



**Bat Survey Report - FINAL**

**Knepp Estate**

**West Grinstead, Nr Horsham**

**RH13 8LJ**

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**9<sup>th</sup> March 2020**

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Green**  
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**Notice to Interested Parties**

To achieve the study objectives stated in this report, we were required to base our conclusions on the best information available during the period of the investigation and within the limits prescribed by our client in the agreement.

No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information. Thus, we cannot guarantee that the investigations completely defined the degree or extent of e.g. species abundances or habitat management efficacy described in the report.

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## EXECUTIVE SUMMARY

- 0.1 This report outlines the findings of bat surveys at Knepp Estate. The surveys were undertaken in line (as far as practicable) with the trapping surveys, radio-tracking surveys (to locate roosts) and emergence surveys carried out by Frank Greenaway in 2009 (Greenaway, 2009). In addition to these surveys, automated static bat detectors were also deployed on site from June to October 2018.
- 0.2 The purpose of the 2018 and 2019 surveys is to evaluate whether there have been changes in the species assemblage and roost use since the baseline surveys were undertaken in 2009, which could be explained by the management of the site.
- 0.3 In addition, further activity surveys to quantify bat use over time, in the form of activity surveys and automated static surveys that will commence in 2018, to provide a baseline survey for future monitoring
- 0.4 The automated static bat detectors recorded a total of 34,956 bat passes at the four locations between June 2018 and October 2018 throughout areas of the estate where management such as the grazing regime and river restoration have been implemented. Location 1 recorded the high number of bat passes (15,222), followed by location 4 (12,719), location 3 (4117) and location 2 (2898).
- 0.5 The most frequent bat pass recorded was soprano pipistrelle (19,739), followed by common pipistrelle (8456), Myotis spp. (4674), pipistrelle social calls (682), noctule (678), Leisler's (285), Plecotus spp. (180), nathusius pipistrelle (91), serotine (88) and barbastelle (83).
- 0.6 A total of nine species of bats barbastelle, Bechstein's, brown long-eared, common pipistrelle, Daubenton's, Natterer's, noctule, soprano pipistrelle and whiskered bats were caught during the trapping surveys. The trapping surveys also confirmed presence of breeding for seven species. Only male barbastelle and male Nathusius' pipistrelle was recorded.
- 0.7 A total of 202 bats were captured both pre-maternity and post maternity in 2009. By comparison, in 2018, only a post maternity survey (essentially half the survey effort) was undertaken and a total of 213 bats were captured. In 2019 a total of 98 bats were captured.
- 0.8 A total of nine species of bats barbastelle, Bechstein's, brown long-eared, common pipistrelle, Daubenton's, Natterer's, noctules, soprano pipistrelle and whiskered bats were caught during the trapping surveys. The trapping surveys also confirmed presence of breeding for seven species. Only male barbastelle and male Nathusius' pipistrelle was recorded. The automated ultrasound static detectors also confirmed the presence of serotine and Leisler's bat, taking the total to eleven species in 2018. The total number of species recorded in 2009 was twelve species. Frank Greenaway (2009) also recorded the presence of a non-breeding Brandt's bat in late summer 2009.
- 0.9 A total of sixteen noctule bats were recorded emerging from a woodpecker hole in a tree just north of Knepp Mill Pond. In 2009 only male noctules were captured and low levels of activity were recorded for this species. The presence of a maternity roost for noctule on the Knepp Estate is a new finding.

- 0.10 One male barbastelle was captured during the trapping surveys at the Knepp Estate in 2018. The roost was located along the river restoration woodland, which is a positive result. The male barbastelle roosted solitary. Barbastelle were not trapped on the estate in 2009 but were recorded on bat detectors during the trapping surveys.
- 0.11 Similarly, one male Nathusius' was captured during the trapping surveys at the Knepp Estate in 2018. The roost was located in a property south of Knepp Mill Pond. The bat is likely to be roosting solitary but other pipistrelle spp. were also roosting in the property. Nathusius' was not trapped on the estate in 2009 but were recorded on bat detectors during the trapping survey.
- 0.12 The 2018 and 2019 surveys on the Knepp Estate has confirmed the importance of the site for bats. The river restoration area from Pound Lane in the west to the A24 in the east is used extensively by the local bat population, as indicated by both the automated surveys and the trapping surveys.
- 0.13 Male noctule and Bechstein's were only confirmed present as adult males in 2009 but both species now having breeding females roosting on the Knepp Estate.

## 1 INTRODUCTION

- 1.1 Arbeco Ltd were commissioned by Knepp Estate to undertake an ecological assessment of bat species at Knepp Estate to input into the ten-year monitoring review of all habitats and species within the estate to evaluate whether the grazing management has had positive, negative or a neutral impact on the bat species assemblage and distribution.
- 1.2 The surveys were undertaken in line (as far as practicable) with the trapping surveys, radio-tracking surveys (to locate roosts) and emergence surveys carried out by Frank Greenaway in 2009 (Greenaway, 2009).
- 1.3 The purpose of the 2018 and 2019 surveys was to evaluate whether there have been changes in the species assemblage and roost use since the baseline surveys were undertaken, which could be explained by the management of the site.
- 1.4 In addition, further activity surveys to quantify bat use over time, in the form of automated static bat activity surveys that will commence in 2018, will provide a baseline survey for future monitoring of bat activity to be assessed against.
- 1.5 The surveys involved carrying out automated static bat detector surveys, trapping surveys, radio-tracking to determine new roost locations of breeding bats and emergence surveys of known and newly located roosts to ascertain colony sizes of breeding bats.
- 1.6 This report details the results of the 2018 and 2019 surveys and provides a comparison with the 2009 baseline pre-restoration surveys.

### **Background to the project**

- 1.7 The management of the Knepp Estate have undertaken an ambitious scheme to create a landscape-scale park in which a variety of large herbivores would roam freely, currently covering about 322 hectares. As far as possible, these animals would be 'de-domesticated'. Near-natural grazing would be replicated with the animals utilising the land with as little human intervention as possible. The intention is that this near-natural grazing system will ultimately include a large part of the Knepp Castle Estate. The River Restoration Centre, in conjunction with the Environment Agency and Defra, also proposes to 're-wild' part of the River Adur as it crosses the Estate. This involves restoring the Adur floodplain to its natural function and the river itself to its original course before it was subjected to canalisation.
- 1.8 Knepp Castle Park has 'historic parkland' status, and it has thus been possible to revert large areas from arable to parkland under Defra's Countryside Stewardship Scheme (CSS), a reversion of historical relevance (Knepp Castle Fact Sheet, 2005). The restoration of the deer park began in 2001, when some 202 hectares (500 acres) of this former park were taken out of arable and commercial grassland. This land was deer fenced and internal boundary fences were removed (Knepp Castle Fact Sheet, 2005). The ground was 'sterilised' by continual cultivation and spraying with herbicide, and subsequently planted with native grasses.

### **Survey work to date**

1.9 In 2009 a baseline biological inventory was undertaken of the Knepp Castle Estate which the developed a monitoring strategy that included the recording and evaluation of:

- changes in vegetation structure and communities;
- changes to habitat pattern and distribution;
- changes to vegetation species composition with time;
- changes to habitat pattern across zones of likely change;
- changes in the abundance and distribution of key plant species / groups with habitat change over time;
- changes in the abundance and distribution of key animal species / groups with habitat change over time;
- the impacts, positive and negative, of near-natural grazing on the Estate over time;
- inform the River Adur restoration project and contribute to its subsequent evaluation

1.10 Baseline bat surveys in 2003 and 2005 showed considerable bat interest, enhanced by the discovery that female barbastelles were commuting from the nursery roost in The Mens, Petworth to forage over Knepp (Greenaway 2009). Baseline surveys undertaken by Frank Greenaway (2009). Bats were trapped to identify species and sexual status in the most metabolically demanding time of year. Traps were placed across the river restoration area and further upstream of tributaries joining the river near Tenchford Bridge. Thirteen species of bat were recorded:

- Common pipistrelle
- Bechstein's bat
- Soprano pipistrelle
- Noctule
- Nathusius' pipistrelle
- Leisler's bat
- Natterer's bat
- Brown long-eared bat
- Whiskered bat
- Serotine
- Daubenton's bat
- Barbastelle

- Brandt's bat

- 1.11 Ten bat species were captured or recorded along the Adur corridor itself during this survey. The main foraging area for many of these was nearby woodland, but the River Adur was shown to be an important forage area for soprano pipistrelles, with a nursery roost close by, and a significant foraging area and commuting route for all other recorded species.
- 1.12 Twelve nursery roosts of six species, common and soprano pipistrelles, whiskered bat, Daubenton's bat, Natterer's bat and brown long-eared bat were located, 6 of which were in buildings and 6 in tree cavities. Noctule and Bechstein's bat were the only two species with a confirmed presence of adult males but no adult females. A total of 33% of the trapped adult bats were male and 40% were female.

### **Purpose of the 2018 and 2019 surveys**

- 1.13 The Knepp Castle Estate is required to complete a ten-year monitoring review of all habitats and species within the estate to evaluate whether the grazing management has had a positive, negative or neutral impact on the bat species assemblage and distribution. This was achieved by assessing the bat assemblage, level of activity and roosts in proximity to the Knepp Castle Estate. The 2018 and 2019 surveys also aim to monitor known maternity roosts within the site by undertaking emergence surveys of buildings where known roosts were identified in 2009. The 2018 and 2019 surveys also aimed to identify new maternity roosts of species within the site, specifically tree roosting species, by radio-tagging trapped bats, and subsequently undertaking roost counts of subsequently identified bat tree and/or building roosts.

### **Legislation**

- 1.14 All 17 bat species resident in the UK are fully protected under UK and European legislation. In England bats and their places of shelter or protection are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and within Europe all bat species and their places of shelter or protection are protected Schedule 2 of the Conservation of Habitats and Species Regulations 2017.
- 1.15 These pieces of legislation make it an offence to:
- Deliberately, intentionally, or recklessly disturb, capture, injure or kill a bat;
  - Obstruct, damage or destroy a place used for shelter or protection; and
  - Damage or destroy a bat roost (breeding site or resting place).
- 1.16 Further details of the legislation are outlined in Appendix 1.

### **Site Description**

- 1.17 The Knepp Castle Estate lies to the south of Horsham, West Sussex (Figure 1.1). Its long history has resulted in a number of features of archaeological, cultural and geological interest, including the remains of the original 11th century castle. Knepp Castle Estate originated in the Middle Ages, when it was one of King John's hunting parks. It now extends to a total of 1,416 hectares (3,500 acres). The original Estate seems to have



been a hunting park throughout the mediaeval period, following which the land was used for iron working in the 16th century. Since this industry fell into decay, the Estate has been an area of farmland and woods (Knepp Castle Fact Sheet, 2005). Following World War II, it was increasingly under intensive farming. An unusual feature of the Estate is that its historic field system has largely been retained. Many fields are 4 hectares (10 acres) or less and are still bordered by hedgerows.

- 1.18 The Estate lies within the Low Weald Natural Area (English Nature, 1997) and has a heavy clay soil. It is traversed by the River Adur and some of its tributaries. Kneppmill Pond is a hammer pond constructed for nearby iron workings prior to 1568. There are two Sites of Nature Conservation Interest (SNCI) on the Estate - H18 Kneppmill Pond, the River Adur and Lancing Brook, Shipley; and H30 Horsham Common, Alder Copse, Coate's Furzefield and Constable's Furze, Southwater. These were designated in 1992 by West Sussex County Council. SNCIs are non-statutory designations.

## 2 METHODS

### Survey area

- 2.1 The survey area encompasses the Knepp Castle estate (Figure 2.1) and focused on areas of the estate where management such as the grazing regime and river restoration have been implemented.

### Emergence surveys of buildings 2018 and 2019

The Estate's ecologist, Penny Green, and bat surveyor, Ryan Greaves, visited several known bat roosts in Estate buildings in May and June in 2018, and Ryan re-visited some of the sites in 2019.

