Habitat assessment for the conservation of *Osmia pilicornis* Smith

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Abstract

Concerns raised in recent years about the status of the Fringe-horned Mason Bee, *Osmia pilicornis* Smith, in Britain prompted targeted searches by a number of entomologists. Unfortunately, these yielded very few records and it would appear that *O. pilicornis* has undergone a rapid decline in population in the last decade. This study sought to investigate this trend further by looking at the specific habitat requirements of *O. pilicornis* and assessing the suitability of a number of woodland sites for this species in the High Weald area of Kent and Sussex. The findings show that a population of *O. pilicornis* still persists at the Royal Society for the Protection of Birds (RSPB) Tudeley Woods reserve in Kent, and they indicate that there is further potentially suitable habitat for the species in surrounding woodland. A habitat assessment sheet for *O. pilicornis* was produced and will be circulated to RSPB site staff and landowners in areas with previous records of the species. Recommendations for woodland management practices that could benefit *O. pilicornis* as well as other threatened coppice species such as the Pearl-bordered Fritillary butterfly *Boloria euphrosyne*, have been discussed with site staff and will be more widely disseminated in the future. Current and future threats to *O. pilicornis* populations are considered and it is hoped that targeted conservation efforts in future years will help to overcome some of these so that the concerns about its status in Britain will be no more.

Introduction

The rare Fringe-horned Mason Bee, *Osmia pilicornis* Smith, has suffered an alarming decline in recent years in Britain. The open-structured woodland that it inhabits is at risk of further loss as a result of woodland neglect and alternative management practices. This reduction in suitable habitat poses a significant threat to the future of this species in Britain and highlights the need for research into its specific habitat requirements in order to aid its conservation.

Osmia pilicornis, is listed as a Nationally Notable (Na) species in Britain, indicating that it is found in 30 or fewer 10 kilometre squares of the National Grid (Falk, 1991). It was first described in 1846 and has since been recorded in various woodlands across the South of England and parts of Wales (NBN, 2012). Recently, however, the populations of this rare species seem to be declining at a dramatic rate: there were 34 occupied tetrads from 1980-1994, but only 23 from 1995-2010 (Mike Edwards, pers. comms.). Since 2005 it has only been recorded at two sites in Britain, despite efforts by a number of entomologists to search for it (Beavis, 2012). The current status of *O. pilicornis* in Britain has consequently been of much concern, particularly in the last few years, and has prompted discussions about the probable need to re-designate it with a more threatened status (Mike Edwards & Steven Falk, pers. comms.). This study is therefore timely and hopes to

provide a better understanding of the ecological requirements of *O. pilicornis*, which in turn will act to support its conservation.

Osmia pilicornis is clearly a scarce species in Britain, but its distribution extends to continental Europe. There are relatively few records of it there, with a handful from Germany and Finland in the early 20th century and a number of 20th and 21st century records from Sweden (GBIF, 2012). There is little published information on *O. pilicornis* in continental Europe, but Andreas Müller, a curator of entomology in Switzerland, states that it is rather widespread but rare everywhere (Andreas Müller, pers. comms.). Indeed, the only country where there seem to be regular recent records is Sweden (e.g. Johansson, 2010) and even here it is listed on the Regional Red List (Andersson, 2010). It is also on the Red List in Germany where it is 'extremely rare' with the exact extent of the threat unknown (Paul Westrich, pers. comms.). The long-term trend in populations of *O. pilicornis* in Germany seem unclear, but it appears to be showing declines in the short-term (Westrich *et al*., 2008; Esser *et al*., 2010) and it would seem that it is even going extinct from some regions (e.g. Dathe & Saure, 2000). Similarly, *O. pilicornis* has been recorded in Austria, but has been declared extinct in some regions (Hauser & Weiβmair, 2007). Given the threatened status of *O. pilicornis* outside of Britain, there is a more pressing need for targeted conservation work, which will be facilitated through the outcomes of this study.

While there is a general lack of information on the ecology of *Osmia pilicornis*, it is clear that some knowledge of it does exist, which has been provided through field observations (e.g. Chambers, 1949; Westrich, 1989; Beavis, 2012; Else, in prep.). These various independent observations offer the same information, however, there has not been an in depth study about the specific habitat requirements of *O. pilicornis* and it would therefore be worthwhile investigating these further to increase our knowledge of this elusive and apparently declining species. One of the two sites where it remains in Britain is Tudeley Woods in Kent, which the Royal Society for the Protection of Birds (RSPB) manages and consists largely of coppiced, broadleaf woodland. Locating *O. pilicornis* at Tudeley Woods would be instructive in providing further information about its habitat requirements, which would be very useful to the RSPB in terms of how they manage the reserve.

Osmia pilicornis is a species inhabiting mainly broadleaved woodland, preferring open areas such as woodland rides and clearings (Beavis, 2002; Else, in prep.). It benefits from regular coppicing, which helps to keep the canopy open, allowing a rich ground flora to grow (Beavis, 2012). It is a polylectic species, foraging from a number of flowers including *Ajuga reptans* and *Glechoma hederacea* in Britain (BWARS, 1998; Baldock, 2008; Else, in prep.) and *Pulmonaria* in continental Europe (Westrich, 1989; Müller, 1995). The species nests in dead wood, using existing holes and crevices (Chambers, 1949; Calabuig, 2000). An important habitat requirement appears to be warm, open areas of woodland as the bees like to rest on sunlit leaf litter and tree stumps (Beavis, 2007; Mike Edwards, pers. comms.).

