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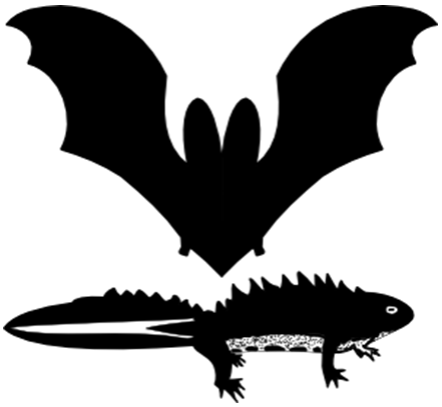

BatCRU
Bat Conservation & Research Unit

Barbastelle Bats

In
The South Downs National Park

Daniel Whitby & Sean Shereston

2015

Contents

Bat Conservation and research Unit - Registered Office: Butler's House, North Street, Petworth, West Sussex, GU28 0DP
Registered Charity in England and Wales No. 1162707

AEWC Ltd - Registered Office: Butler's House, North Street, Petworth, West Sussex, GU28 0DP
Registered in England & Wales no 06527840

Contact Daniel Whitby – daniel@aewc.co.uk

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A special thanks to our South Downs barbastelle officer Sean Shereston who has worked tirelessly for endless hours throughout the summer above and beyond normal working requirements towards the success of the project.

1. Introduction

1.1. There are records of barbastelle bats within the project area of Sussex going back to the 1980s; the first record within the Sussex Biodiversity Records Centre is of one individual from Cocking abandoned railway tunnel, with odd individuals being recorded since this then at Cocking and Drovers railway tunnels.

1.2. In 1996 barbastelle bats were identified at Ebernoe common, with the first identified breeding colony in 1998 through the radio tracking of females from this site. Since this time extensive studies have been conducted between 1998 and 2008 on this species at Ebernoe during which a second colony was identified in 2001 at The Mens. These colonies were studied between 2001 and 2008.

1.3. Between 1998 and 2008 there has been extensive research conducted at both sites on the colonies present with 329 individuals ringed and 38 radio tagged. This has identified roost and foraging habitat use and requirements, colony structure, breeding success and longevity – providing the most extensive study into this species within the UK. (F. Greenaway, Bats in the West Sussex West Weald 1997-2008)

1.4. Two breeding female barbastelle bats were caught in Slindon Wood in the summer of 2013 during a research training course, which prompted radio-tracking surveys of these individuals. These surveys revealed a maternity colony within the wood. Further surveys of the colony in 2014 identified a number of new roosts, some important flight lines and core foraging areas, and established an approximate roost size of forty bats with an unknown number of adults and juveniles. (D. Whitby Barbastelle Radio tracking Survey 2014, AEWC Ltd))

1.5. During a trapping survey on Goodwood estate in 2014 another breeding female barbastelle was caught, subsequent radio tagging identified a new maternity colony at Goodwood estate. From this roost 18 bats were caught and ringed and subsequently that autumn 2 individuals were caught at Drovers SAC abandoned tunnel, Barbastelle bats have been caught for over two decades at this site and this was the first identification of a breeding colony being connected with the bats found at this site.

1.6. This report is to cover the data collected from surveys conducted in 2015 along with previously identified information, notably the 2014 barbastelle survey work with the aim of identifying important foraging areas, roosting sites and flight lines.

1.7. Trapping surveys were conducted by Daniel Whitby and radio-tracking by Sean Shereston, both Natural England Licensed bat workers. The surveys involved trapping, radio-tagging, and radio-tracking barbastelle bats within the South Downs National Park – predominantly for the already identified two new colonies at the Slindon National Trust estate, and Goodwood estate.

1.8. Radio-tracking surveys provide details of important flight lines and core foraging areas for tagged individuals, as well as identifying both maternity and satellite roost sites.

1.9. This report provides the results from radio-tracking of six individuals from Goodwood, and five individuals from Slindon estate, as well as information on additional barbastelle bats

from three newly discovered groups which require further research. 2014 Radio-tracking data from four individuals from Slindon, and one from Goodwood is also included.

Aims

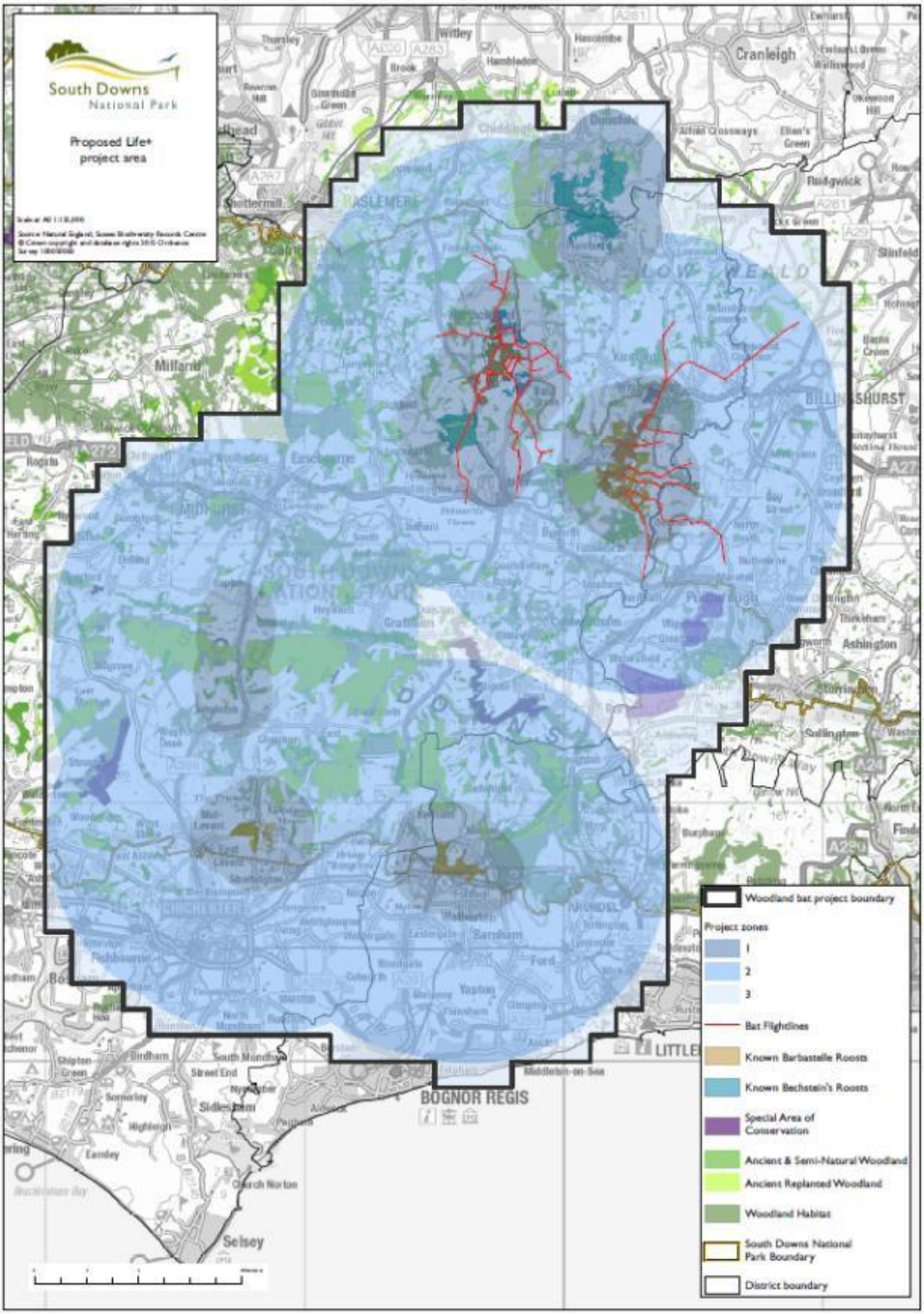
1.10. The purpose of the project is multi-faceted – it is predominantly to gather information to inform conservation and enhancement of Barbastelle bats within the project area, most notably through a LIFE+ bid application for a wide area including the colonies already studied at Ebernoe and The Mens.

1.11. Following on from the success of a SITA Trust grant to conduct habitat enhancements at Slindon, a LIFE+ bid (E.U Application) is being prepared with the National Trust and South Downs National Park Authority to conduct habitat enhancements and improvements for barbastelle and Bechstein's bats within the project area (See plan 1). This is supported by a number of organisations including AEWC, Bat Conservation Trust, and BatCRU (Bat Conservation Research Unit) a charity who advise on species requirements.

1.12. This research can also be used for any other grant applications for further research or habitat improvements and enhancements, which may be at a site level, and to provide information to land owners and estate managers on management recommendations for this species. The data and research within this project will be made available to a number of parties to inform decision making.

1.13. The aims of the project can be summarised as -

- To conduct research into the population, core maternity roosting areas, flight lines, and core foraging areas for the barbastelle colonies at Goodwood and Slindon estate.
- To search for new barbastelle colonies that are within, or using habitat within the LIFE+ proposed project's area.
- To provide guidance on management and recommendations to estate managers where barbastelle colonies are present.
- To provide information to local councils to inform planning policy pertaining to potential impacts on barbastelle bats and their habitats.
- To identify further areas of research or potential impacts on barbastelle bats, nationally or locally.
- To provide data and recommendations to inform habitat enchantments for grant applications – notably, but not restricted to, the LIFE+ bid.



Plan 1 – Showing proposed LIFE+ bid project area.

2. Methodology

2.1. **Trapping**

Trapping surveys began in May 2015, running throughout the active season with a break between the end of June and the middle of July when the colonies were heavily pregnant and giving birth.

Trapping surveys involved the placement of harp traps and mist nets on flight-lines used by barbastelle in 2013 and 2014, as well as within the maternity woodland, in order to target bats from these colonies. Acoustic lures (Sussex Autobat) were employed during some surveys, however these were used sparingly and not near any known maternity roost locations.

