



Norwich Western Link

Environmental Statement Chapter 11: Bats – Appendix 2: 2021 Bat Radio Tracking Survey Report

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1 Introduction

1.1.1 This bat-trapping and radio-tracking report was commissioned by WSP UK Ltd on behalf of Norfolk County Council to:

- provide further up-to-date information to determine the importance of the defined Survey Area for bats by locating bat roosts, identifying foraging areas related to key roost sites (including those used for breeding), and identifying flight-lines connecting roosts and foraging areas within the Survey Area;
- gain further information on habitat use and roosting locations within a primary focus on barbastelle *Barbastella barbastellus* and, in addition, to gather additional knowledge, where possible, on other species which form the woodland bat assemblage (including Daubenton's bat *Myotis daubentonii*, Natterer's bat *Myotis nattereri*, brown long-eared bat *Plecotus auritus* and noctule *Nyctalus noctula*) across the defined Survey Area;
- radio-track key individuals (selecting females, specifically breeding females, in preference to male bats), using the Survey Area to locate breeding colonies of barbastelle and as a secondary objective, other tree-roosting bats, and determine activity patterns and habitat use;
- determine the Core Sustainment Zones (CSZs) and home ranges of radio-tracked bats. A CSZ refers to the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the resilience and conservation status of the colony using the roost;
- investigate the current local presence of barbastelle within the Survey Area in the early maternity period (May and June 2021) and late maternity period (August 2021);



- gain further information on the extent of each of the colonies of barbastelle and interactions between them to better understand the potential impacts of the Scheme to inform mitigation options; and
- evaluate the behavioural data obtained on barbastelle bats within the Survey Area compared to behavioural data on colonies of barbastelle bats within other areas of the UK.

1.1.2 This report builds on previous work undertaken in 2019 to further inform the Environmental Impact Assessment for the scheme (WSP, 2020).

1.1.3 We have included a summary of key information shown in this document in an accessible format. However, some users may not be able to access all technical details. If you require this document in a more accessible format please contact norwichwesternlink@norfolk.gov.uk.



Norfolk County Council

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2021 Bat Radio Tracking Survey Report





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2021 Bat Radio Tracking Survey Report

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1 Introduction

- 1.1.1. The Norwich Western Link Road (NWL) is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.
- 1.1.2. The NWL, hereafter referred to as the Scheme, will comprise:
 - Dualling the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 400m to the northwest.
 - Construction of a new roundabout.
 - Constructing a dual carriageway link from the new roundabout to a new junction with the A47 near Honingham.
- 1.1.3. As part of a separate planned scheme, National Highways proposes to realign and dual the A47 from the existing roundabout at Easton to join the existing dual carriageway section at North Tuddenham. If that scheme proceeds, it is expected that National Highways will construct the Honingham junction and the Norwich Western Link will connect to the north-eastern side of that junction.
- 1.1.4. The Scheme will cross the River Wensum and its flood plain by means of a viaduct. In addition, six other structures are proposed to cross minor roads and to provide habitat connectivity. The Scheme will include ancillary works such as provision for non-motorised users, necessary realignment of the local road network, including the stopping up of some minor roads, and the provision of environmental mitigation measures.

1.2 Ecological background

- 1.2.1. Baseline bat surveys were undertaken in 2019 to inform the route optioneering process (WSP UK Ltd, 2020). This included ground level tree assessments (GLTAs), bat activity surveys, bat radio-tracking and bat hibernation surveys.
- 1.2.2. Following selection of the Scheme (Route C) and further consultation, the methodology and Survey Area was refined to provide a complete data set to inform appropriate mitigation measures for the Scheme. Survey data from 2020 is reported in an interim bat survey report (WSP UK Ltd, 2021). This technical report presents the methods and results of bat-trapping and radio-tracking undertaken in 2021 and should be read in conjunction with the bat roost report (WSP UK Ltd, 2022a) and bat activity report (WSP UK Ltd, 2022b) which together capture the results of surveys completed between 2019-2021 to inform the Scheme.
- 1.2.3. Bat surveys have also been completed in association with the separate planned scheme to realign and dual the A47 to the south of the Scheme, and construction of the Northern Broadway to the north-east of the Scheme. Data gathered by third parties is cross-referenced as appropriate within this report; specifically, the results of radio-tracking surveys is considered during interpretation of the 2021 data (Mott Macdonald, 2020, Greena Ecological Consultancy, 2013a and 2013b, and BSG, 2010). Additional third-party data that

is not available in the public domain has been requested, however this has not yet been received.

1.3 Brief and objectives

- 1.3.1. This bat-trapping and radio-tracking report was commissioned by WSP UK Ltd on behalf of Norfolk County Council to:
- provide further up-to-date information to determine the importance of the defined Survey Area for bats by locating bat roosts, identifying foraging areas related to key roost sites (including those used for breeding), and identifying flight-lines connecting roosts and foraging areas within the Survey Area;
 - gain further information on habitat use and roosting locations within a primary focus on barbastelle *Barbastella barbastellus* and, in addition, to gather additional knowledge, where possible, on other species which form the woodland bat assemblage (including Daubenton's bat *Myotis daubentonii*, Natterer's bat *Myotis nattereri*, brown long-eared bat *Plecotus auritus* and noctule *Nyctalus noctula*) across the defined Survey Area;
 - radio-track key individuals (selecting females, specifically breeding females, in preference to male bats), using the Survey Area to locate breeding colonies of barbastelle and as a secondary objective, other tree-roosting bats, and determine activity patterns and habitat use;
 - determine the Core Sustainance Zones (CSZs) and home ranges of radio-tracked bats. A CSZ refers to the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the resilience and conservation status of the colony using the roost;
 - investigate the current local presence of barbastelle within the Survey Area in the early maternity period (May and June 2021) and late maternity period (August 2021);
 - gain further information on the extent of each of the colonies of barbastelle and interactions between them to better understand the potential impacts of the Scheme to inform mitigation options; and
 - evaluate the behavioural data obtained on barbastelle bats within the Survey Area compared to behavioural data on colonies of barbastelle bats within other areas of the UK.
- 1.3.2. This report builds on previous work undertaken in 2019 to further inform the Environmental Impact Assessment for the scheme (WSP, 2020).

1.4 Survey Areas

- 1.4.1. Acknowledging the good practice guidelines (Collins, 2016), trapping and tracking locations were based on the ecology of the target species, known roost locations and habitats with suitability to the support these species. The 'Survey Area' covers approximately 5.5 km east to west and 6 km north and south, encompassing the scheme, which is linked to suitable habitats and land subject to access agreements. However, search radii were on occasion extended where possible, on publicly accessible land. The main area of bat trapping and



radio-tracking were undertaken within this Survey Area. Appendix A shows a map of the Survey Area.

- 1.4.2. The Scheme starts at the A1067 Fakenham Road in the north and travels in a south-westerly direction crossing the River Wensum (SAC & SSSI), and links to the A47 in the south, via a new junction at Wood Lane (B1535). The latter forms part of Highways England's plan to dual the A47 between North Tuddenham and Easton.

2 Methods

2.1 Overview

- 2.1.1. Bat-trapping and radio-tracking surveys were undertaken within the Survey Area. Where bats flew outside the Survey Area, they were tracked where access was available i.e. largely from public highways and public rights of way. Surveys were targeted to capture and radio-tag female barbastelles, with trapping effort focussed on the maternity period (late May to early June) and late maternity period (August).

2.2 Desk study

- 2.2.1. A review of the bat radio-tracking surveys completed in 2019 to inform the Scheme has been undertaken to inform the 2021 surveys (WSP UK Ltd 2020 – Appendix F Bat Survey Report 2019). Another report referred to with regards to barbastelles and bat trapping included the Norwich Northern Distributor Road; Post Construction Barbastelle Bat radio-tracking monitoring report: Year 1 2018 (Mott Macdonald, 2020).

2.3 Bat trapping

- 2.3.1. Bat-trapping and radio-tracking survey work targeted barbastelle species and other species of the woodland bat assemblage: Natterer's, Daubenton's and brown long-eared bats.
- 2.3.2. All bats were caught, handled and radio-tagged under Natural England project licence 2021-52179-SCI-SCI issued to named ecologist who holds Level 3 and 4 bat survey class licences and is a registered consultant for the Bat Mitigation Class Licence. The named ecologist has held several Science & Conservation Project Licences (covering trapping methods and radio-tagging).
- 2.3.3. Six bat ecologists were listed as accredited agents under the licence (considered to have sufficient knowledge and expertise to act in accordance with the licence conditions).
- 2.3.4. Bat trapping surveys were led by staff with Level 3 (mist-net) and/or Level 4 (harp-trap) licensed bat surveyors. Level 2 and Level 4 licensed surveyors also assisted with the surveys.
- 2.3.5. Trapping surveys were undertaken in eight locations on and adjacent to the Scheme within the Survey Area. Trapping locations for each session are provided in Appendix A and Table 2-1. Survey locations were chosen which had suitable bat habitat and historically high bat activity and/or roosts had been identified nearby. These trapping locations were subject to a ground-truthing assessment prior to commencement of trapping.
- 2.3.6. Trapping surveys were carried out by two teams on each night during each of the following sessions:
- 16 – 18th May 2021, in five locations: 18th: Primrose Grove, Roarr! Dinosaur Park; 17th: Roarr! Dinosaur Park, Rose Carr; 16th: Long Plantation, Royal Norwich Golf Course.

- 9th -12th June 2021 – all eight locations.
- 9th -12th August 2021 – all eight locations.

2.3.7. A total of three nights trapping by each of the two teams were undertaken in May, and four nights by two teams in June and August.

Table 2-1 – Trapping locations and survey nights in 2021

Location	Site Name	Eastings	Northings	Survey Month May	Survey Month June	Survey Month August	Total
1	Roarr! Dinosaur Park	610640	317414	2	1	1	4
2	Royal Norwich Golf Course	611742	317239	2	1	1	4
3	Long Plantation	612647	315253	1	1	1	3
4	Rose Carr	613427	315334	1	1	1	3
5	Primrose Grove	613235	314815		1	1	2
6	Foxburrow Plantation	610407	313532		1	1	2
7	The Broadway	610407	313532		1	1	2
8	Telegraph hill	611724	313428		1	1	2
Totals	Trapping nights total (two teams, one location each per night)	Not Applicable	Not Applicable	6	8	8	22
Total	Actual nights	Not applicable	Not Applicable	3	4	4	11

2.3.8. Trapping surveys commenced at sunset and continued for at least six hours. Trapping was terminated early if the weather became unsuitable, i.e., temperatures below 8°C or if there was heavy wind or rain. In May the weather was wet and windy, and surveys were terminated early on the 17th and 18th due to rain and the final fourth night was cancelled as a result.