Woodland in Britain covers about 12 percent of the land surface, but less than one percent of this is coppiced woodland (Forestry Commission, 2003). Significant fragmentation of woodland habitat has occurred since the end of the last ice age: about 10,000 years ago (Rackham, 1990). Evidence of the earliest coppice management comes from the Somerset Levels in about 3900 BC (Rackham, 2006) and this practice was widespread in England when the Domesday Book provided

records of woodland in 1086 (Peterken, 1993). Before the 20th century, when coppicing was largely abandoned, the majority of lowland woodland was managed through the practice of coppicing (HMSO, 1994; Hopkins & Kirby, 2007). The extent of coppice in Britain decreased dramatically in the 20th century from making up 21 percent of broadleaved woodland in 1947 (HMSO, 1952) to under 3 percent in 2000 (Smith & Gilbert, 2003). The loss of woodland habitat, coupled with the decline in coppicing, has limited the extent of suitable habitat available for *Osmia pilicornis* in Britain.

Changing woodland management practices, particularly coppicing, may be having an adverse effect on the population of *Osmia pilicornis* in Britain (BWARS, 1998). Given the concern regarding the apparent decline of this rare species and the fact that one of the remaining sites for it is an RSPB reserve, it seems that a study on the habitat requirements of this species would be very valuable not just for the RSPB but also for ascertaining the potential reasons for its apparent population crash and for ensuring that *O. pilicornis* survives in future years. The purpose of this study was therefore to ascertain the specific habitat requirements of *O. pilicornis* and to use these to assess habitat suitability and aid its conservation. The aims and objectives were:

1. to locate *Osmia pilicornis* in order to assess the specific habitat of the site where it is found;
2. to locate a number of potential sites for *Osmia pilicornis* at Tudeley Woods;
3. to devise a habitat suitability index (HSI) for *Osmia pilicornis*, which could be applied to a wide range of sites;
4. to implement the HSI on the sites located in the second aim;
5. to visit other woods in the area, including Broadwater Warren (RSPB) and conduct the HSI there; and
6. to make recommendations to site staff on managing for *Osmia pilicornis*.

Materials and Methods

The study was carried out in woodland near the town of Tunbridge Wells in the High Weald area of West Kent and East Sussex. Tudeley Woods was selected as the main study site because it is an RSPB reserve and was, at the time of proposing this study, the only known site in Britain to have records of *Osmia pilicornis* since 2005. Sites of surrounding woodland that either had previous records of *O. pilicornis* or were deemed to be potentially suitable habitat were also looked at. These included the Woodland Trust's Hargate Forest, the RSPB's Broadwater Warren and the Sussex Wildlife Trust's Eridge Rocks (Figure 1, Appendix I).

A provisional visit to Tudeley Woods was conducted in early May to meet the site warden, Mat Allen, and look at potential sites for *Osmia pilicornis*. A total of 14 sites were identified as either having had previous records of the species or as having potential for harbouring the species. These sites were selected after taking into account where areas of recent coppice were. There were three areas of the Tudeley Woods Reserve that were targeted: The Plants, Brakeybank Wood and Pembury Walks (Figure 2, Appendix I). A two day search was carried out with the help

of an amateur entomologist, Grant Hazlehurst, and the curator of the Tunbridge Wells Museum, Ian Beavis, who had previously recorded *O. pilicornis* at the reserve.

A habitat suitability index (HSI) was formulated using the information collected on the preliminary visit and based upon the HSI for Great Crested Newts (Oldham *et al*., 2000). The factors included in the HSI were decided upon after talks with a number of entomologists about the specific habitat requirements of *Osmia pilicornis* and after an extensive literature review. The effectiveness of this HSI was tested at Tudeley Woods on further visits to the site on 9 and 10 August 2012. This involved revisiting the 14 sites identified in May and collecting various data related to the surrounding habitat, which included:

- age of the coppice;
- width of the ride or open area;
- abundance of dead wood;
- flowering plant composition;
- canopy cover; and
- height of trees near the ride or open area.

The full details of the methodologies used are outlined in the HSI in Appendix II. The data collected from the further visits to Tudeley Woods were entered into the HSI formula, which gave an index score for each site. Given that *Osmia pilicornis* was only recorded at two of the 14 sites this year, it was not possible to statistically analyse the data and therefore to test the HSI. Some minor alterations to the HSI were made following these further visits to Tudeley Woods, after the sites where *O. pilicornis* had been recorded were assessed in more detail. The effectiveness of the HSI would therefore have been strengthened by looking at the specific habitat features of these sites. Some further changes that were made to the HSI involved making it simpler to use because the aim was to circulate it to site staff and it was therefore important to make it as quick and easy to conduct as possible. When testing the HSI at Tudeley Woods, a densiometer to measure canopy cover and a clinometer to measure tree height were used, but the decision that no instruments should be required to conduct the HSI was made subsequent to this.

The improved HSI was implemented in woodland near Tudeley Woods where there were previous records of *Osmia pilicornis* and also in woodland where it had never been recorded but which could have potential to support a population. There are a number of woodlands that were all once part of the same complex, encircling Tunbridge Wells from the north-east (where Tudeley Woods is located), through to the south-west; Figure 1 in Appendix I shows the location of the other woodland sites that were looked at. These three sites were visited on 17 August 2012. The site manager of Broadwater Warren, Steve Wheatley, indicated the key areas of coppice to look at on the reserve and also on the neighbouring Eridge Rocks reserve. After a walk around these key areas, a total of two sites on each reserve were identified as worthy of conducting the HSI. The HSI was carried out as outlined in Appendix II. Target areas of Hargate Forest were identified following talks with Ian Beavis, who had a previous record of *O. pilicornis* there, and after consulting the management plan for the site. The HSI was carried out at two sites in these target areas, after a walkover survey.

The purpose of these HSI surveys was to identify sites that may be worth checking for the presence of *Osmia pilicornis* next year during its flight period, which normally runs between April and May (Ian Beavis, pers. comms.). Site staff from the four reserves surveyed will be informed about suitable sites within their reserves for *O. pilicornis* and will be provided with recommendations about how to manage their reserve for the benefit of this species.

