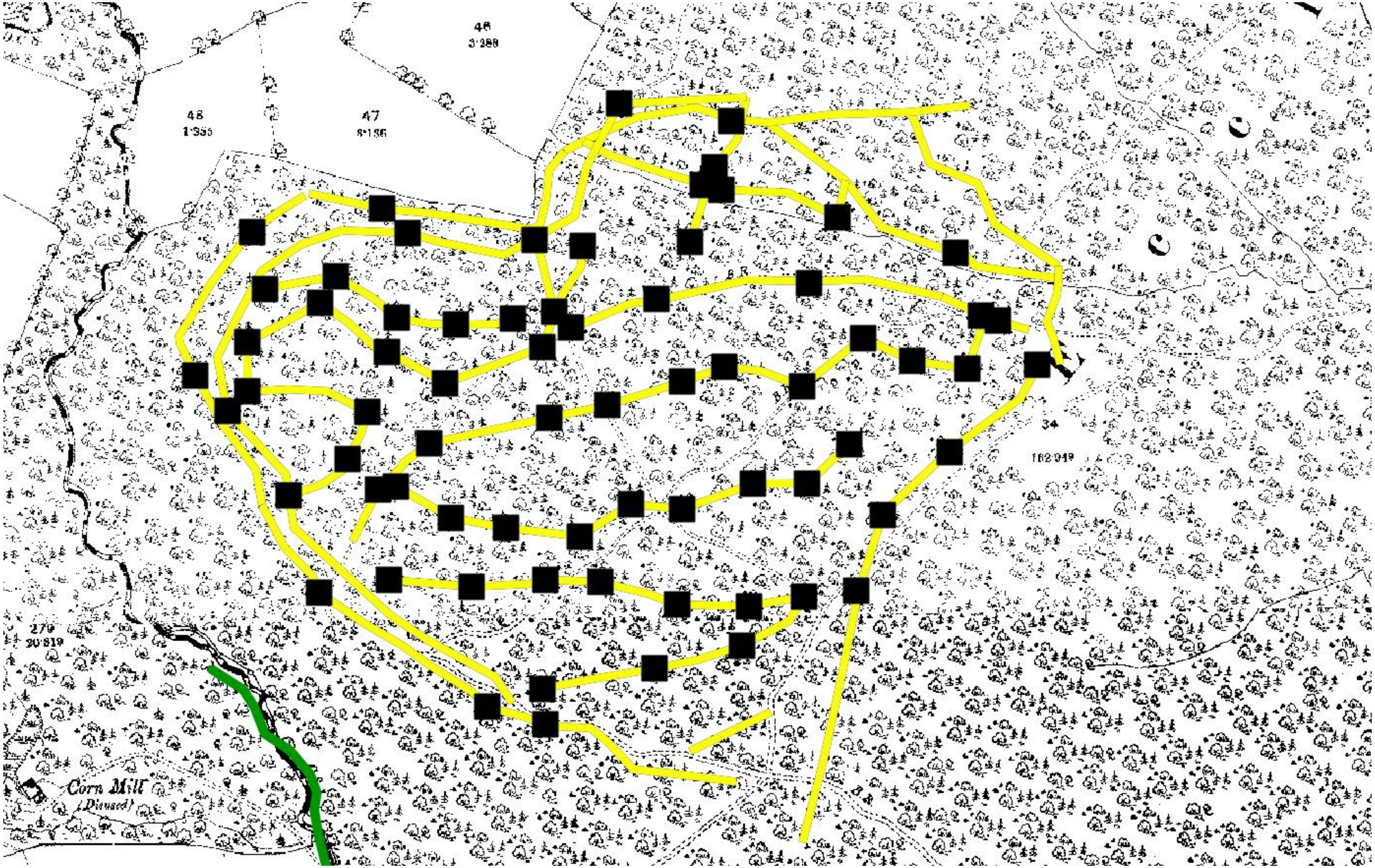


Figure 12.12 – *Cardamine amara*

Species maps for Ecclesall Woods

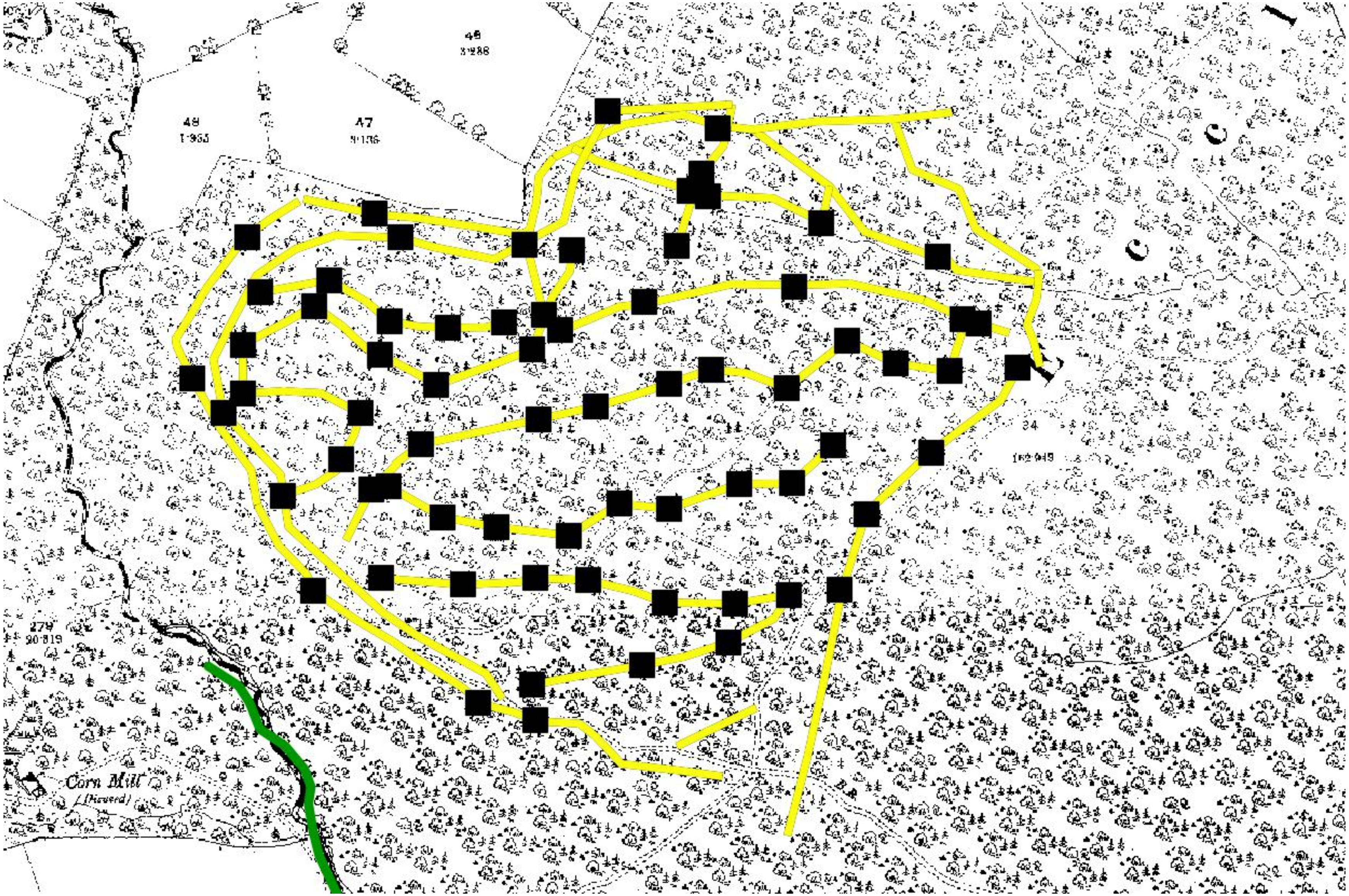


Figure 13.13 – Carex *pendula*

Species maps for Ecclesall Woods

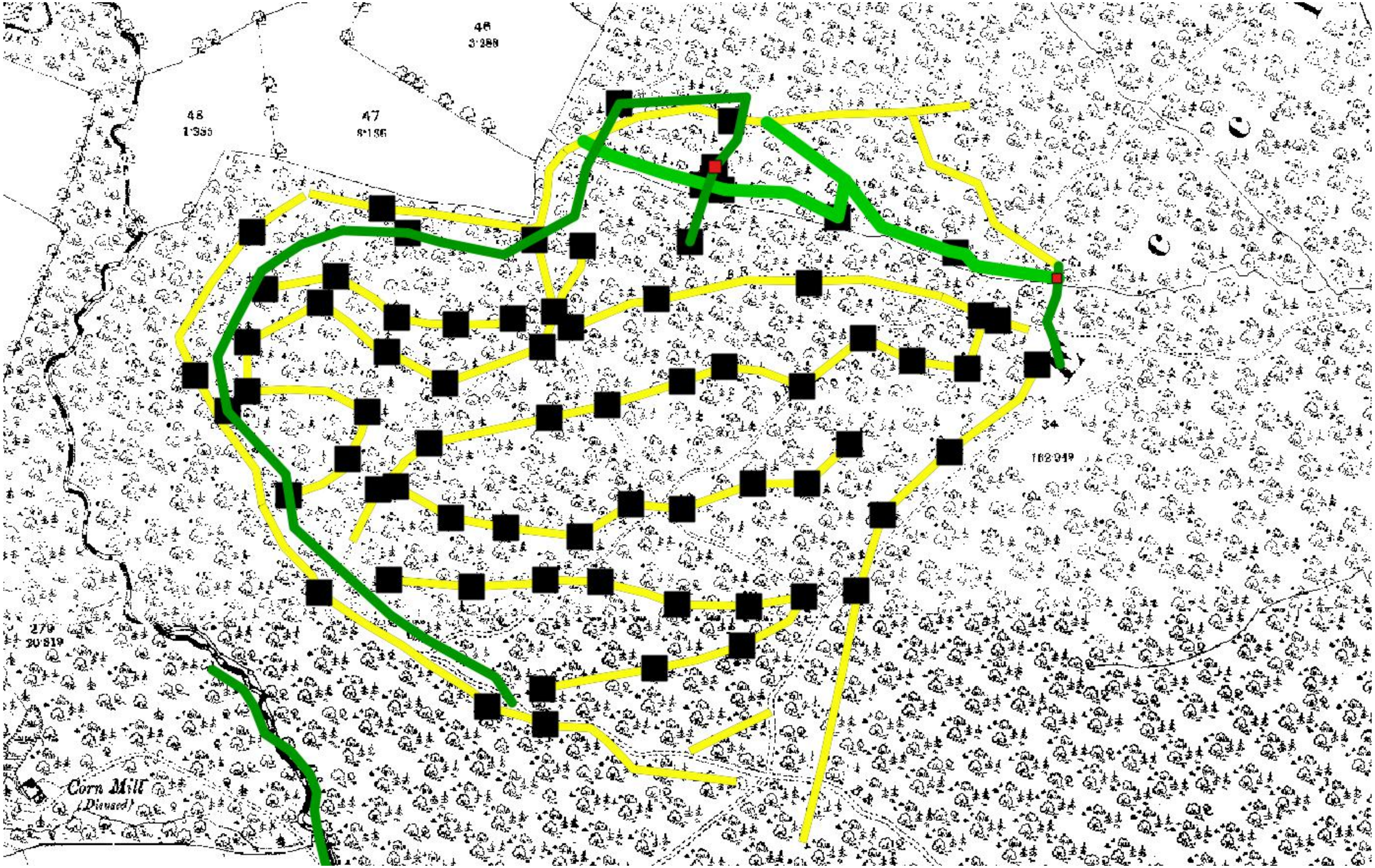


Figure 14.14 – *Carex remota*

Species maps for Ecclesall Woods

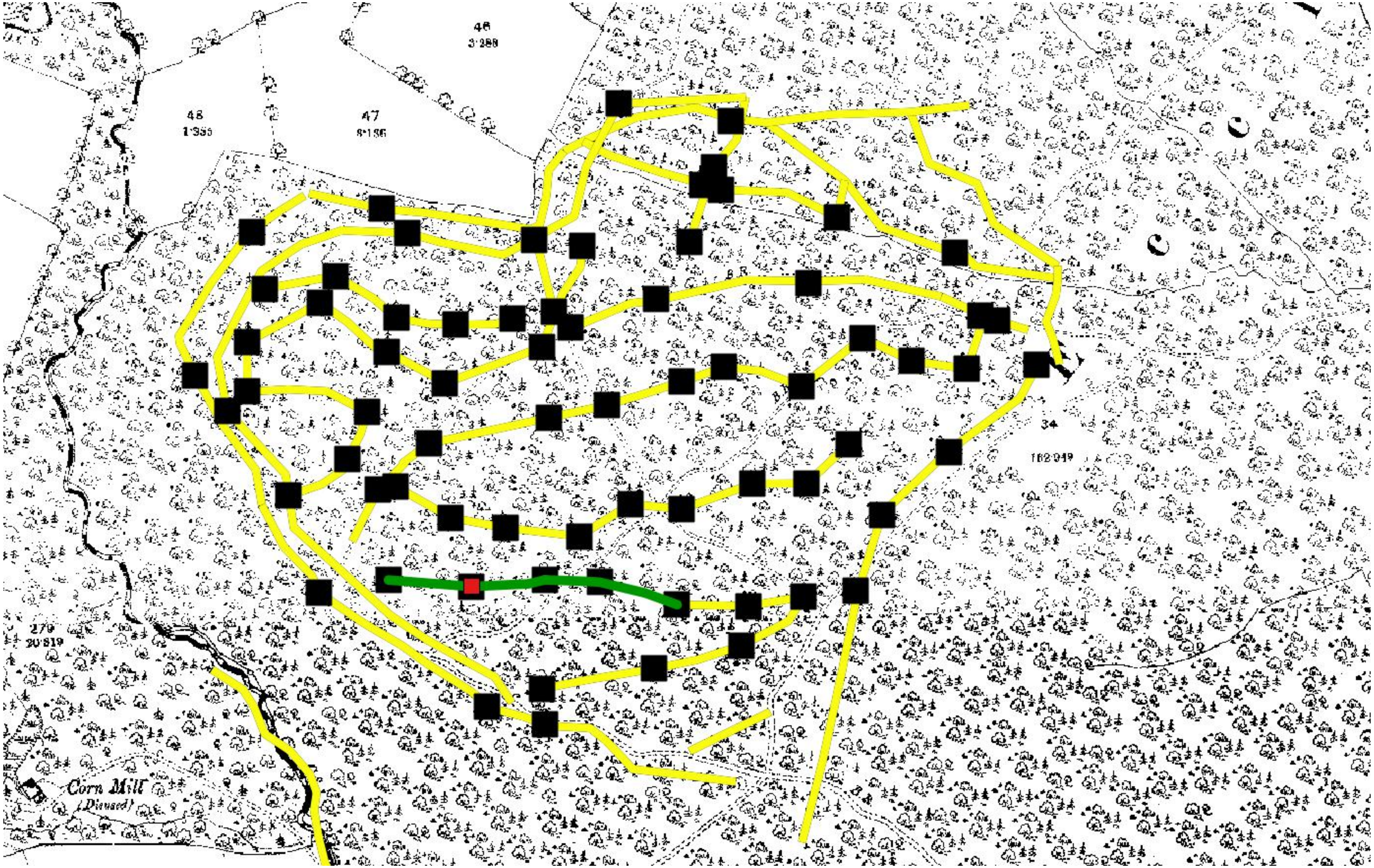


Figure 15.15 – *Ceratocapnos claviculata*

Species maps for Ecclesall Woods

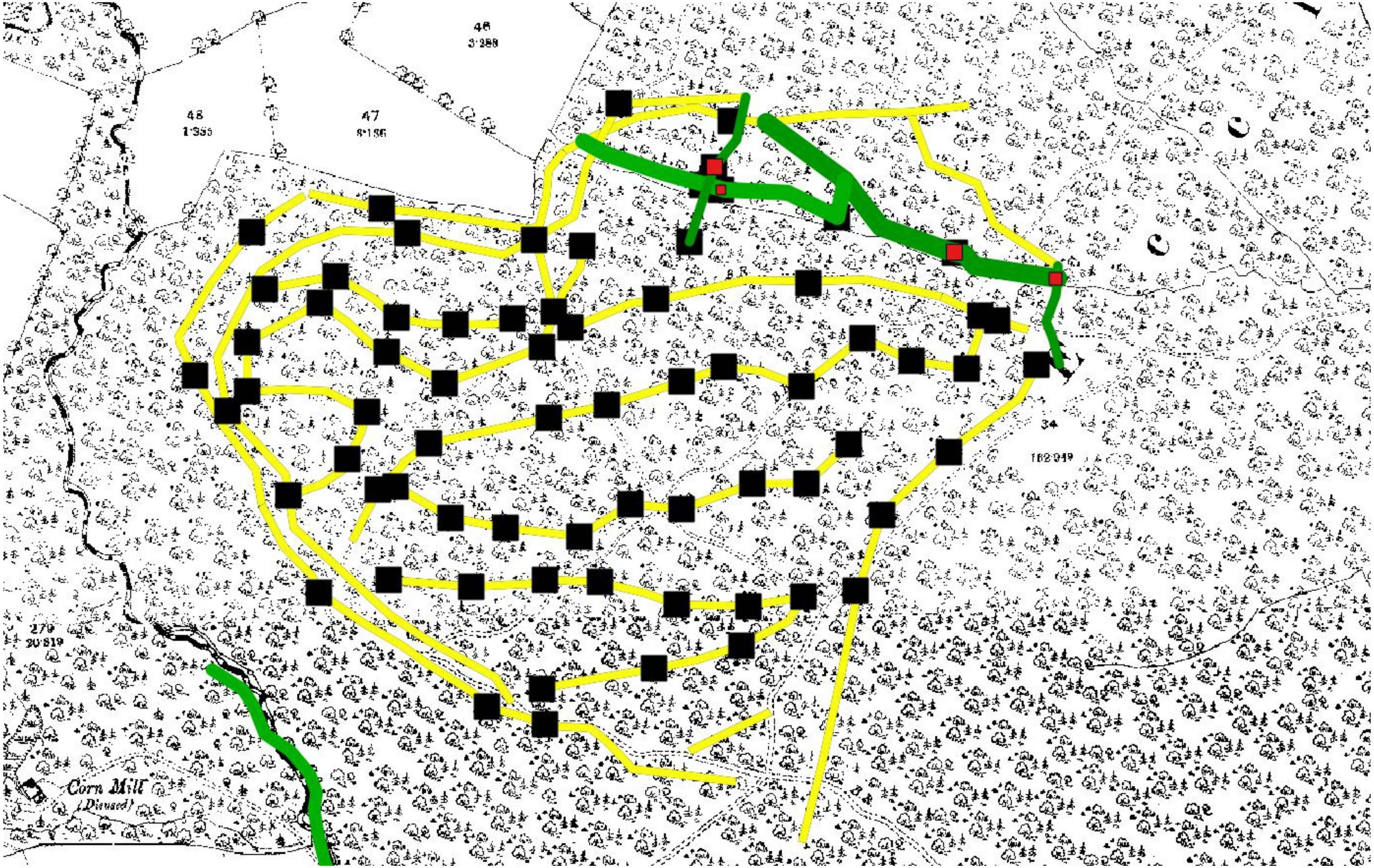


Figure 16.16 – *Chrysosplenium oppositifolium*

Species maps for Ecclesall Woods

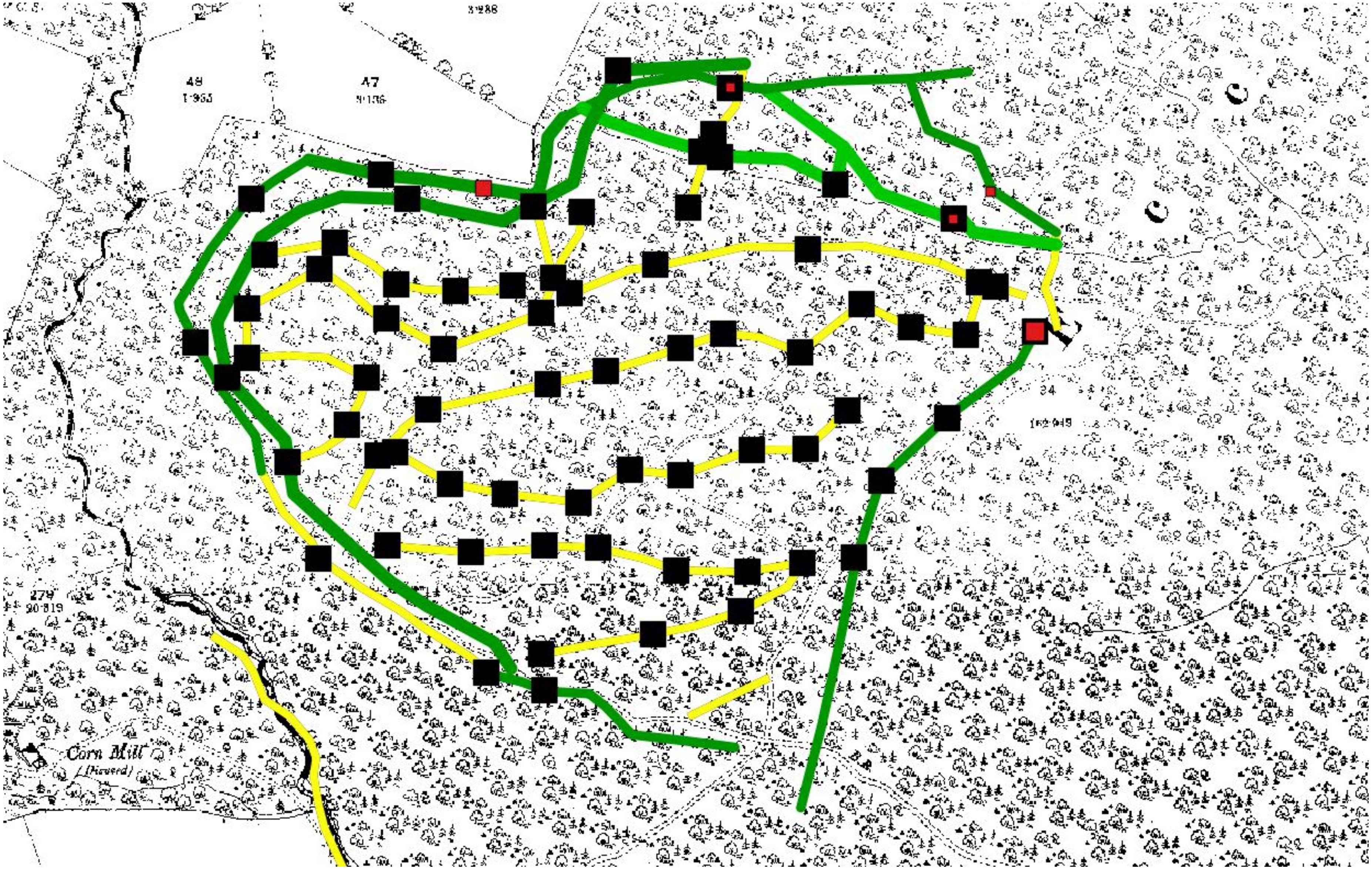


Figure 17.17 – *Circaea lutetiana*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

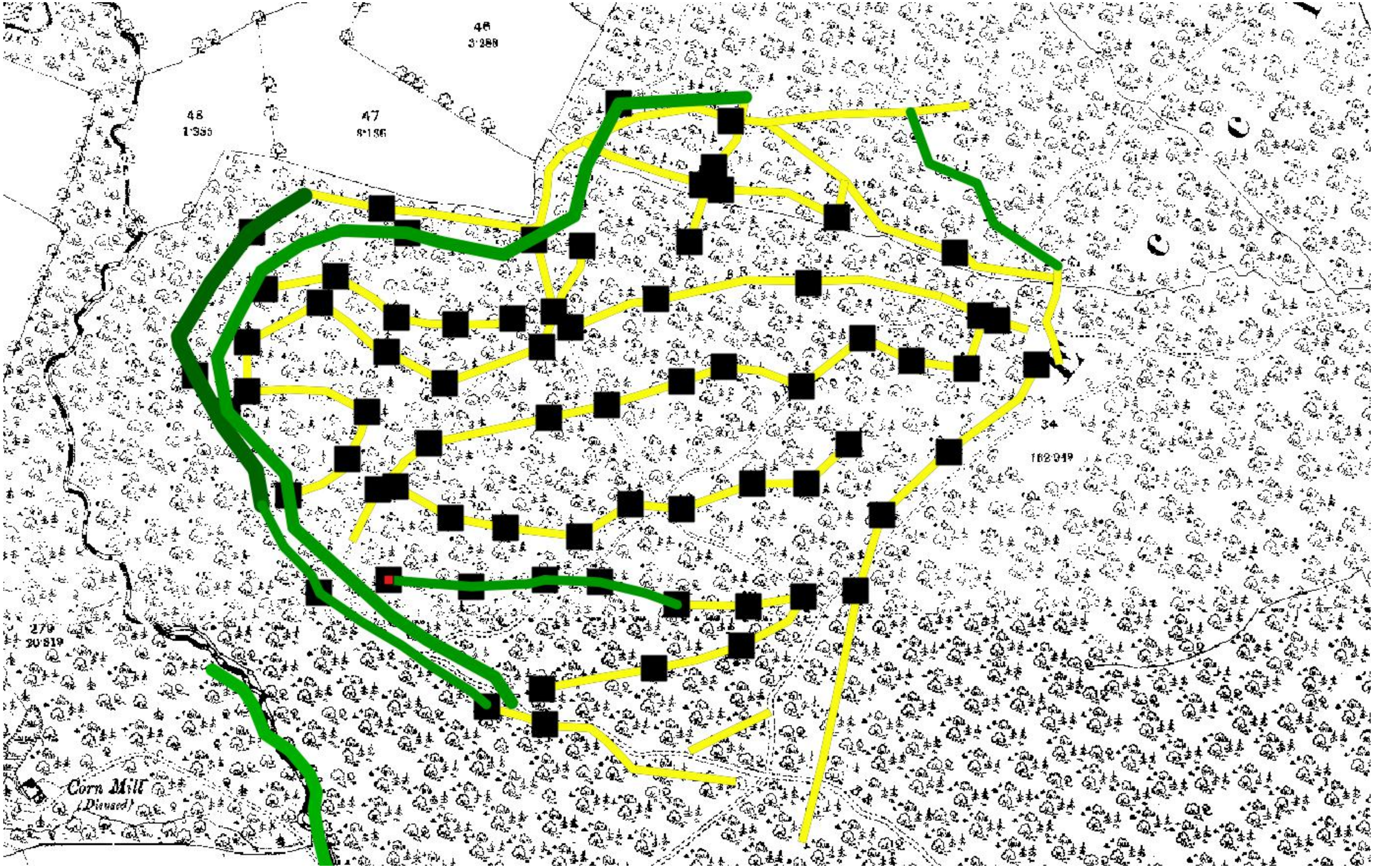


Figure 18.18 – *Deschampsia flexuosa*

Species maps for Ecclesall Woods

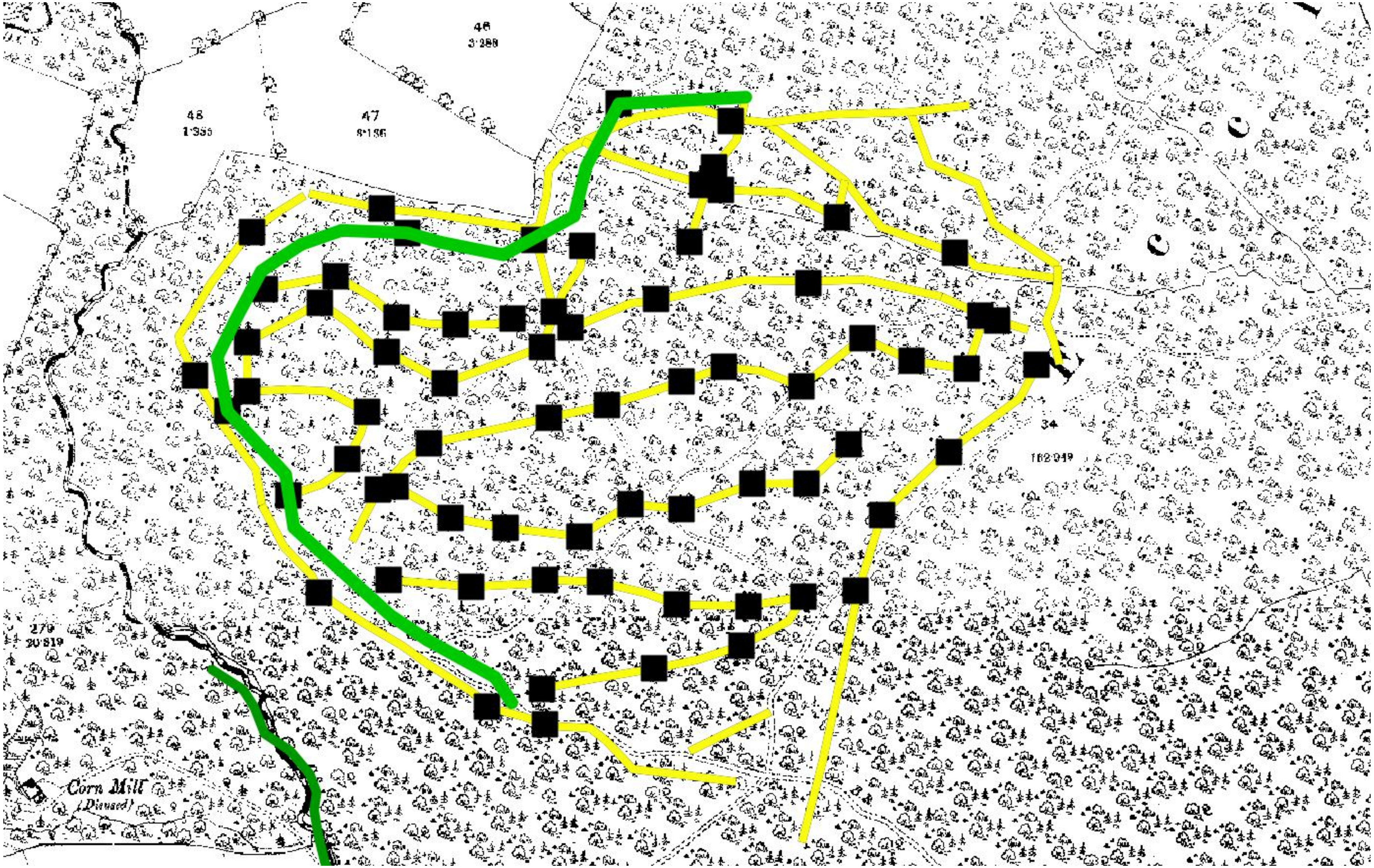


Figure 19.19 – *Dryopteris affinis*

Species maps for Ecclesall Woods

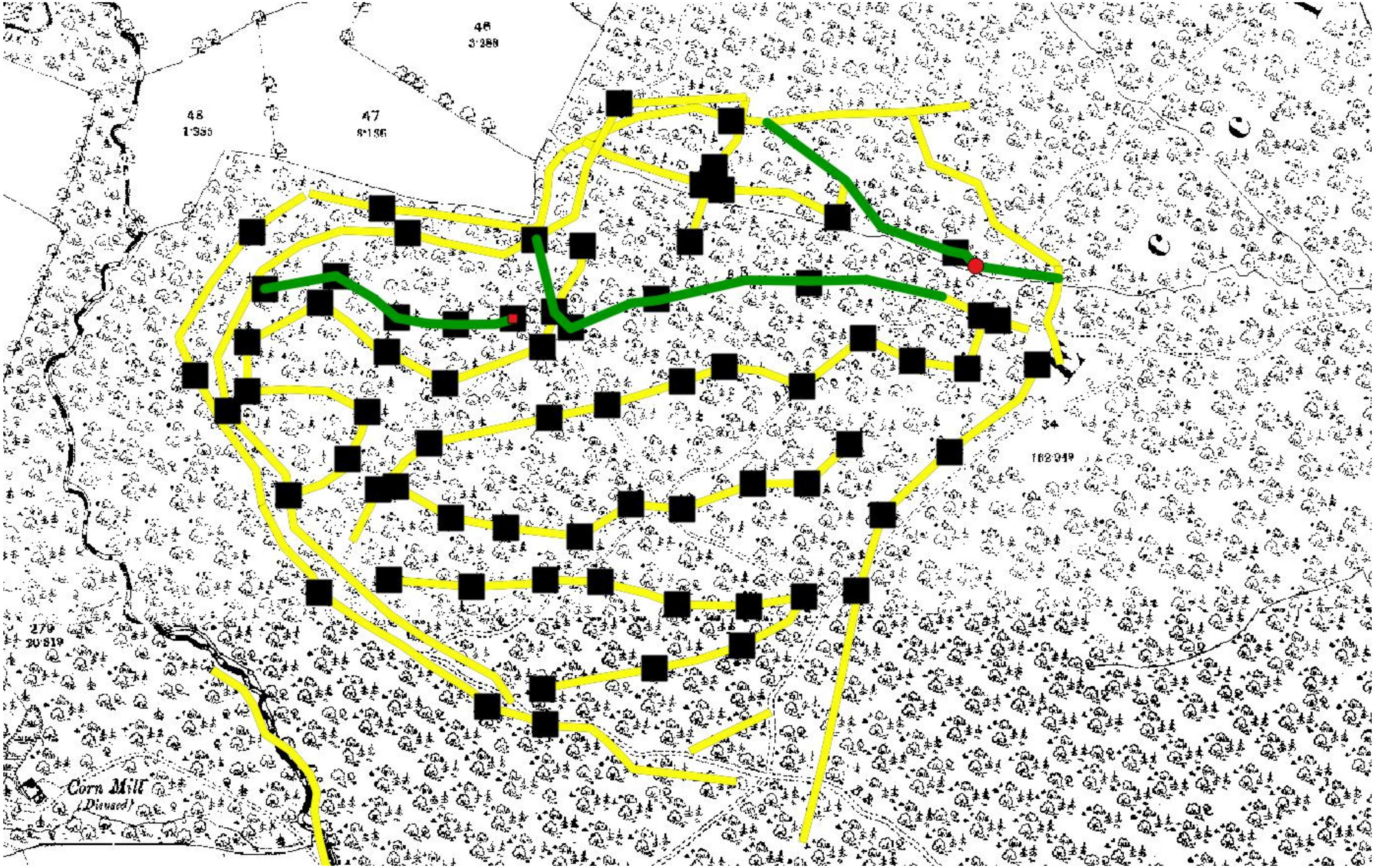


Figure 20.20 – *Dryopteris carthusiana*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

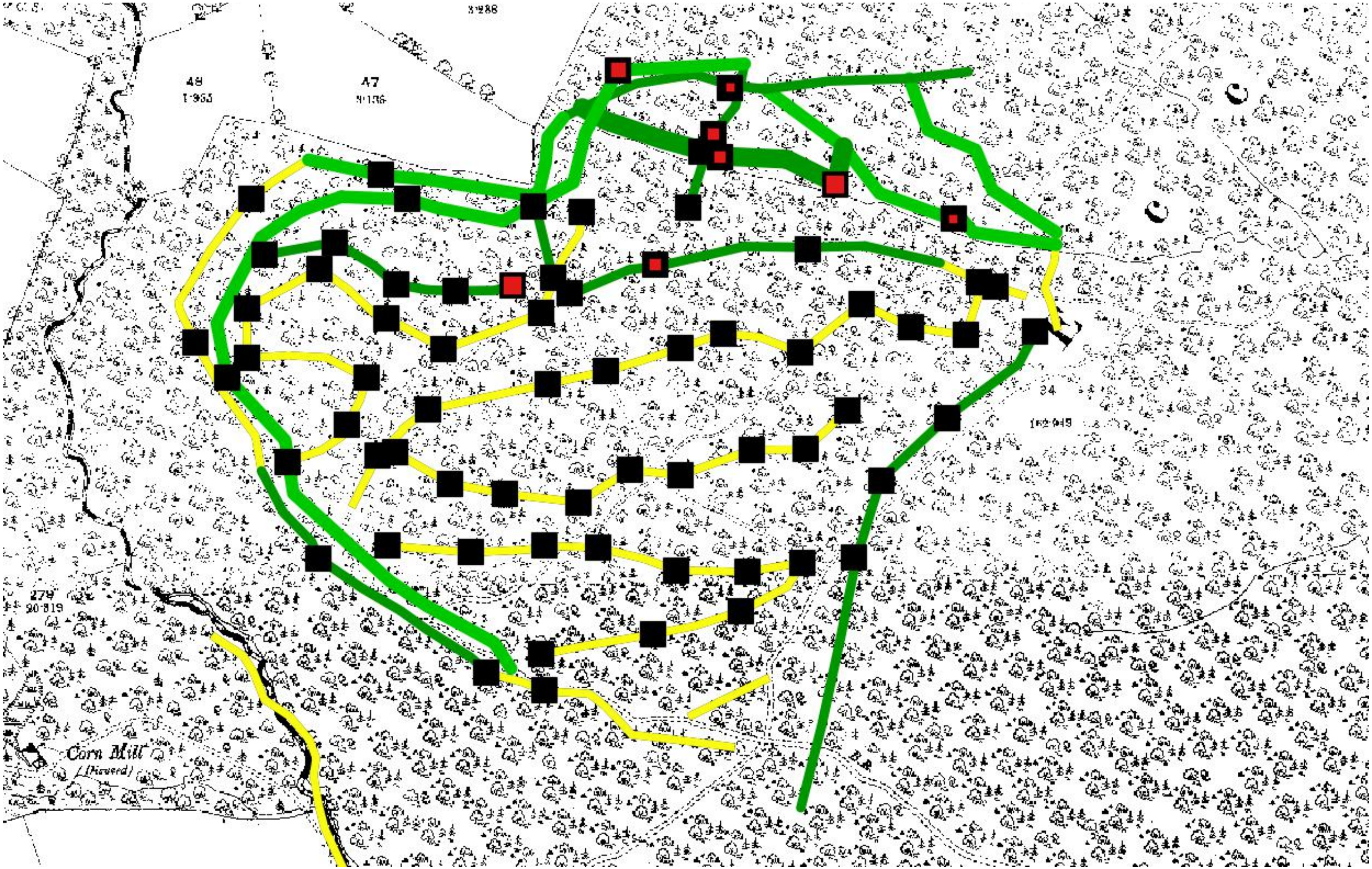


Figure 21.21 – *Dryopteris filix-mas*

Species maps for Ecclesall Woods

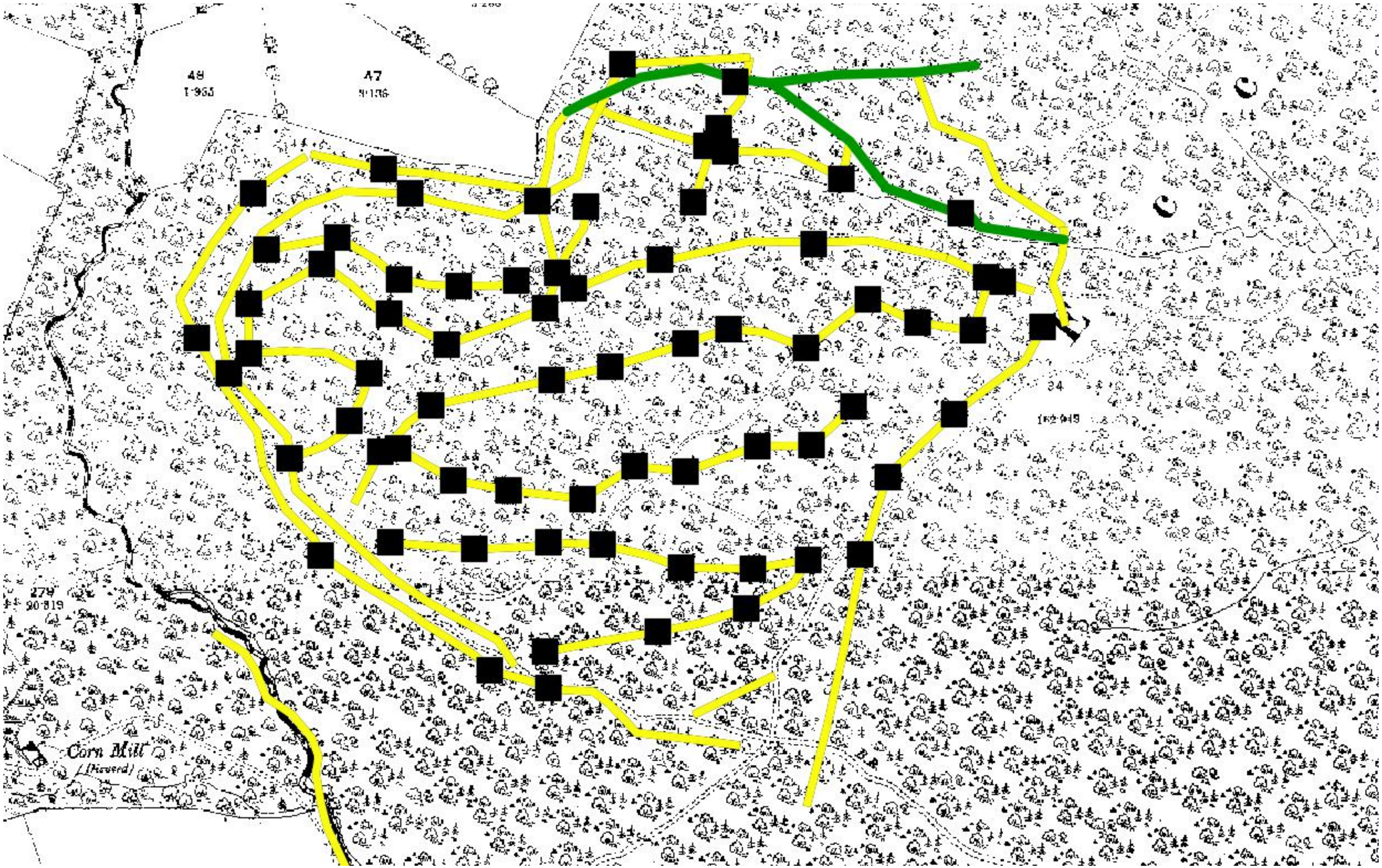


Figure 22.22 – *Epilobium montanum*

Species maps for Ecclesall Woods

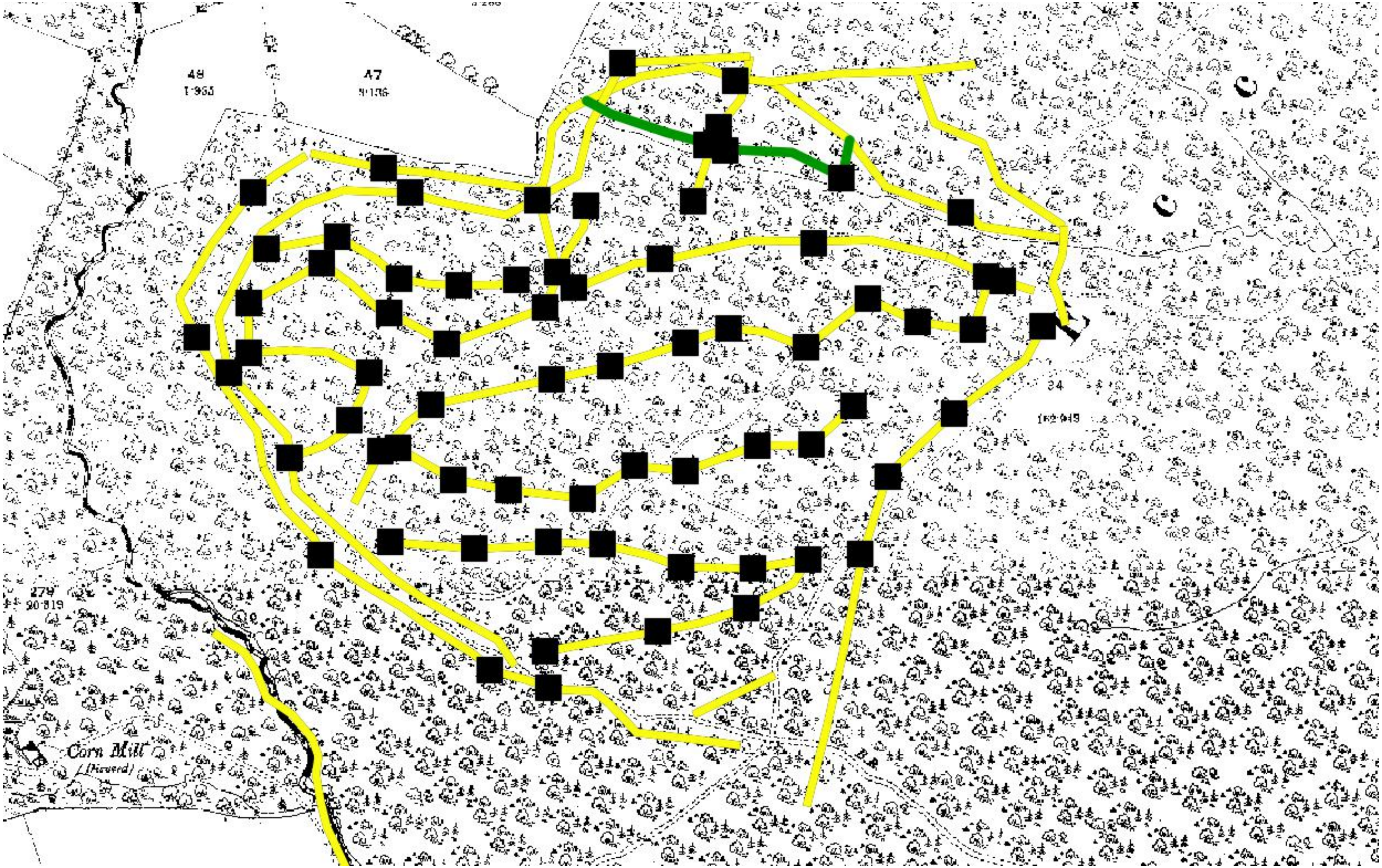


Figure 23.23 – *Festuca gigantea*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

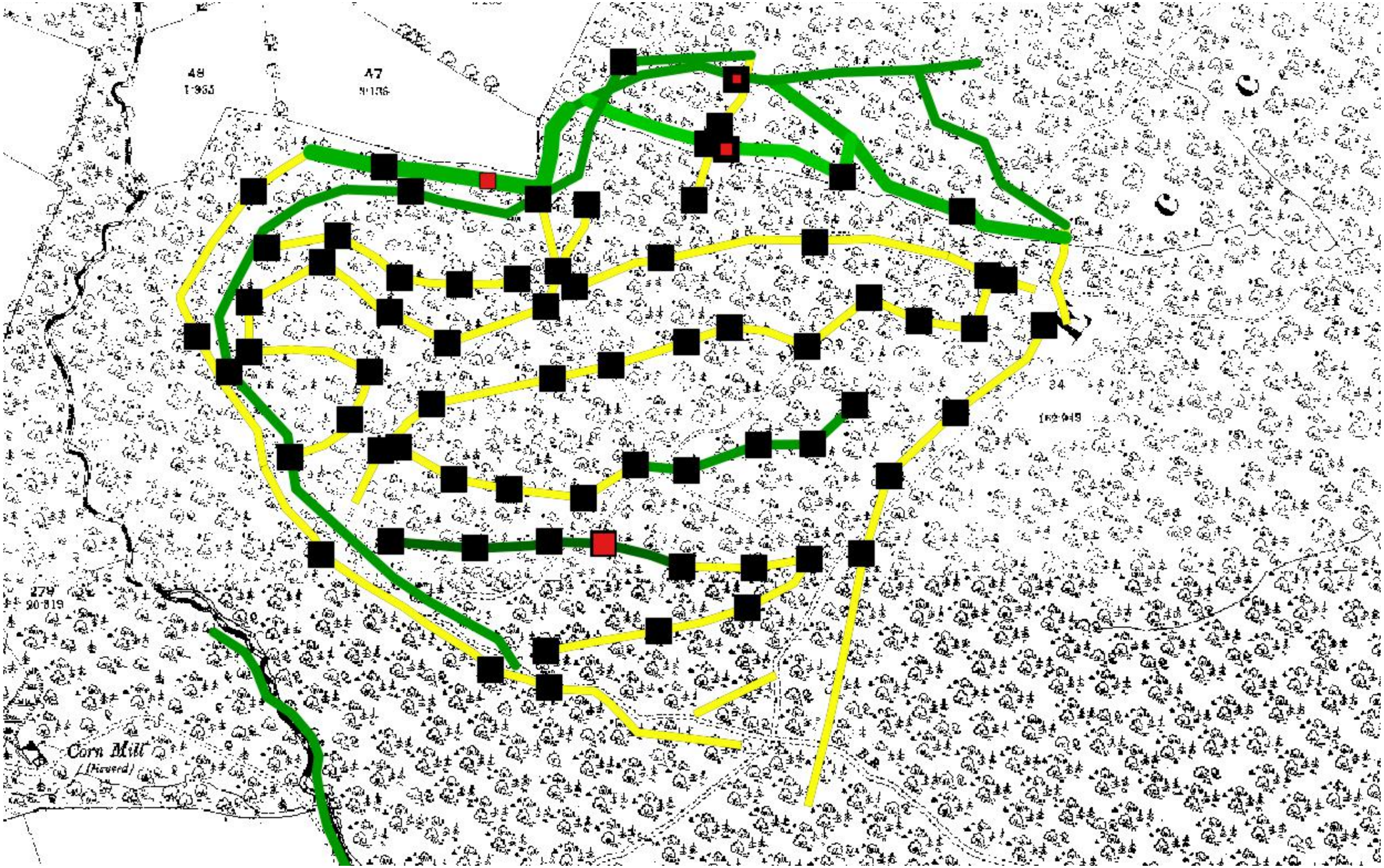


Figure 24.24 – *Geranium robertianum*

Species maps for Ecclesall Woods

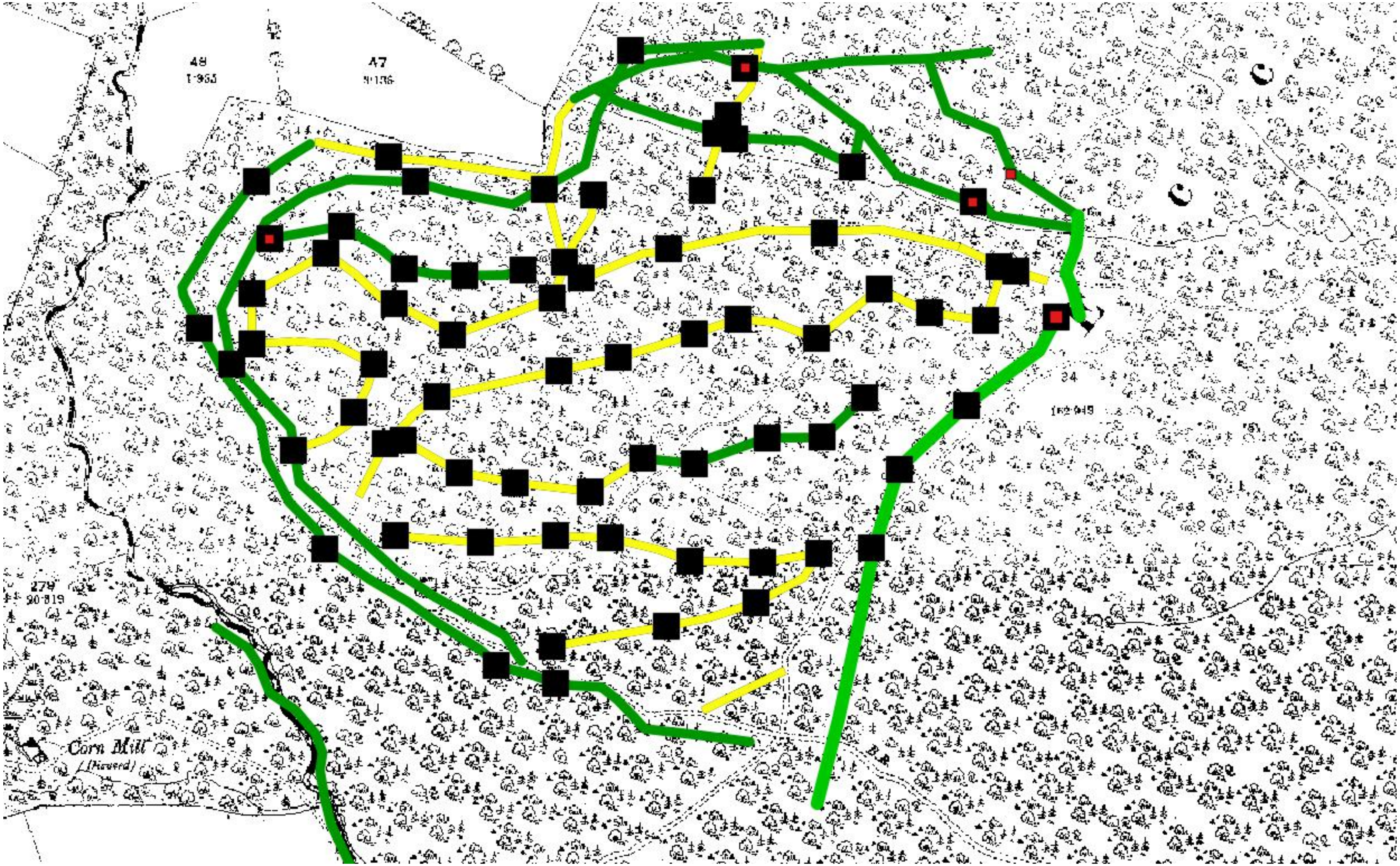


Figure 25.25 – *Geum urbanum*

Species maps for Ecclesall Woods

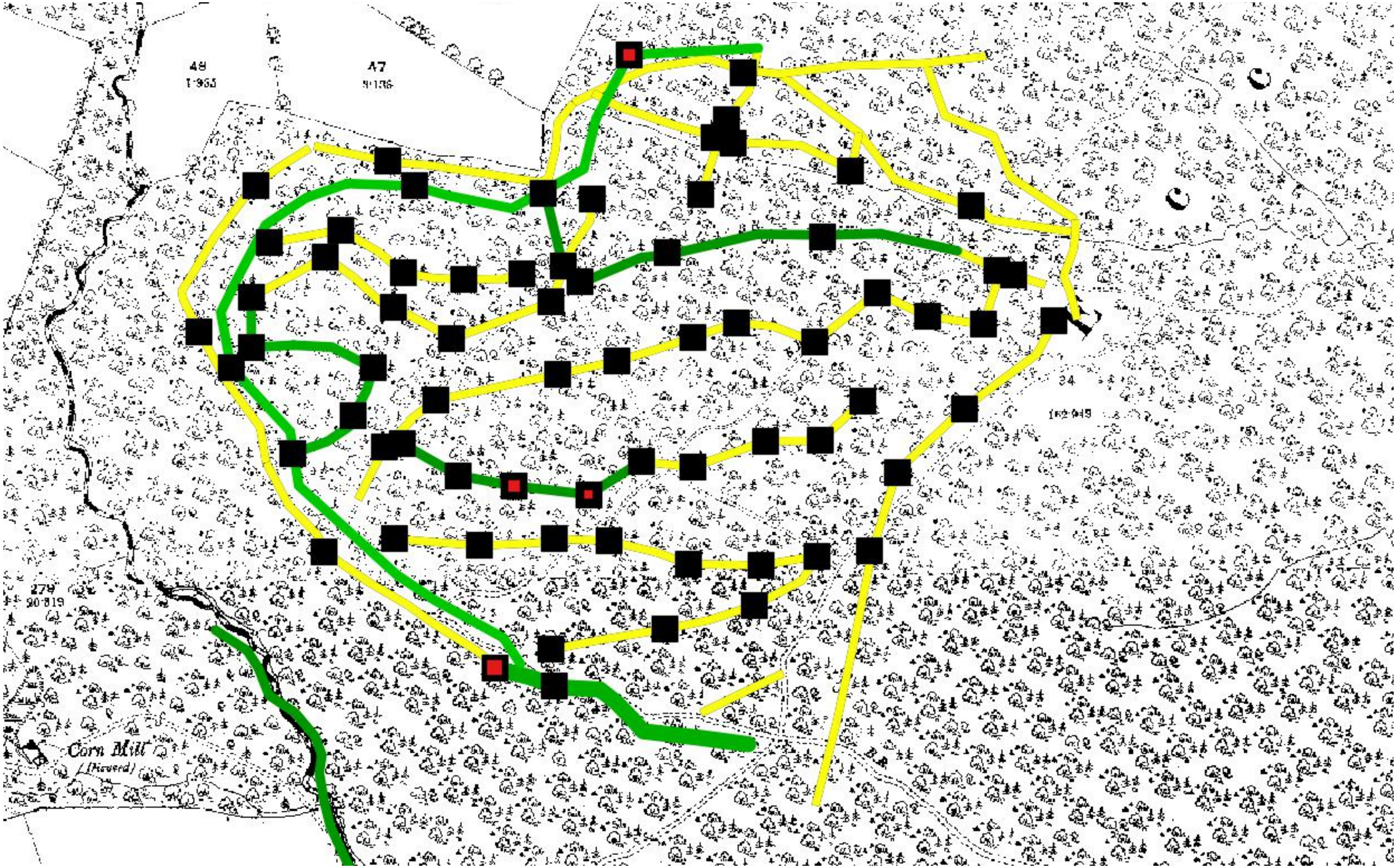


Figure 26.26 – *Hedera helix*

Species maps for Ecclesall Woods

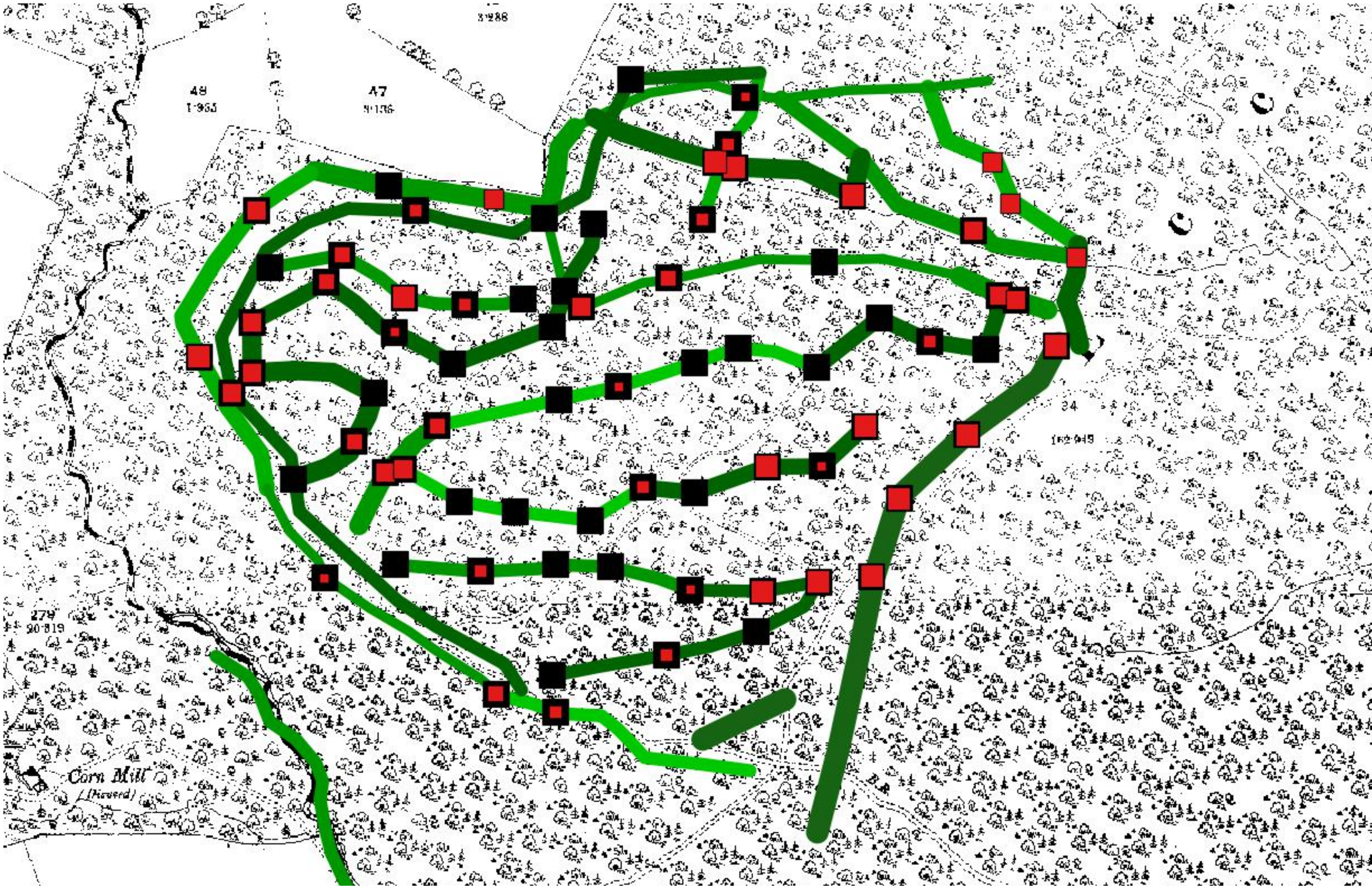


Figure 27.27 – *Holcus mollis*

Species maps for Ecclesall Woods

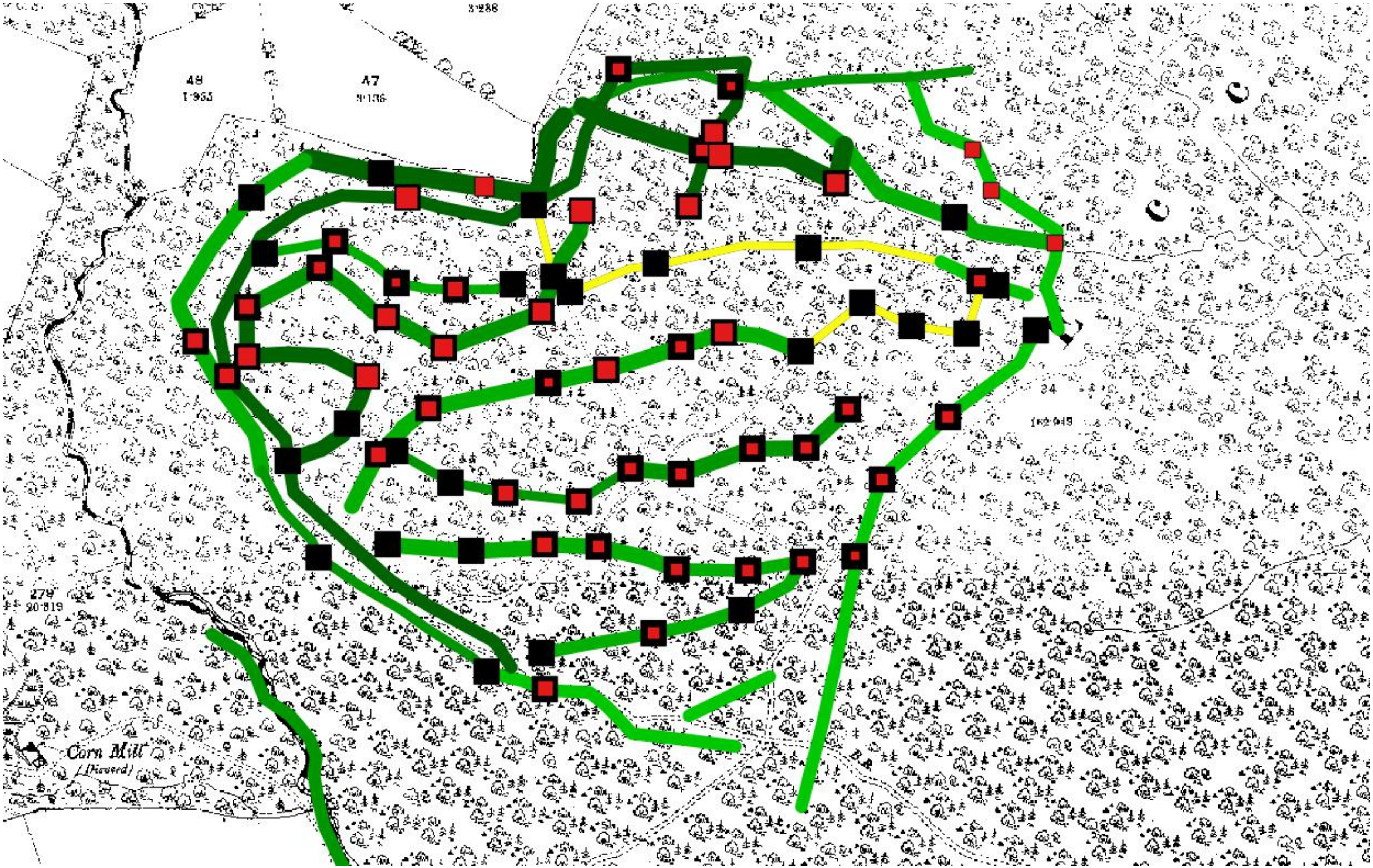


Figure 28.28 – *Hyacinthoides non-scripta*

Species maps for Ecclesall Woods

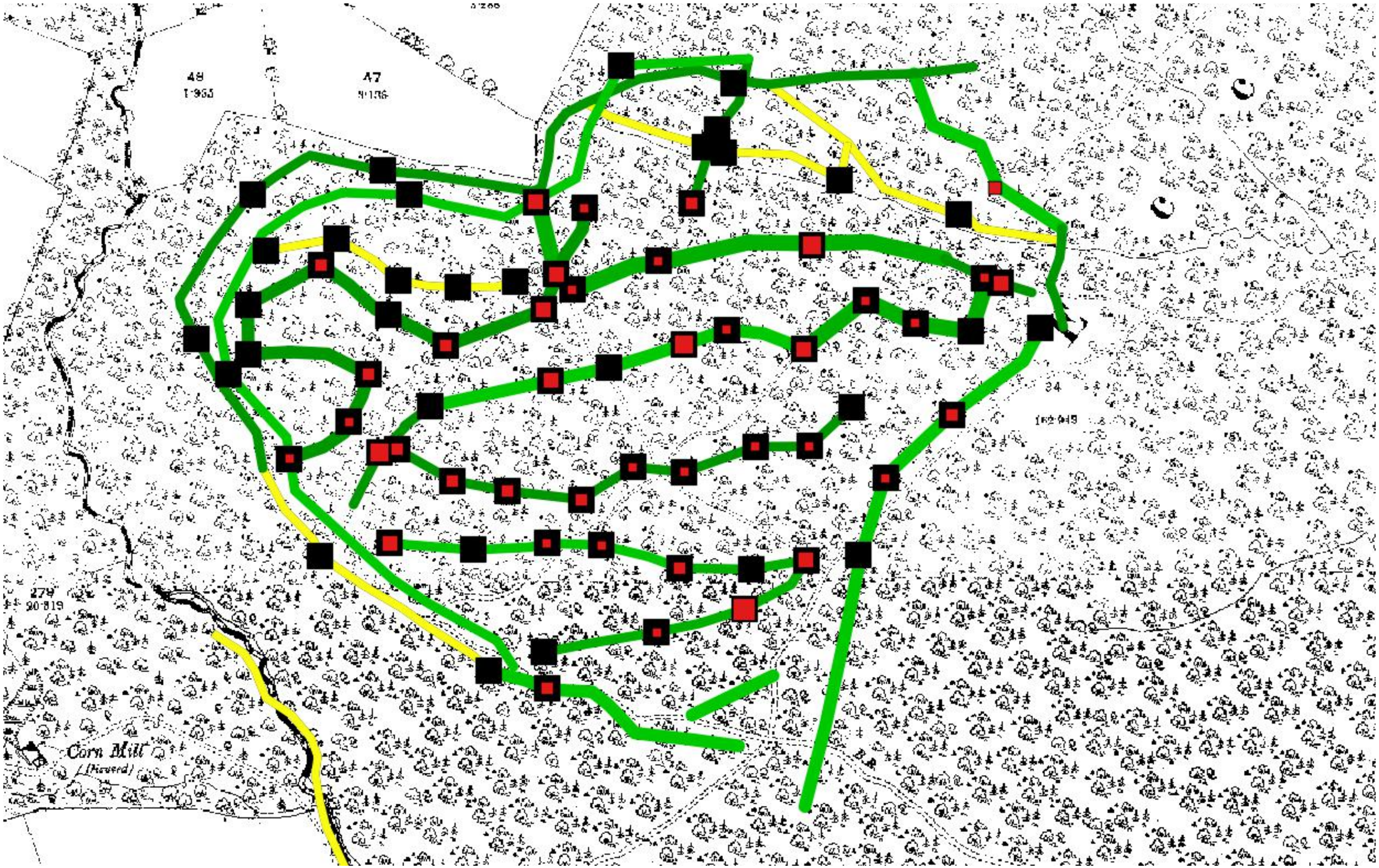


Figure 29.29 – *Ilex aquifolium*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

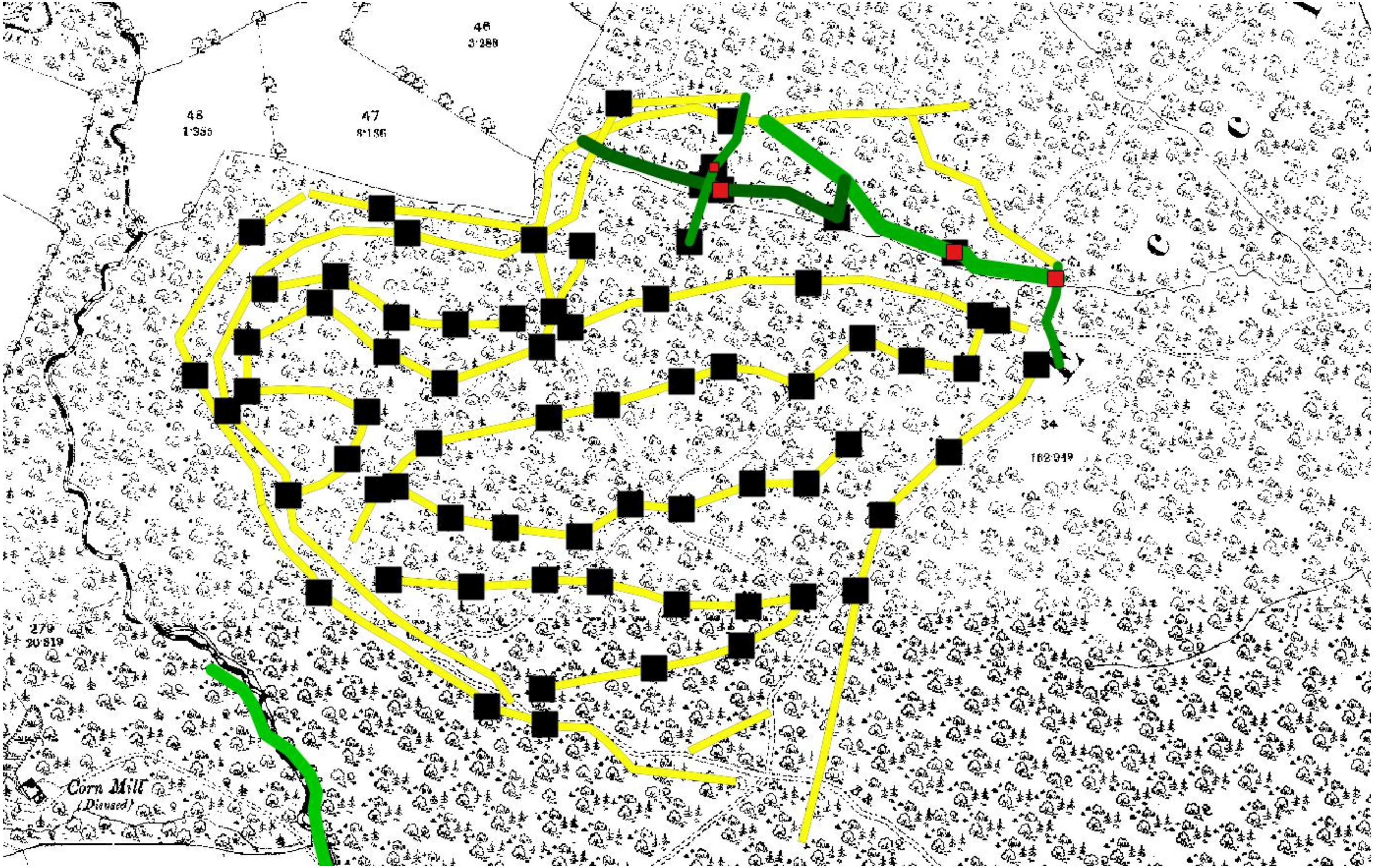


Figure 30.30 – *Lamiastrum galeobdolon*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

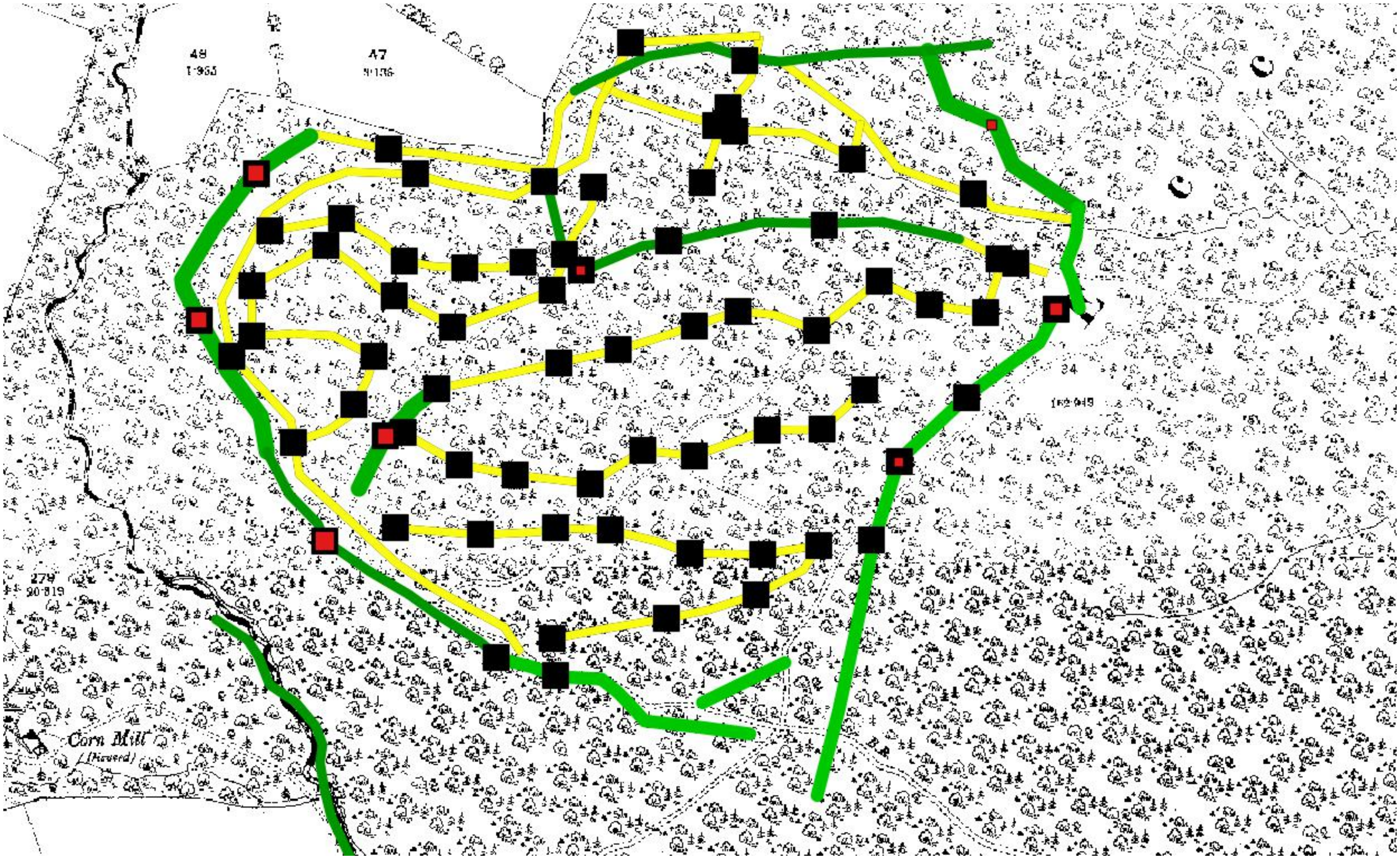


Figure 31 – *Lonicera periclymenum*

Species maps for Ecclesall Woods

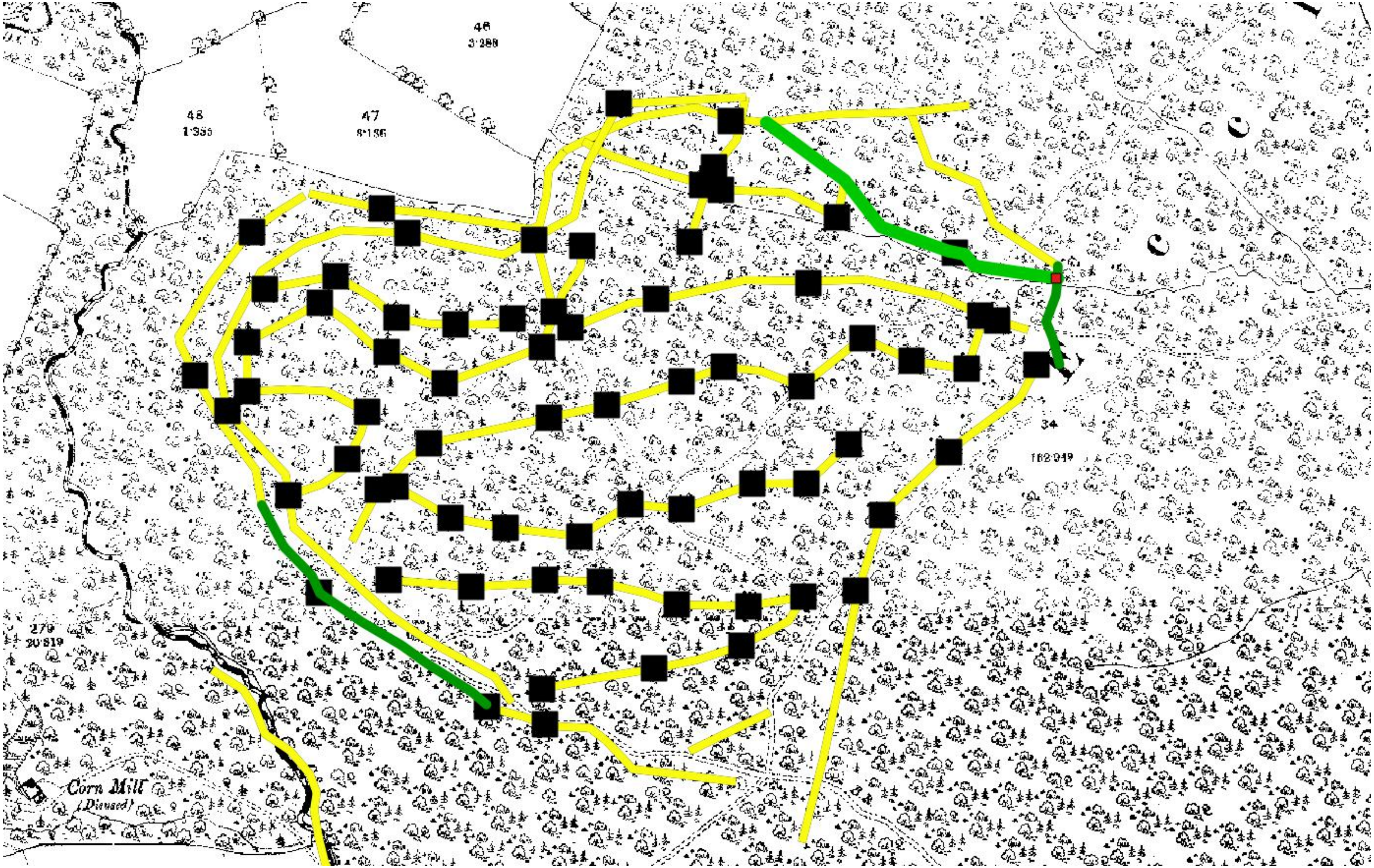


Figure 32.32 – *Luzula pilosa*

Species maps for Ecclesall Woods

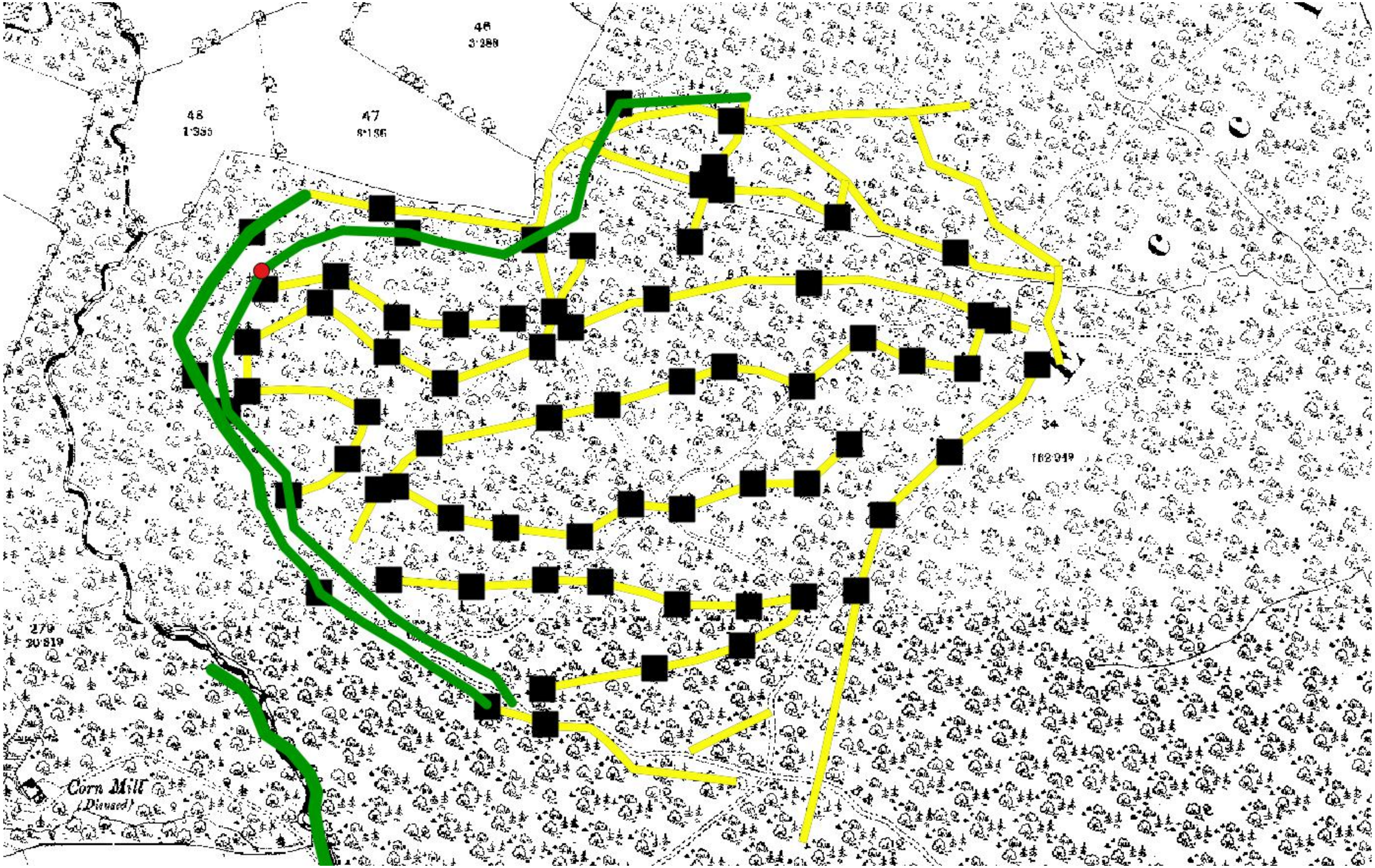


Figure 33.33 – *Luzula sylvatica*

Species maps for Ecclesall Woods

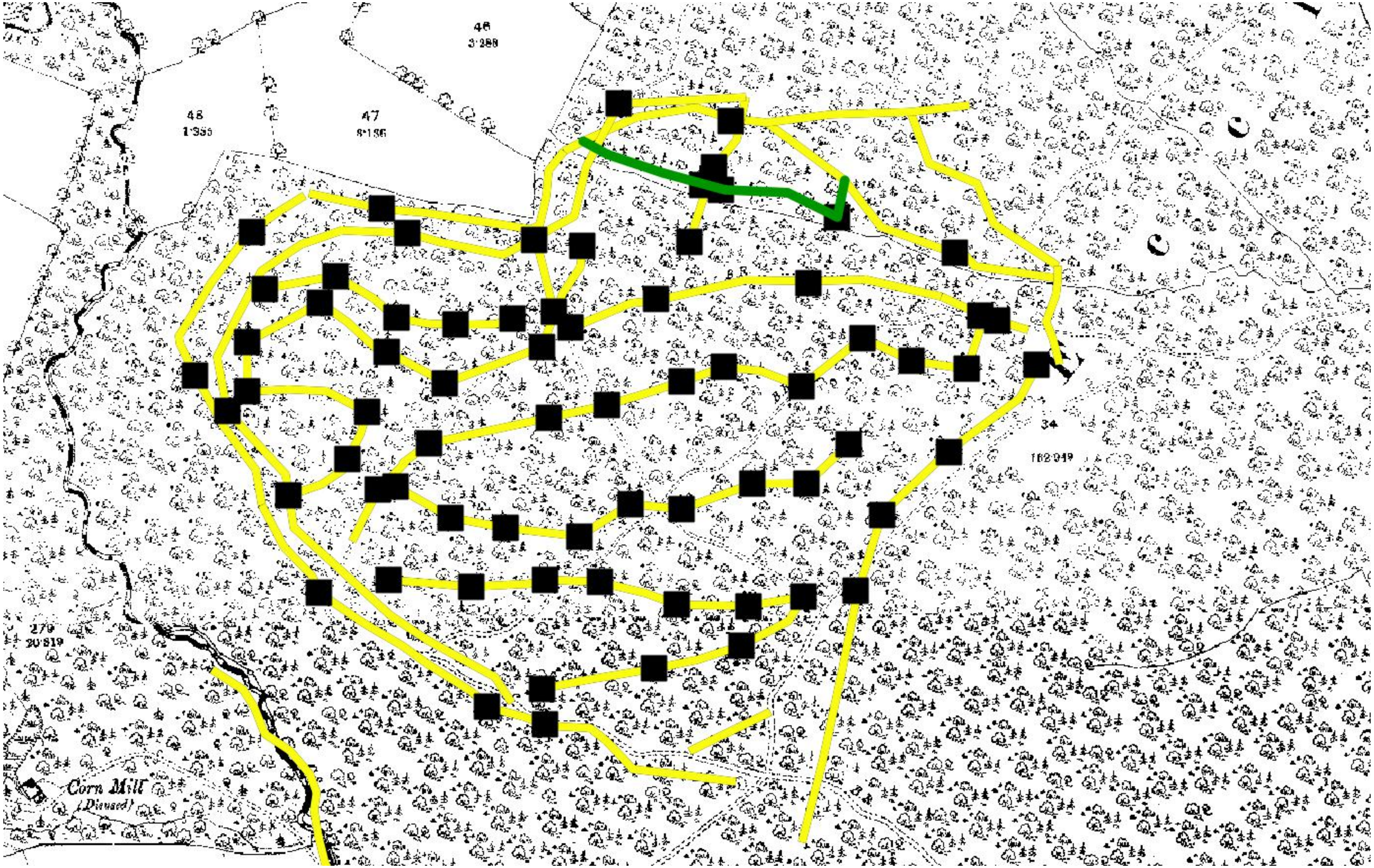


Figure 34.34 – *Lysimachia nemorum*

Species maps for Ecclesall Woods

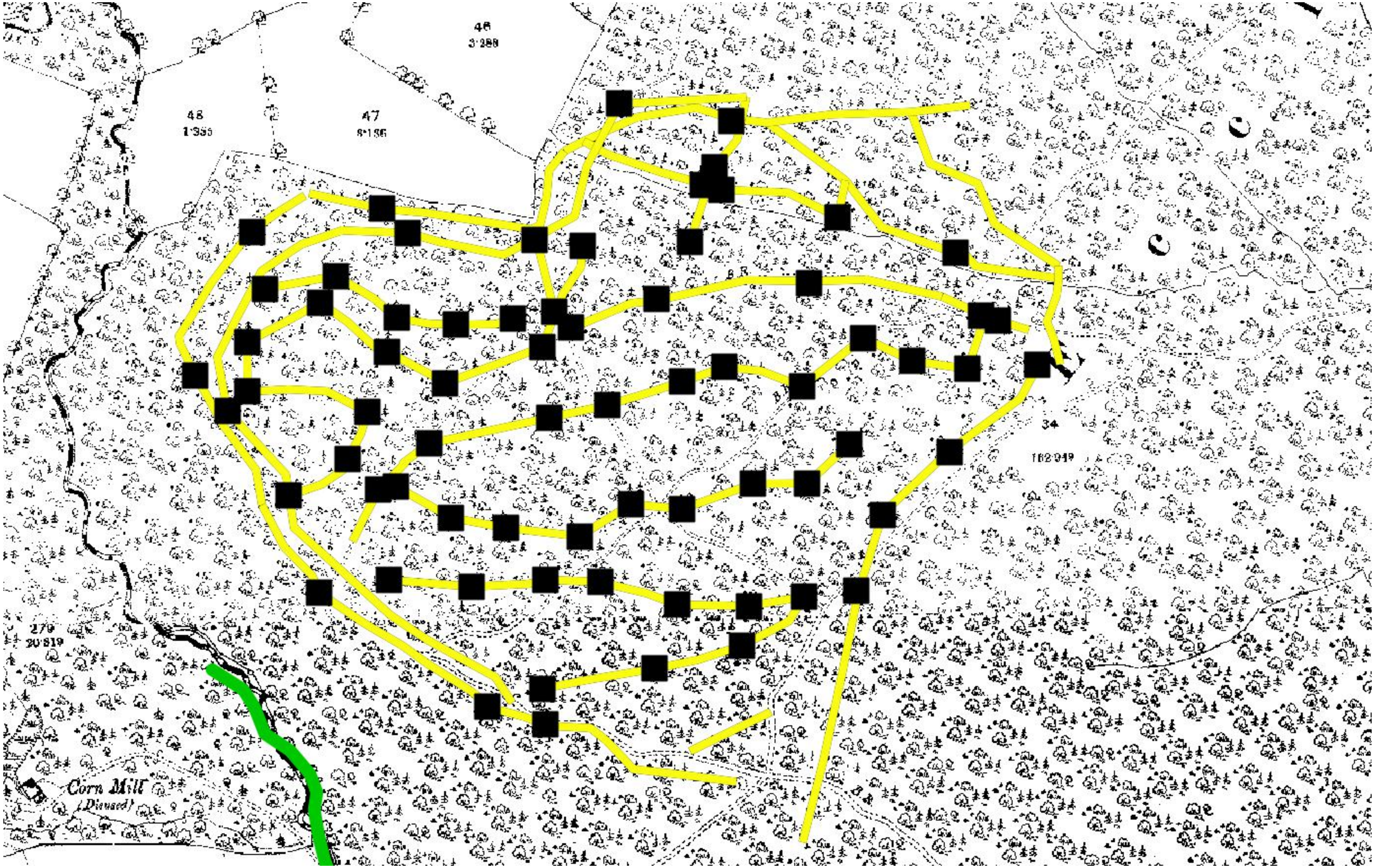


Figure 35.35 – *Melica uniflora*

Species maps for Ecclesall Woods

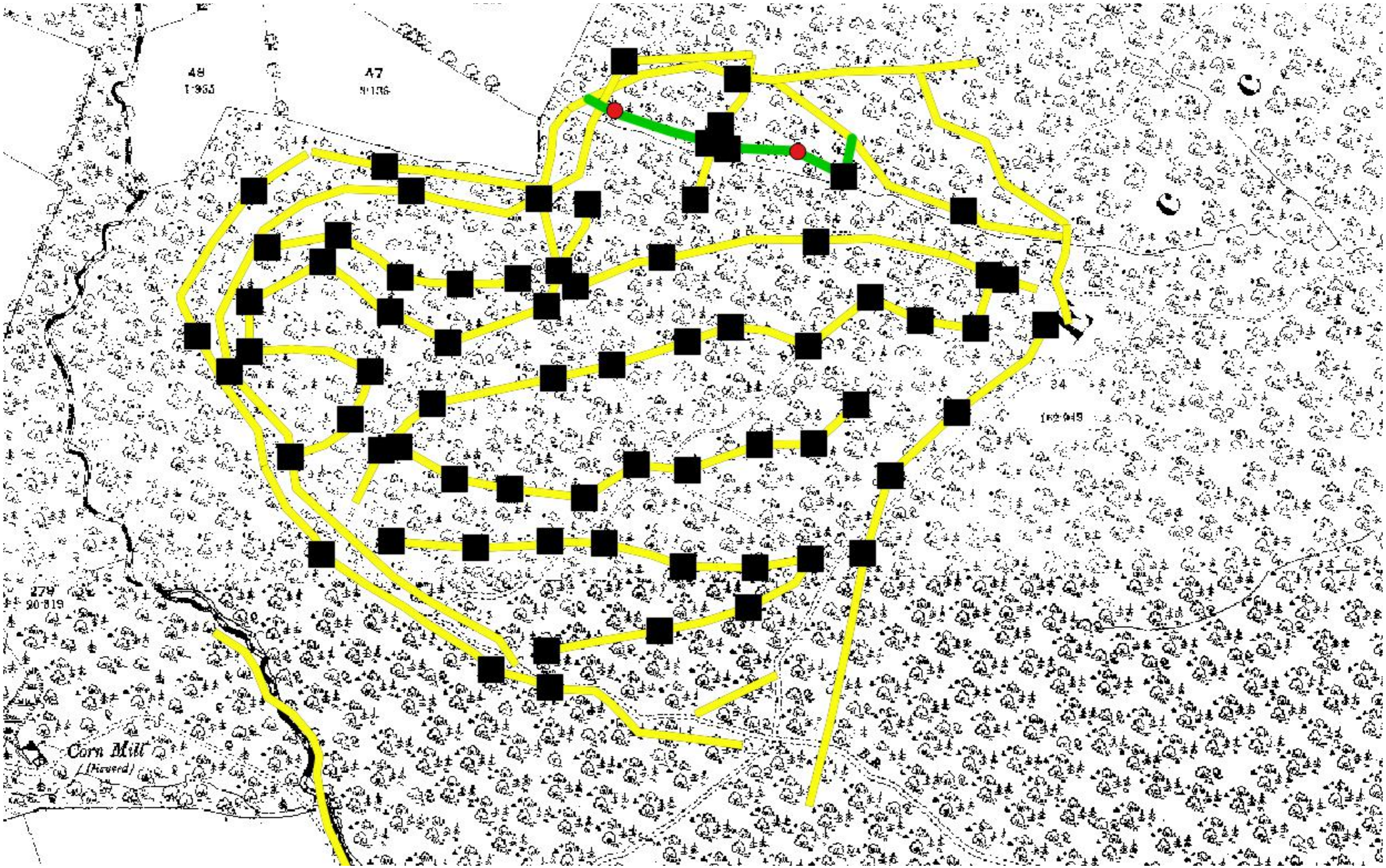


Figure 36.36 – *Mercurialis perennis*

Species maps for Ecclesall Woods

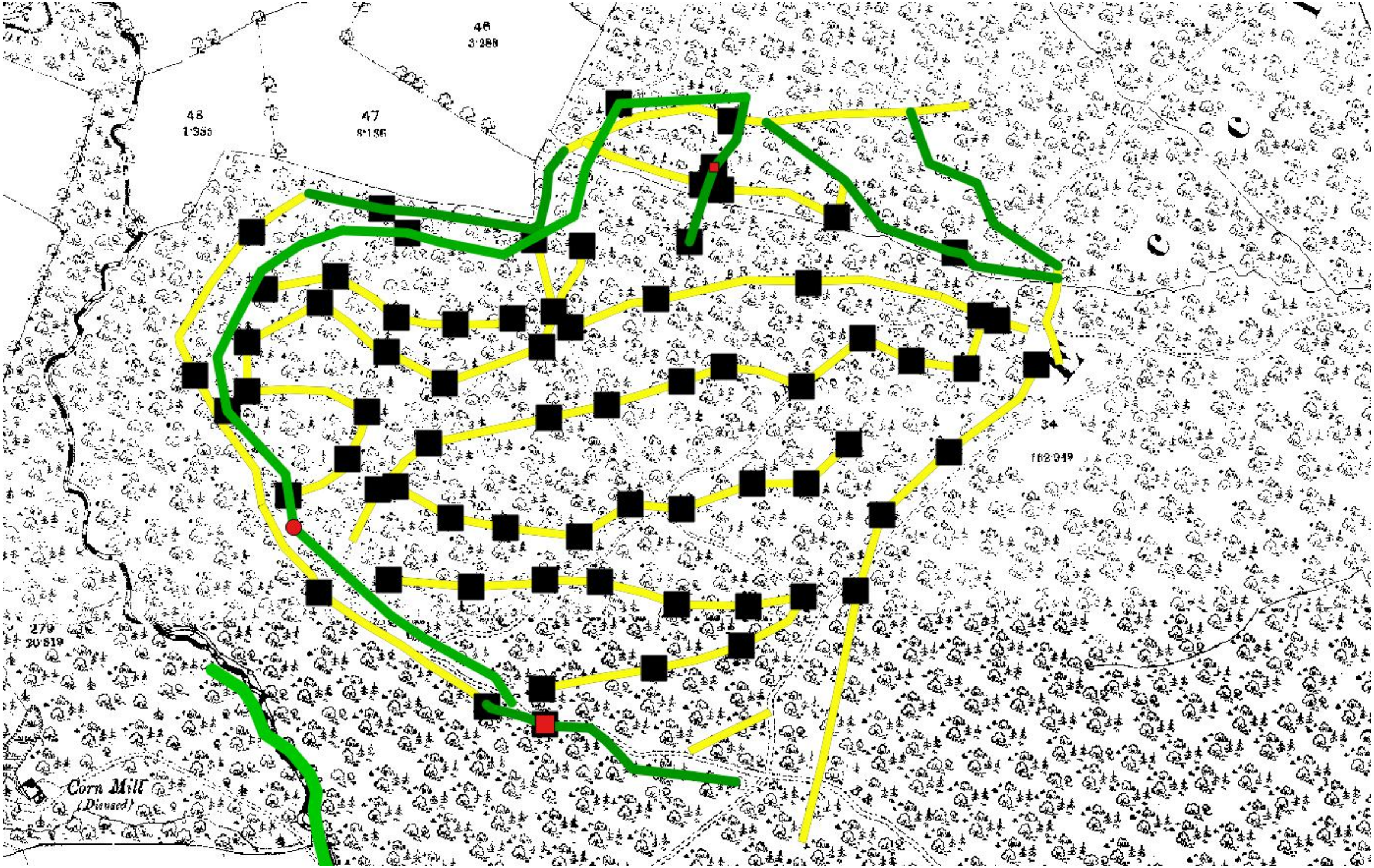


Figure 37.37 – *Milium effusum*

Species maps for Ecclesall Woods

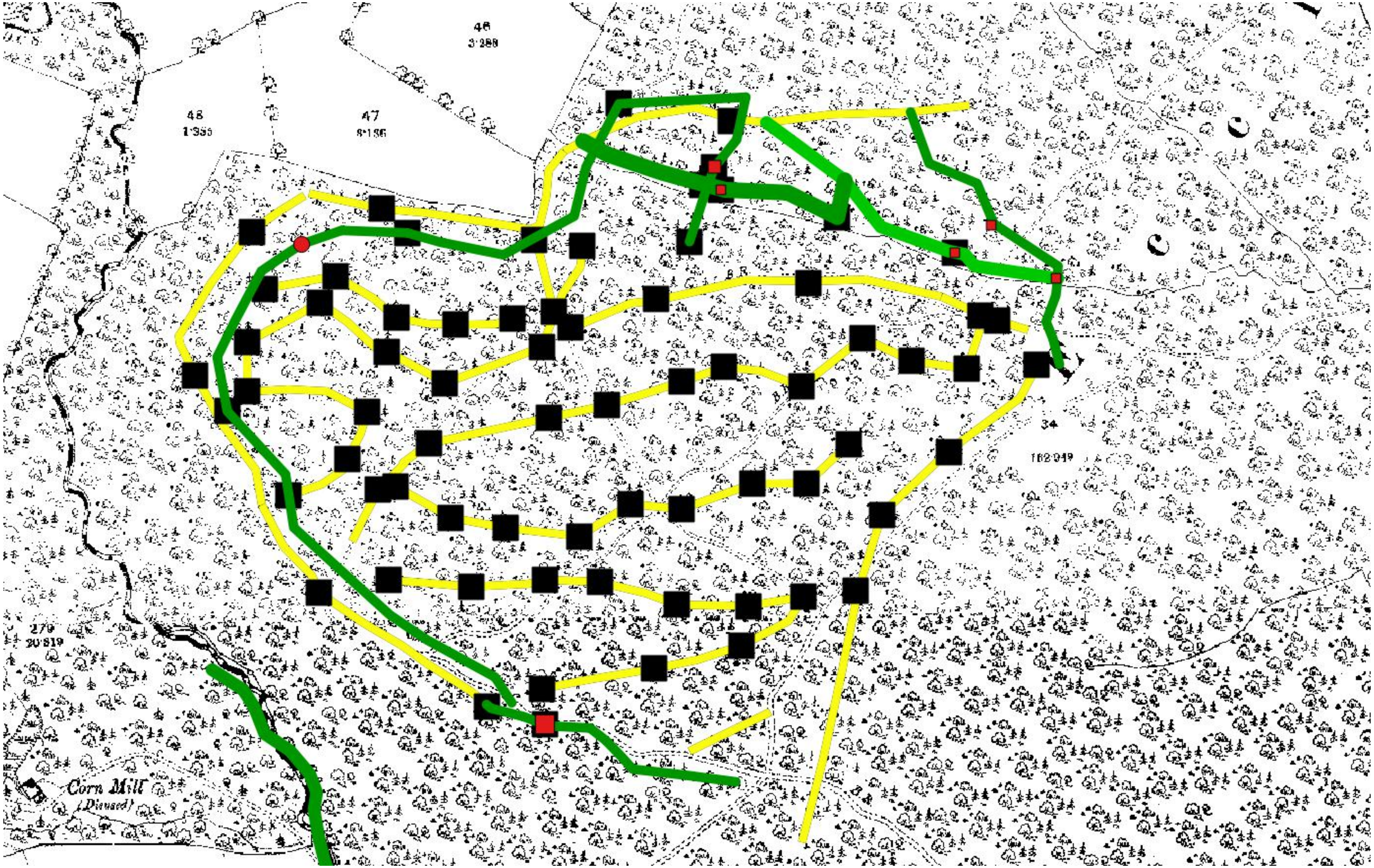


Figure 38.38 – *Oxalis acetosa*

Species maps for Ecclesall Woods

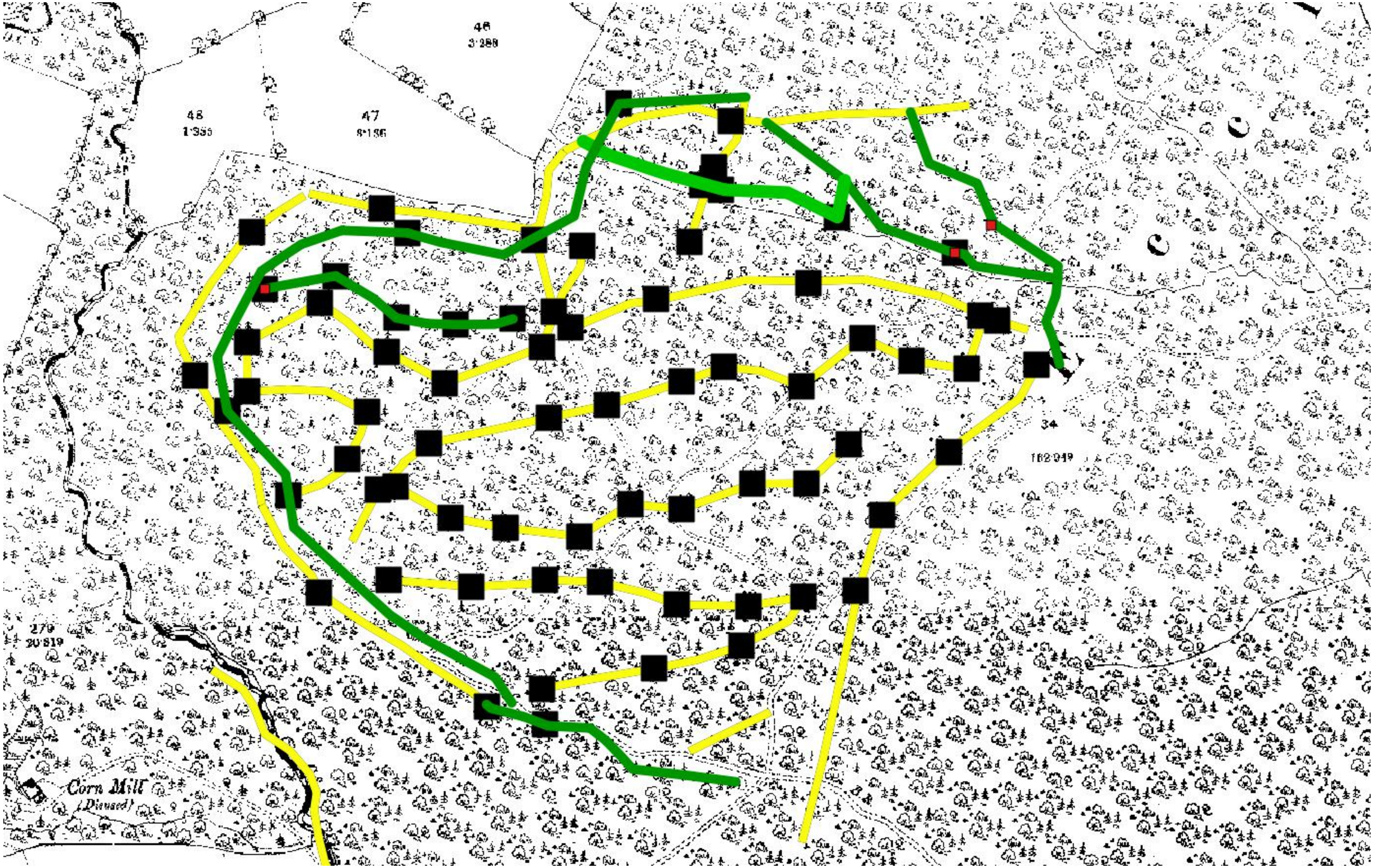


Figure 39.39 – *Poa nemoralis*

Species maps for Ecclesall Woods

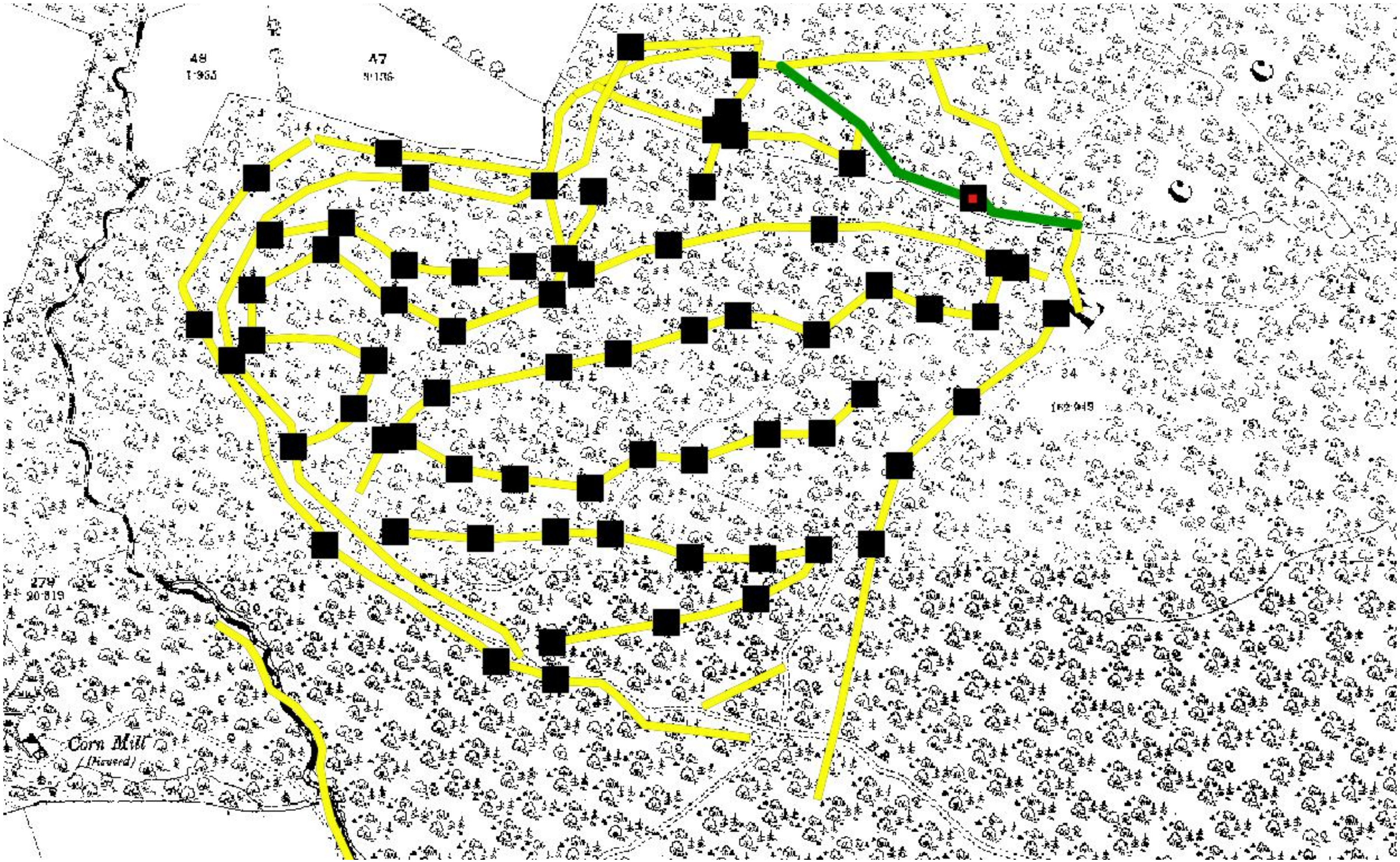


Figure 40.40 – *Ranunculus ficaria*

Species maps for Ecclesall Woods

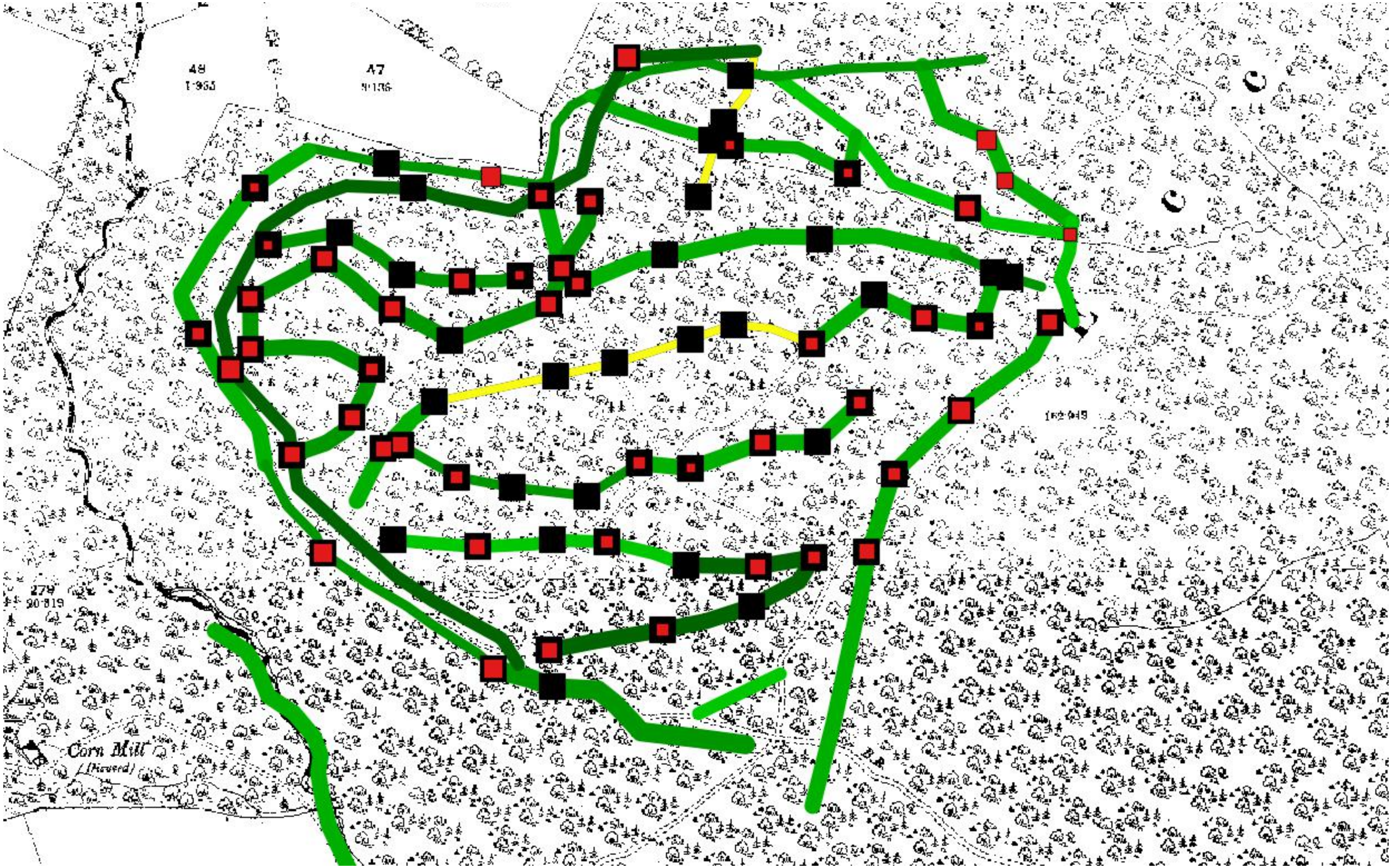


Figure 41.41 – *Rubus fruticosus*

Species maps for Ecclesall Woods

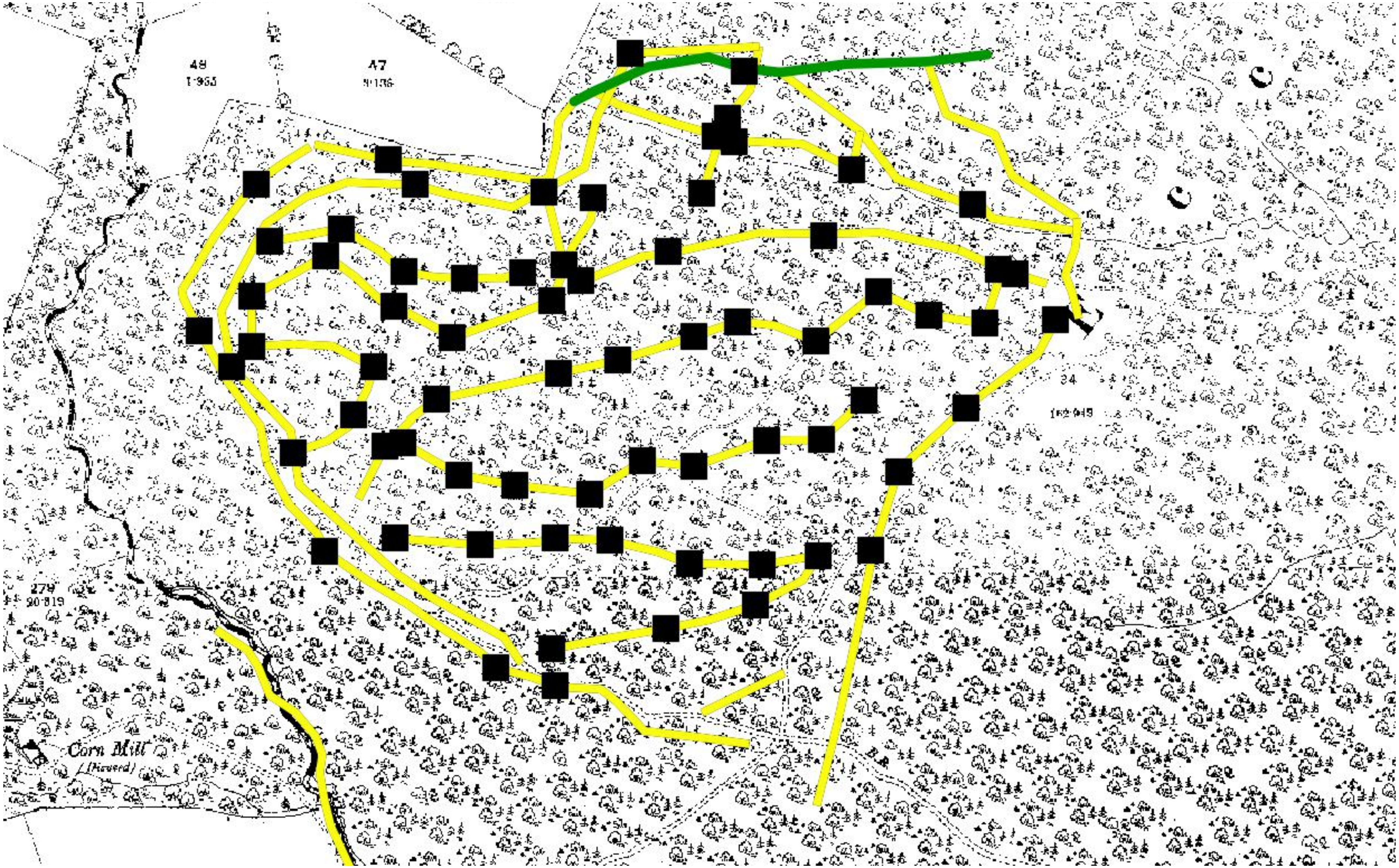


Figure 42.42 – *Rubus idaeus*

Species maps for Ecclesall Woods

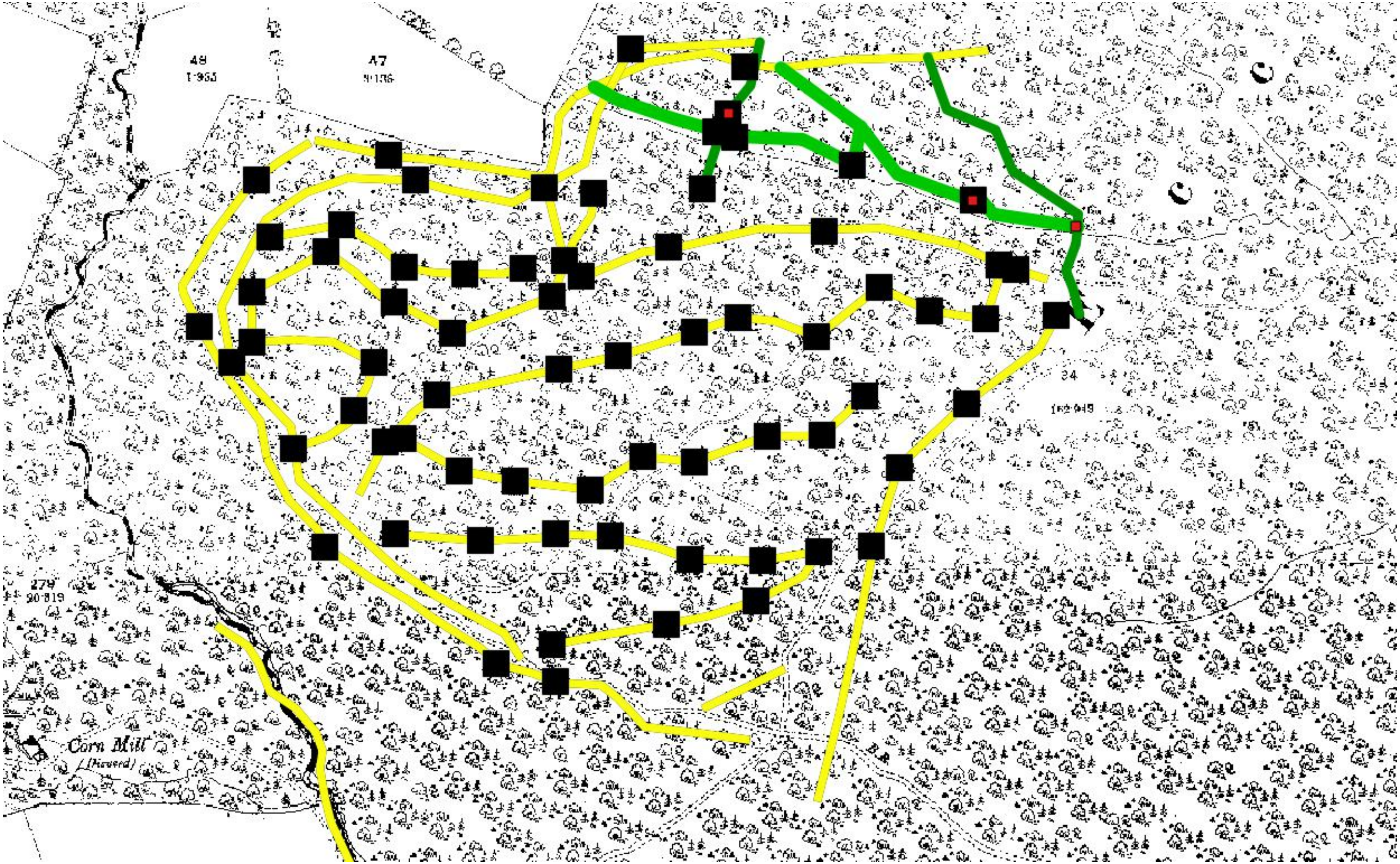


Figure 43.43 – *Silene dioica*

Appendix 14 - Results for Ecclesall Woods

Species maps for Ecclesall Woods

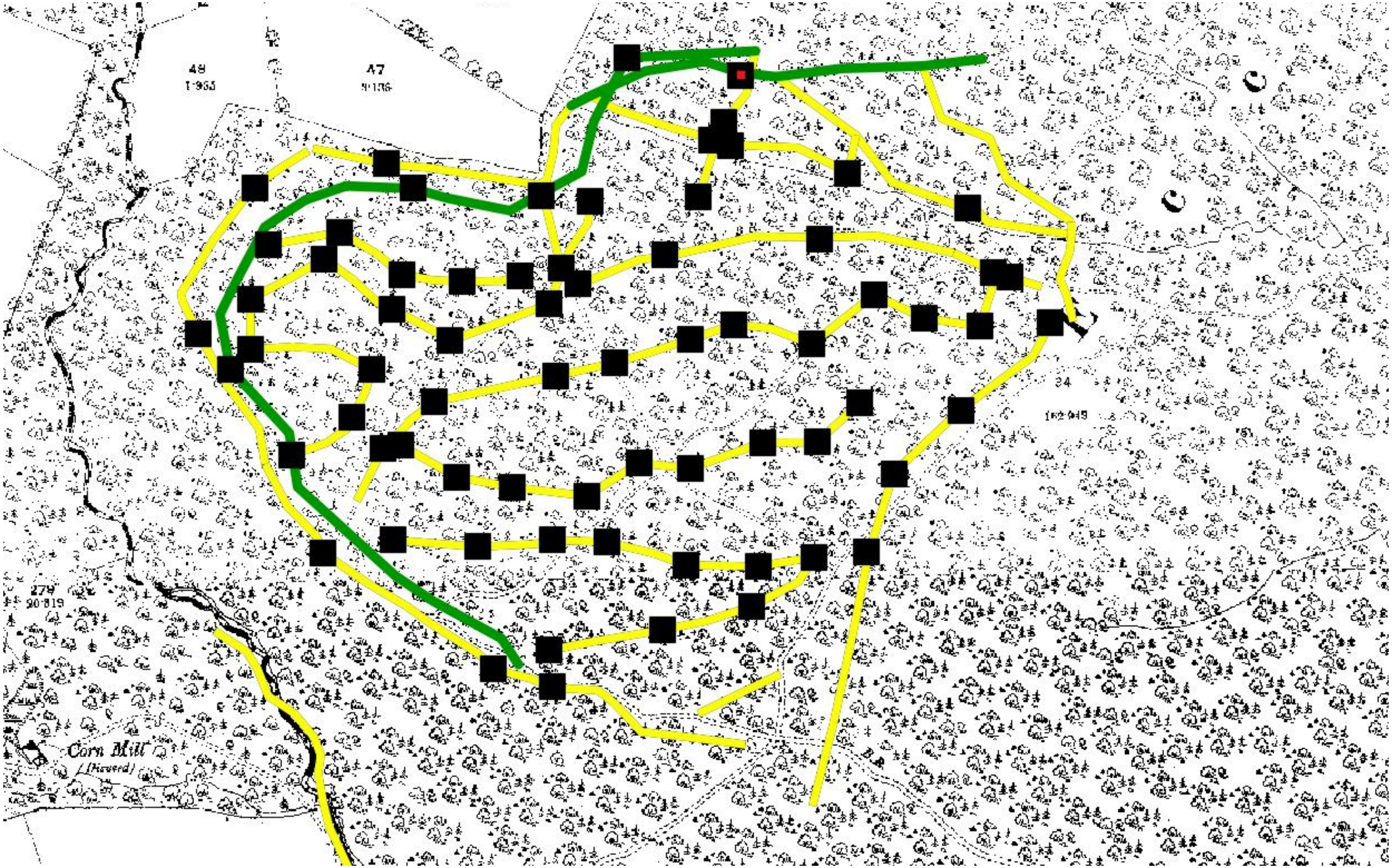


Figure 44.44 – *Stachys sylvatica*

Species maps for Ecclesall Woods

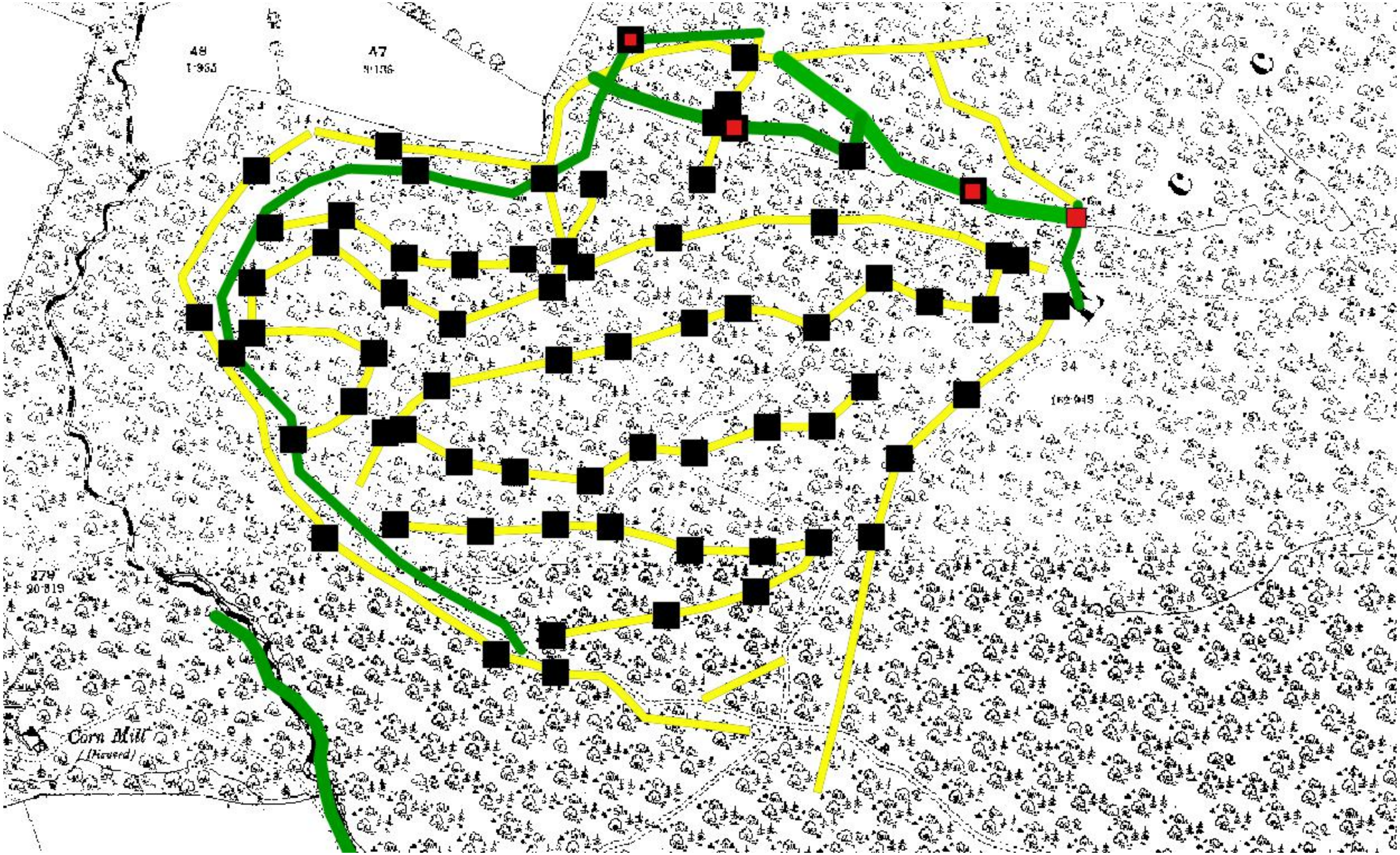


Figure 45.45 – *Stellaria holostea*

Species maps for Ecclesall Woods

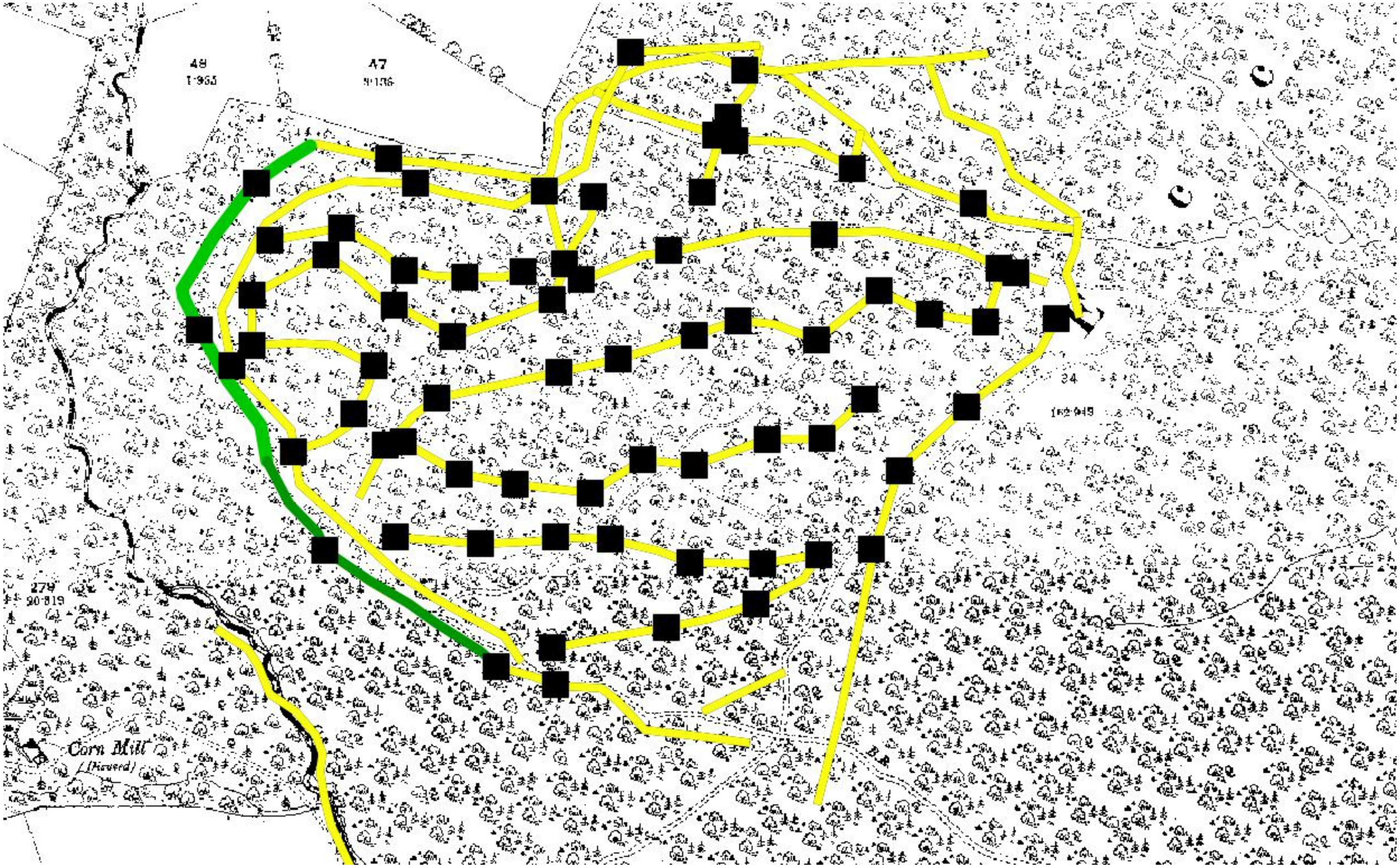


Figure 46.46 – *Teucrium scorodonia*

Species maps for Ecclesall Woods

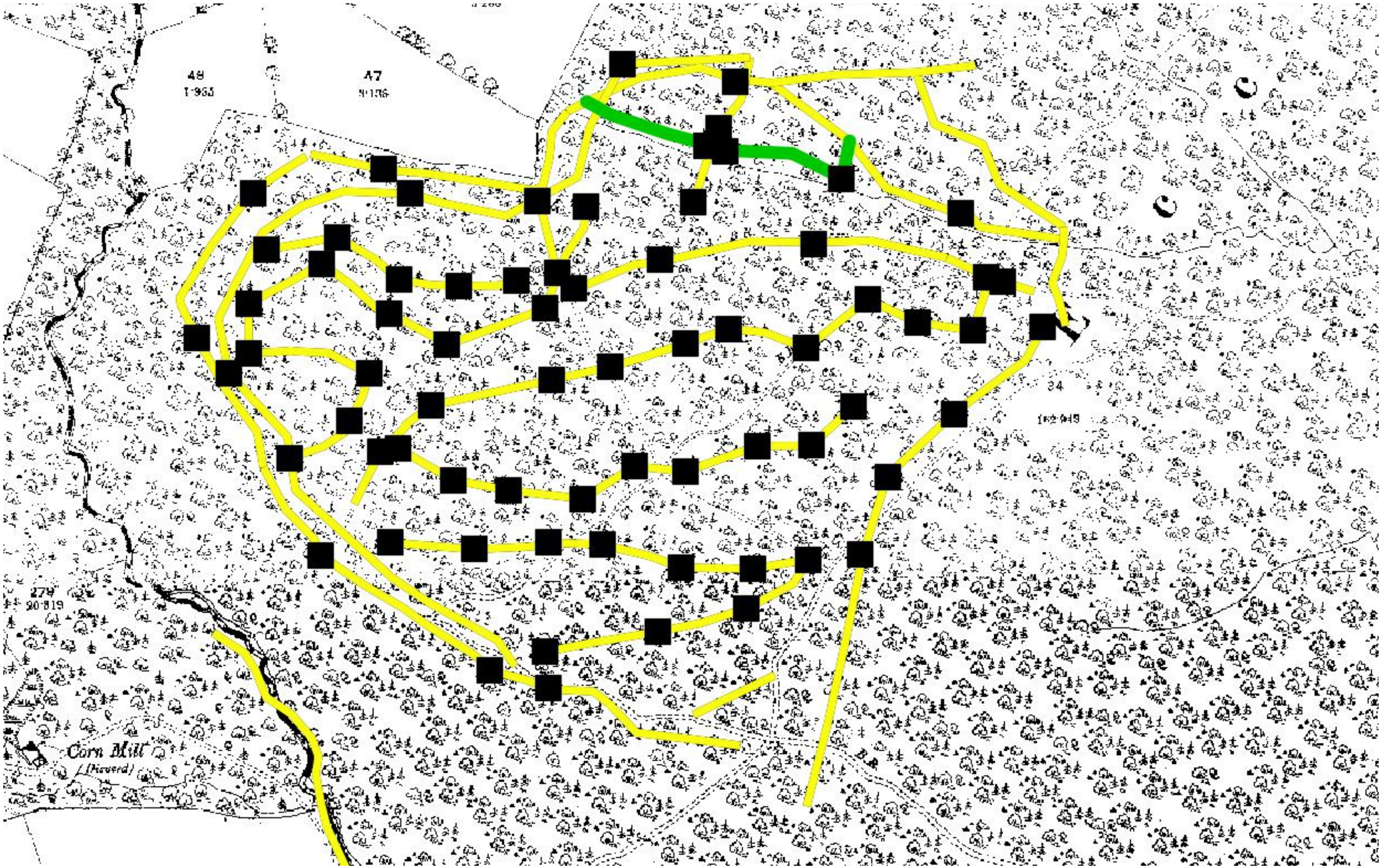


Figure 47.47 – *Valeriana officinalis*

Species maps for Ecclesall Woods

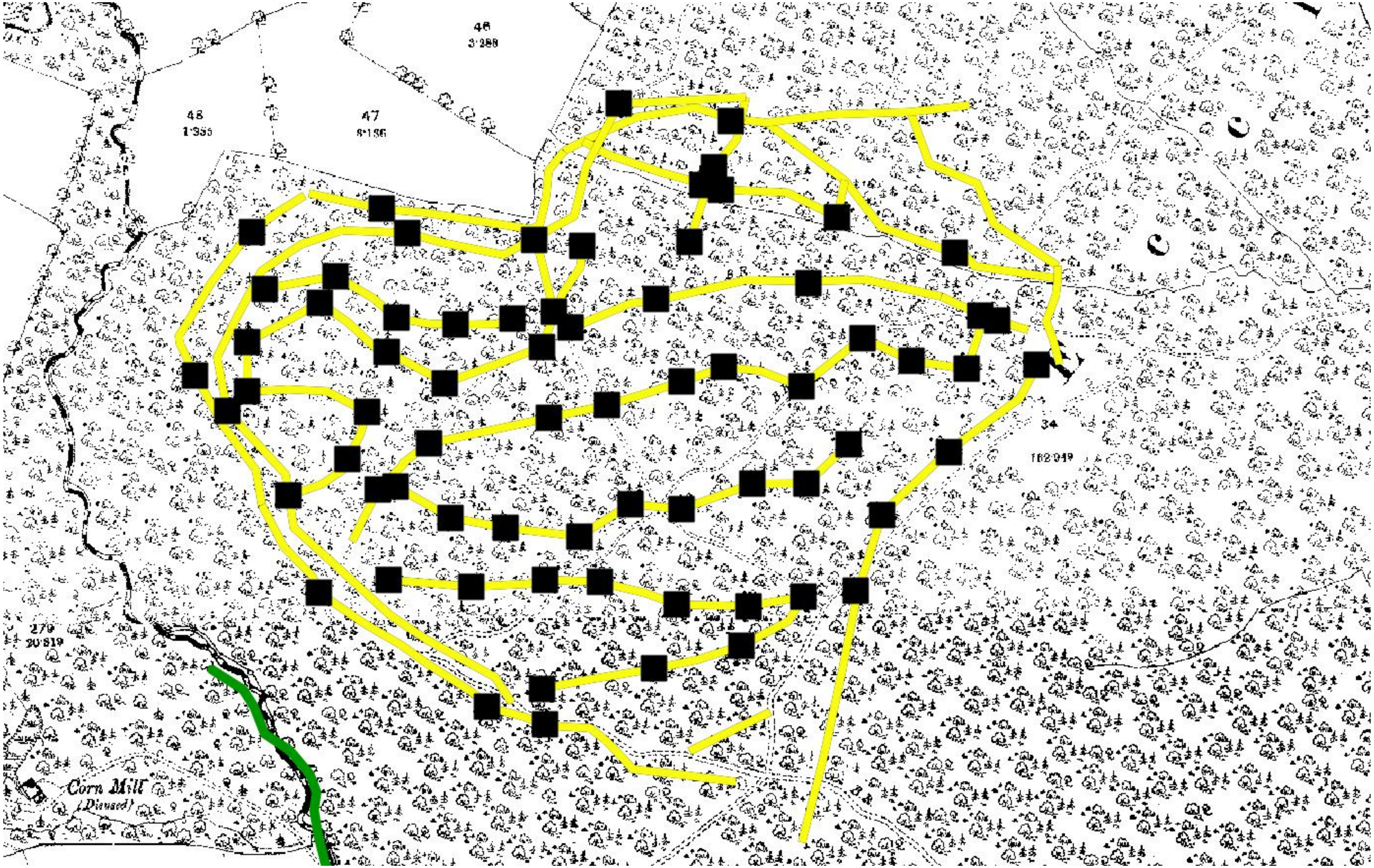


Figure 48.48 – *Veronica montana*

Species maps for Ecclesall Woods

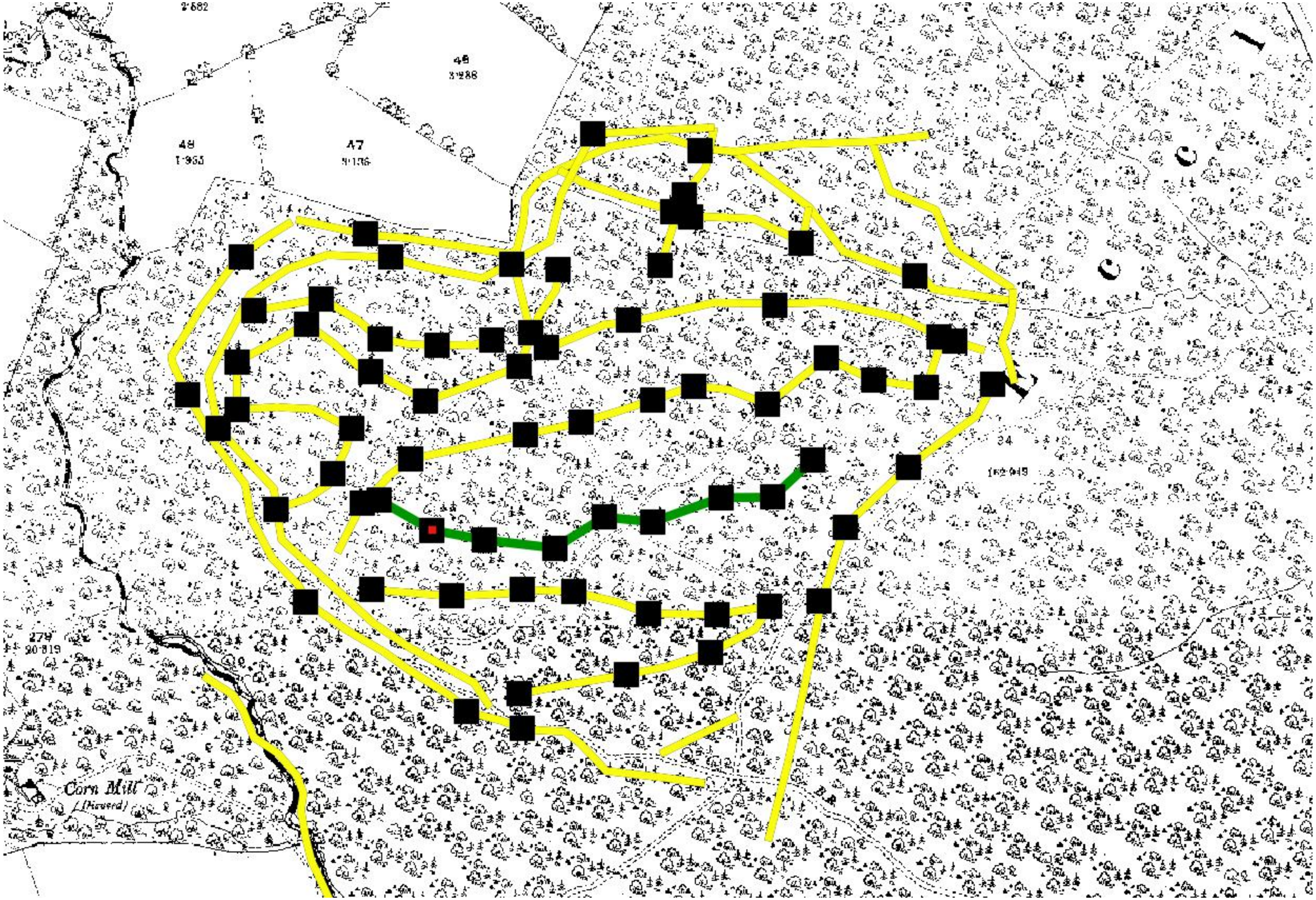


Figure 49.49 – *Vicia sepium*

Species maps for Ecclesall Woods

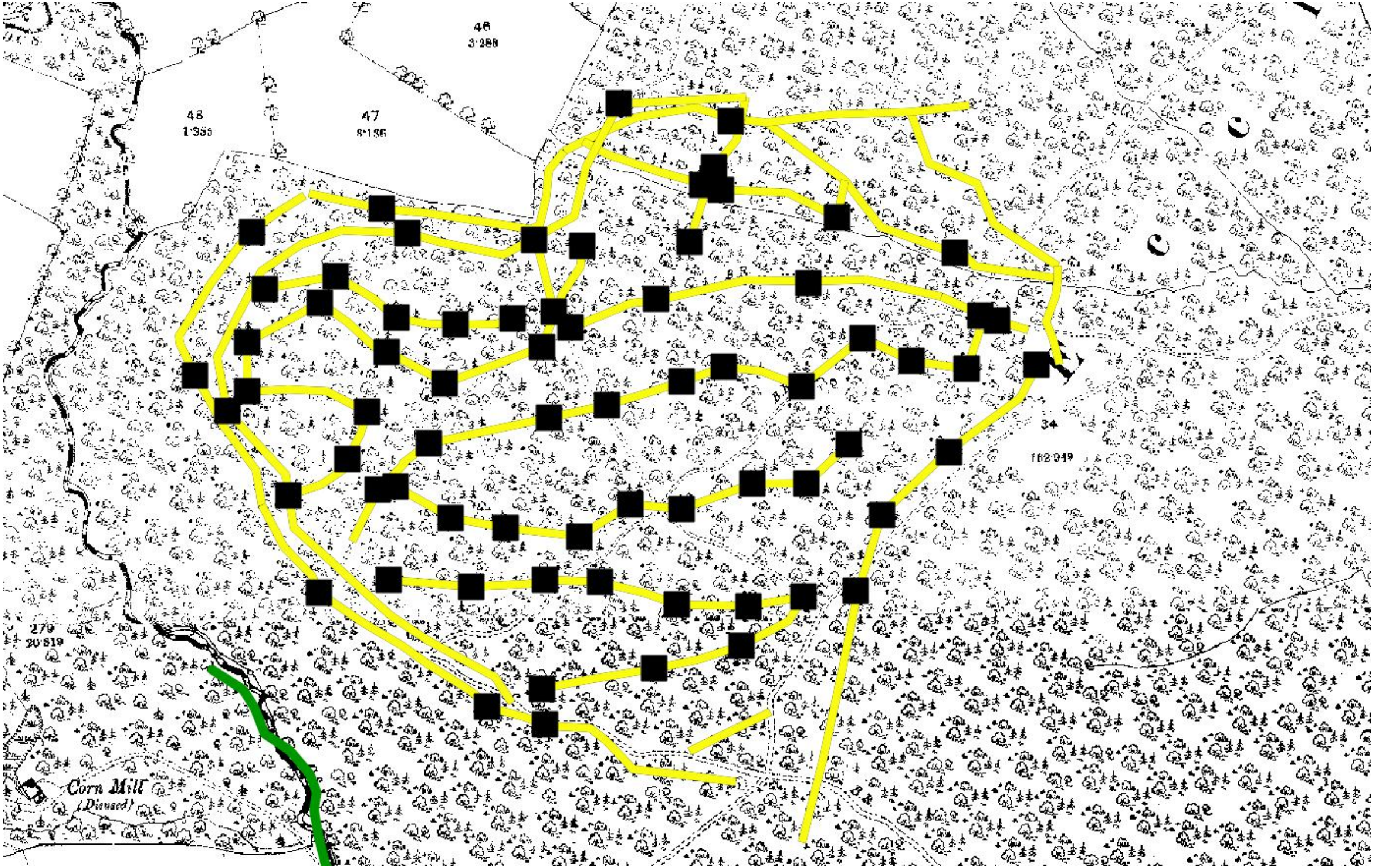


Figure 50.50 – *Viola riviniana*

Appendix 14 - Results for Ecclesall Woods

Table 51.1 – Survey data for Ecclesall Woods - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																									
Species	CB671-CB674	CB610-CB617	CB641-CB648	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667
Ace-Pse	11			22						22	22	11		11		22				11		11	11	22	11	
ACE-PSE										33	33	22				33						22	22			
aju-rep							11																			
all-urs	14																									
ALN-GLU	11			11				11																		
ane-nem	24	22			11																					
ang-syl		11																								
ant-syl	22											11														
ath-fil	22	22	33		11	11																				
BARE				22		11			45	44	45									22						
Bet-Pen									11			11	11						11		11				11	
BET-PEN				22		11	22	11	22			11			11			11					22		33	
ble-spi																										
bra-syl	11		22																							
BRYO	33		22	23	22	11	13					33		11	22	22				11	11		22	33	22	11
car-ama	11																									
car-pen	14																									
car-rem	14	22	22	11	11		11																			
car-syl																										

Appendix 14 - Results for Ecclesall Woods

Table 51.1 – Survey data for Ecclesall Woods - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																									
Species	CB671-CB674	CB610-CB617	CB641-CB648	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667
Cas-Sat				11	22		11	11	11	11	11	22	22		11					11			23			11
CAS-SAT				34	44	33	14	33	44	33	22	33	22	22	45				33	11	11	33	45	35		33
cer-cla														11												
cha-ang				11		11		11				11														
chr-opp	23	44	33		11		11																			
cir-lut		22	22	24		11		11		11	11	24	11													
Cor-Ave		22		22				11																		
Cra-Mon									11		11								11		11					11
des-fle	23			24		11			11	35				14												
dry-aff	11			22																						
dry-car		11													11	11										
dry-dil	22	33	44	33	11	33	23	11	11	11	22	22	33	13	34	44	22	33	24	22	11	33	24	34	34	22
dry-fil		22	44	22		22	11	11	11			22	11		14	11										
epi-mon		11						11																		
Fag-Syl	11				22	11				33		11	22	11		22						22			11	
FAG-SYL				25	44	33	11		33			33	11	45		33	22	11	45		11	25		11	11	33
fes-gig			11																							
Fra-Exc				11				11			22	11									11		11			11
FRA-EXC				14							44															

Appendix 14 - Results for Ecclesall Woods

Table 51.1 – Survey data for Ecclesall Woods - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																									
Species	CB671-CB674	CB610-CB617	CB641-CB648	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667
gal-apa								11				11												11		
ger-rob	11	23	22	11		11		11				33		15					14							
geu-urb	11	11	11	11	22	11		11	11	11	11		22		11				11							
hed-hel	11			12							33					11					11		13			
her-sph		23																								
hol-mol	24	34	45	25	45	33	23	11	11	33	22	44	55	24	24	11	55	44	35	44	22	25	45	35	35	22
hya-non	24	33	45	25	22	22	25	11	11	33	22	45	22	33	13		22	33	34	22	11	23	35	34		33
Ile-Aqu				12	11	22	11	11		11	22	11	22	12		33	22	11	11	11	11	13	24	24	33	22
imp-gla	11	25	11																							
lam-gal	22	33	25		11		11																			
lap-com								11																		
LAR-KAE								11	11		22			22										22		
LITTER			33	35	33	33	45	44		44	44	33		35	45	44		33	35		11	45	35	45	45	44
lon-per	11				22	33		11	11	33	22		22			11	22	33								
luz-pil		22			11				11																	
luz-syl	24			11					11	24																
lys-nem			14																							
mel-uni	22																									
mer-per			12																							

Appendix 14 - Results for Ecclesall Woods

Table 51.1 – Survey data for Ecclesall Woods - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																									
Species	CB671-CB674	CB610-CB617	CB641-CB648	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667
mil-eff	22	11		13		11	11				11	11														
oxa-ace	24	22	34	14	11	11	11				11															
poa-nem		11	22	14	11	11					11				11											
Pru-Lau					11	11	11		11						11											11
pte-aqu		22	22	11	22	35	22	11	11	24	22	11	22	13		22	22	22		11	11	25	23	24	35	
QUE-PET								11	33	11	22	22				11				11					33	33
Que-Rob				11	22	11	11						44	11								11				
QUE-ROB	11			34	22	22	22						44	22	24				35		11	35	35	22		
ran-fic		11																								
Rho-Pon																					11					
rub-fru	33	22	23	25	22	33		11	11	33	44	11	33	22	24	33	22	33	33	11	11	35	34	34	33	
Rub-Ide								11																		
Sam-Nig											11	11			11				11		11			22		22
sil-dio		22	22		11	11	11																			
Sor-Auc	11			11	11	22		11	11	11		11	11	12	11	22		11			11	12	11	11	22	
SOR-AUC				11			12							12		22			23		11			11		
sta-syl				11				11																		
ste-hol	24	33	24	14	11																					
TAX-BAC						11						11								11					11	

Appendix 14 - Results for Ecclesall Woods

Table 51.1 – Survey data for Ecclesall Woods - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																									
Species	CB671-CB674	CB610-CB617	CB641-CB648	CL570-CL578	CB483-CB611	CB611-CB615	CL567-CL570	CB615-CB620	CB628-CB631	CB624-CB628	CB631-CB635	CB620-CB624	CB604-CB608	CL522-CL526	CL532-CL536	CB649-CB655	CB636-CB637	CB667-CB670	CL513-CL517	CB655-CB657	CL517-CL521	CL526-CL531	CL557-CL561	CL561-CL566	CB658-CB662	CB662-CB667
teu-sco									11	22																
ULM-GLA					11							11														
urt-dio				14				11																		
val-off			22																							
ver-mon	11																									
vic-sep																			11		11					
vio-riv	11																									

Appendix 14 - Results for Ecclesall Woods

Table 56.2 – Survey data for Ecclesall woods - Quadrat/ point records - part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
Species	CB605	CB606	CB607	CB608	CB610	CB612	CB613	CB618	CB622	CB625	CB627	CB629	CB632	CB633	CB638	CB640	CB644	CB645	CB646	CB647	CB649	CB650	CB651	CB652	CB653
Ace-Pse																						1			
ACE-PSE													2	3							2	2	5	4	
aju-rep																									
all-urs																									
ALN-GLU																									
ane-nem					1																				
ang-syl																1									
ant-syl									1																
ath-fil					2	1											1								
BARE						1																			
Bet-Pen	1	1	1	1																					
BET-PEN													2												
ble-spi																									
bra-syl																									
BRYO						1											1		2						2
car-ama																									
car-pen																									
car-rem					1																				
car-syl																									
Cas-Sat					1			1			1														
CAS-SAT					4																				
cer-cla																									
cha-ang								1																	

Appendix 14 - Results for Ecclesall Woods

Table 56.2 – Survey data for Ecclesall woods - Quadrat/ point records - part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
Species	CB605	CB606	CB607	CB608	CB610	CB612	CB613	CB618	CB622	CB625	CB627	CB629	CB632	CB633	CB638	CB640	CB644	CB645	CB646	CB647	CB649	CB650	CB651	CB652	CB653
chr-opp					2											3			1						
cir-lut				4		1		1	3							1									
Cor-Ave																									
Cra-Mon														1											
des-fle																									
dry-aff																									
dry-car															9										
dry-dil	1		2	2	2	1		2					2			2	3		2		1		3		2
dry-fil								1								1	4		2					2	
epi-mon																									
Fag-Syl				1	1	2				1														1	
FAG-SYL																					2			4	5
fes-gig																									
Fra-Exc						1		1	1					1											
FRA-EXC													4	5											
gal-apa									4																
ger-rob								1	3										2						
geu-urb				2		1		1								1									
hed-hel													3												
her-sph																3									
hol-mol	5	5	5	5	4	4	4	1	4	4	5	1	3	2		4	5		5				4	3	
hya-non	1	2	2		3	3	3	1	4		3			3			4		5						
Ile-Aqu		1	2			2								2							3	3	1	1	4

Appendix 14 - Results for Ecclesall Woods

Table 56.2 – Survey data for Ecclesall woods - Quadrat/ point records - part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
Species	CB605	CB606	CB607	CB608	CB610	CB612	CB613	CB618	CB622	CB625	CB627	CB629	CB632	CB633	CB638	CB640	CB644	CB645	CB646	CB647	CB649	CB650	CB651	CB652	CB653
imp-gla																									
lam-gal					3											3			3						
lap-com																									
LAR-KAE																									
LITTER						2	3	4	3	4	4		4	4							2	2	3	4	5
lon-per		1		2			1			3	3	4											1		
luz-pil					1																				
luz-syl																									
lys-nem																									
mel-uni																									
mer-per																		9		9					
mil-eff														4											
oxa-ace					1	1								4		1			1						
poa-nem						1										1									
Pru-Laur					1																				
pte-aqu			1			1		1			2	1					1		1						
QUE-PET													1										1		
Que-Rob		1	1	1	1	1																			
QUE-ROB																									
ran-fic																1									
Rho-Pon																									
rub-fru	3	2	4	3	2	3	4		4	1	2	4	4			3	1		1		2	3	2		
Rub-Ide																									

Appendix 14 - Results for Ecclesall Woods

Table 56.2 – Survey data for Ecclesall woods - Quadrat/ point records - part 1																									
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.																									
	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
Species	CB605	CB606	CB607	CB608	CB610	CB612	CB613	CB618	CB622	CB625	CB627	CB629	CB632	CB633	CB638	CB640	CB644	CB645	CB646	CB647	CB649	CB650	CB651	CB652	CB653
Sam-Nig																									
sil-dio					1											1									
Sor-Auc			2			1			1	1		1									2				
SOR-AUC																						2			
sta-syl								1																	
ste-hol					4											3			3						
TAX-BAC																									
teu-sco																									
ULM-GLA					1																				
urt-dio																									
val-off																									
ver-mon																									
vic-sep																									
vio-riv																									

Table 60.3 – Survey data for Ecclesall Woods - Quadrat/ point records - part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																									
SPECIES	CB656	CB658	CB659	CB660	CB661	CB662	CB663	CB664	CB665	CB666	CB667	CB668	CB672	CL513	CL514	CL515	CL516	CL517	CL518	CL519	CL520	CL521	CL522	CL523	CL524	CL525
Ace-Pse		1																						1		
ACE-PSE																										
aju-rep																										
all-urs																										
ALN-GLU																										
ane-nem																										
ang-syl																										
ant-syl																										
ath-fil																										
BARE	2																									
Bet-Pen				3																	2	2				
BET-PEN		4	5	4		4						2														
ble-spi													9													
bra-syl																										
BRYO	1					2	2		2	3	2								2		2		1	3	3	
car-ama																										
car-pen																										
car-rem																										
car-syl																										
Cas-Sat	2								3																	
CAS-SAT	5							4	4		3			1		5				1	3	4			2	
cer-cla																								3		
cha-ang																										

Table 60.3 – Survey data for Ecclesall Woods - Quadrat/ point records - part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																									
SPECIES	CB656	CB658	CB659	CB660	CB661	CB662	CB663	CB664	CB665	CB666	CB667	CB668	CB672	CL513	CL514	CL515	CL516	CL517	CL518	CL519	CL520	CL521	CL522	CL523	CL524	CL525
chr-opp																										
cir-lut																										
Cor-Ave																										
Cra-Mon									2	2						1				1						
des-fle																							1			
dry-aff																										
dry-car																										
dry-dil	1	2	3			3		3	3		2	3		1	1	2		4	2		4	2	1	4	1	1
dry-fil																										
epi-mon																										
Fag-Syl			2			2																	2			
FAG-SYL					5		4		4	5	5	4			5		5	4		5		2	4		5	2
fes-gig																										
Fra-Exc									2										1							
FRA-EXC																										
gal-apa																										
ger-rob																										5
geu-urb																										
hed-hel																			1	2						
her-sph																										
hol-mol	4	4		2					1		3	4		5	1	5		2				4		2		
hya-non	2						4	2	4	1	3	3		2	2	2	2	2	3	3					3	2
Ile-Aqu	1	3		1	1	3	1	4		3		4			1	1	1	1	2	2	2	2	3		1	1

Table 60.3 – Survey data for Ecclesall Woods - Quadrat/ point records - part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																									
SPECIES	CB656	CB658	CB659	CB660	CB661	CB662	CB663	CB664	CB665	CB666	CB667	CB668	CB672	CL513	CL514	CL515	CL516	CL517	CL518	CL519	CL520	CL521	CL522	CL523	CL524	CL525
imp-gla																										
lam-gal																										
lap-com																										
LAR-KAE																							4	5		
LITTER			3	3	3		5	5	5	5	5	5		3	5	4	5	4	5	5	5	5	5	3	5	5
lon-per												3														
luz-pil																										
luz-syl																										
lys-nem																										
mel-uni																										
mer-per																										
mil-eff																										
oxa-ace																										
poa-nem																										
Pru-Laur																										
pte-aqu	1	2	4	4																		1	2	4		
QUE-PET	1	3	2	3		2		3	4	3																
Que-Rob																									1	
QUE-ROB														5	2	2	2	4		1	5	3				3
ran-fic																										
Rho-Pon																						1				
rub-fru			1	3		2						3		2		3	1	2			2	3		3		2
Rub-Ide																										

Appendix 14 - Results for Ecclesall Woods

Table 60.3 – Survey data for Ecclesall Woods - Quadrat/ point records - part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																									
SPECIES	CB656	CB658	CB659	CB660	CB661	CB662	CB663	CB664	CB665	CB666	CB667	CB668	CB672	CL513	CL514	CL515	CL516	CL517	CL518	CL519	CL520	CL521	CL522	CL523	CL524	CL525
Sam-Nig									2									2	1							
sil-dio																										
Sor-Auc		1	2									1									1	1	1	1		1
SOR-AUC														1	1			2			3			1		
sta-syl																										
ste-hol																										
TAX-BAC	1		1																							
teu-sco																										
ULM-GLA																										
urt-dio																										
val-off																										
ver-mon																										
vic-sep																					1					
vio-riv																										

Table 64.4 – Survey data for Ecclesall woods – Quadrats, point records – part 3

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																												
Species	CL526	CL527	CL528	CL529	CL530	CL531	CL532	CL533	CL534	CL535	CL536	CL557	CL558	CL559	CL560	CL561	CL562	CL563	CL564	CL565	CL566	CL567	CL568	CL569	CL571	CL572	CL573	CL574	CL575	CL576
Ace-Pse						1														2					1					
ACE-PSE						2								1																
aju-rep																								2						
all-urs																														
ALN-GLU																														
ane-nem																														
ang-syl																														
ant-syl																														
ath-fil																														
BARE																														
Bet-Pen																														
BET-PEN							1					2												2		1				
ble-spi																														
bra-syl																														
BRYO	3										4		2	1				2	2	3		2		3						
car-ama																														
car-pen																														
car-rem																								2						
car-syl																														
Cas-Sat							1			1						1						1			1	2				
CAS-SAT			1			2	5	5	5	5	4		4	5	5	2	3	4		4	1	4	1	3	2	4			2	
cer-cla																														

Table 64.4 – Survey data for Ecclesall woods – Quadrats, point records – part 3

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																													
Species	CL526	CL527	CL528	CL529	CL530	CL531	CL532	CL533	CL534	CL535	CL536	CL557	CL558	CL559	CL560	CL561	CL562	CL563	CL564	CL565	CL566	CL567	CL568	CL569	CL571	CL572	CL573	CL574	CL575	CL576
cha-ang																														
chr-opp																								3						
cir-lut																														
Cor-Ave																														
Cra-Mon																														
des-fle																														
dry-aff																														
dry-car											1																			
dry-dil	1	2	1			4		5	1	3			2	2	2		4	2	2	3	3	2		3		2				
dry-fil											4													2	3					
epi-mon																														
Fag-Syl						1																								
FAG-SYL	5				5																5	1								
fes-gig																														
Fra-Exc																														
FRA-EXC																									4					
gal-apa																														
ger-rob																														
geu-urb							1																							
hed-hel																									2					
her-sph																														

Appendix 14 - Results for Ecclesall Woods

Table 64.4 – Survey data for Ecclesall woods – Quadrats, point records – part 3

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																													
Species	CL526	CL527	CL528	CL529	CL530	CL531	CL532	CL533	CL534	CL535	CL536	CL557	CL558	CL559	CL560	CL561	CL562	CL563	CL564	CL565	CL566	CL567	CL568	CL569	CL571	CL572	CL573	CL574	CL575	CL576
hol-mol	1	5	5		2			3	5	2			3		4	4	3	1				2	5	2		2			4	
hya-non	2	2	2		2			2	1	3				5	4	3	2	4	4	4	5	4	2	4	2	5			3	
Ile-Aqu	2		3	5	1							1	1	2			2		2	3	1	2								
imp-gla																														
lam-gal																								1						
lap-com																														
LAR-KAE																	3		3	1										
LITTER	5	4	3	5	5	5	4	4	4	4	4	4	4	5	5	5	4	4	5	5	4	5	2	3	4	5			4	
lon-per																														
luz-pil																														
luz-syl																												9		
lys-nem																														
mel-uni																														
mer-per																														
mil-eff																								1						9
oxa-ace																								2			9			
poa-nem							1																							
Pru-Laur							1															1								
pte-aqu			2										3			2	1	3	3				5	1						
QUE-PET																														
Que-Rob			1																			1				1				

Appendix 14 - Results for Ecclesall Woods

Table 64.4 – Survey data for Ecclesall woods – Quadrats, point records – part 3

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																													
Species	CL526	CL527	CL528	CL529	CL530	CL531	CL532	CL533	CL534	CL535	CL536	CL557	CL558	CL559	CL560	CL561	CL562	CL563	CL564	CL565	CL566	CL567	CL568	CL569	CL571	CL572	CL573	CL574	CL575	CL576
QUE-ROB	1	5	5				1				2	5	2	1	1	4	2	3	3				1			2			4	
ran-fic																														
Rho-Pon																														
rub-fru		3	2		2	3	1			3	1	3	3	2	3	3	3	3		3	2				4				4	
Rub-Ide																														
Sam-Nig							1		3																					
sil-dio																								1						
Sor-Auc									1					1				1		1	1					1				
SOR-AUC																				1				2						
sta-syl																														
ste-hol																									2					
TAX-BAC																														
teu-sco																														
ULM-GLA																														
urt-dio																														
val-off																														
ver-mon																														
vic-sep																														
vio-riv																														

Appendix 15 - Results for Gillfield Wood

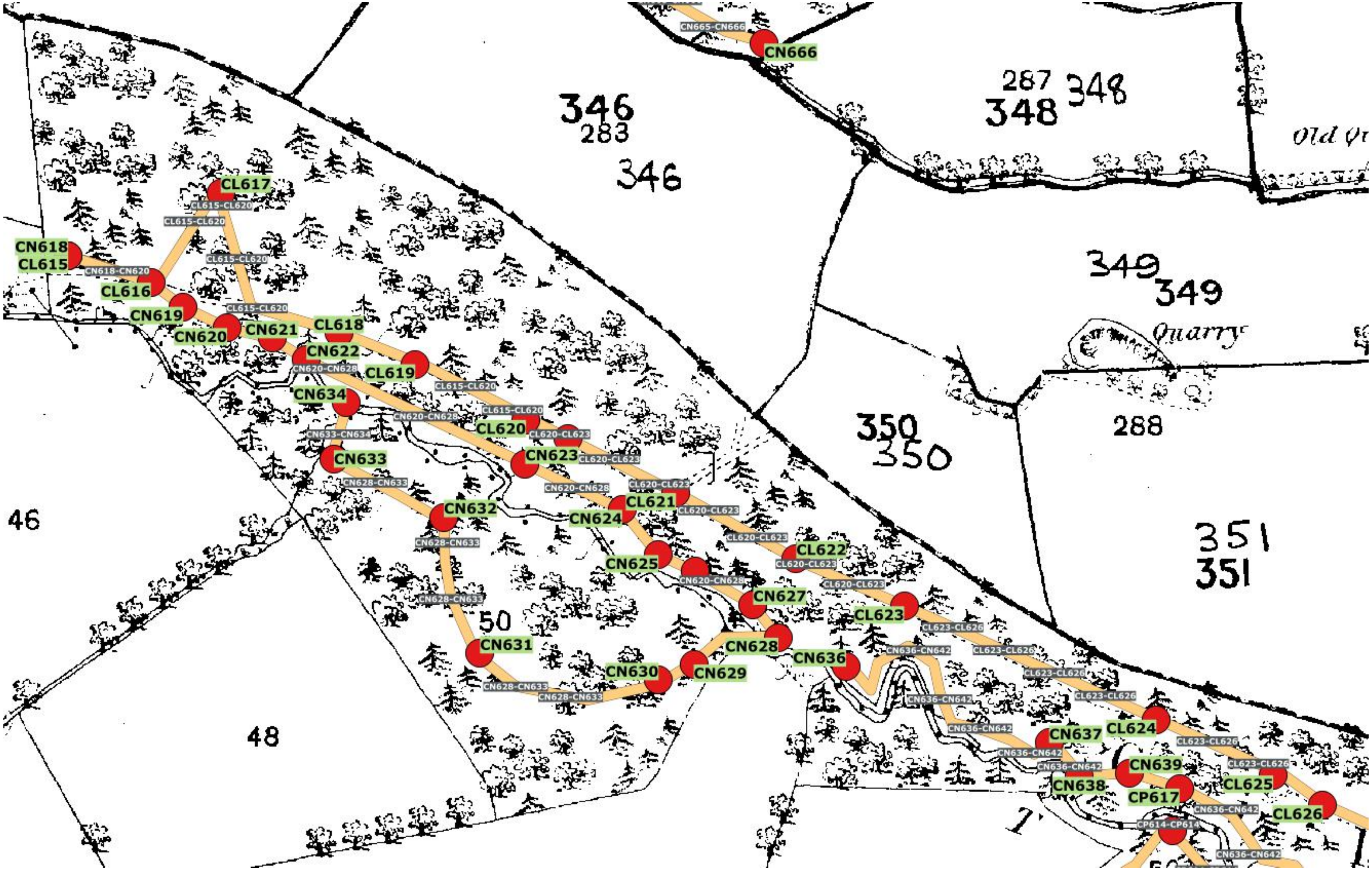


Figure 1.1 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part -01.

Appendix 15 - Results for Gillfield Wood

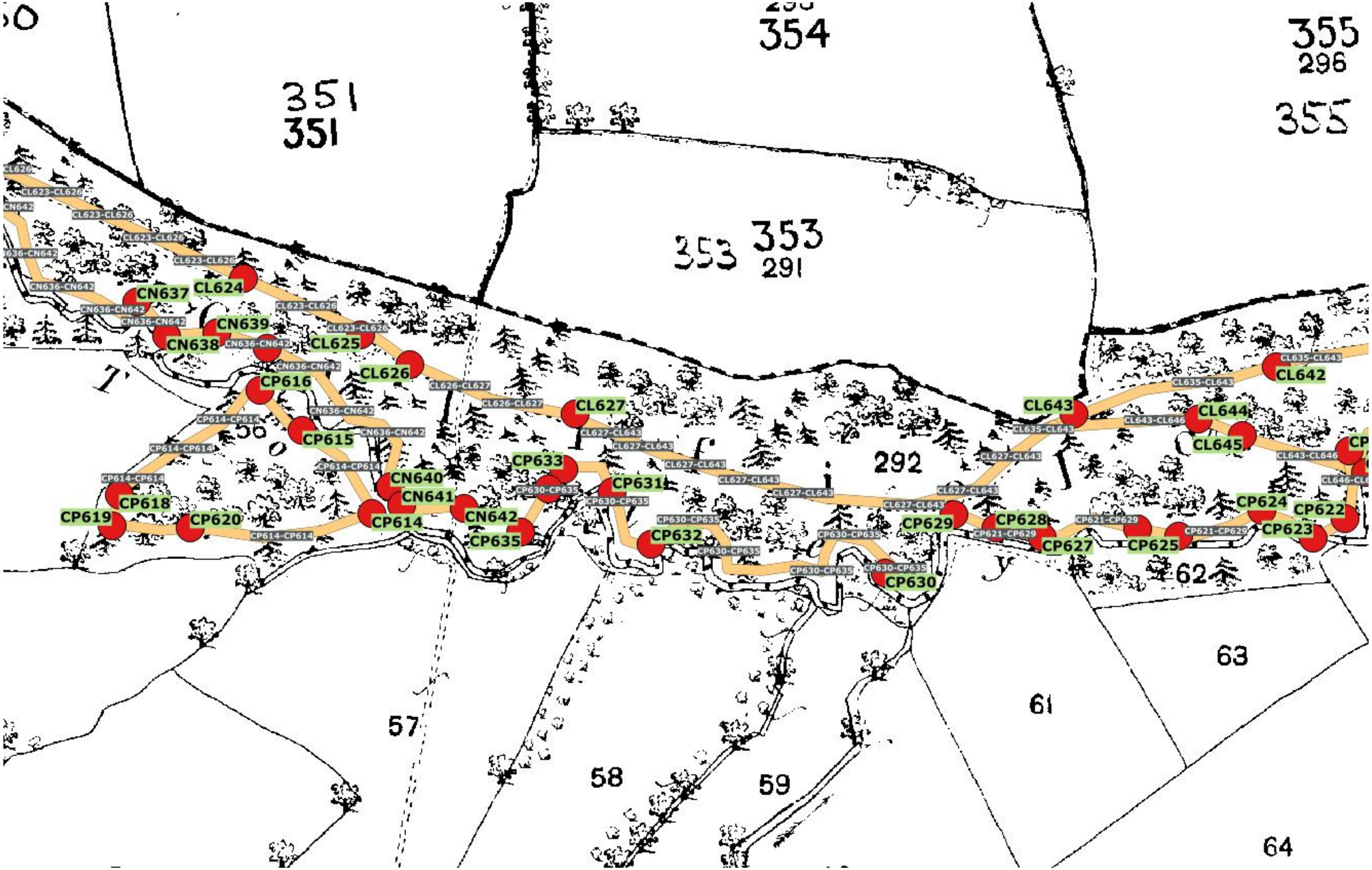


Figure 2.2 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part 02.

Appendix 15 - Results for Gillfield Wood

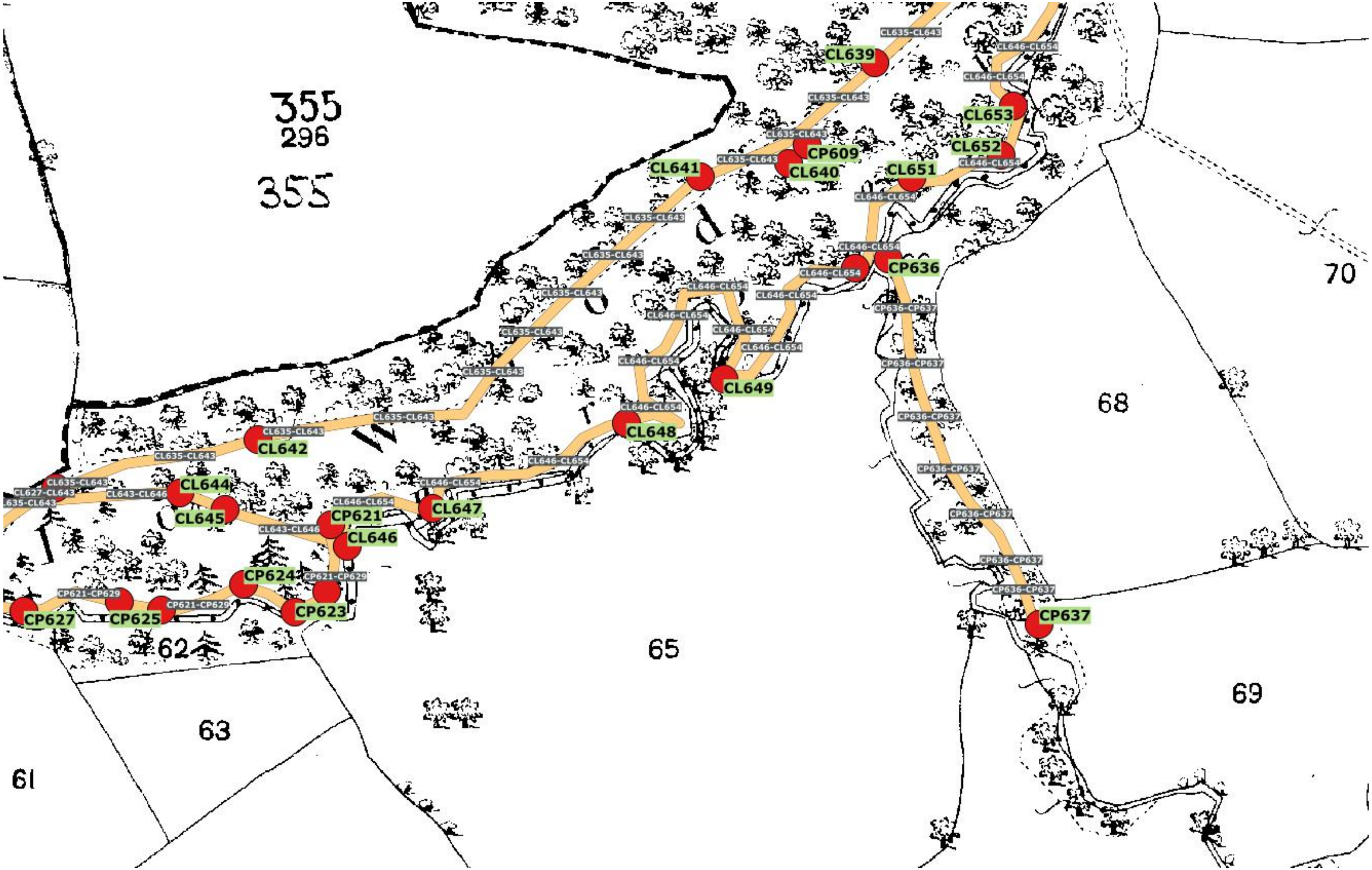


Figure 3.3 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part 03.