- 2.3.9. Trapping surveys were carried out using Faunatech Austbat Harp Traps (double and triple bank) and Ecotone microfilament mist nets (single, double and triple height ranging from 3-12m in length).
- 2.3.10. The locations for the placement of traps were selected based on the presence of habitat features commonly used by commuting and/or foraging bats including woodland habitat, hedgerows and watercourses.
- 2.3.11. Sussex Autobat acoustic lures were used to increase the likelihood of catching bats within the Survey Area. The acoustic lure simulates a variety of bat social calls. Simulations of barbastelle and Bechstein's, Daubenton's, Natterer's, and brown long-eared bats were used. A maximum of two lures were used at any one location on one evening. Lures were not placed within 50m of known bat roosts in accordance with licence conditions.
- 2.3.12. The bats captured in the traps were removed by a suitably qualified person, under the direction of one of the persons named under the Natural England survey licence and transferred to a clean cloth bag.
- 2.3.13. Bats captured were identified to species and processed as soon as practicable after capture. Biometric data was collected wherever possible, including sex, weight (using a Pesola light-line spring-scale), forearm length (using digital callipers), reproductive status, and any other general health observations. The time of capture, person who extracted the bat from the trap, trap location and ring number or tag frequency (where applicable) were also recorded.
- 2.3.14. Bats selected for radio-tagging were retained, to have a radio-transmitter attached and were released at the site of capture after processing. All other bats were safely released immediately, near the site of capture.
- 2.3.15. Female bats (specifically reproductive females) were selected for radio-tagging in preference to male bats, as tracking breeding females enables the identification of maternity roosts which are of higher conservation significance, than other roost types used by bats in the active season. Bats were selected so that the radio-tag comprised no more than 5% of the total weight of the bat. Bats which were in the advanced stages of pregnancy were not selected for radio-tracking.

2.4 Ringing

- 2.4.1. Each bat radio-tagged was ringed under licence. All barbastelles radio-tagged were ringed (recently volant bats were not ringed) and a 2.9mm metal ring fitted to their forearm. Each ring has a unique serial number and the inscription 'London Zoo' (London Zoo has an arrangement to notify the Bat Conservation Trust of any ring or number sent in). The use of rings allowed the project team to avoid tagging any bat twice in one season should it be recaptured.

- 2.4.2. All ring numbers were shared with the other project licence holder working in the Survey Area during the same survey period so that both parties could avoid tagging the same bat twice in the season.
- 2.4.3. Where a ringed bat was recaptured, biometric data including the ring number was recorded before the bat was released. Ringing data was provided to the local researcher working under a Natural England licence within the Survey Area during 2021 (Natural England Reference Number: 2020-50066-SCI-SCI). This data feeds into the local barbastelle monitoring project and will enable future data comparison and monitoring of local colony movements.

2.5 Bat radio-tracking

- 2.5.1. Bats captured and selected for tagging had their fur clipped between the shoulder blades. Transmitters (Lotek® pico and nano tags) were attached to each bat using an adhesive (Skin-Bond® Pfizer Inc). Each radio-tagged bat was assigned a unique identification number associated with the radiofrequency of the transmitter attached to it. This frequency was programmed into the radio-receivers carried by the radio-tracking teams.
- 2.5.2. Bats fitted with radio-transmitters were released on the same night of capture near the capture site. Bats were radio-tracked immediately after release, but the data was not included in the analysis, to avoid recording atypical behaviour (caused by the immediate experience of being captured and having a transmitter fitted). On subsequent survey nights, bats were tracked from the time they emerged from their roosts until they returned to roost or until the transmitter signal was lost. A daytime roost search team located the tagged bats, which, in turn, enabled an emergence survey to be undertaken to ascertain the colony size and also (see Bat Emergence Surveys section) to identify the features used by the radio-tagged bats as flight-lines to commute between roosting locations and foraging habitat.
- 2.5.3. Bats were radio-tracked using a Biotrack® 'Sika' radio receiver and a combination of Yagi 3-element antenna and car-mounted antenna. To determine the position of radio-tagged bats during the day (daytime roost location) and night (commuting and foraging locations), bats were radio-tracked on foot and by car by a minimum of two surveyors in each team.
- 2.5.4. The position of radio-tagged bats was determined by two methods: triangulation and close-approach.
 - Triangulation required a minimum of two radio-tracking teams in different locations taking simultaneous bearings (paired bearings) at regular intervals from the direction of the strongest signal of the bat. Notes were made of the compass bearing of the direction of the strongest signal to identify the location of each bat at a given time (termed as a fix). The point where the two separate teams' bearings crossed determined the location of the fix; and
 - the close-approach method required the radio-tracking team to follow an individual bat and maintain close contact to enable observations of its behaviour and use of habitat when close contact to be made.

- 2.5.5. The following information was recorded during each bat position recording taken and observation made during the radio-tracking survey:
- time;
 - signal strength;
 - compass bearing;
 - GPS coordinates;
 - description of bat behaviour (where possible); and
 - weather conditions.
- 2.5.6. Each bat was radio-tracked for up to five sequential nights (depending on the length of time contact was received). This enabled an estimate of flight-lines, home ranges, core and peripheral foraging areas within the home range, and roost locations to be identified. This was undertaken using the following techniques:
- The positions of the radio-tagged bat at intervals after leaving its roost were used to identify flight-lines between roost and foraging areas.
 - The data from each night of radio-tracking was added to a cumulative database for each bat and used to estimate its home range, flight-lines, and foraging areas (see Section 2.7).
 - Emergence surveys were undertaken at day-roost locations to confirm the number of bats emerging from the roost (see Section 2.6).
- 2.5.7. The number of surveyors and dates for daytime roost searches and radio-tracking surveys are provided in Appendix E.

2.6 Roost counts

- 2.6.1. Where bat roost locations were identified during radio-tracking surveys, these roosts were subject to dusk emergence surveys, where access permitted.
- 2.6.2. Canon XA-20 or Canon XA-30 video recorders with the assistance of infra-red lighting and / or FLIR T1020 thermal cameras paired with Elekon Batlogger M real-time bat detectors were used to record the number of bats that emerged from the roost.
- 2.6.3. Dusk emergence surveys commenced approximately 15 minutes before sunset and continued for approximately 90 minutes after sunset. No surveys were stopped earlier than 30 minutes after the last bat emergence was recorded, to ensure any late emergences were recorded.
- 2.6.4. Surveyors used a Biotrack 'Sika' radio receiver and Yagi 3-element antenna to identify when radio-tagged bats had emerged from their respective roosts. The time and the direction in which the radio-tagged bats flew after emerging was communicated to the other radio-tracking teams via radios to allow the bats commuting flight-lines to be determined.
- 2.6.5. Video and sound recordings were subject to post-survey analysis by suitably qualified bat ecologists. Videos were examined using VideoLan VLC media player to confirm the number of bats (if any) that emerged from the videoed location. Bat echolocation sound files were

subsequently analysed using Elekon BatExplorer or Wildlife Acoustics Kaleidoscope Pro computer software, which facilitates species identification.

2.7 Roost monitoring

- 2.7.1. Any roosts identified within the Scheme boundary during the radio-tracking surveys were then subject to follow-up monitoring roost surveys to obtain further data on roost characterisation. This applied to a single roost (R13) which was identified during the June surveys. Monitoring surveys consisted of dusk emergence surveys, which were undertaken each week for a period of four weeks, where access permitted, following the completion of the June survey. Roost monitoring surveys were undertaken in line with the methodology for dusk emergence surveys outlined in Section 2.6 above.

2.8 Home range analysis

- 2.8.1. The Core Sustenance Zones (CSZs) and home ranges of radio-tracked bats, trapped and tracked to inform this Scheme, were determined. A CSZ refers to the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the resilience and conservation status of the colony using the roost (BCT, 2016).
- 2.8.2. CSZs were calculated by recording the mean-maximum foraging radius of each bat. The mean-maximum foraging radius comprised the maximum distance travelled by each bat across all nights of the study, averaged across all bats. CSZs were calculated for the Primrose Grove, Royal Norwich Golf Course and Roarr! Dinosaur Park barbastelle colonies only. This is due to the paucity of data for the Broadway / Telegraph Hill barbastelle colony and the brown long-eared bats, Daubenton's bats and Natterer's bats radio-tagged during the study. CSZs were calculated using the maximum foraging radius from communal roosts only, i.e. roosts where >2 bats were recorded emerging during roost count surveys and / or where multiple radio-tagged bats were present within a roost.
- 2.8.3. A home range is the area in which an animal lives and moves on a periodic basis and is the region that contains the resources the animal requires to survive and reproduce (note that home ranges may differ between seasons and may be geographically distinct, particularly between summer and winter). Home range analysis provides data on the entire home range area and the core foraging area of radio-tracked bats during the 'bat-active' period.
- 2.8.4. Home range analysis uses 'fixes' of the location of each radio-tagged bat (collected as explained in Section 2.5) at a certain point in time. Fixes were analysed using the software package LOAS (version 2.12, Ecological Software Solutions). This software was used when fixes were obtained using triangulation.
- 2.8.5. These were subsequently recorded in a database along with the approximate bat locations obtained using the close-approach method and, the combination of all fixes were subsequently analysed using BIOTAS (version 2.0 Alpha, Ecological Software Solutions).

The results of the home range analysis were then imported into QGIS (version 3.10) to produce a visual representation of the calculated ranges.

- 2.8.6. Two methods were used to estimate the home ranges of radio-tracked bats. The first was 100% Minimum Convex Polygon (100% MCP), which provides the maximum home range. This connects the outermost points of mapped locations so that the sum of linkage distances between edge points is minimised. 100% MCP is very sensitive to outliers and requires large data sets for accurate estimations for home range size (Powell, 2000). This method does not provide information regarding how an animal uses its home range (Harris et al., 1990).
- 2.8.7. The second method, Kernel Density Estimation (KDE), is a probabilistic approach to home range estimators where the density of fixes is estimated throughout the area used by the animal. Kernel Density Estimation is a non-parametric estimator that describes home ranges by means of hierarchical probabilities for the intensity of habitat utilisation, termed isopleths. A series of isopleths can be plotted around the smallest area where the cumulative probability reaches a particular value. For example, the 95% isopleth encompasses the area where the probability of finding an animal is 95%, and the 50% isopleth encompasses the area where the probability of finding an animal is 50%.
- 2.8.8. Core areas (50% isopleths) are useful considerations when investigating patterns of behaviour or identifying particular resources. As per the standard approach, the 95% isopleth (median value) was taken as an indicator of the peripheral foraging area.
- 2.8.9. Individual fixes, MCP, 95% KDE and 50% KDE were plotted onto an OS map to produce a visual representation of the home range of each radio-tracked bat (see Appendix C, Figures C1-6).