Results

One female *Osmia pilicornis* was found at Tudeley Woods on 11 May 2012 as a result of targeted searching with Grant Hazlehurst. It was foraging on *Glechoma hederacea* and was in a floristically rich area of Sweet Chestnut coppice that was cut in 2011. There were no further individuals found despite extensive searching the following day. However, Ian Beavis recorded two females on 27 May 2012 at a different site within Tudeley Woods.

The 14 sites identified at Tudeley Woods in May as either having had previous records of *Osmia pilicornis* or having potential for future records are shown in Figure 2 in Appendix I. Figure 3 in Appendix I indicates the sites at Broadwater Warren, Eridge Rocks and Hargate Forest that were identified as potential sites in future years.

The Plants area of Tudeley Woods had two sites with the maximum HSI score, one of which being the site where *Osmia pilicornis* was found in 2012 (Figure 4). The other site in The Plants where it was found this year had a relatively low score of just 0.31 and that where it was found in 2011 was even less at just 0.23 (Figure 4). Eridge Rocks and Hargate Forest had the highest average HSI scores of the different woodland areas with scores of 0.63 and 0.62 respectively. The Plants and Brakeybank Wood had fairly high scores on average as well (0.55 and 0.53 respectively), whereas the scores from Pembury Walks and Broadwater Warren were quite low (0.20 and 0.19 respectively).

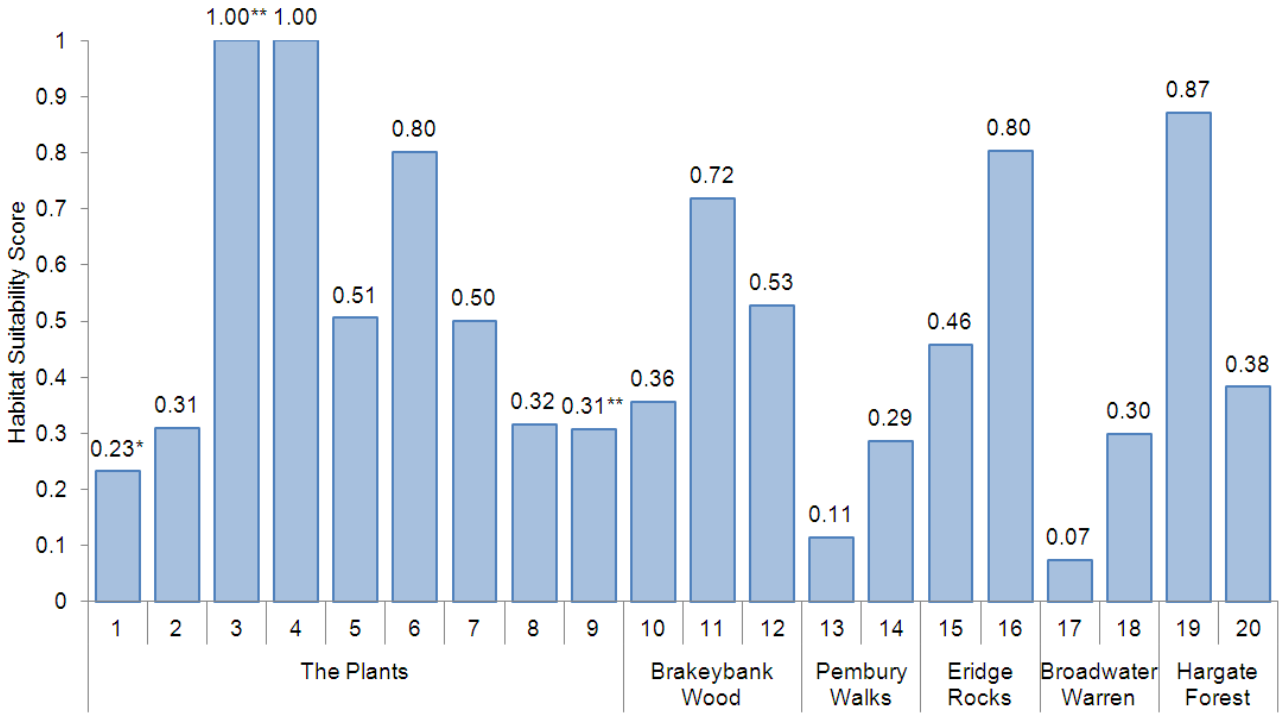

Figure 4: Habitat Suitability Index scores for sites at Tudeley Woods (sites 1-14), Eridge Rocks (sites 15-16), Broadwater Warren (sites 17-18) and Hargate Forest (sites 19-20), where * denotes the site having a record of *Osmia pilicornis* in 2011 and ** indicates a record of *O. pilicornis* from 2012.

Discussion

Osmia pilicornis was found at Tudeley Woods, which helped to identify the key habitat features required for a site to support this species. The habitat suitability index (HSI) produced as a result of this is evaluated in this section and habitat management for *O. pilicornis* is discussed.

As outlined in the HSI in Appendix II, the HSI surveys should be carried out in the spring if possible because that is the time when *Osmia pilicornis* will be flying and therefore the plant species flowering at this time will be the ones that it will forage on. It is easier to identify *Ajuga reptans* and *Glechoma hederacea* at this stage and for Factor 8 (abundance of nectar/pollen sources), it is necessary to see the flowers available at this time of year to give a reliable score. It was not possible during this study to conduct the HSI surveys in the spring, so *A. reptans* and *G. hederacea* were identified in their vegetative stage and the abundance of nectar/pollen sources was gauged from looking at the abundance of these two plants and any other spring flowering species to give a proxy for the abundance of spring nectar/pollen sources available. The sites surveyed could be revisited next spring to obtain an HSI score and match it against the one from this year to assess the reliability of surveying outside of the optimum season.