On three occasion bats were trapped from the roost to enable ringing of individuals and selection of a suitable bat to tag. This was performed using a specialist roost harp trap, and only carried out once for each colony.

2.2. **Processing**

All captured bats were identified, sexed, and reproductive status assessed. All bats were released at the capture site on the same night. In addition, female barbastelle bats were weighed, forearm measurement taken, and assessed for suitability to attach a radio tag. Suitability was assessed on an individual basis, following the rule that the tag weight must not be over 5% of the bat's body weight.

Radio tags (Biotrack UK) were affixed to the bat between the shoulder blades at the most suitable centre of gravity, using a latex based adhesive (Torbot bonding cement).

All tagged bats were ringed so that the bat is uniquely identifiable in the event of a recapture, to ensure that the individual is not radio tagged again in the same year, or in subsequent years where the research work does not warrant the impact on the individual bat.

Bats were kept post-tagging for approximately ten to fifteen minutes, to ensure that aerials are cleaned and the bats are thoroughly checked prior to release. Following their release, bats' movements were monitored to identify movement and direction of travel to inform future nights tracking and monitoring, but no data was collected as behaviour is commonly altered on the night of radio tagging.

2.3 Radio-tracking

Biotrack Sika radio telemetry receivers were used in conjunction with various antenna in order to maintain signal on the bats across the landscape while commuting and foraging ensuring consistent and proportional data collection of each bat.

Tracking was conducted predominantly from a mobile 4x4 unit, employing close approach and triangulation where possible with assistant teams tracking on some occasions. Tracking was conducted for three nights as standard if repeatable behaviour was observed, where bats altered their behaviour then additional nights tracking were conducted where necessary.

Bearings were taken at a minimum of 5 minute intervals, which involved recording the approximate position of the bat using ten digit OS grid reference, noting down time, and confidence in the bearing (low to high, relating to approximately 25%, 50%, >100%).

Tagged bats were checked daily to identify roost locations and roost type. Roost counts were ascertained by filming the roost emergence with professional infra-red night vision cameras and IR illuminators at dusk enabling accurate roost counts even in very low light levels. Visual survey counts are inaccurate and were not conducted.

3. Constraints

3.1. The spring of 2015 was very cold, meaning barbastelle bats caught from the Slindon and Goodwood colonies were not showing signs of pregnancy until late June. This meant that it was difficult to ascertain the current breeding status (with regards to pregnancy) of bats caught early in the season in order to select females which were likely to be forming maternity colonies. Thus very early data yielded behaviour typical of non-breeding females and identified predominantly solitary roosting individuals.

3.2. Later in the summer it was found that a high proportion of the barbastelle bats were not breeding, having aborted or lost their young as is typical of poor years with low early summer temperatures and poor foraging conditions. The data within this report may not be fully representative of a typical summer behaviour as non-breeding females and poor weather may have affected foraging and roosting behaviour recorded.

3.3. Due to their fast flight and vast foraging range, barbastelle bats are notoriously difficult to radio-track. Field data is accurate to within approximately 100m; a fine level of accuracy is not possible due to several factors such as:

- Vague directionality where contours and obstructions can bounce signals;
- The time it takes for a surveyor to move position to self-triangulate;
- Variance in ability between volunteers when triangulating.

3.4. Very few maternity roosts were suitable to trap out of due to their height or feature type, and so much of the radio-tracking data is collected from bats which have been caught on flight lines. Trapping on flight lines or foraging areas can create an inherent bias in foraging data, favouring the direction of flight or area in which the bat was caught. However to mitigate for this, trapping took place at numerous flight lines in all directions and where possible bats were tagged from the roost therefore a reduction in bias has been achieved.

3.5. The limited budget and amount of time to collect post-maternity data has resulted in fewer bats being tracked than perhaps could have been over the season if not for an August deadline, especially in a year with a poor spring. This has led to a reduction in overall data collected over the season than could have been achieved.

4. Results

4.1. Trapping Surveys

Slindon National Trust

4.2. Following the discovery of the Slindon colony in 2013, some radio-tracking had already been conducted at Slindon estate identifying flight lines, foraging areas and roosts in 2014. This work is amalgamated into this report.

4.3. During 2015 there have been nine nights trapping at Slindon including one night trapping out of a roost. There have been seven new individuals ringed which were all adults. No roosts were trapped with flying juveniles present. In total over 2014/15 there have been thirty five individuals ringed at Slindon and one identified as already ringed, twenty one of these have been adult females.

4.4. A roost trap on the 21st June caught eight individuals, three were new un-ringed individuals however approximately a dozen bats escaped through a gap and so not all bats were caught; it is believed that there are still some un-ringed individuals. Additionally the spring of 2015 was considered very poor, as a result a number of bats tagged were exhibiting solitary behaviour and as is typical for this species there are likely to have been number of bats not roosting with the main group. It is currently estimated that the adult female population at Slindon is around thirty, however if other satellite groups are present it may be more than this.

4.5. In total nine bats have been successfully radio-tagged in 2014 and 2015 to both identify important areas for this colony and to search for other satellite roosts associated with part of this colony, while none were found it does not mean that there are not still other satellite groups of bats present in the wider area.

Roost sites

4.6. A total of twenty one barbastelle roost sites have been identified from the research conducted on Slindon estate in 2014 and 2015, of which sixteen were found in 2015. Of these, nine were used as maternity roosts and the rest were solitary or had an unknown minimum count.

4.7. On one occasion, H4366 roosted in Downe's Barn, which is an old disused barn located toward the north of the estate. The roost feature was not identified and as a result a full count could not be performed during emergence. It is likely that this was a solitary roost, as it was early in the year (when tagged bats were roosting predominantly solitarily) and not used by any tagged bats since.

4.8. Tree roost selection comprised of 75% (15) oak, 20% (4) beech, and 5% (1) ash. All maternity roosts were identified to be in oak trees bar two, which were found in a beech tree, in both cases damaged and one with a large split going into the stem as a result of a codominant union failure.

Plan 2 – Showing roost sites identified at Slindon

Radio tracking

4.9. Below are details for each bat radio-tracked from the Slindon estate.

2014 Radio-Tracking Data

4.10. **H4302** - This bat was tagged on the 2nd July and found roosting in roost 1This bat had the farthest foraging range of those tracked in 2014, extending approximately three kilometers north of Sutton (approximately 9.8km from the roost). The bat was the first to identify flight lines leaving Slindon wood along the drove road north of Slindon up to Nore Wood, and along Nore Wood Lane heading northeast.

4.11. **H4305** – This bat was tagged on the 7th July and roosted in roost 1. This had the second farthest foraging range of the bats tracked in 2014, with a single data point recorded just south of the A285 in Upwaltham. This bat foraged predominantly in Eartham Wood and edges and regularly used the old drove road to move quickly between areas.

4.12. **H4306** – This bat was tagged on the 16th July and roosted in roost 1, 3 and 4. This bat foraged primarily in Slindon wood, using the drove road to commute north to forage in Nore Wood.

4.13. **H4308** – This bat was tagged on the 21st July and foraged predominantly in the open to the west of Slindon wood, as well as in and around small woodland blocks such as The Reeds, Crouch Ham, and Little Heath Plantation.

2015 Radio-Tracking Data

4.14. **H4366** – Tagged 10th May 2015 - The first to be caught and tagged in Slindon Wood in 2015, this bat used two flight lines to reach its core foraging area in Great Down, just north of Northwood Cottages. Butt Lane, a track heading northeast from the area opposite the entrance to Slindon College, was favoured slightly of the two.

4.15. **H4301** – Tagged 22nd May 2015 - This bat foraged in Slindon Wood prior to heading southwest as it got dark. Before crossing the A27, it would fly southwest crossing Duke's Road toward Littleheath Road, only flying south over the A27 once it had reached a point approximately 300m from the final street lamp on that stretch of carriageway.

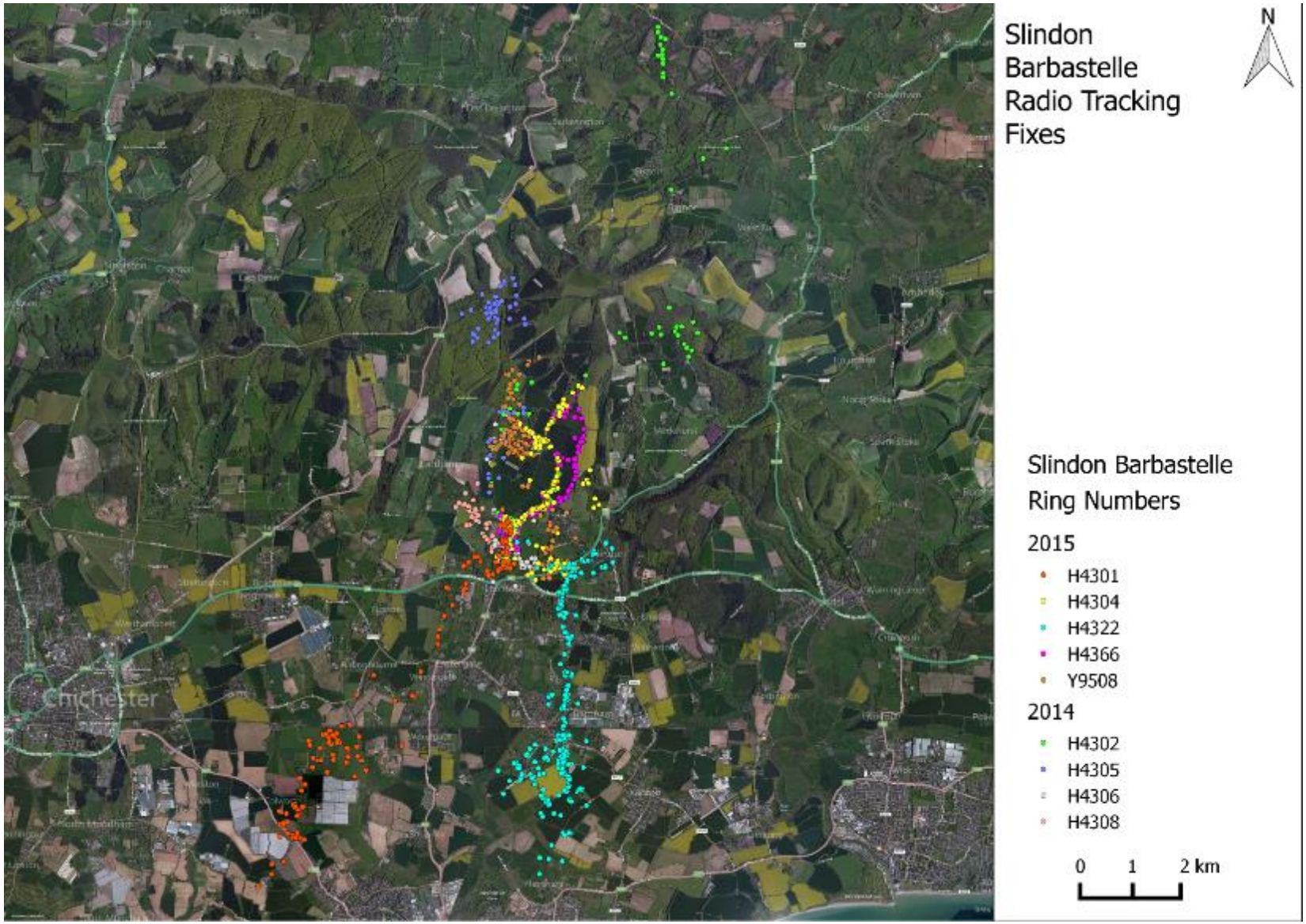
The core foraging area for this bat was a wide area around Colworth, including over several fields used to grow strawberry crops in polytunnels . This is an area of significance as it overlaps with at least two individuals from the Goodwood colony, coming very close to a third individual from that colony.