2.9 Notes and limitations

- 2.9.1. Every effort has been made to provide a comprehensive set of survey data. However, the following notes and limitations apply to the surveys described above:

Trapping Surveys

- Adverse weather conditions in the May session (heavy wind and rain) meant that the trapping surveys had to be cut short by one night. Surveys on 17th and 18th were impacted by rain and were terminated early as a result. This was compensated for by the addition of a June survey session (through a licence modification agreed with Natural England) to ensure sufficient data were gathered in both the pre-maternity and post-maternity seasons.
- Survey work in May did not include all eight trapping locations within the Survey Area. Due to the curtailed survey effort, it was considered important to concentrate on the areas of known barbastelle hotspots in the north of the project area, to increase the likelihood of trapping a barbastelle bat suitable for tagging.

- Biometric data was not obtained for all individuals trapped, for several reasons to do with bat welfare. If a bat was stressed and not the target species, then it was released as soon as possible. Where there were a high number of bats to process and the temperature and weather were inclement, non-target species were similarly released without measurements being undertaken to avoid prolonged periods in human care. However, all radio-tagged bats were subject to full biometric sampling.
- Some pipistrelles were recorded as ‘Pipistrellus sp.’ rather than being assigned to species, either because they displayed features consistent with both common and soprano bats and proved hard to separate, or due to bat welfare reasons (including pregnancy) to reduce time in the hand.
- Surveys were timed in liaison with Natural England and other research project licence holders who were simultaneously working in the same Survey Area, on the same population of bats. Licence conditions outlined protocols which included data-sharing with third-party ecologists. Data to be shared included known roost locations (to avoid use of acoustic lures near roosts); sharing tag frequencies; communicating details of bats tagged every day as the project progressed; and dividing the project area to ensure that both parties were able to work with no overlap at any one time. This was to avoid double-handling bats and maintain bat welfare standards.
- The location of known roosts within the area was limited to historic data (Mott Macdonald, 2020), bats radio-tagged under the project licenses (WSP UK Ltd 2020 – Appendix F Bat Survey Report 2019), and other surveys completed to inform the Scheme assessment (WSP UK Ltd, 2020; 2021).
- Trap locations varied slightly between months due to access or health and safety issues. Grid references therefore differ slightly from locations surveyed in July and August 2020. However, the same woodland blocks / habitats were surveyed, and this is not considered to be a significant limitation to the study.
- Trap locations used during each survey session were maintained as much as possible in the same spots, however, where the traps could be sited in better habitat in later survey months, the traps were relocated, within the broad trapping area.

Radio-tracking and tagging

- All bat species, and particularly barbastelle bats, are highly mobile and use a variety of roost sites, commuting routes and foraging areas throughout the year. The survey effort outlined in this report gives a snapshot in time of the bat’s life cycle, based on a sampling effort considered appropriate for obtaining information on roost location, in line with best practice guidelines (Collins, 2016), flight-lines and foraging areas within the early maternity period (May and June) and late season (August). These methods do not provide a complete picture bat activity outside of these survey periods. However, the results of the surveys reported here, in combination with other surveys conducted to inform the scheme, provide a robust understanding of the use of the Survey Area by bat species.

- No barbastelle bats were trapped or radio-tagged in the May session; this was likely to have resulted from a late start in the bat active season due to poor spring weather, in combination with the curtailed trapping effort. As noted above, an extra survey session in June was undertaken to compensate for the lack of data on radio-tracked bats in May.
- All bats that were radio-tagged were ringed or their ring number noted if they had previously been ringed. One tagged brown long-eared bat (bat 4) was not ringed in June due to welfare reasons.
- The positions of the radio-tagged bats were received at intervals after leaving the roost and this information was used to plot flight-lines between the roost and foraging areas. Therefore, flight-lines and foraging areas were partially estimated based on the best available data. This could potentially result in areas not being identified as core foraging area or flight-lines, however, it is considered that the risk is small, given an understanding of bat behavioural ecology and reasonable assumptions that can be made on flight direction and likely use of landscape features.
- Due to licensing requirements, best practice and pressures on the extant bat population, only a percentage of each colony and the overall population were radio-tagged. Therefore, the conclusions within this report are limited to the behaviour exhibited by these individuals and not the whole populations of each of the colonies.

Roost Surveys

- Access was not possible to all survey locations (including roost sites) to undertake emergence surveys across all months. This is considered a limitation, as data could not be obtained on these nights, and roost counts for tagged bats could not be undertaken. However, approximate roost locations were established from as close to the roost as possible.
- The exact location of roosting features could not always be identified during emergence surveys due to the cluttered nature of the woodland and/or the roost feature being obscured by branches from ground level. In these cases, an accurate roost count could not be obtained and, therefore, the roost was characterised using the reproductive status of the radio-tagged bat.

3 Results

3.1 Overview

- 3.1.1. Bat trapping undertaken in May and June, and August 2021 over 11 trapping nights in eight locations caught a total of 309 bats of seven species. A total of 27 bats were radio-tagged including four species, barbastelle, Natterer's bat, Daubenton's bat and brown long-eared bat, of which 22 were barbastelles.
- 3.1.2. A total of 38 bat roosts were located of which 26 were verified through emergence surveys. Most roosts were recorded in trees, however, one roost, a brown long-eared bat roost (R8) was in a residential bungalow.
- 3.1.3. The highest roost count was a Daubenton's bat roost (R6) with a count of 50 bats located in Royal Norwich Golf Course on 18 May 2021. The highest recorded roost count of 21 barbastelles was recorded in Primrose Grove (R10) on 12 June 2021 and three tagged bats 5, 6 & 7 were all recorded roosting together in this location. The highest roost count of Natterer's bat was 10 bats in Morton Plantation (R4 & R5 on 18 and 20 May respectively). The highest roost count for brown long-eared bat was in a bungalow (R8) off Broadway on 10 June 2021, when 20 bats were recorded emerging.

3.2 Desk study

- 3.2.1. Extensive pre-construction surveys bat surveys (2009 - 2013) undertaken to inform the Norwich Northern Distributor Road identified barbastelle 'hot spots' (roost clusters and home ranges) in the Morton, Felthorpe and Rackheath areas as also described in the post-construction monitoring (Mott Macdonald, 2020).
- 3.2.2. Bat trapping surveys were undertaken between 19-30 May 2019 to inform the Scheme designs (WSP, 2020). The 2019 surveys confirmed previous findings that an extant barbastelle maternity population occurred within the Morton area associated with the Royal Norwich Golf Course and the Roarr! Dinosaur Park in the north-west of the Survey Area. Additionally, this survey identified a second area in the south of the Survey Area which supports a cluster of barbastelle roosts, in woodland close to The Broadway (WSP, 2020).

3.3 Bat trapping

- 3.3.1. A total of 309 bats of seven species were captured over 11 trapping nights (with two teams each night) in May, June and August 2021. Three of these, two Daubenton's bat and one soprano pipistrelle, were recaptured the same night, giving an overall total of 306 individuals. Appendix A shows the trapping locations; Table 3.1 below shows the numbers of bats caught by species.

Table 3-1 – Number of bats caught by species

Species	Number of bats	Percentage of total
Barbastelle	35	11%
Brown long-eared bat	30	10%
Common pipistrelle	83	27%
Soprano pipistrelle	65	21%
<i>Pipistrelle</i> spp.	6	2%
Daubenton's bat	31	10%
Natterer's bat	37	12%
Noctule	22	7%
Grand Total	309	100%

- 3.3.2. A total of 35 barbastelle bats were caught (25 females, 10 male) at seven of the eight locations surveyed. Barbastelles were not trapped at The Broadway. No barbastelles were caught in May. Table 3-3 Table 3-2 summarises the results by location and species trapped. The highest number of barbastelles trapped in one night was 10, trapped in August at Roarr! Dinosaur Park, with the second highest (seven bats) being trapped in June at the Royal Norwich Golf Course which adjoins Roarr! Dinosaur Park.
- 3.3.3. Trapping effort per site differed as detailed in Table 2-1 and thus any comparisons between the overall number of bats captured at any one site must take this into account (see mean bats per trap night, set out in Table 3-3).
- 3.3.4. The highest average number of bats caught of all species was at the Royal Norwich Golf Course (mean of 25 bats per trap-night) followed by Roarr! Dinosaur Park/Rose Carr (each a mean of 15) and then Primrose Grove (mean 14). This aligns with the highest number of bats trapped on any one night: 46 (all species combined) at the Royal Norwich Golf Course on 11th August. The least successful night resulted in no bats trapped (Broadway, 9th August), which would not appear to be due to trap location nor weather as bats were trapped on that night in other locations and bats had been trapped at this location previously.
- 3.3.5. Of the 35 barbastelle bats captured, 22 were fitted with radio tags, 10 in June and 12 in August 2021.



Table 3-2 – Bats caught per location

Site number	Site Name	Month	Date	B. barb	P. aur	P.pip	P.pyg	Pip. Sp	M. daub	M. natt	N. noc	TOTAL
1	Roarr! Dinosaur Park	May	17/05/2021			4	7		5			16
1	Roarr! Dinosaur Park	May	18/05/2021			3	1					4
1	Roarr! Dinosaur Park	June	11/06/2021	1		3	1	4	3	1	2	15
1	Roarr! Dinosaur Park	Aug	12/08/2021	10		2	3	1	5	2		23
2	Royal Norwich Golf Course	May	16/05/2021			7	5		5	2		19
2	Royal Norwich Golf Course	May	18/05/2021			1	2		1			4
2	Royal Norwich Golf Course	June	12/06/2021	7	2		3				4	16
2	Royal Norwich Golf Course	August	11/08/2021	4	7	6	7	1	8	3	10	46
3	Long Plantation	May	16/05/2021							1		1
3	Long Plantation	June	11/06/2021	1	5	9	7				3	25
3	Long Plantation	August	12/08/2021	1	1	5	1					8
4	Rose Carr	May	17/05/2021			1				2		3
4	Rose Carr	June	12/06/2021			4				2		6
4	Rose Carr	August	11/08/2021	4	2	6	9		2	12		35
5	Primrose Grove	May										



Site number	Site Name	Month	Date	B. barb	P. aur	P.pip	P.pyg	Pip. Sp	M. daub	M. natt	N. noc	TOTAL
5	Primrose Grove	June	10/06/2021	4	2	5	4		1	2	1	19
5	Primrose Grove	Aug	10/08/2021	1		1	4		1	2		9
6	Foxburrow Plantation	May										0
6	Foxburrow Plantation	June	09/06/2021		2	4	1					7
6	Foxburrow Plantation	Aug	09/08/2021	1	2	8				4		15
7	The Broadway	May										0
7	The Broadway	June	09/06/2021		2	6	2			1		11
7	The Broadway	Aug	09/08/2021	0	0	0	0	0	0	0	0	0
8	Telegraph Hill	May										0
8	Telegraph Hill	June	10/06/2021	1	2	6	4			2	1	16
8	Telegraph Hill	Aug	10/08/2021		3	2	4			1	1	11
				35	30	83	65	6	31	37	22	309

B.bar = *Barbastella barbastellus* (barbastelle), P.aur = *Plecotus auritus* (brown long-eared bat), P.pip = *Pipistrellus* (common pipistrelle), P.pyg = *Pipistrellus pygmaeus* (soprano pipistrelle), Pip sp. = *Pipistrellus* species, M.daub = *Myotis daubentonii* (Daubenton's bat), M.natt = *Myotis nattereri* (Natterer's bat) and N.noc = *Nyctalus noctula* (noctule).