A further consideration when assessing habitat suitability is that the dynamics of a site can change very rapidly, such that a site with a high HSI score one year may have a significantly decreased score the following year. This is largely due to the re-growth of coppice stools, which can dramatically alter the habitat in the space of only a year or two. Sweet Chestnut has a particularly rapid re-growth (Braden & Russell, 2001; Broome *et al*., 2011) and this made up the majority of the coppiced woodland at Tudeley Woods. The rapid change in habitat dynamics might act to explain why the HSI score for Site 1 in The Plants where *Osmia pilicornis* was found in 2011 was so low. From observations of the sites at Tudeley Woods, it was concluded that areas that had just been coppiced were largely unsuitable because there was very little or no ground flora present. Areas of one year coppice were deemed to be the most suitable from direct observation because they tended to have the most rich ground flora, were very open and therefore had more exposure to sunlight so were warmer. Indeed, of the 20 sites surveyed, those with one year coppice scored the most highly, on average, on the HSI: they had a score of 0.72 compared with 0.39 for other ages of coppice. It was a one year coppice area at Tudeley Woods where *O. pilicornis* was found in the spring. This highlights the importance of regular coppice rotation within woodland, such that there will always be pockets of suitable habitat for specialist coppice species.

It is important when thinking about habitat management that the different parts of the life cycle of a species are considered. Westrich *et al.* (2000) highlight the importance of this for *Osmia pilicornis*, stating that it is dependent upon a spatial network of several sub-habitats, without which the population will cease to be viable. The presence of *O. pilicornis* at Site 9 at Tudeley Woods in 2012, despite the relatively low HSI score (Figure 4) may reflect the fact that the potential sites in The Plants were quite close together and therefore *O. pilicornis* individuals might move between these sites. For example, one site might be important for foraging while another may be better for providing good nesting habitat. It is well documented that bees can travel over a mile to forage (e.g. Beekman & Ratnieks, 2000; Walther-Hellwig & Frankl, 2000) and *Osmia* species are estimated to have maximum foraging distances of over 500m (e.g. Rust, 1990; Gathmann &

Tscharntke, 2002), so it is clearly plausible that *O. pilicornis* could be moving between different sites within a wood. This emphasises the importance of a network of interconnected habitats within the woodland, which would be important for other woodland specialists as well, as has been shown for butterflies (e.g. Sutcliffe & Thomas, 1996; Haddad & Baum, 1999).

The geology of the High Weald is varied, with some areas dominated by Weald clay and others by sandstone. The Northern part of Tudeley Woods, which encompasses The Plants and Brakeybank Wood sits on clay, whereas Pembury Walks to the south of this is on sandstone. Sandstone soils are generally more acidic than clay soils (Rackham, 1980) and the plant species richness in woodland tends to be greater the higher the soil pH (e.g. Kirby, 1988; Eycott *et al.*, 2006), so this would suggest that Pembury Walks would have a lower plant species richness than the other areas of Tudeley Woods. The two sites looked at within Pembury Walks were largely devoid of ground flora, with neither *Ajuga reptans* nor *Glechoma hederacea* present. The HSI scores for Pembury Walks were lower than those for The Plants and Brakeybank Wood; this is in part due to the differences in the ground floral assemblages, which may be explained by differences in soil type. This agrees with the findings of Warr *et al.* (1994), that the ground flora abundance resulting from coppicing was lower for acid woodland sites than for base-rich sites.

The HSI is a work in progress and due to time constraints this year it was not possible to collect enough data to conduct any statistical tests to assess its effectiveness. A future study could look to address this by visiting as many sites as possible where *Osmia pilicornis* is found and getting a better idea of the specific habitat at these sites. The HSI could then be tested at these sites and, if there are enough sites where *O. pilicornis* is present, then statistical analysis could be conducted. The specific habitat requirements of *O. pilicornis* could be tested using statistics to compare habitat features between sites where it is present and those where it is absent. It remains unclear whether or not the HSI is a reliable way of assessing a site for the potential suitability for *O. pilicornis*. Therefore, as an alternative to the HSI, a habitat assessment sheet for *O. pilicornis* was developed (Appendix III). This was thought to be a better option for present use because, while it will not give a score of suitability, it aims to identify key features of the habitat that are beneficial for *O. pilicornis*. This will therefore help site staff to recognise what is potential “good” habitat on their site and, where this habitat is not present, it will help them to understand what could be done to improve the habitat for this species and other coppice woodland specialists. This is based upon the HSI, with the minor addition of a section on the abundance of flowers with long corolla tubes such as those from the Lamiaceae and Boraginaceae families, which *O. pilicornis* shows a clear preference for when pollen collecting (Müller, 1995).

The management recommendations supplied will not just be of benefit to *Osmia pilicornis*, they could also benefit a whole host of other specialists of coppiced and open-structured woodland such as the Pearl-bordered Fritillary butterfly *Boloria euphrosyne*, and the Drab Looper moth *Minoa murinata* (Fuller & Warren, 1993). Indeed, there is an increasing need to conserve such species associated with the early successional stages of coppice because there have been extensive declines since the widespread abandonment of coppicing (Warren & Key, 1991; HMSO, 1994). This has been particularly well documented for vascular plants, with the richness of vascular plants tending to increase as a result of coppicing due to the opening up of woodland gaps (e.g. Barkham, 1992). These ‘coppicing plants’ are of great importance to some coppice

specialist species and *O. pilicornis* will forage on these plant species, highlighting the importance of maintaining open areas of woodland.

Climate change has the potential to impact on the populations of *Osmia pilicornis*. In recent years, weather patterns have been quite unsettled with prolonged periods of wet weather (Frich *et al*., 2002) and climate change could be one of the main drivers in the decline of bee populations (Potts *et al*., 2010). Current climate models predict that such weather patterns are likely to become more frequent in future years as a result of climate change (e.g. Benison *et al.*, 2007) and this could have significant effects on the emergence time and the brood success of *O. pilicornis*. These effects will not necessarily be negative; indeed, prolonged periods of warm, sunny weather would probably be beneficial to populations.