A FLIR E60 thermal imaging camera was used in conjunction with a Batbox Griffin detector to count the bats out of the roosts at dusk, which was aided by volunteer Fi Hailstone in 2018.

### Automated static bat detector surveys

- 2.2 Automated surveys were carried out during June to October 2018 as part of the survey effort for Knepp Estate.
- 2.3 The locations of the statics can be seen in Figure 2.1.
- 2.4 Four Elekon Batlogger A+ units were programmed to record bat echolocation calls in WAV format from 30 minutes prior to dusk until 30 minutes after dawn.
- 2.5 All units were set out for a minimum of three consecutive nights. The specific recording dates for each unit is detailed in the results section.
- 2.6 The recorded WAV files were analysed in full spectrum using Kaleidoscope software (version 3.1.4B).
- 2.7 All sound files were subject to manual analysis by an experienced bat ecologist. Where possible, identification was carried out to species level, except for the *Myotis* bats, as they are often inseparable through sound analysis alone, due to overlapping call parameters, and therefore were analysed to genus level only. Descriptions of bat species assemblage therefore represent the minimum number present rather than a definite list of all species present.
- 2.8 Where several bat species were present within a 15 second segment, then all the species were tagged in the results spreadsheet. For example, a common pipistrelle, soprano pipistrelle and *Myotis* bat all calling simultaneously would result in three individual bat registrations for calculating bat call counts.
- 2.9 Analysed data was used to produce a table comparing the location of the static bat detectors and the total number of passes per species per night with Microsoft Excel. The calls were separated by species or genus in the case of *Myotis* bats.

### **Trapping surveys**

- 2.10 The trapping surveys were carried out at four locations across the site. The trapping locations were selected on the basis of the locations surveyed by Frank Greenaway (2009).
- 2.11 At each trapping location, five harp traps and one mist net (where appropriate) were set approximately 100 – 150 metres apart. Each trap was fitted with an acoustic lure (Sussex Autobat) to increase the likelihood of catching bats present within the vicinity of the trap. The lure works by producing simulations of a variety of bat social calls. The majority of calls that were used during the survey period are those that are most effective for catching the species assemblage identified in 2009.
- 2.12 Each of the four locations were surveyed for a minimum of one night during the 2018 survey period and a minimum of one night in 2019 (a total of sixteen nights trapping effort) .
- 2.13 The trapping commenced at sunset and last for approximately 4 to 6 hours on each survey night.
- 2.14 The bats captured in the harp traps and mist nets were removed from the traps by a suitably experienced and qualified person (under the direction of the licence holder or accredited agent) and transferred to a clean cloth bag.
- 2.15 Biometric information was obtained from all bats captured. Each bat was sexed, weighed using a light line spring scale (Pesola), forearm measured using digital callipers (Sealey S0707), reproductive status ascertained and any other general health observations noted. Any bats that were selected for radio-tagging were released immediately in close proximity to the site of capture during the hours of darkness.

### **Radio-tracking study**

- 2.16 Bats identified for radio-tagging were predominately females bats selected on the basis of their existing health condition. No underweight bats were selected for radio-tagging and the weight of the radio-tag was always less than 5% of the animal's weight. Female bats were radio-tagging as a preference to male bats, where possible, as this will enabled the identification of important breeding colonies.
- 2.17 Transmitters were attached to the focal animal using Skin-Bond® (Pfizer Inc.) to the area between the shoulder blades from which fur has been clipped. The animals that were fitted with radio-transmitters will be released on the night of capture.
- 2.18 Radio-tagged bats will be tracked during the day to determine the daytime roost locations.

### **Roost counts**

- 2.19 Emergence of the bats from their roosts were monitored around dusk by direct observation and using video recorders with the assistance of infra-red technology where possible. The roosting location of a radio-tagged bat was ascertained by radio-tracking in the daytime when the bat is roosting and if access to the roosting cavity is visible from ground level then filming equipment will be set up to record the bats emerging from the roost.

- 2.20 Emergence surveys were undertaken at seven bat roost locations that had been identified by day roost searches. The emergence surveys aimed to locate the roost access/egress points where possible and to determine the number of bats using the roost. In total, nine dusk emergence surveys were carried out by experienced bat surveyors in appropriate weather conditions following standard guidelines on emergence survey procedure<sup>1</sup>.
- 2.21 Observations were made from the outside of the building or tree identified as a roost. Dusk emergence surveys commenced approximately 15 minutes before sunset and lasted for approximately 90 minutes in accordance with best practice methods to confirm use of a bat roost.
- 2.22 Real time detectors (Elekon Batlogger M and Wildlife Acoustics EchoMeter Touch) were used to record bat echolocation calls of any emerging bats and to identify species where possible.
- 2.23 Canon XA-20 video recorders with the assistance of infra-red lighting were used in conjunction with surveyor's observations during the bat emergence surveys to ensure appropriate coverage of all elevations and to ensure that accurate counts were obtained. The recordings were later examined using VLC media player (version 2.2.6 Umbrella) to ascertain the number of bats (if any) that emerged from the videoed location.
- 2.24 All bat passes were noted and bats were identified to species level where possible. Echolocation calls were recorded onto Apple iPad Air 2 / iPhone 6 or on the in-built sound card of the detector (Batlogger M). These were subsequently analysed using BatExplorer / Kaleidoscope Pro computer software, which facilitates species identification, by an ecologist with experience of call analysis.

### **Survey Constraints**

- 2.25 There was a failure of the automated static detectors on three occasions. In June 2018, no recordings were made at locations 3 and 4. Upon collection of the equipment, there was evidence of livestock damage of the microphone.
- 2.26 There was a failure of the detector at location 2 in July 2018. This was due to a technical fault with the recording equipment.
- 2.27 No sound was recorded on one of the three nights in September at location 3. This could be due to a technical fault, but the detector recorded on the evening prior to this date and after this date, so equally it may be that no bats were present on this date.
- 2.28 No sound was recorded on the last night in October at location 4.
- 2.29 One night of trapping was terminated early due to temperatures of below 8°C on the 24<sup>th</sup> August 2018. Overall, the weather conditions in 2018 were excellent and had no significant impact on the findings of this study.
- 2.30 The pre-maternity study was constrained in May and June 2019. There were long spells of cold front and showers in May and the weather was unsettled and cool until June 20<sup>th</sup>

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<sup>1</sup> Collins, J. (ed.) 2016, Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition), The Bat Conservation Trust, London.

(Met Office 2020). Fog, rain showers and lack of bat activity terminated trapping on two of the five nights due to lack of activity and poor weather conditions. Due to the onset of maternity season, these surveys were re-scheduled in late July and early August.

- 2.31 Access to habitats along outside of the Knepp Estate was limited. This reduced the accuracy of the bearings taken in some areas for roost locations.
- 2.32 It was not possible to carry out emergence counts of the numbers of bats using roosts in areas where access for surveys had not been granted. Therefore, the size of these roosts could not be determined.
- 2.33 Bats are highly mobile species and consequently any bats trapped and tagged within the survey area may not always be identified roosting in the survey area on subsequent survey days.
- 2.34 It was not possible to undertake a pre-maternity survey in 2018 for a number of reasons. Firstly, the late commission of the work, coupled with the early onset of breeding due to warm weather and delays in receiving the project licence resulted in the cancellation of the planned pre-maternity season. However, a pre-maternity survey was undertaken in 2019 to complete the data set and to ensure comparability with the 2009 data (see constraint 2.30 above).
- 2.35 It was not possible to replicate some of the trapping locations of 2019 due to the presence of grazing animals. This was not considered to be a significant constraint as these traps were deployed in areas of suitable bat habitat as close as possible to the original trapping site.
- 2.36 No bats were radio-tagged in 2019. The surveys in pre-maternity 2019 did not catch females of the woodland assemblage that were targets for radio-tagging. The bats captured in 2019 were predominately species that were likely to be roosting in the maternity roosts in buildings on site (brown long-eared, common pipistrelle, soprano pipistrelles and whiskered) or male bats of the woodland assemblage that were not targets for radio-tracking.

### 3 RESULTS

#### **Automated static bat detector surveys**

- 3.1 A total of 34,956 bat passes were recorded at the four locations between June 2018 and October 2018 throughout areas of the estate where management such as the grazing regime and river restoration have been implemented. The locations of these static detectors are shown in Figure 2.1.
- 3.2 The most frequent bat pass recorded was soprano pipistrelle (19,739), followed by common pipistrelle (8456), *Myotis* spp. (4674), pipistrelle social calls (682), noctule (678), Leisler's (285), *Plecotus* spp. (180), Nathusius' pipistrelle (91), serotine (88) and barbastelle (83).
- 3.3 Location 1 recorded at total of 15,222 bat passes of which comprised barbastelle (29), serotine (34), noctule (616), leisler's (276), *Myotis* spp. (719), common pipistrelle (3563),

- soprano pipistrelle (9868), Nathusius' pipistrelle (30), pipistrelle social call (22) and *Plecotus* spp. (65).
- 3.4 Location 2 recorded at total of 2,898 bat passes of which comprised barbastelle (32), serotine (5), noctule (9), *Myotis* spp. (561), common pipistrelle (740), soprano pipistrelle (1406), Nathusius pipistrelle (36), pipistrelle social call (83) and *Plecotus* spp. (26).
- 3.5 Location 3 recorded at total of 4,177 bat passes of which comprised barbastelle (7), serotine (34), noctule (9), leisler's (3), *Myotis* spp. (1497), common pipistrelle (250), soprano pipistrelle (2278), pipistrelle social call (1) and *Plecotus* spp. (38).
- 3.6 Location 4 recorded at total of 12,719 bat passes of which comprised barbastelle (15), serotine (15), noctule (44), leisler's (6), *Myotis* spp. (1897), common pipistrelle (3903), soprano pipistrelle (6187), Nathusius pipistrelle (25), pipistrelle social call (576) and *Plecotus* spp. (51).
- 3.7 The number of bat passes per location is detailed in Table 3.1 and illustrated in Figure 3.1.
- 3.8 The number of bat passes each month per location is detailed in Table 3.2 and illustrated in Figure 3.2.

### **June 2018**

- 3.9 A total of 1513 bat passes were recorded at location 1 of which comprised barbastelle (6), serotine (1), noctule (28), leisler's (4), *Myotis* spp. (117), common pipistrelle (1210), soprano pipistrelle (143), Nathusius' pipistrelle (2), pipistrelle social call (2) and *Plecotus* spp. (1).
- 3.10 A total of 1445 bat passes were recorded at location 2 of which comprised of which comprised barbastelle (12), serotine (5), noctule (2), *Myotis* spp. (396), common pipistrelle (455), soprano pipistrelle (572), nathusius pipistrelle (2), and *Plecotus* spp. (1).
- 3.11 No bat passes were recorded at both location 3 and 4 in June 2018 due to microphone damage by livestock.
- 2.37 Common pipistrelle was the most common species recorded in June at location 1 with a peak of 390 passes at location 1 recorded on 25<sup>th</sup> June 2018.
- 2.38 Table 3.3 shows a summary of the total passes per night for each species (where applicable).

### **July 2018**

- 3.12 A total of 8998 bat passes were recorded at location 1 of which comprised barbastelle (10), serotine (23), noctule (566), leisler's (271), *Myotis* spp. (216), common pipistrelle (1174), soprano pipistrelle (6,688), nathusius pipistrelle (25), pipistrelle social call (1) and *Plecotus* spp. (24).

- 3.13 No bat passes were recorded at location 2 in July 2018 due to a technical fault with the recording equipment.
- 3.14 A total of 2506 bat passes were recorded at location 3 of which comprised of which comprised barbastelle (2), serotine (27), noctule (5), Leisler's (3), *Myotis* spp. (463), common pipistrelle (100), soprano pipistrelle (1905), and pipistrelle social call (1).
- 3.15 A total of 4600 bat passes were recorded at location 4 of which comprised of which comprised serotine (3), noctule (22), leisler's (3), *Myotis* spp. (439), common pipistrelle (2304), soprano pipistrelle (1294), nathusius pipistrelle (2), pipistrelle social call (513) and *Plecotus* spp. (19).
- 2.39 Soprano pipistrelle was the most common species recorded in July with a peak of 2571 passes at location 1 recorded on 27<sup>th</sup> July 2018.
- 2.40 Table 3.4 shows a summary of the total passes per night for each species (where applicable).