Table 3-3 – Total bats caught per trap night in each location

Site Number	Site Name	Survey Month May	Survey Month June	Survey Month August	Total trap-nights	Total bats	Mean bats per trap-night
1	Roarr! Dinosaur Park	2	1	1	4	58	14.5
2	Royal Norwich Golf Course	2	1	1	4	100	25
3	Long Plantation	1	1	1	3	35	11.6
4	Rose Carr	1	1	1	3	44	14.6
5	Primrose Grove		1	1	2	28	14
6	Foxburrow Plantation		1	1	2	22	11
7	The Broadway		1	1	2	11	6
8	Telegraph Hill		1	1	2	11	6
	Trapping nights total (two teams, one location each per night)	6	8	8	22	309	14.6
	Actual nights	3	4	4	11		

3.4 Bat radio-tracking

3.4.1. Bat radio-tracking surveys aimed to identify roosting locations, flight-lines, and home ranges of the 27 radio-tagged bats. Radio-tagged bats are described in Table 3-4 and Table 3-5.

Table 3-4 - Number and species of radio-tagged bats

Species	Number of radio-tagged bats	Bat identification numbers
Barbastelle	22	5,6,7,8,9,10,11,12,13,14,15,17,18,19,20, 21,22,23,24,25,26 and 27
Brown long-eared bat	2	4 and 16
Daubenton's bat	2	1 and 3
Natterer's bat	1	2



Table 3-5 – Radio-tagged bats

Bat No.	Location	Date	Trap type	Time (24hr)	Species	M/F	Juv/ Ad	Breeding status	Tag no.	Ring number
1	Royal Norwich Golf Course	16/05/21	HT	00:30	M.dau	F	Ad	Pregnant	173.8140	H6066
2	Royal Norwich Golf Course	16/05/21	HT	01:30	M.natt	F	Ad	Pregnant	173.9511	H6068
3	Roarr! Dinosaur Park	17/05/21	HT	01:40	M.dau	F	Ad	Pregnant	173.9894	H6069
4	Broadway	09/06/21	HT	00:15	P.aur	F	Ad	Parous	173.8237	Not ringed
5	Primrose Grove	10/06/21	HT	21:30	B.bar	F		Parous	173.8096	J12763
6	Primrose Grove	10/06/21	HT	22:30	B.bar	F		Parous	173.8638	J12764
7	Primrose Grove	10/06/21	HT	22:50	B.bar	F		Parous	173.9638	J12765
8	Telegraph Hill	10/06/21	MN	23:45	B.bar	F	Ad	Parous	173.9212	H6070
9	Roarr! Dinosaur Park	11/06/21	HT	22:15	B.bar	F			173.9034	J12767
10	Long Plantation	11/06/21	MN	not rec	B.bar	F		Pregnant	173.8355	H5987
11	Royal Norwich Golf Course-Morton Plantation	12/06/21	HT	22:09	B.bar	F	Ad	Non-Parous	173.8026	H6088
12	Royal Norwich Golf Course-Morton Plantation	12/06/21	HT	03:30	B.bar	F	Ad	Pregnant	173.9763	H6071
13	Royal Norwich Golf Course-Morton Plantation	12/06/21	HT	03:45	B.bar	F	Ad	Pregnant	173.9338	H6072
14	Royal Norwich Golf Course-Morton Plantation	12/06/21	HT	03:50	B.bar	F	Ad	Pregnant	173.8890	H6073
15	Foxburrow Plantation	09/08/21	HT	21:35	B.bar	F	Ad	Lactating	173.9702	J3551
16	Foxburrow Plantation	09/08/21	MN	22:59	P.aur	F	Ad	Lactating	173.8887	J3552
17	Primrose Grove	10/08/21	HT	22:00	B.bar	F	Ad	Lactating	173.0855	J3542
18	Royal Norwich Golf Course	11/08/21	HT	20:50	B.bar	F	Ad	Parous	1173.690	J3543



Bat No.	Location	Date	Trap type	Time (24hr)	Species	M/F	Juv/ Ad	Breeding status	Tag no.	Ring number
19	Royal Norwich Golf Course	11/08/21	HT	21:20	B.bar	F	Ad	Post-lactating	173.0723	J3544
20	Rose Carr	11/08/21	MN	21:15	B.bar	F	Ad	Lactating	173.9325	J3553
21	Rose Carr	11/08/21	HT	21:15	B.bar	F	Ad	Parous	173.9556	J3554
22	Rose Carr	11/08/21	HT	00:45	B.bar	F	Ad	Lactating	173.1568	J3555
23	Rose Carr	11/08/21	HT	00:45	B.bar	F	Ad	Lactating	173.9903	J3552
24	Roarr! Dinosaur Park	12/08/21	HT	21:15	B.bar	F	Ad	Non-parous	173.2040	J3548
25	Roarr! Dinosaur Park	12/08/21	HT	21:15	B.bar	F	Ad	Non-parous	173.1860	J3547
26	Long Plantation	12/08/21	MN	21:30	B.bar	M	Ad	N/A	173.1454	J14961
27	Roarr! Dinosaur Park	12/08/21	HT	03:30	B.bar	F	Ad	Post-lactating	173.1293	(Existing ring J1497)

- 3.4.2. Activity recorded from individual bats within each bat species is detailed below and summarised in the context of flight-lines, roost locations and core and peripheral foraging areas. Figures C1 and C2 in Appendix A outline the barbastelle core and peripheral foraging areas, flight-lines, and roost locations. Figures C3 and C4 in Appendix A detail Natterer's bat (one individual) and Daubenton's bat (two bats) radio-tagged in May; Figures C5 and C6 in Appendix A detail the brown long-eared bats radio-tagged in June (one bat) and August (one bat) respectively.

Barbastelle

June

Bats 5, 6 and 7 Primrose Grove

Roosts

- 3.4.3. Bats 5, 6 and 7 (adult parous females) were trapped in Primrose Grove on 10 June 2021. These three bats were subsequently recorded using the same day roost in an oak tree (R9) on the southern edge of Primrose Grove on 11 June 2021. A roost emergence survey on 11 June 2021 recorded a peak count of 15 bats emerging from R9 (including the three tagged bats).
- 3.4.4. Bats 5, 6 and 7 were radio-tracked to the same roost location in a different oak tree (R10) approximately 30m to the north-east of R9. A roost emergence survey on 12 June 2021 recorded a peak count of 21 bats emerging from R10.
- 3.4.5. Bats 5 and 6 continued to roost together for the duration of the survey. On the 13 June 2021 and 14 June 2021, Bats 5 and 6 were radio-tracked back to a cluster of adjacent ivy-covered oak trees (R11, R12) on the northern edge of Primrose Grove. Roost emergence surveys of R11 and R12 proved inconclusive due to their complexity (ivy-covered). Bat 7 was radio-tracked to a separate oak tree (R14) within the same cluster as R11 and R12 on the 13 June 2021. A roost emergence survey on 13 June 2021 recorded a peak count of three bats emerging from R14.
- 3.4.6. Bats 5 and 6 were subsequently radio-tracked to an oak tree (R13) on the south-eastern edge of Rose Carr on 15 June 2021. A roost emergence survey on 15 June 2021 recorded a peak count of 18 bats emerging from R13. R13 is directly adjacent to the Scheme and as such was subject to further monitoring surveys to obtain further data on roost characterisation. The surveys, undertaken on 23 June 2021, 16 July 2021, 21 July 2021 and 4 August 2021, however, did not record any bats emerging.
- 3.4.7. Bat 7 was not located on 14 June 2021 but was subsequently recorded day roosting in an ash tree (R15) within Juniper Valley (north of the existing A1067 Fakenham Road and approximately 55m north of the Scheme boundary and 180m north of the road footprint) on 15 June 2021. A roost emergence survey that evening recorded a peak count of four bats emerging from R15. This bat may be part of the Felthorpe Colony previously identified in the NDR monitoring report (Mott Macdonald, 2020).

Foraging Areas and Flight Lines

- 3.4.8. Core foraging areas for Bat 5 were recorded within Primrose Grove within 500m of the Scheme. Core foraging areas for Bat 6 were recorded within Primrose Grove within 250m of the Scheme and over the River Wensum valley within 500m of the Scheme. Core foraging areas for Bat 7 were recorded over the River Wensum valley within 50m of the Scheme and within Primrose Grove within 500m of the Scheme.
- 3.4.9. Peripheral foraging areas for Bats 5, 6 and 7 were recorded directly over the Scheme (Primrose Grove, Rose Carr and habitats to the east of the River Wensum). In addition, these peripheral foraging areas also included a range of habitats beyond the Scheme including agricultural field, hedgerows and riparian habitats predominately to the east of the Scheme.
- 3.4.10. Flight-lines were recorded for Bat 5, 6 and 7 between Primrose Grove and the River Wensum. A flight line between the River Wensum and Juniper Valley was also recorded for Bat 7.

Bat 8 Telegraph Hill

Roosts

- 3.4.11. Bat 8 (adult parous female) was trapped in Blackbreck Plantation on 10 June 2021, and subsequently recorded day roosting in an oak tree (R16) within Ringland Covert (approximately 550m southeast from the Scheme boundary and 770m southeast from the road footprint) on 11 June 2021 and 12 June 2021. Roost emergence surveys of R16 indicated the bat was roosting alone. Bat 8 moved to a different oak tree within Ringland Covert on 13 June 2021 and 14 June 2021 (access could not be gained on these days). Bat 8 moved to a different oak tree (R18) within Ringland Covert on 15 June 2021; a roost emergence survey was undertaken but no bats were recorded, and the bat remained within the roost during the survey.

Foraging Areas and Flight Lines

- 3.4.12. Core foraging areas for Bat 8 were recorded within Blackbreck Plantation within 1km of the Scheme and to the south-east of the village of Ringland within 1.75km of the Scheme.
- 3.4.13. Peripheral foraging areas for Bat 8 were recorded within Blackbreck Plantation and Gravelpit Plantation within 0.75km of the Scheme.
- 3.4.14. No flight-lines were recorded for this bat.