Open-structured woodland is an infrequent habitat nowadays, so it is probably unsurprising that the populations of *Osmia pilicornis* and those of other coppice and open-structure dependent species have been suffering in recent years. Further threats to this habitat including tree diseases and over-grazing by deer provide an even greater challenge for the future, which could be accentuated by the effects of global warming. In light of this and the endangered status of *O. pilicornis* elsewhere in the world, it is becoming increasingly important to conserve this precious habitat and thus safeguard the species which inhabit it.

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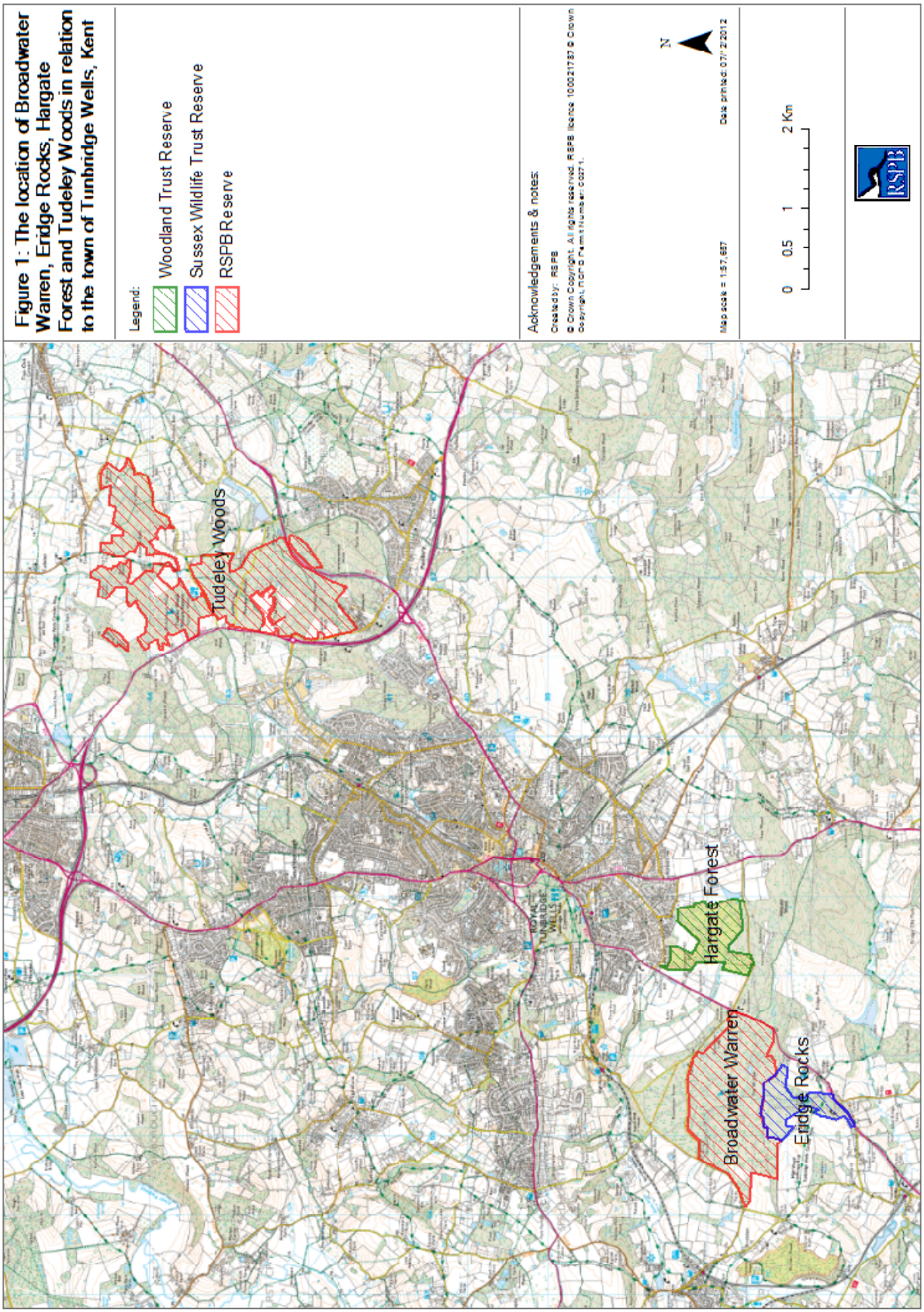
Appendix I: Maps