4.16. **H4304** – Tagged 13th June 2015 - Foraged predominantly in Slindon and North wood, commuting along Nore Wood Lane and extending its range up into Great Down.

4.17. **H4322** – 13th June 2015 - After foraging in Slindon Wood, this bat headed south, crossing the unlit A29, through Slindon Common and Ashbeds. Street lighting on the A27 stops just 100m east of the eastern edge of Ashbeds wood, with a mature hedgerow and good connectivity to the south beyond this point.

This bat flies parallel with the A27 to reach this unlit point before crossing and heading further south toward its core foraging area around Barnham, which is primarily open habitat with hedgerows containing mature standard trees alongside ditches. In addition, H4322 would forage north of Barnham in Nanny Copse and Stemps Wood, both blocks of woodland with small streams and water bodies present.

4.18. **Y9508** – Tagged 12th July 2015 - This individual would forage in Slindon Wood before commuting along the drove road to the northeast of the wood toward Nore Wood. It seemed to use the flight line along Nore Wood Lane to return to the wood, and on one occasion appeared to commute toward the folly almost directly from Court Hill Farm, over open fields and hedgerows.



Plan 3 – showing all radio tracking fixes from all Slindon Barbastelle bats

Flight lines

4.19. Brief description of any main flight lines and interesting behaviour.

4.20. Several flight lines have been identified through tracking and trapping data from 2014 and 2015 (see plan 4) . The first to be discovered was the drove road which runs north to south between Nore Wood and the north-western tip of Slindon Wood. This flight line was used by Y9508, H4302, and H4305. In addition, a number of barbastelle were caught in a harp trap while commuting along this track in both years.

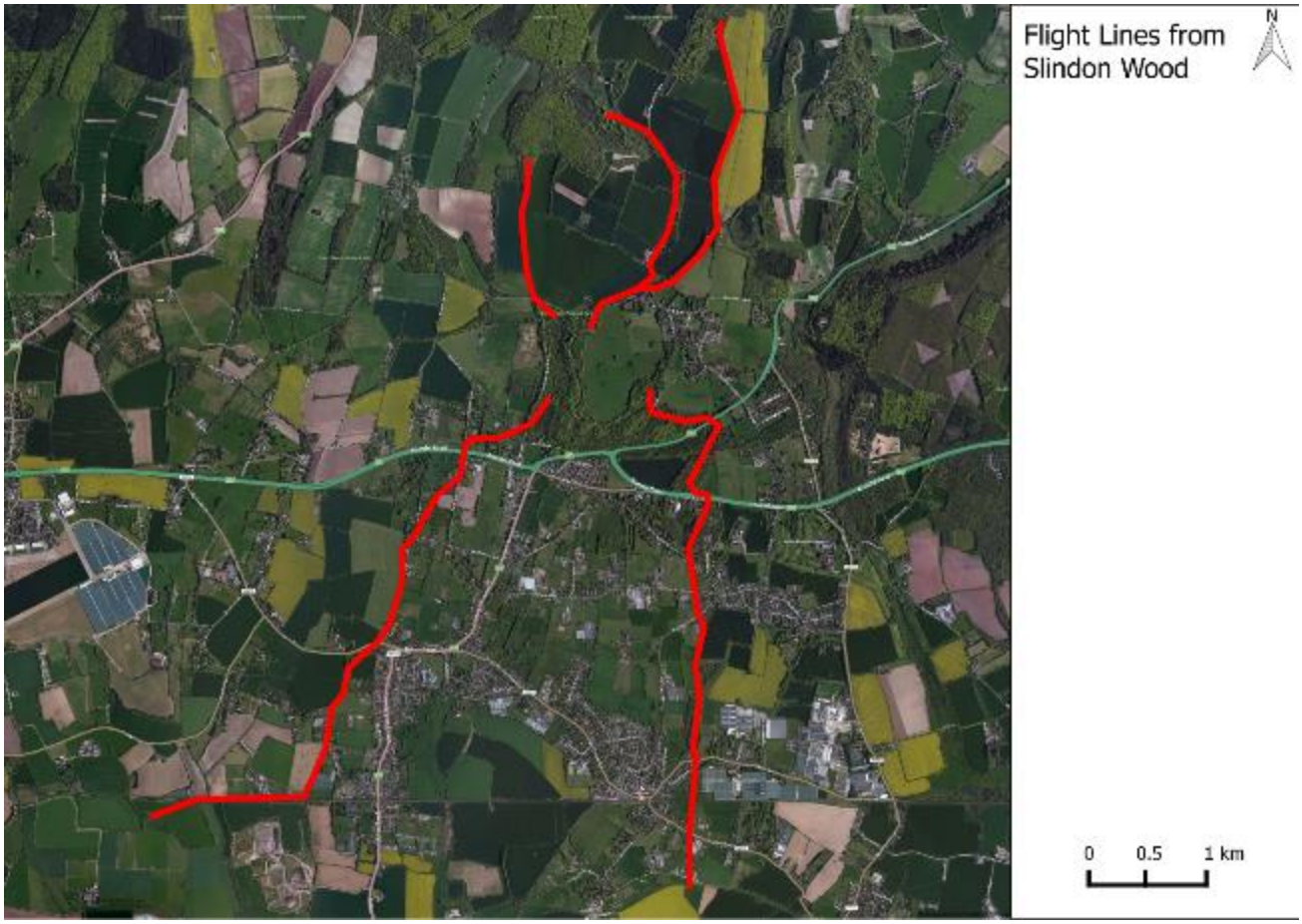
4.21. Another important flight line connecting Slindon Wood to Nore Wood is Nore Wood Lane. This is an old tarmac lane bordered by a mature hedgerow with standard trees leading to North Wood Cottages, providing a well sheltered linear commuting route to Nore Wood where various individuals then disperse in different directions.

4.22. Running parallel to Nore Wood lane is Butt Lane, a flight line which was lesser used by tracked bats but still notable, as not only did radio-tracked individuals use the lane but barbastelle were caught in mist nets commuting along it. H4366 in particular favoured this route, commuting toward its core foraging area in Great Down – a small block of woodland northeast of Northwood Cottages.

4.23. Two southerly flight lines were identified through radio-tracking, heading southeast and southwest respectively. However it was noted that no bats crossed the road immediately south of Slindon wood, even though this was closer to the roost and provided good woodland connectivity. Both of these crossed the A27 at points which were not illuminated, highlighting the impact that artificial light can have on bats' commuting routes even where good connectivity exists. Many bat species are known to avoid lighting and it can have the effect of severing habitats. All bats crossing the road were identified crossing where no street lighting is present.

4.24. The south-western flight line used by H4301 leaves Slindon Wood to the west, parallel with the A27, crossing Dukes Road towards Littleheath Road. The individual then commutes south, crossing the A27 at the approximate area where Denmans Lane joins it from the south. The flight path continues broadly southwest, along Northfields Lane and through Westergate using footpath and field boundary hedgerows before reaching the area near Decoy Farmhouse, where it would then forage in the open over a wide area in Oving spanning as far as two field boundaries west of the A259.

4.25. The south-eastern flight line used by H4322 begins in Slindon Wood, heading southeast towards Slindon Bottom, crossing the unlit A29. It then proceeds south toward the south-eastern corner of Ashbeds, where the bat would commute along the hedgerow to cross the A27 at a point where there is no street lighting, before continuing south to the west of Walberton, towards following a field boundary hedge south through Nanny Copse and south of Barnham, specifically the open habitat south of Yapton Road.



Plan 4 – showing identified flightlines from Slindon

Goodwood Estate

4.26. At the start of this project only one bat had been radio-tagged and tracked from this colony when it was discovered in 2014. Additionally, eighteen bats had been ringed of which nine were adult females.

4.27. During 2015 there have been seven nights trapping at Goodwood and one night trapping out of a roost. There have been thirteen new individuals ringed which were all adults. No roosts were trapped with flying juveniles present. In total there have been thirty two individuals ringed at Goodwood and two individuals identified ringed at other locations, one adult male ringed at West Dean tunnel during a swarming survey in Autumn 2014 and a female juvenile ringed at Drovers railway tunnel in September 2014 were caught in the maternity roost in July 2015. To date twenty one adult females have been caught and identified at Goodwood.

4.28. A roost trap on the 23rd July caught nine individuals, five were new un-ringed individuals however approximately a dozen bats escaped through another gap meaning not all bats were caught and so it is believed that there are still some un-ringed individuals. Additionally the spring of 2015 was considered very poor, as a result a number of bats tagged were exhibiting solitary behaviour and as is typical for this species there are likely to have been number of bats not roosting with the main group. It is currently estimated that the adult female population at Goodwood is at least 30 adult females, however if other satellite groups are present it may be more than this.

4.29. In total seven bats have been successfully radio-tagged in 2014 and 2015 to both identify

important areas for this colony and to search for other satellite roosts associated with part of this colony, while none were found it does not mean that there are not still other satellite groups of bats present in the wider area as these can be very difficult to identify.

Roost sites

4.30. There have been a total number of ten barbastelle roosts identified at Goodwood, of which four are maternity with the rest solitary or having an unknown count or status.

4.31. All of the confirmed maternity roosts identified are within 330m of one another, which in comparison with the farthest maternity roost at Slindon (just over 1.7km) is a very small area. Further comparison with satellite groups at The Mens which are found just over 3km from each other depicts just how small this core maternity area is.

4.32. By contrast, the farthest distance between solitary / unknown roosts at Goodwood is 3.3km, which is comparable with the farthest satellite group spacing at The Mens demonstrating that individuals are roosting over a wide area of the estate.

4.33. Two roost features of note were the farthest western roost – a hanging tile on a domestic dwelling in Lavant, and the farthest eastern roost – a small sycamore *Acer pseudoplatanus* with a diameter at 1.5m of no more than 30cm. The barbastelle roosting under the hanging tile used the roost exclusively for the entire life of the tag (fourteen days). A roost check on 20/08/2015, after all radio tracking had finished, revealed a minimum of two individuals roosting in the sycamore to the east of the territory, confirming that this roost is used by multiple individuals including bat H4359 but cannot be confirmed as a maternity roost and so its status remains unknown.

Plan 5 – Showing roost sites identified at Goodwood

Radio tracking

2014 Radio-Tracking Data

4.34. **H4349** – This was the only bat tracked in 2014 when the first breeding female was discovered at this site and has slightly less data than the 2015 data, however, foraging was still consistent. This individual would forage predominantly in High Wood and The Valdoe, with a range not exceeding 1.5km in the data collected.

2015 Radio-Tracking Data

4.35. **H4357** – Tagged 6th May 2015 - This individual was caught in The Valdoe and was the first to be tagged at Goodwood in 2015. It foraged primarily in The Valdoe and in the woodland strip to the west of Kennel Hill and the golf course in between. It was tracked foraging along Pook Lane which runs along the north of The Valdoe west towards East Lavant where it would roost.

4.36. **H4359** – Tagged 7th May 2015 - This individual was caught in The Valdoe, and found to be roosting in Bexley Bushes – a small block of unmanaged native woodland with a dense understory to the north of The Valdoe. The bat would commute to this roost site via a hedgerow to the east of Forage Yard which leads up to the coniferous Bexley Plantation. Core foraging area appeared to be The Valdoe, also using High Wood and commuting to Seeley Copse, toward the east of the estate, where it roosted in a small sycamore tree.

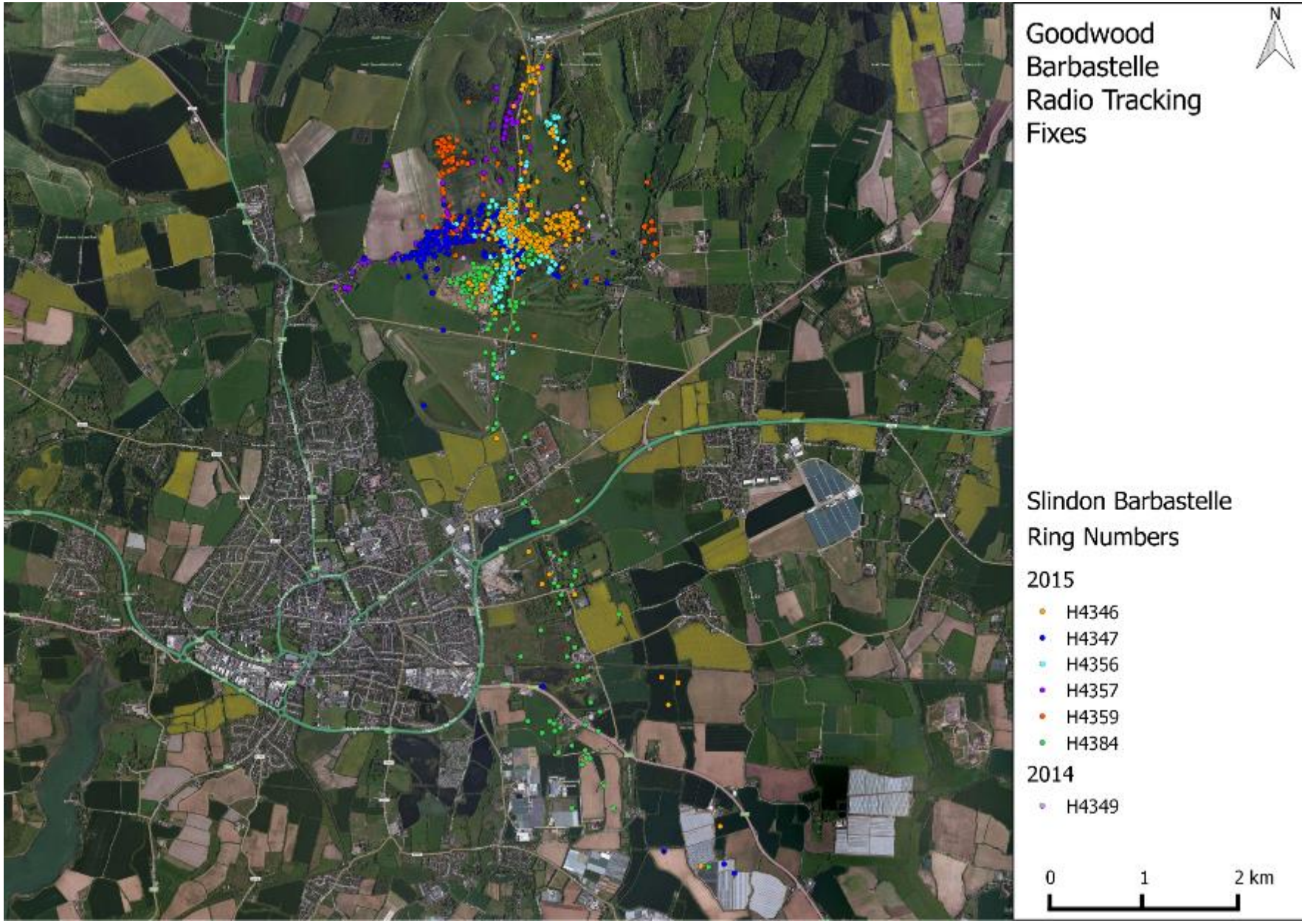
4.37. **H4347** – Tagged 30th May 2015 - This bat foraged predominantly in The Valdoe, favouring the western end of the wood including some foraging in the open around residential properties and hedgerows to the west of the wood. On the second night of tracking (03/06/2015), this individual commuted southeast to Colworth where an individual from Slindon colony was also tracked. This bat was the first from Goodwood to have been tracked to this location, and so an additional night tracking was conducted to see if the behaviour was replicated, which it was not. Subsequent individuals have been tracked to this area, confirming it as a significant foraging area for the species and particularly interesting as it appears to demonstrate overlapping of territories between colonies

4.38. **H4356** – Tagged 17th July 2015 - This individual foraged predominantly around New Barn Hill, as well as the eastern end of The Valdoe and Reservoir Clump, a block of woodland to the northeast of the roost site.

4.39. **H4346** – Tagged 23rd July 2015 and Trapped from the roost. This individual would emerge from the roost and commute into The Valdoe, where it would forage until light levels dropped. From The Valdoe it would commute northeast toward the strip of woodland running up the east side of Kennel Hill, proceeding to forage on both the east and west side of the road.

On cold nights this bat seemed to favour foraging closer to the roost, foraging in Reservoir Clump and High Wood. On milder evenings this individual would commute southeast towards Colworth where the strawberry farm is located, and where an individual (H4301) from the Slindon colony was also tracked foraging.

4.40. **H4384** – Tagged 23rd July 2015 and this individual was caught from the roost. On cooler nights this bat would forage closer to the roost, using the eastern end of The Valdoe, High Wood, and in the open over the gravel works to the south of The Valdoe. Warmer nights prompted this individual to commute southeast towards Colworth where bats H4347 and H4346 were found to be foraging over a strawberry farm with polytunnels, as well as H4301 from Slindon.



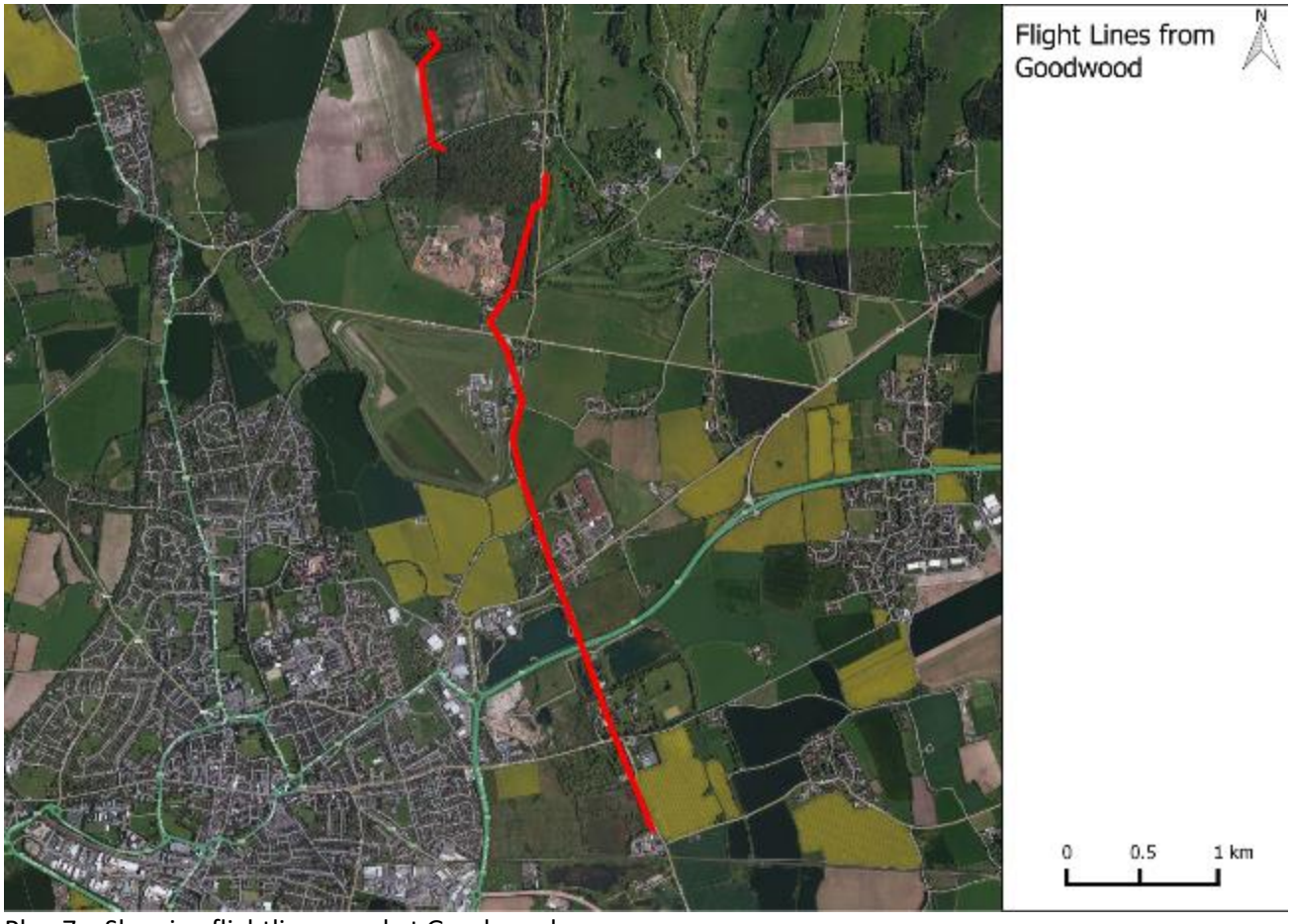
Plan 6 – Showing radio tracking fixes for all barbastelle bats at Goodwood

Flight lines

4.41. Flight lines at Goodwood are limited due to the nature of the individuals foraging very close to the roost; there is very little in the way of dispersal from the core maternal woodland.

4.42. A minor flight line between The Valdo and Bexley Plantations appears to be the hedgerow running north to south just to the east of Forage Yard. This was used by two individuals to commute from The Valdoe to Bexley Plantation, where one (H4359) bat would continue further north to its roost site in Bexley Bushes.

4.43. A major flight line to the southeast was used by three individuals to reach their foraging area near Colworth. Bats would commute south along New Barn Hill, crossing New Road either side of the lit area around the roundabout – most seemed to prefer commuting down the western side, crossing over into the aerodrome before heading further southeast. They would then travel parallel with Claypit Lane crossing Stane Street, where the bats would then cross the A27 at the point where Coach Road comes to an end. After heading southeast following Drayton Lane, bats would then forage in their respective areas, often crossing the A259 and the train line which runs east to west.



Plan 7 – Showing flightlines used at Goodwood

New Colonies

4.44. Throughout the summer, new adult female barbastelle bats caught during trapping surveys conducted within the project area, have been tagged and tracked back to roosts in order to identify roost location. This has resulted in the identification of three new groups of bats.

Storrington

4.45. The radio tracking of an adult female bat in early August identified a new roost near Storrington over 9km from any other known colony. Over the period of a week this bat was found using two adjacent trees and a minimum colony count of 58 bats were identified through emergence surveys on both trees simultaneously, however there were still further juveniles present, remaining within the roost.

4.46. Roost trapping on 6th August caught twenty nine bats from one of these roost trees with a number escaping capture. These consisted of eighteen adult females, eight juvenile females and three juvenile males. All bats caught were new captures and un- ringed.

4.47. This roost is over 9km from any other known colony, the bat was radio tracked for 2 nights which identified it foraging within an area around Bury and Amberley floodplain. (see plan 3A Annex 1)

Black Down

4.48. Trapping conducted at the National Trust Black Down estate near Haslemere caught three adult barbastelle bats, one male and two females. The radio tracking of one individual female was conducted in June which identified a new roost at Black Down, just off the National Trust ownership in a private woodland.

4.49. Surveys on this bat identified a roost of thirteen individuals on two separate emergence surveys using a tree in a dense area of woodland, however trapping of the roost was not possible.

4.50. This roost is less than 5km from Ebernoe common colony, which is considered close, and is within the identified Ebernoe colony foraging territory. This bat was radio tracked for two nights which identified it foraging to the Southeast of Lurgashall which is closer and only 2.5km from Ebernoe common maternity roosts and within the colony's identified foraging range. (see plan 1A Annex 1)

Upperton

4.51. During early August one adult female bat was tagged and tracked to Upperton, near Petworth Park. Monitoring over a period of 7 days identified it using four trees within this area. Surveys on this bat identified a roost of only twenty two individuals on two separate emergence surveys using trees in a very dense area of woodland, however trapping of the roosts was not possible.

4.52. This roost is less than 4km from Ebernoe common colony, which is considered close, and is within the identified Ebernoe colony foraging territory. This bat was radio tracked for a reduced number of nights which identified it foraging south of Fittleworth, while this is further from Ebernoe it is commuting through and within the colony's identified foraging range. (F. Greenaway. Barbastelle bats in the South West Weald)

5. Discussion

5.1. Although this project has a number of aims and objectives it is ultimately aimed at gaining greater knowledge of barbastelle bats within the area, their colonies and core areas in order to inform habitat enhancement and conservation of the species.

5.2. Barbastelle, like many bat species, can have a number of varied and sometime specific requirements these fall into three main core areas that this species needs to survive, and the better these are the better a colony and the species will thrive.

5.3. Barbastelle need good roost availability, good foraging habitat and connectivity between these. They are known to have quite specific roost requirements – not only do they almost exclusively roost in trees, but are specific to what type of tree roosts they use. It is exceptionally rare to find barbastelle bats in rot holes or woodpecker holes, instead selecting cracks and fissures in trees such as hazard beams and splits in the trunk as a result of codominant union failure, as well as roosting behind lose bark plates on older dying trees.

5.4. On top of this specific roost selection, barbastelle bats are known to move roost regularly, with colonies commonly fragmenting into smaller roosting groups or satellite roosts. Bats both roosting as individuals, or a maternal group, are known to move regularly within a core maternity roost area or woodland specific to their colony. This means that a successful colony needs a woodland with a high number and diversity of suitable roosts for the species, making them very susceptible to forestry practices – notably commercial plantations where areas are clear felled and plantations thinned, and where damaged and dying trees are more routinely removed for firewood in favour of healthier more commercially valuable trees. Trees with the highest roosting potential features such as splits in the stem or hazard beams are also most at risk from removal or remedial works due to the potential hazard they pose.

Foraging

5.5. Barbastelle have been found to have specific foraging requirements, and while they have been found foraging throughout a range of habitats, studies have shown that they may specialise in predating tympanate macro moths which are mostly associated with Oak woodland, unimproved grassland, riparian habitat and hedgerows which are the main habitats that barbastelle bats have been associated with.

5.6. It has been found in some studies, notably Ebernoe and The Mens, that in the earlier parts of the summer bats favour foraging in woodland. Later into mid-summer bats are found foraging more in open habitat, notably riparian habitat, water courses and floodplains

which is possibly as a result of increased night time temperatures. There are a number of influencing factors that may cause this including differing seasons of hatches of prey within these areas as well as seasonal weather conditions. During the early, colder, summer period woodlands and dense woodlands are warmer, resulting in higher invertebrate activity compared to open habitats.

5.7. Foraging availability within commuting range to a colony will always be a limiting factor; good foraging close to a maternity colony is important, allowing bats to emerge early and foraging quickly within the woodland as a communal foraging area used by many bats before dispersing to wider landscapes and individual foraging areas.

Connectivity

5.8. Good quality connectivity has a dual functionality, while this provides sheltered flight lines from roosting areas to foraging habitats this should not be viewed as a sole function and is only at its most important close to maternity woodlands.

5.9. Barbastelle bats will fly within open habitats once it is dark are not as reliant on connectivity features to move throughout the wider landscape or for navigation, such as when they forage in open floodplain habitats. However, good sheltered connectivity features close to a maternity colony enable bats to disperse from the sheltered woodland sooner after they emerge from the roost, rather than wait for lower light levels in which they are more vulnerable, and forage in favoured foraging areas sooner increasing foraging success.

5.10. For this reason tree lines which provide canopy cover will always be better than managed hedges which, while providing a commuting feature, do not provide the same shelter for flying bats. In addition tree lines, especially those along ditches, streams or riparian habitat will provide increased foraging availability and suitability than a standard managed hedge, both for foraging close to a roost and where bats may forage commuting en-route to core foraging areas.

Roosts

5.11. Roost selection by barbastelle's identified throughout this project were very similar to many other projects, with barbastelle bats preferring splits, cracks and crevices, notably in large and damaged trees and commonly from trunk splits or limb tears with large cracks in the remaining trunk, as well as hazard beams. The barbastelle colony at Slindon was also found using one tree with lose bark in 2014 and one in 2015. The Goodwood colony were found using trees with lose bark for maternity roosts in both 2014 and 2015.

5.12. Of the thirty six tree roosts identified twenty six were oak, and for the confirmed maternity roosts 15 of the 20 were Oak trees supporting other projects as Oak being the preferred and most commonly used roost tree species. It is worth noting that at both Slindon and Goodwood, Oak trees are far from the most predominant tree species present.

5.13. It was noted that for many of the roosts identified early in the season, particularly May 2015, many bats appeared to be roosting solitarily or possibly in small groups. The larger main groups did not appear to have formed which is likely to have been a result of the unseasonal cold weather conditions during this period.

5.14. All of the colonies and roosting groups identified in 2015 have been found using areas with ancient woodland with veteran trees present, of which a good proportion are oak – a favoured roosting tree species. Slindon has a number of mature oaks throughout the estate with many damaged trees as result of its exposed location and storms, notably the 1987 storm. The southern half of the estate is not subject to commercial forestry practices. Although some individual tree roosts were identified in the northern area of the estate, and in smaller trees, no maternity groups were identified in this area.

5.15. At Goodwood there are large areas of commercial forestry, however there are a number of older and unmanaged areas notably in and around the golf course where there is little or no forestry management. These small reservoirs of ancient and unmanaged non-commercial woodland are believed to be vital for the success of this colony present at this location.

5.16. Of all 36 tree roosts identified throughout 2014/15 at all sites 22 were found to be within denser areas of woodland with a dense well-structured understory. This was very true for the Black Down and Upperton groups identified, although the Storrington roost was much more in the open, however there was a very limited observation and survey on these groups.

5.17. Barbastelle bats are commonly found roosting in very exposed roost locations, and are often visible inside the roost which may be just a crack or lose piece of bark. It may be that the dense understory is important in stabilising the microclimatic conditions around these roosts which may be more important than other roost types such as tree cavities where conditions are more stable. Therefore it is believed that understory clearance around roosts may lead to these becoming less, or, unsuitable as roost trees.

5.18. Confirmed maternity trees identified at Slindon and Goodwood are all within a smaller area than that of the colonies at Ebernoe and The Mens, most notably Goodwood where all maternity roosts are all within a few 100m. Roost availability may be a limiting factor, especially on the Goodwood estate.

Slindon

5.19. The population identified at Slindon has not been identified as large as would have been expected with an estimated thirty adult females. It is possible that there may be another sub group of bats present locally, possibly within the private woodland to the east along the A27. While the strong survey effort and radio-tracking in this area have not shown this, it cannot be dismissed and this area of woodland may be an area to target in future studies.

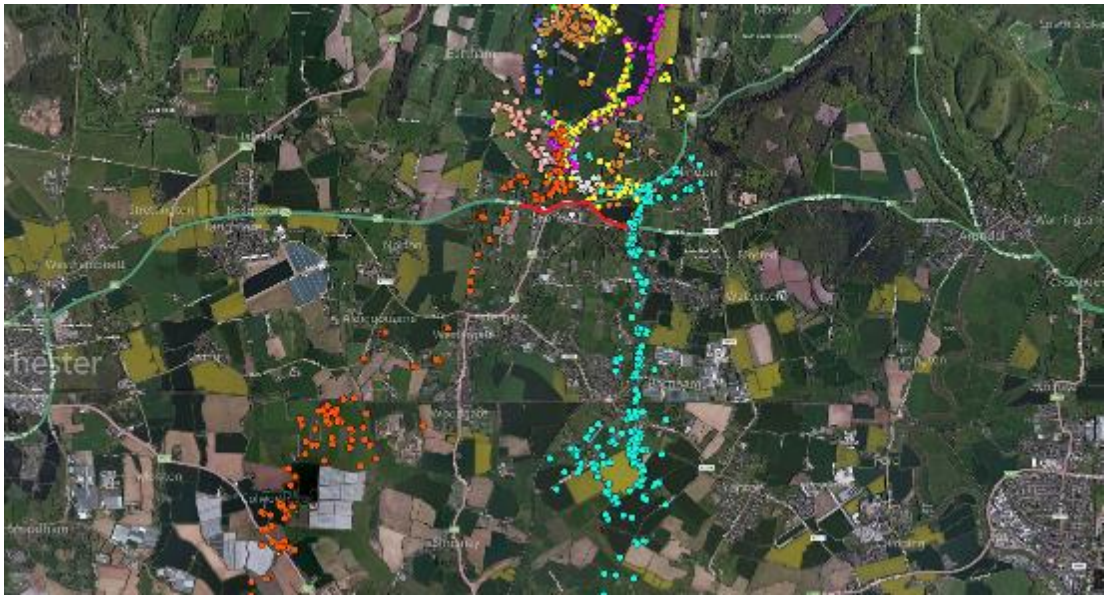
5.20. Slindon is considered to have a good roost diversity and availability, there have been 11 maternity roost trees identified (some used in more than one year), and is what would be expected from a good woodland with oak managed favourably for non-intensive commercial purposes. The main Slindon wood has a high number of damaged trees, many appearing to be from storms and the favourable management has preserved these to develop over years into the range of suitable roosts.

5.21. Given the lower population than was expected and no identification of any additional subgroups, a higher than normal proportion of the colony has been radio tracked than would be expected, so this site is considered to have good representative data.

5.22. Radio tagged bats have predominantly been found foraging closer to roosting areas than other studies, although some individuals have foraged further afield, notably one individual going much further north and one each going southeast and southwest over the A27. Approximately five of the nine bats tagged were found to exhibit foraging activity predominantly within the Slindon National Trust estate.

5.23. The average maximum foraging distance in this study is approximately 5km, similar to what was found at the Ebernoe common and The Mens colonies of 5.2km and 7.1km respectively in 2008 (F. Greenaway), however this is slightly less and 5 of the 9 bats were within 3.5km with one bat going 10km increasing the overall average. This reduced foraging range is likely to be largely due to the notably lower colony sizes – fewer bats results in a higher proportion of the colony being able to forage close to the roosting areas.

5.24. F. Greenaway's study of the colonies at Ebernoe and The Mens produced clear flight lines showing dispersal from the core maternity woodlands into much wider habitat, whereas the smaller colony sizes of Slindon and Goodwood are not conducive to this due to close foraging behaviour. Four main routes were however identified which were used by bats dispersing from the site. The most notable of these were two going southeast and southwest respectively, crossing the A27. It was noted that in both cases the bats moved parallel to the dual carriageway before heading south, avoiding commuting south straight from Slindon wood, despite the closer proximity to the roost and arguably better connective woodland in this area. This is believed to be a result of the street lighting that is present only along the area of the A27 south of Slindon, bats are known to avoid illuminated areas and a number of studies have shown that bats will avoid lighting. (See plan 6 showing two commuting routes and area of street lighting along the A27)



Plan 6 – showing radio tracking fixes and area of the A27 illuminated by streetlights

Goodwood

5.25. The population at Goodwood has also not been identified as particularly high, with an estimated thirty five adult females. However, this has had lower survey effort over fewer years than Slindon estate, and less trapping effort over wider areas of the estate. The possibility of another subgroup cannot be dismissed, but this has not been identified in the trapping and radio-tracking data.

5.26. Surveys at Goodwood have identified a limited range of roost sites, although the survey effort has been high and undoubtedly more roosts will be present. All of the confirmed maternity roosts are all within a few hundred meters around a golf course where there are smaller isolated areas of woodland that are not commercially managed. In both 2014 and 2015 all of the identified maternity roosts were within the same small area, while solitary roosts were found over a much wider area earlier in the year, many in smaller trees. It may be that suitable roost availability for maternity groups is a limiting factor for this colony.

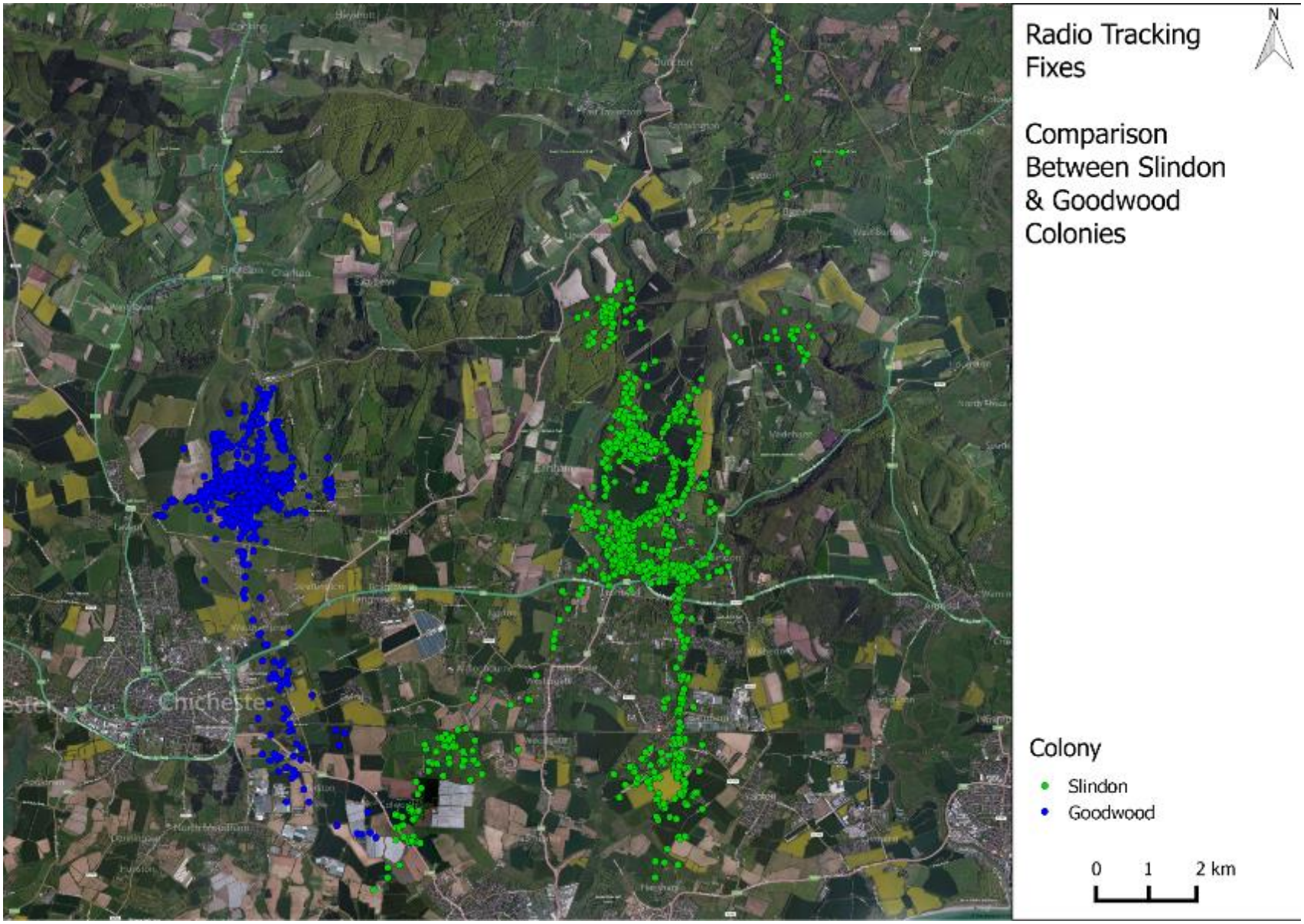
5.27. The foraging data collected for the bats at this colony was notable for two reasons, firstly the very high concentration of activity within The Valdoe and secondly the lower foraging ranges, with an average of 4km and four of the seven bats exclusively foraging within 2km of the roosting areas, with two others predominantly foraging within 2.5km. As with Slindon this is likely to be a result of lower colony sizes and therefore a higher proportion of the colony are able to forage closer to the roost.

5.28. Given that so many of the tracked bats were foraging close to the roost the surveys have not identified a high number of flight lines, this area is well wooded and provides good connectivity, however some bats have been identified foraging and commuting to areas through more open habitat where connectivity is not considered good. (see Goodwood flightlines plan 7)

5.29. Additional interesting observations include the fact that no bats were identified entering, or roosting, in the woodland areas to the north/northeast of the estate. A notable proportion of the estate is commercial forestry, much of it Forestry Commission in the northern half of the estate which is monoculture management and may not be suitable for barbastelle, however the possibility of a sub group or another colony cannot be ruled out.

5.30. Three bats (H4384, H4347 and H4346) were found to be foraging southeast to the south of Chichester, again crossing the A27 and foraging around Colworth, this is the same foraging area occupied by a bat from Slindon (H4301). Previous studies on adjacent colonies have not identified overlapping colony territories before, while odd individuals may stray into other areas, especially in unfavourable or unusual weather conditions, this is a newer observation. See plan 8

5.31. The Goodwood and Slindon barbastelle colonies are behaving as separate colonies and are 7km apart, however, the range used by these two colonies combined is what is expected of one large colony. One possibility is that these two colonies originated from one colony that has fragmented into separate colonies, which would support why individuals from separate colonies are foraging within the same area.



Plan 8 – Showing all fixes for Slindon and Goodwood and foraging areas meeting

New colonies

5.32. The discovery of new colonies within the project area is of great interest, both locally within our project area but also in our understanding of the species population densities and colony distribution.

5.33. The discovery of the Storrington colony creates a ring of five known colonies within the project area adjacent to each other. It is the author's understanding that this is the first time this has been recorded and provides some interesting opportunities to look at the species colony structure and colony mapping. This also shows that colonies may be utilising a greater proportion of the suitable habitats within this area than previously thought.

5.34. Ebernoe and the Mens are both large colonies and have individuals commuting large distances to foraging grounds which could be a limiting factor to a colony population. The newly discovered colonies show that the areas of suitable habitat beyond the previously known colony ranges for Ebernoe and The Mens are likely to be used by these, and possibly other colonies of barbastelle bats. This may mean that the area could be at carrying capacity for this species, and while this could only be proved through a major research project, considering the area and number of colonies present within it and factoring in possible undiscovered colonies – the current evidence supports this conclusion. This would mean that the only way to increase the population within this area would be to increase and improve the habitats suitable for this species, most notably the foraging availability.

5.35. The two roosts of bats identified at Black Down and Upperton have received only very minimal and basic survey effort and so only limited information can be concluded about the population and status of these groups. In both cases it was not possible to trap the roosts out to ring or identify if any individuals are ringed. Both of these roosts are considered to be very close to the Ebernoe maternity colony, particularly the Upperton group which is less than 3km from some of the subgroups using the southern areas of Ebernoe. Additionally, in both cases the individuals were identified foraging within what is considered to be the colony territory for the Ebernoe colony.

5.36. The location suggests that it is distinctly probable that these groups are associated with the Ebernoe colony given their proximity and foraging areas of both bats, however, with the limited data collected on these groups a conclusion cannot be drawn from this and so the status of these groups is considered unknown. If the groups of bats are in fact associated with Ebernoe, it could be an indication that the Ebernoe colony is subdividing and breaking up, or it could be an unrecorded factor of the unseasonal weather recorded in 2015 affecting roost usage and colony structure.

5.37. However, notably there has been some changes in the management of Ebernoe and over the last year; this has included an area of understory clearance, notably holly. The potential effect of this work on the barbastelle colony here should be considered. Holly is believed to be important for this colony as it provides improved thermoregulatory roosting microclimates. In both Upperton and Black Down bats were found roosting in areas with a well-developed dense understory with high proportions of holly, especially the Upperton colony where all roosts identified were in areas with dense understory – however this area also includes notable areas of less suitable invasive rhododendron. While the research conducted and information gathered cannot reach any conclusion or confirmation, the

possibility must be considered that the holly clearance and management changes at Ebernoe could be reducing the suitability of the roosts and hence reducing the favourable status of the colony and causing colony fragmentation.

Threats

5.38. The main threats to barbastelle bat populations are things that affect the three main core requirements for the species: roost availability and suitability, foraging habitat, and connectivity. The highest threats are those that have the potential to affect the whole colony or higher numbers of bats. Impacts on maternity woodlands affecting roosts and roost suitability, especially those which could cause colony fragmentation will have the highest negative impacts. Impacts on foraging habitat around the maternity roosts will be significant, where the highest concentration of foraging (including juveniles) is conducted, whereas impacts on foraging further from the roost will be detrimental to only lower numbers or individual bats. The main threats to any colony can be identified as:

- Threats to roosting availability and loss of roosts within the colony core maternity roost area;
- Threats to roosting suitability and habitat alteration within the colony core maternity roost area;
- Loss of foraging and foraging suitability within the immediate area and woodland of the maternity colonies up to 2km;
- Loss of connectivity for bats dispersing from the maternal woodland;
- Loss of foraging suitability and availability within the wider colony range;
- Increased fragmentation and isolation of habitats.

5.39. The main threats to habitat are those that affect the species core habitat, or prey abundance and availability – particularly those over wide areas that could impact high numbers of bats such as impacts to watercourses. Water and riparian habitats are known to be important for this species and water quality will be important. Threats to water quality, especially river corridors and tributaries, ponds and lakes over large areas could have notable negative impacts on higher numbers of bats. Negative impacts on foraging include:

- Foraging availability and suitability in maternity woodlands for high numbers of adult and juvenile bats, including loss of dense woodland notably oak with dense understory for winter foraging;
- Increased commercial forestry practices and understory removal/thinning;
- Monoculture plantations and non-native species woodland/coniferous woodlands and reduction in proportion of oak woodlands;
- Loss or improvement of unimproved pasture, water meadows and riparian habitats;
- Liming of waterbodies causing loss of water quality and invertebrate prey populations at ponds and lakes;
- Increased use of pesticides and herbicides especially those on or near floodplains and their potential to pollute watercourses.

6. Recommendations

6.1. Recommendations can be classed as being in two main areas:
- General recommendations that can be implemented for a colony which will improve the suitability, success and carrying capacity for any colony;
- Specific recommendations identified through research conducted on a colony.

6.2. This report only considers specific recommendations for Slindon and Goodwood where suitable research has been conducted.

6.3. General recommendations are those that improve the three main requirements for the species, roost suitability and variety, foraging availability and success and connectivity, as well as those that tackle and minimise the identified threats to colonies of this species.

6.4. For a colony general recommendations include:

- **Improved roosting availability and long term provision of roosting succession through improved management.**

6.5. Barbastelle roosts are found predominantly in older damaged, dead, and dying trees, and as a species require a high number of roosts within a smaller colony area to enable the colony to move regularly. The nature of these roost types is that new roosts are regularly becoming available and suitable and existing roosts being lost. To provide long term roost availability management of areas with colonies present is essential to ensure roost trees, and importantly potential future roost trees are retained. Long term roost provision needs to consider a 50+ year plan for providing roosts with a succession of new trees, particularly oaks, developing to provide future roost provision.

6.6. Management plans and awareness training for managers at colony roosting sites to target the retention of many trees considered higher risk, such as those with hazard beams and splits, and commercially poor trees. These trees are the ones that, even smaller as well as larger trees dying and with damage, have the highest ecological roosting value.

6.7. Deliberate roost creation such as ring barking numbers of trees may not be suitable, this can create a boom and bust scenario where there is an influx of roost availability in the short term in trees that may become naturally suitable in the future and a lack of suitable roost availability in the long term. Natural roost tree succession is best achieved through long term management of a site. If a site is believed or shown to have reduced roost availability this may be best achieved through specific provision of specialist barbastelle boxes which can provide roosts in the short term (10 years) which can rot away naturally while management will provide long term roost availability.

- **<u>Improved foraging availability and suitability</u>**

6.8. The foraging availability and suitability, taking into account the varied foraging requirements of Barbastelle bats throughout the year including woodland foraging, riparian habitats and winter foraging is what will ultimately affect the carrying capacity and hence population of any colony.

6.9. The most concentrated foraging areas are within the woodland and around the roosting areas; this is the area predominantly within 1.5-2km of maternal roosting areas which are used by the majority of bats once they emerge from the roost and by juveniles in later summer. This area should receive the highest level of enhancement and habitat improvement to provide the maximum effort and cost to foraging improvement value to a colony.

6.10. This should include –
- Removal and control of non-native species such as *Rhododendron ponticum*.
- Replacing conifer plantations with native broadleaf, particularly Oak.
- Maximising woodland structure to include a well-developed native understory and ancient or semi-natural woodland.
- Maintaining and maximising areas with dense understory, especially around roosts and for winter foraging.
- Retain all known and potential roost trees and retain all standing deadwood.
- Retain and enhance water features, providing new waterbodies and riparian habitats.
- Minimise or eliminate pesticide use and water contamination.

6.11. After this area it is recommended that habitat improvements should be targeted to within 6km of a colony as this is the range that is used by the majority of bats from a colony and maximise foraging habitat for as many individuals within a colony.

6.12. This should include -
- Removal and control of non-native species.
- Promoting moth rich habitats
- Restore PAWS, especially replacing conifer plantations with native broadleaf, particularly Oak.
- Modify management practices to improve woodland structure and understory.
- Provision of uncultivated field margins along hedgerows and flight lines.
- Increase availability and suitability of riparian habitats and water courses.

6.13. General habitat improvements should include

- Control of invasive species
- Increasing and improving woodland structure, especially well developed native understory.
- Improvements of riparian habitats
- Improving water quality and hence insect diversity

- **<u>Improving connectivity and reducing habitat fragmentation.</u>**

6.14. This is most important close to a maternity colony location; barbastelle bats will fly and commute through open habitats, such as favoured foraging grounds flood plains. Improving flight lines close to a maternity colony enables individuals to leave maternity woodlands sooner and disperse to favoured foraging grounds quicker and safer.

6.15. Improving connectivity, most notably through creating tree lines, especially along ditches, streams and rivers, which provide sheltered flight and increased foraging, are the most beneficial. While flight lines can be in some cases quite long, this will vary greatly from colony to colony and may depend on the population present, smaller colonies are likely to by their nature have a smaller foraging territory and as such will have shorter commuting routes.

6.16. Minimising lighting and the creation of dark skies, especially along roads and near foraging areas is important and often overlooked. Lighting can not only prevent bats crossing features such as roads, severing connectivity and reducing foraging availability, but can affect insect biomass and alter many species behavioural, spatial, and breeding ecology.

<u>Slindon improvements and recommendations</u>

6.17. The roost availability at Slindon is considered to be good given the number of old and mature trees, notably the number of storm damaged trees. This is only likely to improve in the coming decades following the discovery of this species present and the improved management practices that are now implemented at this site. In the very long term new roosting provision needs to be considered through the next generation of oak trees, however, given the high level of regeneration following the 1987 storm this is likely to already be provided.

6.18. Given the good roost availability it is more likely that foraging may be more of a limiting factor for this colony. Foraging at Slindon is likely to already be improving locally following the change in farming practices from intensive arable to organic pasture and the rewilding project underway there turning arable farmland back to woodland and pasture. This will improve the foraging suitability and capacity close to the roost.

6.19. Improving the foraging within the woodland can be achieved through the long term removal of invasive species, notably laurel, and gradual replacement of coniferous plantations within Slindon wood to native broadleaf.

6.20. Other foraging enhancements close to the roost woodland could include the enhancement of Slindon Park, this is currently right in the middle of the distribution of maternity colony roosts and is intensive sheep grazing. Changing the farming practices to a more invertebrate rich crop, such as a hay meadow would notably improve the immediate foraging suitability.

6.21. Connectivity around Slindon is good, however one notable observation is that the A27 immediately south of Slindon is illuminated and bats are traversing along the dual carriageway to cross at unlit locations. Any plans to increase the illumination of this road

have the potential to have notable negative impacts if they were to cause bats to stop crossing and sever foraging grounds form roosting areas. The possibility of removing, or reducing the level and specific location of lighting at crossing areas and connective habitats should be pursued.

6.22. Recommended improvements –

- Slowly remove conifer plantations
- Removal of invasive Laurel and planting of native species like holly
- Improve and provide more water bodies/riparian habitats
- Look at changing management of Slindon Park
- Look at removing/reducing lighting along the A27 south of Slindon.

Goodwood improvement and recommendations

6.23. The roost availability at Goodwood has not been identified as being high, while there were some limitations in the research during the poor summer of 2015 the number of maternity roost trees identified is not as high as is identified at other sites. As a result, groups stayed present within the roosts for longer periods than is expected of the species before moving to another roost. The roost availability is likely to improve in the future following the discovery of this species present and the improved awareness and management practices that are now implemented at this site. In the short term it is believed that bat boxes for this species at this site would be beneficial which will also aid monitoring.

6.24. Foraging behavior has been found to be highly concentrated in and around The Valdoe; the wood is clearly an important local foraging area for the colony, and as such appropriate management of this woodland will be key. The Valdoe was once larger, extending south where a large area has been removed for mineral extraction in the past. This operation is coming to an end and the rewilding and recreation of suitable habitat in this area is likely to be one of the most valuable enhancements that could be conducted for this colony with replacement woodland and waterbodies on this site. (see plan – 9 showing area of mineral extraction and historic map of woodland)

Plan 9 – Showing (left) current woodland of Valdoe and area of mineral extraction and original area of the Valdoe woodland (right) approximately twice the size

6.25. Within close proximity to the site additional enhancements on the estate and within 2km include the removal of invasive species, notably laurel and rhododendron, as well as improving the quality of and re-creating lost waterbodies. This is especially important for the area along New Barn Hill opposite the entrance to Goodwood House, where a pond has been swamped by laurel. Improvement of woodland could be achieved through a slow systematic replacement of conifer plantations with native broadleaf species, especially oak, and more notably through the improvement of the woodland understory. It has been noted that there was virtually no use of the woodland to the north/northeast of the estate with predominantly monoculture plantation and has very little or no understory. The development of a native species well-structured understory would be a significant enhancement in this area.

6.26. Due to the restricted foraging of bats at Goodwood there have not been any notable flight lines identified other than bats commuting south over the A27 to the east and southeast of Chichester. Connectivity enhancements, particularly connecting small isolated blocks of woodland such as that north of the Valdoe (Bexley Bushes) and the commuting route south through tree planting creating tree lines would be beneficial.

Recommended improvements –

- Improve roosting availability
- Slowly remove conifer plantations to replace with native broadleaf/Oak
- Removal of invasive Laurel and use of native species like holly
- Improve and provide more water bodies/riparian habitats
- Improve woodland understory structure and density
- Improve connectivity north and south of the Valdoe

7. Further research

7.1. While this project has answered many questions, it has additionally identified new colonies, unexpected groups of bats and raised many new queries.

7.2. Of the colonies studied some further work at Goodwood would be beneficial, notably to find more maternity roosts and identify if there is a shortage of roosts for this colony and to look at the northern area. No bats were found going north any distance, however individuals form this colony are being caught at Drovers 6km North.

7.3. The identification of new colonies and known colony territories have highlighted areas where bats are present, as much as highlight where colonies have not been found. There are still no known colonies associated with records in the Midhurst and Cocking area and so this is a void where a colony may be present. Further surveys and research into more colonies will only increase our understanding of colony dynamics and populations within an area.

7.4. The two new identified groups of bats at Black Down and Upperton were not expected and are not understood, and as such the research conducted cannot categorise these groups as separate colonies or identify if they are subgroups associated with Ebernoe. With the possible concern that these smaller groups could be the result of colony fragmentation as a result of negative habitat alteration at Ebernoe further research here is required to identify any potential relation these groups have and if so the reasons behind the widening of the subgroup areas.

7.5. It is recommended that until this research is conducted a much more precautionary approach is taken to the management and habitat alteration at Ebernoe common.

7.6. The new breeding colony at Storrington appears to have a good population, however with the very limited research on this colony it is unlikely that all of the colony population has been identified. Further research into this colony to match the Slindon, Goodwood, The Mens and Ebernoe colonies data is recommended to provide a full picture on the colony ranges, habitat use, and requirements throughout the project area. This colony links up habitat between the Mens and Slindon colonies and would provide a fuller picture of barbastelle in this area.

7.7. Continued annual monitoring of the colonies present at all sites would be highly valuable in providing the fullest picture into the species' fecundity and population within a large project area with multiple populations.

7.8. With the data showing the possibility of past colony fragmentation creating the separate Slindon and Goodwood colonies, and the indication that there may be colony fragmentation at Ebernoe (including an individual born in one colony moving into another), genetic studies into these colonies and groups of bats could answer many questions. This could show relatedness between colonies, identify gene flow and if colony fragmentation has indeed occurred.

7.9. Smaller colonies are believed to have a lower breeding success and be more vulnerable, where one small colony using one roost could experience a catastrophic event, such as a storm losing the roost and death of a colony, a large colony with many subgroups spreads its eggs in many baskets and survives. If a study identifies that some of these smaller colonies are the fragmented groups of larger colony it could highlight the potential risks to unsuitable management of colony maternal woodlands and colony fragmentation.