### **August 2018**

- 3.16 A total of 674 bat passes were recorded at location 1 of which comprised barbastelle (5), serotine (4), noctule (9), leisler's (1), *Myotis* spp. (68), common pipistrelle (377), soprano pipistrelle (169), nathusius pipistrelle (2), pipistrelle social call (9) and *Plecotus* spp. (30).
- 3.17 A total of 420 bat passes were recorded at location 2 of which comprised barbastelle (17), noctule (6), *Myotis* spp. (74), common pipistrelle (84), soprano pipistrelle (154), nathusius pipistrelle (32), pipistrelle social call (35) and *Plecotus* spp. (18).
- 3.18 A total of 844 bat passes were recorded at location 3 of which comprised *Myotis* spp. (647), common pipistrelle (51), soprano pipistrelle (131), and *Plecotus* spp. (15).
- 3.19 A total of 5289 bat passes were recorded at location 3 of which comprised barbastelle (4), serotine (7), noctule (19), leisler's (3), *Myotis* spp. (244), common pipistrelle (898), soprano pipistrelle (4050), nathusius pipistrelle (22), pipistrelle social call (20) and *Plecotus* spp. (22).
- 2.41 Soprano pipistrelle was the most common species recorded in August with a peak of 916 passes at location 4 recorded on 29<sup>th</sup> August 2018.
- 2.42 Table 3.5 shows a summary of the total passes per night for each species (where applicable).

### **September 2018**

- 3.20 A total of 1961 bat passes were recorded at location 1 of which comprised barbastelle (4), serotine (6), noctule (10), *Myotis* spp. (140), common pipistrelle (115), soprano pipistrelle (1672), nathusius pipistrelle (1), pipistrelle social call (9) and *Plecotus* spp. (4).
- 3.21 A total of 389 bat passes were recorded at location 2 of which comprised barbastelle (2), noctule (1), *Myotis* spp. (14), common pipistrelle (96), soprano pipistrelle (257), pipistrelle social call (14) and *Plecotus* spp. (5).

- 3.22 A total of 128 bat passes were recorded at location 3 of which comprised barbastelle (1), serotine (1), *Myotis* spp. (9), common pipistrelle (25), soprano pipistrelle (90) and *Plecotus* spp. (2).
- 3.23 A total of 2140 bat passes were recorded at location 4 of which comprised barbastelle (4), serotine (6), noctule (4), *Myotis* spp. (378), common pipistrelle (74), soprano pipistrelle (152), and *Plecotus* spp. (21).
- 2.43 Soprano pipistrelle was the most common species recorded in September with a peak of 641 passes at location 1 recorded on 24<sup>th</sup> September 2018.
- 2.44 Table 3.6 shows a summary of the total passes per night for each species (where applicable).

### **October 2018**

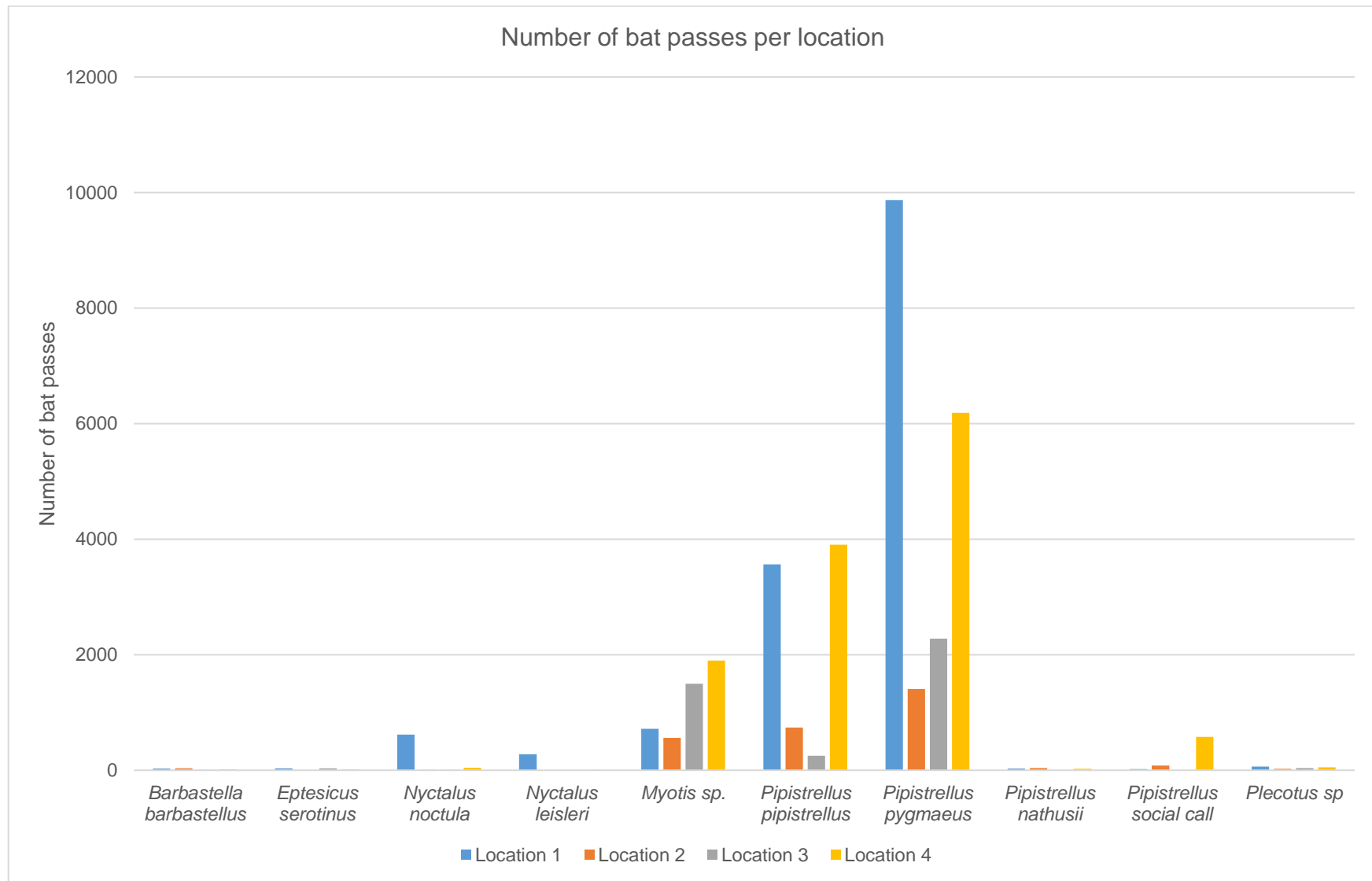
- 3.24 A total of 2076 bat passes were recorded at location 1 of which comprised barbastelle (4), noctule (3), *Myotis* spp. (178), common pipistrelle (687), soprano pipistrelle (1196), nathusius pipistrelle (1), pipistrelle social call (1) and *Plecotus* spp. (6).
- 3.25 A total of 644 bat passes were recorded at location 2 of which comprised barbastelle (1), *Myotis* spp. (77), common pipistrelle (105), soprano pipistrelle (423), nathusius pipistrelle (2) pipistrelle social call (34) and *Plecotus* spp. (2).
- 3.26 A total of 639 bat passes were recorded at location 3 of which comprised barbastelle (4), serotine (6), noctule (4) *Myotis* spp. (42), common pipistrelle (247), soprano pipistrelle (391) and *Plecotus* spp. (21).
- 3.27 A total of 690 bat passes were recorded at location 4 of which comprised barbastelle (5), *Myotis* spp. (42), common pipistrelle (247), soprano pipistrelle (391), and *Plecotus* spp. (5).
- 2.45 Soprano pipistrelle was the most common species recorded in October with a peak of 579 passes at location 1 recorded on 25<sup>th</sup> October 2018.
- 2.46 Table 3.7 shows a summary of the total passes per night for each species (where applicable).



**Table 3.1: Number of bat passes per species at each location recorded at Knepp Estate between June 2018 and October 2018.**

	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Nyctalus noctula</i>	<i>Nyctalus leisleri</i>	<i>Myotis sp.</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Pipistrellus nathusii</i>	<i>Pipistrellus social call</i>	<i>Plecotus sp</i>
Location 1	29	34	616	276	719	3563	9868	30	22	65
Location 2	32	5	9	0	561	740	1406	36	83	26
Location 3	7	34	9	3	1497	250	2278	0	1	38
Location 4	15	15	44	6	1897	3903	6187	25	576	51
<b>Total</b>	<b>83</b>	<b>88</b>	<b>678</b>	<b>285</b>	<b>4674</b>	<b>8456</b>	<b>19739</b>	<b>91</b>	<b>682</b>	<b>180</b>

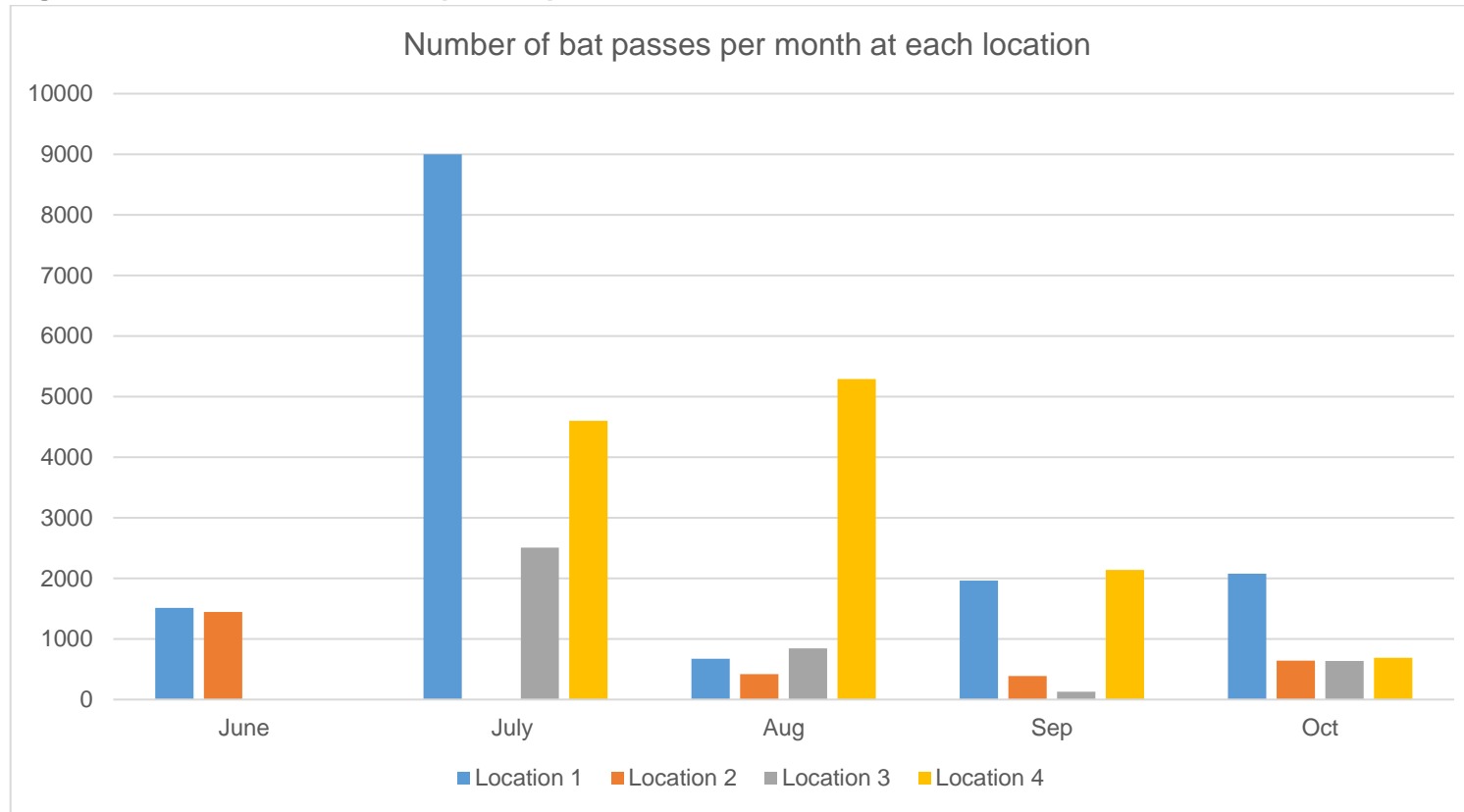
**Figure 3.1: Number of bat passes per species at each location recorded at Knepp Estate between June 2018 and October 2018.**



**Table 3.2: Total number of bat passes per month at each location**

	June	July	Aug	Sep	Oct
Location 1	1513	8998	674	1961	2076
Location 2	1445	0	420	389	644
Location 3	0	2506	844	128	639
Location 4	0	4600	5289	2140	690

**Figure 3.2: Total number of bat passes per month at each location**



**Table 3.3: Species recorded and total number of passes per day at Location 1**

Month	Date	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Nyctalus noctula</i>	<i>Nyctalus leisleri</i>	<i>Myotis sp.</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Pipistrellus nathusii</i>	<i>Pipistrellus social call</i>	<i>Plecotus sp</i>
June	25/06/2018	1	.0	9	1	26	390	21	0	2	0
	26/06/2018	0	0	0	1	42	233	30	0	0	0
	27/06/2018	4	0	3	1	25	365	48	0	0	0
	28/06/2018	1	1	16	1	24	222	44	1	0	1
July	27/07/2018	0	11	130	20	38	406	2571	7	1	0
	28/07/2018	1	1	1	159	26	126	1267	9	0	0
	29/07/2018	5	6	154	13	59	176	329	5	0	5
	30/07/2018	1	4	88	25	64	312	1167	1	0	9
	31/07/2018	3	1	75	54	29	154	1354	3	0	10
August	27/08/2018	0	0	1	0	24	121	67	1	4	6
	28/08/2018	0	0	1	0	0	67	10	0	1	2
	29/08/2018	2	0	5	1	6	60	39	0	3	7
	30/08/2018	3	2	2	0	28	96	25	1	1	10
	31/08/2018	0	2	0	0	10	33	28	0	0	5
September	21/09/2018	4	3	1	0	29	20	376	0	5	0
	22/09/2018	0	0	4	0	4	2	19	0	1	0
	23/09/2018	0	0	0	0	13	61	47	0	2	0
	24/09/2018	0	1	0	0	44	14	641	1	0	3
	25/09/2018	0	2	5	0	50	18	589	0	1	1
October	23/10/2018	1	0	0	0	14	387	562	0	1	0
	24/10/2018	1	0	3	0	7	52	42	0	0	0
	25/10/2018	2	0	0	0	155	248	579	1	0	4
	26/10/2018	0	0	0	0	2	0	13	0	0	2
	27/10/2018	No sound recorded									

**Table 3.4: Species recorded and total number of passes per day at Location 2**

Month	Date	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Nyctalus noctula</i>	<i>Nyctalus leisleri</i>	<i>Myotis sp.</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Pipistrellus nathusii</i>	<i>Pipistrellus social call</i>	<i>Plecotus sp</i>
June	25/06/2018	5	3	0	0	109	120	100	0	0	0
	26/06/2018	1	0	0	0	91	122	82	0	0	0
	27/06/2018	5	0	0	0	92	104	195	1	0	1
	28/06/2018	1	1	16	1	24	222	44	1	0	1
July	27/07/2018	No sound recordings were made during July due to a technical fault with the recording equipment.									
	28/07/2018										
	29/07/2018										
	30/07/2018										
	31/07/2018										
August	27/08/2018	9	0	0	0	16	21	63	0	3	6
	28/08/2018	3	0	2	0	13	11	20	0	14	3
	29/08/2018	3	0	0	0	13	10	22	0	4	2
	30/08/2018	1	0	4	0	19	26	49	1	6	1
	31/08/2018	1	0	0	0	13	16	0	31	8	6
September	21/09/2018	1	0	1	0	8	55	103	0	4	2
	22/09/2018	0	0	0	0	2	14	59	0	3	1
	23/09/2018	0	0	0	0	1	1	39	0	2	0
	24/09/2018	0	0	0	0	2	4	6	0	0	1
	25/09/2018	1	0	0	0	1	22	50	0	5	1
October	23/10/2018	0	0	0	0	14	14	262	0	17	1
	24/10/2018	0	0	0	0	55	82	56	0	17	0
	25/10/2018	1	0	0	0	8	9	105	0	0	1
	26/10/2018	0	0	0	0	0	0	0	1	0	0
	27/10/2018	0	0	0	0	0	0	0	1	0	0

**Table 3.5: Species recorded and total number of passes per day at Location 3**

Month	Date	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Nyctalus noctula</i>	<i>Nyctalus leisleri</i>	<i>Myotis sp.</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Pipistrellus nathusii</i>	<i>Pipistrellus social call</i>	<i>Plecotus sp</i>
June	25/06/2018	No sound recordings were made during June due to a technical fault with the recording equipment.									
	26/06/2018										
	27/06/2018										
	28/06/2018										
	29/06/2018										
July	27/07/2018	0	1	0	1	48	21	249	0	0	0
	28/07/2018	2	14	2	1	307	18	1248	0	0	0
	29/07/2018	0	1	3	0	19	2	6	0	0	0
	30/07/2018	0	7	0	1	53	36	247	0	1	0
	31/07/2018	0	4	0	0	36	23	155	0	0	0
August	27/08/2018	0	0	0	0	235	18	77	0	0	1
	28/08/2018	0	0	0	0	56	2	24	0	0	2
	29/08/2018	0	0	0	0	142	5	11	0	0	4
	30/08/2018	0	0	0	0	120	14	6	0	0	4
	31/08/2018	0	0	0	0	94	12	13	0	0	4
September	21/09/2018	0	0	0	0	5	8	41	0	0	2
	22/09/2018	No sound recorded									
	23/09/2018	0	1	0	0	2	0	41	0	0	0
	24/09/2018	1	0	0	0	2	8	5	0	0	0
	25/09/2018	0	0	0	0	0	9	3	0	0	0
October	23/10/2018	1	1	4	0	131	10	59	0	0	7
	24/10/2018	3	2	0	0	31	55	33	0	0	4
	25/10/2018	0	2	0	0	190	7	58	0	0	10
	26/10/2018	0	1	0	0	23	1	1	0	0	0
	27/10/2018	0	0	0	0	3	1	1	0	0	0

**Table 3.6: Species recorded and total number of passes per day at Location 4**

Month	Date	<i>Barbastella barbastellus</i>	<i>Eptesicus serotinus</i>	<i>Nyctalus noctula</i>	<i>Nyctalus leisleri</i>	<i>Myotis sp.</i>	<i>Pipistrellus pipistrellus</i>	<i>Pipistrellus pygmaeus</i>	<i>Pipistrellus nathusii</i>	<i>Pipistrellus social call</i>	<i>Plecotus sp</i>
June	25/06/2018	No sound recordings were made during June due to a technical fault with the recording equipment.									
	26/06/2018										
	27/06/2018										
	28/06/2018										
	29/06/2018										
July	27/07/2018	0	0	12	1	145	519	340	0	23	0
	28/07/2018	0	0	0	0	99	765	350	0	79	0
	29/07/2018	0	0	0	0	50	388	91	1	193	1
	30/07/2018	0	1	5	0	56	411	146	0	107	0
August	27/08/2018	0	0	5	2	44	295	750	7	4	16
	28/08/2018	1	0	7	0	45	110	787	2	0	3
	29/08/2018	2	1	1	0	65	67	916	3	0	1
	30/08/2018	1	3	4	1	34	90	787	9	9	1
	31/08/2018	0	3	2	0	56	336	810	1	7	1
September	21/09/2018	2	4	3	0	850	237	163	1	34	3
	22/09/2018	0	0	0	0	0	0	3	0	0	0
	23/09/2018	0	0	0	0	52	25	96	0	1	1
	24/09/2018	0	0	0	0	73	100	94	0	2	0
	25/09/2018	4	1	0	0	197	91	96	0	6	1
October	23/10/2018	0	0	0	0	17	212	205	0	0	4
	24/10/2018	1	0	0	0	8	30	29	0	0	0
	25/10/2018	3	0	0	0	13	5	138	0	0	0
	26/10/2018	1	0	0	0	4	0	19	0	0	1
	27/10/2018	No sound recorded									

### Trapping

- 3.28 On five nights in August 2018 a total of 213 bats were captured. The species, sex of the bats and numbers of individuals captured are detailed in Table 3.7. The biometric data for all bats captured is also detailed in Appendix A.
- 3.29 A total of nine species of bats barbastelle, Bechstein's, brown long-eared, common pipistrelle, Daubenton's, Natterer's, noctule, soprano pipistrelle and whiskered bats were caught during the trapping surveys.
- 3.30 The 2018 trapping surveys also confirmed presence of breeding for eight species. Only male barbastelle was recorded.

**Table 3.7** Trapping results Knepp Estate 2018

		Female	Male
Barbastelle bat	<i>Barbastella barbastellus</i>	0	1
Bechstein's bat	<i>Myotis bechsteinii</i>	1	2
Brown long-eared bat	<i>Plecotus auritus</i>	5	6
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	4	9
Daubenton's bat	<i>Myotis daubentonii</i>	19	15
Natterer's bat	<i>Myotis nattereri</i>	4	5
Noctule	<i>Nyctalus noctula</i>	4	6
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	45	67
Whiskered bat	<i>Myotis mystacinus</i>	3	17
<b>Total</b>		<b>85</b>	<b>128</b>

- 3.31 On five nights during May and June 2019 a total of 78 were captured. Due to poor weather conditions in May and June 2019 (see constraint section 2.30) two nights were re-scheduled for post maternity. These focused on the area around the Mill Pond, Hammer Pond and the river restoration to complement the survey effort undertaken by Greenaway 2008. On the 2<sup>nd</sup> and 3<sup>rd</sup> August, a total of 20 bats were captured at these locations.
- 3.32 The species, sex of the bats and numbers of individuals captured are detailed in Table 3.8. The biometric data for all bats captured is also detailed in Appendix A.
- 3.33 A total of seven species of bats including, Bechstein's, brown long-eared, common pipistrelle, Daubenton's, Natterer's, soprano pipistrelle and whiskered bats were caught during the trapping surveys. Noctule and barbastelle were heard on passive detectors during the trapping surveys.
- 3.34 The 2019 trapping surveys also confirmed presence of breeding for five species.



**Table 3.8** Trapping results Knepp Estate 2019

		Female	Male
Bechstein's bat	<i>Myotis bechsteinii</i>	0	2
Brown long-eared bat	<i>Plecotus auritus</i>	2	9
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	2	7
Daubenton's bat	<i>Myotis daubentonii</i>	0	6
Natterer's bat	<i>Myotis nattereri</i>	2	9
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	16	29
Whiskered bat	<i>Myotis mystacinus</i>	3	11
<b>Total</b>		<b>25</b>	<b>73</b>

### Radio-tracking

- 3.35 A total of eight bats were fitted with radio-transmitters and subsequently radio-tracked to determine roosting locations and approximate roost counts, where access was permissible.
- 3.36 The bats fitted with radio-transmitters and radio-tracked are detailed in Table 3.8 and the roost locations and roost counts, where applicable, are detailed in Table 3.9.
- 3.37 The roost locations and roost counts are illustrated in Figure 3.8.

**Table 3.8:** Bats captured and radio-tagged at Knepp Estate 2018

Date	Bat no.	Species	Latin name	Sex	Radio-tag no.	Grid reference capture	
18.8.18	1	Daubentons	<i>Myotis daubentonii</i>	Female	173.2900	515955	121208
18.8.18	2	Brown long-eared	<i>Plecotus auritus</i>	Female	173.3333	515825	121196
18.8.18	3	Natterer's	<i>Myotis nattereri</i>	Female	173.7380	515762	121164
18.8.18	4	Noctule	<i>Nyctalus noctula</i>	Female	173.2290	515900	121213
18.8.18	5	Bechsteins	<i>Myotis bechsteinii</i>	Male	173.9150	515820	121213
18.8.18	6	Bechsteins	<i>Myotis bechsteinii</i>	Female	173.3250	514932	121888
23.8.18	7	Nathusius' pipistrelle	<i>Pipistrellus nathusius</i>	Male	173.7584	514793	120784
25.8.18	8	Barbastelle	<i>Barbastella barbastellus</i>	Male	173.3650	515984	120736

**Table 3.9:** Bats radio-tagged roost locations and roost counts at Knepp Estate 2018

Date	Bat no.	Species	Latin name	Sex	Roost		Roost Count
18.8.18	1	Daubentons	<i>Myotis daubentonii</i>	Female	515916	121623	40
18.8.18	2	Brown long-eared	<i>Plecotus auritus</i>	Female	515556	121103	14
18.8.18	3	Natterer's	<i>Myotis nattereri</i>	Female	514496	121805	n/a
18.8.18	4	Noctule	<i>Nyctalus noctula</i>	Female	516067	122396	16
18.8.18	5	Bechsteins	<i>Myotis bechsteinii</i>	Male	515602	122040	3
18.8.18	6	Bechsteins	<i>Myotis bechsteinii</i>	Female	515706	122024	21
23.8.18	7	Nathusius' pipistrelle	<i>Pipistrellus nathusius</i>	Male	515533	121231	4
25.8.18	8	Barbastelle	<i>Barbastella barbastellus</i>	Male	513797	120782	1

*Bat 1 – Daubentons*

- 3.38 The female post lactating Daubentons was captured in the woodland belt south of Mill Pond on the 18<sup>th</sup> August 2018. She was fitted with a radio-tag and subsequently radio-tracked to a woodland copse to the north-east of Mill Pond. An emergence survey on the 20<sup>th</sup> August recorded a total of 40 Daubentons bats emergence from three different locations on an oak tree. The bats flew around the woodland belt and foraged over Mill Pond upon emergence.

*Bat 2 – Brown Long-eared*

- 3.39 The female post-lactating Brown long-eared was captured in the woodland belt south of Mill Pond on the 18<sup>th</sup> August 2018. She was fitted with a radio-tag and subsequently radio-tracked to a woodland south of Mill Pond. An emergence survey on the 20<sup>th</sup> August recorded a total of 14 Brown Long-eared bat emerge from a fissure on a lateral branch on the southern elevation of an oak tree. The bats flew around the woodland belt upon emergence. Two soprano pipistrelle were also recorded emerging from the same tree on the 20<sup>th</sup> August 2018.

*Bat 3 – Natterer's*

- 3.40 The female post – lactating Natterer's bat was captured in the woodland belt south of Mill Pond on the 18<sup>th</sup> August 2018. She was fitted with a radio-tag and subsequently radio-tracked to Shipley Church on the 21<sup>st</sup> and 24<sup>th</sup> August 2018. An emergence survey was not carried out on the church.

*Bat 4 – Noctule*

- 3.41 A juvenile female noctule bat was captured in the woodland belt south of Mill Pond on the 18<sup>th</sup> August 2018. She was fitted with a radio-tag and subsequently radio-tracked to a woodland north of Mill Pond on the 21<sup>st</sup> August 2018. An emergence count from a woodpecker hole c. 7m on the main trunk of an oak recorded a total of sixteen noctule bats emerging. The majority of bats emerging flew east across the field towards Merrik wood.

*Bat 5 – Bechsteins*

- 3.42 A juvenile male Bechstein's bat was captured in the woodland belt south of Mill Pond on the 18<sup>th</sup> August 2018. He was fitted with a radio-tag and subsequently radio-tracked to a woodland north of Knepp Castle on the 21<sup>st</sup> August 2018. An emergence count from a woodpecker hole c. 5m on the main trunk of an oak recorded a total of three Bechstein's bats emerging. It was not possible to determine direction of flight upon emergence due to the nature of the surrounding woodland.

*Bat 6 – Bechsteins*

- 3.43 A adult post-lactating female was captured in the woodland belt off Pound Lane west of the Knepp Estate on the 18<sup>th</sup> August 2018. She was fitted with a radio-tag and subsequently radio-tracked to a woodland north Knepp Castle on the 21<sup>st</sup> August 2018. An emergence count from a woodpecker hole c. 4m on the main trunk of ash recorded a total of 21 Bechsteins's bats emerging. It was not possible to determine direction of flight upon emergence due to the nature of the surrounding woodland.

*Bat 7 – Nathusius' pipistrelle*

- 3.44 A male adult Nathusius' was captured at Hammer Pond on in the woodland belt off Pound Lane west of the Knepp Estate on the 23<sup>rd</sup> August 2018. He was fitted with a radio-tag and subsequently radio-tracked to a property on the 24<sup>th</sup> August. Four Nathusius' bats were recorded emerging from four different locations around the property.

*Bat 8 - Barbastelle*

- 3.45 A male adult Barbastelle bat was captured on the River Adur tributary on the 24<sup>rd</sup> August 2018. He was fitted with a radio-tag and subsequently radio-tracked to a tree with a split bark on the 25<sup>th</sup> August 2018 to the west of the Knepp Estate. No other bats were recorded present in the tree.

## 4 EVALUATION

- 4.1 All species of bat present in the UK receive full protection under The Conservation of Habitats and Species Regulations 2017, and the Wildlife and Countryside Act 1981 (as amended).

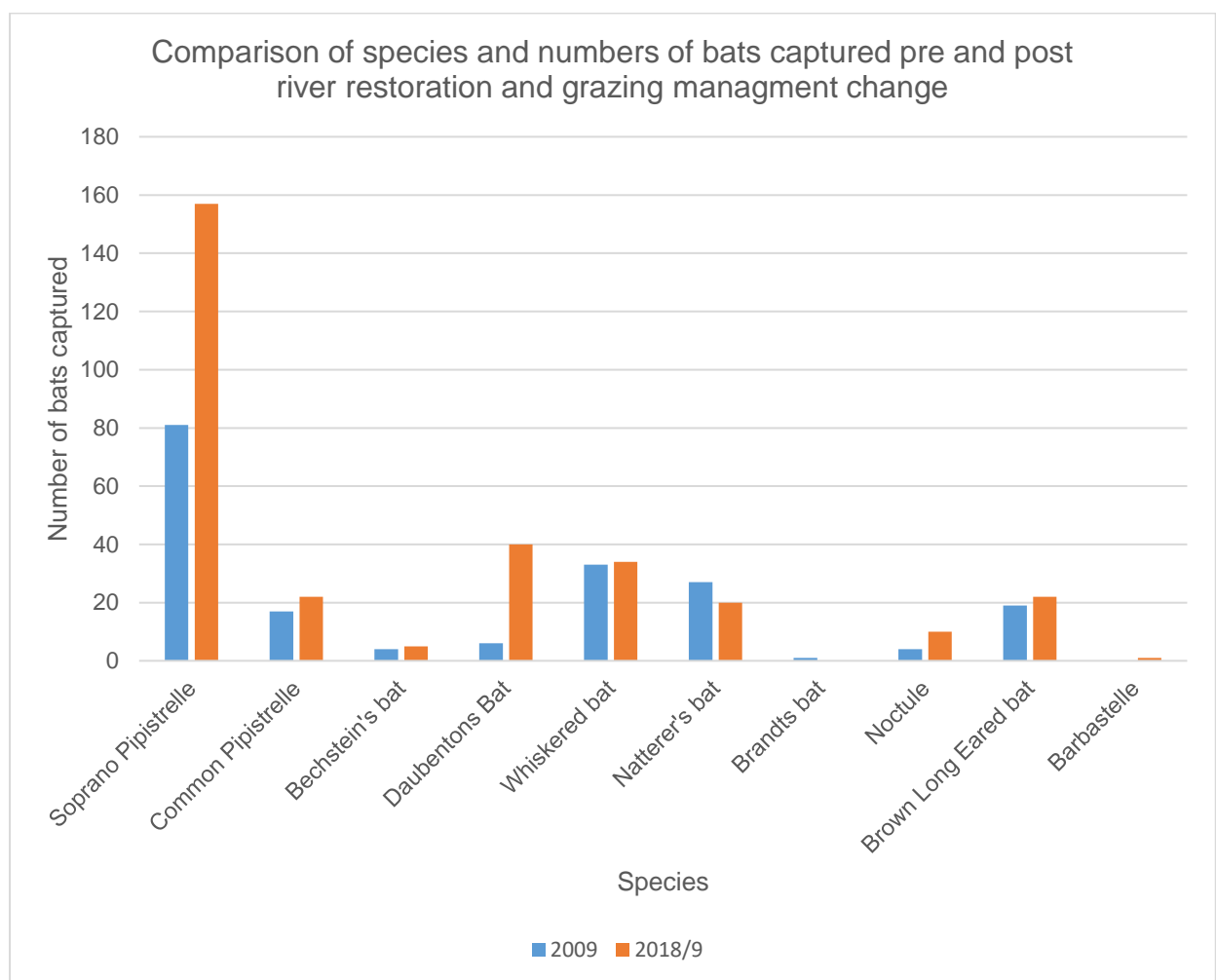
### *Automated Ultrasound Detectors*

- 4.2 The most frequent bat pass recorded was soprano pipistrelle (19,739), followed by common pipistrelle (8456), *Myotis* spp. (4674), pipistrelle social calls (682), noctule (678), Leisler's (285), *Plecotus* spp. (180), nathusius pipistrelle (91), serotine (88) and barbastelle (83). It must be noted that for automated detectors, there is a limitation in that they can only measure a relative index of activity. This is because a single bat foraging near a bat detector may register multiple pulses of ultrasound. This is particularly true for species such as pipistrelle. Nonetheless, the static detectors are useful for confirming species groups, collecting data over time and comparison between locations for general levels of bat activity.
- 4.3 The most frequent bat pass recorded was soprano pipistrelle (19,739), followed by common pipistrelle (8456), *Myotis* spp. (4674), pipistrelle social calls (682), noctule (678), Leisler's (285), *Plecotus* spp. (180), nathusius pipistrelle (91), serotine (88) and barbastelle (83). Location 1 recorded the high number of bat passes (15,222), followed by location 4 (12,719), location 3 (4117) and location 2 (2898).
- 4.4 The high level of passes for *Myotis* species, particularly for location 3 and location 4, is notable. By comparison barbastelle bat was infrequently recorded, but most passes that were registered were at location 1 and location 2.
- 4.5 There were no static detectors deployed during the 2009 surveys by Frank Greenaway. Advances in bat technologies during the last decade have resulted in improved methodologies for recorded bat activity remotely (with the constraints as specified in 4.2). Therefore, the static detectors deployed in 2018 can be viewed as a baseline against which future monitoring can be measured against.

### *Trapping*

- 4.6 A total of nine species of bats barbastelle, Bechstein's, brown long-eared, common pipistrelle, Daubenton's, Natterer's, noctule, soprano pipistrelle and whiskered bats were caught during the trapping surveys. The trapping surveys also confirmed presence of breeding for seven species. Only male barbastelle and male Nathusius' pipistrelle was recorded. The automated ultrasound static detectors also confirmed the presence of serotine and Leisler's bat, taking the total to eleven species in 2018.
- 4.7 The pre maternity survey in 2019 recorded a total of 78 bats of seven species, five of which were confirmed as breeding. The poor weather conditions pre-maternity in 2019 resulted in less bats captured (by comparison to post maternity 2018) but there were higher numbers of bats captured overall compared to the 2009 survey.

- 4.8 The total number of species recorded in 2009 was twelve species. Frank Greenaway (2009) also recorded the presence of a non-breeding Brandt's bat in late summer 2009. The genera of small *Myotis*, whiskered, Brandt's and alcahloe, present in southern England expanded in 2010 when alcahloe was confirmed to be present. It has also since been confirmed that many of the morphological characteristics of Brandt's and whiskered bats over (Berge 2007) and, as such, the most reliable method for identification of small *Myotis* genera is through DNA analysis of faecal droppings. Nonetheless, in 2009, there was no evidence of Brandt's breeding at Knepp Estate and the management of the estate is unlikely to have changed this.
- 4.9 A total of 202 bats were captured both pre-maternity and post maternity in 2009. By comparison, in 2018, only a post maternity survey (essentially half the survey effort) was undertaken and a total of 213 bats were captured and a total of 98 bats (including two additional trapping sessions post maternity) in 2019.
- 4.10 Therefore, when comparing the survey effort and combing pre and post maternity survey data for 2018/19 (excluding the re-scheduled additional survey area for Mill Pond, Hammer Pond and the River restoration), there was 291 bats captured in post restoration compared to 202 bats captured pre-restoration. The breakdown by species is detailed in Table 4.1.



- 4.11 There was a significant increase in the number of soprano pipistrelle (157 in 2018/19 compared to 81 in 2009) and Daubenton's bats in 2018/19 (40 in 2018/19 compared to 6 in 2009). Both species are associated with riparian habitats and the majority of these species were captured along the river restoration or at Hammer Pond or Kneppmill Pond.
- 4.12 There was a slight decrease (20 in 2018/19 compared to 27 in 2009), in the number of Natterer's bats captured in 2018/19 compared to 2009. The roosts were identified at Shipley Church (off site) and it may be that the more riparian habitats where the trapping was focussed was not targeting foraging areas for this species.
- 4.13 There were no significant changes in the capture numbers for the other species.

### *Species Diversity and Roost Counts*

#### **Soprano Pipistrelle**

- 4.14 A roost of 80+ bats was recorded at 64 Knepp Mill Cottages in 2009. A roost emergence survey on 16/05/2018 produced a count of 215, with 298 counted on 11/06/2019 and 270 on 25/06/2019.

Date	Count	Comment
2009	80+	East-facing wall, above kitchen door and below upstairs window
16/05/2018	215	
11/06/2019	298	
25/06/2019	270	

#### **Whiskered Bat**

- 4.15 Two whiskered bat roosts were recorded in buildings in 2009, with 58 counted at 2 Brookhouse Farm Cottages and 22 at Hampshires Barn. Subsequent visits in 2018 and 2019 resulted in these counts:

##### **Brookhouse Farm Cottages**

Date	Count	Comment
2009	58	South-east facing wall, on left hand side of side door, emerging from hanging tile next to drain pipe. They'd moved around to the front of the house in the second 2-18 visit, so may have missed the first few.
14/05/2018	21	
12/06/2018	45+	
06/06/2019	35	
20/06/2019	54	

## Hampshires Barn

Date	Count	Comment
2009	22	Emergenced from northern end of barn (annexe, not main residence). Soprano Pipistrelle detected in garden area.
11/06/2018	64	
09/06/2019	51	
29/06/2019	47	

**Natterer's bat**

- 4.16 A total of 20 natterer's bats were captured during the trapping surveys at the Knepp Estate in 2018 and 2019 and one female was radio-tagged. The roost was in Shipley church, located off the estate. This roost was also identified by Frank Greenaway in 2009, and 10+ bats were counted. Emergence counts on 17/05/2018 during which one natterer's bat was recorded but despite all aspects of the church being covered there wasn't an obvious roost emergence.
- 4.17 It was expected that a greater number of Natterer's bats would have been captured during the trapping surveys by comparison to the 2009 survey (27 bats captured) as predicted by Greenaway (2009). However, it is acknowledged that trapping bats is a selective method and comparison of trapping numbers is unlikely to provide estimates for population increases or decrease.

**Daubenton's bat**

- 4.18 A total of 46 daubenton's bats were captured during the trapping surveys at the Knepp Estate in 2018 and 2019 and one female was radio-tagged. The roost was located on the Knepp Estate near Kneppmill Pond. A total of 40 bats were recorded emerging in August 2018.
- 4.19 Daubenton's were also recorded roosting at this location in 2009, with a roost count of 47 bats. It is likely that the number of trees is used by the Daubenton's colony in proximity to Kneppmill Pond.
- 4.20 The number of Daubentons captured in 2018 post maternity was significantly greater than the number of Daubenton's captured in 2009 both pre maternity and post maternity. Again, it can not be said that the number of bats have increased directly as a result of the management changes and / or river restoration as bat activity is strongly dependant on weather conditions. The number of Daubentons captured pre-maternity in 2019 (6 bats) is broadly similar to the numbers captured pre-maternity in 2009 (4 bats)

**Bechstein's bat**

- 4.21 A total of five Bechstein's bat were captured during the trapping surveys at the Knepp Estate in 2018 and 2019. One female and one male were radio-tagged in 2018. The roosts were both located in the woodland north of Knepp Castle. A total of 3 Bechstein's were recorded emerging from roost with the radio-tagged male and 21 Bechstein's were recorded emerging from the roost with the radio-tagged female in August 2018.

- 4.22 Bechstein's were recorded roosting 1km south of the 2018 roosts in 2009, with a roost count of 10 bats (although the foliage obscured the roost entrance).
- 4.23 This numbers recorded of Bechstein's recorded in 2018 at the Knepp Estate confirms that there is a maternity roost for this species on the estate.

#### **Brown long-eared bat**

- 4.24 No brown long-eared bats were recorded during the buildings roost emergence counts in 2018/19. A roost was noted as being present in 2009 in the loft of 131 West Lodge, Pound Lane, but a count was not conducted. A visit to this roost location in 2018 resulted in none being recorded emerging at dusk.
- 4.25 A total of 22 brown long-eared bats were captured during the trapping surveys at the Knepp Estate in 2018 and 2019. One female was radio-tagged in 2018. The roost was in the woodland south of Knepp Mill Pond.
- 4.26 A total of 14 brown long bats were recorded emerging from a tree roost in August 2018.
- 4.27 Three brown long-eared roosts were identified on the Knepp Estate in 2009 in both trees and woodland.

#### **Barbastelle**

- 4.28 One male barbastelle was captured during the trapping surveys at the Knepp Estate in 2018. The roost was located along the river restoration woodland.
- 4.29 The male barbastelle roosted solitary.
- 4.30 Barbastelle were not trapped on the estate in 2009 but were recorded on bat detectors during the trapping surveys.

#### **Noctule**

- 4.31 A total of 10 noctule bats were captured during the trapping surveys at the Knepp Estate in 2018. No noctules were captured in 2019. One juvenile female was radio-tagged in 2018. The roost was in woodland north of Kneppmill Pond.
- 4.32 A total of sixteen noctule bats were recorded emerging from a woodpecker hole in a tree just north of Knepp Mill Pond.
- 4.33 In 2009 only male noctules were captured and low levels of activity were recorded for this species. The presence of a maternity roost for noctule on the Knepp Estate is a new finding.

#### **Leisler's bat**

- 4.34 No Leisler's bat was caught in 2018 but the recordings from the automated static bat detectors indicate that they are occasionally present.
- 4.35 This is the same finding as 2009.



### **Nathusius' pipistrelle**

- 4.36 One male Nathusius' was captured during the trapping surveys at the Knepp Estate in 2018. No Nathusius' were captured in 2019. The roost was located in a property south of Kneppmill Pond.
- 4.37 The male Nathusius' pipistrelle roosted solitary but it is likely there were other pipistrelle bats roosting solitary in the property.
- 4.38 Nathusius' were not trapped on the estate in 2009 but were recorded on bat detectors during the trapping surveys.

### **Serotine**

- 4.39 No serotine bats were caught in 2018 but the recordings from the automated static bat detectors indicate that they are occasionally present.
- 4.40 This is the same finding as 2009.

## **5 CONCLUSIONS**

- 5.1 The 2018 and 2019 survey on the Knepp Estate has confirmed the importance of the site for bats. The river restoration area from Pound Lane in the west to the A24 in the east is used extensively by the local bat population, as indicated by both the automated surveys and the trapping surveys.
- 5.2 The species diversity of bats has remained unchanged (except for Brandt's not been recorded by trapping in 2018 and 2019 ) but there was a higher number of bats captured, proportionally and a greater proportion of female bats was captured in 2018. In general, female bats tend to forage in more optimal habitat and it is likely that the river restoration has improved the habitat for females.
- 5.3 Male noctule and Bechstein's were only confirmed present as adult males in 2009 but both species now having breeding females roosting on the Knepp Estate.
- 5.4 Roosts at three properties on the Knepp Estate are still extant, with further visits needed on the buildings where inconclusive results were recorded. Most noteworthy is the soprano pipistrelle roost at Knepp Mill Cottages which saw a huge increase in numbers from 80+ in 2009 to 298 in 2019.

## **6 RECOMMENDATIONS**

- 6.1 Given the vision of the Knepp Estate as providing a haven for wildlife re-introductions, there is the potential for the site attract and retain Greater Horseshoe Bat *Rhinolophus ferrumequinum*. This Annex II species is at the edge its UK range in West Sussex. A small maternity roost site for this species has been confirmed by the Sussex Bat Group in Lodsworth West Sussex, some 20km west of the Knepp Estate. It is entirely reasonable to suggest that if the Knepp Estate were to consider re-introduction for bats, this species would be a optimal target.

6.2 The built structures on site, specifically those next to the Mill Pond, could be enhanced to provide additional roosting habitat for species that use residential buildings on site and / or converted to provide a structure for a species re-introduction.

## REFERENCES

Collins, J. (ed.) (2016) *Bat Surveys for Professional Ecologists Good Practice Guidelines* 3<sup>rd</sup> Edition, Bat Conservation Trust, London.

Greenaway, F. (2009) *A survey of the land within the proposed River Adur restoration site and associated watercourses*. Unpublished survey report.

Mitchell-Jones A.J. and McLeish A.P. (2004) *The Bat Workers Manual* 3<sup>rd</sup> Edition. Joint Nature Conservation Committee.

## FIGURES

Figure 1.1 Location of site

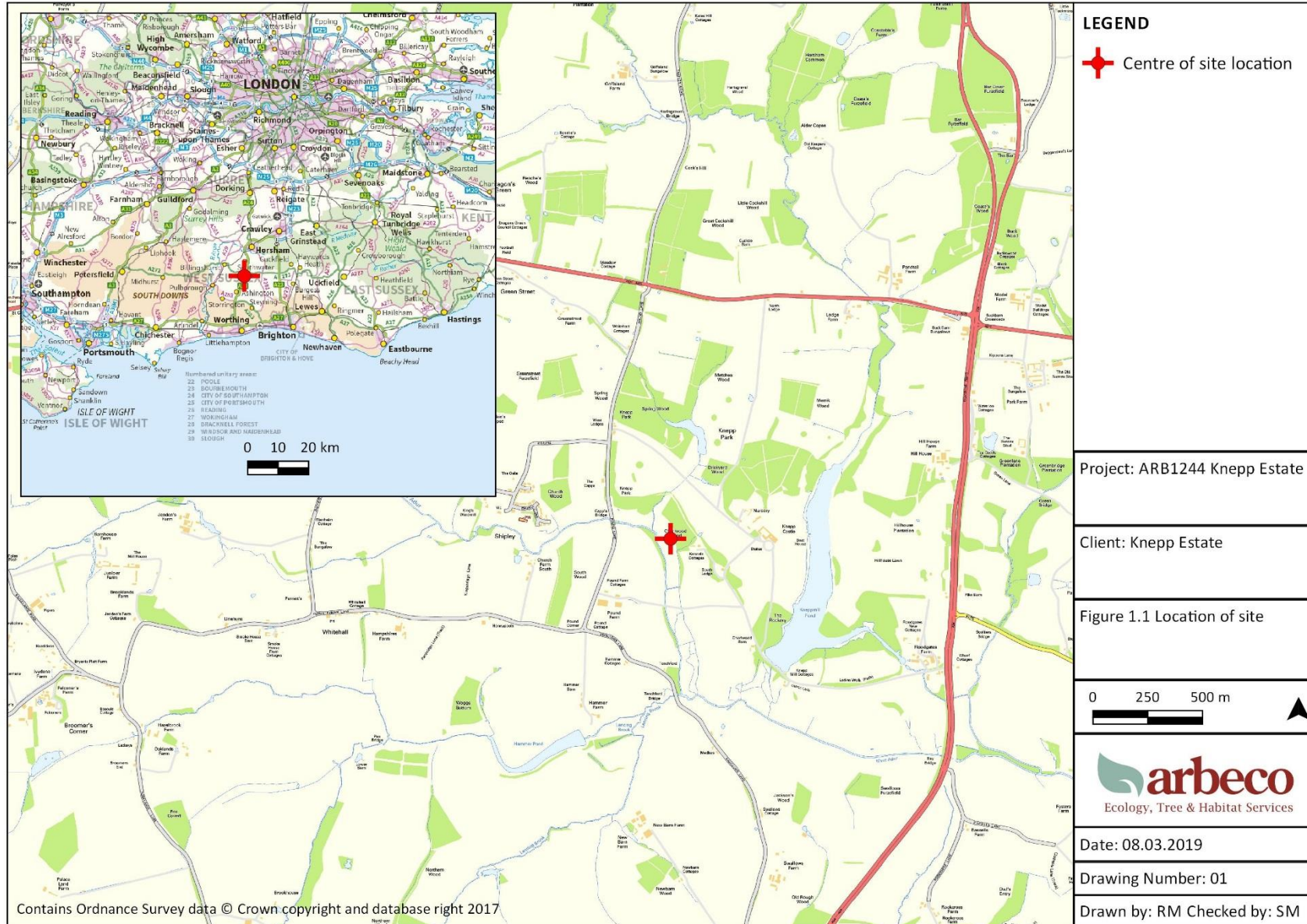
Figure 1.2 Approximate extent of site boundary

Figure 2.1 Static bat detector locations

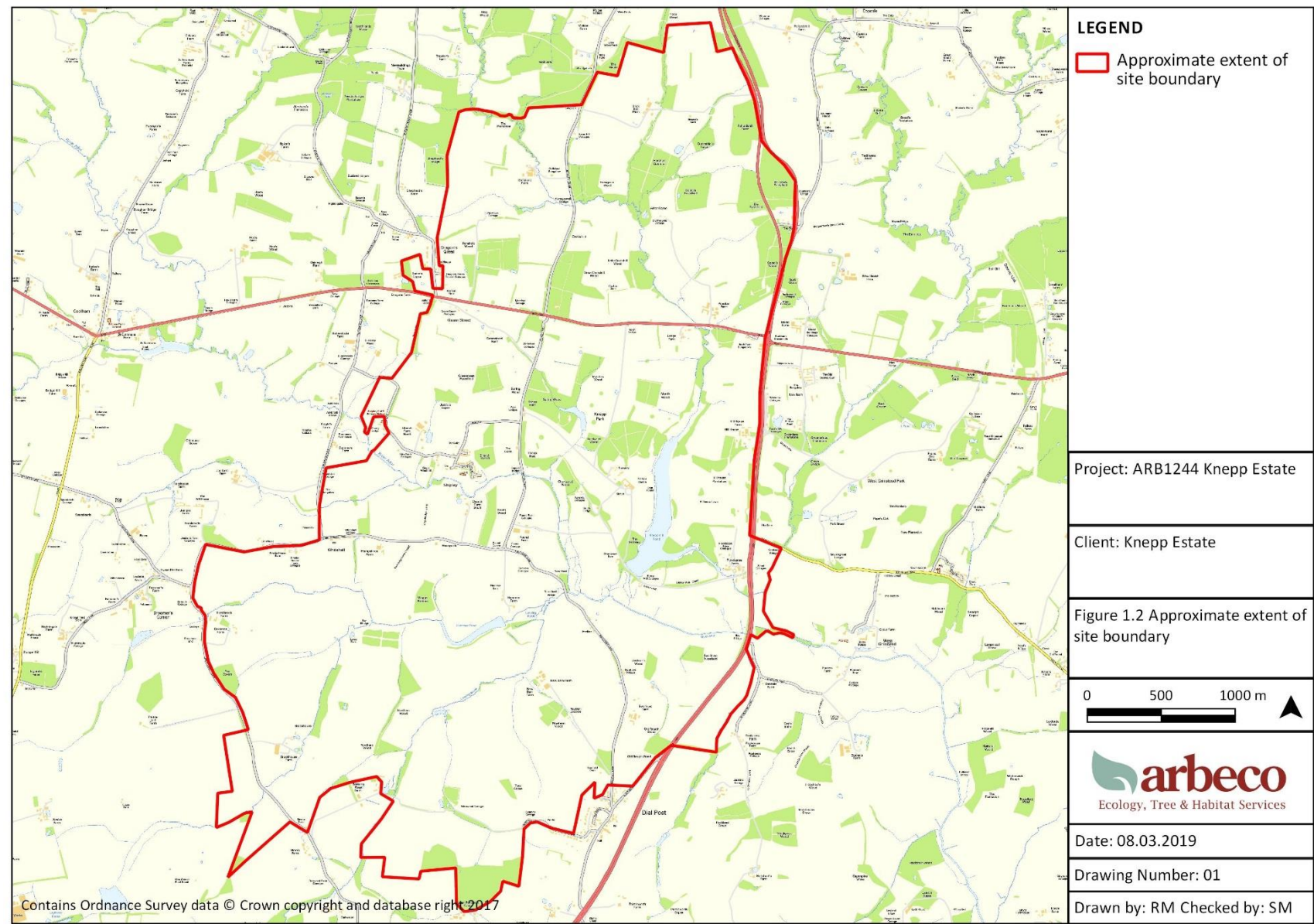
Figure 2.2: Trapping Survey Areas

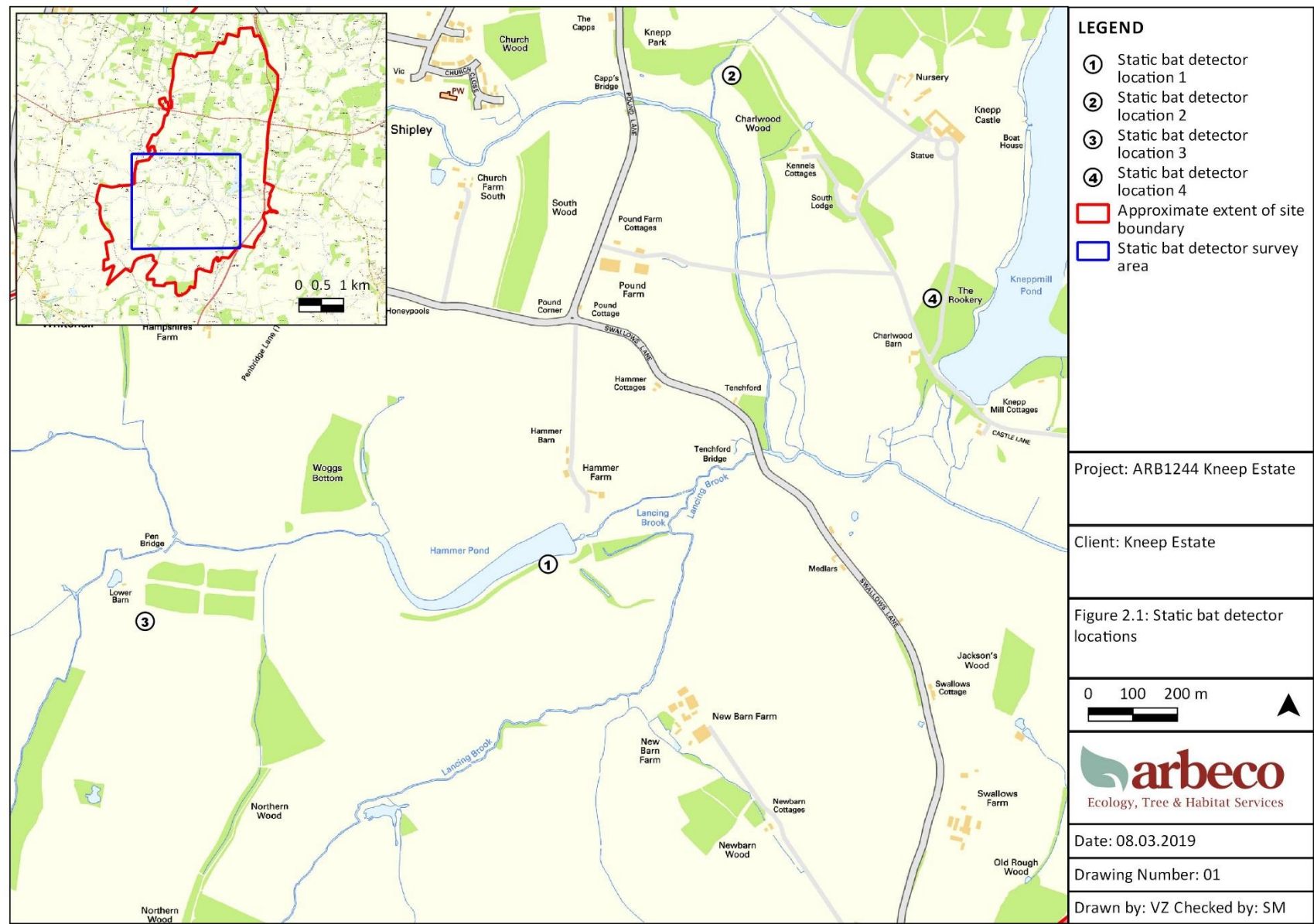
Figure 2.3: Trapping locations

Figure 3.8: Roost locations and roost counts

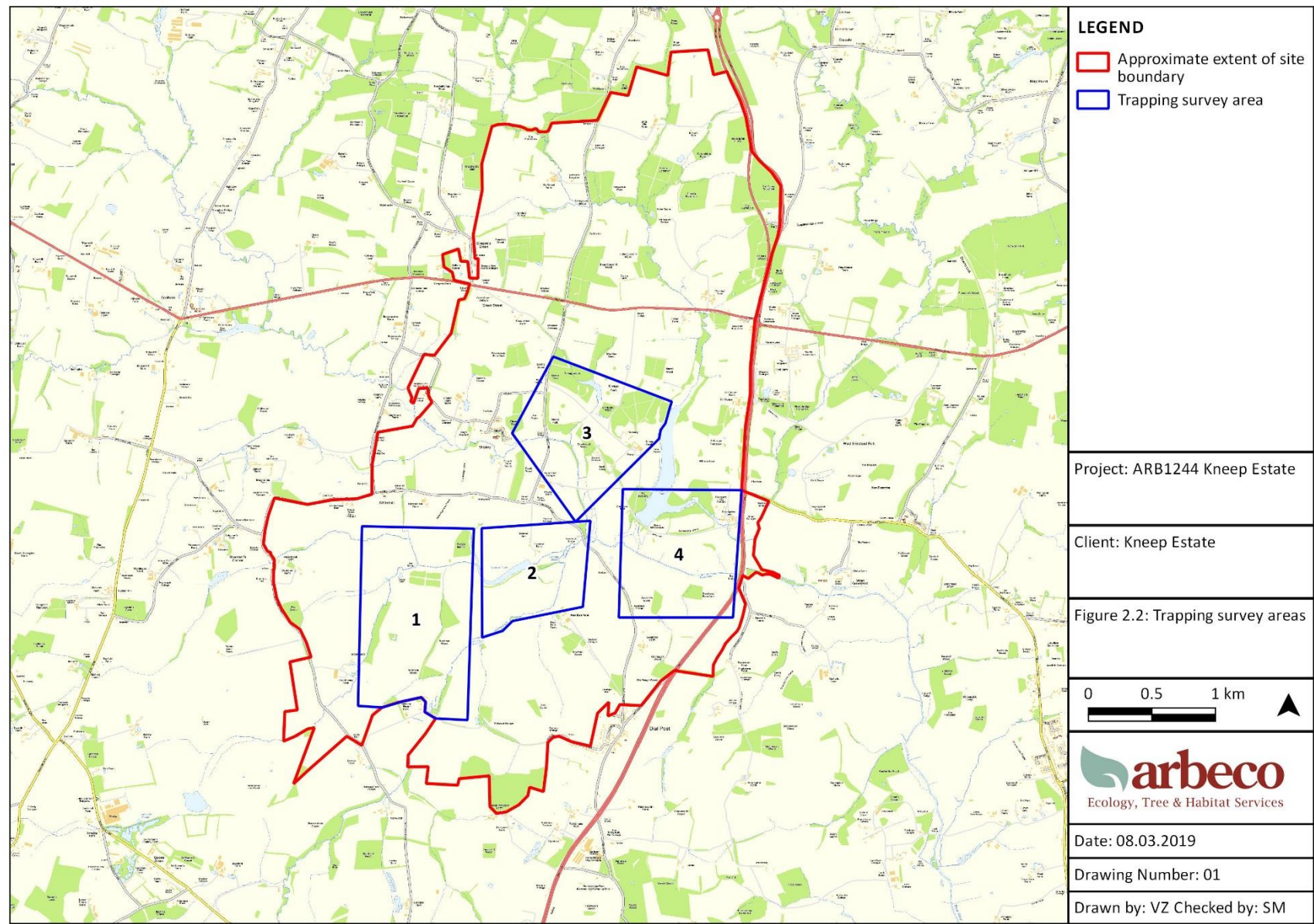




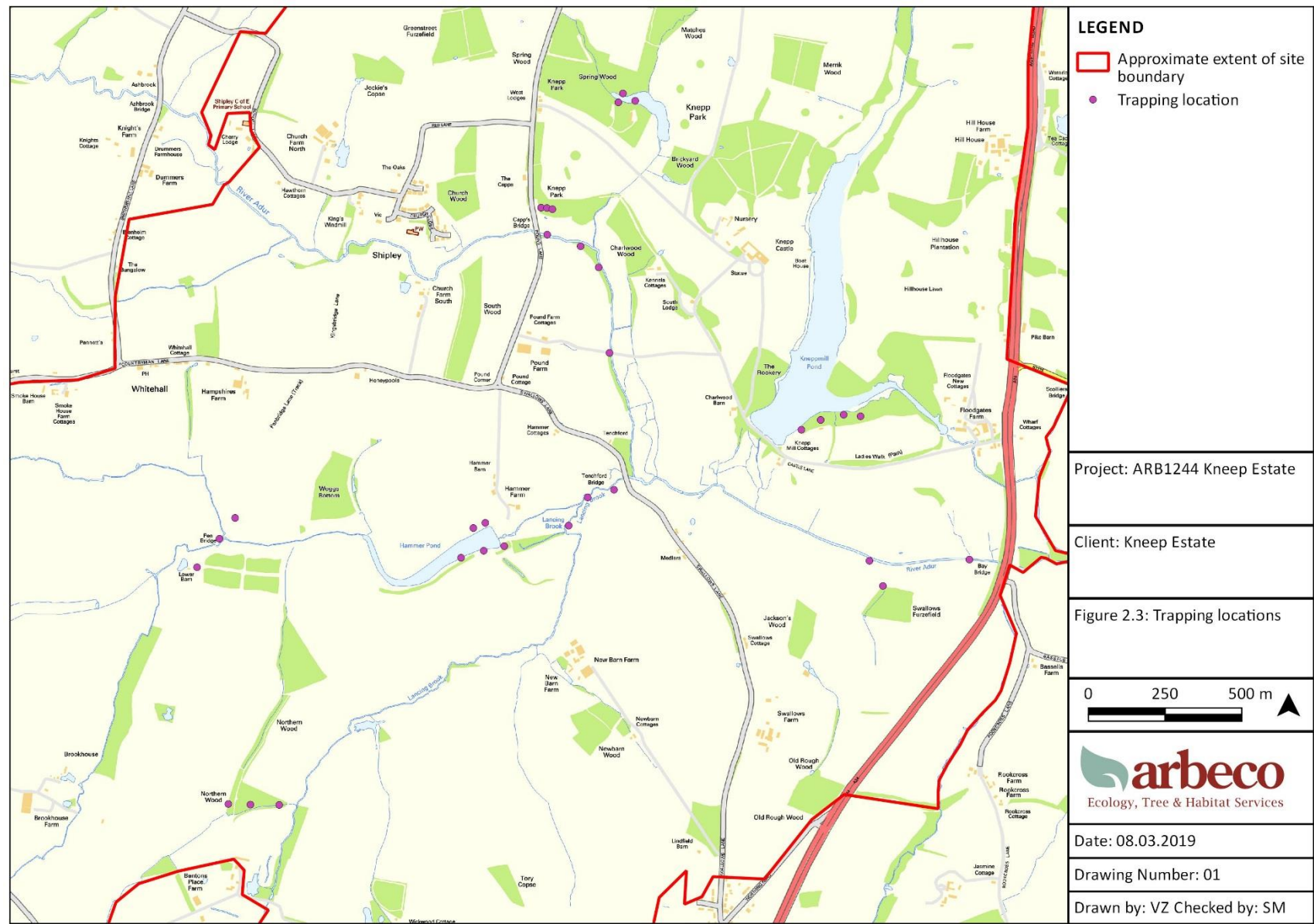


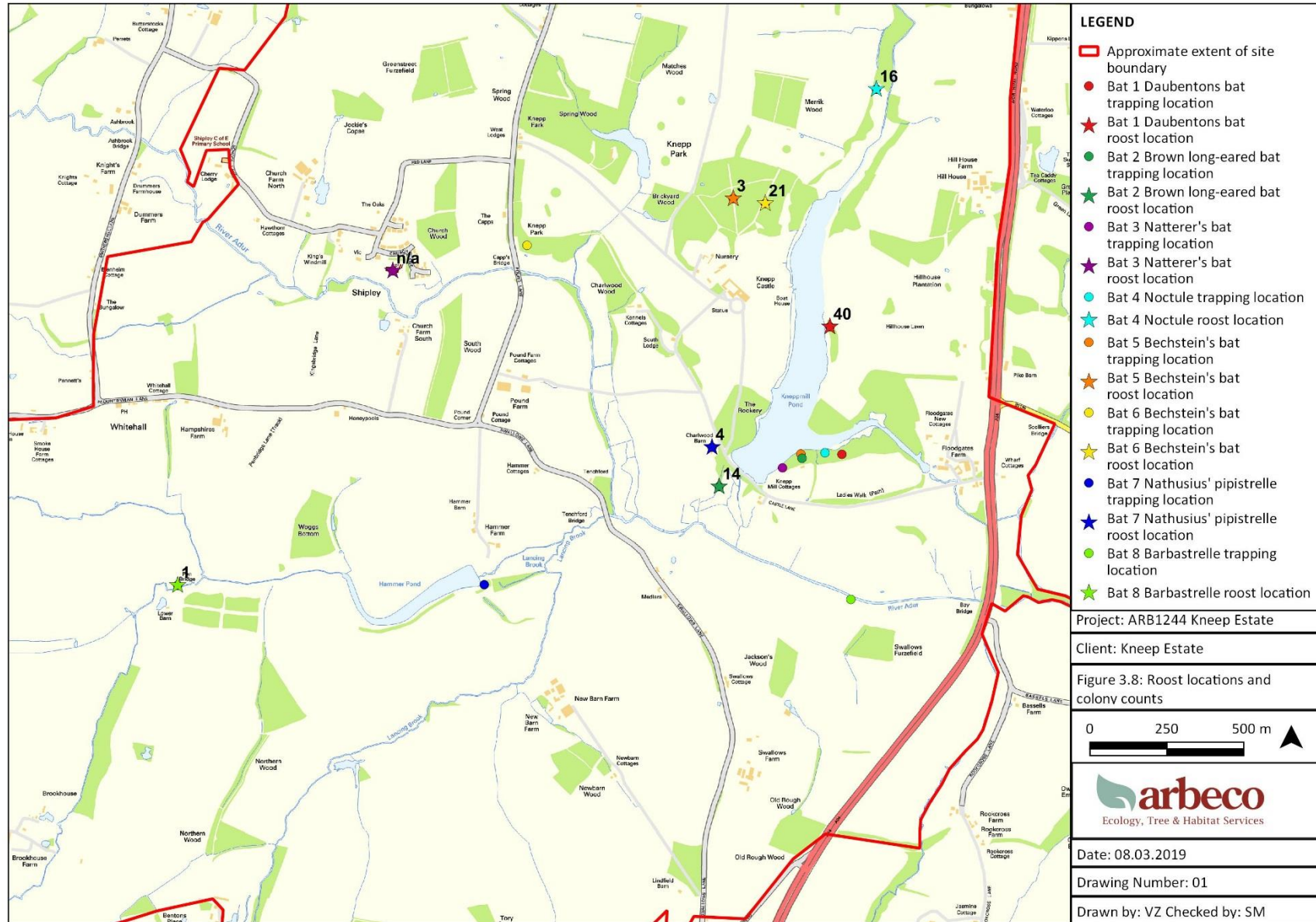














**Photo 1: Male nathusius' pipistrelle and roost site.**



**Photo 2: Male Bechstein's bat and roost site for female Bechstein's woodland north of Knepp Castle.**



**Photo 3: Female brown long-eared, female daubentons and female noctule trapped at Knepp Estate 2018.**



## APPENDIX 1: Legislation relating to bats

Bats and the places they use for shelter or protection i.e. roosts, receive European protection under The Conservation of Habitats and Species Regulations 2017, as amended (Habitats Regulations 2017). They receive further legal protection under the Wildlife and Countryside Act (WCA) 1981, as amended. This protection means that bats, and the places they use for shelter or protection, are capable of being a material consideration in the planning process.

Regulation 43 of the Habitats Regulations 2017 (as amended), states that a person commits an offence if they:

- deliberately capture, injure or kill a bat;
- deliberately disturb bats; or
- damage or destroy a bat roost (breeding site or resting place).

Disturbance of animals includes in particular any disturbance which is likely to impair their ability to survive, to breed or reproduce, or to rear or nurture their young, or in the case of animals of a hibernating or migratory species, to hibernate or migrate; or to affect significantly the local distribution or abundance of the species to which they belong.

It is an offence under the Habitats Regulations 2017 for any person to have in his possession or control, to transport, to sell or exchange or to offer for sale, any live or dead bats, part of a bat or anything derived from bats, which has been unlawfully taken from the wild.

Whilst broadly similar to the above legislation, the WCA 1981 (as amended) differs in the following ways:

- Section 9(1) of the WCA makes it an offence to *intentionally* (rather than deliberately) kill, injure or take any protected species.
- Section 9(4)(a) of the WCA makes it an offence to *intentionally or recklessly\** damage or destroy, *or obstruct access to*, any structure or place which a protected species uses for shelter or protection.
- Section 9(4)(b) of the WCA makes it an offence to *intentionally or recklessly\** disturb any protected species *while it is occupying a structure or place which it uses for shelter or protection*.

\*Reckless offences were added by the Countryside and Rights of Way (CROW) Act 2000.

As bats re-use the same roosts (breeding site or resting place) after periods of vacancy, legal opinion is that roosts are protected whether or not bats are present.

Several bat species are considered to be Species of Principal Importance for Nature Conservation in England.

The reader should refer to the original legislation for the definitive interpretation.