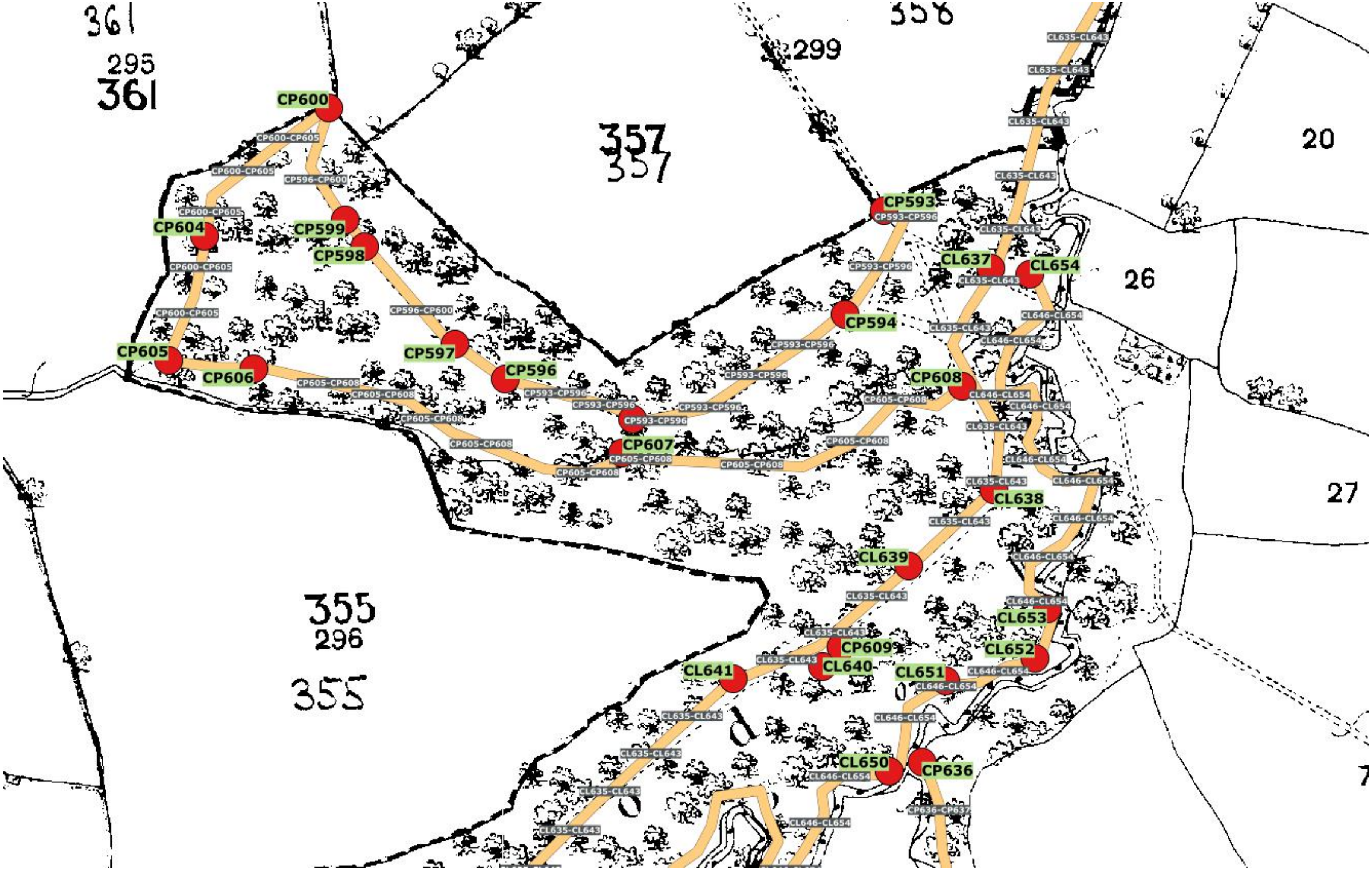


Figure 4.4 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part 04.

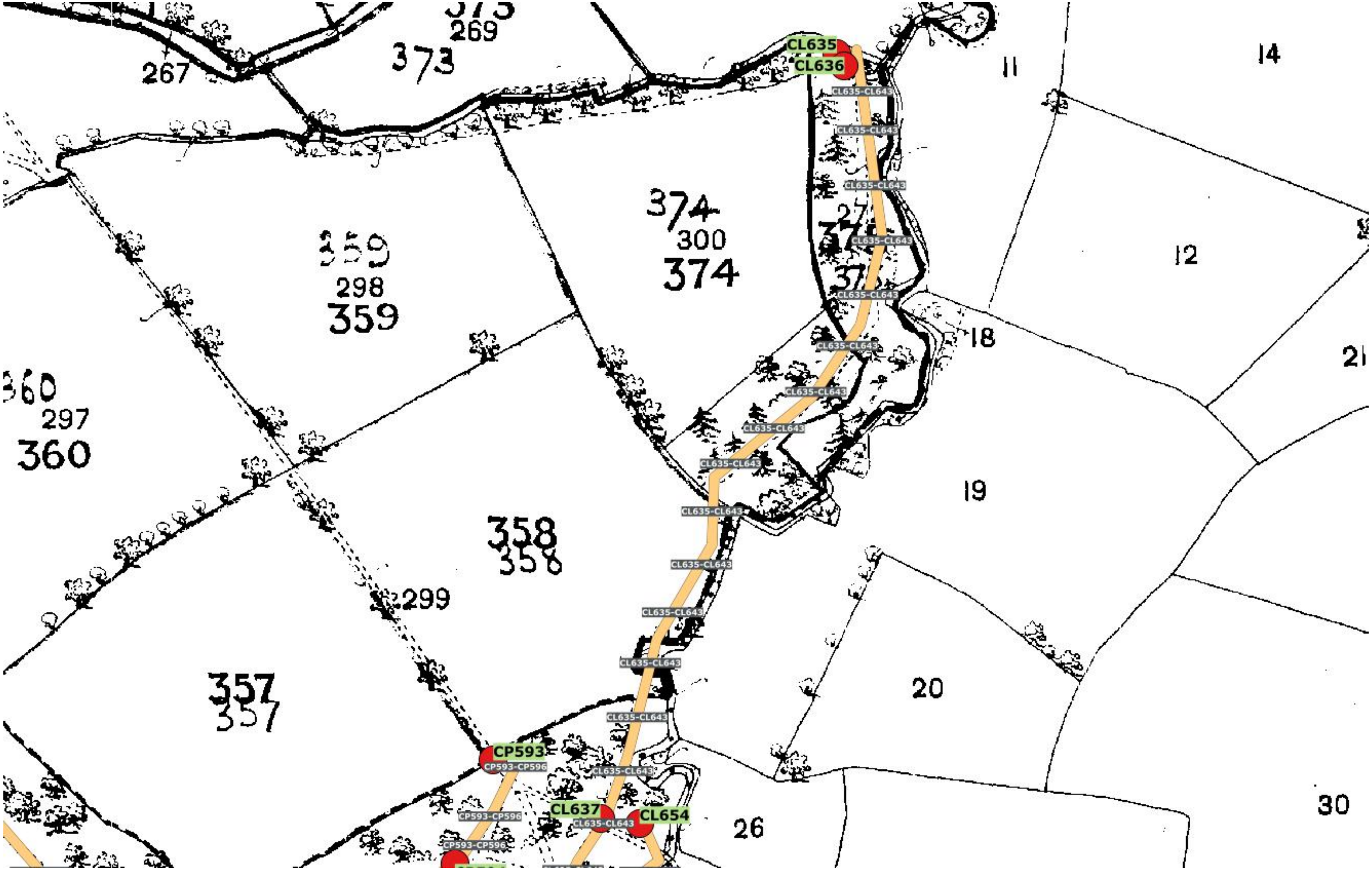


Figure 5.5 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part 05.

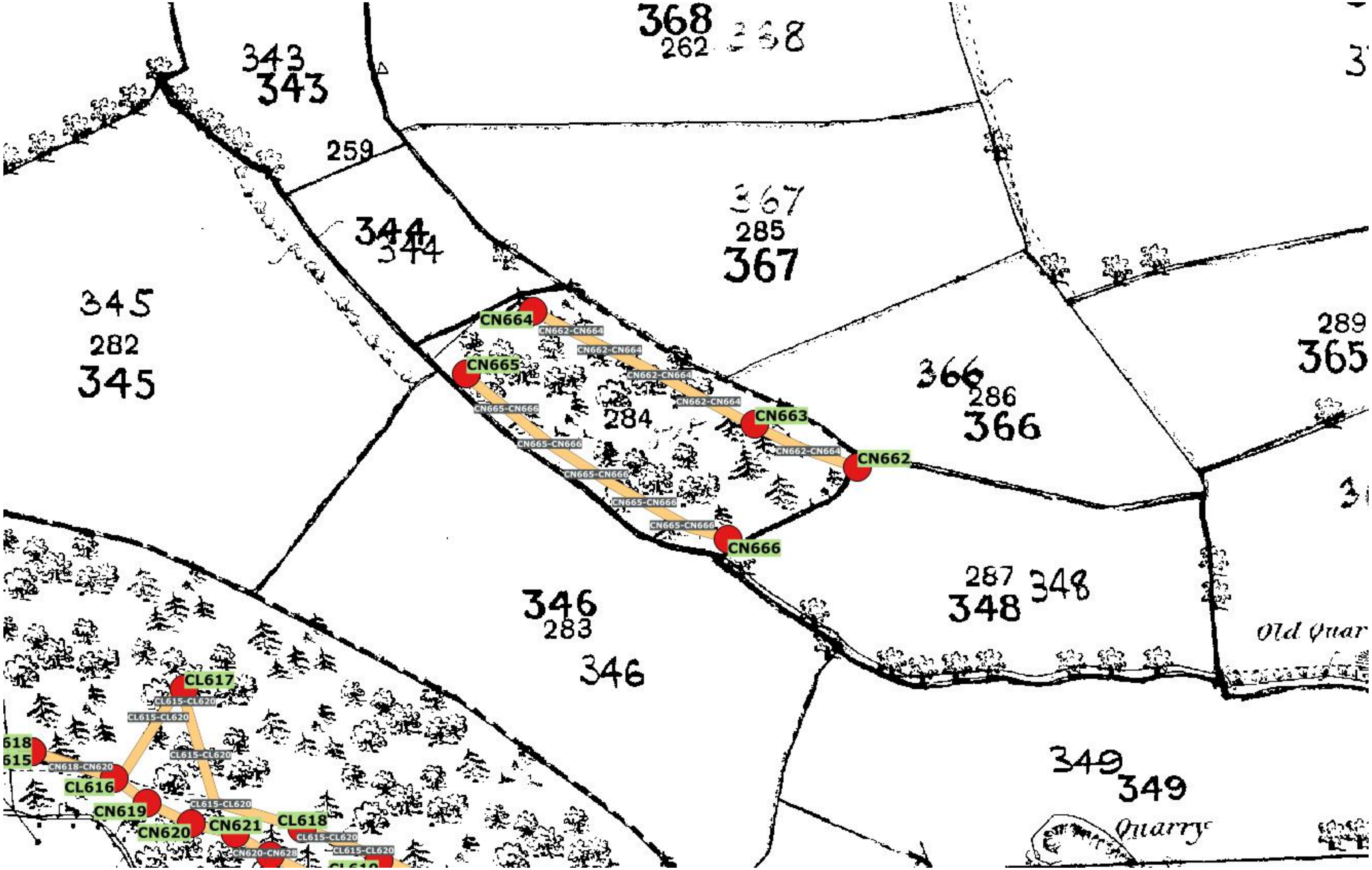


Figure 6.6 – Detailed map of Gillfield Wood showing transect and waypoint numbers – part 06.

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

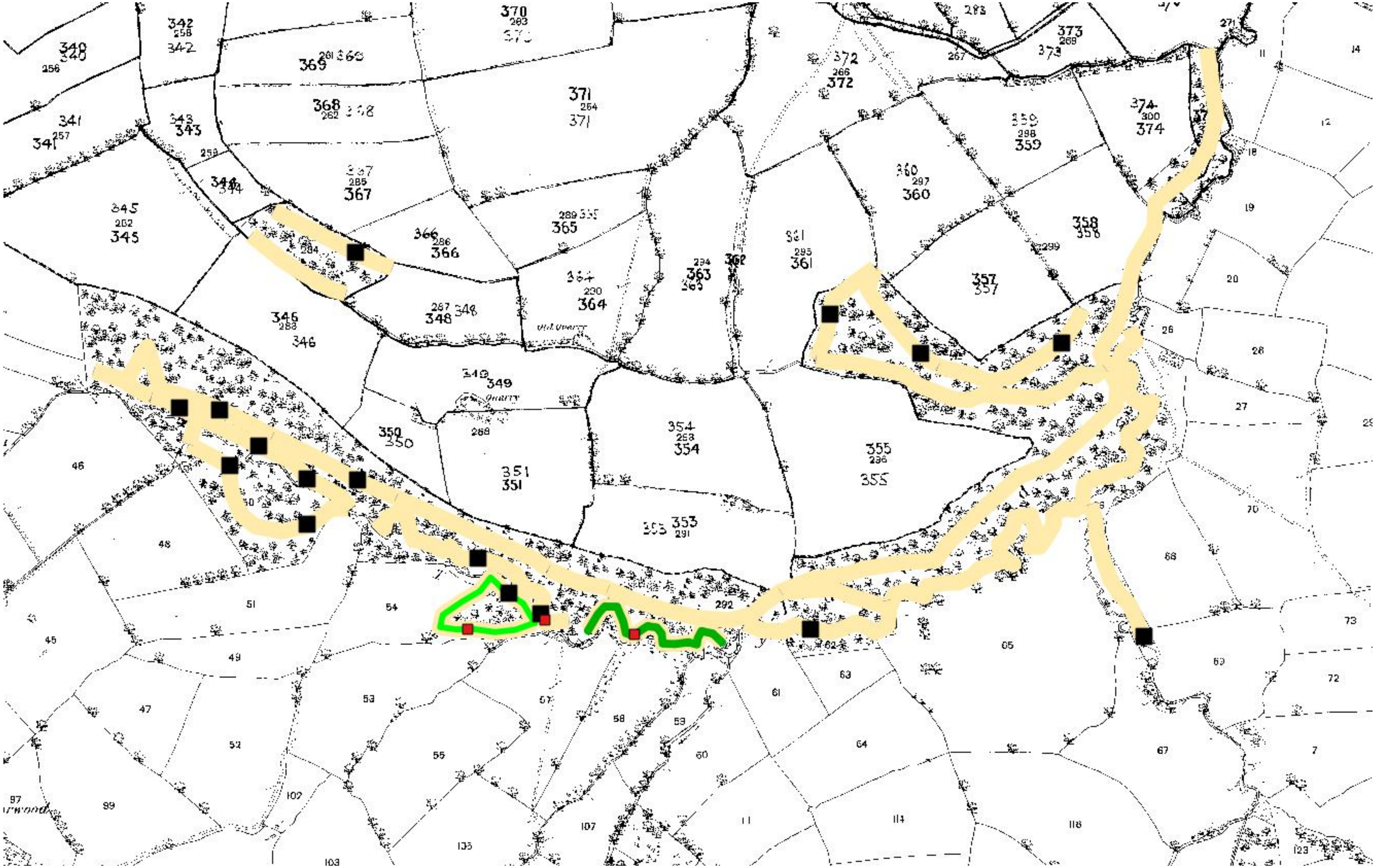


Figure 7.7 – *Adoxa moschatellina*

Species maps for Gillfield wood

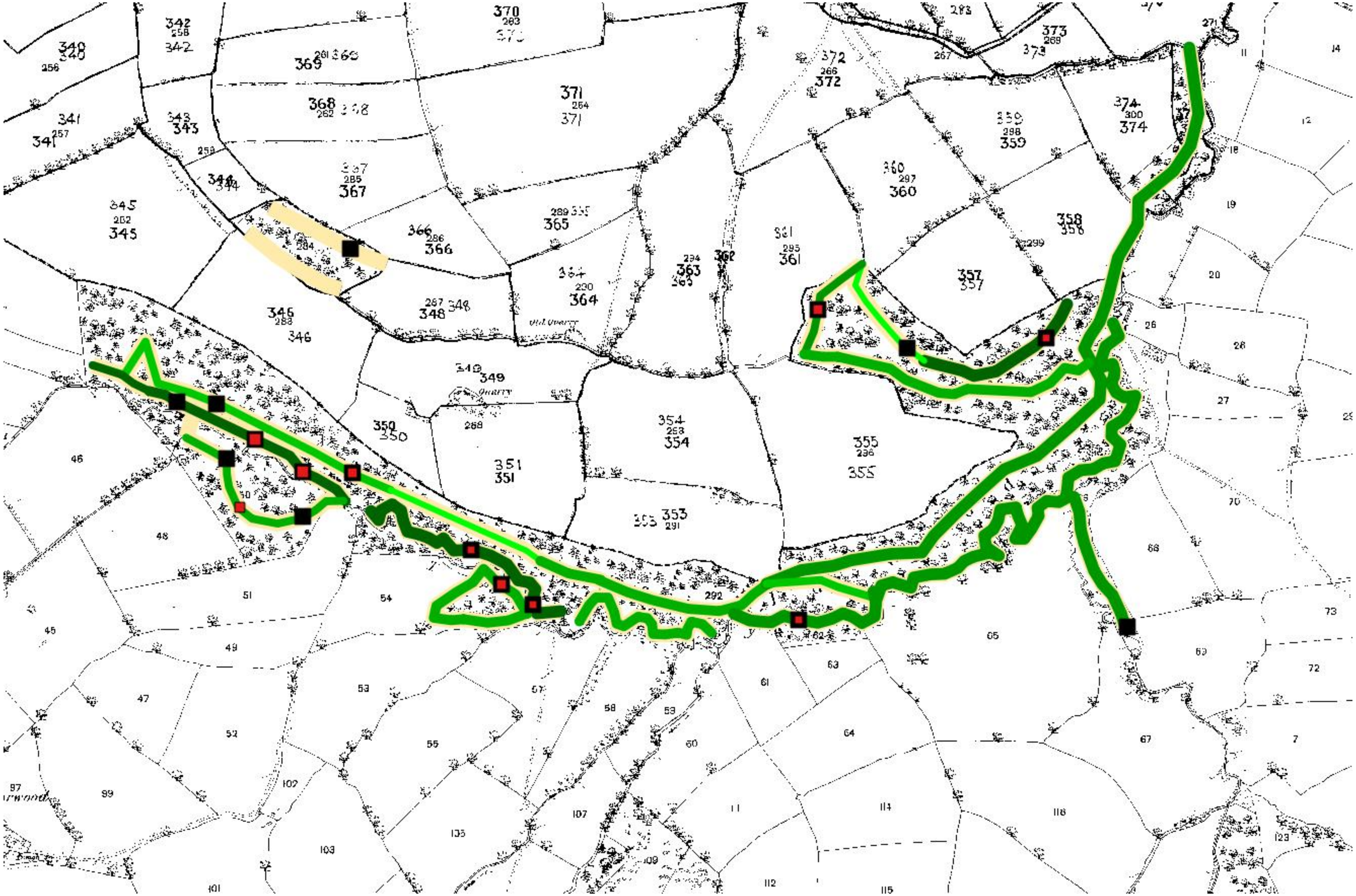


Figure 8.8 – *Anemone nemorosa*

Species maps for Gillfield wood

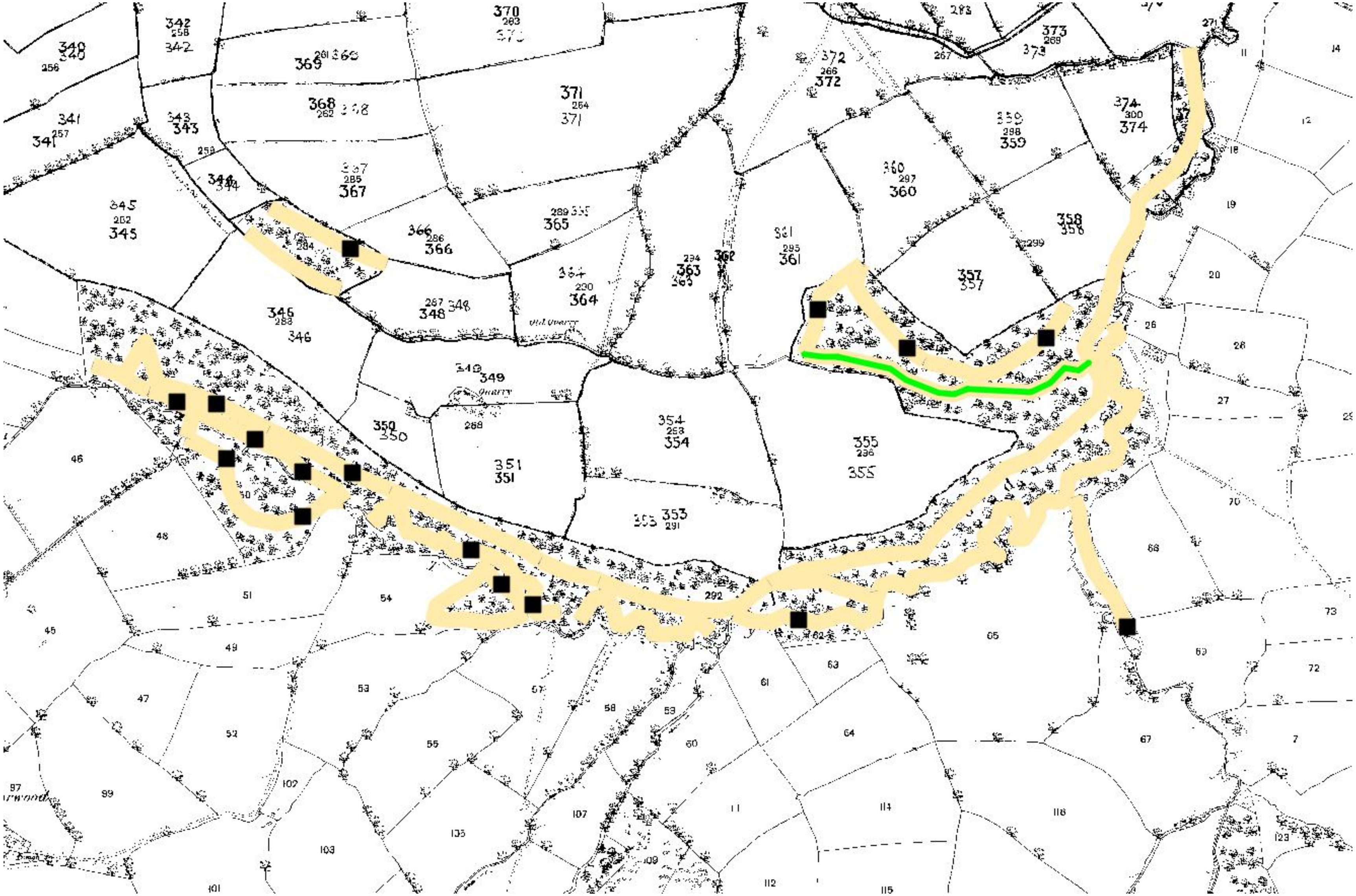


Figure 9.9 – *Arum maculatum*

Species maps for Gillfield wood

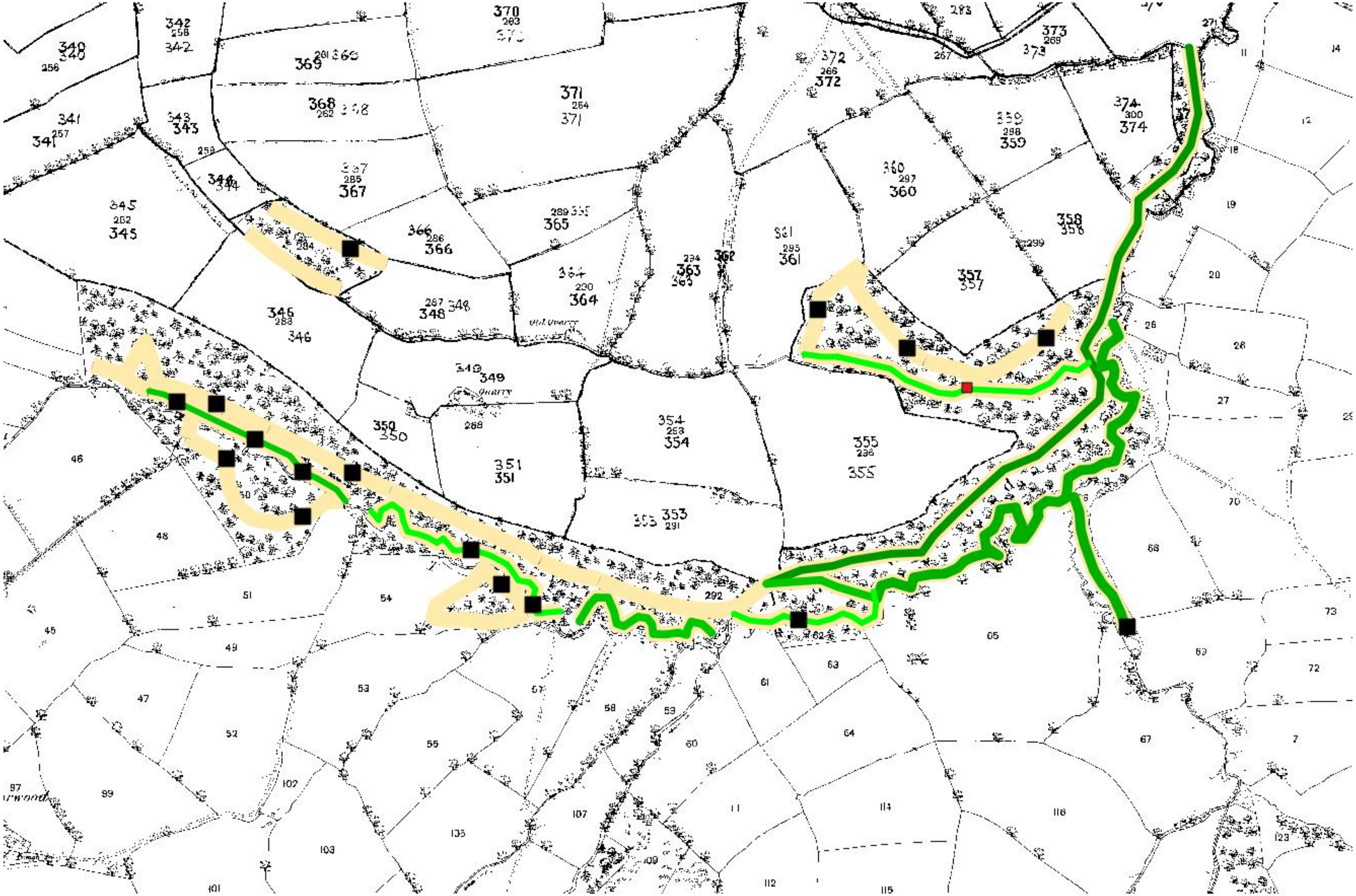


Figure 10.10 – *Athyrium filix-femina*

Species maps for Gillfield wood

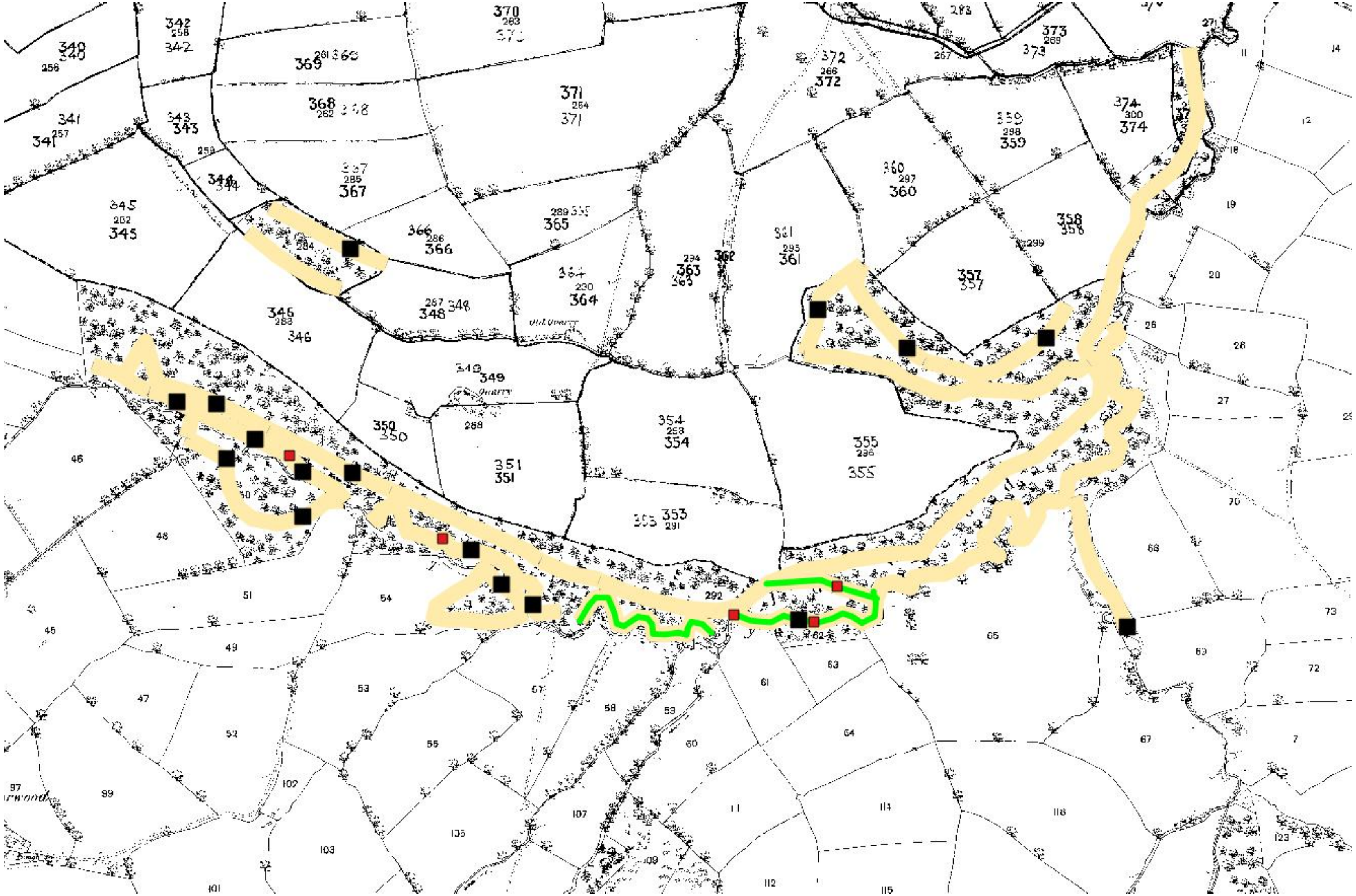


Figure 11.11 – *Blechnum spicant*

Species maps for Gillfield wood

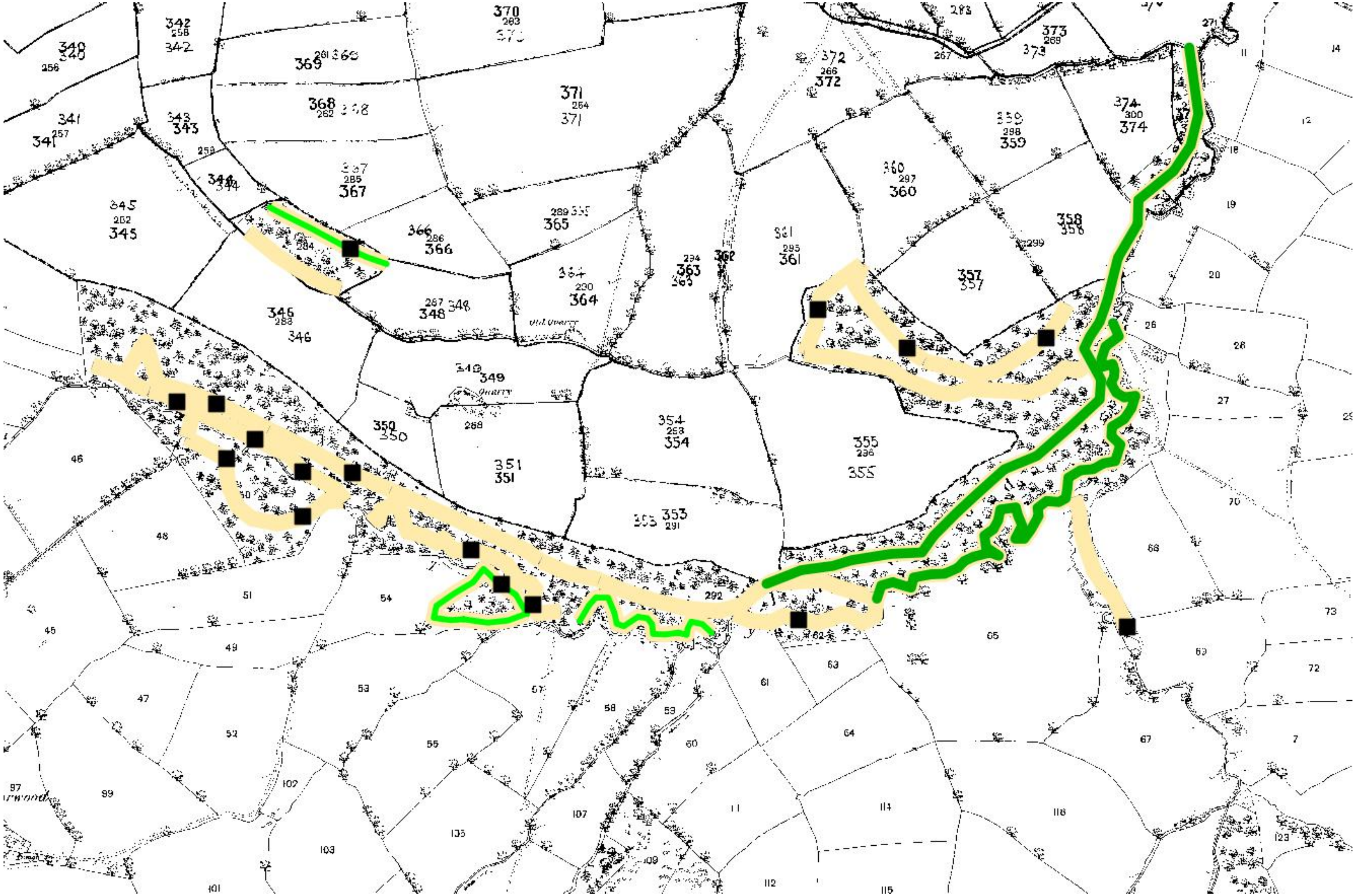


Figure 12.12 – *Brachypodium sylvaticum*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

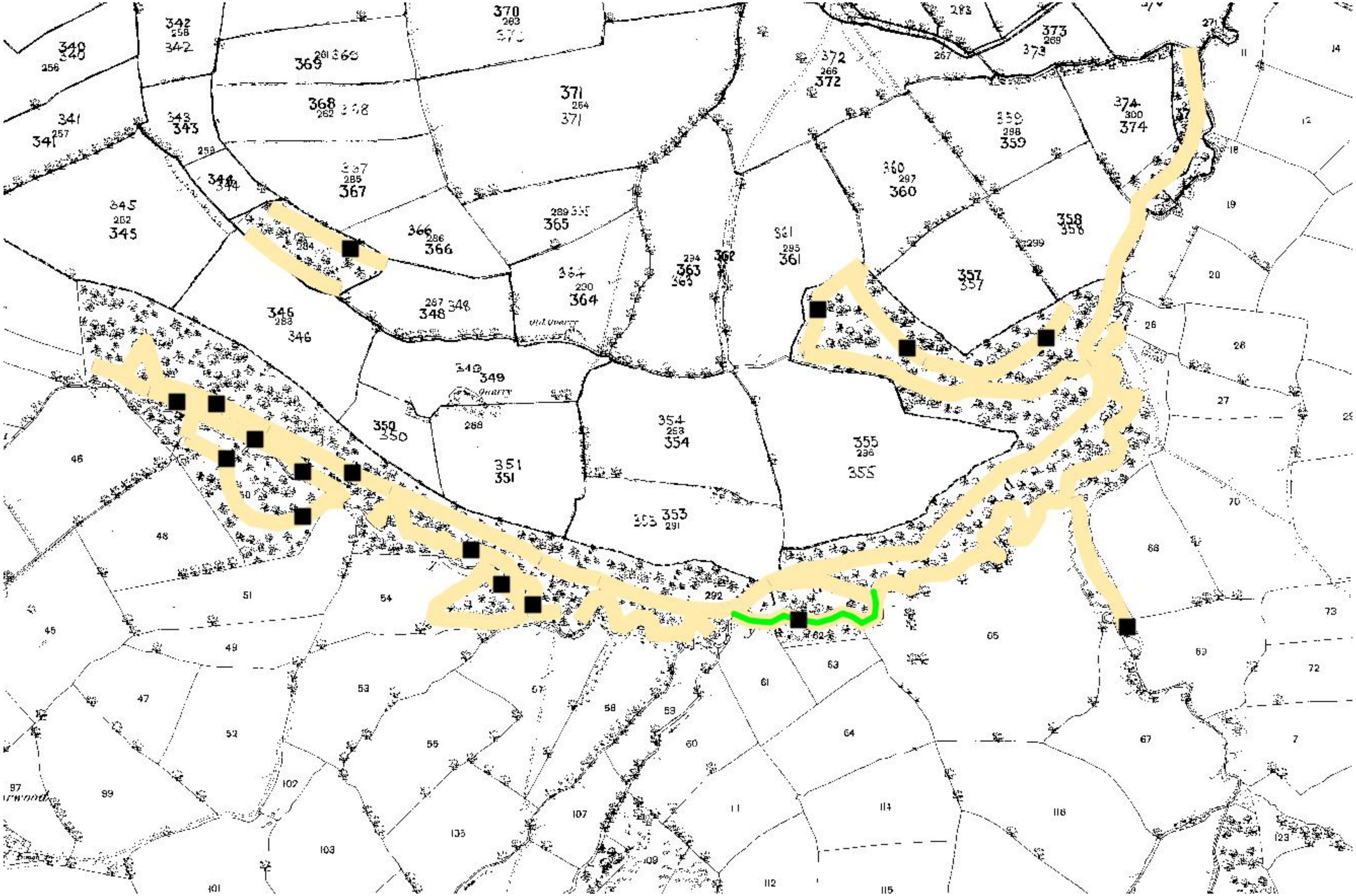


Figure 13.13 – *Caltha palustris*

Species maps for Gillfield wood

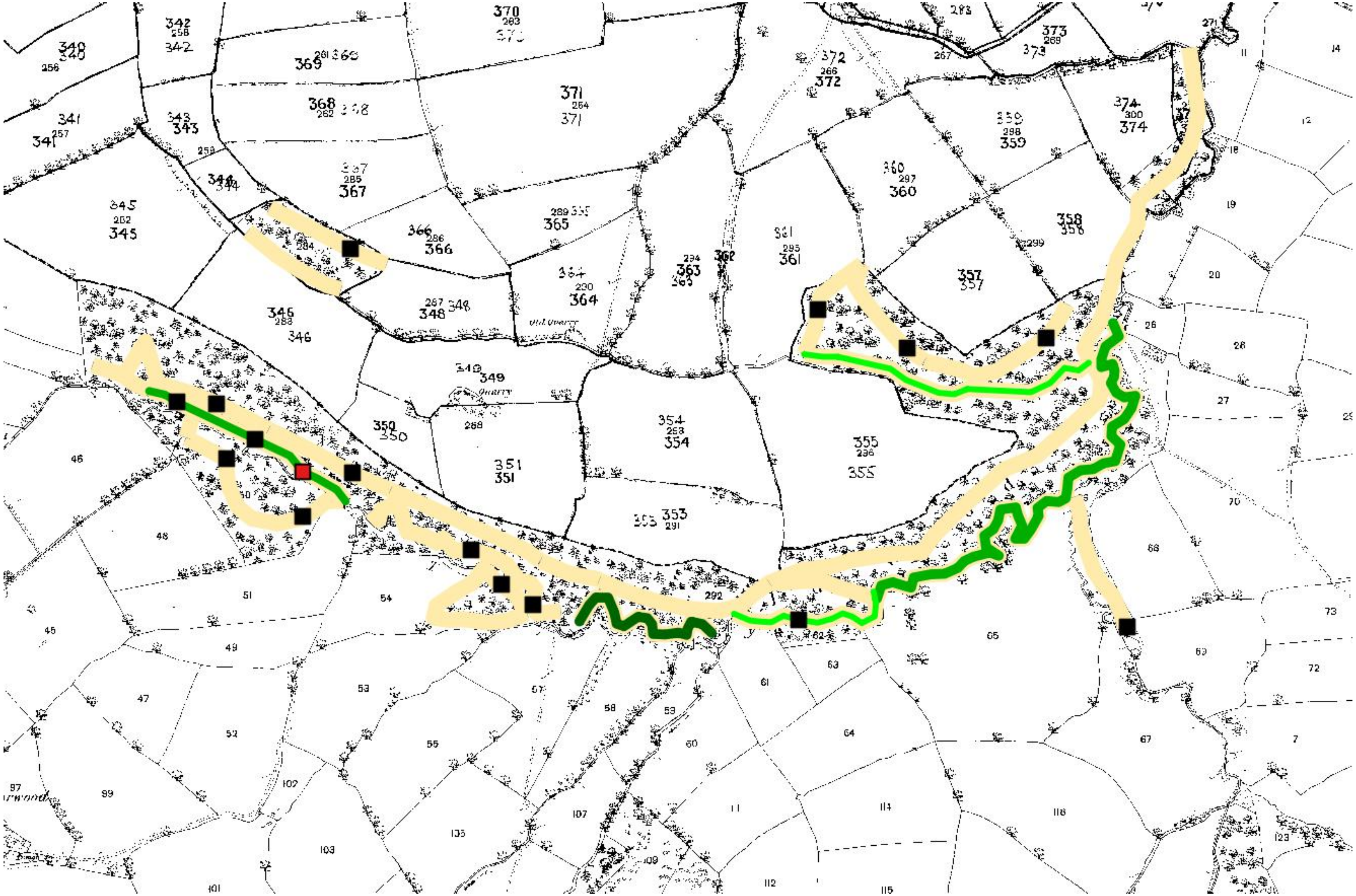


Figure 14.14 – *Cardamine amara*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

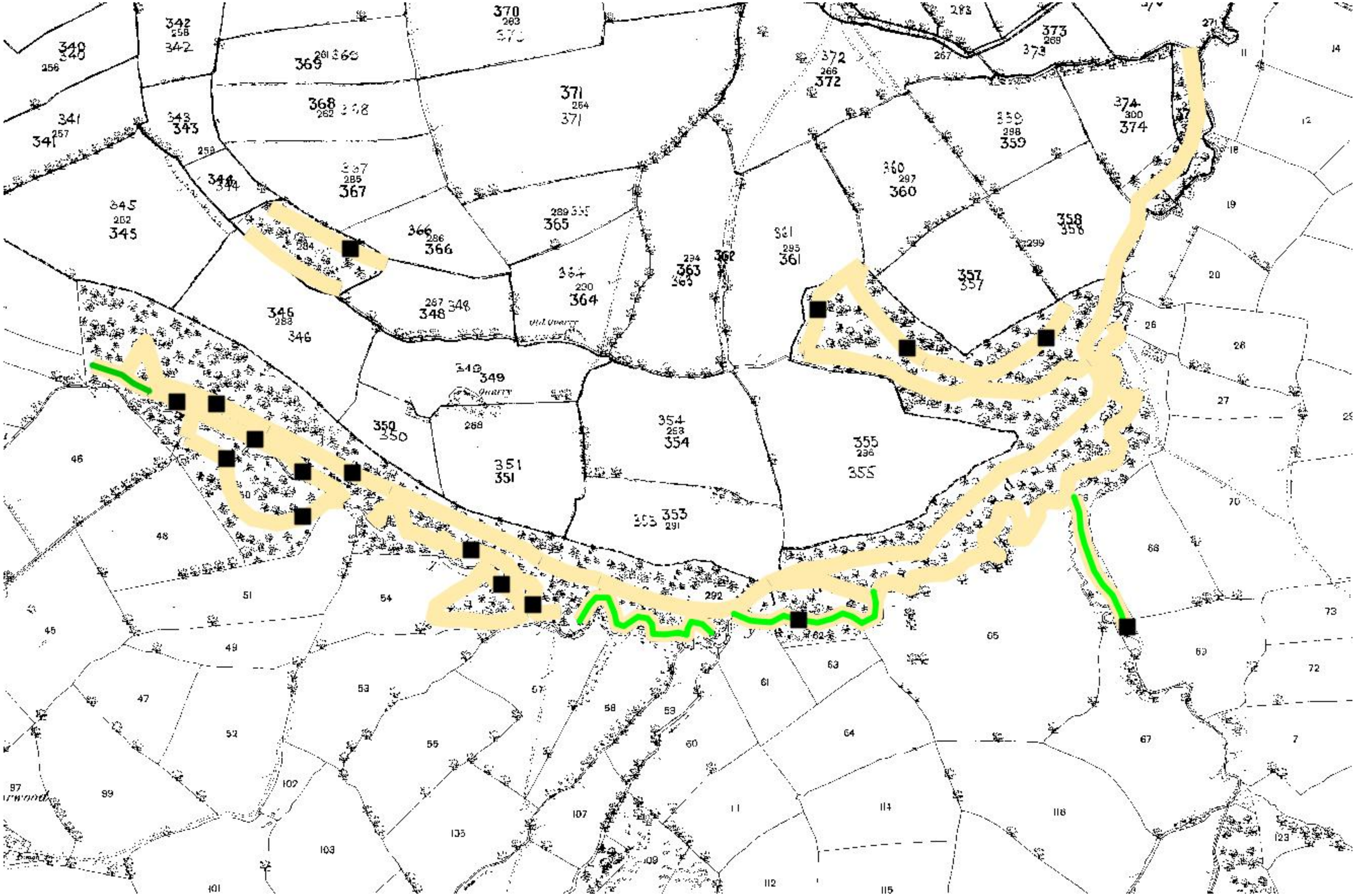


Figure 15.15 – *Carex pendula*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

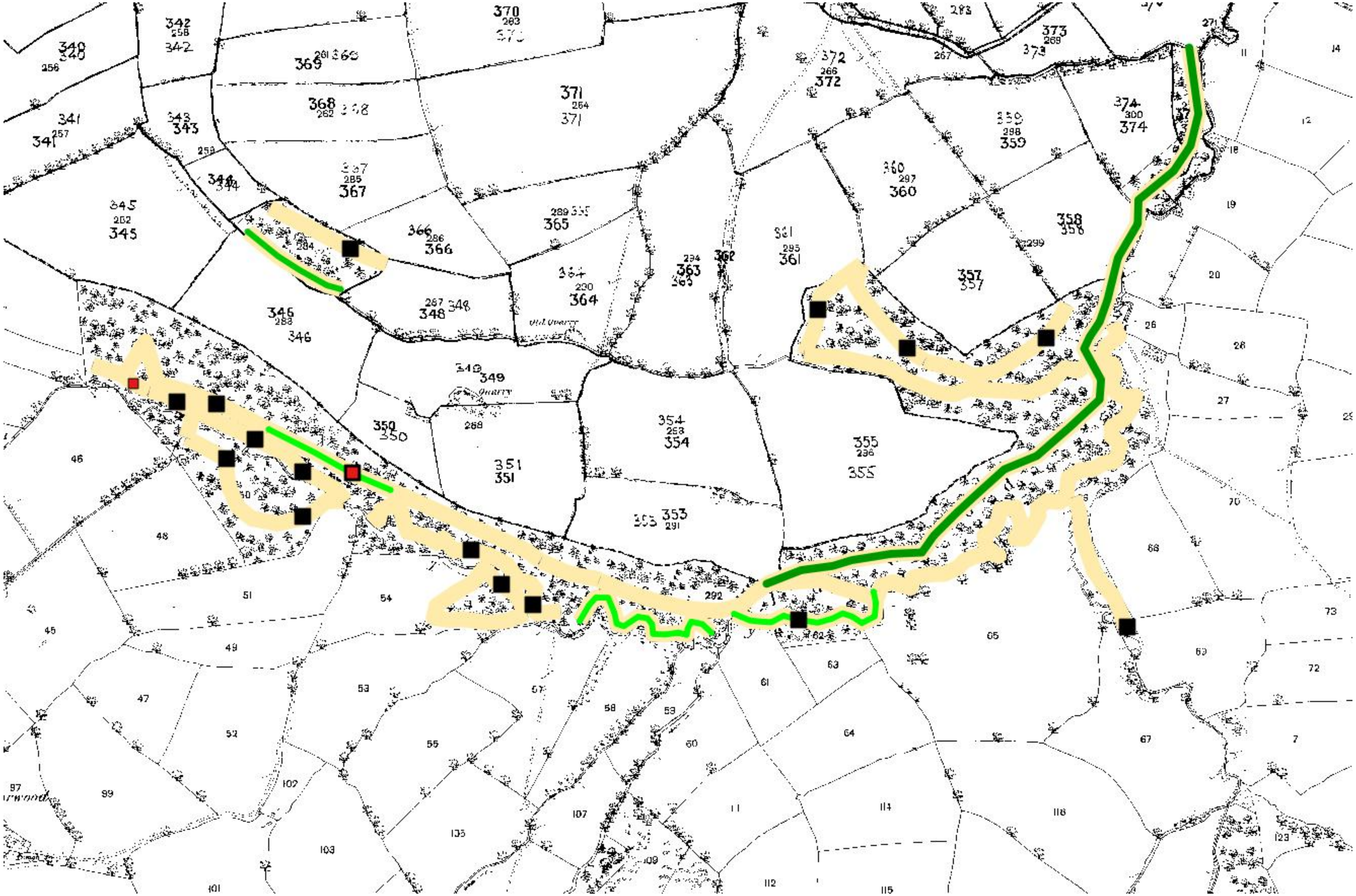


Figure 16.16 – *Carex remota*

Species maps for Gillfield wood

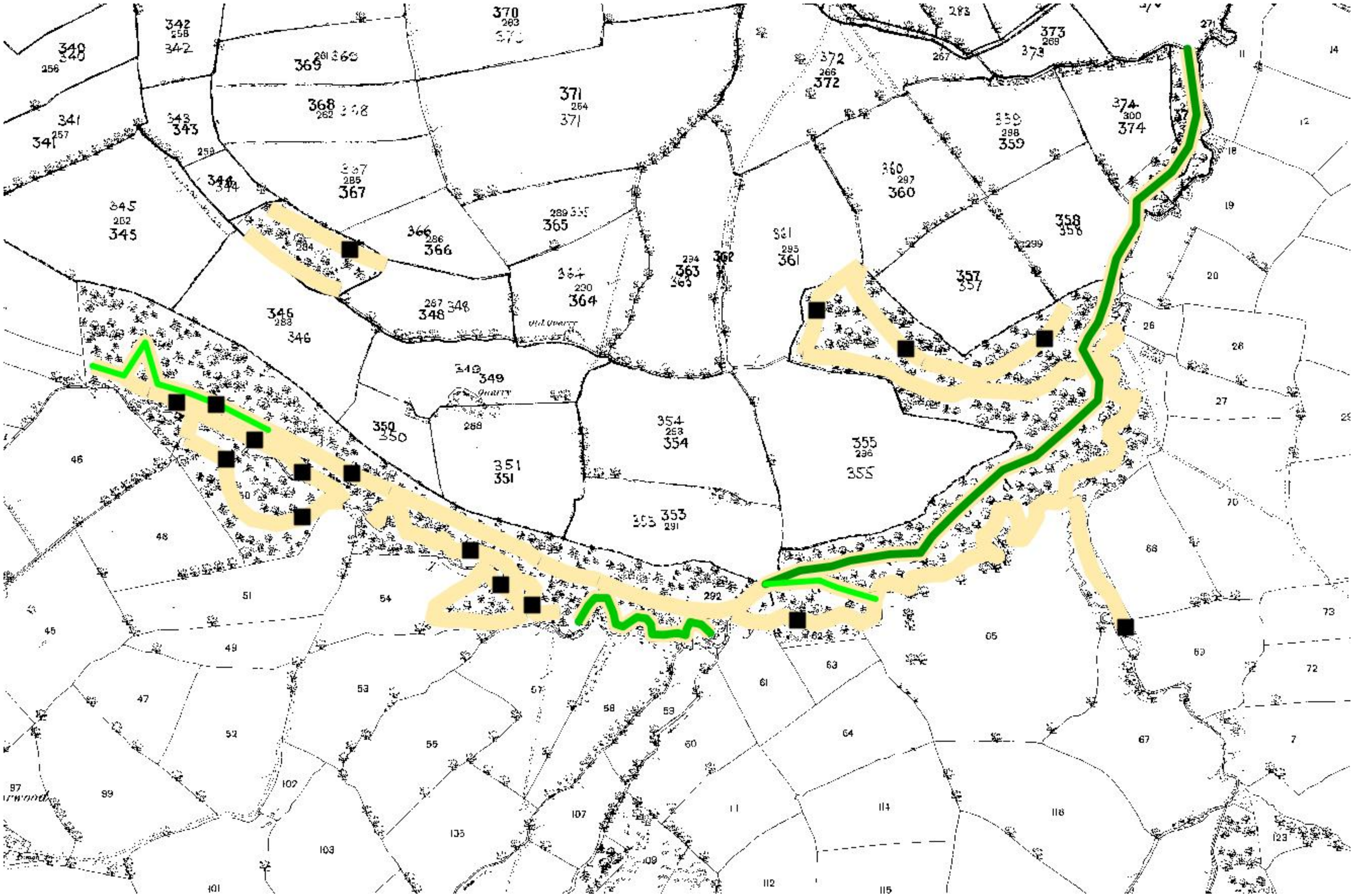


Figure 17.17 – *Carex sylvatica*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

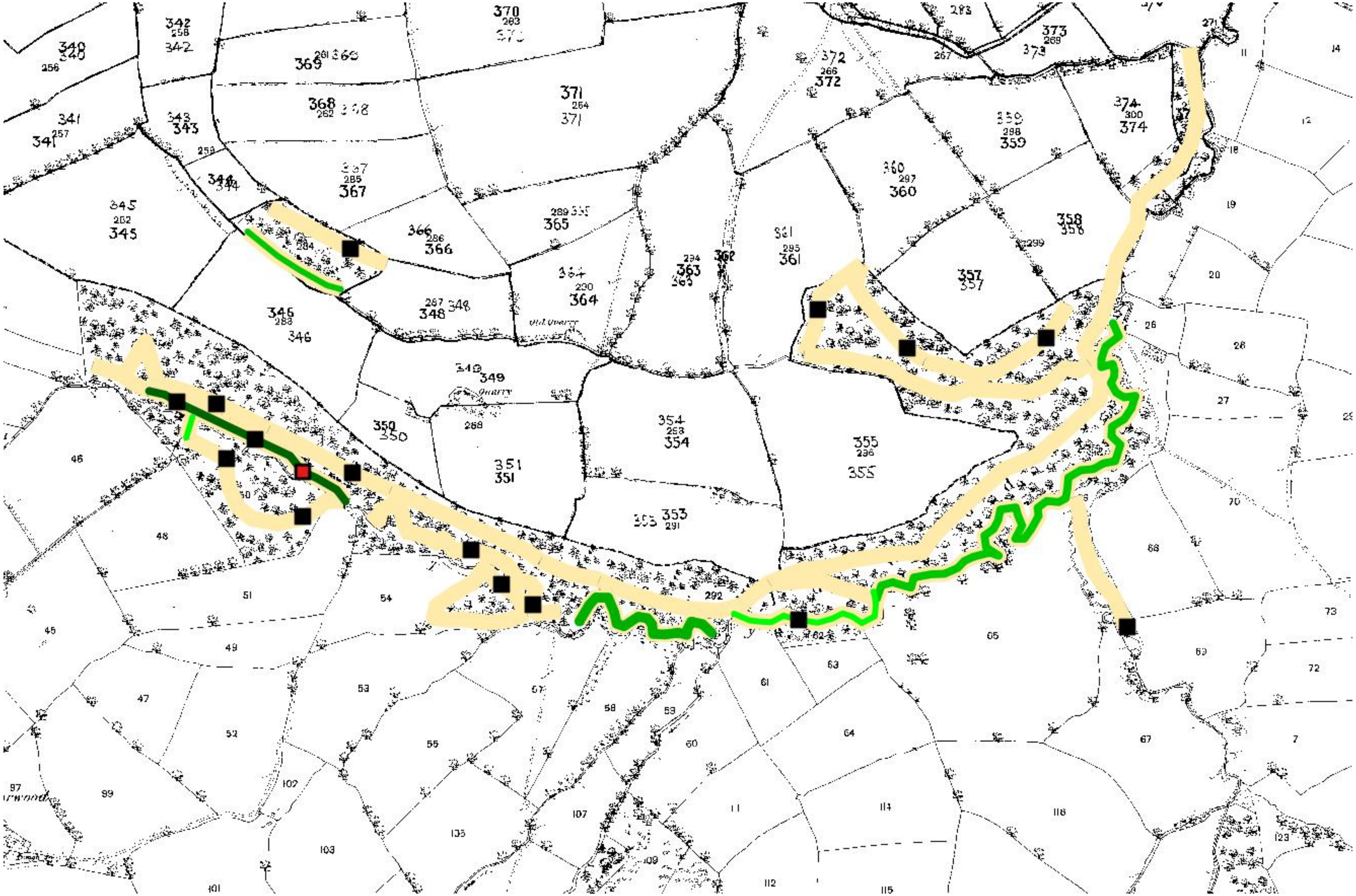


Figure 18.18 – *Chrysosplenium oppositifolium*

Species maps for Gillfield wood

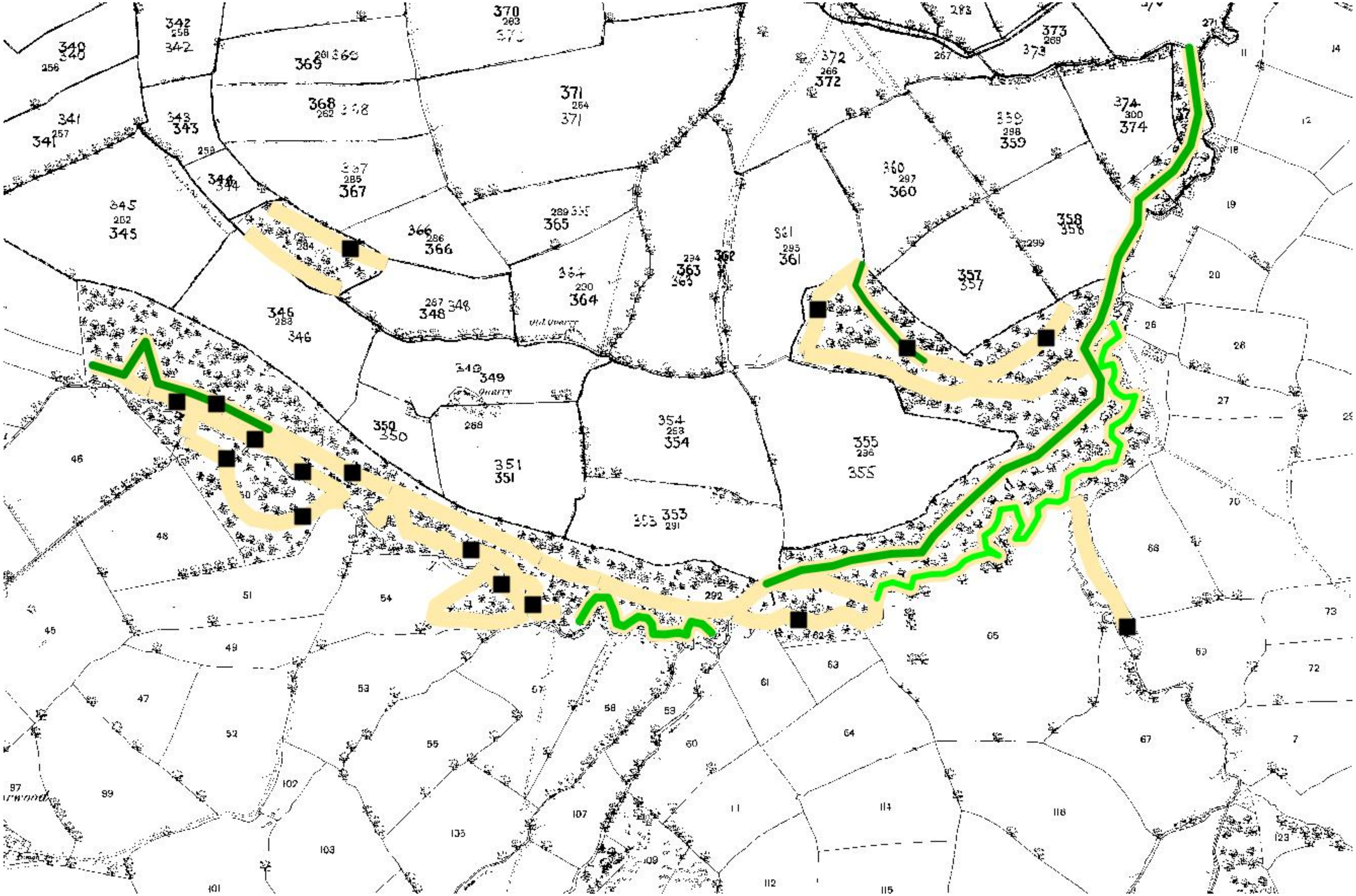


Figure 19.19 – *Circaea lutetiana*

Species maps for Gillfield wood

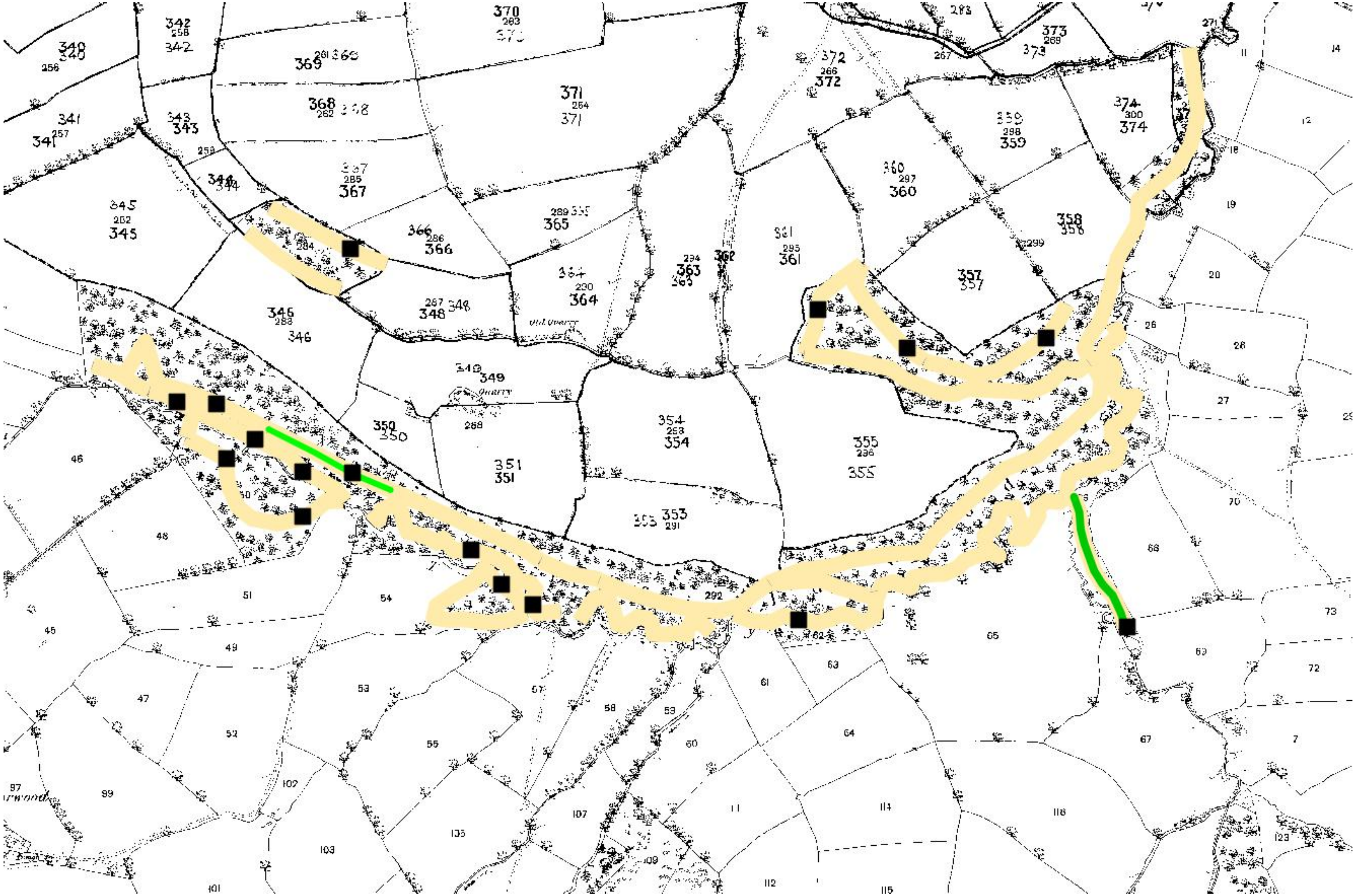


Figure 20.20 – *Conopodium majus*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

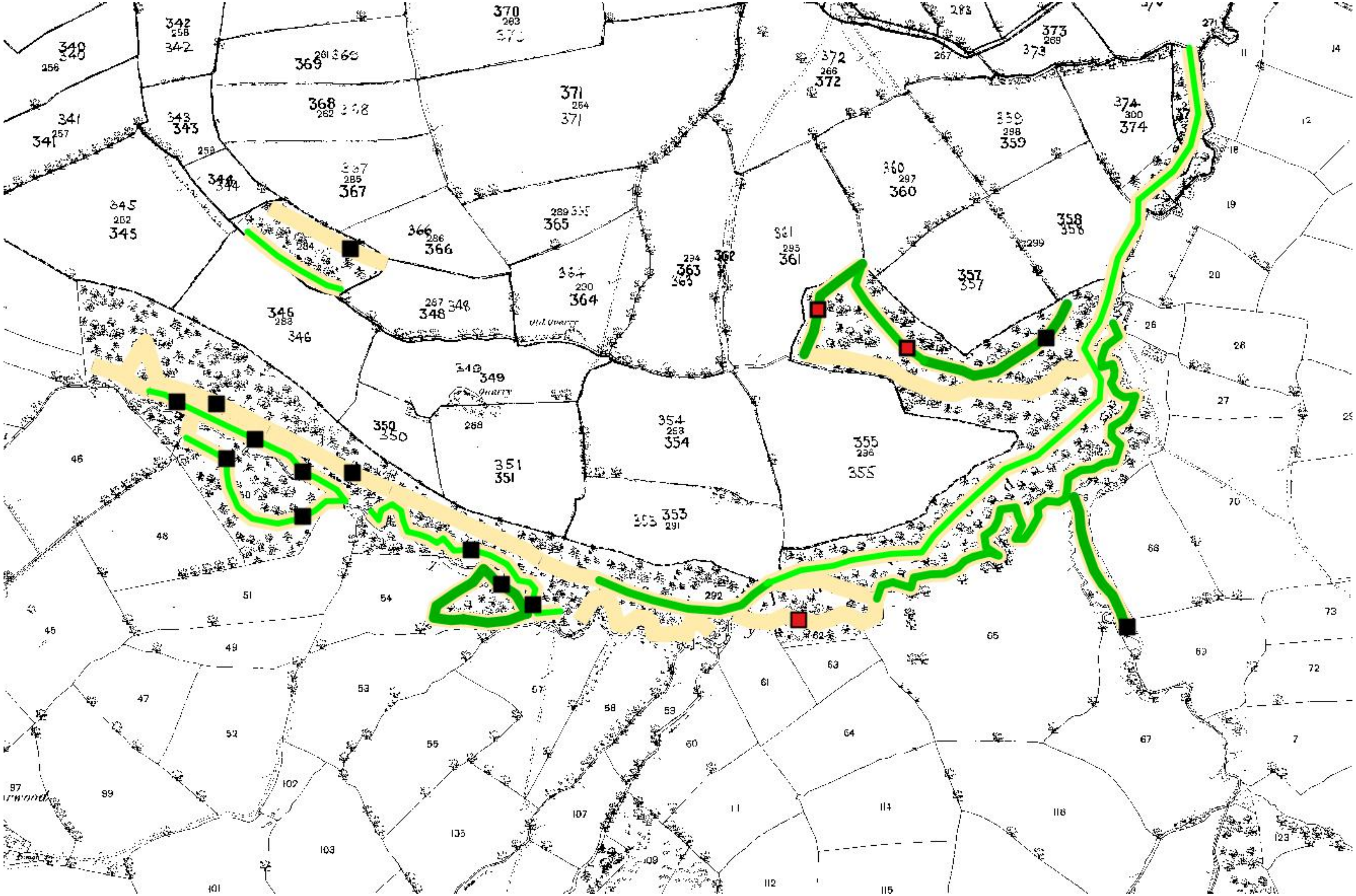


Figure 21.21 – *Corylus avellana*

Species maps for Gillfield wood

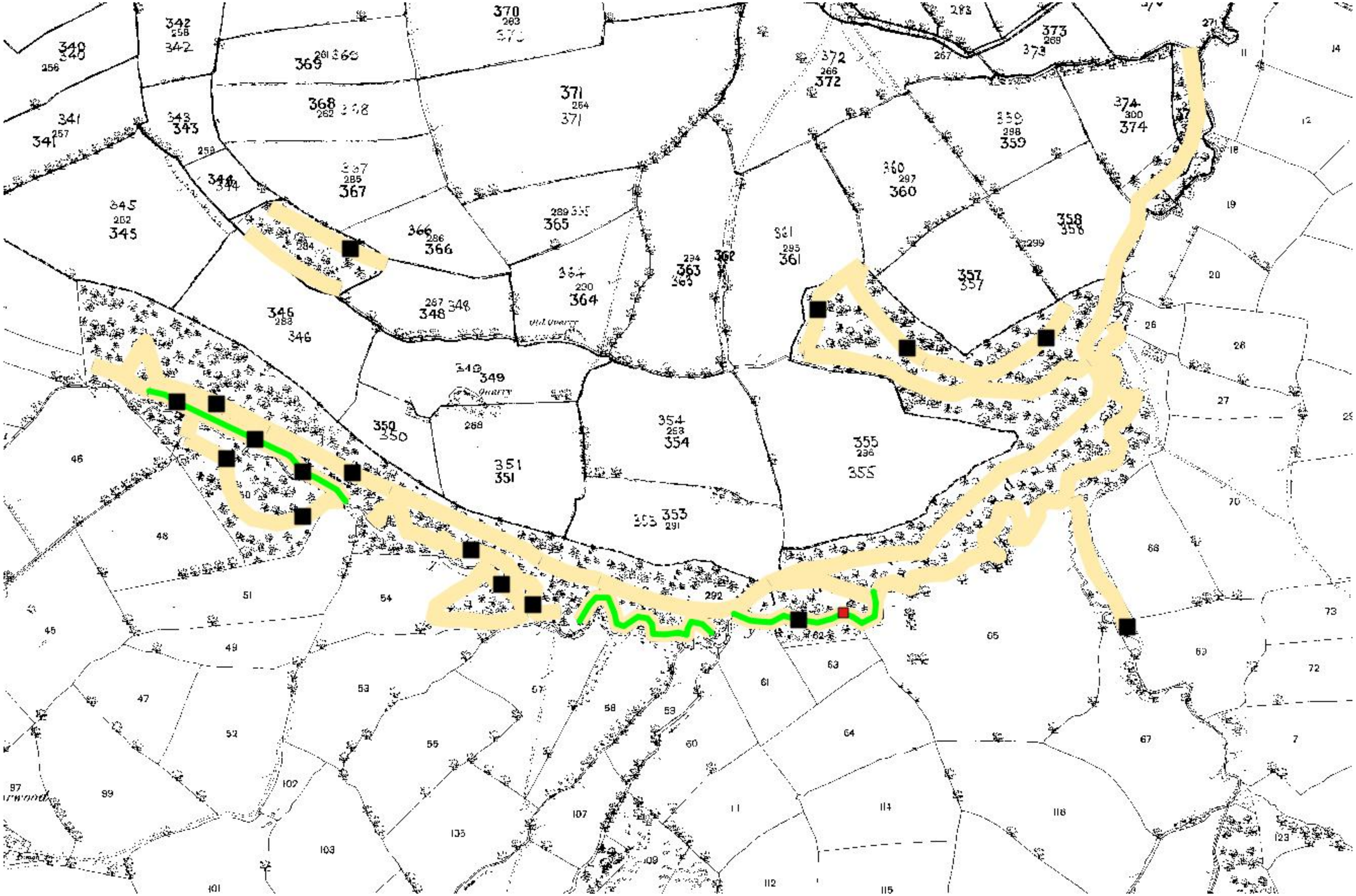


Figure 22.22 – *Dryopteris affinis*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

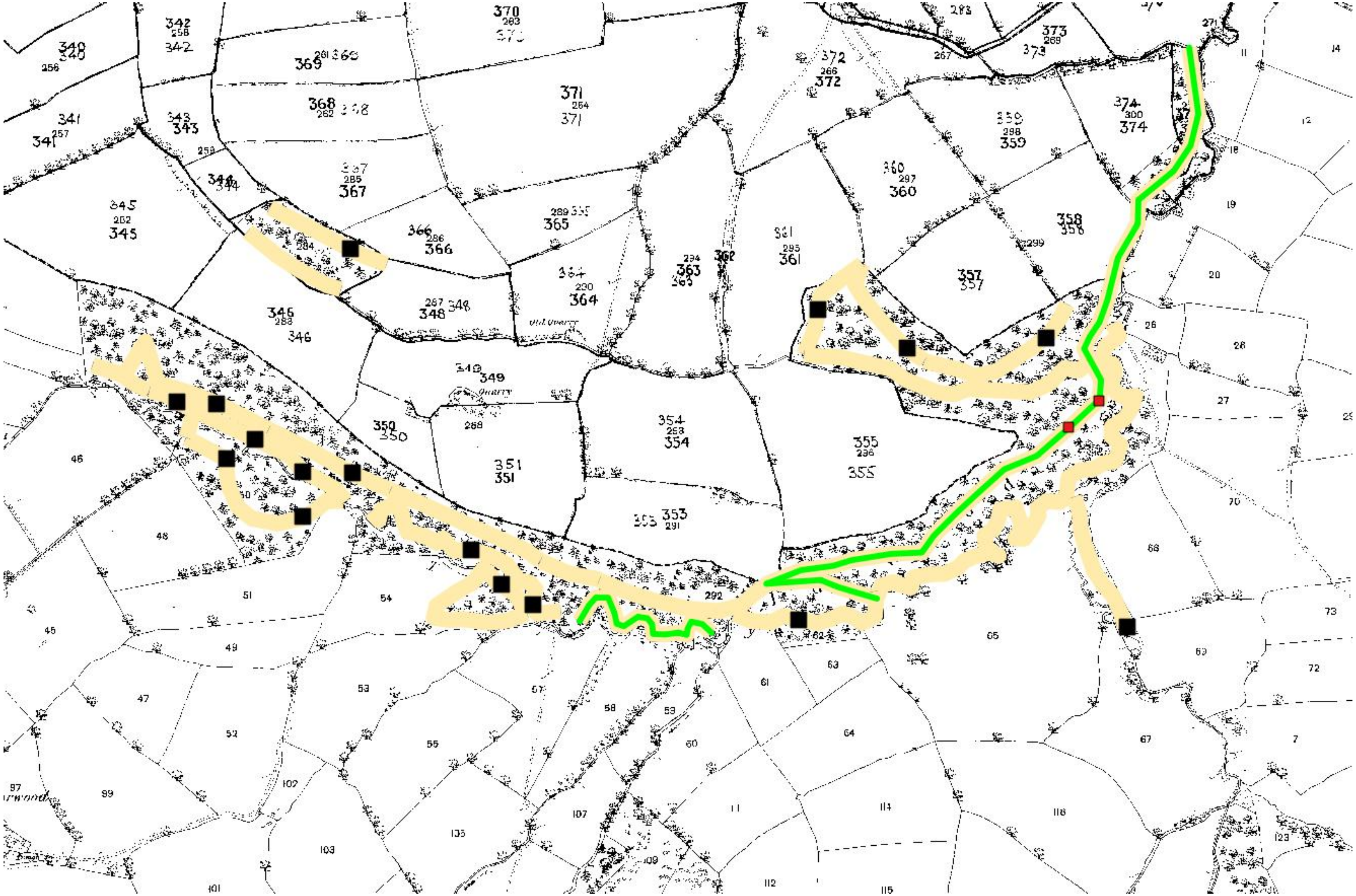


Figure 23.23 – *Dryopteris carthusiana*

Species maps for Gillfield wood

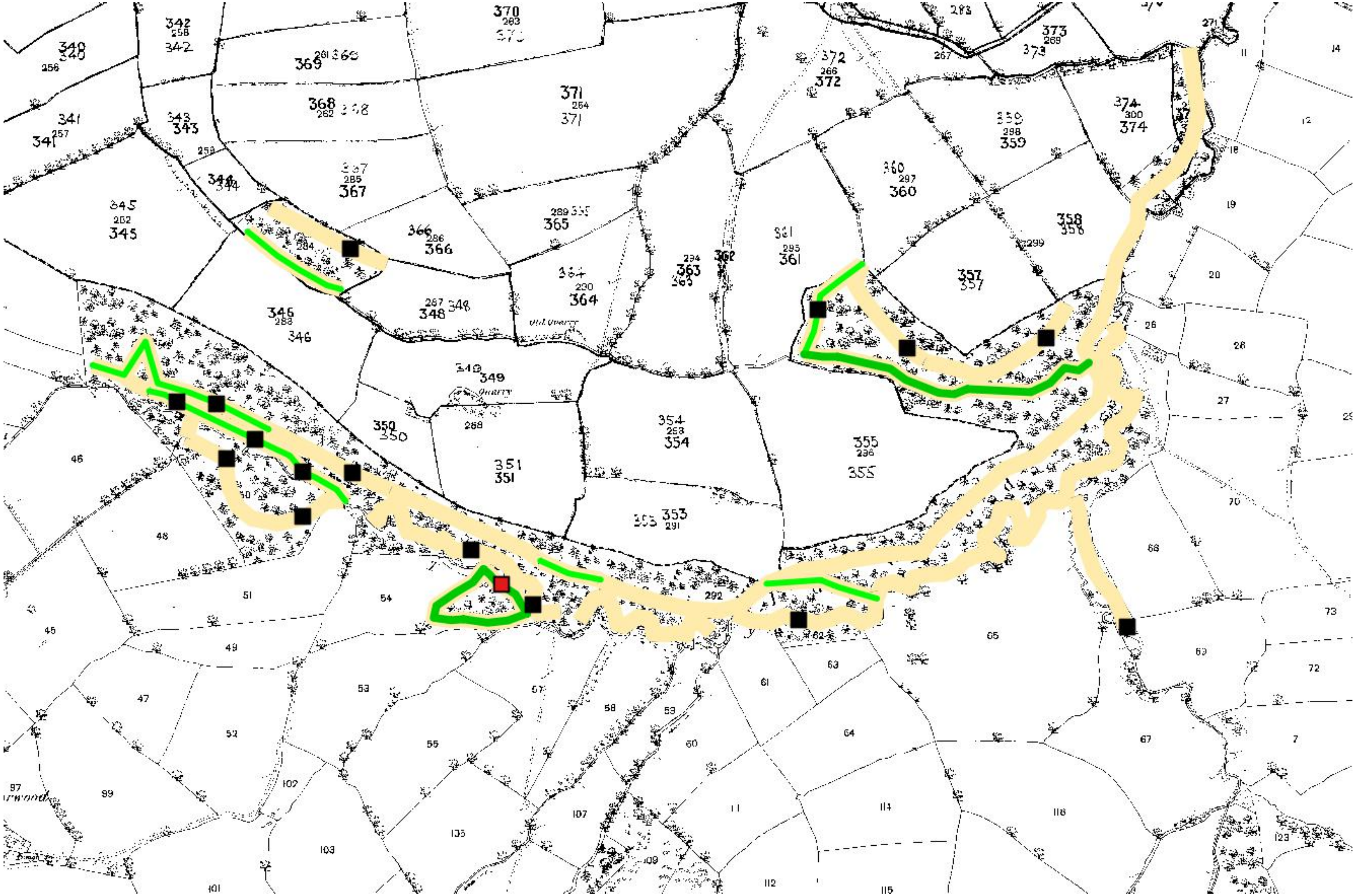


Figure 24.24 – *Dryopteris filix-mas*

Species maps for Gillfield wood

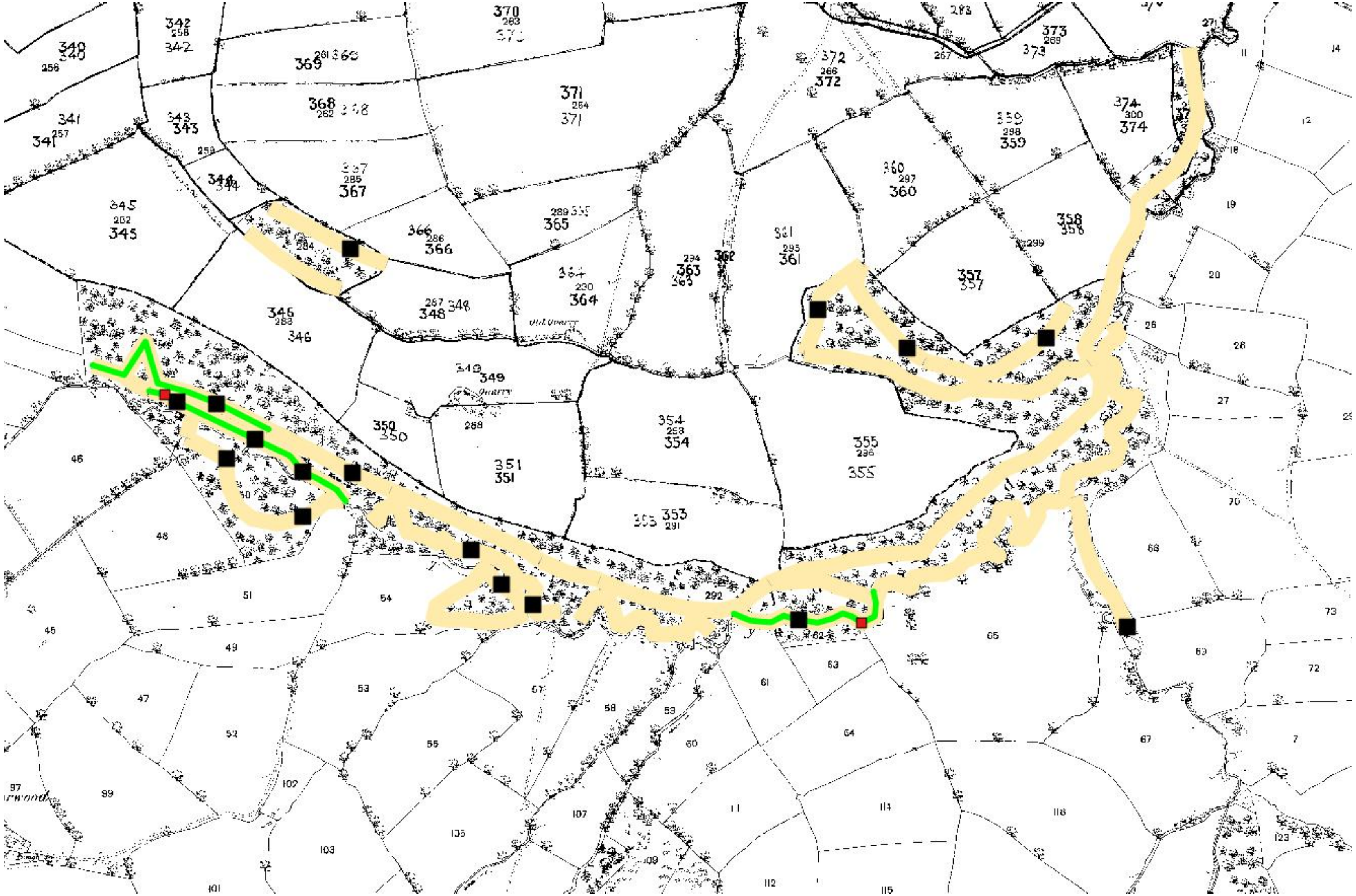


Figure 25.25 – *Equisetum sylvaticum*

Species maps for Gillfield wood

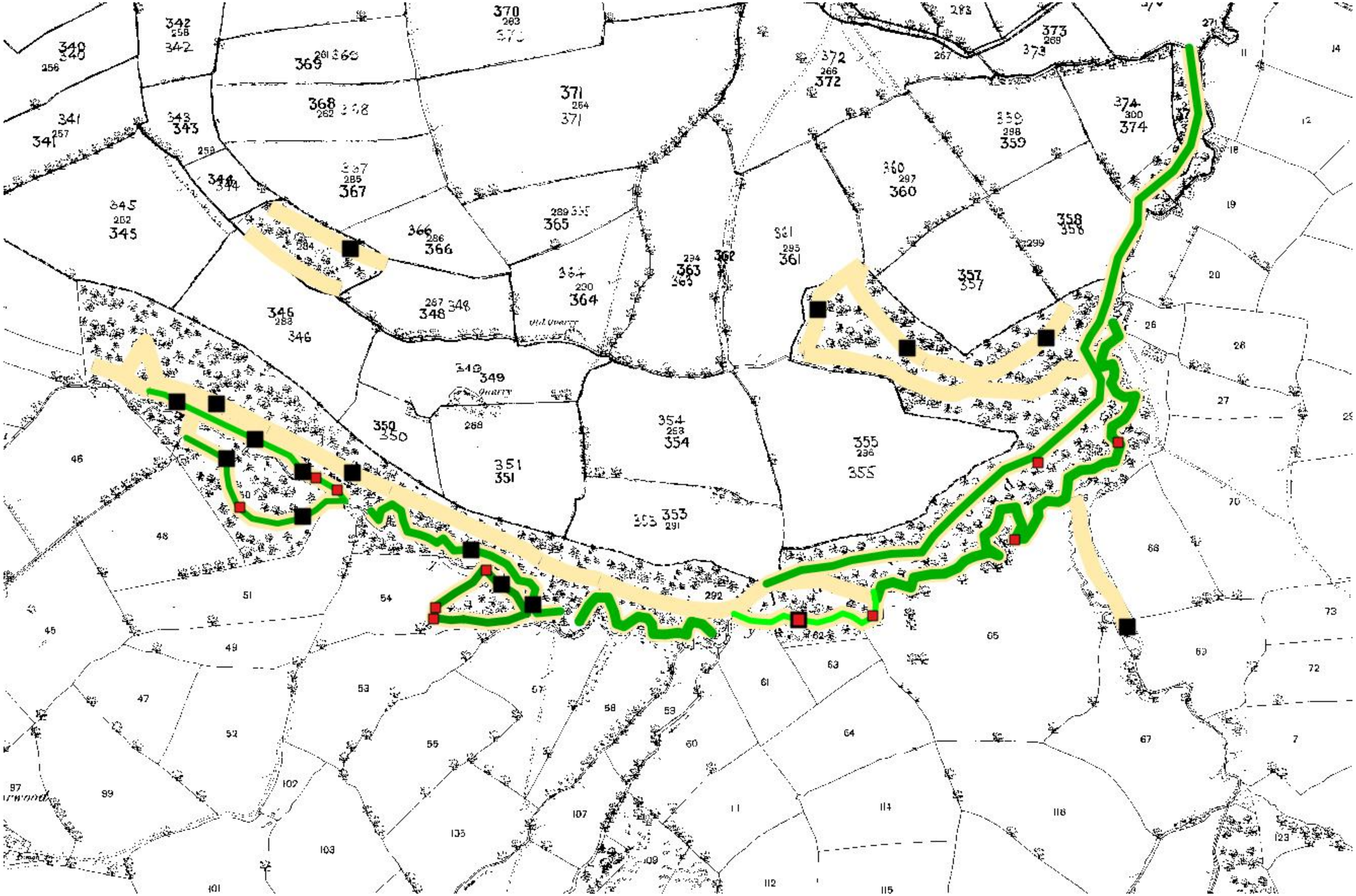


Figure 26.26 – *Galium odoratum*

Species maps for Gillfield wood

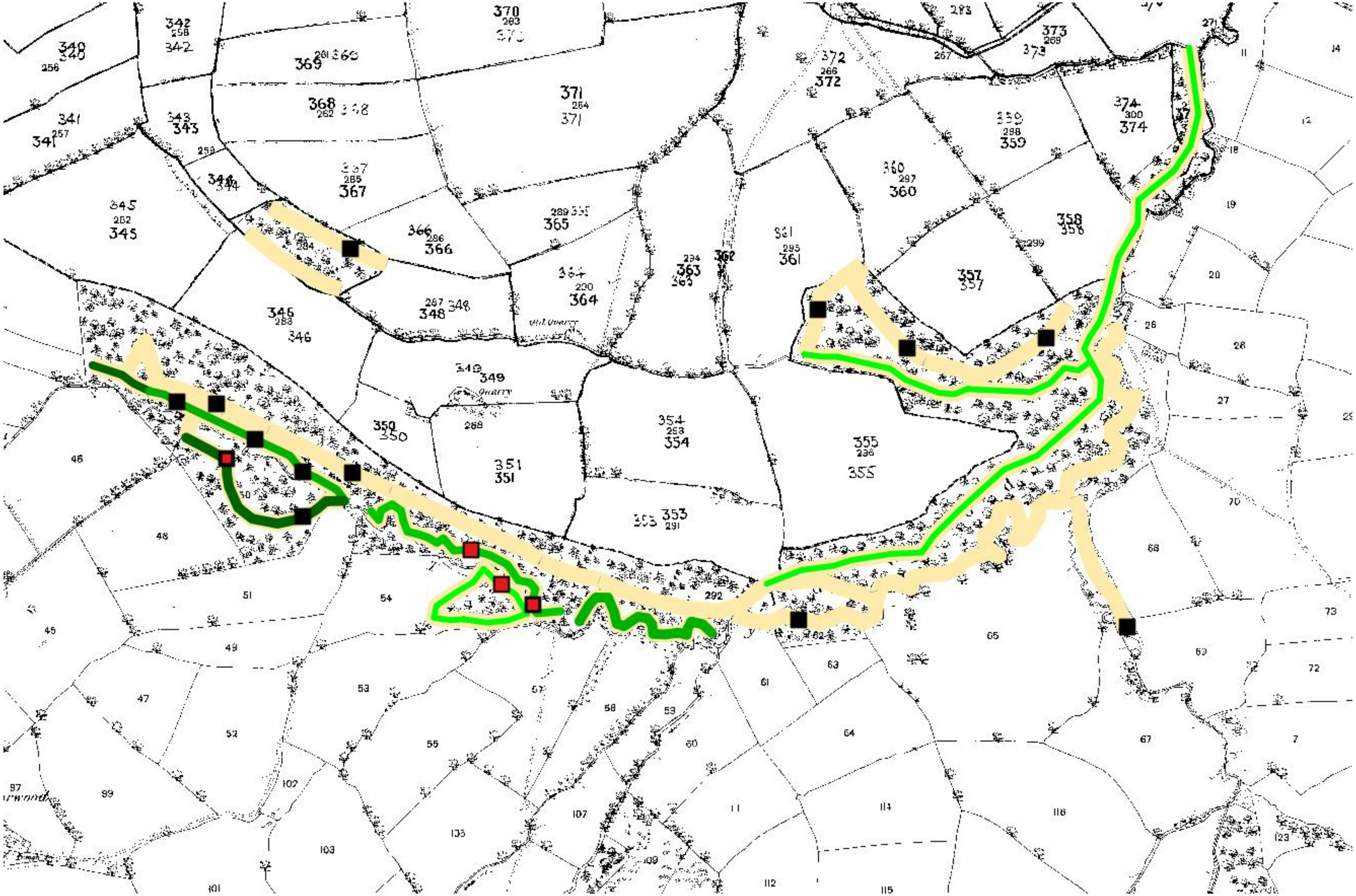


Figure 27.27 – *Geranium robertianum*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

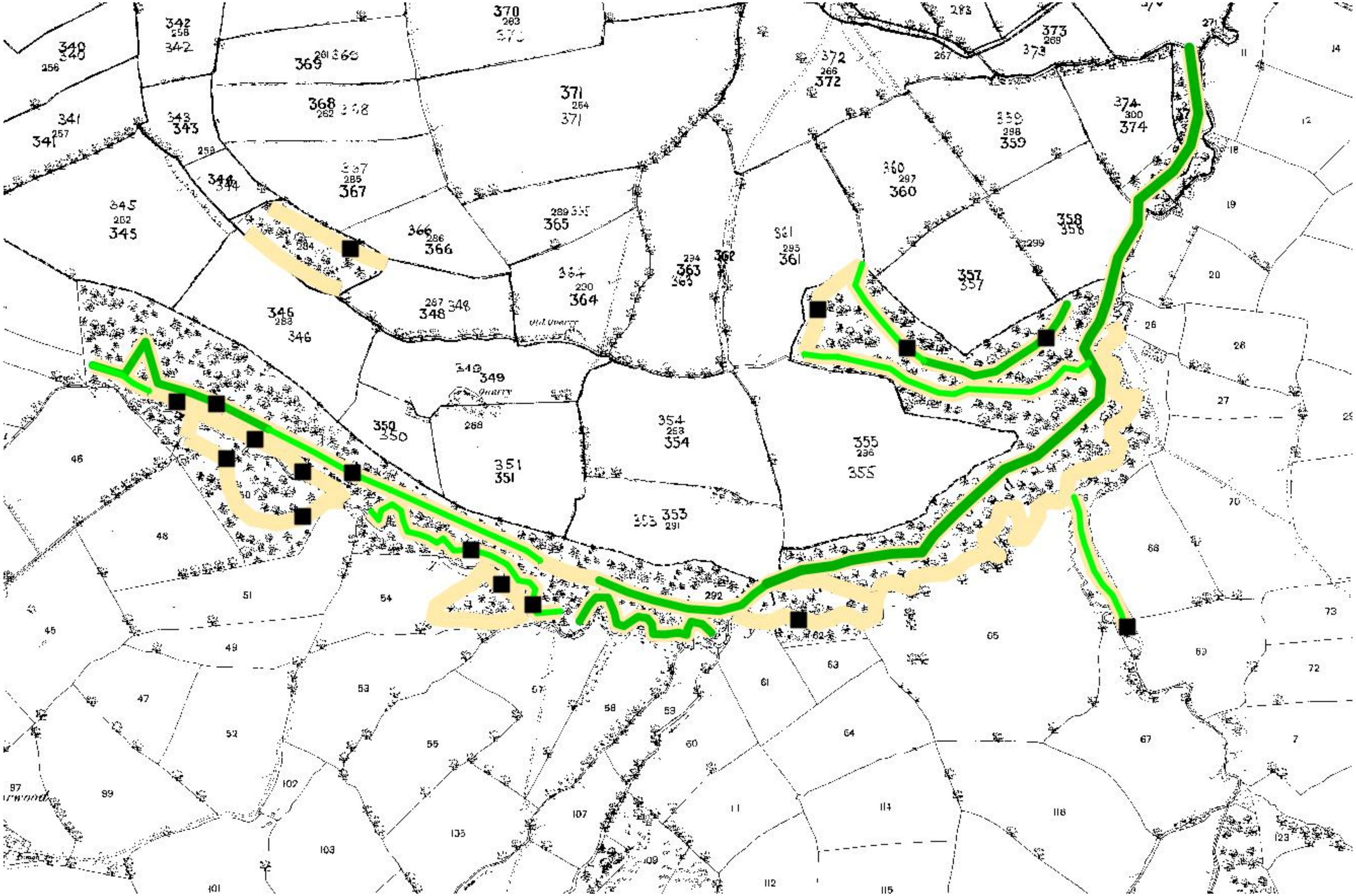


Figure 28.28 – *Geum urbanum*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

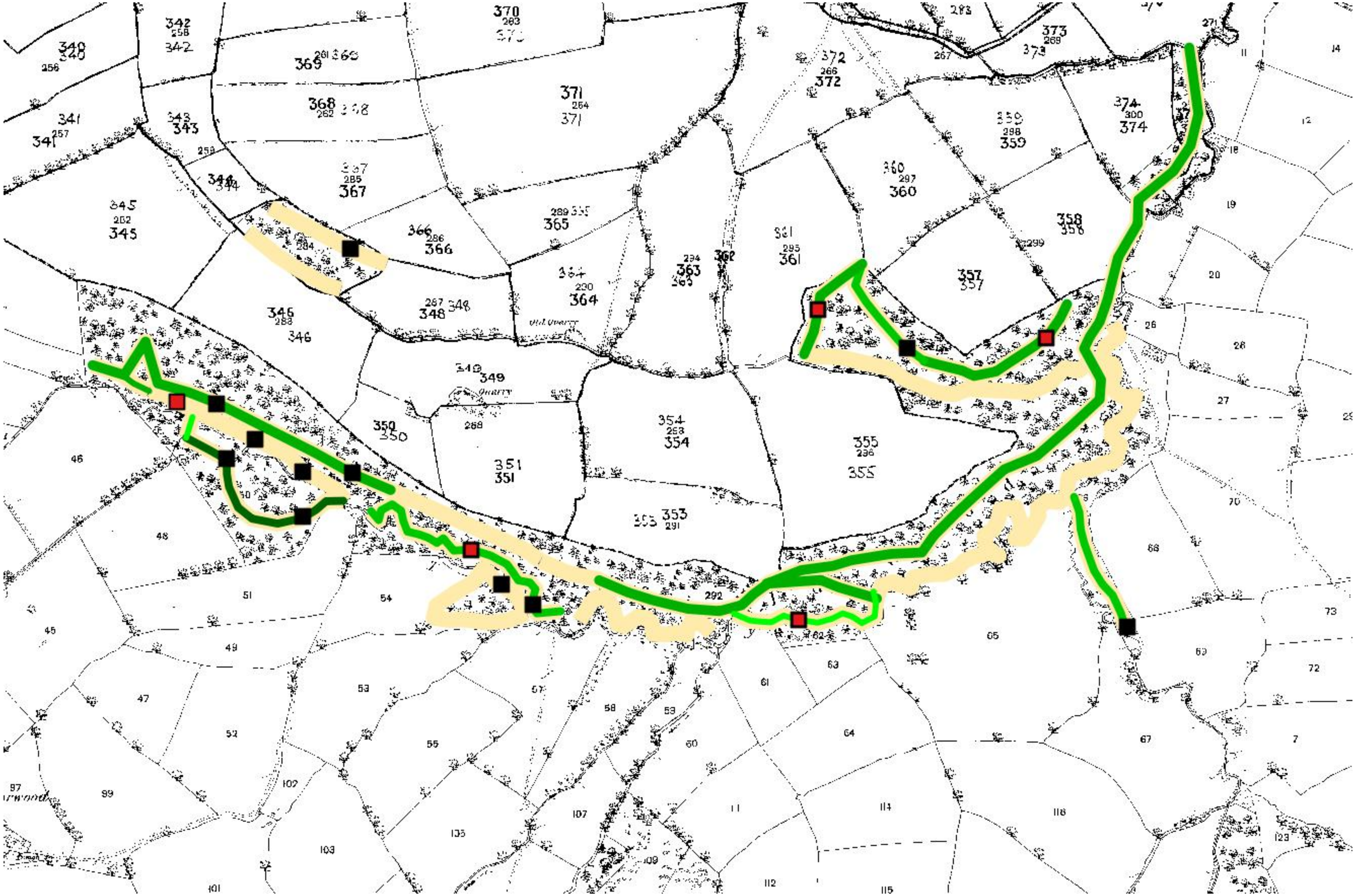


Figure 29.29 – *Hedera helix*

Species maps for Gillfield wood

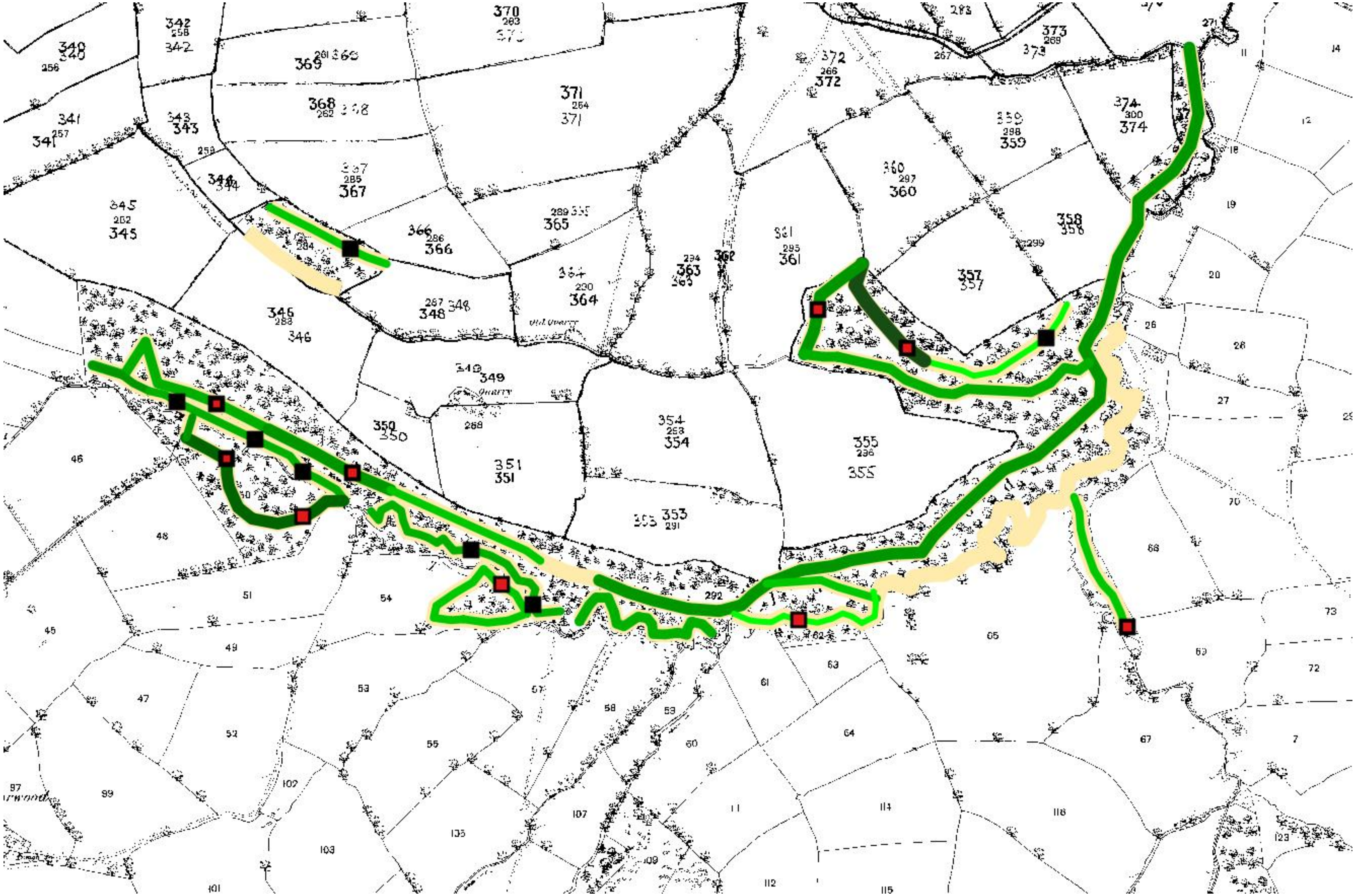


Figure 30.30 – *Holcus mollis*

Species maps for Gillfield wood

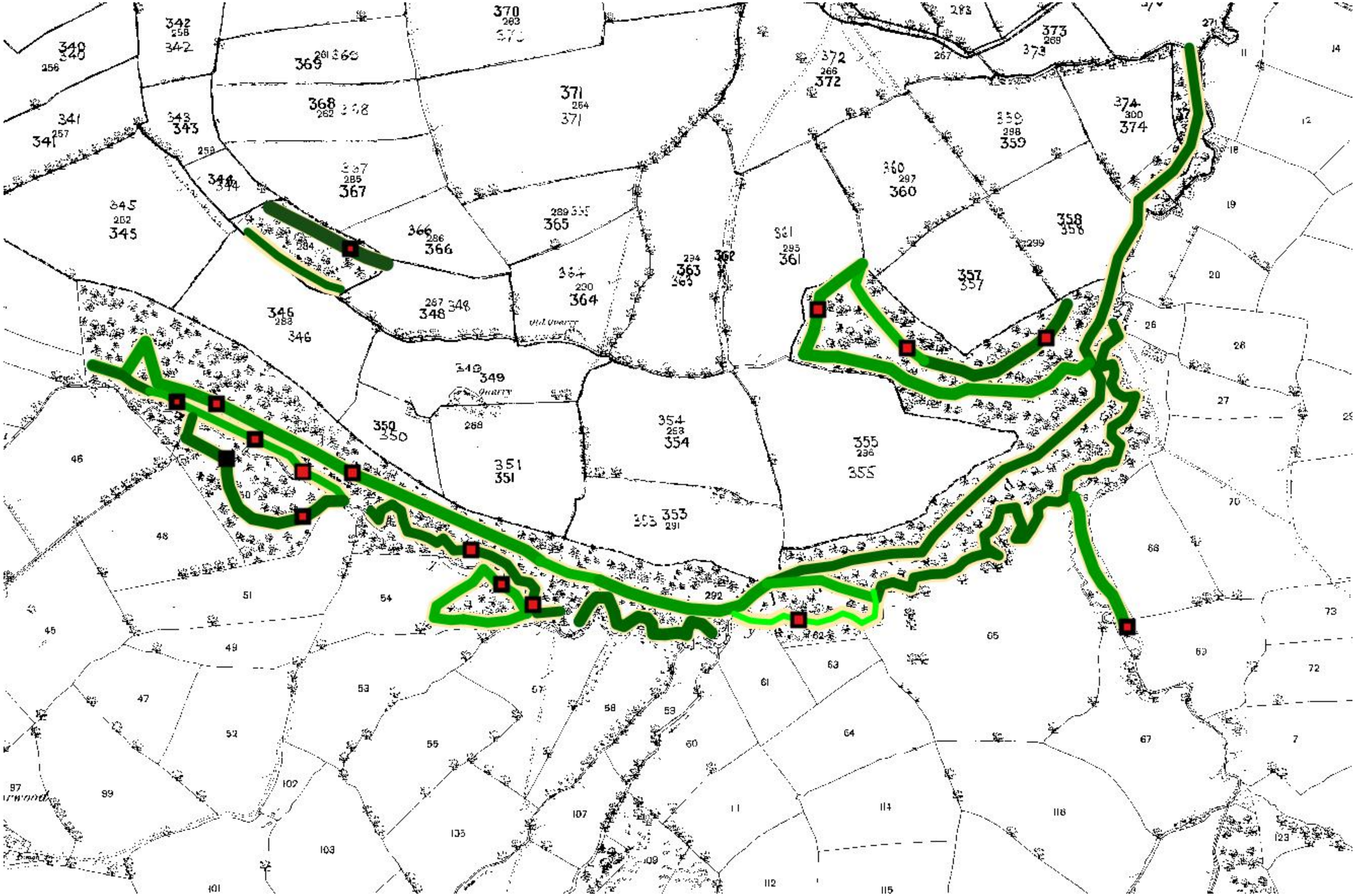


Figure 31.31 – *Hyacinthoides non-scripta*

Species maps for Gillfield wood

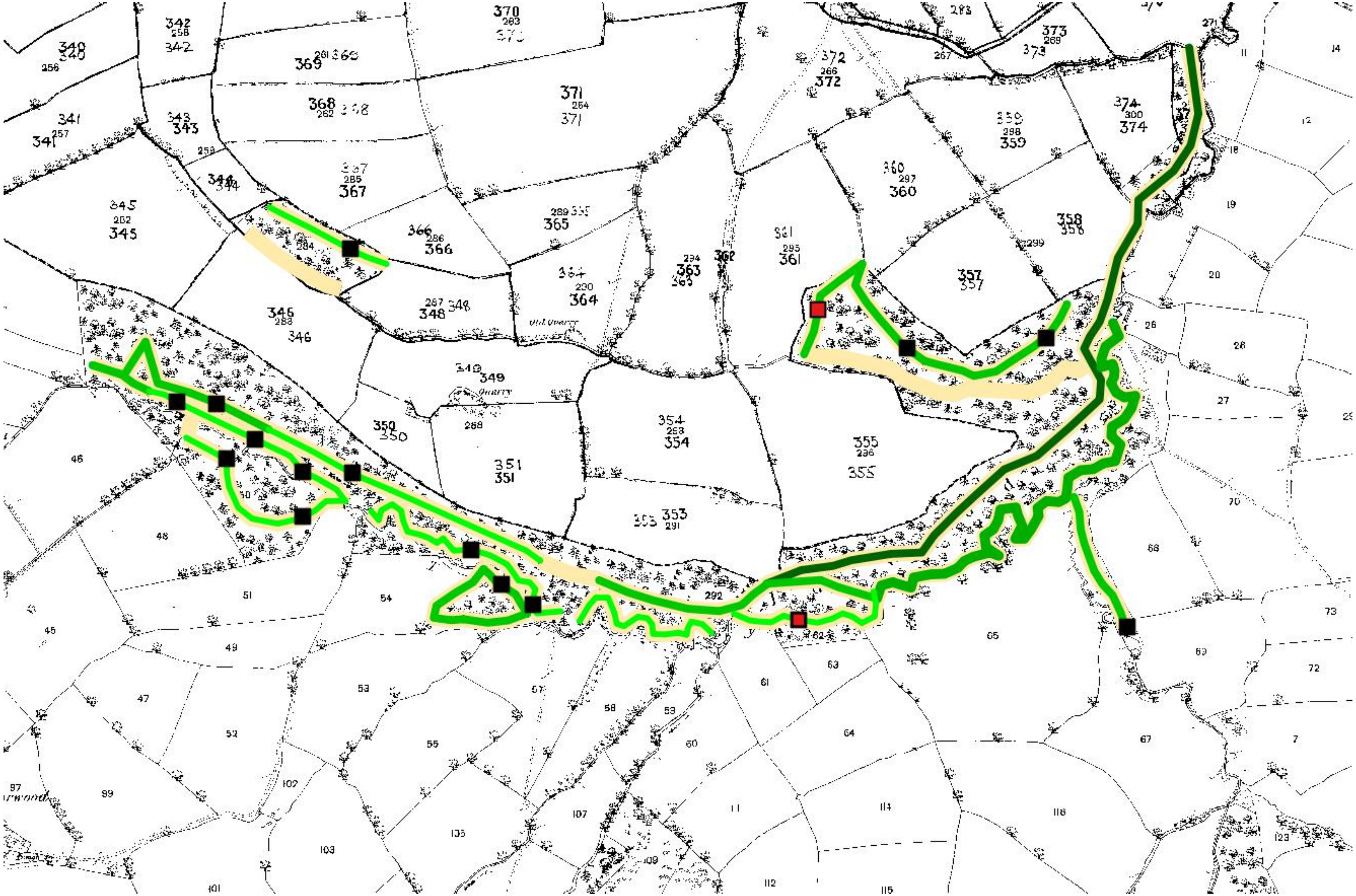
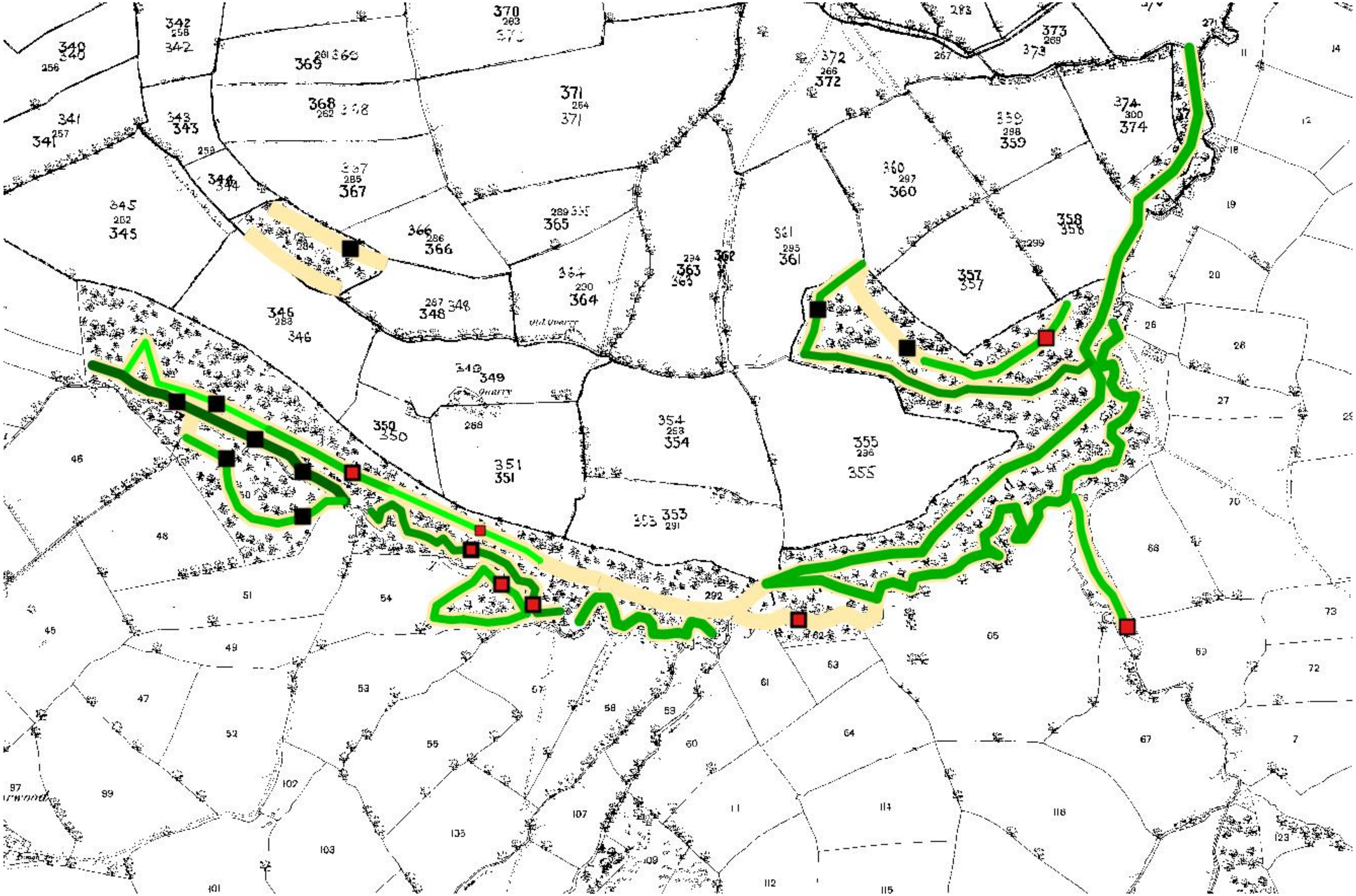


Figure 32.32 – *Ilex aquifolium*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood
 Figure 33.33 – *Lamiastrum galeobdolon*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

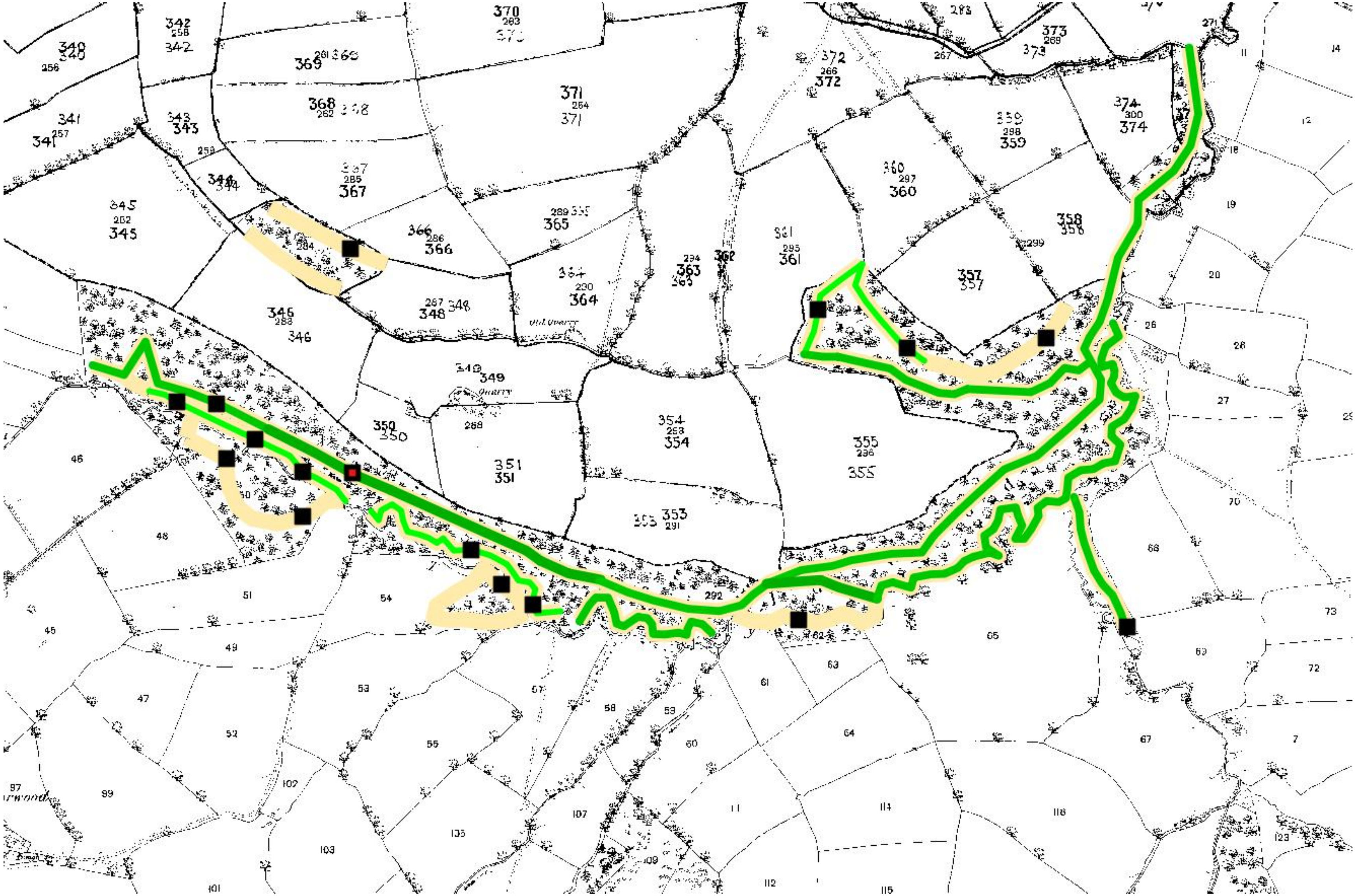


Figure 34.34 – *Lonicera periclymenum*

Species maps for Gillfield wood

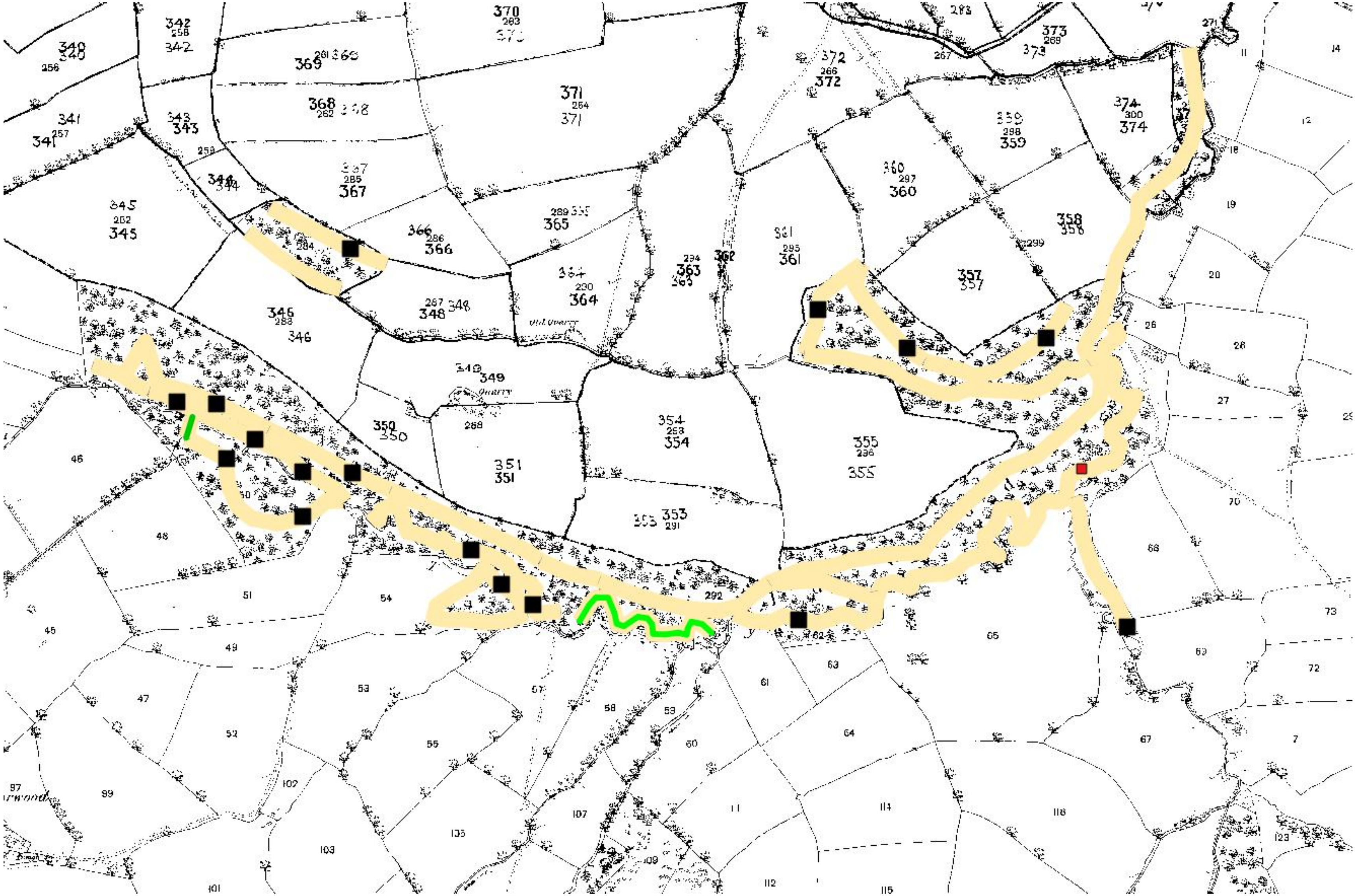


Figure 35.35 – *Luzula pilosa*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

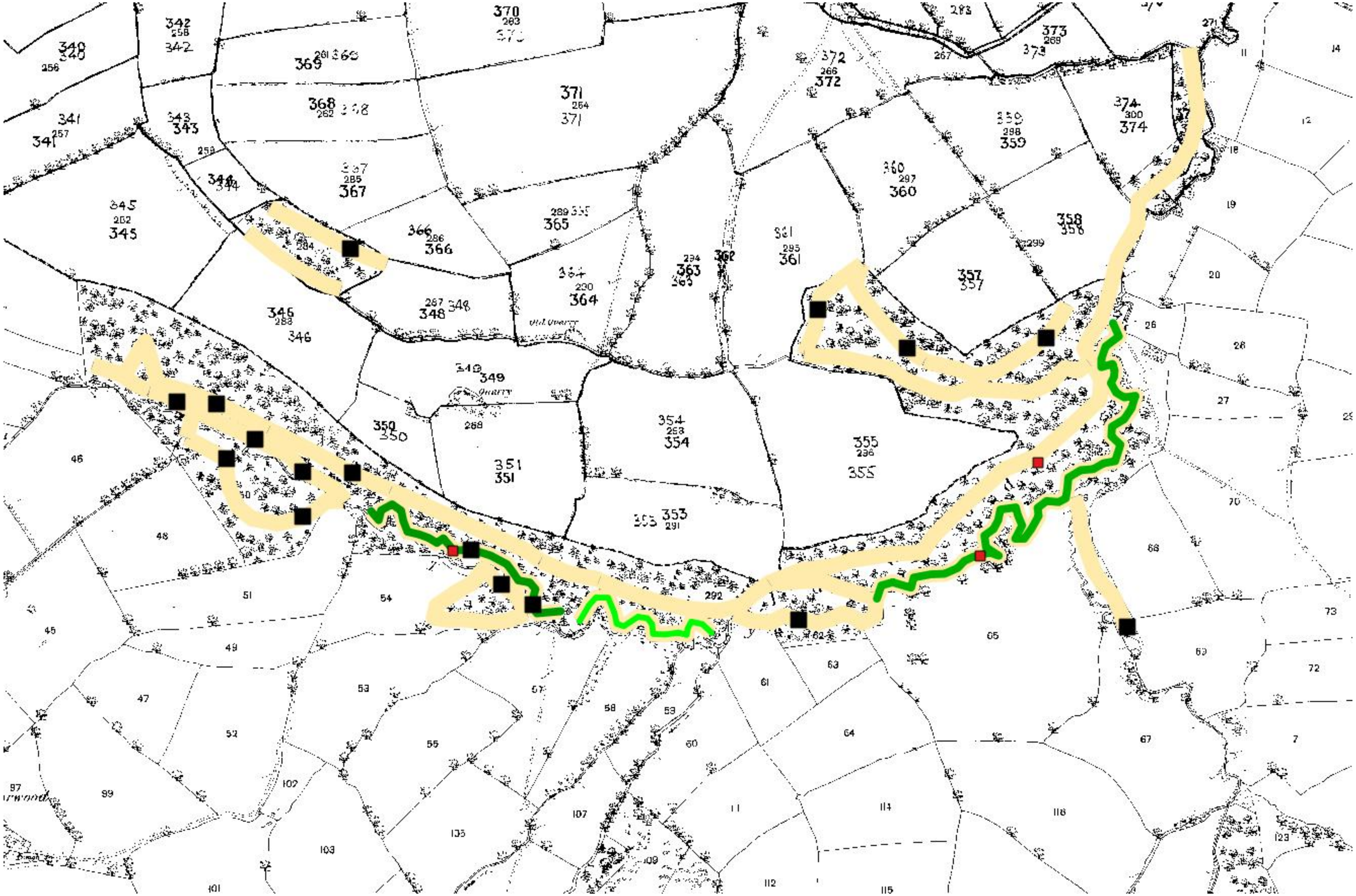


Figure 36.36 – *Luzula sylvatica*

Species maps for Gillfield wood

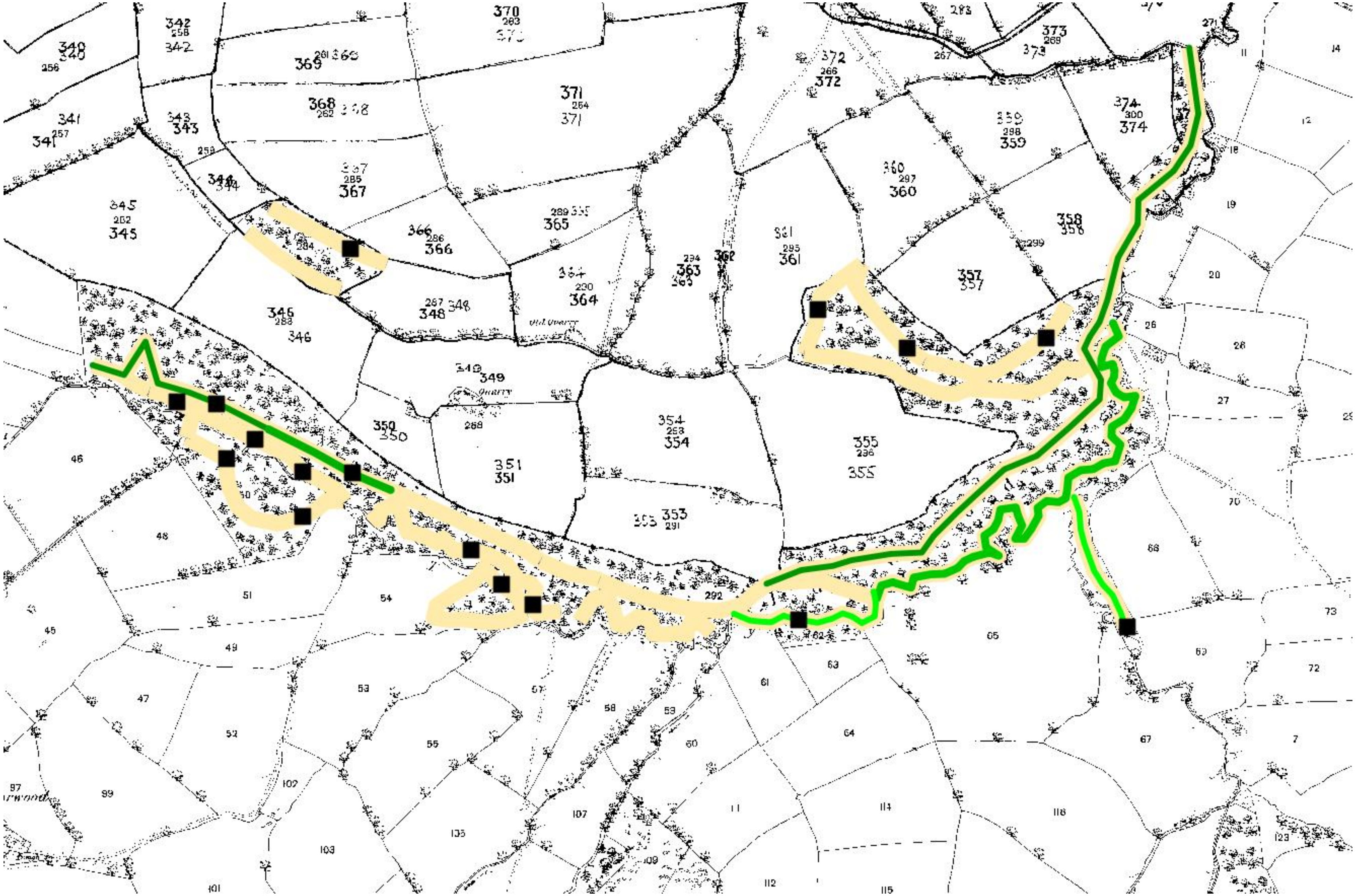


Figure 37.37 – *Lysimachia nemorum*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

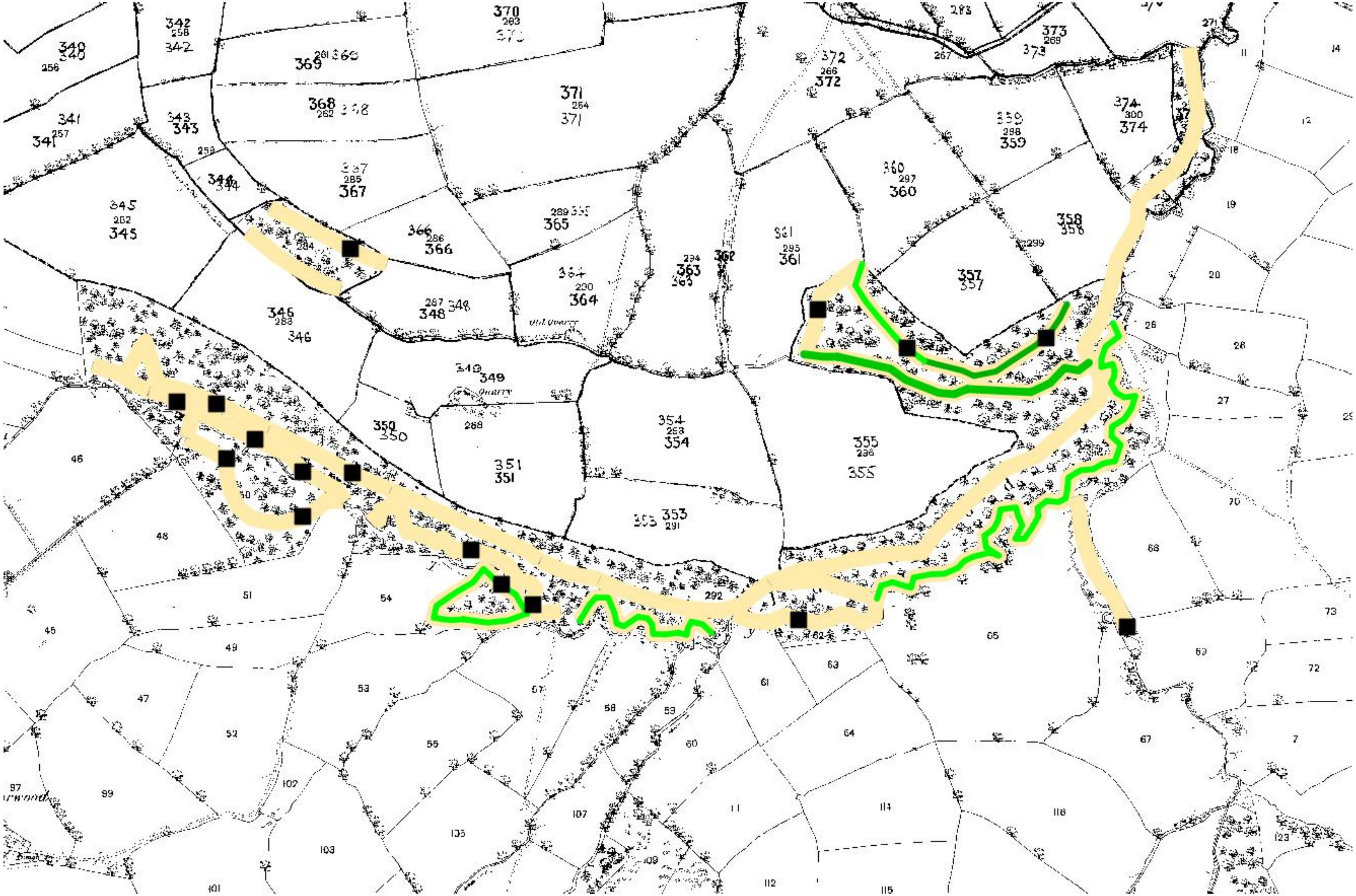


Figure 38.38 – *Melica uniflora*

Species maps for Gillfield wood

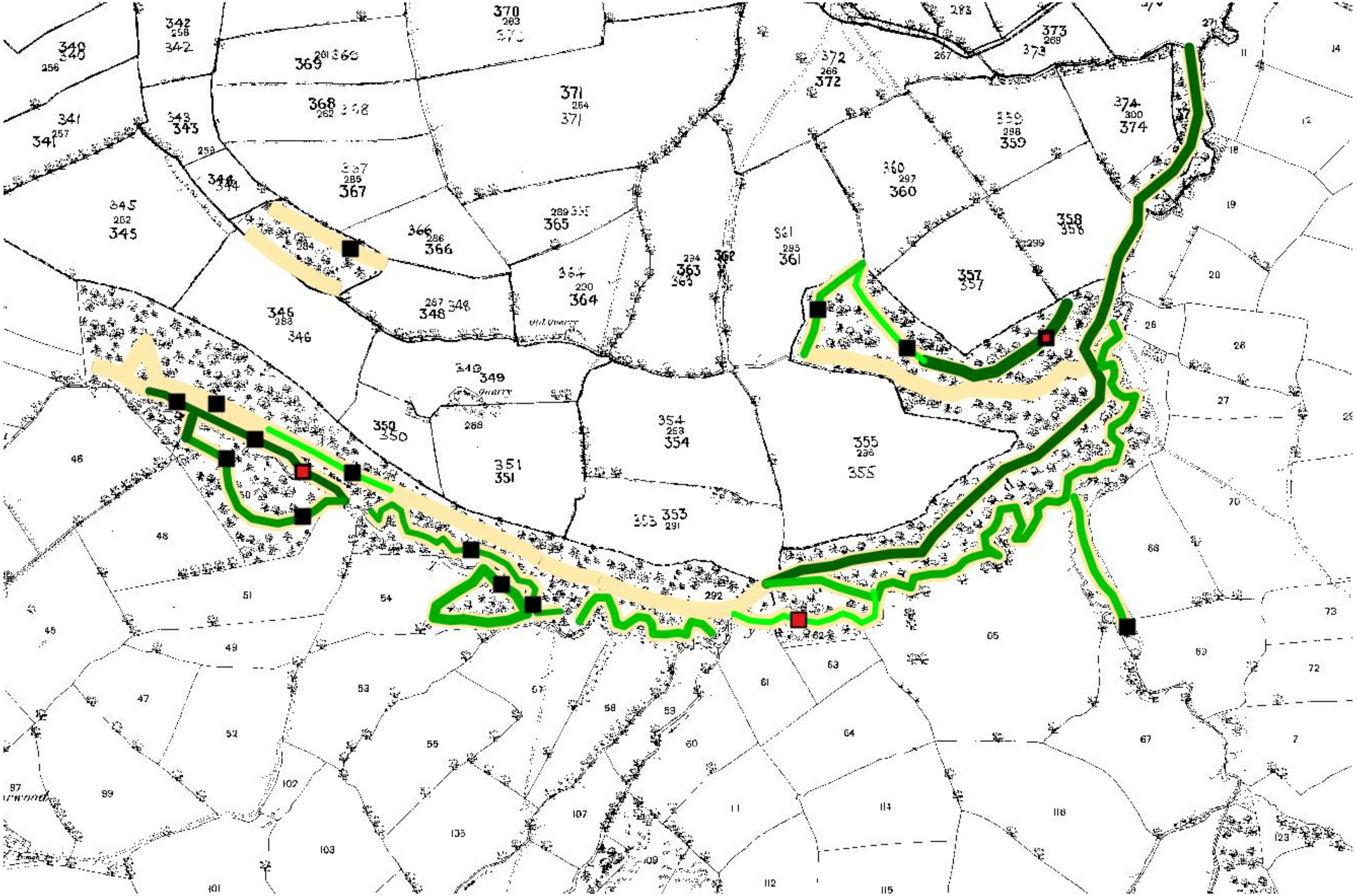


Figure 39.39 – *Mercurialis perennis*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

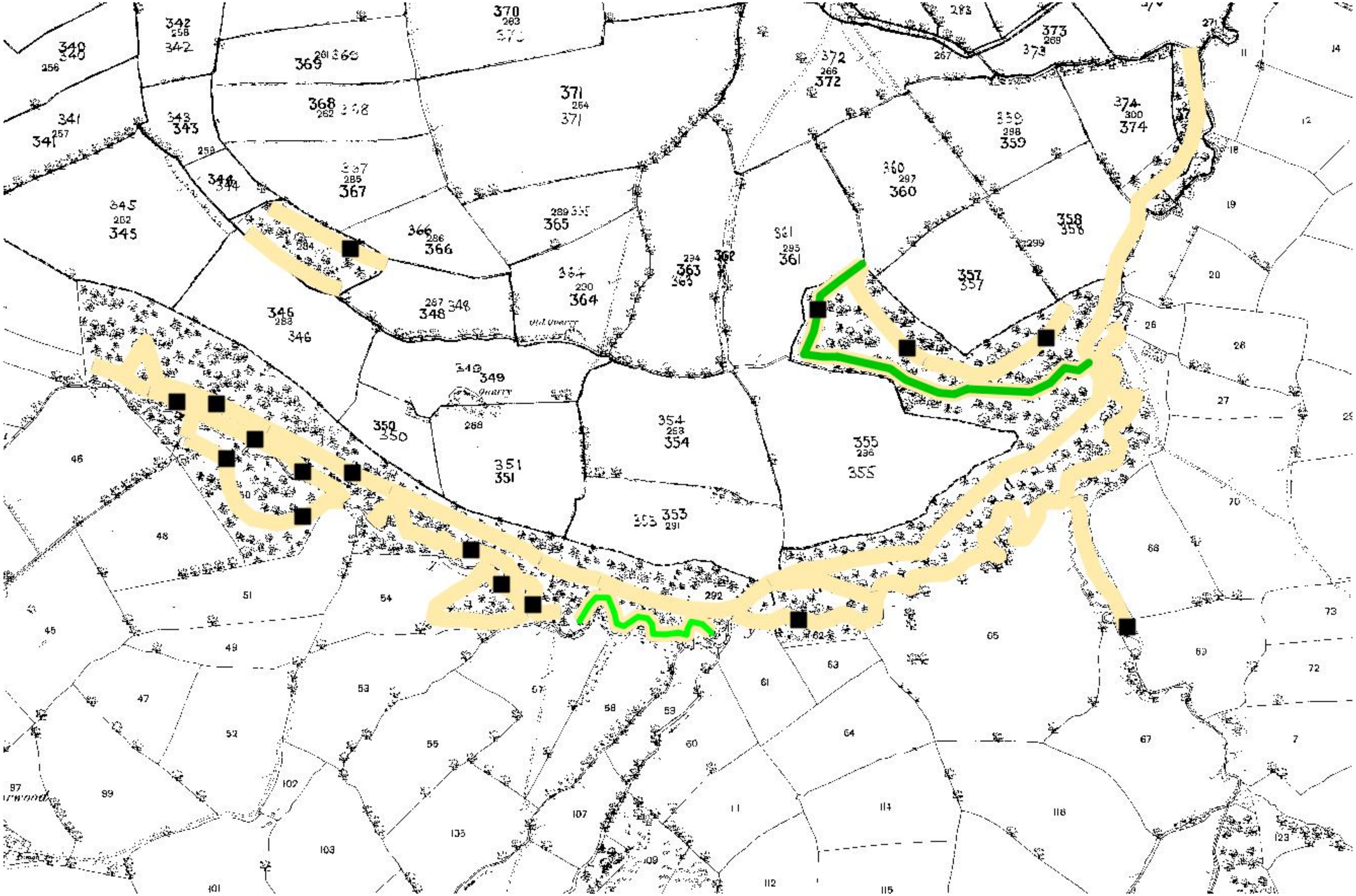


Figure 40.40 – *Milium effusum*

Species maps for Gillfield wood

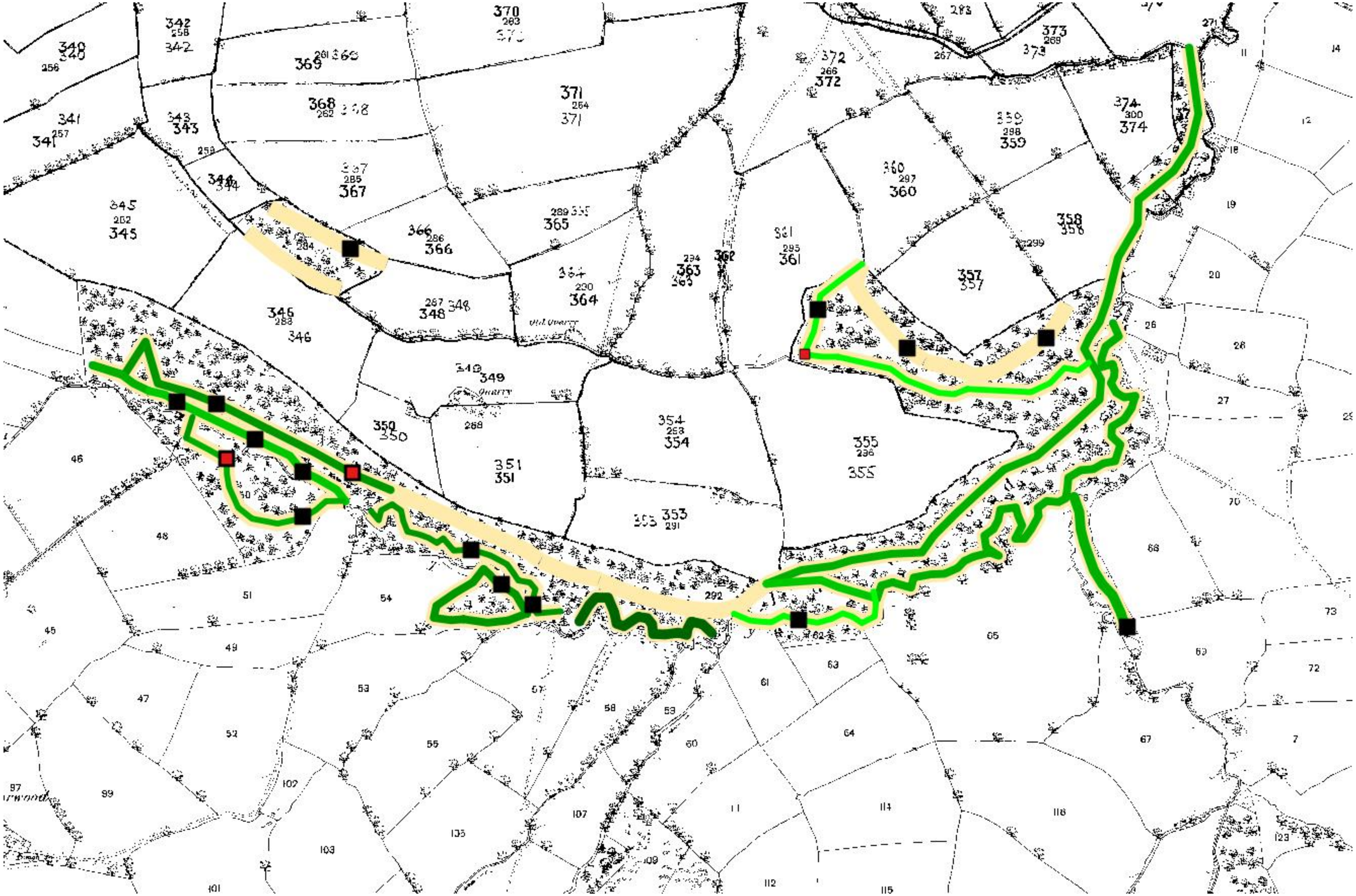


Figure 41.41 – *Oxalis acetosa*

Species maps for Gillfield wood

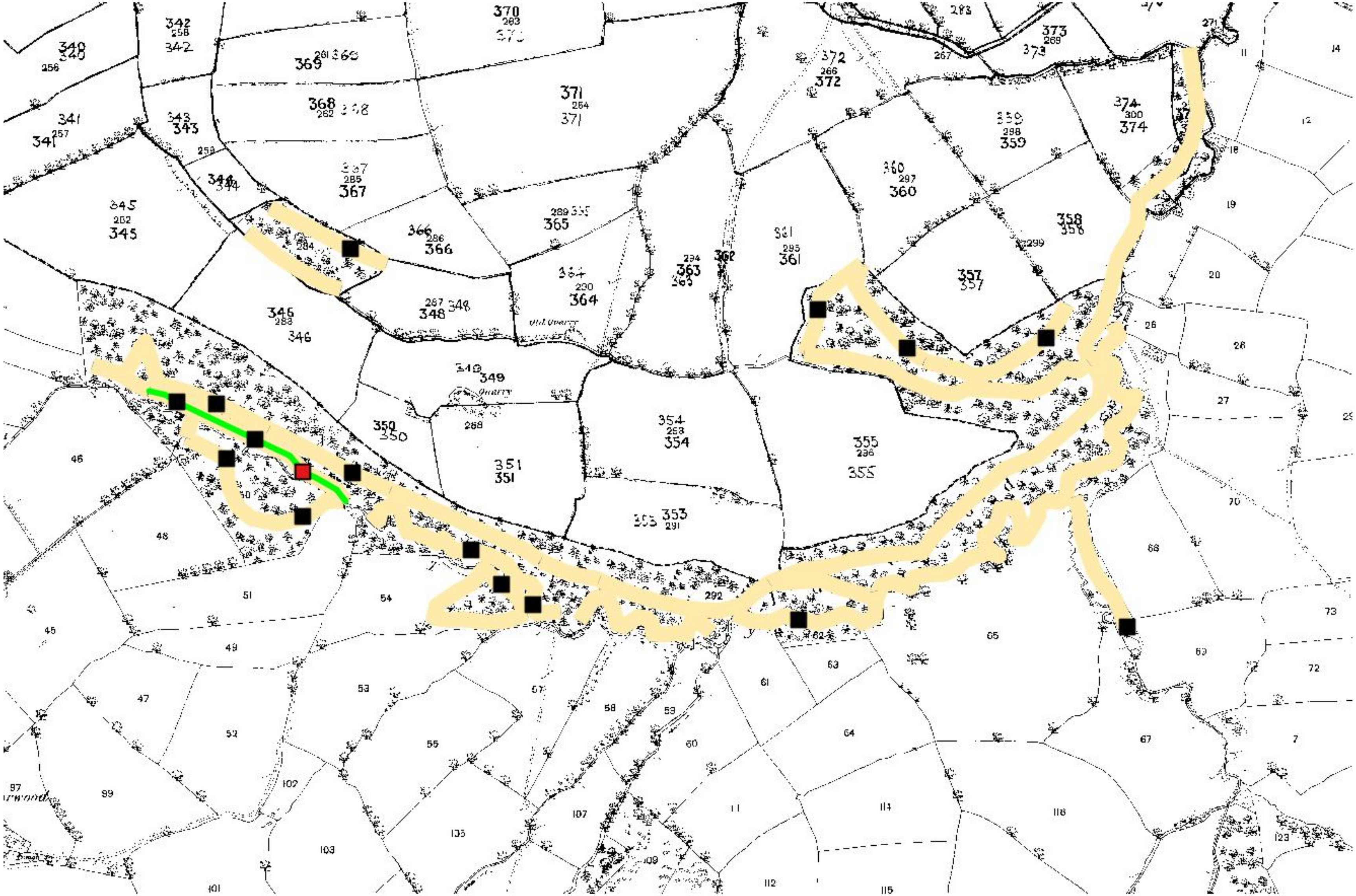


Figure 42.42 – *Phyllitis scolopendrium*

Species maps for Gillfield wood

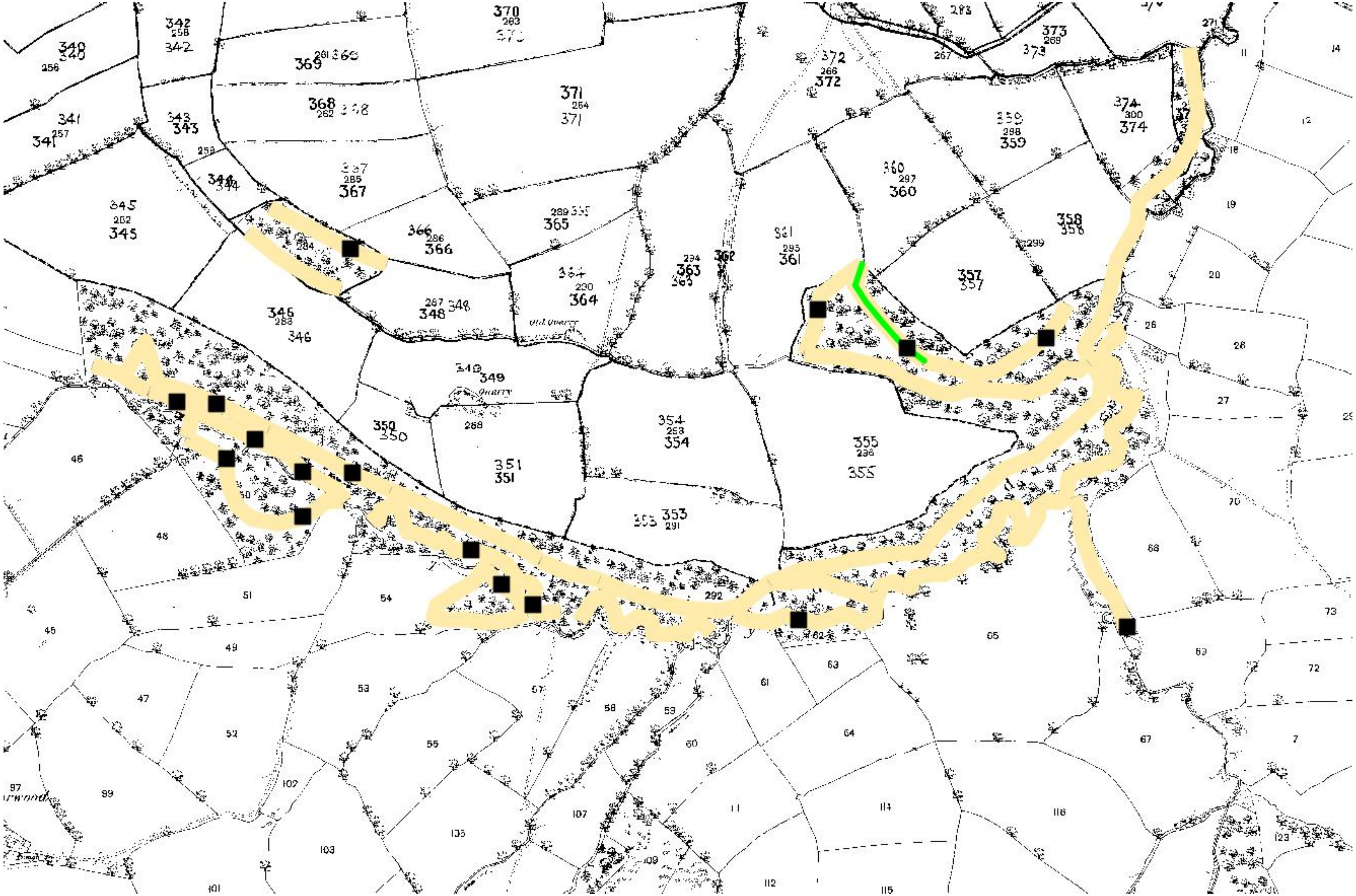


Figure 43.43 – *Poa nemoralis*

Species maps for Gillfield wood

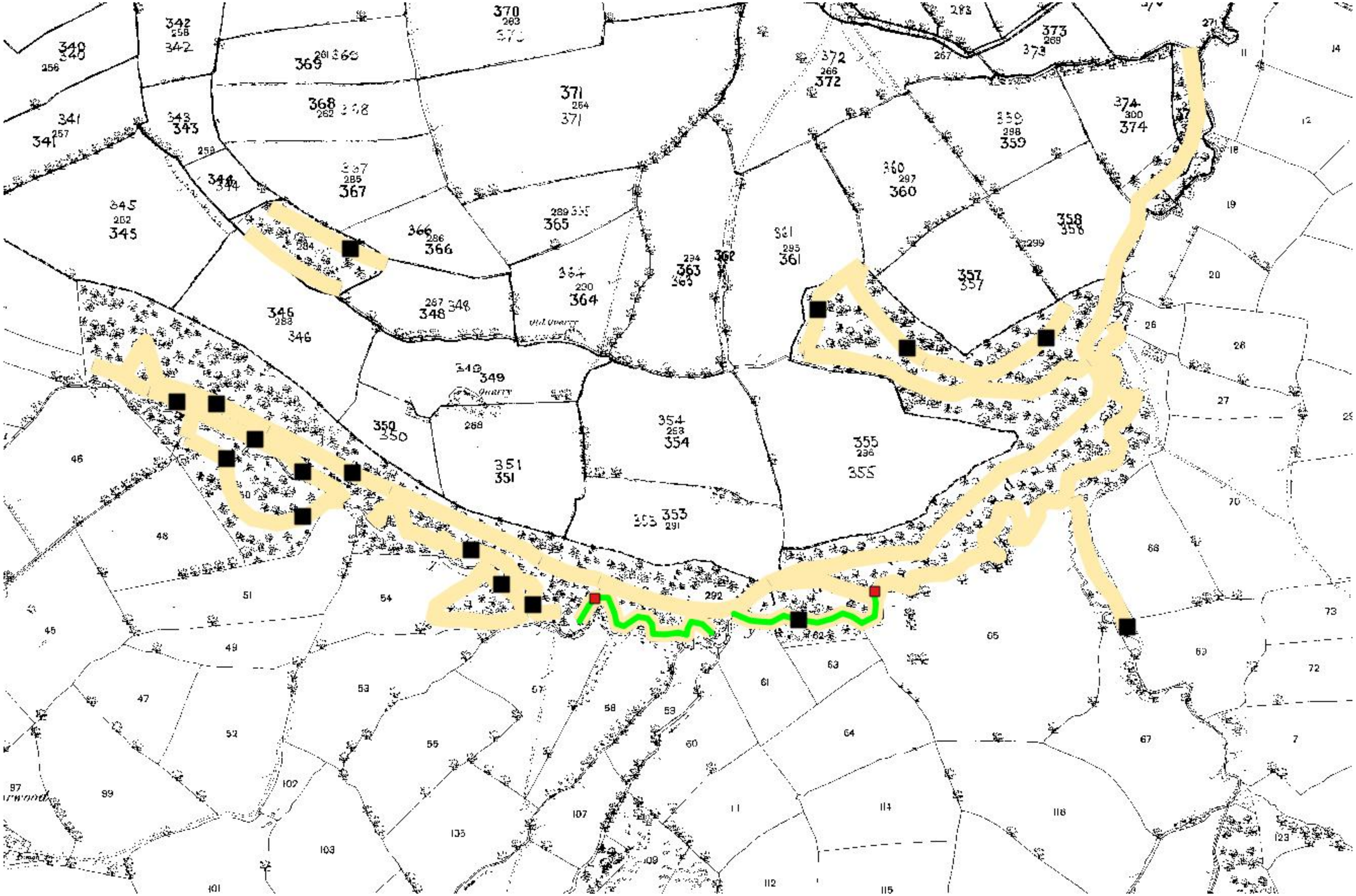


Figure 44.44 – *Polystichum setiferum*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

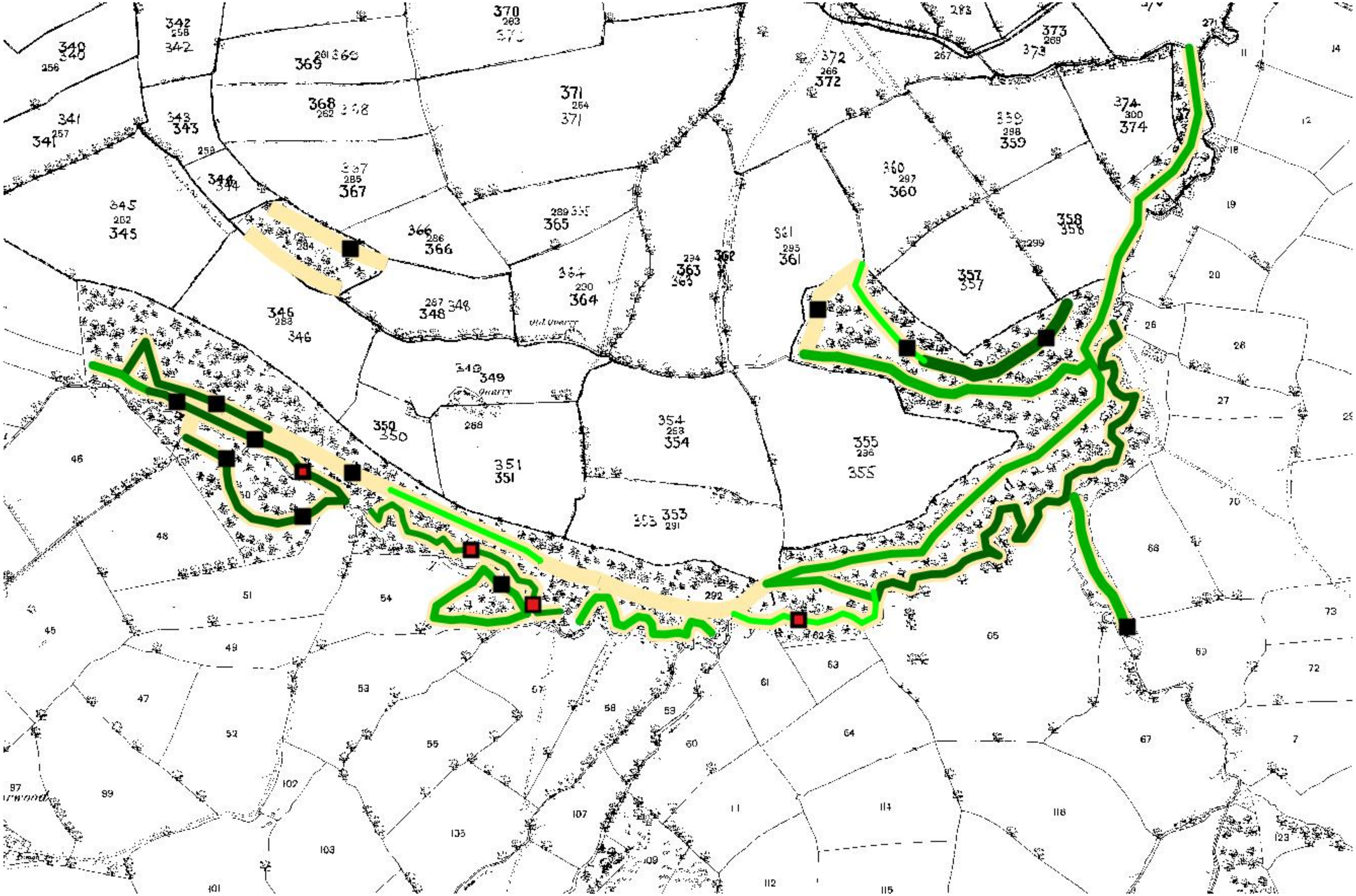


Figure 45.45 – *Ranunculus ficaria*

Species maps for Gillfield wood

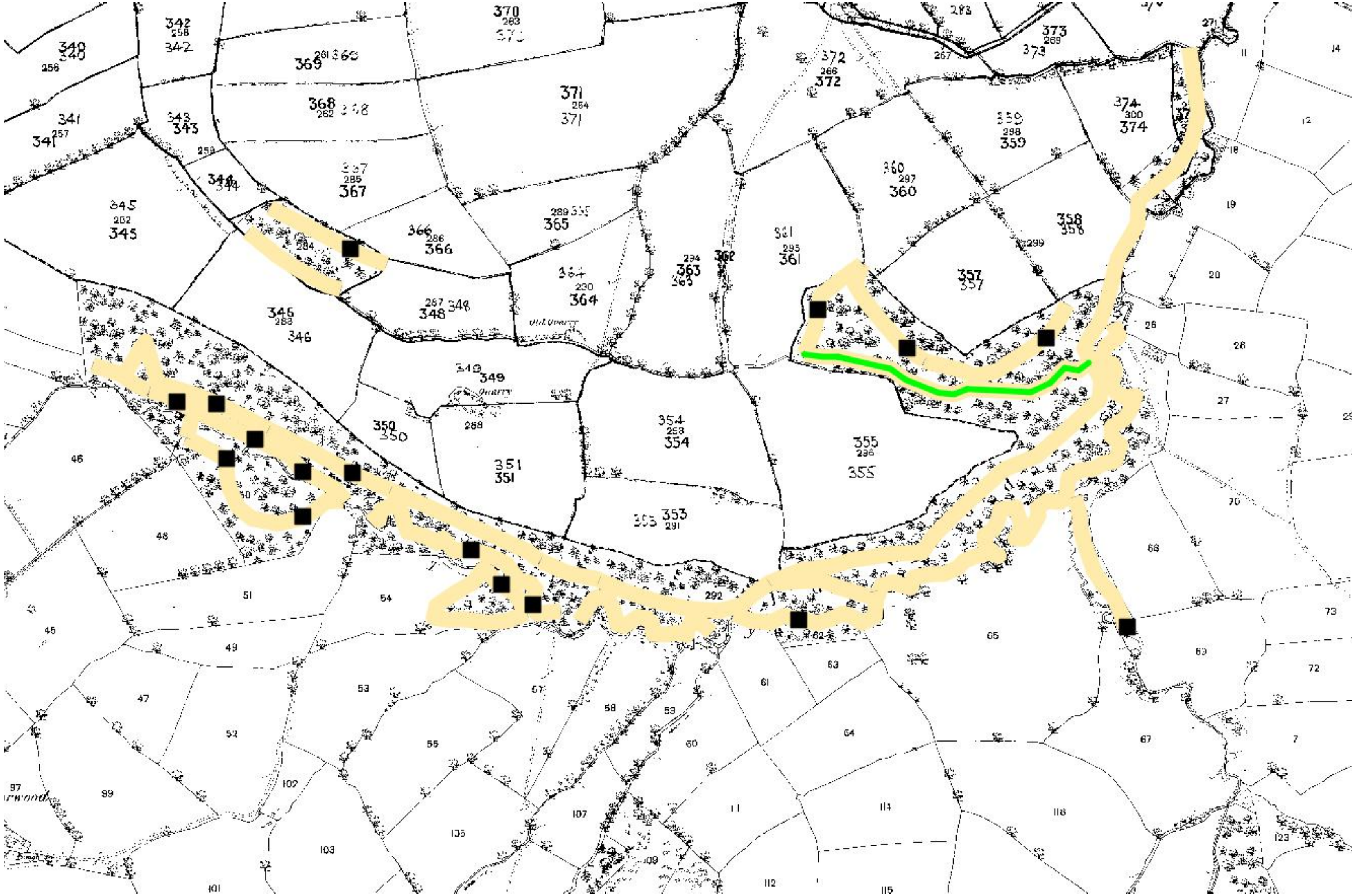


Figure 46.46 – *Ribes nigrum*

Species maps for Gillfield wood

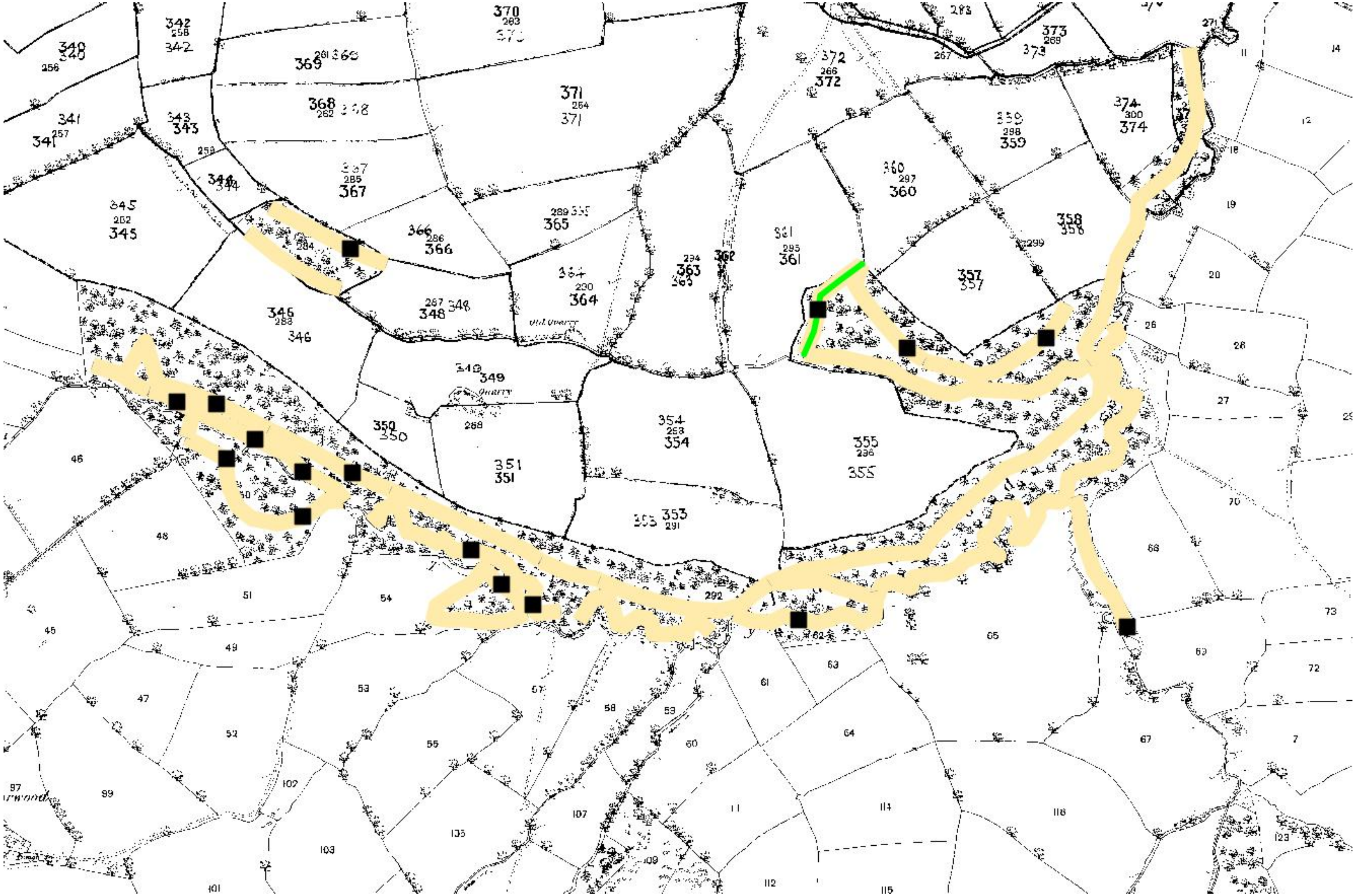


Figure 47.47 – *Ribes uva-crispa*

Species maps for Gillfield wood

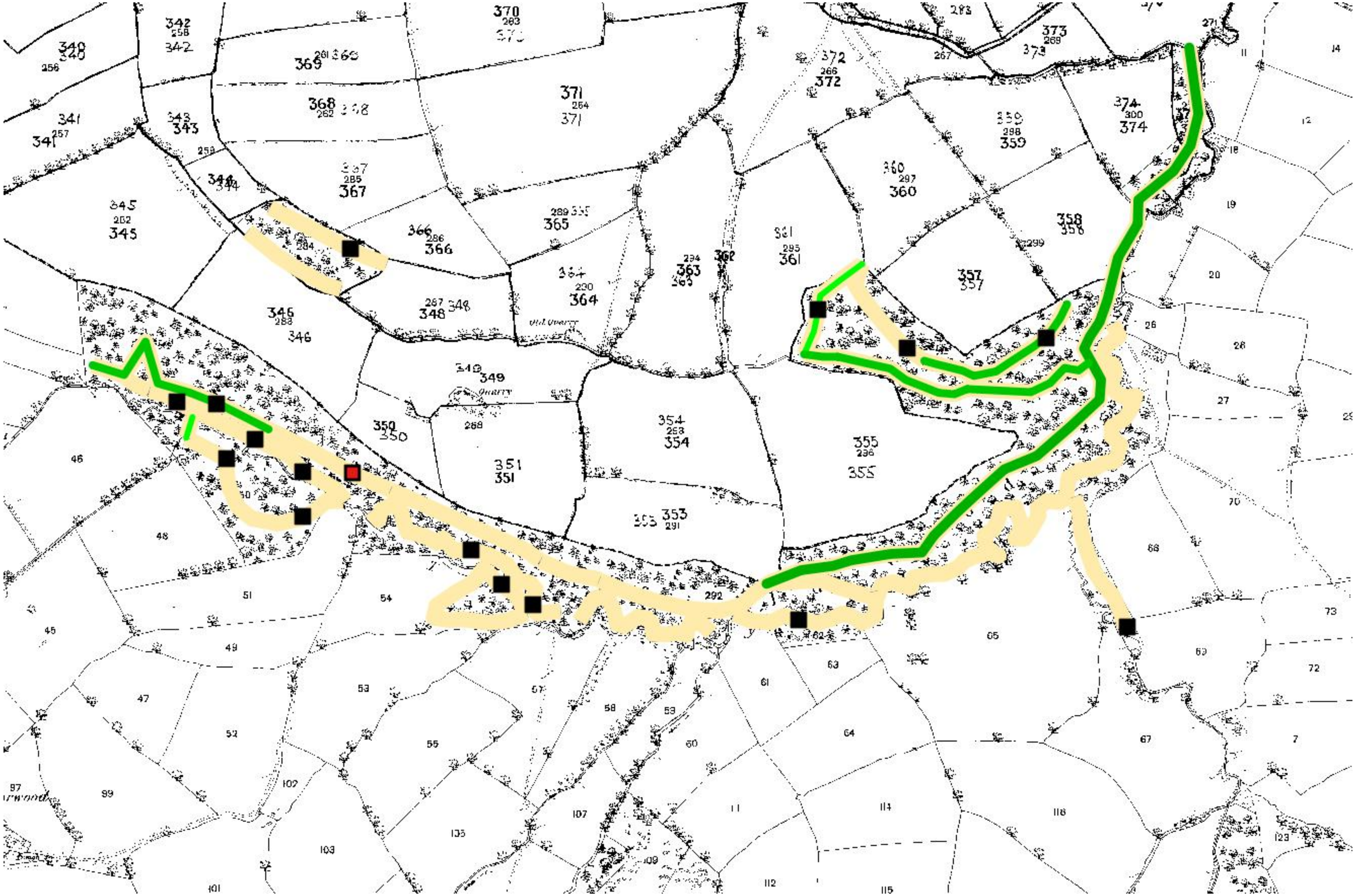


Figure 48.48 – *Rosa arvensis*

Species maps for Gillfield wood

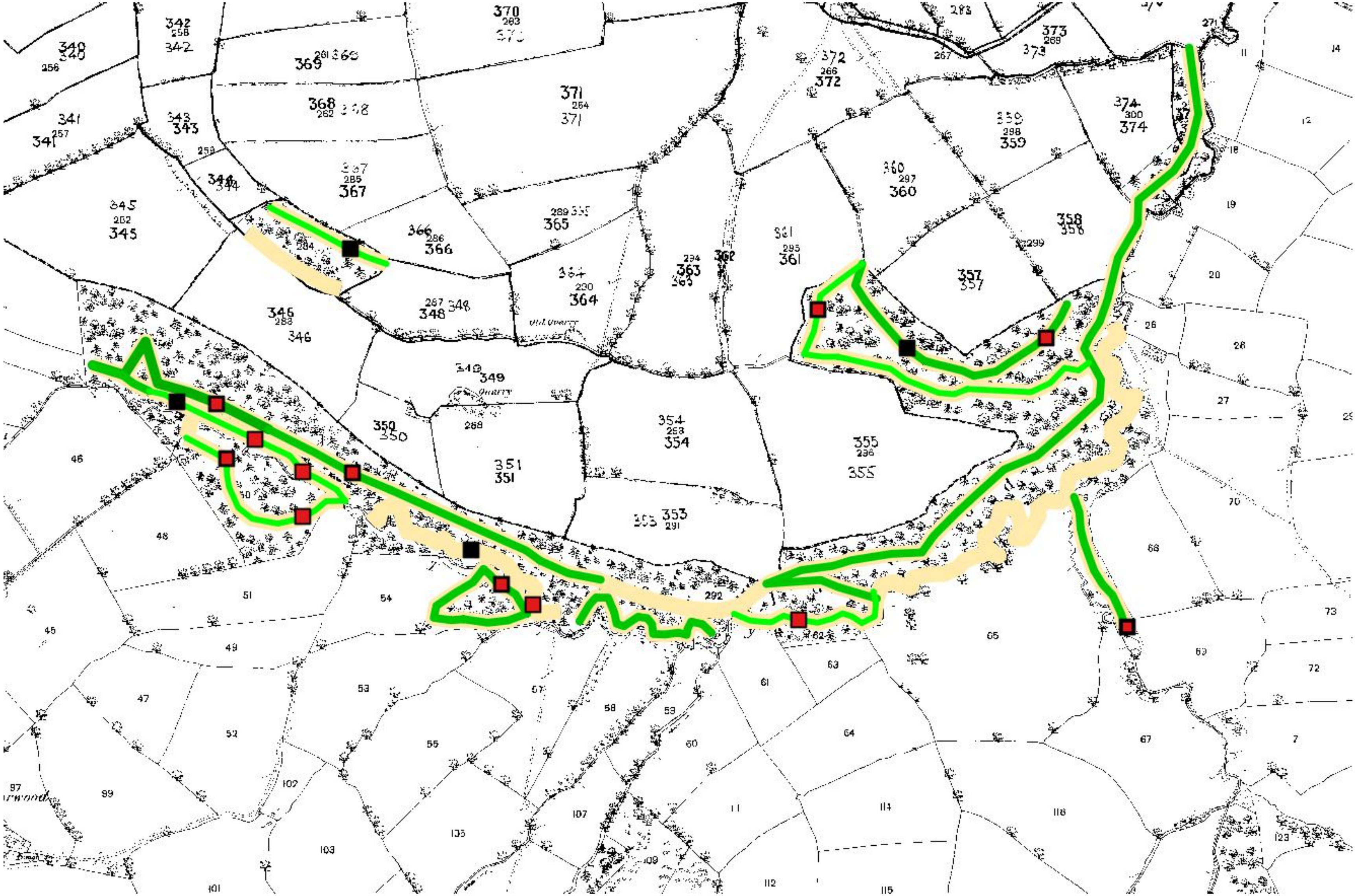


Figure 49.49 – *Rubus fruticosus*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