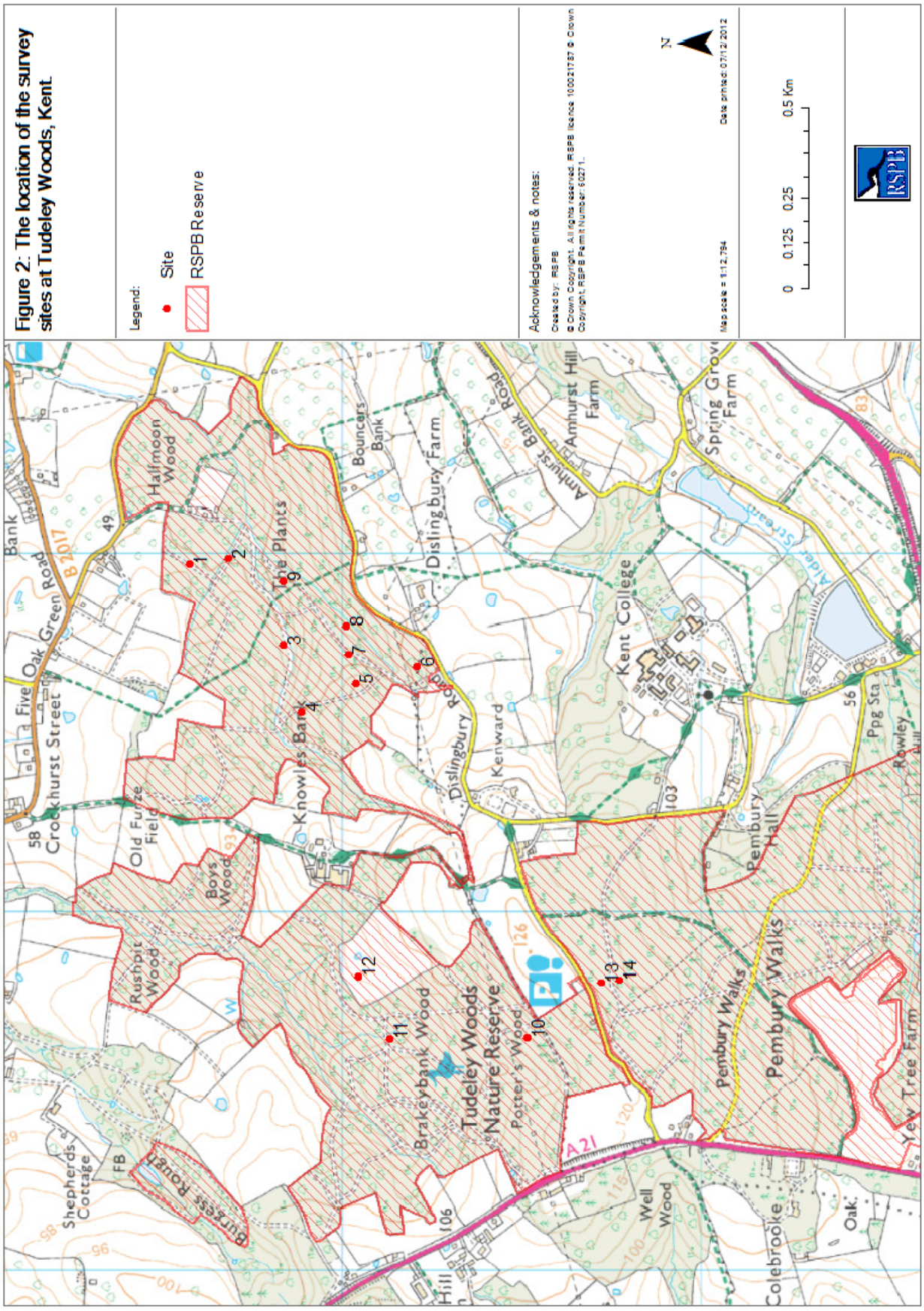


Figure 2: The location of the survey sites at Tudeley Woods, Kent
Legend:
Site
RSPB Reserve
Acknowledgements & notes:
Created by: RSPB
© Crown Copyright. All rights reserved. RSPB licence 100021787 © Crown Copyright, RSPB Permit Number: 6927 1.
Map scale = 1:12,794
Date printed: 07/12/2012
0 0.125 0.25 0.5 Km
N
RSPB
Tudeley Woods Nature Reserve
Brakerybank Wood
Porter's Wood
Pembury Walks
Pembury Hall
Kent College
Dislingbury Farm
Amhurst Hill Farm
Spring Grove Farm
Halfmoon Wood
The Plants
Knowles Bank
Old Furze Field
Boys Wood
Rushpit Wood
Bouncers Bank
Amhurst Bank Road
Dislingbury Road
Kenward
Crockhurst Street
Five Oak Green Road
B 2017
A 21
Burgess Roush
Shepherds Cottage
Well Wood
Colebrooke
Oak
Yew Tree Farm
Rowley
Ppg Sta
Hill
Bank
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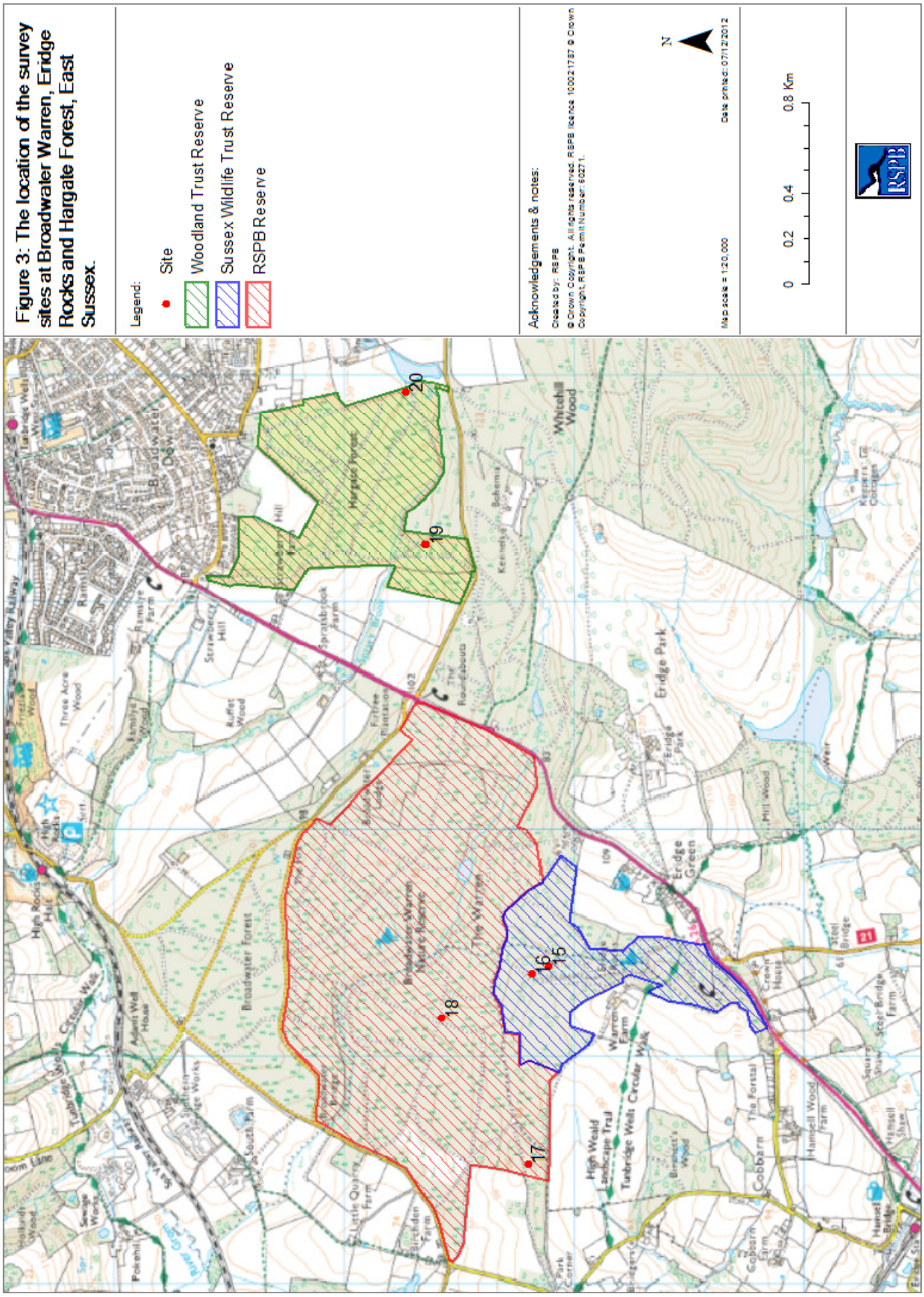
Figure 3: The location of the survey sites at Broadwater Warren, Eridge Rocks and Hargate Forest, East Sussex.
Legend:
Site
Woodland Trust Reserve
Sussex Wildlife Trust Reserve
RSPB Reserve
Acknowledgements & notes:
Created by: RSPB
© Crown Copyright. All rights reserved. RSPB licence 100021787 © Crown Copyright, RSPB Permit Number: 60271.
N
Date printed: 07/12/2012
Map scale = 1:20,000
0 0.2 0.4 0.8 Km
RSPB
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Broadwater Warren Nature Reserve
Hargate Forest
Eridge Park
Whitehill Wood
Broadwater Forest
High Weald Landscape Trail
Tunbridge Wells Circular Walk