Bat 9 Roarr! Dinosaur Park

Roosts

- 3.4.15. Bat 9 (adult female, breeding status not recorded) was trapped at the Roarr! Dinosaur Park on 11 June 2021. Bat 9 was subsequently recorded day roosting in a dead tree (species unknown) (R19) at the Roarr! Dinosaur Park on 12 June 2021, but the subsequent roost emergence survey was inconclusive. Bat 9 was then radio-tracked back to a sweet chestnut

(R20) at the Roarr! Dinosaur Park on 13 June 2021 (roost marked by Wildwings Ecology as Roost 002). The roost emergence survey was inconclusive. Bat 9 was subsequently radio-tracked back to a different sweet chestnut (R21) at the Roarr! Dinosaur Park on 14 June 2021, where a roost emergence survey recorded a count of 16 bats.

Foraging Areas and Flight Lines

- 3.4.16. Radio-tracking data for this bat was insufficient to create foraging areas (only one single bearing, recorded heading west out of one of the roosts). The bat was recorded west of the Survey Area and away from the Scheme.

Bat 10 Primrose Grove

- 3.4.17. Bat 10 (pregnant female) was trapped within Primrose Grove (on a ride 130m from Scheme) on 11 June 2021. This bat was not recorded again, indicating that the bat was outside the Survey Area, or the radio-tag failed.

Bats 11, 12, 13 and 14 Royal Norwich Golf Course

Roosts

- 3.4.18. Bats 11 (adult non-breeding female), 13 (adult pregnant female) and 14 (adult pregnant female) were trapped in Morton Plantation on 12 June 2021. Bat 12 (adult pregnant female) was trapped in a separate woodland on the golf course, also on 12 June 2021.
- 3.4.19. Bats 11, 13 and 14 were subsequently recorded day roosting in a dead oak tree (R22) in Morton Plantation on 13 June 2021. This roost was already marked with a Wildwings Ecology tag as Roost 041. Roost emergence surveys recorded a count of 16 bats on 13 June 2021. Bat 14 remained roosting in R22 for the duration of the tracking period. No other roosts were recorded for Bat 11. Bat 13 was radio-tracked to an oak tree (R24) in a separate woodland on the golf course on 14 June 2021 and 15 June 2021. A roost emergence survey of R24 on 14 June 2021 recorded a count of six bats.
- 3.4.20. Bat 12 was subsequently radio-tracked to an oak tree (R23) in Hardingham Hills (a woodland just to the south-east of Morton Plantation) on 14 June 2021. Roost emergence surveys did not record a count as the bat radio signal remained stationary in the roost for the rest of the survey.

Foraging Areas and Flight Lines

- 3.4.21. Core foraging areas for Bats 11, 13 and 14 were recorded within Morton Plantation and the golf course only. Peripheral foraging areas for Bats 11, 13 and 14 focussed on Morton Plantation and the golf course, but also extended north and west (River Wensum), away from the Scheme.
- 3.4.22. Core foraging areas for Bat 12 were recorded within Hardingham Hills only, approximately 90m north of the Scheme boundary where it extends northwest along Ringland Lane, but approximately 1400m northwest of the road footprint. Peripheral foraging areas for this bat were sparse but included woodland and a ditch system to the east of Hardingham Hills.

3.4.23. Flight-lines were recorded for Bats 11, 13 and 14 going north-east, south-west and west within Morton Plantation and the golf course only. Flight-lines for Bat 12 were recorded going north-east from Hardingham Hills to the River Wensum.

August

Bat 15 Telegraph Hill

Roosts

3.4.24. Bat 15 (lactating female) was trapped in Foxburrow Plantation (ride within 40m of Scheme Option) on 09 August 2021. Bat 15 was subsequently recorded day roosting in a sweet chestnut tree (R25) within Ringland Covert on 11 August 2021. A roost emergence survey recorded a count of 11 bats. Bat 15 was subsequently not recorded roosting near the Scheme until the 15 August 2021 when it was recorded back within the R25.

Foraging Areas and Flight Lines

3.4.25. Core foraging areas for Bat 15 were recorded within Blackbreck Plantation within 0.5km of the Scheme, and Ringland Covert and New Plantation / Pond Plantation within 1km of the Scheme. Peripheral foraging areas for Bat 15 were recorded directly over the Scheme.

3.4.26. Flight-lines were recorded for Bat 15 between Ringland Covert and Plantation / Pond Plantation.

Bat 17 Primrose Grove

Roosts

3.4.27. Bat 17 (lactating female) was trapped within Primrose Grove on 10 August 2021. Bat 17 was subsequently found day roosting in a tree (R29) within The Lings (plantation north of Fakenham Road) on 12 August 2021 and 13 August 2021, approximately 2250m northeast of the Scheme boundary and 2330m northeast of the road footprint (there was no access to this roost for emergence surveys). Bat 17 was subsequently radio-tracked to two separate locations (R30 and R31) within Foxburrow Plantation just off Marriott's Way. Access was restricted, so the precise locations of trees could not be identified, and emergence surveys were not possible.

Foraging Areas and Flight Lines

3.4.28. Core foraging areas for Bat 17 were recorded over the River Wensum within 0.1km of the Scheme. Peripheral foraging areas for Bat 17 were recorded directly over the scheme.

3.4.29. Flight-lines for Bat 17 were recorded over the Scheme at the River Wensum and over the Scheme between the River Wensum and Juniper Valley.

Bat 18 and 19 Royal Norwich Golf Course

Roosts

3.4.30. Bats 18 (breeding female) and 19 (post-lactating female) were trapped at the Royal Norwich Golf Course on 11 August 2021.

- 3.4.31. Both bats were found day roosting in an oak tree roost (R32) within the golf course on 12 August 2021 and 13 August 2021, and subsequently in a second roost (R33) near the gate house lodge on 14 August 2021. Four bats emerged from the R32 on 12 August 2021 (no access was available for surveys to the 'gate house' roost).

Foraging Areas and Flight Lines

- 3.4.32. These bats foraged over the River Wensum to the north of Morton Plantation and near Primrose Grove in the east of the Survey Area. Roost locations were only recorded to the west of the scheme.

Bats 20, 21, 22, 23 Woodland Block east of the Survey Area including Primrose Grove

Roosts

- 3.4.33. Primrose Grove, Rose Carr, Long Plantation and the Nursery are a complex of woodlands, which make up one woodland block within the east of the Survey Area. Bats 20, 21, 22 and 23 were all trapped in Rose Carr on 11 August 2021. All four bats were female: Bat 20 was breeding; Bat 21 was non-breeding; Bats 22 and 23 were lactating.
- 3.4.34. These bats were all found roosting together for two nights in one oak tree (R34) on the southern boundary of Primrose Grove on 12 August 2021 and 13 August 2021, with a maximum count of 17 bats recorded on 12 August 2021. R34 was approximately 550m southeast of the Scheme boundary and 630m from the road footprint. They moved to a second ivy-covered oak tree (R35) (Photograph 2 in Appendix D) within Primrose Grove on 14 August 2021 and 15 August 2021. R35 was difficult to survey but at least eight bats were recorded emerging on 14 August 2021, and three bats on 15 August 2021. None of these roosts were located within the Scheme boundary.

Foraging Areas and Flight Lines

- 3.4.35. Bat 20 and Bat 22 foraged along the flood plain of the River Wensum near and within Primrose Grove. Bat 21 foraged within Primrose Grove only and Bat 23 foraged along the River Wensum, within Primrose Grove, and south out of Primrose Grove towards Ringland and the River Wensum.

Bats 24,25, 27 Roarr! Dinosaur Park

Roosts

- 3.4.36. Bats 24, 25 and 27 were all trapped on 12 August 2021 in the Roarr! Dinosaur Park. Bats 24 and 25 were non-breeding females and 27 was a post-lactating female. All three bats were recorded roosting in a sweet chestnut tree (R37) within the Roarr! Dinosaur Park on 13 August 2021, 14 August 2021 and 15 August 2021 with a maximum recorded count of three bats.

Foraging Areas and Flight Lines

- 3.4.37. Flight-lines for these bats were recorded as follows: Bat 24 followed a flight line west from Roarr! Dinosaur Park towards River Wensum; Bat 25 travelled west from Roarr! Dinosaur

Park along the strip of wood to the north of Middle Grove; Bat 27 travelled west from Roarr! Dinosaur Park towards River Wensum, and north into the golf course.

Bat 26

Roosts

- 3.4.38. Bat 26, an adult male, was caught on 12 August 2021 in Long Plantation and recorded roosting (R37) in in the northern area of Primrose Grove. Emergence surveys of R37 on 13 August 2021 and 14 August 2021 recorded one bat emerging on each occasion.

Foraging Areas and Flight Lines

- 3.4.39. This bat foraged along the River Wensum near and within Primrose Grove.

Barbastelle Core Sustenance Zones

- 3.4.40. Primrose Grove Colony The following communal roosts presented in Table 3-6 were used to calculate the CSZ for the Primrose Grove barbastelle colony (see Table 3.7 for roost locations and descriptions).

Table 3-6 – Summary of communal barbastelle roosts for Primrose Grove Colony

Roost identifier	Bat numbers recorded using roost	Maximum foraging radius (Km)
R9	5,6,7	2.5
R10	5,6,7	2.5
R11	5,6	2.7
R12	5,6	2.7
R13	5,6	2.7
R14	7	1.9
R15	7	1.8
R34	20,21,22,23	2.6
R35	20,21,22,23	2.4
Not applicable	Mean-maximum foraging radius (CSZ)	2.6

Royal Norwich Golf Course and Roarr! Dinosaur Park Colonies

3.4.41. The following communal roosts were used to calculate the CSZ for the western barbastelle colony (see Table 3-8 for roost locations and descriptions).

Table 3-7 - Summary of communal barbastelle roosts for Royal Norwich Golf Course and Roarr! Dinosaur Park Colonies

Roost identifier	Bat numbers recorded using roost	Maximum foraging radius (Km)
R22	11,13,14	8.9
R24	13	1.1
R32	18,19	3.7
R36	24,25,27	6.9
Not applicable	Mean-maximum foraging radius (CSZ)	5.4

Daubenton’s bat

May

Bats 1 and 3

Roosts

3.4.42. Bat 1 was a Daubenton’s bat trapped at Royal Norwich Golf Course on 16 May 2021. This pregnant female bat was identified as having two roosting locations identified in Morton Plantation of which one was confirmed (R2) with a count of 21 bats on 19 May 2021. The inconclusive roost (R1) and R2 were located approximately 1070m and 1100m north of the Scheme boundary where the boundary extends northwest along Ringland Lane, but 2180m and 2370m northwest of the road footprint respectively.

3.4.43. Bat 3 was a Daubenton’s bat trapped at Roarr! Dinosaur Park on 17 May 2021 had two roosting locations in two oak trees (R6, R7), one in the Royal Norwich Golf Course and one within the Roarr! Dinosaur Park. An emergence count of the oak tree roost within the Golf Course (R6) identified a count of 50 bats on 18 May 2021, R7 had a count of seven bats on the Roarr! Dinosaur Park on 20 May 2021 and six bats on 21 May 2021.

Foraging Areas and Flight Lines

3.4.44. These two bats foraged along the floodplain of the River Wensum to the north of the A1067 Fakenham Road and with peripheral foraging within Morton Plantation, flight lines were

recorded west from the roost in Morton Plantation and northeast over the A1067 Fakenham Road to the River Wensum.

Natterer's bat

May

Bat 2

Roosts

- 3.4.45. Bat 2 was a Natterer's bat, trapped at Royal Norwich Golf Course on 16 May 2021. This pregnant female bat had three identified roosting locations in Morton Plantation (R3, R4, R5) of which a roost count of one was recorded on 17 May 2021 in R3, a count of 10 bats was recorded in roosts R4 and R5 on 18 and 20 May 2021 respectively and a count of eight bats in R5 was recorded on 21 May 2021. The three roosts were located within around 100m of each other, with the closest to the Scheme boundary (R5) being approximately 1100m north of the Scheme boundary where the boundary extends northwest along Ringland Lane, but 2340m northwest of the road footprint.

Foraging Areas and Flight Lines

- 3.4.46. Foraging areas for this bat included Morton Plantation with a flight line north over the A1067 Fakenham Road and foraging along the Rover Wensum.

Brown long-eared bat

June

Bat 4

Roosts

- 3.4.47. Bat 4 an adult breeding female brown long-eared bat was caught at the Broadway on 9 June 2021 and identified roosting in a bungalow (R8) on Telegraph Hill approximately 0.8 km east. R8 had a roost count of 20 bats on 10 June 2021.

Foraging Areas and Flight Lines

- 3.4.48. The core foraging area of this bat were within the Broadway and peripheral foraging within Foxburrow Plantation. This bat was crossing the Scheme to travel between foraging and roosting areas.

August

Bat 16

Roosts

- 3.4.49. Bat 16, a lactating female brown long-eared bat, was caught on 9 August 2021 at Foxburrow Plantation. Two roost locations (R27, R28) were identified in The Waterfence approximately 0.5km southeast of the trapping location, in the south of the Survey Area. These roosts, one in a sweet chestnut (R27) and one in an ash (R28) could not be verified

as they were in pheasant pens where no access was available. The roosts were both approximately 330m southeast of the Scheme boundary and 390m southeast from the road footprint

Foraging Areas and Flight Lines

- 3.4.50. This bat had foraging areas within Foxburrow Plantation, The Waterfence and within woodland pockets along the Broadway, through which the Scheme passes.

3.5 Roost count and emergence surveys

- 3.5.1. A total of 26 confirmed roosting locations and 13 'inconclusive' roosting locations were identified from 27 radio-tagged bats of four species: barbastelle, brown long-eared bat, Daubenton's bat and Natterer's bat. The majority were in trees; however, a brown long-eared bat maternity roost (R9) was identified in a bungalow. A summary of the roosts is provided in Table 3-8 below.
- 3.5.2. Roosts were confirmed following emergence surveys. Those labelled 'inconclusive' could not be confirmed as roosts either due to access restrictions or limited visibility during emergence surveys. Many roosts were classified as maternity roosts due to the presence of tagged pregnant, parous or lactating bats.
- 3.5.3. Emergence surveys were undertaken on the 26 confirmed roosts, the emergence counts of which are provided in Table 3-9, while photographs of some of the roost trees identified are provided in Appendix D. The highest roost count for barbastelle was in Primrose Grove on 12 June 2021 when bats 5, 6, 7 were roosting in the same tree and a total count of 21 bats was recorded emerging.



Table 3-8 – Roost Summary

Roost identifier	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint
R1	TG 12010 17265	Oak, Morton Plantation	1070m north	2180m northwest
R2	TG 11701 17340	Oak tree, Morton Plantation	1100m north	2370m northwest
R3	TG 11829 17390	Oak tree, Morton Plantation	1150m north	2390m northwest
R4	TG 11870 17433	Oak tree, Morton Plantation	1200m north	2440m northwest
R5	TG 11808 17340	Oak tree, Morton Plantation	1100m north	2340m northwest
R6	TG 10701 17793	Oak tree, Golf Course	1830m northwest	3250m northwest
R7	TG 10610 17558	Oak tree, Dinosaur Park	1700m northwest	3130m northwest
R8	TG 11655 13509	Bungalow at Telegraph Hill	300m east	490m east
R9	TG 13159 14613	Oak tree, Primrose Grove	560m southeast	715m south
R10	TG 13178 14642	Primrose Grove	570m south	605m south
R11	TG 13204 14942	Primrose Grove	280m south	300m south
R12	TG 13217 14964	Oak tree, Primrose Grove	250m south	280m south
R13	TG 13504 15265	Oak tree, Rose Carr	Within boundary	25m south



Roost identifier	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint
R14	TG 13215 14936	Primrose Grove	285m south	305m south
R15	TG 14129 15914	Juniper Valley	60m north	180m northeast
R16	TG 11842 13321	Ringland Covert	550m southeast	770m southeast
R17	TG 11868 13062	Ringland Covert	730m southeast	970m southeast
R18	TG 11888 13045	Ringland Covert	750m southeast	990m southeast
R19	TG 10569 17146	Dinosaur Park	1420m northwest	2820m northwest
R20/002	TG 10596 17153	Sweet chestnut, Dinosaur Park	1420m northwest	2820m northwest
R21	TG 10607 17164	Sweet chestnut, Dinosaur Park	1420m northwest	2820m northwest
R22/041	TG 11908 17285	Dead oak, Morton Plantation	1880m northwest	2230m northwest
R23	TG11734 16355	Oak tree, Hardingham Hills	130m north	1490m northwest
R24	TG 11579 16954	Oak tree, Morton/Golf Course	730m north	2070m northwest
R25	TG 11884 13203	West Ringland, Sweet Chestnut	650m southeast	870m southeast
R26	TG 11526 12485	Hall Hills Woodland	1180m southeast	1240m southeast



Roost identifier	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint
R27	TG 11027 13177	The Waterfence, sweet chestnut inside pheasant pen	330m southeast	390m southeast
R28	TG 10932 13191	The Waterfence, Ash Tree	330m southeast	390m southeast
R29	TG 15797 17425	The Ling's woodland	2250m northeast	2330m northeast
R30	TG 15193 16812	King William's Drive	1390m northeast	1470m northeast
R31	TG 15270 16794	Foxburrow Plantation	1430m northeast	1510m northeast
R32	TG 11585 16958	Golf Course, Oak	730m north	2070m northwest
R33	TG11946 17384	Near Gate Lodge	1180m north	2320m northwest
R34	TG 13149 14626	Primrose Grove, Oak	540m southeast	670m southeast
R35	TG 13473 14829	Primrose Grove	185m south	450m south
R36	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest
R37	TG 13486 14805	Primrose Grove	210m south	480m south

Table 3-9 – Roost and Emergence Summary

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
1	R1	Daubenton's bat	F	Pregnant	TG 12010 17265	Oak, Morton Plantation	1070m north	2180m northwest	18 May 2021	Inconclusive	Maternity
1	R2	Daubenton's bat	F	Pregnant	TG 11701 17340	Oak tree, Morton Plantation	1100m north	2370m northwest	19 May 2021	21	Maternity
2	R3	Natterer's bat	F	Pregnant	TG 11829 17390	Oak tree, Morton Plantation	1150m north	2390m northwest	17 May 2021	1	Maternity
2	R4	Natterer's bat	F	Pregnant	TG 11870 17433	Oak tree, Morton Plantation	1200m north	2440m northwest	18 May 2021	10	Maternity
2	R5	Natterer's bat	F	Pregnant	TG 11808 17340	Oak tree, Morton Plantation	1100m north	2340m northwest	20 May 2021	10	Maternity
2	R5	Natterer's bat	F	Pregnant	TG 11808 17340	Oak tree, Morton Plantation	1100m north	2340m northwest	21 May 2021	8	Maternity
3	R6	Daubenton's bat	F	Pregnant	TG 10701 17793	Golf Course	1830m northwest	3250m northwest	17 May 2021	Inconclusive	Maternity
3	R6	Daubenton's bat	F	Pregnant	TG 10701 17793	Oak tree, Golf Course	1830m northwest	3250m northwest	18 May 2021	50	Maternity
3	R7	Daubenton's bat	F	Pregnant	TG 10610 17558	Oak tree, Dinosaur Park	1700m northwest	3130m northwest	20 May 2021	7	Maternity
3	R7	Daubenton's bat	F	Pregnant	TG 10610 17558	Oak tree, Dinosaur Park	1700m northwest	3130m northwest	21 May 2021	6	Maternity
4	R8	Brown long-eared bat	F	Parous	TG 11655 13509	Bungalow at Telegraph Hill	300m east	490m east	10 June 2021	20	Maternity
5	R9	Barbastelle	F	Parous	TG 13159 14613	Oak tree, Primrose Grove	560m southeast	715m south	11 June 2021	15	Maternity

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
5	R10	Barbastelle	F	Parous	TG 13178 14642	Primrose Grove	570m south	605m south	12 June 2021	21	Maternity
5	R11	Barbastelle	F	Parous	TG 13204 14942	Primrose Grove	280m south	300m south	13 June 2021	Inconclusive – No Access	Inconclusive (Assumed Maternity)
5	R12	Barbastelle	F	Parous	TG 13217 14964	Oak tree, Primrose Grove	250m south	280m south	14 June 2021	Inconclusive – No Access	Inconclusive (Assumed Maternity)
5	R13	Barbastelle	F	Parous	TG 13504 15265	Oak tree, Rose Carr	Within boundary	25m south	15 June 2021	18	Maternity
6	R9	Barbastelle	F	Parous	TG 13159 14613	Oak tree, Primrose Grove	560m southeast	715m south	11 June 2021	15	Maternity
6	R10	Barbastelle	F	Parous	TG 13178 14642	Primrose Grove	570m south	605m south	12 June 2021	21	Maternity
6	R11	Barbastelle	F	Parous	TG 13204 14942	Primrose Grove	280m south	300m south	13 June 2021	Inconclusive	Inconclusive (Assumed Maternity)
6	R12	Barbastelle	F	Parous	TG 13217 14964	Oak tree, Primrose Grove	250m south	280m south	14 June 2021	Inconclusive	Inconclusive (Assumed Maternity)
6	R13	Barbastelle	F	Parous	TG 13504 15265	Rose Carr	Within boundary	25m south	15 June 2021	18	Maternity
7	R9	Barbastelle	F	Parous	TG 13159 14613	Oak tree, Primrose Grove	560m southeast	715m south	11 June 2021	15	Maternity
7	R10	Barbastelle	F	Parous	TG 13178 14642	Primrose Grove	570m south	605m south	12 June 2021	21	Maternity
7	R14	Barbastelle	F	Parous	TG 13215 14936	Primrose Grove	285m south	305m south	13 June 2021	3	Maternity
7	R15	Barbastelle	F	Parous	TG 14129 15914	Juniper Valley	60m north	180m northeast	15 June 2021	4	Maternity

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
8	R16	Barbastelle	F	Parous	TG 11842 13321	Ringland Covert	550m southeast	770m southeast	11 June 2021	1	Maternity
8	R17	Barbastelle	F	Parous	TG 11868 13062	Ringland Covert	730m southeast	970m southeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
8	R18	Barbastelle	F	Parous	TG 11888 13045	Ringland Covert	750m southeast	990m southeast	15 June 2021	Inconclusive	Inconclusive (Assumed Maternity)
9	R19	Barbastelle	F	Not Recorded	TG 10569 17146	Dinosaur Park	1420m northwest	2820m northwest	12 June 2021	Inconclusive	Inconclusive (Assumed Maternity)
9	R20/002	Barbastelle	F	Not Recorded	TG 10596 17153	Sweet chestnut, Dinosaur Park	1420m northwest	2820m northwest	13 June 2021	Inconclusive	Inconclusive (Assumed Maternity)
9	R21	Barbastelle	F	Not Recorded	TG 10607 17164	Sweet chestnut, Dinosaur Park	1420m northwest	2820m northwest	14 June 2021	16	Maternity
11	R22/041	Barbastelle	F	Not Recorded	TG 11908 17285	Dead oak, Morton Plantation	1880m northwest	2230m northwest	13 June 2021	16	Maternity
12	R23	Barbastelle	F	Non-Parous	TG11734 16355	Oak tree, Hardingham Hills	130m north	1490m northwest	14 June 2021	Signal stationary in roost all night	Inconclusive
13	R22/041	Barbastelle	F	Pregnant	TG 11908 17285	Dead oak, Morton Plantation	1880m northwest	2230m northwest	13 June 2021	16	Maternity
13	R24	Barbastelle	F	Pregnant	TG 11579 16954	Oak tree, Morton/Golf Course	730m north	2070m northwest	14 June 2021	6	Maternity
14	R22/041	Barbastelle	F	Pregnant	TG 11908 17285	Dead oak, Morton Plantation	1880m northwest	2230m northwest	13 June 2021	16	Maternity
15	R25	Barbastelle	F	Lactating	TG 11884 13203	West Ringland, Sweet Chestnut	650m southeast	870m southeast	11 August 2021	11	Maternity

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
15	R26	Barbastelle	F	Lactating	TG 11526 12485	Hall Hills Woodland	1180m southeast	1240m southeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
16	R27	Brown long- eared bat	F	Lactating	TG 11027 13177	The Waterfence, sweet chestnut inside pheasant pen	330m southeast	390m southeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
16	R28	Brown long- eared bat	F	Lactating	TG 10932 13191	The Waterfence, Ash Tree	330m southeast	390m southeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
17	R29	Barbastelle	F	Post Lactating	TG 15797 17425	The Ling's woodland	2250m northeast	2330m northeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
17	R30	Barbastelle	F	Post Lactating	TG 15193 16812	King William's Drive	1390m northeast	1470m northeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
17	R31	Barbastelle	F	Post Lactating	TG 15270 16794	Foxburrow Plantation	1430m northeast	1510m northeast	n/a	Inconclusive	Inconclusive (Assumed Maternity)
18	R32	Barbastelle	F	Parous	TG 11585 16958	Golf Course, Oak	730m north	2070m northwest	12 August 2021	4	Maternity
18	R33	Barbastelle	F	Parous	TG11946 17384	Near Gate Lodge	1180m north	2320m northwest	n/a	Inconclusive	Inconclusive (Assumed Maternity)
19	R32	Barbastelle	F	Parous	TG 11585 16958	Golf Course, Oak	730m north	2070m northwest	12 August 2021	4	Maternity
19	R33	Barbastelle	F	Parous	TG11946 17384	Near Gate Lodge	1180m north	2320m northwest	n/a	Inconclusive	Maternity
20	R34	Barbastelle	F	Parous	TG 13149 14626	Primrose Grove, Oak	540m southeast	670m southeast	12 August 2021	17	Maternity
20	R35	Barbastelle	F	Parous	TG 13473 14829	Primrose Grove	185m south	450m south	14 August 2021	8	Maternity
20	R35	Barbastelle	F	Parous	TG 13473 14829	Primrose Grove	185m south	450m south	15 August 2021	3	Maternity

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
21	R34	Barbastelle	F	Non-Parous	TG 13149 14626	Primrose Grove, Oak	540m southeast	670m southeast	12 August 2021	17	Maternity
21	R35	Barbastelle	F	Non-Parous	TG 13473 14829	Primrose Grove	185m south	450m south	14 August 2021	8	Maternity
21	R35	Barbastelle	F	Non-Parous	TG 13473 14829	Primrose Grove	185m south	450m south	15 August 2021	3	Maternity
22	R34	Barbastelle	F	Lactating	TG 13149 14626	Primrose Grove, Oak	540m southeast	670m southeast	12 August 2021	17	Maternity
22	R35	Barbastelle	F	Lactating	TG 13473 14829	Primrose Grove	185m south	450m south	14 August 2021	8	Maternity
22	R35	Barbastelle	F	Lactating	TG 13473 14829	Primrose Grove	185m south	450m south	15 August 2021	3	Maternity
23	R34	Barbastelle	F	Lactating	TG 13149 14626	Primrose Grove, Oak	540m southeast	670m southeast	12 August 2021	17	Maternity
23	R35	Barbastelle	F	Lactating	TG 13473 14829	Primrose Grove	185m south	450m south	14 August 2021	8	Maternity
23	R35	Barbastelle	F	Lactating	TG 13473 14829	Primrose Grove	185m south	450m south	15 August 2021	3	Maternity
24	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	13 August 2021	2	Maternity
24	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	14 August 2021	3	Maternity
24	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	15 August 2021	3	Maternity

Bat Number	Roost identifier	Species	Sex	Breeding Status	OS Grid reference	Location*	Approximate Closest Distance and Direction from Scheme boundary	Approximate Closest Distance and Direction from road footprint	Date of emergence	Count	Roost Characterisation
25	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	13 August 2021	2	Maternity
25	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	14 August 2021	3	Maternity
25	R36	Barbastelle	F	Non-Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	15 August 2021	3	Maternity
26	R37	Barbastelle	M	n/a	TG 13486 14805	Primrose Grove	210m south	480m south	13 August 2021	1	Day
27	R36	Barbastelle	F	Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut	1420m northwest	2820m northwest	13 August 2021	2	Maternity
27	R36	Barbastelle	F	Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut			14 August 2021	3	Maternity
27	R36	Barbastelle	F	Parous	TG 10586 17152	Dinosaur Park, Sweet Chestnut			15 August 2021	3	Maternity

*Golf course refers to Royal Norwich Golf Course and Dinosaur Pak refers to Roarr! Dinosaur Park. Where roost identifier is listed in blue this is a roost previously identified by WildWings Ecology.

3.5.4. Of the 22 barbastelles caught, 21 were female. Based on the trapping and recorded roost locations, the females were allocated to a colony and the total counts and percentage breakdown of those radio-tagged is presented in Table xx below. Further data on radio-tagged bats is provided within Appendix G.

Table 3-10 – Radio-tagged Barbastelle Percentage Split per Colony area

Colony	Total Radio-Tagged	Percentage
Roarr! Dinosaur Park Colony	4	19
Royal Norwich Golf Course Colony	6	29
Primrose Grove Colony	8	38
Broadway / Telegraph Hill Colony	2	10
Inconclusive (not tracked to roost) Caught within the north	1	5
Total	21	5

3.6 Flight-Lines

Barbastelle

June

3.6.1. Eight barbastelle flight-lines were identified during the June radio-tracking session (Appendix C, Figure C1). A summary of which is detailed below:

- Four flight-lines originated from Roost R22 in the Morton Plantation: two towards the River Wensum Valley wetlands to the North; one south through the plantation woodland; and one north-west over the Roarr! Dinosaur Park towards the Lenwade Belt woodland.
- A fifth flight line originated from Roost R23 in the Hardingham Hills woodland and continued north-east towards the Wensum Valley.
- Three further flight-lines were identified further east. One from west of Roost R13 in Rose Carr that followed the Wensum Valley south towards Ringland Hills woodland; two further flight-lines were recorded from Primrose Grove east towards Ringland.

August

3.6.2. In total, 11 flight-lines were identified for barbastelle bats during the August radio-tracking session (Appendix C, Figure C2). A summary of which is detailed below:

- Three flight-lines originated from Roost R36 in the Roarr! Dinosaur Park. One north-west towards the Lenwade Covert sewage works; one westward towards Middle Grove woodland; and one northwards over the Roarr! Dinosaur Park.
- Two flight-lines originated from Roost R33 at Gate Lodge, northwards over the A1067 towards the Wensum Valley; another directed west to east over the Wensum Valley.
- Two flight-lines originated in Primrose Grove. One was directed north-west through the same woodland, another south-east towards the Wensum Valley wetlands.
- One flight line originated from the Wensum Valley, north of Primrose Grove, and traced south-east across the scheme following the Wensum Valley wetlands.
- One flight line originated in Juniper Valley woodland and traced south across the A1067 towards the Wensum Valley wetlands.
- One flight line was identified from roost R25 in West Ringland and traced south towards roost R26 in Hall Hills Woodland.

Daubenton's bat

- 3.6.3. Three flight-lines were identified for the two Daubenton's bats radio-tagged in May 2021. One between Roosts R2 in Morton Plantation and R6 in Royal Norwich Golf Course, and two between Roost R2 and the peripheral foraging area over the River Wensum to the North.

Natter's Bat

- 3.6.4. Two flight-lines were identified from the single Natterer's bat tracked in May 2021. Both originated from the location of Roost R4 in Morton Plantation and continued north to the peripheral foraging area over the River Wensum to the North (Appendix C, Figure C4).

Brown long eared bat

- 3.6.5. No flight-lines were identified for the two brown long-eared bats tagged during the radio-tracking surveys, one tagged in June and one in August 2021.

3.7 Foraging areas

- 3.7.1. Radio-tagged barbastelles were recorded on both sides of the A1067, and either side of the Scheme, with flight-lines and foraging areas both extending over the current A1067 road and Scheme (Appendix C, Figures C1 & C2).
- 3.7.2. The barbastelle foraging areas corresponded with four distinct areas Morton, Felthorpe, Primrose Grove and Broadway/Telegraph Hill, located northwest, northeast, east and south of the Scheme, respectively.
- 3.7.3. The findings of the other target bat species radio-tagged (brown long-eared bat, Natterer's bat, Daubenton's bat) are based on very limited numbers of tagged bats and as such the findings indicate what the individual bats habitat usage and foraging areas are, however, further understanding of colony behaviour cannot be inferred from such low numbers of radio-tagged bats.