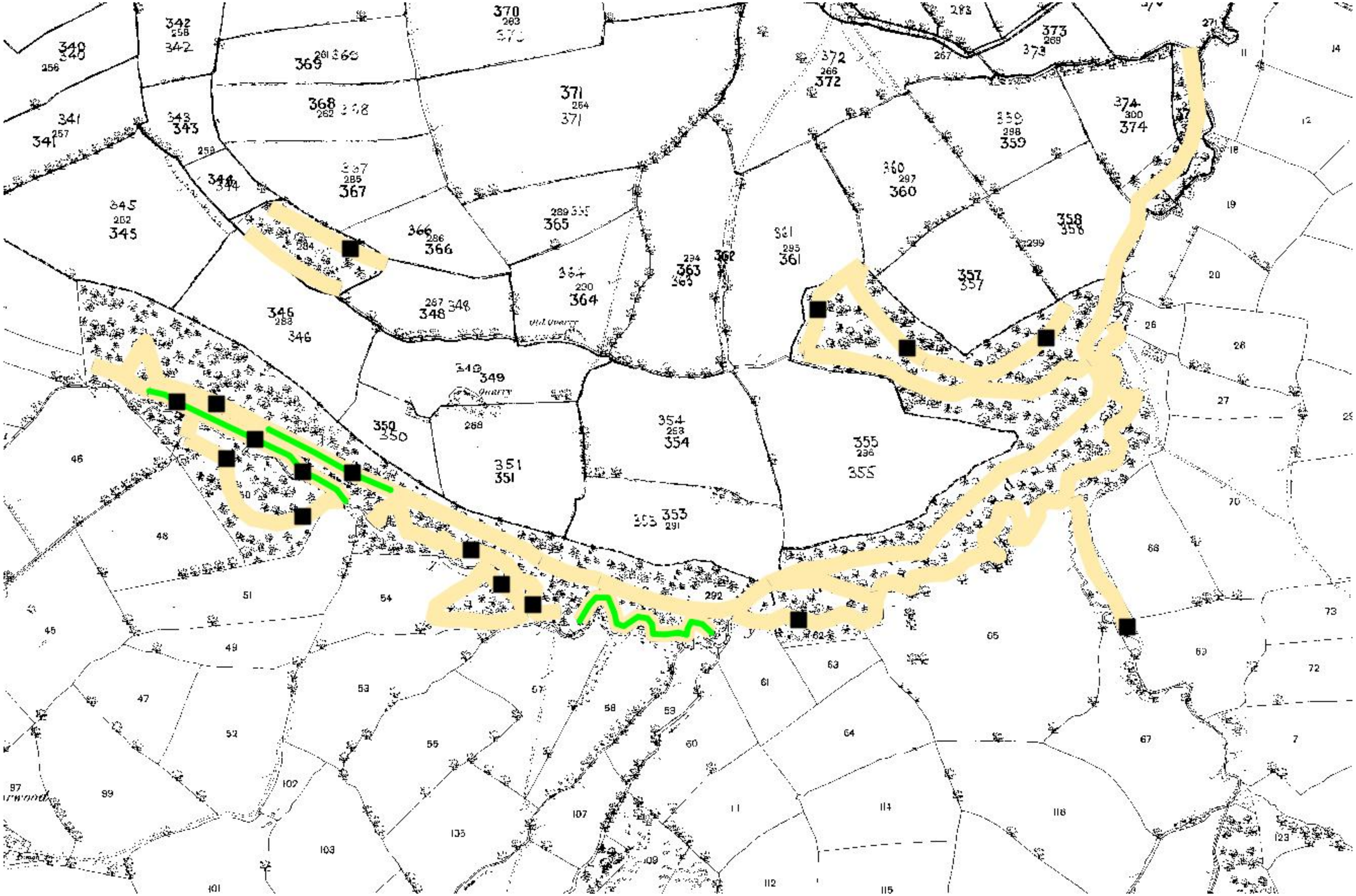


Figure 50.50 – *Rumex sanguineus*

Species maps for Gillfield wood

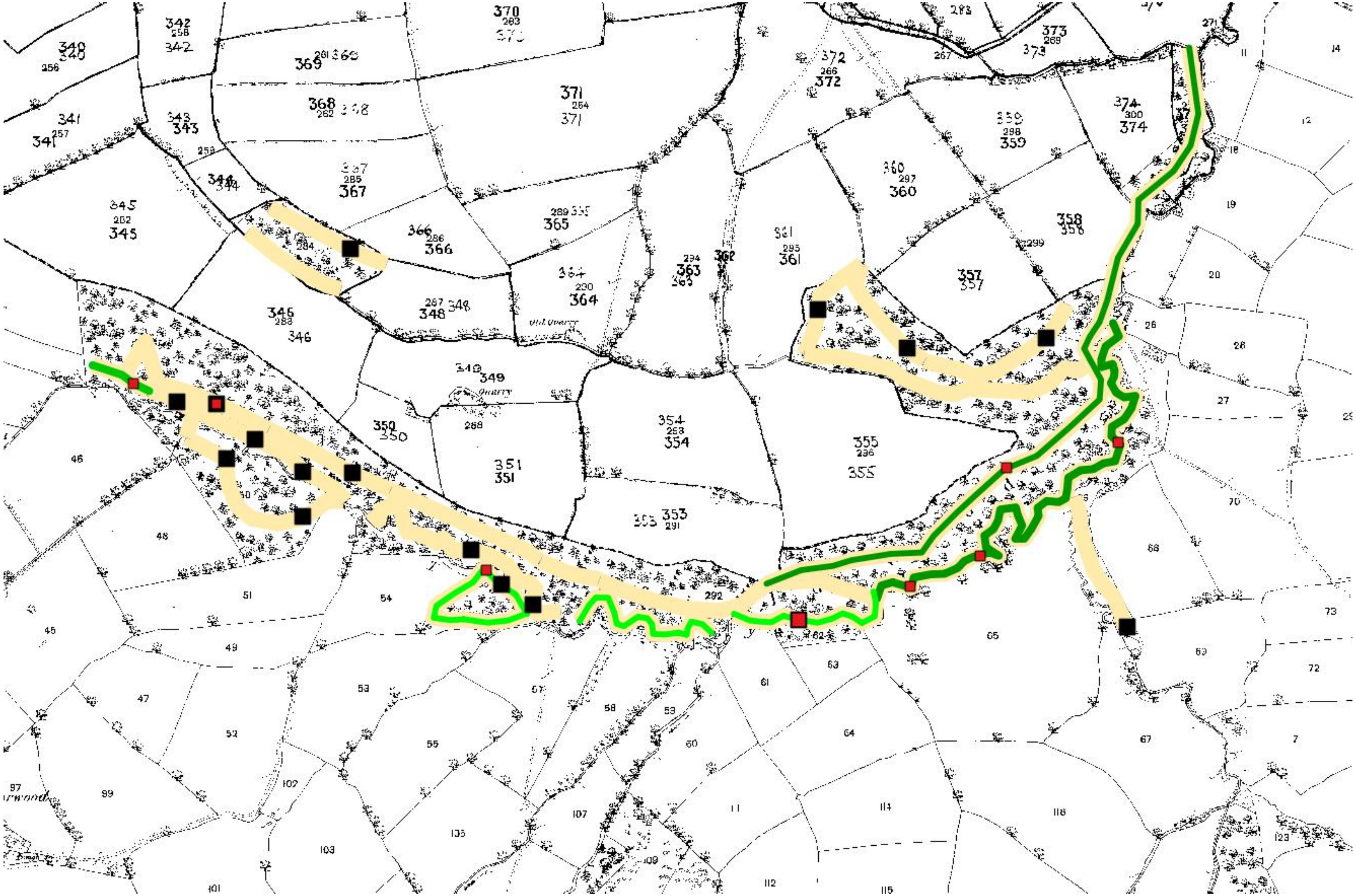


Figure 51.51 – *Sanicula europaea*

Species maps for Gillfield wood

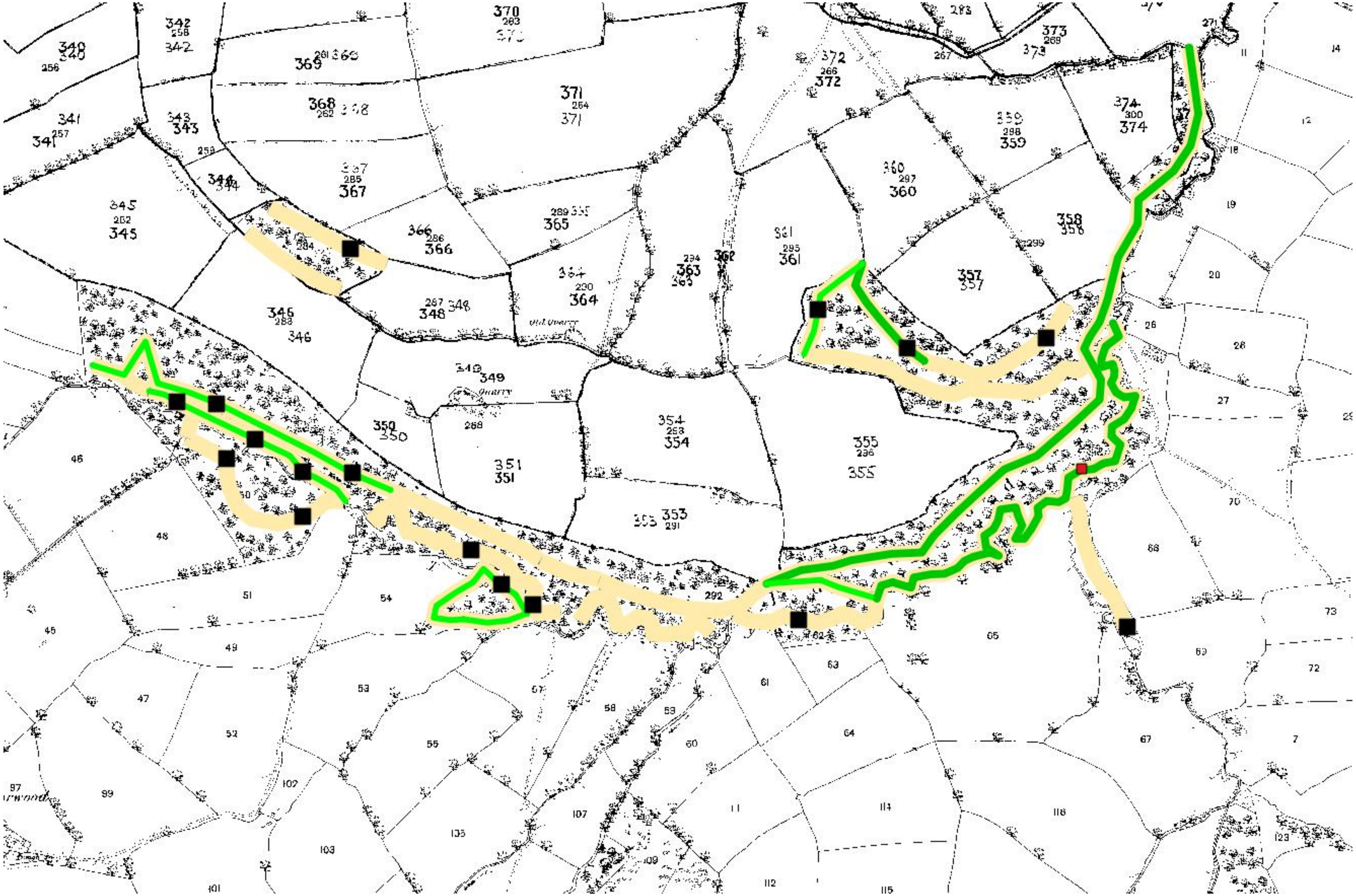


Figure 52.52– *Sorbus aucuparia* - Shrub

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

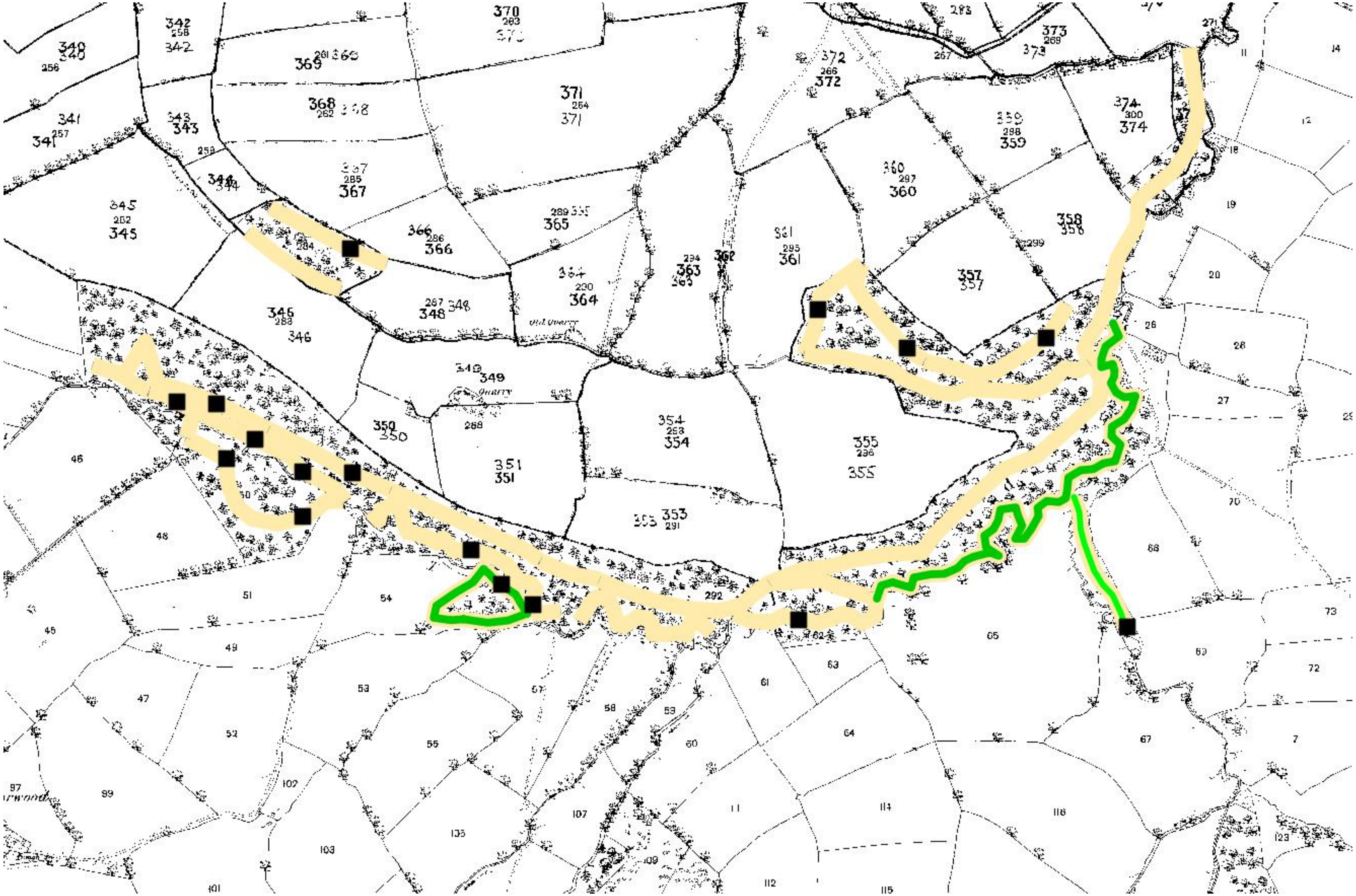


Figure 53.53– *Sorbus aucuparia* - Tree

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

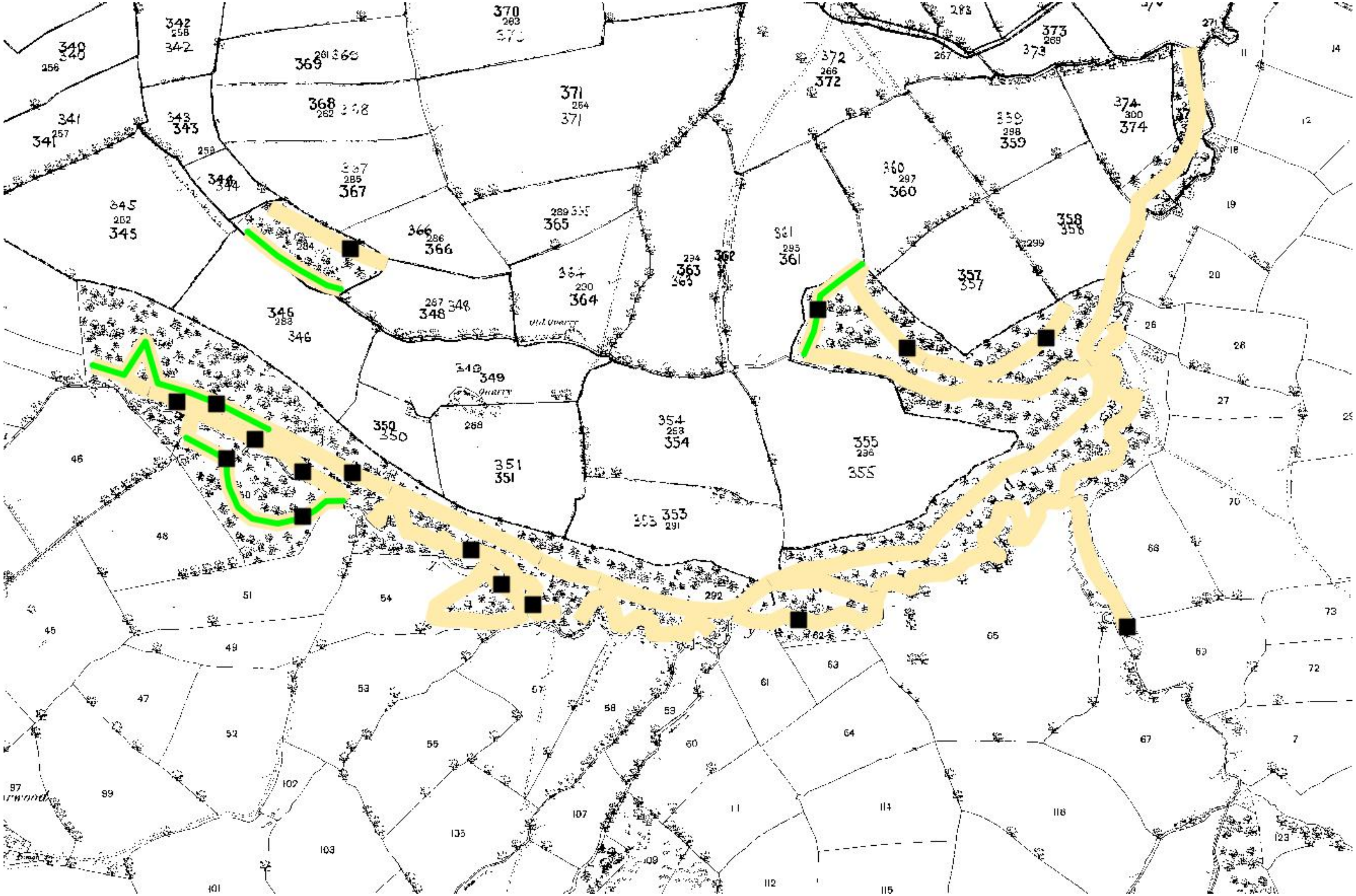


Figure 54.54 – *Stachys sylvatica*

Species maps for Gillfield wood

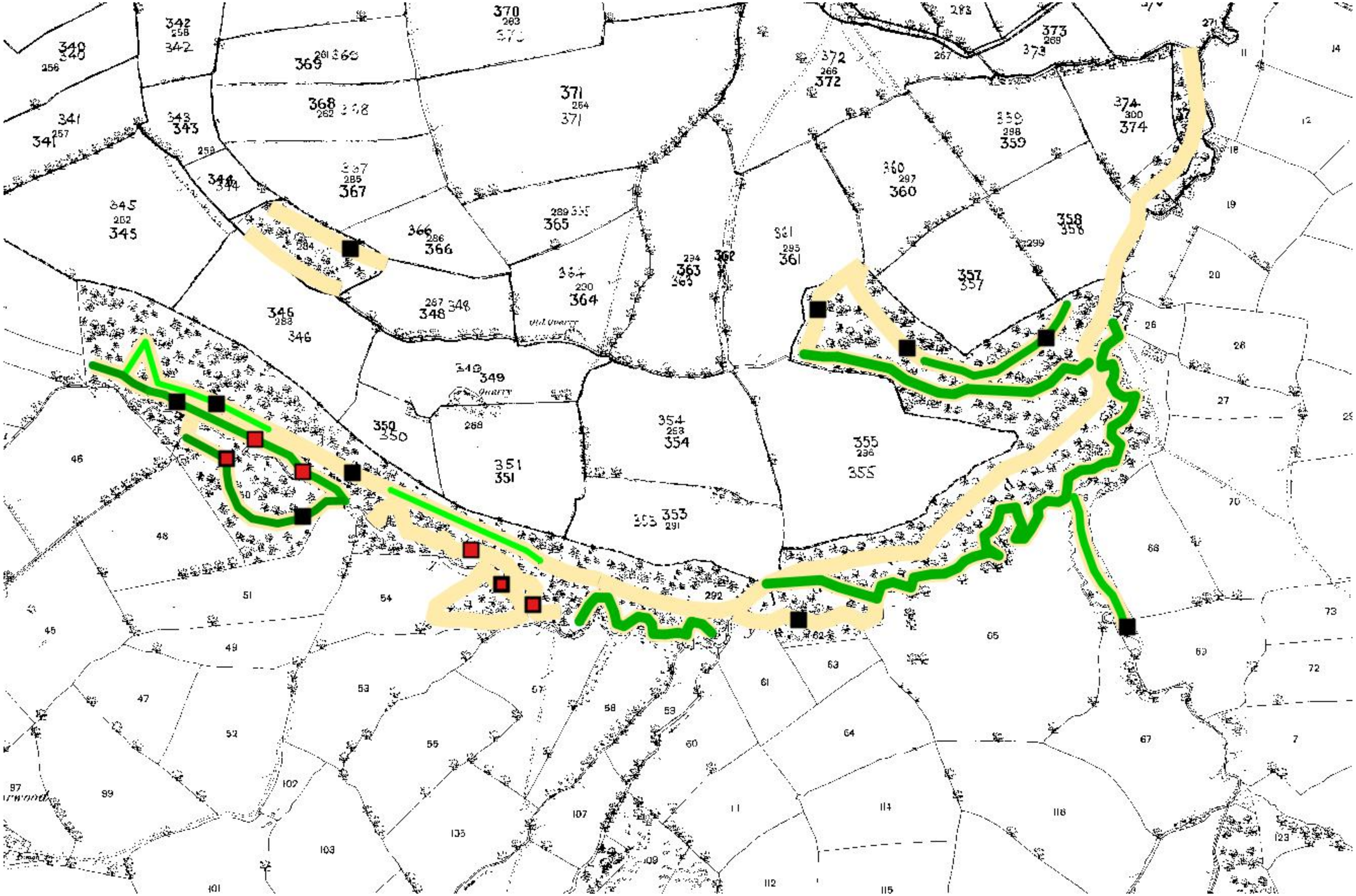


Figure 55.55 – *Stellaria holostea*

Species maps for Gillfield wood

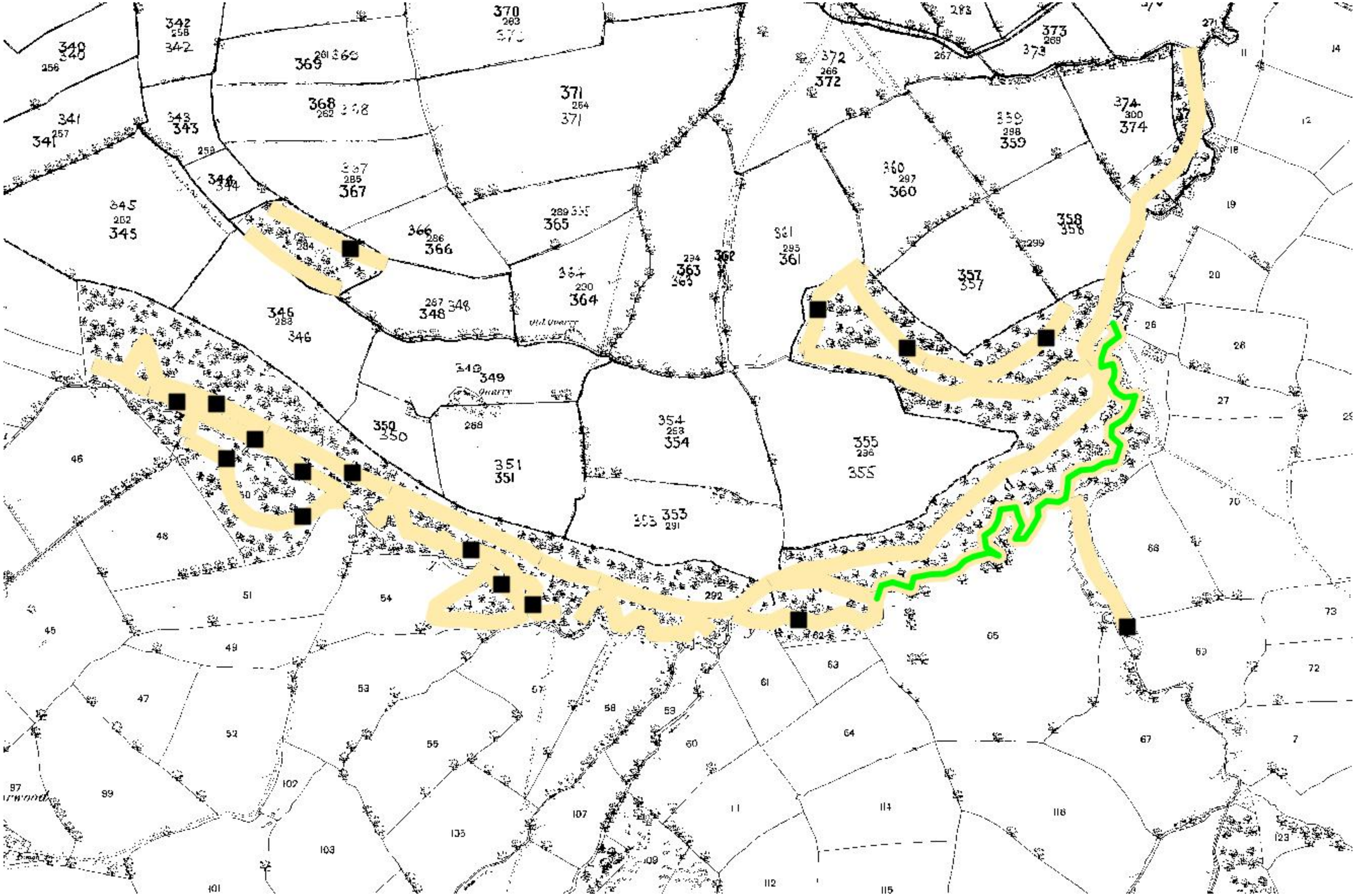


Figure 56.56 – *Valeriana officinalis*

Appendix 15 - Results for Gillfield Wood

Species maps for Gillfield wood

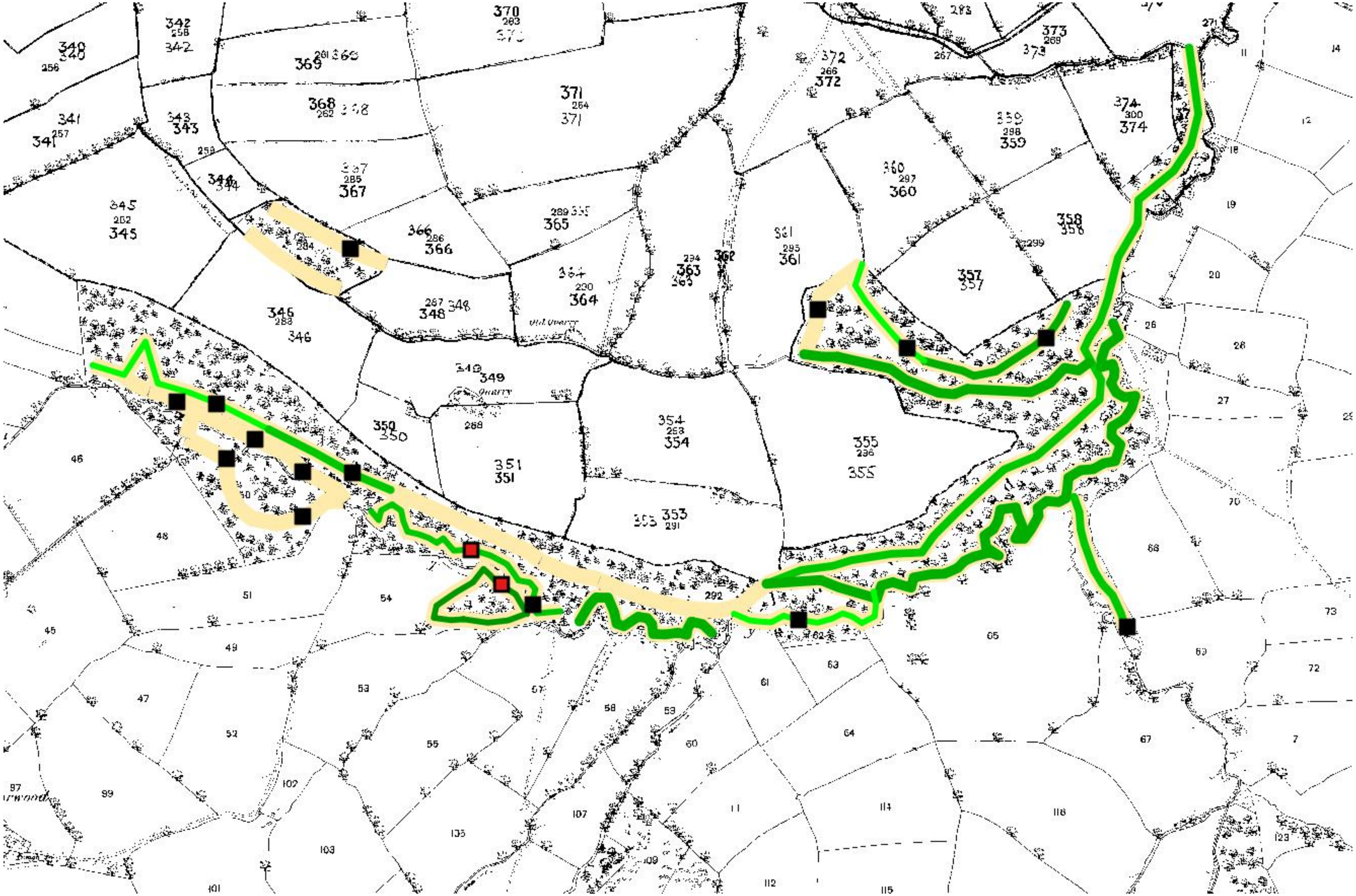


Figure 57.57 – *Veronica montana*

Species maps for Gillfield wood

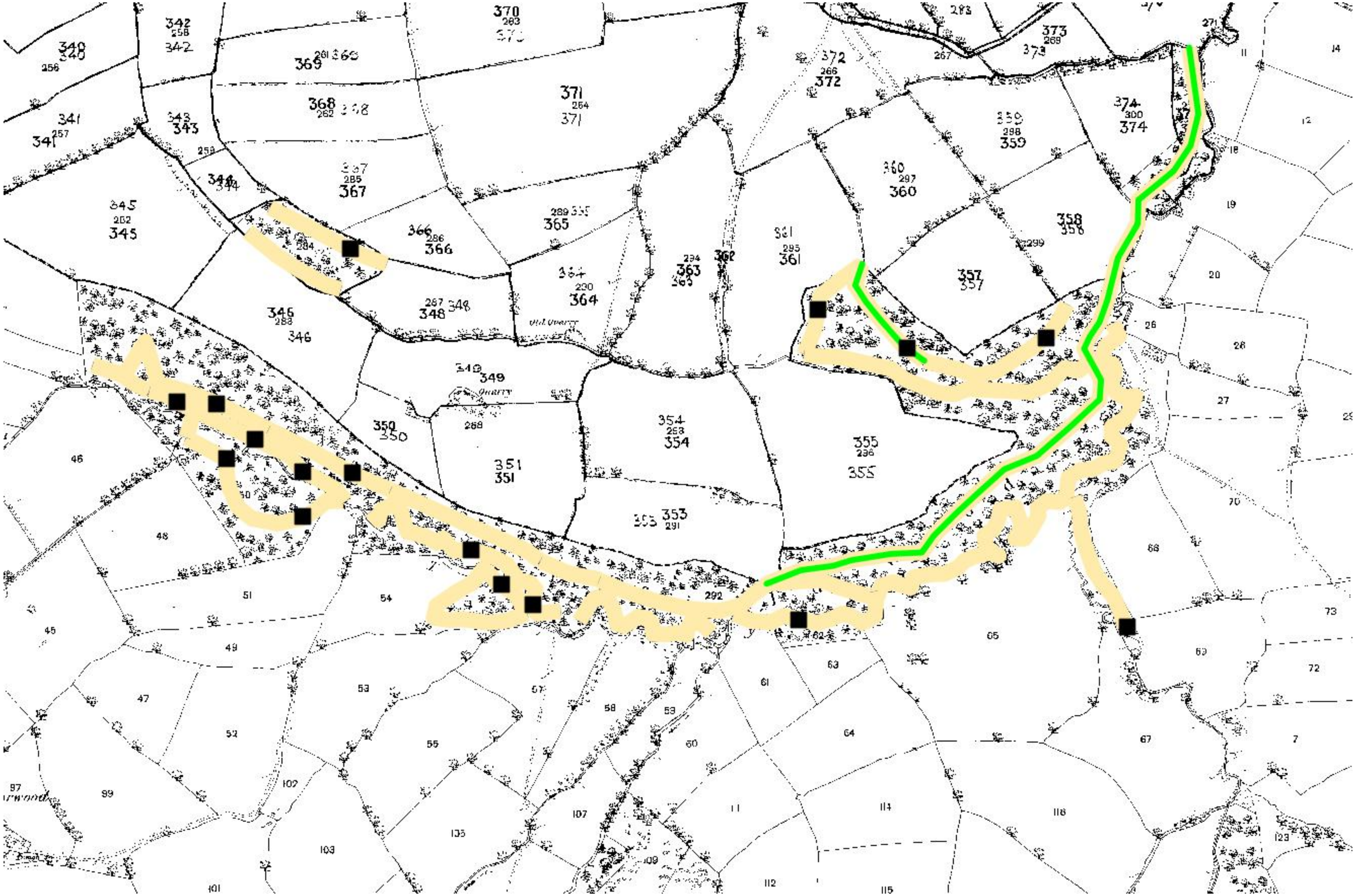


Figure 58.58 – *Vicia sepium*

Species maps for Gillfield wood

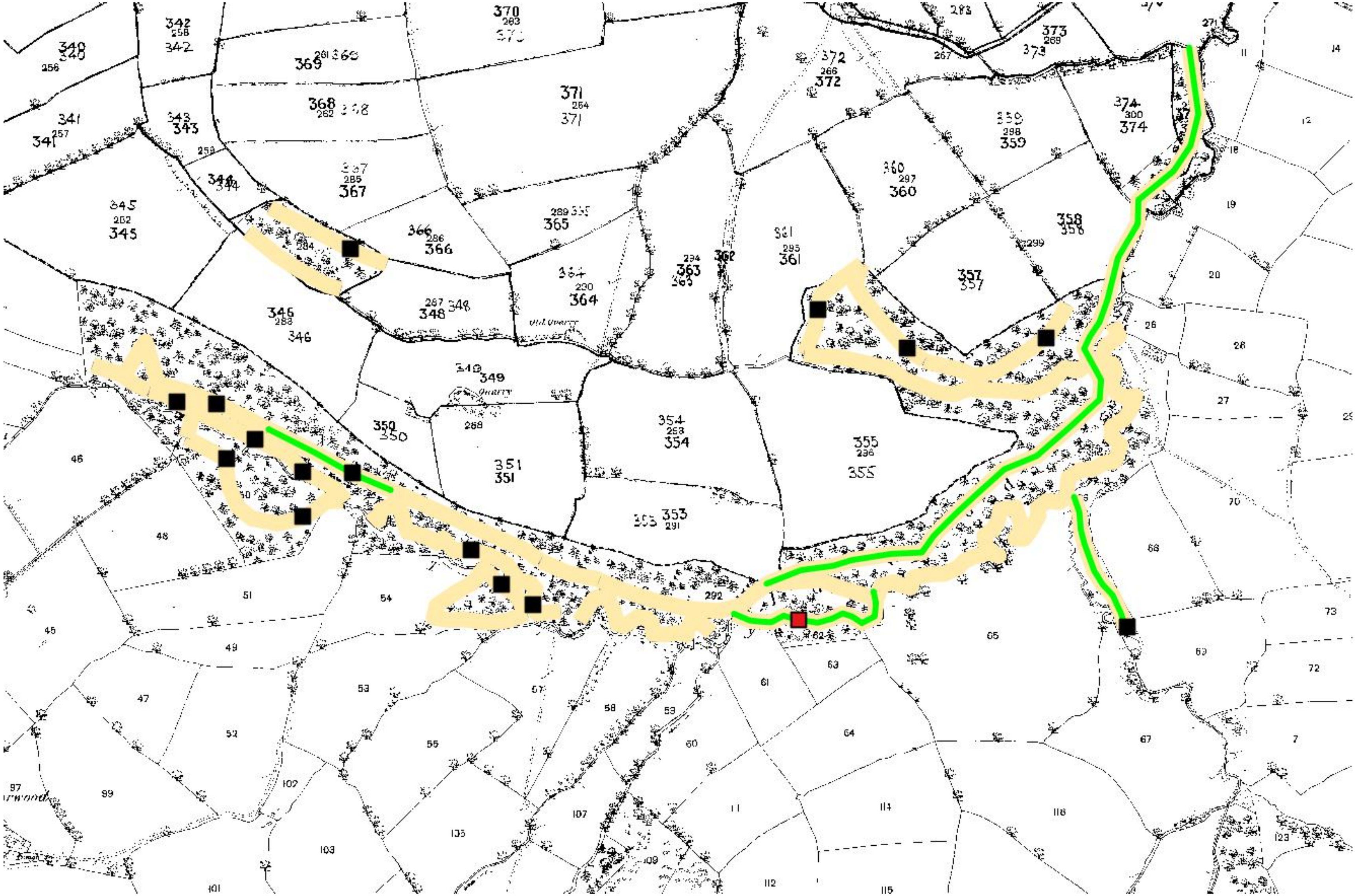


Figure 59.59 – *Viola riviniana*

Appendix 15 - Results for Gillfield Wood

Table 60.1 - Survey data for Gillfield Wood – Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																						
Species	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CL646-CL654	CN618-CN620	CN620-CN628	CN628-CN633	CN633-CN634	CN636-CN642	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637
ACE-PSE	33		22			44		44	11	33					33	22					11		
ace-pse	11	33	22		11	22												22			11		
ado-mos																				11		24	
all-pet		11				22													11				
ALN-GLU						11		22															
ane-nem	22	22	11	33	33	44	22	44	25	34	24		45			45	11	23	33	33	44	33	44
ang-syl								11	11	12											11	11	
ant-syl						22				11					11	11					11	33	11
aru-mac																			11				
ath-fil						23	22	33		12			11						11		11	22	33
BET-PEN					11																		
ble-spi							11														11	11	
bra-syl						33		33						11						11		11	
BRYO									24	34						22		22		33			
cal-pal																					11		
car-ama								33		24									11		11	34	
CAR-BET								11															
scar-pen									12												11	11	11
car-rem		11				23									12						11	11	
car-spp															11								
car-syl	11					23	11															22	
chr-opp								22		25		11			12						11	33	
cir-lut	23					24		11									14					22	
con-mac				33																			

Appendix 15 - Results for Gillfield Wood

Table 60.1 - Survey data for Gillfield Wood – Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																					
Species	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CL646-CL654	CN618-CN620	CN620-CN628	CN628-CN633	CN633-CN634	CN636-CN642	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637
con-maj		11																					22
cor-ave					22	11		22		11	11		11		11	33	22	33		33			33
cra-mon	11	11								11			11		11	22	11	22				22	
des-ces		11																				11	
dig-pur		11																					
dry-aff										11											11	11	
dry-car						11	11															11	
dry-dil	22	22	11	11		22	22	22	11	22	11		11		12		11	23	22	33	11		33
dry-fil	11			11			11			11					11			11	22	22			
epi-hir															12								
epi-mon																							
equ-arv								11															
equ-syl	11									11											11		
FAG-SYL	22			11		22							45	44									
fag-syl	22		11			11	22									22	22			33		22	
fil-ulm						22															11		11
FRA-EXC										33					12								
fra-exc	11	11				11		11											11				11
gal-apa										22	11											11	
gal-odo						24		33		12	13		24							23	11	33	
ger-rob						11			25	24	34		22						11	11		33	
geu-urb	22	11	11		22	33			11				11			22	11		11			22	11
hed-hel	33	33			33	33	33		13		25	11	22			33	22	33			11		22
her-sph										11						11						11	11

Appendix 15 - Results for Gillfield Wood

Table 60.1 - Survey data for Gillfield Wood – Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																						
Species	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CL646-CL654	CN618-CN620	CN620-CN628	CN628-CN633	CN633-CN634	CN636-CN642	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637
hol-mol	33	44	22		44	44	22		23	24	45	23	24	22		11	55	44	33	22	11	33	22
hya-non	44	44	44	33	44	35	33	35	35	24	45	34	35	55	25	45	33	44	44	33	11	45	44
hyp-spp		11																					
Ile-Aqu	22	11	11		22	25	22	33	22	11	11		11	11		22	22	22		22	11	11	22
lam-gal	11	22	11			33	33	33	34	34	22		23			22		24	23	22		33	22
LAR-KAE	23			33		33																	
LITTER																	22	33		24	33		22
lon-per	22	33	33	33	22	22	33	22		11	1		11				11	11	22			22	22
luz-pil												12										11	
luz-syl								24					23									11	
lys-nem	14	24				14		22													11		11
mel-uni								11								13	11		22	11		11	
mer-per		11				35	22	24		25	23	34	13			45	11	22		33	11	22	22
mil-eff																		22	22			11	
myo-spp									11														
oxa-ace	23	23				24	22	24	24	22	13	14	14					11	11	23	11	34	33
pha-aru																							
phy-sco										11													
poa-nem																	11						
pol-set																					11	11	
pru-spi											11						11	11				11	
pte-aqu	22	11	11				22				11									11			
QUE-ROB	22					22				44	11									22			
que-rob																							

Appendix 15 - Results for Gillfield Wood

Table 60.1 - Survey data for Gillfield Wood – Transects																							
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)																							
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																						
Species	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CL646-CL654	CN618-CN620	CN620-CN628	CN628-CN633	CN633-CN634	CN636-CN642	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637
ran-rep		11																					
ran-fic	25		11			24	24	25	24	25	25		14			45	11		33	24	11	22	33
ros-arv	22					33						11				22		11	22				
rib-nig																			11				
rib-uva																		11					
Rho-Pon																							
rub-fru	33	22	22	22		22	22		22	11	11			11		22	22	11	11	22	11	22	22
rum-obt																							
rum-san		11								11												11	
Sam-Nig										11											11		
san-eur						14		23	22											11	11	11	
SOR-AUC								22												22			11
sor-auc	11	11				22	11	22		11							22	11		11			
sta-syl	11										11				11			11					
ste-hol	11		11				33	33	23	24	23					24			33			33	22
sym-riv																							
tar-off	11	11																					
ulm-gla		22				22																	
urt-dio									24		11	11					11	11					
val-off								11															
ver-cha																							
ver-mon	11	22				22	33	33					12			24	11		33	14	11	33	22
ver-bec									22											11			
vic-sep						11											11						

Appendix 15 - Results for Gillfield Wood

Table 60.1 - Survey data for Gillfield Wood – Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number																						
Species	CL615-CL620	CL620-CL623	CL623-CL626	CL626-CL627	CL627-CL643	CL635-CL643	CL643-CL646	CL646-CL654	CN618-CN620	CN620-CN628	CN628-CN633	CN633-CN634	CN636-CN642	CN662-CN664	CN665-CN666	CP593-CP596	CP596-CP600	CP600-CP605	CP605-CP608	CP614-CP614	CP621-CP629	CP630-CP635	CP636-CP637
vio-riv		11				11															11		11

Appendix 15 - Results for Gillfield Wood

Table 65.2 - Survey data for Gillfield Wood – Quadrats, point records – part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																						
Species	CL618	CL619	CL622	CL624	CL629	CL630	CL638	CL639	CL640	CL641	CL645	CL647	CL648	CL649	CL650	CL651	CL653	CN619	CN621	CN622	CN623	CN624	CN625
ACE-PSE		3	3																				
ace-pse																							
ado-mos																							
all-pet																							
ALN-GLU																							
ane-nem			3																		4		4
ang-syl																							
ant-syl																							
aru-mac																							
ath-fil																							
BET-PEN																							
ble-spi											3											3	
bra-syl																							
BRYO																							
cal-pal																							
car-ama																							5
CAR-BET																							
scar-pen																							
car-rem			4															3					
car-spp																							
car-syl																							
chr-opp																							4
cir-lut																							
con-mac																							
con-maj																							
cor-ave																							
cra-mon																							

Appendix 15 - Results for Gillfield Wood

Table 65.2 - Survey data for Gillfield Wood – Quadrats, point records – part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																						
Species	CL618	CL619	CL622	CL624	CL629	CL630	CL638	CL639	CL640	CL641	CL645	CL647	CL648	CL649	CL650	CL651	CL653	CN619	CN621	CN622	CN623	CN624	CN625
des-ces																							
dig-pur																							
dry-aff																							
dry-car							3	3															
dry-dil		3																		5	5		
dry-fil																							
epi-hir																							
epi-mon																							
equ-arv															3								
equ-syl																			3				
FAG-SYL																							
sag-syl	3		4																				
fil-ulm																							
FRA-EXC																							
fra-exc																							
gal-apa																							
gal-odo									3					3			3						
ger-rob																							
geu-urb																							
hed-hel																				5			
her-sph																							
hol-mol		2	3																				
hya-non		2	3																	1	2		4
hyp-spp																							
Ile-Aqu																							
lam-gal			4	3																			
LAR-KAE			2																				

Appendix 15 - Results for Gillfield Wood

Table 65.2 - Survey data for Gillfield Wood – Quadrats, point records – part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																					
Species	CL618	CL619	CL622	CL624	CL629	CL630	CL638	CL639	CL640	CL641	CL645	CL647	CL648	CL649	CL650	CL651	CL653	CN619	CN621	CN622	CN623	CN624	CN625
LITTER																				3	2		
lon-per			2																				
luz-pil					3											3							
luz-syl						3			3				3										
lys-nem																							
mel-uni																							
mer-per																							4
mil-eff																							
myo-spp																							
oxa-ace			4																				
pha-aru																							
phy-sco																							5
poa-nem																							
pol-set																							
pru-spi																							
pte-aqu																							
QUE-ROB		3	4																				
que-rob		3																					
ran-rep																							
ran-fic																							2
ros-arv			4																				
rib-nig																							
rib-uva																							
rho-pon																							
rub-fru		4	4																		5		5
rum-obt																							
rum-san																							

Table 65.2 - Survey data for Gillfield Wood – Quadrats, point records – part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																						
Species	CL618	CL619	CL622	CL624	CL629	CL630	CL638	CL639	CL640	CL641	CL645	CL647	CL648	CL649	CL650	CL651	CL653	CN619	CN621	CN622	CN623	CN624	CN625
Sam-Nig																							
san-eur		3			3					3		3	3				3	3					
SOR-AUC																							
sor-auc																3							
sta-syl																							
ste-hol																					5		5
sym-riv																							
tar-off																							
ulm-gla			4																				
urt-dio																							
val-off																							
ver-cha																							
ver-mon																							
ver-bec																							
vic-sep																							
vio-riv																							

Appendix 15 - Results for Gillfield Wood

Table 69.3 – Survey data for Gillfield wood – Quadrats, point records – part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)

Species	CN626	CN627	CN630	CN631	CN632	CN637	CN638	CN639	CN640	CN641	CN663	CP594	CP597	CP604	CP605	CP607	CP615	CP616	CP618	CP619	CP620	CP621	CP622	CP623	CP624	CP625	CP626	CP629	CP632	CP633	CP637
ACE-PSE																															
ace-pse								5																							
ado-mos										3											3								3		
all-pet																															
ALN-GLU																															
ane-nem				3				2	2			2		3			3										2				
ang-syl																															
ant-syl																															
aru-mac																															
ath-fil																3															
BET-PEN																															
ble-spi						3																				3		3			
bra-syl																															
BRYO					3							4		4			4														
cal-pal																															
car-ama																															
CAR-BET																															
scar-pen																															
car-rem																															
car-spp																															
car-syl																															
chr-opp																															
cir-lut																															
con-mac																															
con-maj																															
cor-ave													4	4													5				
cra-mon														4			5														
des-ces																															
dig-pur																															

Appendix 15 - Results for Gillfield Wood

Table 69.3 – Survey data for Gillfield wood – Quadrats, point records – part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																													
Species	CN626	CN627	CN630	CN631	CN632	CN637	CN638	CN639	CN640	CN641	CN663	CP594	CP597	CP604	CP605	CP607	CP615	CP616	CP618	CP619	CP620	CP621	CP622	CP623	CP624	CP625	CP626	CP629	CP632	CP633	CP637
dry-aff																									3						
dry-car																															
dry-dil					5																										
dry-fil																	5														
epi-hir																															
epi-mon																															
equ-arv																															
equ-syl																								3							
FAG-SYL																															
fag-syl																															
fil-ulm																															
FRA-EXC																															
fra-exc																															
gal-apa																															
gal-odo	3	3		3														3	3	3			3				4				
ger-rob					3			5	4								5														
geu-urb																															
hed-hel								4				4		4													4				
her-sph																															
hol-mol			4		2								3	3			4										4				3
hya-non			2					3	3		1	3	3	3			2										3				2
hyp-spp																															
Ile-Aqu														5													4				
lam-gal								3	4			5					4										4				5
LAR-KAE																															
LITTER			4		2			2	3		2	4	3	5			4										4				3
lon-per																															
luz-pil																															
luz-syl							3																								

Table 69.3 – Survey data for Gillfield wood – Quadrats, point records – part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																														
Species	CN626	CN627	CN630	CN631	CN632	CN637	CN638	CN639	CN640	CN641	CN663	CP594	CP597	CP604	CP605	CP607	CP615	CP616	CP618	CP619	CP620	CP621	CP622	CP623	CP624	CP625	CP626	CP629	CP632	CP633	CP637
lys-nem																															
mel-uni																															
mer-per												2															5				
mil-eff																															
myo-spp																															
oxa-ace					4										3																
pha-aru																															
phy-sco																															
poa-nem																															
pol-set																						3								3	
pru-spi																															
pte-aqu																	5														
QUE-ROB																															
que-rob																															
ran-rep																															
ran-fic								3	4																		3				
ros-arv																															
rib-nig																															
rib-uva																															
rho-pon																															
rub-fru			5		4				5			4		4			4										5				3
rum-obt																															
rum-san																															
Sam-Nig																															
san-eur																		3									5				
SOR-AUC																															
sor-auc																															
sta-syl																															
ste-hol					4			5	4								3														

Table 69.3 – Survey data for Gillfield wood – Quadrats, point records – part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																													
Species	CN626	CN627	CN630	CN631	CN632	CN637	CN638	CN639	CN640	CN641	CN663	CP594	CP597	CP604	CP605	CP607	CP615	CP616	CP618	CP619	CP620	CP621	CP622	CP623	CP624	CP625	CP626	CP629	CP632	CP633	CP637
sym-riv																															
tar-off																															
ulm-gla																															
urt-dio																															
val-off																															
ver-cha																															
ver-mon								4									4														
ver-bec																															
vic-sep																															
vio-riv																											5				

Appendix 16 - Results for Gunter Wood

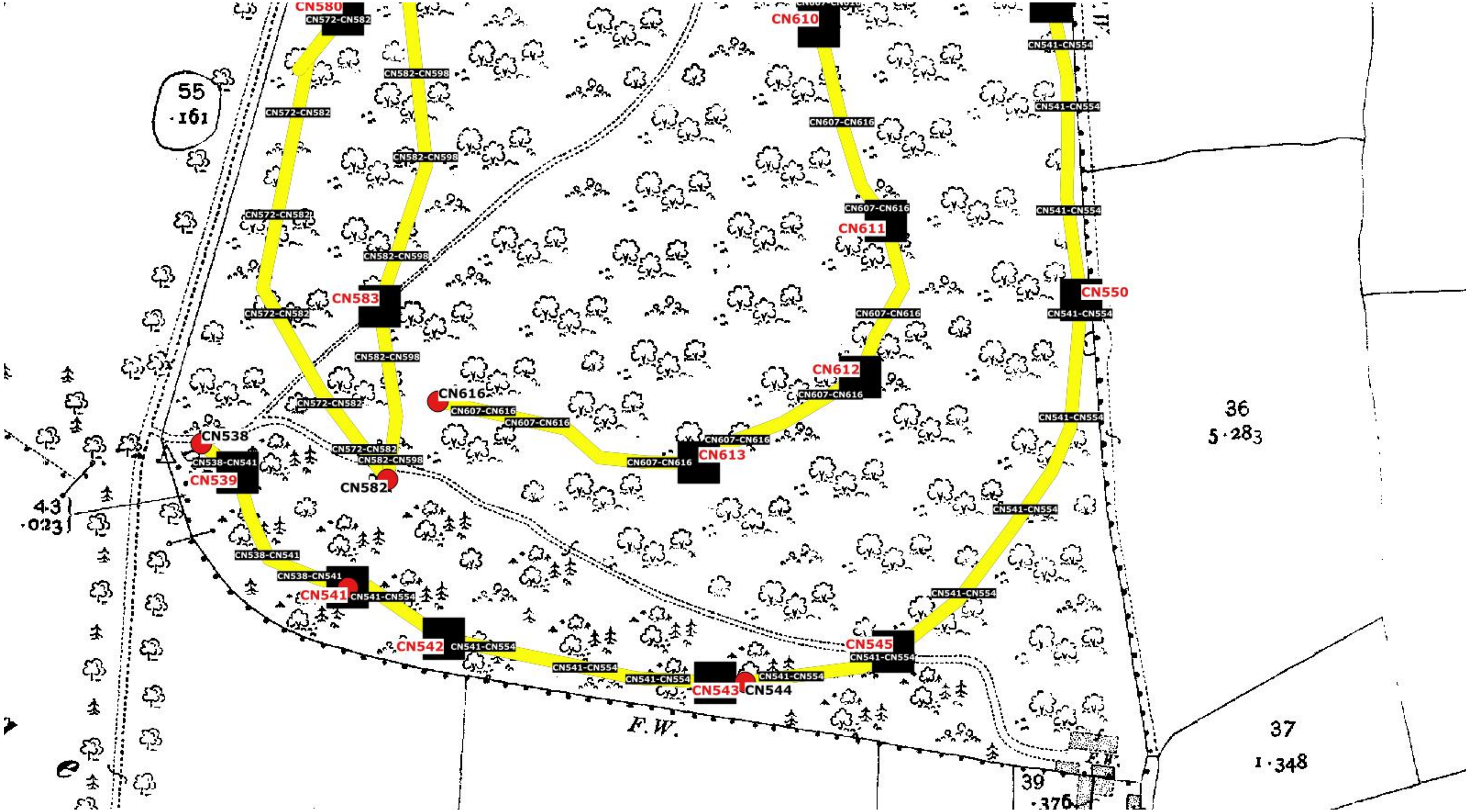


Figure 1.1 – Map showing transects and quadrats for Gunter Wood – part 01

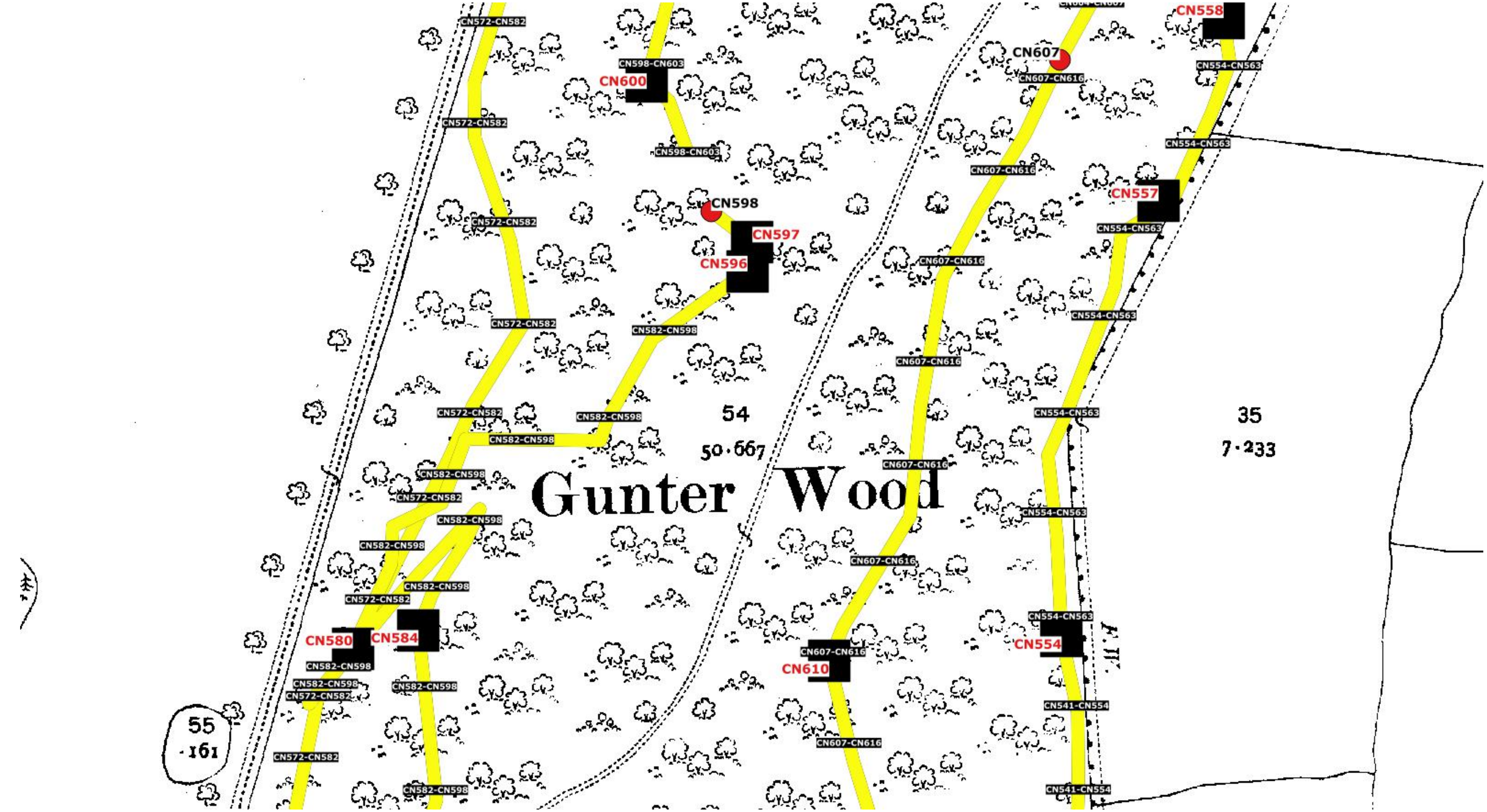


Figure 2.2 - Map showing transects and quadrats for Gunter Wood – part 02

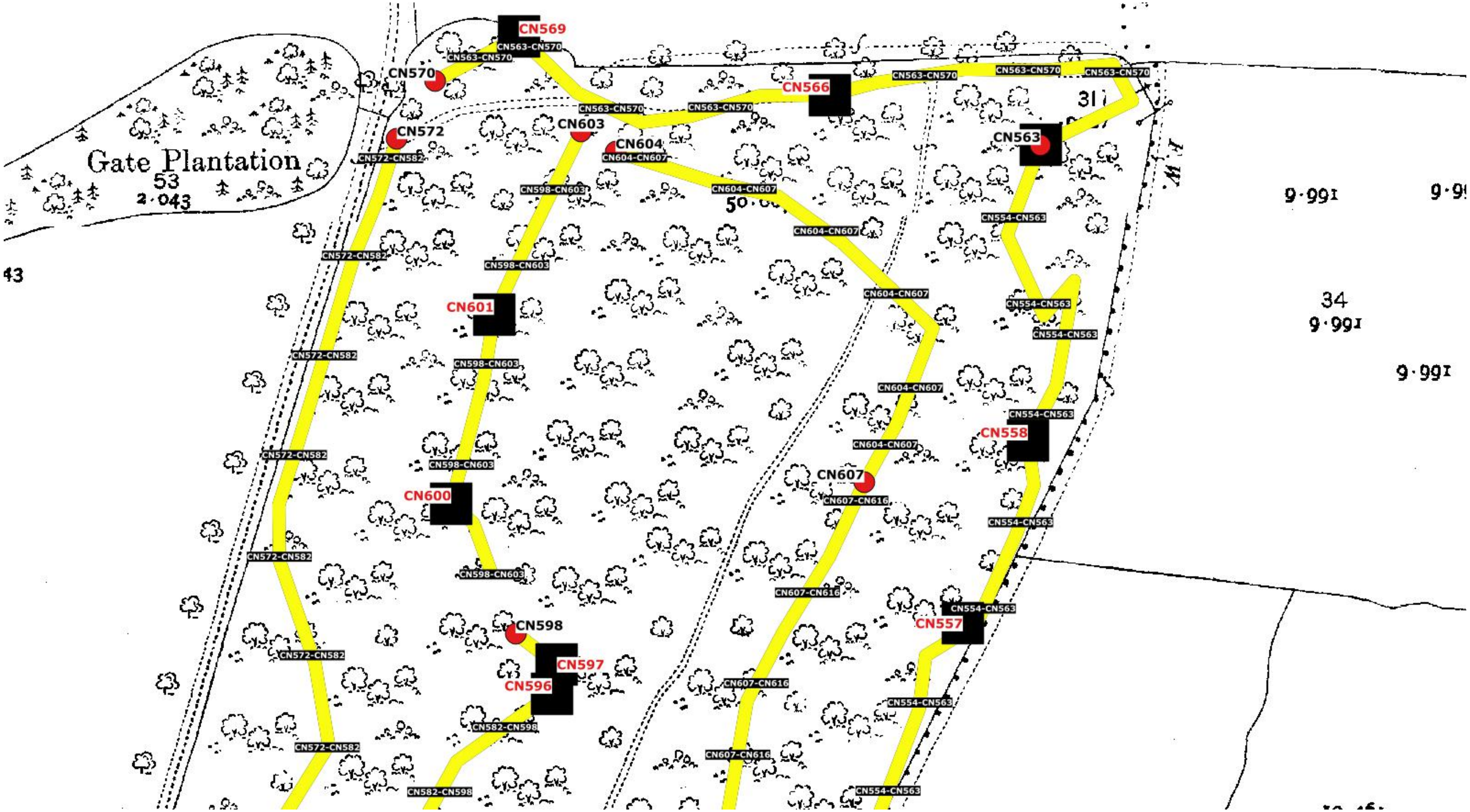


Figure 3.3 - Map showing transects and quadrats for Gunter Wood – part 03

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

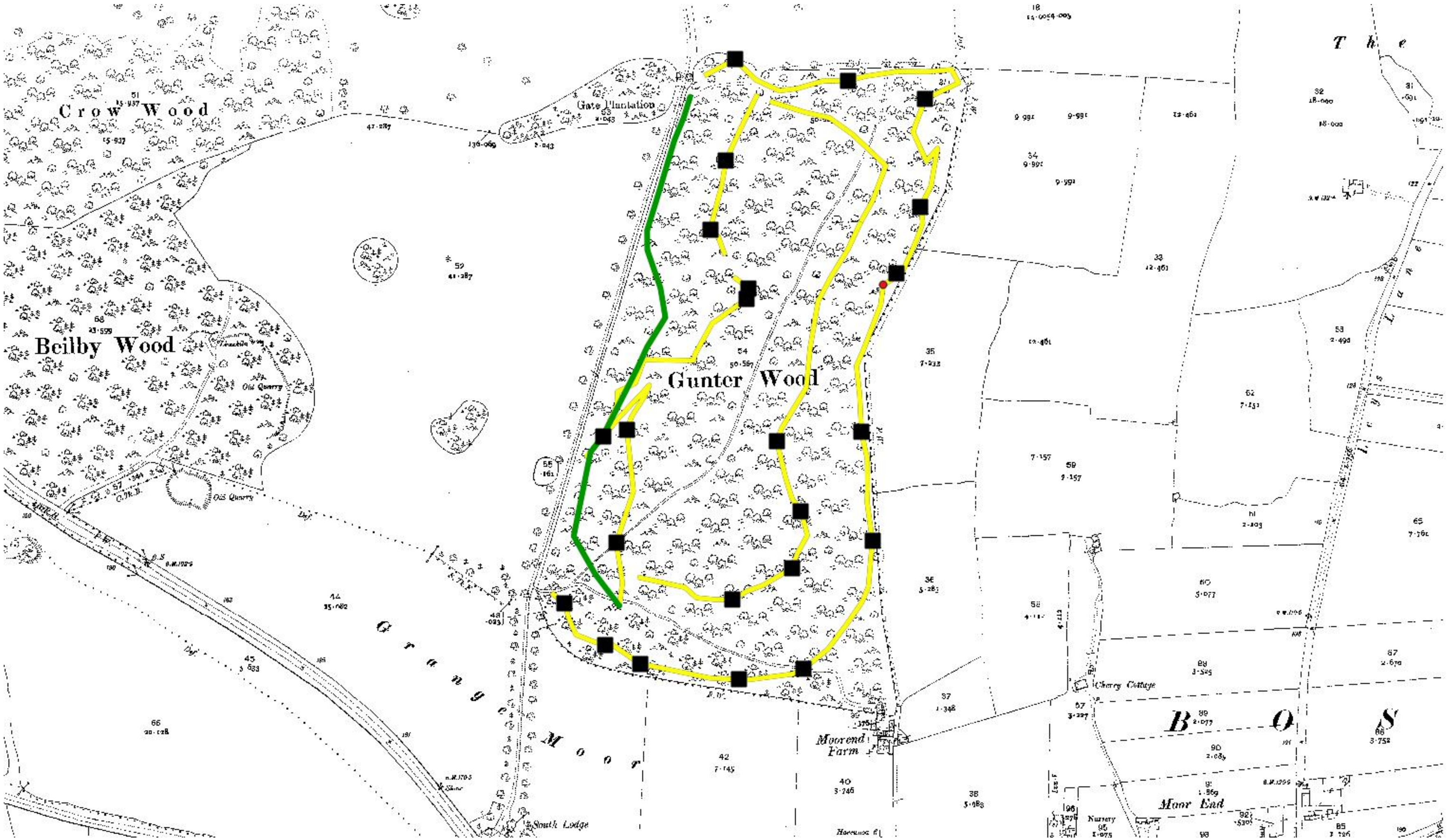


Figure 4.4 – *Ajuga reptans*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

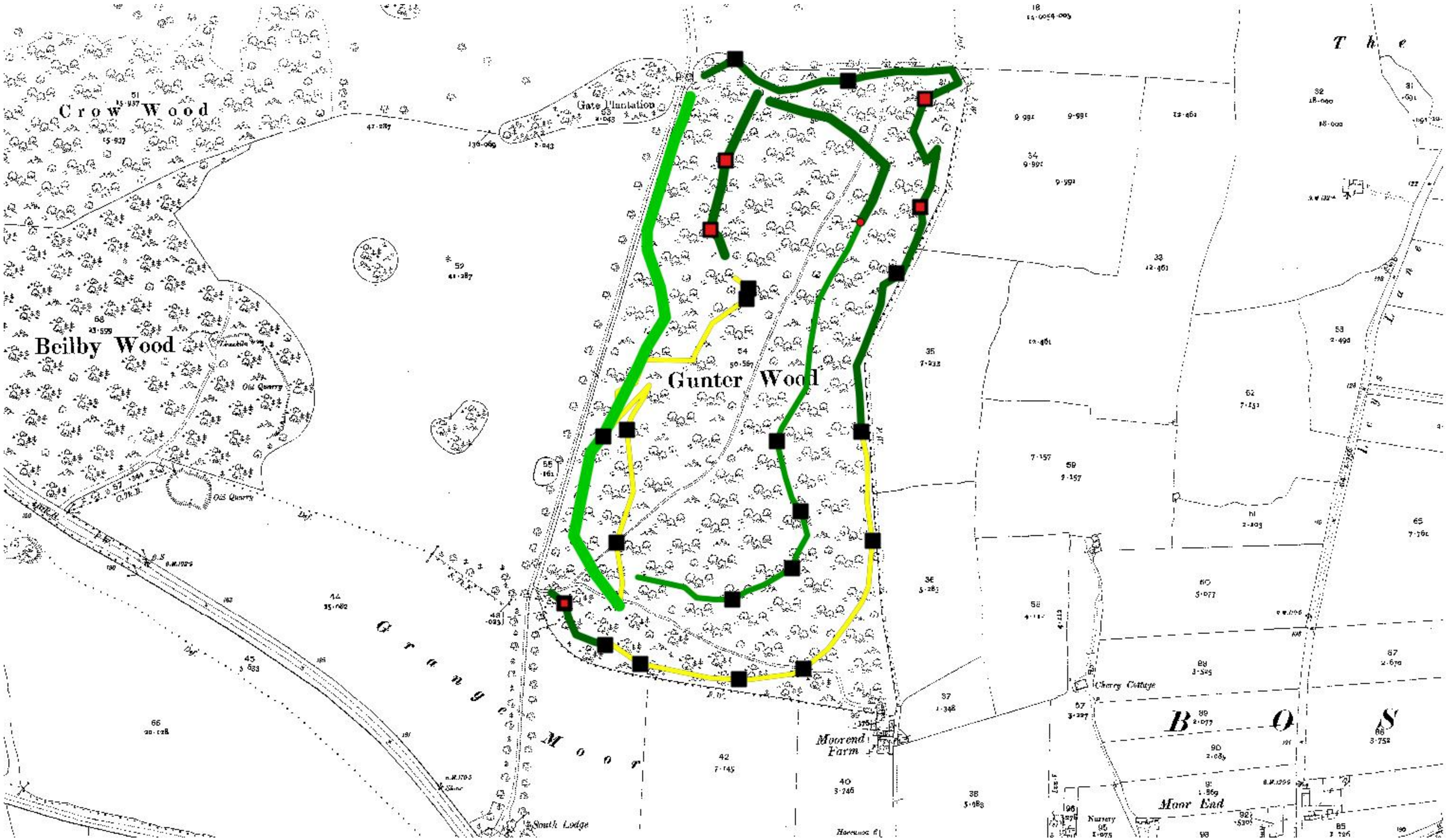


Figure 5.5 – *Allium ursinum*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

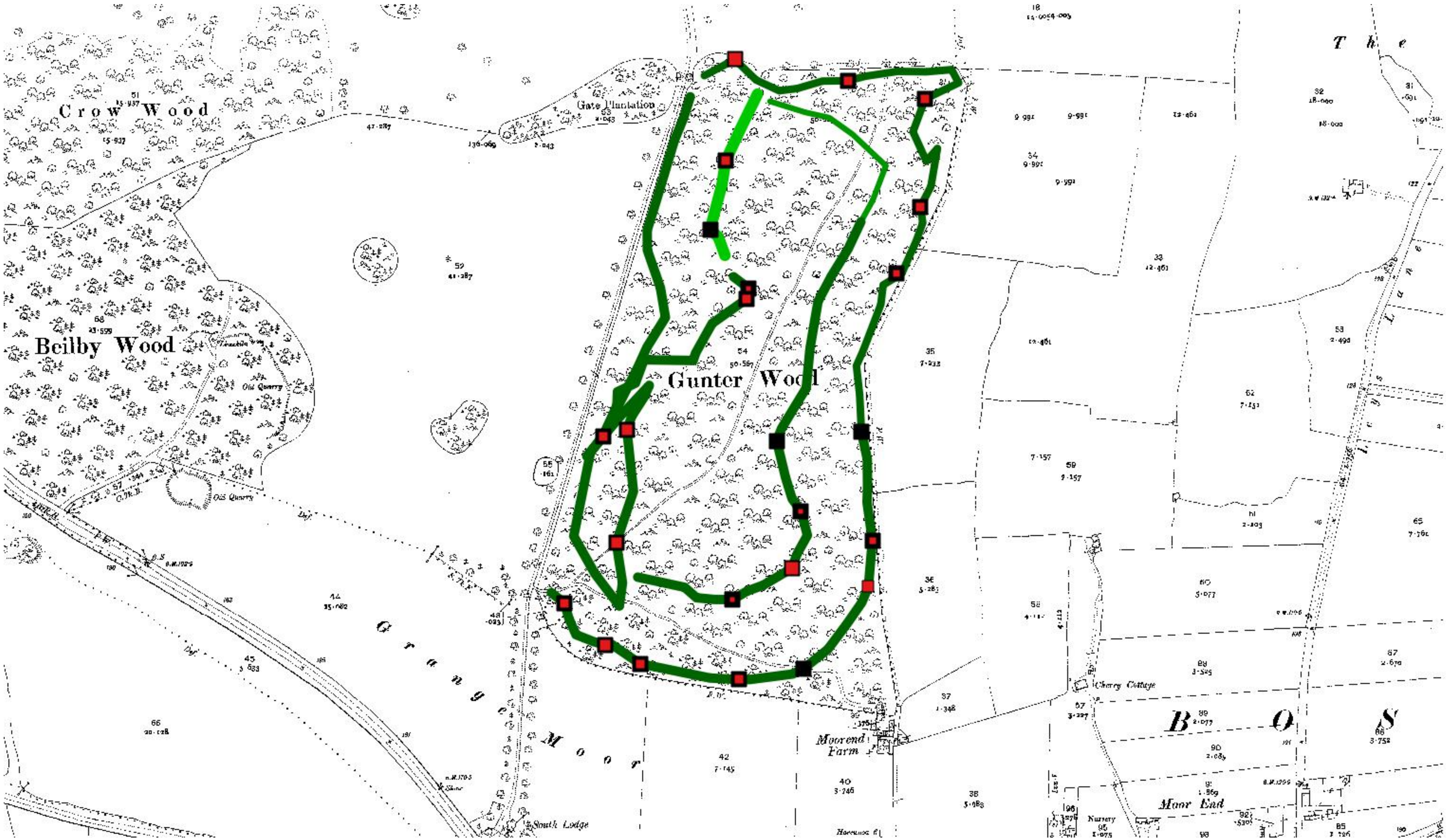


Figure 6.6– *Anemone nemorosa*

Species maps for Gunter wood

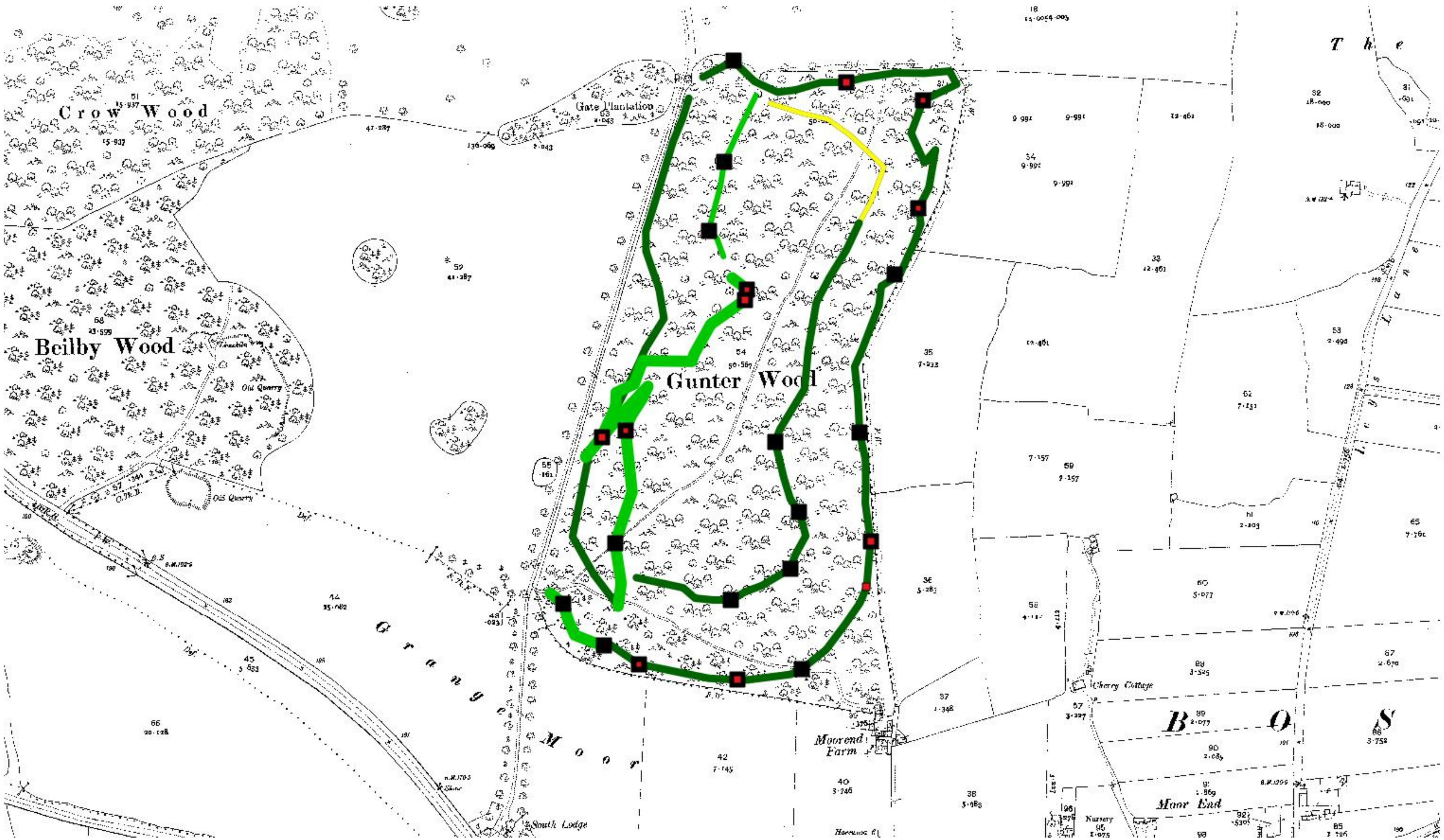


Figure 7.7 – *Arum maculatum*

Species maps for Gunter wood

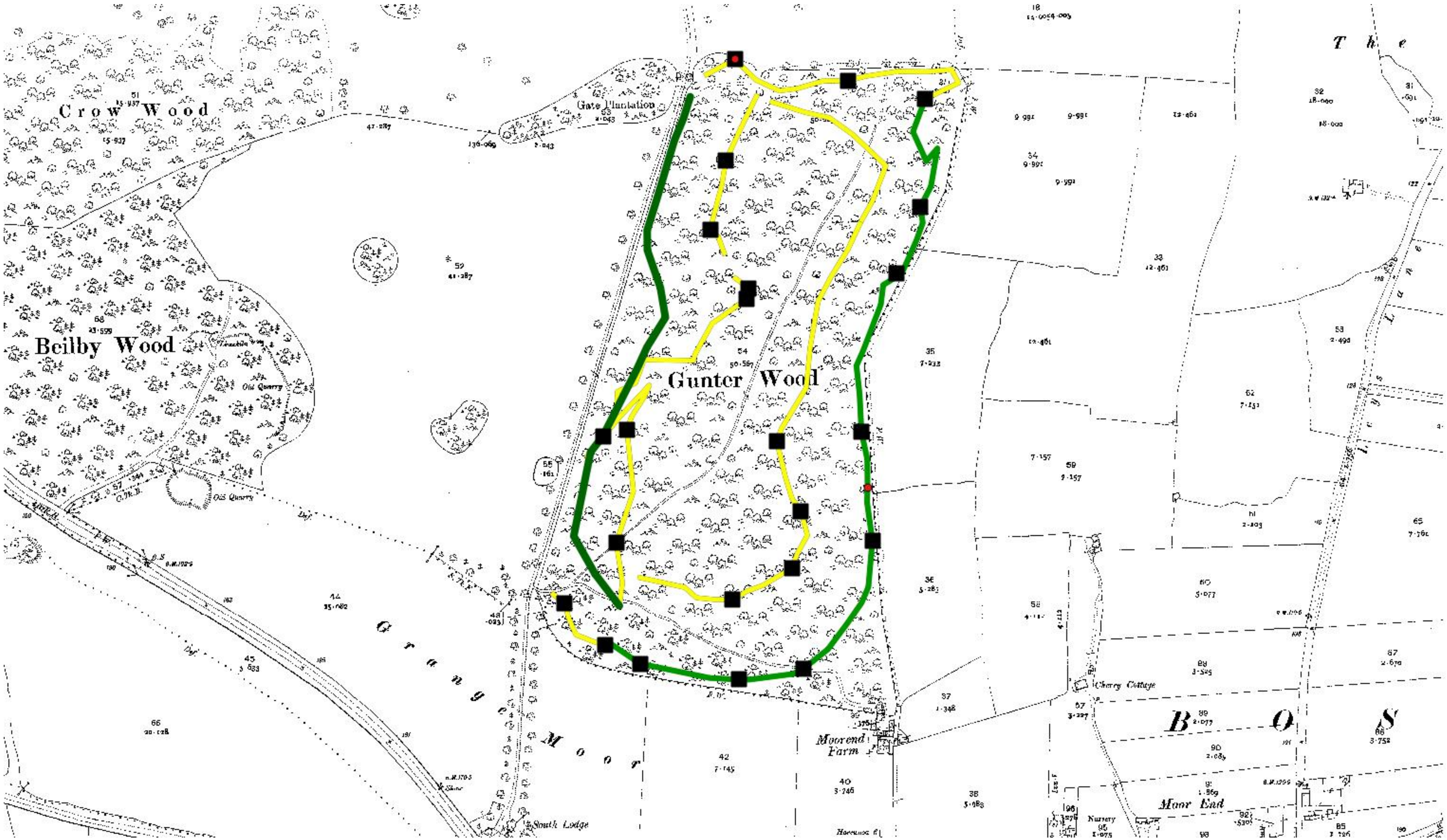
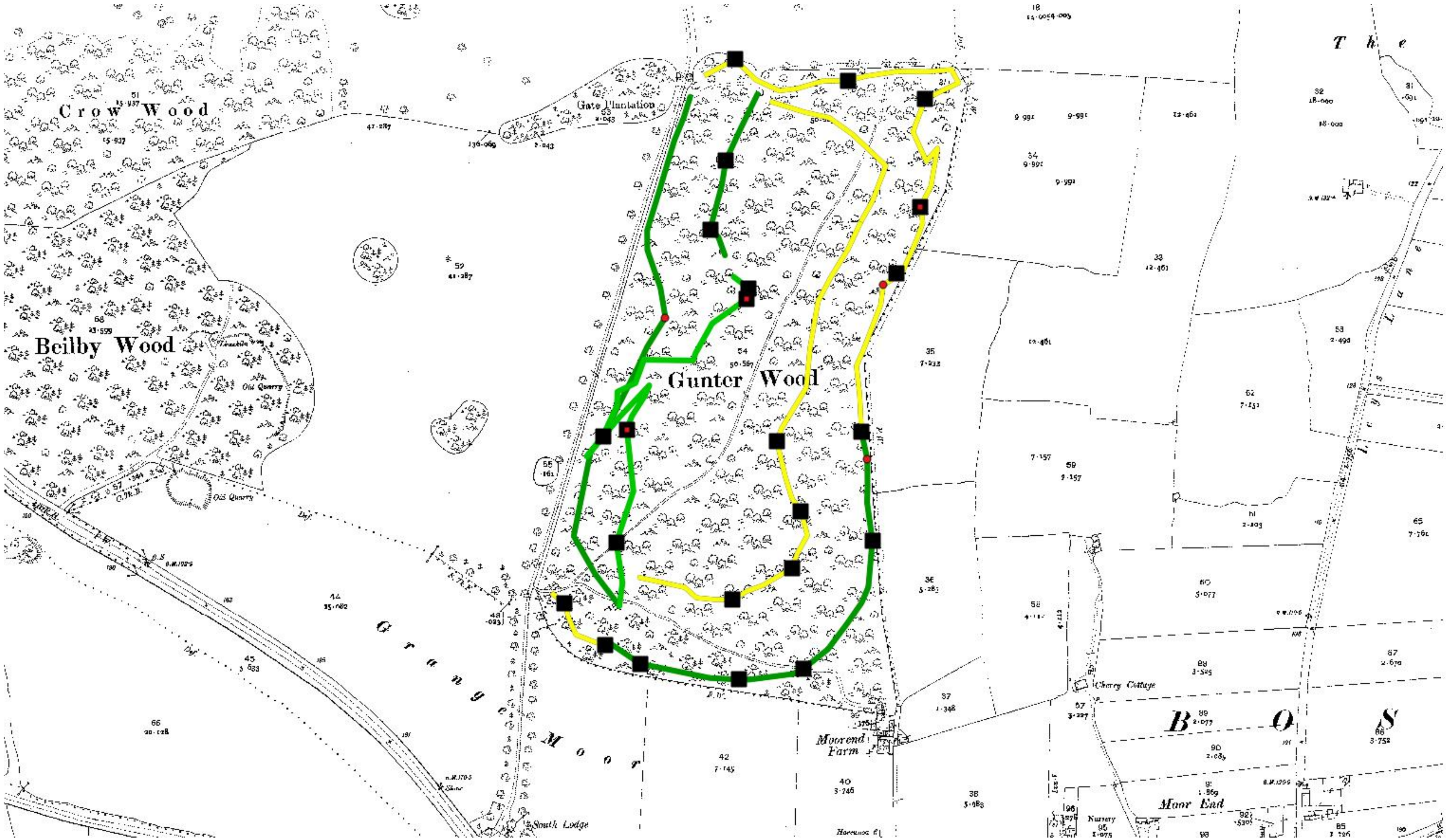


Figure 8.8– *Brachypodium sylvaticum*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood
 Figure 9.9– *Carex sylvatica*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

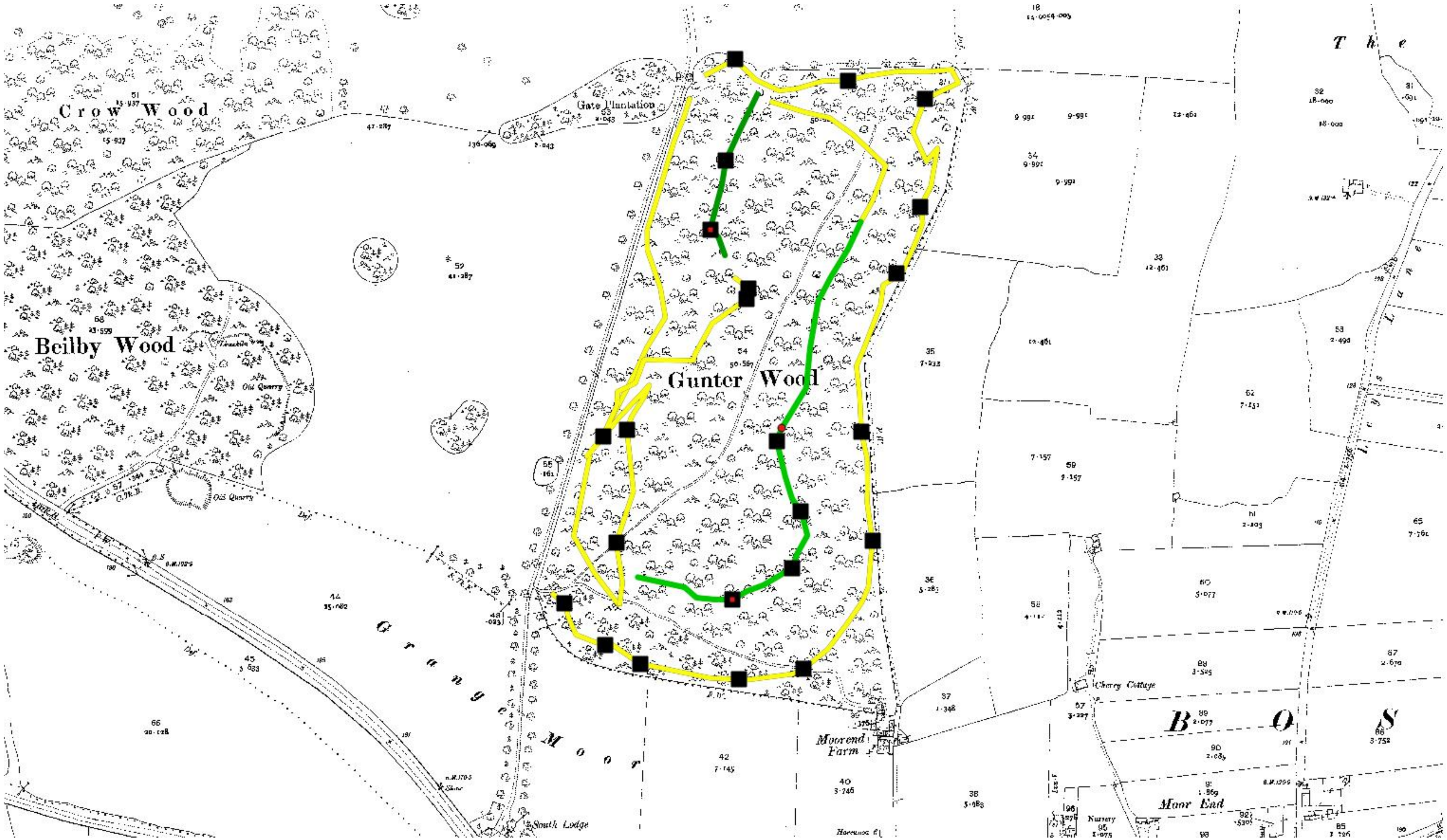


Figure 10.10– *Circaea lutetiana*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

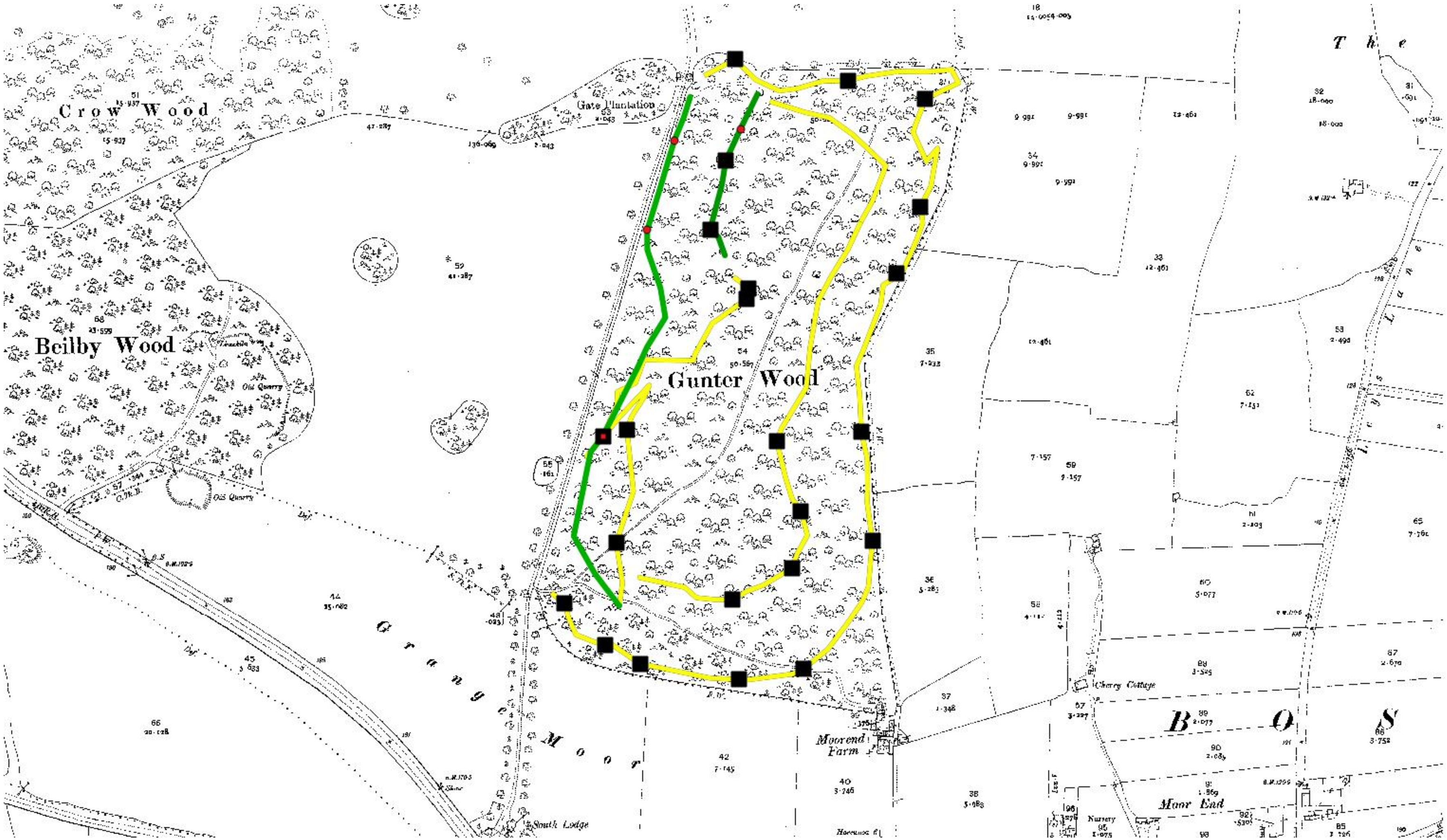


Figure 11.11 – *Conopodium majus*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

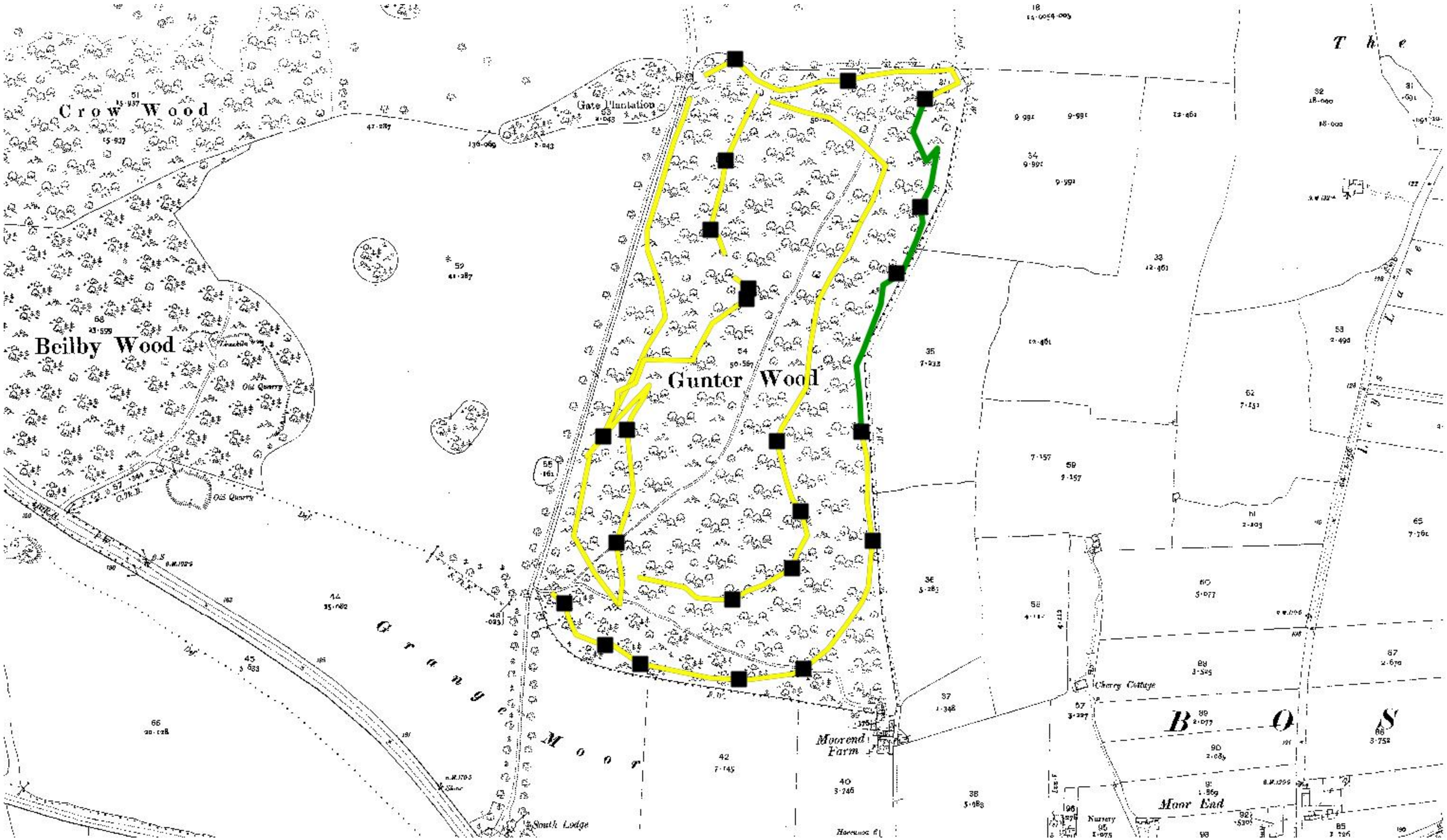



Figure 12.12– *Corylus avellana*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

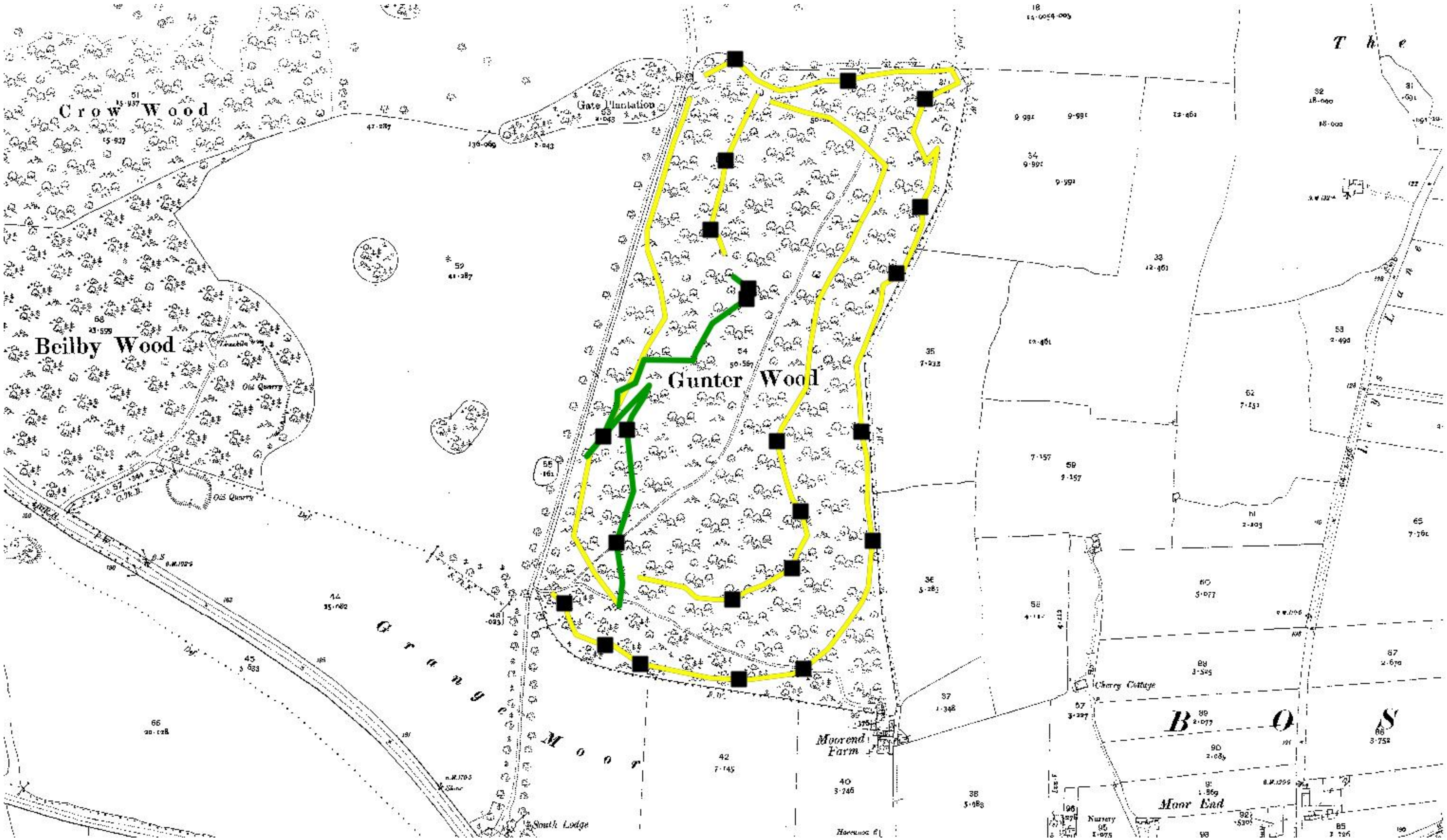


Figure 13.13 – *Dryopteris affinis*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

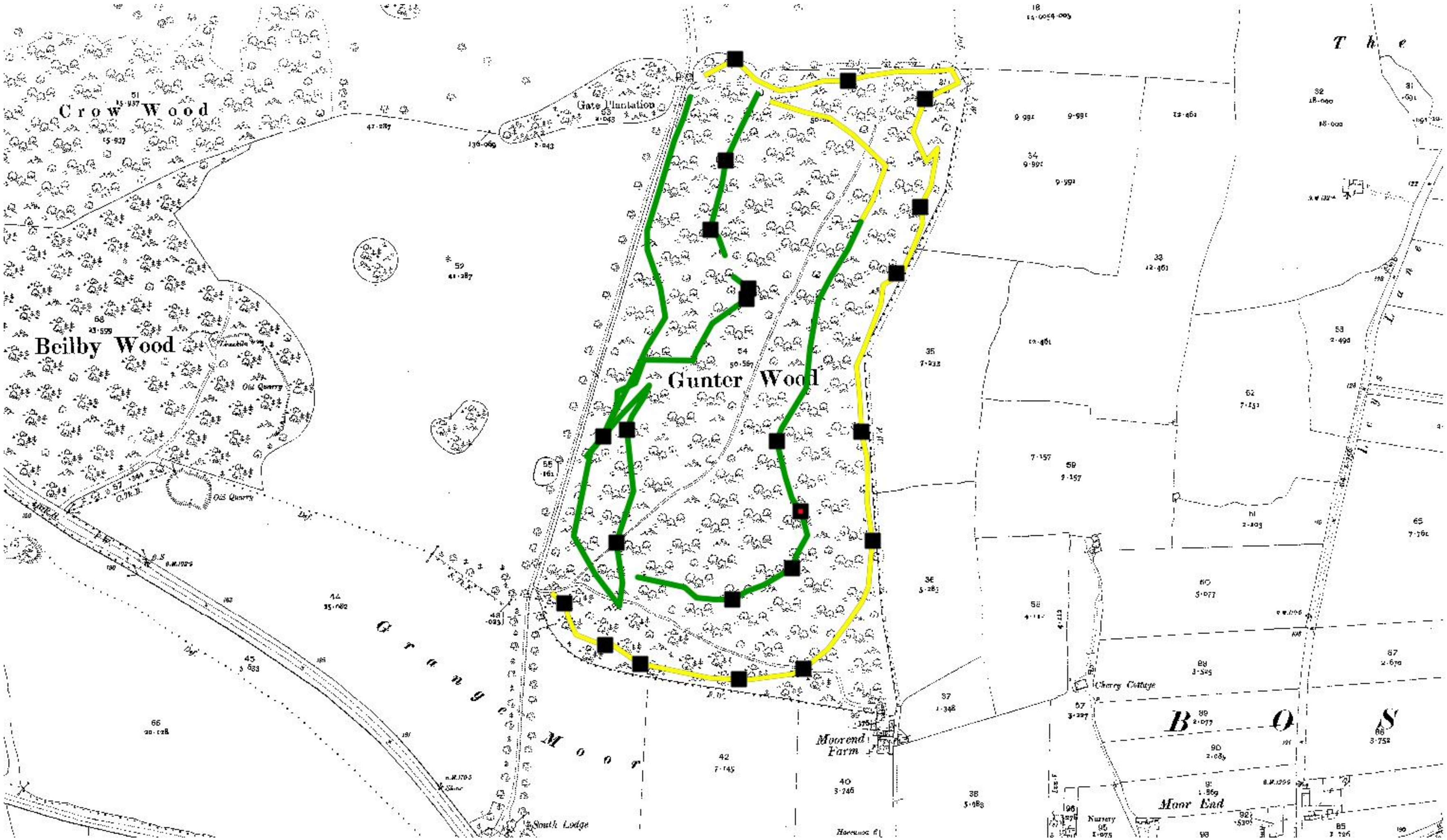


Figure 14.14 – *Dryopteris filix-mas*

Species maps for Gunter wood

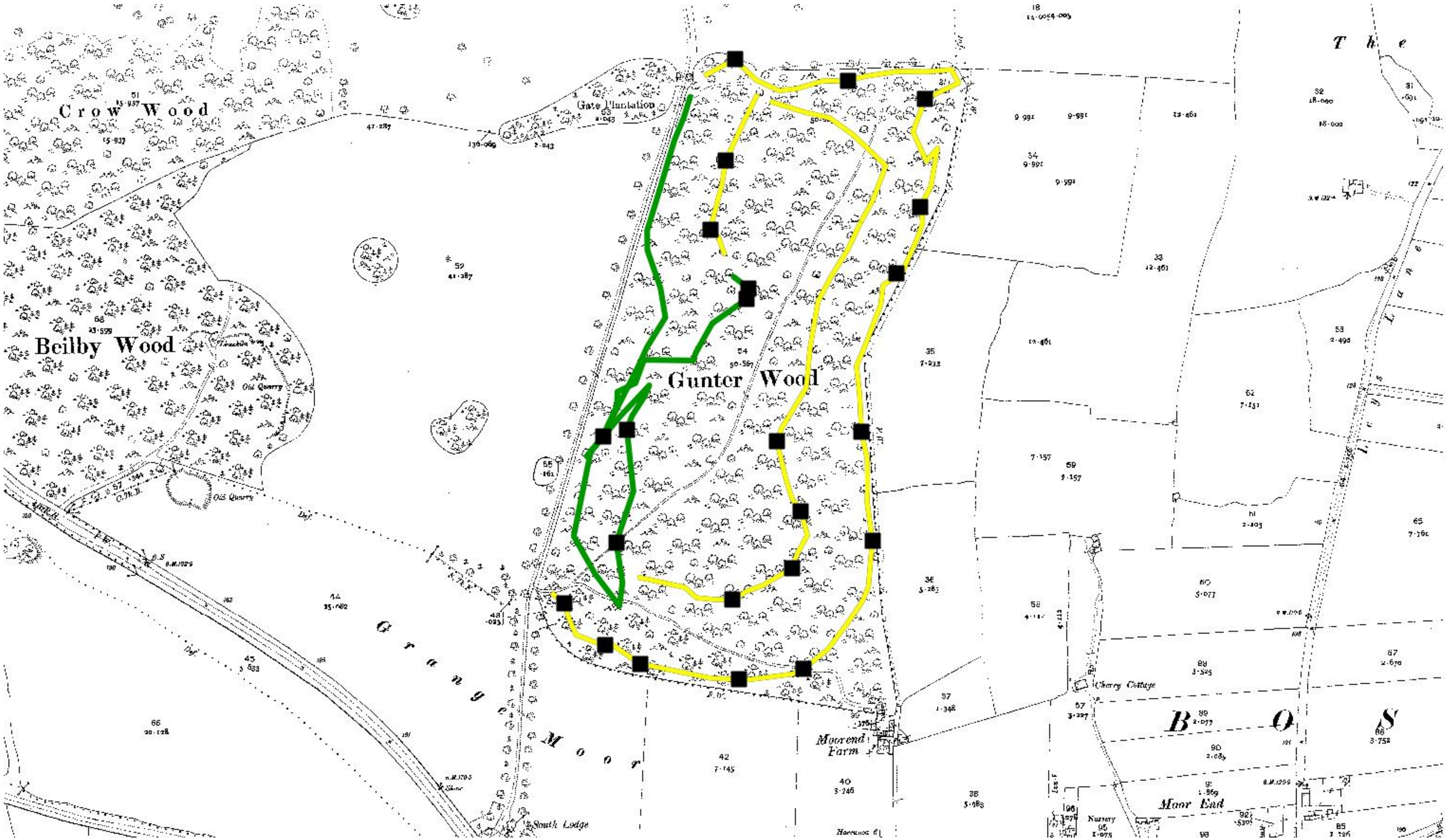


Figure 15.15 – *Geranium robertianum*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

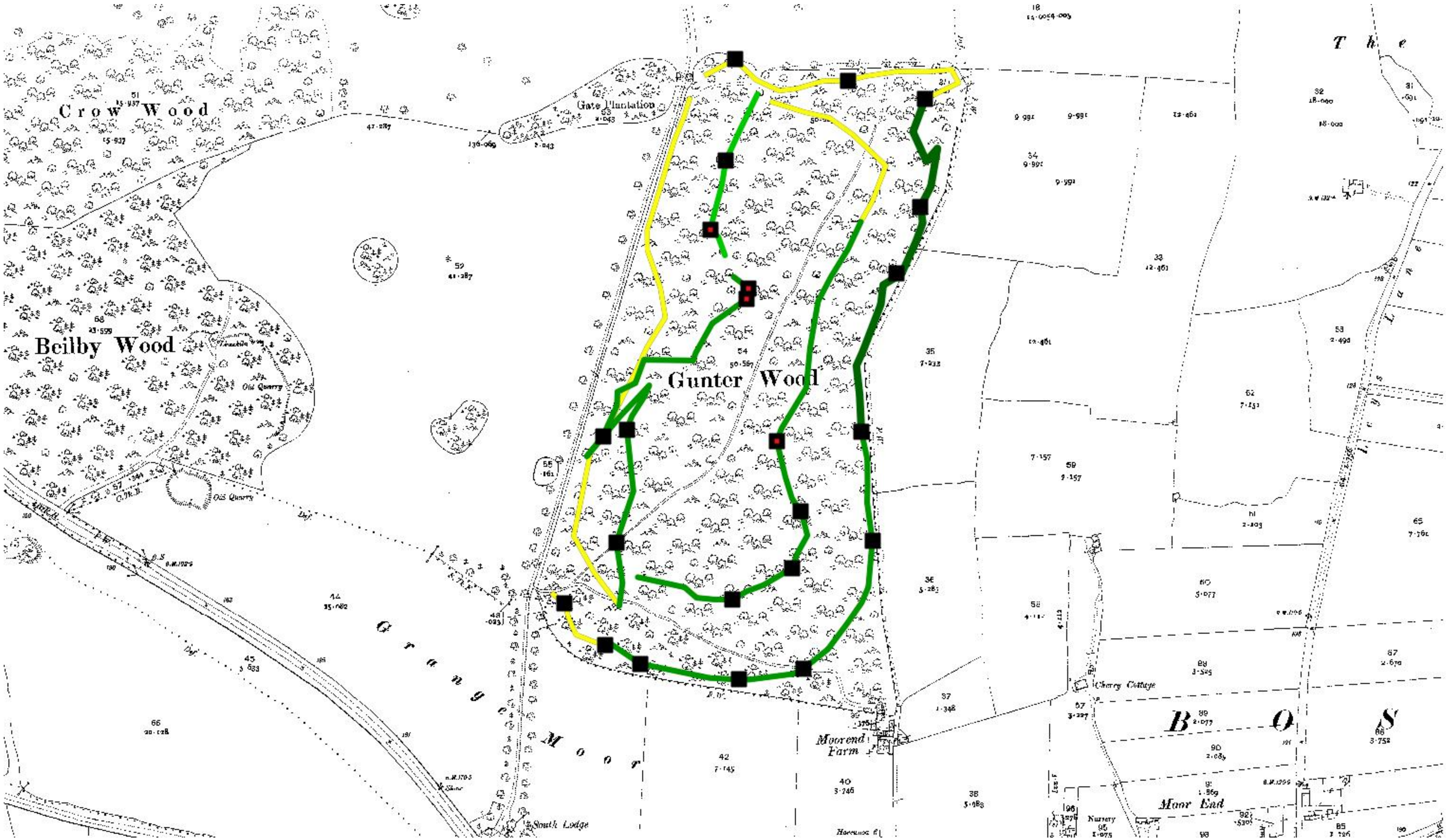


Figure 16.16 – *Geum urbanum*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

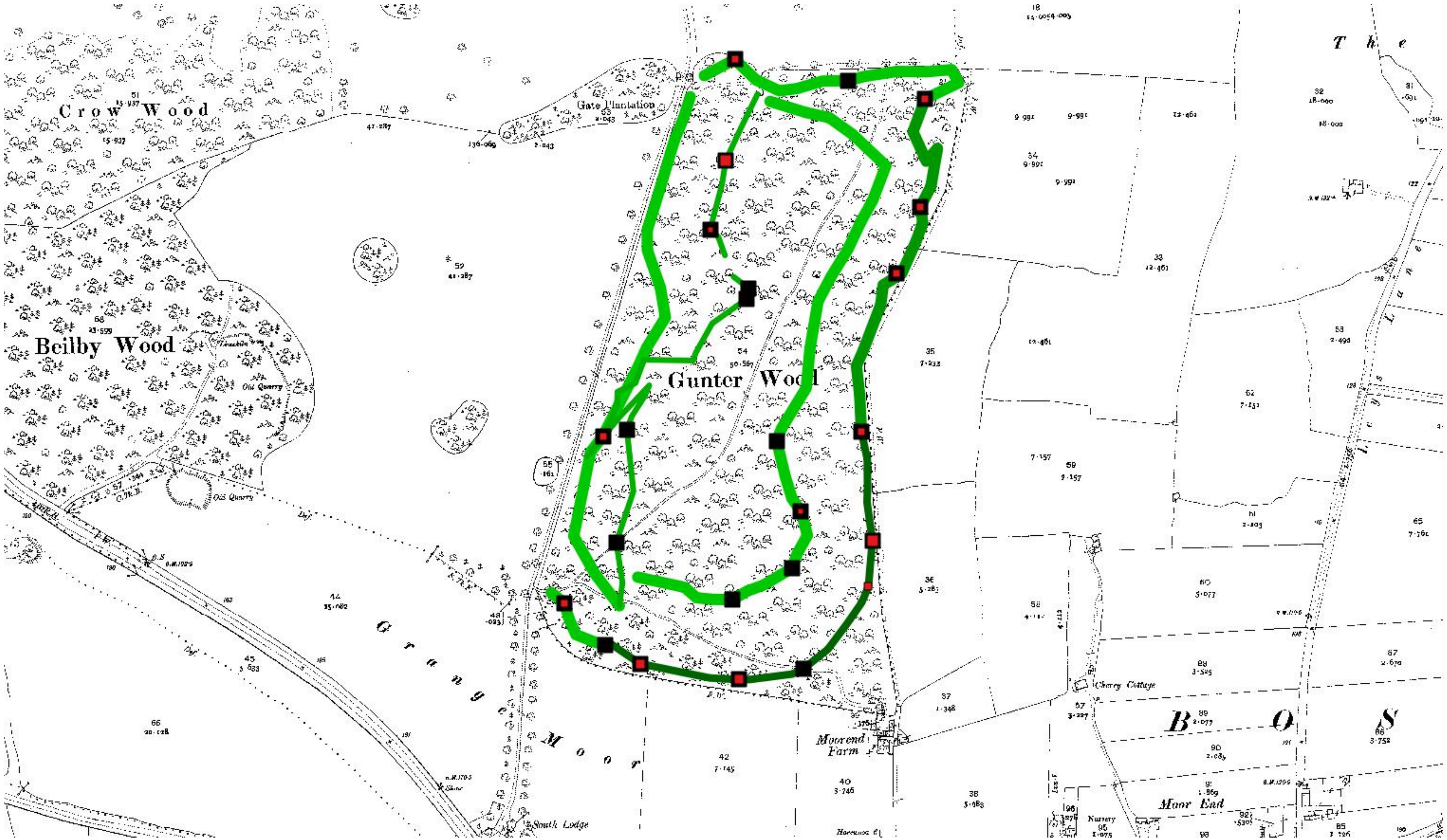


Figure 17.17– *Hyacinthoides non-scripta*

Species maps for Gunter wood

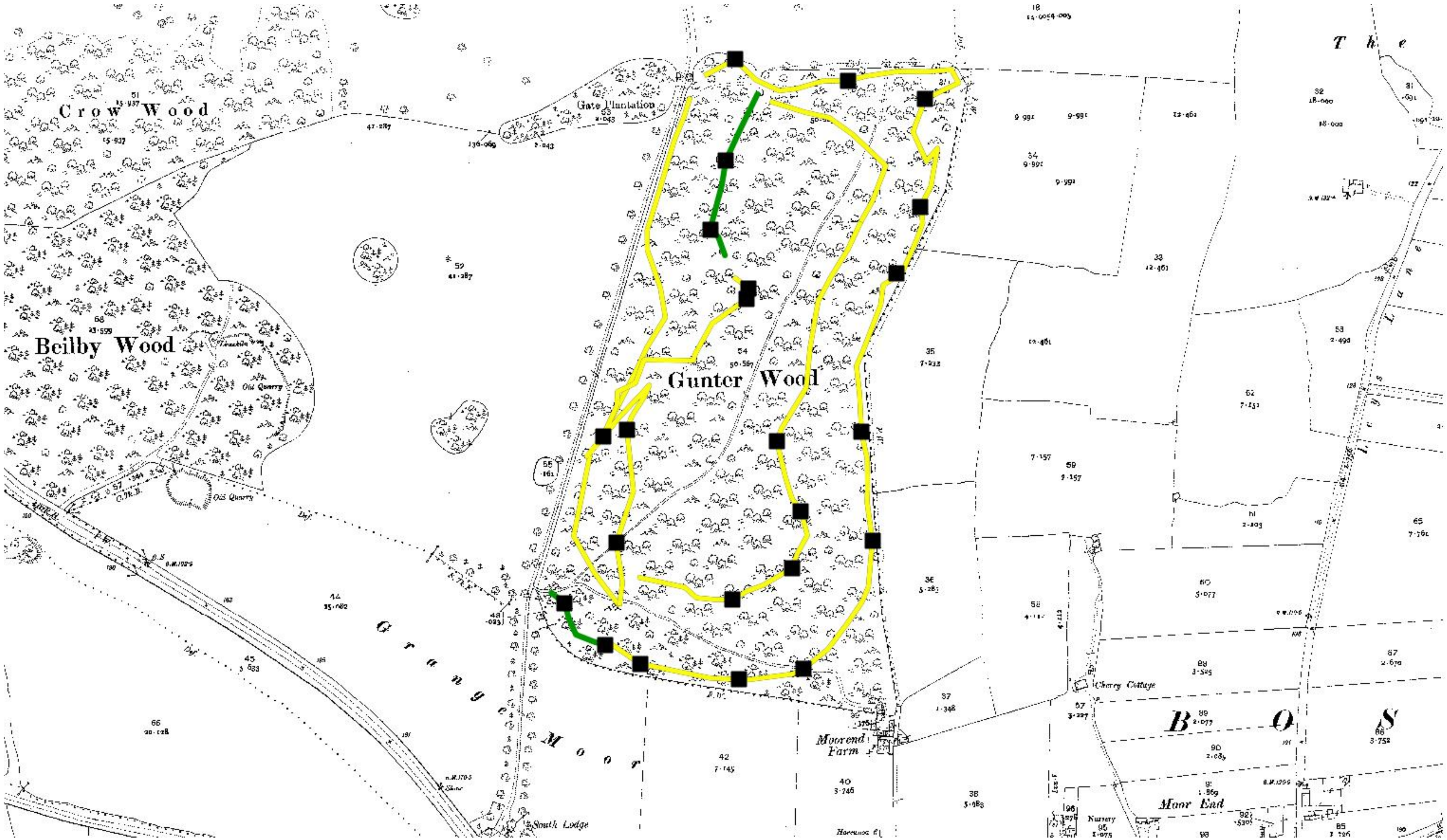



Figure 18.18 – *Ilex aquifolium*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

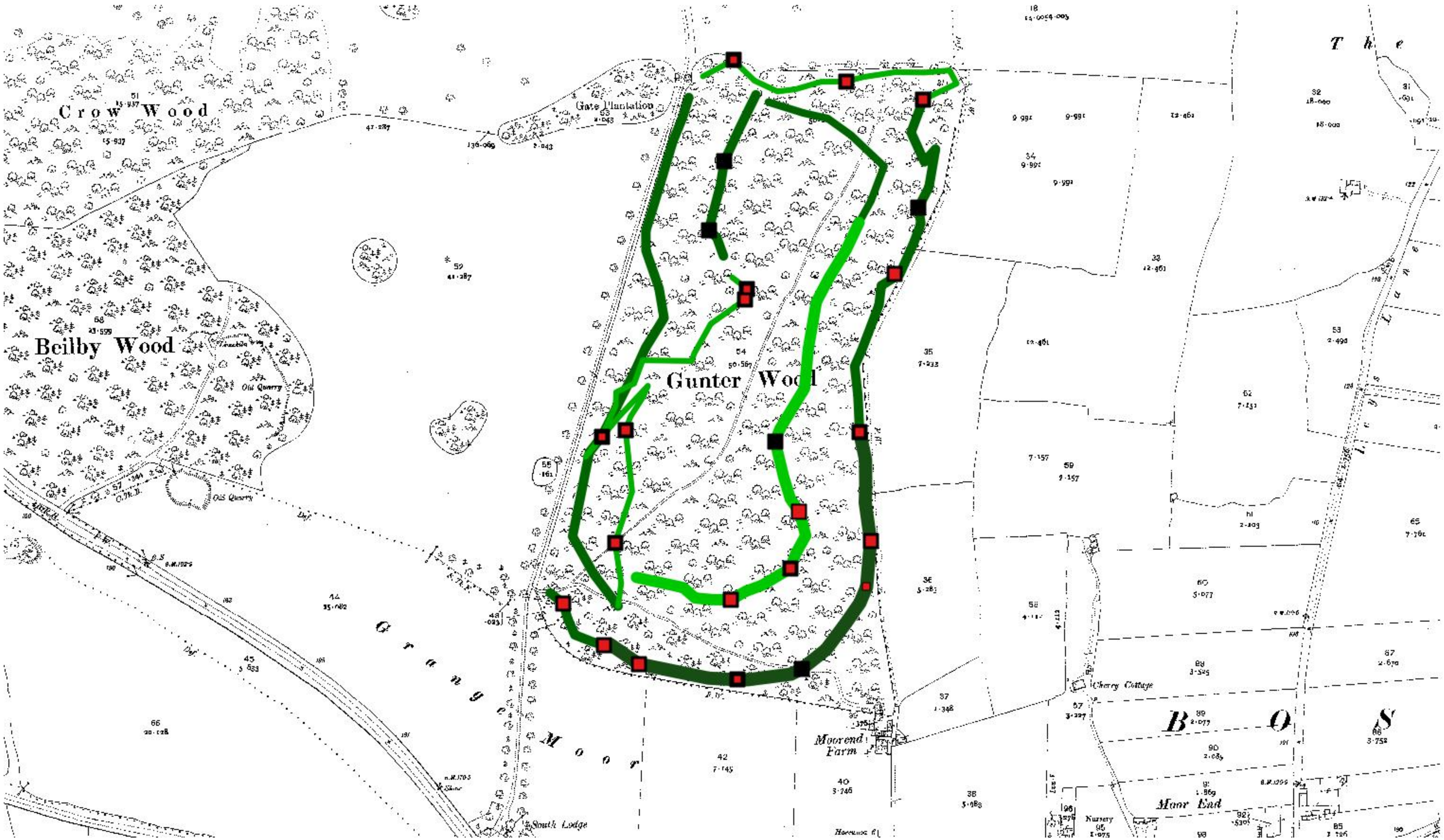


Figure 19.19 – *Mercurialis perennis*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

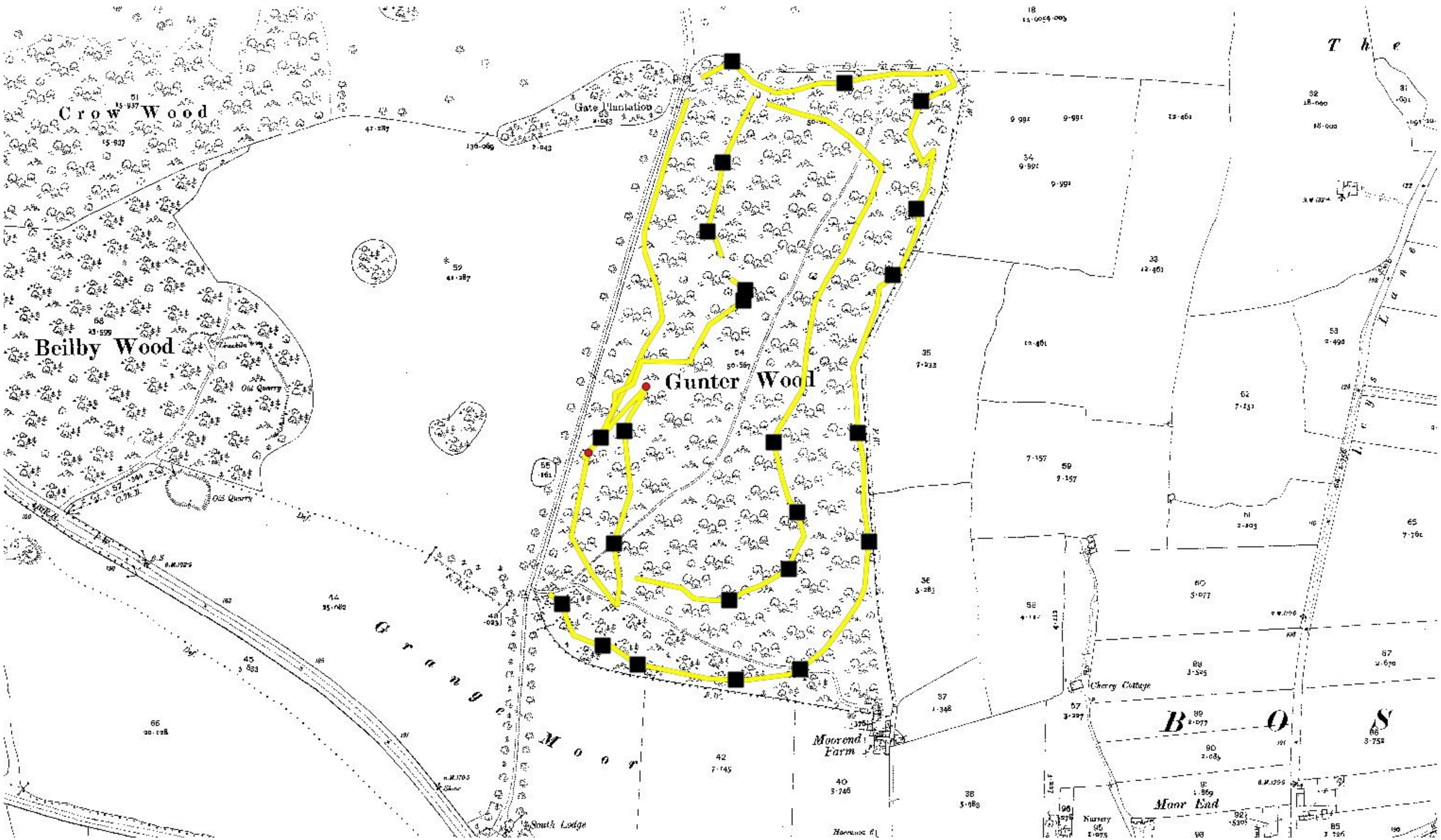


Figure 20.20 – *Orchis mascula*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

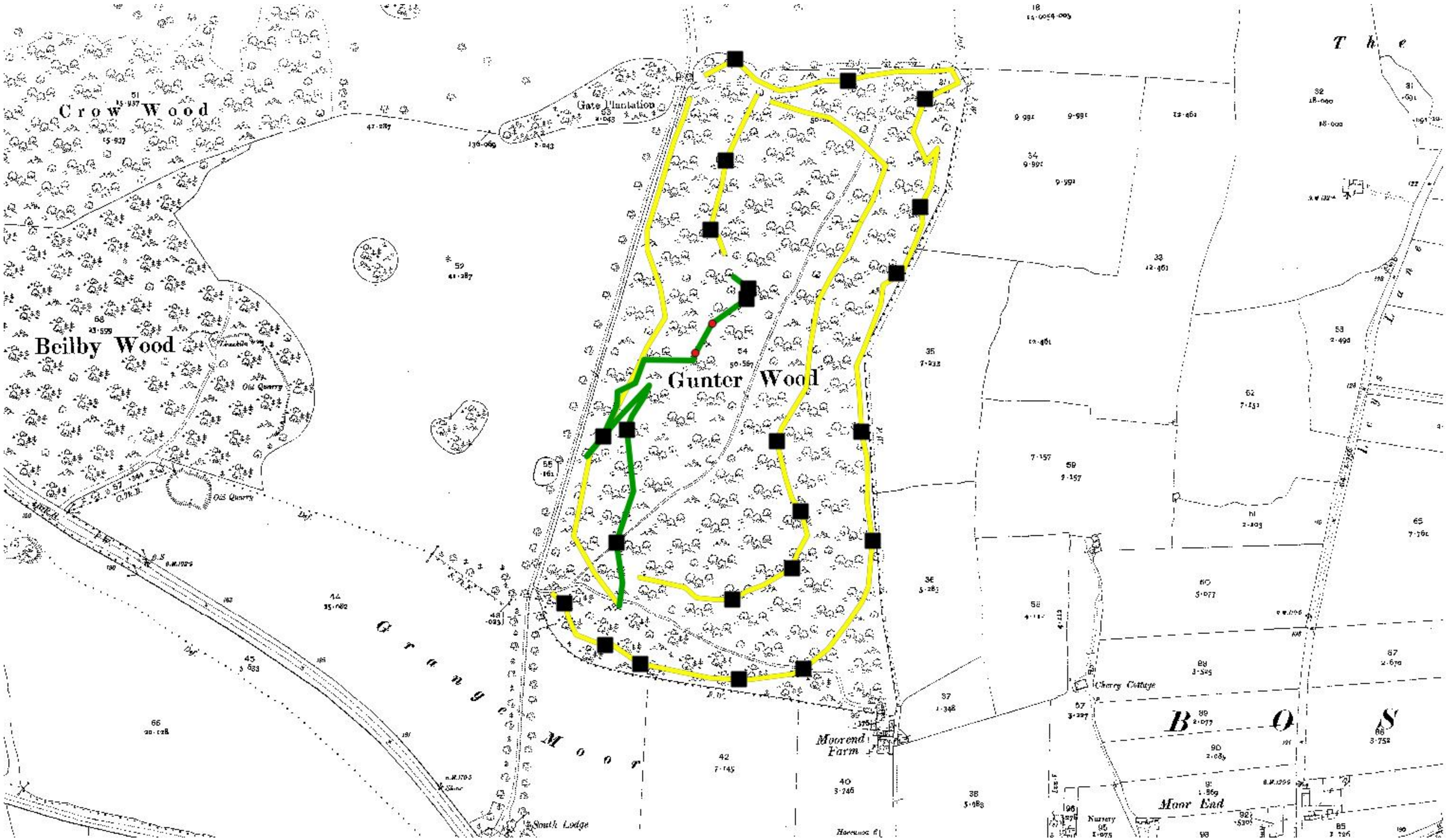


Figure 21.21 – *Oxalis acetosella*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

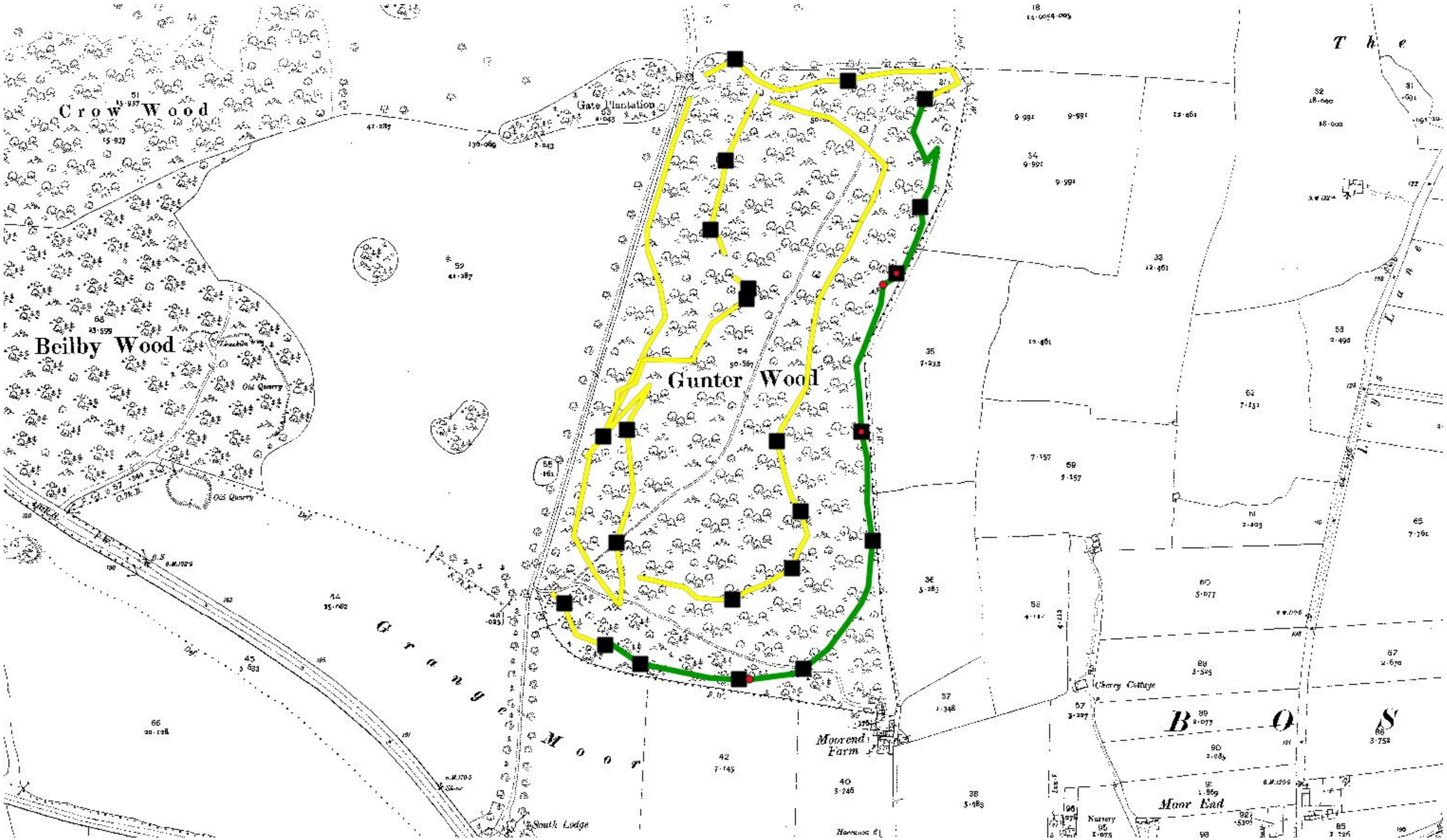


Figure 22.22 – *Primula vulgaris*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

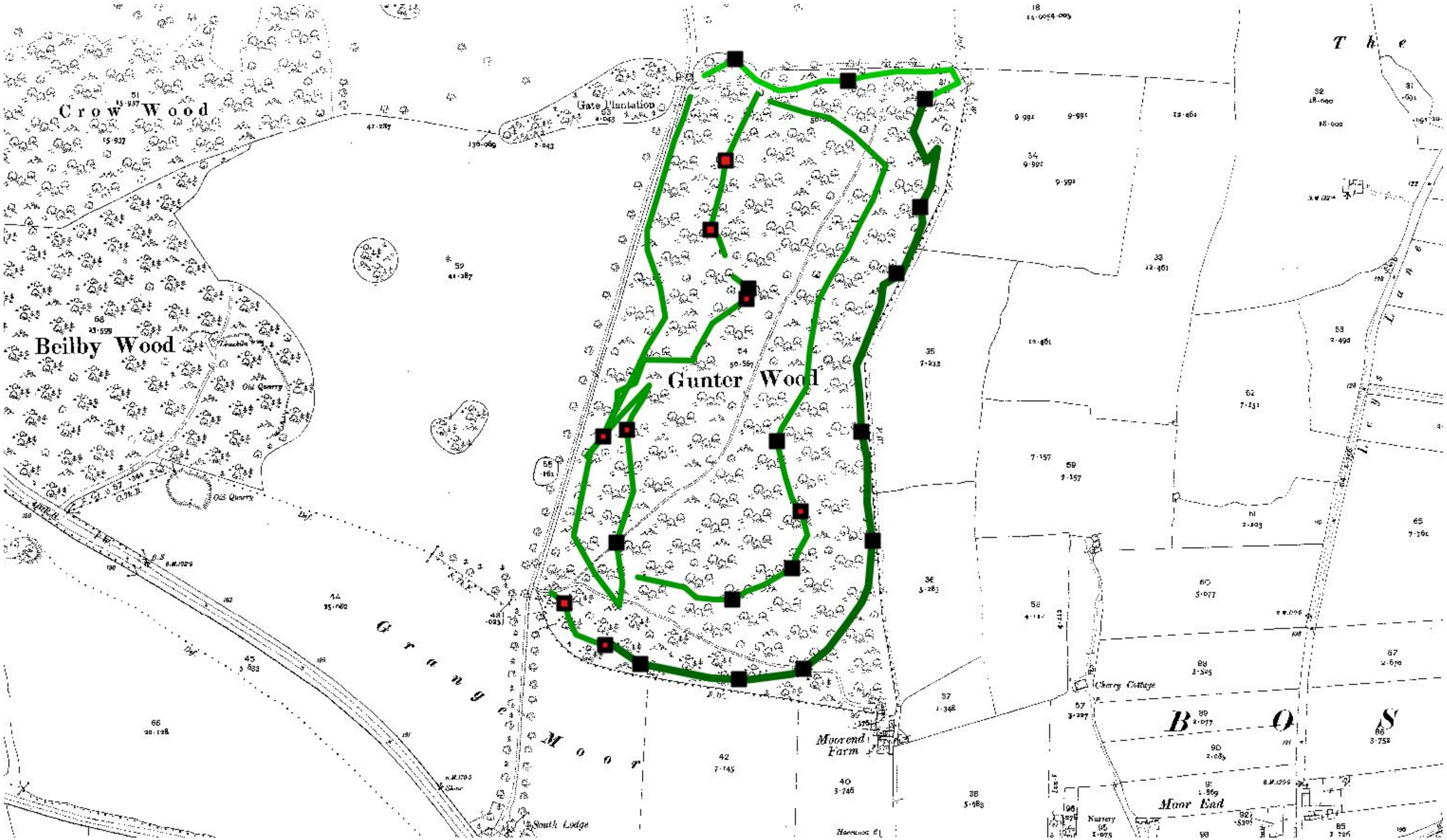


Figure 23.23 – *Ranunculus ficaria*

Species maps for Gunter wood

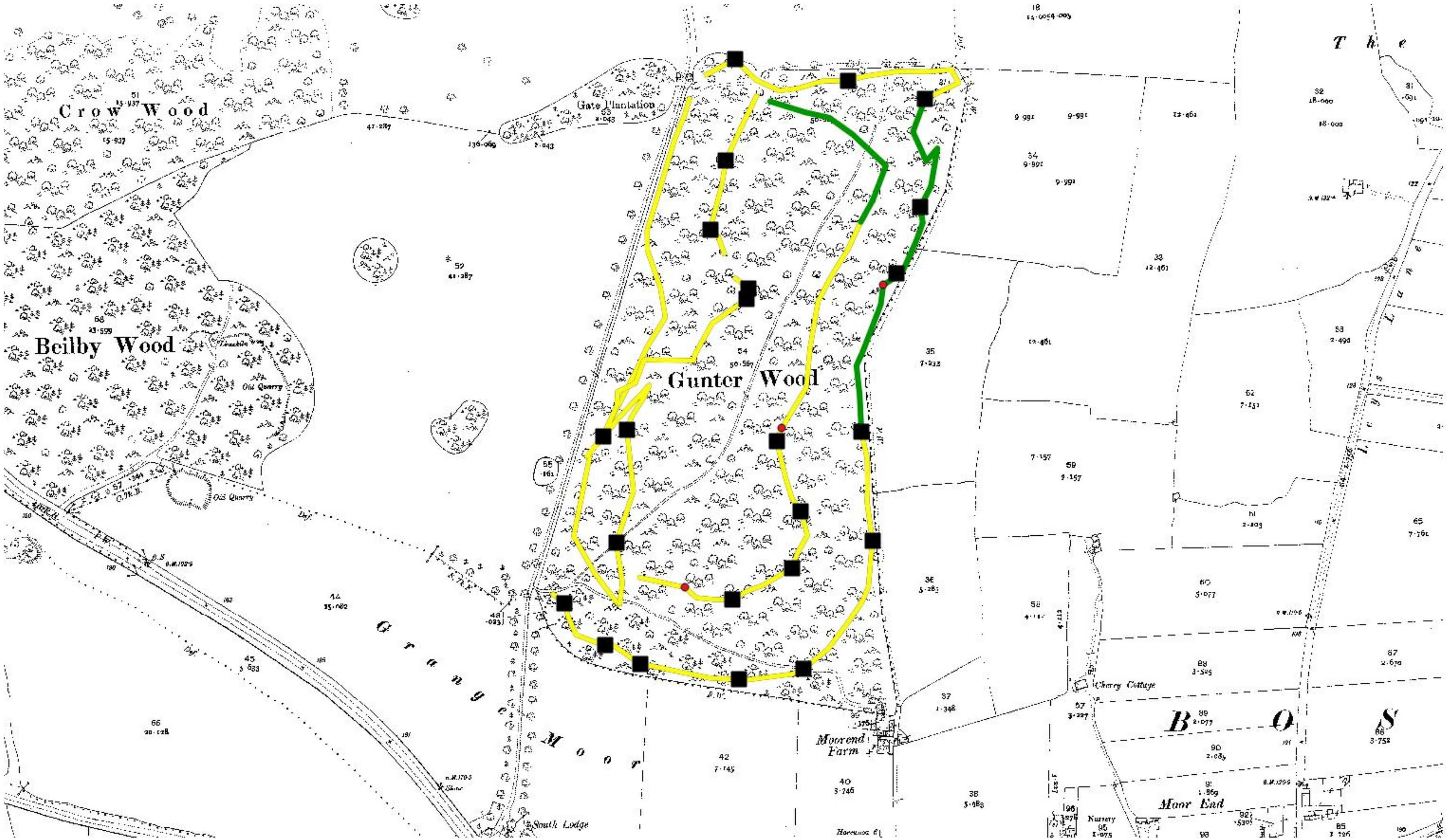


Figure 24.24 – *Ribes nigrum*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

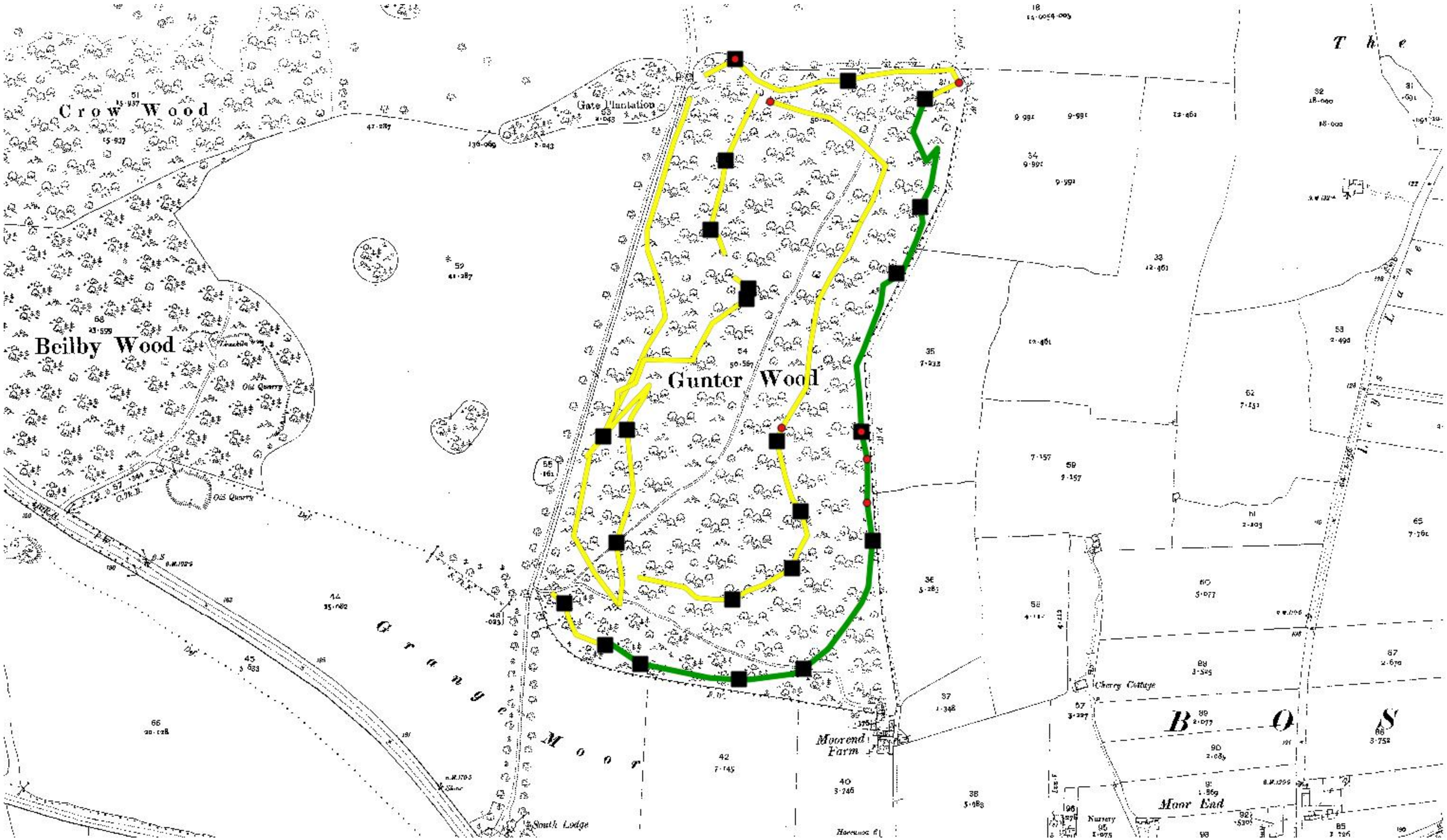


Figure 25.25 – *Ribes uva-crispa*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

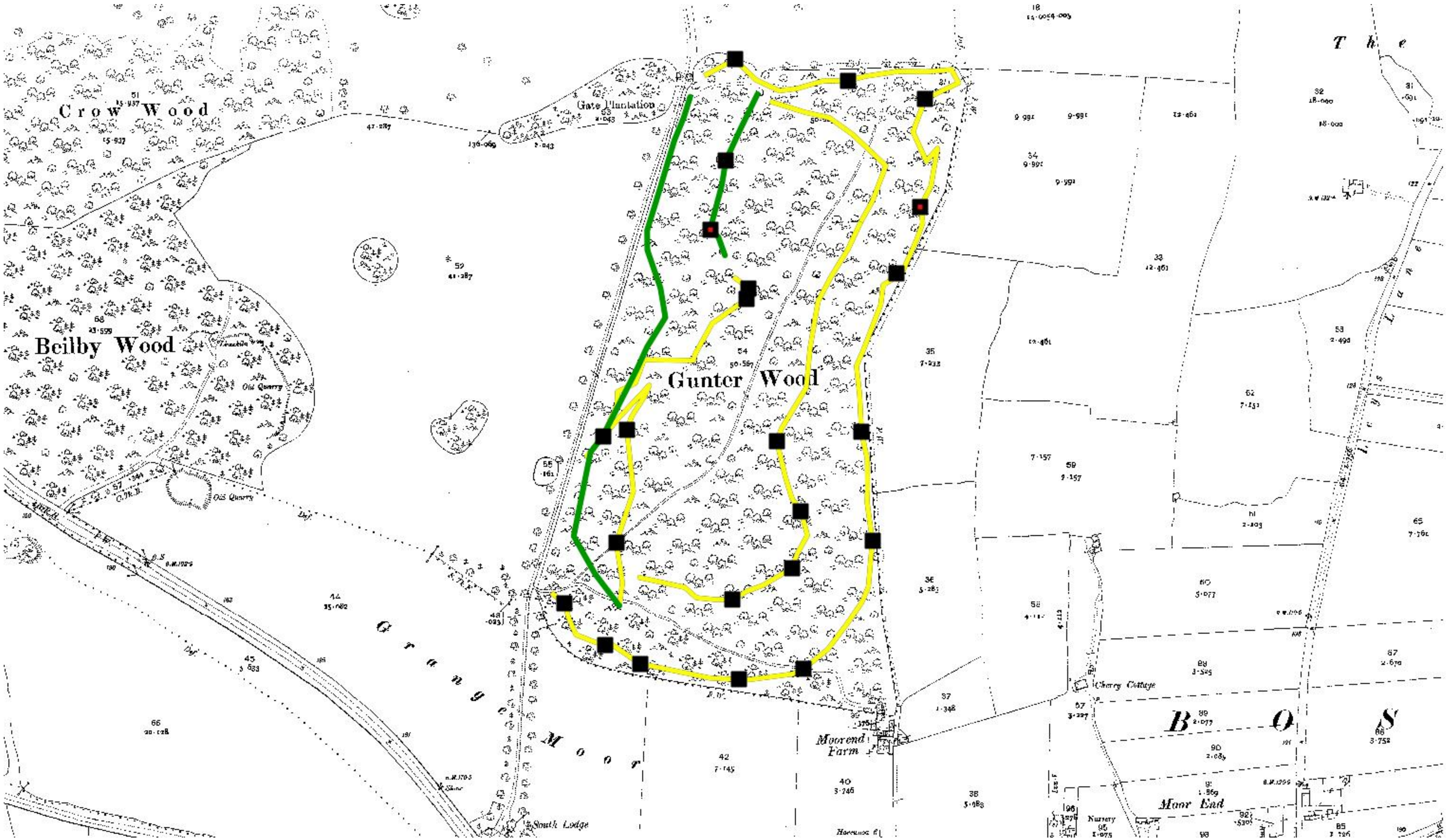


Figure 26.26 – *Rubus fruticosus*

Appendix 16 - Results for Gunter Wood

Species maps for Gunter wood

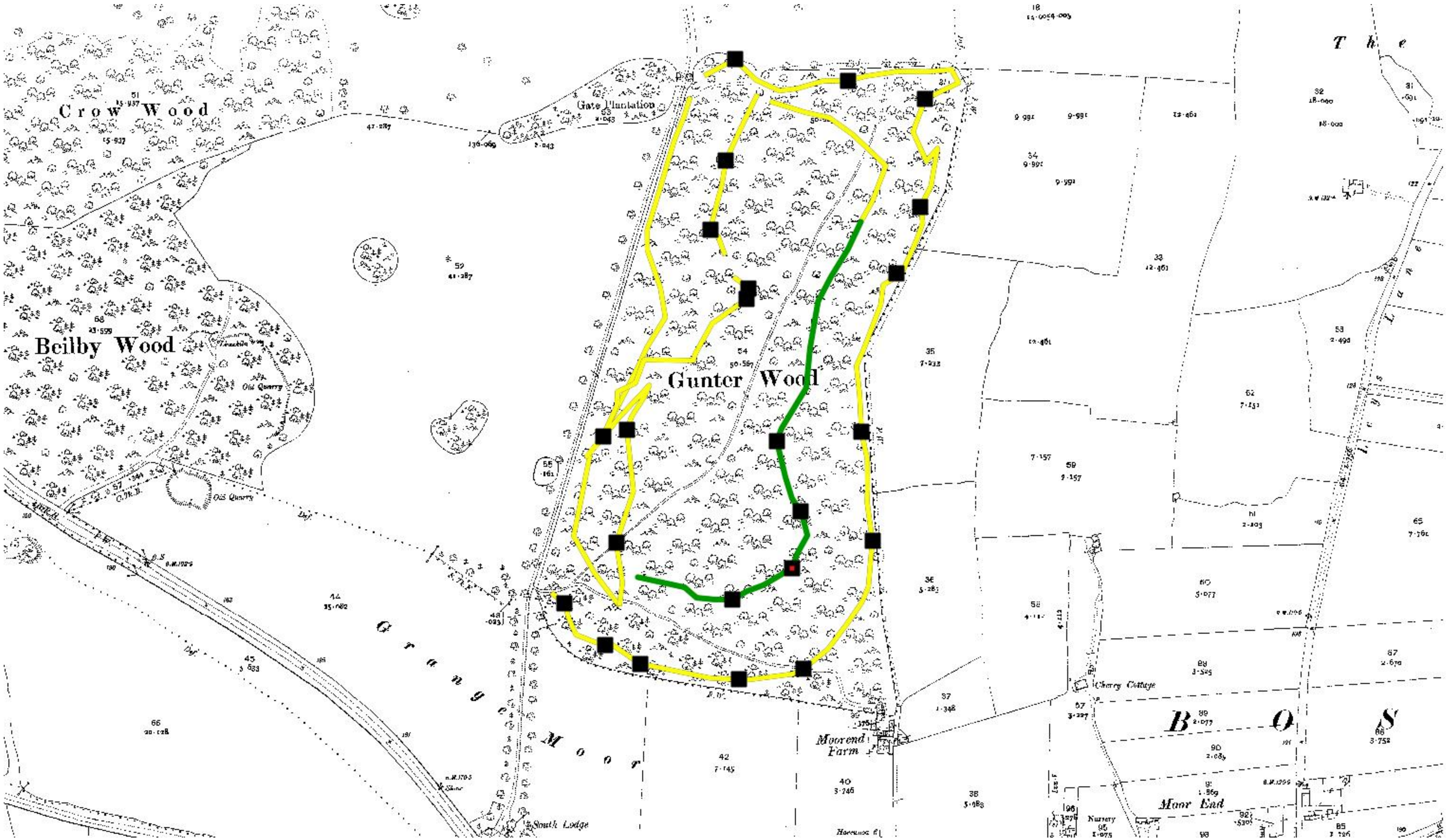


Figure 27.27 – *Stachys sylvatica*

Species maps for Gunter wood

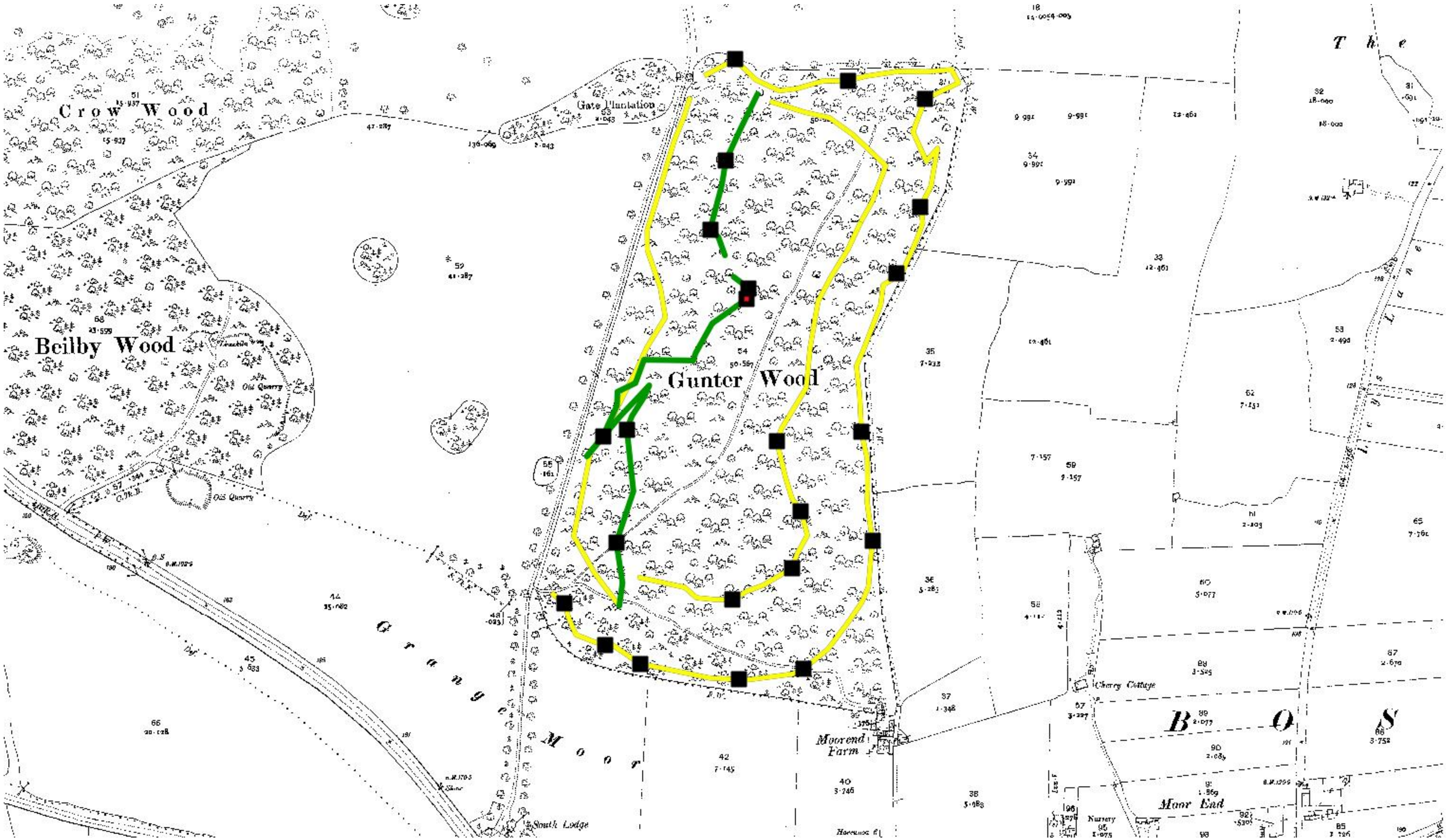


Figure 28.28– *Veronica montana*

Species maps for Gunter wood

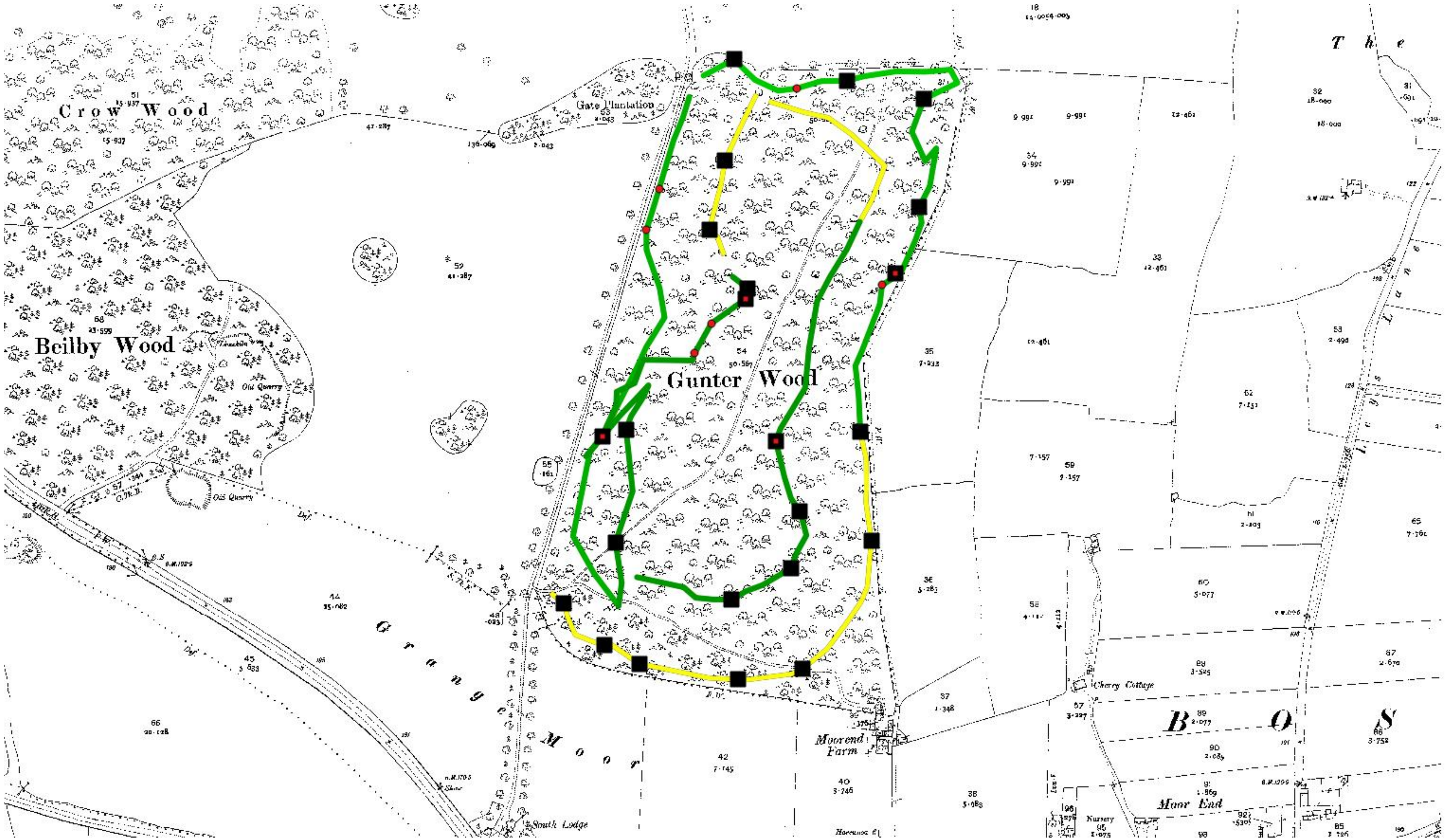


Figure 29.29– *Viola riviniana*

Appendix 16 - Results for Gunter Wood

Table 30.1 – Species data for Gunter wood – Transects									
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)									
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number								
Species	CN538-CN541	CN541-CN554	CN554-CN563	CN563-CN570	CN572-CN582	CN582-CN598	CN598-CN603	CN604-CN607	CN607-CN616
Ace-Pse		11							
aju-rep					11				
all-urs	25		24	22	23		35	35	11
ane-nem	35	35	24	25	35	35	23	11	35
arc-min	11		11	11					
aru-mac	23	22	22	22	22	23	12		22
BARE	24	24	22	13	33	25	35		14
bra-syl		11	11		22				
BRYO		22	22	45		35	34	33	35
car-syl		11			11	12	11		
cir-lut							11		12
con-maj					13		11		
Cor-Ave			11						
Cra-Mon		11	11			11			
des-ces						12			
dry-aff						11			
dry-dil							11		
dry-fil					11	11	11		11
Fag-Syl									22
fil-ulm					11				
ger-rob					11	11			
geu-urb		11	22			11	12		11
hya-non	23	24	44	23	23	13	13	23	23
hyp-spp					11				
Ile-aqu	11						11		
LITTER	24	24	22	13		13	23		25
mer-per	35	55	34	13	35	13	35	24	23
orc-mas									
oxa-ace						11			
pri-vul		11	11						
pru-spi			11	11					
pte-aqu	11	11							

Appendix 16 - Results for Gunter Wood

Table 30.1 – Species data for Gunter wood – Transects									
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)									
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number								
Species	CN538-CN541	CN541-CN554	CN554-CN563	CN563-CN570	CN572-CN582	CN582-CN598	CN598-CN603	CN604-CN607	CN607-CN616
ran-fic	11	22	22	12	11	11	11	11	11
Rib-Nig			14					11	
Rib-uva		11	11						
rub-fru					11		11		
Sam-Nig	11	23			11			11	11
sta-syl									11
Sym-Riv				13					
urt-dio	23	12							11
ver-mon						11	11		
vio-riv			13	12	13	11			11

Appendix 16 - Results for Gunter Wood

Table 32.2 – Species data for Gunter wood – Quadrats, point records – part 1

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																						
Species	CN539	CN541	CN542	CN543	CN544	CN549	CN550	CN551	CN552	CN553	CN554	CN556	CN557	CN558	CN563	CN564	CN566	CN567	CN569	CN573	CN574	CN575	CN576	CN577
aju-rep												9												
all-urs	2													3	4									
ane-nem	3	4	3	3		4	2						2	3	3		3		5					
aru-mac			1	2		2	2							1	1		2							
BARE	2	1	1				2				3		2	2	1				1					
bra-syl									9										9					
BRYO							2				3			2	3		4		3					
car-syl										9		9		1										9
con-maj																				9		9		
hya-non	2		3	3		2	4				2		2	2	2				2					
LITTER		1	1	2			2				2			2	1		1		1					
mer-per	4	4	4	2		2	4				3		4		3		3		2					
pri-vul					9						1	9	1											
ran-fic	2	1																						
Rib-Nig												9												
Rib-uva								9		9	9					9			9					
rub-fru														1										
Sam-Nig				1																				
Sym-riv																	1							
vio-riv												9	1					9			9	9		

Appendix 16 - Results for Gunter Wood

Table 33.3 – Species data for Gunter wood – Quadrats, point records - part 2																				
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.																				
	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																			
Species	CN580	CN581	CN583	CN584	CN587	CN594	CN595	CN596	CN597	CN600	CN601	CN602	CN604	CN607	CN609	CN610	CN611	CN612	CN613	CN615
all-urs										4	4			9						
ane-nem	3		4	4				3	1		3						1	5	1	
aru-mac	2			1				2	1											
BARE	3		2	1				2	1	3	2									
BRYO	3		2	3				3	5	2	3					1	3	4	4	
car-syl				1				1												
cir-lut										1					9				1	
con-maj	1											9								
Cra-Mon				1																
des-ces				1				2												
dry-fil																	1			
Fag-Syl																3				
geu-urb								1	1	1						1				
hya-non	2									1	4						1			
hyp-spp		9																		
LITTER			2	1				1	1	2	2					5		3	4	
mer-per	2		3	3				3	2								5	3	4	
orc-mas		9			9															
oxa-ace						9	9													
ran-fic	1			1				1		2	3						1			

Appendix 16 - Results for Gunter Wood

Table 33.3 – Species data for Gunter wood – Quadrats, point records - part 2

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																			
Species	CN580	CN581	CN583	CN584	CN587	CN594	CN595	CN596	CN597	CN600	CN601	CN602	CN604	CN607	CN609	CN610	CN611	CN612	CN613	CN615
Rib-Nig															9					9
Rib-Uva													9		9					
rub-fru										1										
Sam-Nig																1				
sta-syl																		1		
urt-dio																	1			
ver-mon								1												
vio-riv	1					9	9	1								1				

Appendix 17 - Results for Hackfall Wood

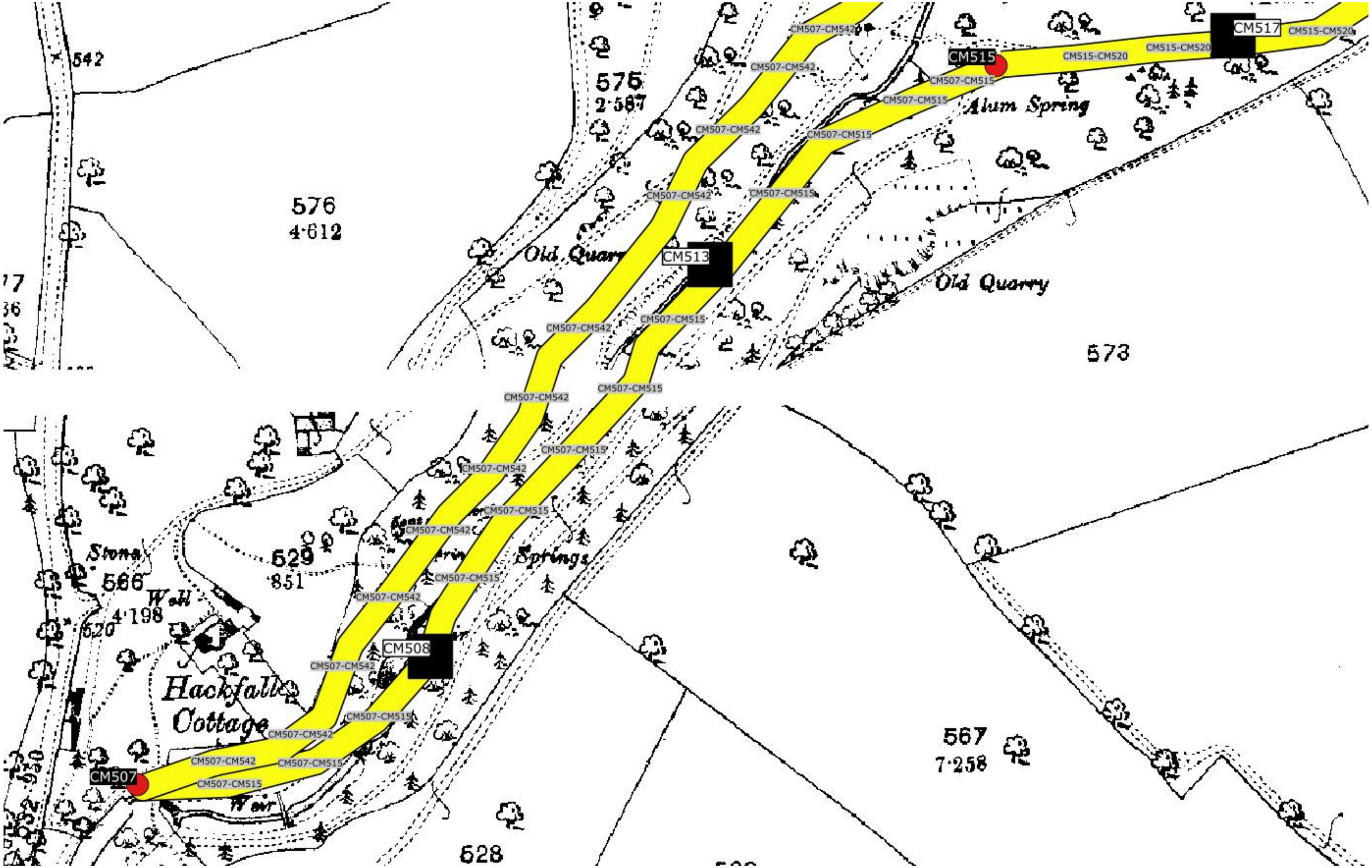


Figure 1.1 – Detailed map of Hackfall Wood showing the transect and quadrat numbers – part 01.

Appendix 17 - Results for Hackfall Wood

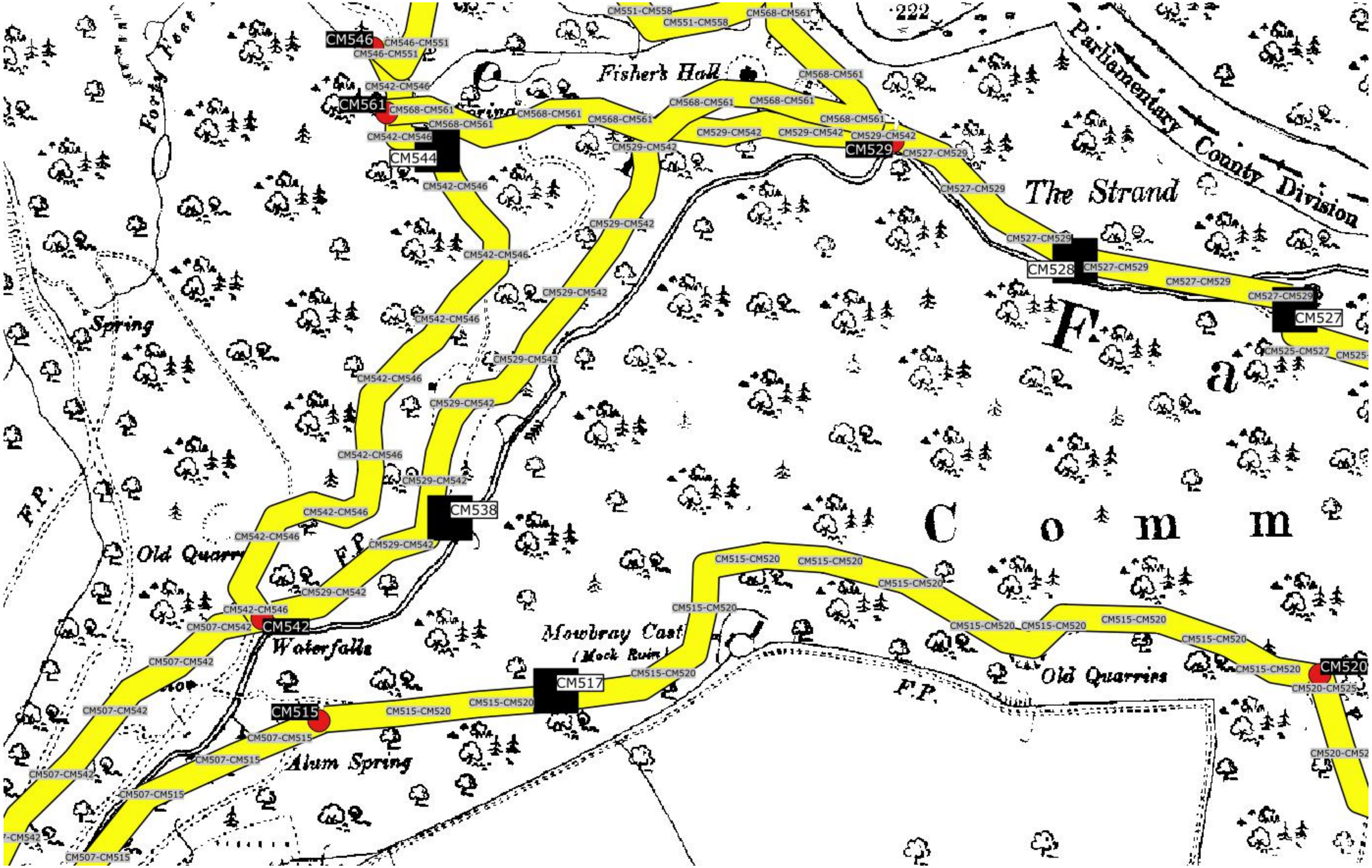


Figure 2.2 - Detailed map of Hackfall Wood showing the transect and quadrat numbers – part 02

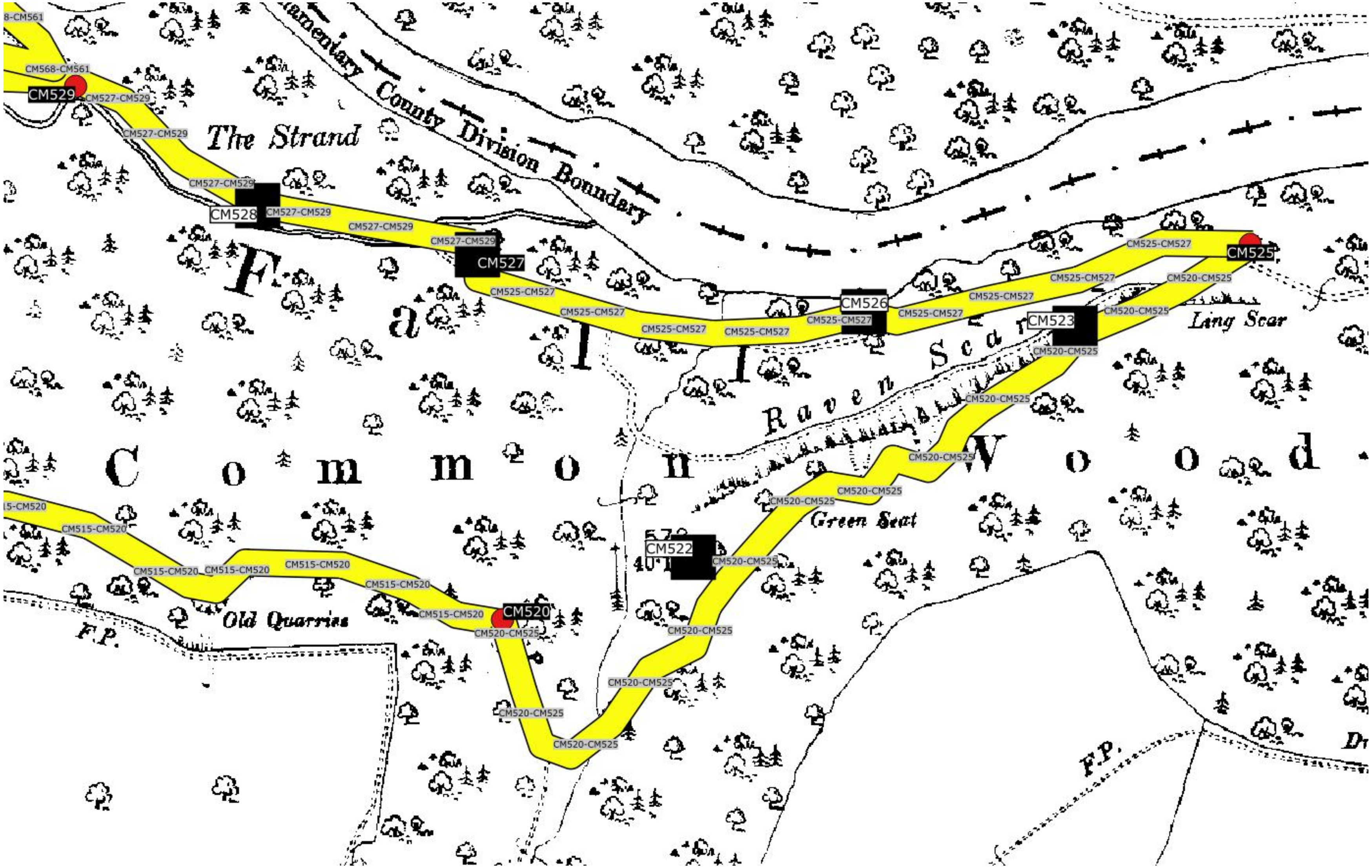


Figure 3.3 - Detailed map of Hackfall Wood showing the transect and quadrat numbers – part 03

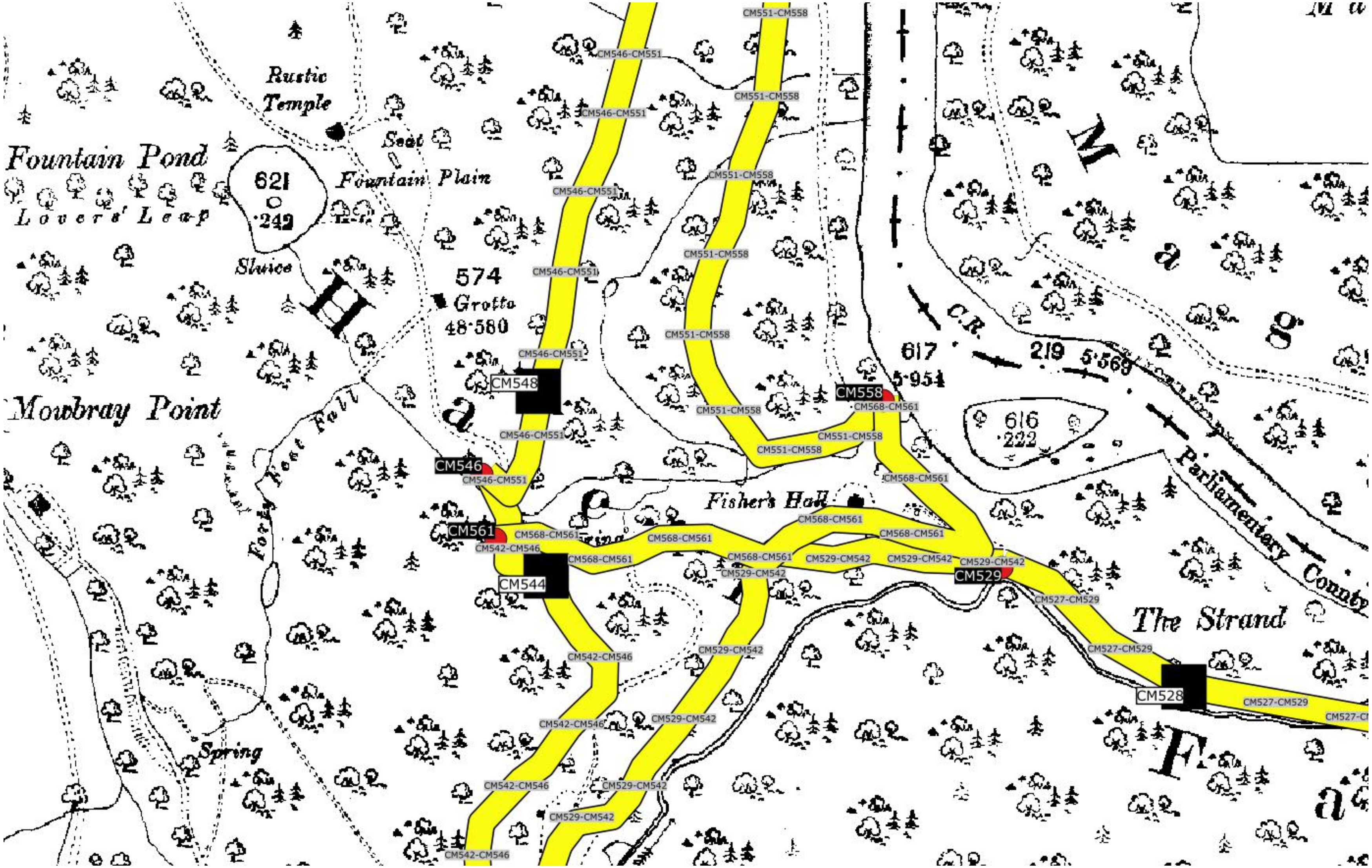


Figure 4.4 - Detailed map of Hackfall Wood showing the transect and quadrat numbers – part 04

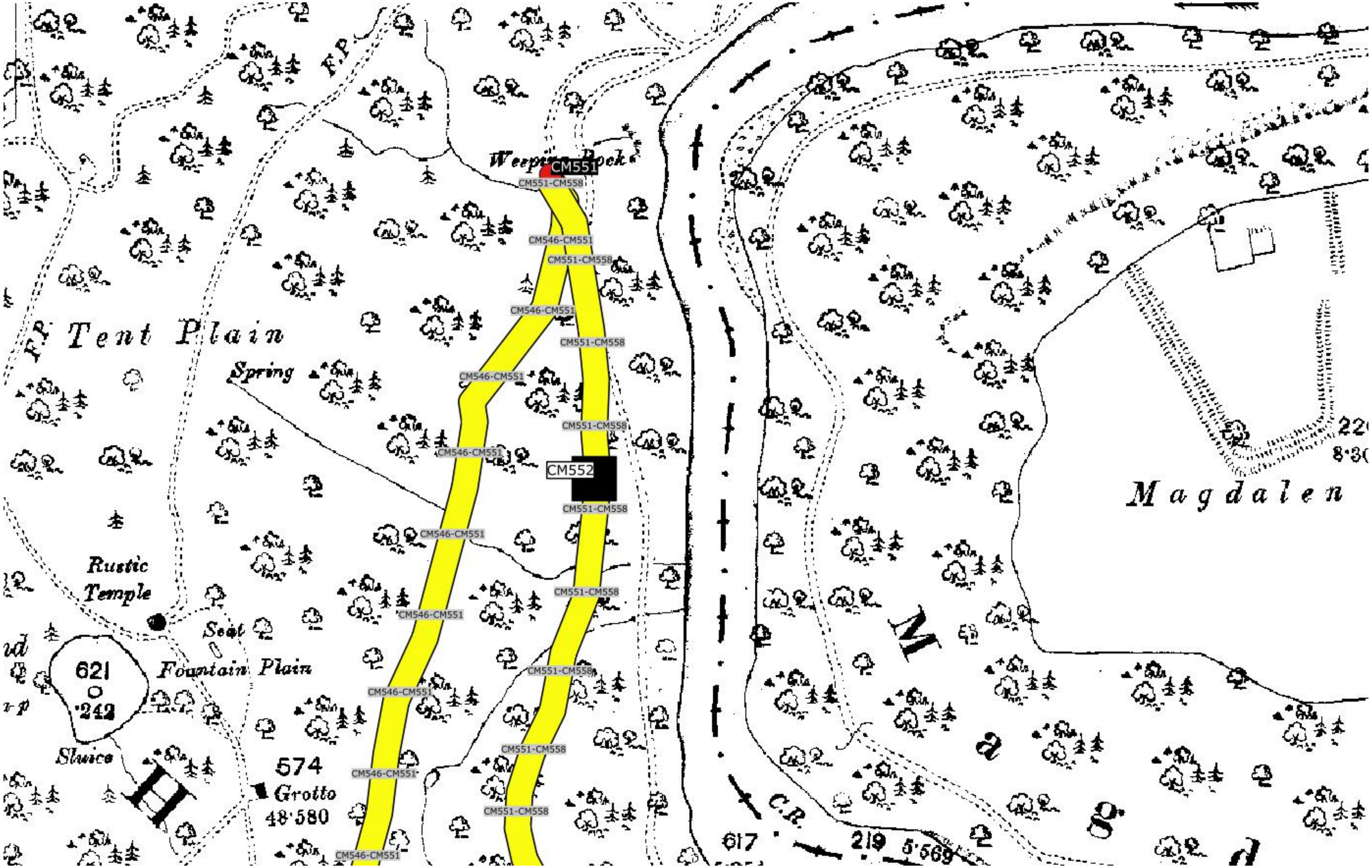


Figure 5.5 - Detailed map of Hackfall Wood showing the transect and quadrat numbers – part 05

Species maps for Hackfall wood

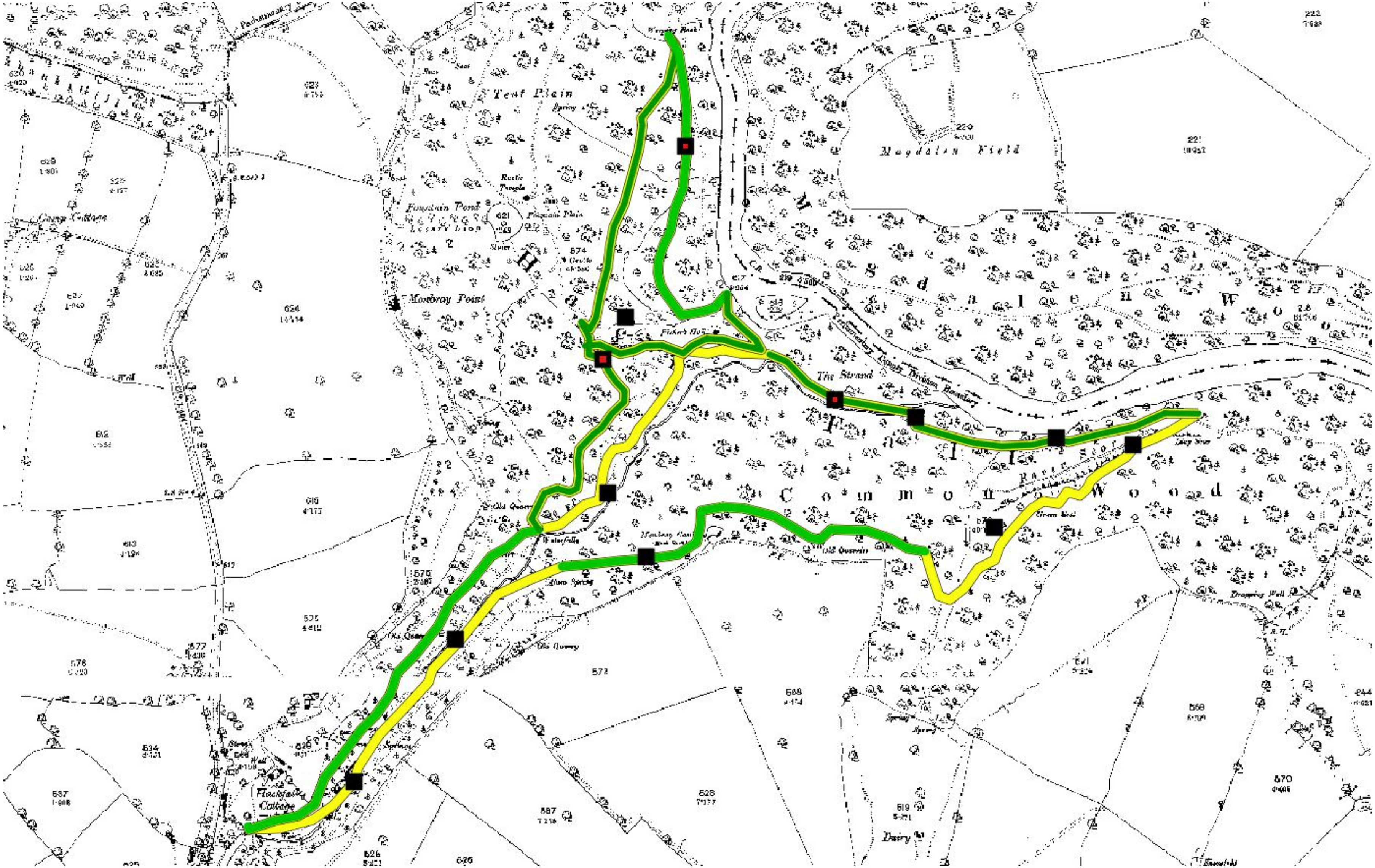


Figure 6.6 – *Ajuga reptans*

Species maps for Hackfall wood

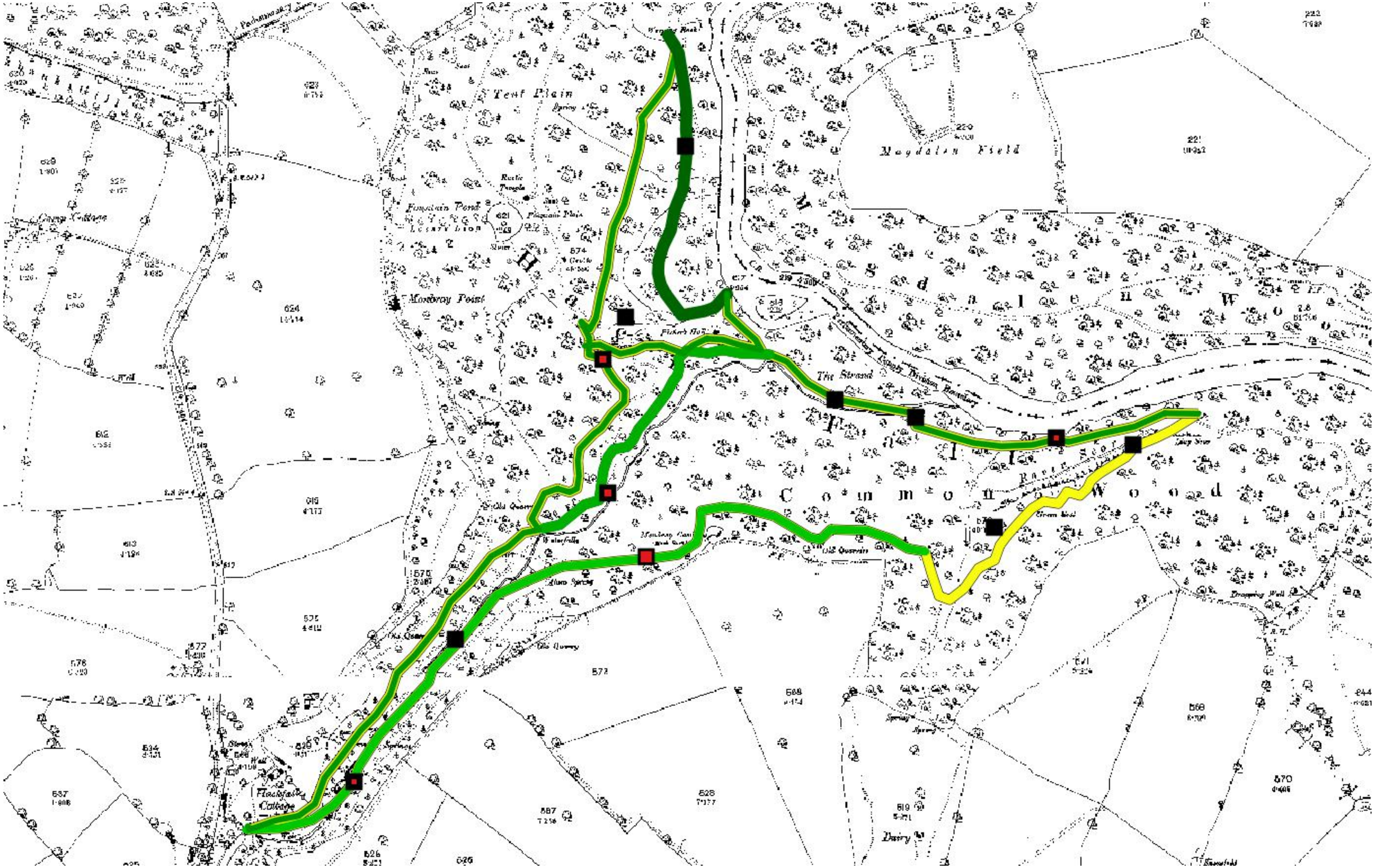


Figure 7.7 – *Allium ursinum*

Species maps for Hackfall wood

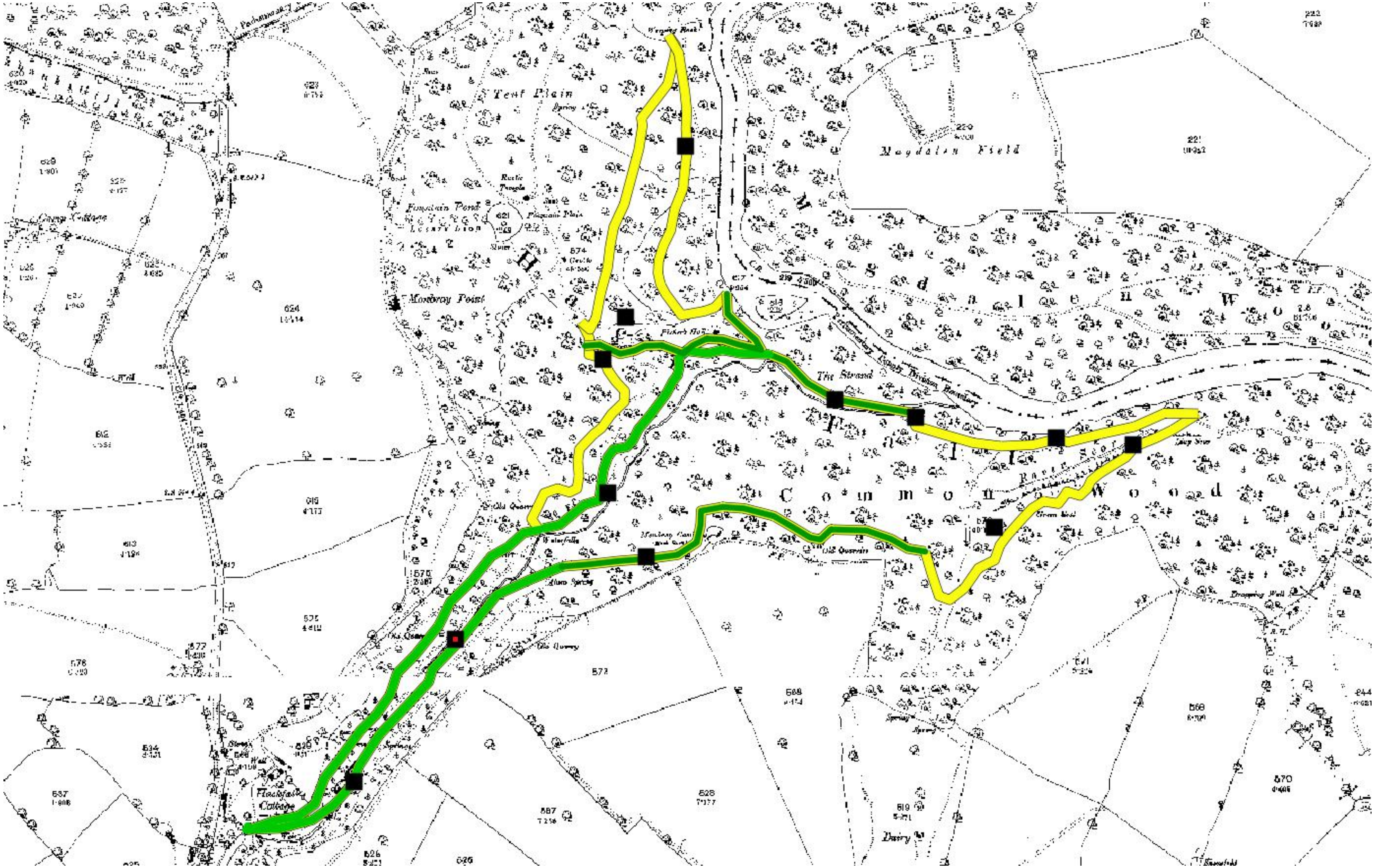


Figure 8.8 – *Anemone nemorosa*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

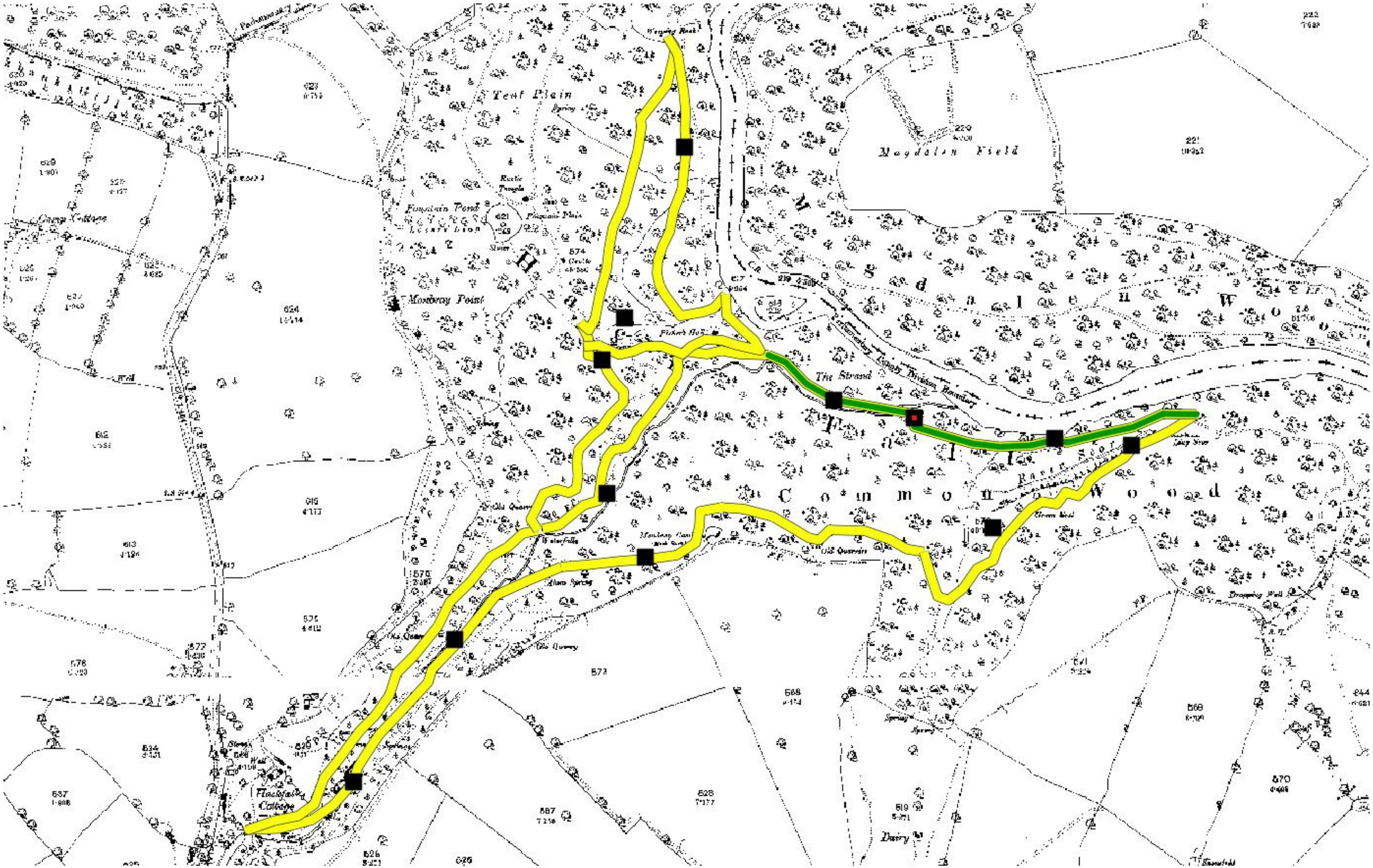


Figure 9.9 – *Arum maculatum*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

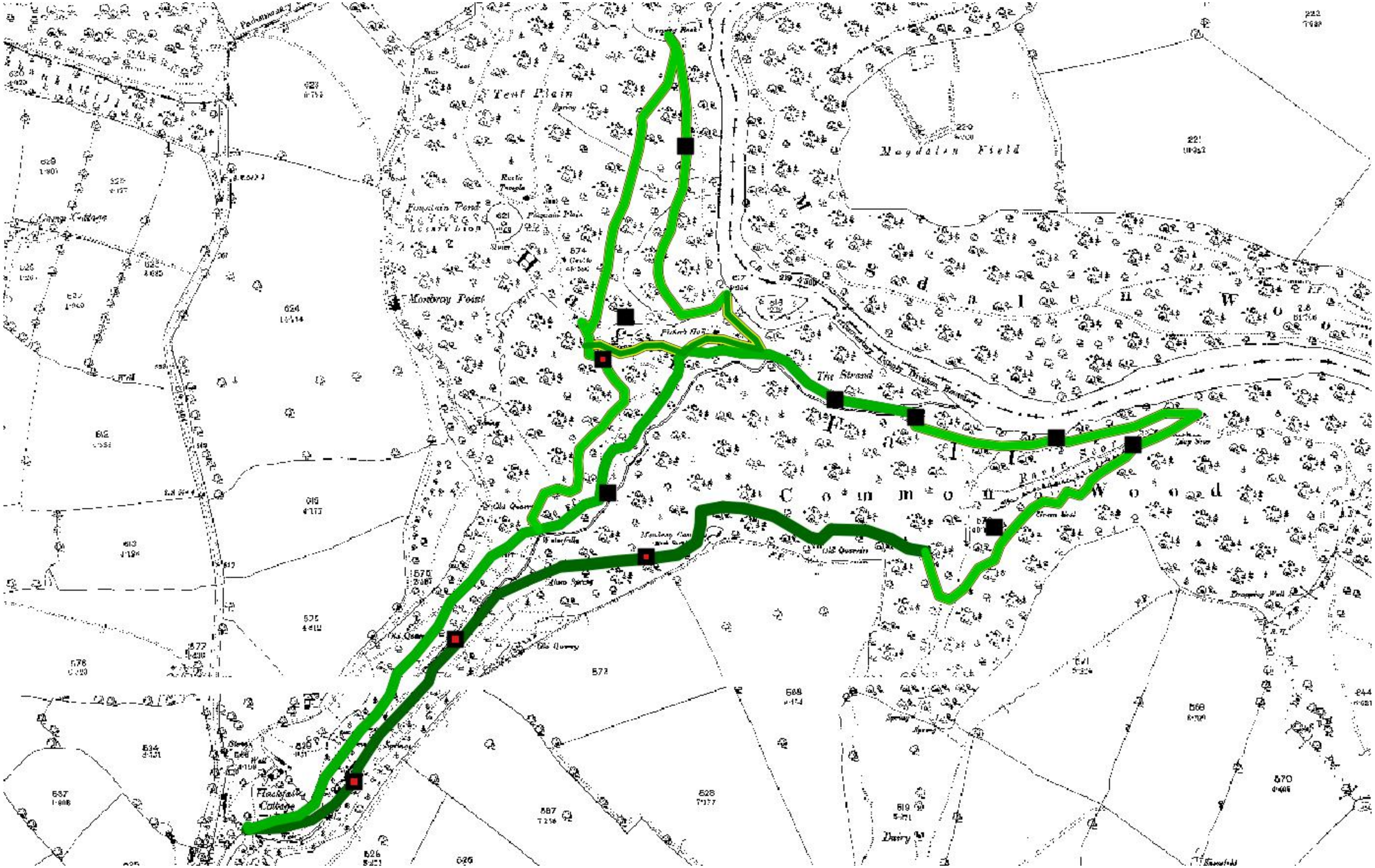


Figure 10.10 – *Athyrium filix-femina*

Species maps for Hackfall wood

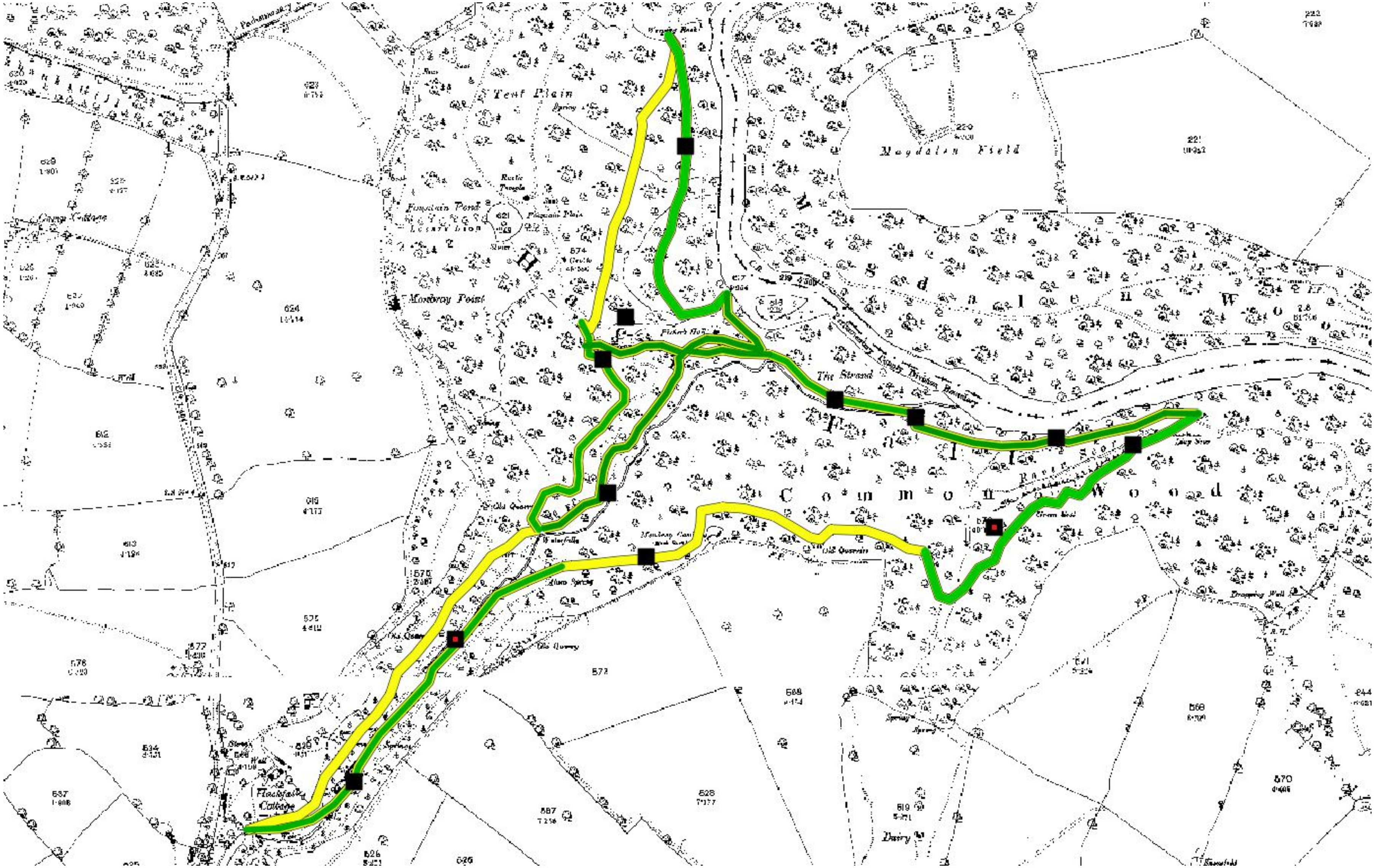


Figure 11.11 – *Blechnum spicant*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

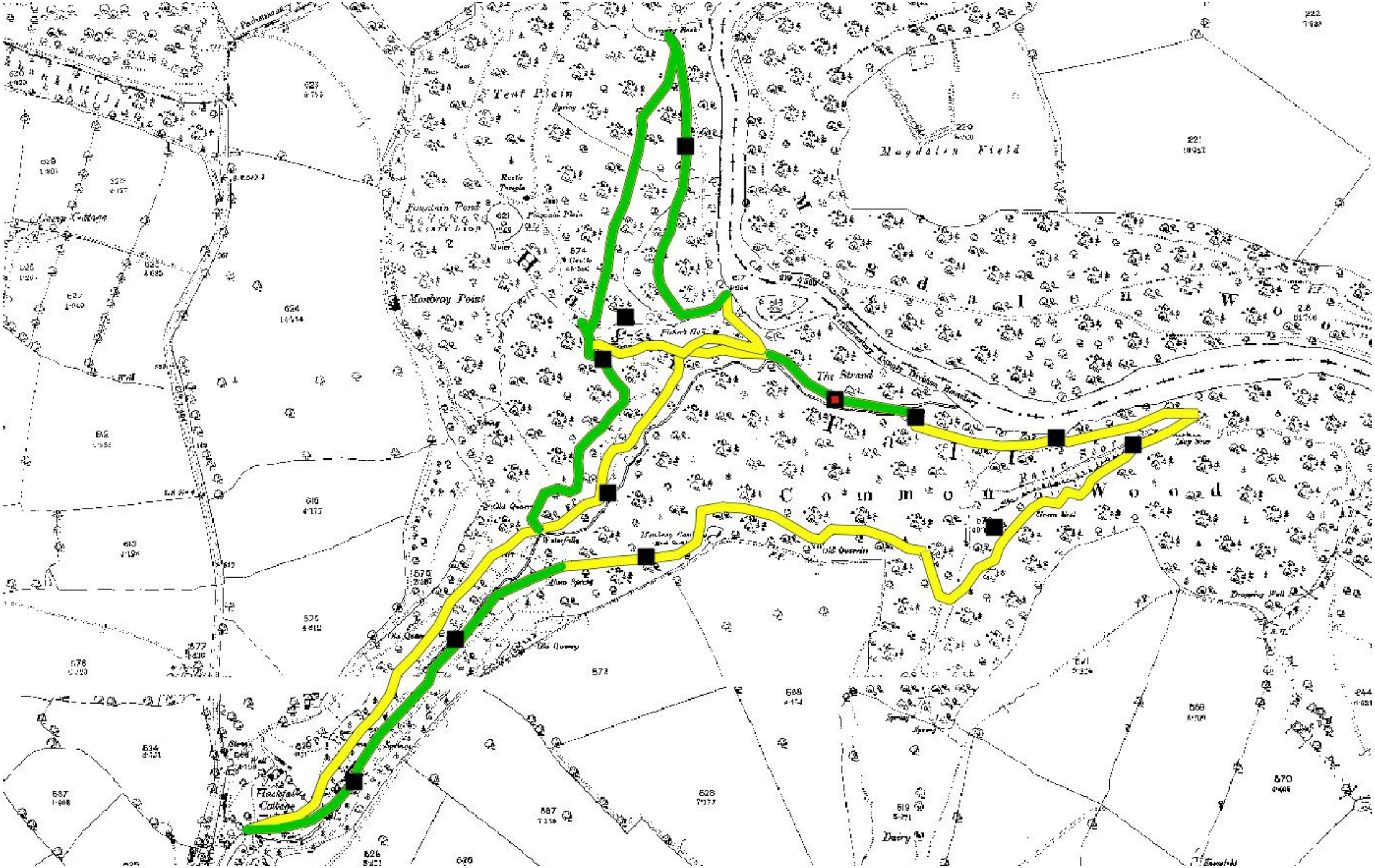


Figure 12.12 – *Brachypodium sylvaticum*

Species maps for Hackfall wood

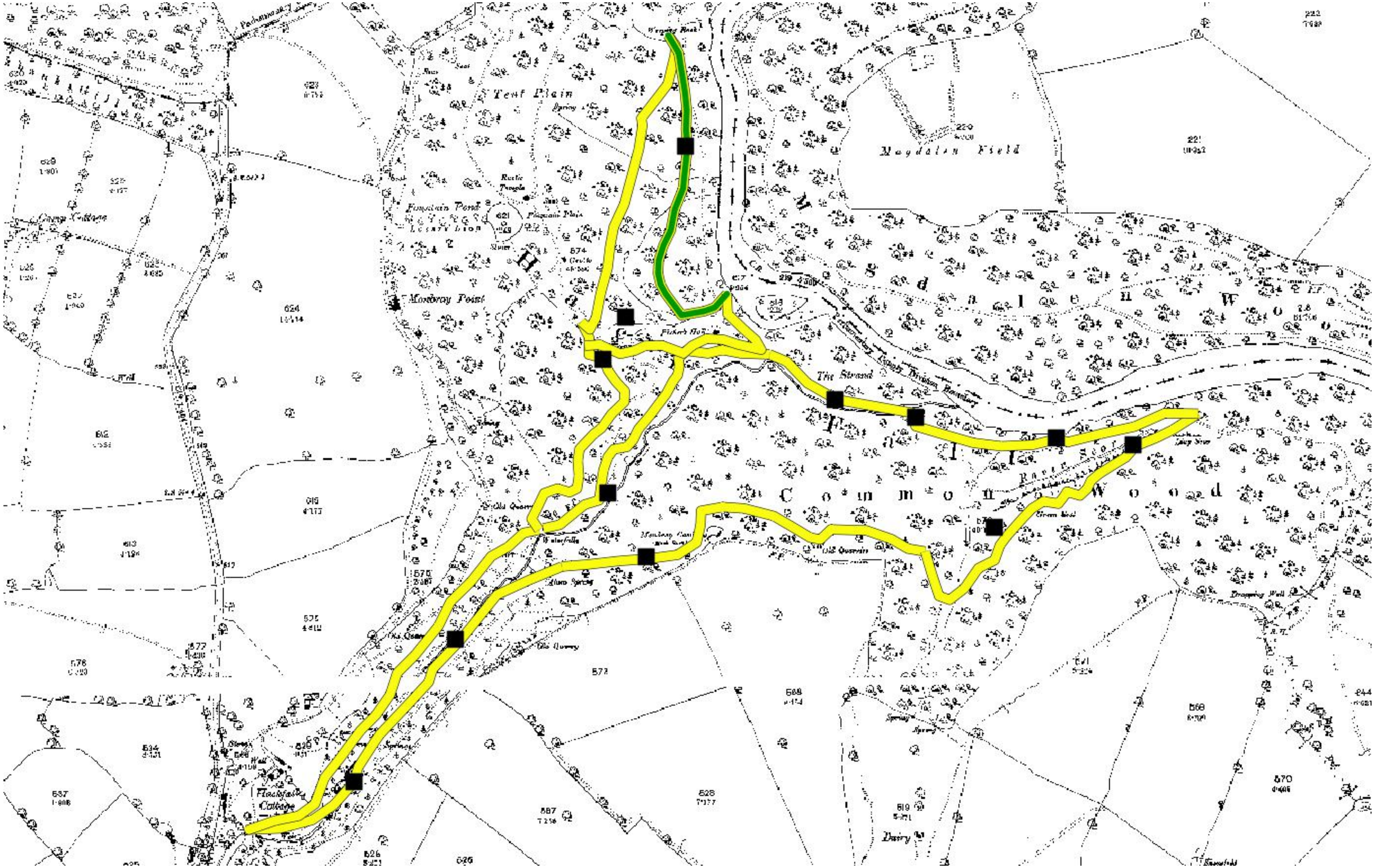


Figure 13.13 – *Bromopsis ramosa*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

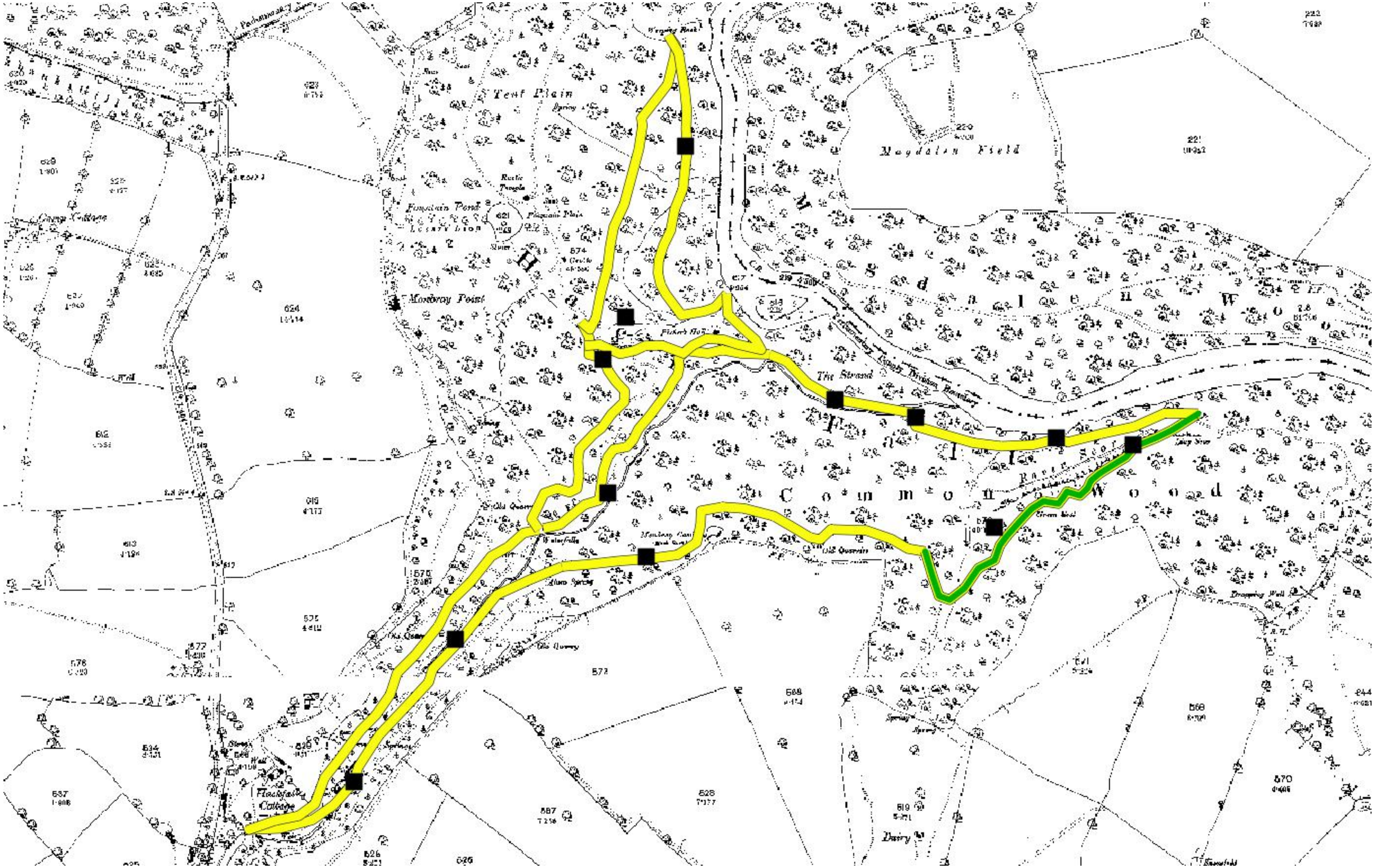


Figure 14.14 – *Calluna vulgaris*

Species maps for Hackfall wood

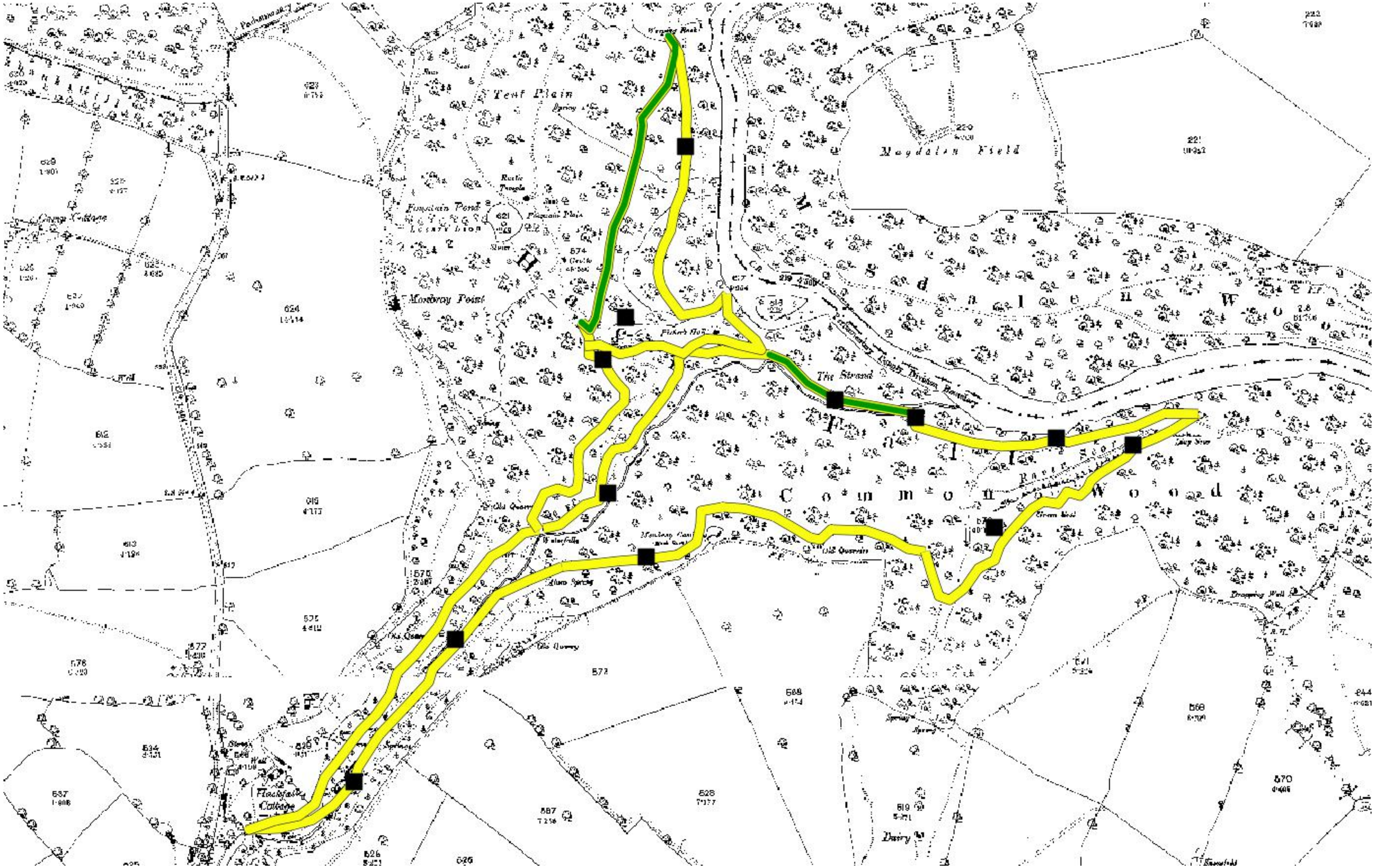


Figure 15.15 – *Campanula latifolia*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

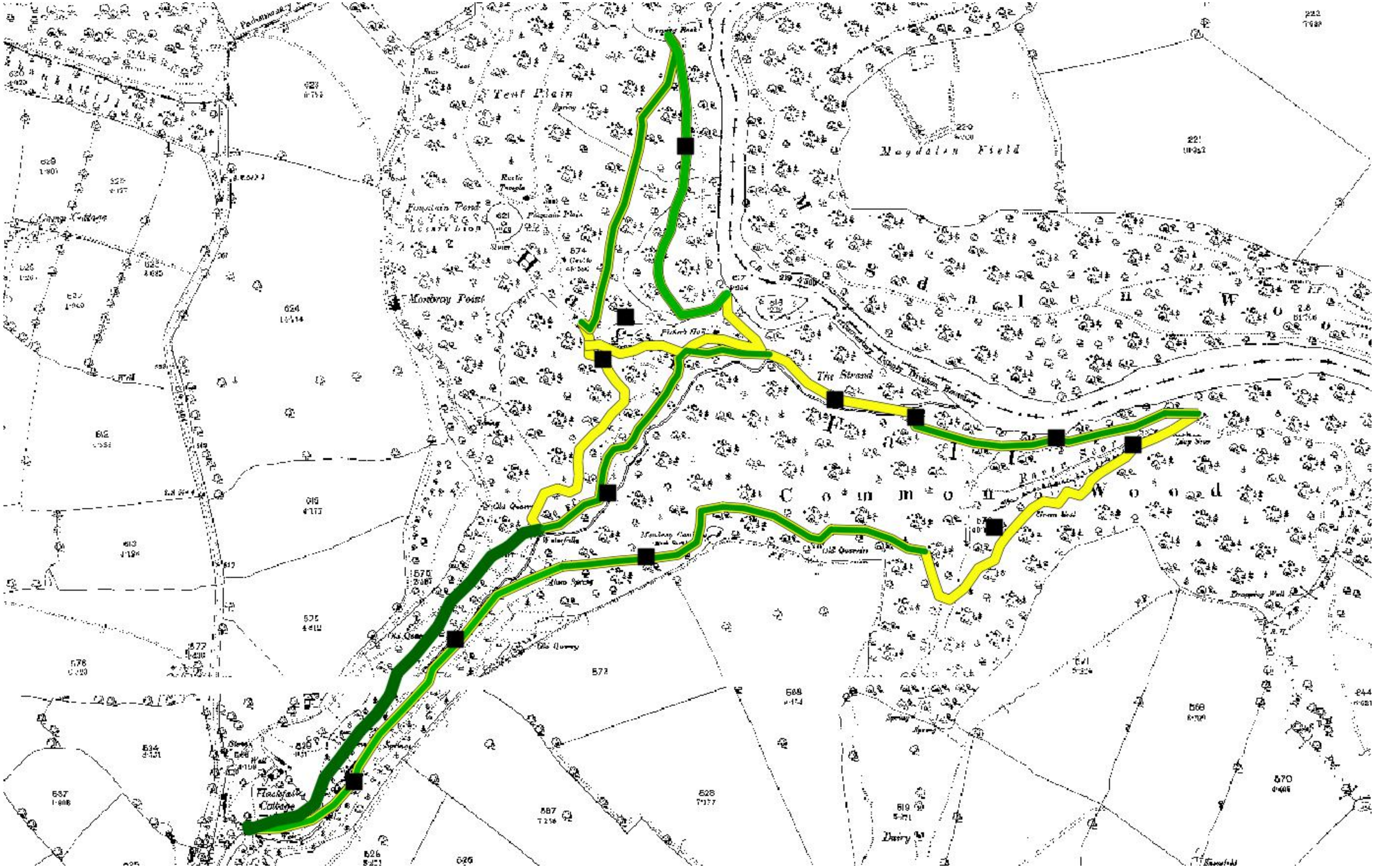


Figure 16.16 – *Carex pendula*

Species maps for Hackfall wood

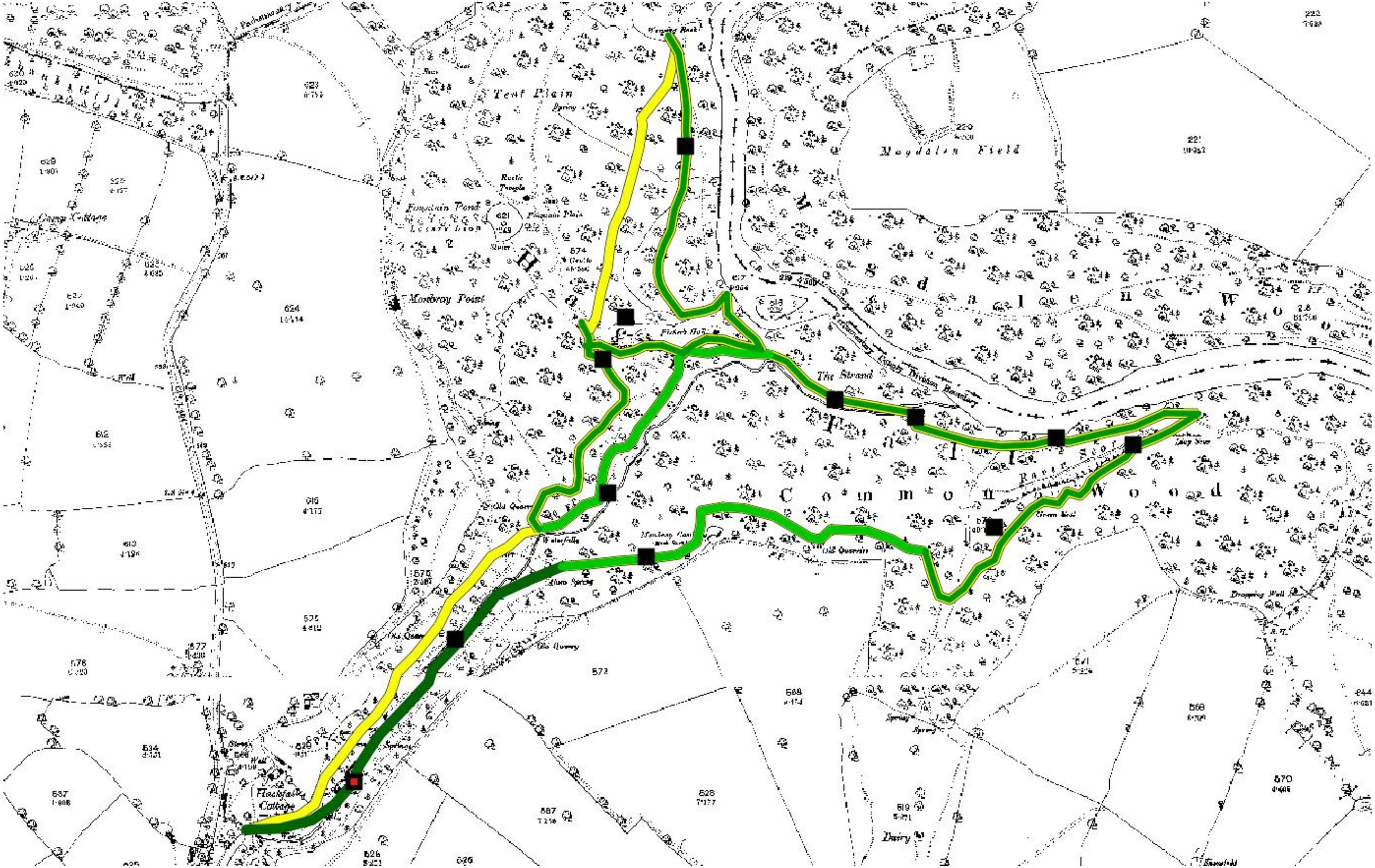


Figure 17.17 – *Carex remota*

Species maps for Hackfall wood

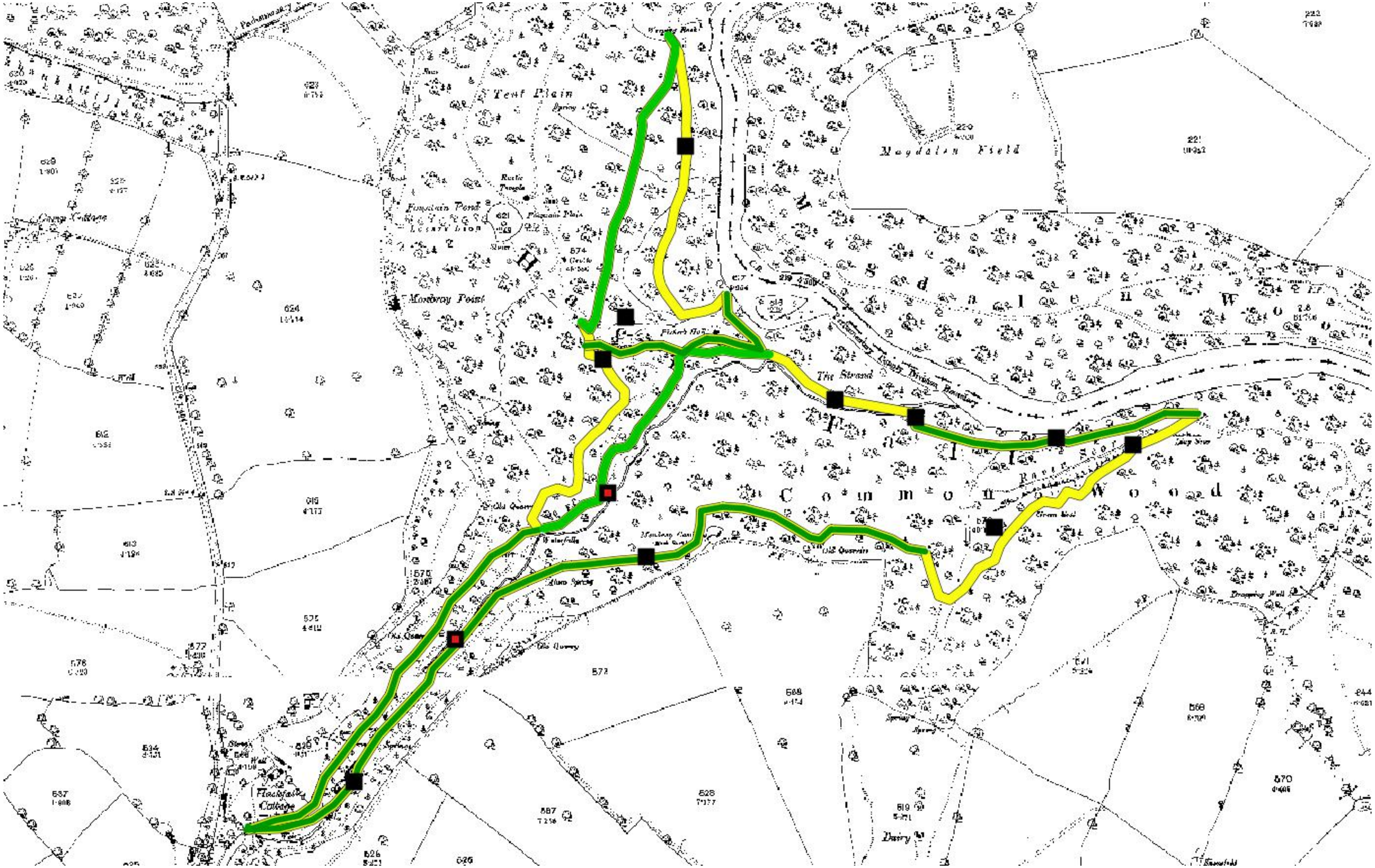


Figure 18.18 – *Carex sylvatica*

Species maps for Hackfall wood

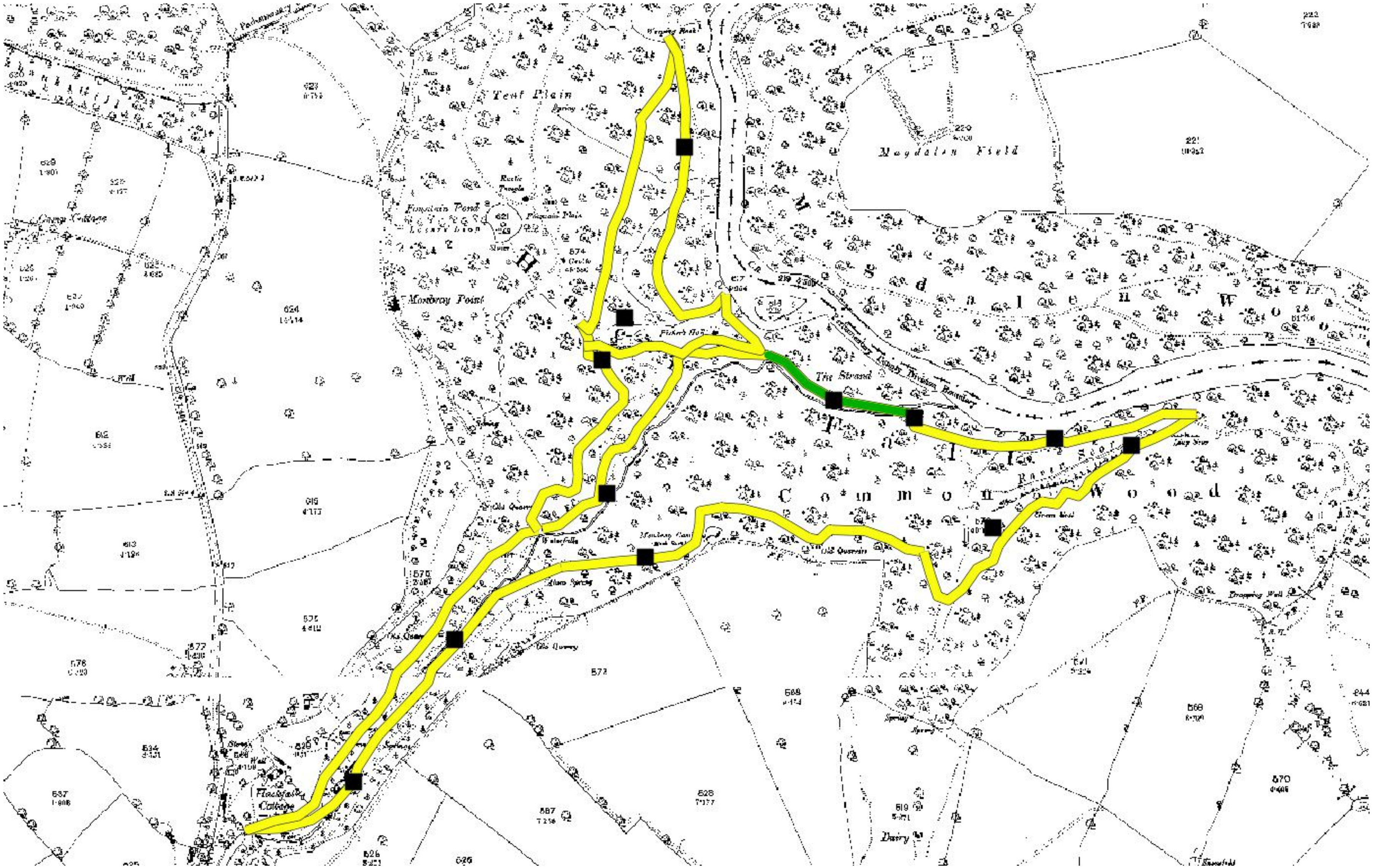


Figure 19.19 – *Chrysosplenium alternifolium*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

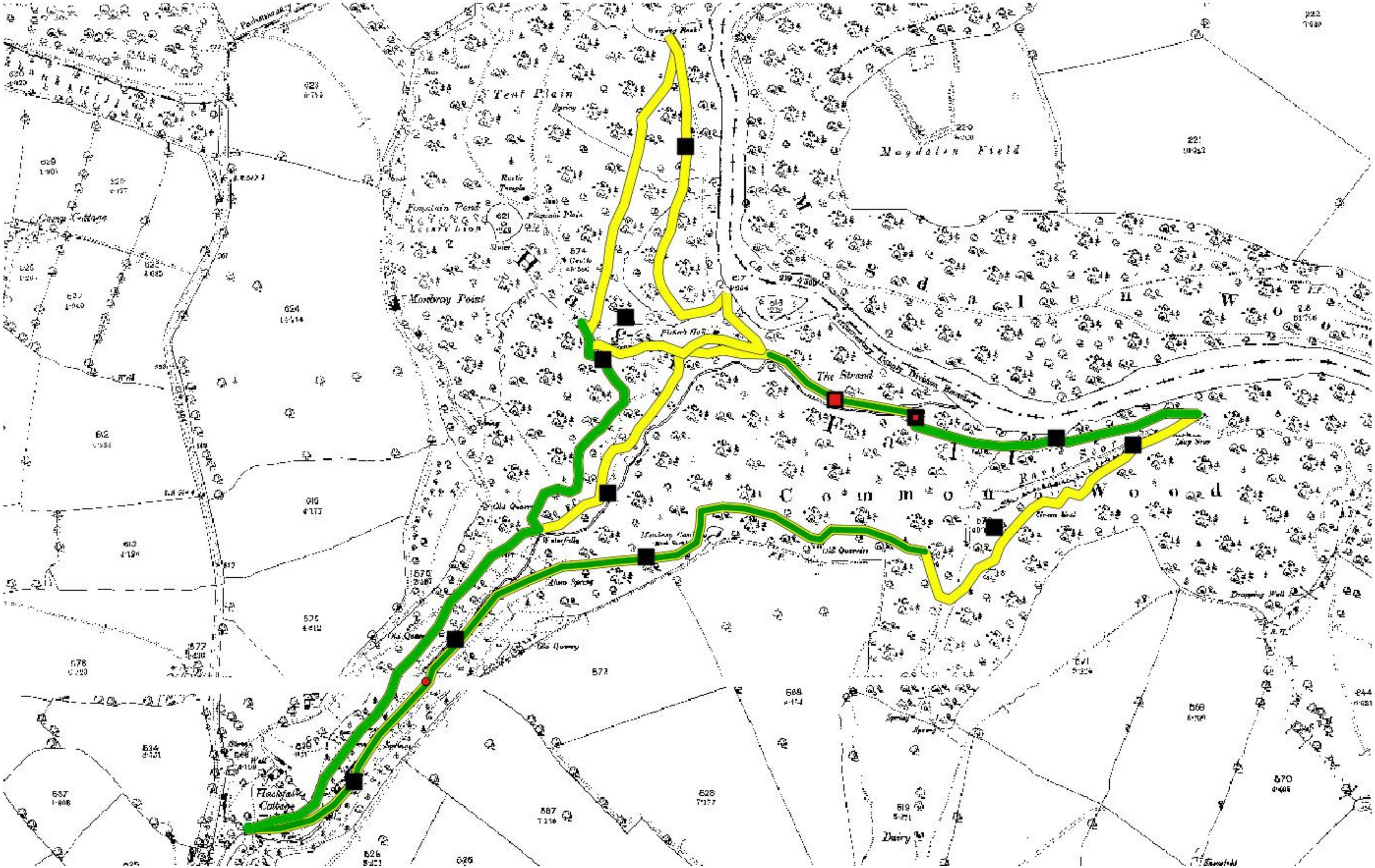


Figure 20.20 – *Chrysosplenium oppositifolium*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

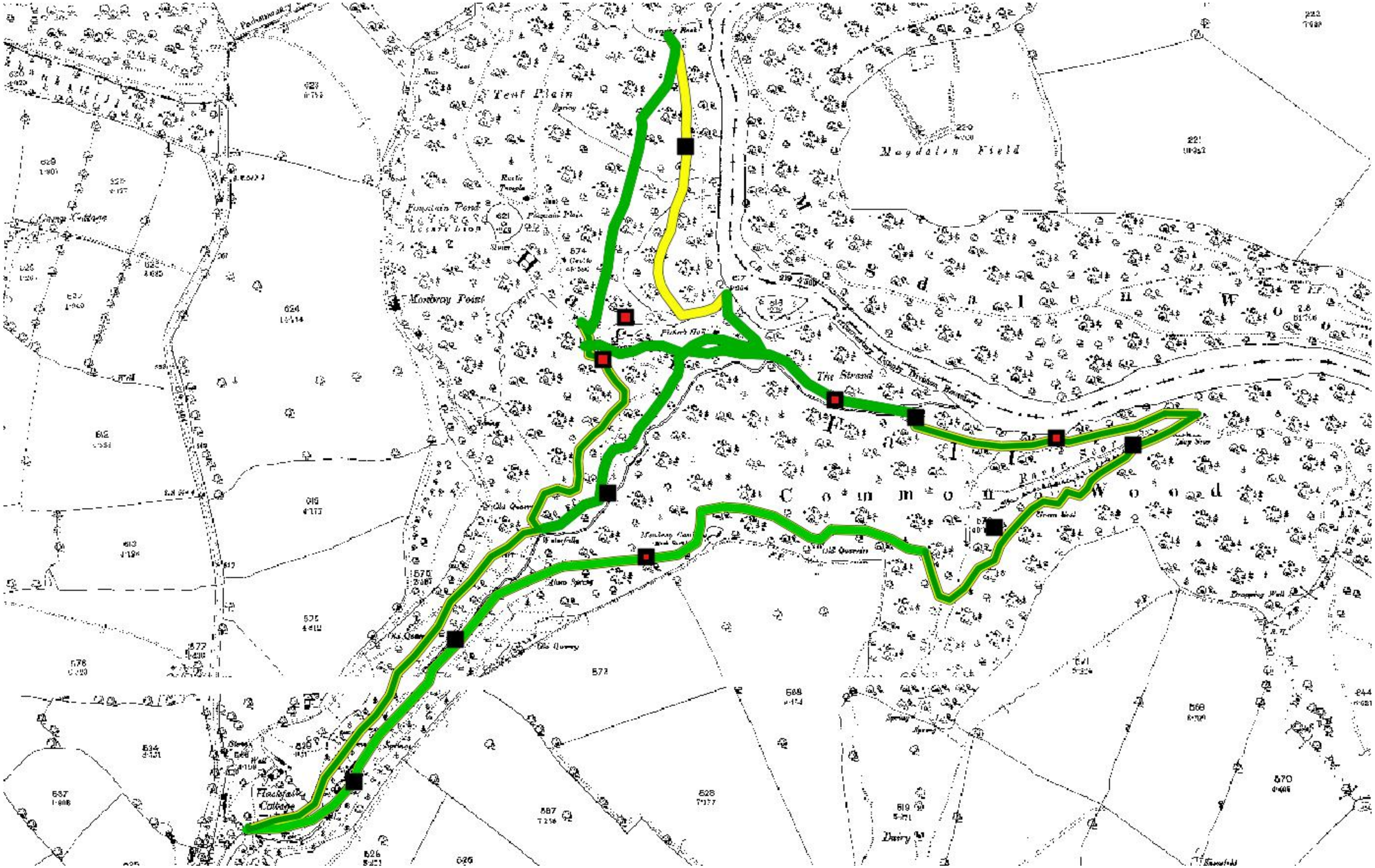


Figure 21.21 – *Circaea lutetiana*

Species maps for Hackfall wood

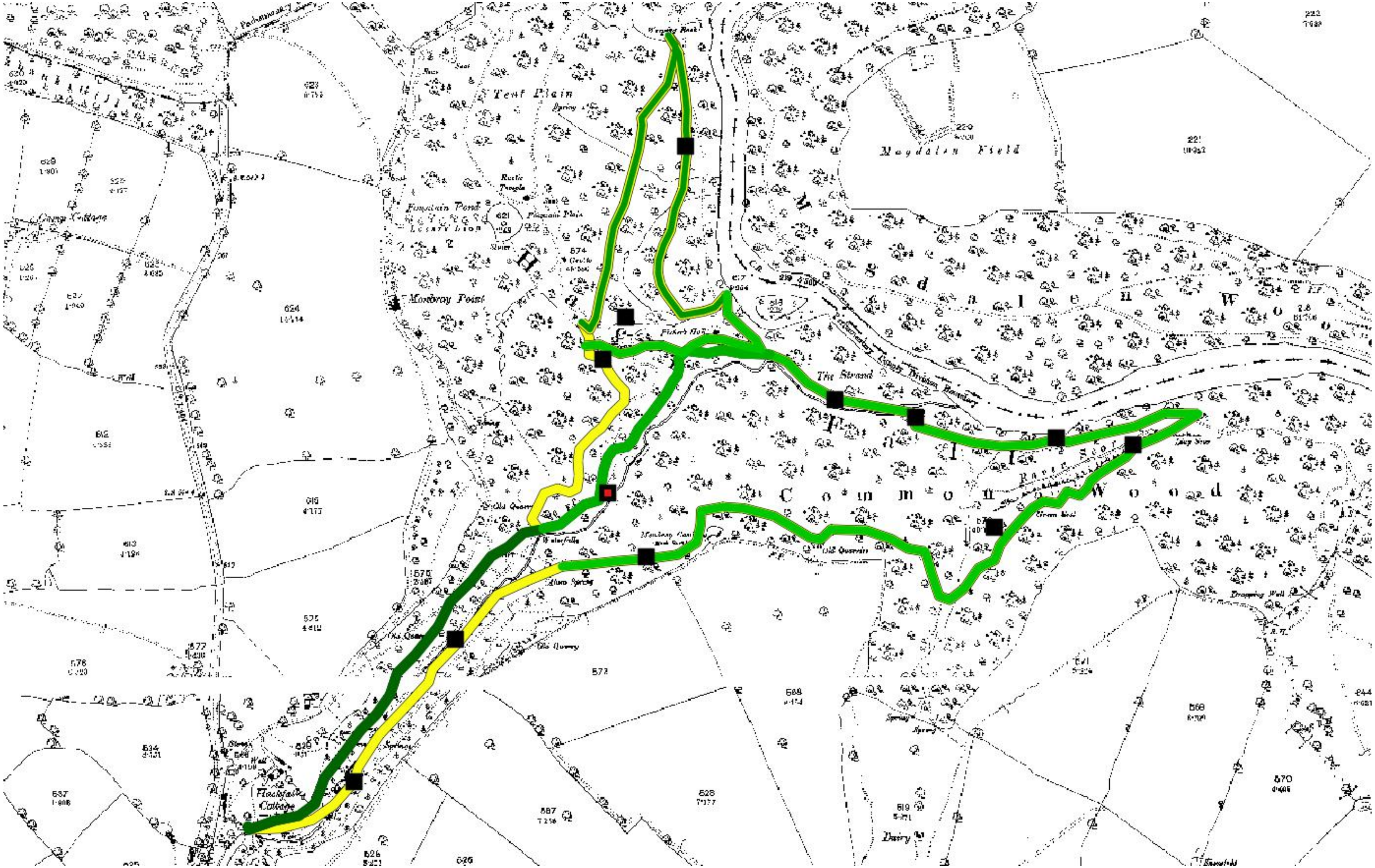


Figure 22.22 – *Corylus avellana*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

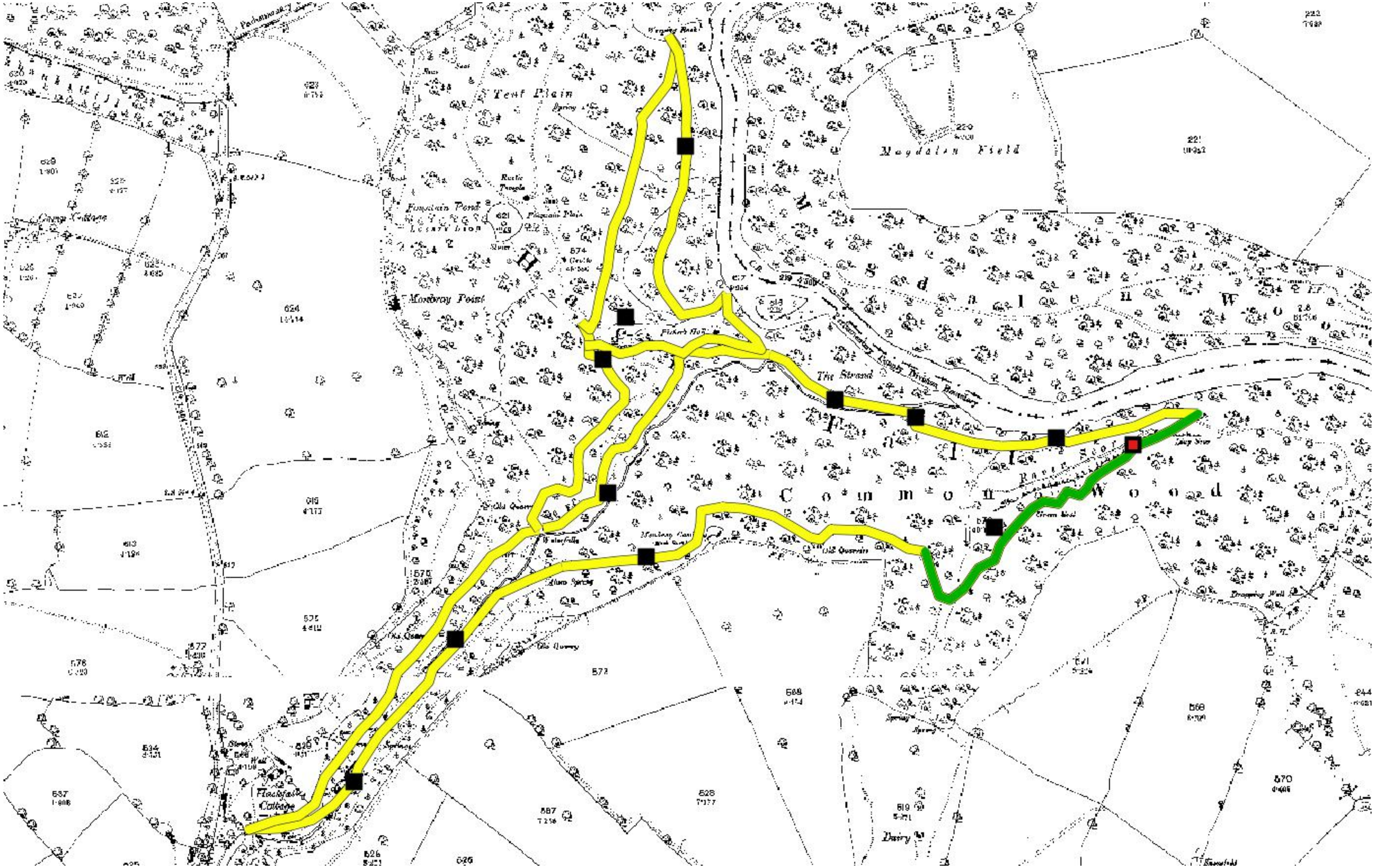


Figure 23.23 – *Deschampsia flexuosa*

Species maps for Hackfall wood

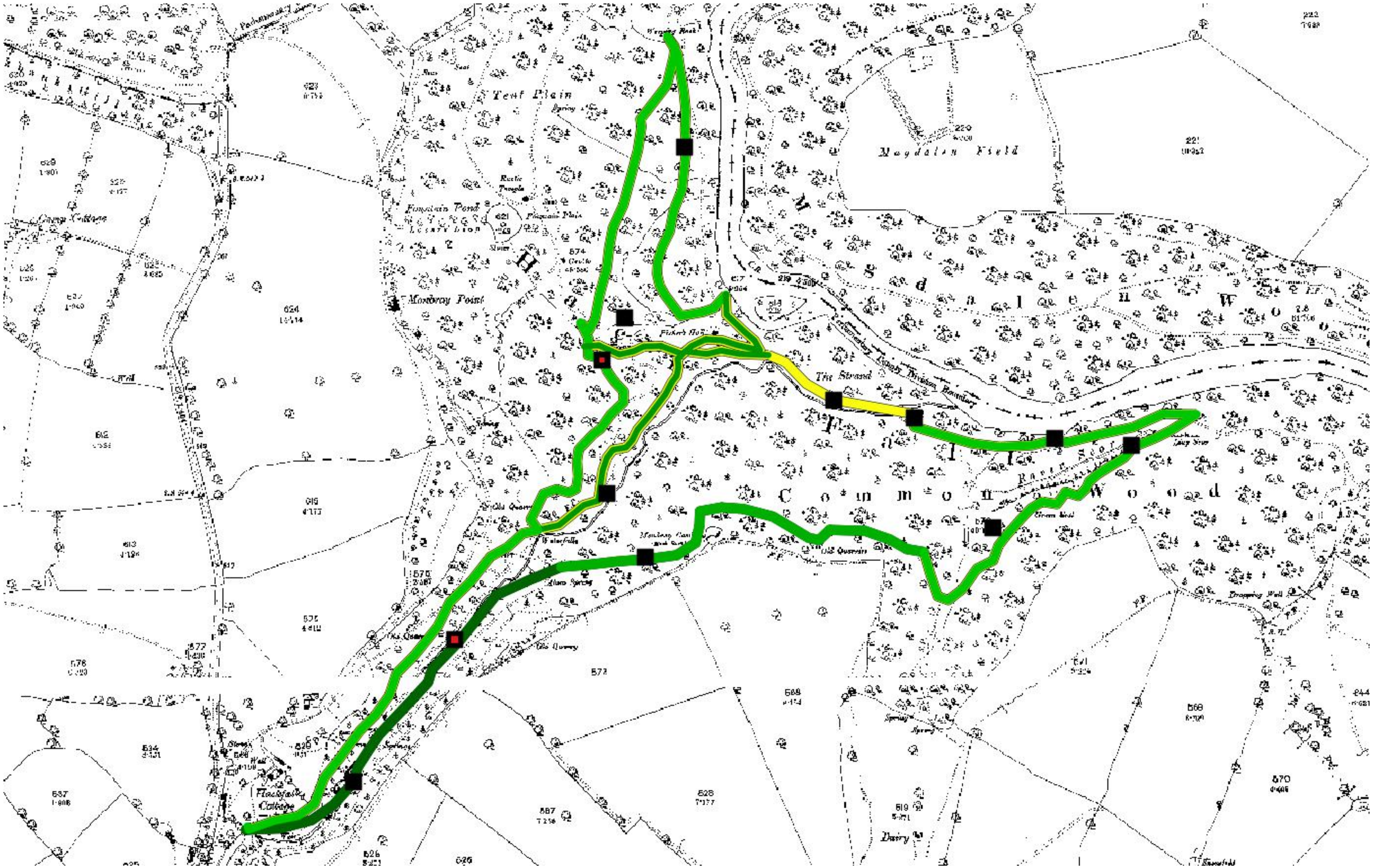


Figure 24.24 – *Dryopteris affinis*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

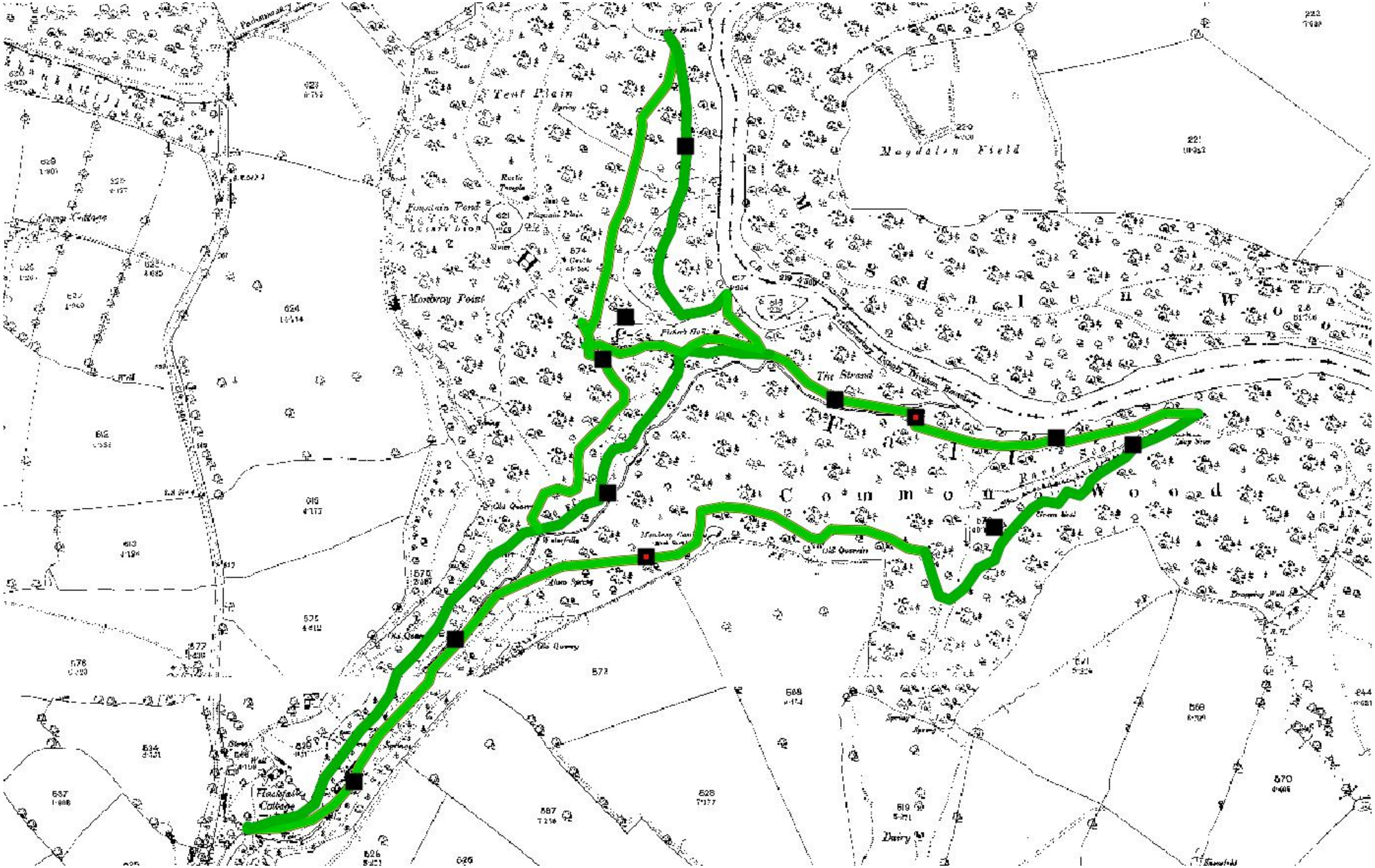


Figure 25.25 – *Dryopteris filix-mas*

Species maps for Hackfall wood

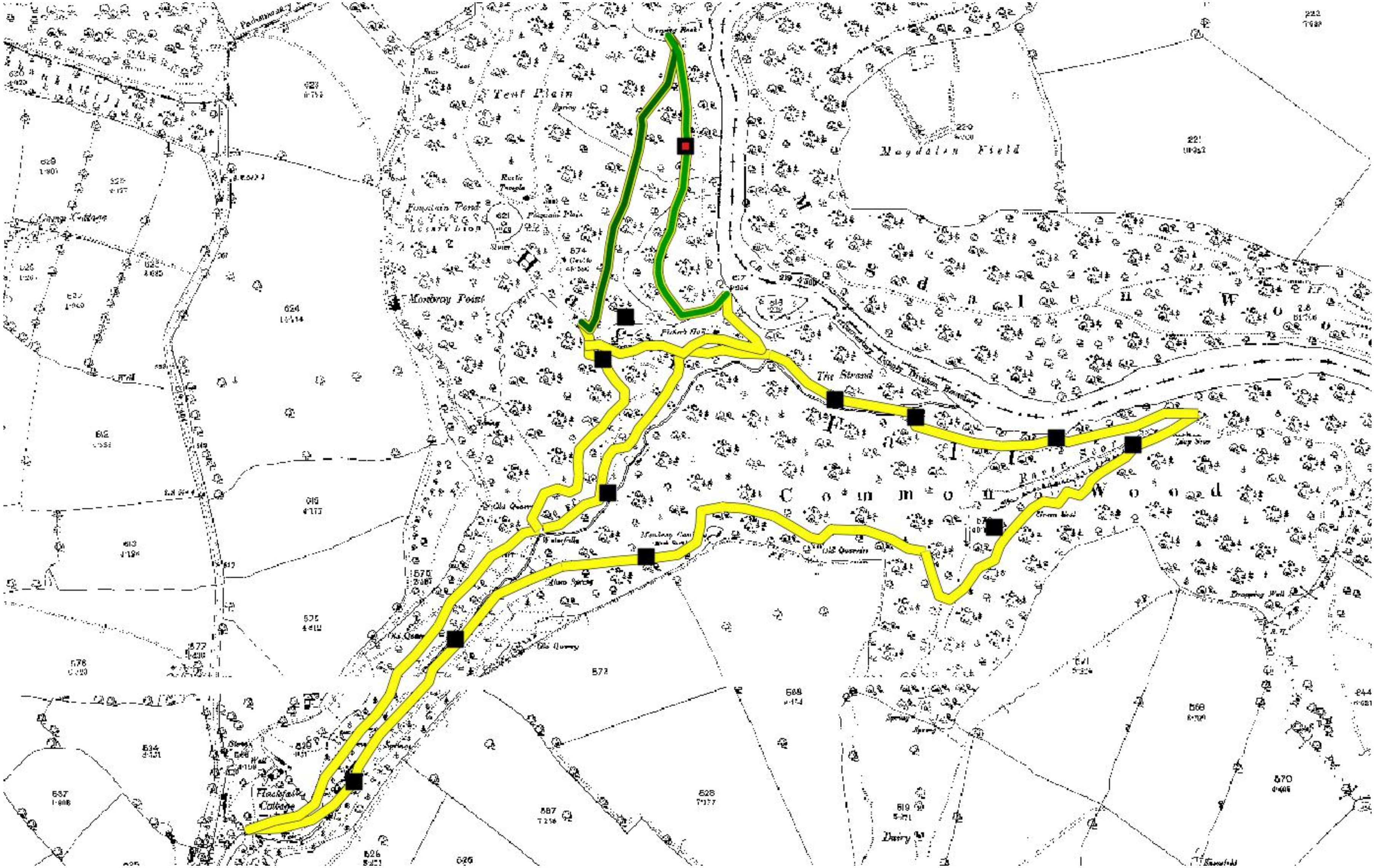


Figure 26.26 – *Equisetum telmateia*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

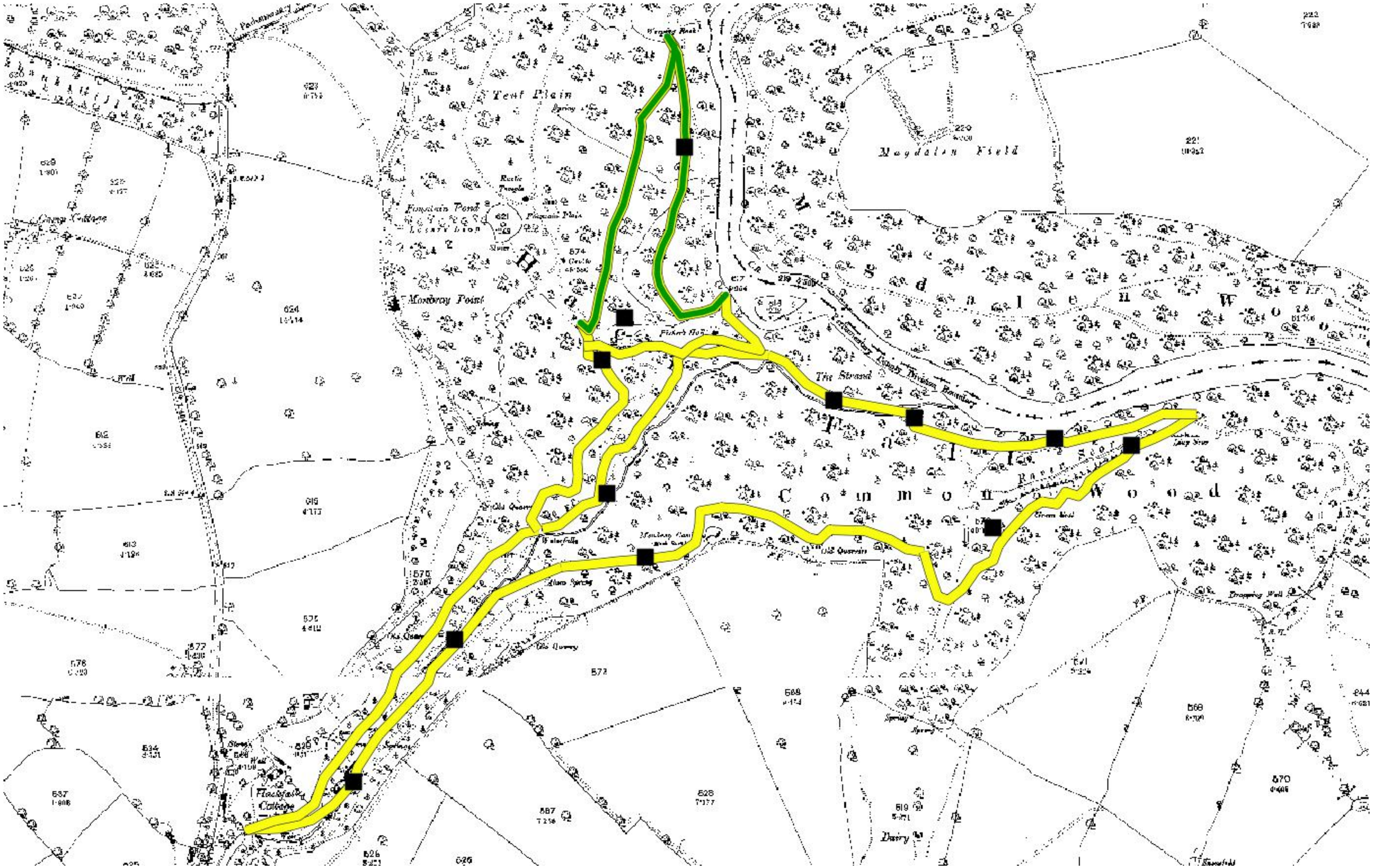


Figure 27.27 – *Fragaria vesca*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

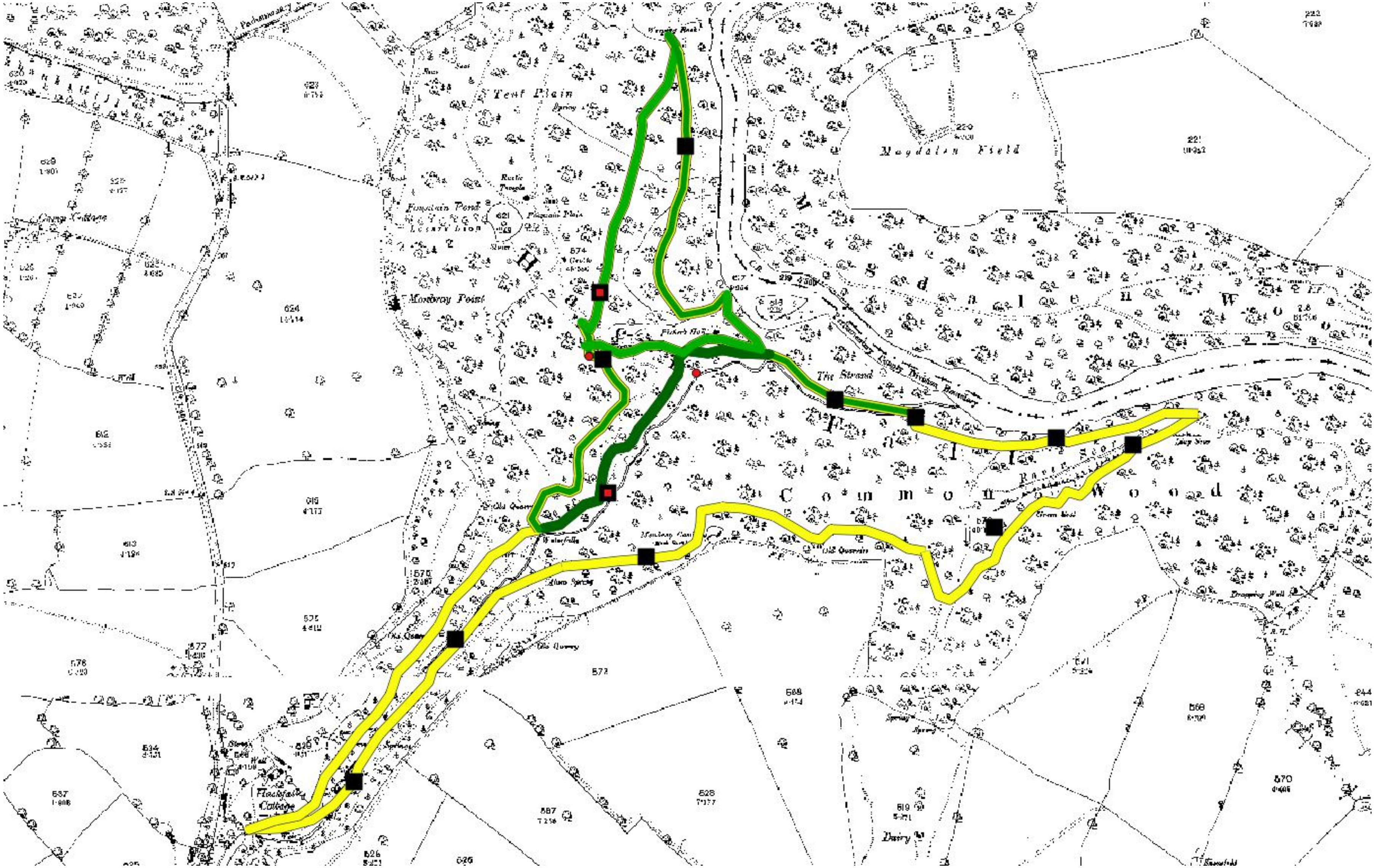


Figure 28.28 – *Galium odorata*

Species maps for Hackfall wood

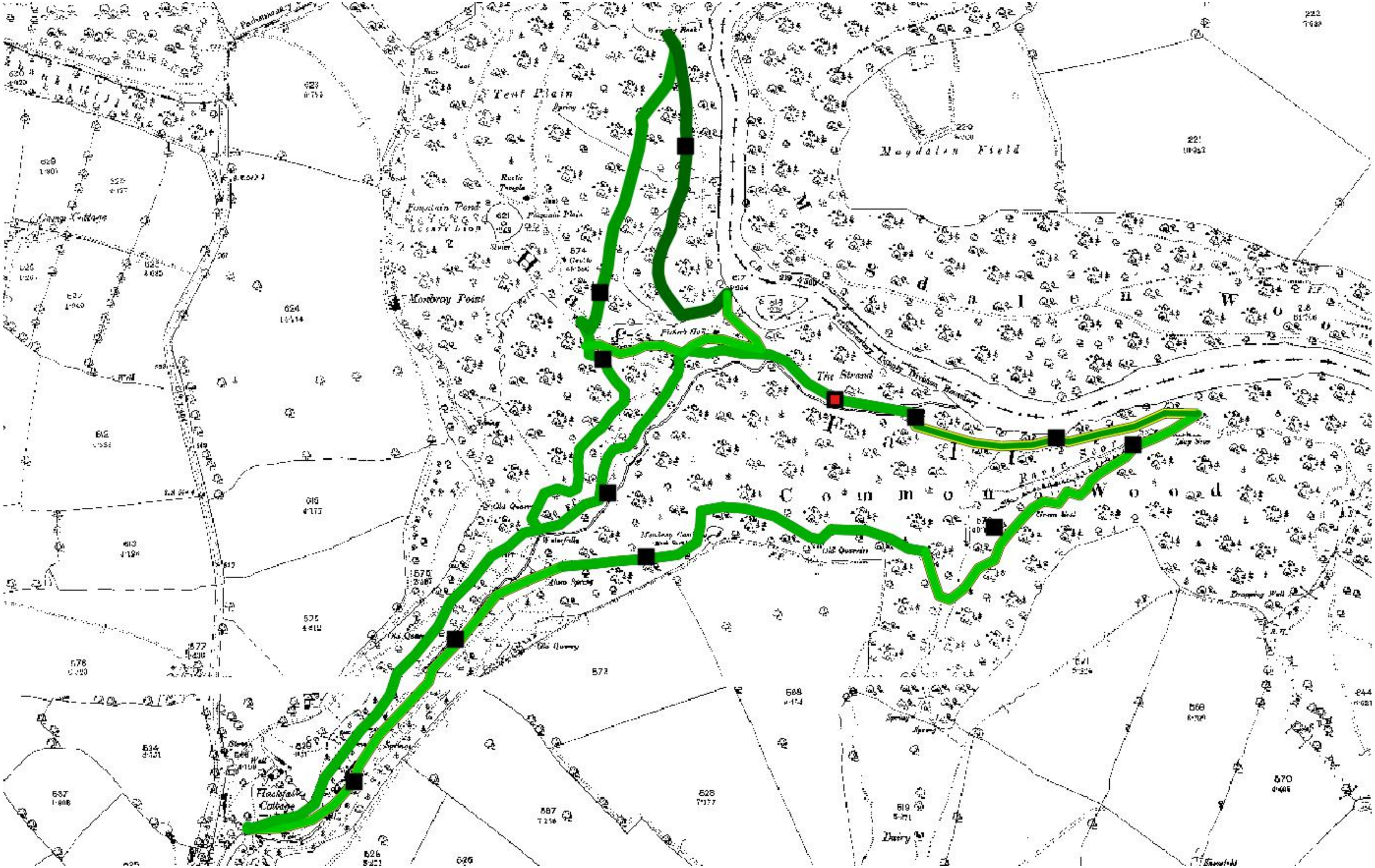


Figure 29.29 – *Geranium robertianum*

Species maps for Hackfall wood

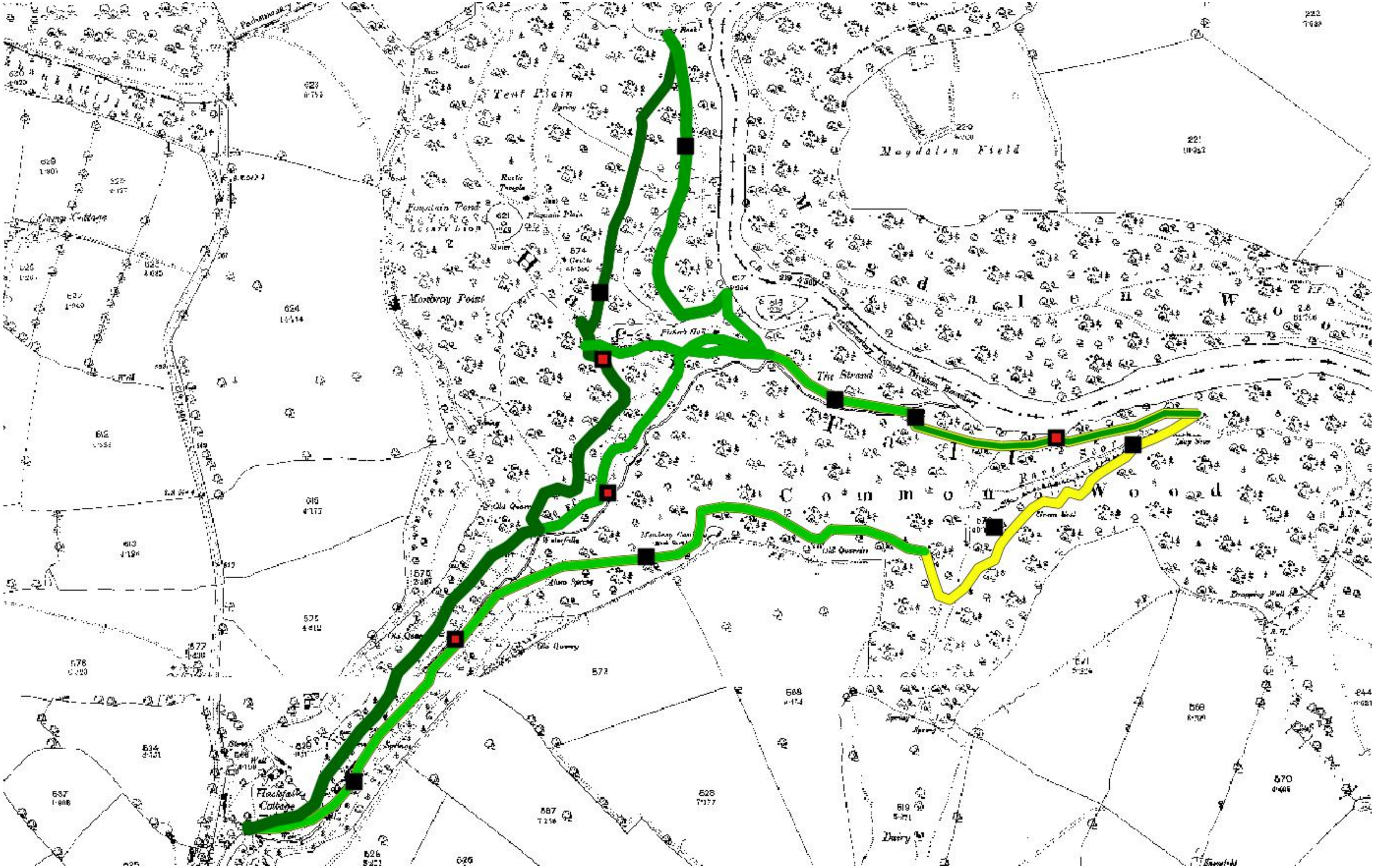


Figure 30.30 – *Geum urbanum*

Species maps for Hackfall wood

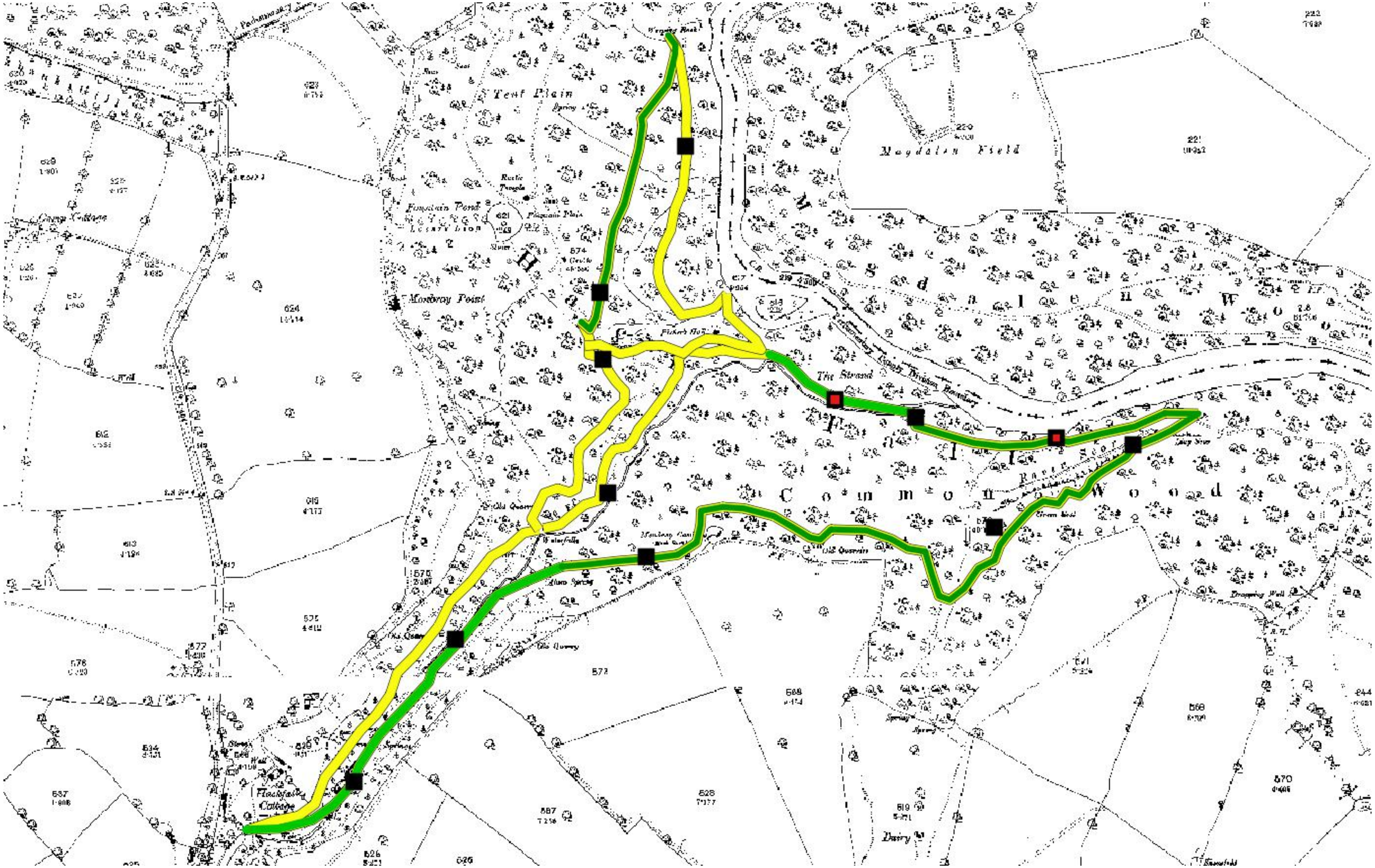


Figure 31.31 – *Glechoma hederacea*

Species maps for Hackfall wood

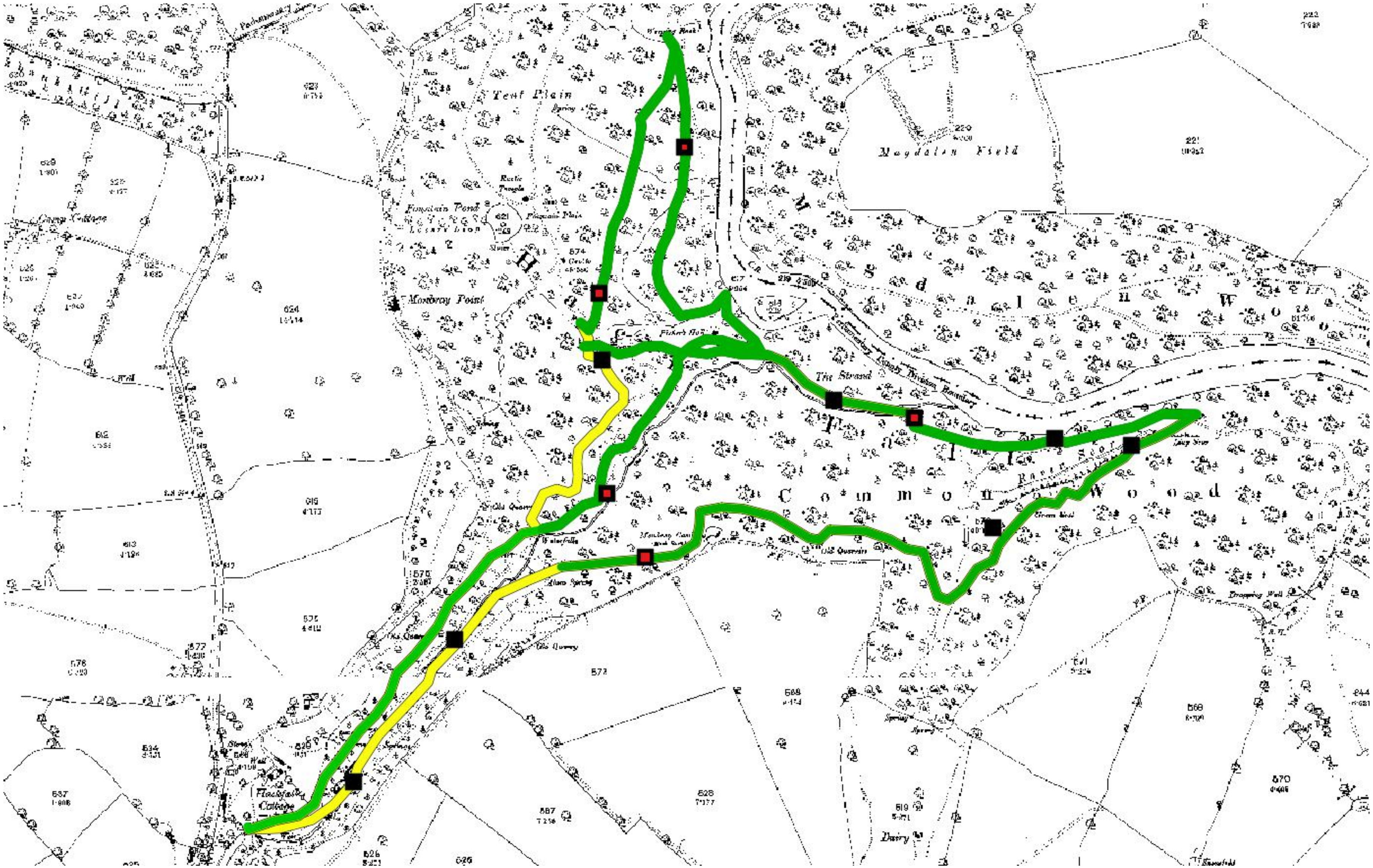


Figure 32.32 – *Hedera helix*

Species maps for Hackfall wood

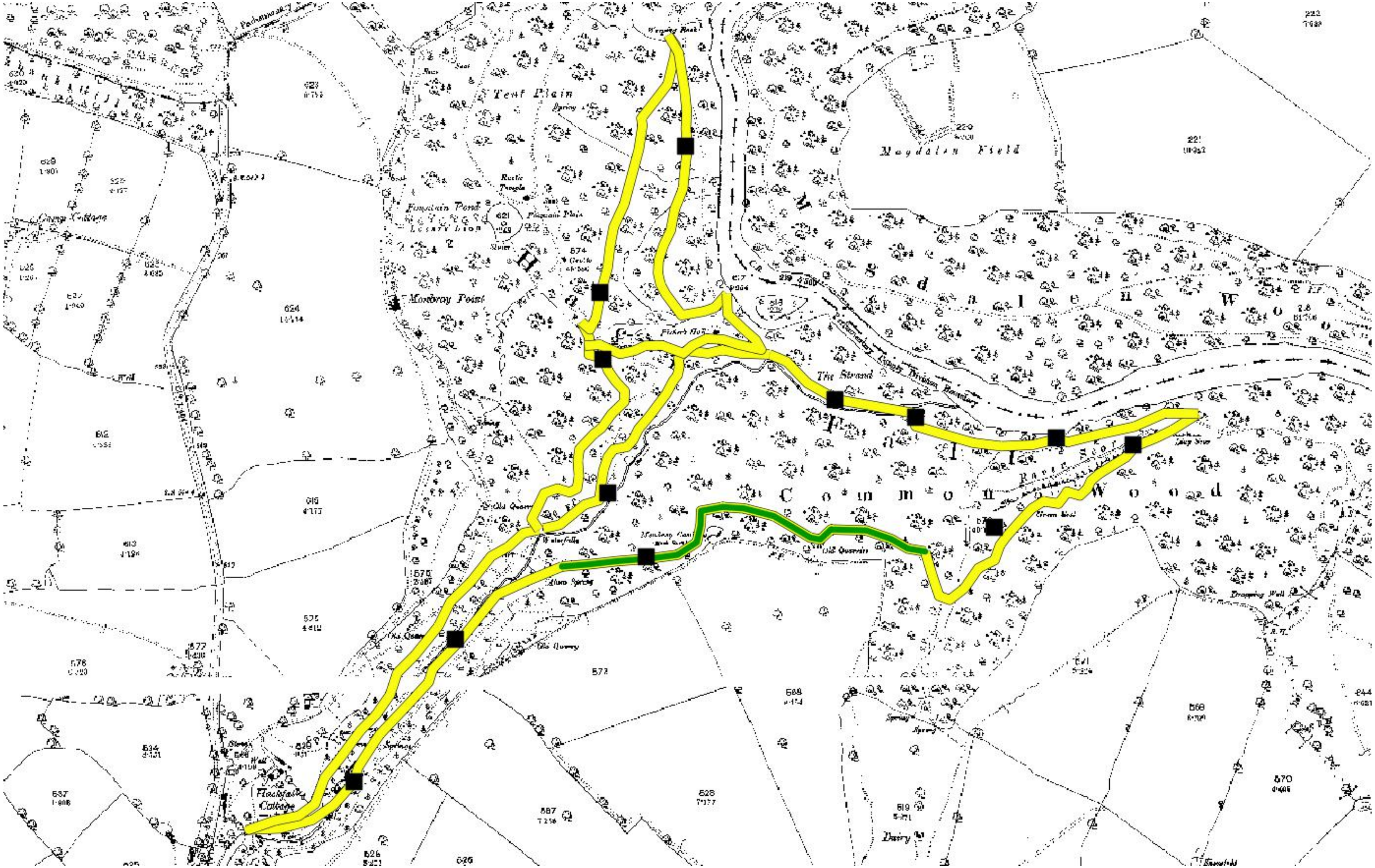


Figure 33.33 – *Holcus mollis*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

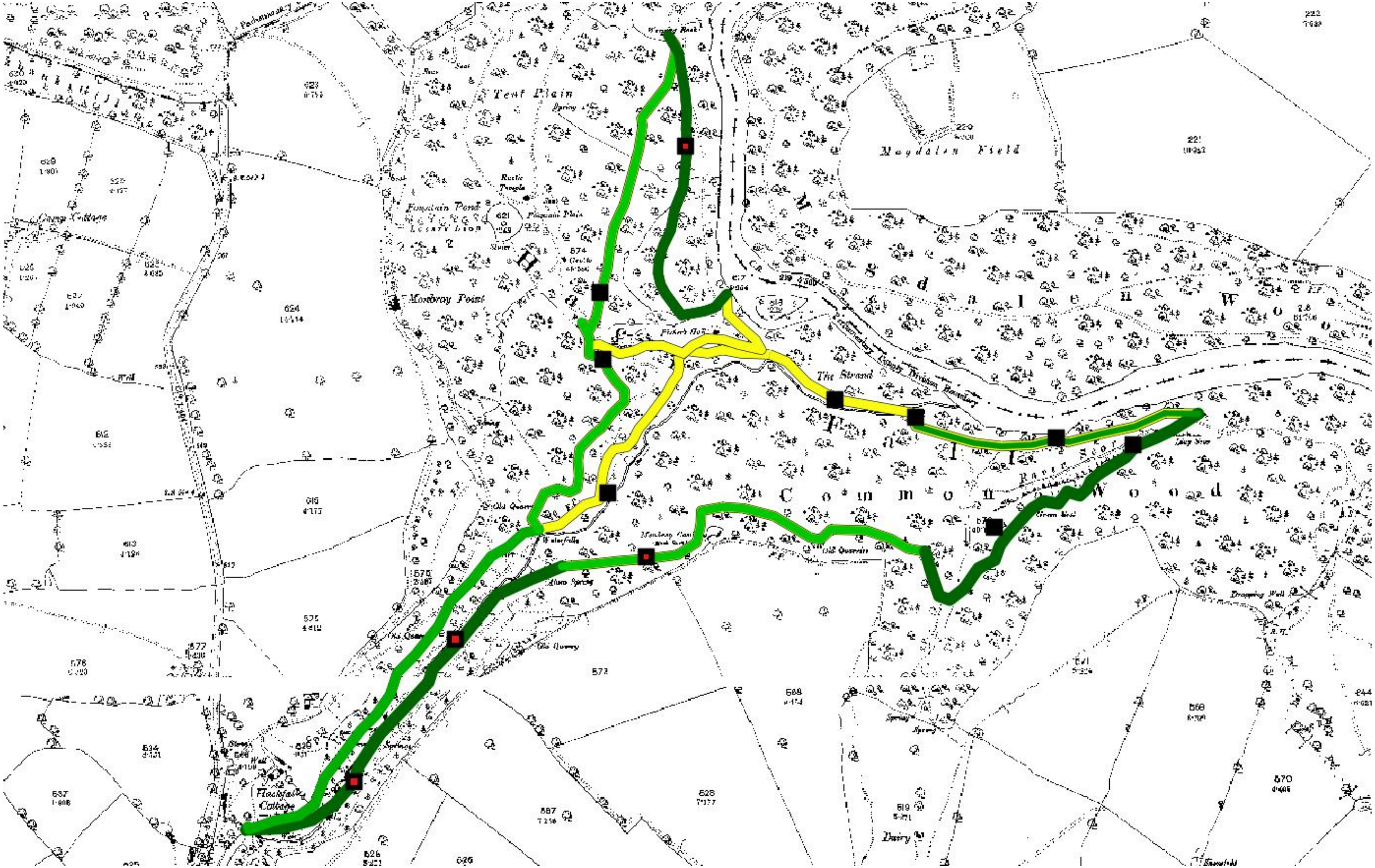


Figure 34.34 – *Hyacinthoides non-scripta*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

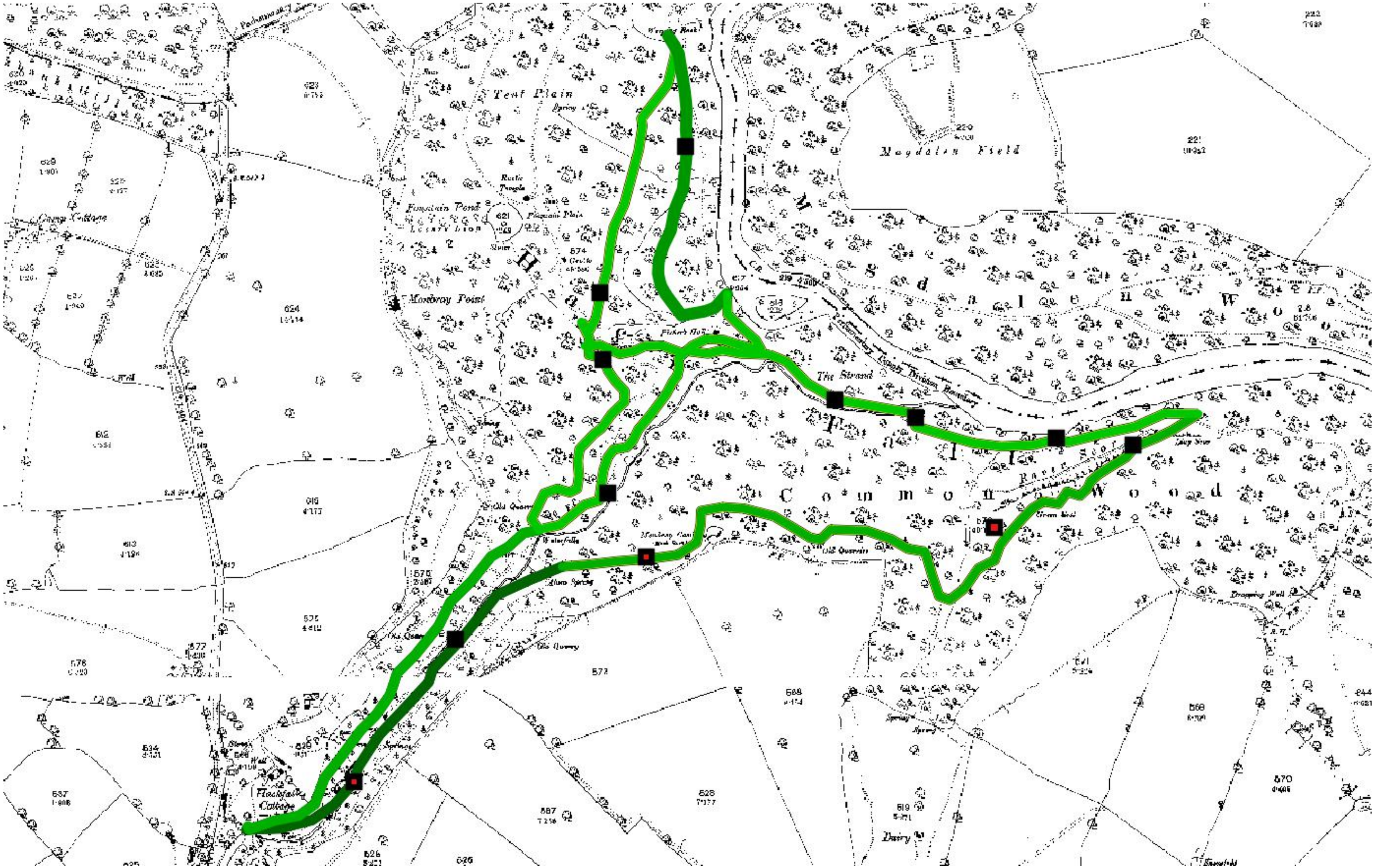


Figure 35.35 – *Ilex aquifolium*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

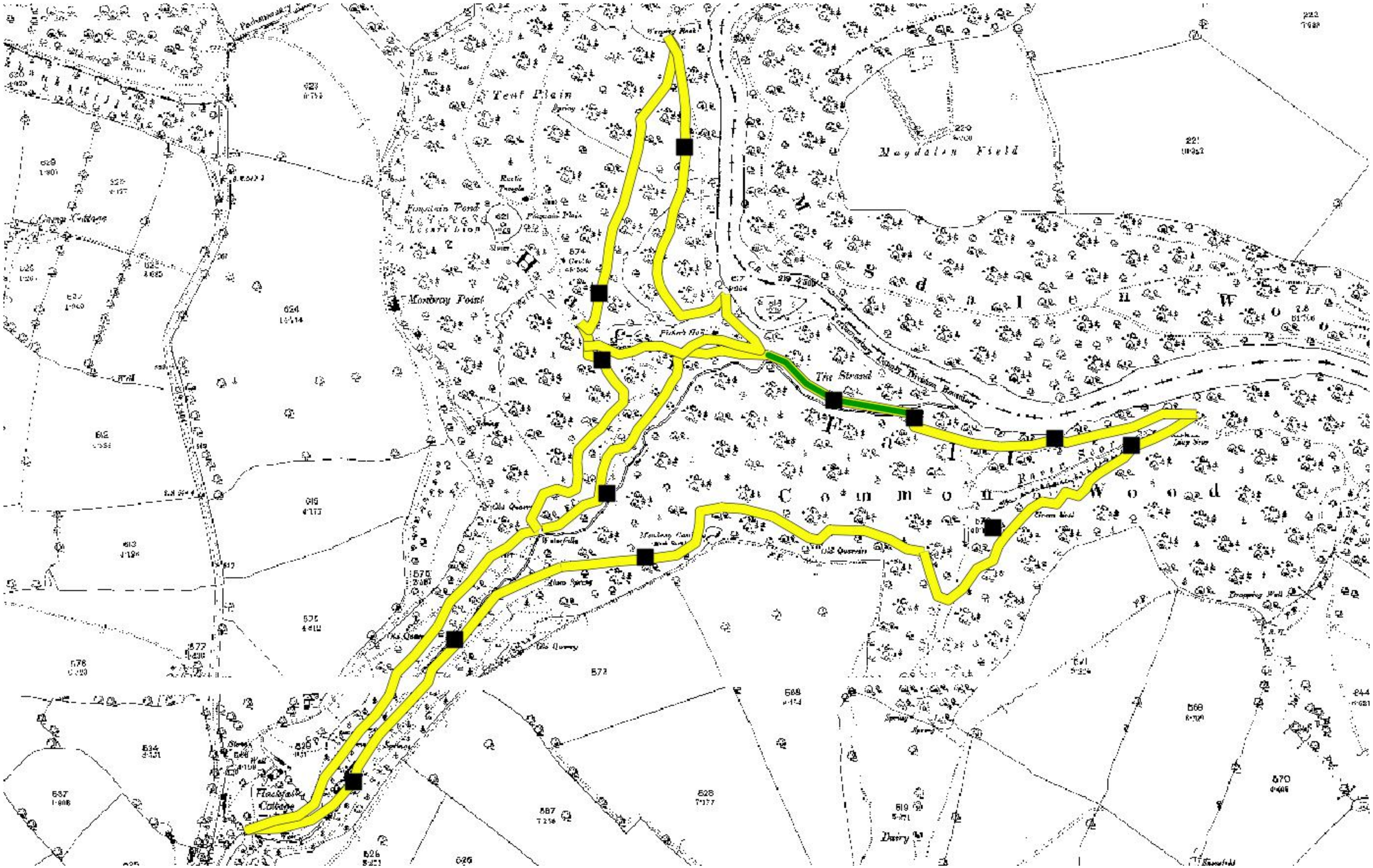


Figure 36.36 – *Lathraea squamaria*

Species maps for Hackfall wood

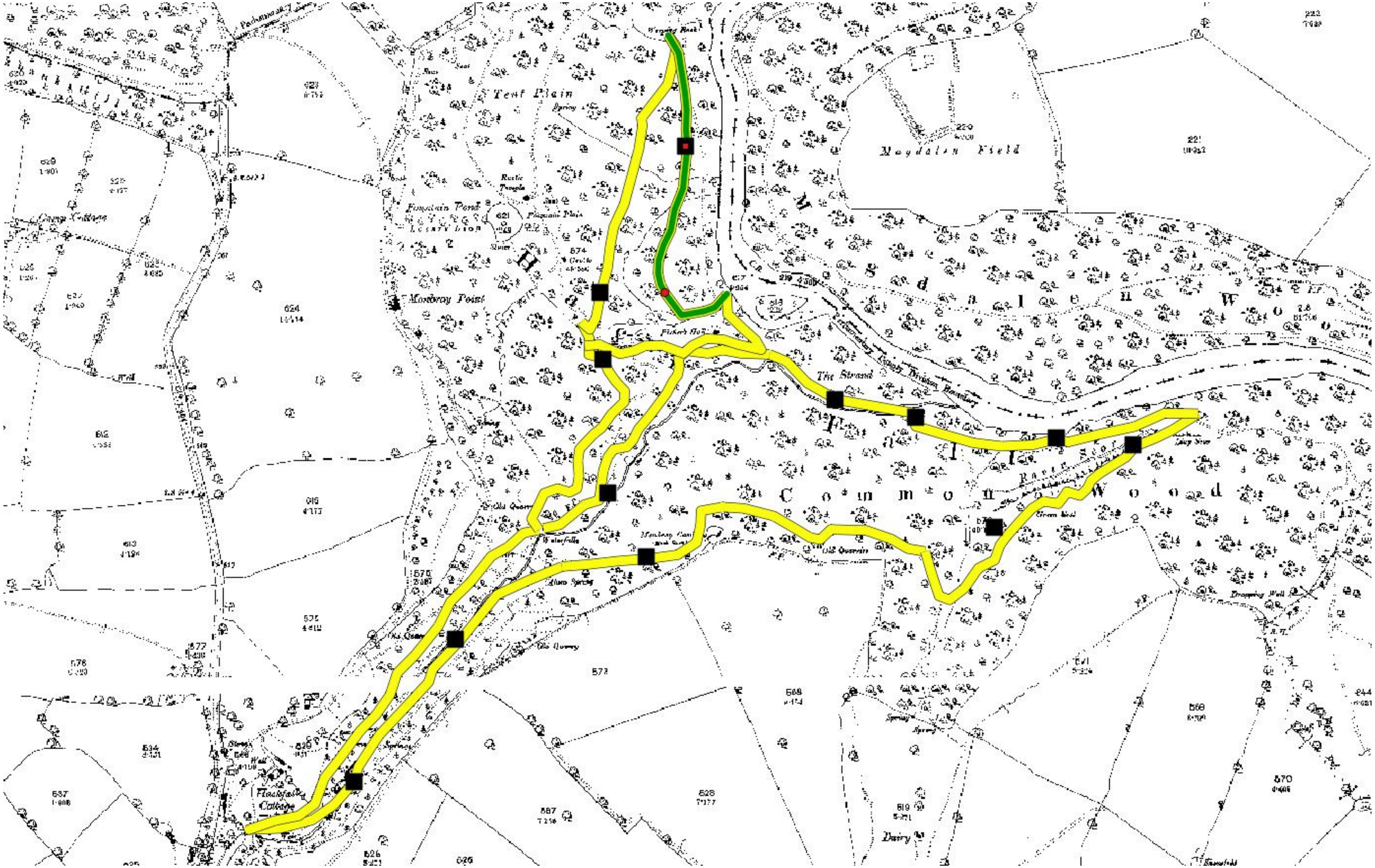


Figure 37.37 – *Listera ovata*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

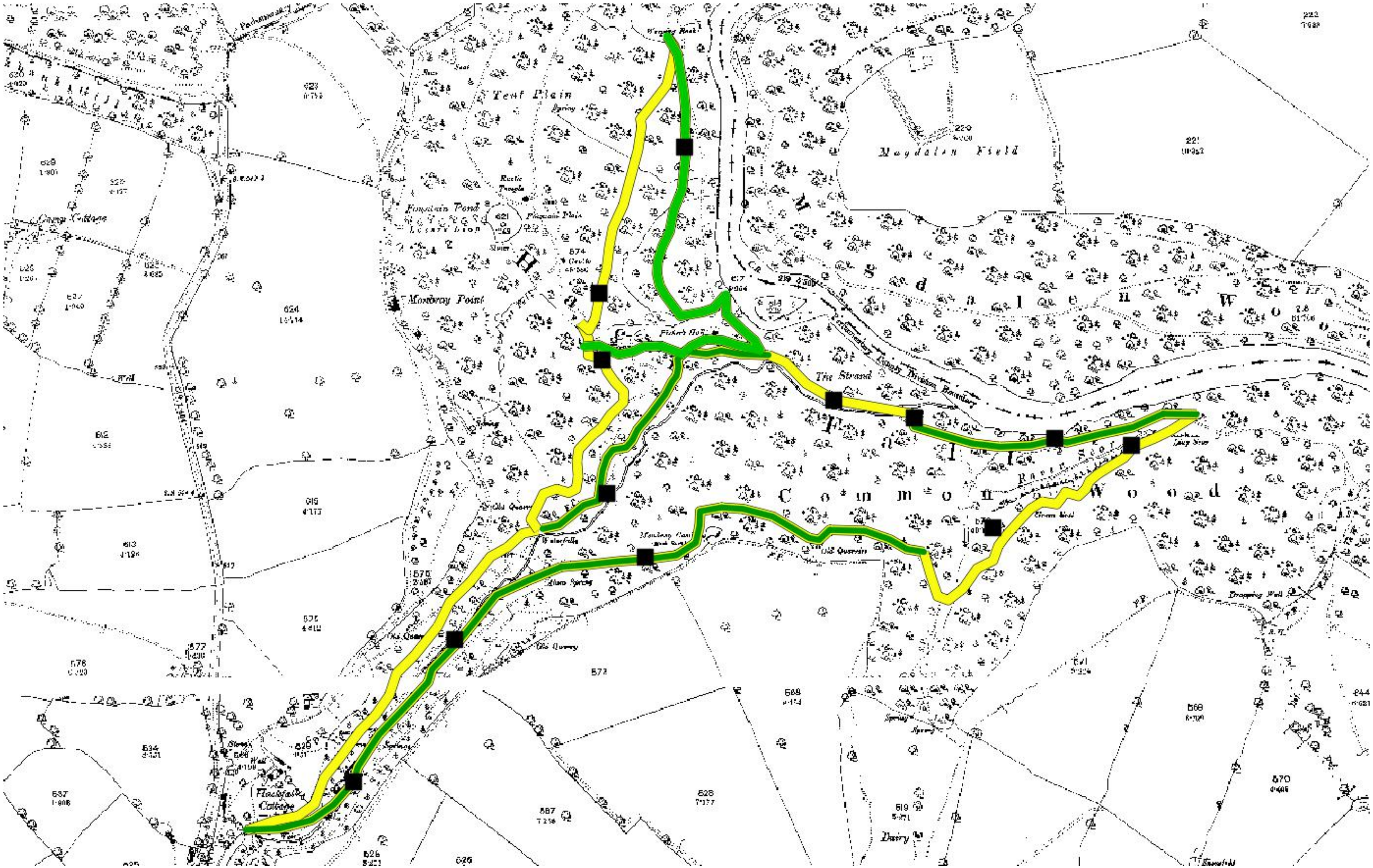


Figure 38.38 – *Lonicera periclymenum*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

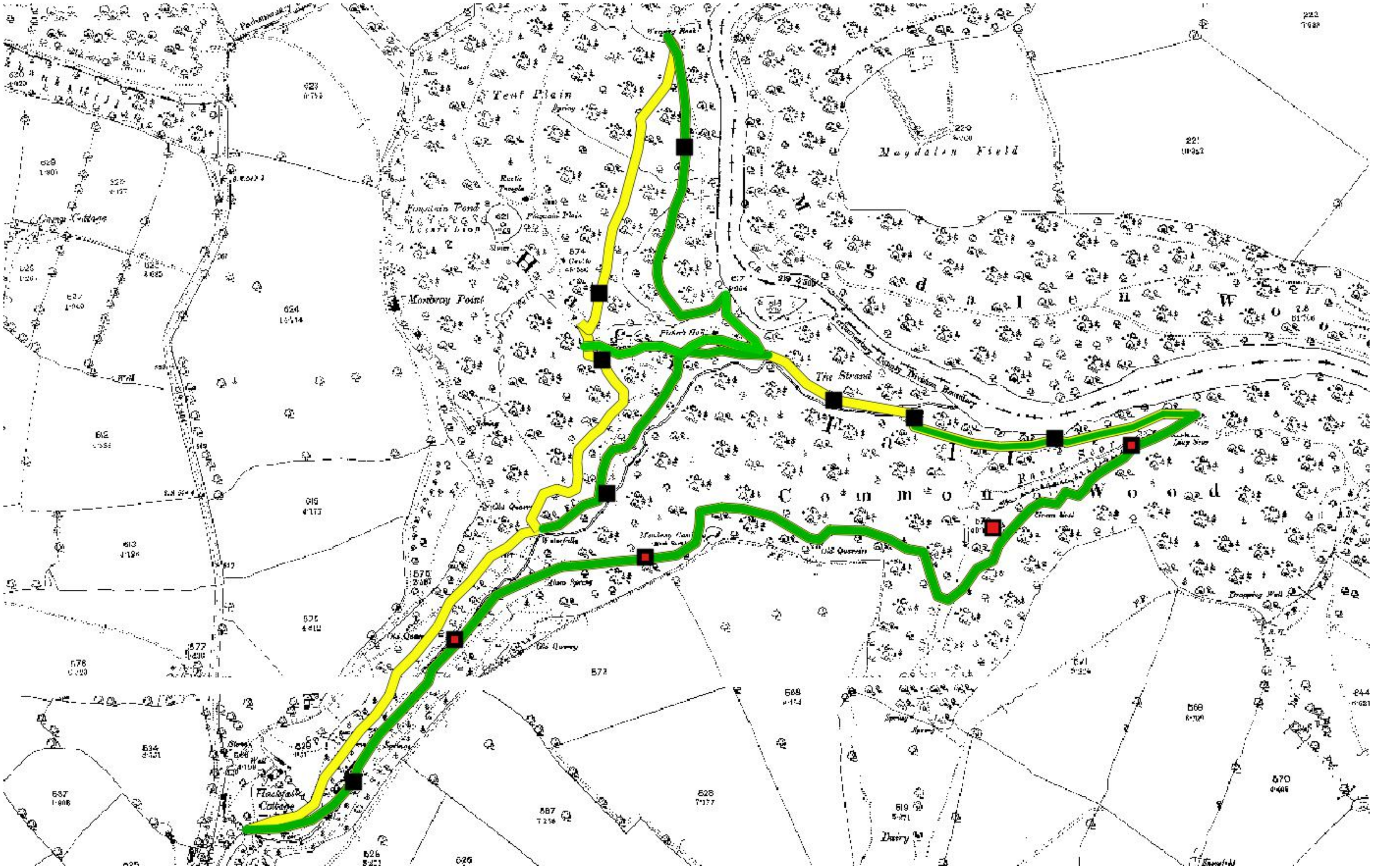


Figure 39.39 – *Luzula sylvatica*

Species maps for Hackfall wood

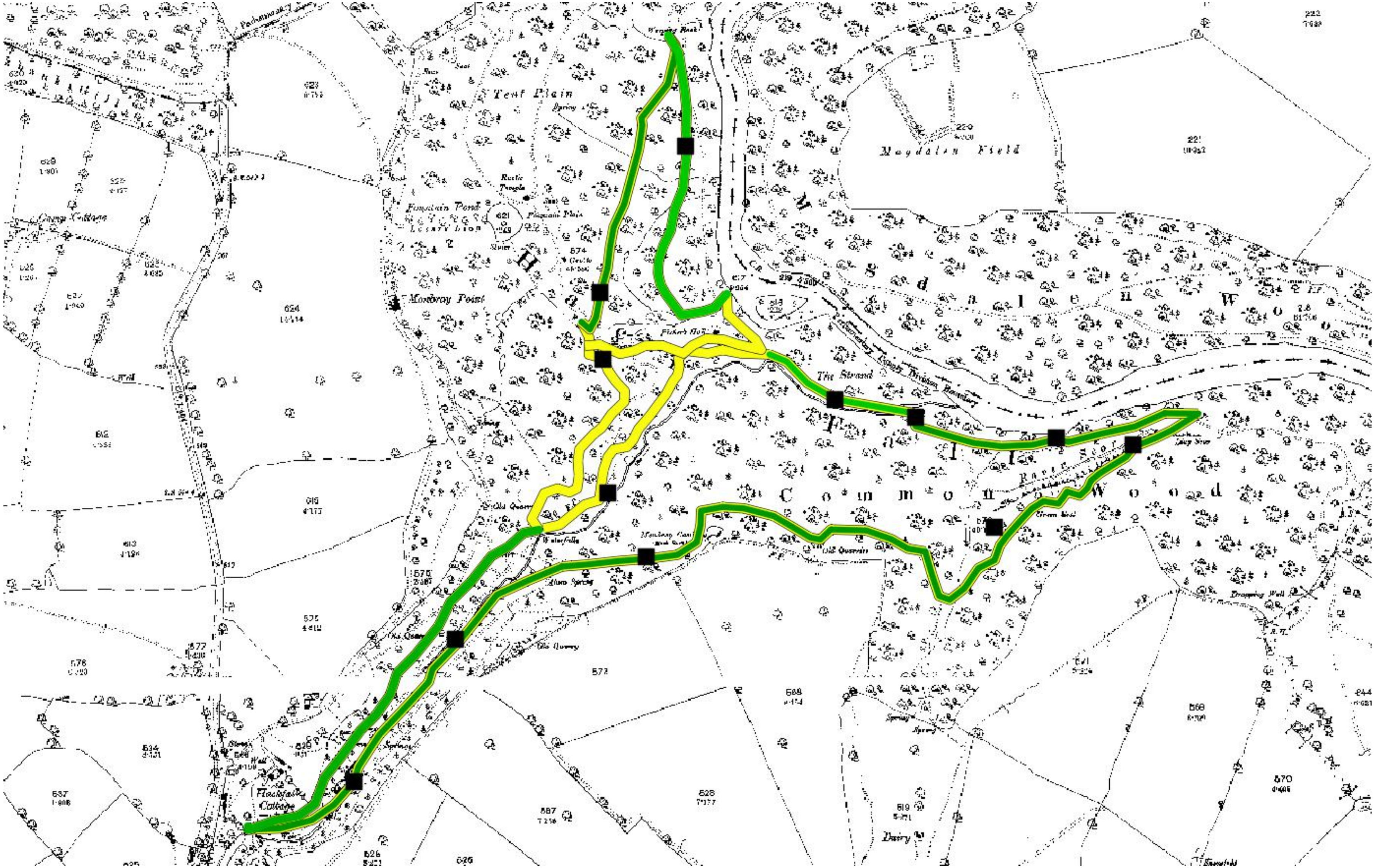


Figure 40.40 – *Lysimachia nemorum*

Species maps for Hackfall wood

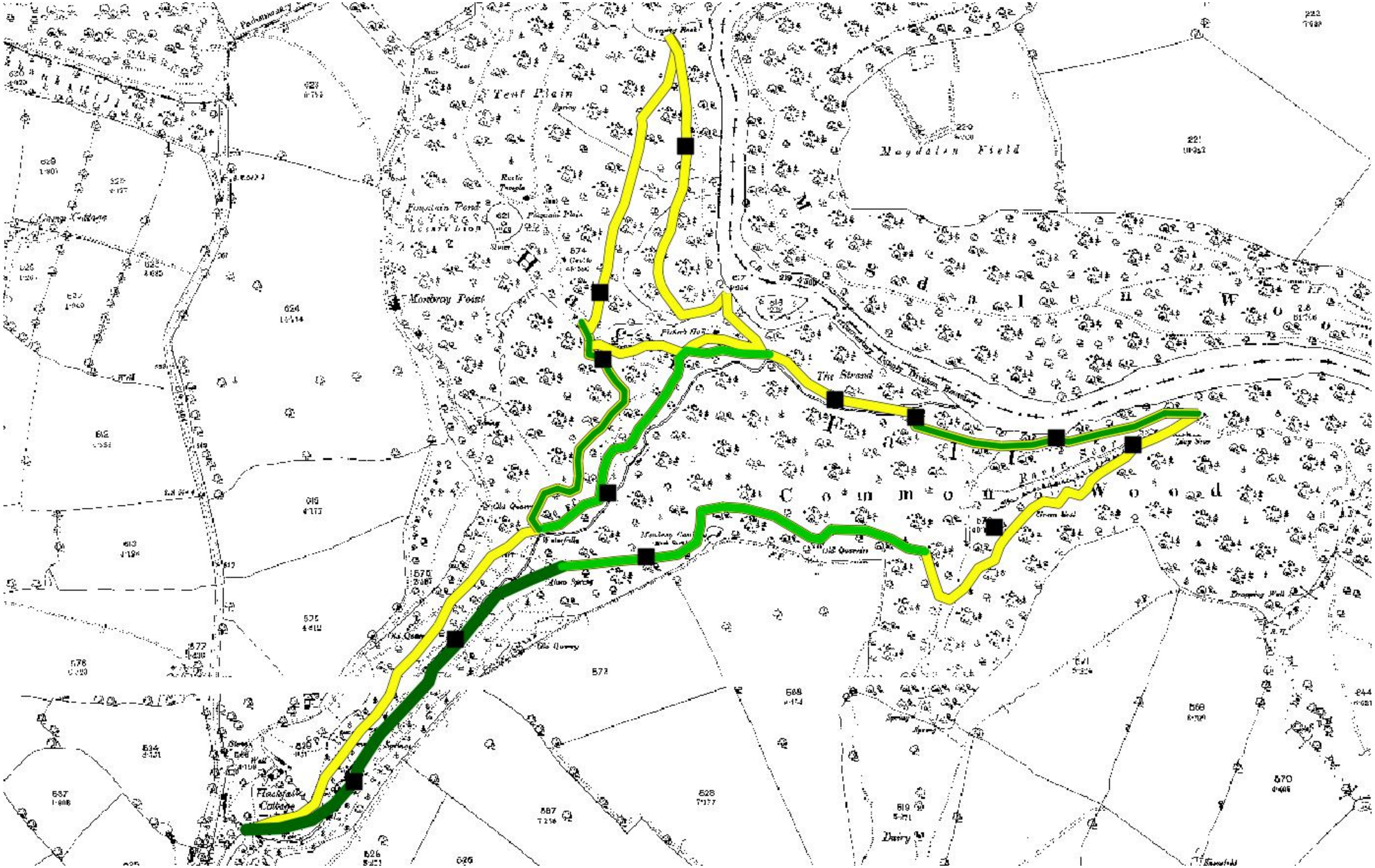


Figure 41.41 – *Melica uniflora*

Species maps for Hackfall wood

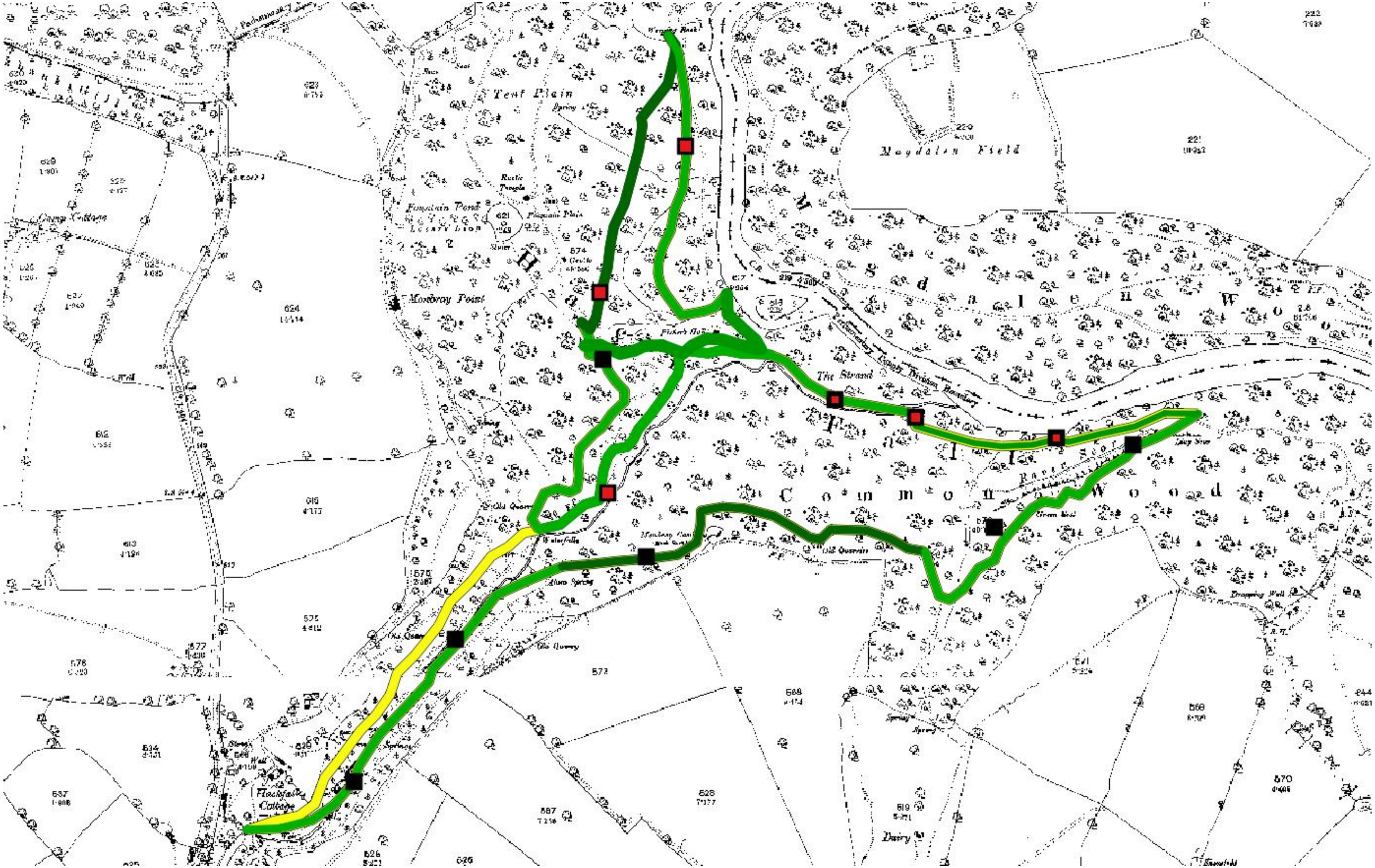


Figure 42.42 – *Mercurialis perennis*

Species maps for Hackfall wood

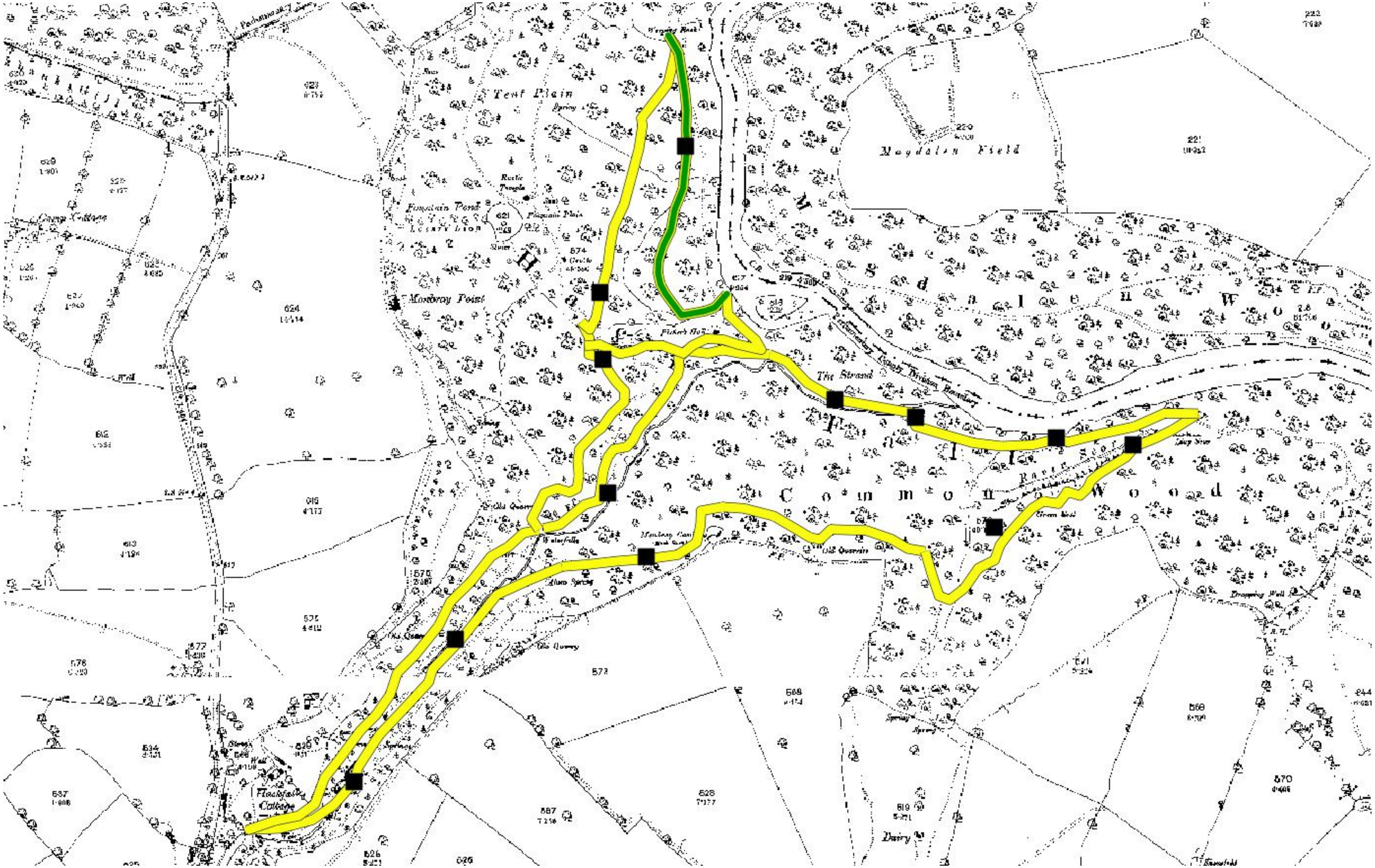


Figure 43.43 – *Orchis mascula*

Species maps for Hackfall wood

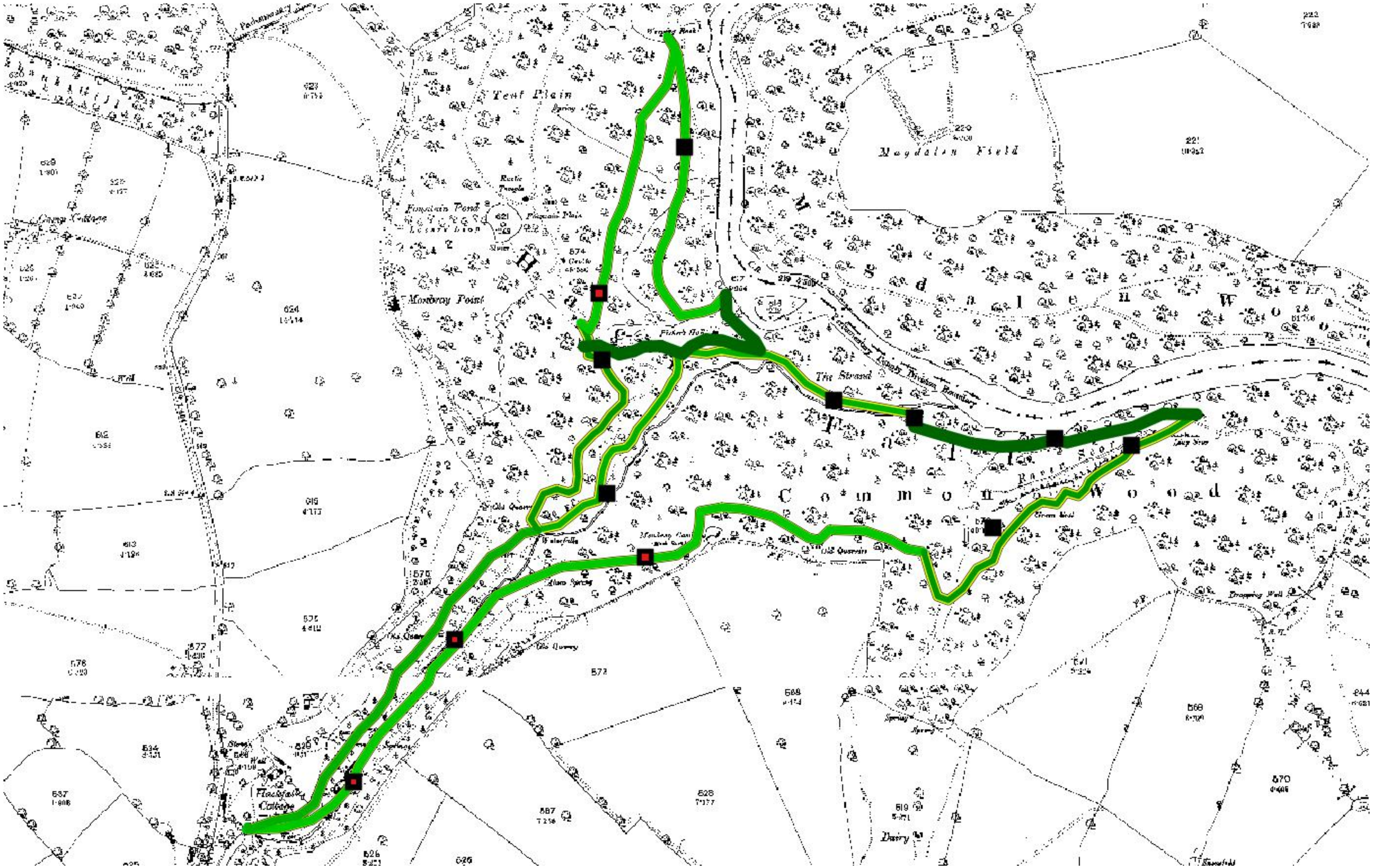


Figure 44.44 – *Oxalis acetosella*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

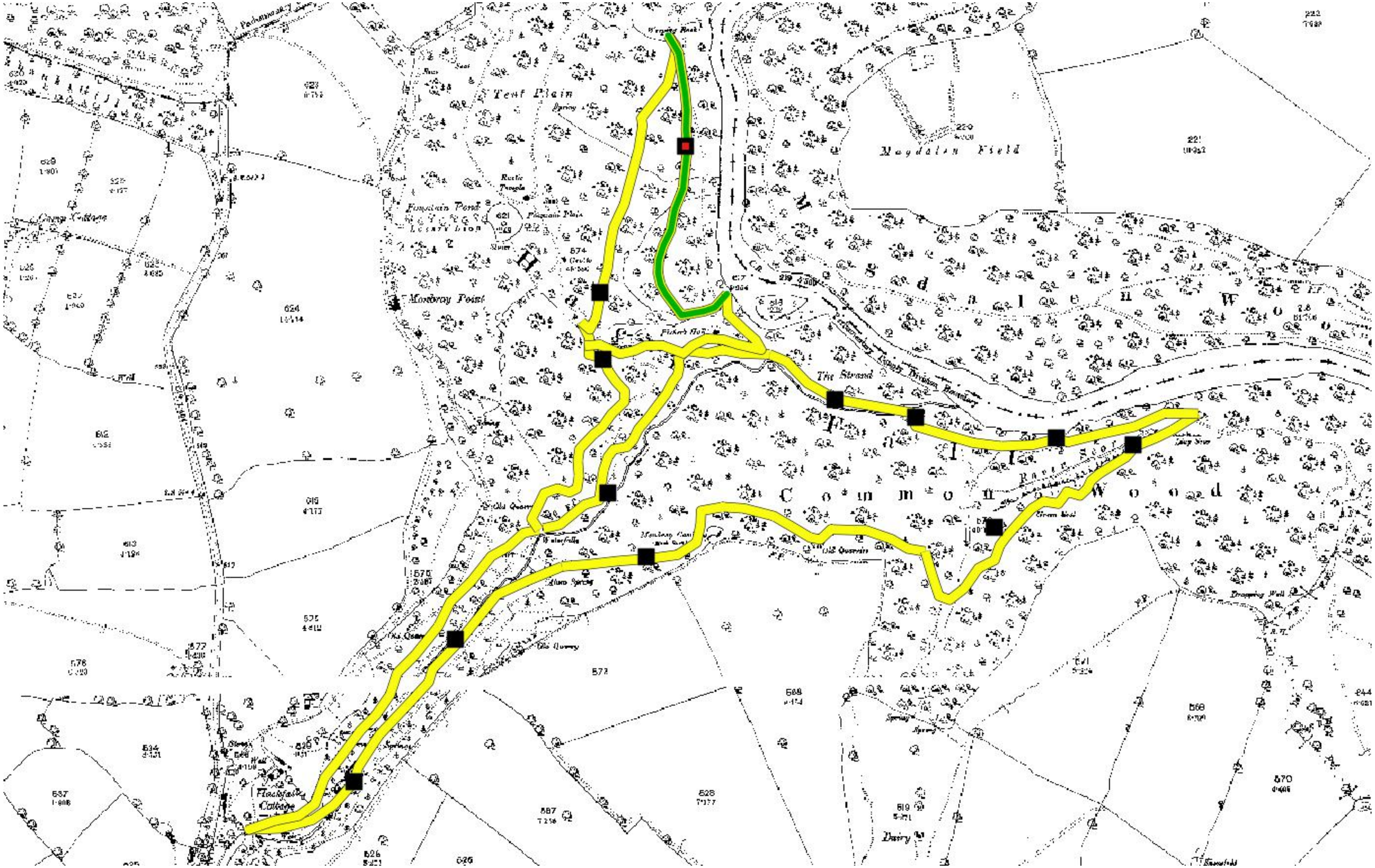


Figure 45.45 – *Paris quadrifolia*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

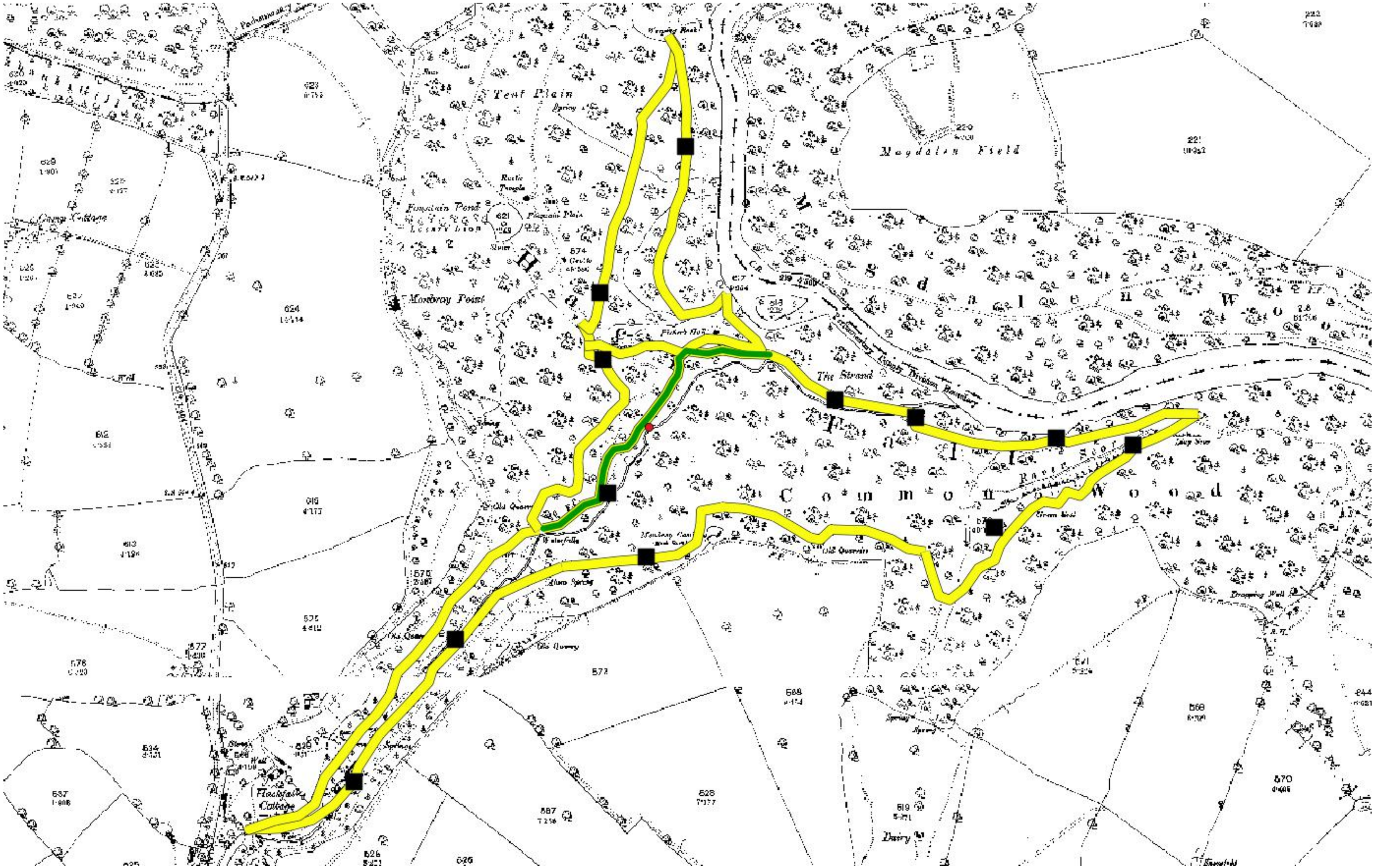


Figure 46.46 – *Phegopteris connectilis*

Species maps for Hackfall wood

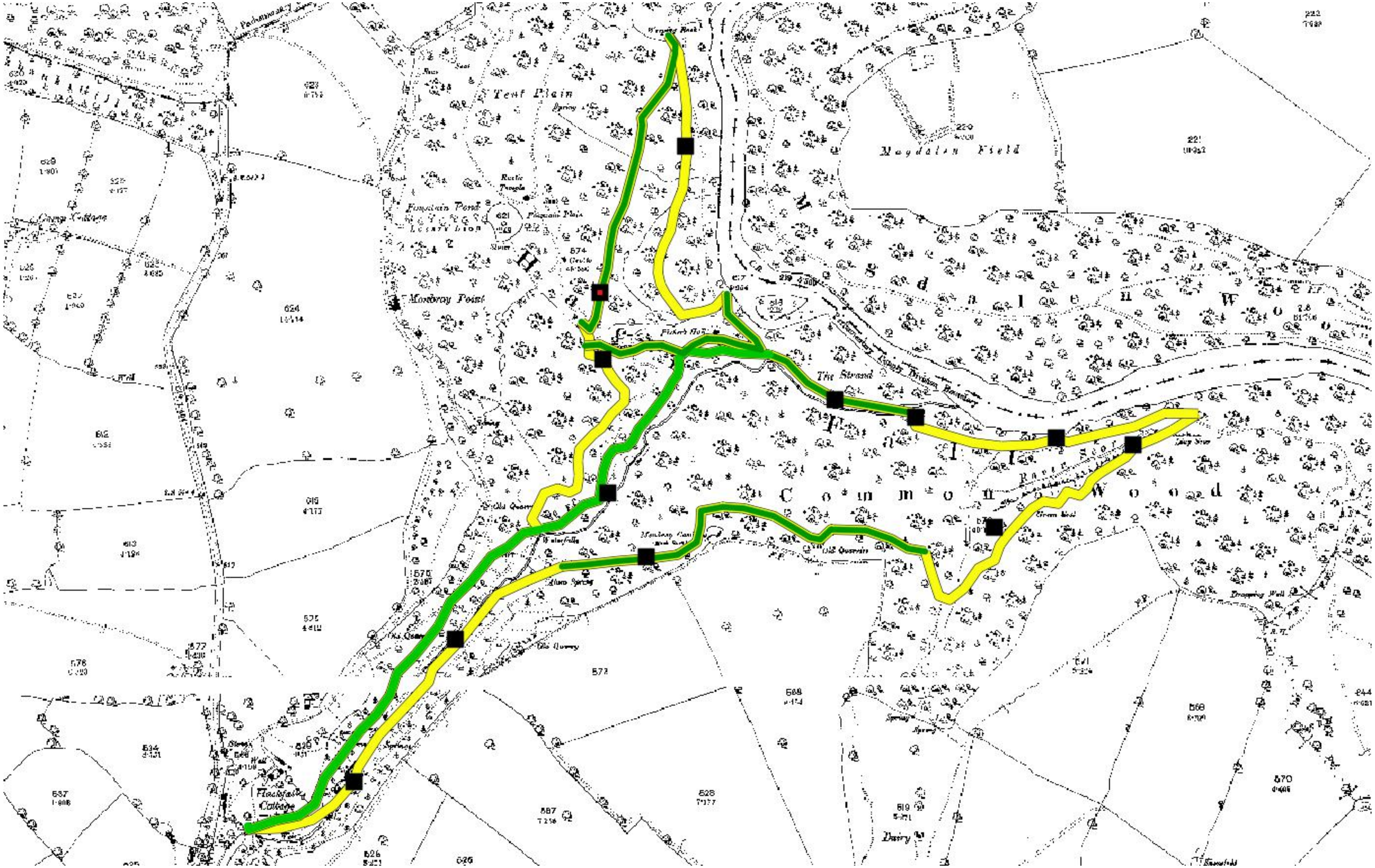


Figure 47.47 – *Phyllitis scolopendrium*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

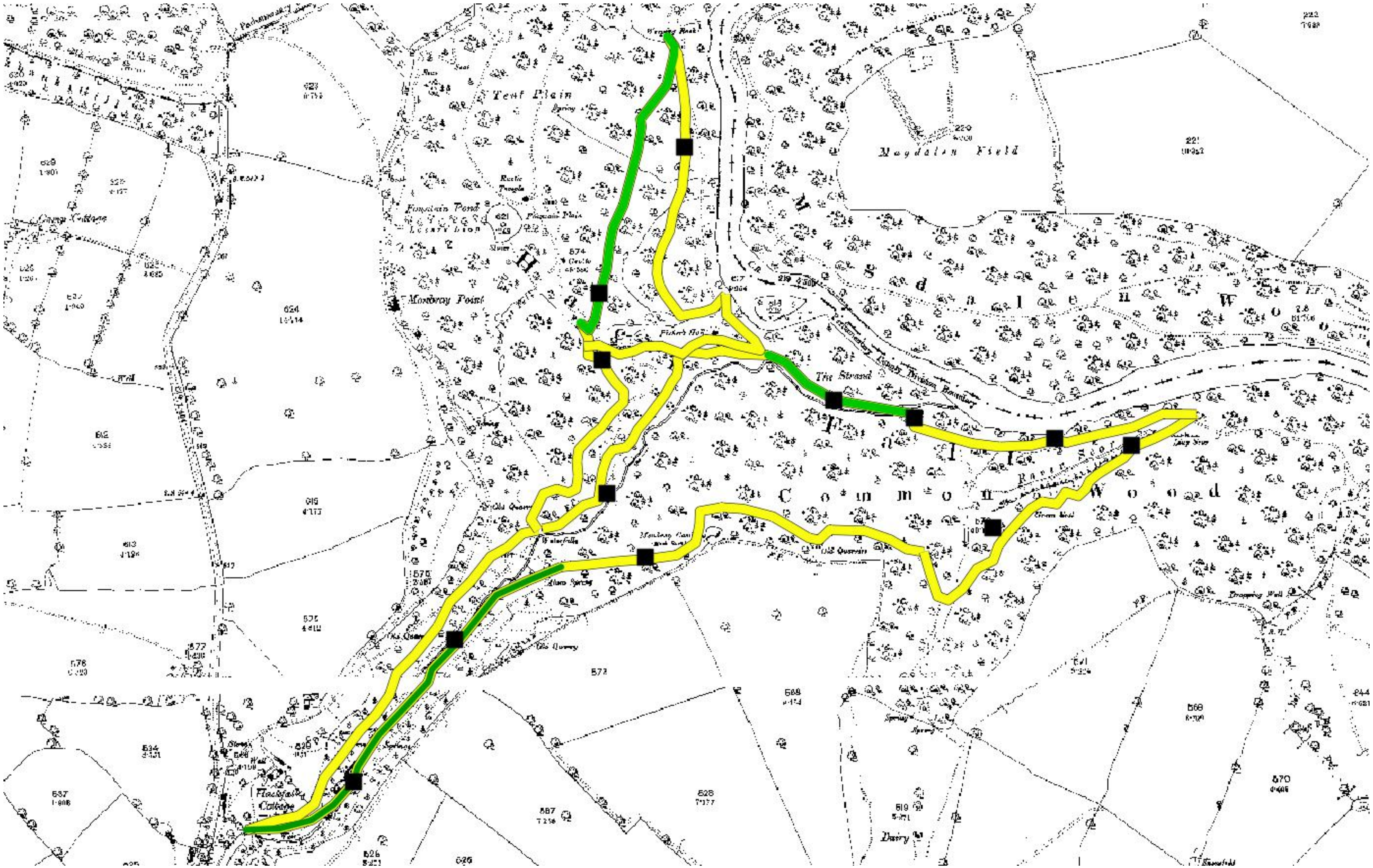


Figure 48.48 – *Poa nemoralis*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

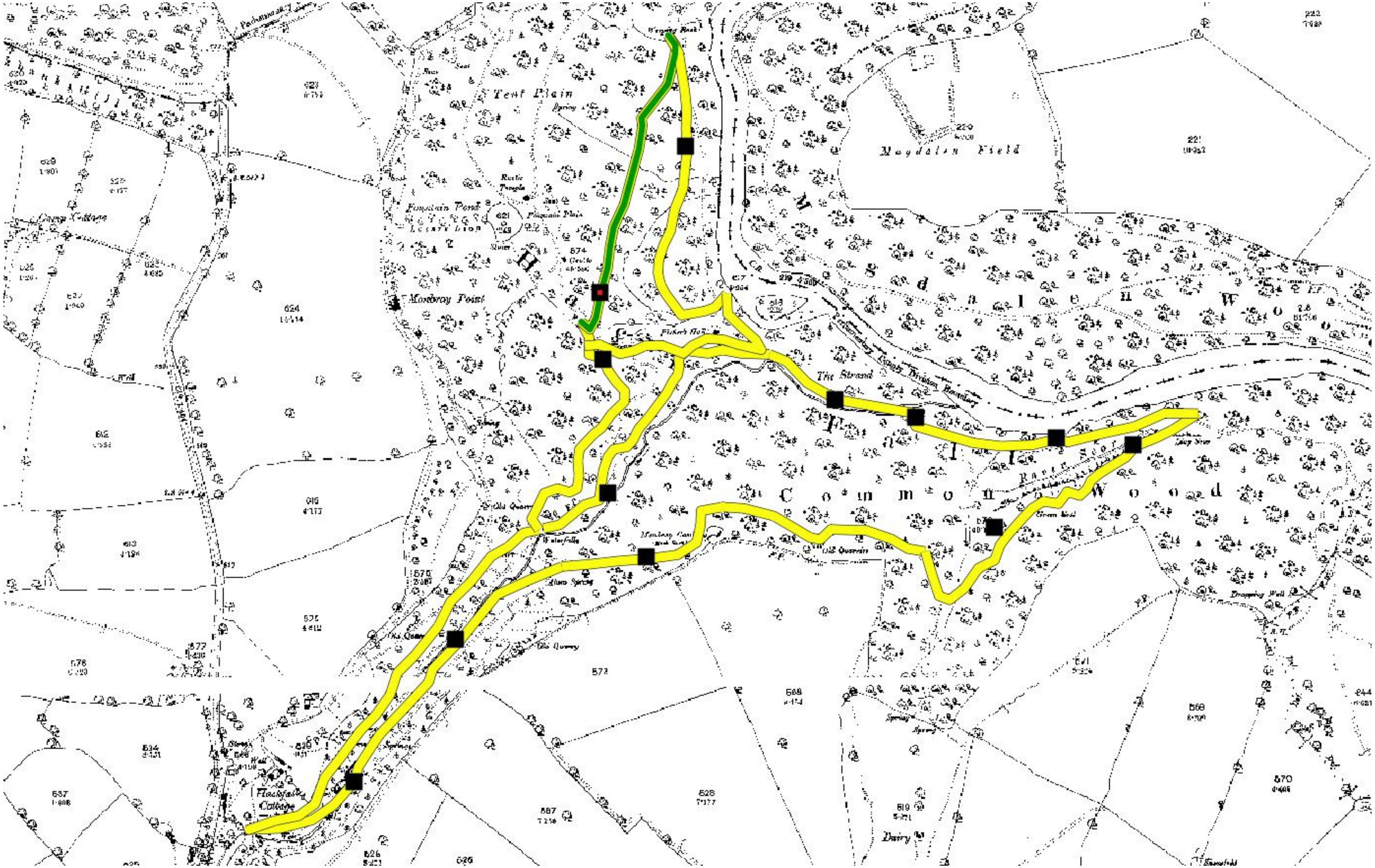


Figure 49 – *Polystichum aculeatum*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

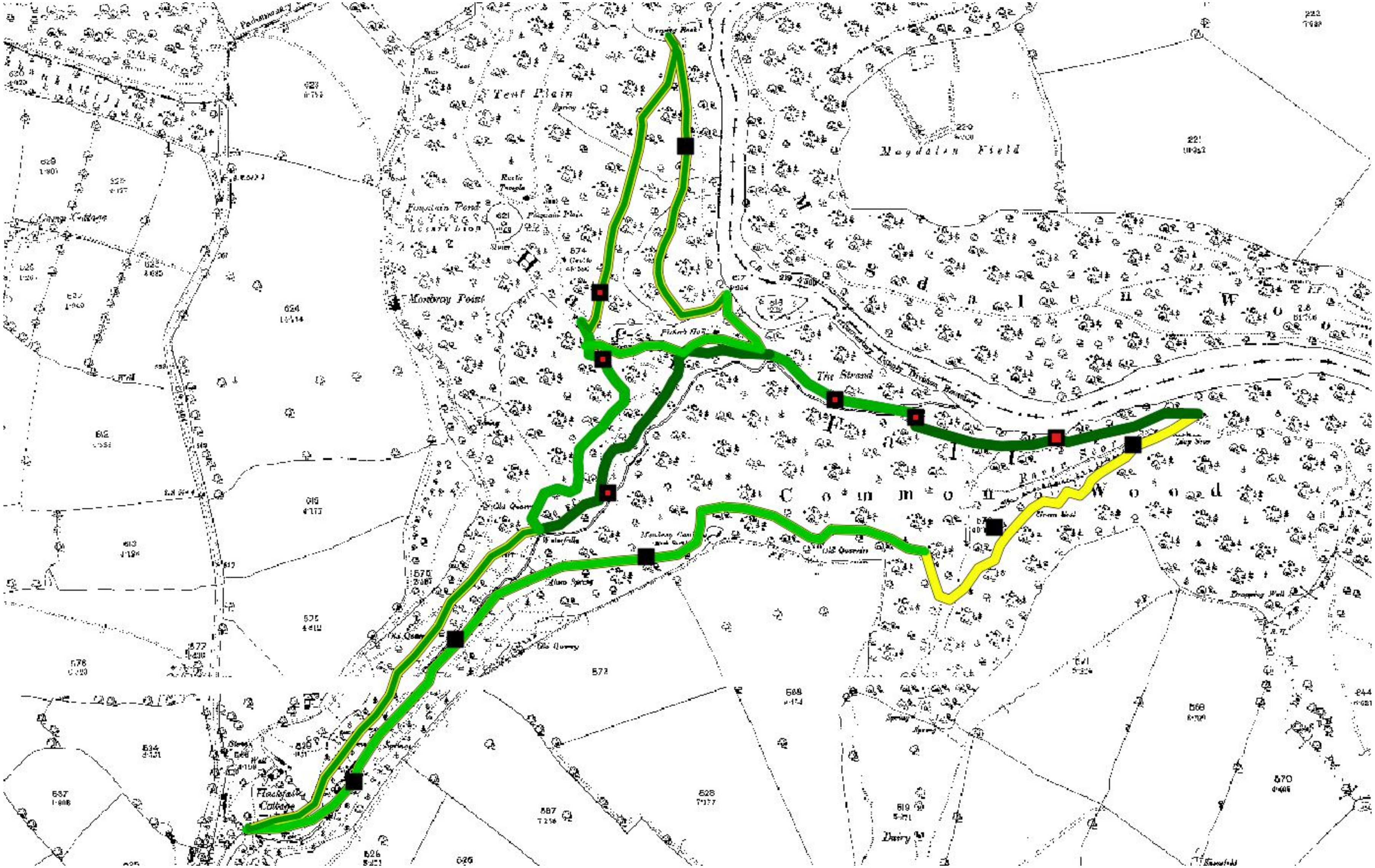


Figure 50.50 – *Polystichum setiferum*

Species maps for Hackfall wood

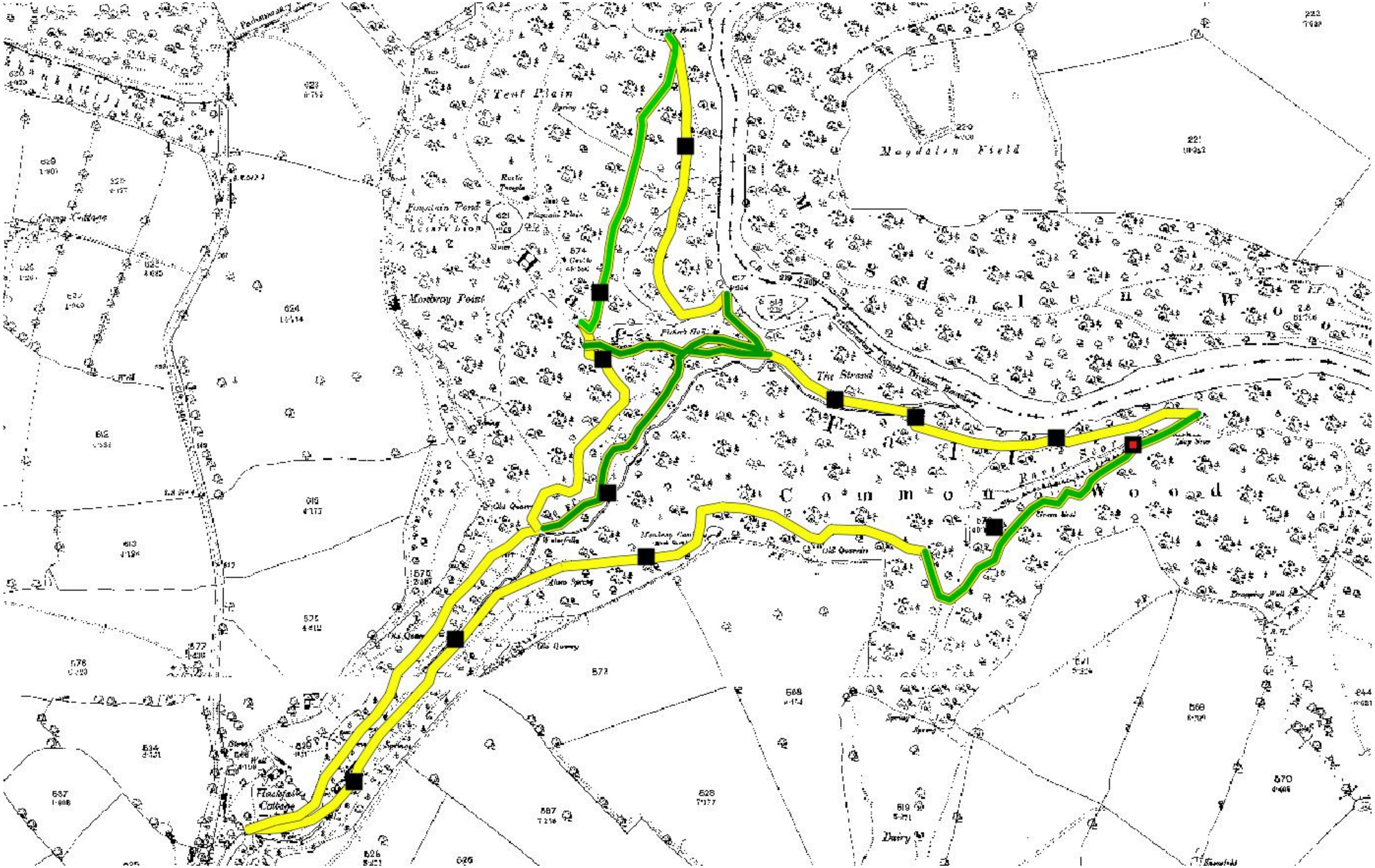


Figure 51.51 – *Polypodium vulgare*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

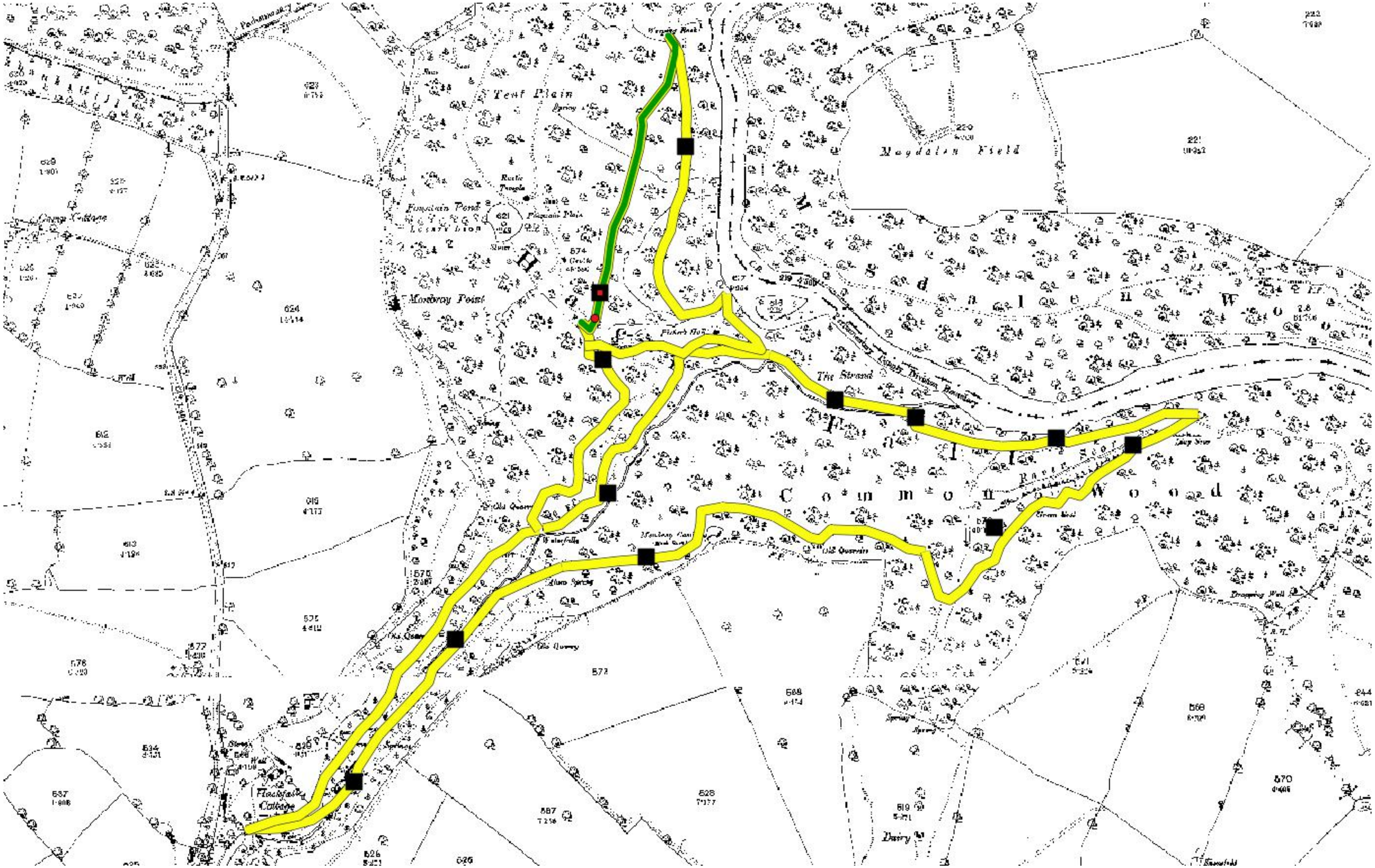


Figure 52.52 – *Polystichum x bicknellii*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

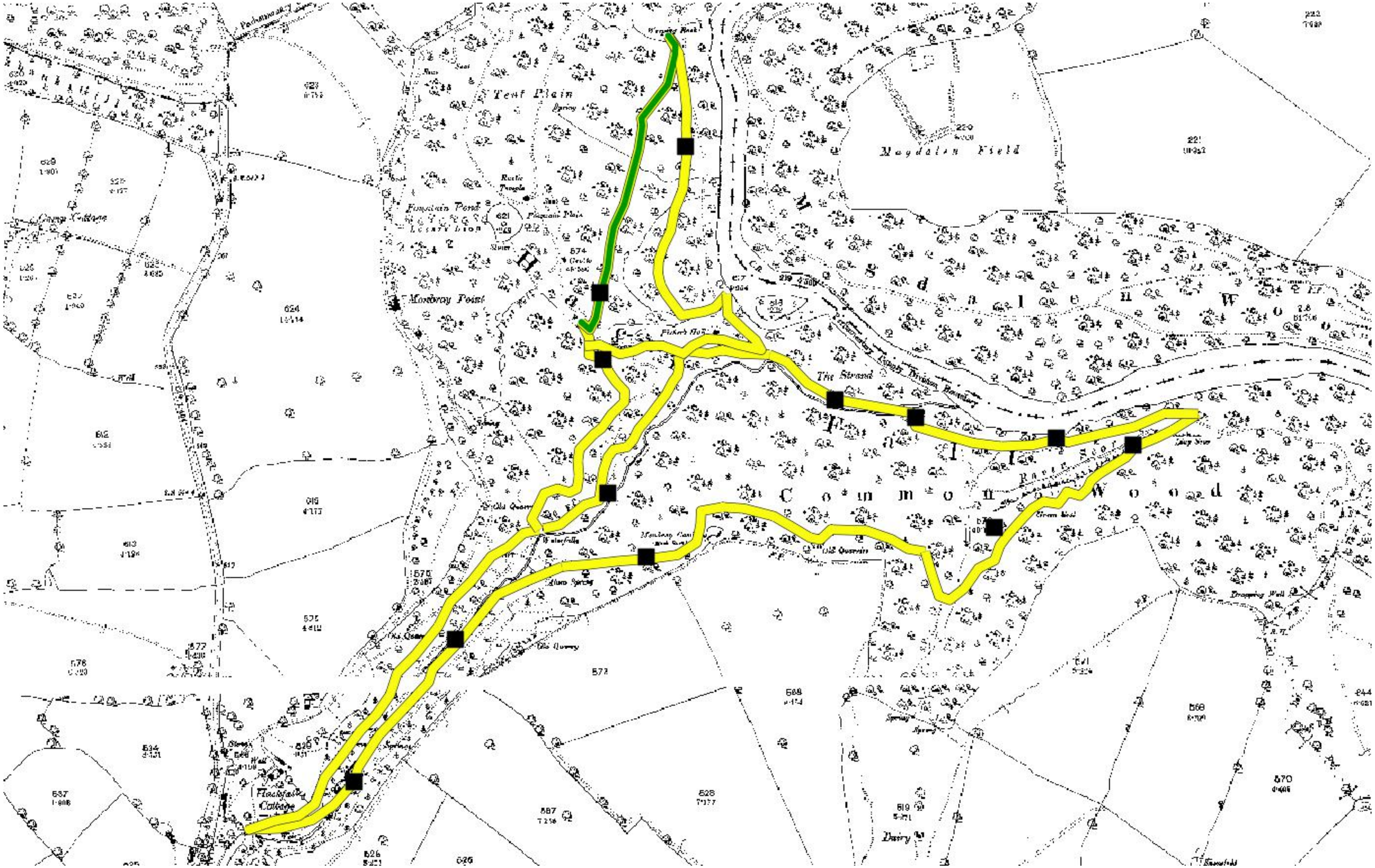


Figure 53.53 – *Potentilla sterilis*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

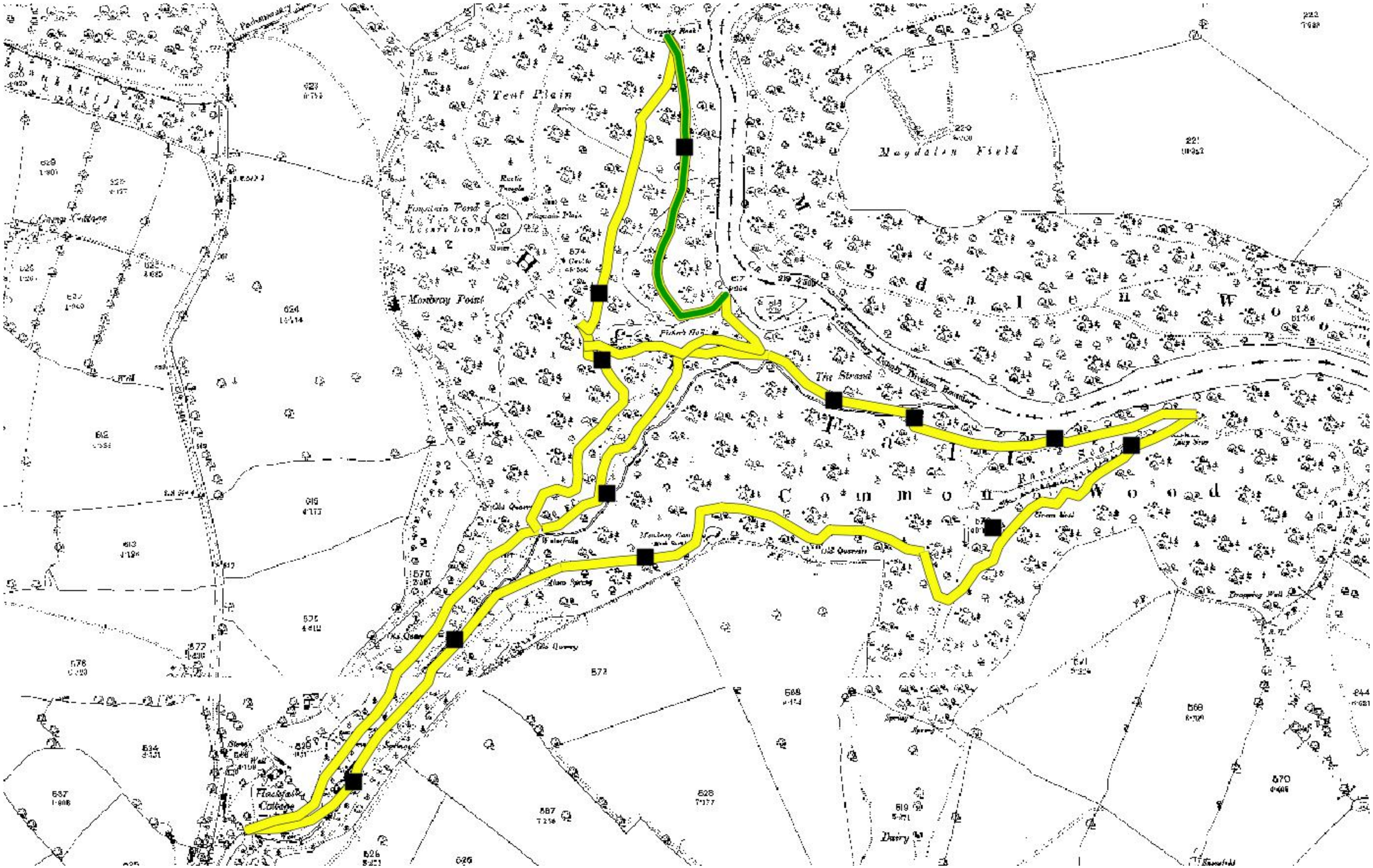


Figure 54.54 – *Primula vulgaris*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

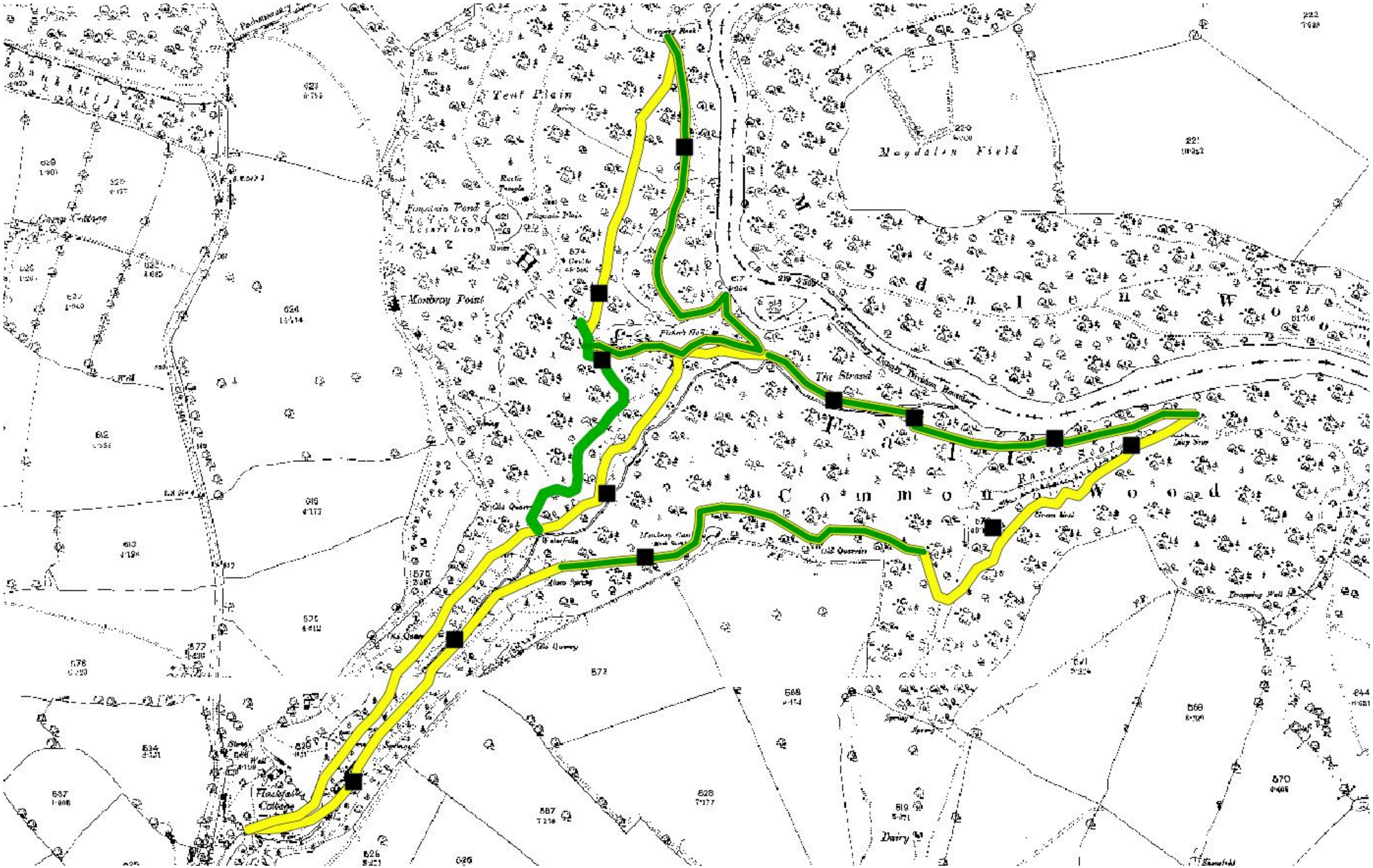


Figure 55.55 – *Prunus avium*

Species maps for Hackfall wood

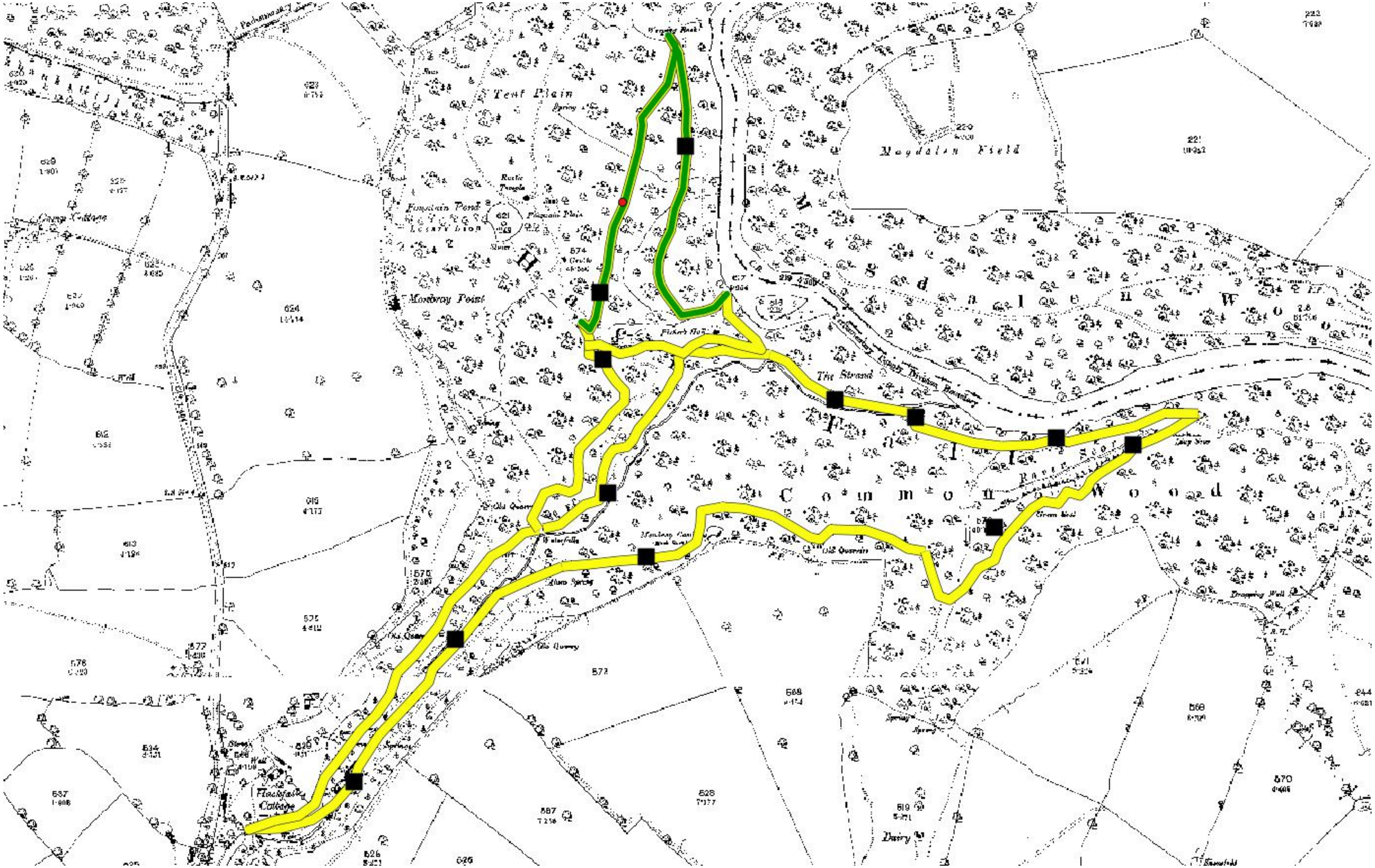


Figure 56.56 – *Ribes nigrum*

Species maps for Hackfall wood

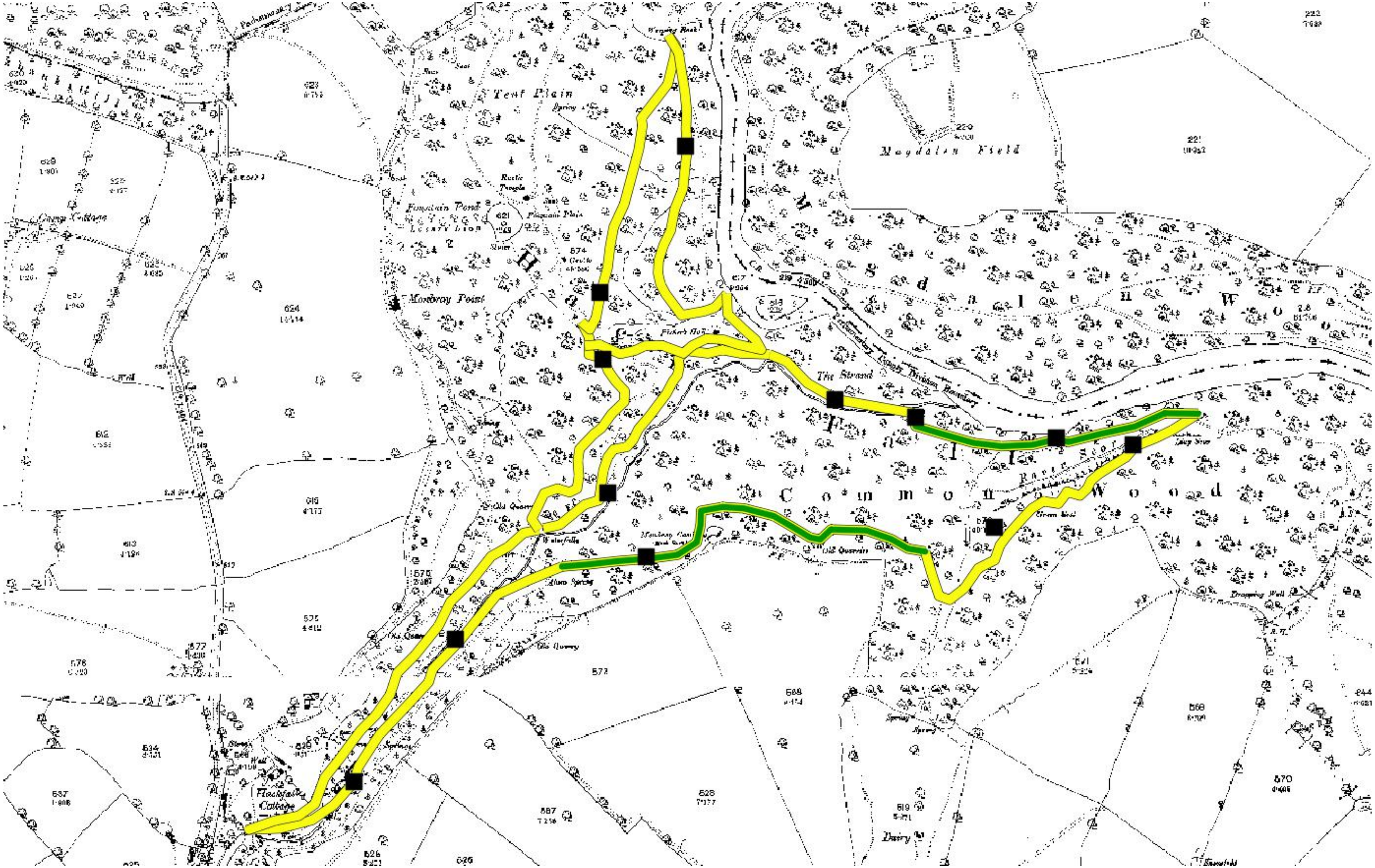


Figure 57.57 – *Ribes uva-crispa*

Species maps for Hackfall wood

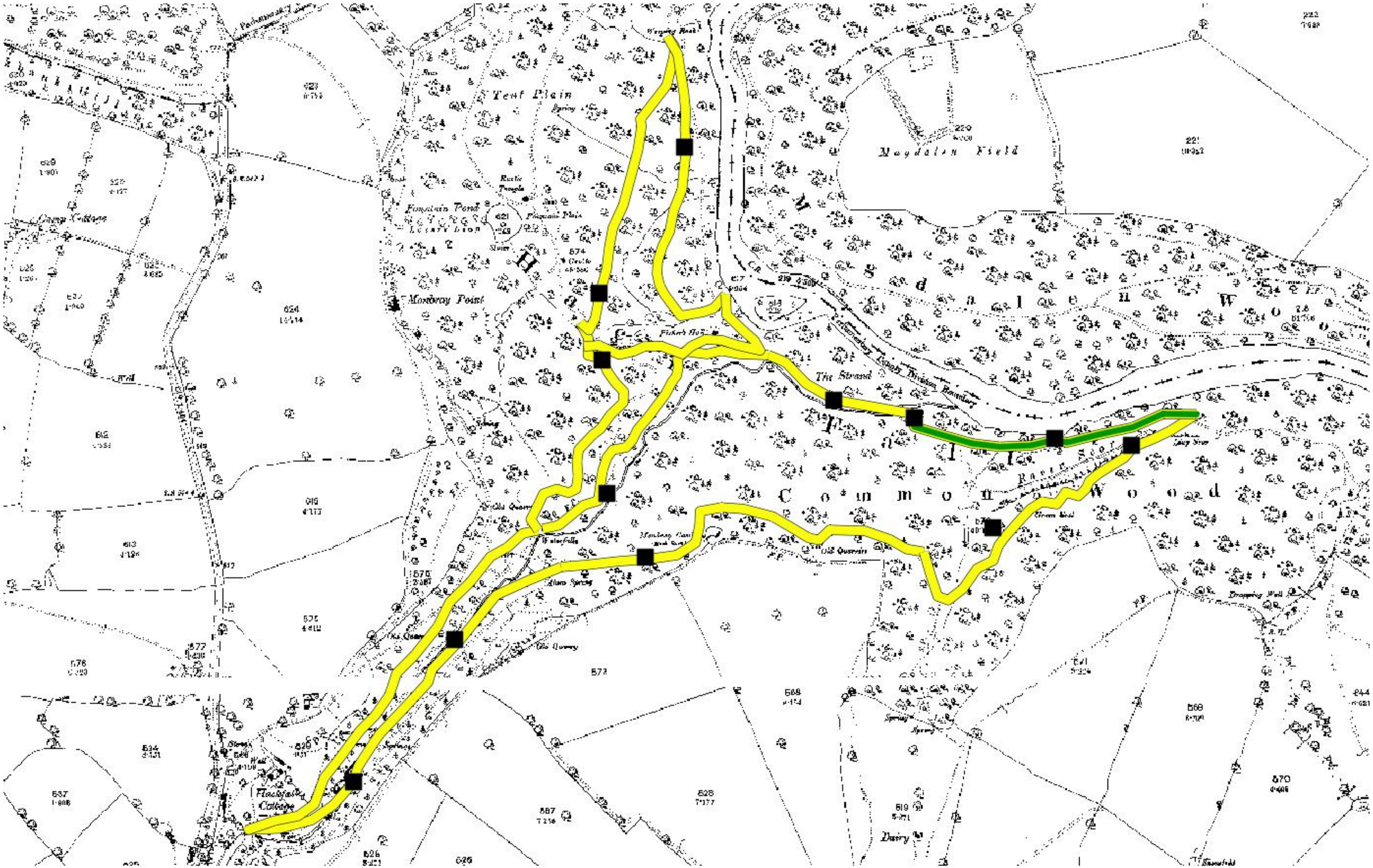


Figure 58.58 – *Rosa arvensis*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

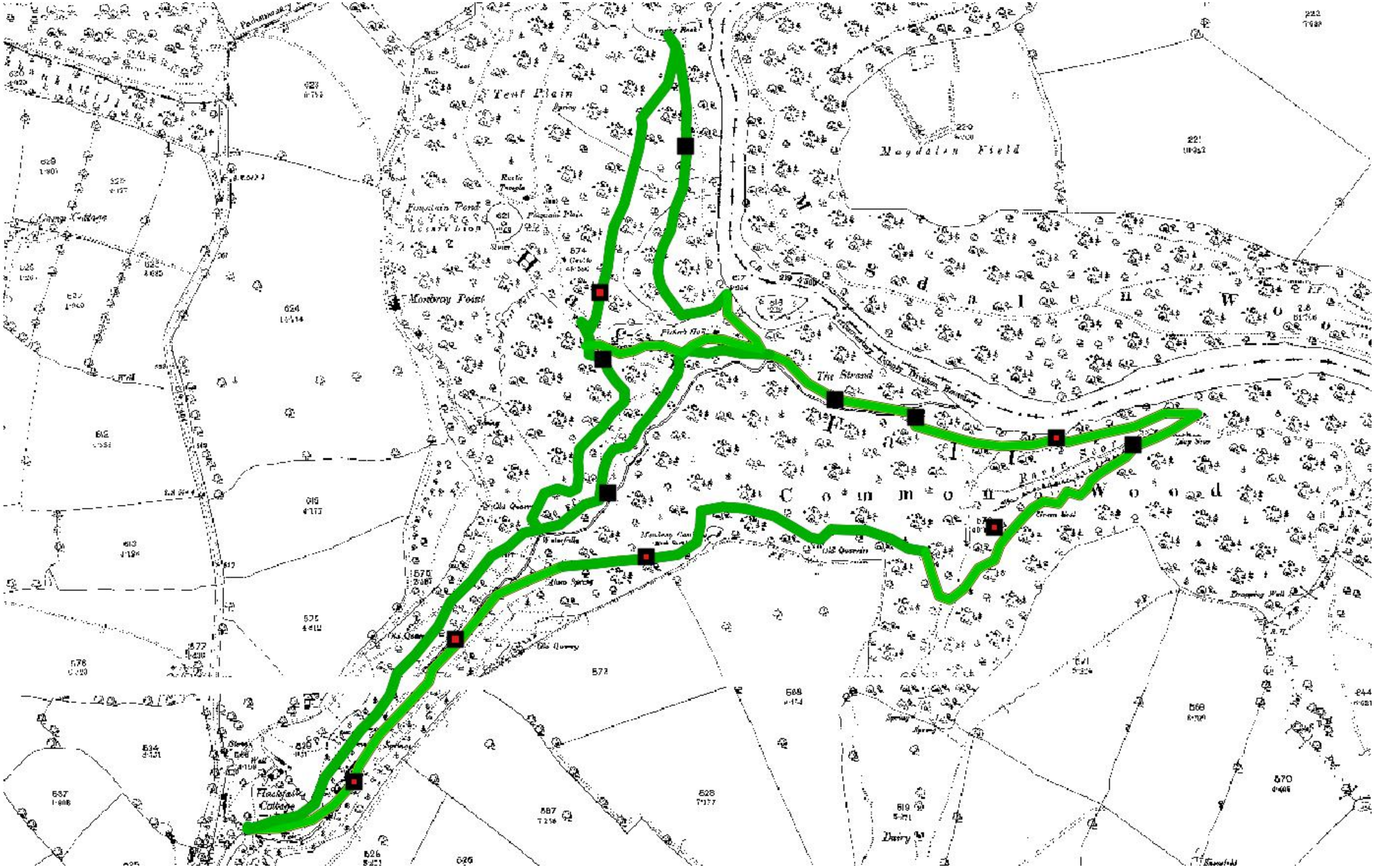


Figure 59.59 – *Rubus fruticosus*

Species maps for Hackfall wood

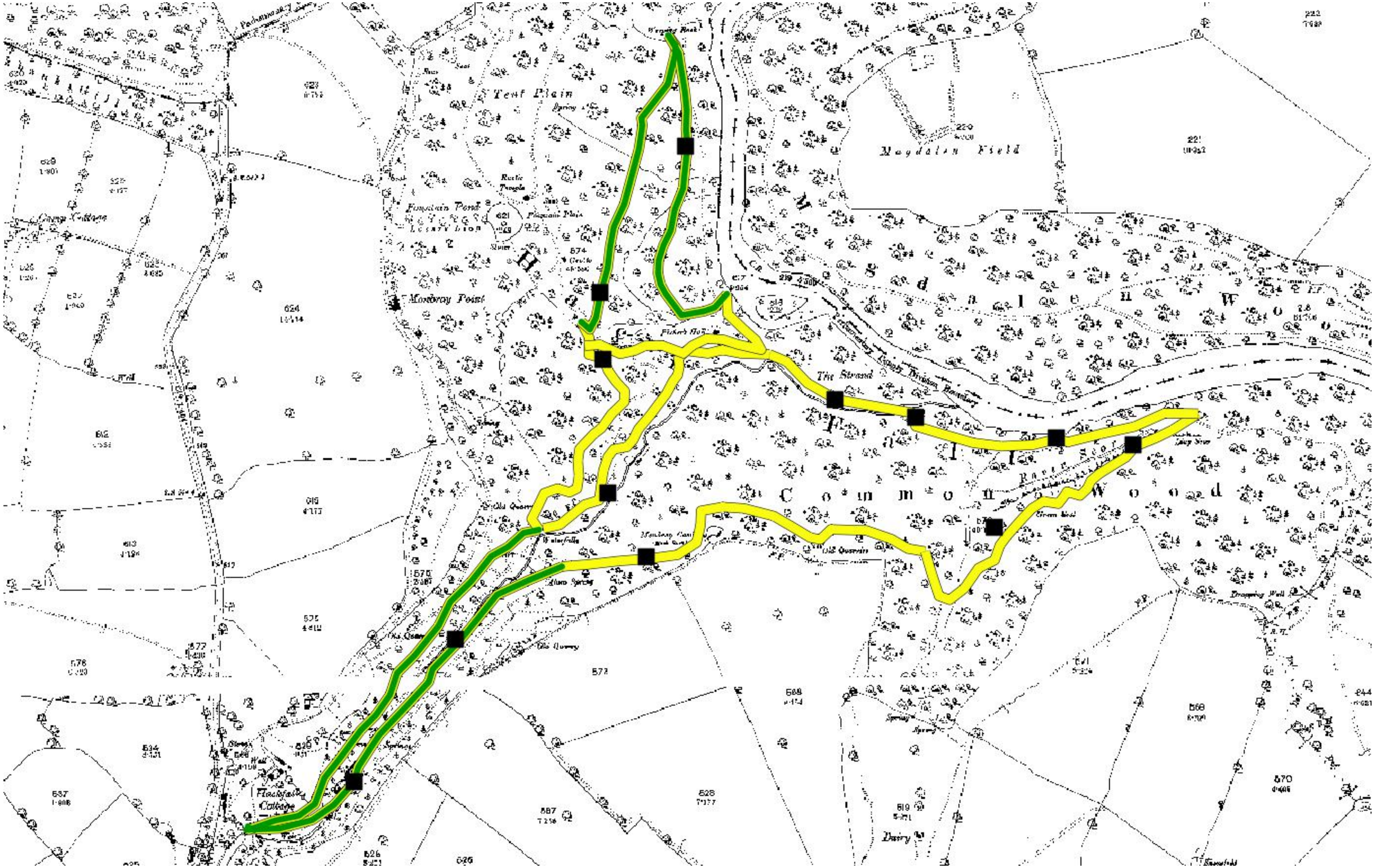


Figure 60.60 – *Rubus idaeus*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

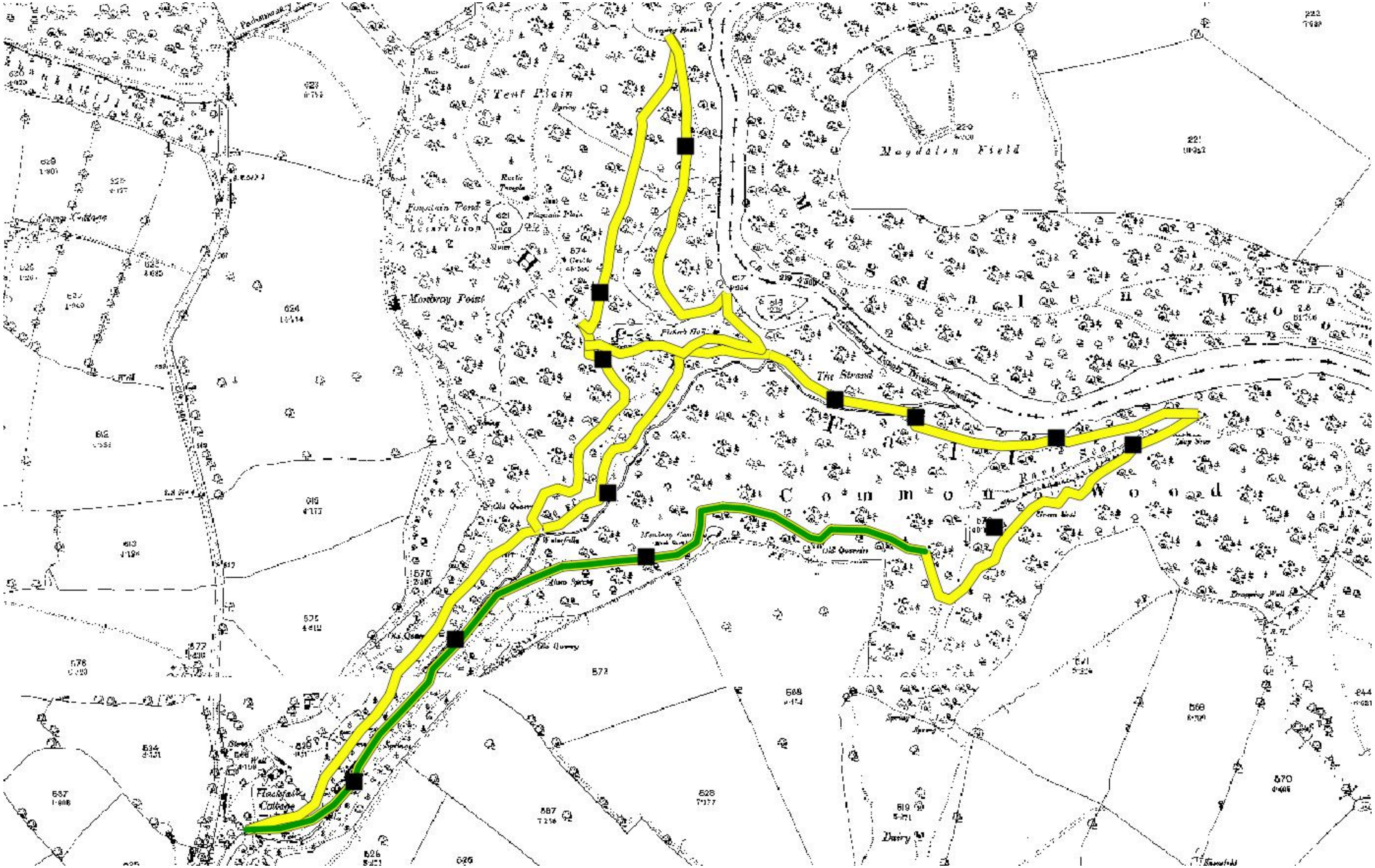


Figure 61.61 – *Rumex sanguineum*

Species maps for Hackfall wood

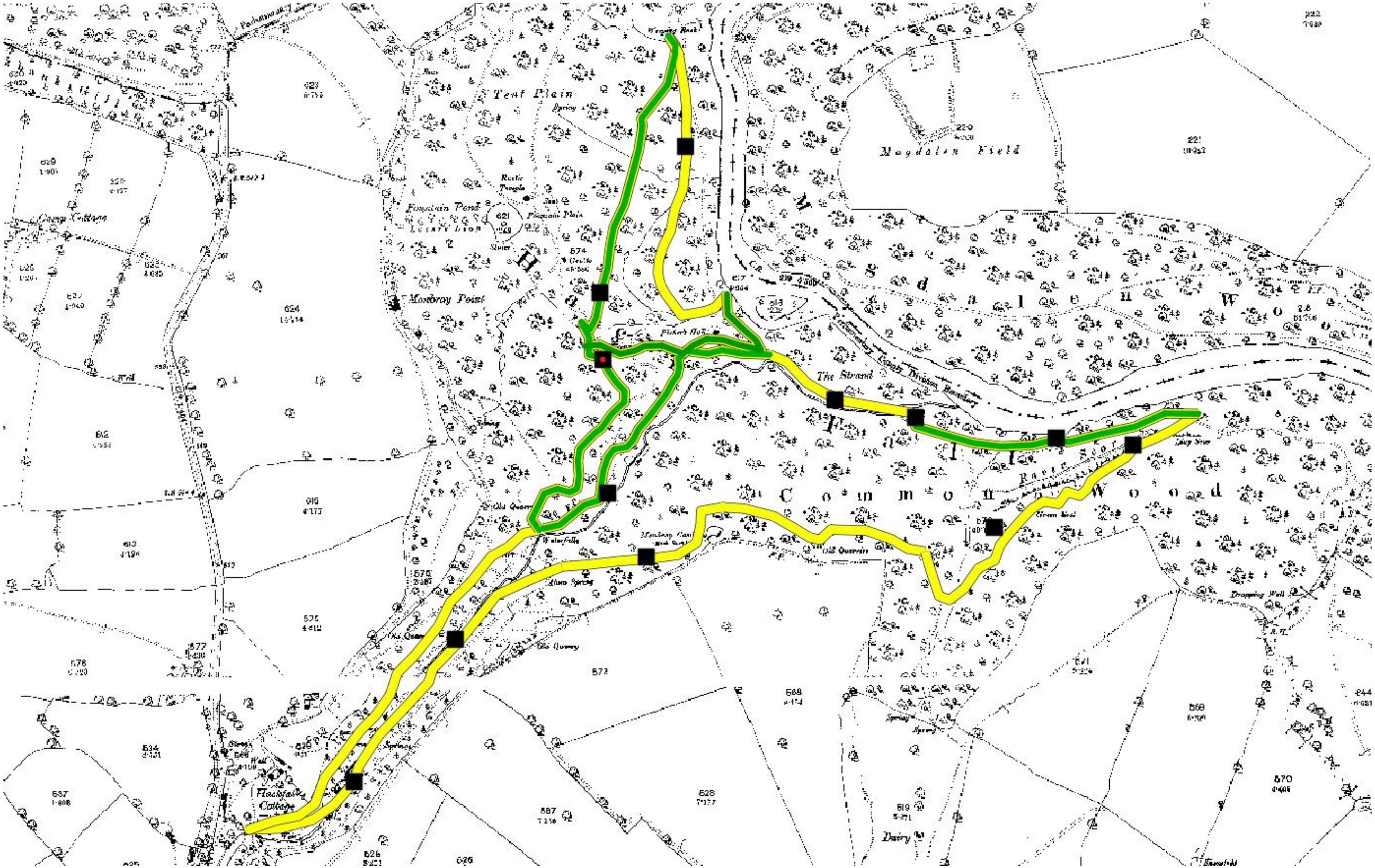


Figure 62.62 – *Sanicula europaea*

Species maps for Hackfall wood

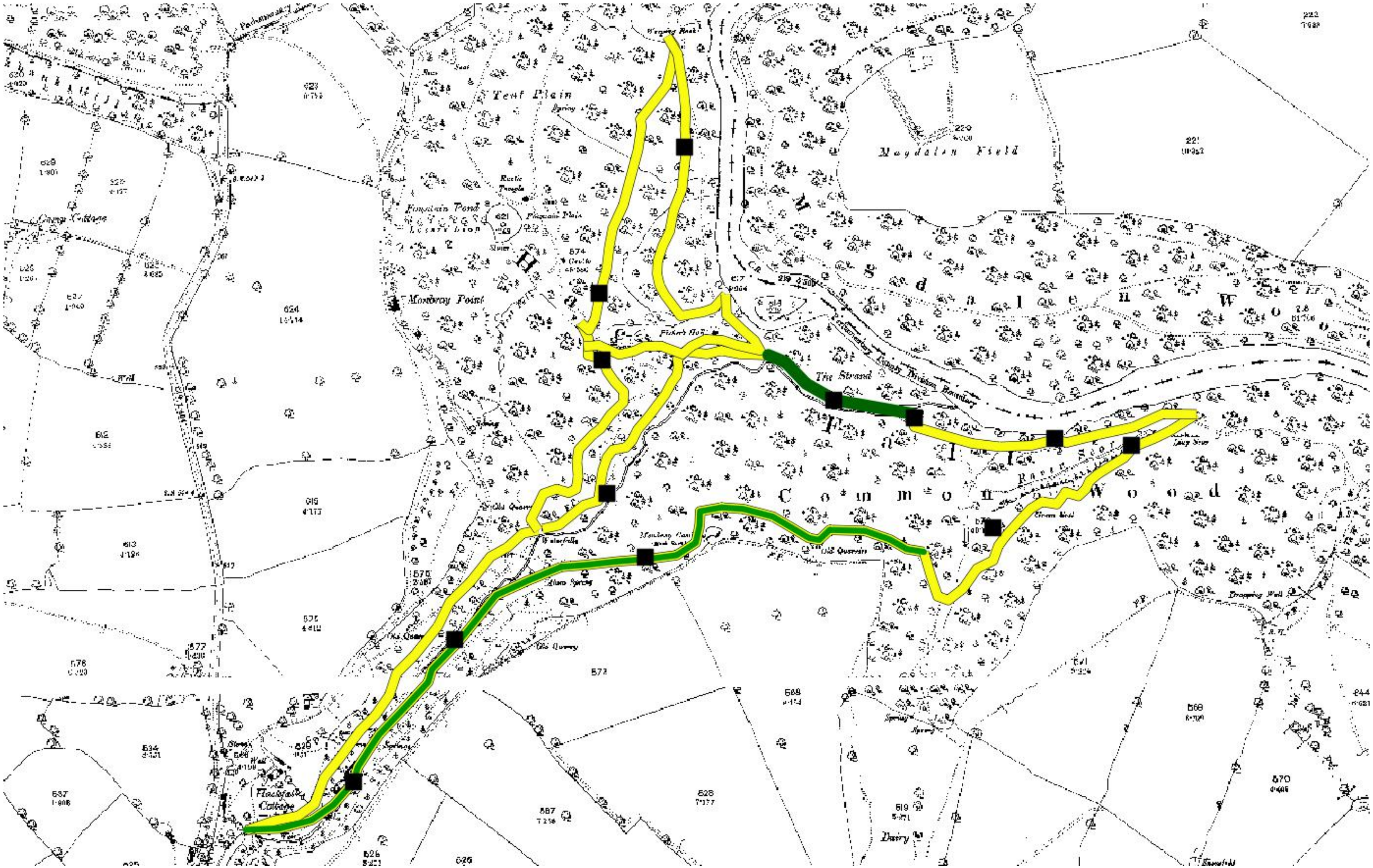


Figure 63.63 – *Silene dioica*

Species maps for Hackfall wood

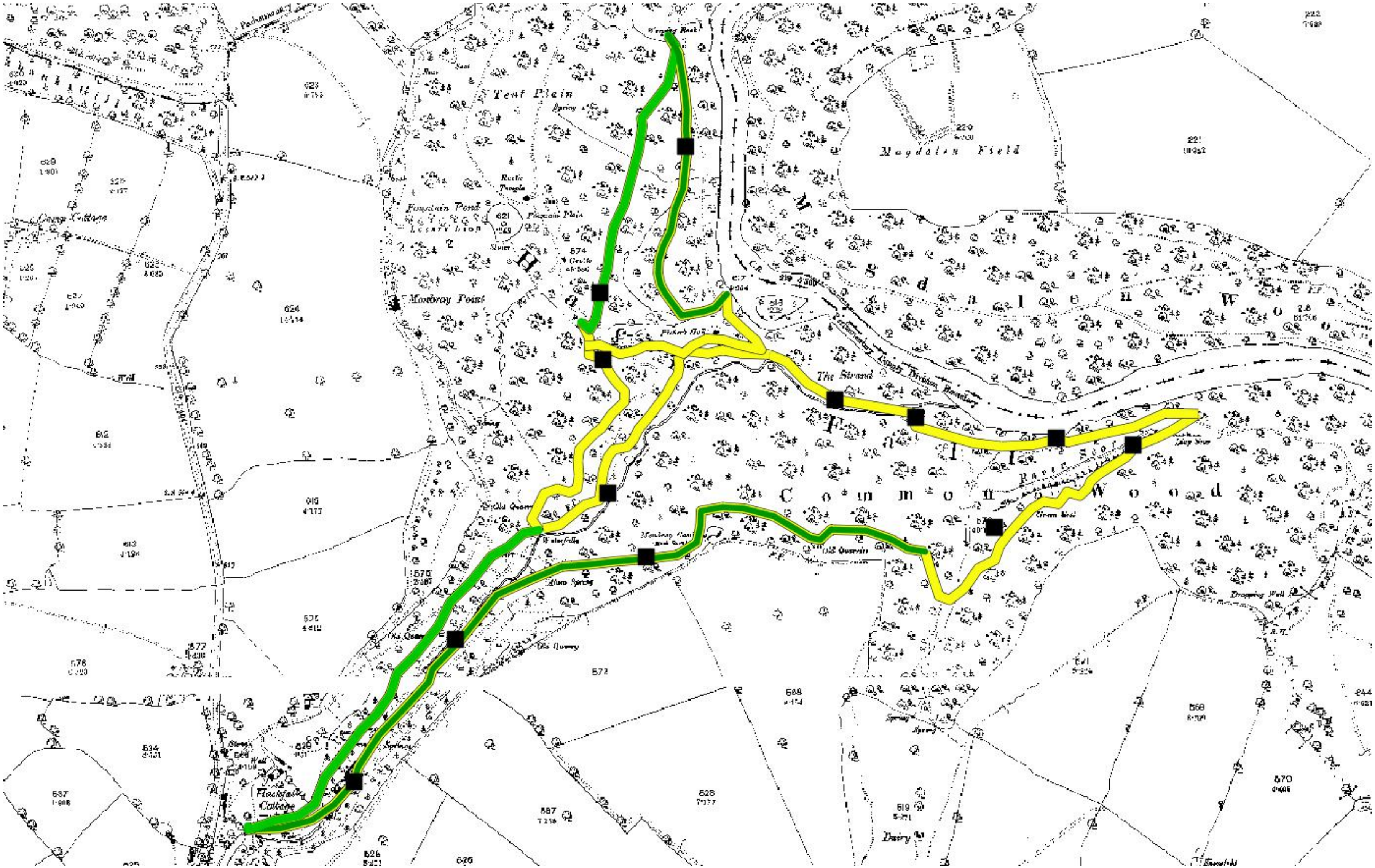


Figure 64.64 – *Stachys sylvatica*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

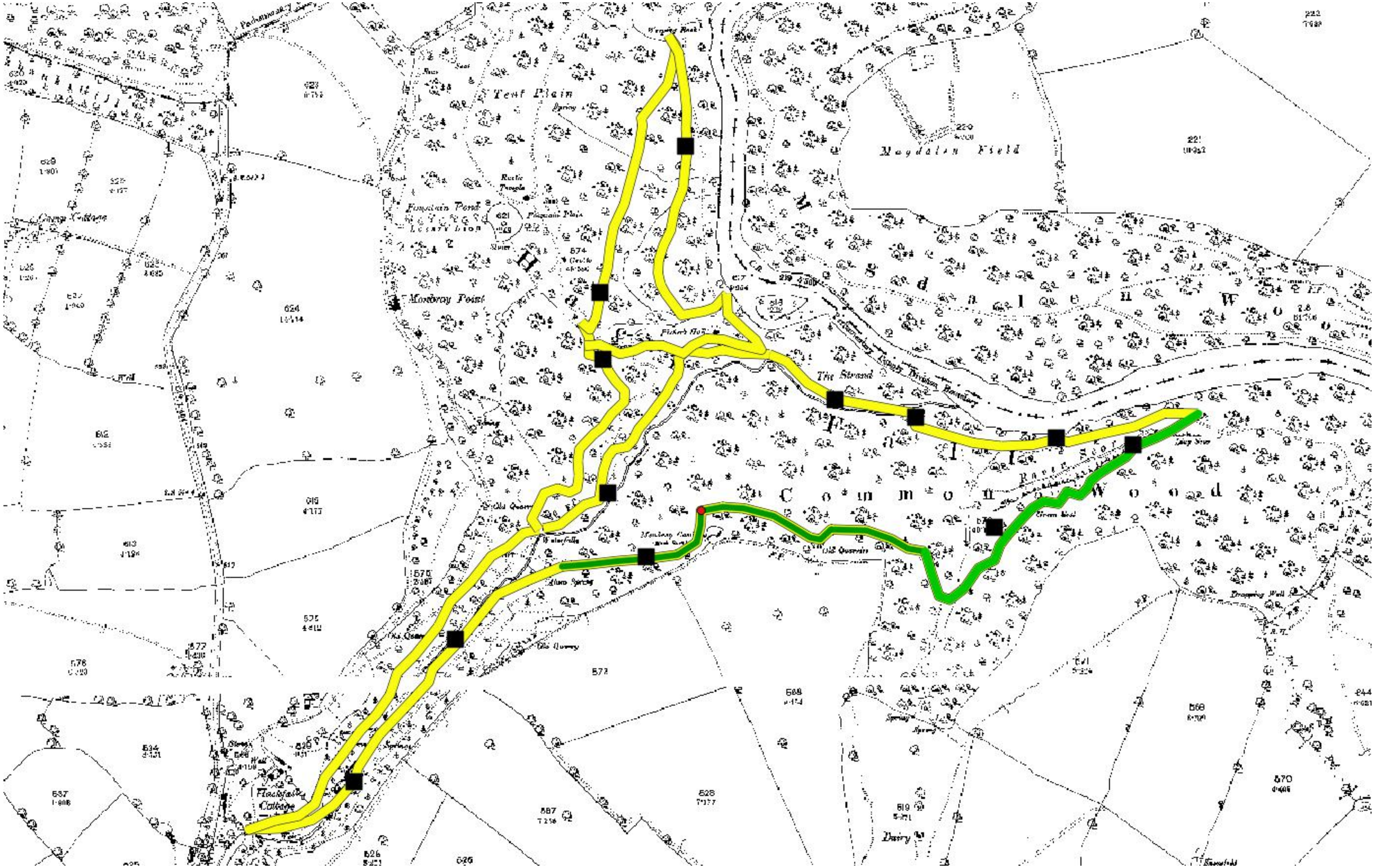


Figure 65.65 –*Teucrium scorodonia*

Species maps for Hackfall wood

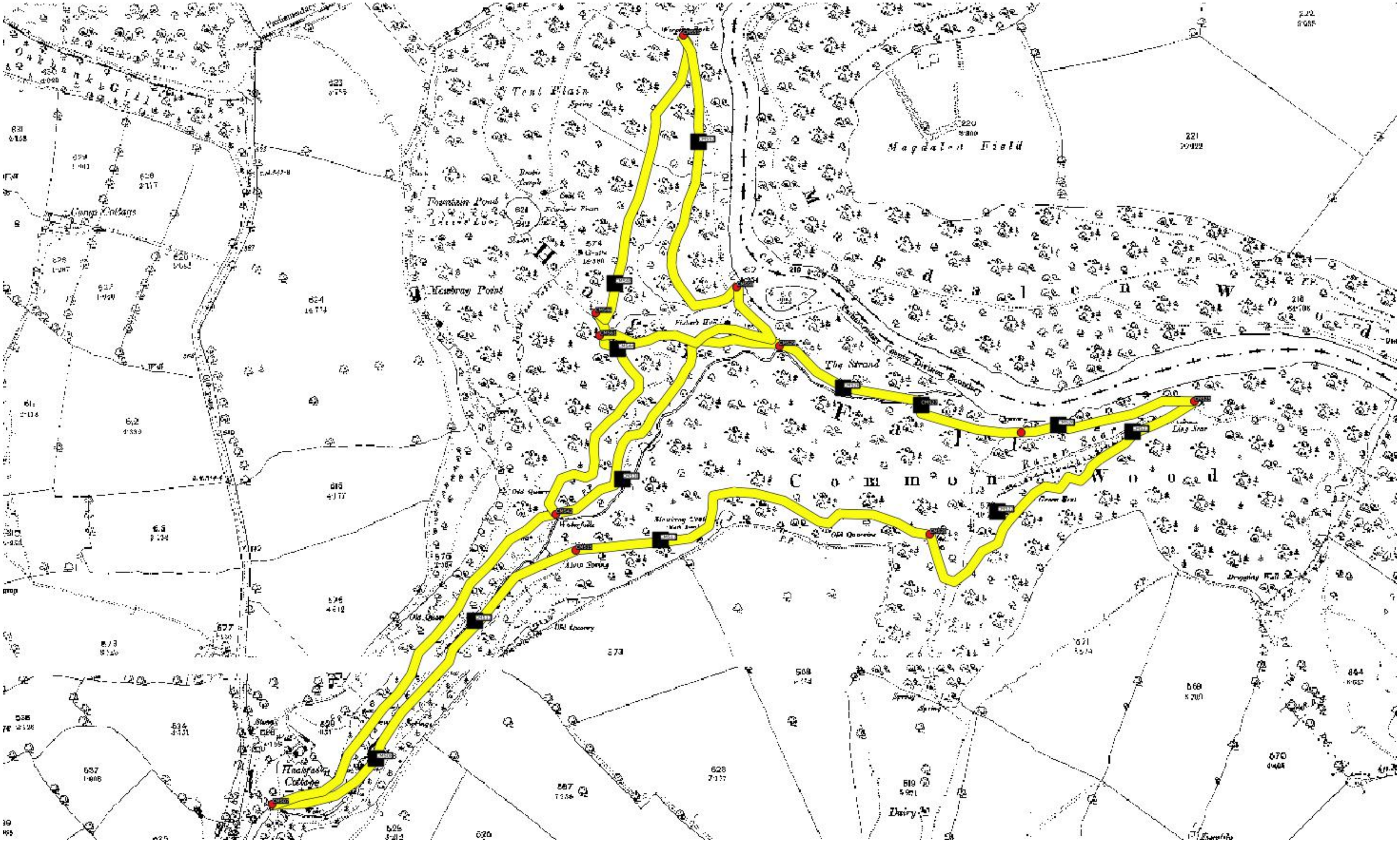


Figure 66.66 –*Trichomanes speciosum*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

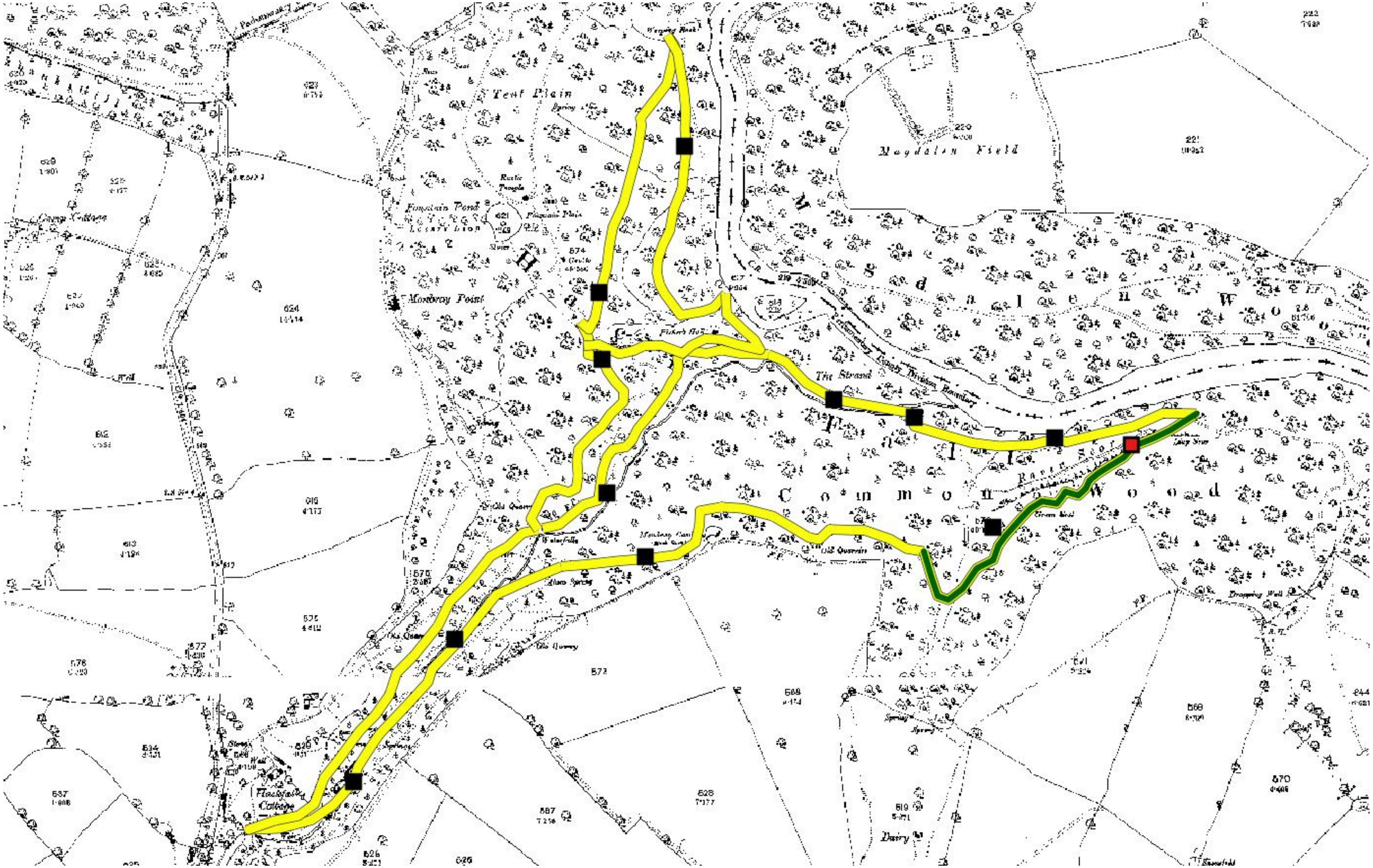


Figure 67.67 – *Vaccinium myrtillus*

Appendix 17 - Results for Hackfall Wood

Species maps for Hackfall wood

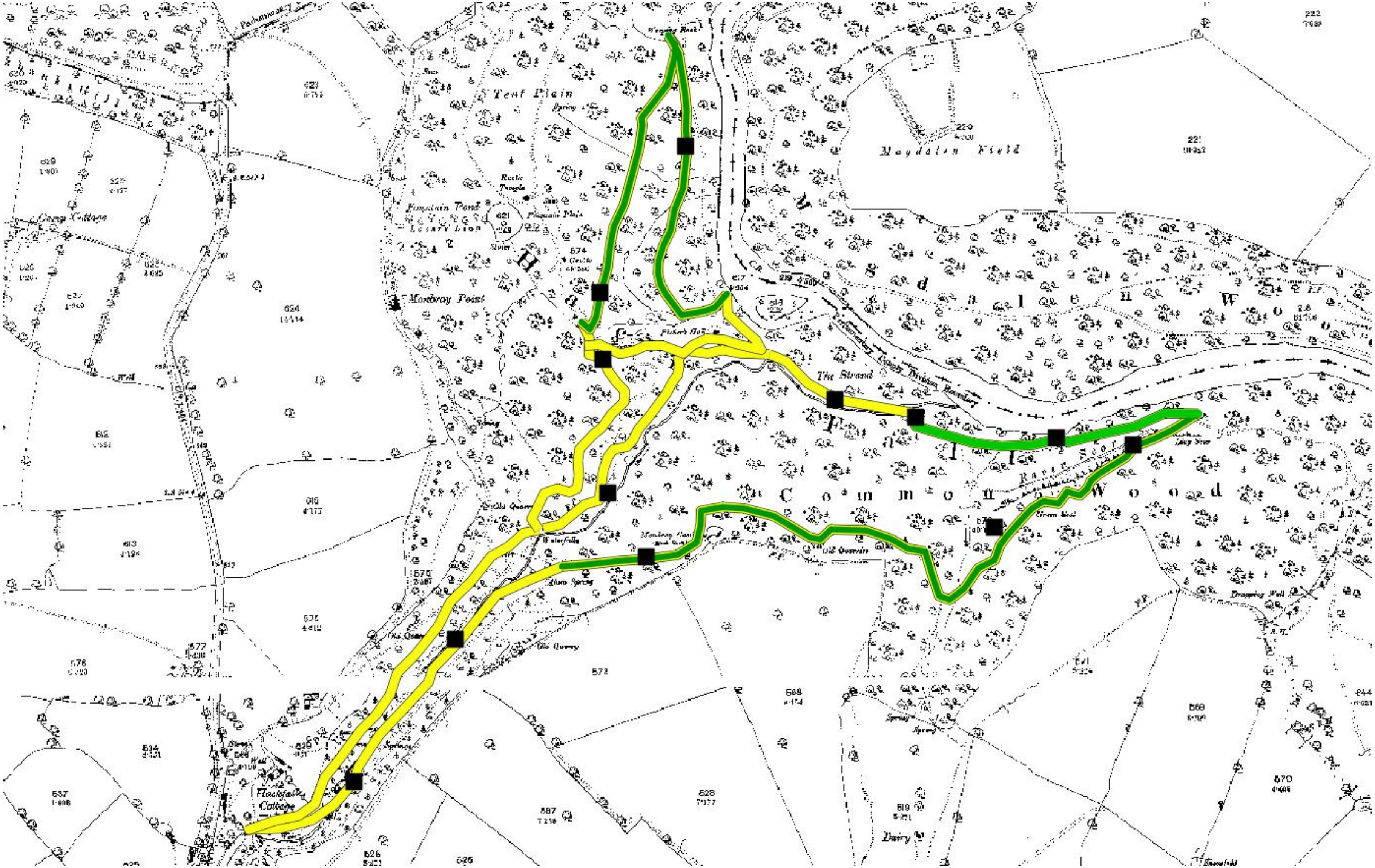


Figure 68.68 – *Viola riviniana*

Appendix 17 - Results for Hackfall Wood

Table 69.1 - Species data for Hackfall wood - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number										
Species	CM507-CM515	CM507-CM542	CM515-CM520	CM520-CM525	CM525-CM527	CM527-CM529	CM529-CM542	CM542-CM546	CM546-CM551	CM551-CM558	CM568-CM561
Ace-Cam										11	11
ACE-CAM						11				11	
Ace-Pse	11	11		22	11	22	11	11	11	11	
ACE-PSE	55	33	55	33	44	33	33	33	33	34	
aeg-pod						14					
aju-rep		22	22		14	14		11	11	22	11
all-urs	22	11	22		11	11	33	11	11	23	11
ALN-GLU						11				22	
ane-nem	22	22	11			11	22				11
ang-syl											
ant-syl											
arc-min	24		11								
aru-mac					11	11					
ath-fil	34	33	23	22	22	33	33	22	22	22	11
BARE	25		44	44	34	44	44	44		34	44
Bet-Pen											
BET-PEN	11		11	22							
ble-spi	13			22	11	13	11	13		22	11
bra-syl	22					22		22	22	22	
bro-ram										11	
BRYO			22	33	24	33	33	33	33	22	33
cal-vul				13							
cam-lat						11			11		
car-ama											
car-pen	13	23	11		11		11		11	24	
car-rem	34		22	11	11	11	22	11		14	11
car-syl	14	11	11		11		22		22		11
Cas-Sat											
CAS-SAT											
cer-cla											
cha-ang											
chr-opp	14	24	14		24	14		24			

Appendix 17 - Results for Hackfall Wood

Table 69.1 - Species data for Hackfall wood - Transects											
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)											
	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number										
Species	CM507-CM515	CM507-CM542	CM515-CM520	CM520-CM525	CM525-CM527	CM527-CM529	CM529-CM542	CM542-CM546	CM546-CM551	CM551-CM558	CM568-CM561
chr-alt						24					
cir-lut	22	11	22	11	11	33	33	11	33		33
Cor-Ave		34	22	22	22	22	33		11	11	22
Cra-Mon			11								11
des-fle				24							
dry-aff	34	22	33	22	22		11	22	22	22	11
dry-car											
dry-dil	34	33	33	33	33	33	33		22	33	33
dry-fil	22	33	22	33	22	22	33	22	22	33	22
epi-mon											
equ-tel									15	11	
Fag-Syl	11		11	11							
FAG-SYL	22		33	22							
fes-gig											
Fra-Exc	33	11	22	11	11			11		11	
FRA-EXC	44	33	44	33	33	55	33	44	22	44	
fra-ves									11	11	
gal-apa											
gal-odo						14	34	14	24	14	24
ger-rob	22	33	33	22	11	33	33	33	44	23	22
geu-urb	22	23	22		11	22	33	45	34	44	33
gle-hed	22		11	11	11	22			11		
hed-hel		22	24	24	33	24	33		33	33	33
her-sph											
hol-mol			11								
hya-non	23	33	22	23	11			22	22	34	
Ile-Aqu	34	33	24	24	22	22	22	22	22	44	22
imp-gla											
lam-gal											
lap-com		22	11		11						11
LAR-KAE											
lat-squ						11					

Appendix 17 - Results for Hackfall Wood

Table 69.1 - Species data for Hackfall wood - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number										
Species	CM507-CM515	CM507-CM542	CM515-CM520	CM520-CM525	CM525-CM527	CM527-CM529	CM529-CM542	CM542-CM546	CM546-CM551	CM551-CM558	CM568-CM561
lis-ova										11	
LITTER	35		44	24	24	33	33	33			33
lon-per	11		11		11		11			22	22
luz-pil											
luz-syl	24		24	24	13		24			24	22
lys-nem	11	24	11	11	11	12			11	22	
mel-uni	23		22		11		22	11			
mer-per	24		25	24	14	24	33	24	35	24	44
mil-eff											
orc-mas										11	
oxa-ace	22	24	22	11	23	13	13	14	22	22	23
par-qua										13	
phe-con							14				
phy-sco		22	14			11	22		11		11
poa-nem	11					22			22		
pol-acu									11		
polxbic									11		
pol-set	22	11	22		34	33	34	33	11	11	22
pot-ste									11		
pol-vul				13			14		12		11
pri-vul										11	
Pru-Avi			11		11	11		33		11	11
Pru-Lau											
pte-aqu											
QUE-PET											
Que-Rob	11	11	11	11	22		11				
QUE-ROB	22	33	22	35	33		23				
ran-fic											
Rho-Pon	11										
Rib-Nig									11	11	
Rib-Uva			11		11						
Ros-Arv					11						

Appendix 17 - Results for Hackfall Wood

Table 69.1 - Species data for Hackfall wood - Transects

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DDAFOR converted to numbers 1-5 - Rare to Dominant (11 = Rare + Rare)

	Transect reference code - Node to node. Node ID = GPS device letter prefix and waypoint number										
Species	CM507-CM515	CM507-CM542	CM515-CM520	CM520-CM525	CM525-CM527	CM527-CM529	CM529-CM542	CM542-CM546	CM546-CM551	CM551-CM558	CM568-CM561
rub-fru	22	33	33	22	22	22	33	33	33	33	22
Rub-Ide	11	11							11	11	
rum-san	11		11								
Sam-Nig				11							
san-eur					13		13	13	13		11
sil-dio	11		11			23					
SOR-AUC				11		11				22	22
Sor-Auc	11		11	22		22				11	11
sta-syl	11	22	11						22	11	
ste-hol											
TAX-BAC	11										
teu-sco			11	22							
Til-Spp		11	11		22	22	11		11	11	22
TIL-SPP		33			22	22	11		33	22	22
Tri-spe					11						
ULM-GLA	11	33	11	11	22	22	35	44	33	22	22
urt-dio	24			11							
vac-myr				15							
val-off											
ver-mon	22	24	11	11	12	22	22	33			11
vic-sep											
vio-riv			11	11	22				11	11	

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
Ace-Cam																									
ACE-CAM																									
Ace-Pse																									
ACE-PSE	5				5	5					2	5									4		4		
aeg-pod																									
aju-rep													1					2					1		
all-urs	1					4					1						2	2							
ALN-GLU																									
ane-nem					1																				
ang-syl																									
ant-syl																									
arc-min																									
aru-mac												1													
ath-fil	2				2	1												1							
BARE	3				4	4			4	4	3	3					4	4							
Bet-Pen																									
BET-PEN																									
ble-spi		9		9	1			9	1																
bra-syl													2												
bro-ram																									
BRYO						2			2	3	1	3	3				2	2			3		3		
cal-vul																									
cam-lat																									

Appendix 17 - Results for Hackfall Wood

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
car-ama																									
car-pen																									
car-rem	2																								
car-syl					2												2								
Cas-Sat																									
CAS-SAT																									
cer-cla																									
cha-ang																									
chr-opp			9									1	4												
chr-alt																									
cir-lut						1					2		2					3			3				
Cor-Ave																	2								
Cra-Mon																									
des-fle										3															
dry-aff					2													1							
dry-car																									
dry-dil	2				3						2	1													
dry-fil						1						1													
epi-mon																									
equ-tel																							2		
Fag-Syl										1															
FAG-SYL																									
fes-gig																									

Appendix 17 - Results for Hackfall Wood

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
Fra-Exc	2					1			1														1		
FRA-EXC					3	2			4		4		5				3	5			3				
fra-ves																									
gal-apa																									
gal-odo														9			2		9		2				
ger-rob													3												
geu-urb					2						3						2	3							
gle-hed											2		3												
hed-hel						3						2					2				2		1		
her-sph																									
hol-mol																									
hya-non	2				2	1																	1		
Ile-Aqu	1					1			2																
imp-gla																									
lam-gal																									
lap-com																									
LAR-KAE																									
lat-squ																									
lis-ova																							1	9	
LITTER	4				4	4			3	3	2	2					2	2							
lon-per																									
luz-pil																									
luz-syl					2	2			4	2															

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																							
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
lys-nem																									
mel-uni																									
mer-per											2	3	2				4				4		4		
mil-eff																									
orc-mas																									
oxa-ace	1				1	2															2				
par-qua																							2		
phe-con															9										
phy-sco																					1				
poa-nem																									
pol-acu																					1				
polxbic																				9	1				
pol-set											3	1	1				1	1			1				
pot-ste																									
pol-vul										2															
pri-vul																									
Pru-Avi																									
Pru-Lau																									
pte-aqu																									
QUE-PET																									
Que-Rob						1			1	2															
QUE-ROB					2	3			4	5															
ran-fic																									

Appendix 17 - Results for Hackfall Wood

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
Rho-Pon																									
Rib-Nig																						9			
Rib-Uva																									
Ros-Arv																									
rub-fru	1				2	1			1		1										2				
Rub-Ide																									
rum-san																									
Sam-Nig																									
san-eur																		1							
sil-dio																									
SOR-AUC																									
Sor-Auc									1	1															
sta-syl																									
ste-hol																									
TAX-BAC																									
teu-sco							9																		
Til-Spp																									
TIL-SPP											3														
tri-spe																									9
ULM-GLA					1	1						2	2				4	3			4		4		
urt-dio																									
vac-myr										4															
val-off																									

Appendix 17 - Results for Hackfall Wood

Table 73.2 - Species data for Hackfall wood - Quadrats, Point records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - 1-5 = DAFOR. 9 = point present.

	Quadrat/ point record reference ID (Waypoint reference - device letter code and waypoint number)																								
SPECIES	CM508	CM510	CM511	CM512	CM513	CM517	CM518	CM521	CM522	CM523	CM526	CM527	CM528	CM532	CM536	CM537	CM538	CM544	CM545	CM547	CM548	CM549	CM552	CM556	CC145
ver-mon	1																	2							
vic-sep																									
vio-riv																									

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

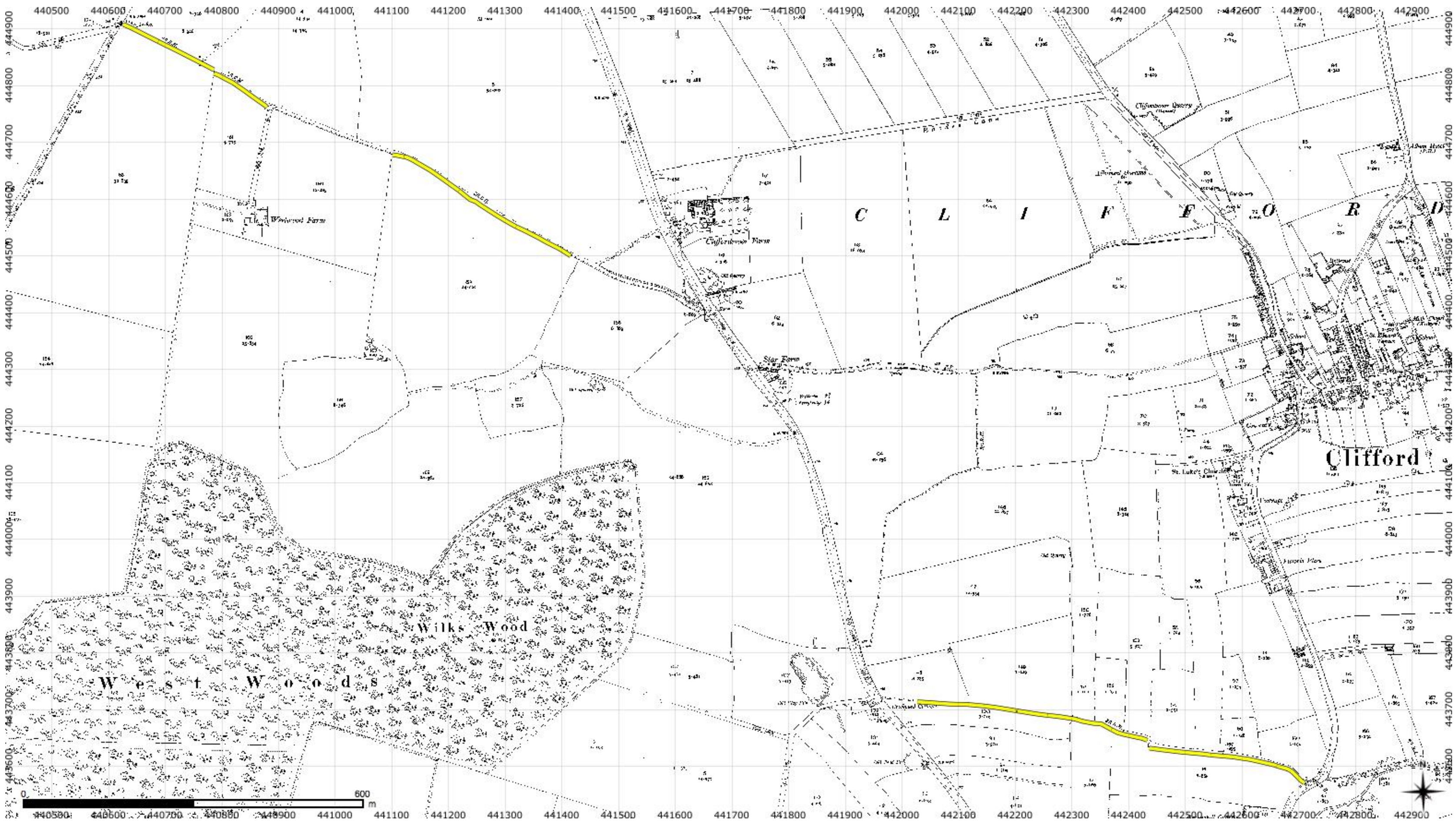


Figure 1.1 – Clifford Boundary Hedgerows General layout of surveyed hedgerows (Yellow)

Maps for Clifford Boundary Hedgerow survey

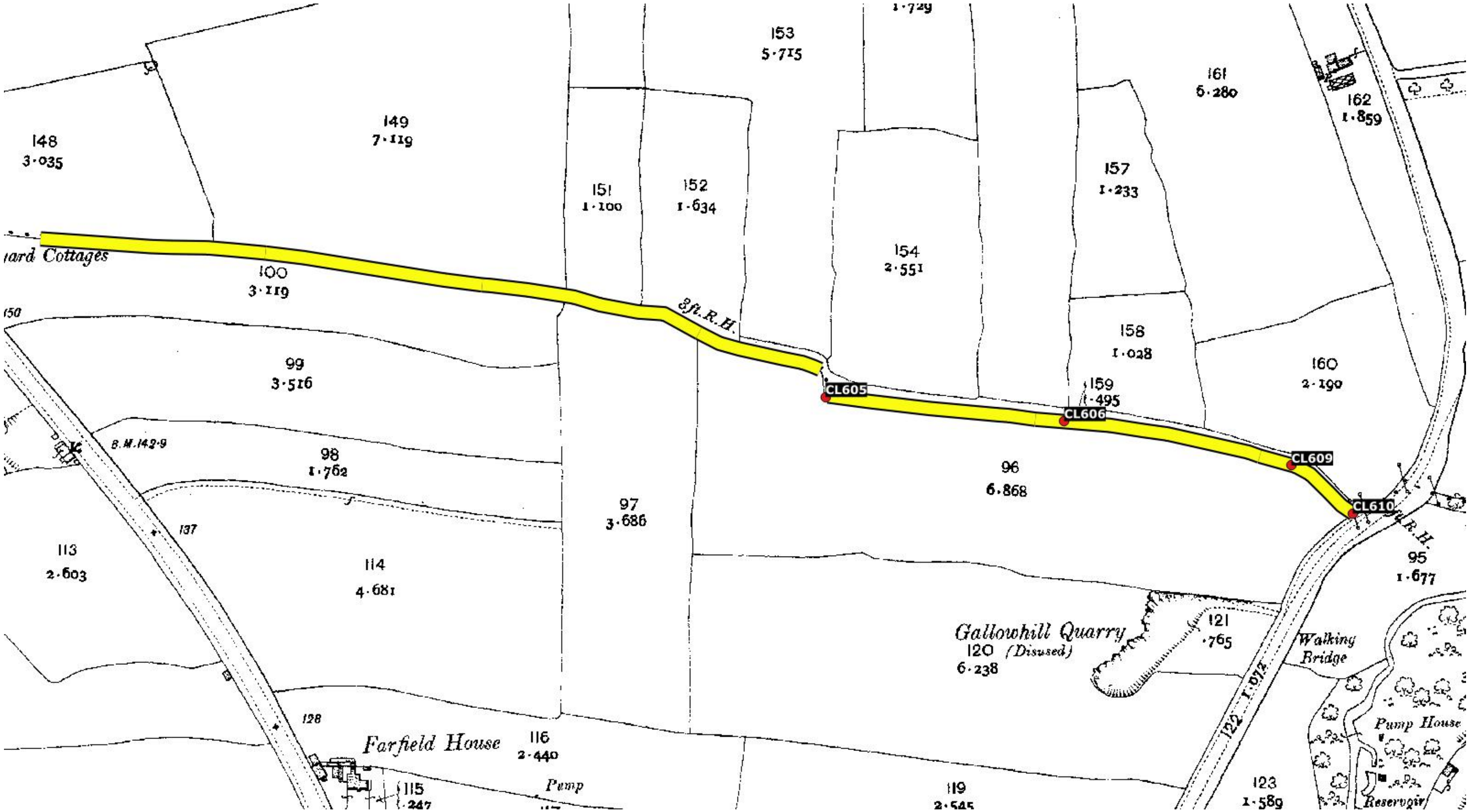


Figure 2.2 – Clifford Boundary Hedgerows – CL Section and node numbers for Eastern area E2

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

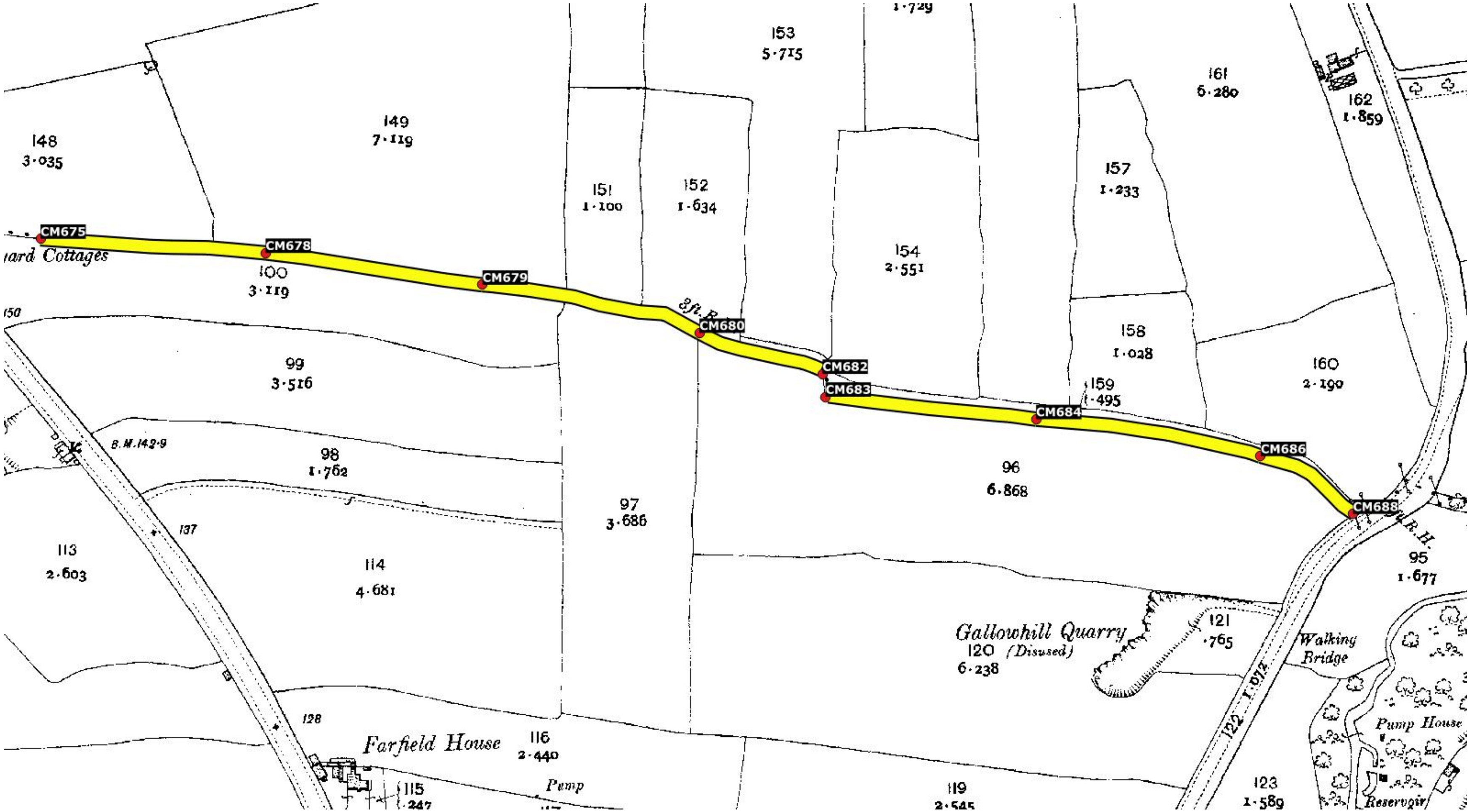


Figure 3.3 – Clifford Boundary Hedgerows – CM Section and node numbers for E1 (CM675-CM682) and E2 (CM683-CM688)

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

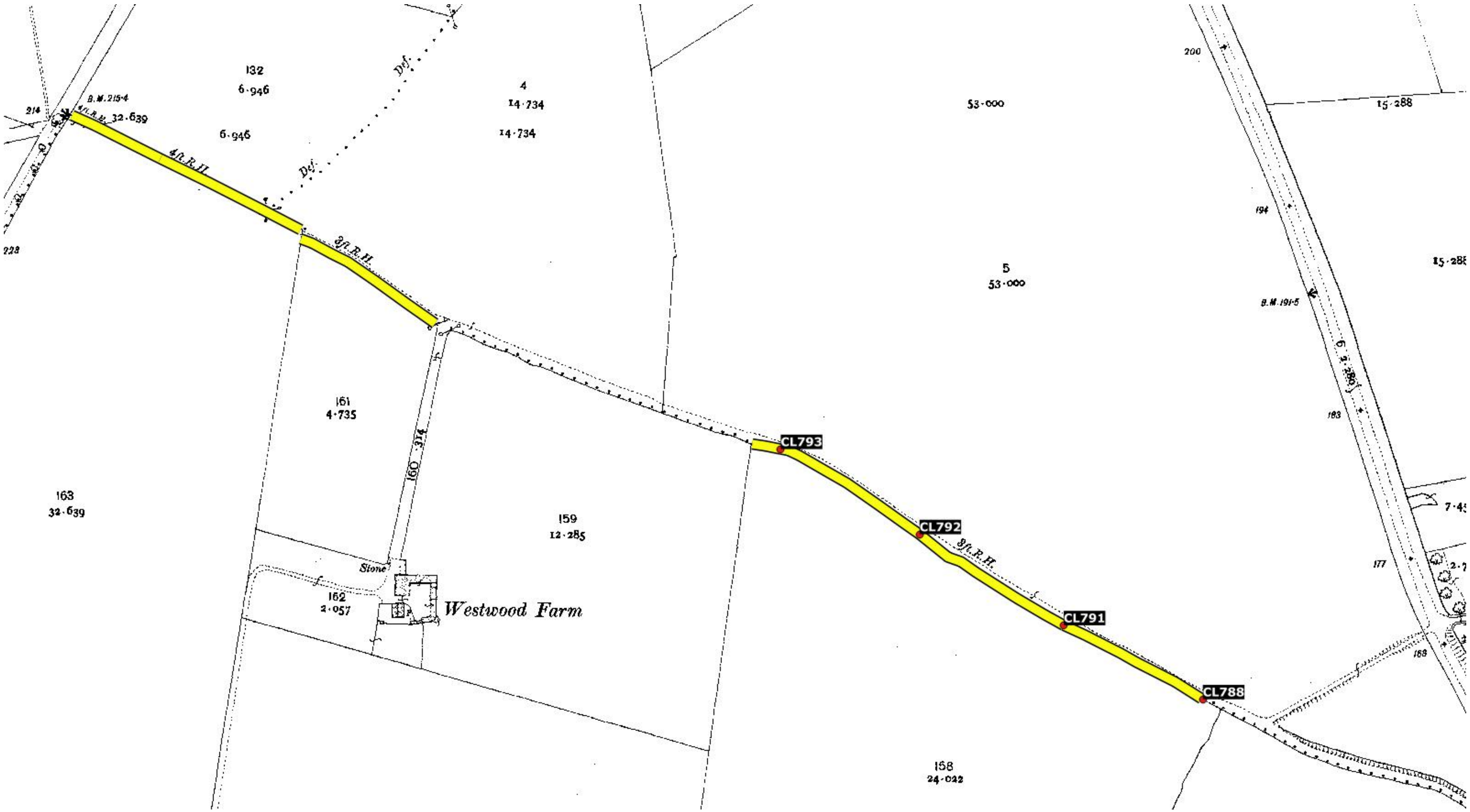


Figure 4.4 – Clifford Boundary Hedgerows – Section and node numbers for Western area – CL = W1

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

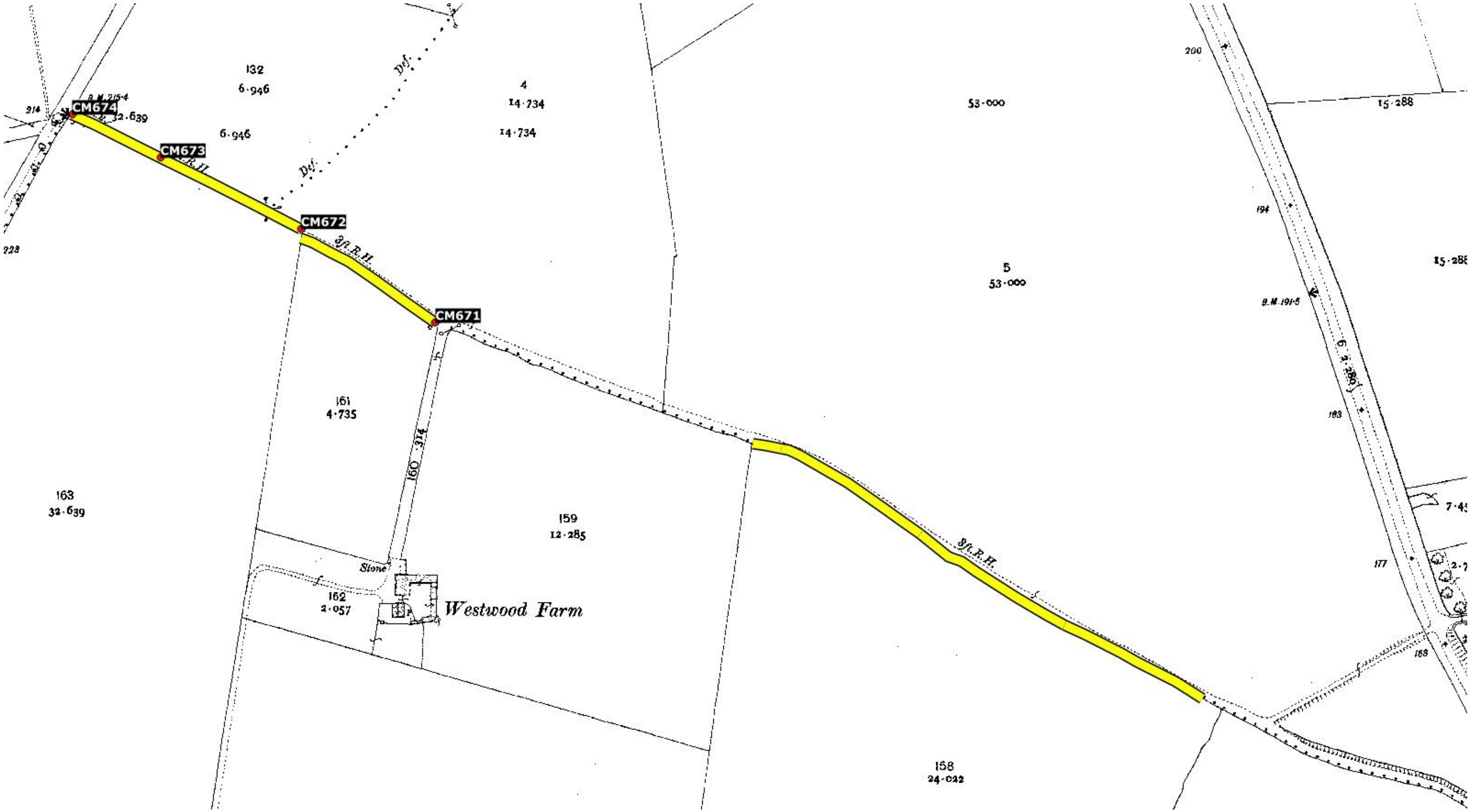


Figure 5.5 – Clifford Boundary Hedgerows – CM Section and node numbers for Western area – W2 (CM671-CM672), W3 (CM672-CM674)

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

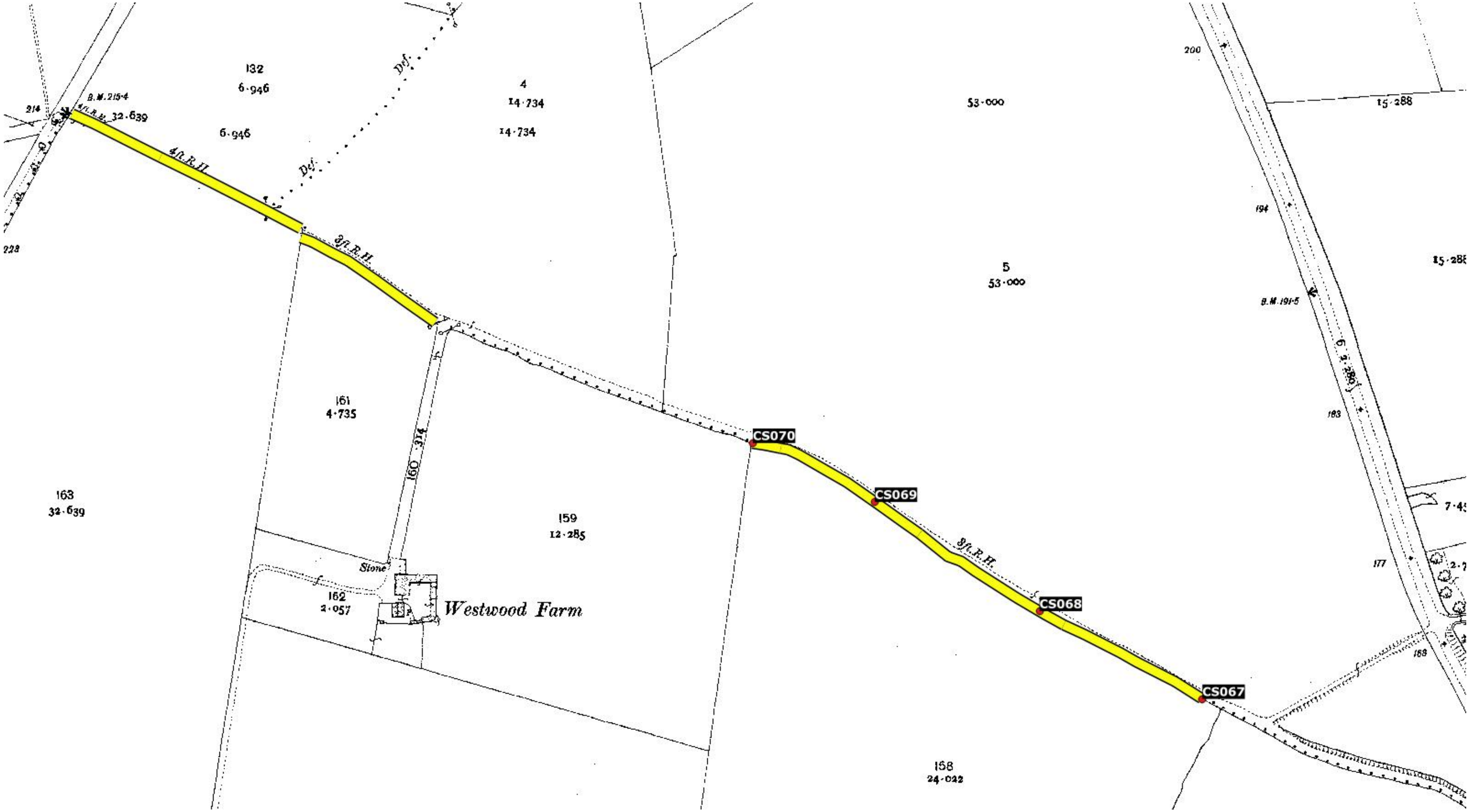


Figure 6.6 – Clifford Boundary Hedgerows – Section and node numbers for Western area – CS = W1

Appendix 18 - Clifford boundary hedgerow survey

Maps for Clifford Boundary Hedgerow survey

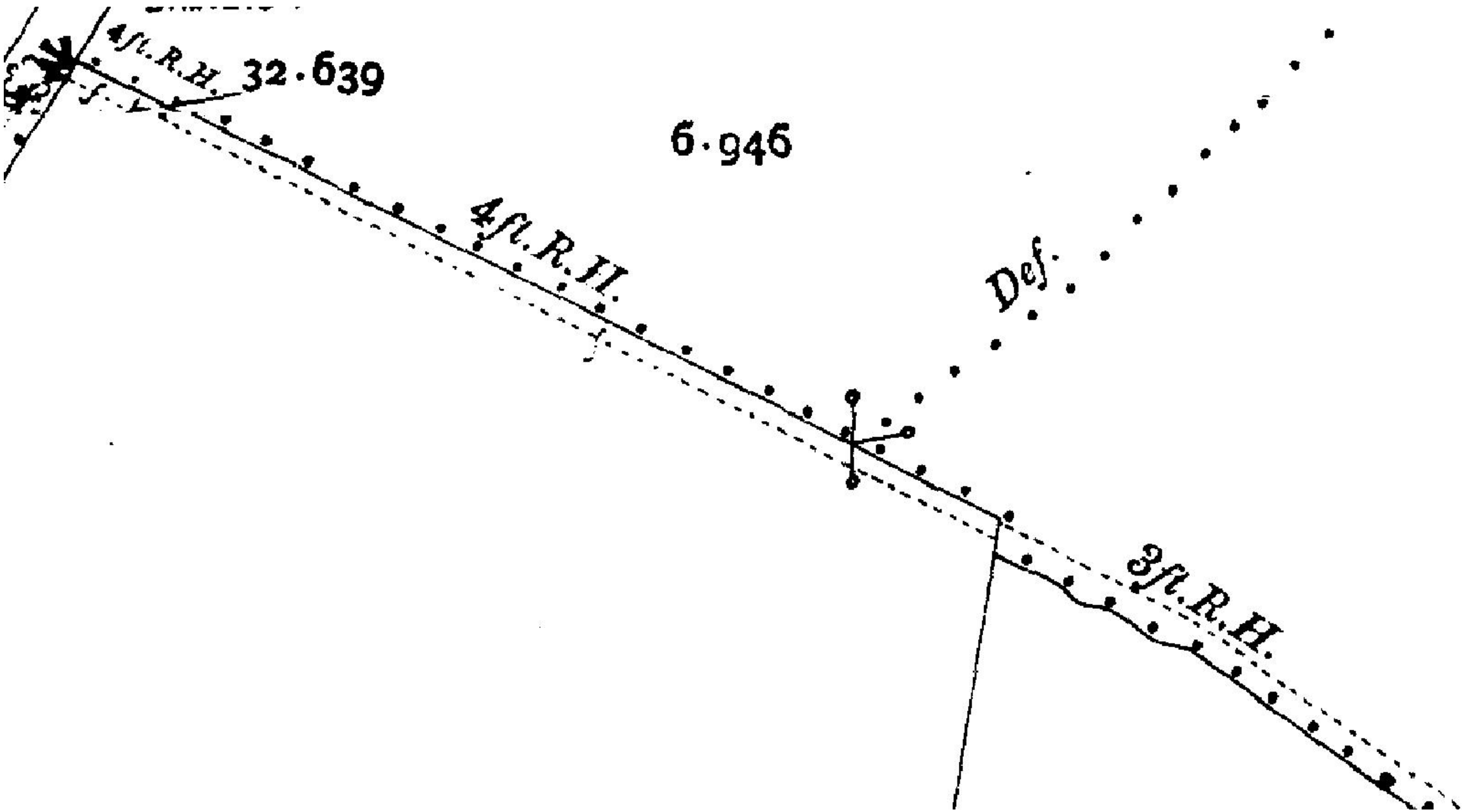


Figure 7.7 – Clifford Boundary Hedgerows – Alignment of township boundaries between W2 and W3.

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

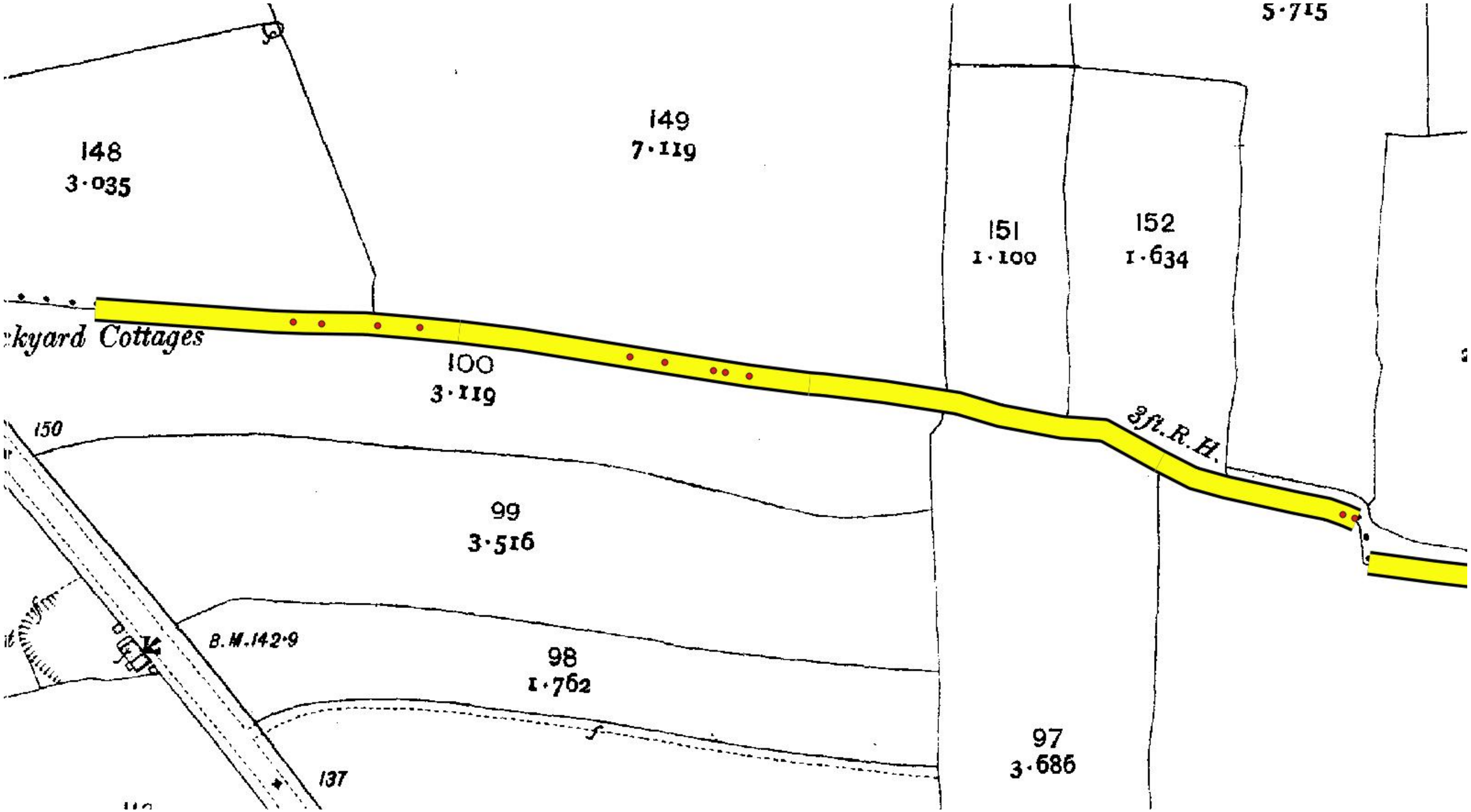


Figure 8.8 – Clifford Boundary Hedgerows – E1 – Winter survey – *Alliaria petiolata*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

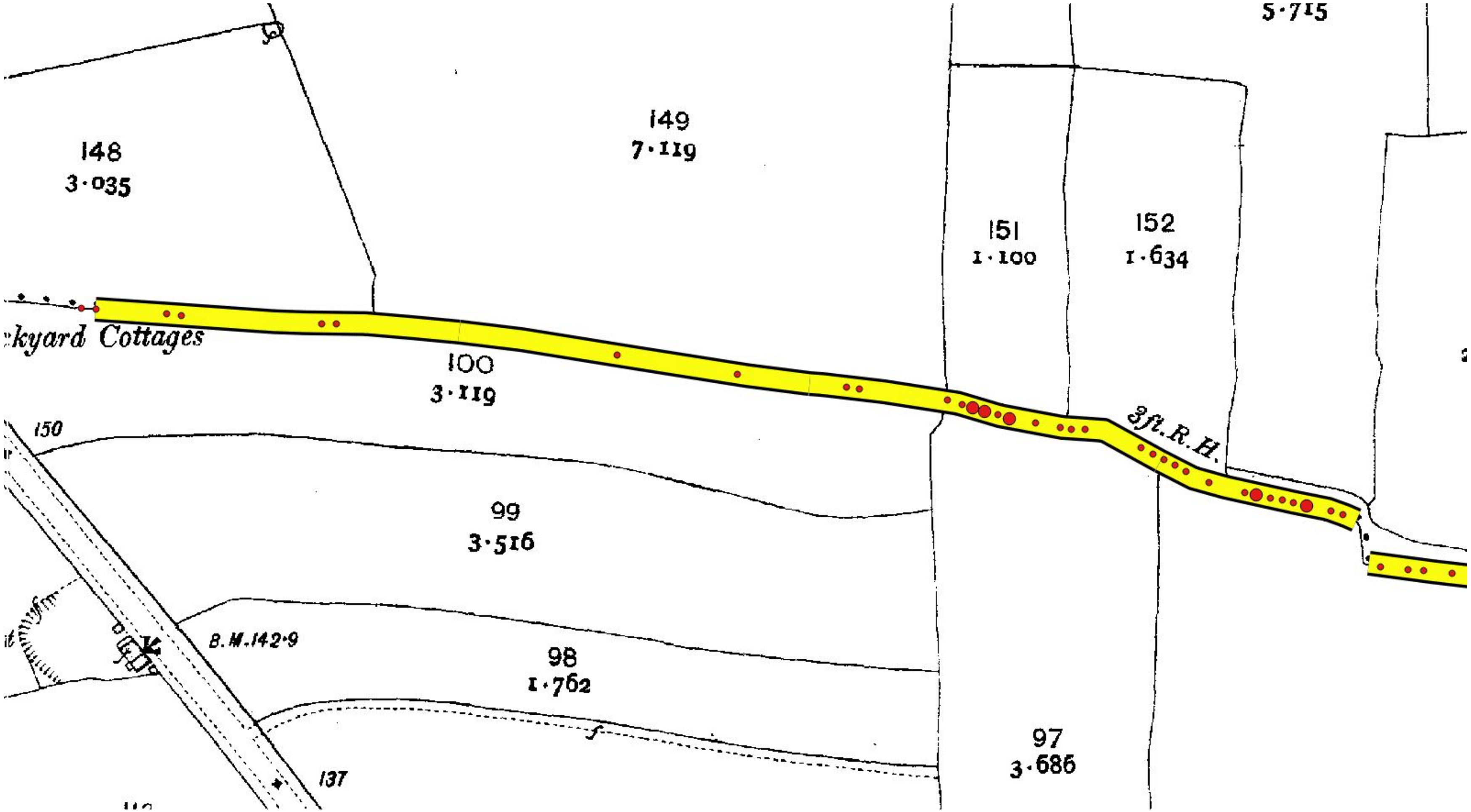


Figure 9.9 – Clifford Boundary Hedgerows – E1 – Winter survey – *Arum maculatum*

Species maps for Clifford Boundary Hedgerows

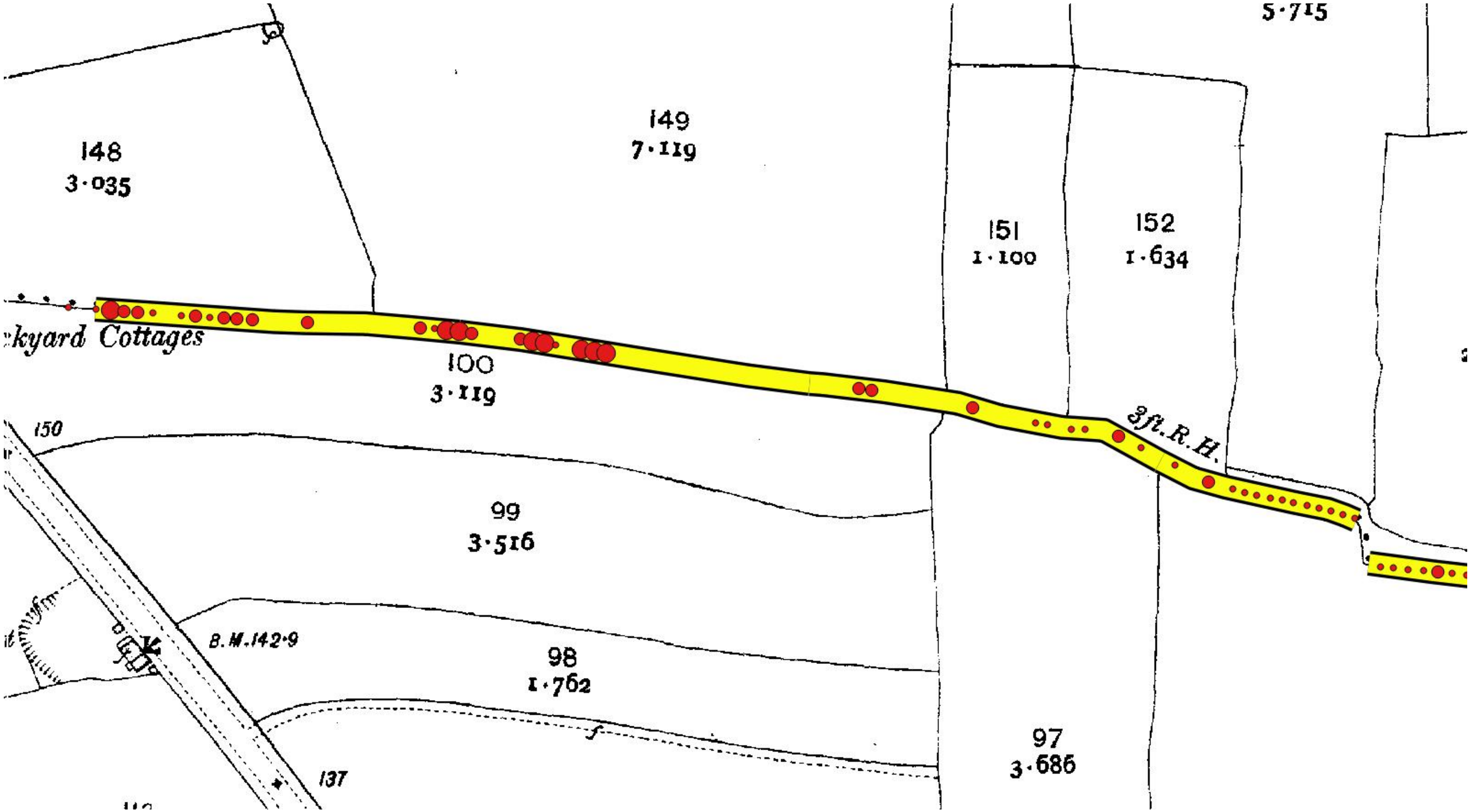


Figure 10.10 – Clifford Boundary Hedgerows – E1 – Winter survey – *Hedera helix* - arboreal

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

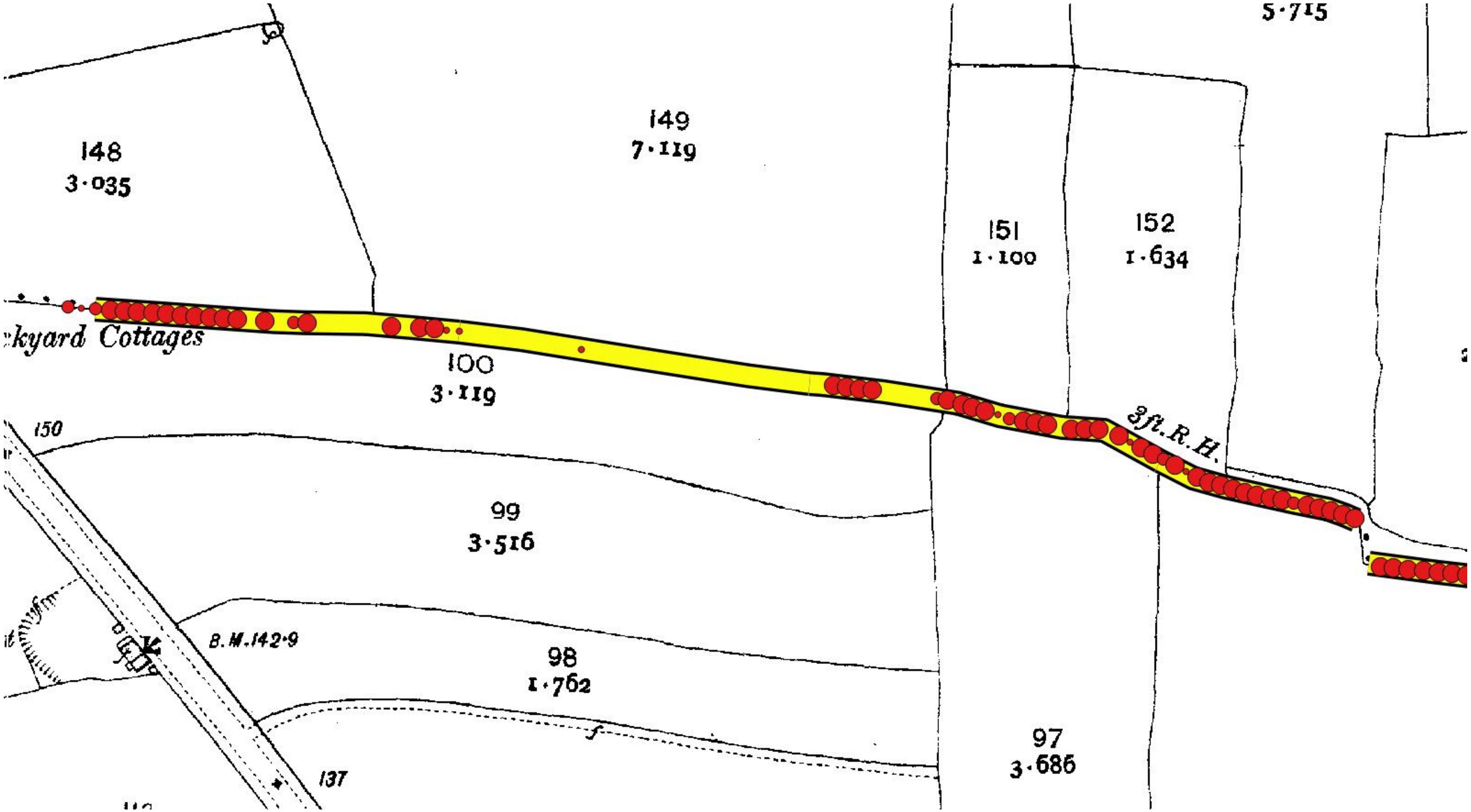


Figure 11.11 – Clifford Boundary Hedgerows – E1 – Winter survey – *Hedera helix* - terrestrial

Species maps for Clifford Boundary Hedgerows

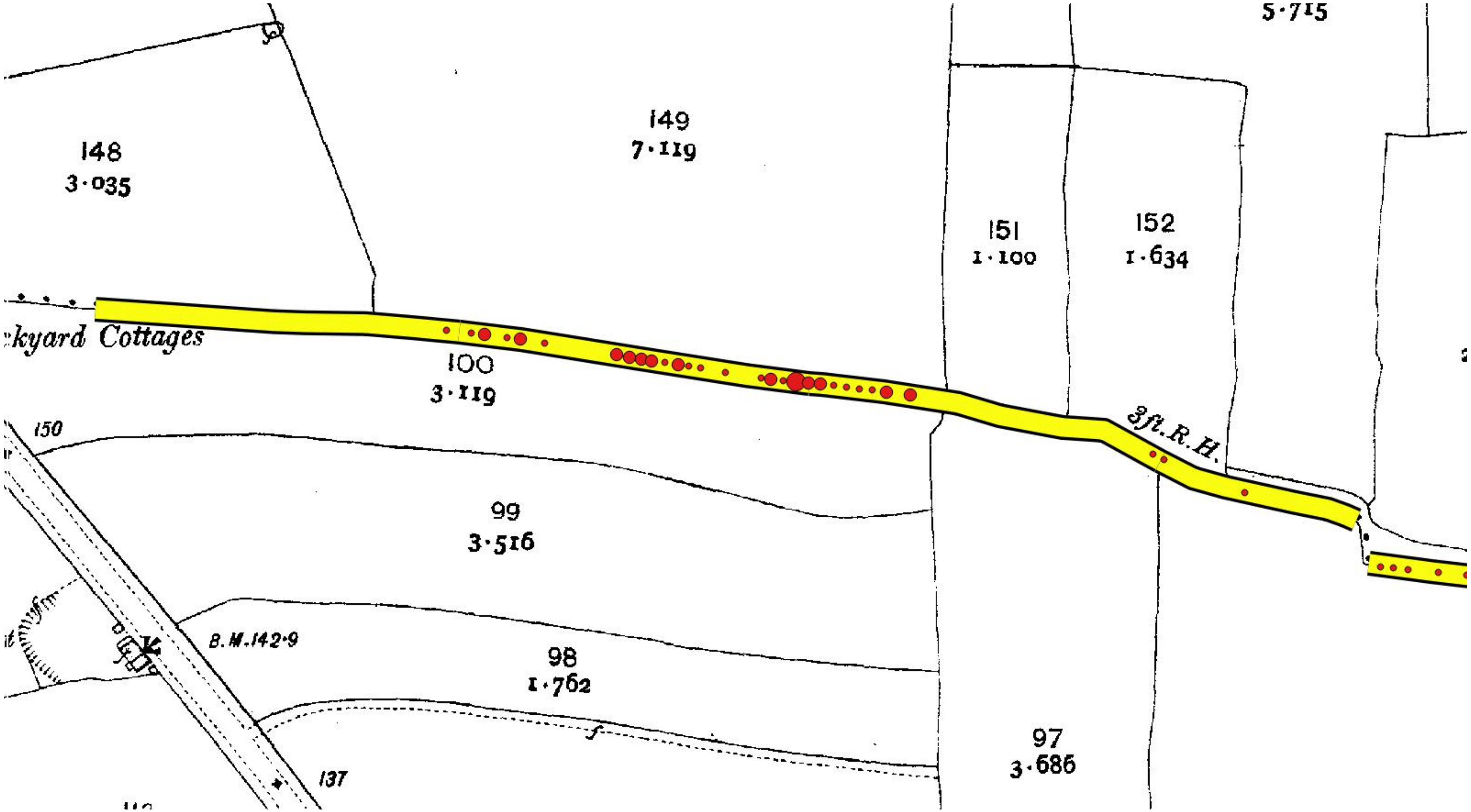


Figure 12.12 – Clifford Boundary Hedgerows – E1 – Winter survey – *Hyacinthoides non-scripta*

Species maps for Clifford Boundary Hedgerows

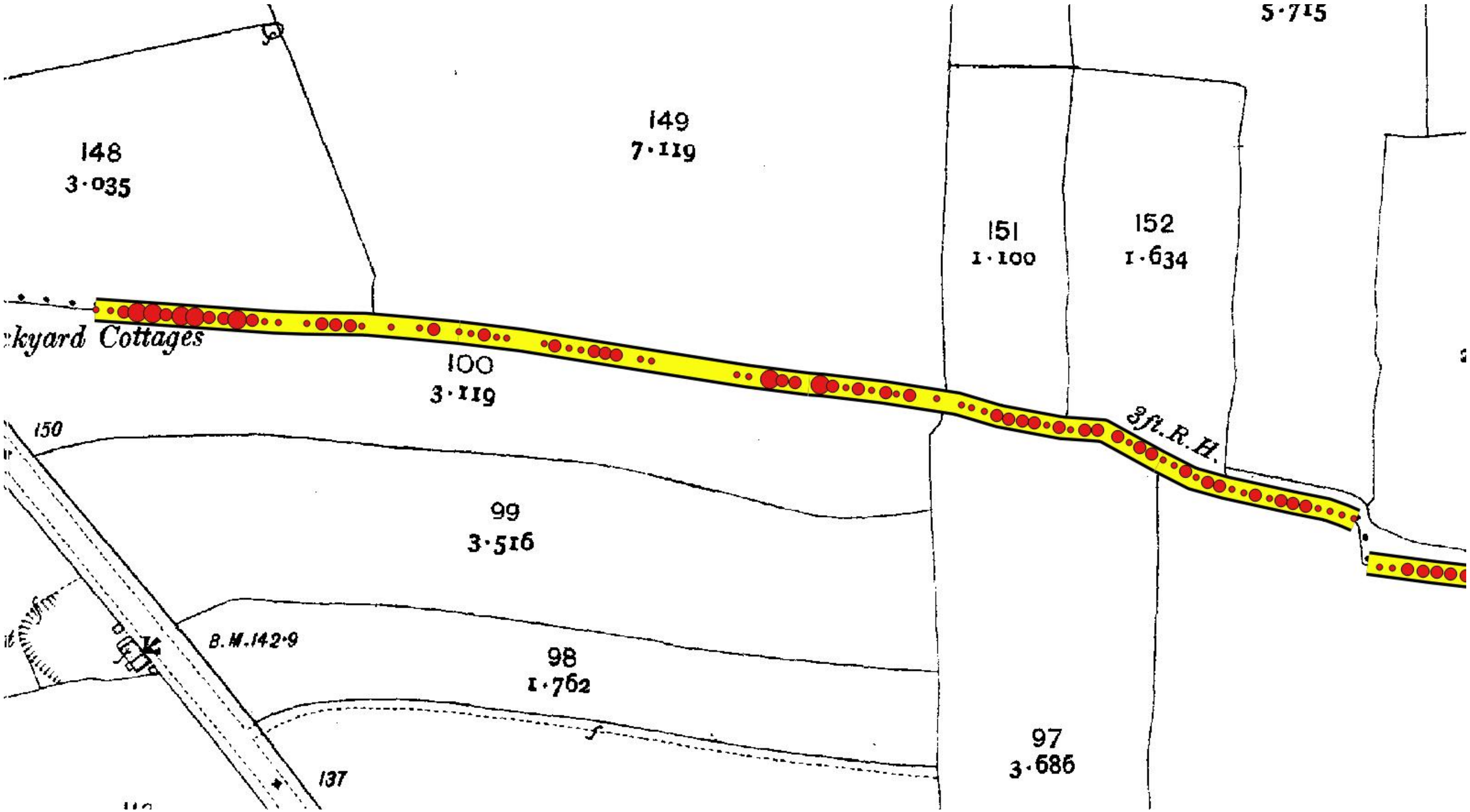


Figure 13.13 – Clifford Boundary Hedgerows – E1 – Winter survey – *Mercurialis perennis*

Species maps for Clifford Boundary Hedgerows

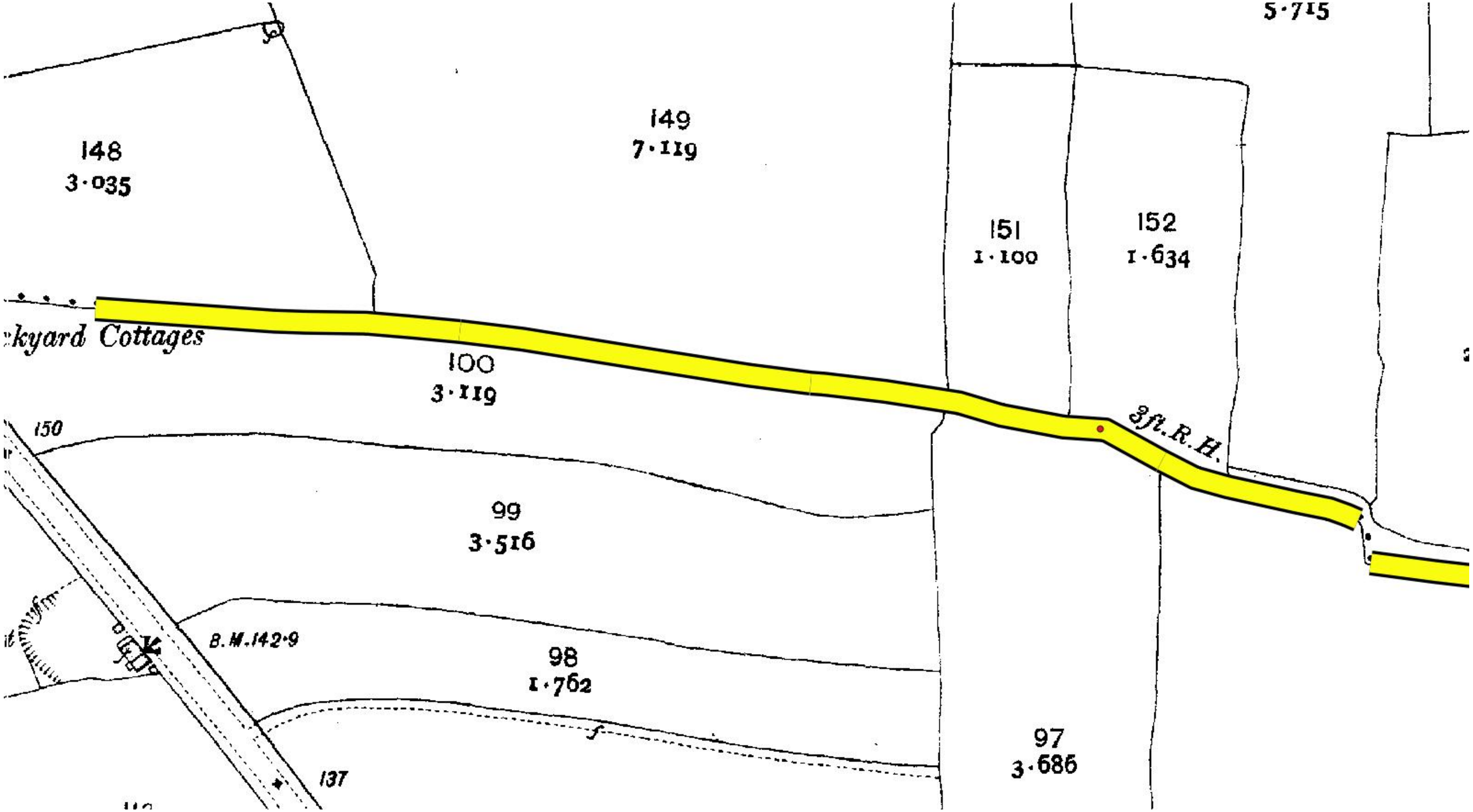


Figure 14.14 – Clifford Boundary Hedgerows – E1 – Winter survey – *Pteridium aquilinum*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

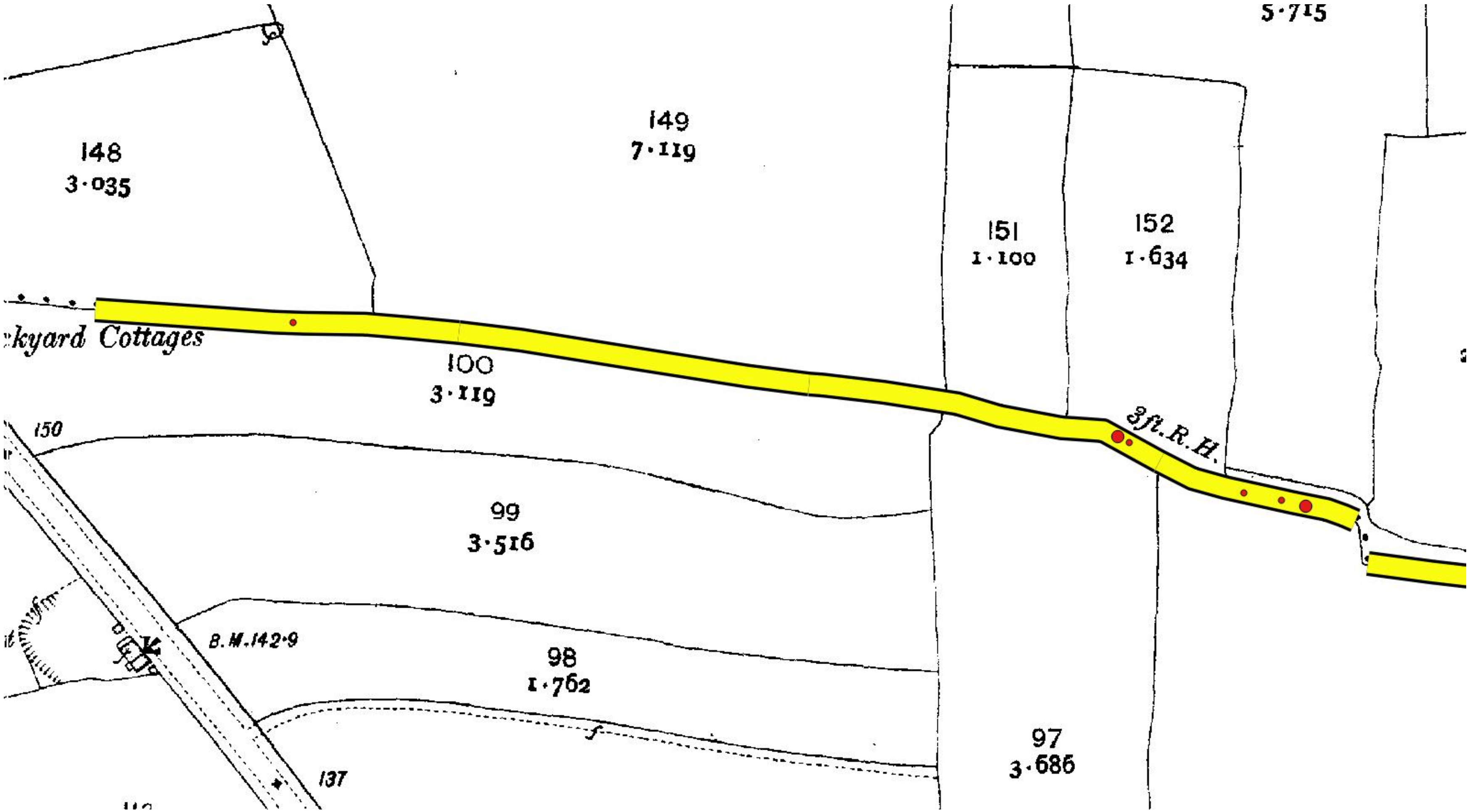


Figure 15.15 – Clifford Boundary Hedgerows – E1 – Winter survey – *Ranunculus ficaria*

Species maps for Clifford Boundary Hedgerows

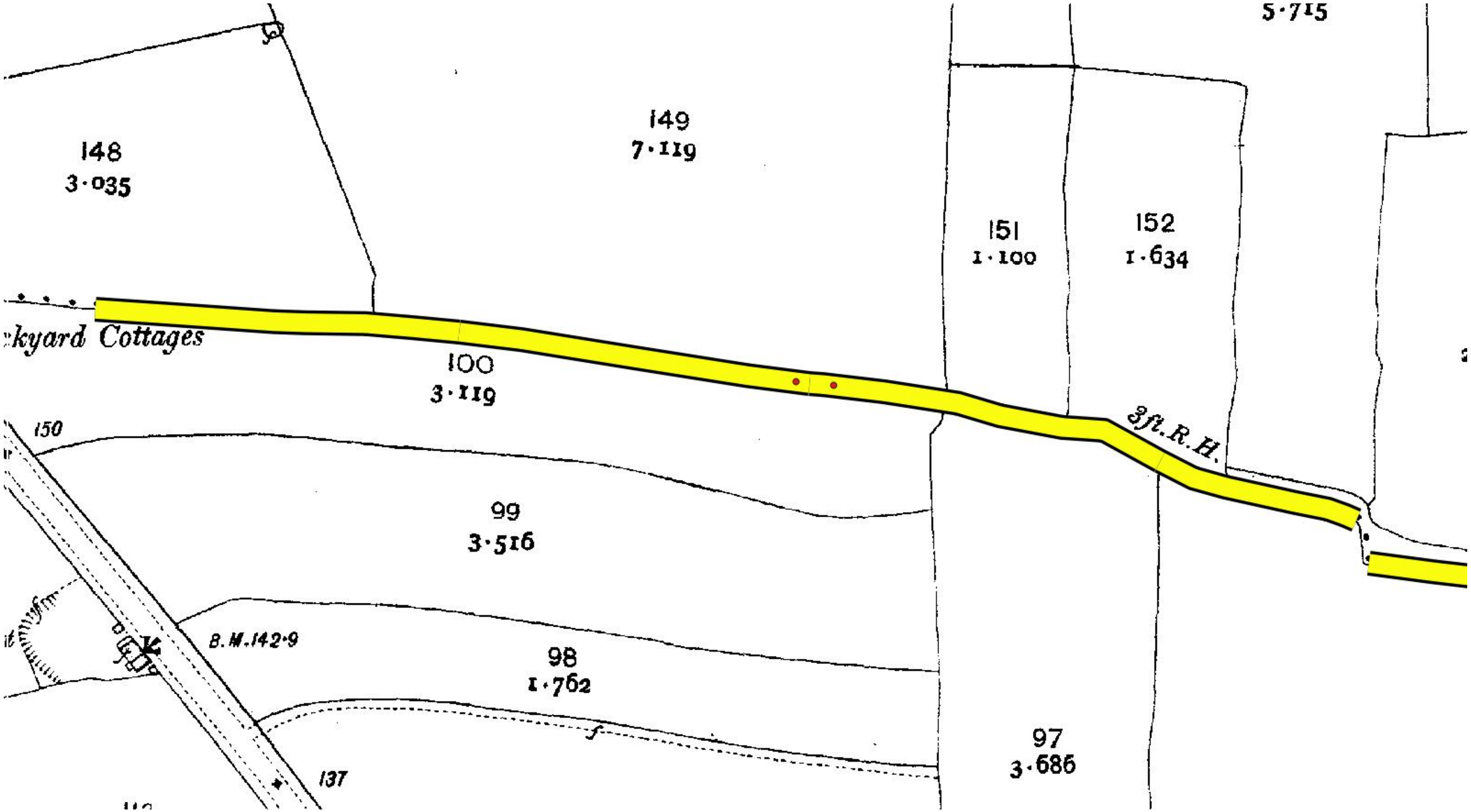


Figure 16.16 – Clifford Boundary Hedgerows – E1 – Winter survey – *Stachys sylvatica*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

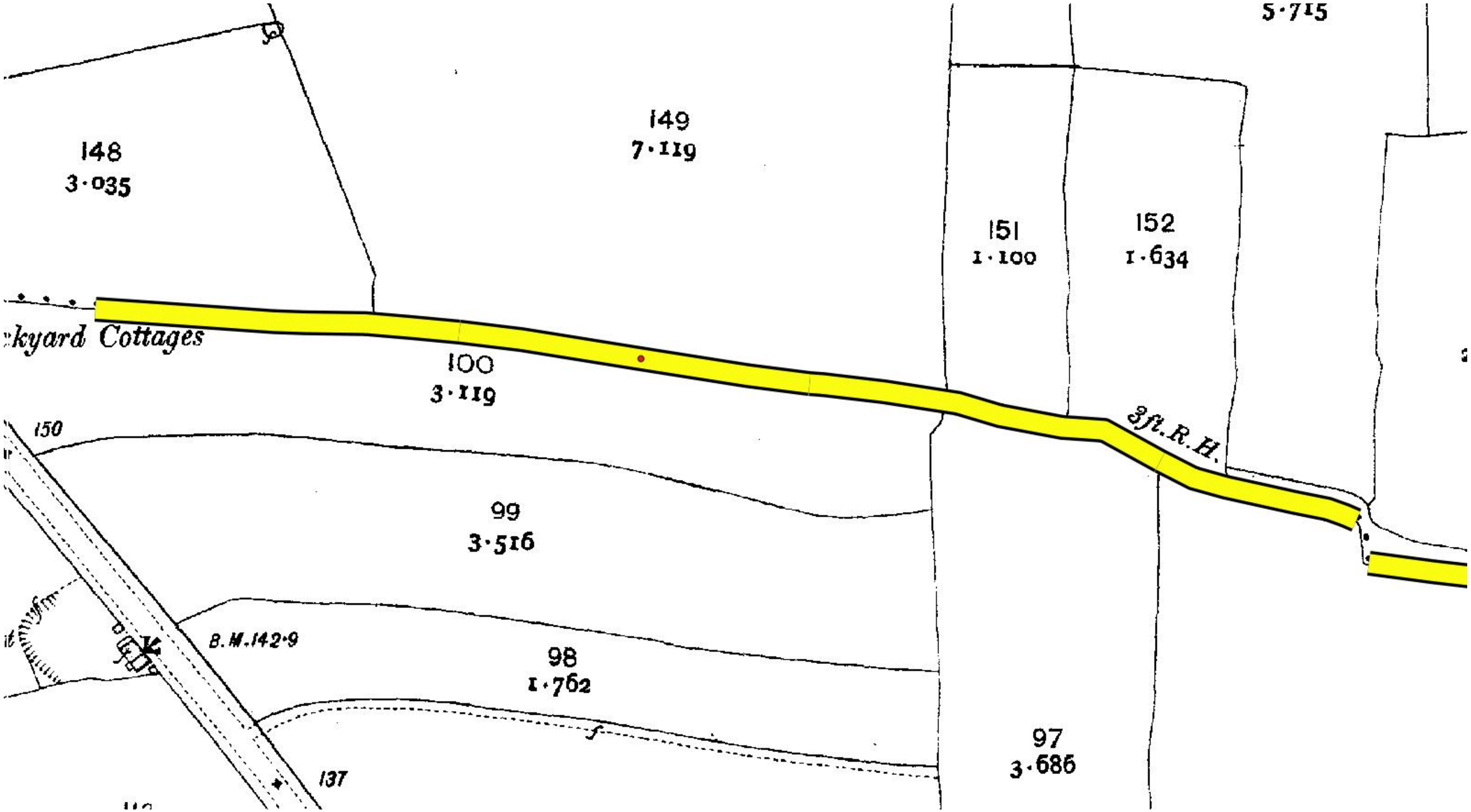


Figure 17.17 – Clifford Boundary Hedgerows – E1 – Winter survey – *Viola odorata*

Species maps for Clifford Boundary Hedgerows

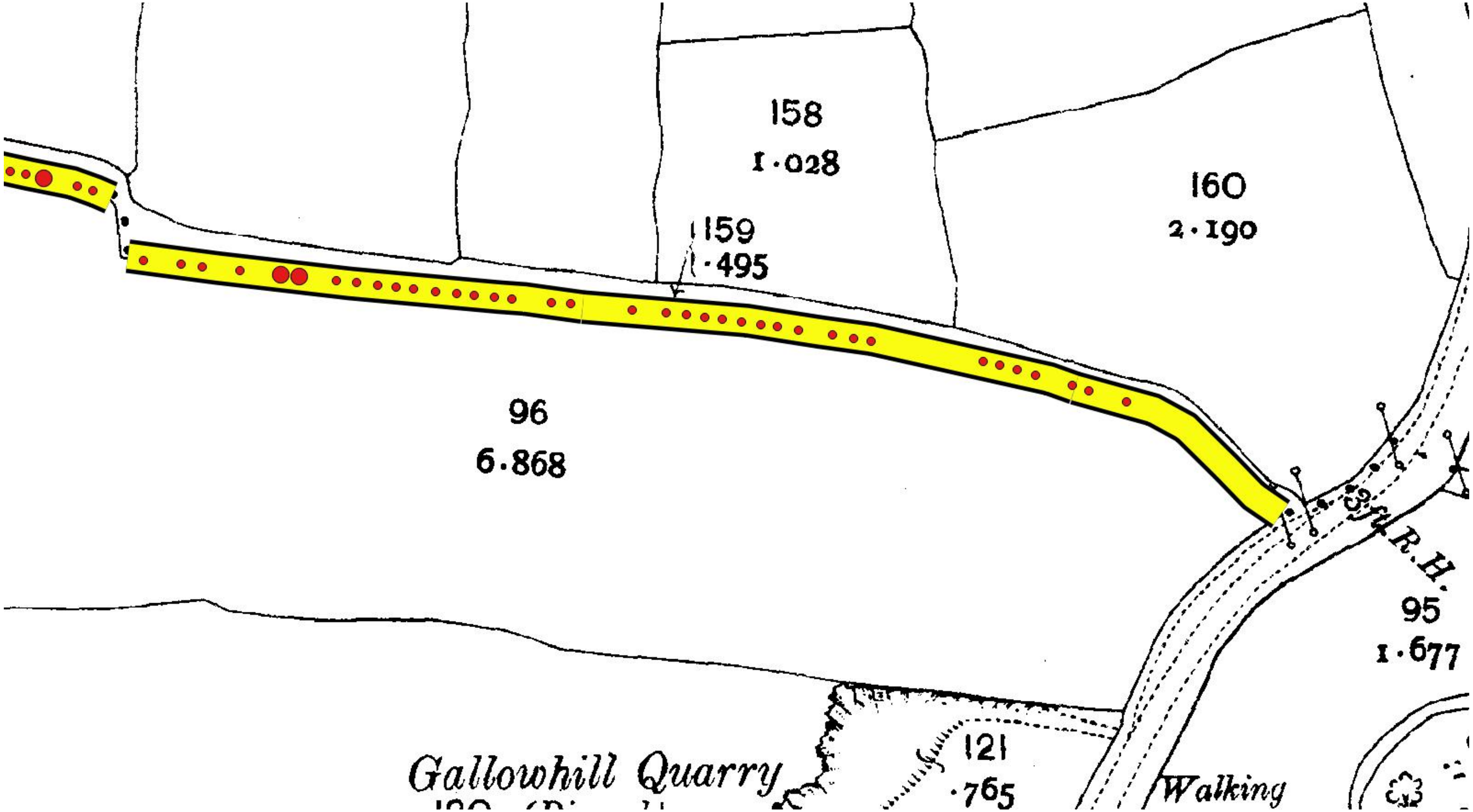


Figure 18.18 – Clifford Boundary Hedgerows – E2 – Winter survey – *Arum maculatum*

Species maps for Clifford Boundary Hedgerows

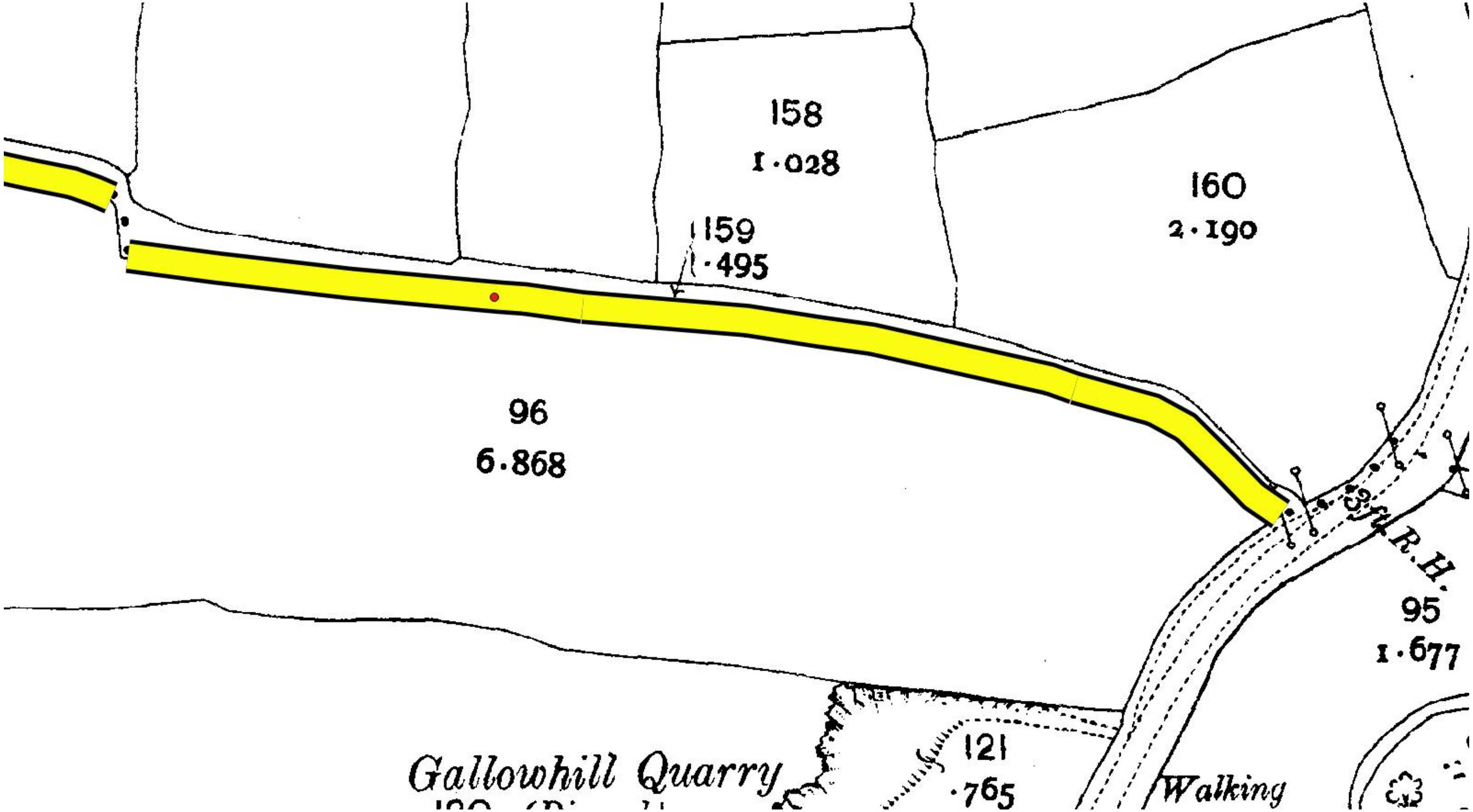


Figure 19.19 – Clifford Boundary Hedgerows – E2 – Winter survey – *Geum urbanum*

Species maps for Clifford Boundary Hedgerows

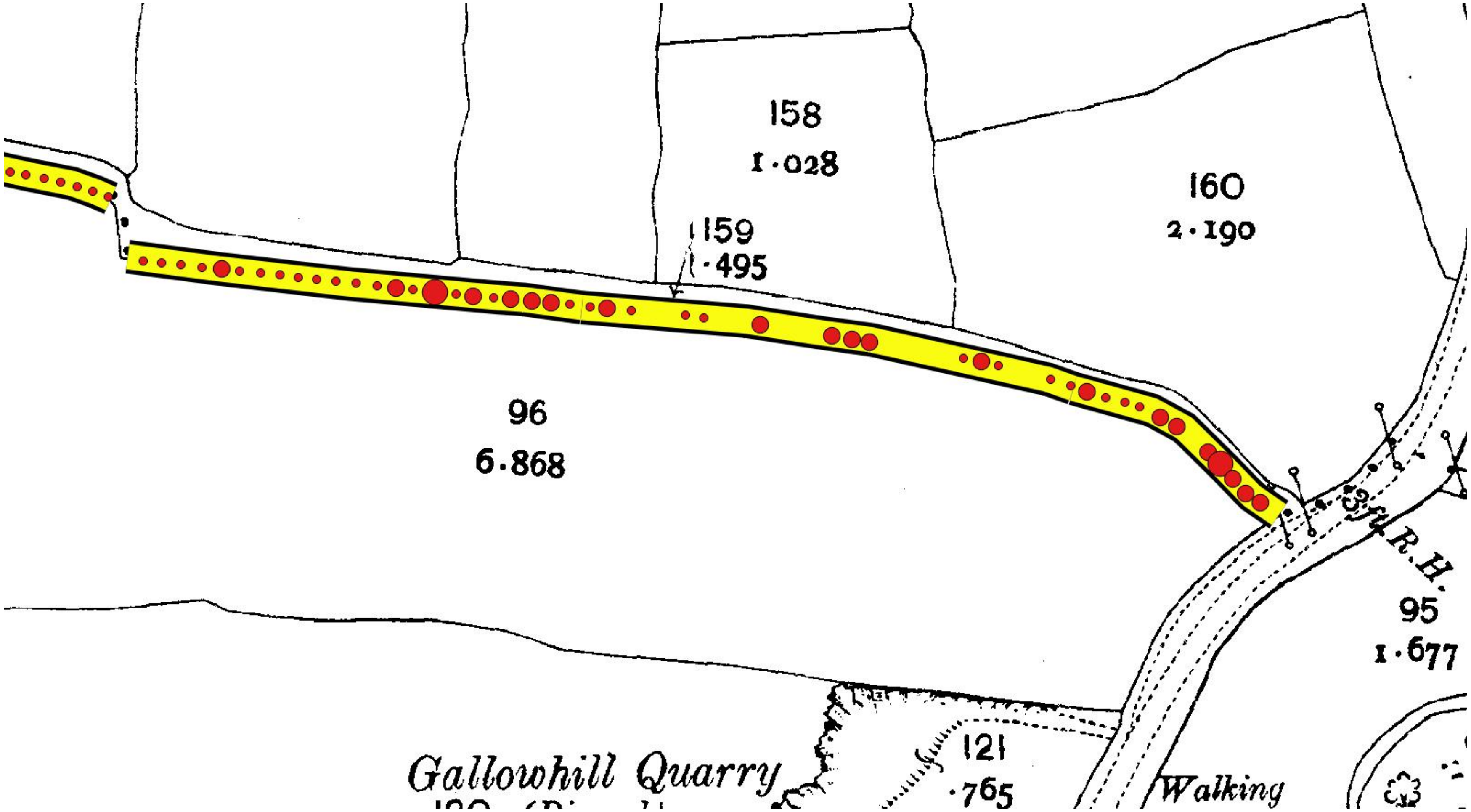


Figure 20.20 – Clifford Boundary Hedgerows – E2 – Winter survey – *Hedera helix* - arboreal

Species maps for Clifford Boundary Hedgerows

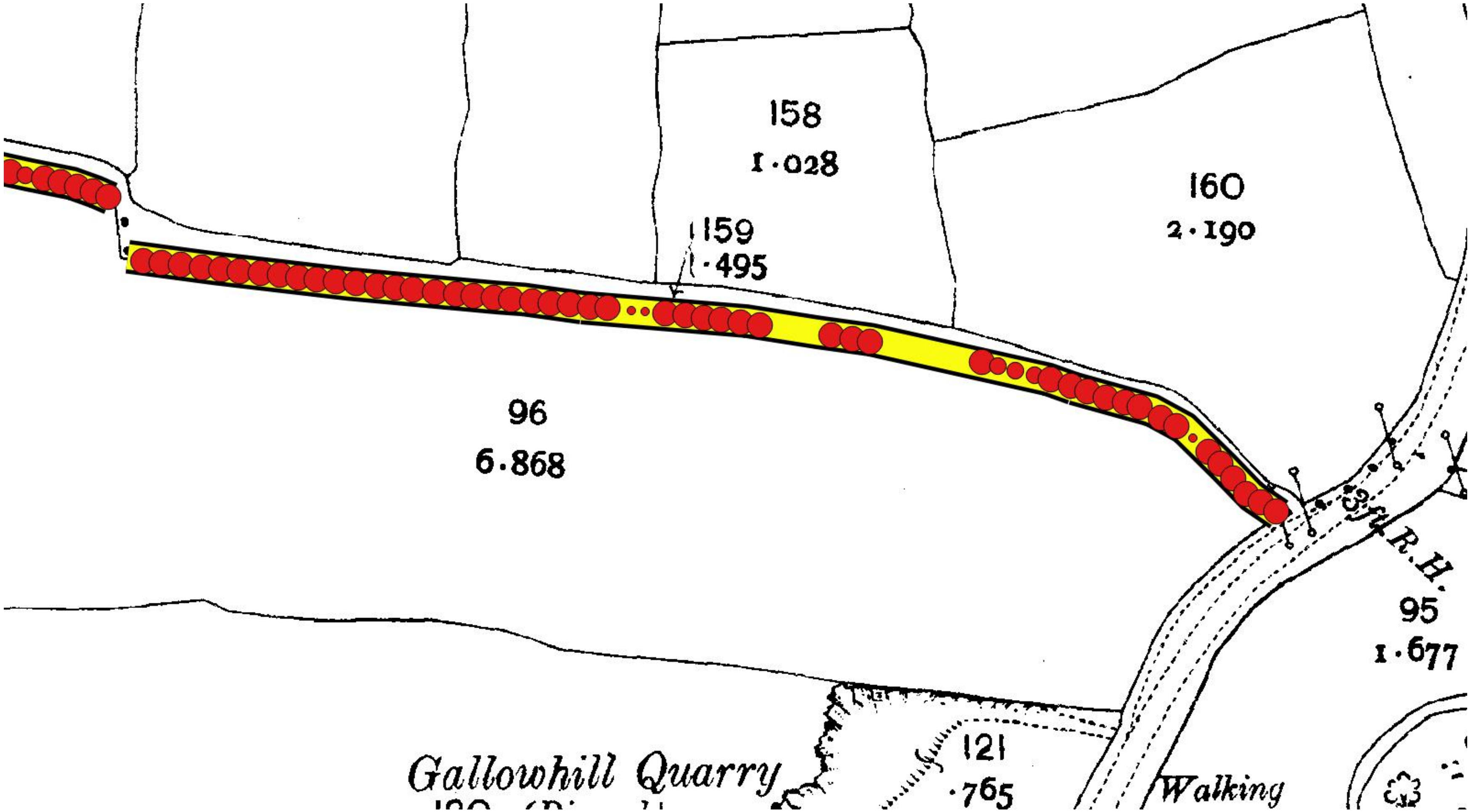


Figure 21.21 – Clifford Boundary Hedgerows – E2 – Winter survey – *Hedera helix* - terrestrial

Species maps for Clifford Boundary Hedgerows

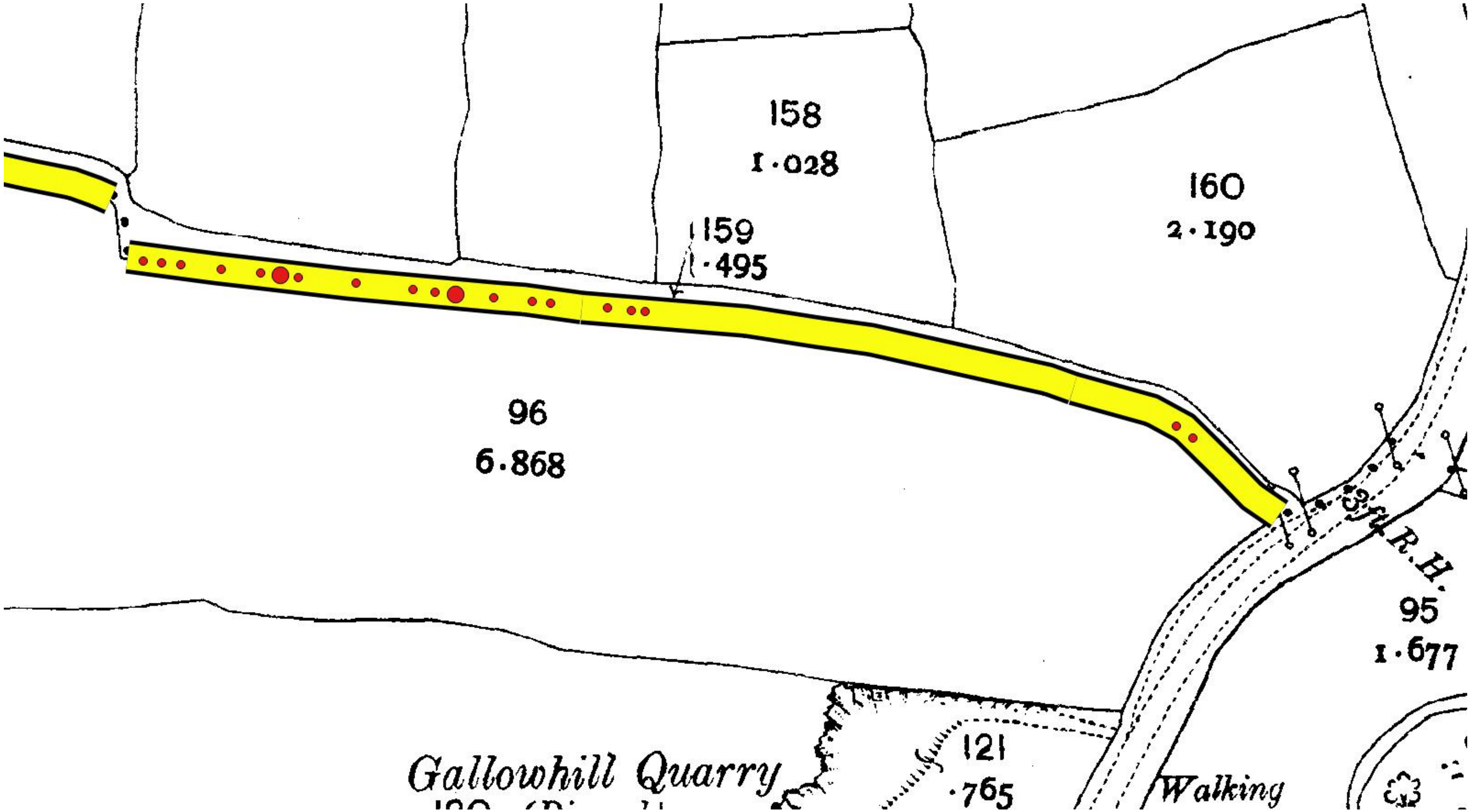


Figure 22.22 – Clifford Boundary Hedgerows – E2– Winter survey – *Hyacinthoides non-scripta*

Species maps for Clifford Boundary Hedgerows

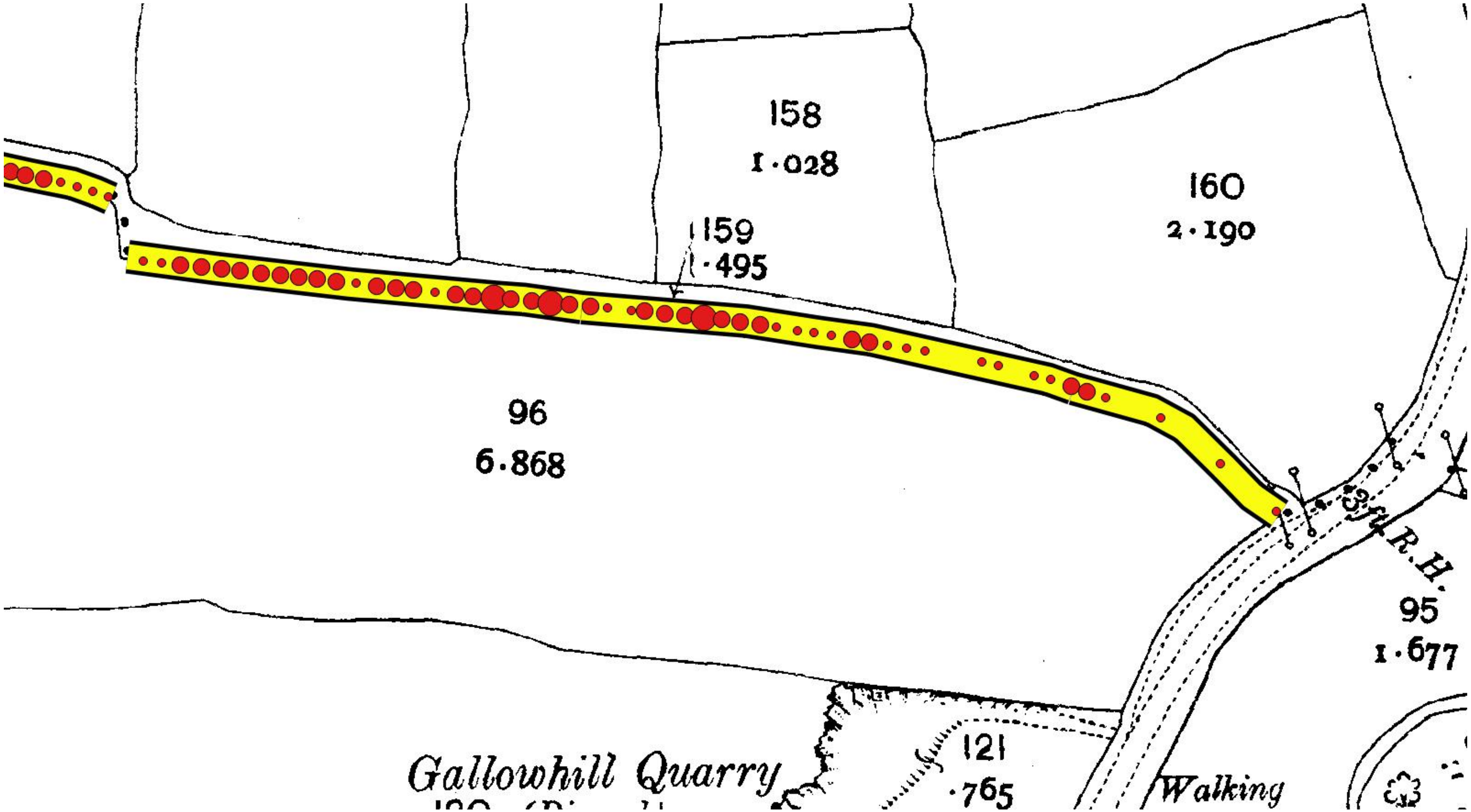


Figure 23.23 – Clifford Boundary Hedgerows – E2 – Winter survey – *Mercurialis perennis*

Species maps for Clifford Boundary Hedgerows

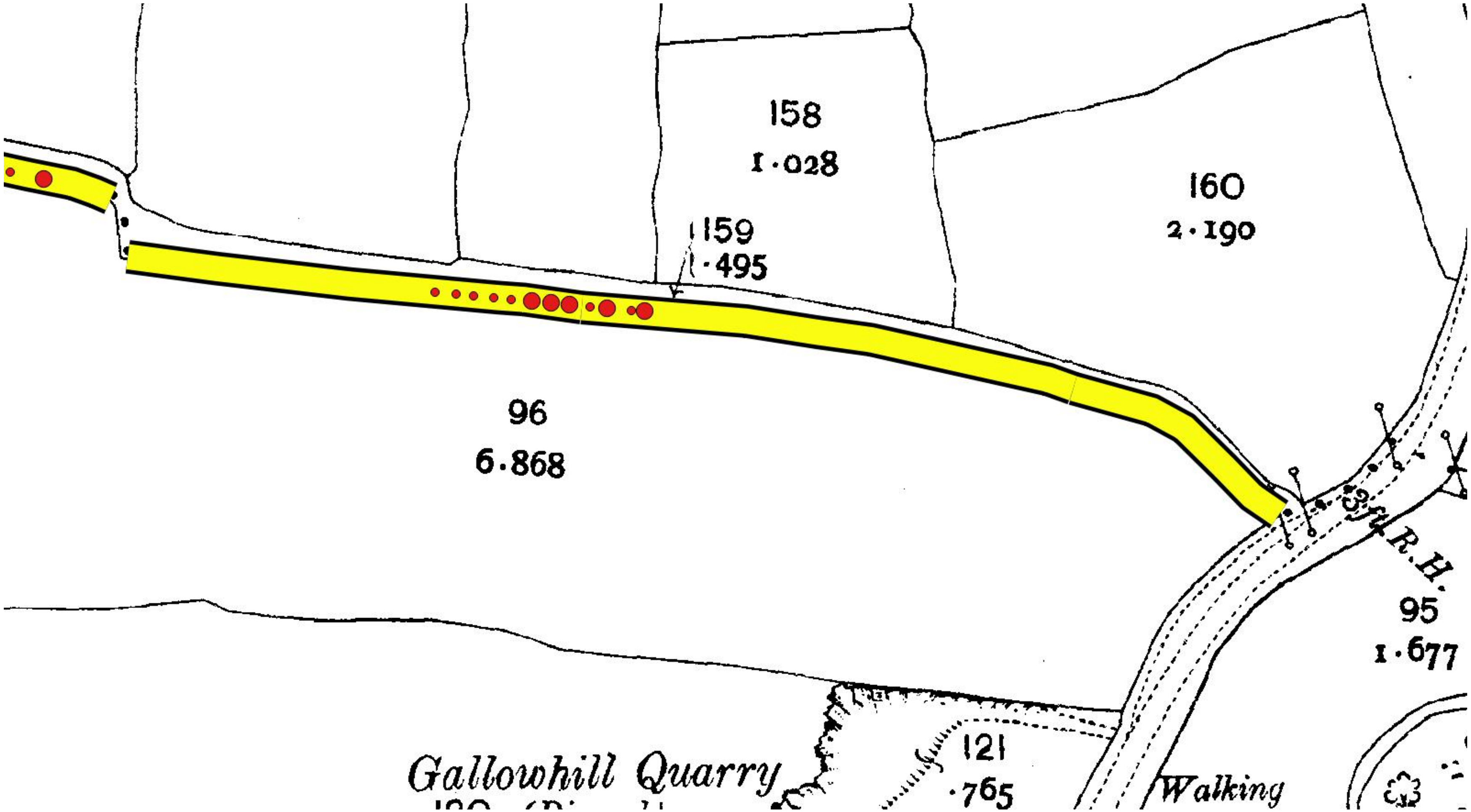


Figure 24.24 – Clifford Boundary Hedgerows – E2 – Winter survey – *Ranunculus ficaria*

Species maps for Clifford Boundary Hedgerows

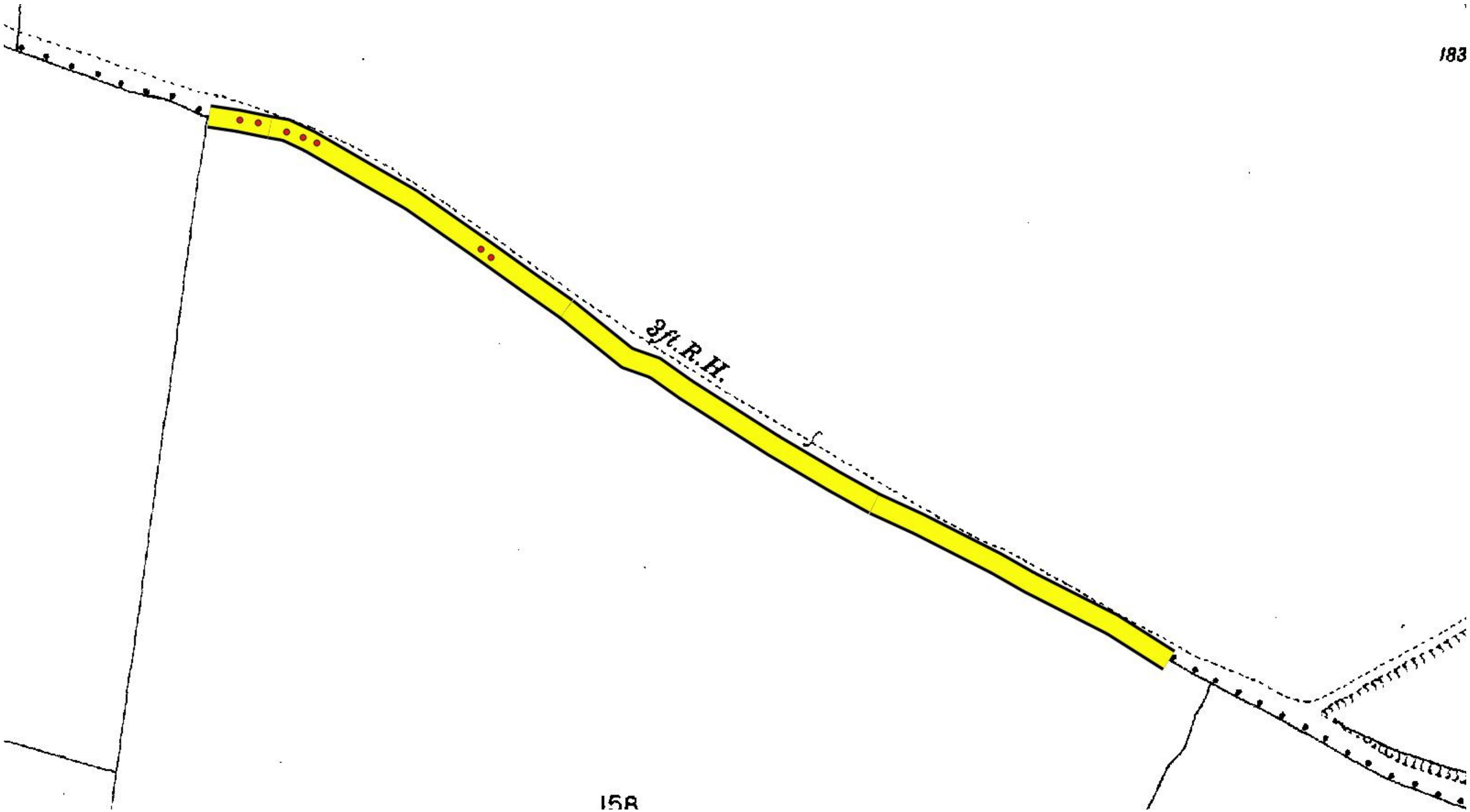


Figure 25.25 – Clifford Boundary Hedgerows – W1– Winter survey – *Anemone nemorosa*

Species maps for Clifford Boundary Hedgerows

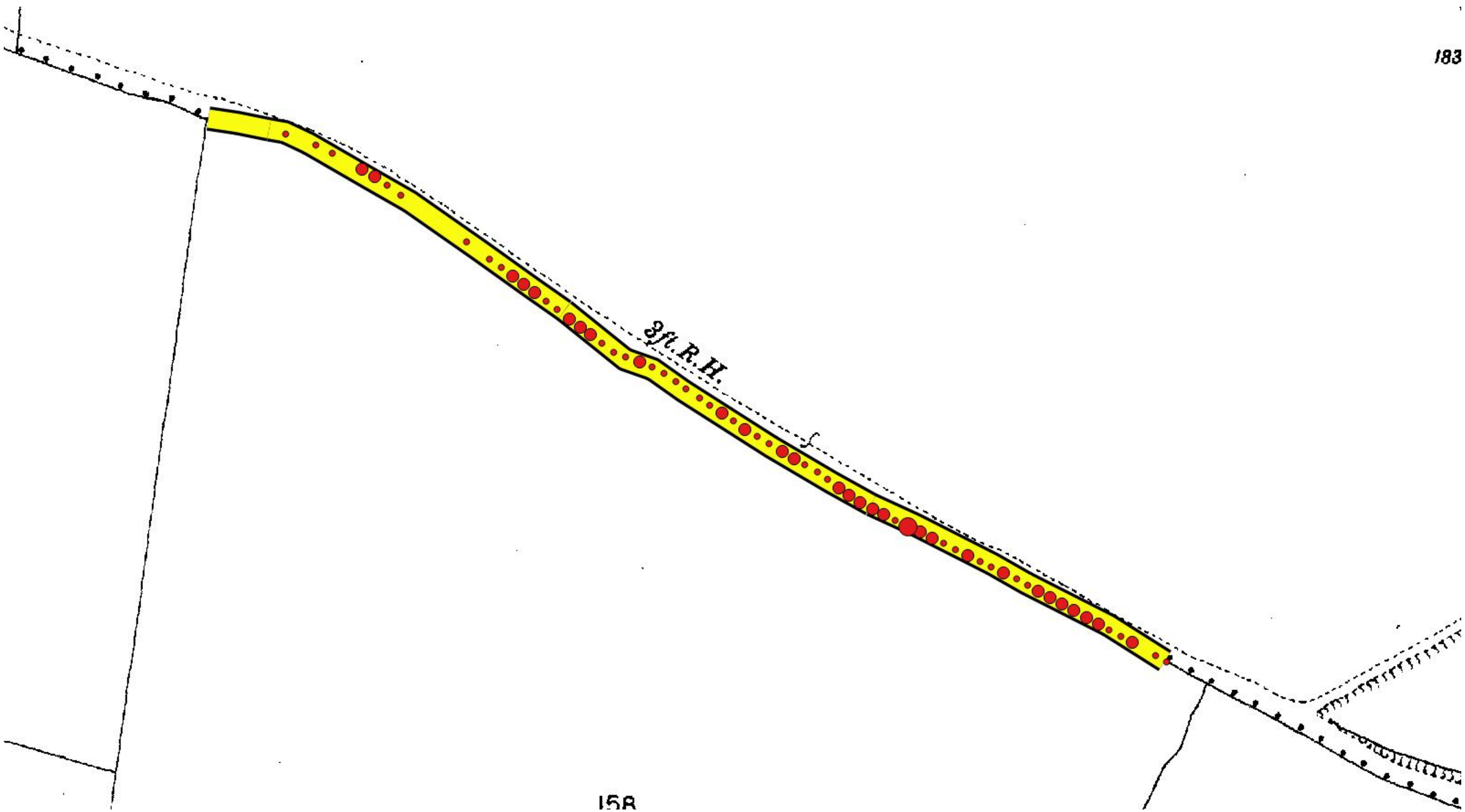


Figure 26.26 – Clifford Boundary Hedgerows – W1 – Winter survey – *Arum maculatum*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

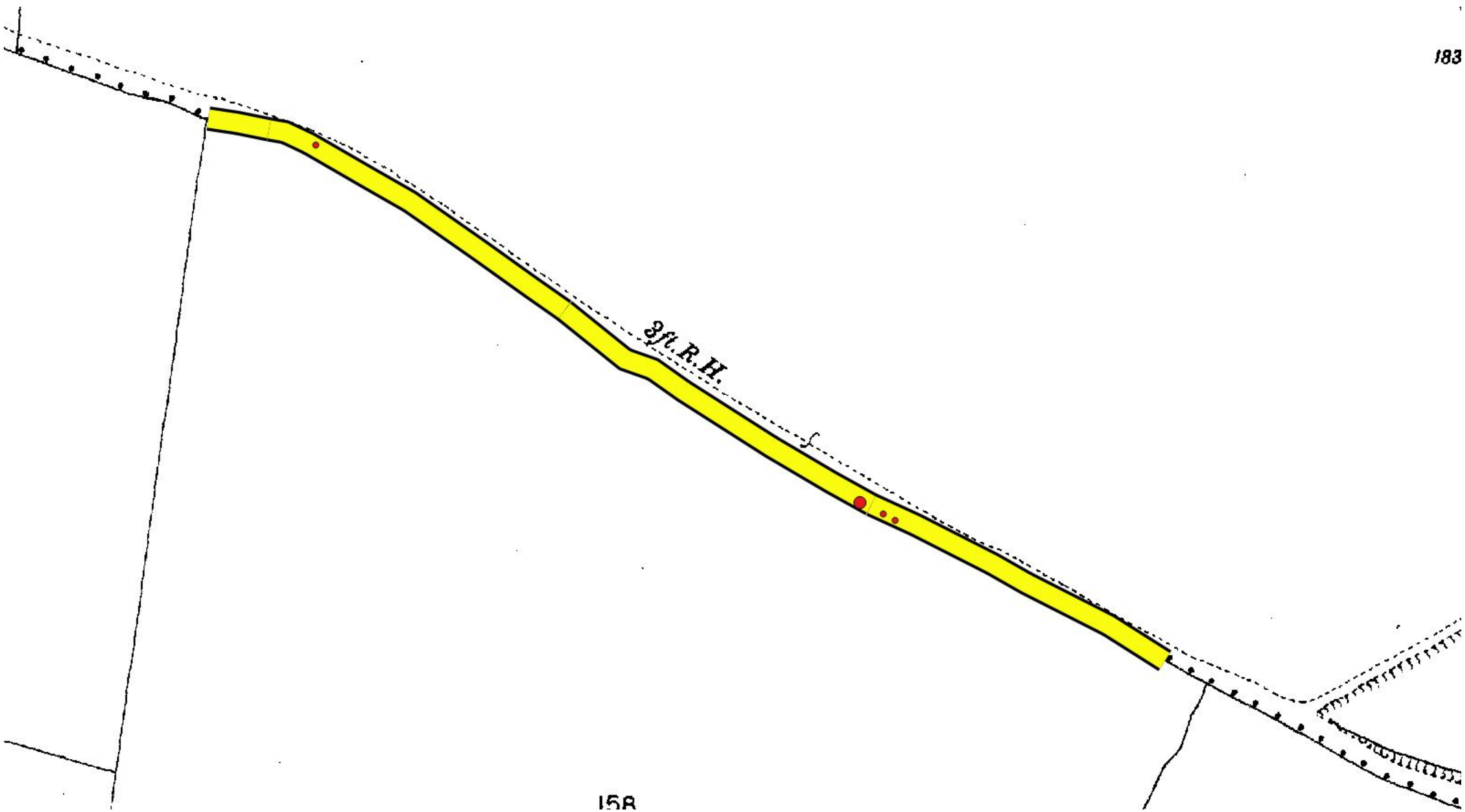


Figure 27.27 – Clifford Boundary Hedgerows – W1 – Winter survey – *Hedera helix* - arboreal

Species maps for Clifford Boundary Hedgerows

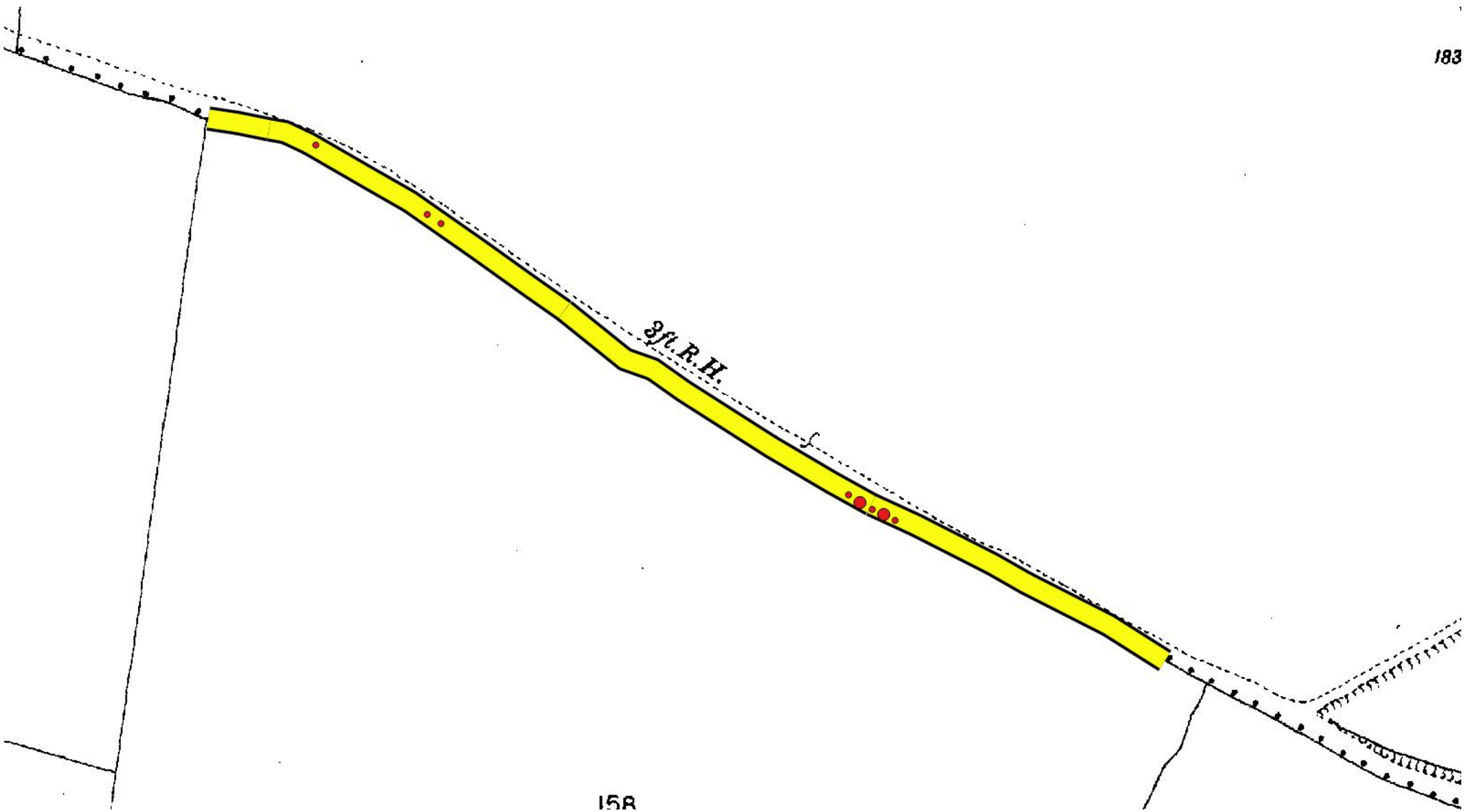


Figure 28.28 – Clifford Boundary Hedgerows – W1 – Winter survey – *Hedera helix* - terrestrial

Species maps for Clifford Boundary Hedgerows

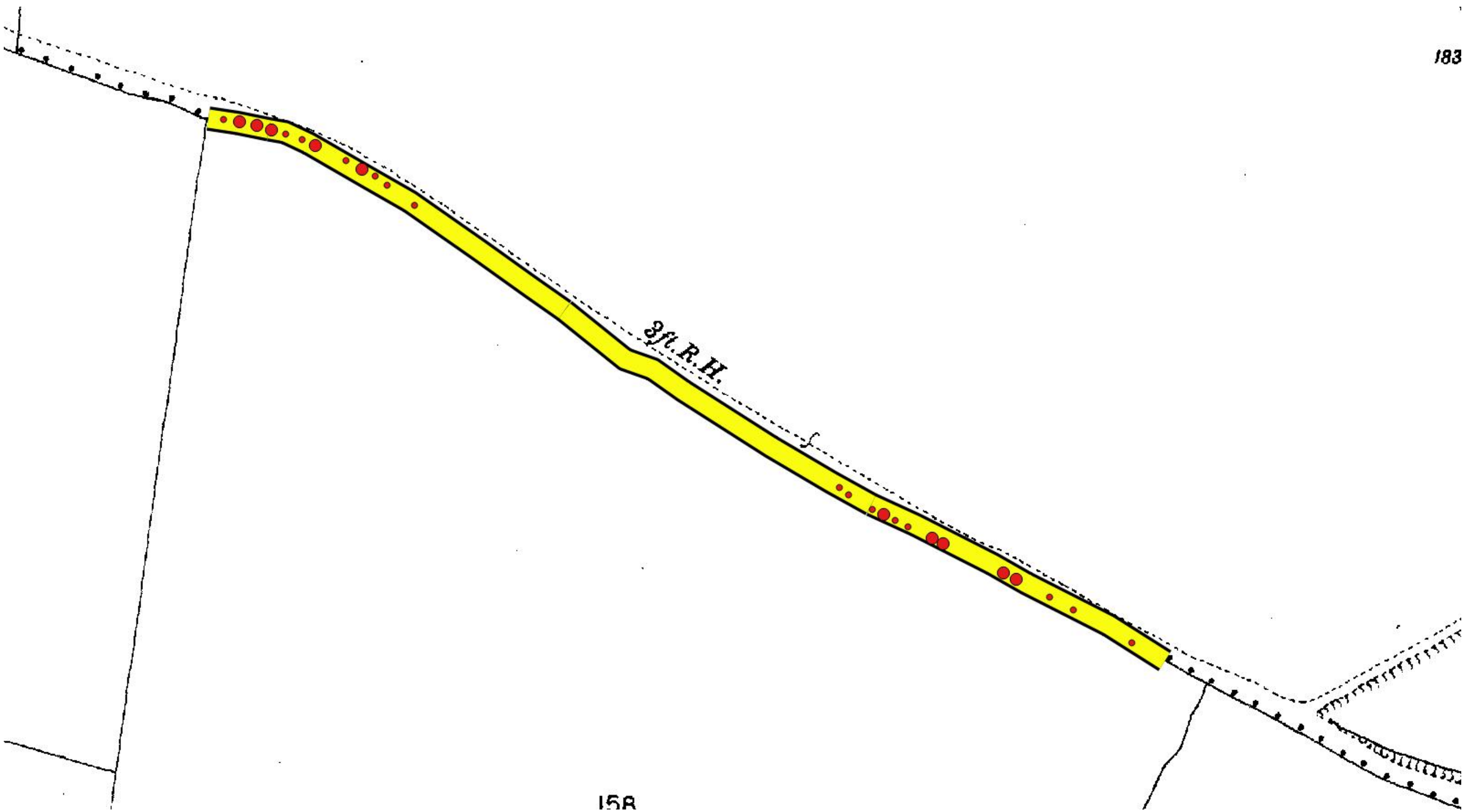


Figure 29.29 – Clifford Boundary Hedgerows – W1 – Winter survey – *Hyacinthoides non-scripta*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

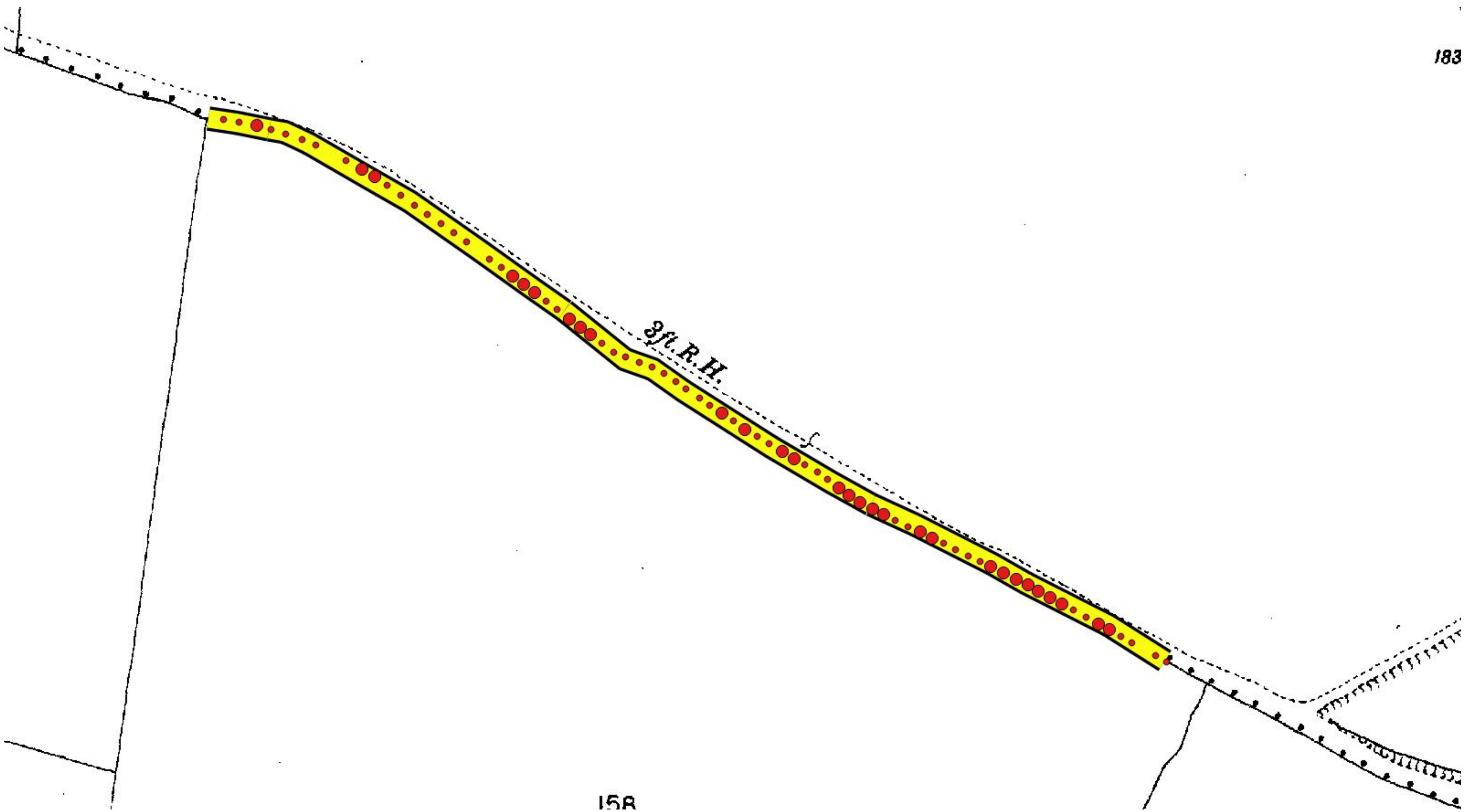


Figure 30.30 – Clifford Boundary Hedgerows – W1 – Winter survey – *Mercurialis perennis*

Species maps for Clifford Boundary Hedgerows

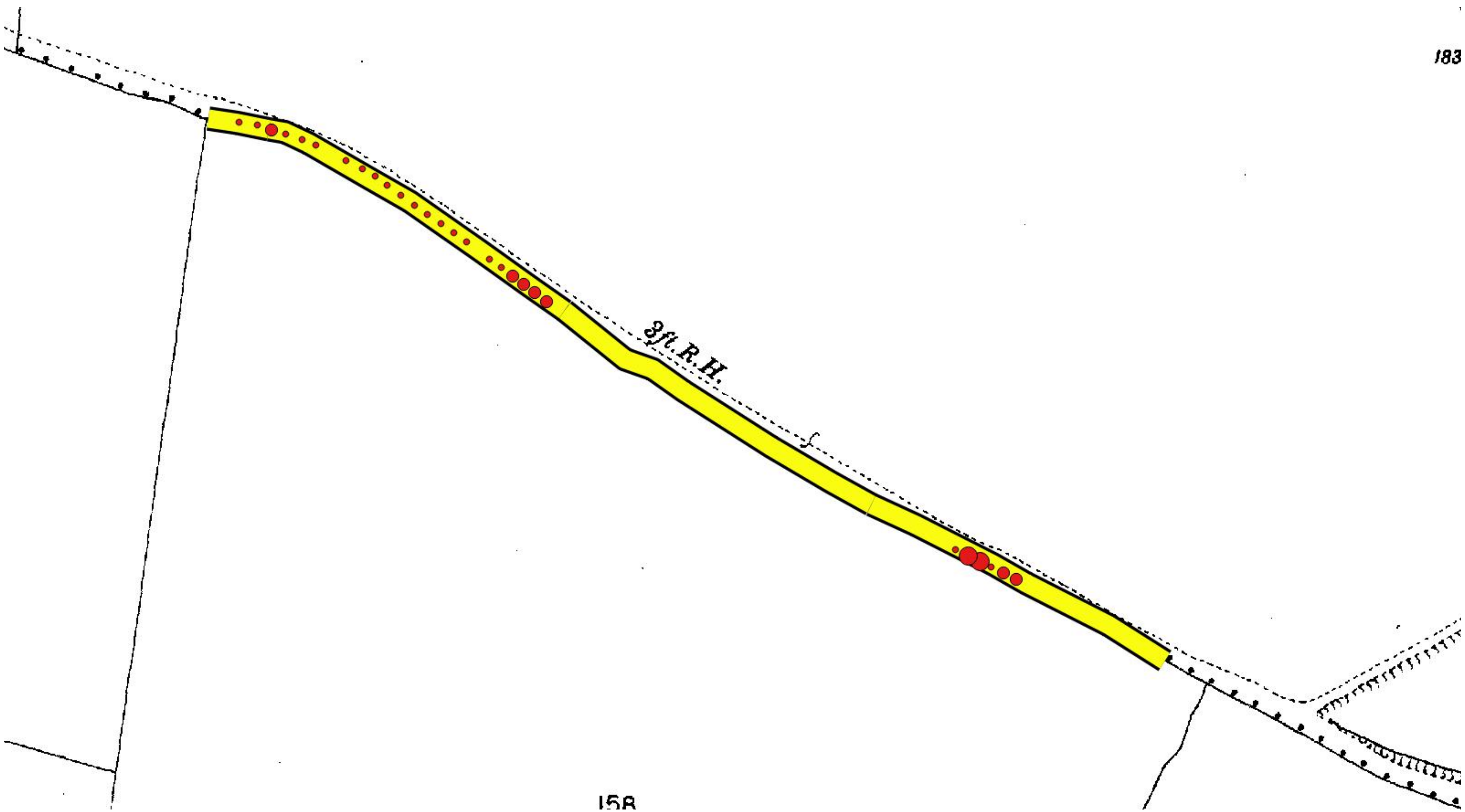


Figure 31.31 – Clifford Boundary Hedgerows – W1 – Winter survey – *Pteridium aquilinum*

Species maps for Clifford Boundary Hedgerows

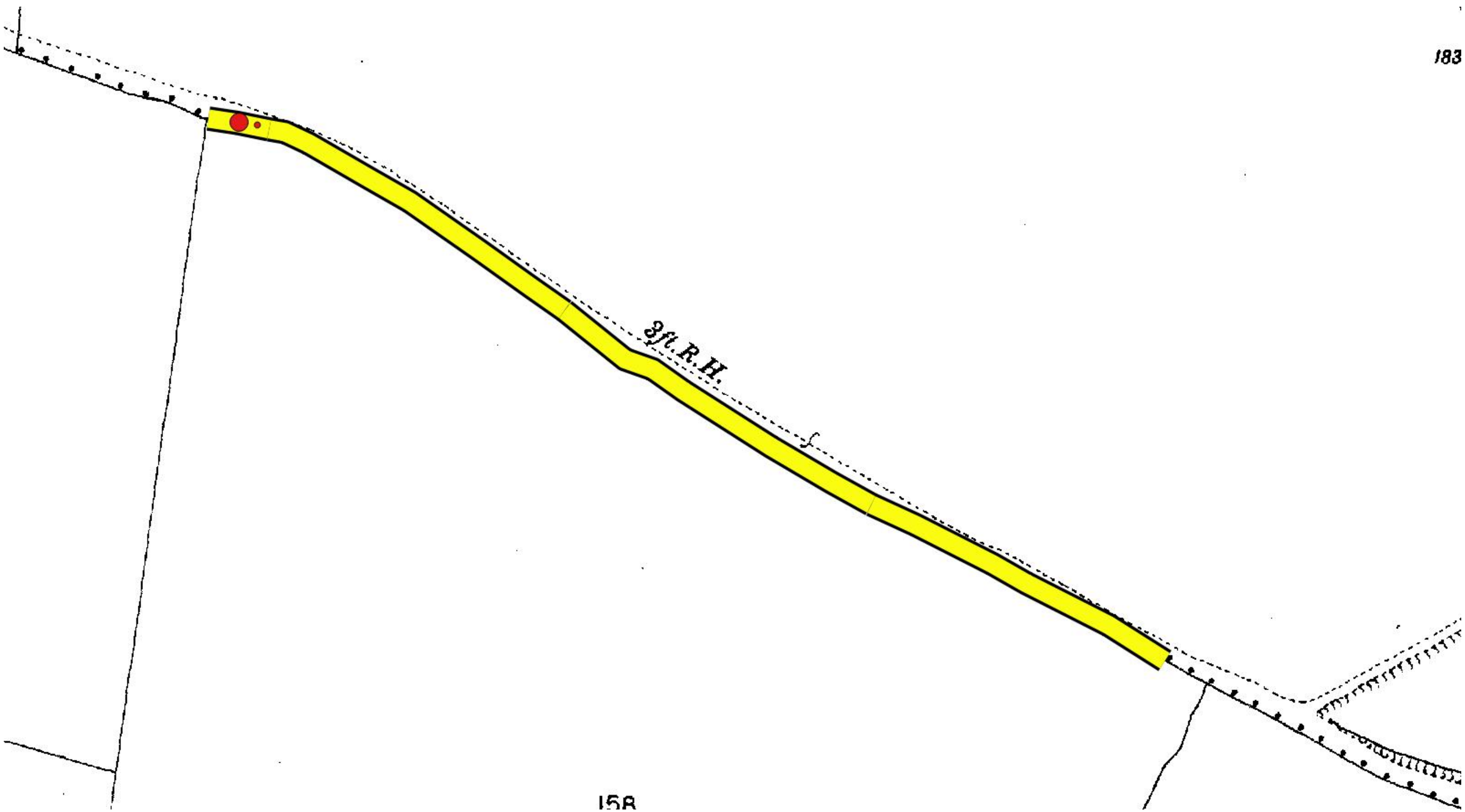


Figure 32.32 – Clifford Boundary Hedgerows – W1 – Winter survey – *Ranunculus ficaria*

Species maps for Clifford Boundary Hedgerows

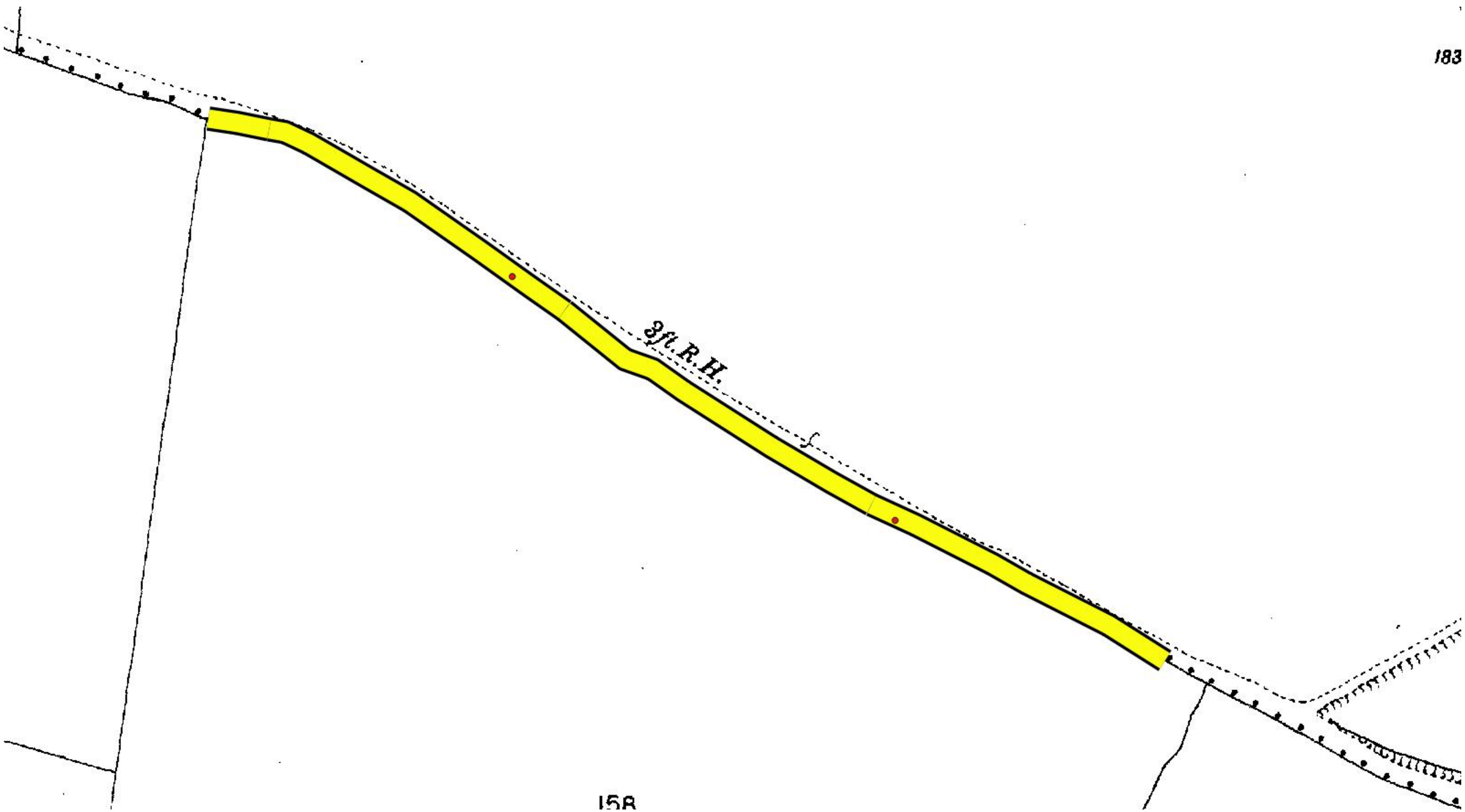


Figure 33.33 – Clifford Boundary Hedgerows – W1 – Winter survey – *Tamus communis*

Species maps for Clifford Boundary Hedgerows

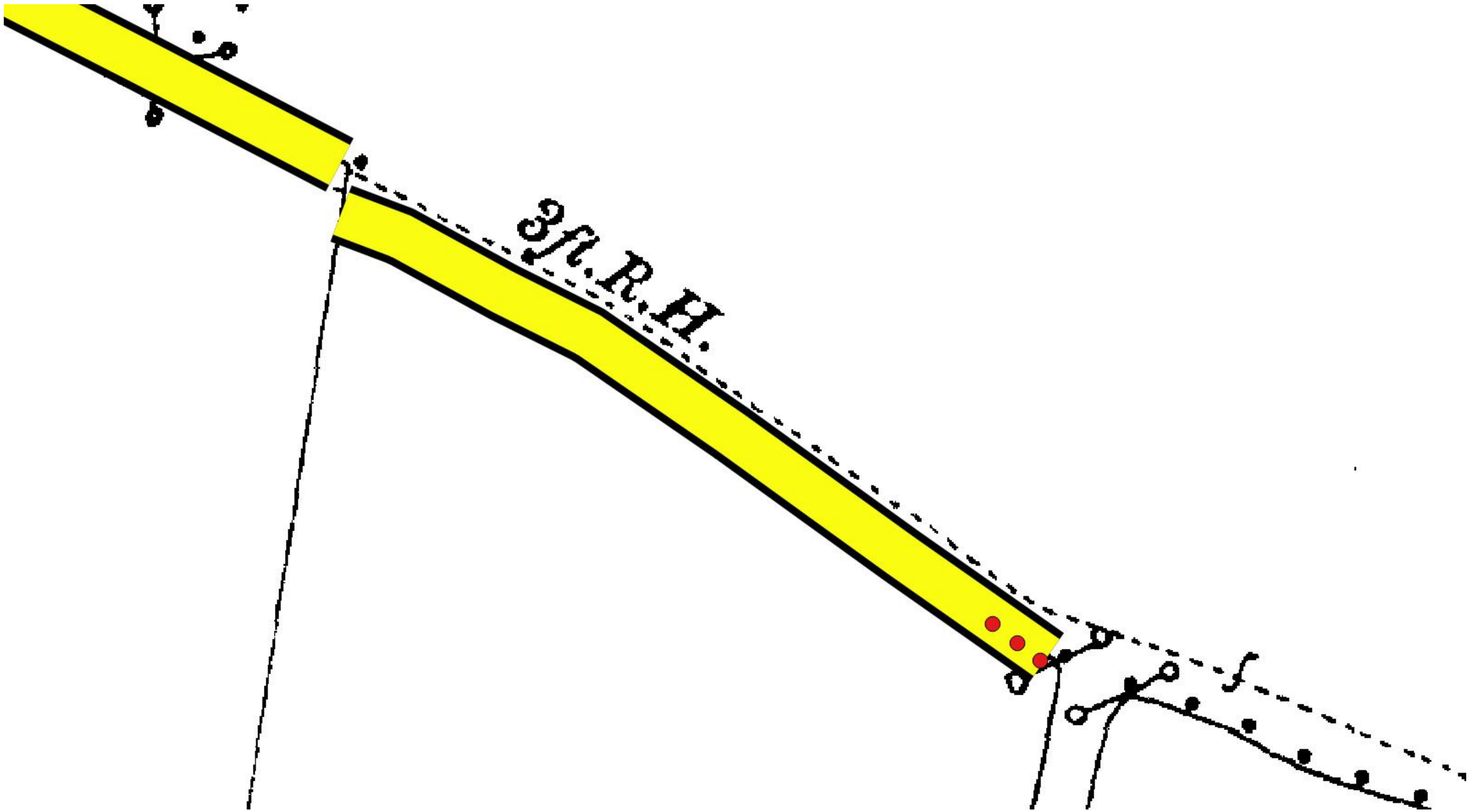


Figure 34.34 – Clifford Boundary Hedgerows – W2 – Winter survey – *Alliaria petiolata*

Species maps for Clifford Boundary Hedgerows

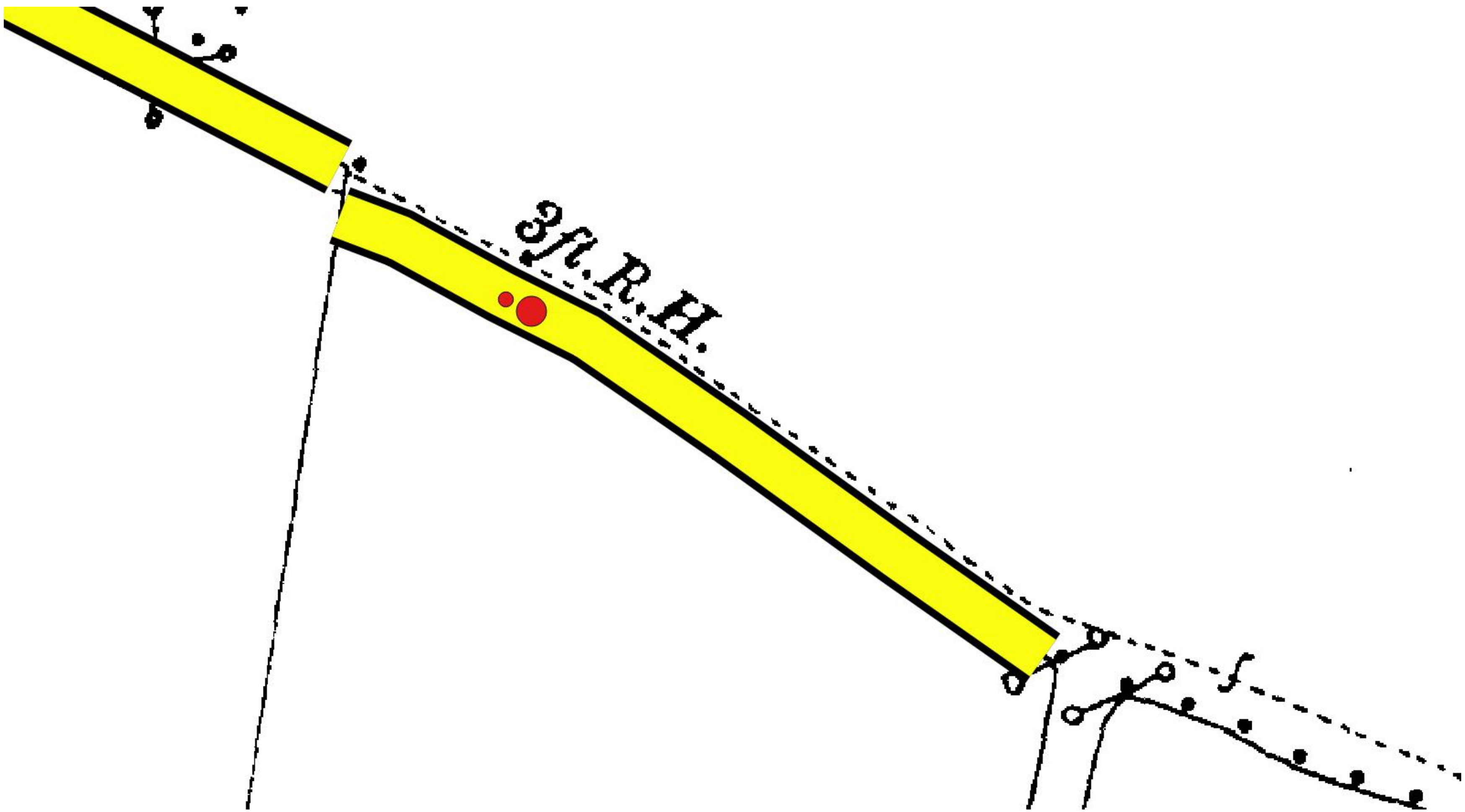


Figure 35.35 – Clifford Boundary Hedgerows – W2 – Winter survey – *Allium ursinum*

Species maps for Clifford Boundary Hedgerows

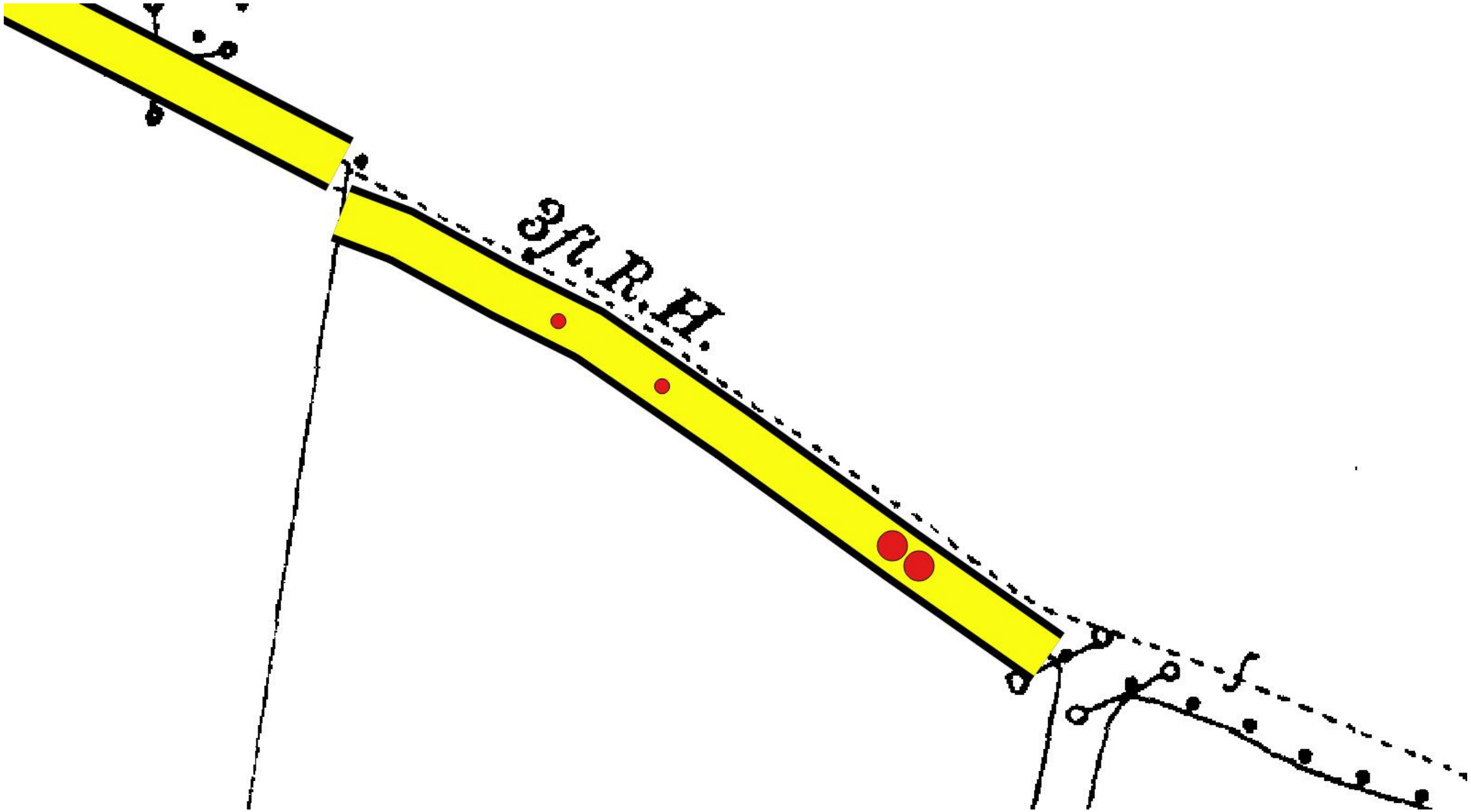


Figure 36.36 – Clifford Boundary Hedgerows – W2 – Winter survey – *Hedera helix*-arboreal

Species maps for Clifford Boundary Hedgerows

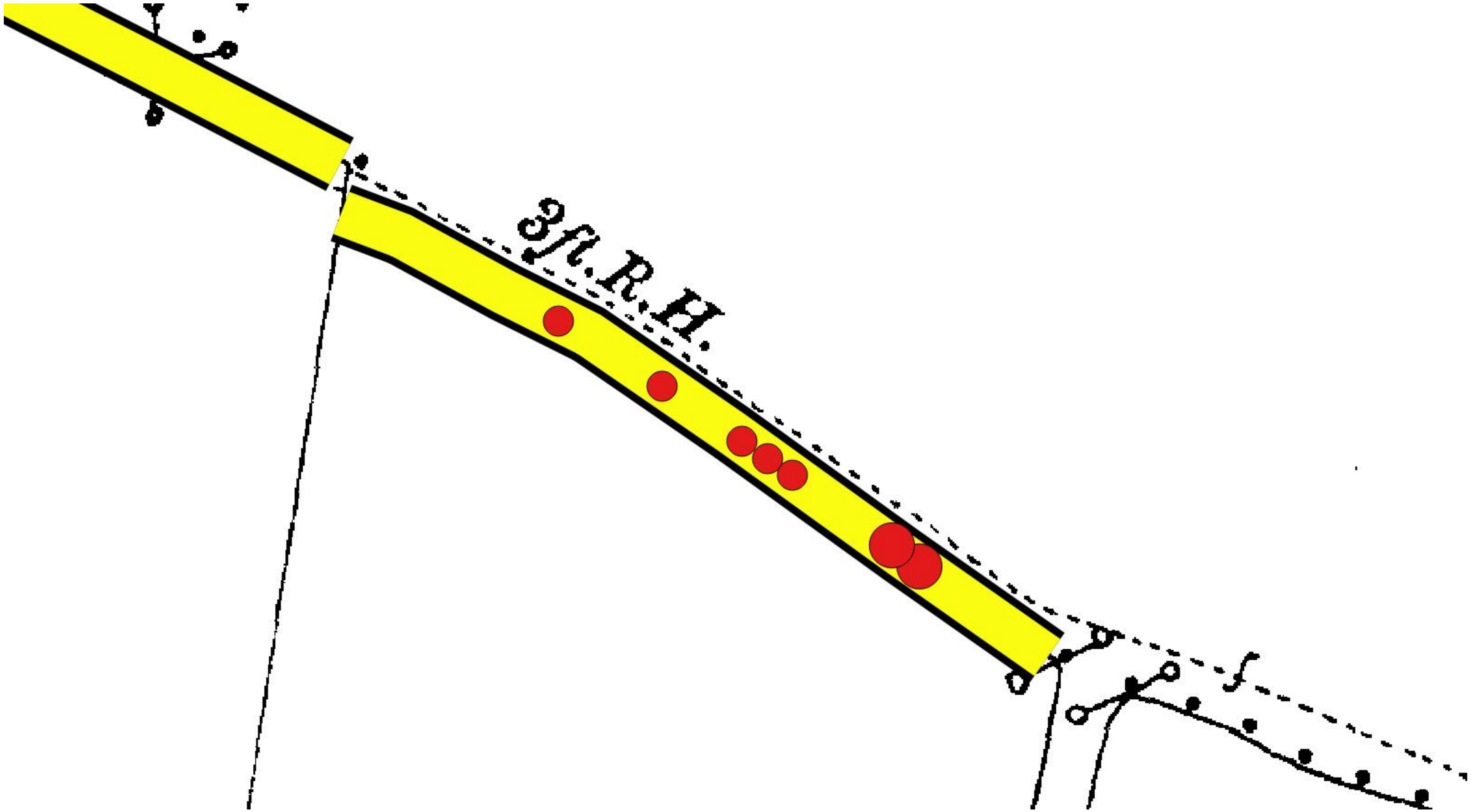


Figure 37.37 – Clifford Boundary Hedgerows – W2 – Winter survey – *Hedera helix* - terrestrial

Species maps for Clifford Boundary Hedgerows

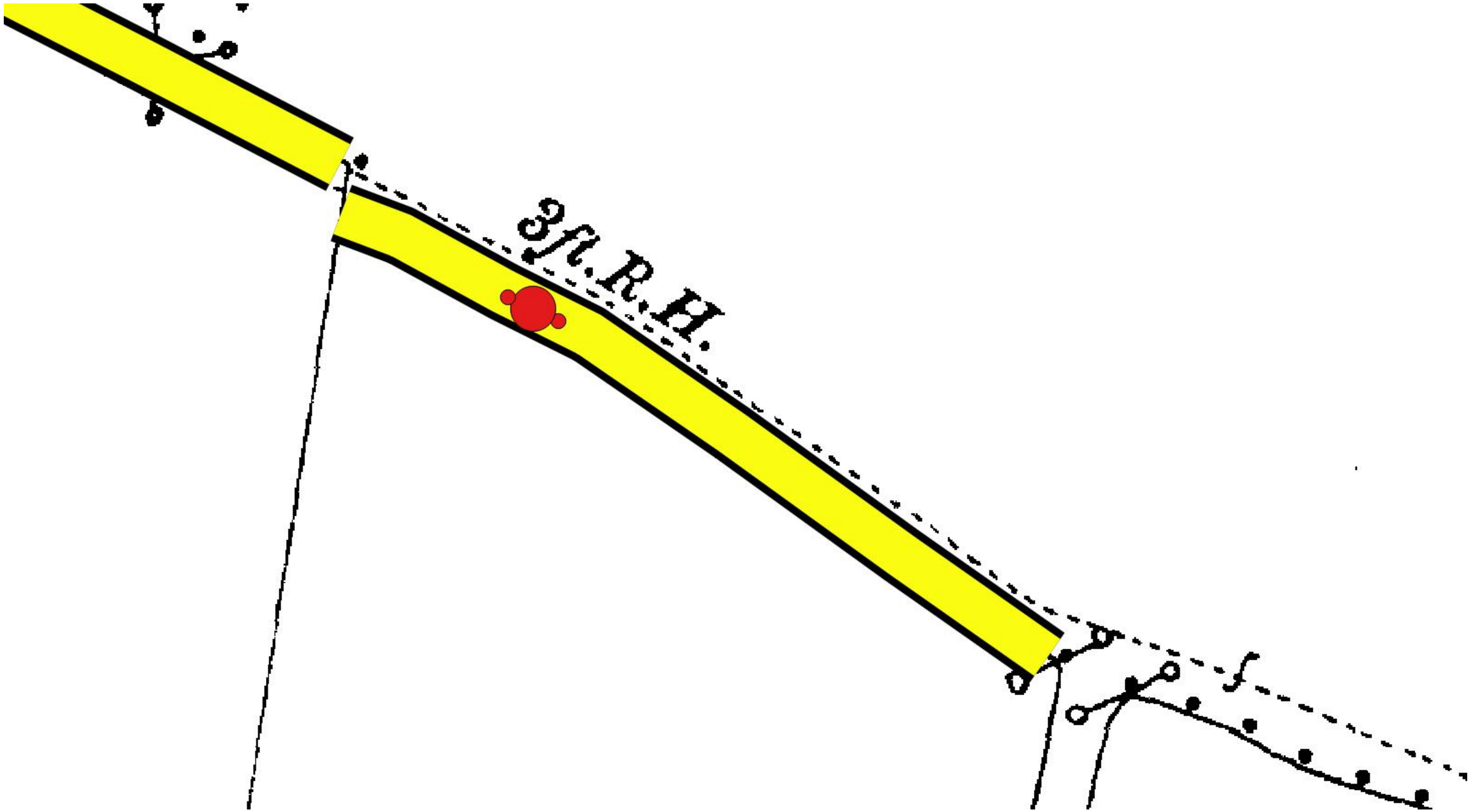



Figure 38.38 – Clifford Boundary Hedgerows – W2 – Winter survey – *Mercurialis perennis*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

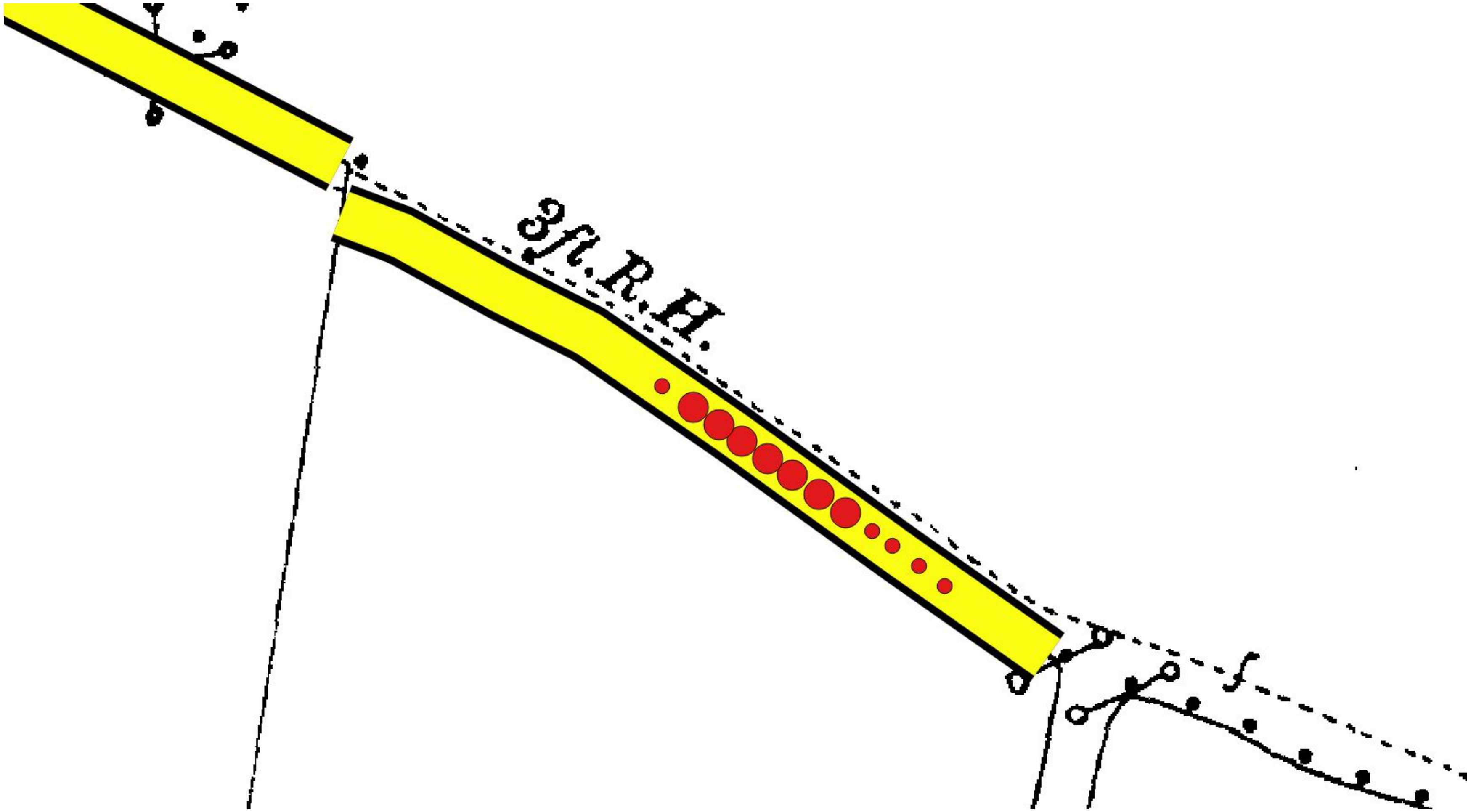


Figure 39.39 – Clifford Boundary Hedgerows – W2 – Winter survey – *Pteridium aquilinum*

Species maps for Clifford Boundary Hedgerows

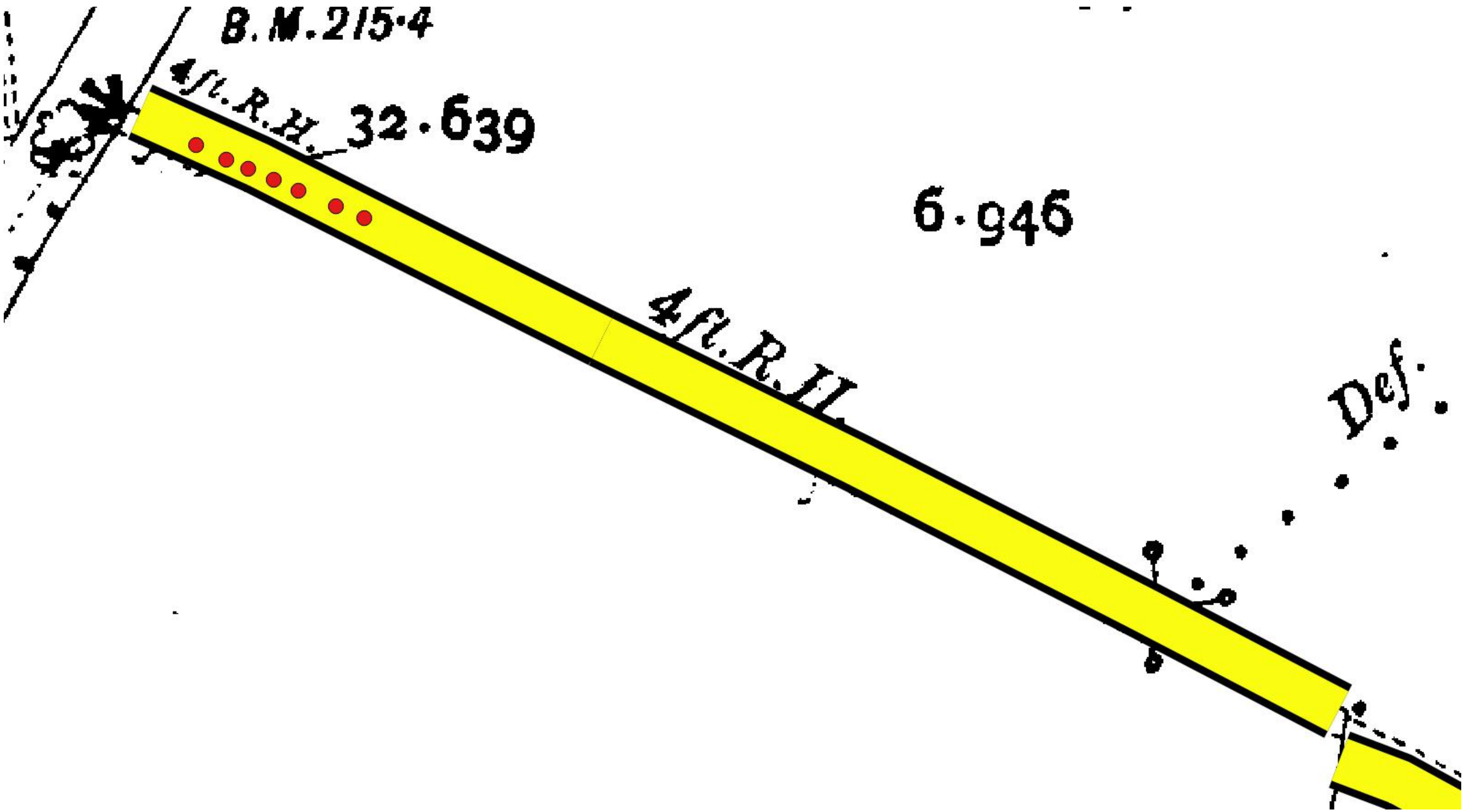


Figure 40.40 – Clifford Boundary Hedgerows – W3 – Winter survey – *Arum maculatum*

Species maps for Clifford Boundary Hedgerows

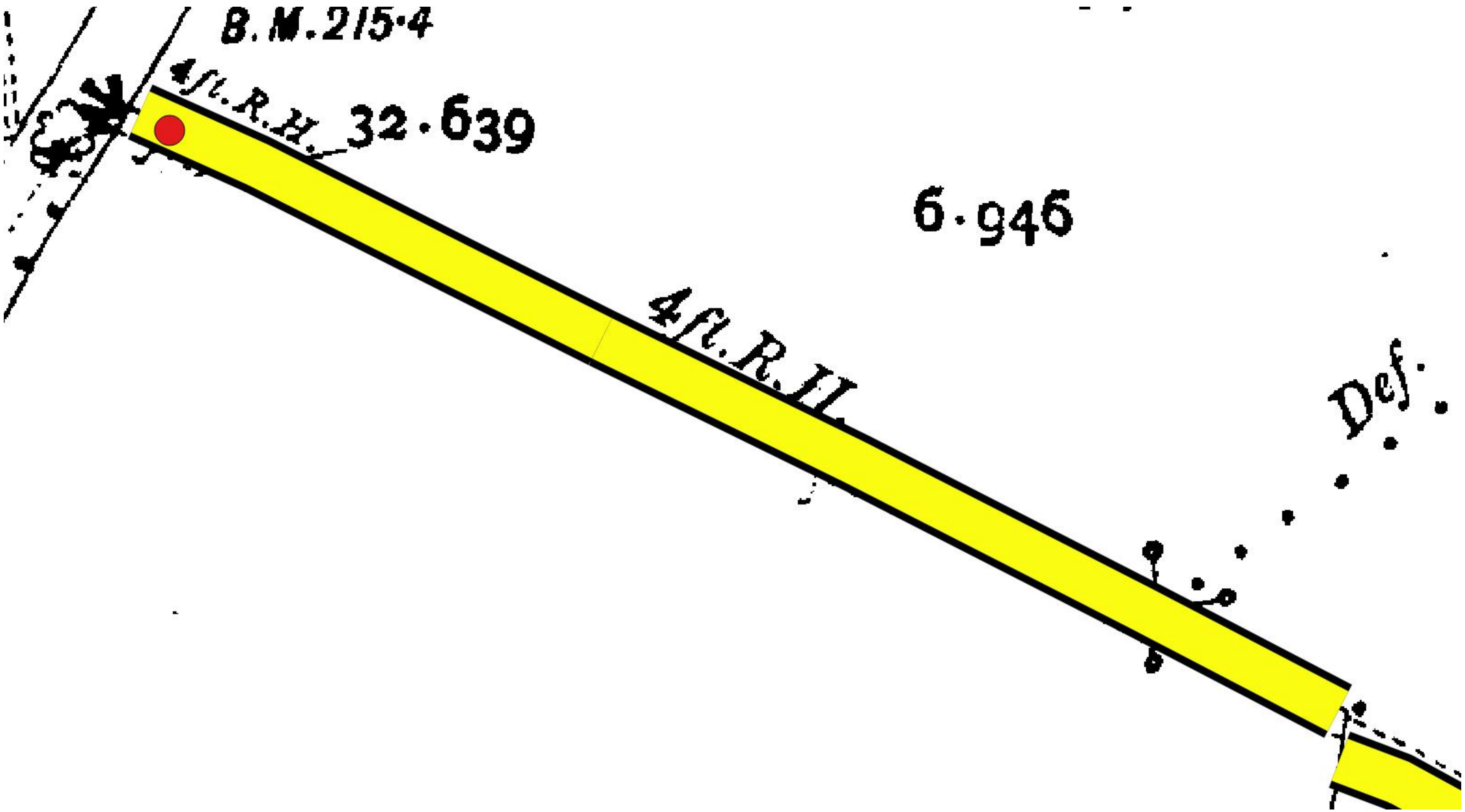


Figure 41.41 – Clifford Boundary Hedgerows – W3 – Winter survey – *Hedera helix* - terrestrial

Species maps for Clifford Boundary Hedgerows

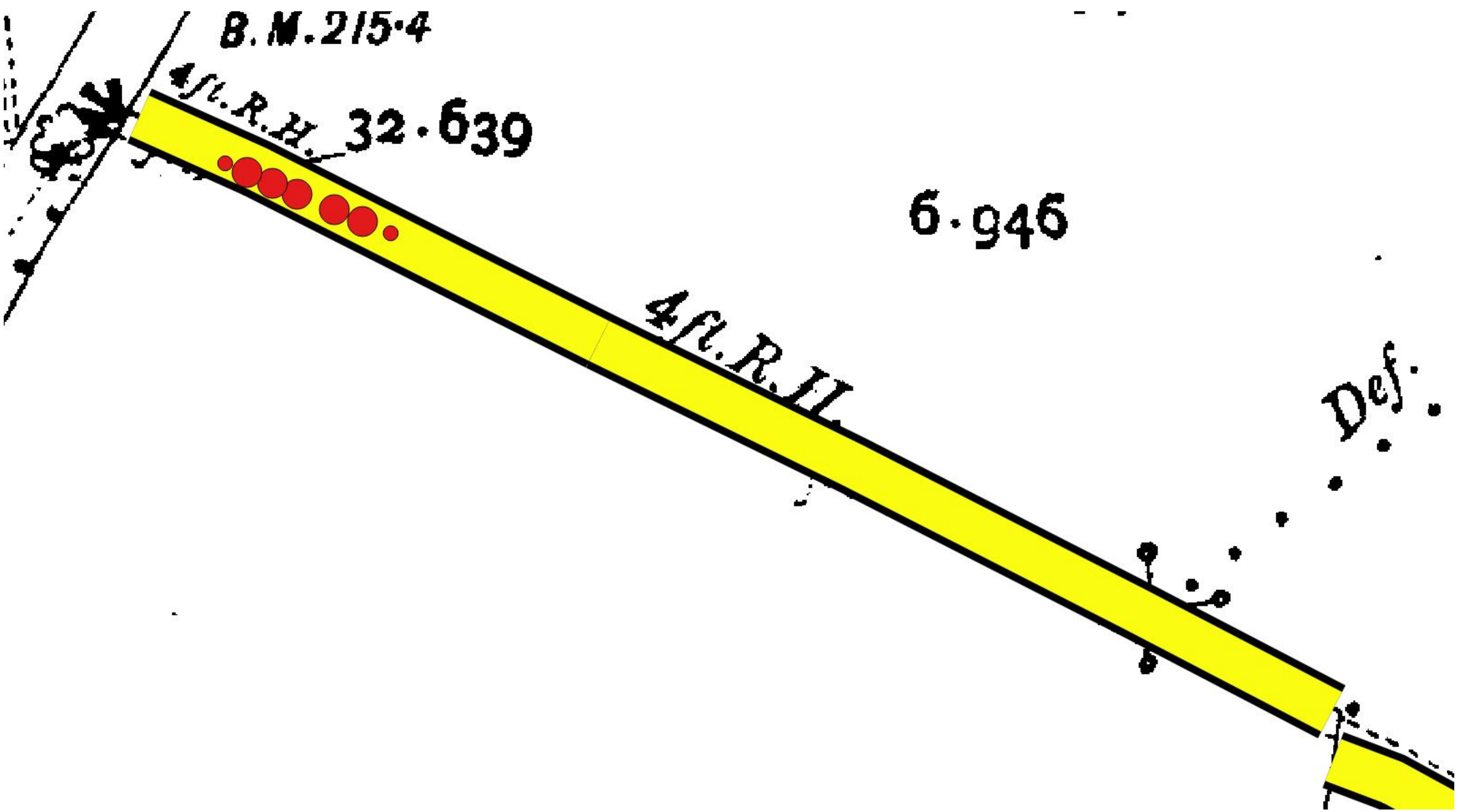


Figure 42.42 – Clifford Boundary Hedgerows – W3 – Winter survey – *Pteridium aquilinum*

Species maps for Clifford Boundary Hedgerows

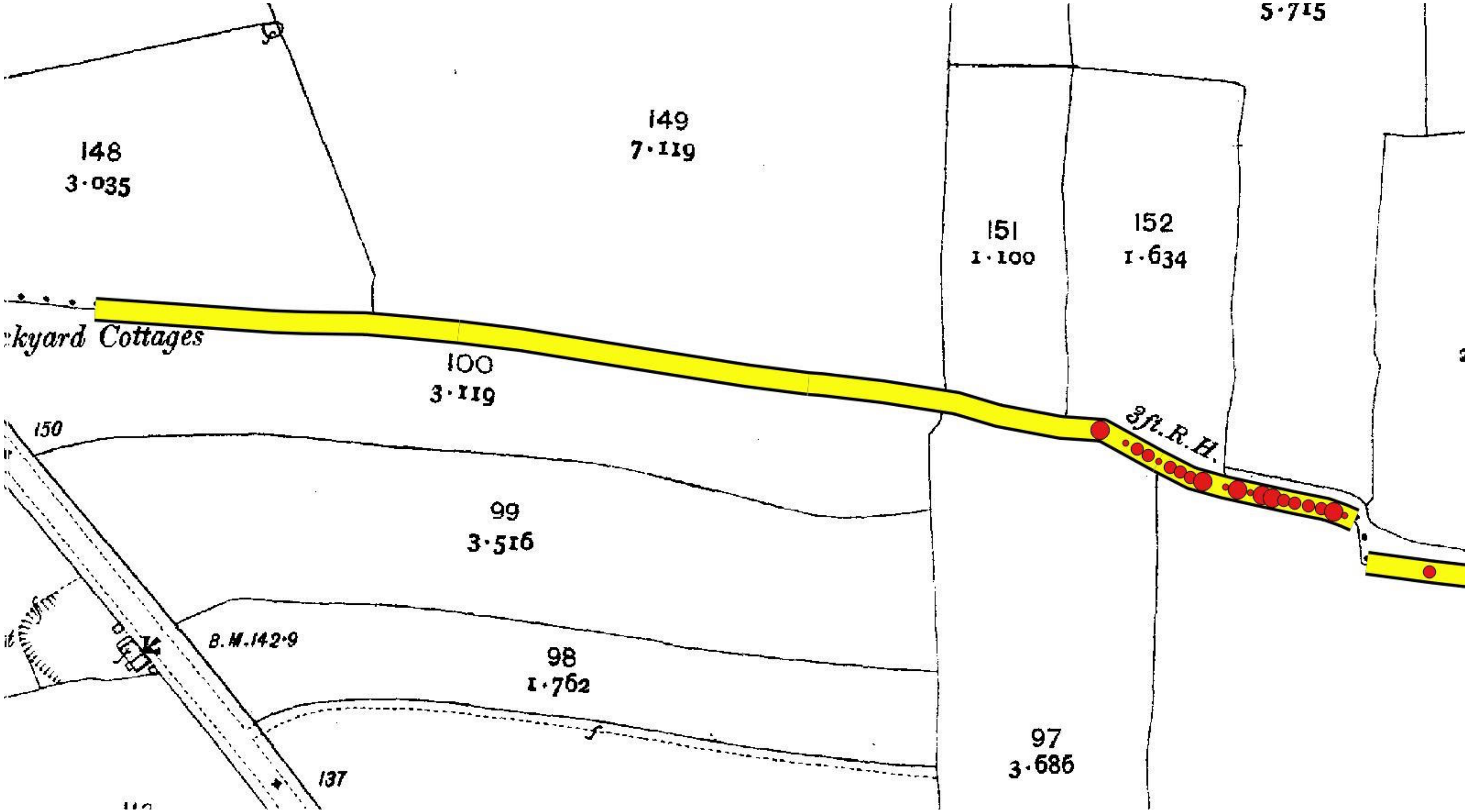


Figure 43.43 – Clifford Boundary Hedgerows – E1 – Summer – *Acer campestre*

Species maps for Clifford Boundary Hedgerows

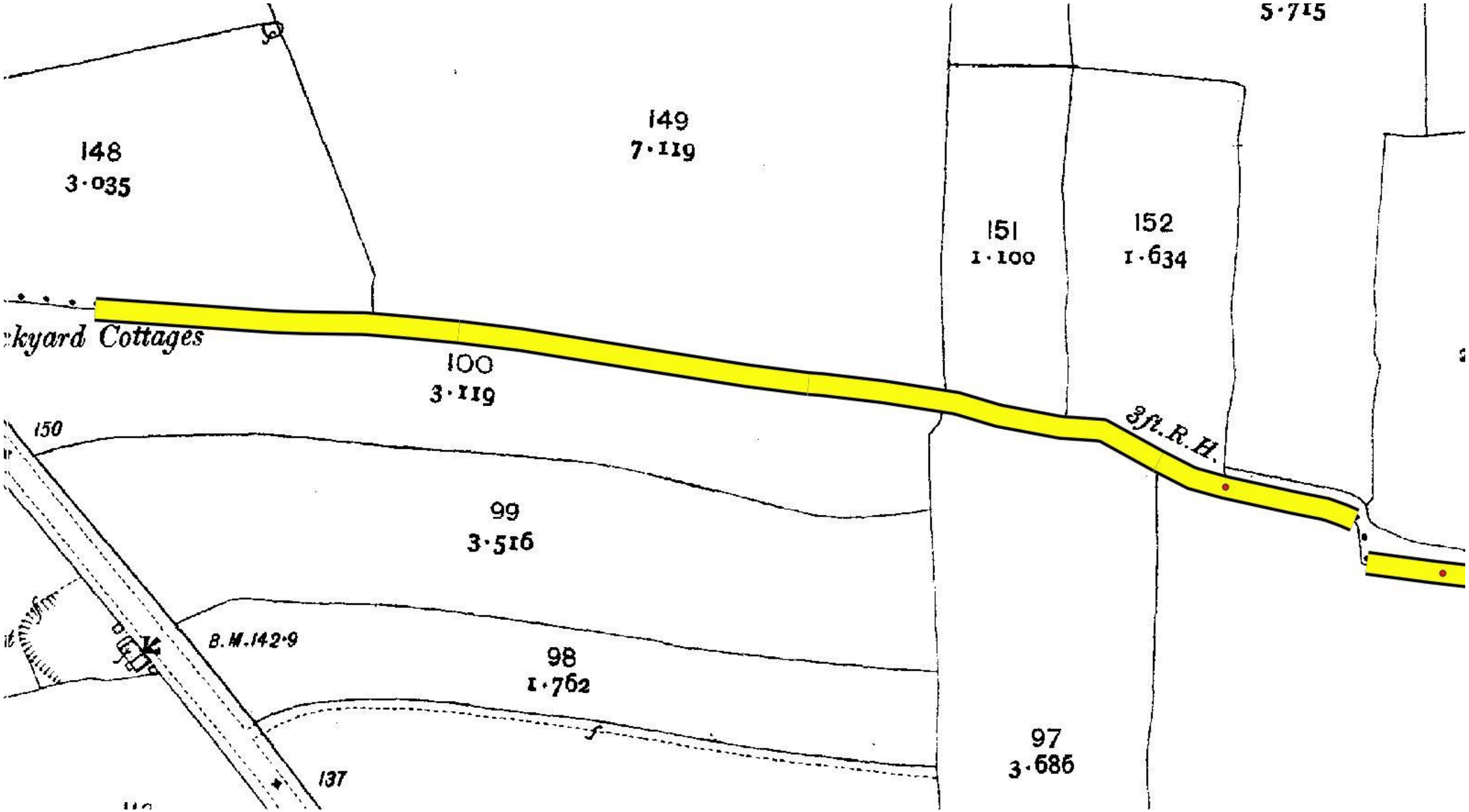


Figure 44.44 – Clifford Boundary Hedgerows – E1 – Summer – *Bryonia dioica*

Species maps for Clifford Boundary Hedgerows

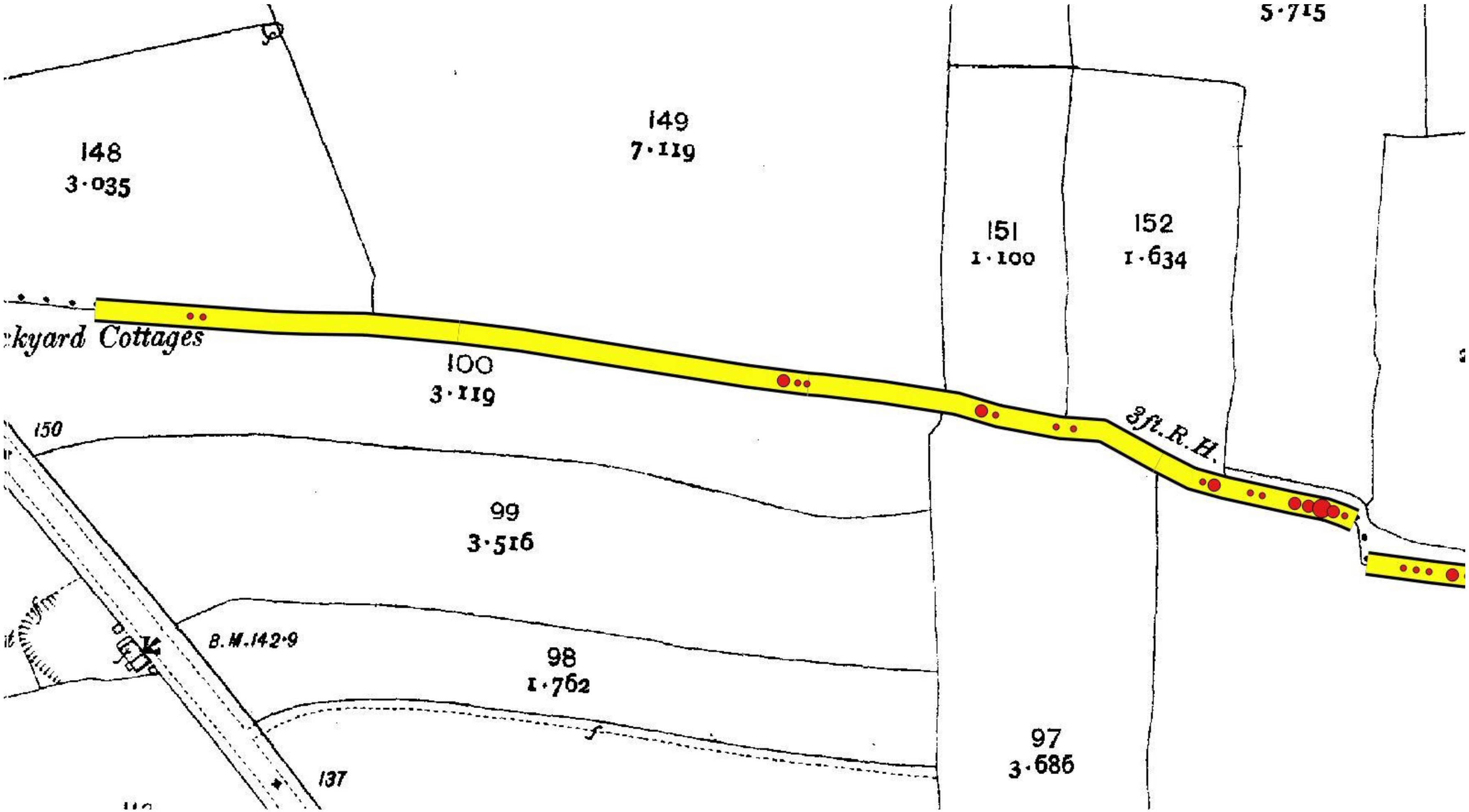


Figure 45.45 – Clifford Boundary Hedgerows – E1 – Summer – *Corylus avellana*

Species maps for Clifford Boundary Hedgerows

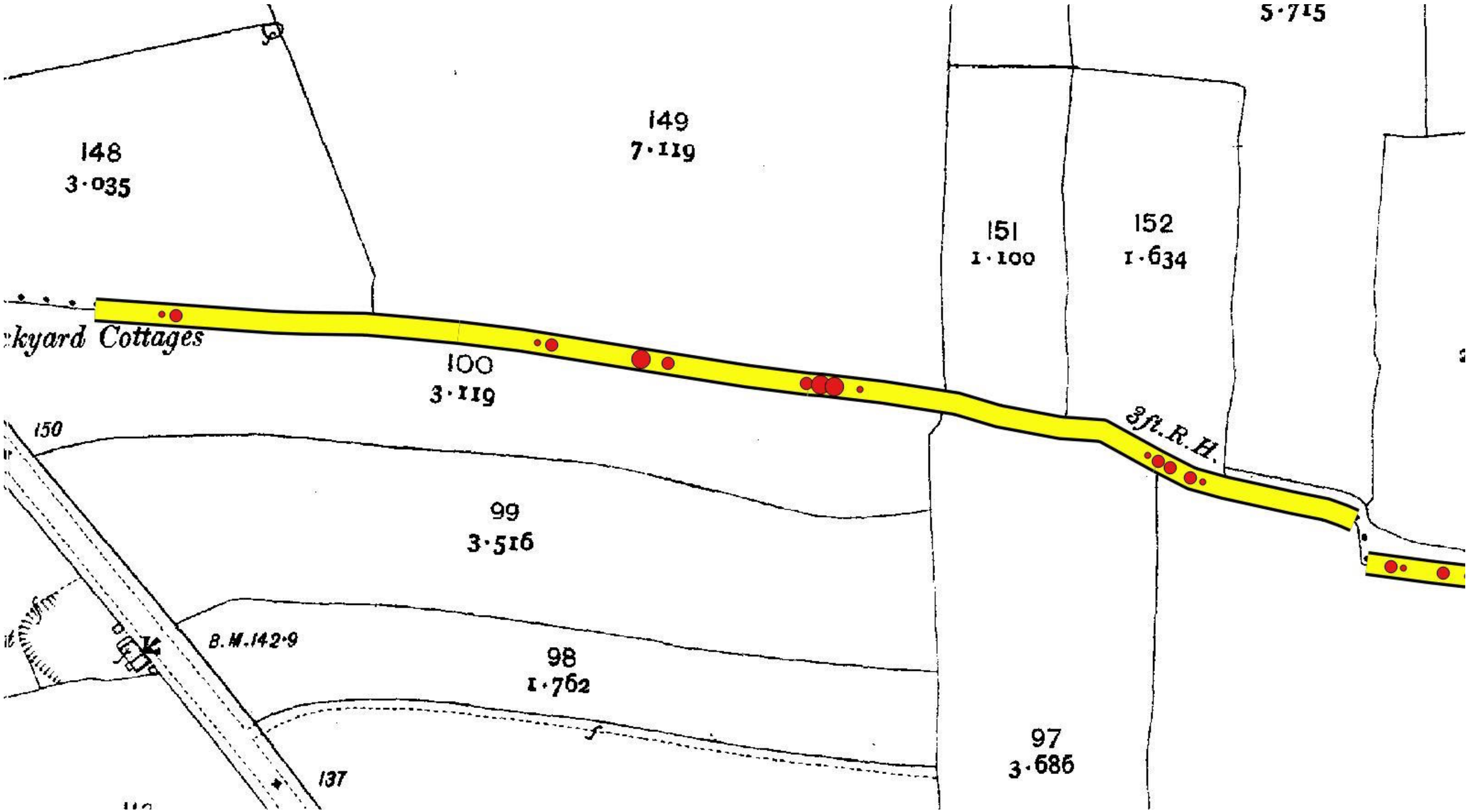


Figure 46.46 – Clifford Boundary Hedgerows – E1 – Summer – *Cornus sanguinea*

Species maps for Clifford Boundary Hedgerows

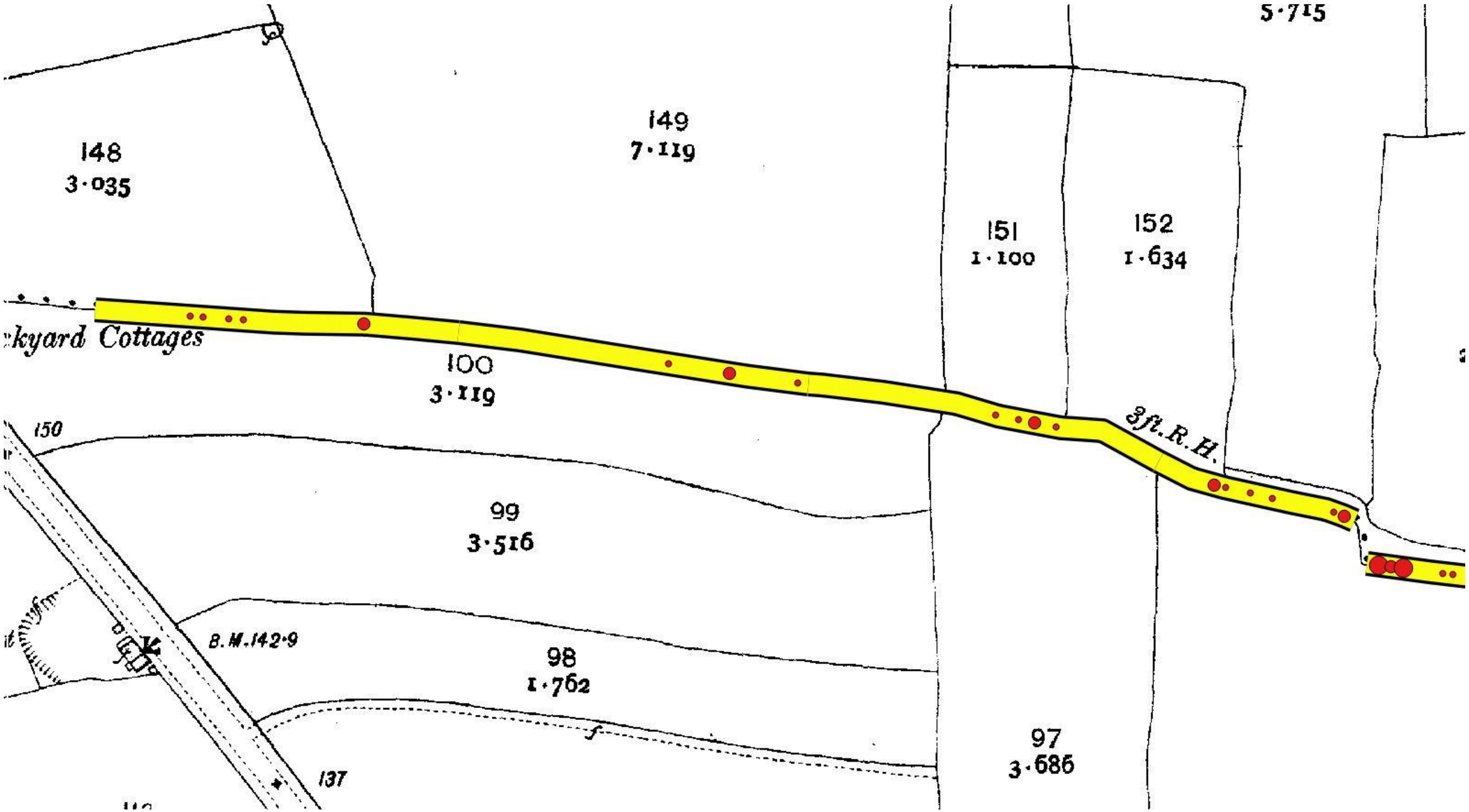


Figure 47.47 – Clifford Boundary Hedgerows – E1 – Summer – *Crataegus monogyna*

Species maps for Clifford Boundary Hedgerows

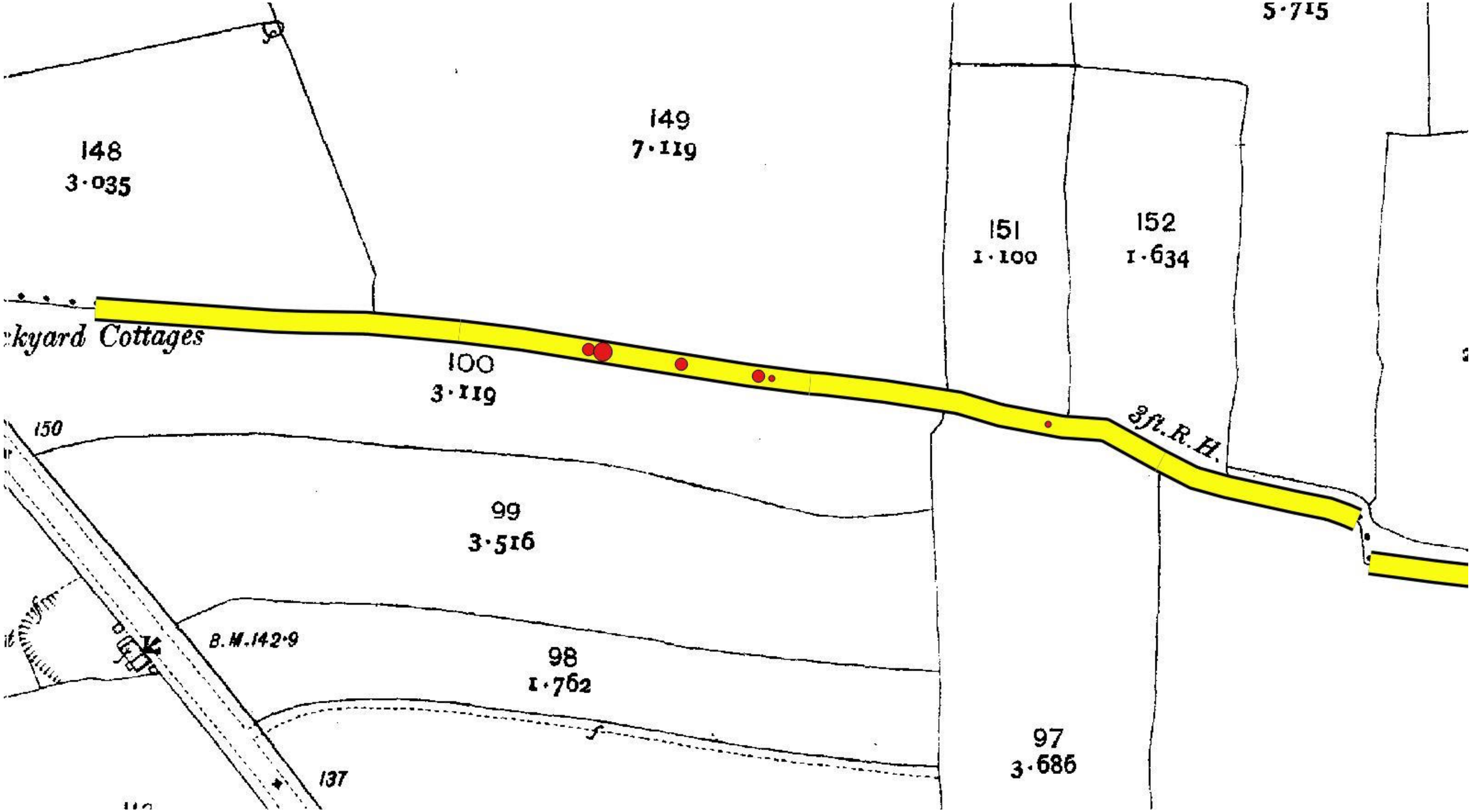


Figure 48.48 – Clifford Boundary Hedgerows – E1 – Summer – *Euonymus europaeus*

Species maps for Clifford Boundary Hedgerows

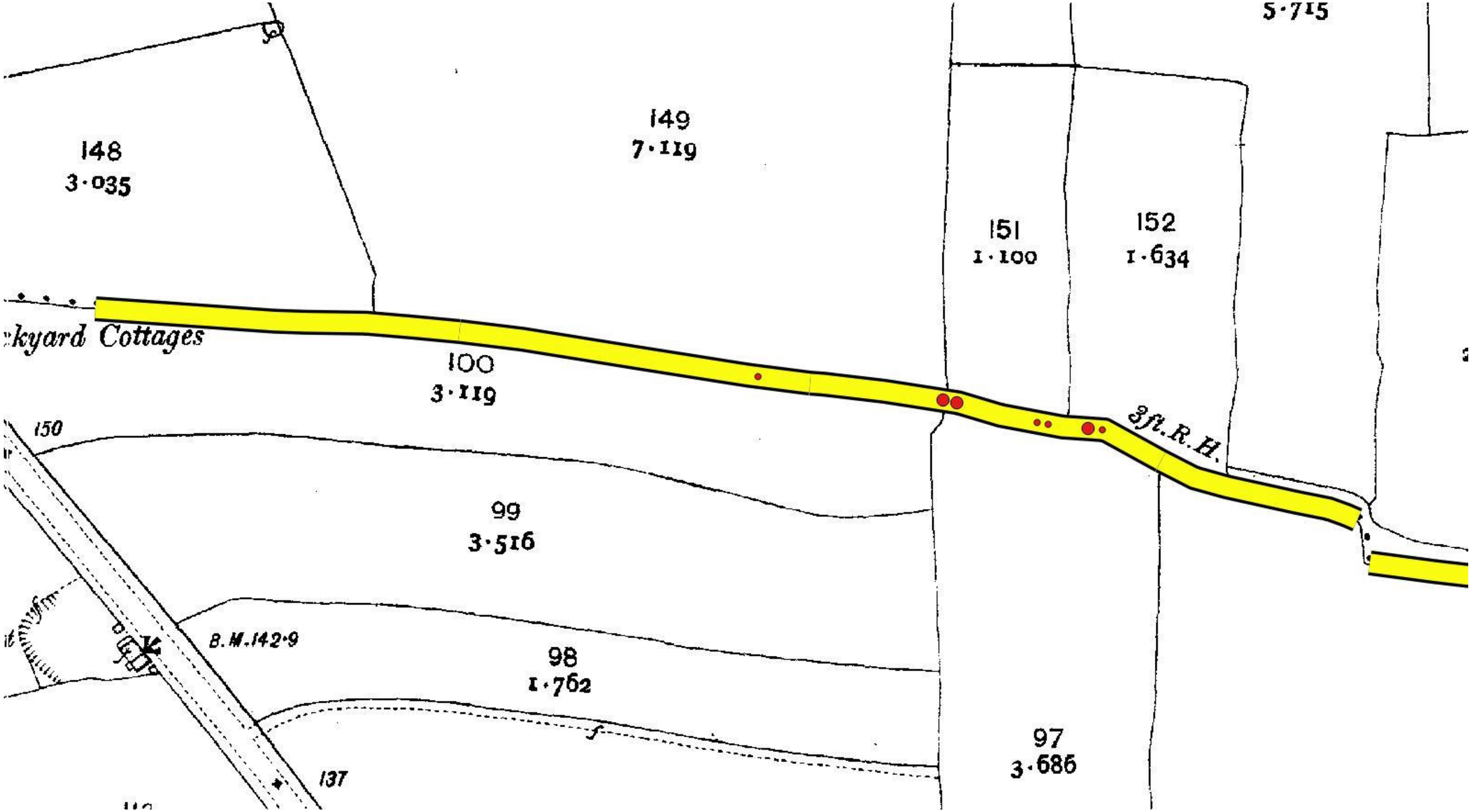


Figure 49.49 – Clifford Boundary Hedgerows – E1 – Summer – *Fraxinus excelsior*

Species maps for Clifford Boundary Hedgerows

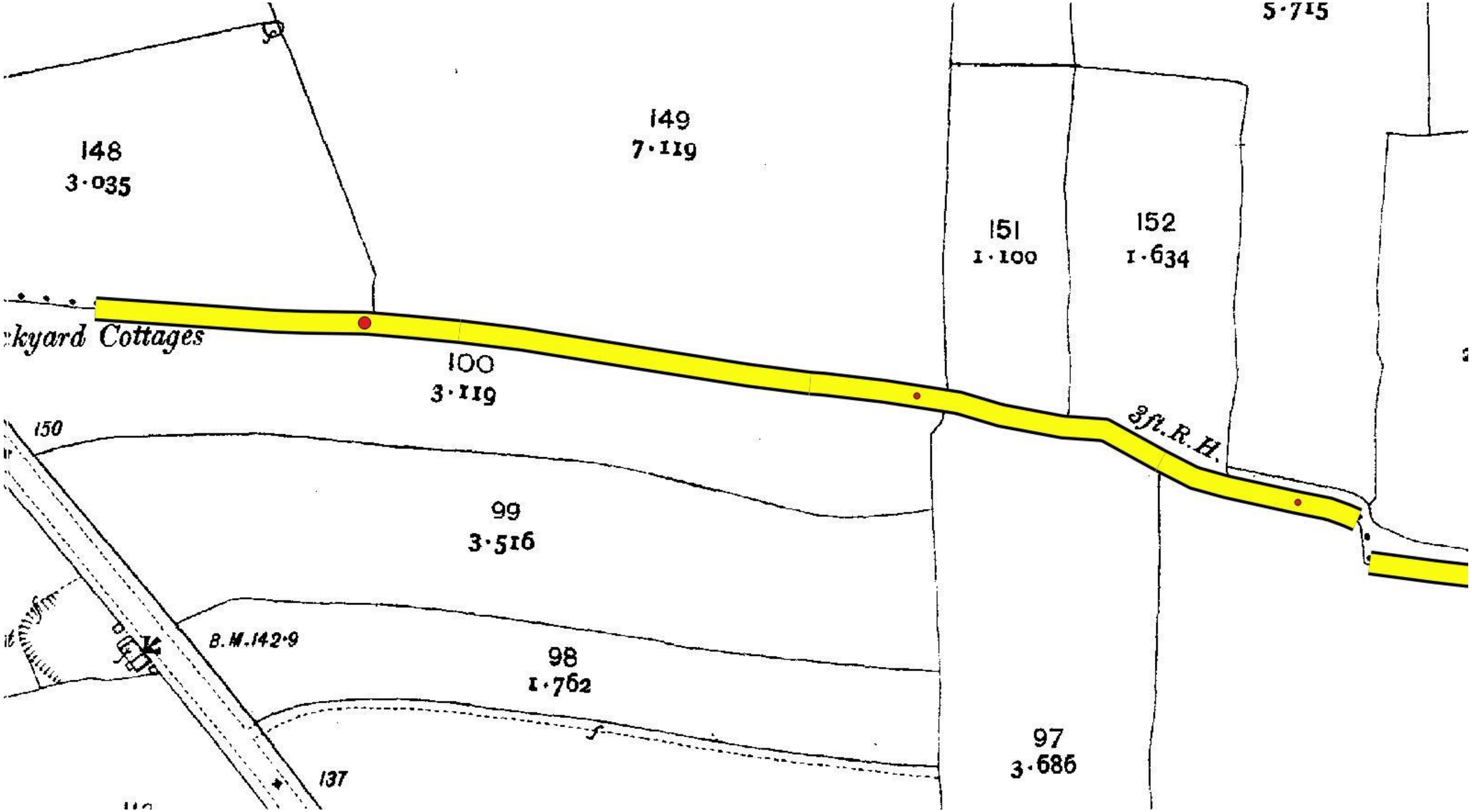


Figure 50.50 – Clifford Boundary Hedgerows – E1 – Summer – *Ilex aquifolium*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

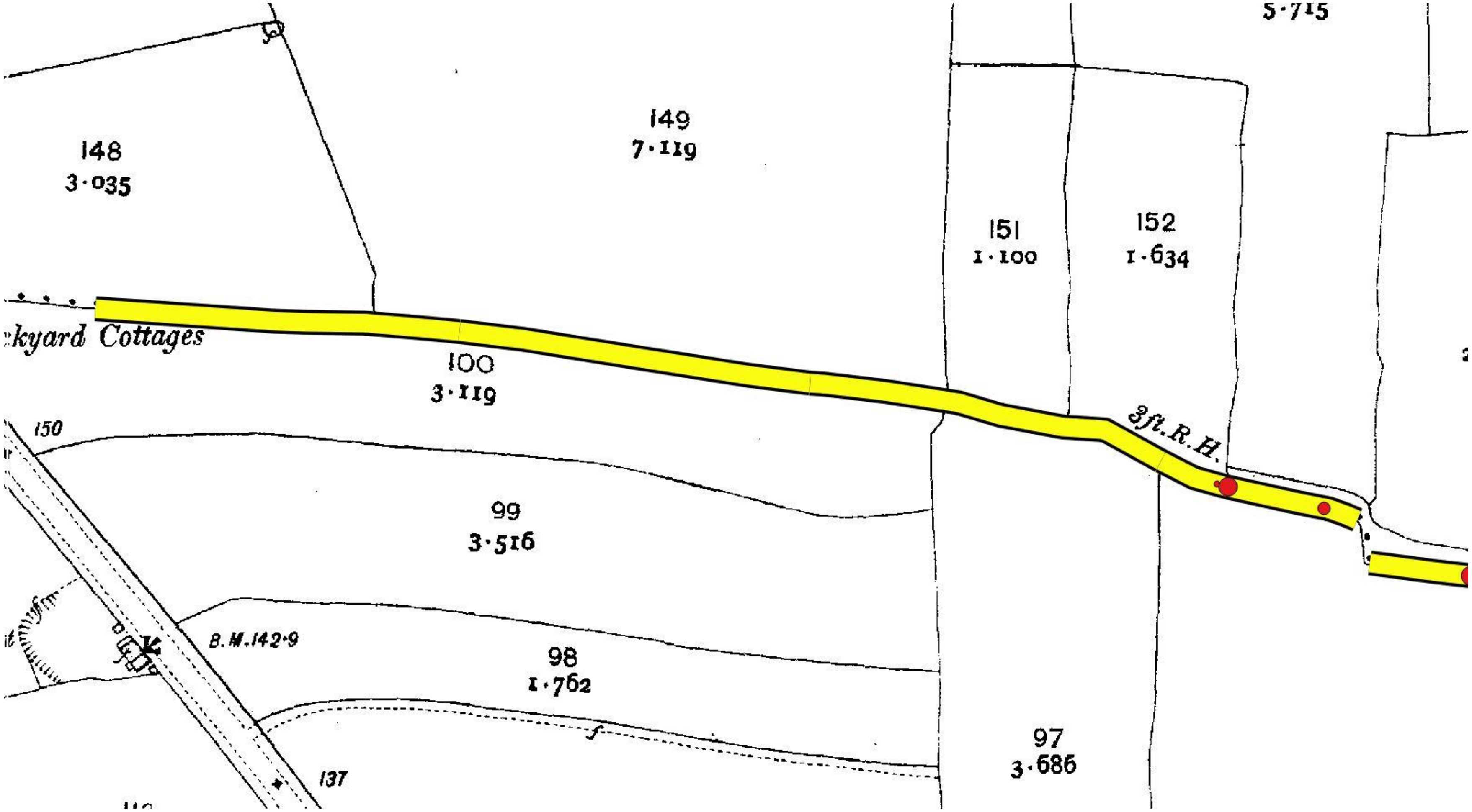


Figure 51.51 – Clifford Boundary Hedgerows – E1 – Summer – *Malus sylvestris*

Species maps for Clifford Boundary Hedgerows

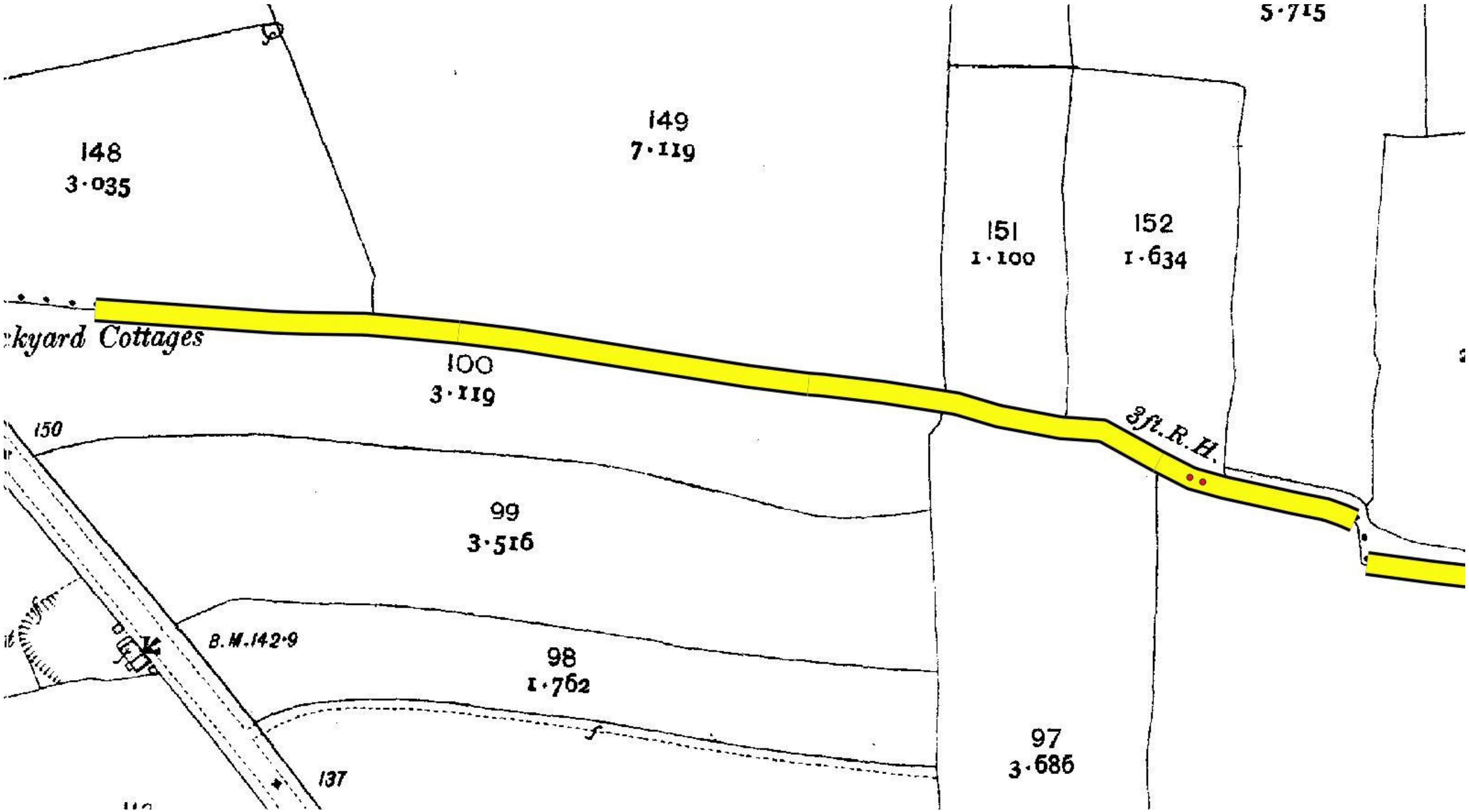


Figure 52.52 – Clifford Boundary Hedgerows – E1 – Summer – *Prunus inisititia*

Species maps for Clifford Boundary Hedgerows

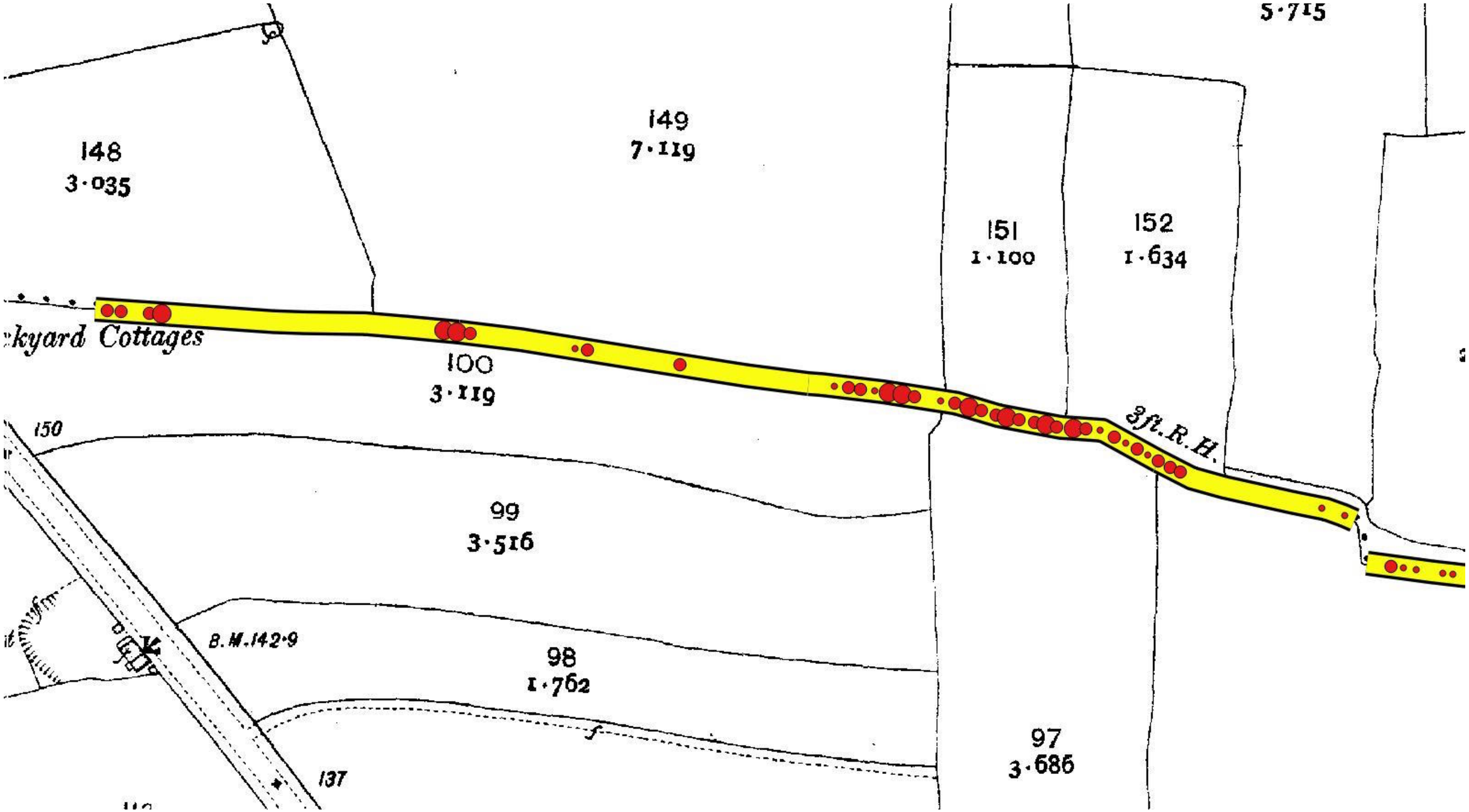


Figure 53.53 – Clifford Boundary Hedgerows – E1 – Summer – *Prunus spinosa*

Species maps for Clifford Boundary Hedgerows

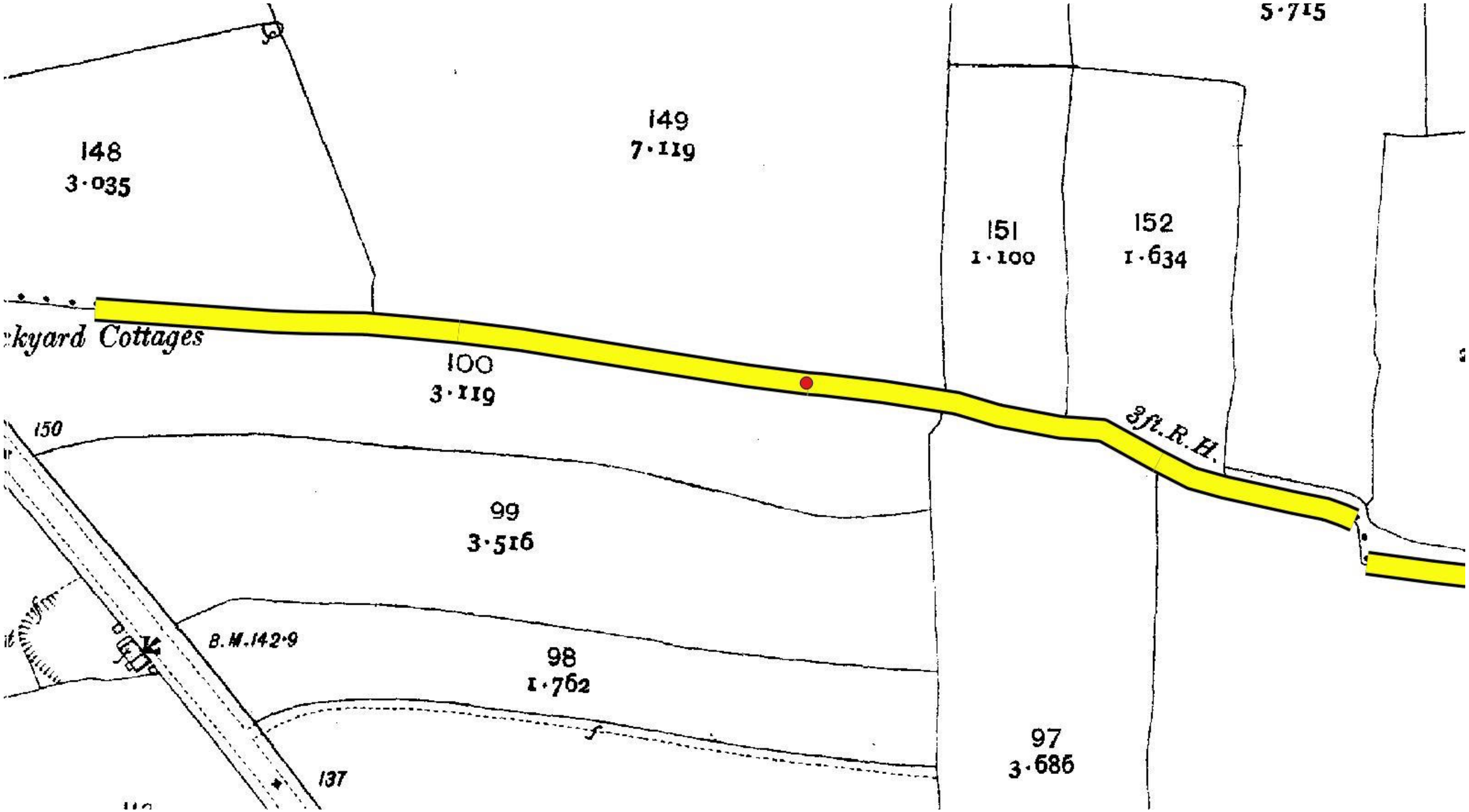


Figure 54.54 – Clifford Boundary Hedgerows – E1 – Summer – *Rhamnus cathartica*

Species maps for Clifford Boundary Hedgerows

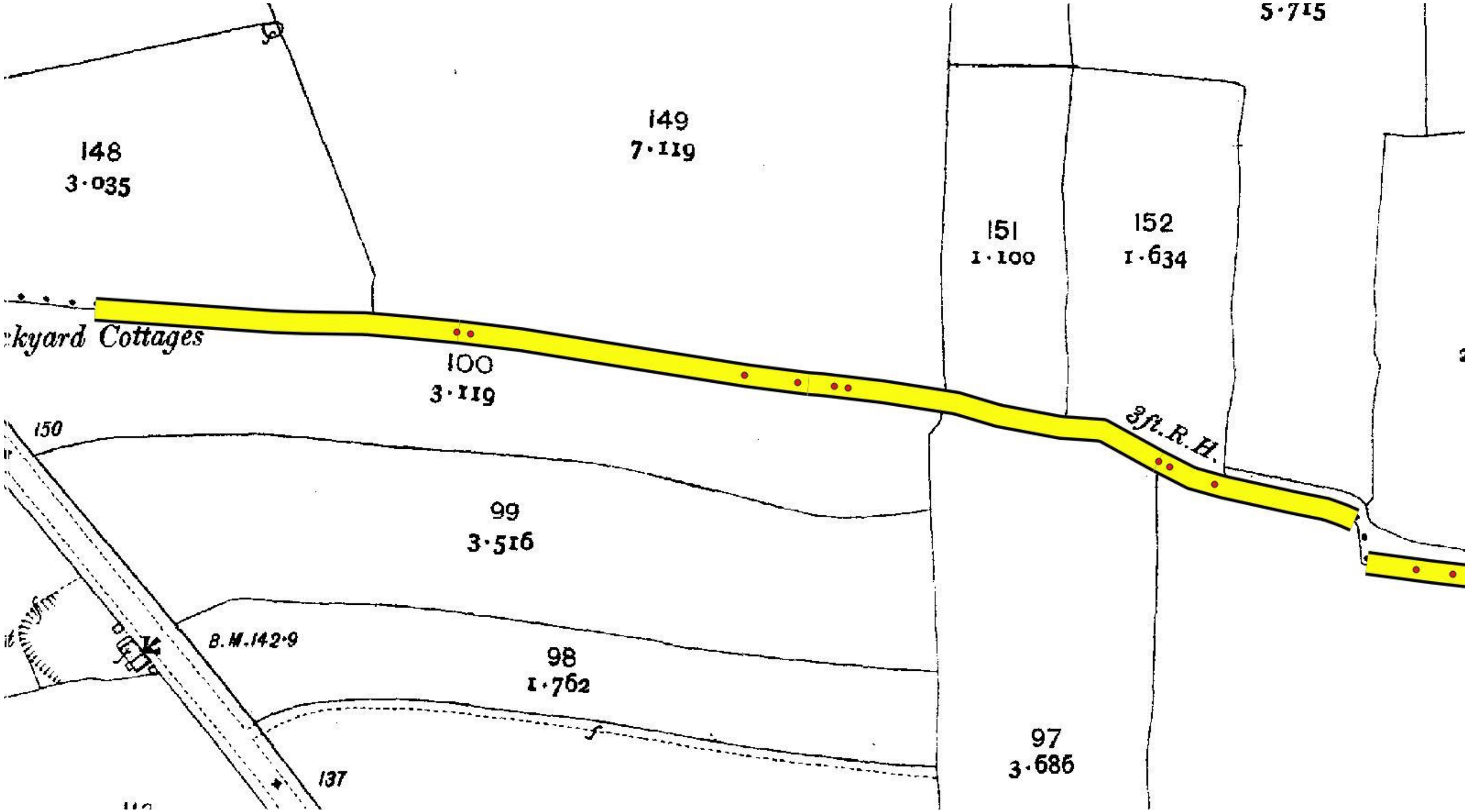


Figure 55.55 – Clifford Boundary Hedgerows – E1 – Summer – *Rosa canina*

Species maps for Clifford Boundary Hedgerows

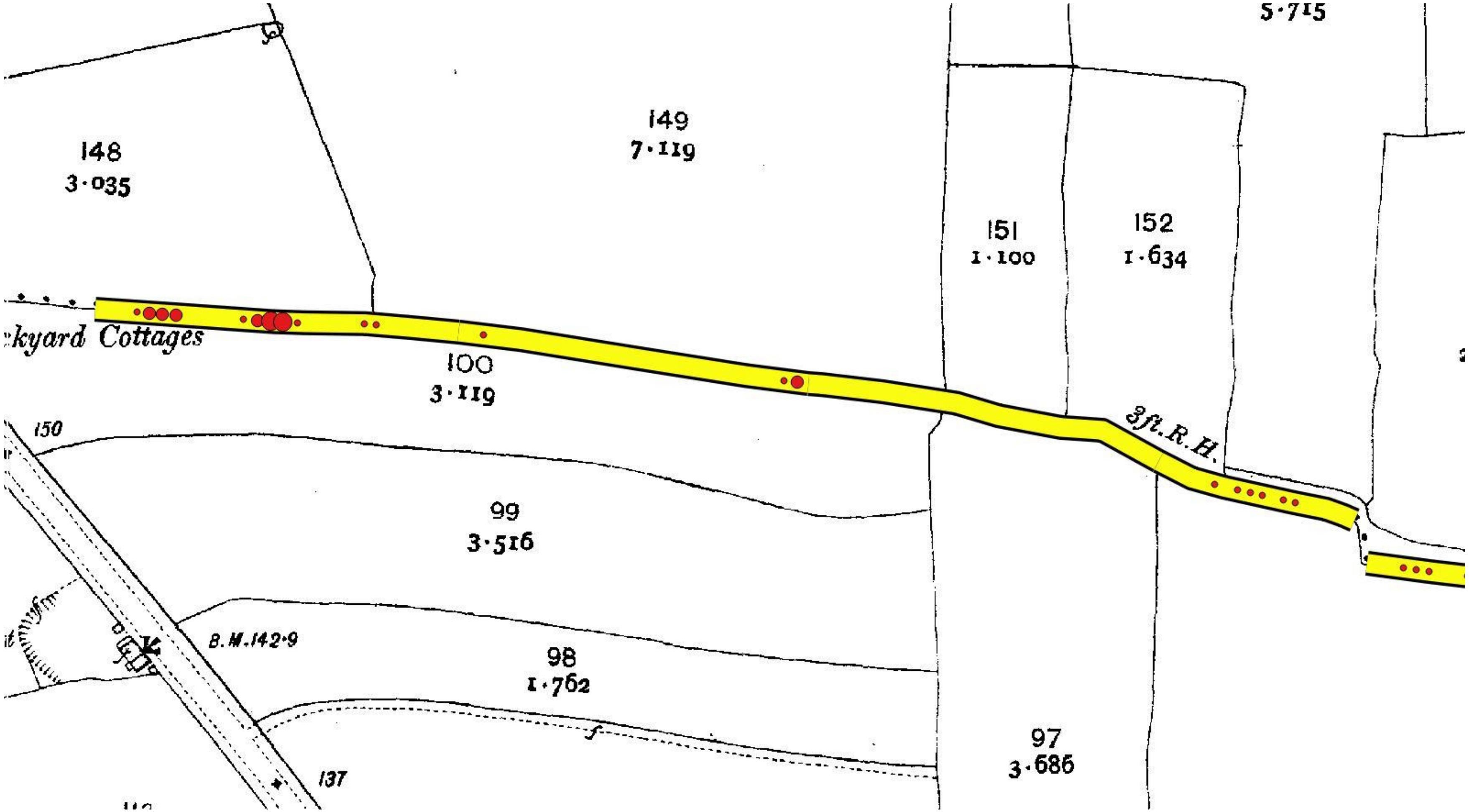


Figure 56.56 – Clifford Boundary Hedgerows – E1 – Summer – *Rubus fruticosus*

Species maps for Clifford Boundary Hedgerows

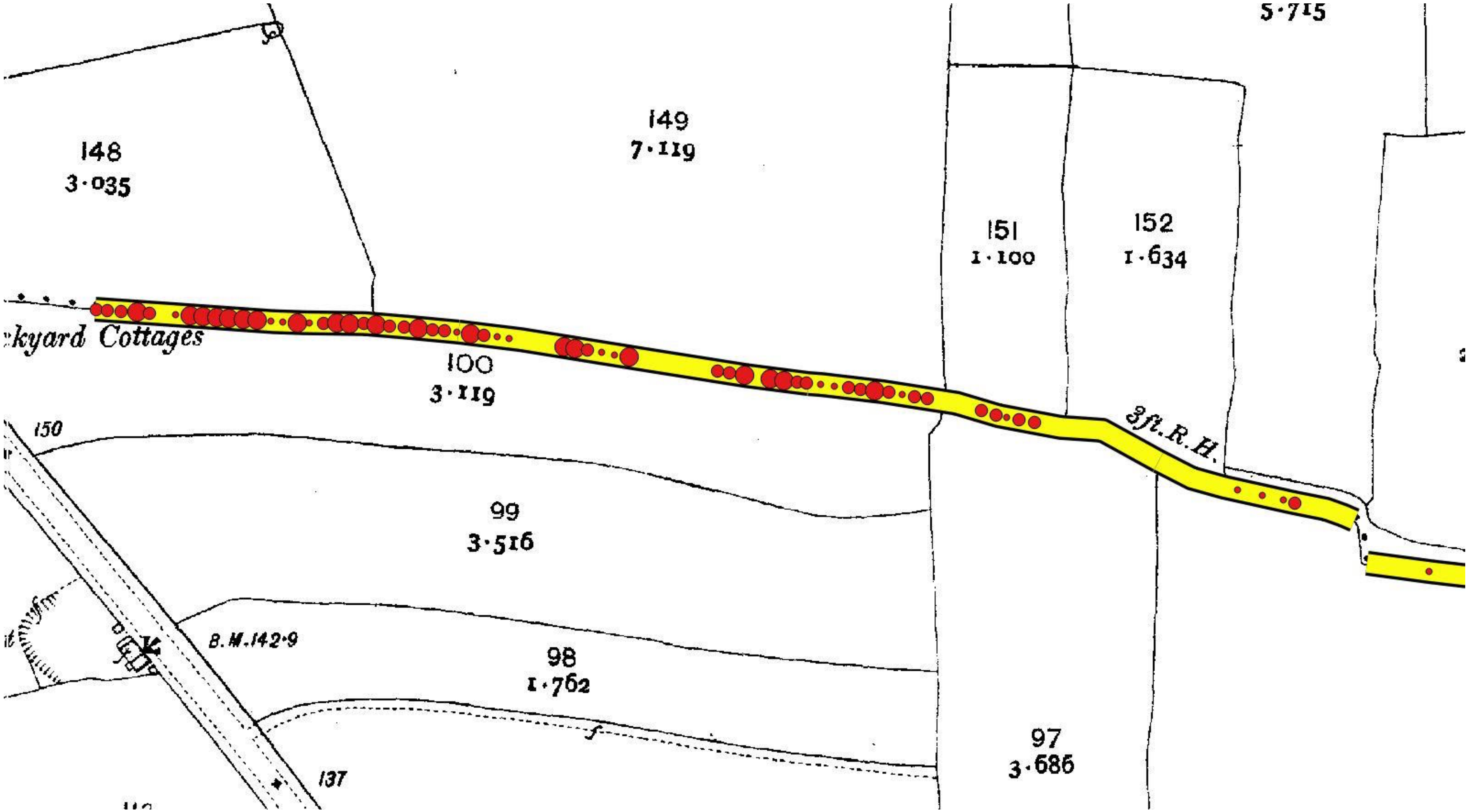


Figure 57.57 – Clifford Boundary Hedgerows – E1 – Summer – *Sambucus nigra*

Species maps for Clifford Boundary Hedgerows

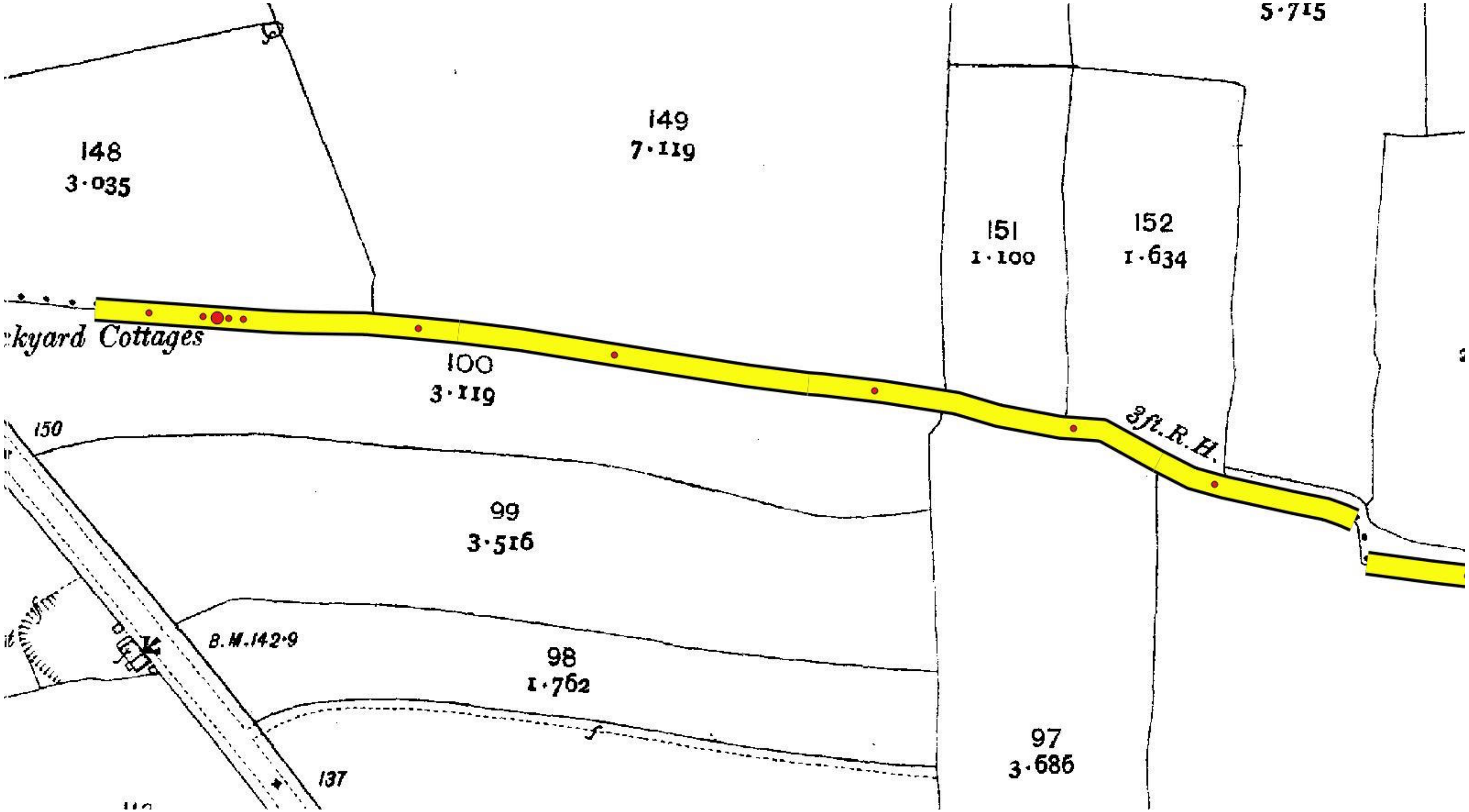


Figure 58.58 – Clifford Boundary Hedgerows – E1 – Summer – *Tamus communis*

Species maps for Clifford Boundary Hedgerows

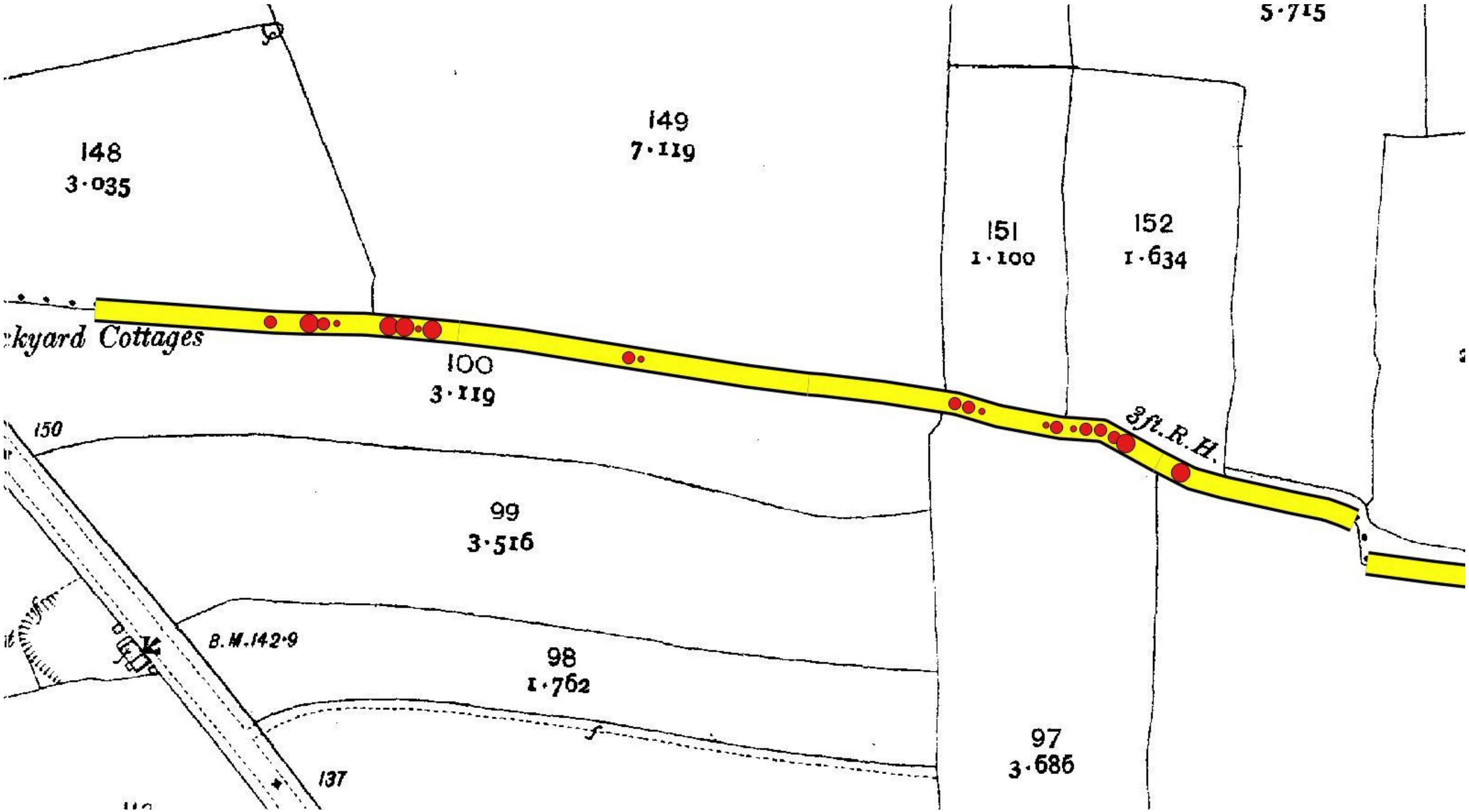


Figure 59.59 – Clifford Boundary Hedgerows – E1 – Summer – *Ulmus glabra*

Species maps for Clifford Boundary Hedgerows

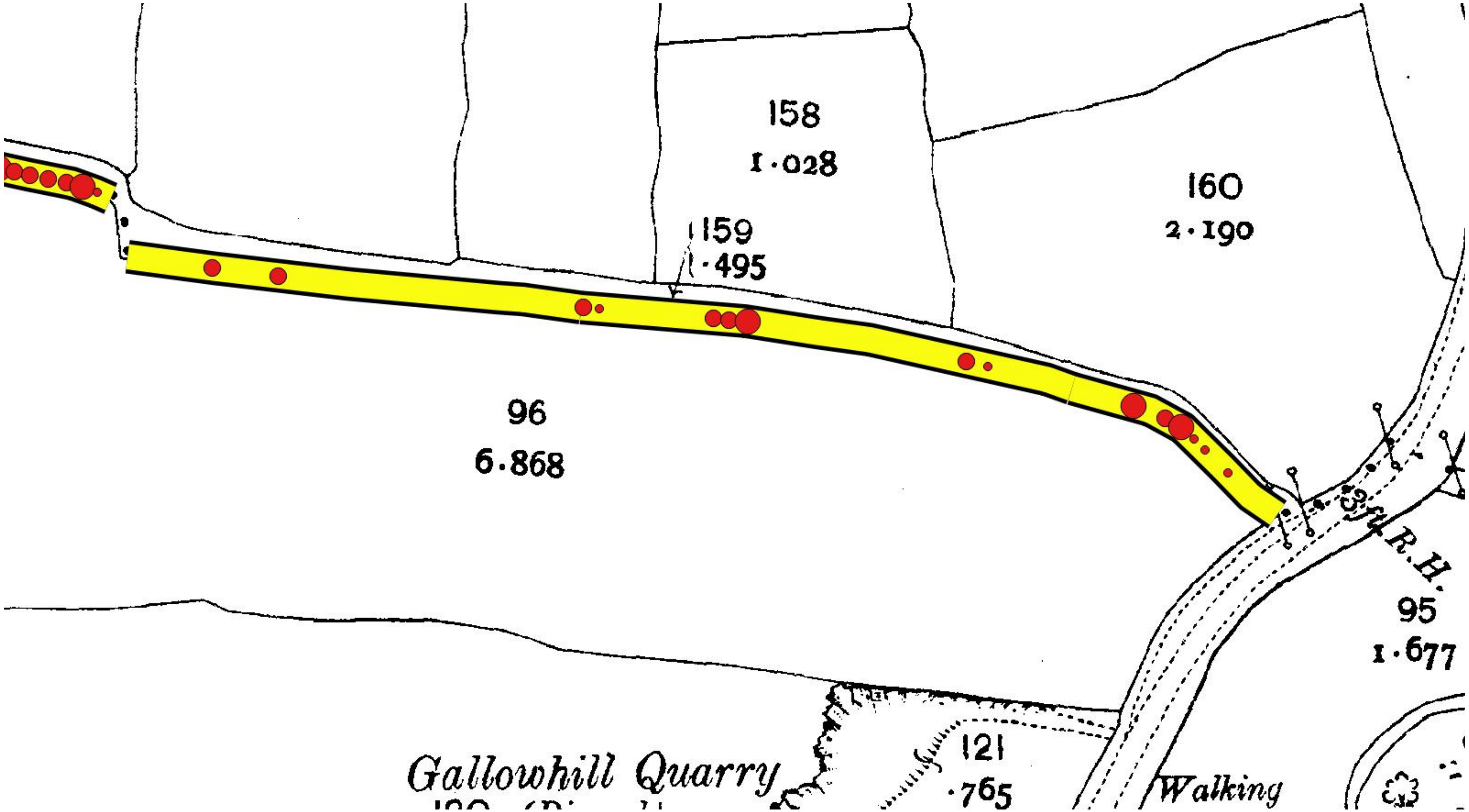


Figure 60.60 – Clifford Boundary Hedgerows – E2 – Summer – *Acer campestre*

Species maps for Clifford Boundary Hedgerows

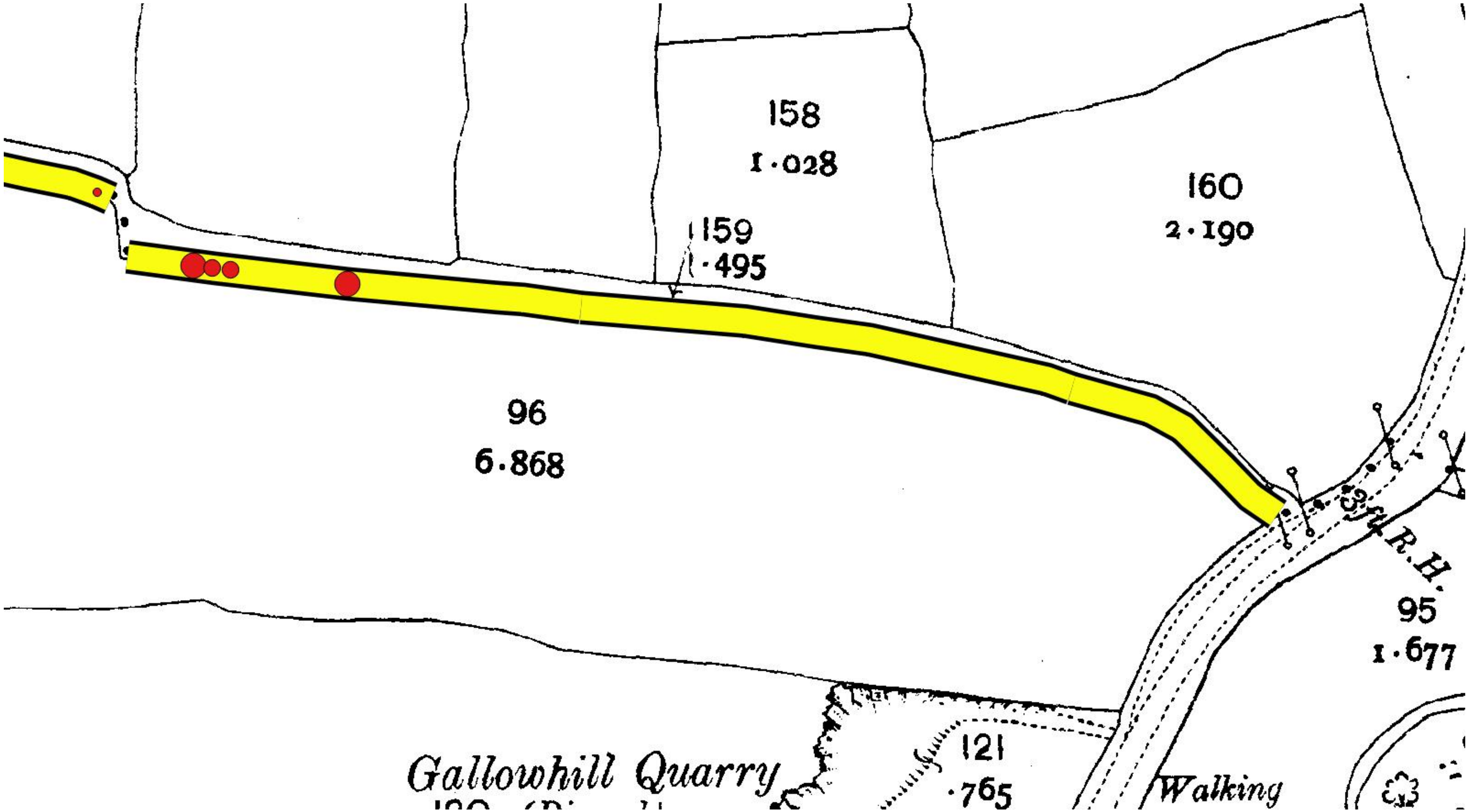


Figure 61.61 – Clifford Boundary Hedgerows – E2 – Summer – *Acer pseudoplatanus*

Species maps for Clifford Boundary Hedgerows

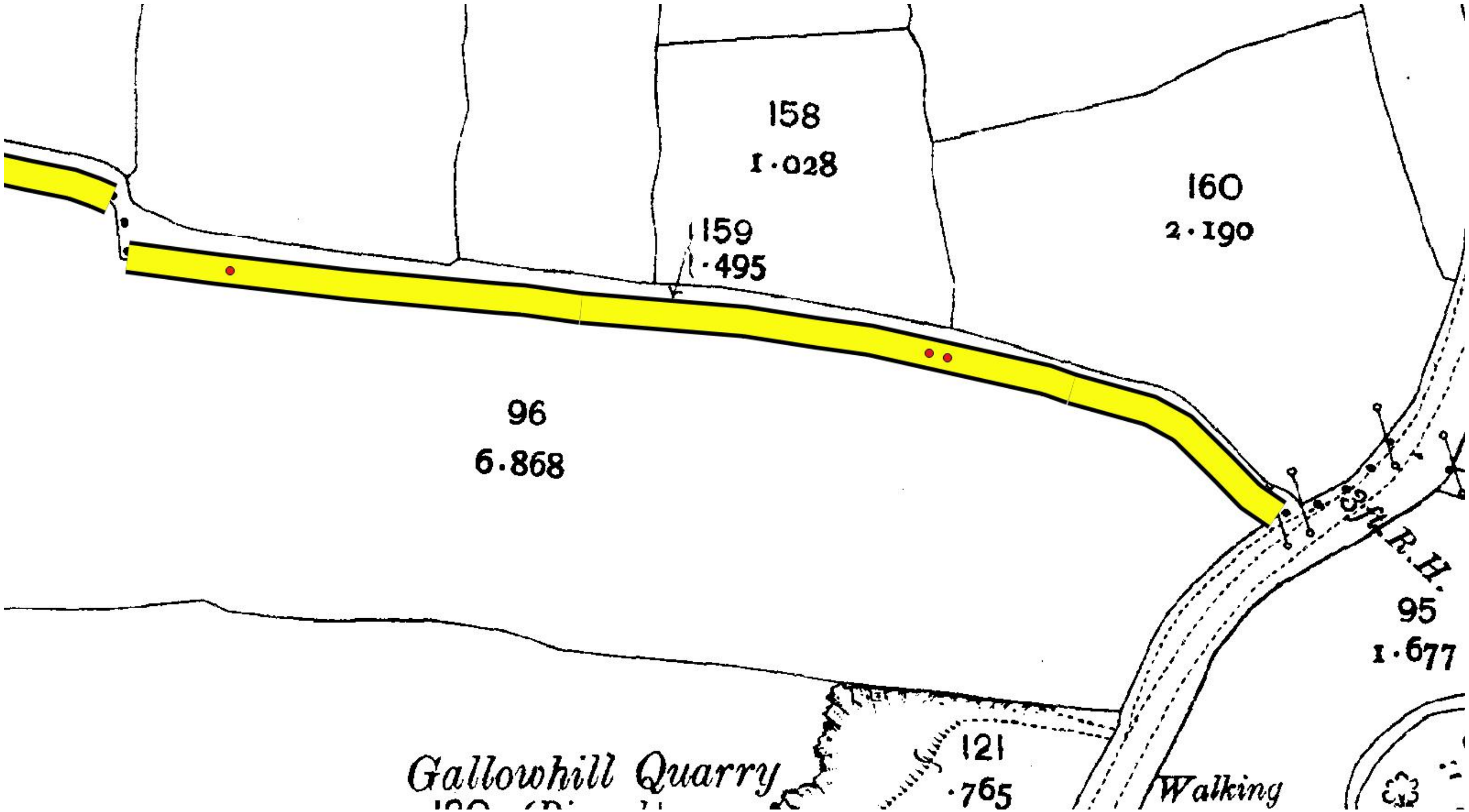


Figure 62.62 – Clifford Boundary Hedgerows – E2 – Summer – *Bryonia dioica*

Species maps for Clifford Boundary Hedgerows

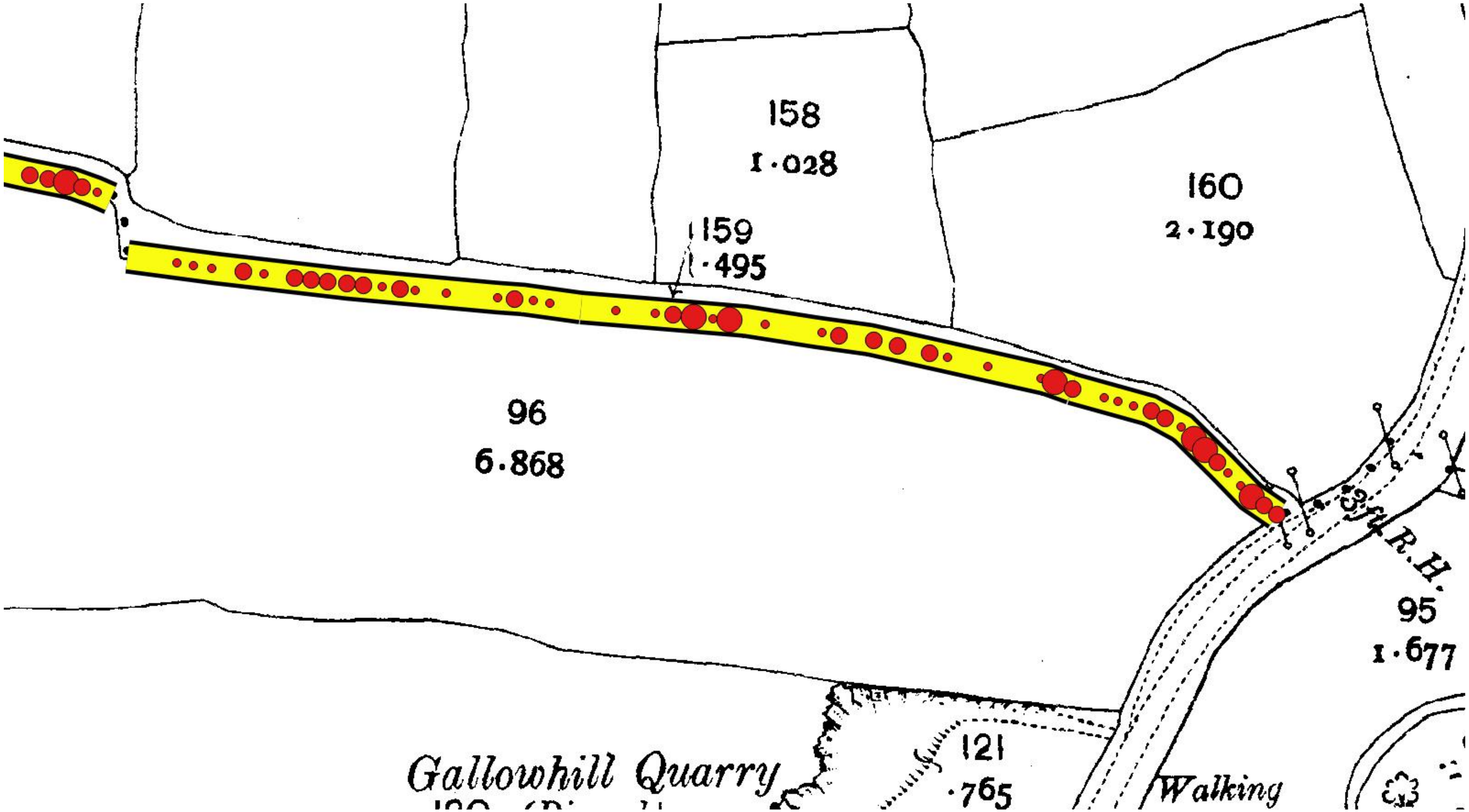


Figure 63.63 – Clifford Boundary Hedgerows – E2 – Summer – *Corylus avellana*

Species maps for Clifford Boundary Hedgerows

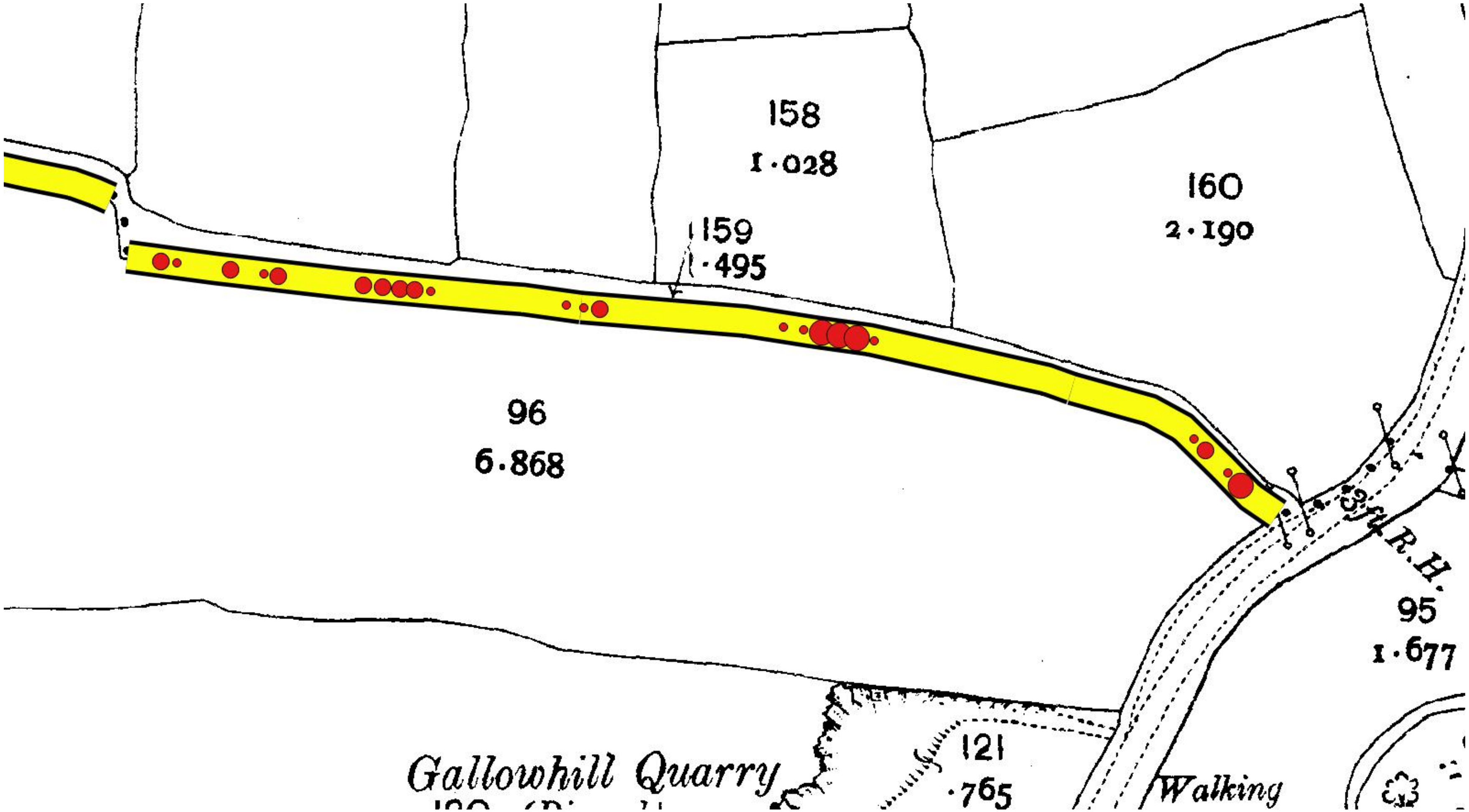


Figure 64.64 – Clifford Boundary Hedgerows – E2 – Summer – *Cornus sanguinea*

Species maps for Clifford Boundary Hedgerows

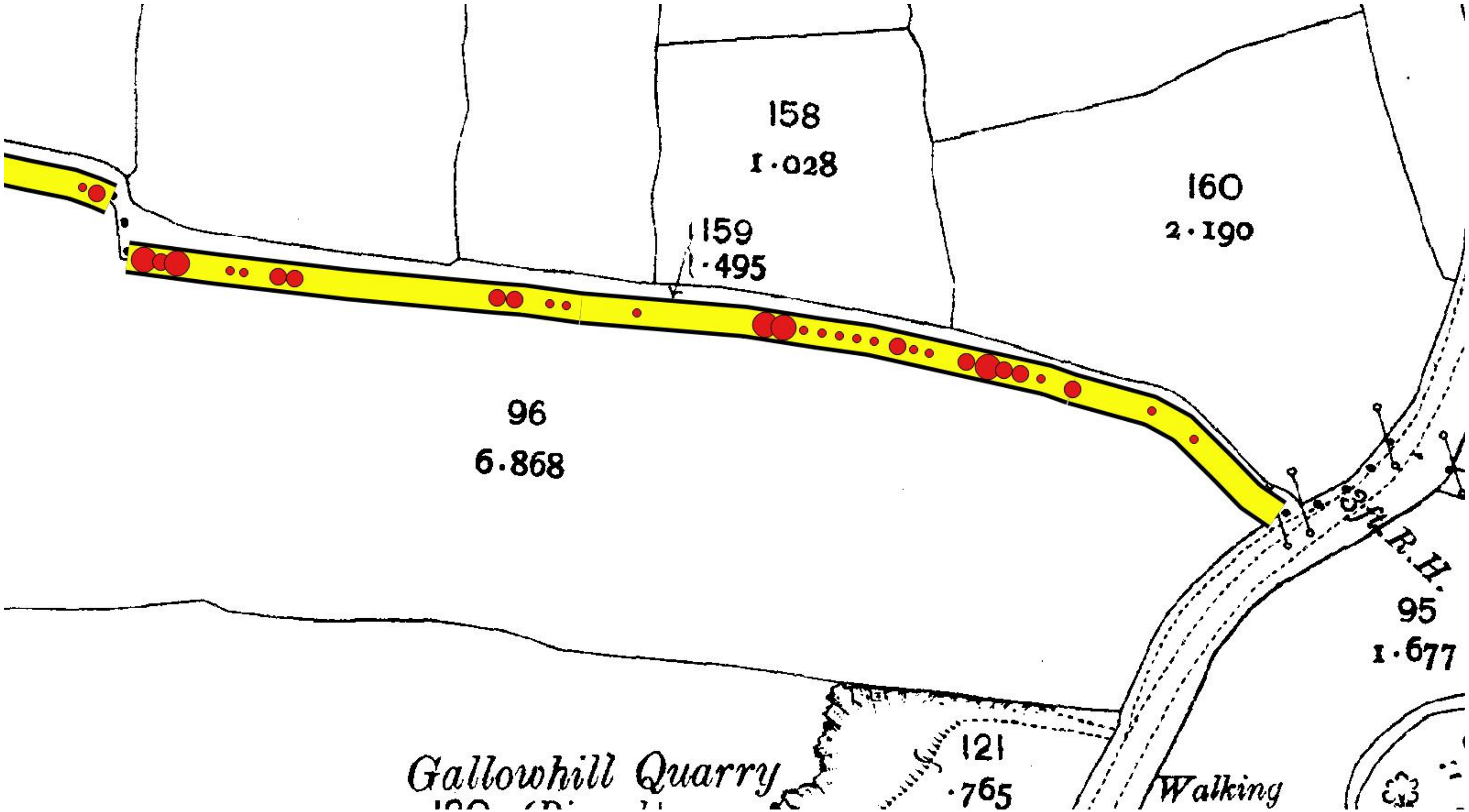


Figure 65.65 – Clifford Boundary Hedgerows – E2 – Summer – *Crataegus monogyna*

Species maps for Clifford Boundary Hedgerows

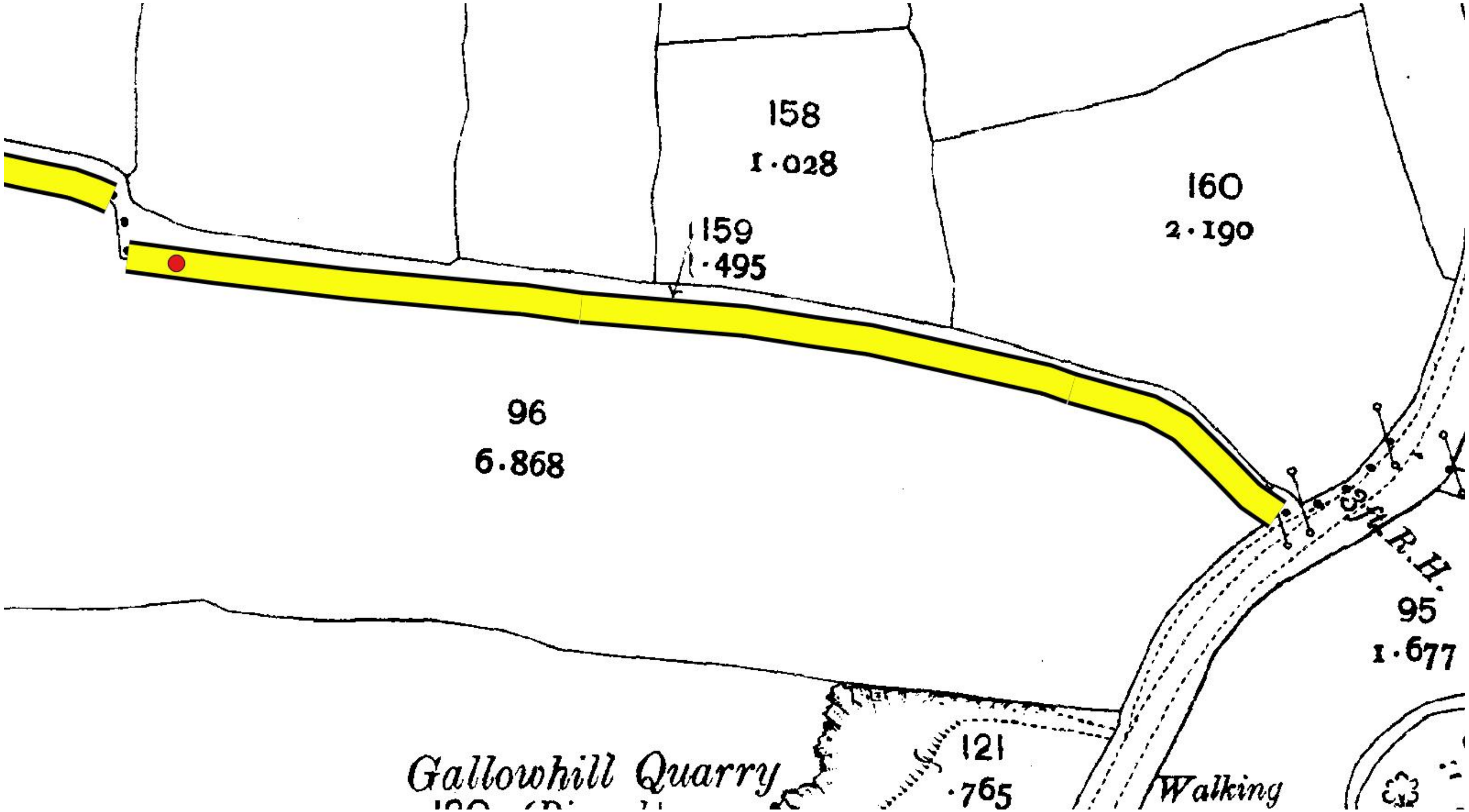


Figure 66.66 – Clifford Boundary Hedgerows – E2 – Summer – *Daphne laureola*

Species maps for Clifford Boundary Hedgerows

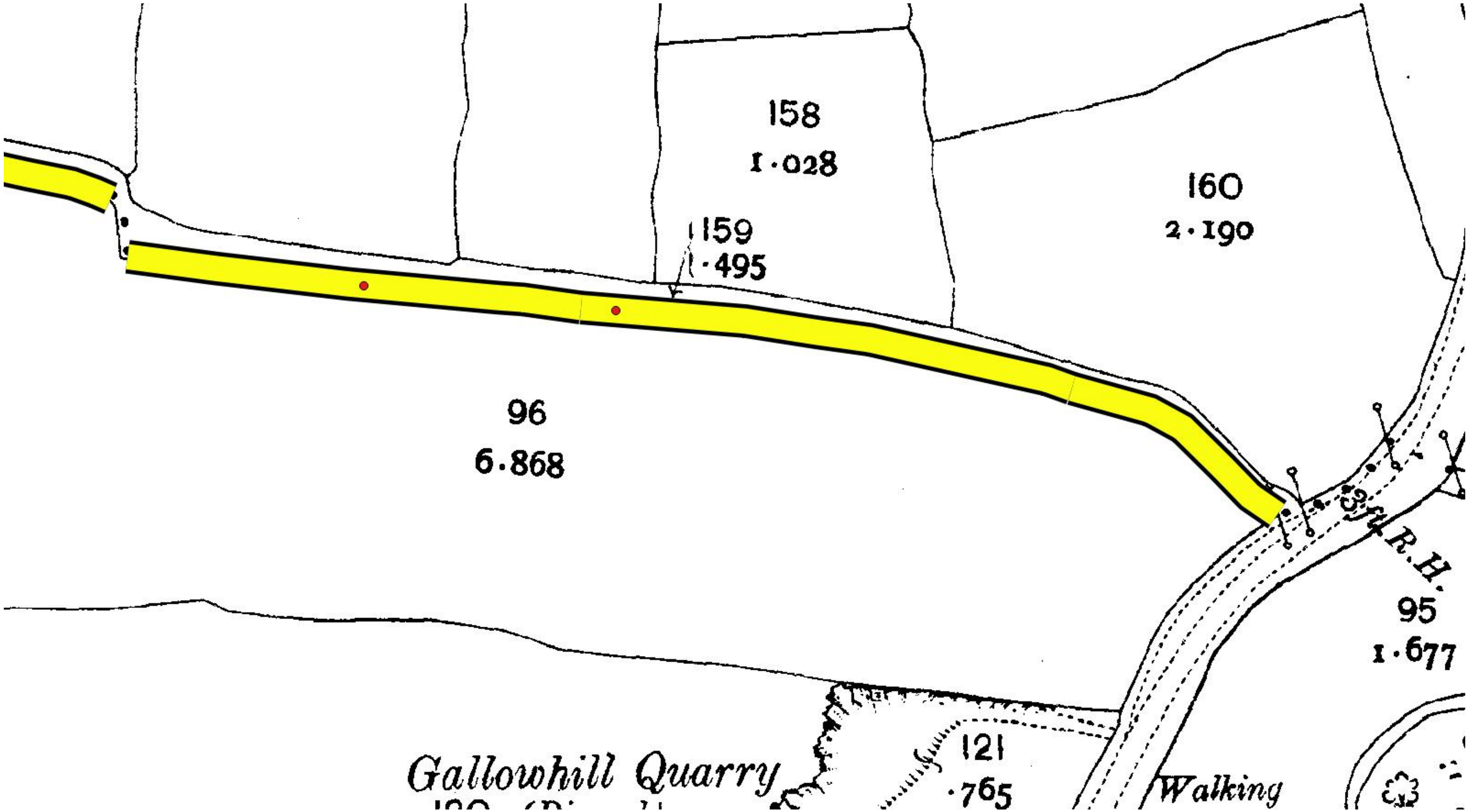


Figure 67.67 – Clifford Boundary Hedgerows – E2 – Summer – *Euonymus europaeus*

Species maps for Clifford Boundary Hedgerows

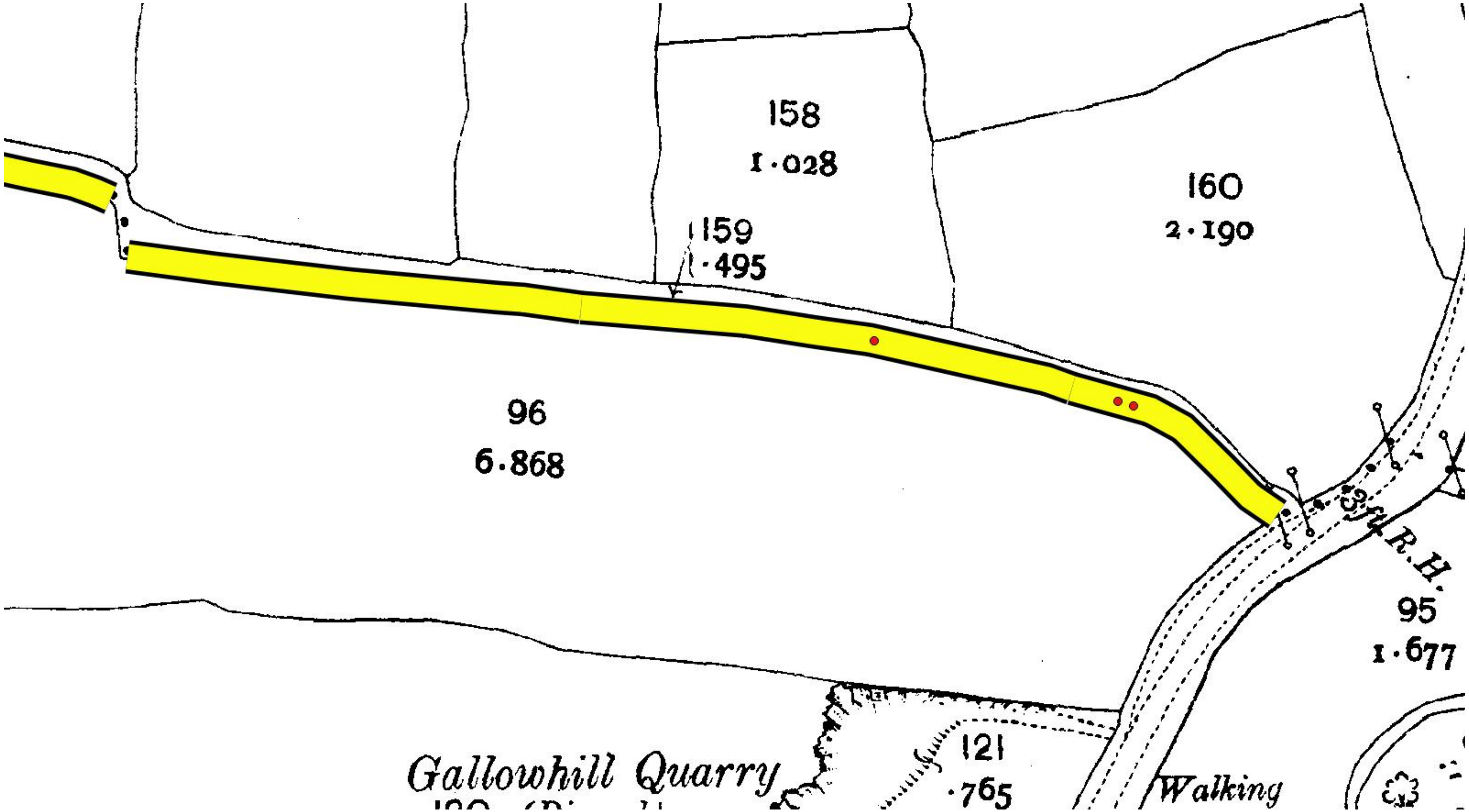


Figure 68.68 – Clifford Boundary Hedgerows – E2 – Summer – *Fraxinus excelsior*

Species maps for Clifford Boundary Hedgerows

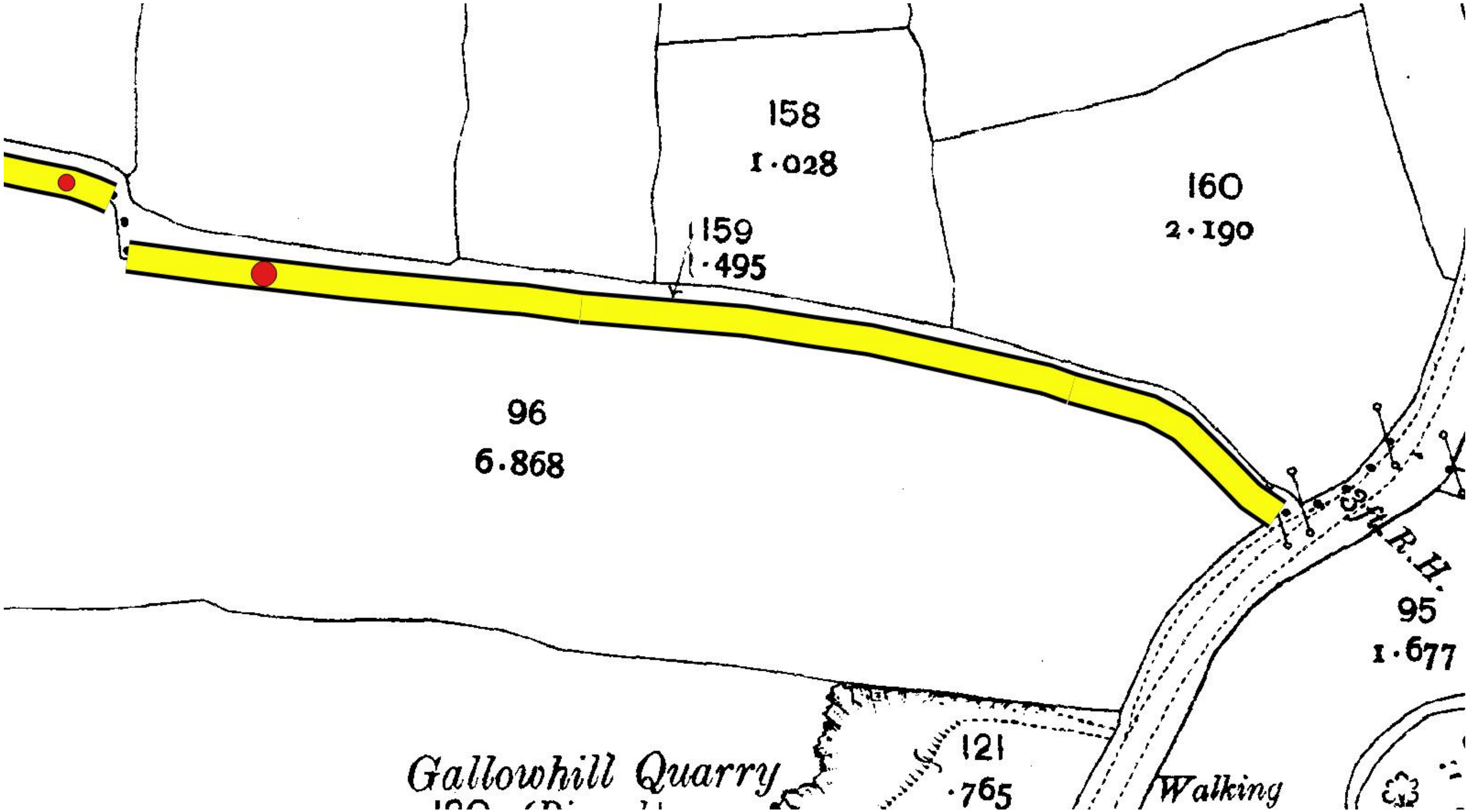


Figure 69.69 – Clifford Boundary Hedgerows – E2 – Summer – *Malus sylvestris*

Species maps for Clifford Boundary Hedgerows

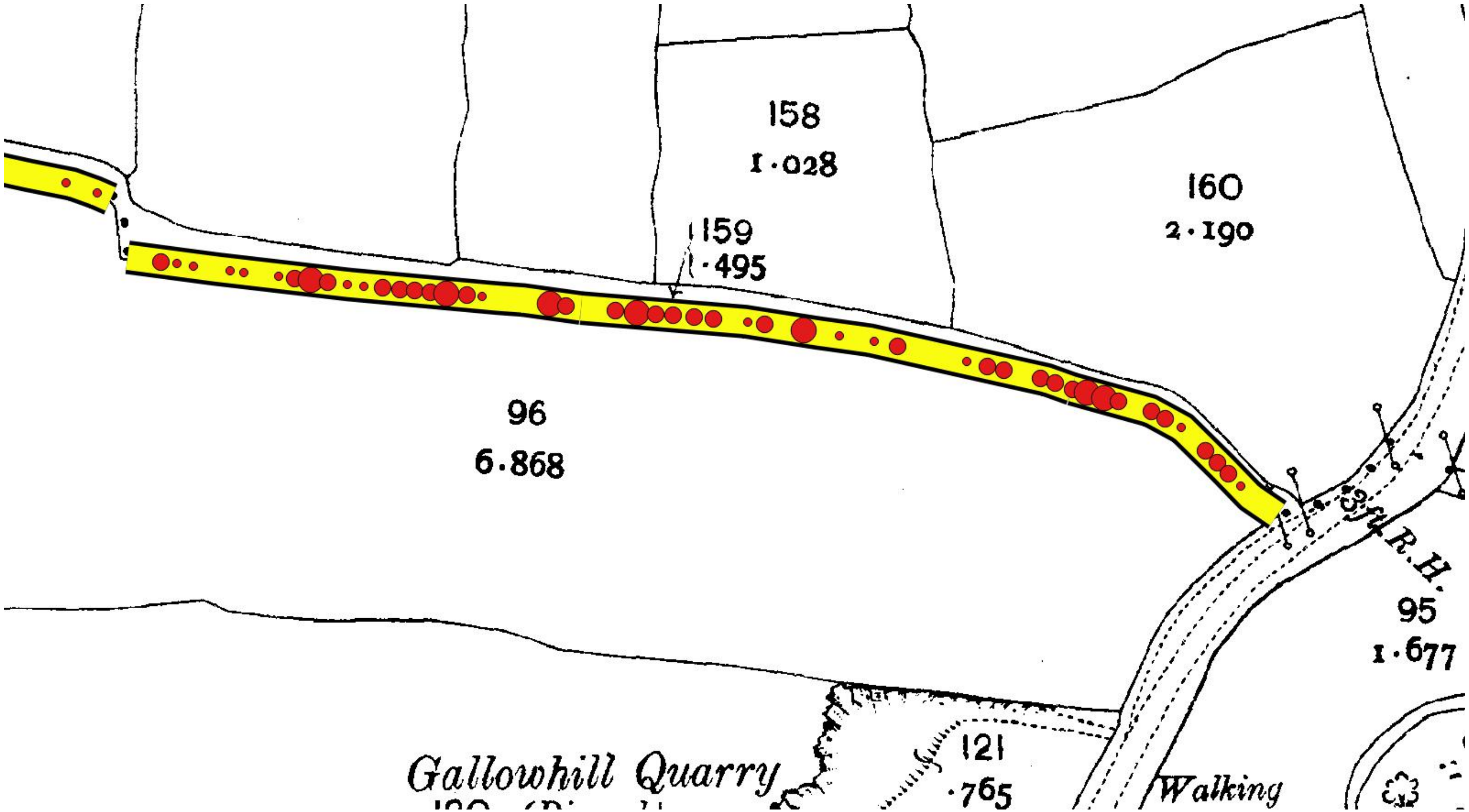


Figure 70.70 – Clifford Boundary Hedgerows – E2 – Summer – *Prunus spinosa*

Species maps for Clifford Boundary Hedgerows

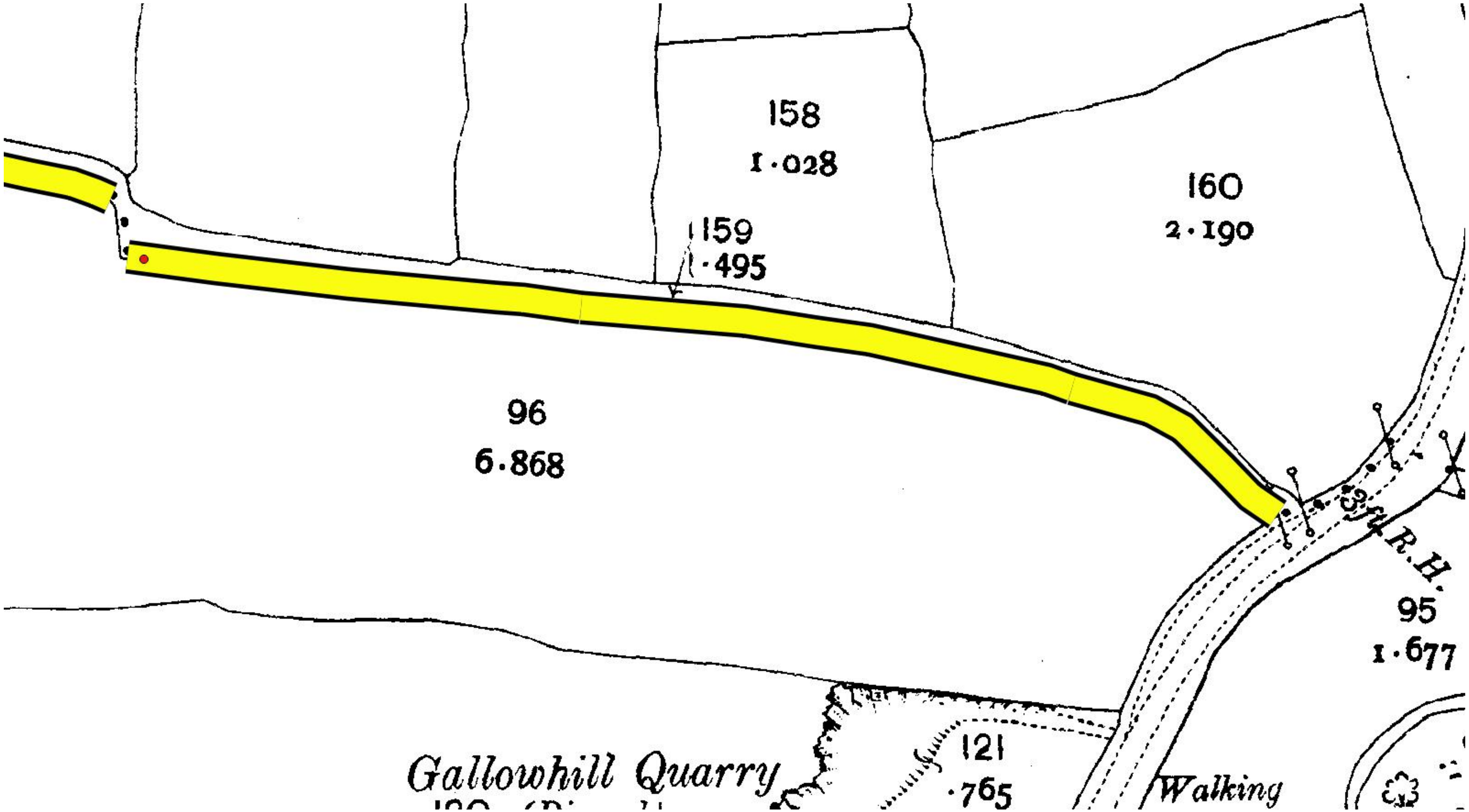


Figure 71.71 – Clifford Boundary Hedgerows – E2 – Summer – *Ribes idaeus*

Species maps for Clifford Boundary Hedgerows

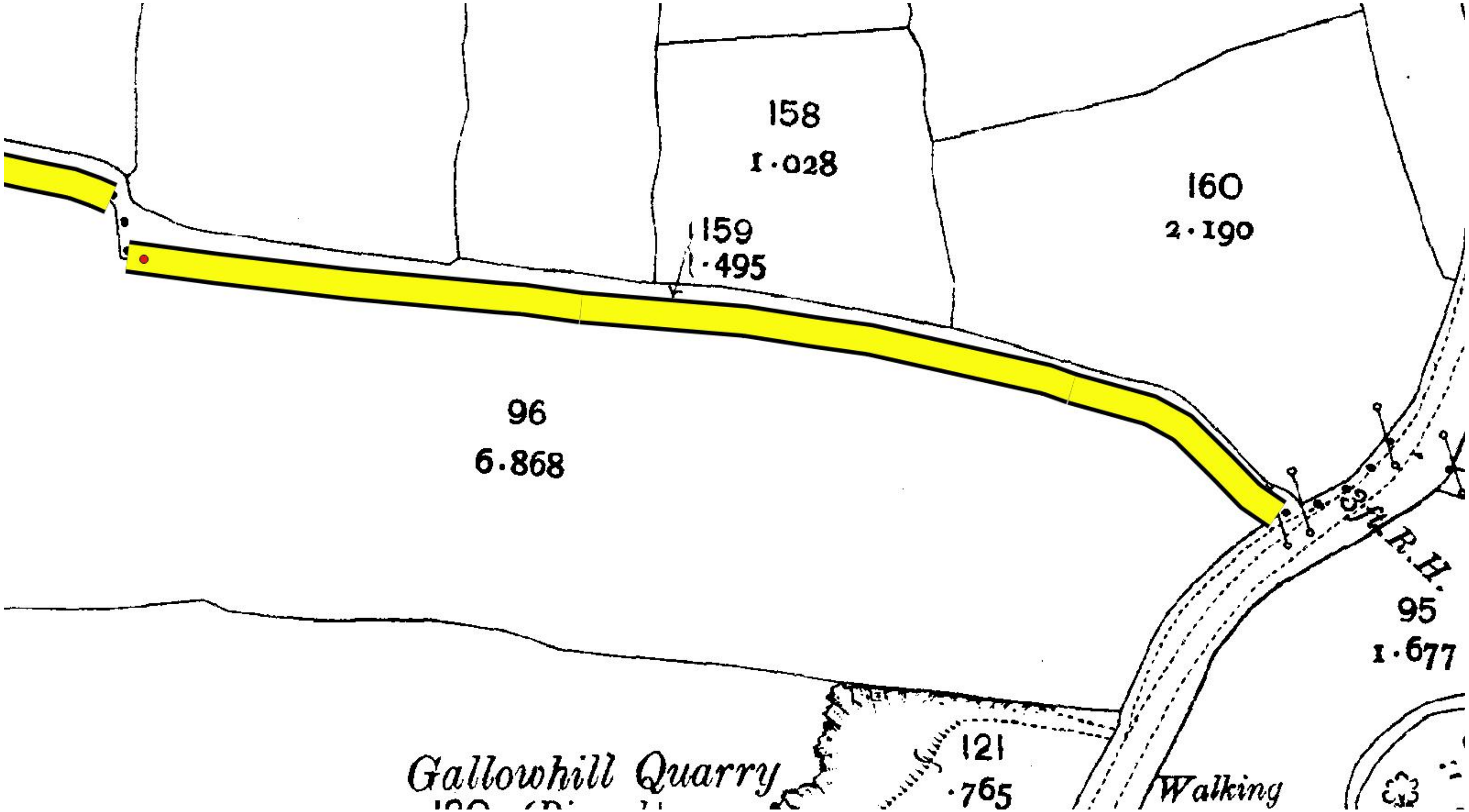


Figure 72.72 – Clifford Boundary Hedgerows – E2 – Summer – *Rosa arvensis*

Species maps for Clifford Boundary Hedgerows

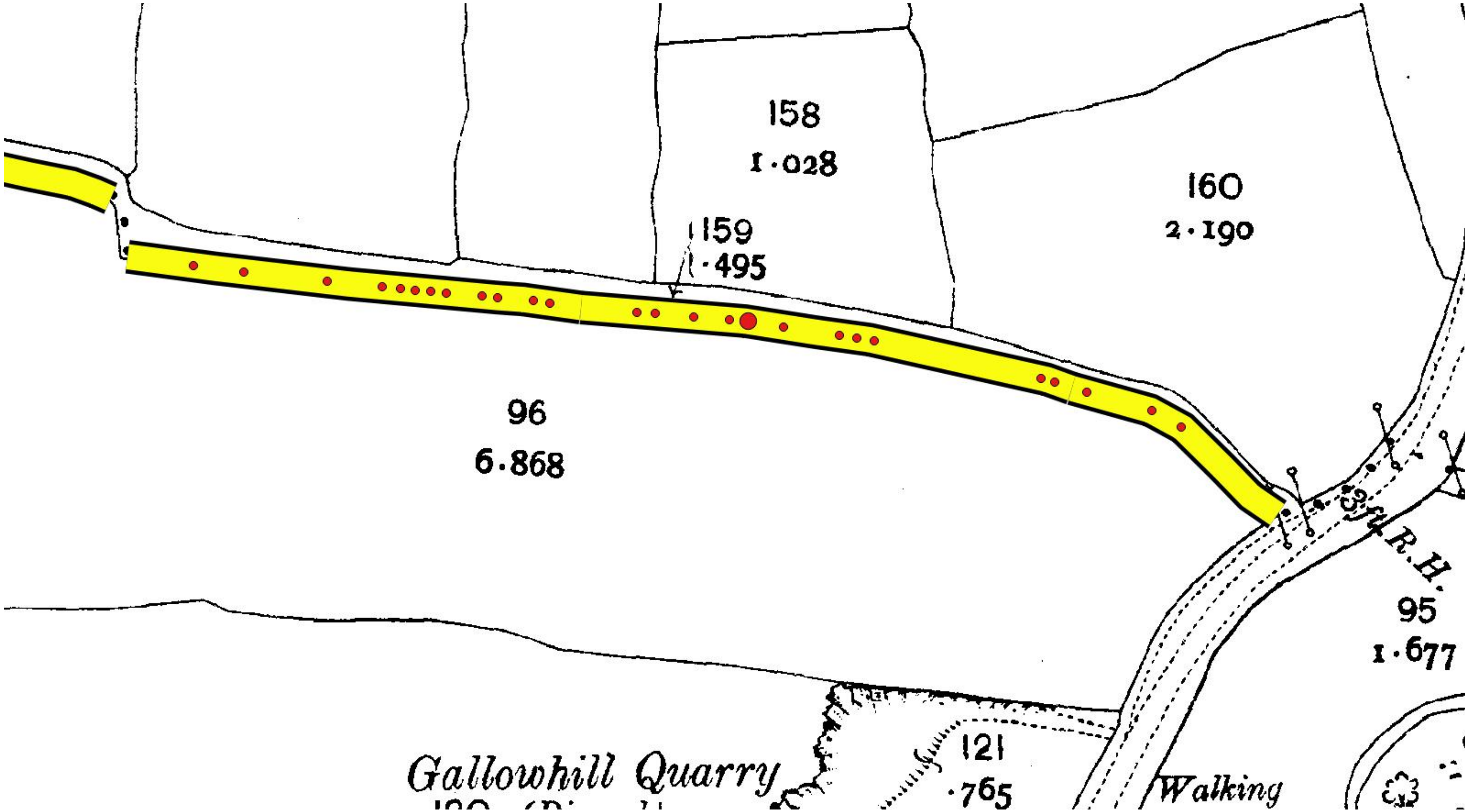


Figure 73.73 – Clifford Boundary Hedgerows – E2 – Summer – *Rosa canina*

Species maps for Clifford Boundary Hedgerows

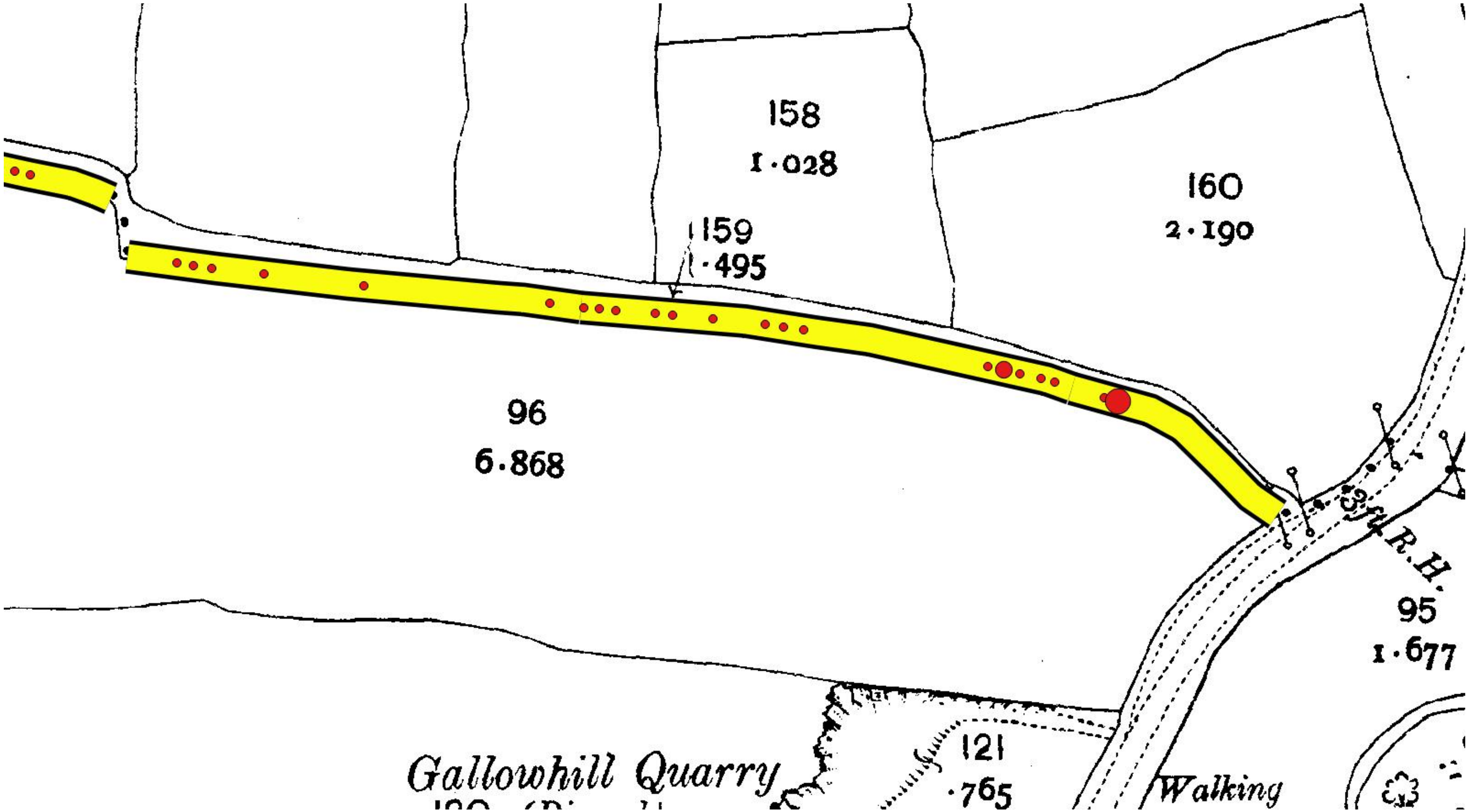


Figure 74.74 – Clifford Boundary Hedgerows – E2 – Summer – *Rubus fruticosus*

Species maps for Clifford Boundary Hedgerows

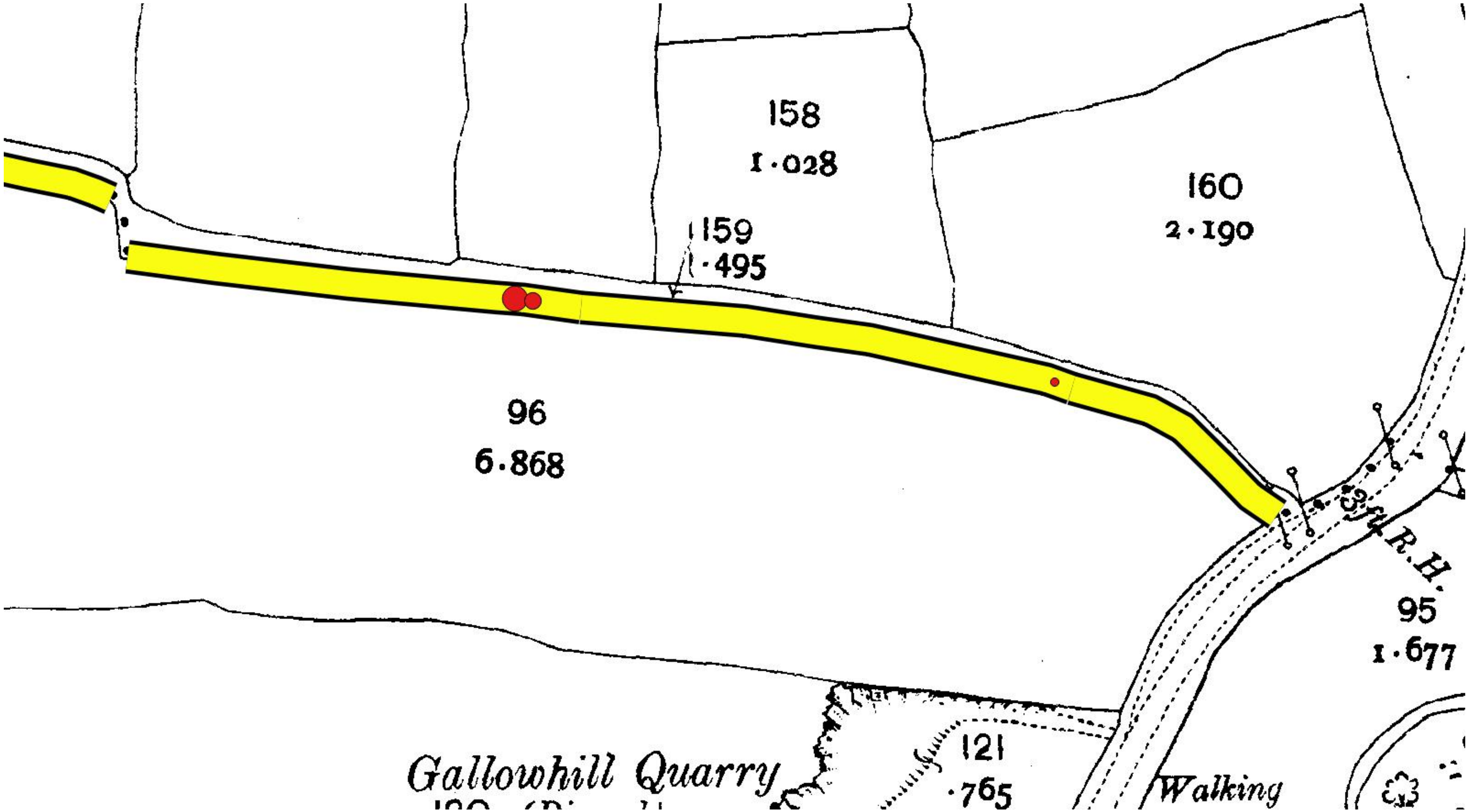


Figure 75.75 – Clifford Boundary Hedgerows – E2 – Summer – *Salix cinerea*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

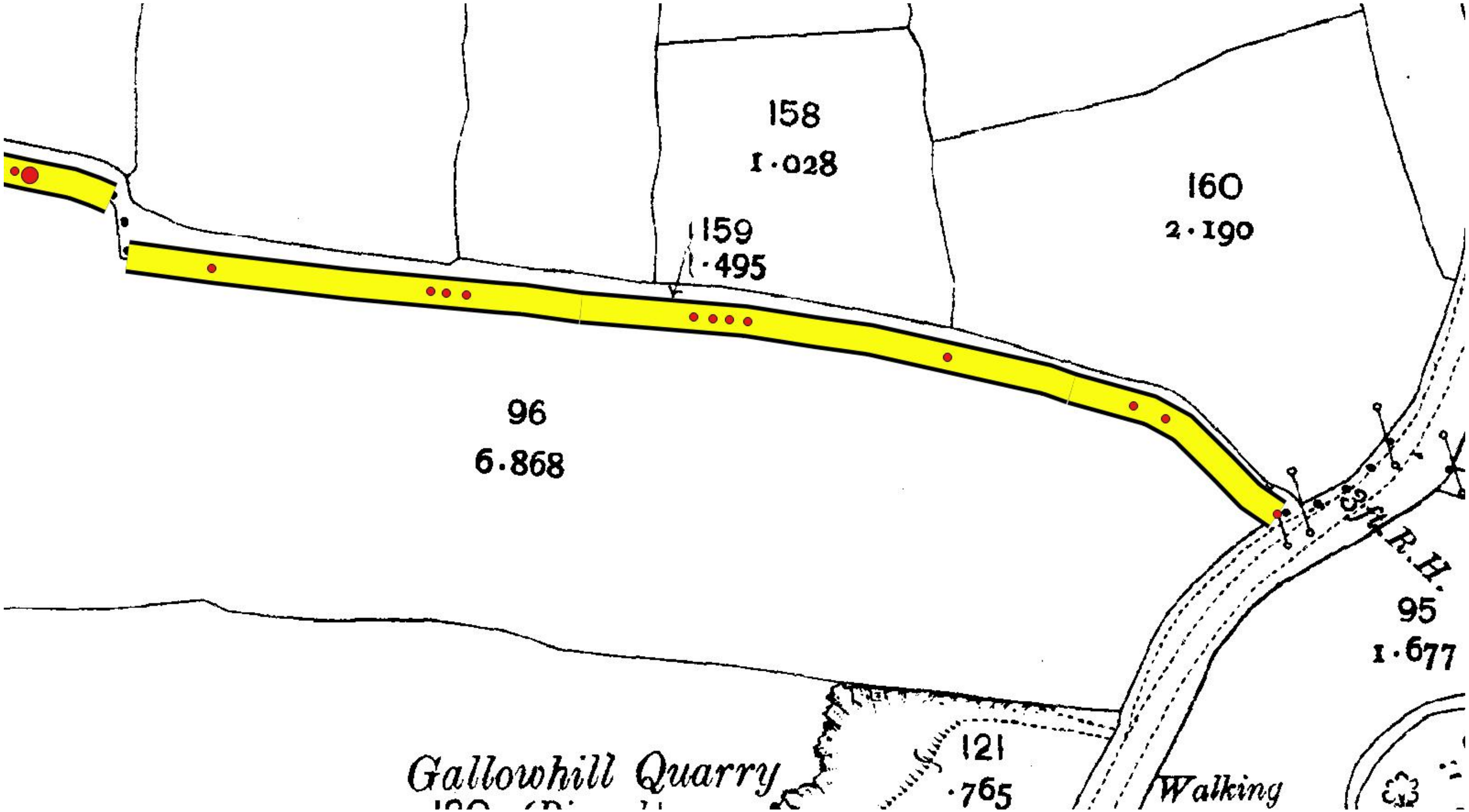


Figure 76.76 – Clifford Boundary Hedgerows – E2 – Summer – *Sambucus nigra*

Species maps for Clifford Boundary Hedgerows

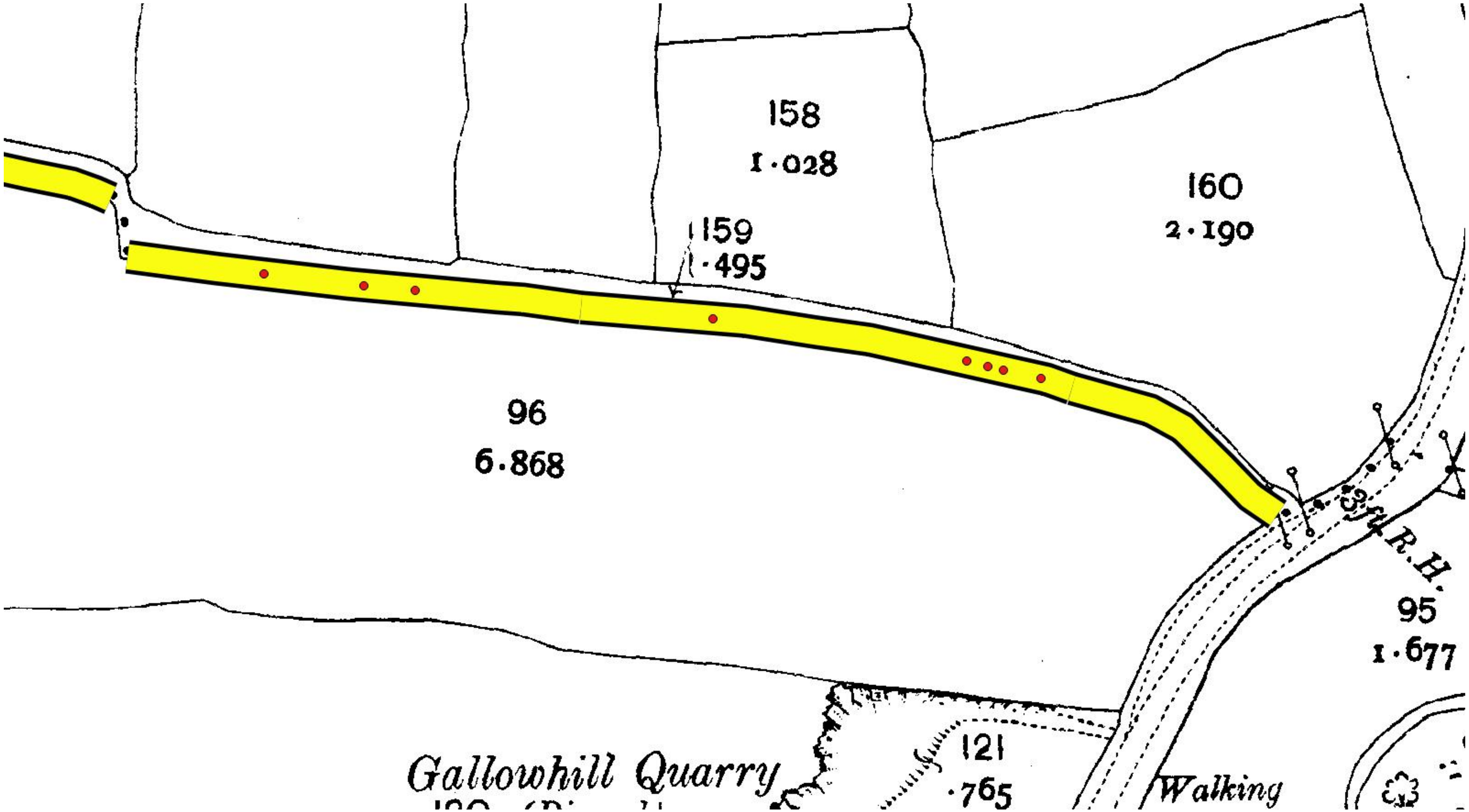


Figure 77.77 – Clifford Boundary Hedgerows – E2 – Summer – *Tamus communis*

Species maps for Clifford Boundary Hedgerows

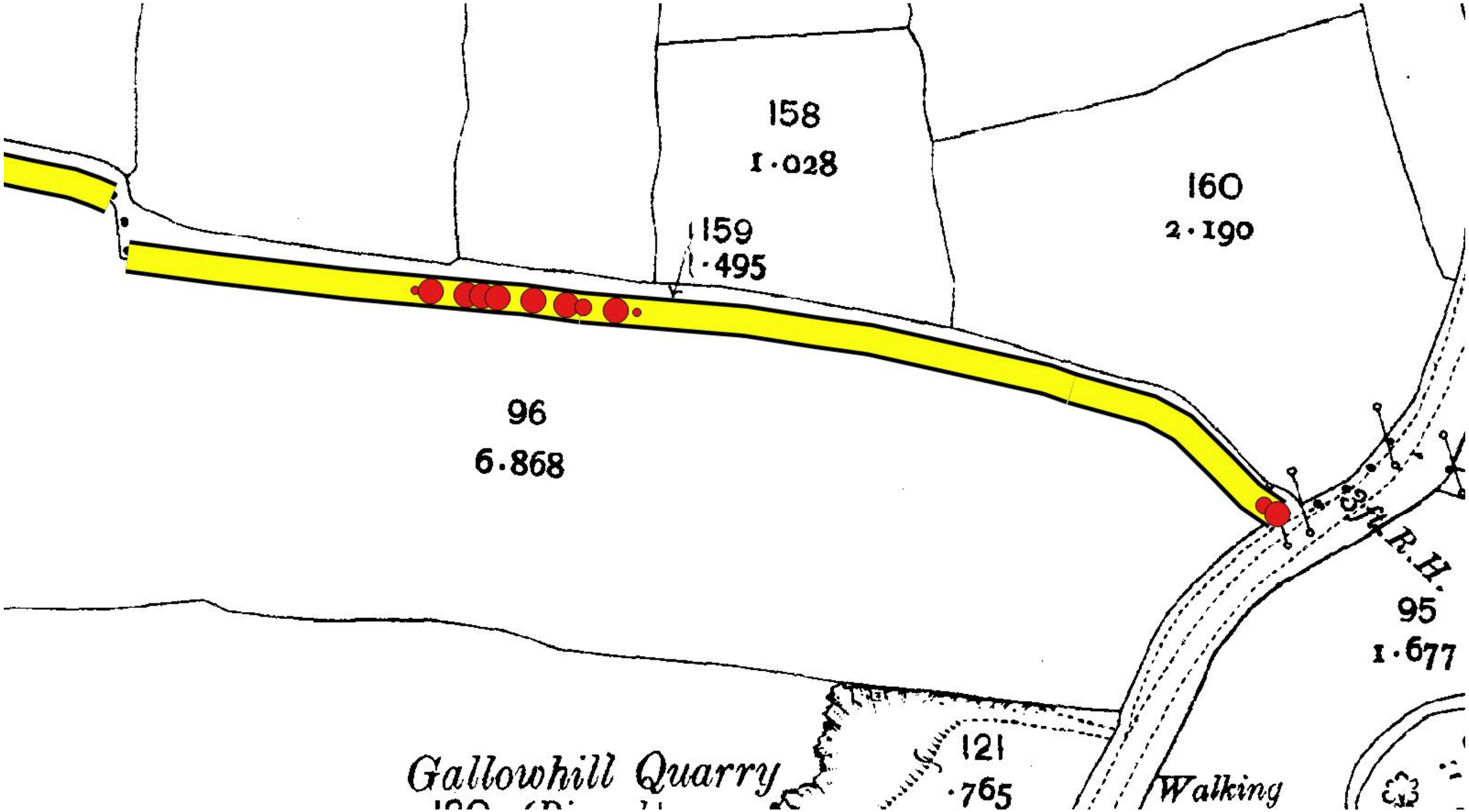


Figure 78.78 – Clifford Boundary Hedgerows – E2 – Summer – *Ulmus glabra*

Species maps for Clifford Boundary Hedgerows

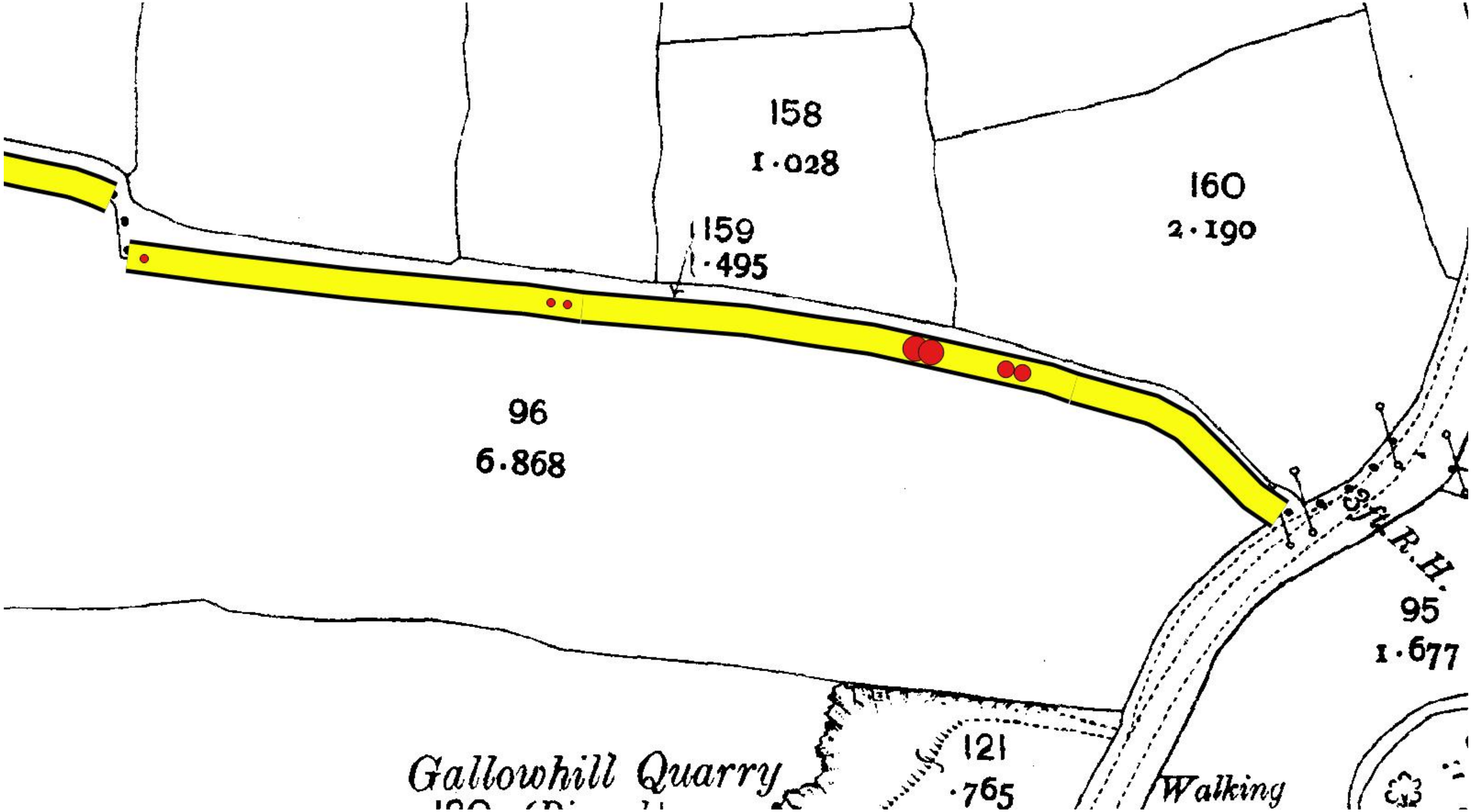


Figure 79.79 – Clifford Boundary Hedgerows – E2 – Summer – *Viburnum opulus*

Species maps for Clifford Boundary Hedgerows

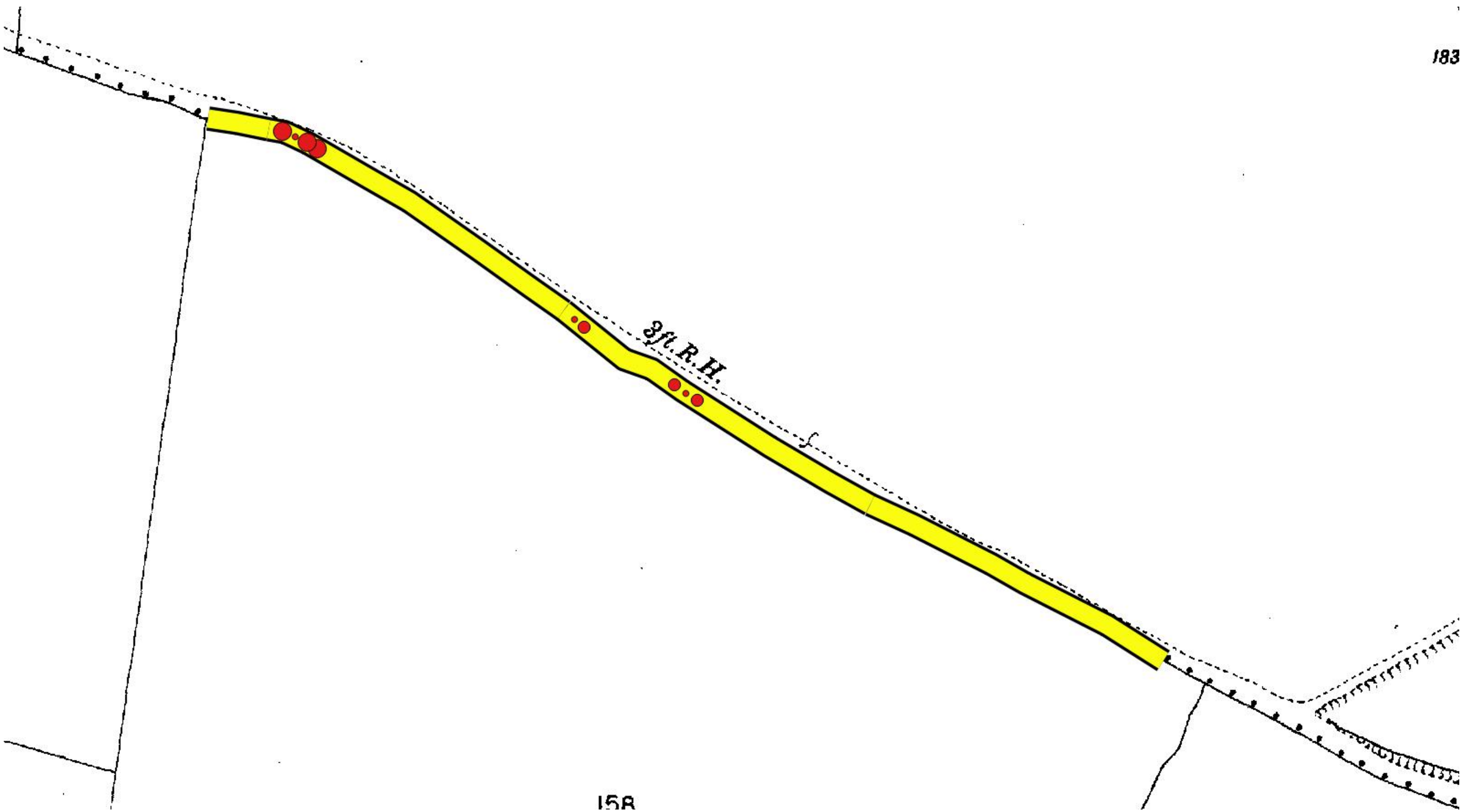


Figure 80.80 – Clifford Boundary Hedgerows – W1 – Summer – *Acer campestre*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

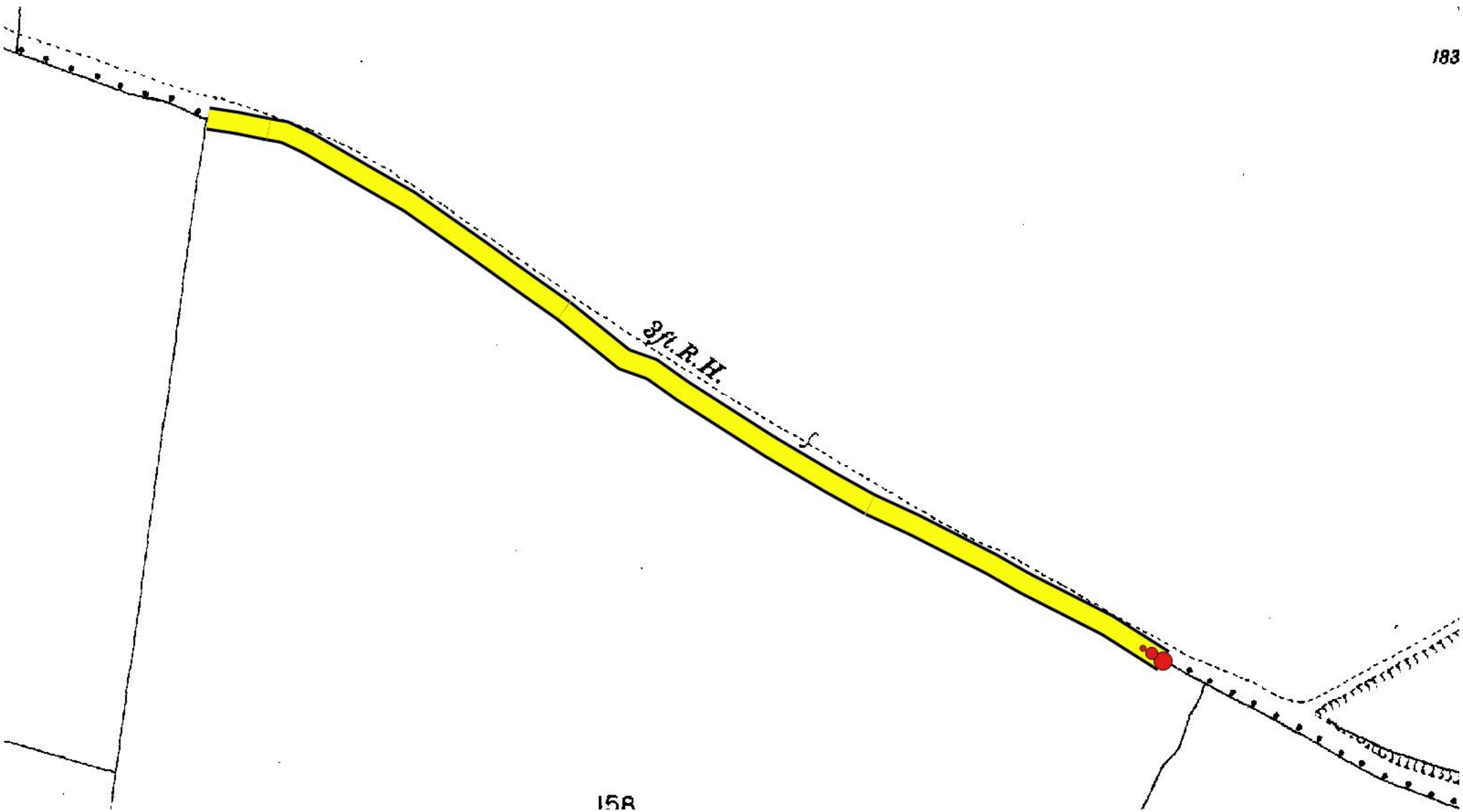


Figure 81.81 – Clifford Boundary Hedgerows – W1 – Summer – *Berberis vulgaris*

Species maps for Clifford Boundary Hedgerows

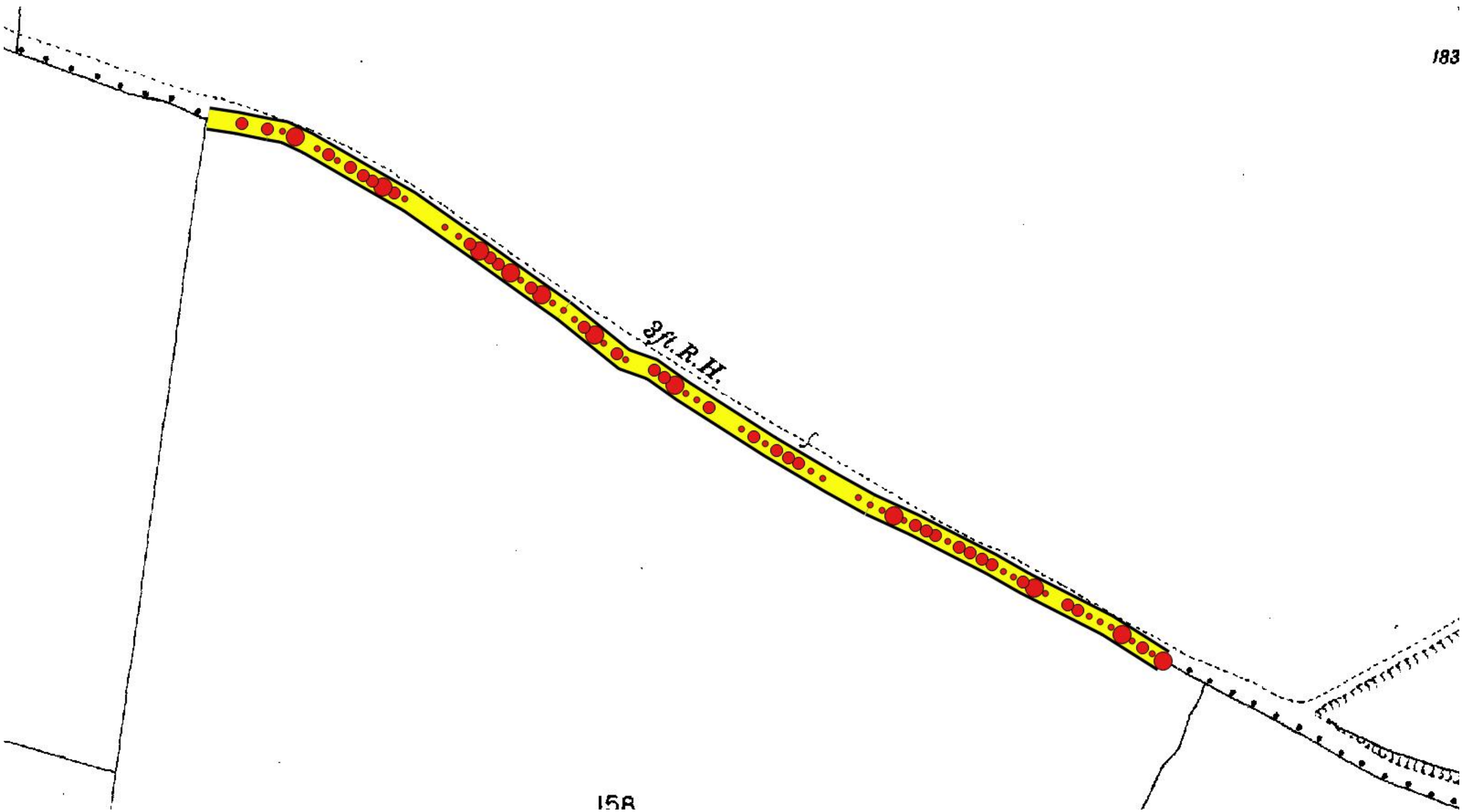



Figure 82.82 – Clifford Boundary Hedgerows – W1 – Summer – *Corylus avellana*

Species maps for Clifford Boundary Hedgerows

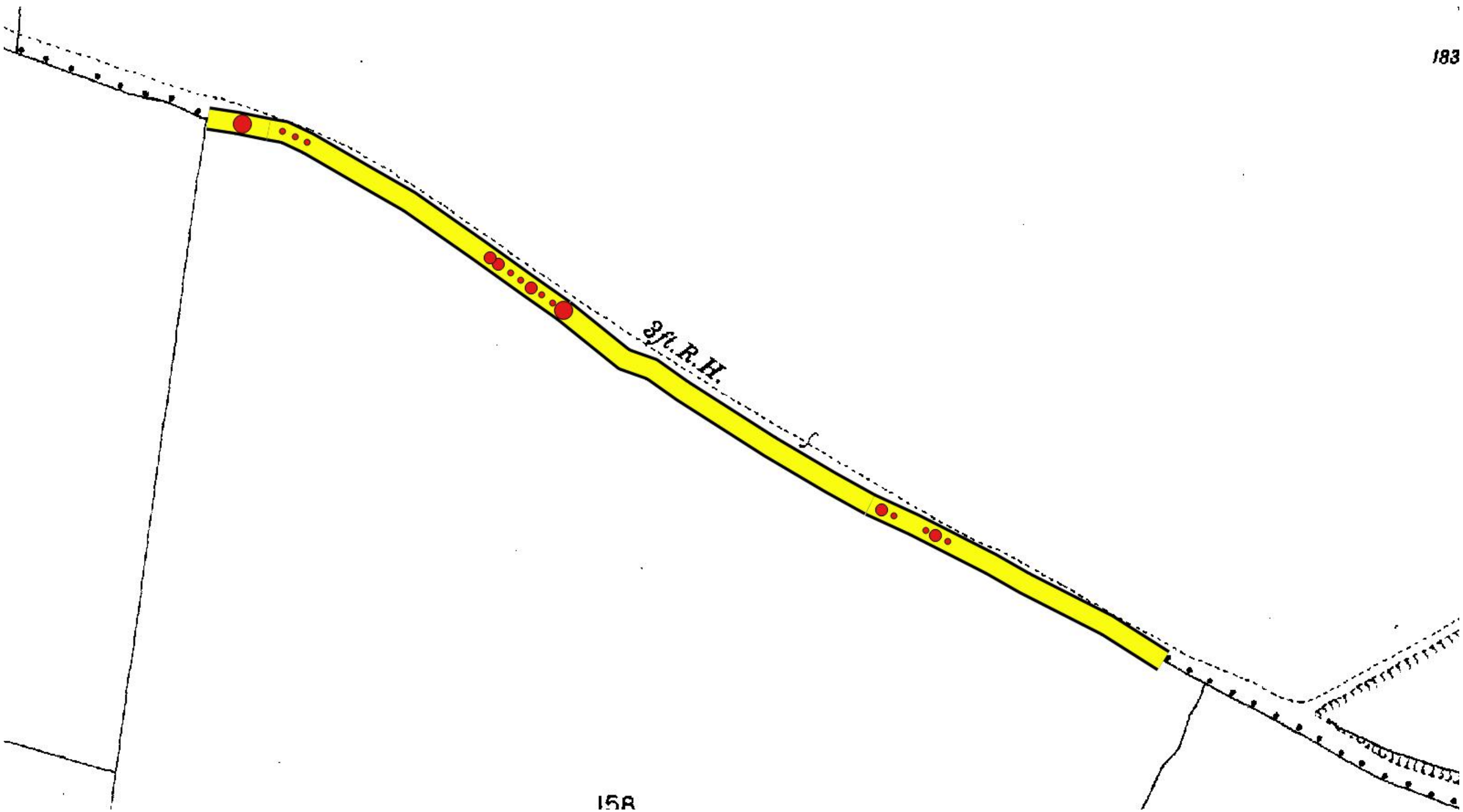


Figure 83.83 – Clifford Boundary Hedgerows – W1 – Summer – *Cornus sanguinea*

Appendix 18 - Clifford boundary hedgerow survey

Species maps for Clifford Boundary Hedgerows

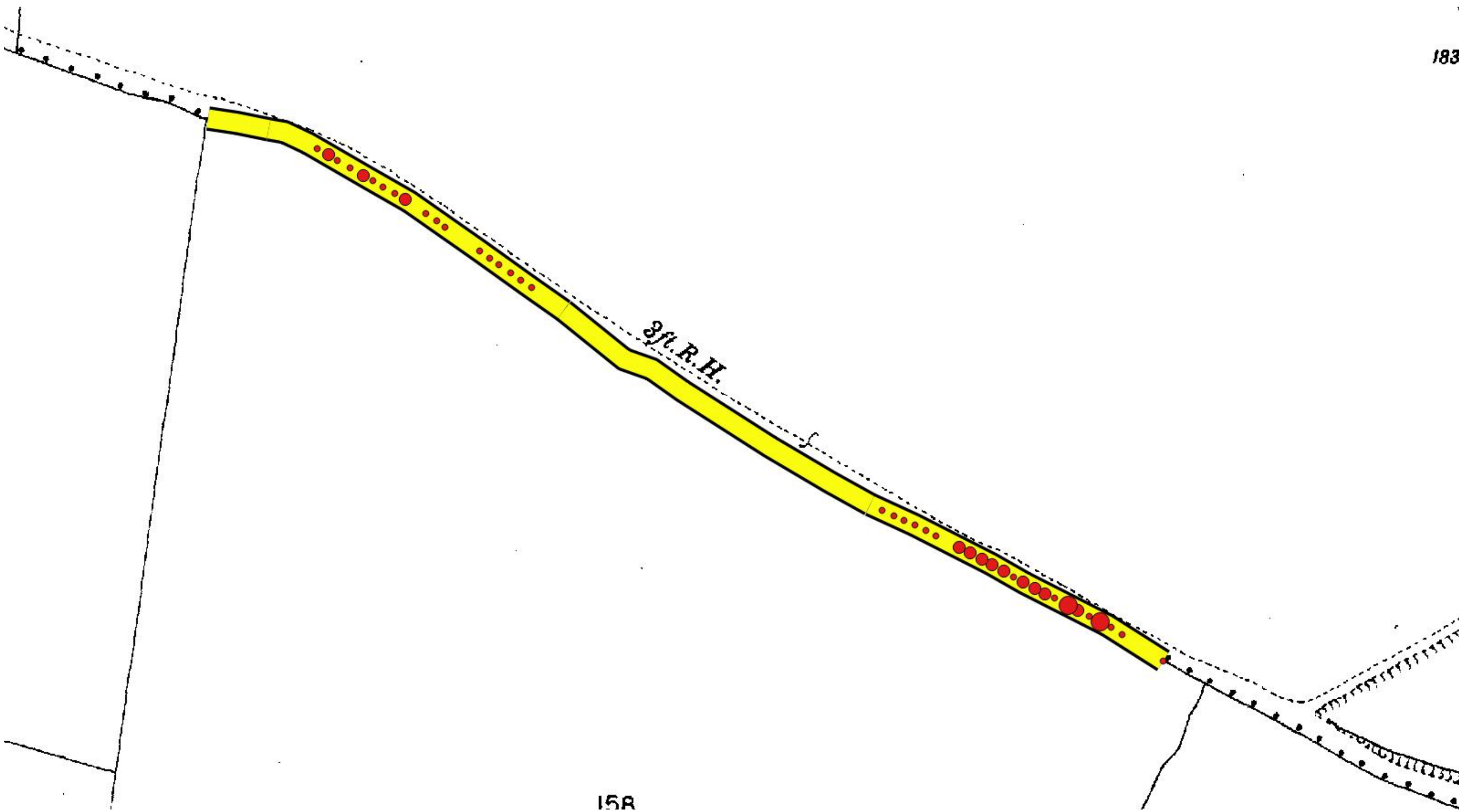


Figure 84.84 – Clifford Boundary Hedgerows – W1 – Summer – *Crataegus monogyna*

Species maps for Clifford Boundary Hedgerows

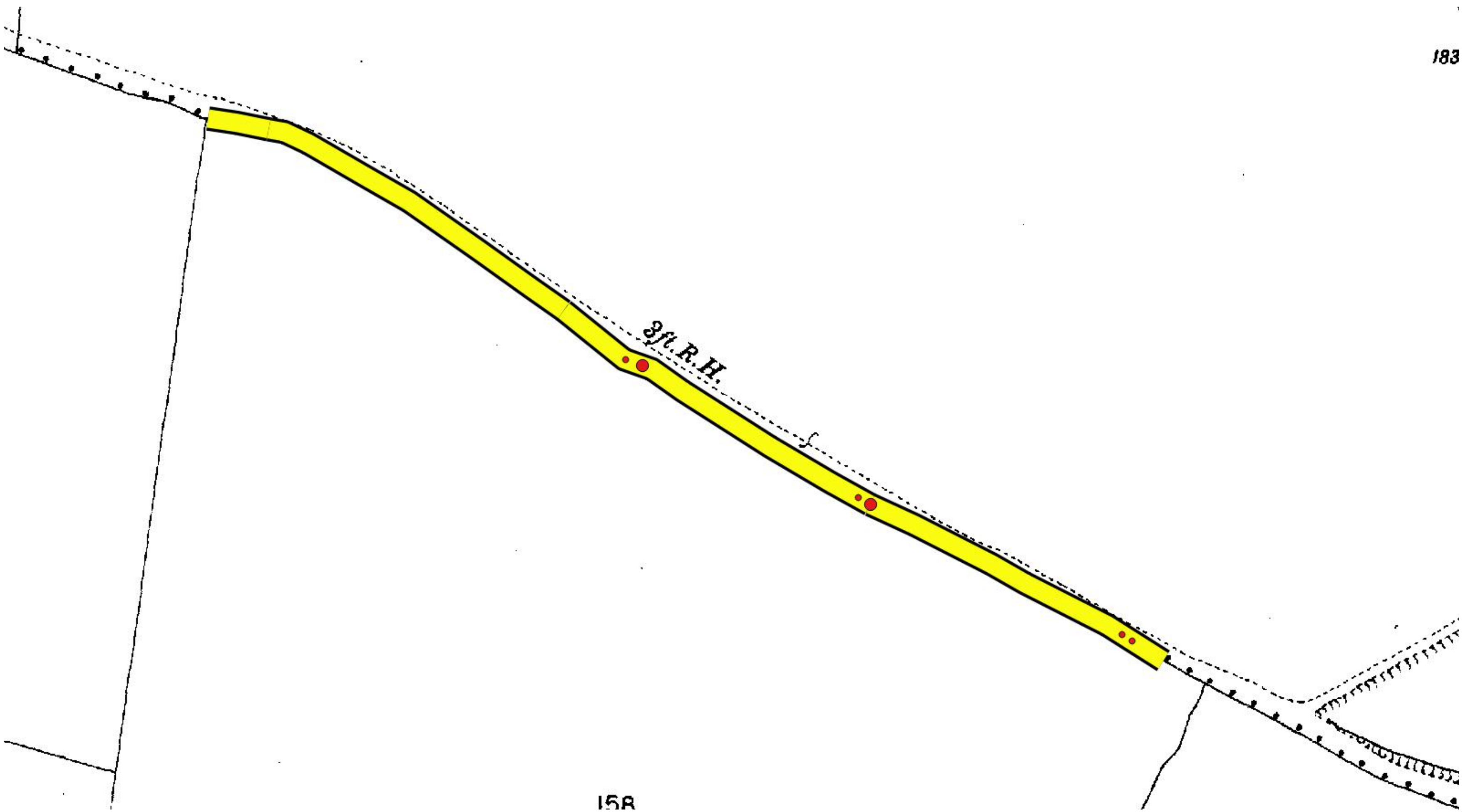


Figure 85.85 – Clifford Boundary Hedgerows – W1 – Summer – *Euonymus europaeus*

Species maps for Clifford Boundary Hedgerows

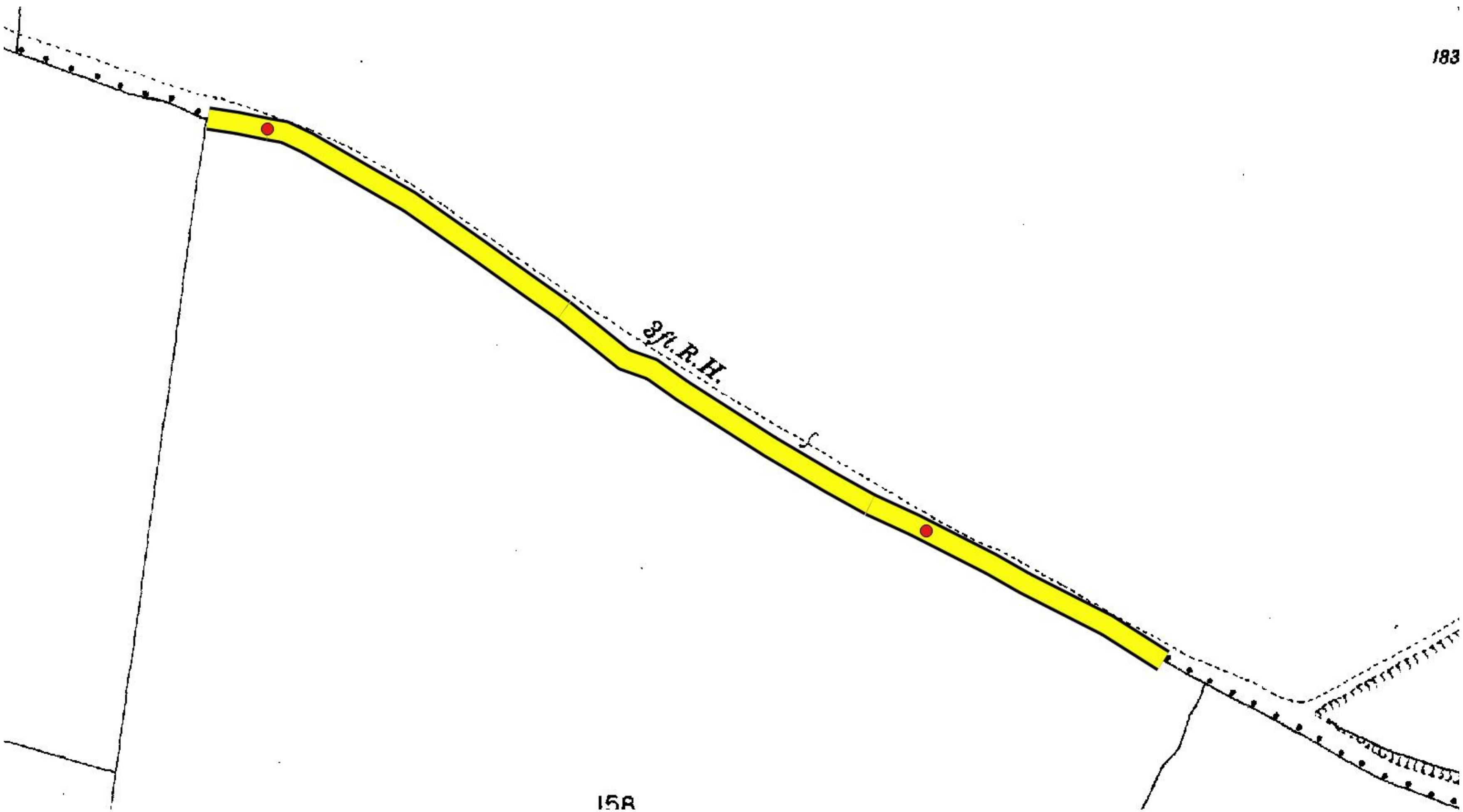


Figure 86.86 – Clifford Boundary Hedgerows – W1 – Summer – *Fraxinus excelsior*

Species maps for Clifford Boundary Hedgerows

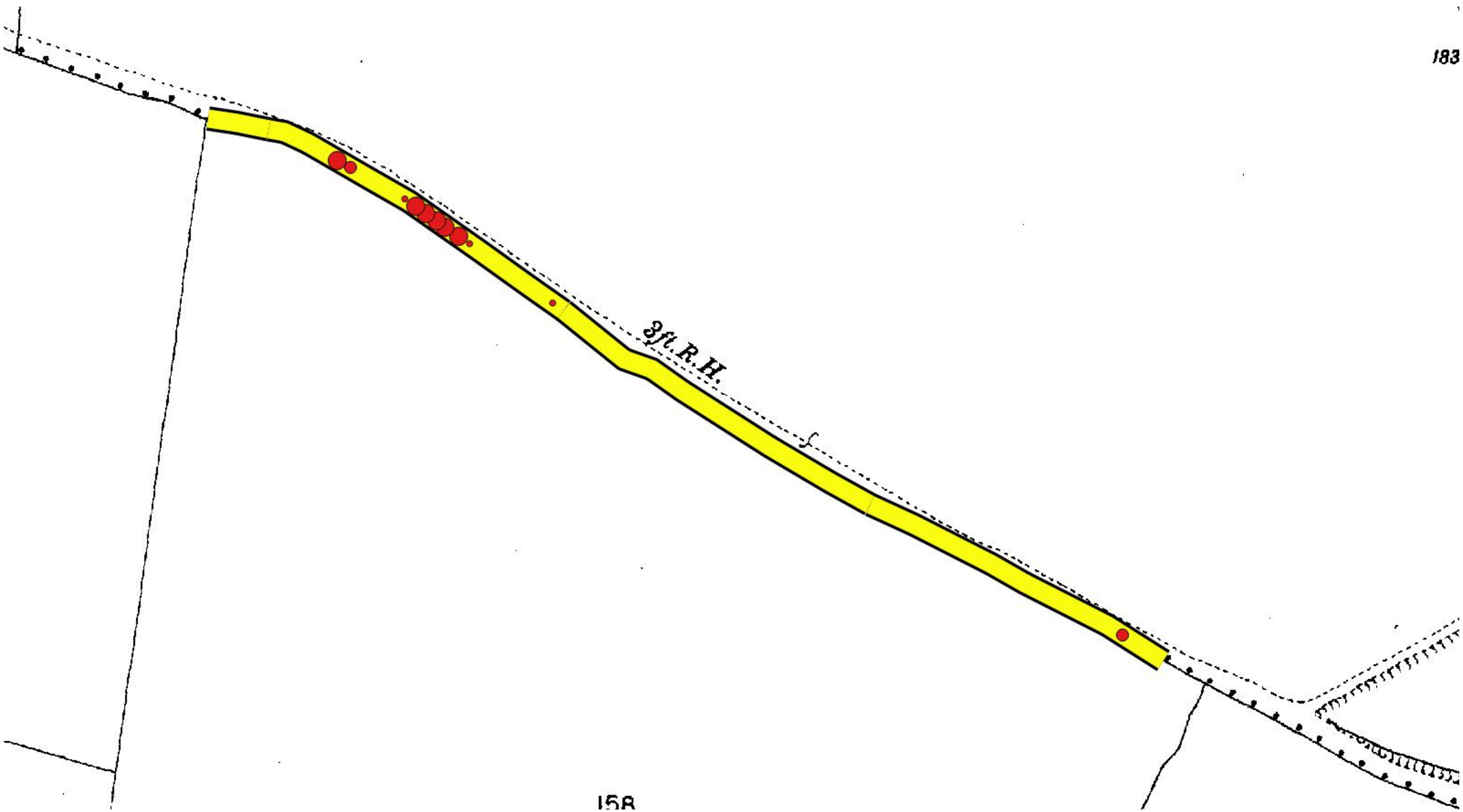


Figure 87.87 – Clifford Boundary Hedgerows – W1 – Summer – *Ilex aquifolium*

Species maps for Clifford Boundary Hedgerows

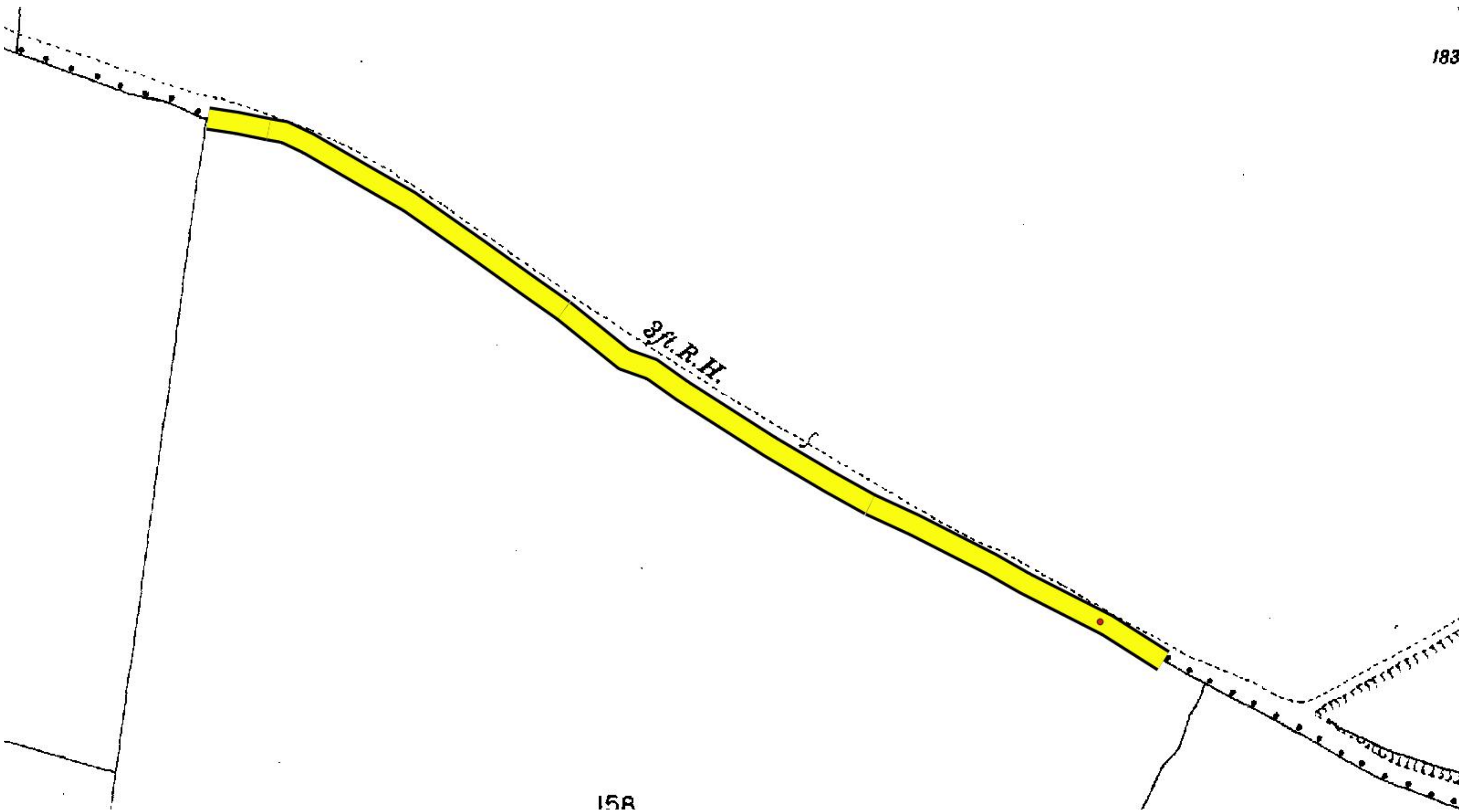


Figure 88.88 – Clifford Boundary Hedgerows – W1 – Summer – *Prunus inisititia*

Species maps for Clifford Boundary Hedgerows

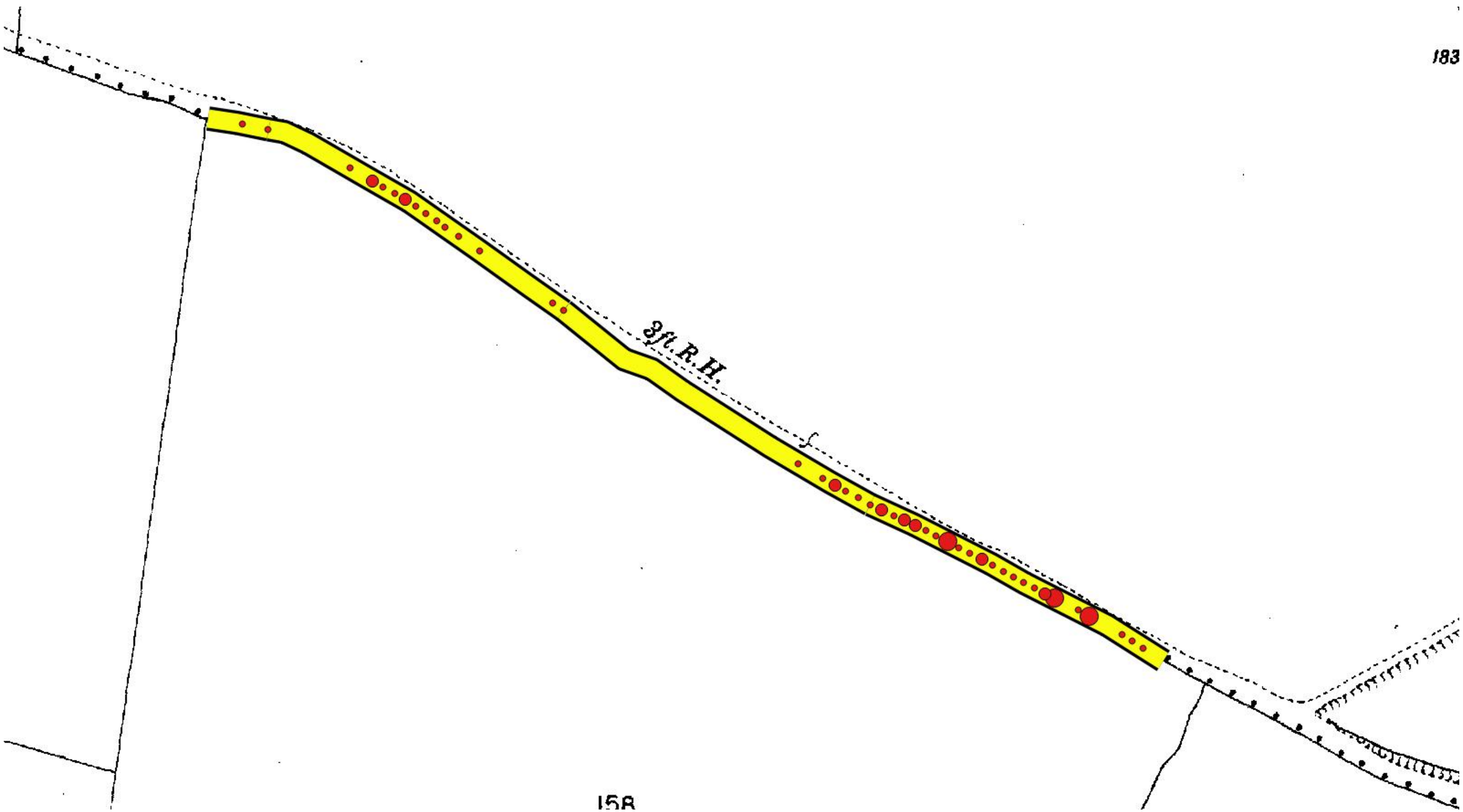


Figure 89.89 – Clifford Boundary Hedgerows – W1 – Summer – *Prunus spinosa*

Species maps for Clifford Boundary Hedgerows

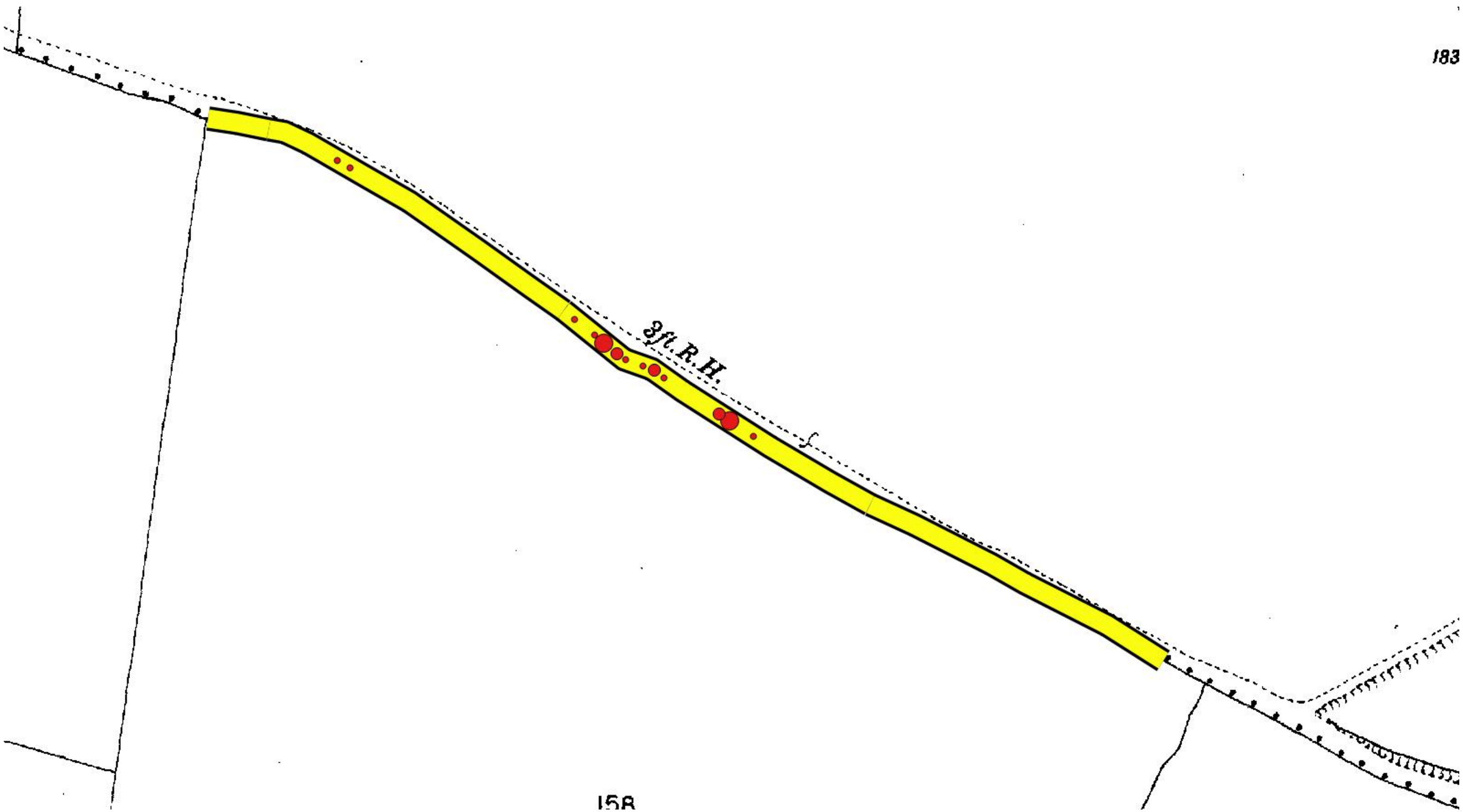


Figure 90.90 – Clifford Boundary Hedgerows – W1 – Summer – *Quercus robur*

Species maps for Clifford Boundary Hedgerows

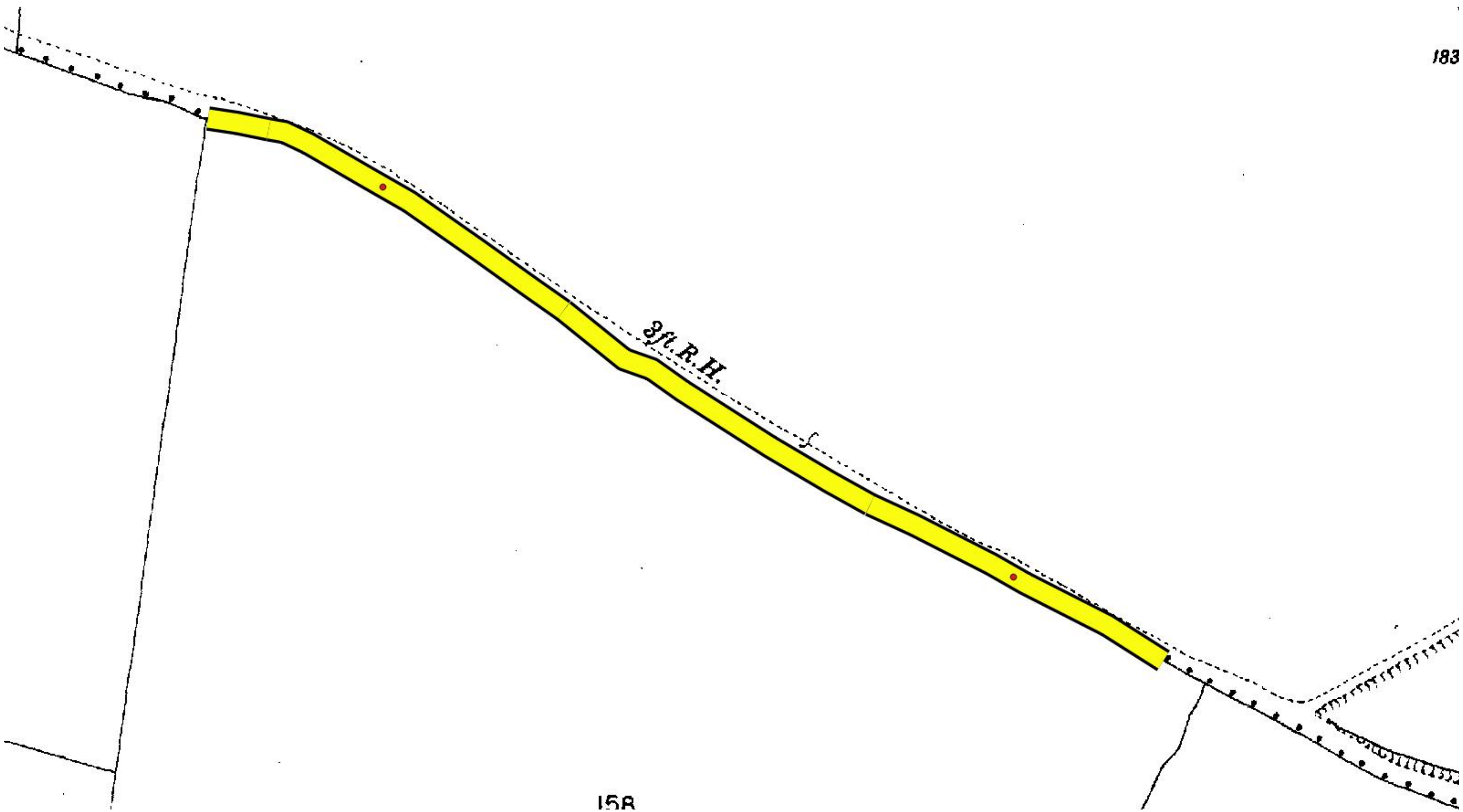


Figure 91.91 – Clifford Boundary Hedgerows – W1 – Summer – *Rhamnus cathartica*

Species maps for Clifford Boundary Hedgerows

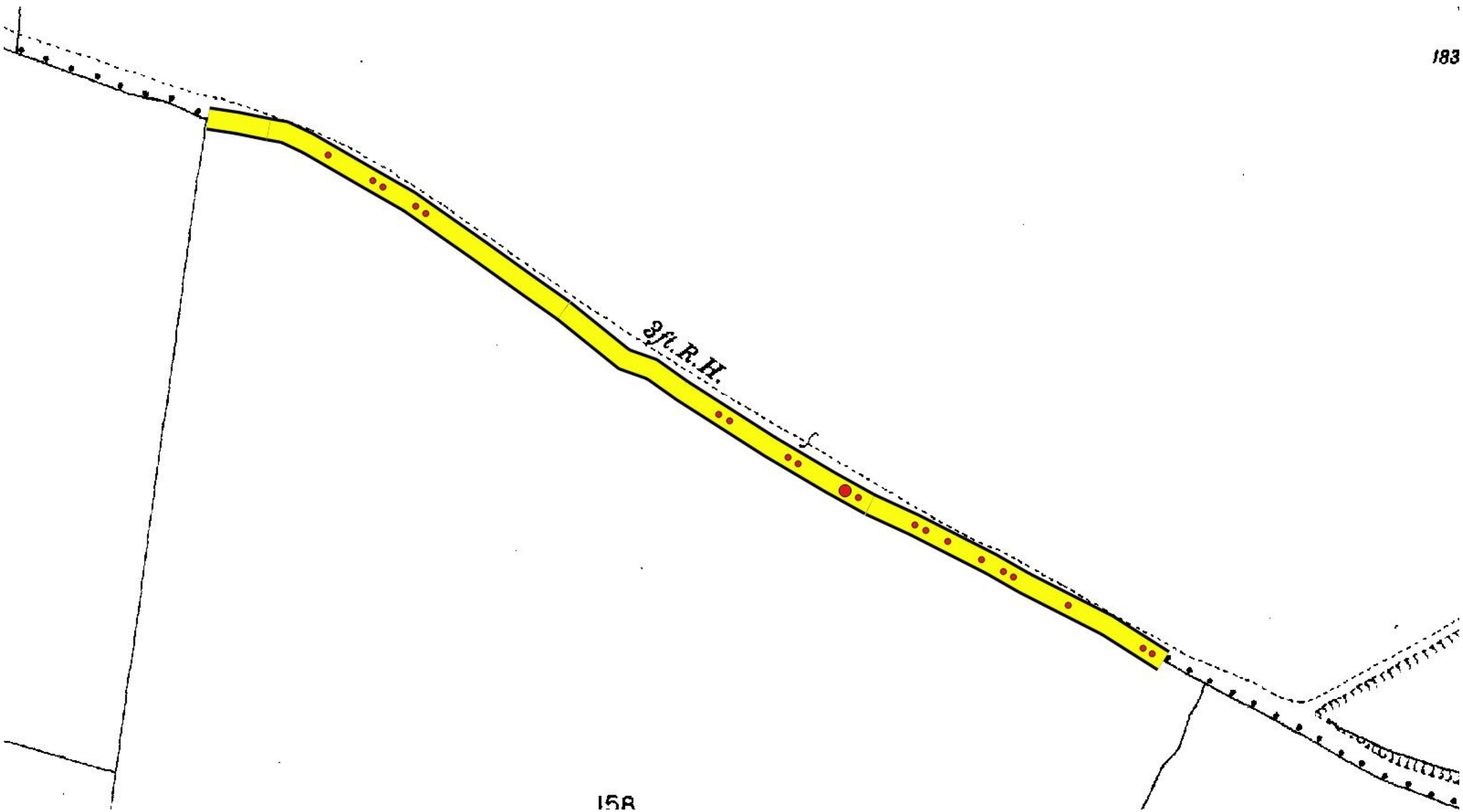


Figure 92.92 – Clifford Boundary Hedgerows – W1 – Summer – *Rosa canina*

Species maps for Clifford Boundary Hedgerows

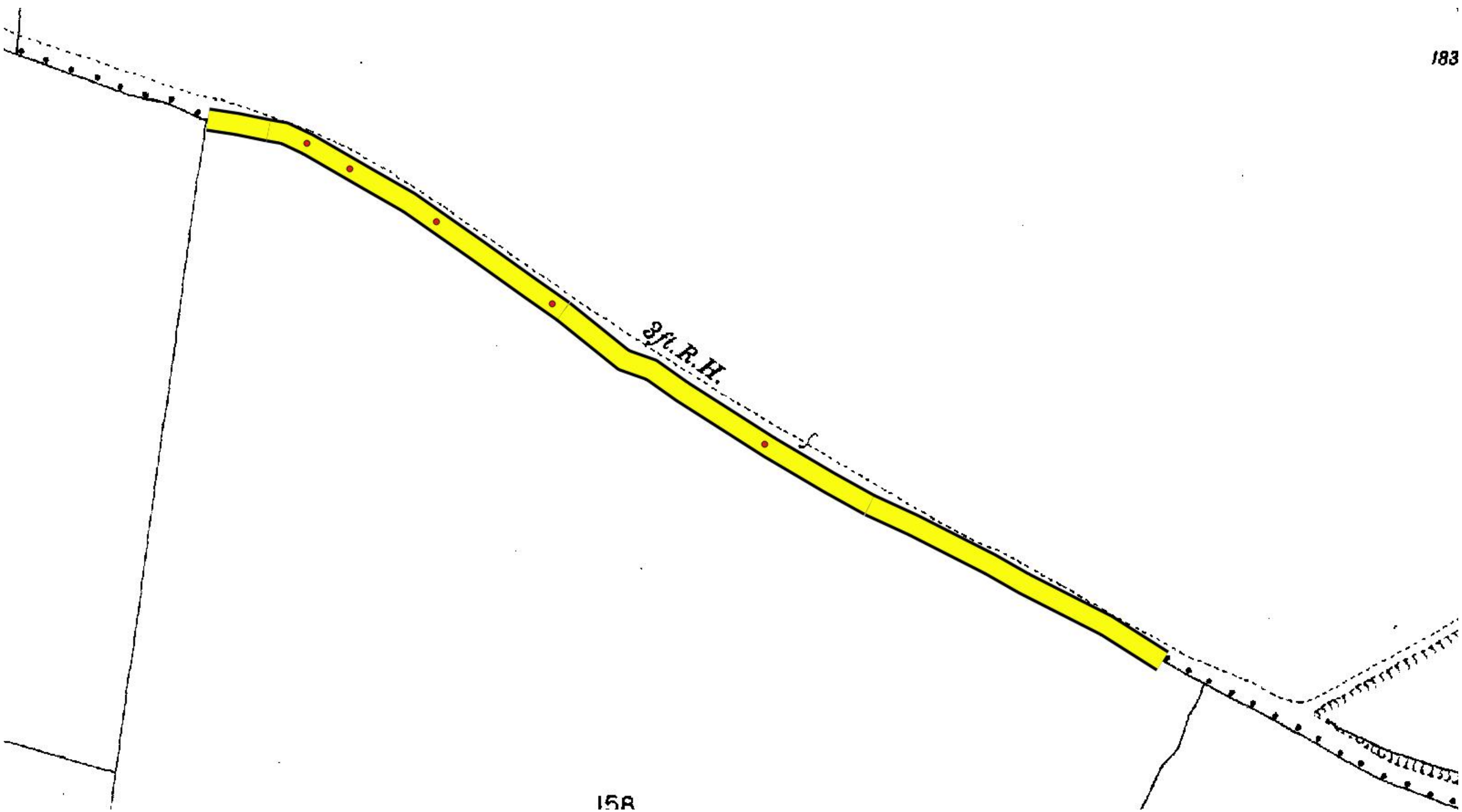


Figure 93.93 – Clifford Boundary Hedgerows – W1 – Summer – *Rubus fruticosus*

Species maps for Clifford Boundary Hedgerows

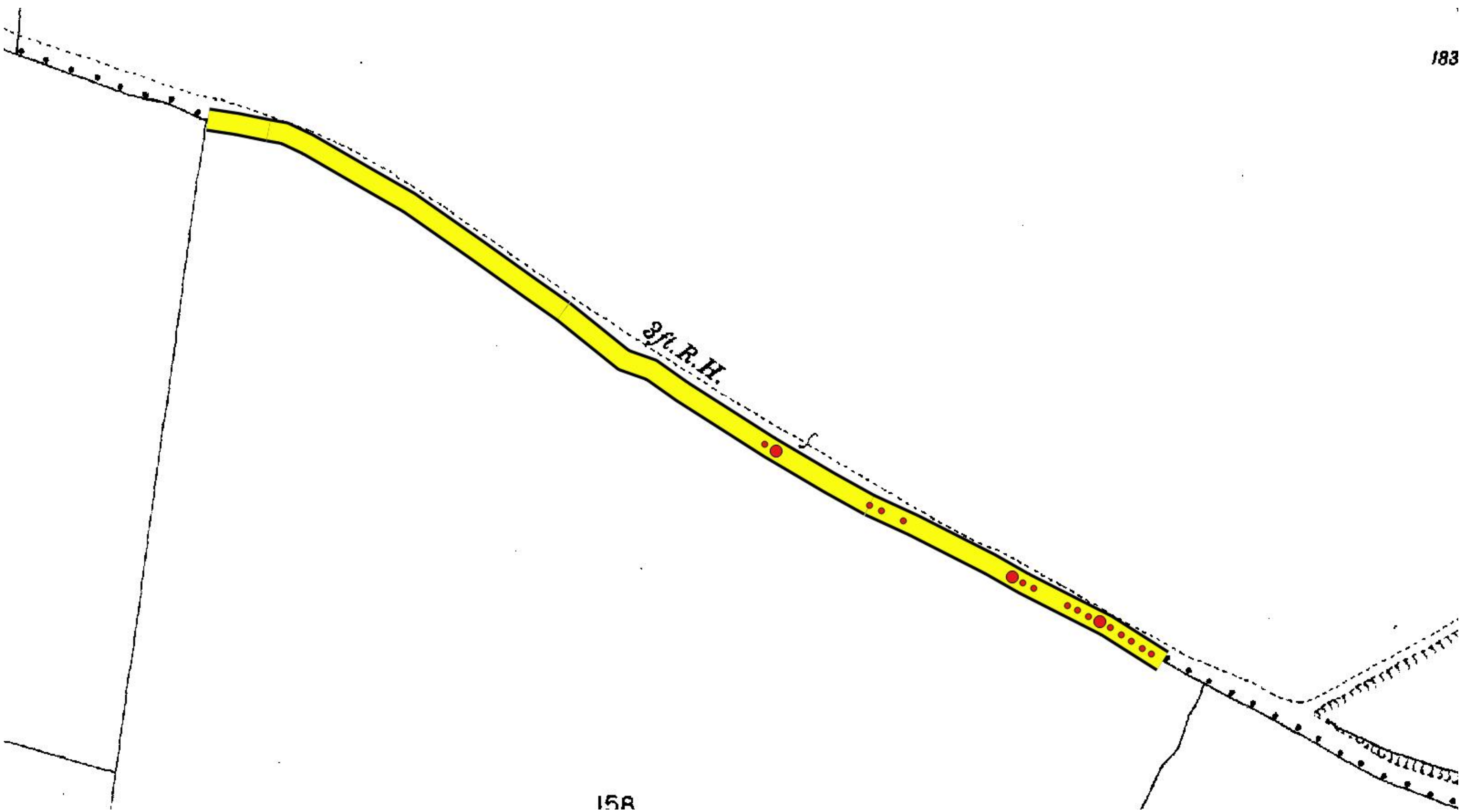


Figure 94.94 – Clifford Boundary Hedgerows – W1 – Summer – *Sambucus nigra*

Species maps for Clifford Boundary Hedgerows

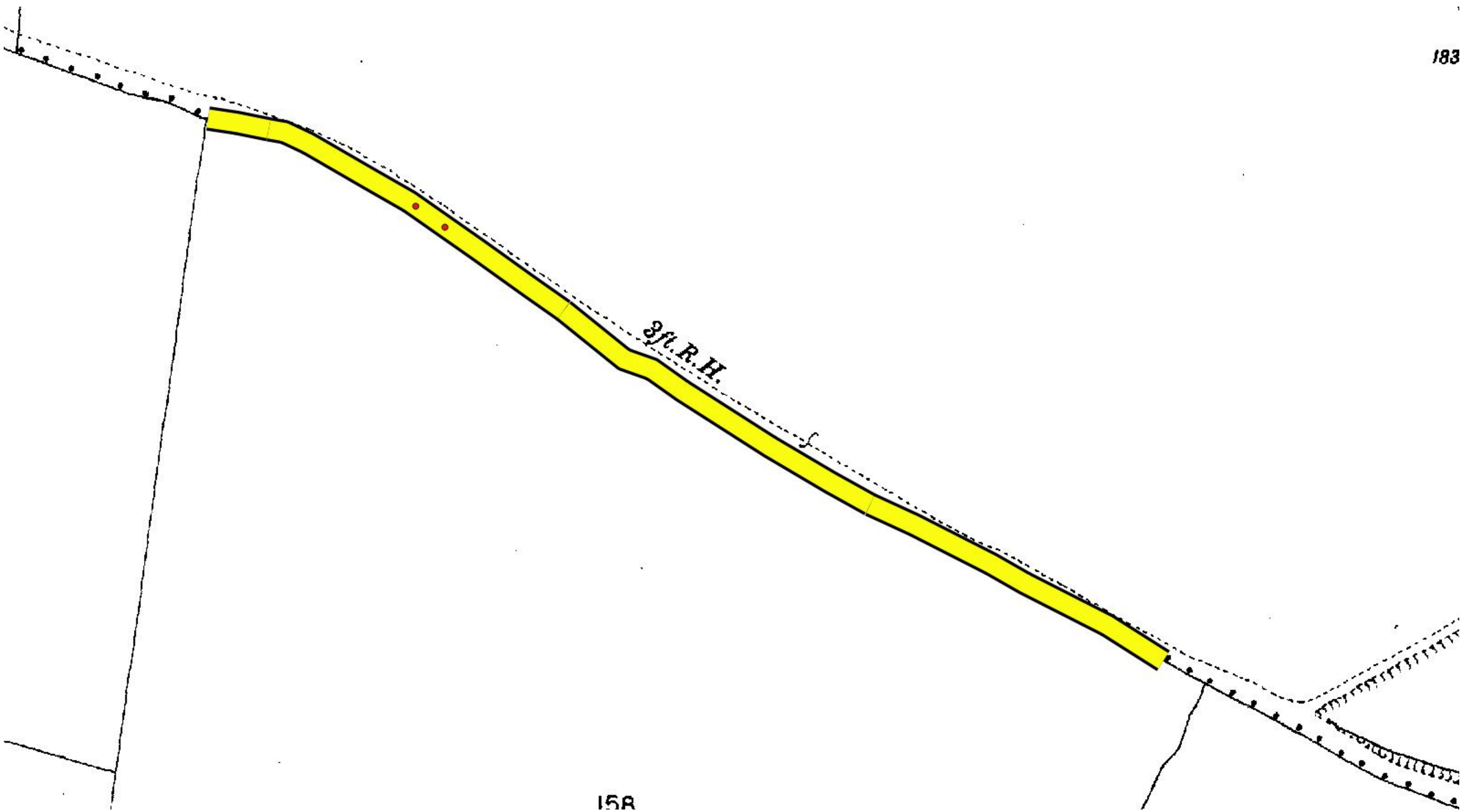


Figure 95.95 – Clifford Boundary Hedgerows – W1 – Summer – *Tamus communis*

Species maps for Clifford Boundary Hedgerows

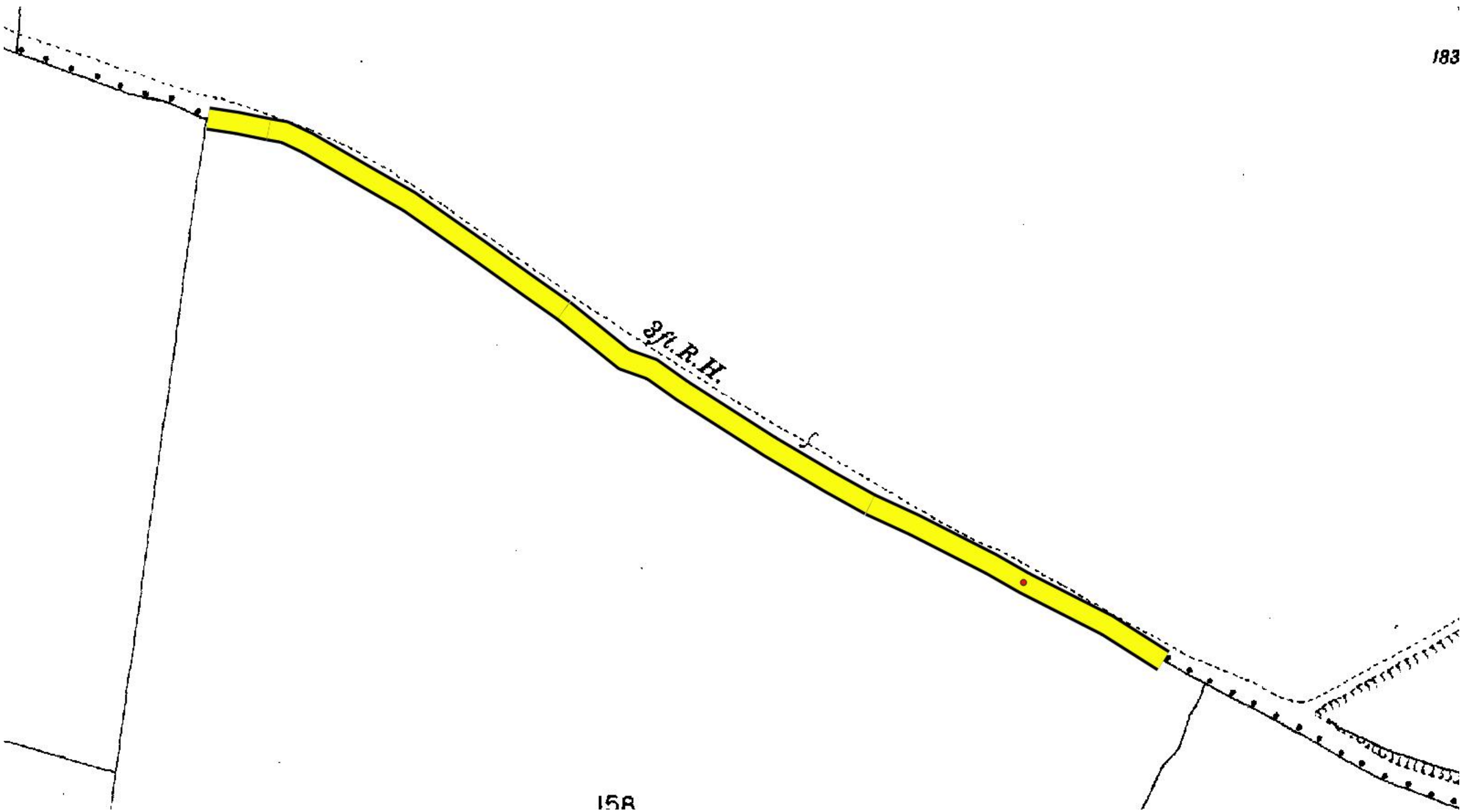


Figure 96.96 – Clifford Boundary Hedgerows – W1 – Summer – *Viburnum opulus*

Species maps for Clifford Boundary Hedgerows

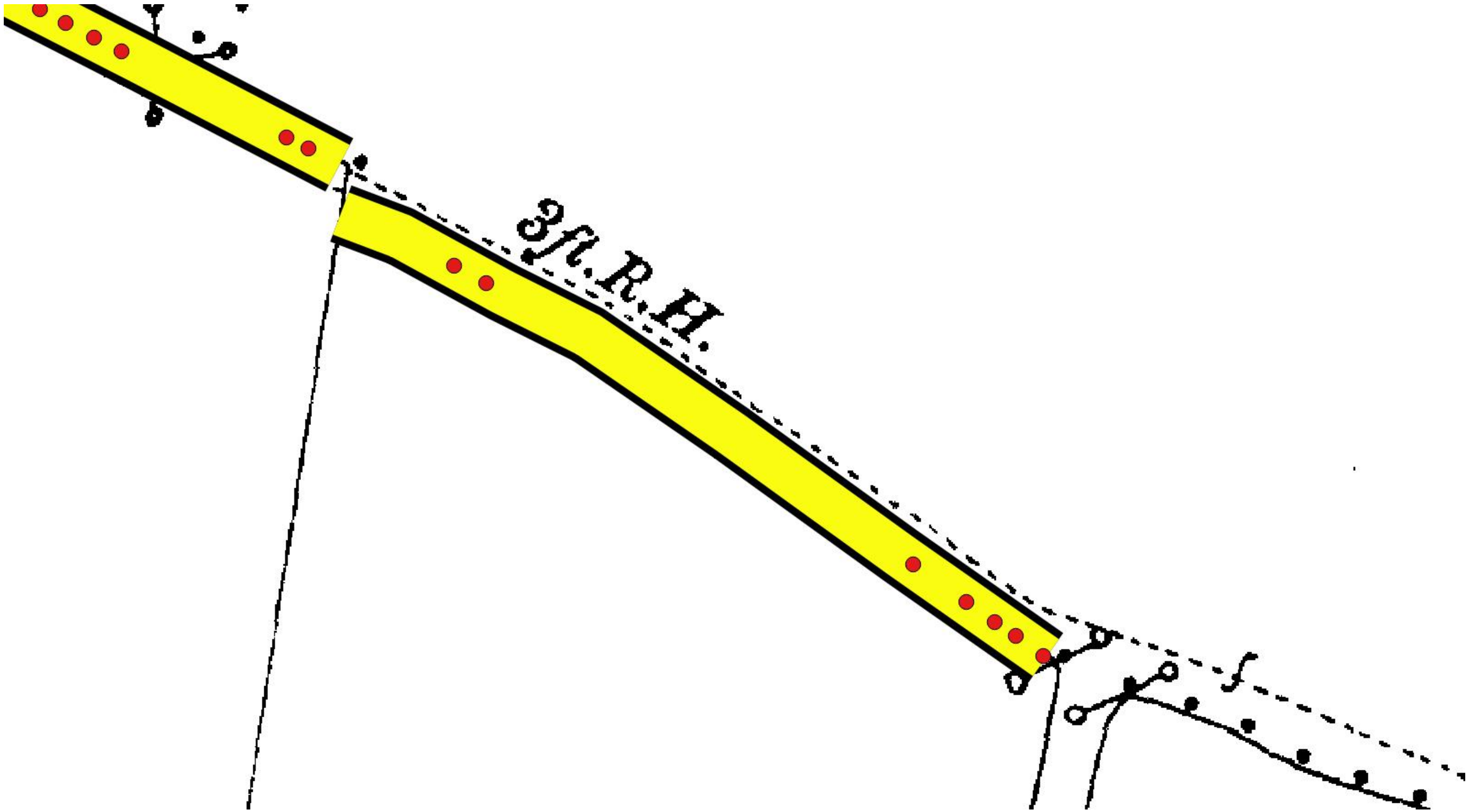


Figure 97.97 – Clifford Boundary Hedgerows – W2 – Summer – *Bryonia dioica*

Species maps for Clifford Boundary Hedgerows

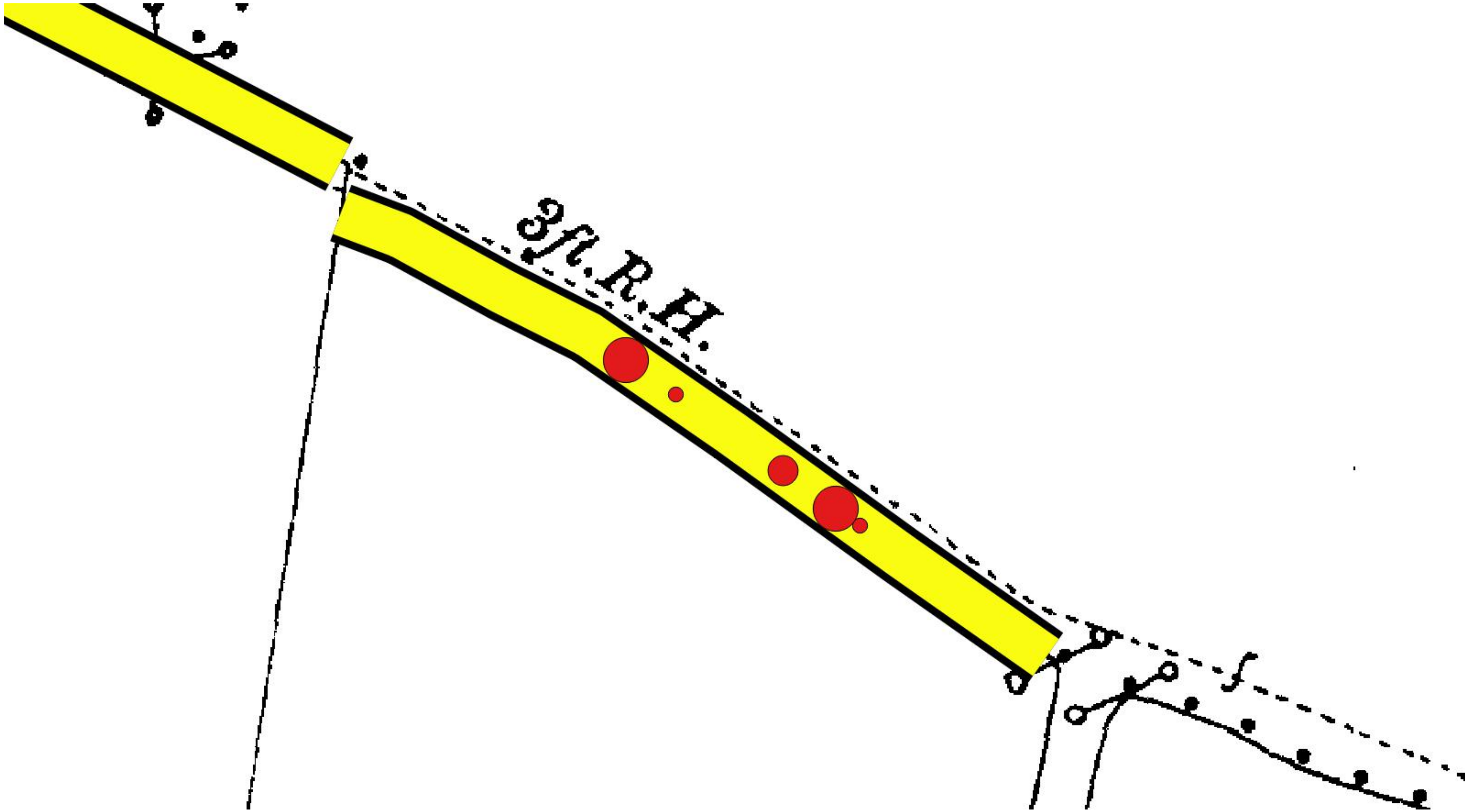


Figure 98.98 – Clifford Boundary Hedgerows – W2 – Summer – *Corylus avellana*

Species maps for Clifford Boundary Hedgerows

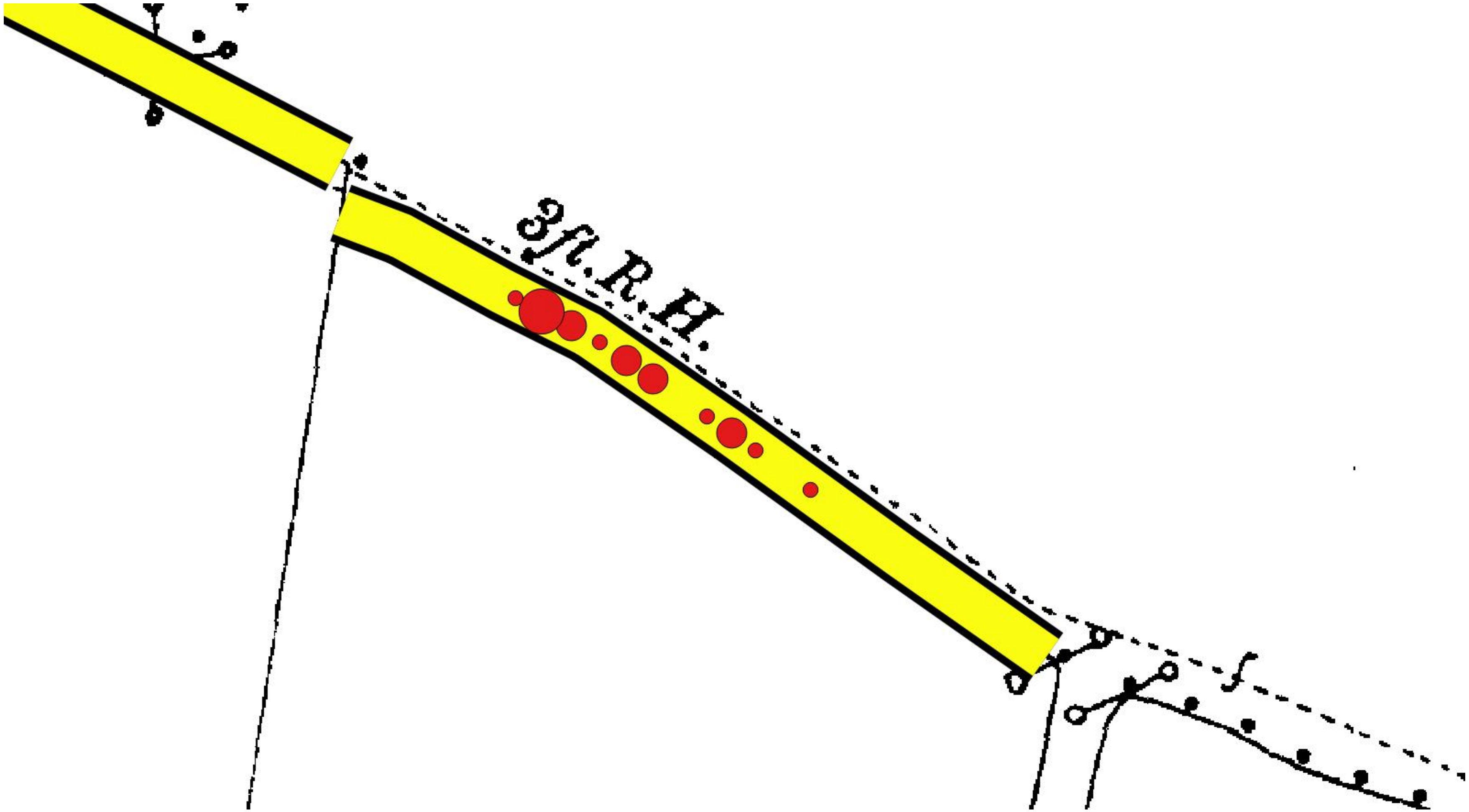


Figure 99.99 – Clifford Boundary Hedgerows – W2 – Summer – *Cornus sanguinea*

Species maps for Clifford Boundary Hedgerows

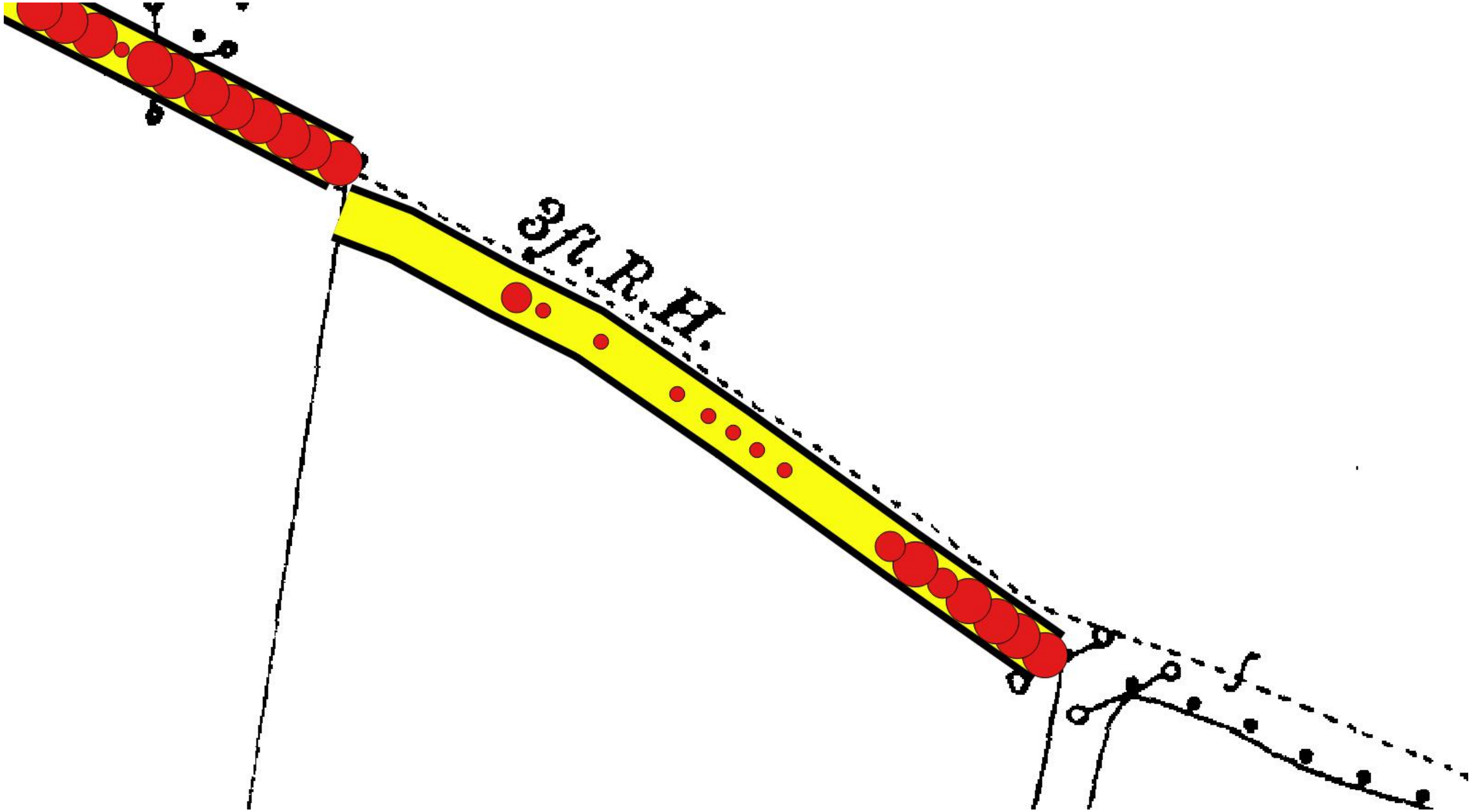


Figure 100.100 – Clifford Boundary Hedgerows – W2 – Summer – *Crataegus monogyna*

Species maps for Clifford Boundary Hedgerows

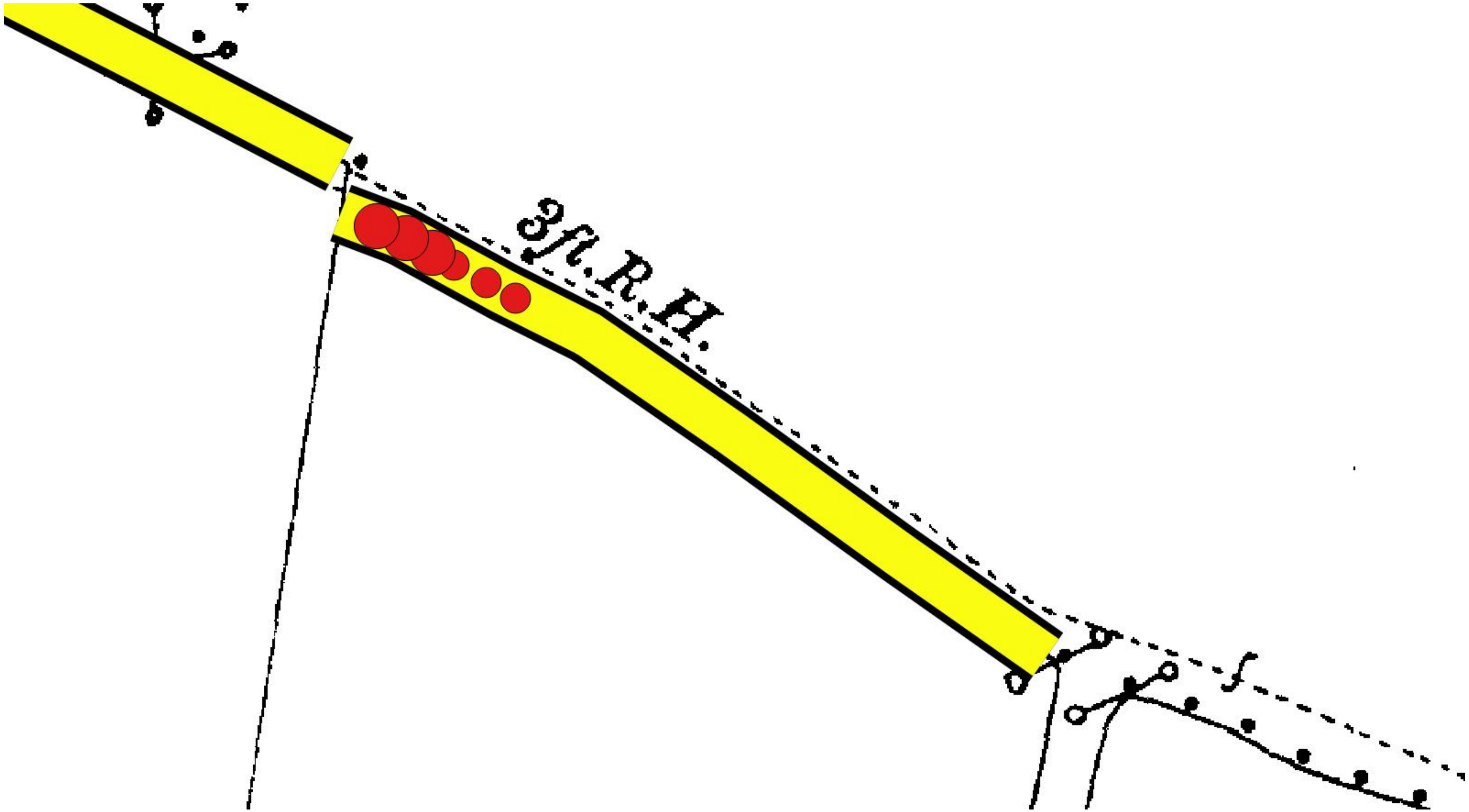


Figure 101.101 – Clifford Boundary Hedgerows – W2 – Summer - GAP

Species maps for Clifford Boundary Hedgerows

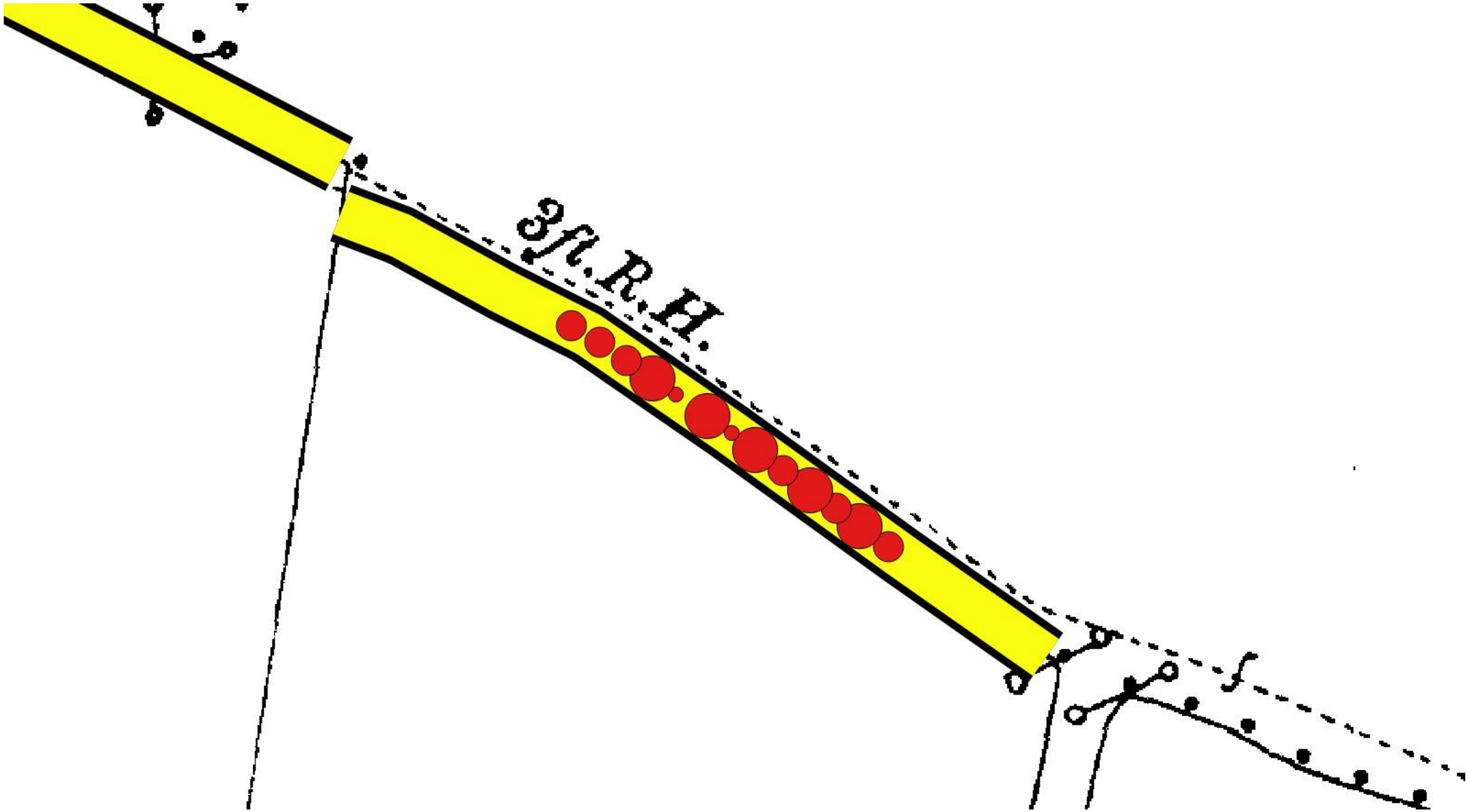


Figure 102.102 – Clifford Boundary Hedgerows – W2 – Summer – *Ilex aquifolium*

Species maps for Clifford Boundary Hedgerows

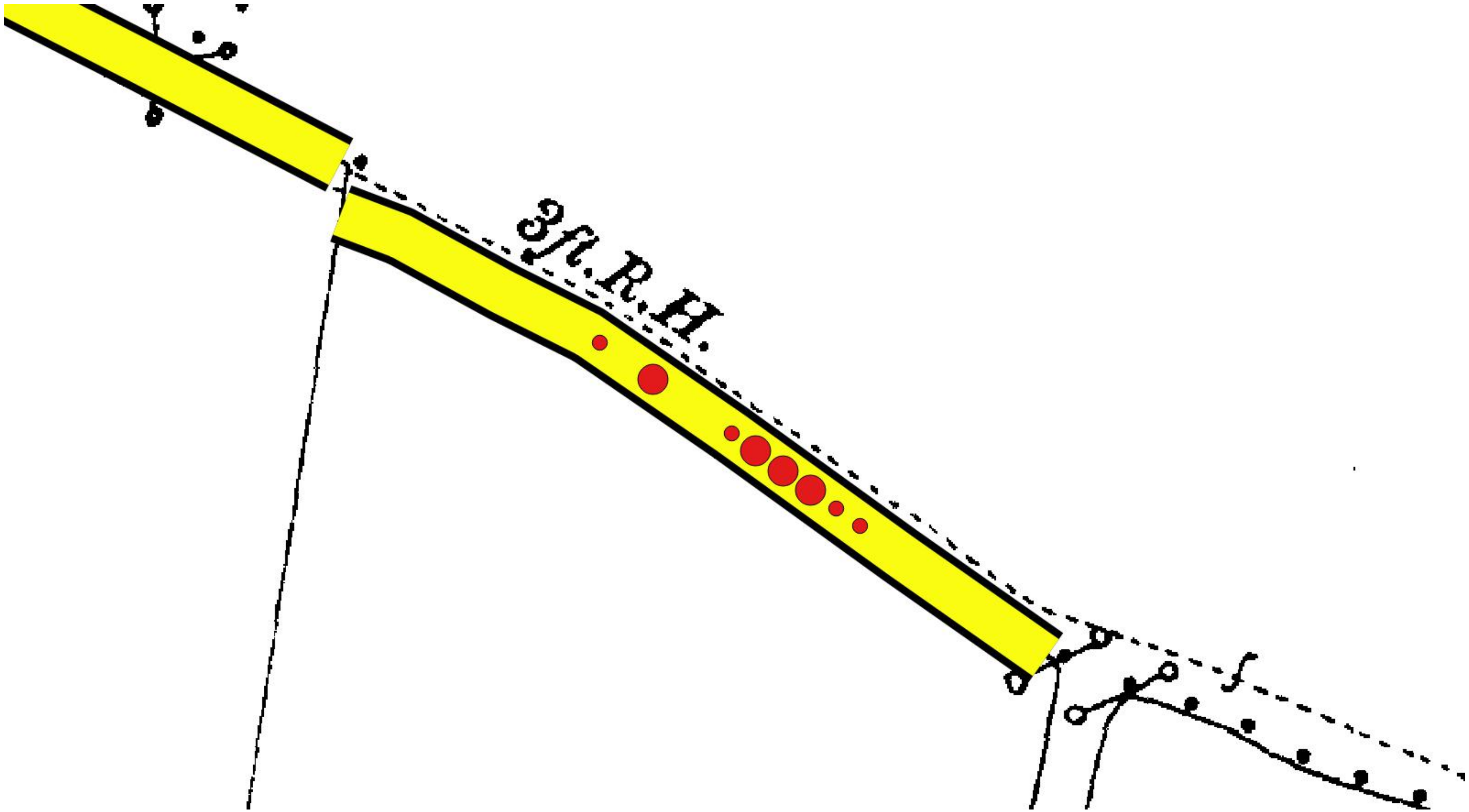


Figure 103.103 – Clifford Boundary Hedgerows – W2 – Summer – *Prunus spinosa*

Species maps for Clifford Boundary Hedgerows

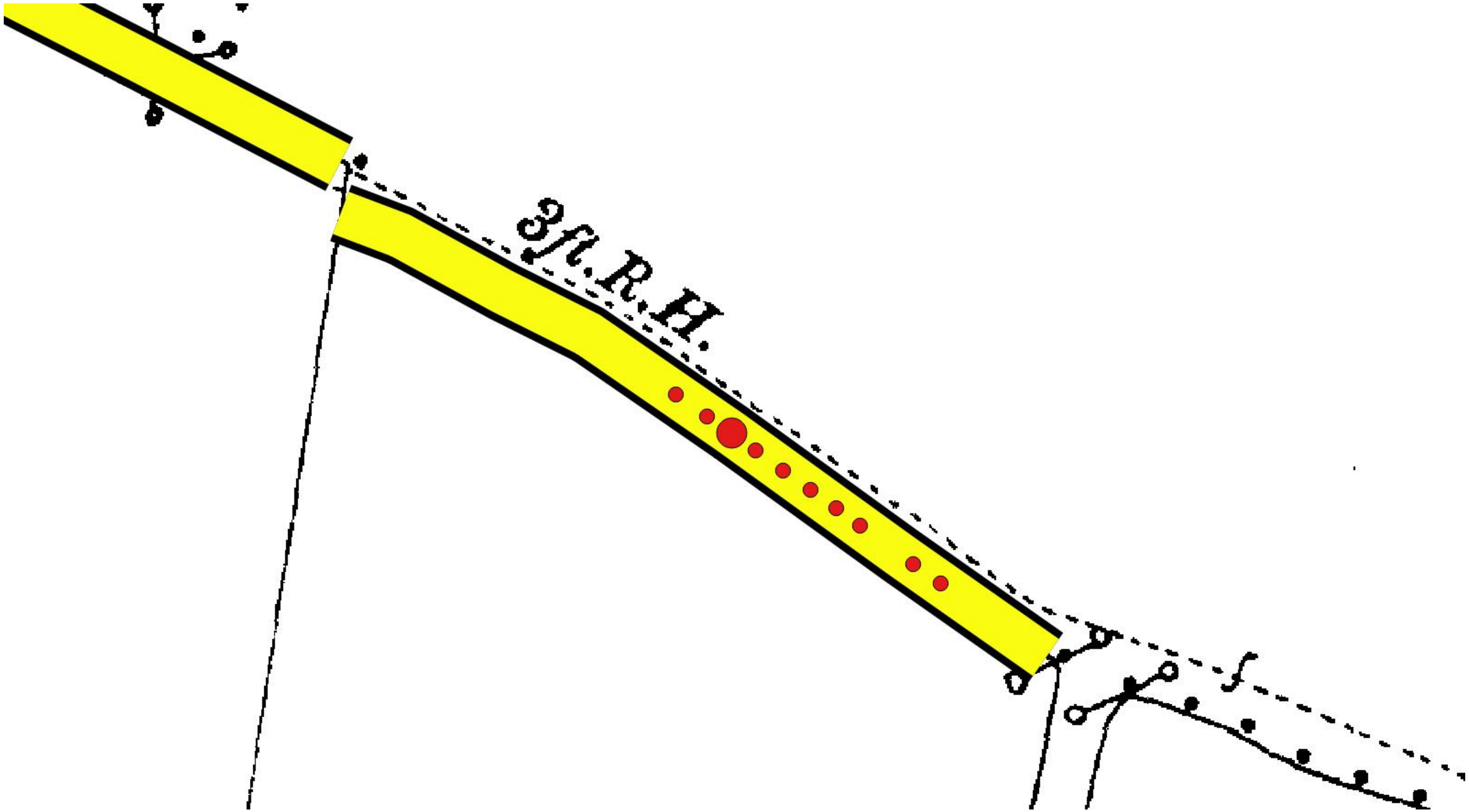


Figure 104.104 – Clifford Boundary Hedgerows – W2 – Summer – *Pteridium aquilinum*

Species maps for Clifford Boundary Hedgerows

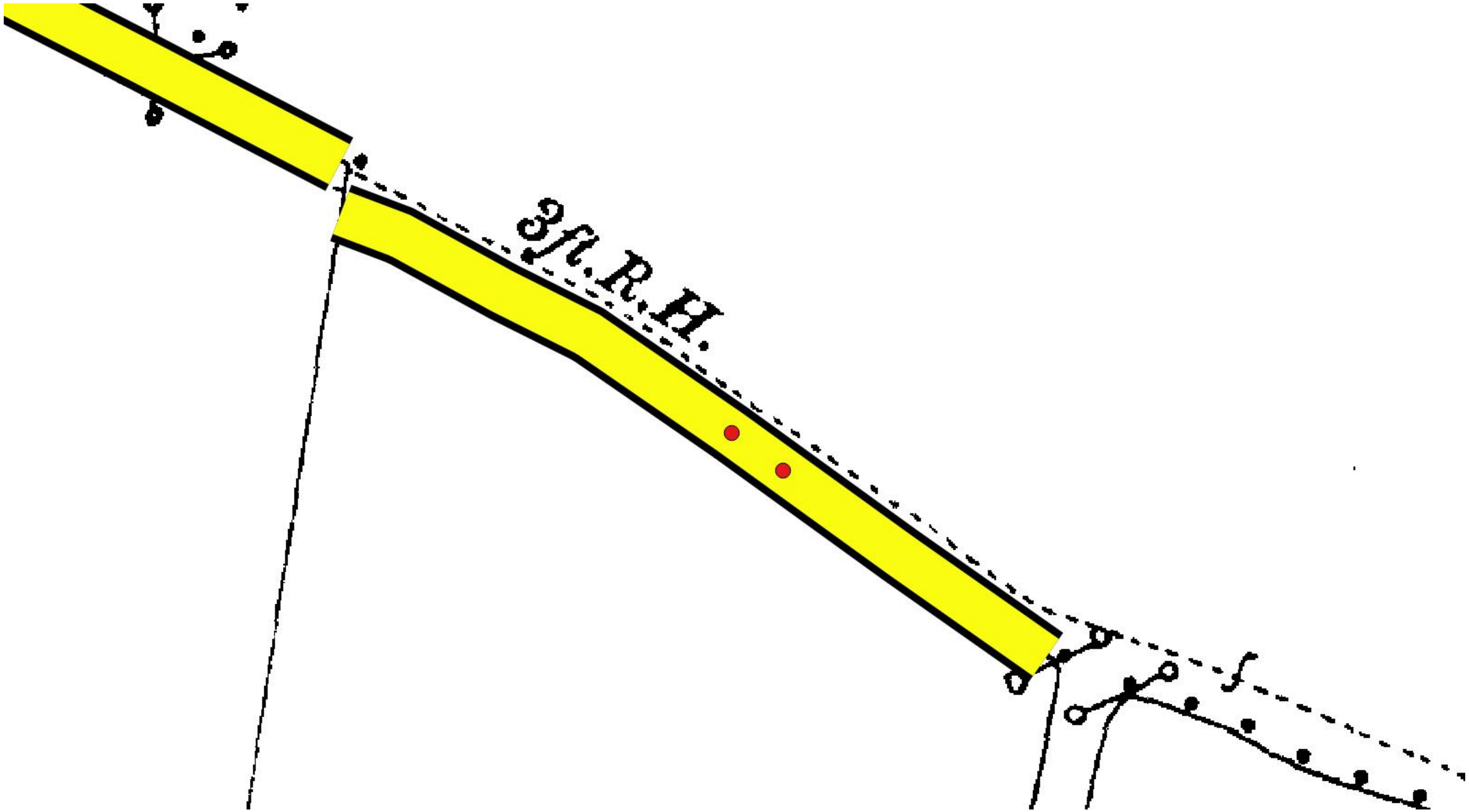


Figure 105.105 – Clifford Boundary Hedgerows – W2 – Summer – *Rosa canina*

Species maps for Clifford Boundary Hedgerows

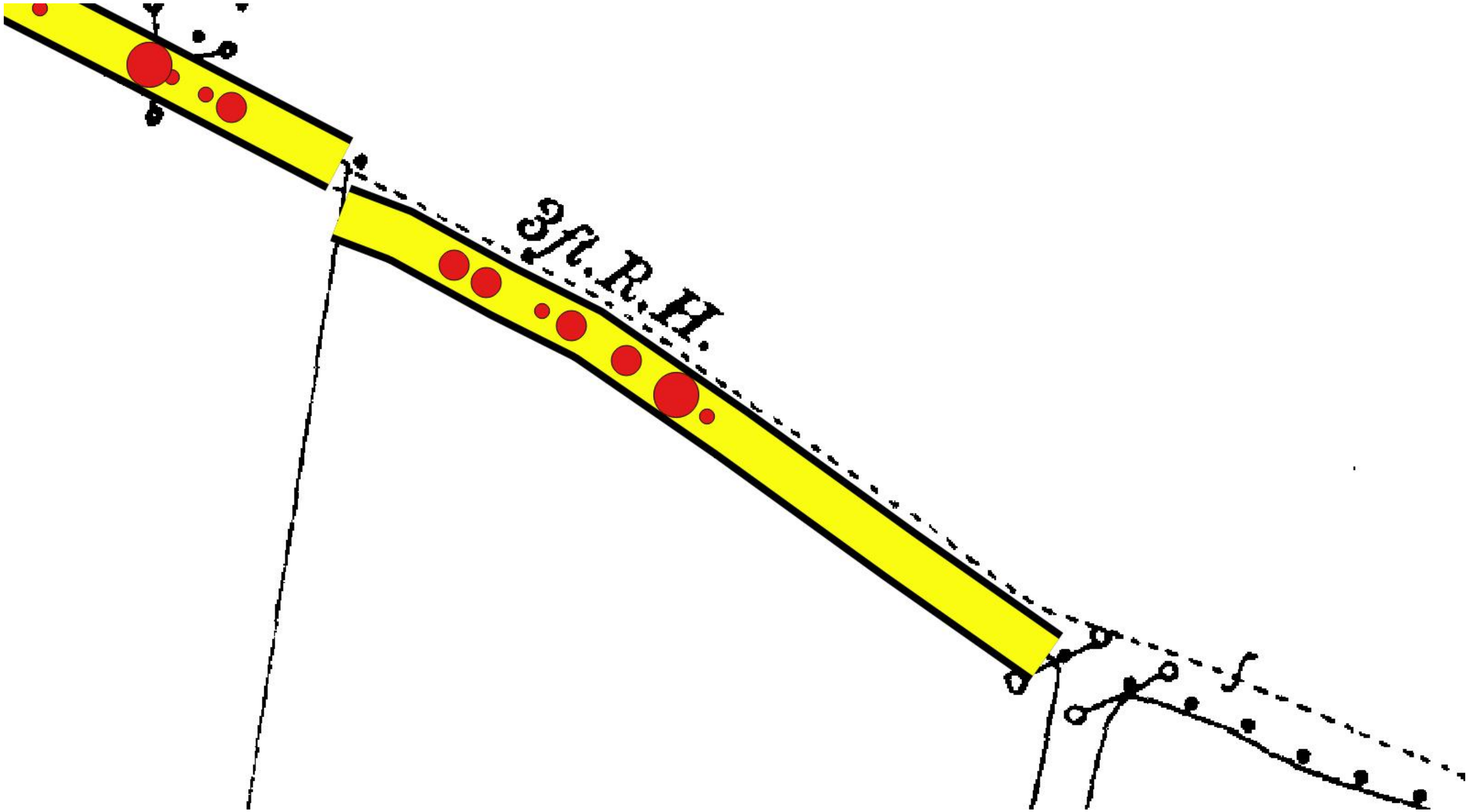


Figure 106.106 – Clifford Boundary Hedgerows – W2 – Summer – *Sambucus nigra*

Species maps for Clifford Boundary Hedgerows

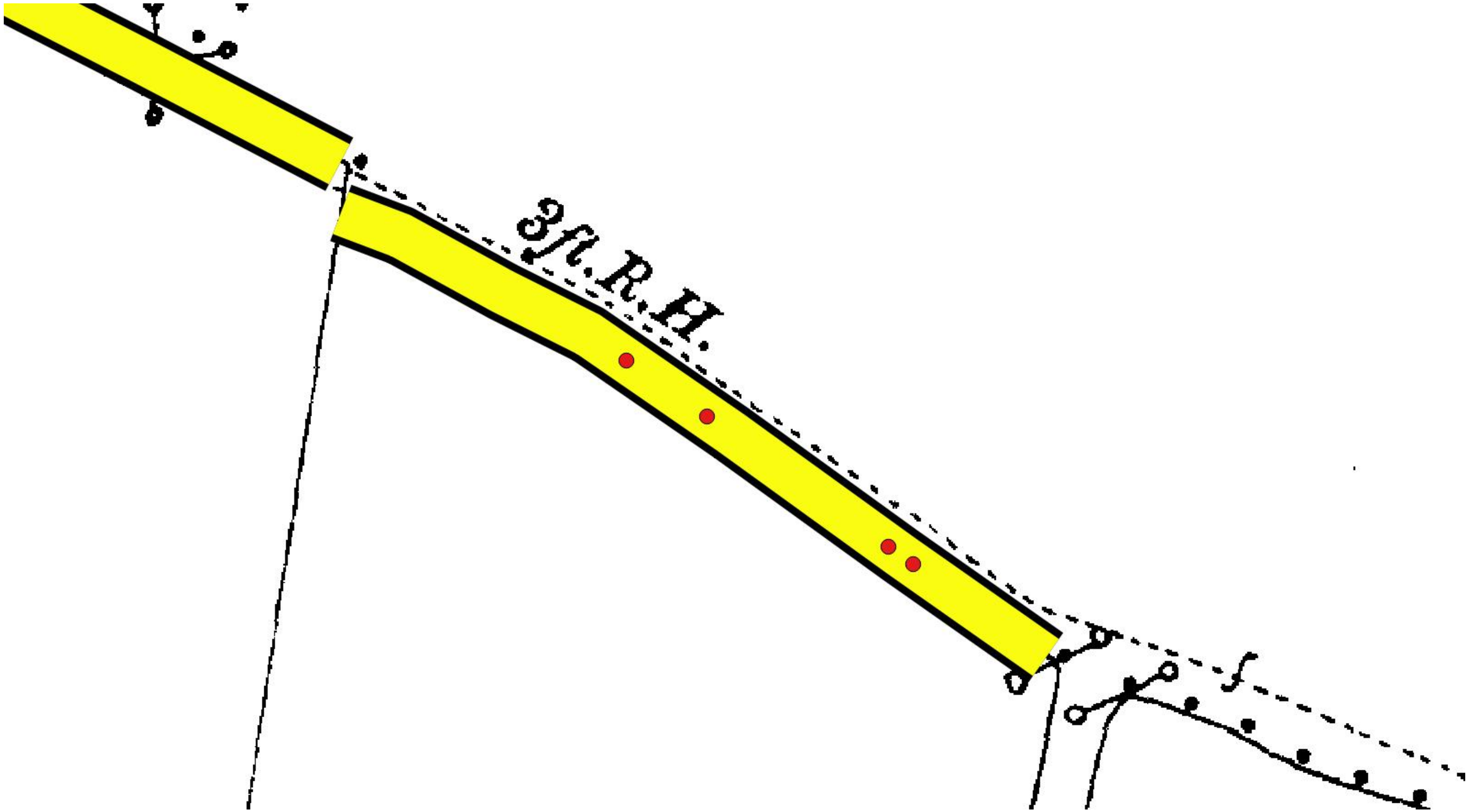


Figure 107.107 – Clifford Boundary Hedgerows – W2 – Summer – *Tamus communis*

Species maps for Clifford Boundary Hedgerows

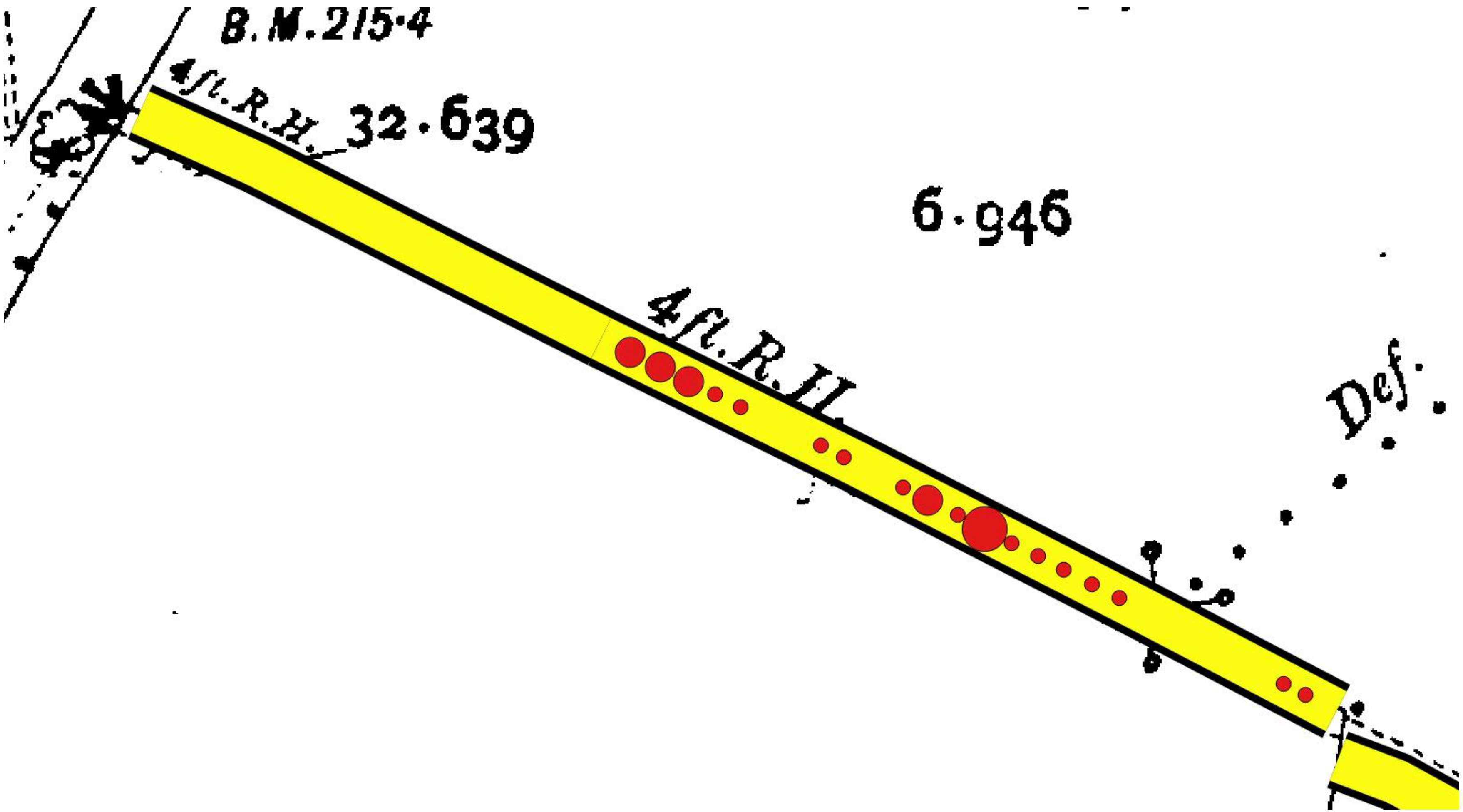


Figure 108.108 – Clifford Boundary Hedgerows – W3 – Summer – *Bryonia dioica*

Species maps for Clifford Boundary Hedgerows

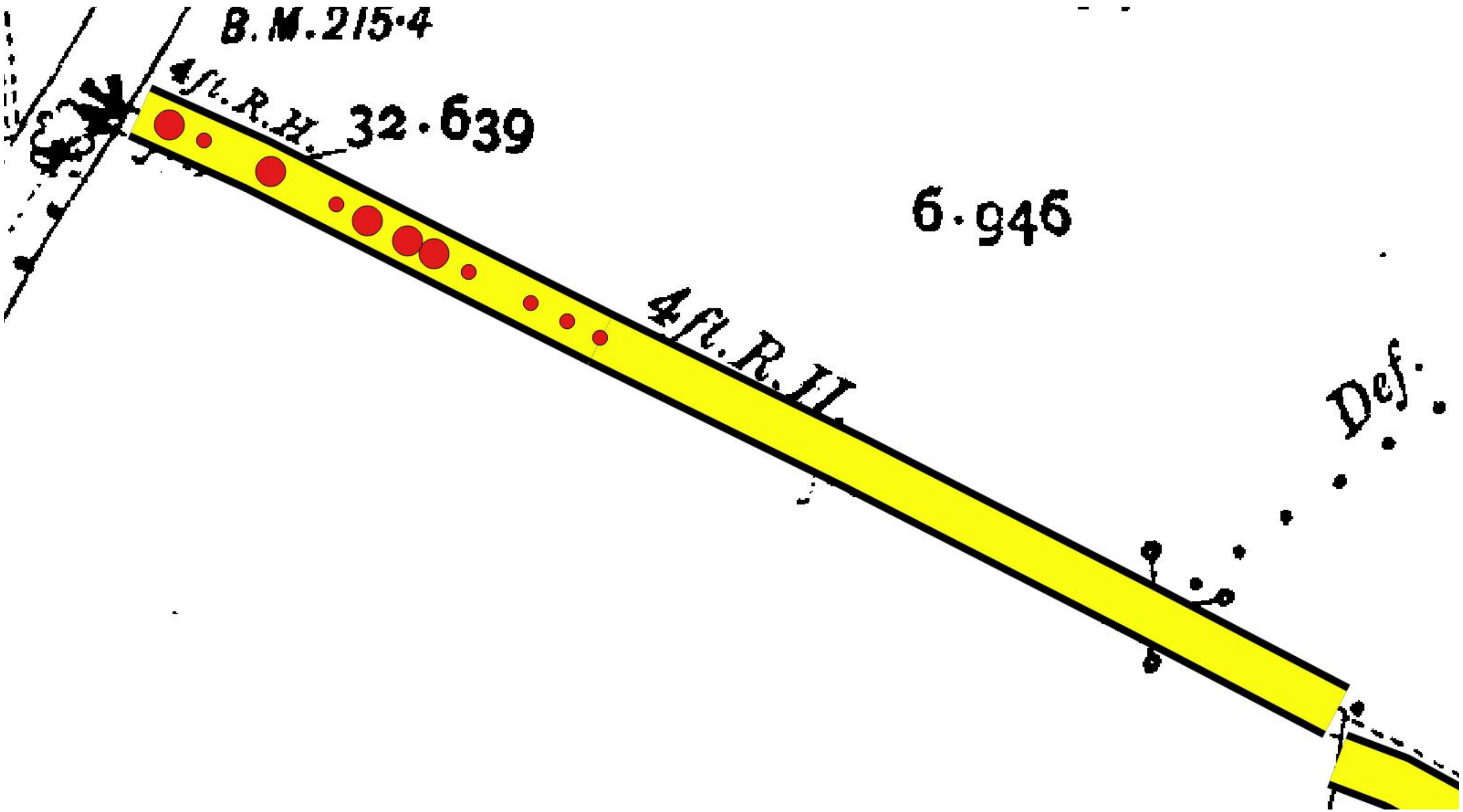


Figure 109.109 – Clifford Boundary Hedgerows – W3 – Summer – *Corylus avellana*

Species maps for Clifford Boundary Hedgerows

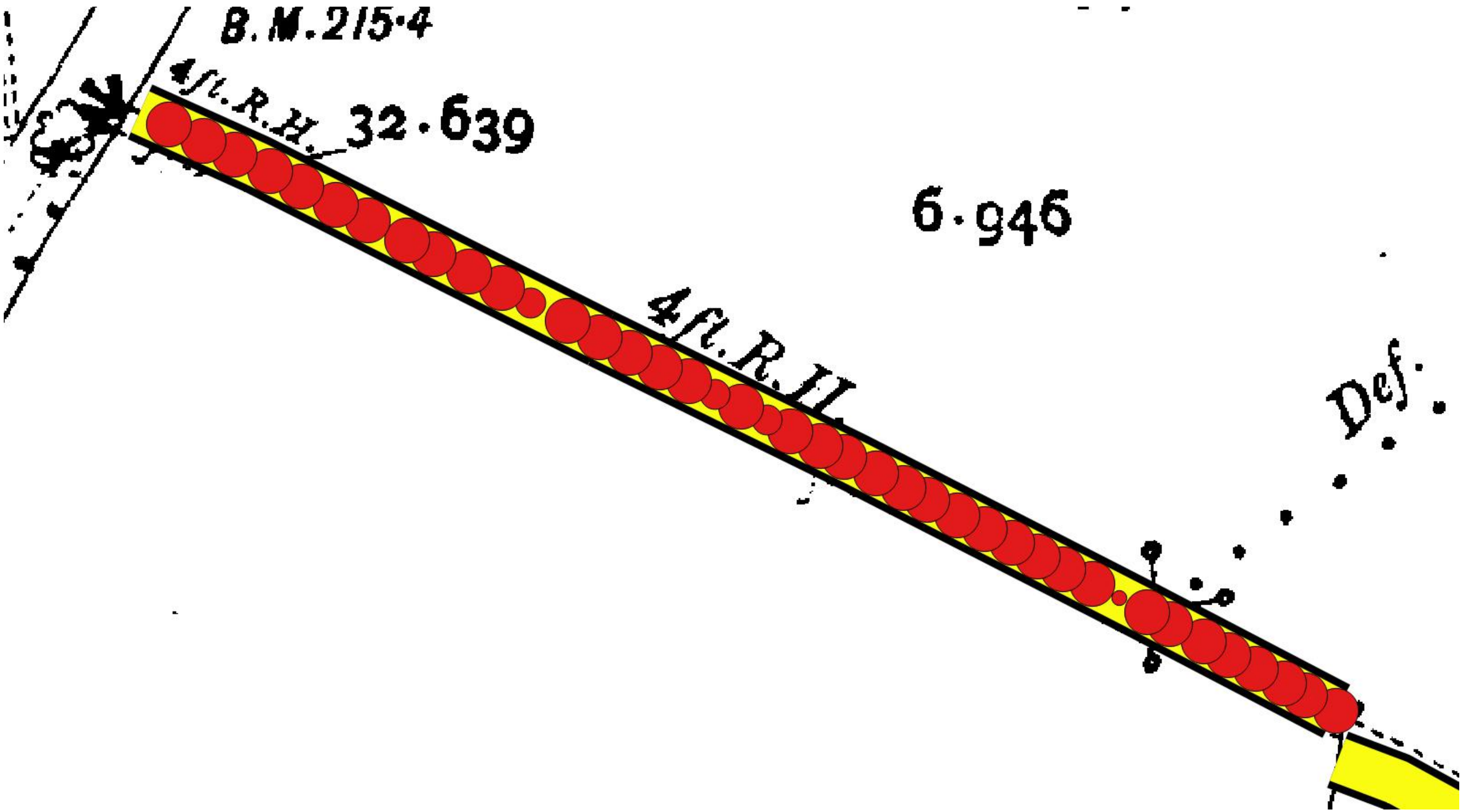


Figure 110.110 – Clifford Boundary Hedgerows – W3 – Summer – *Crataegus monogyna*

Species maps for Clifford Boundary Hedgerows

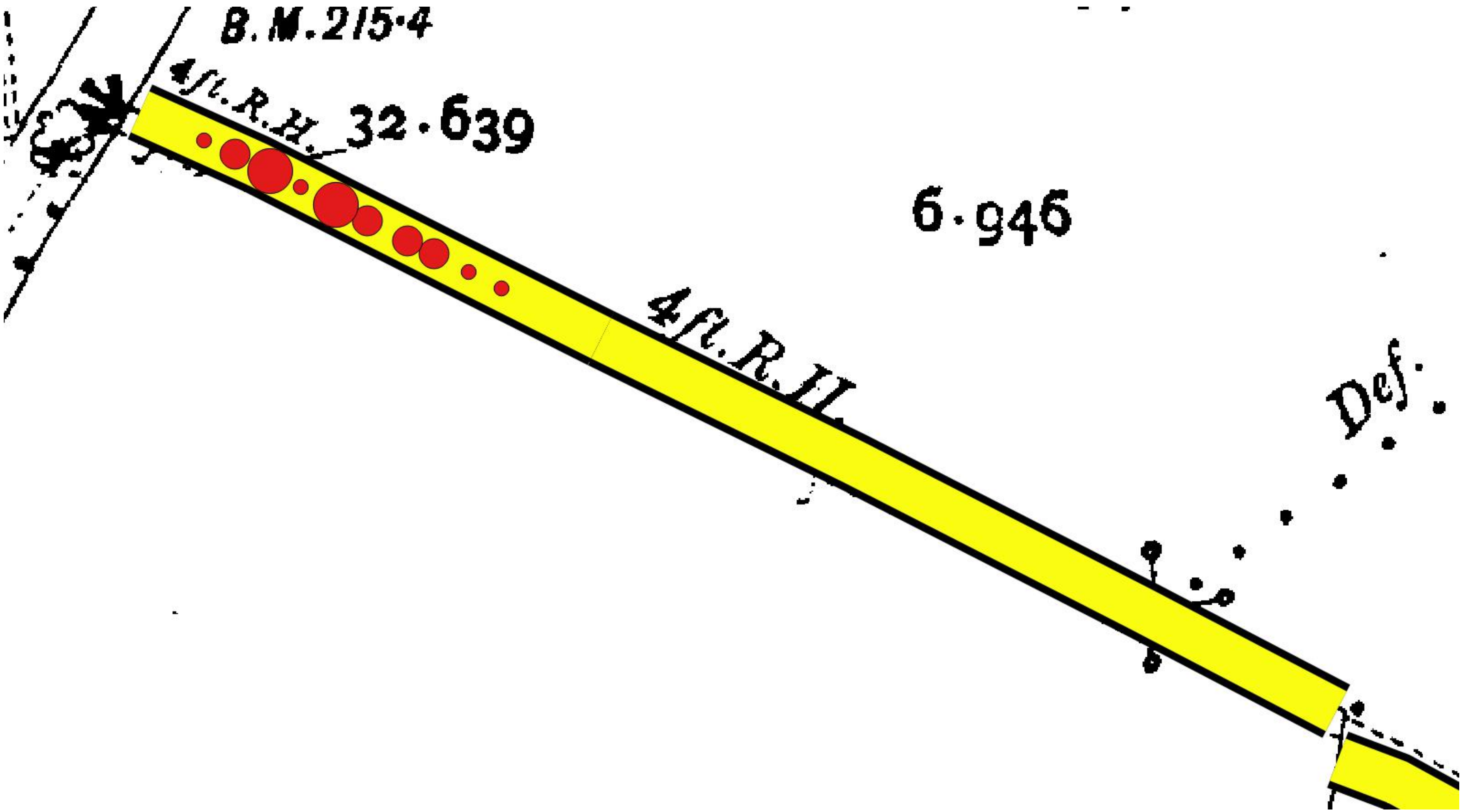


Figure 111.111 – Clifford Boundary Hedgerows – W3 – Summer – *Pteridium aquilinum*

Species maps for Clifford Boundary Hedgerows

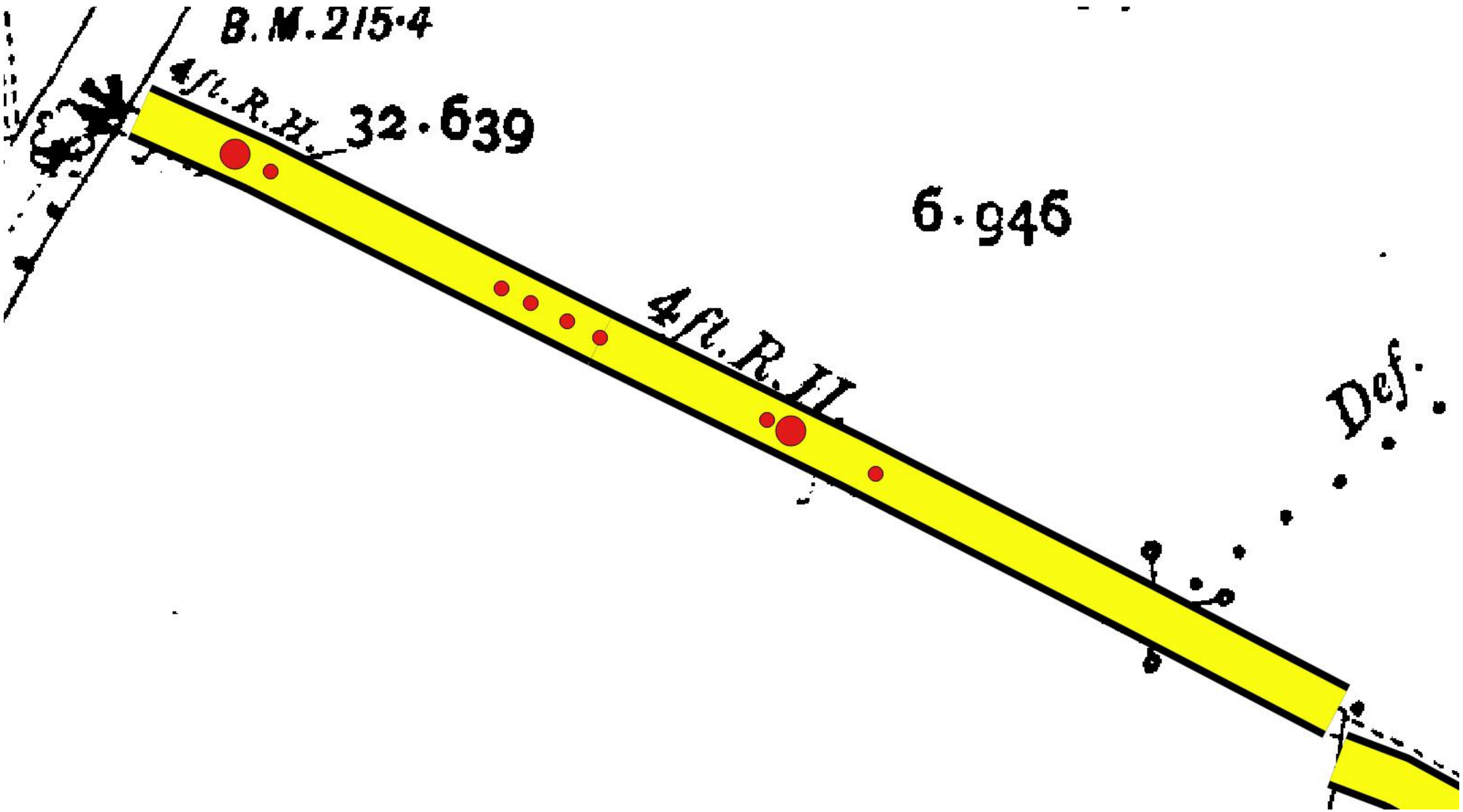


Figure 112.112 – Clifford Boundary Hedgerows – W3 – Summer – *Rubus fruticosus*

Species maps for Clifford Boundary Hedgerows

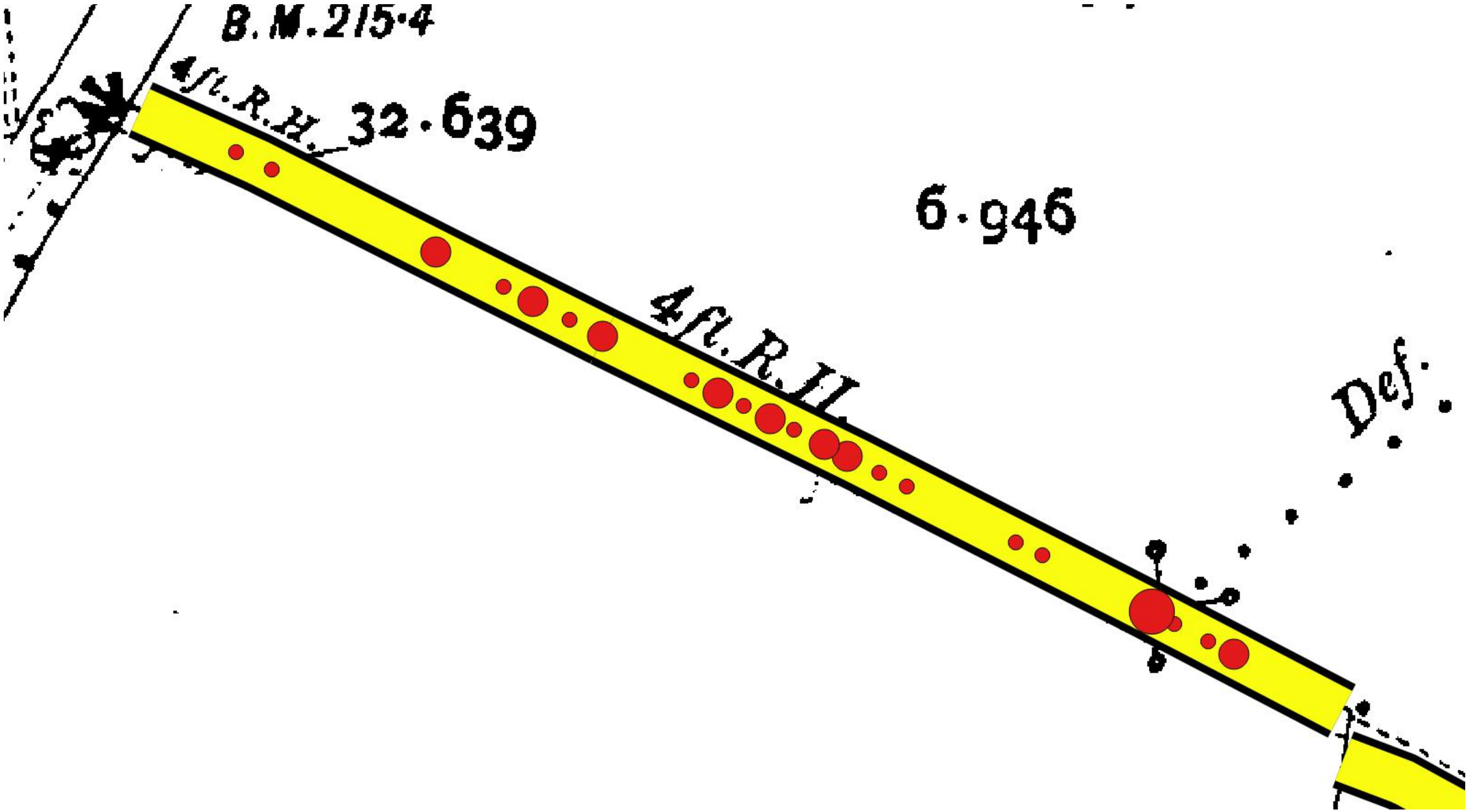


Figure 113.113 – Clifford Boundary Hedgerows – W3 – Summer – *Sambucus nigra*

Species maps for Clifford Boundary Hedgerows

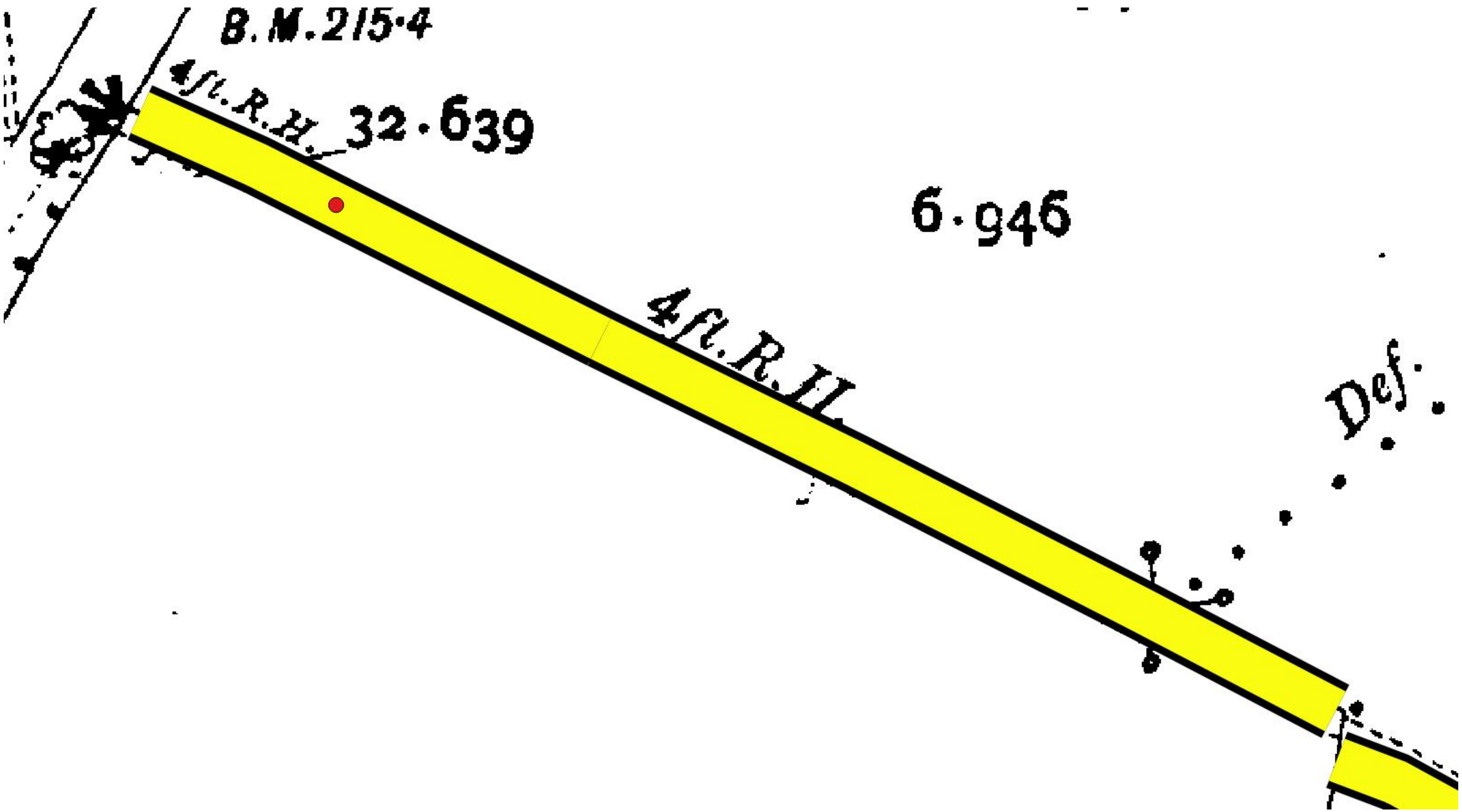


Figure 114.114 – Clifford Boundary Hedgerows – W3 – Summer – *Tamus communis*

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL591-CL593-01	E1	1													
CL591-CL593-02	E1	1													
CL591-CL593-03	E1	1													
CL591-CL593-04	E1														
CL591-CL593-05	E1											1			
CL591-CL593-06	E1						2	3				1			
CL591-CL593-07	E1						2	3				1			
CL591-CL593-08	E1											1			
CL591-CL593-09	E1											2			
CL591-CL593-10	E1											2			
CL591-CL593-11	E1							2				2			
CL591-CL593-12	E1							2				2			
CL591-CL593-13	E1							2				2			
CL591-CL593-14	E1											2			
CL591-CL593-15	E1											2			
CL591-CL593-16	E1						1	2				1			
CL591-CL593-17	E1														
CL591-CL593-18	E1														
CL591-CL593-19	E1														
CL591-CL593-20	E1						1	2		1					
CL591-CL593-21	E1		2							3					
CL591-CL593-22	E1		1							1					
CL591-CL593-23	E1														
CL591-CL593-24	E1														
CL591-CL593-25	E1														
CL591-CL593-26	E1														
CL591-CL593-27	E1														
CL593-CL594-01	E1														
CL593-CL594-02	E1														
CL593-CL594-03	E1														
CL593-CL594-04	E1														
CL593-CL594-05	E1														

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter															
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).															
		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL593-CL594-06	E1														
CL593-CL594-07	E1														
CL593-CL594-08	E1														
CL593-CL594-09	E1														
CL593-CL594-10	E1														
CL593-CL594-11	E1														
CL593-CL594-12	E1														
CL593-CL594-13	E1														
CL593-CL594-14	E1														
CL593-CL594-15	E1														
CL593-CL594-16	E1														
CL593-CL594-17	E1														
CL593-CL594-18	E1														
CL593-CL594-19	E1														
CL593-CL594-20	E1														
CL593-CL594-21	E1														
CL593-CL594-22	E1														
CL593-CL594-23	E1														
CL593-CL594-24	E1														
CL593-CL594-25	E1														
CL593-CL594-26	E1														
CL593-CL594-27	E1														
CL594-CL596-01	E1														
CL594-CL596-02	E1														
CL594-CL596-03	E1														
CL594-CL596-04	E1														
CL594-CL596-05	E1														
CL594-CL596-06	E1														
CL594-CL596-07	E1											1			
CL594-CL596-08	E1				1							2			
CL594-CL596-09	E1				1							2			
CL594-CL596-10	E1				1							2			

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL594-CL596-11	E1				1							2			
CL594-CL596-12	E1				1							2			
CL594-CL596-13	E1				1							1			
CL594-CL596-14	E1				1										
CL594-CL596-15	E1							2							
CL597-CL600-01	E1						1	2							
CL597-CL600-02	E1				1			1							
CL597-CL600-03	E1				1		1	2		1					
CL597-CL600-04	E1						3	3		1					
CL597-CL600-05	E1						2	3		2					
CL597-CL600-06	E1						2	3		3					
CL597-CL600-07	E1						1	3		3					
CL597-CL600-08	E1				1			3		2					
CL597-CL600-09	E1				1		1	3		3					
CL597-CL600-10	E1						2	3		3					
CL597-CL600-11	E1						1	3		2					
CL597-CL600-12	E1						2	3		2					
CL597-CL600-13	E1						2	3		3					
CL597-CL600-14	E1						2			2					
CL597-CL600-15	E1							3		1					
CL597-CL600-16	E1									1					
CL597-CL600-17	E1	1						2			1				
CL597-CL600-18	E1						2	3		1					
CL597-CL600-19	E1	1			1					2					
CL597-CL600-20	E1				1					2					
CL597-CL600-21	E1									2					
CL597-CL600-22	E1									1					
CL597-CL600-23	E1	1													
CL597-CL600-24	E1							3		1					
CL597-CL600-25	E1														
CL597-CL600-26	E1	1					2	3		1					
CL597-CL600-27	E1						1	3		2					

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL600-CL601-01	E1						3	1	1						
CL600-CL601-02	E1						3	1		1					
CL600-CL601-03	E1						2		1	1					
CL600-CL601-04	E1								2	2					
CL600-CL601-05	E1									1					
CL600-CL601-06	E1								1	1					
CL600-CL601-07	E2						2		2						
CL600-CL601-08	E2						3								
CL600-CL601-09	E2						3		1	1					
CL600-CL601-10	E2						1			2					
CL600-CL601-11	E2									1					
CL600-CL601-12	E2						3	1		1					
CL600-CL601-13	E2						3			2					
CL600-CL601-14	E2						3			2					
CL600-CL601-15	E2				1				2	2					
CL600-CL601-16	E2	1							2						
CL600-CL601-17	E2								2	1					1
CL600-CL601-18	E2								2	1					
CL600-CL601-19	E2	1							1						
CL600-CL601-20	E2								2						
CL600-CL601-21	E2								1						
CL600-CL601-22	E2								1						
CL600-CL601-23	E2	1													
CL600-CL601-24	E2	1							1						
CL600-CL601-25	E2				1					1					
CL600-CL601-26	E2	1								1					
CL600-CL601-27	E2								1						
CL601-CL602-01	E2								2	3					
CL601-CL602-02	E2								1	2					
CL601-CL602-03	E2								3	2			1		
CL601-CL602-04	E2								2						
CL601-CL602-05	E2								2	3					

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL601-CL602-06	E2							3	1	2			1		
CL601-CL602-07	E2				1			3	1	1					
CL601-CL602-08	E2				1		2	3	1	2					
CL601-CL602-09	E2						2	3	1	1					
CL601-CL602-10	E2								2	2					
CL601-CL602-11	E2									1					
CL601-CL602-12	E2								2	2					
CL601-CL602-13	E2														
CL601-CL602-14	E2							2		1					
CL601-CL602-15	E2				1			3							
CL601-CL602-16	E2				1			3		1					
CL601-CL602-17	E2				2		2	3		1					
CL601-CL602-18	E2				2			3		1					
CL601-CL602-19	E2				1			1		2					
CL601-CL602-20	E2				2			2		2					
CL601-CL602-21	E2							3		2					
CL601-CL602-22	E2				1		1	3		2					
CL601-CL602-23	E2						1	3		1					
CL601-CL602-24	E2				1					2					
CL601-CL602-25	E2				1		1	3		1					
CL601-CL602-26	E2				1		1	3		2					
CL601-CL602-27	E2							3		2		1			
CL602-CL604-01	E2						2	3		2	2				
CL602-CL604-02	E2							1		1	1				
CL602-CL604-03	E2				1		1	3		2					
CL602-CL604-04	E2				1			3	1	2					
CL602-CL604-05	E2				1			2	1	1					
CL602-CL604-06	E2				1		1	3		1					
CL602-CL604-07	E2				1			1		2					
CL602-CL604-08	E2							3		1					
CL602-CL604-09	E2				1		2	3		2					
CL602-CL604-10	E2							3		2					

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL602-CL604-11	E2						1	3		1					
CL602-CL604-12	E2				1		1	3	1	1	1				
CL602-CL604-13	E2				2		1	3		2					
CL602-CL604-14	E2				1		1	3		1					
CL602-CL604-15	E2				1		1	3		2	1				
CL602-CL604-16	W1				1		1	2		2					
CL602-CL604-17	W1				2		1	3		2	2				
CL602-CL604-18	W1						1	3		1					
CL602-CL604-19	W1				1		1	3		1					
CL602-CL604-20	W1	1			1		1	3		1					
CL602-CL604-21	W1	1					1	3		1					
CL605-CL606-01	W1				1		1	3	1	1					
CL605-CL606-02	W1						1	3	1	1					
CL605-CL606-03	W1				1		1	3	1	2					
CL605-CL606-04	W1				1		1	3		2					
CL605-CL606-05	W1						2	3	1	2					
CL605-CL606-06	W1				1		1	3		2					
CL605-CL606-07	W1						1	3	1	2					
CL605-CL606-08	W1				2		1	3	2	2					
CL605-CL606-09	W1				2		1	3	1	2					
CL605-CL606-10	W1						1	3		2					
CL605-CL606-11	W1				1		1	3		2					
CL605-CL606-12	W1				1		1	3	1	1					
CL605-CL606-13	W1				1		1	3		2					
CL605-CL606-14	W1				1		2	3		2					
CL605-CL606-15	W1				1		1	3	1	2					
CL605-CL606-16	W1				1		3	3	1	1	1				
CL605-CL606-17	W1				1		1	3	2	2	1				
CL605-CL606-18	W1				1		2	3		2	1				
CL605-CL606-19	W1				1	1	1	3	1	3	1				
CL605-CL606-20	W1				1		2	3		2	1				
CL605-CL606-21	W1						2	3	1	2	2				

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL605-CL606-22	W1				1		2	3	1	3	2				
CL605-CL606-23	W1				1		1	3		2	2				
CL605-CL606-24	W1						1	3		2	1				
CL605-CL606-25	W1						2	3	1	1	2				
CL605-CL606-26	W1				1		1	1	1	1	1				
CL605-CL606-27	W1							1	1	2	2				
CL606-CL609-01	W1				1			3		2					
CL606-CL609-02	W1				1		1	3		2					
CL606-CL609-03	W1				1		1	3		3					
CL606-CL609-04	W1				1			3		2					
CL606-CL609-05	W1				1			3		2					
CL606-CL609-06	W1				1		2	3		2					
CL606-CL609-07	W1				1					1					
CL606-CL609-08	W1				1					1					
CL606-CL609-09	W1									1					
CL606-CL609-10	W1				1		2	3		1					
CL606-CL609-11	W1				1		2	3		2					
CL606-CL609-12	W1				1		2	3		2					
CL606-CL609-13	W1									1					
CL606-CL609-14	W1									1					
CL606-CL609-15	W1									1					
CL606-CL609-16	W1														
CL606-CL609-17	W1						1								
CL606-CL609-18	W1				1		2	3		1					
CL606-CL609-19	W1				1		1	2		1					
CL606-CL609-20	W1				1			2							
CL606-CL609-21	W1				1			2		1					
CL606-CL609-22	W1						1	3		1					
CL606-CL609-23	W1				1		1	3		2					
CL606-CL609-24	W1				1		2	3		2					
CL606-CL609-25	W1						1	3		1					
CL606-CL609-26	W1				1		1	3							

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CL606-CL609-27	W1						1	3							
CL609-CL610-01	W1						2	3		1					
CL609-CL610-02	W1						2	3	1						
CL609-CL610-03	W1							1	1						
CL609-CL610-04	W1						2	3							
CL609-CL610-05	W1						3	3		1					
CL609-CL610-06	W1						2	3							
CL609-CL610-07	W1						2	3							
CL609-CL610-08	W1						2	3							
CL609-CL610-09	W1							3		1					
CS067-CS068-01	W1				1					1					
CS067-CS068-02	W1				1					1					
CS067-CS068-03	W1														
CS067-CS068-04	W1				2				1	1					
CS067-CS068-05	W1				1					1					
CS067-CS068-06	W1				1					2					
CS067-CS068-07	W1				2					2					
CS067-CS068-08	W1				2					1					
CS067-CS068-09	W1				2				1	1					
CS067-CS068-10	W2				2					2					
CS067-CS068-11	W2				2				1	2					
CS067-CS068-12	W2				2					2					
CS067-CS068-13	W2				1					2					
CS067-CS068-14	W2				1				2	2		2			
CS067-CS068-15	W2				2				2	2		2			
CS067-CS068-16	W2				1					2		1			
CS067-CS068-17	W2				1					1		3			
CS067-CS068-18	W2				2					1		3			
CS067-CS068-19	W2				1					1		1			
CS067-CS068-20	W2				1				2	1					
CS067-CS068-21	W2				2				2	2					
CS067-CS068-22	W2				2					2					

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter															
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).															
		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CS067-CS068-23	W2				3				1	1					
CS067-CS068-24	W2				1		1	1	1	1				1	
CS067-CS068-25	W2				2		1	2	2	2					
CS067-CS068-26	W2				2			1	1	2					
CS067-CS068-27	W2				2		2	2		2					
CS067-CS068-28	W2				2			1	1	2					
CS067-CS068-29	W2				2				1	2					
CS067-CS068-30	W2				1					1					
CS068-CS069-01	W2				1					1					
CS068-CS069-02	W2				1					1					
CS068-CS069-03	W2				2					2					
CS068-CS069-04	W2				2					2					
CS068-CS069-05	W2				1					1					
CS068-CS069-06	W2				1					1					
CS068-CS069-07	W3				2					2					
CS068-CS069-08	W3				1					1					
CS068-CS069-09	W3				2					2					
CS068-CS069-10	W3				1					1					
CS068-CS069-11	W3				1					1					
CS068-CS069-12	W3				1					1					
CS068-CS069-13	W3				1					1					
CS068-CS069-14	W3				1					1					
CS068-CS069-15	W3				1					1					
CS068-CS069-16	W3				2					1					
CS068-CS069-17	W3				1					1					
CS068-CS069-18	W3				1					1					
CS068-CS069-19	W3				1					1					
CS068-CS069-20	W3				2					2					
CS068-CS069-21	W3				2					2					
CS068-CS069-22	W3				2					2					
CS068-CS069-23	W3				1					1					
CS068-CS069-24	W3				1					1		2			

Appendix 18 - Clifford boundary hedgerow survey

Table 115.1 – Species data for Clifford Boundary Hedgerows – Winter															
Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).															
		SPECIES													
RECORD POINT	SECTION	all-pet	all-urs	ane-nem	aru-mac	geu-urb	Hed-Hel	hed-hel	hya-non	mer-per	ran-fic	pte-aqu	sta-syl	tam-com	vio-odo
CS068-CS069-25	W3				2					2		2			
CS068-CS069-26	W3				2					2		2			
CS068-CS069-27	W3				2					2		2		1	
CS068-CS069-28	W3				1					1		1			
CS068-CS069-29	W3			1	1					1		1			
CS068-CS069-30	W3			1											
CS069-CS070-01	W3				1					1		1			
CS069-CS070-02	W3									1		1			
CS069-CS070-03	W3							1		1		1			
CS069-CS070-04	W3							1		1		1			
CS069-CS070-05	W3								1	1		1			
CS069-CS070-06	W3				1					1		1			
CS069-CS070-07	W3				1				1	1		1			
CS069-CS070-08	W3				2				1	2		1			
CS069-CS070-09	W3				2				2	2		1			
CS069-CS070-10	W3								1	1		1			
CS069-CS070-11	W3				1										
CS069-CS070-12	W3			1	1		1	1	2	1		1			
CS069-CS070-13	W3			1					1	1		1			
CS069-CS070-14	W3			1	1				1	1		1			
CS069-CS070-15	W3								2	1		2			
CS069-CS070-16	W3			1					2	2	1	1			
CS069-CS070-17	W3			1					2	1	3	1			
CS069-CS070-18	W3								1	1					

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM675-CM678-01	E1											2																2				
CM675-CM678-02	E1																		2									2				
CM675-CM678-03	E1																		2									2				
CM675-CM678-04	E1																									1		3				
CM675-CM678-05	E1																		2							2		2		1		
CM675-CM678-06	E1						1												3							2						
CM675-CM678-07	E1						2																			2		1				
CM675-CM678-08	E1					1		1																				3				
CM675-CM678-09	E1					1		1																				3		1		
CM675-CM678-10	E1											1																3		2		
CM675-CM678-11	E1							1																				3		1		
CM675-CM678-12	E1							1																		1		3		1		
CM675-CM678-13	E1																									2		3				
CM675-CM678-14	E1																									3		1			2	
CM675-CM678-15	E1																									3		1				
CM675-CM678-16	E1																									1		3				
CM675-CM678-17	E1																											1			3	
CM675-CM678-18	E1																1											2			2	
CM675-CM678-19	E1																											3			1	
CM675-CM678-20	E1																											3				
CM675-CM678-21	E1							2							2											1		2				
CM675-CM678-22	E1																									1		3				
CM675-CM678-23	E1																											2			3	
CM675-CM678-24	E1																											2			3	

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM675-CM678-25	E1																											3		1	1	
CM675-CM678-26	E1																											2			3	
CM675-CM678-27	E1																		3									2				
CM678-CM679-01	E1																		3						1			1				
CM678-CM679-02	E1																		2						1			3				
CM678-CM679-03	E1																									1		2				
CM678-CM679-04	E1																											1				
CM678-CM679-05	E1																											1				
CM678-CM679-06	E1																															
CM678-CM679-07	E1						1																									
CM678-CM679-08	E1						2																									
CM678-CM679-09	E1																											3				
CM678-CM679-10	E1																		1									3				
CM678-CM679-11	E1									2									2									2				
CM678-CM679-12	E1									3																		1				
CM678-CM679-13	E1																											1		1		
CM678-CM679-14	E1																											3			2	
CM678-CM679-15	E1						3																								1	
CM678-CM679-16	E1																															
CM678-CM679-17	E1						2	1																								
CM678-CM679-18	E1									2									2													
CM678-CM679-19	E1																															
CM678-CM679-20	E1																															
CM678-CM679-21	E1																											2				

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																													
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM678-CM679-22	E1							2																				2				
CM678-CM679-23	E1																								1			3				
CM678-CM679-24	E1									2	1																					
CM678-CM679-25	E1									1																		3				
CM678-CM679-26	E1					2																				1		3				
CM678-CM679-27	E1					1		1																	1	2		2				
CM679-CM680-01	E1					1	2														2							2				
CM679-CM680-02	E1						3																					1				
CM679-CM680-03	E1						3												1						1			1				
CM679-CM680-04	E1																		2						1			2				
CM679-CM680-05	E1						1												2									2				
CM679-CM680-06	E1																		1									3		1		
CM679-CM680-07	E1																		3									2				
CM679-CM680-08	E1																		3									1				
CM679-CM680-09	E1														1				2									2				
CM679-CM680-10	E1																											2				
CM679-CM680-11	E1										2								1													
CM679-CM680-12	E1										2								2												2	
CM679-CM680-13	E1																		3												2	
CM679-CM680-14	E1					2													2									2			1	
CM679-CM680-15	E1					1		1											2									2				
CM679-CM680-16	E1																		3									1				
CM679-CM680-17	E1							1											2									2				
CM679-CM680-18	E1							2			1								2									2				

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM679-CM680-19	E1									1	1								3												1	
CM679-CM680-20	E1					1		1											2												2	
CM679-CM680-21	E1					1													3											1	1	
CM679-CM680-22	E1										2								2												2	
CM679-CM680-23	E1		3								1								1												2	
CM679-CM680-24	E1																		2												2	
CM679-CM680-25	E1		1																1												3	
CM679-CM680-26	E1		2																2													
CM679-CM680-27	E1		2				1												1													
CM680-CM682-01	E1		1				2												2						1							
CM680-CM682-02	E1		2				2												2						1							
CM680-CM682-03	E1		2																2												3	
CM680-CM682-04	E1		2				2											1														
CM680-CM682-05	E1		3			1	1											1														
CM680-CM682-06	E1					2		2								1									1	1				1		
CM680-CM682-07	E1		1		1			1								3																
CM680-CM682-08	E1		3																							1		1				
CM680-CM682-09	E1		1			1		1																		1						
CM680-CM682-10	E1		3			1																				1		1				
CM680-CM682-11	E1		3					1																								
CM680-CM682-12	E1		2																							1		1				
CM680-CM682-13	E1		2			2									1											1		2				
CM680-CM682-14	E1		2			2																										
CM680-CM682-15	E1		2			3										2			1													

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM680-CM682-16	E1		3			2		1																								
CM680-CM682-17	E1	1	1			1		2											1													
CM682-CM684-01	E2							3														1		1								1
CM682-CM684-02	E2						2	2											2													
CM682-CM684-03	E2					1	1	3									1		1							1						
CM682-CM684-04	E2	3				1													1						1	1						
CM682-CM684-05	E2	2	2			1																				1		1				
CM682-CM684-06	E2	2			1		2	1											1													
CM682-CM684-07	E2					2		1											1						1							
CM682-CM684-08	E2					1	1									3										1				1		
CM682-CM684-09	E2		2				2	2											1													
CM682-CM684-10	E2					2		2					1						2													
CM682-CM684-11	E2					2													3													
CM682-CM684-12	E2					2													2						1							
CM682-CM684-13	E2	3				2													1													
CM682-CM684-14	E2					2	2			1									1							1				1		
CM682-CM684-15	E2					1	2												2						1							
CM682-CM684-16	E2					2	2												2						1							
CM682-CM684-17	E2					1	2												2						1					1	1	
CM682-CM684-18	E2						1												2						1			1			3	
CM682-CM684-19	E2					1													3						1			1				
CM682-CM684-20	E2																		2									1			3	
CM682-CM684-21	E2																		1						1						3	
CM682-CM684-22	E2					1		2																	1						3	

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM682-CM684-23	E2					2		2																			3					
CM682-CM684-24	E2					1																			1		2				3	
CM682-CM684-25	E2					1		1											3						1	1						1
CM682-CM684-26	E2						1	1											2												3	1
CM682-CM684-27	E2		2				1																			1					2	
CM684-CM686-01	E2																															
CM684-CM686-02	E2																															
CM684-CM686-03	E2																															
CM684-CM686-04	E2																															
CM684-CM686-05	E2																															
CM684-CM686-06	E2																															
CM684-CM686-07	E2																															
CM684-CM686-08	E2																															
CM684-CM686-09	E2																															
CM684-CM686-10	E2																															
CM684-CM686-11	E2																															
CM684-CM686-12	E2																															
CM684-CM686-13	E2																															
CM684-CM686-14	E2																															
CM684-CM686-15	E2																															
CM684-CM686-16	E2																															
CM684-CM686-17	E2																															
CM684-CM686-18	E2																															
CM684-CM686-19	E2																															

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM684-CM686-20	E2																															
CM684-CM686-21	E2																															
CM684-CM686-22	E2																															
CM684-CM686-23	E2																															
CM684-CM686-24	E2																															
CM684-CM686-25	E2																															
CM684-CM686-26	E2																															
CM684-CM686-27	E2																															
CM686-CM688-01	E2																															
CM686-CM688-02	E2																															
CM686-CM688-03	E2																															
CM686-CM688-04	E2																															
CM686-CM688-05	E2																															
CM686-CM688-06	E2																															
CM686-CM688-07	E2																															
CM686-CM688-08	E2																															
CM686-CM688-09	E2																															
CM686-CM688-10	E2																															
CM686-CM688-11	E2																															
CM686-CM688-12	E2																															
CM686-CM688-13	E2																															
CM686-CM688-14	E2																															
CM686-CM688-15	E2																															
CL788-CL791-01	W1			3		3		1																								

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																												
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CL788-CL791-02	W1			2		1																			1			1				
CL788-CL791-03	W1			1		2													1						1			1				
CL788-CL791-04	W1					1				1									1									1				
CL788-CL791-05	W1					3		1		1					2				1									1				
CL788-CL791-06	W1					1		1																				1				
CL788-CL791-07	W1					1		3										1										2				
CL788-CL791-08	W1					1		1											3									1				
CL788-CL791-09	W1					2		2											1									1				
CL788-CL791-10	W1					2		3																	1			1				
CL788-CL791-11	W1							1											3													
CL788-CL791-12	W1					1		2											2													
CL788-CL791-13	W1					3		2											1									1				
CL788-CL791-14	W1					2		2											1									1				1
CL788-CL791-15	W1					1		1											1		1				1			2				
CL788-CL791-16	W1					1		2											1						1							
CL788-CL791-17	W1					2		2											1													
CL788-CL791-18	W1					2		2											2						1							
CL788-CL791-19	W1					2		2											1													
CL788-CL791-20	W1					2		2											1													
CL788-CL791-21	W1					1	1												3						1							
CL788-CL791-22	W1					2	2	1											1													
CL788-CL791-23	W1					2	1	1			2								1						1							
CL788-CL791-24	W1					2		1											2						1							
CL788-CL791-25	W1					1		1											2									1				

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CL788-CL791-26	W1					3	1	1											1													
CL788-CL791-27	W1					1	2	1											2									1				
CL791-CL792-01	W1					1				2									1									1				
CL791-CL792-02	W1					1				1									1						1							
CL791-CL792-03	W1																		1						2							
CL791-CL792-04	W1																		2													
CL791-CL792-05	W1					1													1													
CL791-CL792-06	W1					1																										
CL791-CL792-07	W1					2													1						1							
CL791-CL792-08	W1					2																			1							
CL791-CL792-09	W1					2																						2				
CL791-CL792-10	W1					1																				1		1				
CL791-CL792-11	W1					2														1												
CL791-CL792-12	W1					1																										
CL791-CL792-13	W1																			3					1							
CL791-CL792-14	W1																			2					1							
CL791-CL792-15	W1					2																										
CL791-CL792-16	W1		2			1																										
CL791-CL792-17	W1		1			1																										
CL791-CL792-18	W1		2			3																										
CL791-CL792-19	W1					2														1												
CL791-CL792-20	W1					2														2												
CL791-CL792-21	W1									2										1												
CL791-CL792-22	W1					1				1										1												

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CL791-CL792-23	W1					2														2												
CL791-CL792-24	W1					1														3												
CL791-CL792-25	W1					3														1												
CL791-CL792-26	W1		2			2																										
CL791-CL792-27	W1		1			1														1												
CL792-CL793-01	W1					1	3												1													
CL792-CL793-02	W1					1	1								1				1							1						
CL792-CL793-03	W1					3	1																									
CL792-CL793-04	W1					2	2	1																								
CL792-CL793-05	W1					1	1	1																								
CL792-CL793-06	W1					3	1	1																								
CL792-CL793-07	W1					2	2	1																								
CL792-CL793-08	W1					2	2	1																								
CL792-CL793-09	W1					3		1											1													
CL792-CL793-10	W1					2									1																	
CL792-CL793-11	W1					1									3				1													
CL792-CL793-12	W1					1		1							3				1											1		
CL792-CL793-13	W1							1							3				1							1						
CL792-CL793-14	W1							1							3				1						1							
CL792-CL793-15	W1														3				1						1					1		
CL792-CL793-16	W1					1		2							1				2													
CL792-CL793-17	W1					2		1				1							1													
CL792-CL793-18	W1					3		1											1		1				1							
CL792-CL793-19	W1					2		1											2						1							

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CL792-CL793-20	W1					2		2																								
CL792-CL793-21	W1					2		1							2				1	1						1						
CL792-CL793-22	W1					1		1							3					1												
CL792-CL793-23	W1					2		2																	1							
CL792-CL793-24	W1		3			1		1				2																				
CL792-CL793-25	W1		3				1					1														1						
CL792-CL793-26	W1		1			3	1																									
CL792-CL793-27	W1		3			1	1																									
CL793-CL794-01	W1					2					2								1													
CL793-CL794-02	W1					2	3												1													
CM671-CM672-01	W2				1			3																								
CM671-CM672-02	W2				1			3																								
CM671-CM672-03	W2				1			3																								
CM671-CM672-04	W2				1			3																								
CM671-CM672-05	W2							2																					1			
CM671-CM672-06	W2				1			3																					1	1		
CM671-CM672-07	W2							2							2															1		
CM671-CM672-08	W2					1									3				1										1			
CM671-CM672-09	W2					3									2				1										1			
CM671-CM672-10	W2						1								3				2										1			
CM671-CM672-11	W2					2		1							2				2						1				1			
CM671-CM672-12	W2						1	1							3				2										1			
CM671-CM672-13	W2						2	1							1				1						1				2			
CM671-CM672-14	W2						1	1							3													1	1	1		

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM671-CM672-15	W2					1		1							1													3	1			
CM671-CM672-16	W2						2								3				2													
CM671-CM672-17	W2					3	2								2													2		1		
CM671-CM672-18	W2						1	1							2				1													
CM671-CM672-19	W2						2								2													2				
CM671-CM672-20	W2						3	1																				1				
CM671-CM672-21	W2						1	2				2																				
CM671-CM672-22	W2				1							2																2				1
CM671-CM672-23	W2				1							2																2				1
CM671-CM672-24	W2											3																				
CM671-CM672-25	W2											3																				
CM671-CM672-26	W2											3																				
CM672-CM673-01	W3							3																								
CM672-CM673-02	W3				1			3																								
CM672-CM673-03	W3				1			3																								
CM672-CM673-04	W3							3																								
CM672-CM673-05	W3							3																				2				
CM672-CM673-06	W3							3																				1				
CM672-CM673-07	W3							3																				1				
CM672-CM673-08	W3							3																				3				
CM672-CM673-09	W3				1			1																								
CM672-CM673-10	W3				1			3																								
CM672-CM673-11	W3				1			3																								
CM672-CM673-12	W3				1			3																				1				

Appendix 18 - Clifford boundary hedgerow survey

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM672-CM673-13	W3				1			3																				1				
CM672-CM673-14	W3				3			3																								
CM672-CM673-15	W3				1			3																								
CM672-CM673-16	W3				2			3																								
CM672-CM673-17	W3				1			3																				1				
CM672-CM673-18	W3							3																		1		1				
CM672-CM673-19	W3				1			3																				2				
CM672-CM673-20	W3				1			3																				2				
CM672-CM673-21	W3							3																		2		1				
CM672-CM673-22	W3							2																		1		2				
CM672-CM673-23	W3				1			3																				1				
CM672-CM673-24	W3				1			2																				2				
CM672-CM673-25	W3				2			3																				1				
CM672-CM673-26	W3				2			3																								
CM672-CM673-27	W3				2			3																								
CM673-CM674-01	W3					1		3																		1		2				
CM673-CM674-02	W3					1		3																		1		1				
CM673-CM674-03	W3					1		2																		1		2				
CM673-CM674-04	W3							3																		1		1	1			
CM673-CM674-05	W3					1		3				1																	1			
CM673-CM674-06	W3					2		3					1															2	2			
CM673-CM674-07	W3					2		3																					2			
CM673-CM674-08	W3					2		3																					2			
CM673-CM674-09	W3					1		3																					3	1		

Table 125.2 - Species data for Clifford Boundary Hedgerows – Summer

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - abbreviated DAFOR scale - DFR - 1 = Rare; 2 = Frequent/common; 3 = Dominant. Sections are E1-E2 - east of the A1 and W1-W3 west of the A1. Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-27).

		SPECIES																														
RECORD POINT	SECTION	Ace-Pse	Ace-Cam	Ber-Vul	bry-dio	Cor-Ave	Cor-San	Cra-Mon	Dap-Lau	Euo-Eur	Fra-Exc	GAP	Hed-Hel	hed-hel	Ile-Aqu	Mal-Syl	mer-per	Pru-Ini	Pru-Spi	Que-Rob	Rha-Cat	Rib-Ida	Rib-Uva	Ros-Arv	Ros-Can	Rub-Fru	Sal-Cin	Sam-Nig	pte-aqu	tam-com	Ulm-Gla	Vib-Opu
CM673-CM674-10	W3							3																					1			
CM673-CM674-11	W3					2		3																		1		1	3			
CM673-CM674-12	W3							3																		2		1	2			
CM673-CM674-13	W3					1		3																					1			
CM673-CM674-14	W3					2		3																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

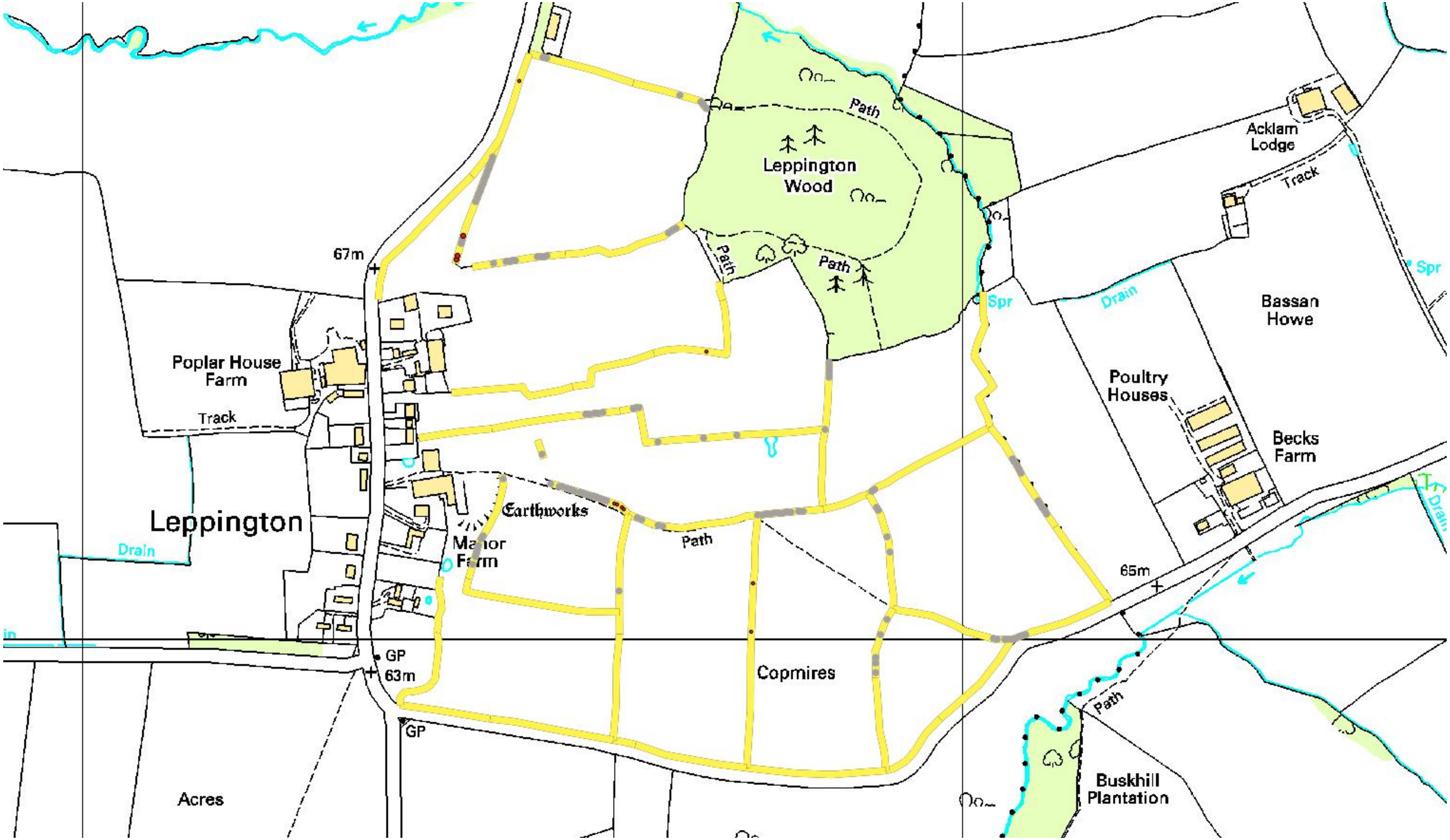


Figure 1.1 – *Acer campestre*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

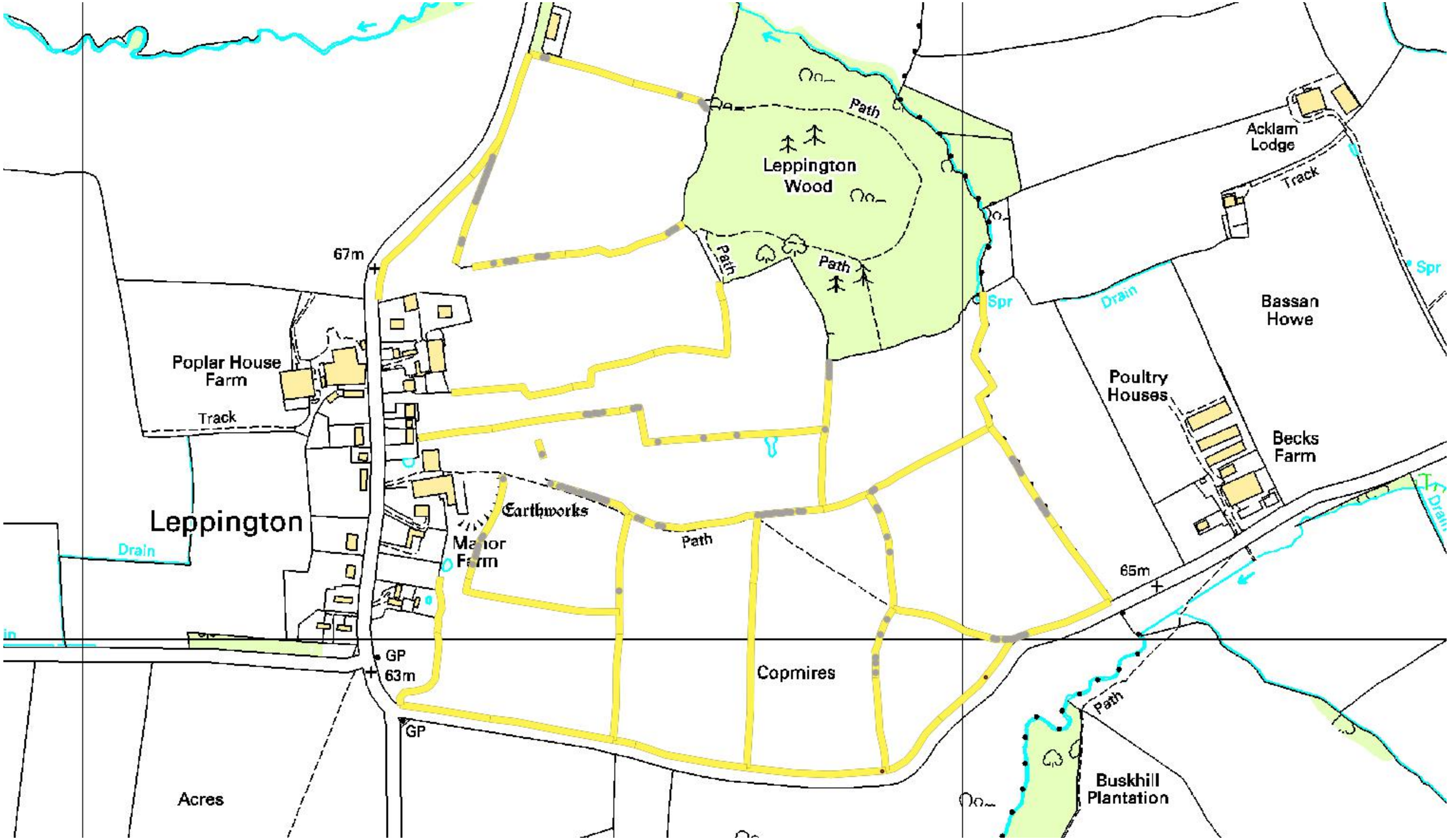


Figure 2.2 – *Acer pseudoplatanus*

Species maps for Manor Farm, Leppington.

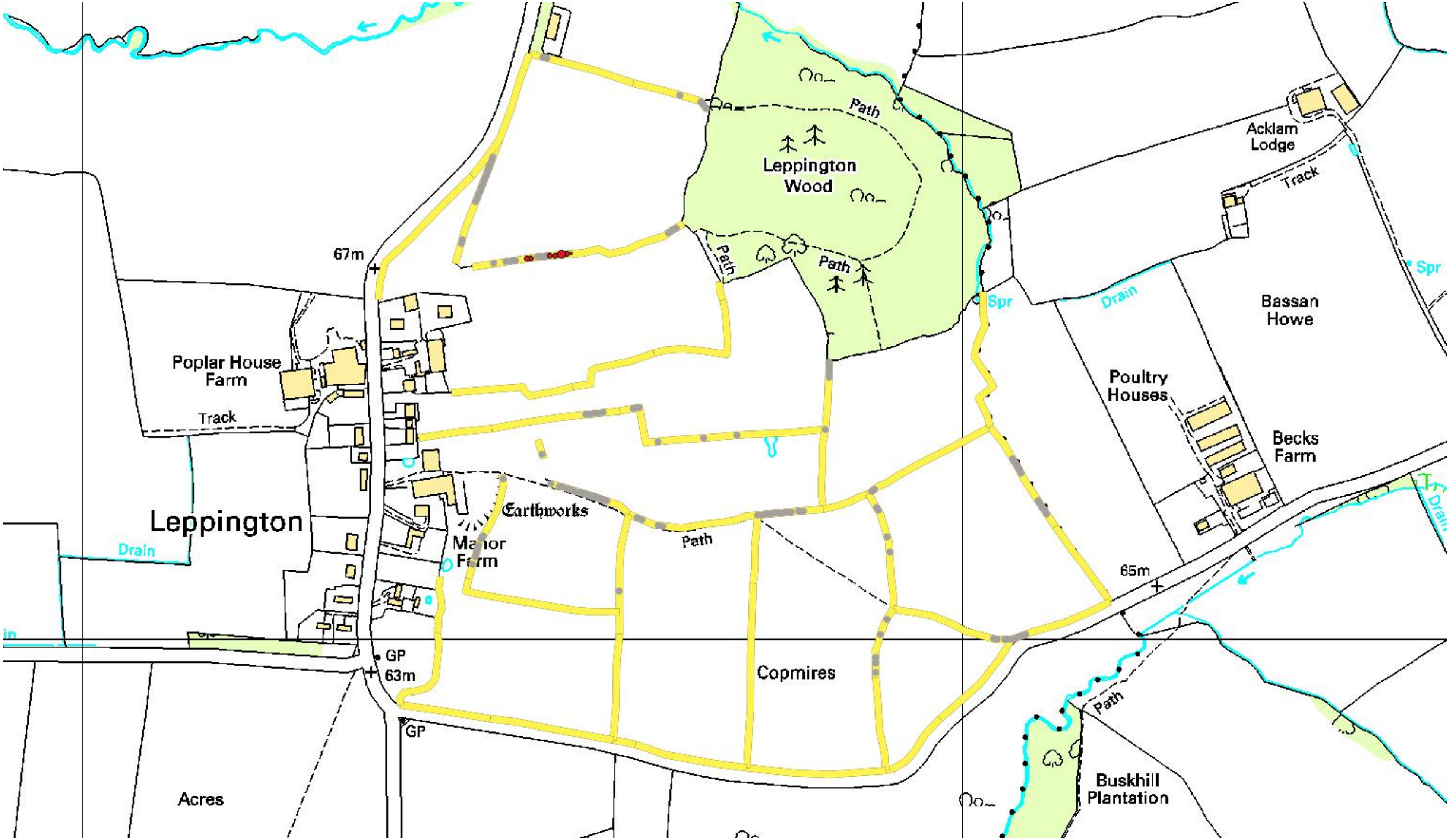


Figure 3.3 – *Allium ursinum*

Species maps for Manor Farm, Leppington.

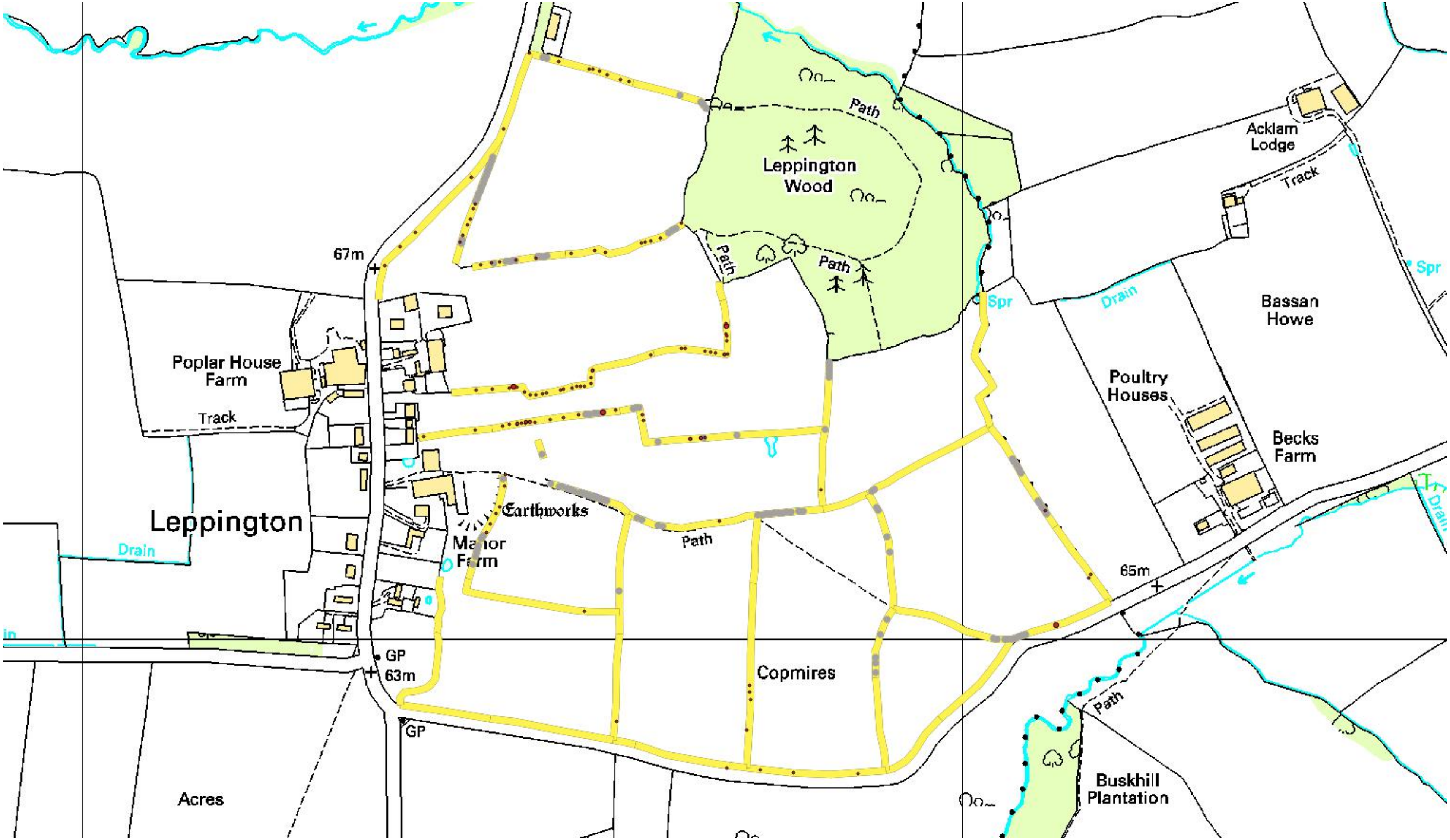


Figure 4.4 – *Arum maculatum*

Species maps for Manor Farm, Leppington.

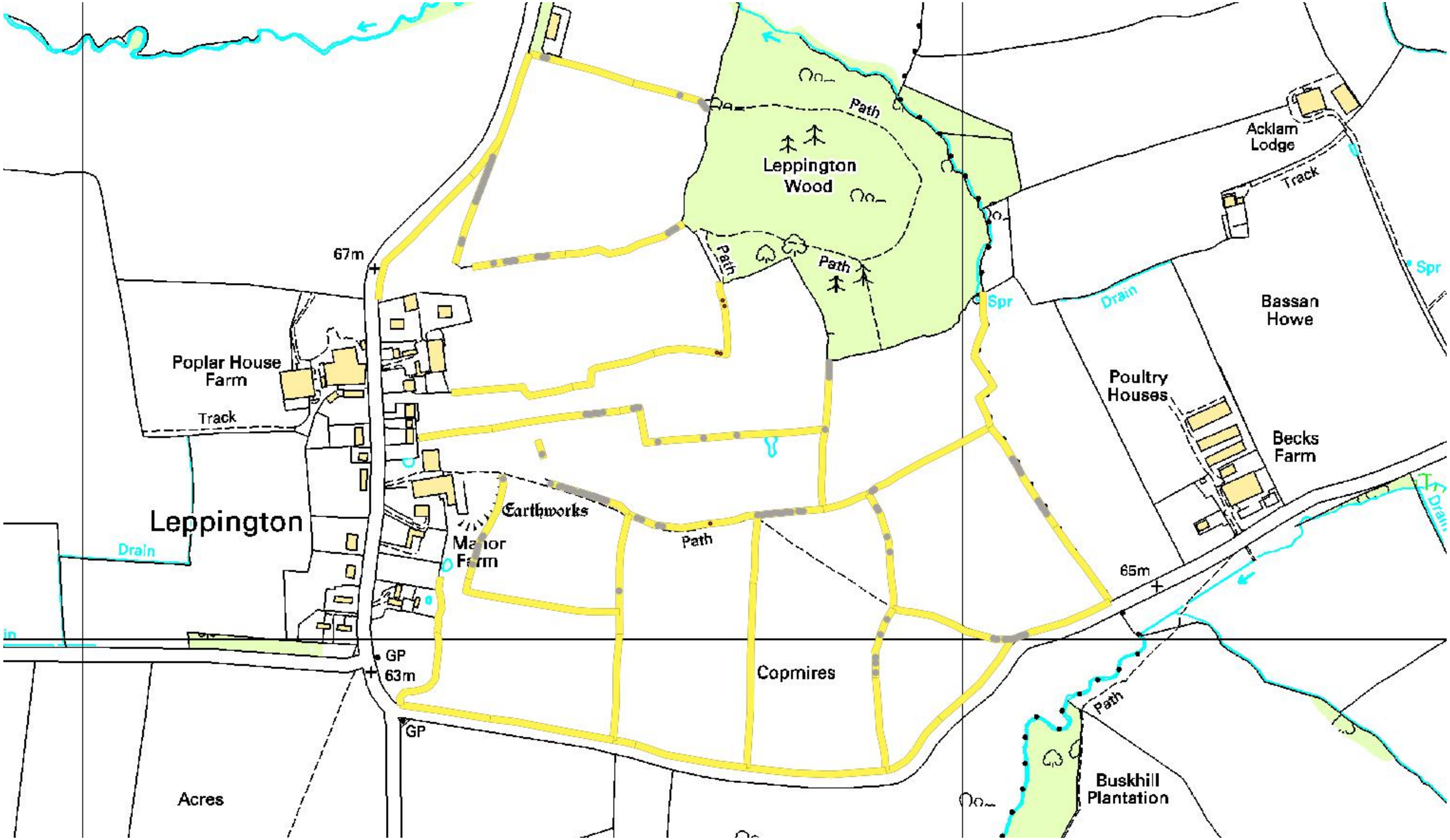


Figure 5.5 – *Corylus avellana*

Species maps for Manor Farm, Leppington.

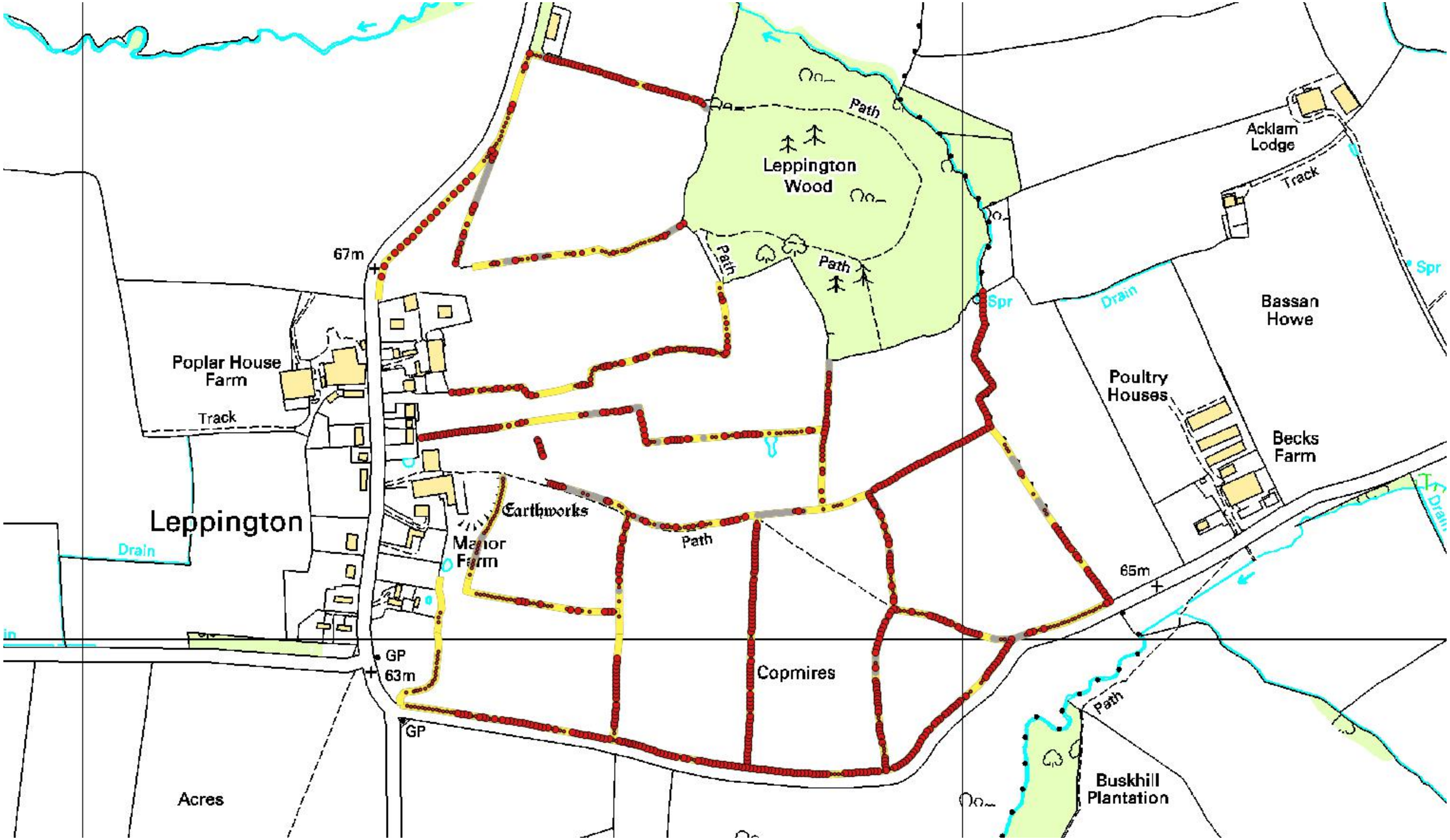


Figure 6.6 – *Crataegus monogyna*

Species maps for Manor Farm, Leppington.

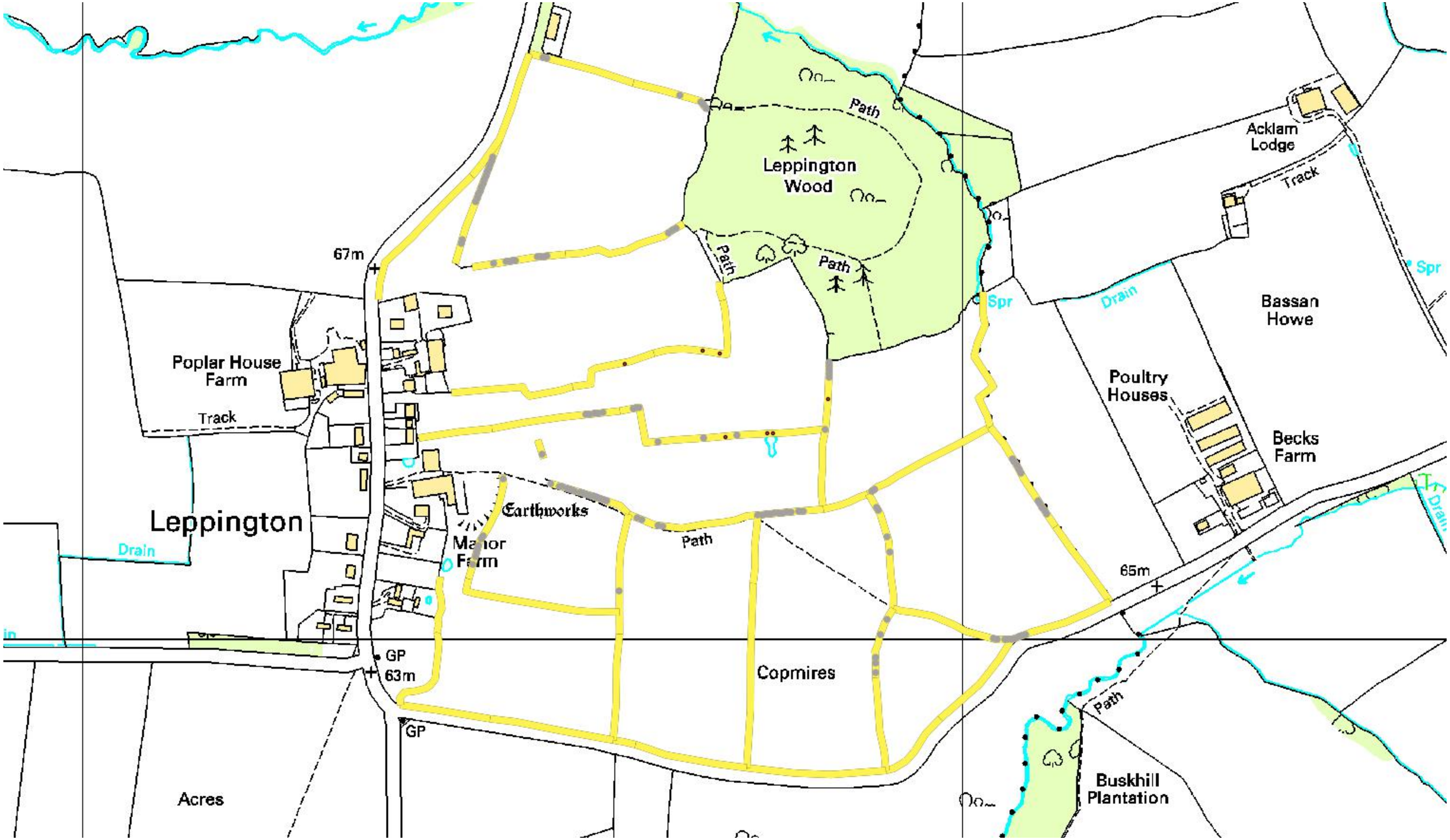


Figure 7.7 – *Dryopteris dilatata*

Species maps for Manor Farm, Leppington.

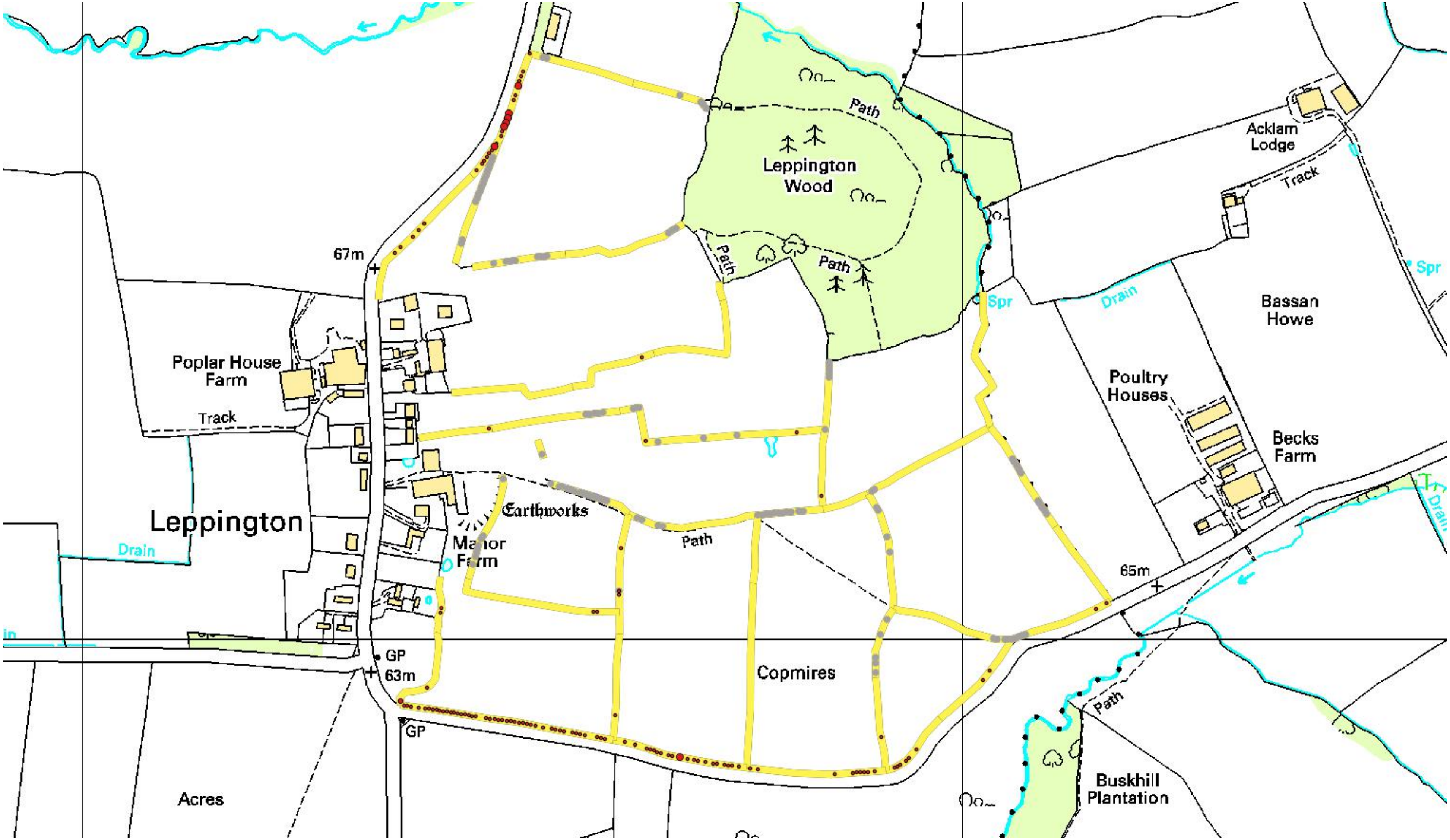


Figure 8.8 – *Fraxinus excelsior*

Species maps for Manor Farm, Leppington.

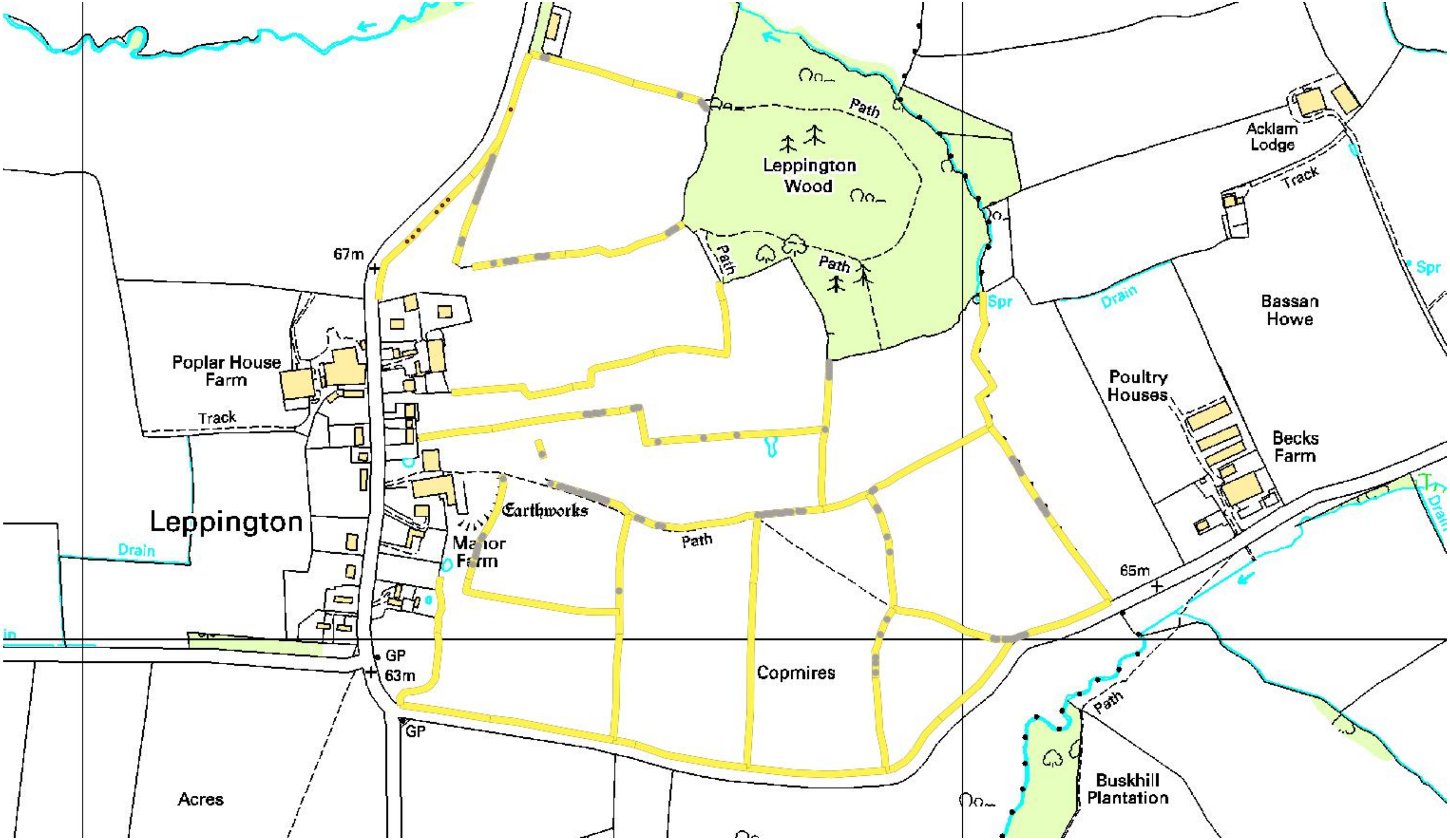


Figure 9.9– *Hedera helix*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

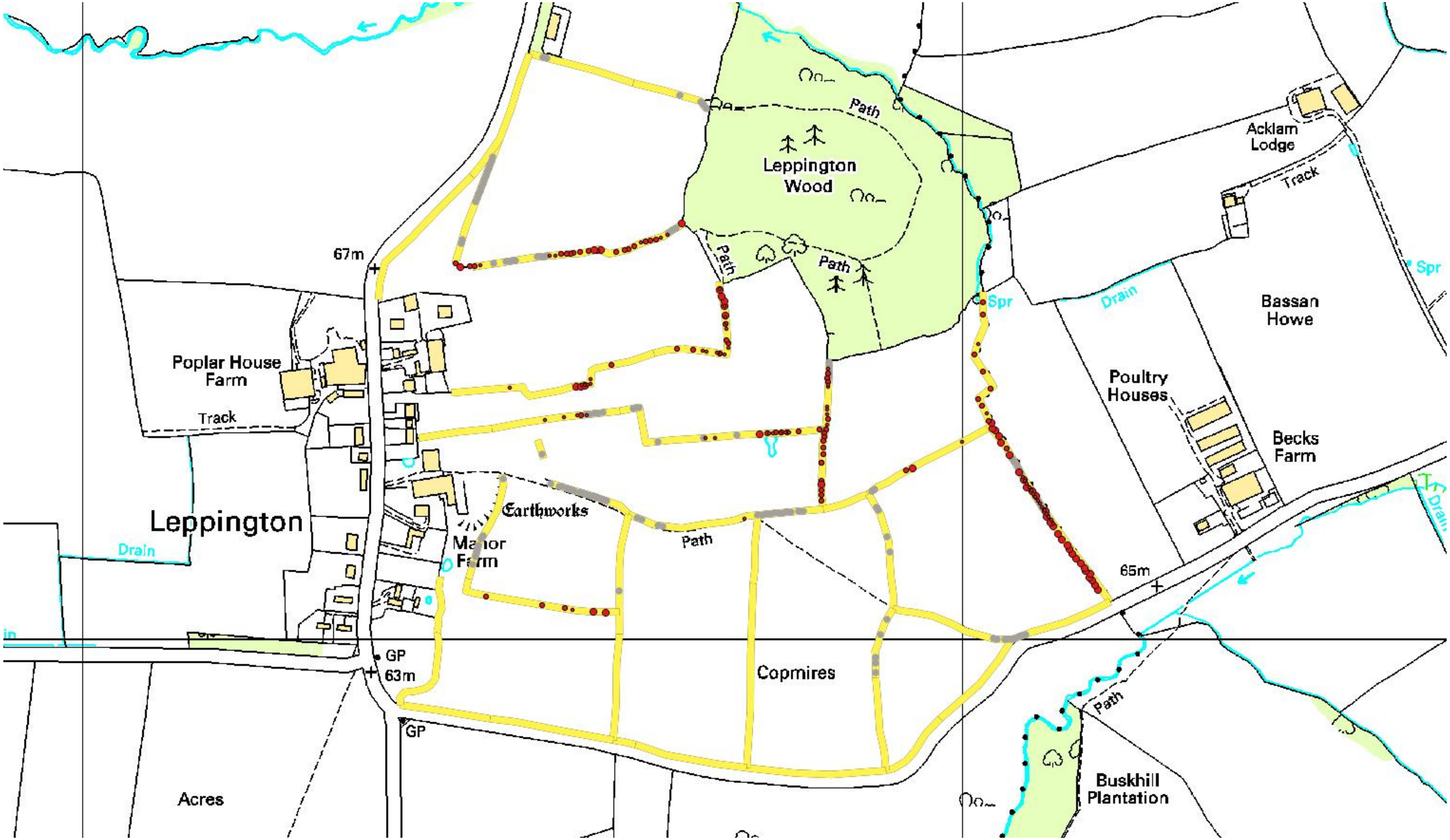


Figure 10.10 – *Hyacinthoides non-scripta*

Species maps for Manor Farm, Leppington.

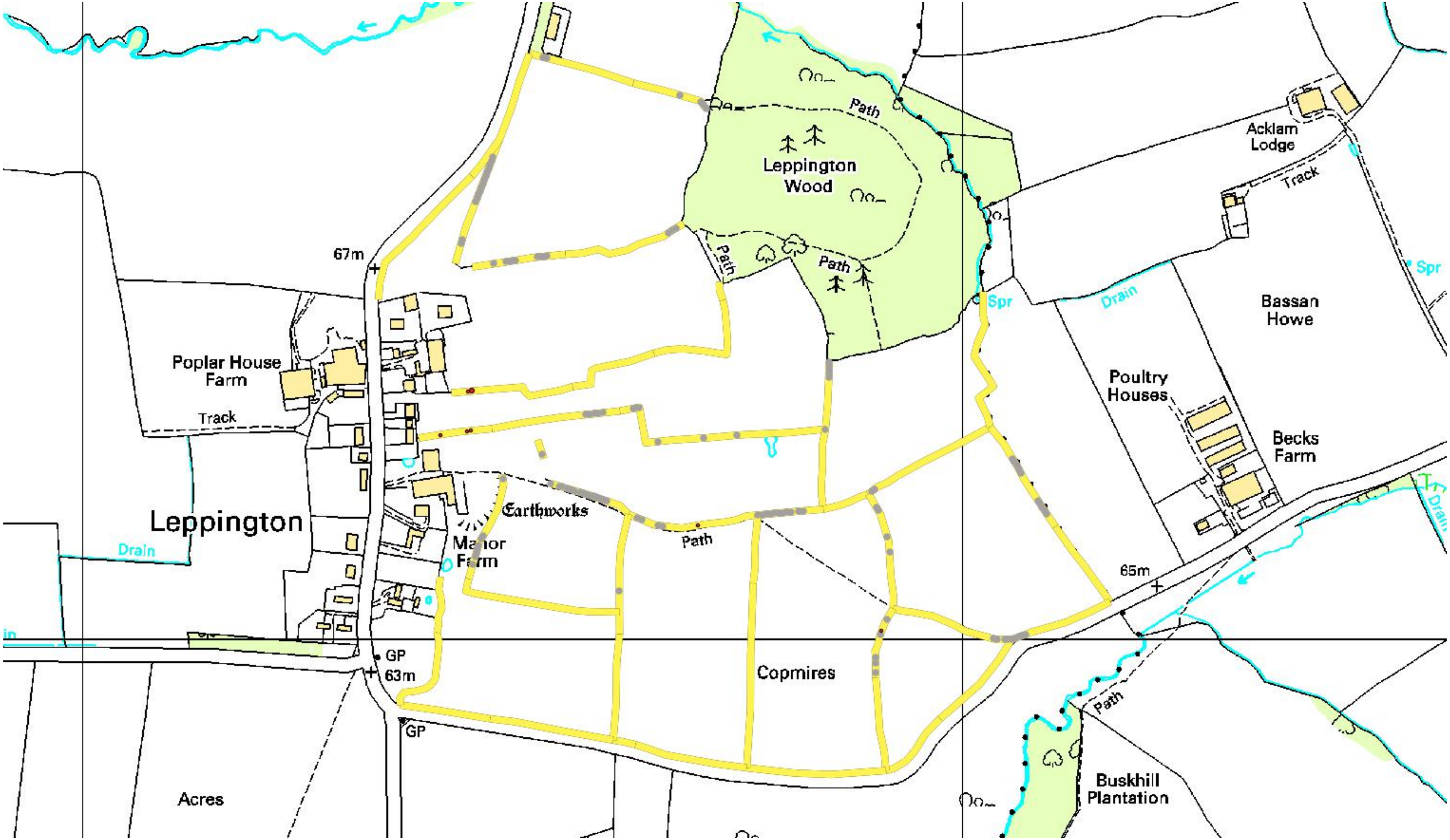


Figure 11.11 – *Ilex aquifolium*

Species maps for Manor Farm, Leppington.

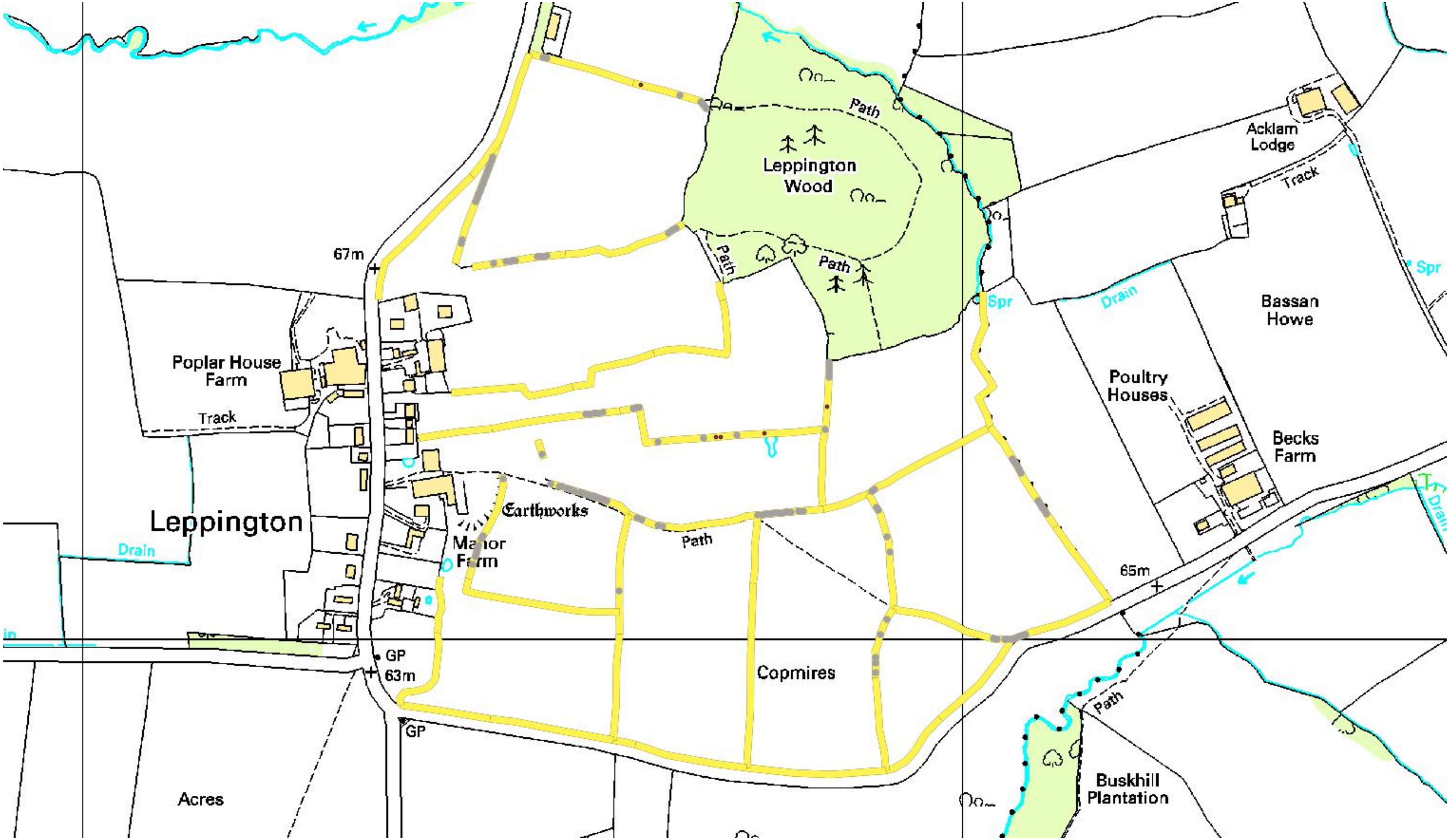


Figure 12.12 – *Lonicera periclymenum*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

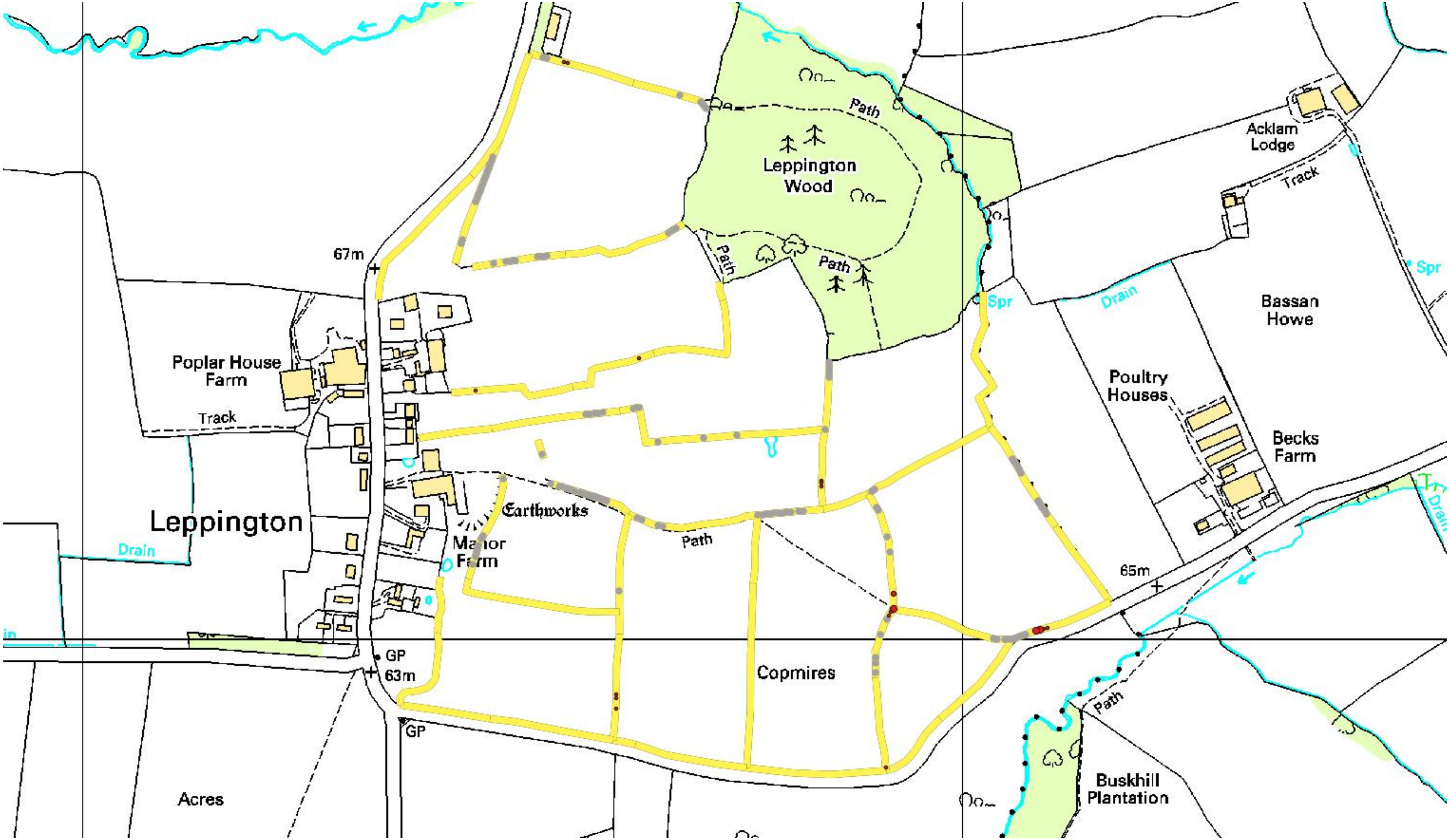


Figure 13.13 – *Malus sylvestris*

Species maps for Manor Farm, Leppington.

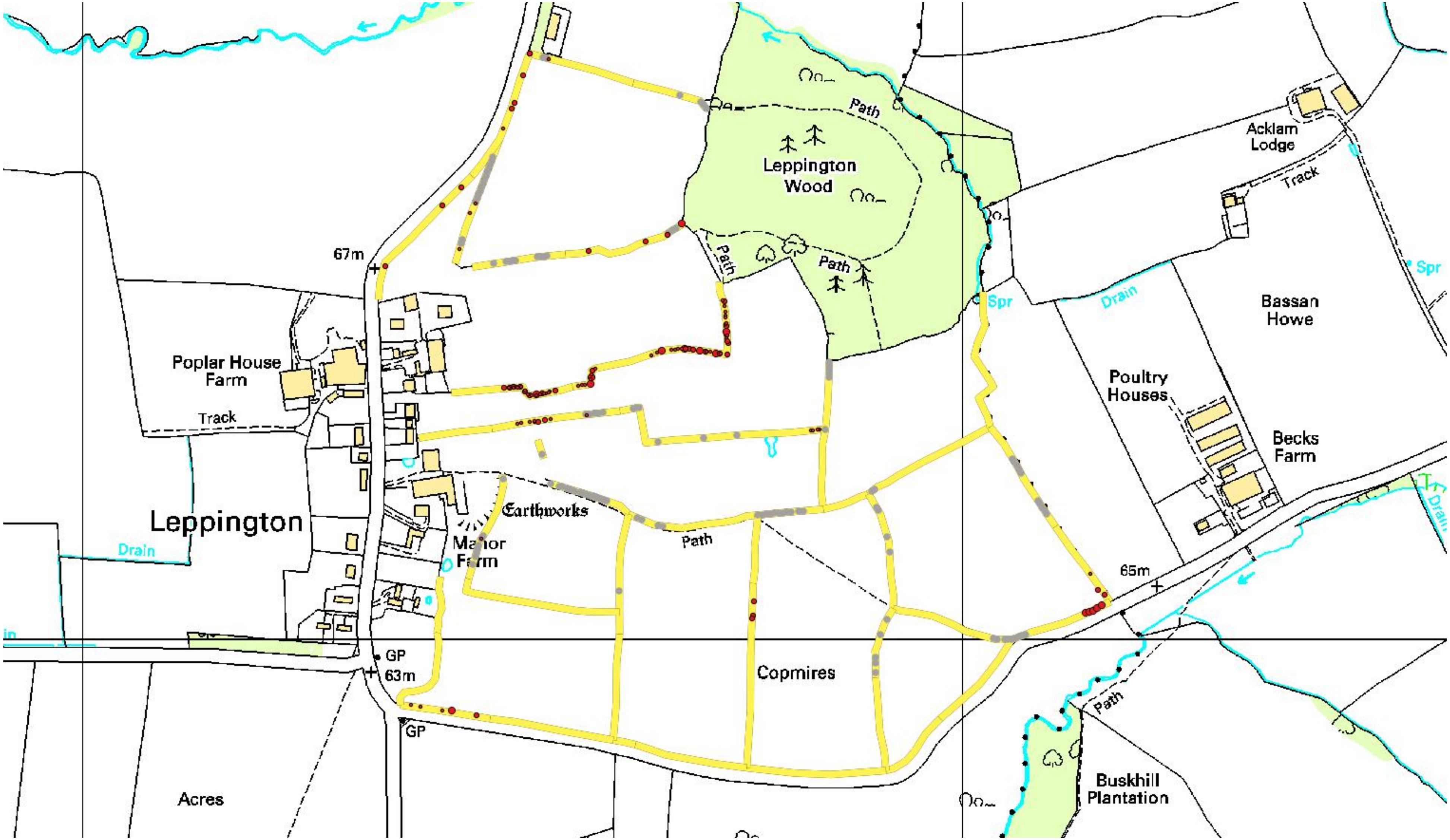


Figure 14.14 – *Mercurialis perennis*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

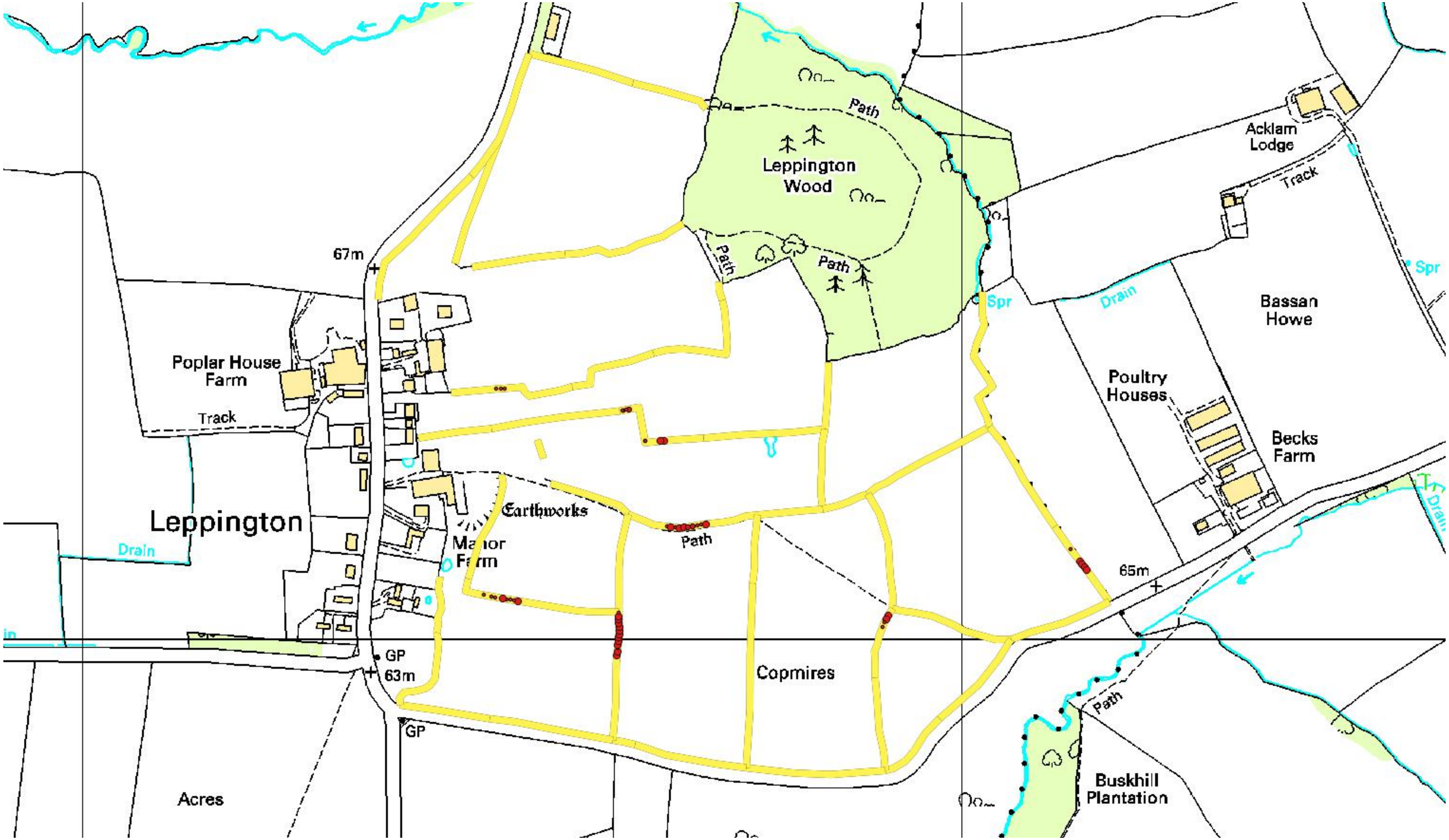


Figure 15.15 – *Prunus spp* - Damson/ Bullace/ Blackthorn/ hybrid?

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

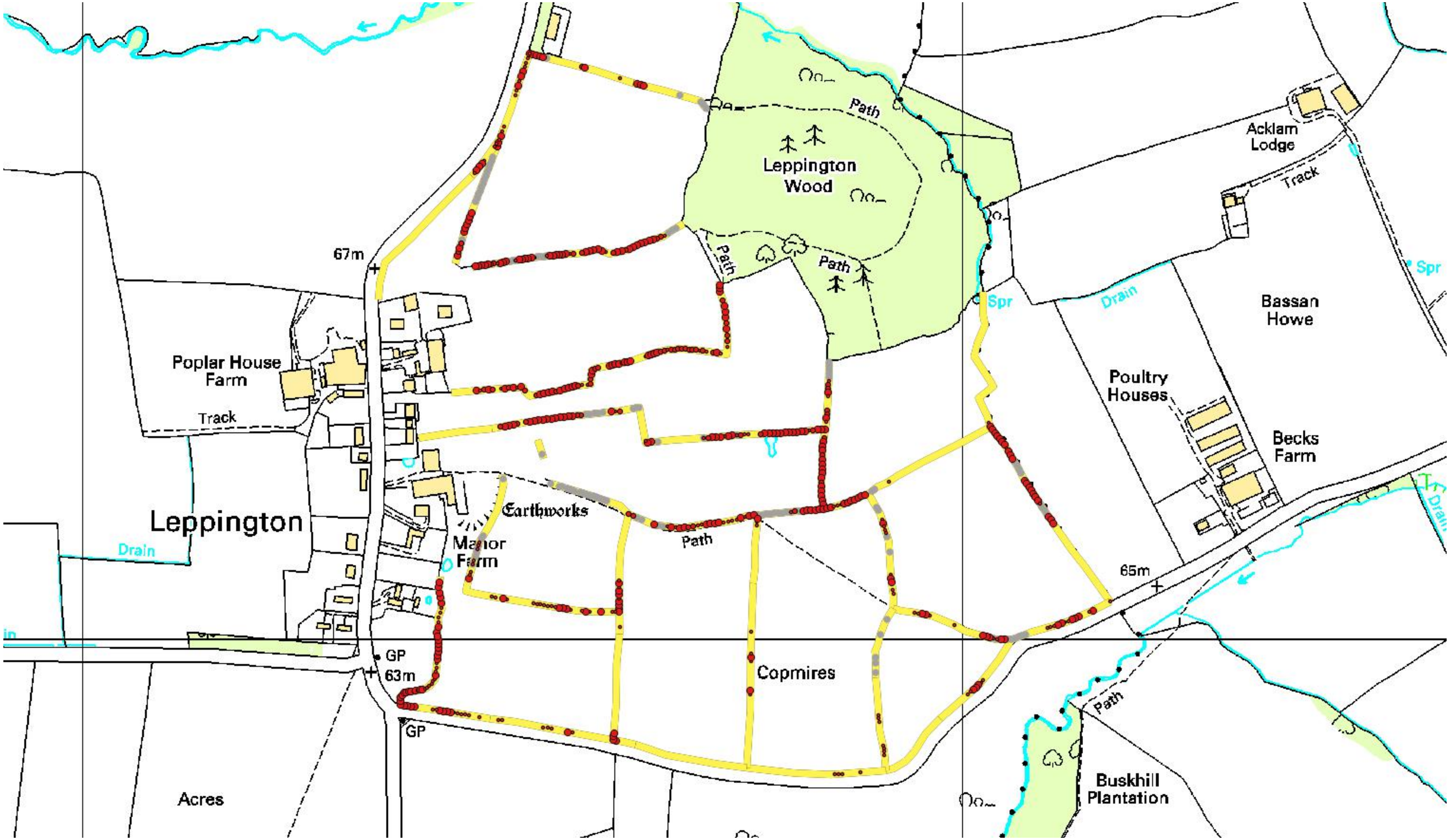


Figure 16.16 – *Prunus spinosa*

Species maps for Manor Farm, Leppington.

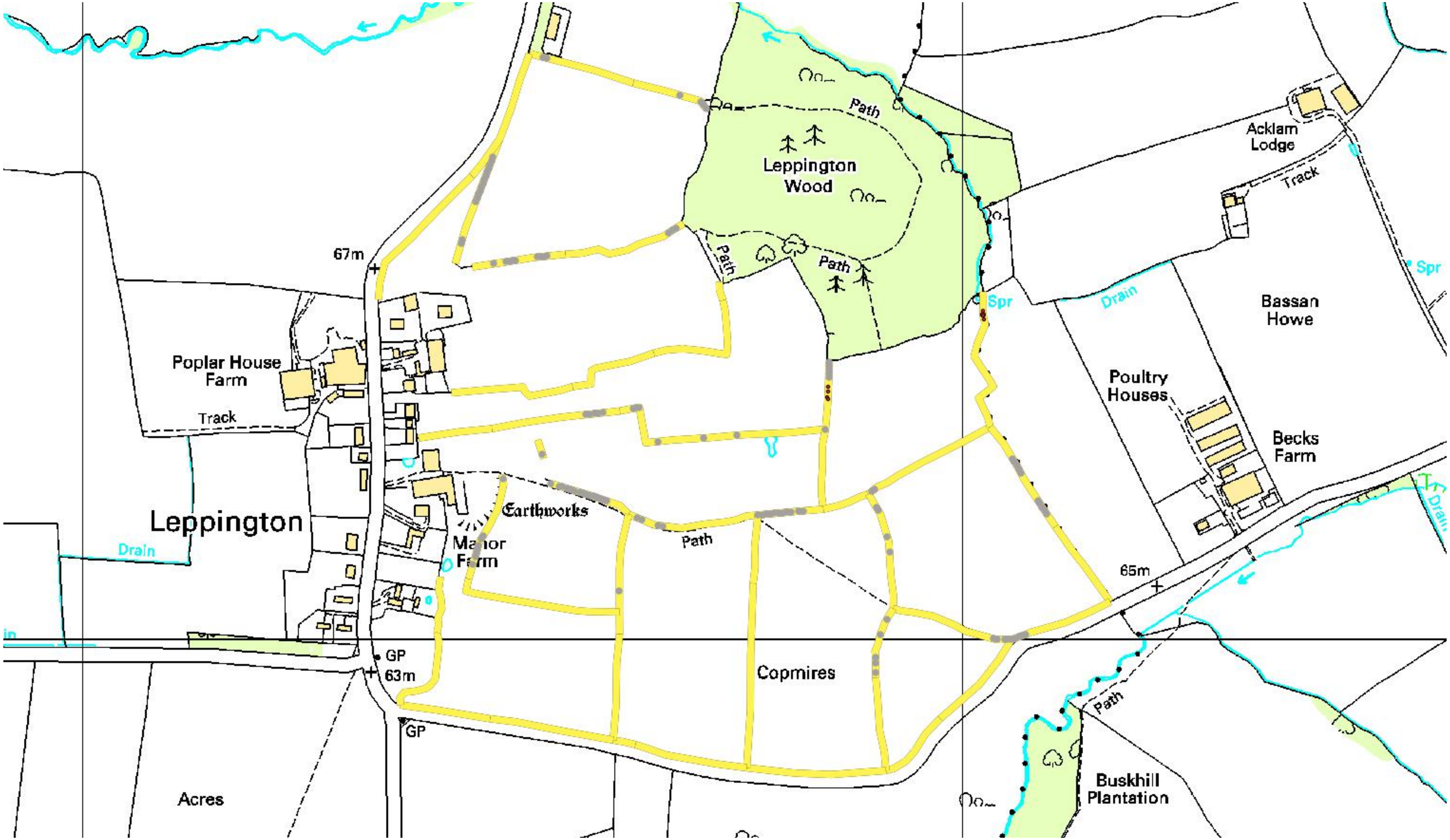


Figure 17.17 – *Pteridium aquilinum*

Species maps for Manor Farm, Leppington.

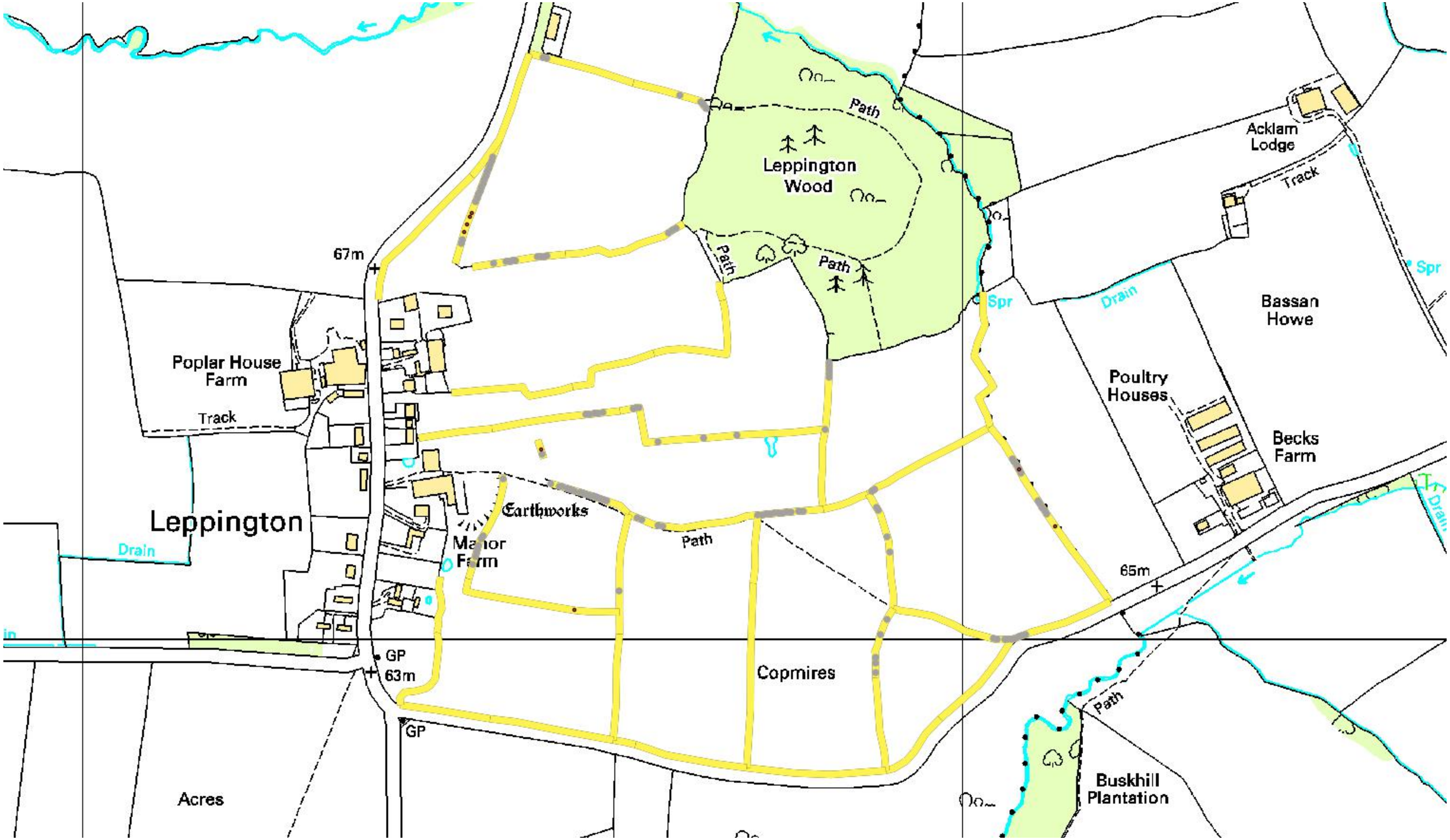


Figure 18.18 – *Quercus robur*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

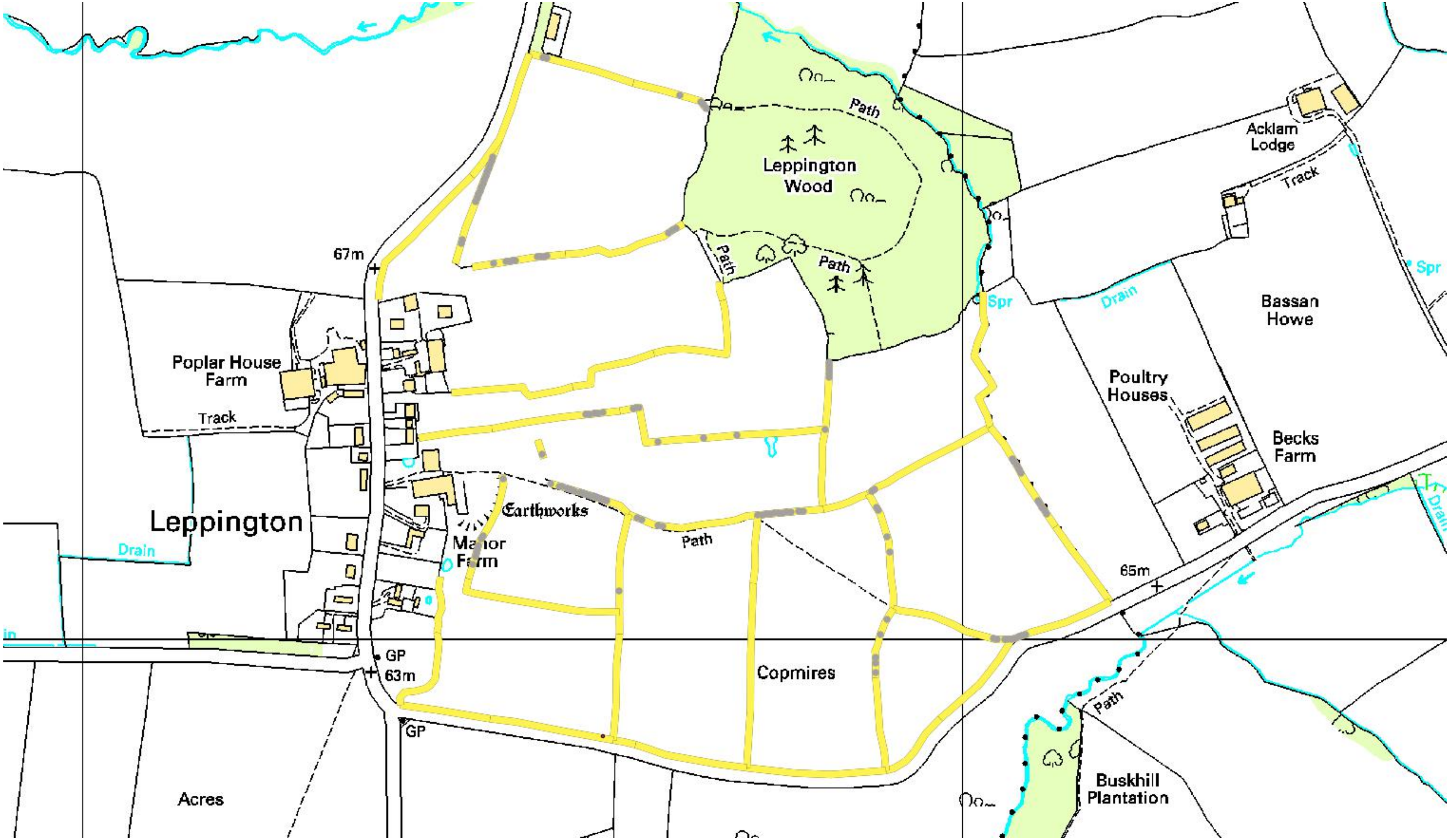


Figure 19.19 – *Ranunculus auricomis*

Species maps for Manor Farm, Leppington.

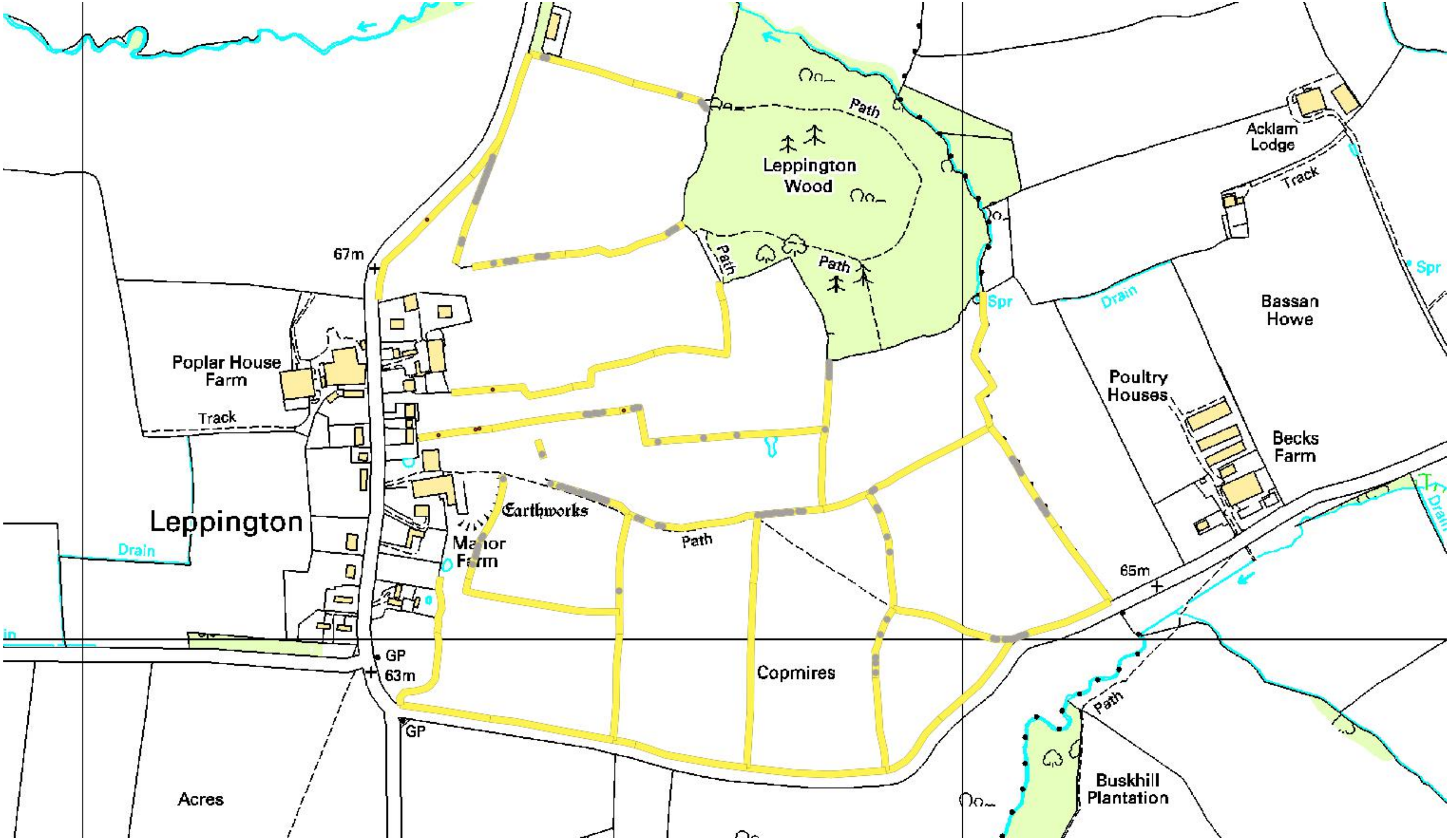


Figure 20.20 – *Ribes uva-crispa*

Species maps for Manor Farm, Leppington.

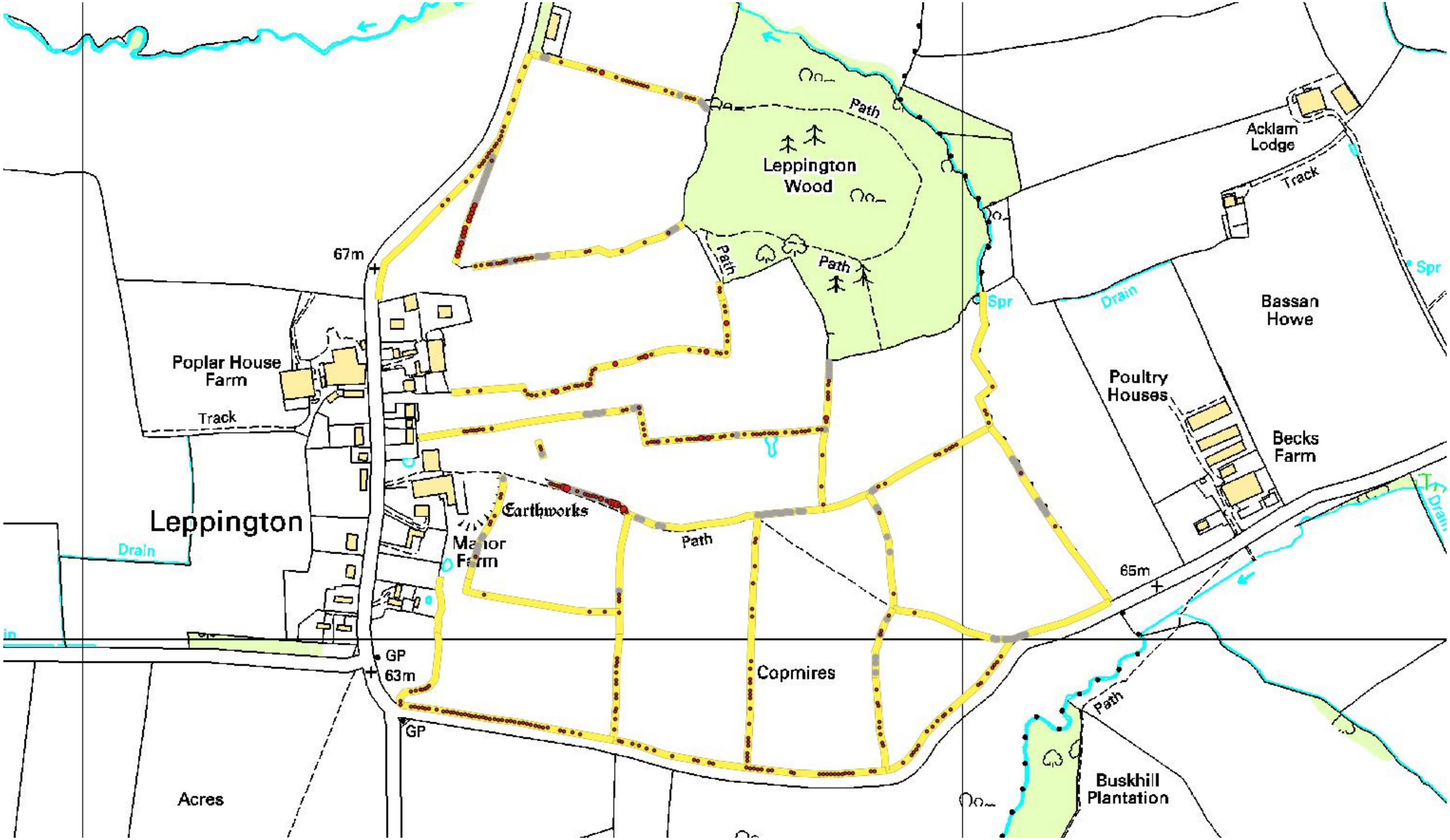


Figure 21.21 – *Rosa canina*

Species maps for Manor Farm, Leppington.

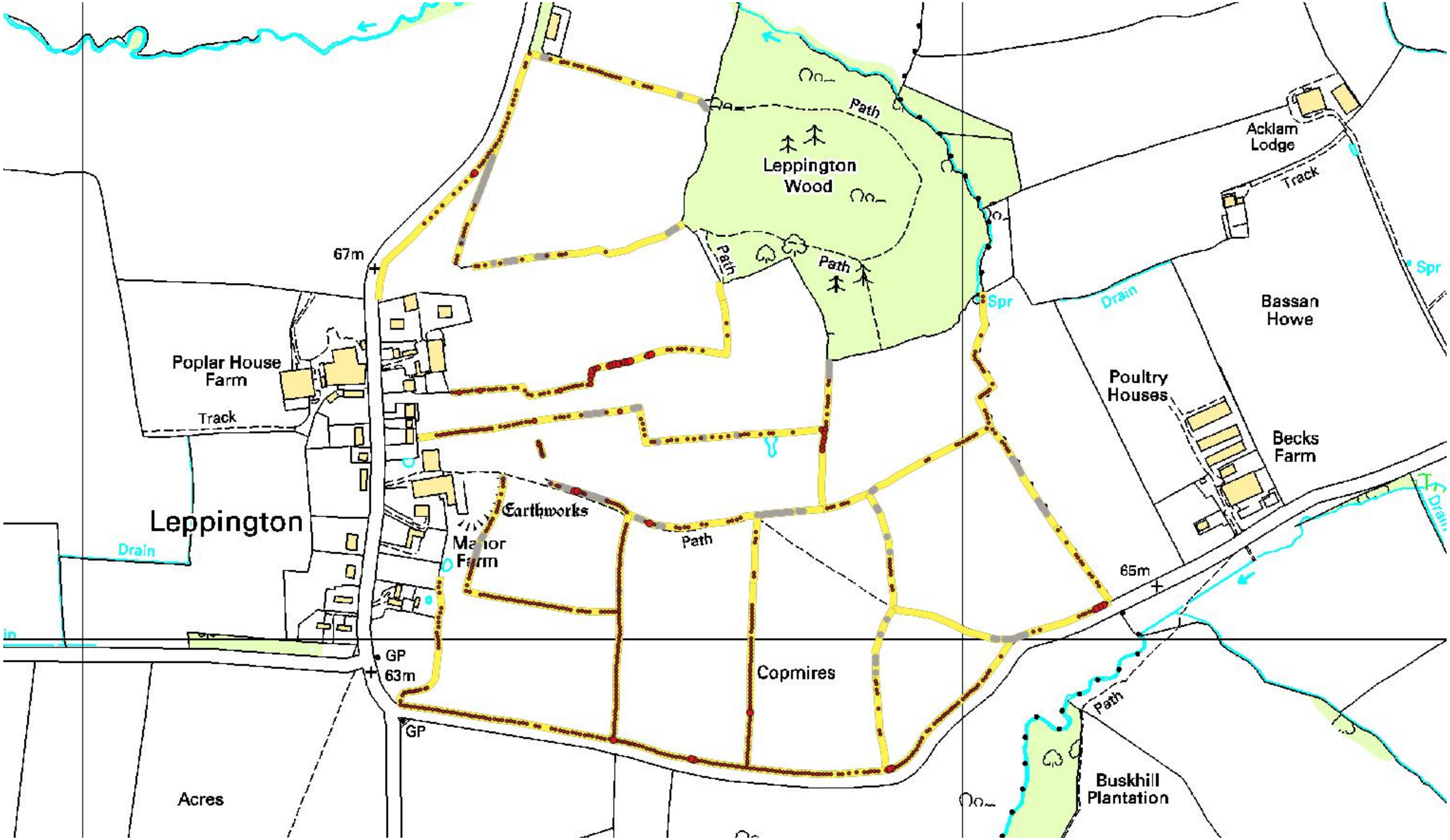


Figure 22.22 – *Rubus fruticosus*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Species maps for Manor Farm, Leppington.

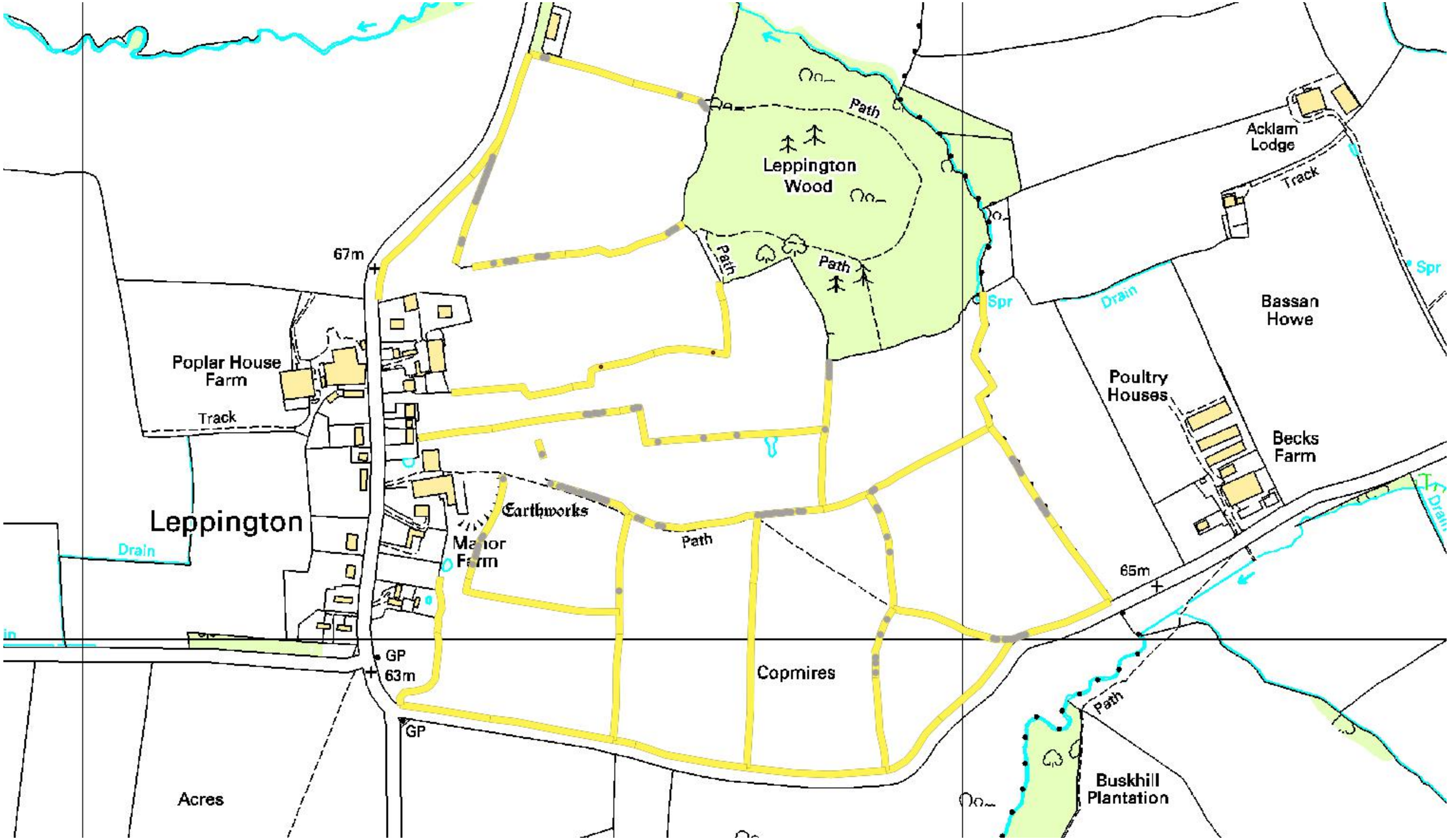


Figure 23.23 – *Salix cinerea*

Species maps for Manor Farm, Leppington.

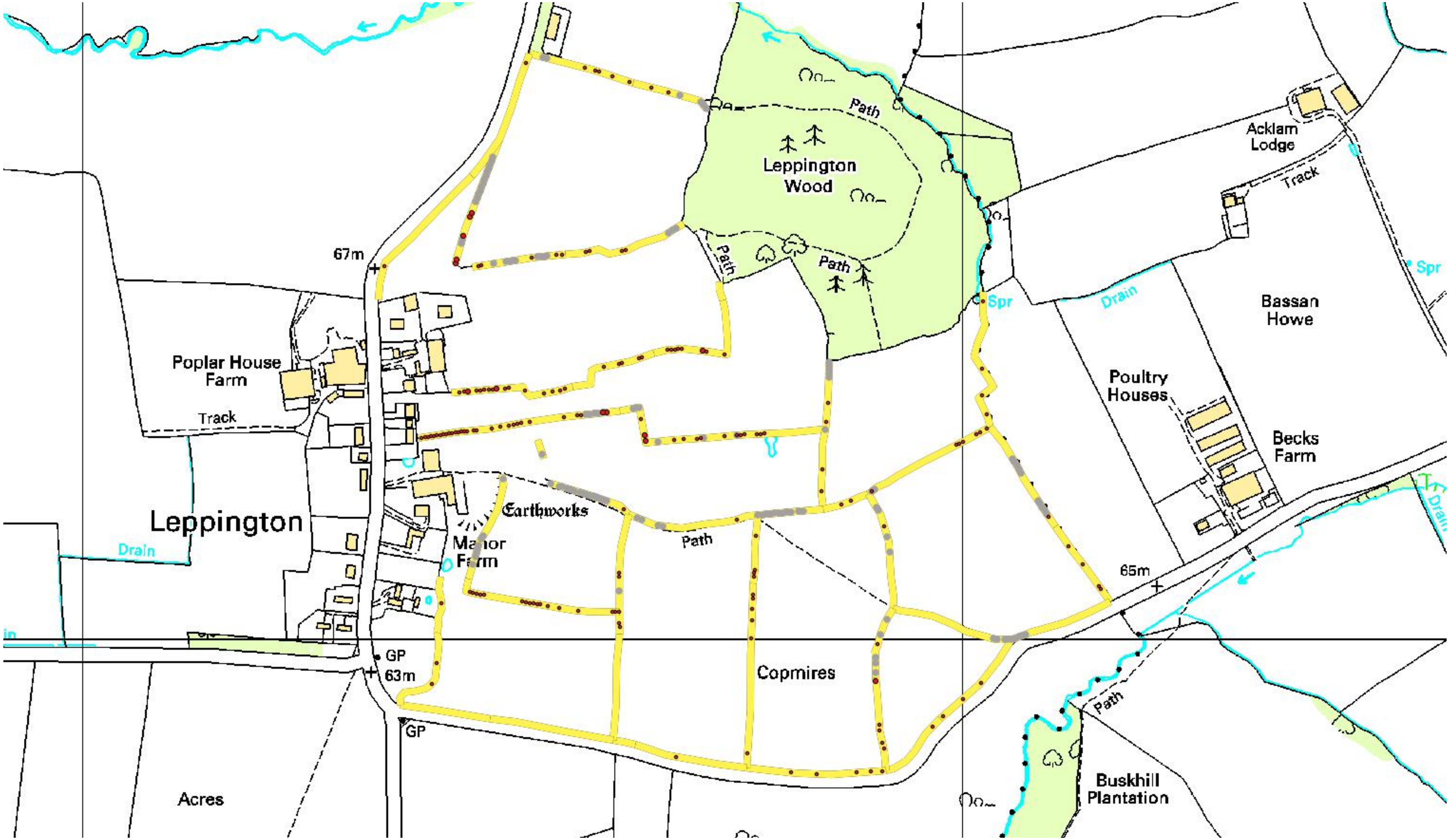


Figure 24.24 – *Sambucus nigra*

Species maps for Manor Farm, Leppington.

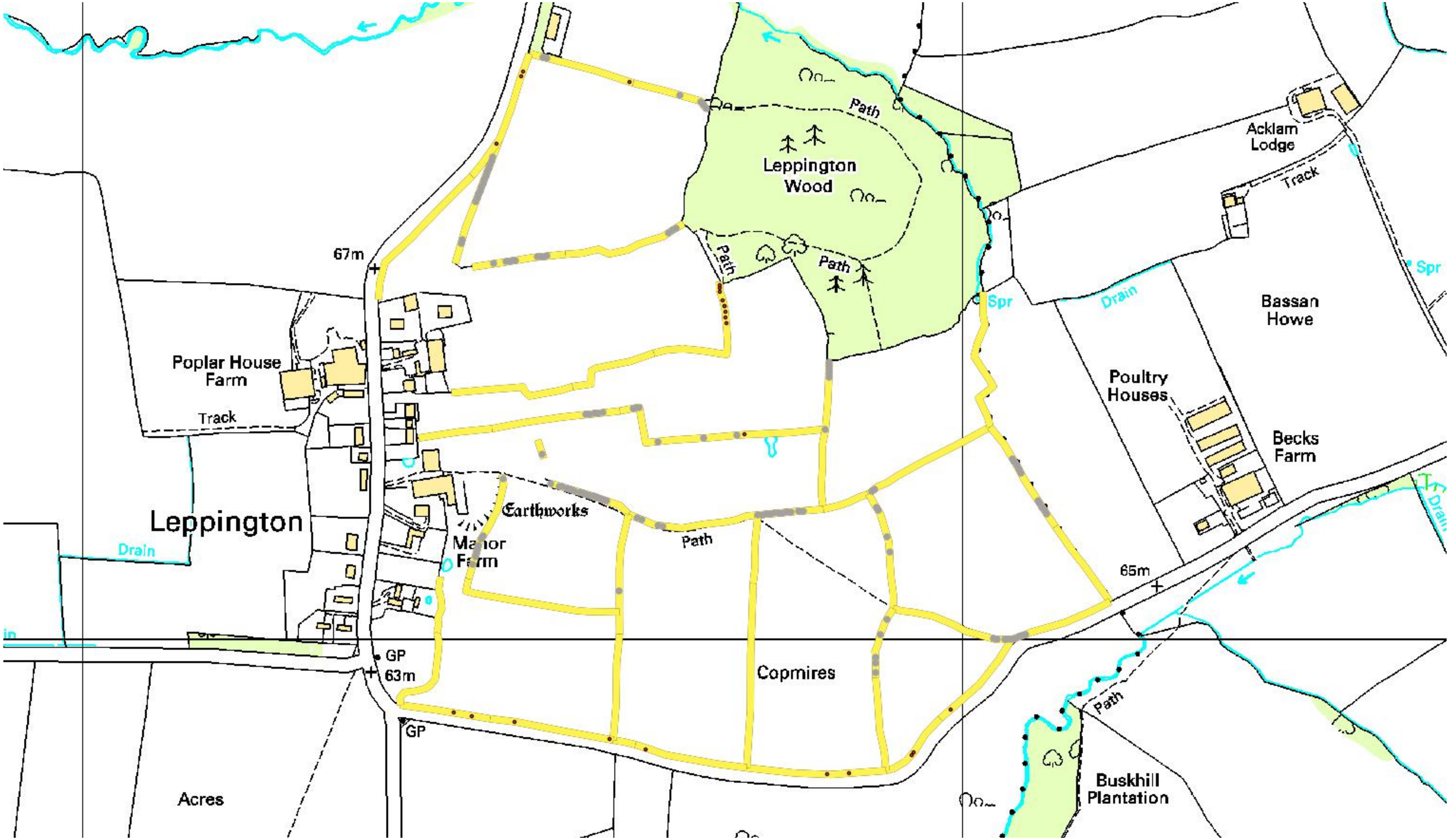


Figure 25.25 – *Tamus communis*

Species maps for Manor Farm, Leppington.

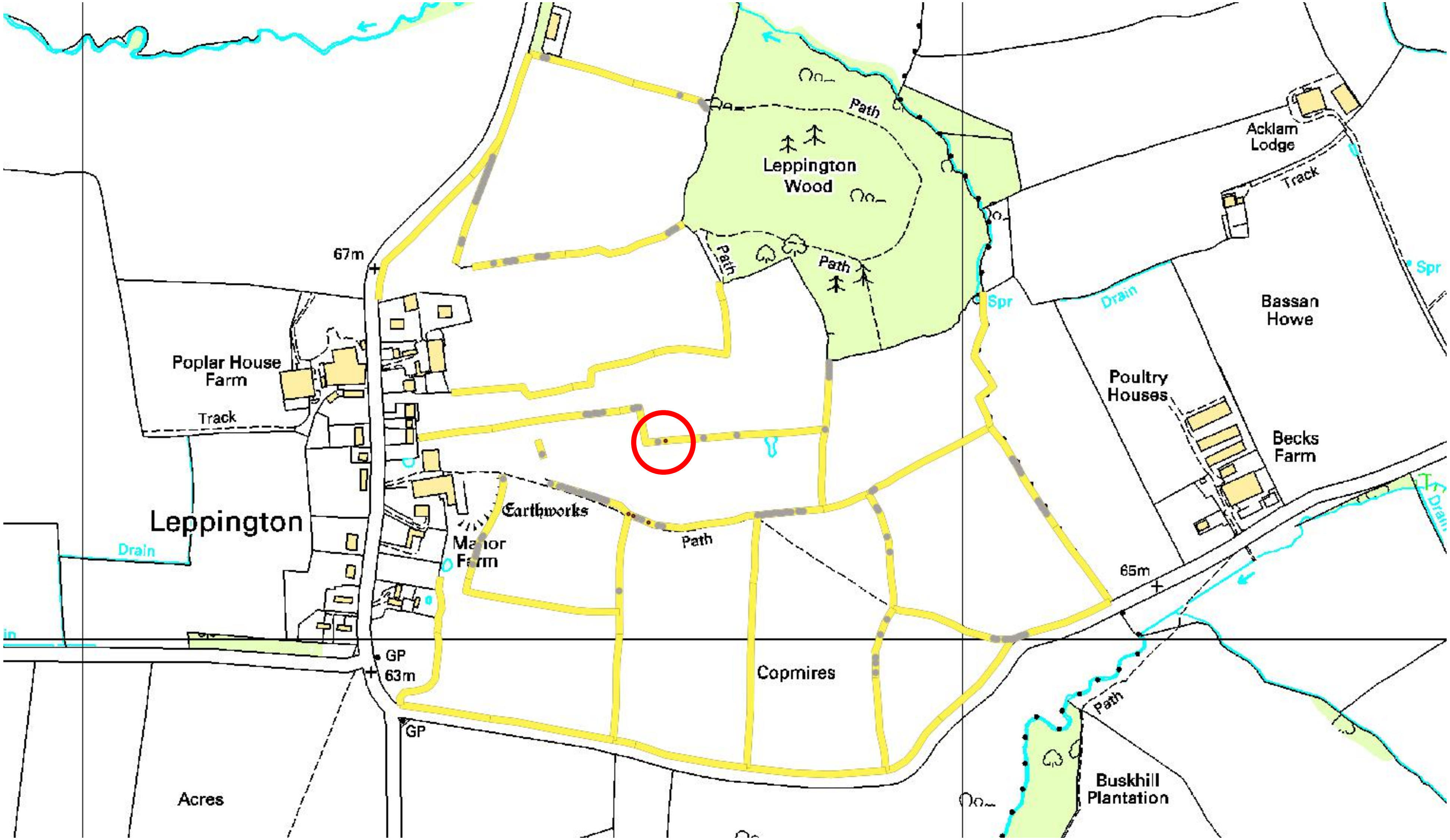


Figure 26.26 – *Viola riviniana*

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL029-BL031-01				3												1														
BL029-BL031-02				2												1														
BL029-BL031-03				3												2			1											
BL029-BL031-04				3												1			1											
BL029-BL031-05				2				1							1	1			2											
BL029-BL031-06				2				2								1														
BL029-BL031-07												3				1			1											
BL029-BL031-08				2								1			1	2			1											
BL029-BL031-09				2								2				1			1											
BL029-BL031-10				1								3				1			1											
BL029-BL031-11				2								2				1			1											
BL029-BL031-12				3							1					1			2											
BL029-BL031-13				3							1	1				1														
BL029-BL031-14				1							1	3				1			1											
BL029-BL031-15				2								2							1							1				
BL029-BL031-16				1								3				1										1				
BL029-BL031-17				3								1				1										1				
BL029-BL031-18				2								3														1				
BL029-BL031-19				3								2			1	1			1							1				
BL029-BL031-20				3											1	1										1				
BL029-BL031-21				3											1	1										1				
BL029-BL031-22				2								2			1											1				
BL029-BL031-23												3				1										1				
BL029-BL031-24												3			1	1			1							1				
BL029-BL031-25												3				1										1				

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL029-BL031-26												3			1				1											
BL029-BL031-27												2			2	1														
BL029-BL031-28												3				2			1											
BL029-BL031-29												3			1	1			1											
BL029-BL031-30												3			1	1														
BL031-BL033-01												3				1														
BL031-BL033-02				1								3			1	1														
BL031-BL033-03				2								2			1	1										1				
BL031-BL033-04				3								1			1	1									1	1				
BL031-BL033-05				3																					1	1				
BL031-BL033-06				2								1			2	1									1					
BL031-BL033-07				2								2			1	2									1					
BL031-BL033-08				2								2			1	2									1	1				
BL031-BL033-09				1								3			1	3										1				
BL031-BL033-10				1								3			1	3					1					2				
BL031-BL033-11				2								2			1	2										1				
BL031-BL033-12				1								2				2														
BL031-BL033-13				2													1													
BL031-BL033-14				3															1											
BL031-BL033-15				3																										
BL031-BL033-16				3								3				3														
BL031-BL033-17				1								3				3														
BL031-BL033-18				2								3			2	3														
BL031-BL033-19				1								3				3			1											
BL031-BL033-20				3								1				1			1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL031-BL033-21												3				3														
BL031-BL033-22												3				3														
BL031-BL033-23												3				3														
BL031-BL033-24																														
BL031-BL033-25				3																										
BL031-BL033-26				2						1					1				1											
BL031-BL033-27				3	1										1				1											
BL031-BL033-28				3								1			2	1														
BL031-BL033-29				1								3				3														
BL031-BL033-30												3			1	3														
BL033-BL035-01				1								3																		
BL033-BL035-02				2								3																		
BL033-BL035-03				3								2																		
BL033-BL035-04				2								2																		
BL033-BL035-05				3								1				1			1											
BL033-BL035-06				2								2				1			1							1				
BL033-BL035-07				2								2							1							1				
BL033-BL035-08				2								2				1			1							1				
BL033-BL035-09				2								2				1			1							1				
BL033-BL035-10				2								2				1										2				
BL033-BL035-11				2								2			1															
BL033-BL035-12				2								2				1														
BL033-BL035-13				2								2																		
BL033-BL035-14				3								1			1															
BL033-BL035-15				3								2				1			2				1		1					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL033-BL035-16	1			3								1			2				1						1	1				
BL033-BL035-17				3																						1				
BL033-BL035-18				3								2					1													
BL033-BL035-19			1	1								3			1										1					
BL033-BL035-20			1	1								1			1										1	1				
BL033-BL035-21				3															1		1				1					
BL033-BL035-22				3											1															
BL033-BL035-23				3								1																		
BL033-BL035-24				2								2			1											2				
BL033-BL035-25				2								2			1	1										1				
BL033-BL035-26				1								3													1					
BL033-BL035-27				2								2			2	1									1	1				1
BL033-BL035-28				1								3													1	1				1
BL033-BL035-29												3			1											1				1
BL033-BL035-30			1									3			1										1					1
BL035-BL036-01			1	3								2														1				1
BL035-BL036-02				2																										
BL035-BL036-03				2																										
BL035-BL036-04												3			1															1
BL035-BL036-05				1								3			1															1
BL035-BL036-06												3																		1
BL038-BL039-01						3																								
BL038-BL039-02						3																								
BL038-BL039-03						3																								
BL038-BL039-04				2		2																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL038-BL039-05				2		2																								
BL038-BL039-06				2								1			1	1														
BL038-BL039-07				2								2			1	1									1					
BL038-BL039-08				1								2																		
BL038-BL039-09				3								3			1															
BL038-BL039-10				3								1			1	1														
BL038-BL039-11				3											1	1							1				1			
BL038-BL039-12				3												1			1											
BL038-BL039-13				2					1							1														
BL038-BL039-14				2								2																		
BL038-BL039-15				2								2				1														
BL038-BL039-16				2								3			2															
BL038-BL039-17				3								1			1	1			1											
BL038-BL039-18				3												1														
BL039-BL040-01						1						3																		
BL039-BL040-02												3			1	2														
BL039-BL040-03												3			1											1				
BL039-BL040-04				2								2														1				
BL039-BL040-05				3								1			1															
BL039-BL040-06												3			1															
BL039-BL040-07				1								3			1															
BL039-BL040-08				1	1							3			1															
BL039-BL040-09				1								3			1	1														
BL039-BL040-10				1								3													1					
BL039-BL040-11				1								3			1										1					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL039-BL040-12				1								3													1					
BL039-BL040-13				1								3			1															
BL039-BL040-14												3			1	1							1		1					
BL039-BL040-15				1								3			1	1									1					
BL039-BL040-16									1			3			1				1											
BL039-BL040-17				2								2			1	1			1											
BL039-BL040-18				3											1				1											
BL039-BL040-19				3											1															
BL039-BL040-20				3								1				1														
BL039-BL040-21				3								1			1	1			1											1
BL039-BL040-22				2								2				1			1											
BL039-BL040-23				3		1						1							1											
BL039-BL040-24				1								3			1															
BL039-BL040-25				1								3				1														
BL039-BL040-26				3								1			1				1											
BL039-BL040-27									1			3			1	1														
BL039-BL040-28				1					1			3																		
BL039-BL040-29				1								3			1	1														
BL039-BL040-30												2			2															
BL039-BL061-01				3												2														
BL039-BL061-02				3												2														
BL039-BL061-03				2								2				2														
BL039-BL061-04				2								3				2														
BL039-BL061-05				2								3				2														
BL039-BL061-06				2								3				2														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL039-BL061-07				2								2			1															
BL039-BL061-08				2								3																		
BL039-BL061-09												3																		
BL039-BL061-10				2								3							1											
BL039-BL061-11				2								3																		
BL039-BL061-12												3																		
BL039-BL061-13										1		2																		
BL039-BL061-14										1		3			1															
BL039-BL061-15				2								3							1											
BL039-BL061-16					1							3																		
BL039-BL061-17				2								3																		
BL039-BL061-18												3			1															
BL040-BL042-01				33		1						1			1							1								
BL040-BL042-02															2	1			1		1									
BL040-BL042-03															1				1											
BL040-BL042-04															1	1														
BL040-BL042-05				2											1						1									
BL040-BL042-06				3											1	1														
BL040-BL042-07																			1											
BL040-BL042-08				3											1															
BL040-BL042-09				3											1	1														
BL040-BL042-10				3															1											
BL040-BL042-11				3												1														
BL040-BL042-12				3											1	1														
BL040-BL042-13				31							3																			

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL040-BL042-14											3																			
BL040-BL042-15						1									1															
BL040-BL042-16				1											1	1														
BL040-BL042-17				1								3			1	1														
BL040-BL042-18				3								3			1															
BL040-BL042-19				3	1							1							2											
BL040-BL042-20				3											1	1			2											
BL040-BL042-21				3											1	1														
BL040-BL042-22				3											1	1														
BL040-BL042-23				3												1			1											
BL040-BL042-24				3											1															
BL040-BL042-25						1									1															
BL040-BL042-26						3																								
BL040-BL042-27						3																								
BL040-BL042-28				3							2																			
BL040-BL042-29				3							1				1															
BL040-BL042-30				3							1				1															
BL042-BL043-01				3								2				2														
BL042-BL043-02				3								1																		
BL042-BL043-03				2								3																		
BL042-BL043-04				3												1			2											
BL042-BL043-05				3		2													2		2									
BL042-BL043-06						3																								
BL042-BL043-07						3																								
BL042-BL043-08						3																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL042-BL043-09				2		3																								
BL042-BL043-10				2								2				1			1						2					
BL042-BL043-11												2							1						1					
BL042-BL043-12												3																		
BL042-BL043-13												3				1														
BL042-BL043-14												3				1			1											
BL042-BL043-15												3				1														
BL042-BL043-16												3				1														
BL042-BL043-17												3																		
BL042-BL043-18												3																		
BL042-BL043-19												3																		
BL042-BL043-20												3																		
BL042-BL043-21												3				2										1				
BL042-BL043-22												3				1			1		1					1				
BL042-BL043-23				2								2				1					1									
BL042-BL043-24				3												1			1							1				
BL042-BL043-25				2								2				1			1		1					1				
BL042-BL043-26												3				1			1											
BL042-BL043-27				2								3				1			1											
BL042-BL043-28												3				1														
BL042-BL043-29				2								2				1			1											
BL042-BL043-30				3																										
BL043-BL044-01				3											1	1			1											
BL043-BL044-02				3	1											1														
BL043-BL044-03				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL043-BL044-04				3											1	1														
BL043-BL044-05				3											1	1														
BL043-BL044-06				3											1	1			1											
BL043-BL044-07				3											1	1			1											
BL043-BL044-08				3				1							1	1														
BL043-BL044-09				3				1							1	1			1											
BL043-BL044-10				3											1	1			1											
BL043-BL044-11				3												1			1											
BL043-BL044-12				3												1			1											
BL043-BL044-13				3												1			1											
BL043-BL044-14				3												1			1											
BL043-BL044-15				3												1			1											
BL043-BL044-16				3												1			1											
BL043-BL044-17				3												1			1											
BL043-BL044-18				3				1								1			1											
BL043-BL044-19				3												1			1											
BL043-BL044-20				3															1											
BL043-BL044-21				3															1											
BL043-BL044-22				3															1											
BL043-BL044-23				3															1											
BL043-BL044-24				3															1											
BL045-BL046-01				3												1			2											
BL045-BL046-02	2			2												1			2											
BL045-BL046-03	2			2								3			2	1														
BL045-BL046-04				3								2			2															

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL045-BL046-05				2								3			2															
BL045-BL046-06				2		2						2			2	1														
BL045-BL046-07						3																								
BL045-BL046-08	2			3											2	1			2											
BL045-BL046-09				2								3	1		2	1														
BL045-BL046-10												3			2	1														
BL045-BL046-11				2								3	1			1														
BL045-BL046-12												3			2															
BL045-BL046-13												3	1		2				2											
BL045-BL046-14				2								3	1		2				2											
BL045-BL046-15				3											2	1														
BL045-BL046-16				3											2	1														
BL045-BL046-17						3																								
BL045-BL046-18						3																								
BL045-BL046-19						3																								
BL045-BL046-20						3																								
BL045-BL046-21						3																								
BL045-BL046-22						3																								
BL045-BL046-23						3																								
BL045-BL046-24						3																								
BL045-BL046-25						3																								
BL045-BL046-26						3																								
BL045-BL046-27						3																								
BL045-BL046-28				2		3									1															
BL045-BL046-29				3		3																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL045-BL046-30				3																										
BL045-BL046-31																														
BL045-BL046-32												3																		
BL045-BL046-33												3																		
BL047-BL048-01												3																		
BL047-BL048-02				1								3																		
BL047-BL048-03				1								3																		
BL047-BL048-04				1								3																		
BL047-BL048-05						2						3																		
BL047-BL048-06				3		2																								
BL047-BL048-07				3												1														
BL047-BL048-08				3																										
BL047-BL048-09				3																										
BL047-BL048-10				3											1	1														
BL047-BL048-11				3						1						1														
BL047-BL048-12				3						1						1														
BL047-BL048-13				3																										
BL047-BL048-14				3												1														
BL047-BL048-15				3												1														
BL047-BL048-16				3								2				1														
BL047-BL048-17				2								3							1											
BL047-BL048-18				3											1	1														
BL047-BL048-19				3											1	1														
BL047-BL048-20				3											1	1			1											
BL047-BL048-21				3												1			1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL047-BL048-22				2											2	1														
BL047-BL048-23				3												1														
BL047-BL048-24				3												1														
BL047-BL048-25				3												1			1											
BL047-BL048-26				3											1	1														
BL047-BL048-27				3								1				1														
BL047-BL048-28				3											1															
BL047-BL048-29				3											1															
BL047-BL048-30				3											1				1											1
BL047-BL866-01				3	1							1				1														
BL047-BL866-02				1								1																		
BL047-BL866-03				1								1				1			1											
BL047-BL866-04				3								1			1	1														
BL047-BL866-05				1	1							3																		1
BL047-BL866-06					1							3																		1
BL047-BL866-07	1				1							1			1															
BL047-BL866-08					3							3																		
BL047-BL866-09												1				1														
BL047-BL866-10					1							1				1														
BL047-BL866-11					1										1	1														
BL047-BL866-12				3												1														
BL047-BL866-13				3			1																							
BL047-BL866-14				1	3										1	1														
BL047-BL866-15				1	3											1														
BL047-BL866-16				1	3											1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL047-BL866-17				1	3							1			1	1														
BL047-BL866-18				1	1							1			1	1														
BL047-BL866-19				1	1							3			1	1														
BL047-BL866-20				1								1			1	1														
BL047-BL866-21				1	1							1			1	1														1
BL047-BL866-22				1	3							1			1	1														
BL047-BL866-23				3	1										1	1														
BL047-BL866-24				1	1										1	1														
BL047-BL866-25				1	1										1	1														
BL047-BL866-26				1	1							1			1	1														
BL047-BL866-27					1							3			1	1														
BL047-BL866-28												3			1	1														
BL047-BL866-29					1							3																		
BL047-BL866-30												1				3														
BL048-BL049-01				3											1	1														
BL048-BL049-02				1								3			1															
BL048-BL049-03									1			3			1															
BL048-BL049-04				1								3			1	1														
BL048-BL049-05				3											1	1														
BL048-BL049-06				3												1			1											
BL048-BL049-07				3																										
BL048-BL049-08				3																										
BL048-BL049-09				3																										
BL048-BL049-10				3											1															
BL048-BL049-11				3															1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES														
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can
BL048-BL049-12				3											1
BL048-BL049-13				3											
BL048-BL049-14				3		1									
BL048-BL049-15				3											
BL048-BL049-16				3											1
BL048-BL049-17				1											1
BL048-BL049-18				3											1
BL048-BL049-19				3											
BL048-BL049-20				3		3									
BL048-BL049-21				2		3									
BL048-BL049-22						3									
BL050-BL052-01				3											
BL050-BL052-02				3											
BL050-BL052-03						3									
BL050-BL052-04						3									
BL050-BL052-05				1		3									1
BL050-BL052-06				3								1			
BL050-BL052-07				2								2			
BL050-BL052-08				2								2			
BL050-BL052-09				1								3			
BL050-BL052-10				1								3			
BL050-BL052-11				1								3			1
BL050-BL052-12				1								3			
BL050-BL052-13				1								3			
BL050-BL052-14				1								3			

	SPECIES														
RECORD POINT	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL048-BL049-12															
BL048-BL049-13															
BL048-BL049-14															
BL048-BL049-15															
BL048-BL049-16															
BL048-BL049-17															
BL048-BL049-18															
BL048-BL049-19															
BL048-BL049-20															
BL048-BL049-21															
BL048-BL049-22															
BL050-BL052-01															
BL050-BL052-02															
BL050-BL052-03															
BL050-BL052-04															
BL050-BL052-05															
BL050-BL052-06															
BL050-BL052-07															
BL050-BL052-08															
BL050-BL052-09															
BL050-BL052-10															
BL050-BL052-11															
BL050-BL052-12															
BL050-BL052-13															
BL050-BL052-14															

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL050-BL052-15				1								3																		
BL050-BL052-16				2								2							1											
BL050-BL052-17				1								3			1				1											
BL050-BL052-18				1								3																		
BL050-BL052-19				2								2																		
BL050-BL052-20				1																										
BL050-BL052-21				1								1				1														
BL050-BL052-22				1								3																		
BL050-BL052-23												3																		
BL050-BL052-24				1								3																		
BL050-BL052-25												3			1				1											
BL050-BL052-26												3			1				1											
BL050-BL052-27				2								2																		
BL050-BL052-28																														
BL050-BL052-29				2								2																		
BL050-BL052-30				1								1																		
BL052-BL053-01				1								3				1														
BL052-BL053-02												3				1			1											
BL052-BL053-03												3				1														
BL052-BL053-04												3							1											
BL052-BL053-05												3																		
BL052-BL053-06				1								3																		
BL052-BL053-07				1		1						1				1														
BL052-BL053-08				1		1																								
BL052-BL053-09						1																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL052-BL053-10						3																								
BL052-BL053-11				3								1																		
BL052-BL053-12												3			1				1											
BL052-BL053-13				1								3			1															
BL052-BL053-14												3			1															
BL052-BL053-15				1								3			1	1														
BL052-BL053-16				1								3			1															
BL052-BL053-17				3		2						1			1															
BL052-BL053-18						3																								
BL052-BL053-19						1																								
BL052-BL053-20						1						3			1															
BL052-BL053-21												3			1															
BL052-BL053-22												3			1	1														
BL052-BL053-23				2								1			1															
BL052-BL053-24				2		1						2																		
BL052-BL053-25				1								2			1															
BL052-BL053-26												3			1															
BL052-BL053-27												3				1														
BL052-BL053-28												3			1				1											
BL052-BL053-29												3				1			1											
BL052-BL053-30												3			1	1														
BL054-BL055-01				3																										
BL054-BL055-02				3												1														
BL054-BL055-03				2												2														
BL054-BL055-04				3											1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL054-BL055-05				1									1		1	1														
BL054-BL055-06				3												1														
BL054-BL055-07				3		1										1														
BL054-BL055-08				3												1														
BL056-BL058-01				3		1									1	1														
BL056-BL058-02				3											1															
BL056-BL058-03				3											1	1														
BL056-BL058-04				3		1									1	1														
BL056-BL058-05				3		1									1															
BL056-BL058-06				2											3															
BL056-BL058-07						1									3															
BL056-BL058-08						3																								
BL056-BL058-09						3																								
BL056-BL058-10						1										3														
BL056-BL058-11															1	3														
BL056-BL058-12						3										1														
BL056-BL058-13				1		3										1														
BL056-BL058-14						3									1	1														
BL056-BL058-15				1		3									1															
BL056-BL058-16						3									1															
BL056-BL058-17						3									1															
BL056-BL058-18						3									1															
BL056-BL058-19						3																								
BL056-BL058-20						2									2															
BL056-BL058-21						3																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL056-BL058-22				3		1									1	1														
BL056-BL058-23				3											1	1														
BL056-BL058-24				1											3	1														
BL056-BL058-25	1														3	1														
BL056-BL058-26	1														3	1														
BL056-BL058-27				1											1	1														
BL056-BL058-28	1			1											1	1														
BL056-BL058-29	1														3	1			1											
BL056-BL058-30				1											1	1														
BL058-BL060-01				2								2												1					1	
BL058-BL060-02				2								2																	1	
BL058-BL060-03						3																								
BL058-BL060-04				2		3																								
BL058-BL060-05				3												1														
BL058-BL060-06				1												3														
BL058-BL060-07				1								3				1														
BL058-BL060-08						3																								
BL058-BL060-09				2		3																								
BL058-BL060-10				2								1																		
BL058-BL060-11				1								3																		
BL058-BL060-12				3								1				1														
BL058-BL060-13				1								3				1														
BL058-BL060-14				1								3				1														
BL058-BL060-15				2								2				1														
BL058-BL060-16				2								2																		

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL058-BL060-17				1				1				1																		
BL058-BL060-18				3								1				1														
BL058-BL060-19				1								3				1														
BL058-BL060-20			1	1								3																		
BL058-BL060-21												3																		
BL058-BL060-22												3																		
BL058-BL060-23				3								1																		
BL058-BL060-24				3								1				1														
BL058-BL060-25				3								1				1														
BL058-BL060-26				3								1				1			1											
BL058-BL060-27				1								3				1														
BL058-BL060-28				3								1																		
BL058-BL060-29												3																		
BL058-BL060-30												3																		
BL060-BL061-01						3																								
BL060-BL061-02						3																								
BL060-BL061-03						3																								
BL060-BL061-04						3																								
BL060-BL061-05						3																								
BL060-BL061-06						3																								
BL060-BL061-07						3																								
BL060-BL061-08						3																								
BL060-BL061-09						3						1																		
BL060-BL061-10				2								2																		
BL060-BL061-11				3		1																								

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL060-BL061-12				1		1						3																		
BL060-BL061-13												3																		
BL060-BL061-14												3																		
BL060-BL061-15												3																		
BL060-BL061-16												3																		
BL061-BL799-01				1								3																		
BL061-BL799-02												3				1														
BL061-BL799-03												3				1														
BL061-BL799-04				1								1				1														
BL061-BL799-05				1								1																		
BL061-BL799-06				1								1				1			1											
BL061-BL799-07												3				1														
BL061-BL799-08												3				1														
BL061-BL799-09												3							1											
BL061-BL799-10				1								3																		
BL061-BL799-11												3																		
BL061-BL799-12												3																		
BL061-BL799-13												3																		
BL799-BL811-01				3								1																		
BL799-BL811-02				3												1			1											
BL799-BL811-03				3																										
BL799-BL811-04				3															1											
BL799-BL811-05				3												1			1											
BL799-BL811-06				3												1														
BL799-BL811-07				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL799-BL811-08				3												1														
BL799-BL811-09				3												1			1											
BL799-BL811-10				3												1			1											
BL799-BL811-11				3											1	1			1											
BL799-BL811-12				3											1															
BL799-BL811-13				3											1															
BL799-BL811-14				3											1															
BL799-BL811-15				3																										
BL799-BL811-16				3											1															
BL799-BL811-17				3											1															
BL799-BL811-18				3																										
BL799-BL811-19				3												1														
BL799-BL811-20				3												1														
BL799-BL811-21				3																										
BL799-BL811-22				3																										
BL799-BL811-23				3																										
BL799-BL811-24				3																										
BL799-BL811-25				3																										
BL799-BL811-26				3																										
BL799-BL811-27				3																										
BL799-BL811-28				3																										
BL799-BL811-29				3																										
BL799-BL811-30				3																										
BL799-BL811-31				3								1																		
BL799-BL811-32				3											1															

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL799-BL811-33				3																										
BL799-BL811-34				3											1															
BL799-BL811-35				3		1																								
BL799-BL811-36				1		1													1											
BL799-BL824-01				3																										
BL799-BL824-02				3																										
BL799-BL824-03				3																										
BL799-BL824-04				3																										
BL799-BL824-05				3																										
BL799-BL824-06				1		3																								
BL799-BL824-07				1		1																								
BL799-BL824-08				3											1															
BL799-BL824-09				3																										
BL799-BL824-10				1								1																		
BL799-BL824-11				1								3																		
BL799-BL824-12				3								1							1											
BL799-BL824-13				1								1																		
BL799-BL824-14				1								1																		
BL799-BL824-15				3		1																								
BL799-BL824-16				3																										
BL799-BL824-17				3																										
BL799-BL824-18																														
BL799-BL824-19				1		1																								
BL799-BL824-20				3																										
BL799-BL824-21				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL799-BL824-22				3												1														
BL799-BL824-23				3												1														
BL799-BL824-24				3												1														
BL799-BL824-25				1								1				1														
BL799-BL824-26				1								3																		
BL799-BL824-27				1								3																		
BL799-BL824-28				3												1														
BL799-BL824-29				1								1				1														
BL799-BL824-30				1						2		1			1															
BL799-BL824-31				3																										
BL799-BL824-32				3																										
BL799-BL824-33																														
BL806-BL811-01				3																										
BL806-BL811-02				3												1														
BL806-BL811-03				3												1			1											
BL806-BL811-04				3																										
BL806-BL811-05				3																							1			
BL806-BL811-06				3																							1			
BL806-BL811-07				3																							1			
BL806-BL811-08				3																										
BL806-BL811-09				3																										
BL806-BL811-10				3																										
BL806-BL811-11				3												1														
BL806-BL811-12				3																										
BL806-BL811-13				3																										

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL806-BL811-14				3																										
BL806-BL811-15				3												1														
BL806-BL811-16				3												1														
BL806-BL811-17				3												1														
BL806-BL811-18				3												1														
BL806-BL811-19				3												1														
BL806-BL811-20				3												1			1											
BL806-BL811-21				3												1														
BL806-BL811-22				3																										
BL806-BL811-23				3																										
BL806-BL811-24				3																										
BL806-BL811-25				3												1														
BL806-BL811-26				3											1															
BL806-BL811-27				3												1														
BL806-BL811-28				3												1														
BL806-BL811-29				3												1														
BL806-BL811-30				3												1			1											
BL806-BL811-31				3												1														
BL806-BL811-32				3																										
BL806-BL811-33				3																										
BL806-BL811-34				3																										
BL806-BL811-35				3											1	1														
BL806-BL811-36				3											1	1			1											
BL806-BL811-37				3												1														
BL806-BL811-38				3								1			1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL811-BL817-01												3																		
BL811-BL817-02												3				1														
BL811-BL817-03												3				1														
BL811-BL817-04												3																		
BL811-BL817-05												3																		
BL811-BL817-06												3				1														
BL811-BL817-07				1								3				1														
BL811-BL817-08				1								1				1														
BL811-BL817-09				1								3				1														
BL811-BL817-10												3																		
BL811-BL817-11						1						3																		
BL811-BL817-12						3																								
BL811-BL817-13						3																								
BL811-BL817-14						3							1																	
BL811-BL817-15				3		1									1															
BL811-BL817-16				1																					1					
BL811-BL817-17												3													1					
BL811-BL817-18												3													1					
BL811-BL817-19												3													1					
BL811-BL817-20												3													1					
BL811-BL817-21				1								3													1					
BL811-BL817-22												3													1					
BL811-BL817-23						1						3													1					
BL811-BL817-24						3						1													1					
BL811-BL817-25						3																		1	1					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL811-BL817-26				1		1																			1					
BL811-BL817-27				1		1																			1					
BL811-BL817-28												3							1						1					
BL811-BL817-29												3													1					
BL811-BL817-30												3													1					
BL817-BL818-01				3									1		1															
BL817-BL818-02				3												1														
BL817-BL818-03				3																										
BL817-BL818-04				3																										
BL817-BL818-05				3																										
BL817-BL818-06				3												1														
BL817-BL818-07				3															1											
BL817-BL818-08				3							1																			
BL817-BL818-09																														
BL817-BL818-10				3												1														
BL817-BL818-11				3												1														
BL817-BL818-12				1							3					1														
BL817-BL818-13											3					1			1											
BL817-BL818-14											3																			
BL817-BL818-15				3							3																			
BL817-BL818-16				3												1														
BL817-BL818-17				3												1														
BL817-BL818-18				3																										
BL817-BL818-19				3												1														
BL817-BL818-20				3												1			1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL817-BL818-21				3															1											
BL817-BL818-22				3																										
BL817-BL818-23				3																										
BL817-BL818-24				3																										
BL818-BL821-01				3								1																		
BL818-BL821-02				3	1											1														
BL818-BL821-03				1												3														
BL818-BL821-04				1												3														
BL818-BL821-05				1	1											3														
BL818-BL821-06				1								3				1														
BL818-BL821-07				1								1				1														
BL818-BL821-08				1												1														
BL818-BL821-09				1												1														
BL818-BL821-10				1								3				1														
BL818-BL821-11				1								3																		
BL818-BL821-12				1								3																		
BL818-BL821-13				1								1																		
BL818-BL821-14				1								1																		
BL818-BL821-15				1								3																		
BL818-BL821-16				1								3																		
BL818-BL821-17				1								1																		
BL818-BL821-18				1								1																		
BL818-BL821-19				1						1		1																		
BL818-BL821-20				3						1																				
BL818-BL821-21				1						3						1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL818-BL821-22				1						3																				
BL818-BL821-23				3												1														
BL818-BL821-24				3																										
BL818-BL821-25				1		3																								
BL818-BL821-26						3																								
BL818-BL821-27						1																								
BL818-BL821-28						1																								
BL821-BL824-01						3																								
BL821-BL824-02						3																								
BL821-BL824-03				1		1						3																		
BL821-BL824-04				1								3																		
BL821-BL824-05						1						1																		
BL821-BL824-06						3						1																		
BL821-BL824-07												3																		
BL821-BL824-08												3																		
BL821-BL824-09												3																		
BL821-BL824-10				3																										
BL821-BL824-11				3																										
BL821-BL824-12				3																										
BL821-BL824-13				3																										
BL821-BL824-14				3																										
BL821-BL824-15				3																										
BL821-BL824-16				3																										
BL821-BL824-17				1								1																		
BL821-BL824-18				3																										

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL821-BL824-19				3																										
BL821-BL824-20				3																										
BL821-BL824-21				3																										
BL821-BL824-22				3																										
BL821-BL824-23				3																										
BL821-BL824-24				3								1																		
BL821-BL824-25				1								3																		
BL821-BL824-26				1								3																		
BL821-BL824-27				1								1																		
BL821-BL824-28				1								1			1															
BL821-BL824-29				3																										
BL821-BL824-30				1																										
BL821-BL824-31				1																										
BL821-BL824-32				1																										
BL821-BL824-33				3																										
BL821-BL827-01				3																										
BL821-BL827-02				3																										
BL821-BL827-03				3																										
BL821-BL827-04				3																										
BL821-BL827-05				3																										
BL821-BL827-06				3											1	1														
BL821-BL827-07				3																										
BL821-BL827-08				3											1															
BL821-BL827-09				3											1															
BL821-BL827-10				3											1															

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL821-BL827-11				3	1											1														
BL821-BL827-12				3											1	1														
BL821-BL827-13		1		3												1														
BL821-BL827-14				1	1							1				1														
BL821-BL827-15				1								1			1				1											
BL821-BL827-16												3			1	1														
BL821-BL827-17												3				1														
BL821-BL827-18												3				1														
BL821-BL827-19				1								1				1														
BL821-BL827-20				1								1				1														
BL821-BL827-21				3												1														
BL821-BL827-22				1												1			1											
BL821-BL827-23				3																										
BL821-BL827-24				3												1														
BL821-BL827-25				3												1														
BL821-BL827-26				3												1														
BL821-BL827-27				3											1	1														1
BL821-BL827-28				3												1														
BL821-BL827-29				3											1	1														
BL821-BL827-30				1											1	1			1											
BL824-BL832-01				3						3																				
BL824-BL832-02				3						1																				
BL824-BL832-03				3						1	3				1															
BL824-BL832-04				1		2					3																			
BL824-BL832-05				3							1																			

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL824-BL832-06				3							1																			
BL824-BL832-07				3				1							1															
BL824-BL832-08				3		2									1															
BL824-BL832-09				3																										
BL824-BL832-10				3															1											
BL824-BL832-11				3																										
BL824-BL832-12				3																										
BL824-BL832-13						3																								
BL824-BL832-14				1		3																								
BL824-BL832-15				3																										
BL824-BL832-16						3																								
BL827-BL830-01				3												1														
BL827-BL830-02				3											1	1														
BL827-BL830-03				3												1														
BL827-BL830-04				1											1				1											
BL827-BL830-05				3												1														
BL827-BL830-06				3											1	1														
BL827-BL830-07				3																										
BL827-BL830-08				3												1														
BL827-BL830-09				3												1														
BL827-BL830-10				3											1	1														
BL827-BL830-11				3	1										1	1														
BL827-BL830-12				3											1	1														1
BL827-BL830-13				3											1	1														1
BL827-BL830-14				3	1											1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL827-BL830-15				3	1											1														
BL827-BL830-16				3											1	1														
BL827-BL830-17				3	1											1														
BL827-BL830-18				3	1											1														
BL827-BL830-19				3	1											1														
BL827-BL830-20				1												3														
BL827-BL830-21				1												3														
BL830-BL832-01																														
BL830-BL832-02				3												1			2											
BL830-BL832-03				3												1														
BL830-BL832-04				3																										
BL830-BL832-05				3											1	1														
BL830-BL832-06				3												1														
BL830-BL832-07				3																										
BL830-BL832-08				3																										
BL830-BL832-09				3											1															
BL830-BL832-10				3											1															
BL830-BL832-11				3												1														
BL830-BL832-12				3																										
BL830-BL832-13				1								1																		
BL830-BL832-14				1								1																		
BL830-BL832-15				1								1			1															
BL830-BL832-16				3															1											
BL830-BL832-17				3											1															
BL830-BL832-18				3												1			1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL830-BL832-19				3											1	1														
BL830-BL832-20				3	1																									
BL830-BL832-21				1																										
BL830-BL832-22				3											1				1											
BL830-BL832-23				1								1			1															
BL830-BL832-24				1								1							1											
BL830-BL832-25				1								1																		
BL830-BL832-26				1								1																		
BL830-BL832-27				3																										
BL830-BL832-28				3																										
BL830-BL832-29				3																										
BL830-BL832-30				3						1																				
BL830-BL836-01				3												1														
BL830-BL836-02		1		1															1											
BL830-BL836-03				3												1														
BL830-BL836-04				3	1										1	1														
BL830-BL836-05				3											1	1			1											
BL830-BL836-06				3	1											1														
BL830-BL836-07				3	1											1														
BL830-BL836-08				3	1							1																		
BL830-BL836-09				3	1											1			1											
BL830-BL836-10				3	1										1															
BL830-BL836-11				3											1	1														1
BL830-BL836-12				3											1															
BL830-BL836-13				1								1			1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL830-BL836-14				1								1			1	1														
BL830-BL836-15				1	1							1			1															
BL830-BL836-16				1											1	1														
BL830-BL836-17				3											1	1														1
BL830-BL836-18				3											1	1														
BL830-BL836-19				3											1	1														
BL830-BL836-20				3												1			1											
BL830-BL836-21				3												1														
BL830-BL836-22				3												1														
BL830-BL836-23				3												1														
BL830-BL836-24				3												1														
BL830-BL836-25				3												1														
BL830-BL836-26				3											1	1														
BL830-BL836-27				3											1	1			1											
BL830-BL836-28				3												1														
BL830-BL836-29				3												1														
BL830-BL836-30				3												1														
BL830-BL836-31				3												1														
BL830-BL836-32				3											1	1														
BL830-BL836-33				3											1	1														
BL830-BL836-34				3												1														
BL830-BL836-35				3											1	1														
BL830-BL836-36				3	1										1	1														
BL830-BL836-37				3											1	1														
BL830-BL836-38				3	1										1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL836-BL838-01				3											1	1														
BL836-BL838-02				3												1														
BL836-BL838-03				3											1	1														
BL836-BL838-04				3											1	1														
BL836-BL838-05				3											1	1			1											
BL836-BL838-06				3												1														
BL836-BL838-07				3											1	1														
BL836-BL838-08				3											1	1														
BL836-BL838-09				3											1	1														
BL836-BL838-10				3												1														
BL836-BL838-11				3												1														
BL836-BL838-12				3												1														
BL836-BL838-13				3											1	1														
BL836-BL838-14				3												1														
BL836-BL838-15				3												1														
BL836-BL838-16				1												3														
BL836-BL838-17				3											1	1														
BL836-BL838-18				3												1														
BL836-BL838-19				3												1														
BL836-BL838-20				3											1	1														
BL836-BL838-21				3								1			1	1														
BL836-BL838-22												3			1	1														
BL836-BL838-23				3												1														
BL836-BL838-24				3											1	1														
BL836-BL838-25				3											1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL836-BL838-26				3												1														
BL836-BL838-27				3												1														
BL836-BL838-28				3											1	1														
BL836-BL838-29				3												1														
BL836-BL838-30				3								1			1	1														
BL836-BL838-31				1								3				1														
BL836-BL838-32				3								1				1														
BL836-BL838-33				3												1														
BL836-BL838-34				3												1														
BL836-BL838-35				3												1														
BL836-BL838-36				1												1			1											
BL836-BL838-37				1																										
BL836-BL838-38	1			3								1				1														
BL836-BL838-39				3												1														
BL836-BL838-40				3												1														
BL836-BL838-41				3												1			1											
BL836-BL838-42				3											1	1														
BL836-BL838-43				3												1														
BL836-BL838-44				3											1	1			1											
BL836-BL838-45				3												1														
BL836-BL838-46				3																										
BL836-BL838-47				3															1											
BL836-BL838-48				3															1											
BL836-BL838-49				3																										
BL836-BL838-50				3																										

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL836-BL841-01				3												1														
BL836-BL841-02				3												1														
BL836-BL841-03				3	1											1														
BL836-BL841-04				3												1														
BL836-BL841-05				3	1											1														
BL836-BL841-06				3	1											1														
BL836-BL841-07				3	1											1														
BL836-BL841-08				3												1														
BL836-BL841-09				3	1											1														
BL836-BL841-10				3	1										1	1														
BL836-BL841-11				3											1	1														
BL836-BL841-12				3	1											1														
BL836-BL841-13				3												1														
BL836-BL841-14				3	1										1	1														
BL836-BL841-15				1	1										1	3														
BL836-BL841-16				1												3														
BL836-BL841-17				3	1											1														
BL836-BL841-18				3												1														
BL836-BL841-19				1	3											1														
BL836-BL841-20				3												1			1											
BL836-BL841-21				3	1										1	1														
BL836-BL841-22				3	1											1														
BL836-BL841-23				3												1														
BL836-BL841-24				3	1											1														
BL836-BL841-25				3	1											1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL836-BL841-26				3	1										1	1														
BL836-BL841-27				3	1											1														
BL836-BL841-28				3	1										1	1														
BL836-BL841-29				3												1														
BL836-BL841-30				3											1	1														
BL836-BL841-31				3																										
BL838-BL840-01	1			3											1															
BL838-BL840-02				3																										
BL838-BL840-03				1												1			1											
BL838-BL840-04				3												1			1											
BL838-BL840-05				3															1											
BL838-BL840-06				3											1															
BL838-BL840-07				3																										
BL838-BL840-08				3																										
BL838-BL840-09				3																										
BL838-BL840-10				3																										
BL838-BL840-11				3																										
BL838-BL840-12				3																										
BL838-BL840-13				3											1	1														
BL838-BL840-14				3											1	1														
BL838-BL840-15				3															1											
BL838-BL840-16				3												1														
BL838-BL840-17				3																										
BL838-BL840-18				3								1																		
BL838-BL840-19				1								1																		

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL838-BL840-20												3																		
BL841-BL843-01				3	1											1														
BL841-BL843-02				3											1	1														
BL841-BL843-03				3												1														
BL841-BL843-04				3												1														
BL841-BL843-05				3	1											1														
BL841-BL843-06				3											1	1														
BL841-BL843-07				3											1	1														
BL841-BL843-08				1								3				1														
BL843-BL845-01												3				1														
BL843-BL845-02												3				1														
BL843-BL845-03				1								3				1														
BL843-BL845-04				1											1	1														
BL843-BL845-05				3												1														
BL843-BL845-06				3												1														
BL843-BL845-07				3											1	1														
BL843-BL845-08				3	1											1														
BL843-BL845-09				3											1	1														
BL843-BL845-10				3						1					1	1														
BL843-BL845-11				3												1														
BL843-BL845-12				1												1														
BL843-BL845-13				3						1					1	1														
BL843-BL845-14				3						1					1	1														
BL843-BL845-15				3												1														
BL843-BL845-16				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL843-BL845-17				3											1	1														
BL843-BL845-18				3											1	1														
BL843-BL845-19				3												1														
BL843-BL845-20				3											1	1														
BL843-BL845-21				3												1														
BL843-BL845-22				3											1	1														
BL843-BL845-23				3											1	1														
BL843-BL845-24				3											1	1														
BL843-BL845-25											3					1														
BL843-BL845-26											3					1														
BL843-BL845-27											1					1														
BL843-BL845-28											3					1														
BL843-BL845-29											3					1														
BL843-BL845-30											3					1														
BL843-BL852-01				1												3														
BL843-BL852-02				3												1														1
BL843-BL852-03				3	1											1														
BL843-BL852-04				3	1											1														
BL843-BL852-05				3	1											1														
BL843-BL852-06				3												1														
BL843-BL852-07				3												1														
BL843-BL852-08				3	1											1														
BL843-BL852-09				3	1										1	1														
BL843-BL852-10				3	1											1														
BL843-BL852-11				3	1							1			1	1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL843-BL852-12												3				1														
BL843-BL852-13				1	1										1	1														
BL843-BL852-14				1	1										1	1														
BL843-BL852-15				3	1											1														
BL843-BL852-16				1	1							1				1														
BL843-BL852-17				3								1			1															
BL843-BL852-18				3	1							1			1															
BL843-BL852-19				3											1	1														
BL843-BL852-20				3	1										1	1														
BL843-BL852-21				3	1										1															
BL843-BL852-22				3	1										1	1														
BL843-BL852-23				3	1										1	1														
BL843-BL852-24				3	1										1	1														
BL843-BL852-25				3	1										1	1														1
BL843-BL852-26				3	1										1	1														
BL843-BL852-27				3	1										1	1														
BL843-BL852-28				3	1							1			1	1														
BL843-BL852-29				1	1							1			1	1														
BL843-BL852-30				3	1										1	1														
BL845-BL847-01											3					1														
BL845-BL847-02											3					1														
BL845-BL847-03											3	1				1			1											
BL845-BL847-04											3					1			1											
BL845-BL847-05											3					1														
BL845-BL847-06				1							3					1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL845-BL847-07											1				1	1														
BL845-BL847-08												3				1														
BL845-BL847-09												3				1														
BL845-BL847-10				1								3			1	1														
BL845-BL847-11												1			1	1														
BL845-BL847-12					1							3			1	1														
BL845-BL847-13					1	2						3				1														
BL845-BL847-14				1								1				1														
BL845-BL847-15				1								3				1														
BL845-BL847-16				3								1				1														
BL845-BL847-17				1												1			1											
BL845-BL847-18				3												1			1											
BL845-BL847-19				3												1														
BL845-BL847-20				3												1														
BL845-BL847-21				1												1														
BL845-BL847-22				3												1														
BL845-BL847-23				3												1														
BL845-BL847-24				3												1														
BL845-BL847-25				3	1											1														
BL845-BL847-26				1												1														
BL845-BL847-27				3												1														
BL845-BL847-28				3												1														
BL845-BL847-29				1												1														
BL845-BL847-30				1												1														
BL845-BL847-31				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL845-BL847-32				3												1														
BL845-BL847-33				1																										
BL845-BL847-34				1																										
BL848-BL851-01												3				1			1											
BL848-BL851-02				1								1				1			1											
BL848-BL851-03				3								1				1			1											
BL848-BL851-04				3												1														
BL848-BL851-05				3											1	1														
BL848-BL851-06												3				1														
BL848-BL851-07					1																									
BL848-BL851-08					1																									
BL848-BL851-09				1								1			1	1														
BL848-BL851-10												3				1														
BL848-BL851-11				1								1				1														
BL848-BL851-12				3												1			1											
BL848-BL851-13													1																	
BL848-BL851-14				3								1				1														
BL848-BL851-15				1								3				1														
BL848-BL851-16												3				1														
BL848-BL851-17												3				1			1											
BL848-BL851-18												1				1														
BL848-BL851-19				1								1				1														
BL848-BL851-20				1								1				1			1											
BL848-BL851-21				1								1				1														
BL848-BL851-22				3								1				1			1											

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL848-BL851-23				1								1				1			1											
BL848-BL851-24				1								1				1			1											
BL848-BL851-25				1												1			1											
BL848-BL851-26				3												1			1											
BL848-BL851-27				3												1			1											
BL848-BL851-28				3							3					1														
BL848-BL851-29				1							1					1														
BL848-BL851-30				1							1					1														
BL848-BL851-31				1							1	1				1														
BL848-BL851-32				1							3	3				1														
BL848-BL851-33				1												1														
BL848-BL851-34				1							1	1				1														
BL848-BL851-35				1							1	1				1														
BL848-BL851-36				1												1														
BL848-BL851-37				1							1				1	1			1											
BL848-BL851-38				1												1			1											
BL848-BL851-39				1															1											
BL848-BL851-40																			1											
BL848-BL851-41																1			1											
BL848-BL851-42																1														
BL848-BL851-43																1														
BL851-BL864-01												3				1														
BL851-BL864-02				1								1				1														
BL851-BL864-03												1				1														
BL851-BL864-04				1												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL851-BL864-05				1		1						1				1														
BL851-BL864-06				1								1				1														
BL851-BL864-07						1									1															
BL851-BL864-08				1		3																								
BL851-BL864-09				1		1						1																		
BL851-BL864-10				1		1						1																		
BL851-BL864-11				1								1																		
BL851-BL864-12						3																								
BL851-BL864-13						3																								
BL851-BL864-14				1																										
BL851-BL864-15				1												1														
BL851-BL864-16				1												1														
BL851-BL864-17				1											1	1														
BL851-BL864-18				1											1	1														
BL851-BL864-19				1												1														
BL851-BL864-20				1											1															
BL851-BL864-21				1												1														
BL851-BL864-22				1												1														
BL851-BL864-23				1												1														
BL851-BL864-24				1												1														
BL851-BL864-25				1											1															
BL851-BL864-26				1											1	1														
BL851-BL864-27				1																										
BL851-BL864-28				1												1														
BL851-BL864-29				1												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL851-BL864-30				1		1										1														
BL852-BL853-01				1	1										1	1														
BL852-BL853-02				3	1										1	1														
BL852-BL853-03				3											1	1														
BL852-BL853-04				3								1			1	1														
BL852-BL853-05				1	1										1	1														
BL852-BL853-06				1	1										1	1														1
BL852-BL853-07				3	1							1			1	1														
BL852-BL853-08				3	1							1			1	1														
BL852-BL853-09				3	1							1			1	1														
BL852-BL853-10				3	1							1			1	1														
BL852-BL853-11				1	1							1			1	1														1
BL852-BL853-12				1	1							3			1	1														
BL852-BL853-13				1	1							3			1	1														
BL852-BL853-14				1	1							3			1	1														
BL852-BL853-15				1	1							3				1														
BL852-BL853-16				1	1							1			1	1														
BL852-BL853-17				1	1							1				1														
BL852-BL853-18				1	1										1	1														
BL852-BL853-19				1	1										1	1														
BL852-BL853-20				1											1	1														
BL852-BL853-21				1	1										1	1														
BL852-BL853-22				1								3			1	1														
BL852-BL853-23				1	1							3			1	1														
BL852-BL853-24				1	1							3				1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL852-BL853-25					1							3				1														
BL856-BL859-01												3				1														
BL856-BL859-02												3				1														
BL856-BL859-03				1								1				1														
BL856-BL859-04				1								1				1														
BL856-BL859-05				1	1							1				1														
BL856-BL859-06					1							1				1														
BL856-BL859-07												3							1											
BL856-BL859-08												3																		
BL856-BL859-09												3				1														
BL856-BL859-10												3				1														
BL856-BL859-11												3				1														
BL853-BL856-01												3			1	1														
BL853-BL856-02					2							3			1	1														
BL853-BL856-03												3																		
BL853-BL856-04												3				1														
BL853-BL856-05												3				1														
BL853-BL856-06				1								3				1														
BL853-BL856-07												3				1														
BL853-BL856-08												3			1	1														
BL853-BL856-09				1								1				1														
BL853-BL856-10				1								3			1	1														
BL853-BL856-11				1								1				1														
BL853-BL856-12				1								3			1	1														
BL853-BL856-13												3			1															

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL853-BL856-14				1								1			1	1														
BL853-BL856-15					1							1			1	1														
BL853-BL856-16				1								1			1															
BL853-BL856-17				1								1							1											
BL853-BL856-18				1								1																		
BL853-BL856-19				1								1																		
BL853-BL856-20				1								3																		
BL853-BL856-21				1								1																		
BL853-BL856-22				1								1																		
BL853-BL856-23				1								1							1											
BL853-BL856-24				1								3																		
BL853-BL856-25				1								3																		
BL853-BL856-26				1								3																		
BL853-BL856-27												3				1														
BL853-BL856-28												3				1														
BL853-BL856-29												3				1														
BL853-BL856-30												3				1														
BL866-BL868-01				3											1	1														
BL866-BL868-02				3											1	1														
BL866-BL868-03				3												1														
BL866-BL868-04				3												1														
BL866-BL868-05				1			1								1															
BL866-BL868-06				3			1								1	1														
BL866-BL868-07				3			1									1														
BL866-BL868-08				3												1														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 27.1 – Species data for Leppington Hedgerows - Record points

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling).
Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Record points are the 4m sections numbered by the hedge section start and end nodes and the sequential number (from 1-30).

	SPECIES																													
RECORD POINT	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
BL866-BL868-09				3	1											1														
BL866-BL868-10				3	1		1																							
BL866-BL868-11				3	1		1																							
BL866-BL868-12				3			1																							
BL866-BL868-13				3	1																									
BL866-BL868-14				3	1																									
BL866-BL868-15				1																										
BL866-BL868-16				3															1											
BL866-BL868-17				3																										
BL866-BL868-18																														

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL334										1											1									
CL335														1							1									
CL336																										2				
CL337																					1				1	2				
CL338																					2					2				
CL339																					1					1				
CL340																										2				
CL341																					1					2				
CL342																					1					2				
CL343																					1					3				
CL344																					1					2				
CL345																					1					1				
CL346																										1				
CL347																										2				
CL348																					1									
CL349																					1									
CL350																					1									
CL351																					1				3					
CL352																					1				3					
CL353																					1				3					
CL354																					1					3				
CL355																					1					3				
CL356																					1					1				
CL357																									2					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL358																							1							
CL359																														
CL360																					1					1				
CL361																										1				
CL362																										3				
CL363																									2					
CL364																					1									
CL365																					1					3				
CL366																										2				
CL367																									2	2				
CL368																										3				
CL369																					1					2				
CL370																					1									
CL371																					1					3				
CL372																							1		2	2				
CL373																					1					2				
CL374																									1					
CL375																									2	2				
CL376																					1				2					
CL377																										1				
CL378																					1									
CL379																					1					2				
CL380																										3				
CL381																														
CL382																					2					2				

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL383																					1				2	1				
CL384																									3	1				
CL385																									3	1				1
CL386																									3	2				
CL387																									3					
CL388																									3					
CL389																									1					
CL390																														
CL391																					1				3	3				
CL392																									1	2				
CL393																					1				1					
CL394																									2					
CL395																					1				2					
CL396																					1				2	2				
CL397																					1				1					
CL398																									2					
CL399																									2					
CL400																									2					
CL401																									2					
CL402																					1									
CL403																									3					
CL404																									2					
CL405																					1				3					
CL406																									2	2				
CL407																									2					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL408																									2					
CL409																				1	1				2					
CL410																				2					2					
CL411																				3					2					
CL412																				2					1					
CL413																				2					1					
CL414																					1									
CL415																				2										
CL416																				2										
CL417																														
CL418																					1									
CL419																					1									
CL420																					1									
CL421																					1				1					
CL422																									2					
CL423																									2					
CL424																									3					
CL425																									2					
CL426																										1				
CL427																					1									
CL428																					1									
CL429																					1									
CL430																					1									
CL431																										1				
CL432																					1									

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL433																					1					1				
CL434														1																
CL435																					1									
CL436														1							1									
CL437														1																
CL438																					1									
CL439																					1									
CL440																					1									
CL441																					1									
CL442																					1									
CL443																														
CL444																					1					1				
CL445																										2				
CL446																														
CL447																									1	2				
CL448																					1					1				
CL449																					1				1					
CL450																														
CL451																					1									
CL452																									1	1				
CL453																					1									
CL454																					1									
CL455											1			1																
CL456																					1									
CL457																					1									

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL458											1																			
CL459																													1	
CL460																														
CL461																					1				1					
CL462																									1					
CL463																							1							
CL464																									3					
CL465																							1		2					
CL466																									2					
CL467																									2					
CL468																									2					
CL469																									2					
CL470																										1				
CL471																									2	1				
CL472																									2					
CL473																									2					
CL474																									1					
CL475																									2					
CL476																									2					
CL477																									2					
CL478																									1		1			
CL479																											1			
CL480																											1			
CL481																														
CL482																									1					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL483																									1					
CL484																									1					
CL485																									1					
CL486																									2					
CL487																									2					
CL488																									2					
CL489																									2					
CL490																									2					
CL491																									2					
CL492																									2					
CL493										1															2					
CL494																									3					
CL495																					1				2					
CL496																									2					
CL497																									2					
CL498																									1					
CL499																														
CL500																					1									
CL501											1																			
CL502																													1	
CL503																										1				
CL504																					1									
CL505																					1									
CL506																					1									
CL507																					1									

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CL508																					1									
CL509																					1									
CM091																														
CM092																					2									
CM093																										3				
CM094																										3				
CM095																										3				
CM096																										3				
CM097																										3				
CM098																										2				
CM099																									3	2				
CM100																									3					
CM101																									3					
CM102																					1				3					
CM103																					1				3	1				
CM104																									3					
CM105																									3					
CM106																									3					
CM107																									3					
CM108																									3					
CM109																									3					
CM110																									3					
CM111																									3					
CM112																									3					
CM113																									3					

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CM114																									3					
CM115																									3					
CM116																					1				3					
CM117																									3					
CM118																									3					
CM119																									3					
CM120																									3					
CM121																									3					
CM122																									3					
CM123																									2					
CM124																									3					
CM125																									3					
CM126																									3					
CM127																									3					
CM128																									3					
CM129																									2					
CM130																									1					
CM131																									2					
CM132																									2					
CM133																									2					
CM134																									2					
CM135																									2					
CM136																									1					
CM137																									2		2			
CM138																									2					

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CM139																									1					
CM140																									3					
CM141																									2					
CM142																														
CM143																														
CM144																														
CM145																														
CM146																														
CM147																														
CM148																														
CM149																														
CM150																										1				
CM151																										1				
CM152																										1				
CM153																										3				
CM154																										2				
CM155																														
CM156																												1		
CM157																					1									
CM158																										2				
CM159																										2				
CM160																										2				
CM161																					1									
CM162																					1									
CM163																					1									

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CM164																					1									
CM165																					1									
CM166																					1									
CM167																					1									
CM168																					1									
CM169																														1
CM170																									3					
CM171																									3					
CM172																					1									
CM173																									1					
CM174																									2					
CM175																									2					
CM176																									2					
CM177																										2				
CM178																					1					2				
CM179																					1					2				
CM180																					1									
CM181																					1									
CM182														1																
CM183																										2				
CM184																										2				
CM185																					1									
CM186																					1					1				
CM187																										2				
CM188																										2				

Appendix 19 - Manor Farm, Leppington - hedgerow survey

Table 77.2 – Species data for Leppington Hedgerows - Point Records

Species use 3 + 3 abbreviated systematic names (case sensitive for shrubs and trees - ACE-CAM = tree; Ace-Cam = bush; ace-cam = seedling). Values - DFR scale 1 = Rare; 2 = Frequent/common; 3 = Dominant.
Points Records are the individual locations for each record.

	SPECIES																													
POINT RECORD	Ace-Cam	Ace-Pse	Cor-Ave	Cra-Mon	Fra-Exc	GAP	Hed-Hel	Ile-Aqu	Lon-Per	Mal-Syl	Pru-Ini	Pru-Spi	Que-Rob	Rib-Uva	Ros-Can	Rub-Fru	Sal-Cin	Sal Fra	Sam-Nig	all-urs	aru-mac	con-maj	dry-dil	geu-urb	hya-non	mer-per	pte-aqu	ran-aur	vio-riv	Tam-Com
CM189																										2				
CM190																										2				
CM191																										1				
CM192																					1									
CM193																					1									
CM194																					1									
CM195																					1									
CM196																					1									
CM197																					1									
CM198																					1									