Appendix II: Habitat Suitability Index Score Categorisation for *Osmia pilicornis*

Factor 1: Geographic location (SI_1)

Sites are scored according to the geographic zones illustrated in Figure 5. These zones are based upon the previous known distribution of *Osmia pilicornis*. Those sites which fall on the boundary of two zones should be scored as Zone B.

- Zone A, location is optimal, SI = 1
- Zone B, location is marginal, SI = 0.5
- Zone C, location is unsuitable, SI = 0.01

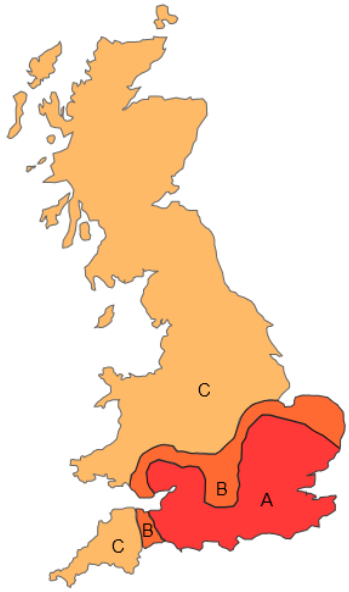

Figure 5: Map of Britain, where Zone A indicates the geographic area where *Osmia pilicornis* has been previously recorded, Zone B indicates the area where it has future potential of being recorded, and Zone C indicates the area where it is unlikely to be recorded.

Factor 2: Previous records (SI_2)

A good number of records of *Osmia pilicornis* have been submitted to the National Biodiversity Network (NBN) Gateway, so this online resource should be used to see if the site has any previous records (http://data.nbn.org.uk/imt/?mode=SPECIES&species=NHMSYS0000876498). It is also worth contacting the county recorder and/or the local biodiversity record centre to see if they have any further records. If it is already known that the bee has been recorded at a site then obviously these actions would not be necessary.

- Previous records at the site, SI = 1
- No previous records at the site, but previous records at a nearby site (<5km away), SI = 0.5
- No previous records at the site, SI = 0.01

Factor 3: Matrix habitat (SI_3)

The matrix habitat is the habitat type surrounding the site. This is best ascertained by observations on the ground, but can also be done through the use of a 1:25,000 Ordnance Survey map.

- Network of woodland surrounding the site, SI = 1
- Some woodland surrounding the site (within 2km), SI = 0.5
- The site is an isolated patch of woodland with no woodland patches within 2km of the site, SI = 0.01

Factor 4: Age of coppice (SI_4)

The age of coppice can normally be estimated by the diameter of the regrowth, but if possible the site manager should be contacted to give a more precise age. If it is a woodland clearing then the score will be 1 and if the woodland is not coppiced or has no areas of clear fell then the score will be 0.01.

- One year coppice, SI = 1
- Two –three year coppice, SI = 0.67
- New coppice, SI = 0.33
- Four year or older coppice, SI = 0.01

Factor 5: Presence of rides/clearings (SI_5)

The presence of rides or clearings can be seen from aerial photographs (Google Earth is useful here), but the best approach is to visit the site. A coppiced area of one year or less can be counted as a clearing.