- 3.7.4. The two radio-tagged brown long-eared bats were recorded predominantly to the south of the scheme area around Broadway, with peripheral foraging areas extending over the Scheme.
- 3.7.5. The two radio-tagged Daubenton's bats were recorded within the wetland areas surrounding the Wensum Valley, north-west of the Scheme, associated with the Morton area of the Royal Norwich Golf Course and Roarr! Dinosaur Park. The bats were recorded crossing the current A1067 but not found to be using habitats with the Scheme or adjacent habitats.
- 3.7.6. The single radio-tagged Natterer's bat was recorded within the Morton Plantation and Wensum Valley wetlands to the north. The bat was recorded crossing the current A1067 but not found to be using the Scheme area or adjacent habitats.
- 3.7.7. Figures C1-6 in Appendix C show the roosts, foraging areas and flight-lines for the radio-tagged bats. Table F-1, Appendix F shows the core (indicated by a 'C') and peripheral (indicated by a 'P') foraging areas for the radio-tagged bats. Where an area was used as both a core and peripheral area, only the core area is shown.

4 Summary of Results

4.1 Overview

- 4.1.1. Surveys undertaken in 2021 have confirmed the presence of at least seven bat species within the Survey Area, comprising barbastelle, brown long-eared bat, common pipistrelle, soprano pipistrelle, Daubenton's bat, Natterer's bat and noctule. Of the bats radio-tagged, both barbastelle and brown long-eared bats were confirmed to be using the NWL Scheme for foraging, and barbastelle were confirmed as using the Survey Area for roosting and flight-lines.
- 4.1.2. Barbastelle is listed on Annex II of the Habitats Directive and categorised as Near Threatened on the International Union for the Conservation of Nature Red List of Threatened Species (Hutson and Paunovic, 2016). This species is identified as a Species of Principal Importance (Section 41 of the NERC Act, 2006) and regarded as very rare in the UK (Bat Conservation Trust, 2010).
- 4.1.3. The trapping surveys undertaken in 2021 support previous findings which identified that a population of barbastelle bats is located within the project area. Within the bat species assemblage, barbastelle comprised 11% of 309 bats caught.

4.2 Bat radio-tracking

Barbastelle

- 4.2.1. The data obtained in 2021 and historically indicates that there are four distinct colonies within the Survey Area, comprising:
 - Royal Norwich Golf Course Colony
 - Roarr! Dinosaur Park Colony associated with the Morton Plantation
 - Primrose Grove Colony associated with Primrose Grove, Rose Carr, The Nursery and Long Plantation
 - Broadway / Telegraph Hill Colony
- 4.2.2. Historically, a fifth distinct colony area was identified outside the 2021 Survey Area to the north at Felthorpe (the Felthorpe Colony). This has been identified through Northern Distributor Road pre-construction surveys between 2009 and 2013 (Mott Macdonald, 2020). Bat 17, which was trapped within Primrose Grove, was recorded roosting within this Felthorpe area. This may indicate a level of interaction between the Primrose Grove and Felthorpe colonies.
- 4.2.3. These colonies have been identified through a combination of bat roost fidelity, flight line locations, and core foraging areas, which show little to no cross-over between individuals of these four colonies. The Royal Norwich Golf Course Colony and Roarr! Dinosaur Park Colony at Morton and Broadway / Telegraph Hill Colony have previously been identified and noted as part of the pre-construction and post-construction monitoring surveys undertaken

to inform the construction of the Northern Distributor Road (NDR) (Mott Macdonald, 2020) and earlier 2019 radio-tracking surveys for the NWL Scheme (WSP, 2020).

Flight-Lines

- 4.2.4. A total of 19 flight-lines were identified for barbastelle during the 2021 surveys. Three of these flight-lines intersected the Scheme and scheme boundary. One was identified originating in the Wensum Valley, north of Rose Carr and the scheme. It then followed the river across the scheme and south towards Low Common and Ringland village. The other two flight-lines were focused over the Wensum Valley and intersected the proposed roundabout junction of the new proposed road and the A1067.
- 4.2.5. Additional flight-lines were identified outside the scheme boundary, predominantly around Primrose Grove, Ringland Covert and the Wensum Valley. These indicated further commuting routes in the habitats surrounding the scheme.

Foraging areas

- 4.2.6. Core barbastelle foraging areas were identified in Primrose Grove, adjacent to Scheme. However, the main barbastelle core foraging areas were identified outside the Scheme boundary during 2021.
- 4.2.7. Peripheral foraging areas were identified across the north of the Scheme, within the woodland and wetlands surrounding Primrose Grove, Rose Carr and the Wensum Valley.

Core Sustenance Zones

- 4.2.8. The CSZ for the Primrose Grove barbastelle colony was 2.4km and was smaller than the CSZ for the Royal Norwich Golf Course and Roarr! Dinosaur Park barbastelle colonies which was 5.2km. This was despite the sample size for the Primrose Grove barbastelle colony being larger.

Daubenton's bat

Flight-lines

- 4.2.9. Three Daubenton's flight-lines were identified during the June radio-tracking surveys. These were focused within the Dinosaur Park, Royal Norwich Golf Course and Wensum Valley wetlands north of the current A1067. These flight-lines are over 2km north-east of the proposed new scheme boundary.

Foraging areas

- 4.2.10. Three core foraging areas were identified for Daubenton's bats during the 2021 surveys. These are focused on the wetlands within the Wensum Valley. Peripheral foraging areas were sporadically scattered throughout the northern sections of the Wensum Valley wetland, with the nearest being approximately 1.5km north-west of the scheme boundary.

Natterer's bat

Flight-lines

- 4.2.11. Two flight-lines for Natterer's bats were identified during the 2021 radio-tracking surveys; however, only a single individual of this species was tracked. The flight-lines originated from roosts in the Morton plantation and crossed the A1067 towards the Wensum Valley wetlands.

Foraging areas

- 4.2.12. Two Natterer's bat core foraging areas were identified during 2021, based on a single individual tracked. These were focused on the Wensum Valley wetlands to the north of the A1067 and the proposed scheme boundary. Peripheral foraging areas were scattered throughout the northern sections of the Wensum Valley.

Brown long-eared bat

Flight-lines

- 4.2.13. No flight-lines used by brown long-eared bats were recorded; this may be because only two individuals of this species were radio-tracked and because the bats were recorded foraging in close proximity to their roosts.

Foraging areas

- 4.2.14. Two brown long-eared bat core foraging areas were identified in 2021. Both were located adjacent to the scheme boundary, one on The Broadway and one on Telegraph Hill. Further peripheral foraging areas were focused around the Waterfence and the Broom woodlands. These foraging areas intersect with the proposed scheme and show that brown long-eared bats are using the woodland on either side of the proposed new road as foraging habitat.

4.3 Roosts

Barbastelle

- 4.3.1. In total, 28 barbastelle tree-roosts were identified during the 2021 radio-tracking surveys (none were found in buildings). Twenty-seven of these were classified as maternity roosts due to the presence of radio-tagged breeding bats. All roosts were found in trees of oak and sweet chestnut species. One in Primrose Grove (R37) was classified as a day roost due to the presence of a single male bat. Emergence counts from these roosts ranged from 1-21 barbastelle.
- 4.3.2. One barbastelle roost (R13), located within Rose Carr woodland, is within the proposed scheme boundary and adjacent to the proposed new road. The remaining roosts were identified in woodland to the east of the scheme boundary, including Primrose Grove, Ringland Covert and Hall Hills.

- 4.3.3. Further roosts were identified north of the scheme boundary in Foxburrow plantation, Morton Plantation and the woodlands surrounding the Roarr! Dinosaur Adventure and the Royal Norwich Golf Club.

Daubenton's bat

- 4.3.4. The two Daubenton's bats tagged in May were recorded roosting in two roost locations each and bat 1 had highest roost count of 21 and bat 3 highest roost count of 50. Two were identified within trees in the Morton Plantation (R1 and R2 bat 1). The remaining two (R6 and R7, bat 3) were identified within trees in the Roarr! Dinosaur Park. Roosts R2, R6, R7 were all confirmed as maternity roosts due to the presence of breeding bats. No emergence survey was undertaken of roost R1 and therefore the roost count was not obtained.

Natterer's bat

- 4.3.5. Three roosts were identified for the single Natterer's bat during the 2021 radio-tracking surveys. All three were identified in the Morton Plantation (R3, R4 and R5). Roost R3 only had a single bat (radio-tagged bat 2) emerge. The same bat then re located to roosts R4 and R5 with emergence numbers of ten bats in each roost.

Brown long-eared bat

- 4.3.6. Three brown long-eared bat roosts were identified during the 2021 radio-tracking surveys (R8, R27 and R28). All roosts were identified outside of the proposed scheme area, but still near the scheme. One roost, R8 was located within a bungalow, the further two roosts were tree roosts within a sweet chestnut and an ash, respectively.

5 Conclusions

- 5.1.1. The Survey Area of the Proposed Norwich Western Link supports a population of the rare Annex II Barbastelle bat.
- 5.1.2. The Survey Area and Scheme currently provide core and peripheral foraging habitat for a range of bat species including woodland blocks, riparian habitats and open grassland and hedgerows.
- 5.1.3. Surveys undertaken in 2021 have identified four distinct barbastelle colonies within the Survey Area, comprising the Primrose Grove Colony; the Royal Norwich Golf Course Colony; Roarr! Dinosaur Park Colony; and Broadway / Telegraph Hill Colony.
- 5.1.4. A Core Sustenance Zone (CSZ), for bats, refers to the area surrounding a communal bat roost within which habitat availability and quality will have a significant influence on the resilience and conservation status of the colony using the roost (BCT, 2016). The published core sustenance zone for barbastelles is 6km radius around a communal roost (Collins, 2016). The CSZ of the Royal Norwich Golf Course and Roarr! Dinosaur Park barbastelle colonies at 5.4km therefore roughly correlated with the published CSZ for barbastelle. The CSZ of the Primrose Grove barbastelle colony was however much smaller at 2.4km. This is likely due to the close proximity of high-quality barbastelle foraging habitat to the communal roosts recorded during the study.
- 5.1.5. One barbastelle maternity roost (R13) with a peak count of 18 bats was identified within the scheme boundary and adjacent to the road, within an oak tree on the southern edge of Rose Carr and would be lost under current proposals. This roost is of the highest conservation significance (Mitchell-Jones, 2004).
- 5.1.6. Three barbastelle flight-lines intersected the proposed road and scheme boundary. One was in the Wensum Valley, north of Rose Carr and the proposed road. It then traced the river across the scheme and south towards Low Common and Ringland village. The other two flight-lines were focused over the Wensum Valley and intersected the proposed roundabout junction of the new proposed road and the A1067.

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