- Rides or clearings of >20m in width, SI = 1
- Rides or clearings of 10-20m in width, SI = 0.67
- Rides or clearings of 0-9.9m in width, SI = 0.33
- No rides or clearings present, SI = 0.01

Factor 6: Presence of dead wood (SI_6)

Dead wood can be counted in a number of forms, including: fallen trees; tree stumps and branches on the ground. There are few known observations of *Osmia pilicornis* nests, but where these have been observed they have always been in dead wood on the ground or tree stumps, suggesting that *O. pilicornis* tends to nest at ground level. It would therefore be better to focus on the dead wood on the ground for this score.

- High abundance of dead wood (>10 tree stumps or equivalent i.e. a fallen tree), at least some of which is in an open area where it will catch the sun for at least part of the day, SI = 1
- Some dead wood present (<10 tree stumps), at least some of which is in an open area where it will catch the sun for at least part of the day, SI = 0.67
- Dead wood present in any abundance, but none of which is in an open area, SI = 0.33
- No dead wood present, SI = 0.01

Factor 7: Presence of Bugle, Ajuga reptans, and Ground Ivy, Glechoma hederacea (SI_7)

This is best carried out in the spring when these plants are in flower (late April – early May would be the optimal time).

- Presence of both *A. reptans* and *G. hederacea,* SI = 1
- Presence of *A. reptans* or *G. hederacea*, SI = 0.5
- Neither species present, SI = 0.01

Factor 8: Abundance of nectar/pollen sources (SI_8)

Similarly, this should be carried out in the spring because *Osmia pilicornis* is quite an early bee (mainly April – May) so the plants in flower then will be the plants it will forage on. It seems to have a preference for *Ajuga reptans* and *Glechoma hederacea* in Britain, but it is a polylectic species so will forage on other flowers; therefore, floristic abundance as a whole should be used in this score. This score is based on the DAFOR scale, classifying the number of flowers present as: Dominant, Abundant, Frequent, Occasional or Rare.

- Dominant: very high abundance of nectar/pollen sources, SI = 1
- Abundant: high abundance of nectar/pollen sources, SI = 0.75
- Frequent: moderate abundance of nectar/pollen sources, SI = 0.5
- Occasional/Rare: low or very low abundance of nectar/pollen sources, SI = 0.25
- No nectar/pollen sources present, SI = 0.01

Factor 9: Canopy cover (SI_9)

Canopy cover is probably most accurately measured using a densiometer or by taking photographs, but for the purpose of this index this is not necessary as it can be estimated in the field.

- Low canopy cover (no mature trees or very low density of mature trees (>20m distance between trees) along southern edge of ride or in clearing), SI = 1
- Moderate canopy cover (medium density of mature trees (10-20m distance between trees) along southern edge of ride or in clearing), SI = 0.5
- High canopy cover (high density of mature trees (<10m distance between trees) along southern edge of ride or in clearing), SI = 0.01

Factor 10: Tree height (SI_{10})

Tree height can be accurately measured using a clinometer, but for the purpose of this index this is not necessary because it can be estimated in the field. The idea of measuring tree height is to see if the ride or clearing will be shaded during the day. The height of the tallest tree on the southern side of the ride or clearing should be compared to the width of the ride or clearing in order to ascertain this.

- Ride or clearing width twice or more of tree height, SI = 1
- Ride or clearing width 1-2 times the tree height, SI = 0.67
- Ride or clearing width 0.5-0.99 times the tree height, SI = 0.33
- Ride or clearing width less than half the tree height, SI = 0.01

The HSI score is calculated using the following formula:

$$\text{HSI score} = (SI_1 \times SI_2 \times SI_3 \times SI_4 \times SI_5 \times SI_6 \times SI_7 \times SI_8 \times SI_9 \times SI_{10})^{0.1}$$

The scores will be between 0 and 1 and the higher the score, the higher the likelihood that the habitat will be suitable for *Osmia pilicornis*. However, a score of 0 does not necessarily mean that it will not be present and a score of 1 does not necessarily mean that it will be present.

Appendix III: Habitat Assessment Sheet for *Osmia pilicornis*

Site name:	Surveyor(s):	Date:

Site description:

Previous records of OP? Yes/No | If yes, when was the last record?

Are there any records from sites nearby? Yes (<2km away) ☐ Yes (2-5km away) ☐ No ☐

What is the surrounding matrix habitat? Broad-leaved woodland ☐ Other woodland ☐
Farmland ☐ Residential ☐ Other ☐ (please indicate type)

Area of coppiced woodland: ha | Coppice rotation length: years

Coppiced species: | Presence of one-year coppice? Yes/No

Presence of woodland rides and/or clearings: Yes (>20m width) ☐ Yes (<20m width) ☐ No ☐

If yes, how well-connected are they: All inter-connected ☐
Most are inter-connected ☐ Some connections ☐ No connections ☐

How much canopy cover is there along the southern edge of the ride/clearing?
No canopy cover ☐ Low (little shading) ☐ Medium (some shading) ☐ High (lots of shading) ☐

How tall are the trees on the southern edge of the ride/clearing?
No trees ☐ Short (will shade a little of the ride/clearing) ☐
Medium (will shade some of the ride/clearing) ☐ Tall (will completely shade the ride/clearing) ☐

Is there Bugle, *Ajuga reptans*, and/or Ground Ivy, *Glechoma hederacea*, present?
Bugle: Yes/No Ground Ivy: Yes/No

How abundant are nectar/pollen sources? None present ☐ Low ☐ Medium ☐ High ☐

How abundant are pollen sources (i.e. those with long flower tubes such as the Lamiaceae, Boraginaceae and Fabaceae)? None present ☐ Low ☐ Medium ☐ High ☐

Presence of dead wood? Yes/No | If yes, what type (e.g. stump, branch)?

If yes, is it exposed to the sun? No, never ☐
Yes, some of the time ☐ Yes, all of the time ☐

If yes, how much is there? A few bits ☐
Some ☐ Lots ☐

Comments: