Appendix A.8.25

Bat Derogation Licence Application

A.8.25

N6 Galway City Ring Road

Bat Derogation Licence Application

September 2018

Contents

Annexes

1. Introduction

Galway County Council are submitting this application under Regulation 54 of the *European Communities (Birds and Habitats) Regulations 2011* (S.I. 477 of 2011) for a derogation licence from complying with the requirements of the provisions of Regulations 51, 52 and 53 of the same Regulations.

The application relates to specific residual impacts on bats arising from the construction and operation of the proposed N6 Galway City Ring Road, hereafter referred to as the proposed road development, and its potential impact on bat (*Chirpotera*) species.

The proposed road development, comprises the construction of approximately 5.6km of a single carriageway from the western side of Bearna Village as far as Ballymoneen Road and approximately 11.9km of dual carriageway from Ballymoneen Road to the eastern tie in with the existing N6 at Coolagh, Briarhill, and associated link roads, side roads, junctions and structures, as shown on Figure 5.1.1 to 5.1.15 of the Environmental Impact Assessment (EIA) Report. The section of the proposed road development from the tie-in with the R336 Coast Road to the N59 Letteragh Junction will be a protected road[1] and the section from this junction to the tie-in with the existing N6 at Coolagh, Briarhill will be a motorway. A full description of the proposed road development is provided in **Section 2**.

Potential impacts have been mitigated as far as possible during the design phase of the proposed road development and the residual impacts are those that cannot be ruled out despite applying best practice techniques.

This licence application will be submitted to the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht for approval, if planning approval for the proposed road development is granted by An Bord Pleanála.

The guidance that has been referred to during the preparation of the application for the derogation licence has included:

- Bat Surveys for Professional Ecologists: Good Practice Guidelines (Collins, 2016)
- Bat Mitigation Guidelines for Ireland (Kelleher & Marnell, 2006)
- Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes (NRA, 2006)
- Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. COST 341 Habitat Fragmentation due to Transportation Infrastructure. (Iuell et al, (Eds.), 2003)

[1] A protected road, as defined under Section 45 (1) of the Roads Act, means a public road or proposed public road specified to be a protected road in a protected road scheme approved by An Bord Pleanála. Section 45 (2) of the Roads Act 1993, as amended, states that a protected road scheme approved by the Minister may provide for the prohibition, closure, stopping up, removal, alteration, diversion or restriction of any specified or all means of direct access to the protected road from specified land or from specified land used for a specified purpose or to such land from the protected road.

- SafeBatPaths: Fumbling in the dark - effectiveness of bat mitigation measures on roads: Final report (Elmeros and Dekker, 2016)
- Bat mitigation measures on roads – a guideline: Fumbling in the dark – effectiveness of bat mitigation measures on roads. CEDR Transnational Road Research Programme. Conference of European Directors of Roads. (Elmeros et al, 2016)

It is noted that only activities that may give rise to offences under Regulations 51, 52 and 53 of the 2011 Regulations are within the scope of this application. There may be other potential ecological impacts of the proposed road development that are not relevant to this application and therefore are not discussed further. Other potential impacts, which are not relevant to Regulations 51, 52 and 53 of the 2011 Regulations are set out and considered in **Chapter 8, Biodiversity** of the EIA Report.

Regulation 54 of the *European Communities (Birds and Habitats) Regulations 2011* (S.I. 477 of 2011) states:

4.(1) Any person may apply to the Minister, or the Minister or Ministers of Government with responsibilities for fish species referred to in Part 2 of the First Schedule, for a derogation licence from complying with the requirements of the provisions of Regulations 51, 52 and 53.

(2) Where there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range, the Minister, or the Minister or Ministers of Government with responsibilities for fish species referred to in the Fourth Schedule, may grant such a derogation licence to one or more persons, where it is-

(a) in the interests of protecting wild fauna and flora and conserving natural habitats,

(b) to prevent serious damage, in particular to crops, livestock, forests, fisheries and water and other types of property,

(c) in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment,

(d) for the purpose of research and education, of repopulating and re-introducing these species and for the breeding operations necessary for these purposes, including the artificial propagation of plants, or

(e) to allow, under strictly supervised conditions, on a selective basis and to a limited extent, the taking or keeping of certain specimens of the species to the extent specified therein, which are referred to in the First Schedule.

(3) A derogation licence granted under paragraph (2) shall be subject to such conditions, restrictions, limitations or requirements as the Minister considers appropriate.

(4) Any conditions, restrictions, limitations or requirements to which a derogation licence under paragraph (2) is subject shall be specified therein.

(5) Without prejudice to any conditions, restrictions, limitations or requirements specified therein, a derogation licence granted under this Regulation is subject to the provisions of subsections (2) to (5) of section 14 of the Protection of Animals (Amendment) Act 1965.

This application is set out as follows:

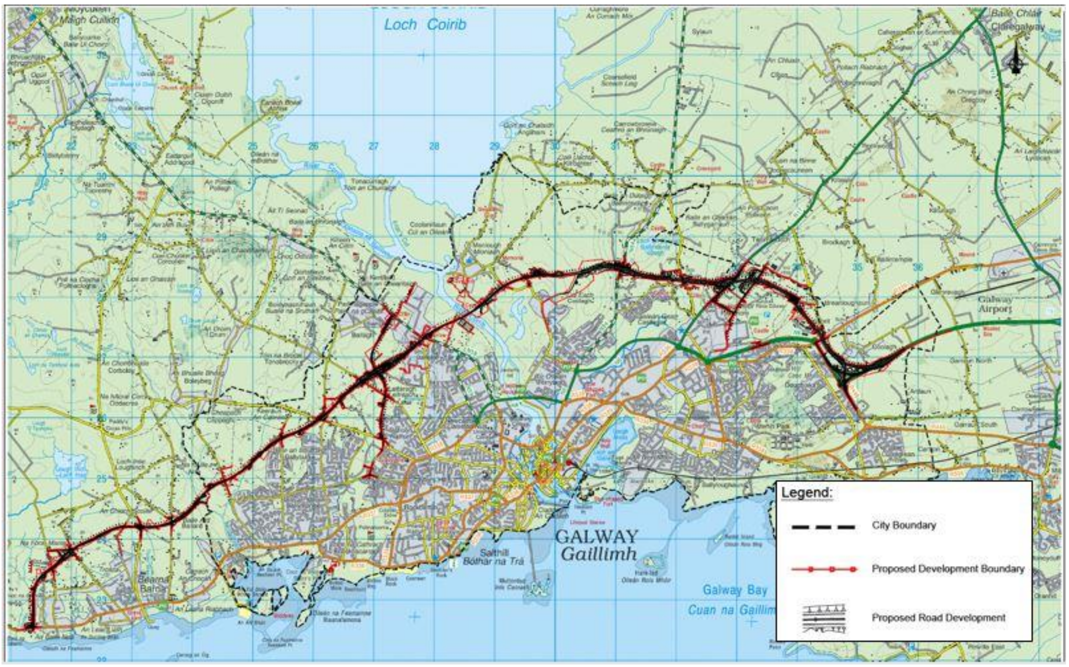
- A description of the proposed road development (Section 2)
- An explanation as to why a derogation is required in terms of the justification for the proposed road development (Section 3)
- Explanation as to why there are no satisfactory alternatives (Section 4)
- Data collected in order to describe the local bat population (Section 5)
- Description of the potential impacts on the local bat population (Section 6)
- Summary of the potential impacts on the local bat population (Section 7)
- Description of the approach proposed toward mitigating the potential impacts and providing compensatory measures impacts cannot be fully mitigated (Section 8)
- Description of residual impacts (Section 9)
- Proposed monitoring programme prior to, during and post-construction (Section 10)

2 Description of the Proposed road development

The proposed road development comprises of the construction of approximately 5.6km of a single carriageway from the western side of Bearna Village as far as the Ballymoneen Road and approximately 11.9km of a dual carriageway from there to the eastern tie in with the existing N6 at Coolagh, Briarhill, along with associated link roads, side roads, junctions and structures and localised works to the existing electricity transmission and distribution networks (specifically comprising of the diversion of 110kV and 38kV services), as shown in **Plate 2.1** below and Figures 5.1.01 to 5.1.15 of the EIA Report.

The total area within the footprint of the proposed development boundary[2] is 280ha. Of this total area, an area of 180ha is required for the footprint of the proposed road development.

Plate 2.1: Proposed Road Development Overview



The proposed road development ties into the existing R336 Coast Road in An Baile Nua with an at-grade roundabout junction approximately 2km to the west of Bearna Village and then proceeds north and east as a single carriageway to the north of Bearna Village and onwards towards Ballymoneen. An at-grade roundabout is proposed at the Bearna to Moycullen Road L1321, and at-grade signalised junctions are proposed at Cappagh Road and Ballymoneen Road.

To the east of the Ballymoneen Road Junction the proposed road development is a dual carriageway and continues east to a grade separated N59 Letteragh Junction located in Letteragh. The junction connects to the N59 Moycullen Road via the proposed N59 Link Road North, and to the Letteragh Road and Rahoon Road via

[2] The extents of the lands to be compulsory acquired for the construction and operation of the proposed road development is referred to as the proposed development boundary.

the proposed N59 Link Road South. The proposed road development continues eastwards to cross the existing N59 Moycullen Road at Dangan and travels on a viaduct over the NUIG Sporting Campus before crossing the River Corrib and Lough Corrib cSAC on a bridge structure.

The proposed road development impacts the NUIG Sporting Campus at Dangan with direct impacts on one of the two existing GAA pitches adjacent to the River Corrib and a training pitch to the front of the existing sports pavilion. To mitigate the impact to these two pitches, it is proposed to construct an all-weather full size GAA pitch and a training pitch at the location of the existing GAA pitches adjacent to the River Corrib.

East of the River Corrib, the proposed road development continues east on embankment toward the townland of Menlough. Additional lands to the north of Menlo Castle are included as part of the proposed road development to provide lands for the enhancement of the core foraging habitat for the Lesser horseshoe bat known to roost at Menlo Castle and mitigate against potential impacts to this species. These lands will be planted with additional hedgerows and maintained as agricultural lands by the local authority and will remain in their ownership.

Continuing east the proposed road development crosses over Bóthar Nua and remains on a viaduct section, the Menlough Viaduct, towards Sean Bóthar before entering a section of cut preceding Lackagh Tunnel, immediately west of Lackagh Quarry, and exits the tunnel in the quarry. There is a tunnel maintenance building located adjacent to Lackagh Tunnel.

The proposed road development continues east with a grade separated junction located at the N84 Headford Road Junction at Ballinfoyle and continues east through the townland of Castlegar to the grade separated junction at the N83[3] Tuam Road. This junction provides access to both the N83 Tuam Road and the proposed Parkmore Link Road between the Ballybrit Business Park and the Parkmore Industrial Estate via the proposed City North Business Park Link road to provide full connectivity at this location.

The proposed road development then continues southeast entering the Galway Racecourse Tunnel at Ballybrit to the north of the racetrack. There is a tunnel maintenance building located adjacent to the Galway Racecourse Tunnel and new stables provided for the Galway Racecourse to mitigate the loss of the existing stables. On emerging from the tunnel, the proposed road development continues southeast, crossing over the R339 Monivea Road on embankment and continuing south to enter a cutting as it reaches its junction with the existing N6 at Coolagh Junction. The proposed Coolagh Junction will be a fully grade separated junction with partial free flow on the major movements.

The proposed road development will also include extensive landscape planting and the creation of Annex I habitat areas[4] (e.g. Calcareous grassland habitat within

[3] Formally known as the N17 Tuam Road

[4] The Annex I habitat creation relates to addressing residual impacts to Annex I habitats outside of any European sites in the EIA Report. It is not in response to any impacts on Annex I habitats that relate in any way to effects on QIs or the conservation objectives of any European sites and that habitat creation does not constitute “compensatory measures” in the meaning of that term in Article 6(4) of the Habitats Directive.

Lough Corrib cSAC on the east bank of the River Corrib). Noise barriers will also be installed at locations along the proposed road development.

There are four significant structures included in the design of the proposed road development, namely the River Corrib Bridge, Menlough Viaduct, Lackagh Tunnel and Galway Racecourse Tunnel. The following is a summary of the main structures to be constructed for the proposed road development and a brief overview of how these structures interact with the Lough Corrib cSAC is provided. The locations are shown on Figures 5.1.01 to 5.1.15 of the EIA Report.

River Corrib Bridge

The proposed road development crosses the River Corrib on a bridge structure (ST09/01) 620m in length between Ch. 8+850 to Ch. 9+500. The proposed structure comprises of an eight-span bridge carrying the proposed road development over the River Corrib adjacent to a retained embankment with five culvert openings on the eastern approach. The proposed structure is a variable depth single concrete box without supports in the river with the main span over the river being 153m. There is no encroachment into the Lough Corrib cSAC on the west side of the River Corrib. On the east side, retaining structures are provided on the approach embankment to limit encroachment of the embankment into the Lough Corrib cSAC. The structural depth of this main span varies from approximately 7m near the supports on either side of the river and reducing to approximately 3m at mid-span over the river, with no associated cables or trusses protruding above the deck.

Menlough Viaduct

A viaduct structure, Menlough Viaduct (ST10/01) is proposed from Ch. 10+100 to Ch. 10+420. The viaduct has a total length of approximately 320m, and the proposed road development is on embankment on both approaches to it. It is located outside but adjacent to the Lough Corrib cSAC, between 45m and 140m north of the cSAC boundary.

The total length of the viaduct is governed by the area of priority Annex I habitat over which it crosses, namely Limestone pavement and a Turlough. Both of these Annex I habitats are located outside of the Lough Corrib cSAC boundary and do not provide a supporting role to, nor form part of the QI for this cSAC. The viaduct contains eight spans of a similar 40m span length. The span lengths have been adjusted to reduce the impact of the substructure and foundations on the Limestone pavement and Turlough (both of which fall outside of the Lough Corrib cSAC boundary). The position of the substructure and foundations will minimise the potential impact on these Annex I habitats. No substructure supports are proposed within the extents of the Turlough.

Lackagh Tunnel

Lackagh Tunnel (ST11/01) is a 270m long mined (drill and blast) tunnel and is located at Ch. 11+150 to Ch. 11+420. The eastern portal of Lackagh Tunnel is located within the inactive Lackagh Quarry, a limestone quarry. The central section of the tunnel will pass under the Lough Corrib cSAC, while the western portal is proposed to be located in agricultural fields outside of Lough Corrib cSAC.

The primary function of the Lackagh Tunnel and its Western Approach is to transverse the Lough Corrib cSAC between Lackagh Quarry and Menlough without directly impacting on the Limestone pavement and Calcareous grassland habitats within the Lough Corrib cSAC. This requires a safe method of excavation and construction of the tunnel such that there will be no impact on the Lough Corrib cSAC during the construction or operation of the tunnel.

Galway Racecourse Tunnel

The proposed Galway Racecourse Tunnel (ST14/02) consists of a 240m twin tube reinforced concrete cut and cover tunnel with central wall from Ch. 14+950 to Ch. 15+900. The purpose of the Galway Racecourse Tunnel is to avoid by design, adverse impacts, namely disruption to operations and functioning, on the Galway Racecourse. The proposed mainline passes through the north-western corner of Galway Racecourse property. This tunnel does not traverse through nor is immediately adjacent to any European site.

3 Need for the Licence

3.1 Introduction

This Section addresses the requirement for the derogation to be issued only under specific qualifying circumstances as set out in Regulation 54(2).

The derogation is being sought on the basis that there are no satisfactory alternatives and the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range. Furthermore, it is being sought as the project has imperative reasons of overriding public interest[5], including those of a social or economic nature. These reasons are outlined below.

3.2 Development of a Transport Solution for Galway

Galway City and its environs have critical transport issues as identified in Section 2 above that require urgent resolution. To address these transport issues, Galway County Council, Galway City Council, Transport Infrastructure Ireland and the National Transport Authority are collaborating in developing a transport vision for Galway where all elements of transport are working together to achieve an integrated sustainable transport solution. The proposed road development which is the subject of this derogation licence, forms an essential part of this transport solution.

The total breakdown of the existing transport network in Galway occurs on a frequent basis as there is no resilience in the network e.g. wet afternoon, road maintenance, vehicle collision and/or signal outage. This random unpredictable shutdown of Galway's transport network costs millions and has the real potential to prohibit Galway functioning as a city or economic engine for the Western Region.

The transport issues facing Galway City and its environs as a result of the inadequacy of the existing road network are wide ranging with associated consequential impacts as noted below:

- Congestion throughout the city road network
- Over capacity of existing junctions
- Journey time unreliability due to uncertain quantum of delay
- Journey time variability throughout the day
- Peak hour traffic delays
- By-passable traffic is in conflict with internal traffic
- Strategic traffic is in conflict with local traffic

[5]Note that the term "Imperative reasons of overriding public interest" is used in this application in the context of Regulation 54(2)(c) and does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive and Regulation 43 of S.I. 477 of 2011.

- Inadequate transport links to access markets within the city
- Inadequate transport connections from Galway onwards to Connemara
- Lack of accessibility to the Western Region as a whole
- Prolonged journey times and delays on the current bus network, due in part to the limited available road space in the city centre for introducing bus priority which both reduces its attractiveness to passengers and increases costs of operating
- Limited road space on most of the principal roads, which reduces opportunities for safe and comfortable cycling
- Connectivity issues on the National and Regional road network resulting in significant volumes of cross-county and strategic travel demand between east and west Galway being concentrated and funnelled through the city area in order to cross the River Corrib
- The impact of traffic congestion on the city's reputation, particularly with regard to inward development
- Accessibility issues due to traffic congestion for businesses and community facilities in Galway City and its environs and the Business Parks in Parkmore and Ballybrit
- The routing of thousands of vehicles per day through the city centre brings with it associated and unmitigated impacts on businesses, public facilities, homes and non-motorised road users
- The stop/start nature of urban driving and platooning of vehicles behind slow moving vehicles adds to the levels of pollution experienced by locals and visitors
- Severance effects of traffic congestion is experienced in urban areas and traffic speeds are increasing in rural areas as local roads are used to avoid the congested national road network

There is a critical need to address the transport issues in Galway City and its environs. As a Gateway to the Connemara and the Western Region, **connectivity and accessibility to and through Galway City** is essential in aiding the region to revitalise, improve and develop into the future. As Galway City and its environs continues to grow, it is crucial to **safeguard the future development** of the city as the principal economic centre in the west of Ireland and to ensure that its development is sustainable. In addition, providing **well developed transport links** via roads, rail and air to the Western Region enables enterprises and the local economy of the west to grow and develop as a viable alternative to the east coast corridor which is of significant public interest at a national level. The existing road network was analysed to establish the underlying issues so that the appropriate transport solution is implemented.

The transport solution recognises that the West Region has a significant and valuable resource in its natural heritage environment with a wide variety of species and habitats of local, national and international importance, whilst also being conscious of the need to establish effective communication links to ensure that the region continues to thrive and to offer an alternative to the east coast corridor. To get Galway City and its environs working and functioning in a sustainable manner for the future is key to this solution.

The physical form of the city, together with the limited available space between the lake and the bay, plus the presence of established communities, commercial and educational facilities, Natura 2000 designated sites[6] (hereinafter referred to as European sites), National Heritage Areas and proposed Natural Heritage Areas, and sites of significant architectural, archaeological and cultural heritage significance presents significant constraints for developing new infrastructure for the city and focuses attention on the importance of considering all alternatives in order to minimise the impact on those designated sites.

3.3 Galway Transport Strategy

The Galway Transport Strategy is the transport solution for Galway and provides Galway City and its environs with a clear implementation framework for transportation over the next 20 years. The GTS took into account the existing transport issues as described above and these issues were carefully considered and analysed with the aim of finding a transport solution to create a safer, smarter and sustainable transport system for Galway City and its environs taking into account travel demands, existing infrastructure and environmental constraints.

The GTS included an evaluation of transport options for all modes, and affirmed the strategic need for an orbital route around the city and a new crossing of the River Corrib, in order to implement the level of service required for each mode of transport, including walking, cycling, public transport and private vehicle. The provision of an additional crossing of the River Corrib would facilitate the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the GTS, namely the improvement of public transport, cycling and walking measures. A new road link to the north of the city is proposed as part of the GTS to deliver the necessary capacity and support the delivery of sustainable transport measures, particularly within the city centre.

3.4 N6 Galway City Ring Road (GCRR)

The initial studies carried out as part of the proposed road development confirmed that a new River Corrib bridge crossing is possible and identified a preferred location for this crossing. Further details on the initial studies (such as constraints

[6] Natura 2000 sites are defined under the Habitats Directive (Article 3) as a European ecological network of special areas of conservation composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II. The aim of the network is to aid the long-term survival of Europe's most valuable and threatened species and habitats. In Ireland these sites are designed as *European sites* – as defined under the Planning and Development Acts and/or Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special area of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as candidate Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs).

and options development) are provided in **Chapter 4, Alternatives Considered** of the EIA Report for the proposed road development.

The proposed road development will deliver the additional crossing of the River Corrib and the new link road as proposed by the GTS. Therefore, the proposed road development forms an essential part of the GTS, it delivers the road component of the overall transport solution for Galway City and its environs, provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment into which it is interwoven.

The need for the proposed road development, is justified as it will deliver the following:

- By tackling the city's congestion issues, it will provide a better quality of life for the city's inhabitants and provide a much safer environment in which to live
- By reducing the number of cars on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using multi-modal transport means. This includes travelling on foot, by bicycle and on the public transport system
- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to improved journey time reliability for public transport
- Caters for the strong demand between zones on either side of the city
- Provides additional river crossing with connectivity back to the city either side of the bridge crossing
- Facilitates improved city centre environment for all due to reduced congestion, thus encouraging walking and cycling as safe transport modes

3.5 Summary

Galway City and its environs have critical transport issues as identified in Section 3.2 above that require urgent resolution. These are regarded to be imperative reasons of overriding public interest in the context of addressing Regulation 54(2)(c) of S.I. 477 of 2011[7].

There are however significant constraints for developing new transport infrastructure for Galway given (i) the physical form of the city, (ii) the limited space available, (iii) the built environment and residential areas on both sides of the River Corrib, and (iv) the presence of designated sites.

[7] Note that the term "Imperative reasons of overriding public interest" is used in this application in the context of Regulation 54(2)(c) and does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive and Regulation 43 of S.I. 477 of 2011.

The physical form of the city in terms of the built and natural environment and residential areas on both sides of the River Corrib, together with the limited available space between the lake and the bay, plus the presence of the designated sites presents significant constraints for developing new infrastructure for the city. The presence of these constraints focuses attention on the importance of considering all alternatives to minimise the impact on the human environment and the designated sites.

To address the transport issues, an overall transportation solution for Galway was developed by Galway County Council, Galway City Council, and NTA culminating in the GTS, of which the proposed road development forms a key element as the road component of this solution.

The GTS included an evaluation of transport options for all modes, and affirmed the strategic need for an orbital route around the city and a new crossing of the River Corrib, in order to implement the level of service required for each mode of transport, including walking, cycling, public transport and private vehicle. The provision of an additional crossing of the River Corrib would facilitate the reduction of congestion on city centre roads, and allow the reallocation of road space in the city network to non-motorised modes of transport, thereby facilitating the effective implementation of all the elements contained in the GTS, namely the improvement of public transport, cycling and walking measures. A new road link to the north of the city is proposed as part of the GTS to deliver the necessary capacity and support the delivery of sustainable transport measures, particularly within the city centre.

The proposed road development will deliver the additional crossing of the River Corrib and the new link road as proposed by the GTS. Therefore, the proposed road development forms an essential part of the GTS, it delivers the road component of the overall transport solution for Galway City and its environs, provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment into which it is interwoven.

The conclusion of all the analysis and work on this scheme is that the proposed road development resolves the transport issues and delivers on the project objectives and represents the optimal solution, both from the perspective of human environment and the natural environment.

The proposed road development is the optimum transport solution and is consistent with proper planning and sustainable development and this view is supported /validated by recent inclusion of policy support for both GTS and constituent measures, including the proposed road development, in the relevant Galway Development Plans.

The need for the proposed road development, is justified as it will deliver the following:

- By tackling the city’s congestion issues, it will provide a better quality of life for the city’s inhabitants and provide a much safer environment in which to live
- By reducing the number of cars on the roads within the city centre and improving streetscapes, workers and students are facilitated to commute using

multi-modal transport means. This includes travelling on foot, by bicycle and on the public transport system

- Provides connectivity to the national roads via junctions to maximise the transfer of cross-city movements to the new road infrastructure, thus releasing and freeing the existing city centre zone from congestion caused by traffic trying to access a city centre bridge to cross the River Corrib
- Attracts traffic from the city centre zone thus facilitating reallocation of road space to public transport leading to improved journey time reliability for public transport
- Caters for the strong demand between zones on either side of the city
- Provides additional river crossing with connectivity back to the city either side of the bridge crossing
- Facilitates improved city centre environment for all due to reduced congestion, thus encouraging walking and cycling as safe transport modes

The route of the proposed road development, which is necessary to provide the optimal transport solution, results in the unfortunate but unavoidable impacts on the receiving environment including the removal of bat roosts. However, this must be viewed and considered and balanced with the overall benefits outlined above that this proposed road development presents for the future of Galway and its environs and connectivity to the Western Region.

4 Absence of satisfactory alternatives

4.1 Introduction

This Section presents the evidence to demonstrate that there are no satisfactory alternatives to the activities covered by the derogation, in order to meet the requirements of Regulation 54(2) of S.I. 477 of 2011. It specifically describes the results of the constraints and route selection studies which resulted in the selection of the preferred route corridor. All of the alternative routes considered, other than the “do-nothing” option would have impacts on local bat populations. The impacts on bat populations varied between routes, as described below.

4.2 Constraints

As noted in Section 3, there are significant constraints for developing new transport infrastructure for Galway given (i) the physical form of the city, (ii) the limited space available, (iii) the built environment and residential areas on both sides of the River Corrib, and (iv) the presence of designated sites.

These constraints are described in more detail below:

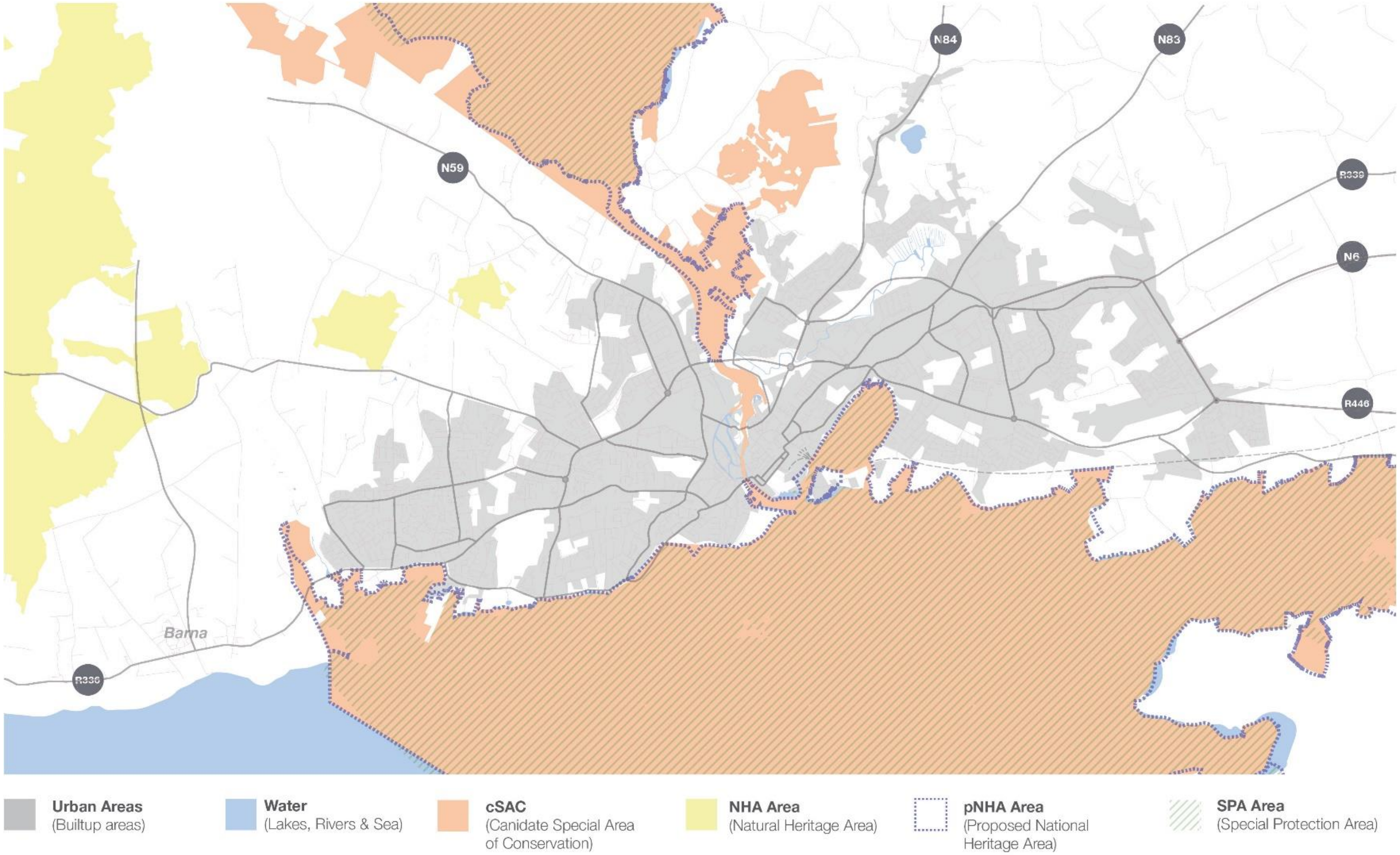
- The low density of the suburbs of Galway has led to reliance on private car usage as a means of travel and makes it difficult to develop an economically efficient public transport solution
- Galway City is divided by the River Corrib as it flows between Lough Corrib and Galway Bay with significant trip attractors, employment centres, education centres and residential areas located on both sides of the river
- Lough Corrib forms a natural division between the east and west of County Galway and the distance between Lough Corrib and Galway Bay is only 4.5km[8] within which lies Galway City, very much at the heart of County Galway
- The city is located in the middle of areas which are rich in natural heritage with a wealth of natural habitats. This has resulted in significant areas around Galway City being designated of international importance

The physical form of the city in terms of the built and natural environment and residential areas on both sides of the River Corrib, together with the limited available space between the lake and the bay, plus the presence of the designated sites presents significant constraints for developing new infrastructure for the city. The presence of these constraints focuses attention on the importance of considering all alternatives in order to minimise the impact on the human environment and the designated sites.

These constraints are depicted on **Plate 4.1** below.

[8] Distance measured from south shore of Lough Corrib to Spanish Arch at Galway Docks

Plate 4.1: Significant Constraints

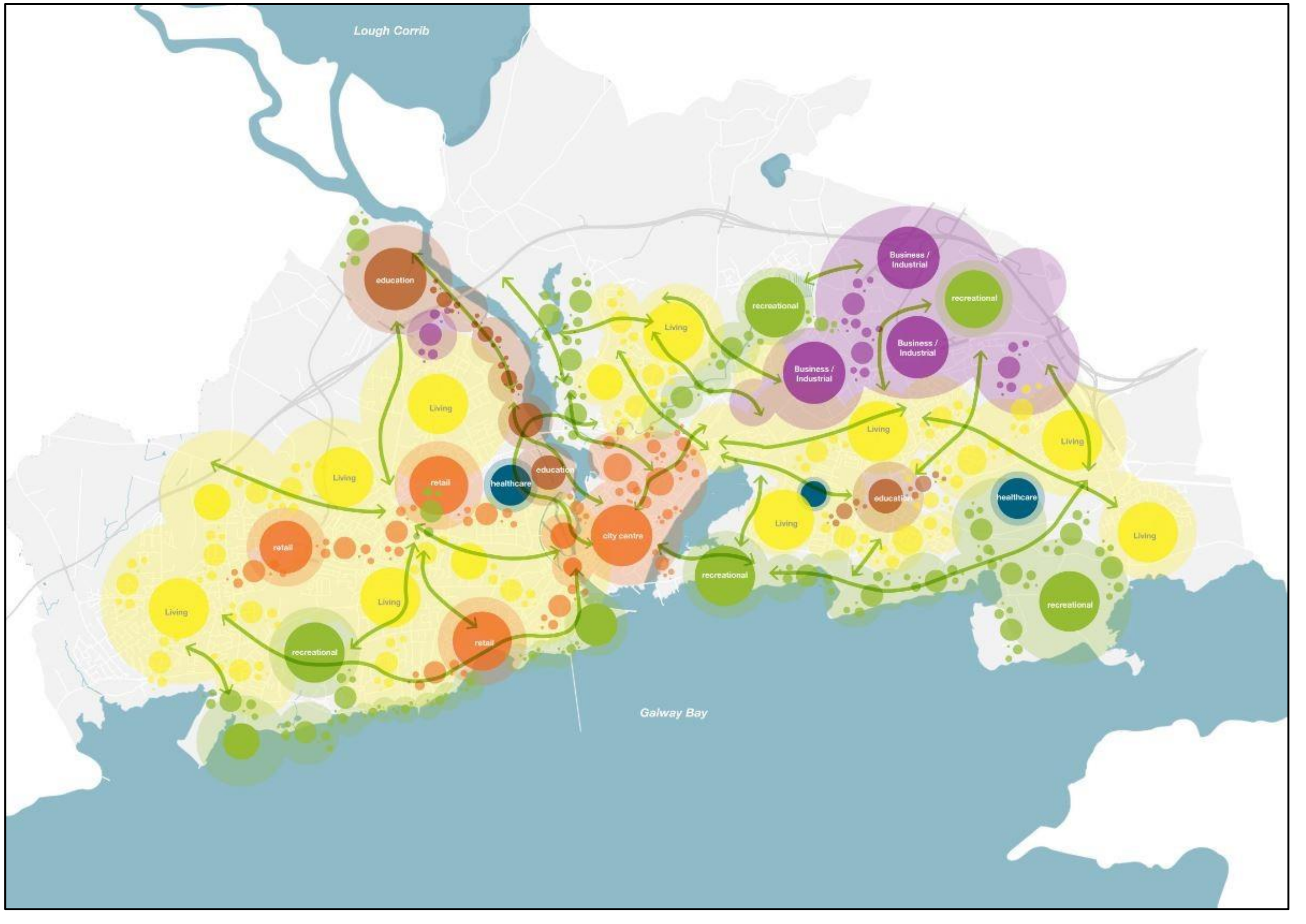


The design team for the proposed road development, carefully considered and analysed the traffic issues in Galway with the aim of finding a transport solution to create a safer, smarter and sustainable transport system for Galway City and its environs taking into account travel demands, existing infrastructure and environmental constraints.

Initial feasibility studies identified the zones of employment, education, retail and residential, i.e. these are known as zones of traffic generators and attractors.

These zones are shown on **Plate 4.2**. This graphic shows the residential areas interwoven with the key attractors with the resultant travel desire lines also displayed, and demonstrates how the River Corrib divides this city.

Plate 4.2: Traffic Generators and Attractors



4.3 Optioneering and Appraisal

The early studies identified that Galway had a transport problem, and moreover it had a multifaceted transport problem that needed more extensive analysis to fully understand all the issues. Full details of this analysis are included in Chapter 6 of the EIA Report.

Following on from the initial feasibility studies, taking cognisance of the judgement on the 2006 Galway City Outer Bypass scheme and the key constraints of the Lough Corrib candidate Special Area of Conservation (cSAC) the options which were considered are outlined below:

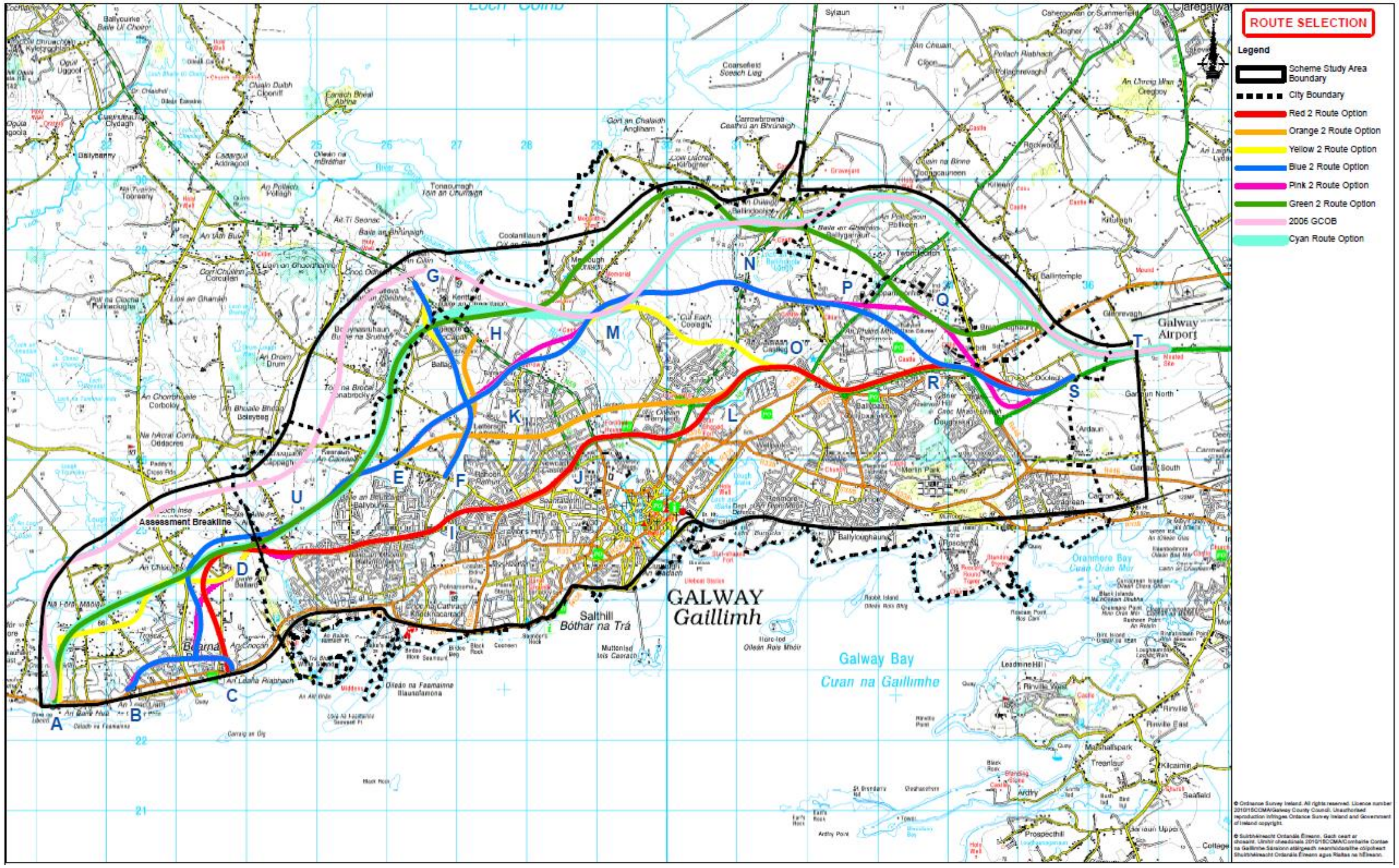
- "Do-Nothing": This option is the Base Year model with growth factors applied to the existing population and traffic data up to the year of opening
- "Do-Minimum": This option includes road and non-road schemes, including smart mobility measures, which have been committed or are likely to proceed before the year of opening
- "Do-Something Public Transport": This option was based on measures, options and schemes identified by the existing *Galway Public Transport Feasibility Study* of 2010 for Galway City Council, including smart mobility measures
- Lough Corrib Route Options
- Coastal Route Options
- Upgrade Existing Road Alternative (On-line): The first road option developed was the on-line upgrade of the existing road infrastructure and utilises the existing N6 and the R338
- Build New Road Alternative (Off-line): This option included off-line route options connecting the R336 in the west to the existing N6 in the east, including the 2006 GCOB route option

An assessment of the following options discounted them from further consideration during the option development stage as they were deemed not to meet the project objectives:

- 'Do-Nothing'
- 'Do-Minimum'
- Traffic Management Alternative
- Lough Corrib Route Options
- Coastal Route Options
- Tunnel over project extents

The options considered further during the route selection phase include the Red, Orange, Yellow, Blue, Pink, Green Route Options and the 2006 GCOB Scheme (i.e. acronym for the N6 Galway City Outer Bypass Scheme of 2006) and the Cyan Route Option (i.e. acronym for the N6 Galway City Outer Bypass of 2006 route option from N6 to the N59 linked to an alternative route option from N59 to R336 on the west to avoid the impacts which were the subject of the refusal by ABP of this section previously) as shown in **Plate 4.3** below.

Plate 4.3: Route Options



At the constraints and route selection stage of the project, a greater proportion of the bat survey effort was focused on describing the Lesser horseshoe bat population, given its status as a qualifying interest species of the Lough Corrib candidate Special Area of Conservation (cSAC). The presence of other bat species at the constraints and route selection stage had been established by a series of walked and vehicle-based acoustic surveys, surveys of a selection of properties and use of static detectors to record bat activity across the site.

A full assessment of the route options including public consultation was undertaken. A summary of the conclusions of this assessment including the comparison of potential impacts on bats is outlined below. Further details on the route options are provided in **Chapter 4, Alternatives Considered** of the EIA Report.

Red and Orange Route Options

In terms of impacts on bats, the red and orange routes were within the foraging area of the Menlo Castle Lesser horseshoe bat roost; although they were one of three route options that were also in close proximity to the mating/hibernation site at Cooper's Cave in the Terryland River Valley. As such, the red and orange routes were considered to be one of the least damaging route options with regard to this species provided that the integrity of Cooper's Cave could be maintained. Given the scale of impacts on properties it is likely that these options would have also resulted in loss of bat roosts within buildings.

The overall assessment of the Red and Orange Route Options through the section from the city boundary to the existing N6 Coolagh Junction concluded that they are not feasible in so far as they are not deliverable or realisable as they create disproportionate impacts on the sensitive urban environment of Galway City and on its inhabitants, communities and neighbourhoods.

The scale and nature of the infrastructure required for the on-line portion of these options is of significant magnitude; this is because the route option would be retrofitted into a sensitive urban environment. The design legacy of such significant heavy engineering solutions associated with these options is likely to radically permanently impact on the experience and image of the city. The scale of this harm is so significant as to deem them to be at significant variance with some of the scheme objectives. The impacts of the Red and Orange Route Options are considered to be on such a large scale as to be disproportionate to the over-riding need for the proposed scheme. Equally as further mitigation by avoidance is very unlikely to improve these route options, these route options were not advanced further. The Red and Orange Route Options are not regarded to be satisfactory alternatives.

2006 GCOB

The western section of the 2006 GCOB did not receive planning permission from ABP under the earlier application due to potential environmental impacts in the area of Moycullen Bogs Bog NHA. Further, the 2006 GCOB would not deliver the optimum intermodal transport solution as extensive traffic modelling shows that it would not deliver relief to congestion to the same level as the proposed road development.

Further still, in terms of the 2006 GCOB:

- It does not provide connection with the N83 Tuam Road, a national road, thereby providing a lesser level of connectivity
- It does not provide any connection to the key employment centres at Parkmore and Ballybrit and, therefore, minimal relief to the existing congestion at the eastern city extents
- It has an adverse impact on the site integrity of the Lough Corrib cSAC per the European Court decision
- It has potential to impact on Lough Inch River which is known to contain Freshwater pearl mussels downstream
- It has a significant impact on the Moycullen Bog Complex NHA from a hydrogeological and hydrological perspective both at Tonabrocky and in the vicinity of Lough Inch
- It has a profound impact on the curtilage of Menlo Castle from a cultural heritage perspective and on the amenity value from Human Beings perspective
- It has less impacts on communities and amenities with an overall improvement in the level of severance experienced, but at the expense of longer journey times and less relevant journey possibilities between east and west

and so it was not advanced further. In terms of potential impacts on the local bat population, the 2006 GCOB would have been within the foraging area of the Menlo Castle Lesser horseshoe bat roost and close to Menlo Castle itself. The 2006 GCOB is not regarded to be a satisfactory alternative.

Cyan Route Option

The Cyan Route Option is a reconfiguration of the 2006 GCOB to address the issues raised by ABP in its refusal of the western section of the 2006 GCOB. This route option reflects the 2006 GCOB route option to the east of the River Corrib (i.e. approved by ABP in 2008) but with the addition of a grade separated junction on N83 at the crossing point. It follows an alternative route to 2006 GCOB to the west of the River Corrib (i.e. refused by ABP in 2008) in order to address the issues raised by ABP. The Cyan Route Option would not deliver the optimum intermodal transport solution as extensive traffic modelling shows that it would not deliver relief to congestion to the same level as the proposed road development.

Further still, in terms of the Cyan Route Option:

- It does not provide a direct connection to the key employment centres at Parkmore and Ballybrit and, therefore, minimal relief to the existing congestion at the eastern city extents
- It has an adverse impact on the site integrity of the Lough Corrib cSAC per the European Court opinion
- It has a profound impact on the curtilage of Menlo Castle from a cultural heritage perspective and on the amenity value from Human Beings perspective

and so it was not advanced further. In terms of potential impacts on bats, the Cyan Route Option would have been within the foraging area of the Menlo Castle Lesser horseshoe bat roost and close to Menlo Castle itself. The Cyan Route Option is not regarded to be a satisfactory alternative.

Preferred Option

In reviewing all remaining route options (i.e. Yellow, Blue, Pink and Green), in each section, an assessment was undertaken under various criteria which sought to balance the potential impact on the ecological constraints, human beings and other constraints.

In terms of impacts on bats all of these route options have the potential to adversely affect local population of bats. All route options are c.1km from two Lesser horseshoe bat roosts, two known Whiskered bat roosts and two known Leisler's roosts at the western end near Bearna. All posed adverse impacts to the local Lesser horseshoe bat population given the scale of habitat loss and severance likely to be associated with habitat loss within their core foraging area, and in the immediate vicinity of the maternity roost at Menlo Castle. The only differences between them related to the length of the proposed road within the core foraging area and the distance from the castle itself. The Yellow and Blue Route Options were within 280m of the castle, the Pink Route Option 170m away and the Green Route Option 330m away.

The outcome of the robust assessment of all constraints for each route option is that the route option selected was a combination of route options which had the least number of residential properties acquired in each section, i.e. Yellow in Section 1 (modified to reduce potential environmental impacts), Pink in Section 2 and Pink in Section 3.

Further, once chosen, the design of the emerging preferred route has been refined in as much as possible to eliminate and reduce impacts on the receiving environment.

The route of the proposed road development, which is necessary to provide the optimal transport solution, results in the unfortunate but unavoidable impacts on the receiving environment including the removal of bat roosts. Due to the location of the core foraging area for the Lesser horseshoe bat population, impacts from the proposed road development are unavoidable when the other environmental variables are also taken into account.

However, this must be viewed and considered and balanced with the overall benefits outlined above that this proposed road development presents for the future of Galway and its environs and connectivity to the Western Region.

The Optimum Transport Solution

The solution proffered in the proposed road development is the optimum transport solution while also being the preferred option from an environmental perspective, both from a human environment and natural habitat perspective. This is the fundamental reason that the proposed road development is deemed to be a proportionate response, and its justification is that it delivers all of the following:

- Provides a strategic route, forming part of the TEN-T comprehensive network, across the River Corrib without the need to go through the city
- Provides the necessary connectivity to all the national roads and the Western Region and for those living within Galway and the rest of the country
- Provides for strategic traffic accessing Galway City and connectivity with zones of traffic generators and attractors
- It meets the functionality of the road component of the overall intermodal transport solution
- Enables the reallocation of existing road space within the city to public transport and smart mobility measures and is part of a sustainable holistic transport solution
- Alleviates congestion within Galway City which would result in reduced air and noise pollution
- Facilitates a more efficient public transport system
- Facilitates the provision of a multi-modal choice of travel
- Improves safety levels for all public road users
- Minimises property demolition and acquisition as far as possible
- Improves the quality of life of those living within Galway City with a reduction in traffic congestion and hence reduced pollution and an increase in opportunities for physical activity

5 Bat Survey Data

5.1 Survey Methodologies

The following sections describe the methodologies employed to carry out the bat surveys undertaken between 2014 and 2017 to inform the various stages of Constraints, Route Selection and EIA for the proposed road development.

The following annexes include stand-alone technical reports for discrete elements of surveys (e.g. radio-tracking studies):

- Annex A: Galway Bat Radio-tracking Project - Bat Radio-tracking surveys. Radio-tracking studies of Lesser horseshoe and vesper bat species, August and September 2014 (Rush & Billington, 2014)
- Annex B: Galway City Transport Project - Bat Acoustic Surveys: Summer-Autumn 2014 (Geckoella Ltd., 2015a)
- Annex C: N6 Galway City Transport Project - Bat Radio-tracking and Roost Surveys 19 to 29 August 2014 (Geckoella Ltd., 2015b)
- Annex D: Galway bat radio-tracking project. Radio tracking studies of Lesser horseshoe bat species, May 2015 (Rush & Billington, 2015)

A summary of all field surveys undertaken is provided in **Table 1** below.

Table 1: Surveys and Survey Dates between 2014 and 2017

Survey type	Survey Date(s)	Surveyor(s)
Winter hibernation surveys	1 - 14 March 2014 21 March 2014 6 February 2015 24 February 2016 15 January 2018	Scott Cawley Ltd.
Autumn/Winter static monitoring surveys to detect mating and hibernation (Cooper's Cave, Newry's Cave, Prospect Hill Railway Tunnel and Menlo Castle)	September-October 2014 February-March 2015	Scott Cawley Ltd.
Vehicle-based bat preliminary roost assessments	July and October 2014	Scott Cawley Ltd.
Daytime manual preliminary roost assessments and dusk/dawn roost characterisation surveys	August and September 2015 July and August 2016 June and July 2017	Scott Cawley Ltd.
Counts of Lesser horseshoe bat roosts at Menlo Castle, Aughnacurra and Cooper's Cave	August 2018	Scott Cawley Ltd.
Daytime surveys of qualifying roosts within Lough Corrib cSAC (Eborhall House)	21 October 2015 23 August 2016 14 July 2017	Scott Cawley Ltd.

Survey type	Survey Date(s)	Surveyor(s)
Tree preliminary roost assessments and dusk/dawn roost characterisation surveys	April to June 2015 September, October and November 2015	Scott Cawley Ltd.
Vehicle-based bat activity surveys	June and July 2014	Scott Cawley Ltd.
Walked bat activity surveys	June and July 2014	Scott Cawley Ltd.
Static bat detectors surveys	August to November 2014 July to September 2015 September to October 2015 July to August 2017 May 2018	Geckoella Environmental Consultants Ltd Scott Cawley Ltd Scott Cawley Ltd
Radio-tracking and marking studies	30 July-7 August 2014 19-29 August 2014 2-9 September 2014 16-23 May 2015	Greena Ecological Consultancy Ltd Geckoella Environmental Consultants Ltd

The bat surveys were carried out under the following licences, issued by the NPWS[9]:

- DER/BAT 2014-17 - Derogation licence to disturb bat roosts throughout the State (valid until 31 December 2018)
- DER/BAT 2014-39 - Derogation licence to disturb bat roosts in Galway County and City
- DER/BAT 2015-02 - Derogation licence to disturb bat roosts in Galway County and City
- DER/BAT 2015-03 - Derogation licence to disturb bat roosts throughout the State
- DER/BAT 2015-24 - Derogation licence to disturb Menlo Castle bat roost and bat roosts north of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen to the North
- DER/BAT 2016/09 Derogation licence to disturb bat roosts throughout the State
- DER/BAT 2017/06 Derogation licence to disturb bat roosts throughout the State
- C056/2014 - Licence to capture protected wild animals (bats) for educational and scientific purposes throughout the State
- C098/2014 - Licence to capture protected wild animals (bats) for educational and scientific purposes in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway
- C009/2014 - Licence to attach a ban, ring, tag or other marking device to a wild animal bat) in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway

[9] The individual licences that applied to individual survey elements are listed under the relevant survey sections.

- 027/2014 - Licence to use an acoustic lure to capture bats in an area bounded by Oranmore and Claregalway to the east across to Moycullen and Furbogh to the west, Galway, including Menlo Castle roost and night/satellite roosts in Galway
- C004/2015 - Licence to attach a ban, ring, tag or other marking device to a wild animal bat) in an area including Menlo Castle, north of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen to the north, County Galway
- C033/2015 - Licence to capture protected wild animals (bats) for educational and scientific purposes throughout the State
- C085/2015 - Licence to capture protected wild animals (Lesser horseshoe bats) for educational and scientific purposes in an area including Menlo Castle, north of Galway City and from Oranmore to Furbogh to the west and from the coast to Moycullen top the north, County Galway

5.1.1 Winter hibernation surveys

As part of preliminary investigations to identify potential winter hibernation roosts for bats, particularly Lesser horseshoe bats which hibernate in caves and cellars, desktop data on such features was researched to draw up a short list of likely locations.

A cave database compiled by David Drew (Drew, 2004), formerly of Trinity College (http://www.ubss.org.uk/irishcaves/irishcaves.php), and the Geological Survey of Ireland (GSI) karst features Geographical Information System (GIS) layer were consulted to locate caves within the wider study area. The National Monuments Service database (http://www.archaeology.ie) was consulted to determine if man-made underground sites (souterrains, mines, ice houses) or unoccupied structures, such as caves and manor houses that may have underground structures or large chimneys, were present within the wider study area.

Potential hibernation sites identified from the desktop study were surveyed internally on the following dates; 11 - 14 March 2014, 21 March 2014, 6 February 2015, 24 February 2016, 8 and 11 January 2018. Sites were visited during daytime and inspected for the presence of hibernating bats and evidence of bat presence (e.g. droppings, staining).

In addition, bat detectors were deployed at potential winter hibernation sites (Cooper’s Cave, Newry’s Cave, Prospect Hill Railway tunnel, and Menlo Castle) to record bat activity both during the mating season (September-October 2014) and the hibernation period (February-March 2015). Surveys were conducted under licence from the NPWS (DER/BAT 2014-17 and DER/BAT 2015-02 and DER/BAT 2016-09) and care was taken not to disturb bats or to affect access to and from these potential roost sites.

5.1.2 Building surveys

In 2014, a list of potential bat roost buildings was compiled following a vehicle-based survey in areas within, and adjacent to, the study area. Buildings regarded to have high potential to support Lesser horseshoe bat roosts were identified as priority early in the Constraints and Route Selection phase with structures that offered roosting opportunities to other bat species identified after that. The physical characteristics (construction material, roofing material, estimated age etc.) and GPS locations were recorded and a photograph of each building was taken. The building inspections were undertaken between July and October 2014.

In 2015, 2016 and 2017, buildings within or immediately adjacent to the proposed road development, and specific buildings within 1 km of the proposed road development, that were identified as being of high potential for roosting bats (as guided by Collins, 2016)) (i.e. buildings with an obvious, or high, likelihood to support roosting bats, their size, shelter, protection, conditions and surrounding habitat) were also surveyed. Daytime building inspections and dusk/dawn surveys were conducted in August and September 2015, July and August 2016 and May, June and October 2017.

The locations of all buildings surveyed are shown on Figure 8.17.1 of the EIA Report.

The daytime building inspections involved a full examination of the internal and external areas of the structures to search for the presence of bats and identify potential roost sites. Bat activity is usually detected by the following signs:

- Bat droppings (these will accumulate under an established roost or under access points)
- Insect remains (under feeding perches)
- Oil (from fur) and urine stains
- Scratch marks
- Bat corpses

Surveyors filled out a standardised roost survey form and these were compiled into a Potential Bat Roost (PBR) building database.

In some situations, where a building had a high potential as a bat roost but no physical evidence was found, a frequency division ultrasound detector (for example an Anabat SD1, Wildlife Acoustic Song Meter 2 or SMZC or similar) was left in-situ for several nights.

Bat droppings were placed in 1.5ml eppendorf tubes with silica and sent to Waterford Institute of Technology for genetic analysis to identify the bat species.

The roost surveys were carried out under licence from the NPWS (DER/BAT 2014-39, and DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28) and DER/BAT 2017-06).

For bat activity surveys conducted in 2015, bat activity around buildings was monitored using a hand-held bat detector (Pettersson 240x, Wildlife Acoustics EM3 or similar) to determine if bats were exiting/entering buildings. Dusk activity surveys were conducted for up to two hours after sunset, while pre-dawn surveys were generally conducted from 2hrs before sunrise. For buildings inside, and within 1km of, the proposed road development at least one internal survey and dusk or dawn survey was conducted. Where internal access was not possible, three activity surveys were conducted on a building, subject to accessibility.

Two additional counts of Lesser horseshoe bats at Menlo Castle, Cooper's Cave and the roost at Aughnacurra (PBR178) were undertaken in August 2018: the first count on the 22 August 2018 and the second count over the 27/28 August 2018.

5.1.3 Surveys of bats using Eborhall House and Ballymaglancy Cave cSAC

Eborhall House and Ballymaglancy Cave, located to the north of Lough Corrib, are both important roost sites for breeding and hibernating Lesser horseshoe bats respectively. Eborhall House is the "qualifying" roost for the Lough Corrib SAC whilst the nearby Ballymaglancy Cave is a cSAC in its own right (No. 000474) and is thought to provide hibernation roosts for the bats from Eborhall House.

As part of the assessment of the potential movement of this bat species across the landscape, it was deemed important to determine if any of the ringed bats[10] that were roosting near the study area were also using these "qualifying" roosts, even though they are located a considerable distance to the north (more than 30km).

Surveys were undertaken at Eborhall House and Ballymaglancy Cave to determine the presence of Lesser horseshoe bats that were ringed at roosts within the study area were undertaken under licence DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28 and DER/BAT 2017-06) on 21 October 2015, 23 August 2016 and 14 July 2017. Surveys in 2015 were undertaken by Paul Scott (Scott Cawley Ltd) with Mr John Higgins (NPWS Local Conservation Ranger) and in 2016 by Dr Daniel Buckley and in 2017 by Paul Scott. Daytime visual surveys were undertaken to count and identify any marked bats. Only the October 2015 surveys included Ballymaglancy Cave. No ringed bats from the study area were recorded during these visits.

5.1.4 Tree Surveys

Trees within, or immediately adjacent to, the proposed road development (see Figure 8.16.1-8.16.14 of the EIA Report) were assessed for their potential as bat roosts as part of multidisciplinary surveys carried out from April to June 2015 and in October/November 2015. The suitability of each tree to support roosting bats was classified using the categories outlined in *Bat Surveys: Good Practice Guidelines* (Hundt, 2012). Whilst these guidelines have been superseded by Collins (2016) the overall approach and valuation criteria are still valid:

- Category 1*: Trees with multiple, highly suitable features capable of supporting larger roosts
- Category 1: Trees with definite bat potential, supporting fewer suitable features than Category 1* trees, or with potential for use by single bats

[10] See Section 2.1.9 of this report for details on bats that were ringed.

- Category 2: Trees with no obvious potential, although the tree is of a size and age that elevated surveys may result in cracks or crevices being found; or the tree supports some features which may have limited potential to support bats
- Category 3: Trees with no potential to support bats

Trees assigned a category of 1*, 1 or 2 were re-inspected from 10 to 25 September 2015. Trees with crevices accessible by ladder were surveyed using an endoscope to determine if bats were roosting in the trees, if there was evidence of bats or simply if the potential roost feature offered good conditions for roosting.

Internal inspection of trees was carried out under licence from the NPWS (DER/BAT 2015-03).

5.1.5 Vehicle transect surveys

Vehicle transect surveys took place in June and July 2014. Three transect routes were designed within the study area; an eastern transect (east of the River Corrib), a western transect (west of the River Corrib) and an urban transect (roads within Galway City). The locations of the vehicle transect routes are shown on Figure 8.4.1 and 8.4.2 of the EIA Report. The survey methodology was designed with reference to that used by the All-Ireland Car-based Bat Monitoring Scheme (Roche et al., 2009). The only deviation from that survey methodology related to the use of a GPS unit to georeference the call records, removing the requirement to survey a section and stop to record location references on a map.

Prior to the first survey, surveyors mapped out their driving route during the day, identifying potential hazards. Roads that were unsafe (carrying large volumes of traffic) were excluded from the survey. Surveys were conducted on nights with potential for high levels of bat flight activity (i.e. warm, dry, calm conditions).

Surveying commenced 45 minutes after sunset with roads being driven at approximately 25km/h. Bat activity was recorded using EM3 bat detectors (Wildlife Acoustics) with a GPS unit (Garmin) attached to record the location of bat calls and to plot the transect route. Detectors were mounted on the passenger window of the survey vehicle. Detectors were set to record continuously, saving call files in the compressed WAC format. Each transect was surveyed twice (eastern and western transects on the 17 and 18 June 2014; the urban transects on the 26 June and 1 July 2014). For the second night of surveying, the transect start and end points were reversed.

Bat calls were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly.

5.1.6 Walked transect surveys

Walked transect surveys took place in June and July 2014. Twenty-one survey sites were selected and a transect route was designed within this to encompass a representative sample of the habitats within the study area. These areas are shown on Figure 8.4.1 and 8.4.2 of the EIA Report.

Prior to the detector survey commencing, the survey sites were walked during the day to plot a route and identify any health and safety issues. Surveys were conducted on nights with potential for high levels of bat flight activity (i.e. warm, dry, calm conditions).

Surveying commenced 45 minutes after sunset. Bat activity was recorded using EM3 bat detectors (Wildlife Acoustics) with a GPS unit (Garmin) attached to record the location of bat calls and to plot the transect route. Detectors were set to record continuously, saving call files in the compressed WAC format. Each transect was walked once. In addition, an Anabat SD1 or an SM2 detector was placed overnight in suitable bat habitat along the transect routes.

Bat calls recorded using EM3 detectors were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly. Bat calls recorded on the Anabat detectors were analysed using the software AnalookW (Titley Scientific).

5.1.7 Static detector activity surveys

In 2014, as part of the Constraints and Route Selection studies, static detector surveys of bat activity in selected locations within the study area were conducted from the 12 August to the 2 November 2014. Twenty-four sites for static detector deployment were selected across the study area to survey the bat species present at different locations, as well as to collect comparative data on species richness and general levels of bat activity. The locations of the static detectors are shown on Figure 8.22.1 of the EIA Report. These locations were selected to cover a range of habitat types and to cover locations that may be crossed by potential route options. The static detectors used were SM2 or SM2+ bat detectors (Wildlife Acoustics). Detectors were set to record in WAC format from half-an-hour before dusk to half-an-hour after dawn set to automatically trigger in response to potential bat calls.

Static monitoring using SM3BAT bat detectors (Wildlife Acoustics) was also conducted at three underground sites in the study area (Cooper's Cave, Newry's Cave and Prospect Hill Railway Tunnel) in the autumn period from the 29 September to the 31 October 2014 and in winter from 4 February to 26 March 2015, in order to determine their use during the autumn mating and winter hibernation periods. An additional bat detector (Wildlife Acoustics SMZC) was placed in the chimney flue in Menlo Castle in winter, underneath the known maternity roost, to determine if bats were present there during the hibernation period. Whilst Lesser horseshoe bats are generally inactive in winter, they do wake up to move around the roost space, and to feed and drink water, and can be detected doing so by the installed equipment. Licences specifically permitting these winter surveys, under certain conditions to protect the roosts and bats, were acquired from the NPWS (DER/BAT 2014-39 and DER BAT 2015-02).

In order to collect long-term data on the bat species flying in specific locations along the route of the proposed road development) in 2015, 42 locations were monitored from the 7 July to the 23 September 2015 using a range of static detectors: seven SM2, one SM3 and one SMZC detector – for locations see Figure 8.22.1 of the EIA Report. Detectors were left to record at each location for a five-night survey period and this was repeated twice providing three survey periods. The static detectors were deployed at locations where the corridor of the proposed road development intersected linear features or woodland edges in the proximity of known bat roosts, or in areas where bats had previously been recorded. The siting of detectors also targeted areas where less-common species were known to occur such as the Lesser horseshoe bat and also for recording “quieter”[11] Brown long-eared bat and *Myotis* bat species.

Of the 42 locations, 19 were subject to further long-term static detector surveys (10 September to 9 October 2015) to determine if bats were flying near linear features and woodland severed by the proposed road development (see Figure 8.22.1 of the EIA Report for locations). Whilst bat flight paths are not restricted to always following linear features, these were regarded to be landscape features that could be severed by the proposed road development. The locations were chosen based on the results of the long-term static detector monitoring carried out earlier in the year outlined above. Locations that had suggested very high bat activity and those with records of less common and quieter species were prioritised; e.g. Lesser horseshoe bats, Brown long-eared bat and *Myotis* bats. For these “crossing point surveys” an SM2 with two microphones was deployed for three consecutive nights at each location. One microphone (fixed to the SM2 unit) was placed on one side of the proposed road development, a second was placed on the opposite side of the proposed road development and connected to the same SM2 unit by a 50m cable. Analysis of bat calls and their temporal relationship were then used to support the identification of bats likely to have crossed the proposed road development – i.e. a bat call recorded at one microphone, followed by a call from the same species within a certain recording interval (between 8 and 30 seconds), was a “potential crossing”. The choice of time period was based on a variety of sources of data which quotes bat flight speeds of “small species” of 3-8m/s (18-29km/h), Pipistrelle species 4.4m/s, Lesser horseshoe bats 3.5m/s and Natterer’s bats 4.5m/s (Baagøe, 1987 and Jones and Rydell, 1994). This method also varies in effectiveness for different species and for different flight characteristics as fast commuting bats with loud echolocation calls (e.g. Leisler’s bats) would be detected almost simultaneously by both microphones. Quieter bats (echolocation calls only detected at close range) which may have more weaving flight patterns, such as Lesser horseshoe bats when foraging, could take much longer to pass between the two detector microphones.

In order to ground-truth the results of the crossing point surveys, manual surveys were also conducted on one night when the static detectors were recording. Surveyors recorded bat flight activity at each location, over a period of 2 hours after sunset, from a vantage point using a hand-held bat detector (Batbox Duet) and recorded the time bats were recorded on the detector and/or visually along with the direction of bat flight. Surveys concluded when bats could no longer be seen.

Bat calls were analysed using the Kaleidoscope auto-identification software (Wildlife Acoustics) and were all manually verified to ensure the software identified calls correctly.

[11] Presence/absence of Brown long-eared bats and some *Myotis* species of bats can be problematic in manual, roving surveys as their echolocation calls have limited volume and range. Longer-term monitoring increases the chances of encountering them.

In order to record and assess bat activity within the lands proposed for habitat enhancement at Menlough, four SM2BAT+ detectors placed along hedgerows from 28 July - 11 August 2017, and again from 2 – 15 May 2018.

5.1.8 Radio-tracking studies

Radio-tracking of bats allows accurate recording of where bats are flying from their roosts, where they feed and other roost sites. It is an intensive method of data collection but provides very useful and reliable data for impact assessment purposes. Radio-tracking work undertaken as part of the collection of baseline data for the purposes of impact assessment was undertaken over four sessions, over two seasons in 2014 and 2015:

- Session 1: 30 July - 7 August 2014 and was led by Greena Ecological Consultancy Ltd., with the aim of radio-tracking Lesser horseshoe bats and (to a lesser extent) vespertilionid bats in order to identify the location and extent of foraging areas and the location of day/night/transitional roosts in the study area
- Session 2: 19 - 29 August 2014 and was led by Geckoella Environmental Consultants Ltd. with the aim of locating vespertilionid bat roosts within the study area
- Session 3: 2 - 9 September 2014 and was led by Greena Ecological Consultancy Ltd., with the aim of identifying and mapping vespertilionid and rhinolophid bat movements to mating sites or winter roosts
- Session 4: 16 - 23 May 2015 and was led by Greena Ecological Consultancy Ltd., with the aim of determining movements of the Lesser horseshoe bats in Menlo Castle during the spring period and to locate day roosts for this species in the western part of the study area

Lesser horseshoe bats were captured at two sites in the wider study area during sessions 1 and 3: Menlo Castle and Cooper's Cave. Bats were captured using mist nets and harp traps as they emerged or arrived at roosts after sunset. Vespertilionid bats were captured at six sites (Bearna Woods, Cooper's Cave, Menlo Woods, Merlin Woods, NUIG, and the NUIG Sporting Campus) using mist nets, harp traps and an acoustic lure (Sussex Autobat) that attracts bats by emitting artificial foraging and social calls (Hill and Greenaway, 2005).

Several licences were issued by the NPWS to permit capture of bats using the traps and use of the acoustic lure and the fitting of the radio transmitters - Refs: C098/2014, C009/2014, 027/2014, C004/2015, C033/2015, C085/2015, DER/BAT 2015-24.

Captured bats were identified to species level and weighed to determine if they were suitable for tagging with radio transmitters. Radio transmitters (Biotrack and Holohil) were glued between the fur-clipped shoulder blades of the bats using latex adhesive and usually detached from the tagged bat within two weeks of being attached. Priority was given to tagging female Lesser horseshoe bats, *Myotis* bats and Common pipistrelles as at that time little was known about where these species were flying, feeding and roosting.

Bats were tracked using Australis 26K and Sika UHF radio receivers with Yaggi rigid aerials. Omni-directional antennas were used to search for bats by vehicle. Both receivers were able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any one time. For sessions 1 and 3, bats were tracked at night while they were foraging to determine home ranges, core foraging areas and identify night roosts; bats were also located using the telemetry signal during the day to identify roosts. For session 2, bats were only tracked during the day to locate roosts. For sessions 1 and 3, foraging and commuting bats were observed from fixed (often elevated) points where suitable radio reception was available, such as at elevated or other suitable vantage points. Where possible, surveyors made close approaches to bats to ascertain the exact foraging area and behaviour, or to attempt pursuit if the bat was moving away. Accurate bearings of bat locations were simultaneously taken, by two or more surveyors, from hand held sighting Silva Expedition 54 compasses. These bearings were then used to calculate a location, using the Locate software. GPS units (Garmin) were used to increase the speed and accuracy of the surveyors recording their locations. Over survey nights, surveyors built up a picture of bat commuting routes and of bat foraging areas. Foraging areas were estimated using minimum convex polygons (MCP) and multi-lateral polygons (MLP) generated from the outermost locations radio-tracked bats were recorded. A MCP is defined as an animal’s home range size, with the shape, and position represented by joining the outermost fixes (Mohr, 1947). A MLP is defined as the minimal area between all confirmed points of an animal’s occurrence during a radio-tracking session.

5.1.9 Marking studies

In order to provide long-term data on bat movements that may be recaptured or rediscovered in other roosts (such as hibernation roosts), several bats that were caught as part of the radio-tracking surveys, over both seasons, were fitted with special anodised aluminium rings, each with a unique serial number. The rings were fitted over the forearm of the bat by experienced bat workers under licence from the NPWS (Licence No. C009/2014 and C004/2015). All Lesser horseshoe bats that were fitted with radio transmitters were also marked with rings so that, if captured again within the same survey session, they would not be re-fitted with transmitters. Bats other than Lesser horseshoe bats were also ringed, in an effort to locate mating or winter hibernation sites if these bats were subsequently recaptured in the mating season.

As stated previously, surveys of roosts in winter 2014 and 2015 included looking for Lesser horseshoe bats that were fitted with rings. In order to identify if ringed bats from the study area were interacting with roosts further north – and in particular the roost at Eborhall House (the Qualifying Interest roost for the Lesser horseshoe bats in Lough Corrib cSAC) – internal surveys were conducted on the 21 October 2015, 23 August 2016 and 14 July 2017 at Eborhall House (and Ballymaglancy Cave on 21 October 2015), which are located more than 30km from Menlo Castle on the northern shores of Lough Corrib. Locating ringed bats at sites like these would provide valuable data as to the relationship between winter roost sites and the location where the bat was originally caught and tagged.

5.1.10 Collection of data on Lesser Horseshoe bat population and distribution

An analysis of the NPWS's Lesser horseshoe bat roost database was conducted to estimate the importance of the maternity colony at Menlo Castle for the Lesser horseshoe bat population at a local, regional and national level. The most recent counts and distribution of all summer roosts in counties Galway, Mayo, Clare and Limerick, which make up the northern sub-population of this species in Ireland according to Dool (2011), were used to determine the proportion that the Menlo Castle roost contributes to the summer population in these counties and therefore its strategic importance for the sub-population at a regional level.

Previous records for Lesser horseshoe bats within the study area were sourced from the Bat Conservation Ireland database and the NPWS's Lesser horseshoe bat database. Mr Conor Kelleher, Mr Brian Keely, Dr Kate McAney, Dr Catriona Carlin (Galway Bat Group) and local NPWS conservation ranger Rebecca Teesdale were also consulted to collate any additional summer and winter roost records that were not in the above databases.

This initial desktop assessment was supplemented by data collected during subsequent field surveys.

5.2 Species-specific survey results

5.2.1 Lesser horseshoe bat *Rhinolophus hipposideros*

5.2.1.1 Historical Records

Prior to the commencement of the surveys to inform the constraints and route selection studies for the proposed road development, there were a small number of records of Lesser horseshoe bats in the study area. They comprised records of the bat roosts at Menlo Castle, suspected night roosts at a barn in Menlough Village and two sheds in Coolagh collected as part of the previous EIA for the Galway City Outer Bypass (RPS, 2006). Menlo Castle has been regarded to be a key maternity colony for the area since it was found in August 2000 and has since been monitored annually by the NPWS. Ad-hoc observations during other bat surveys (e.g. BATLAS 2010) also noted Lesser horseshoe bat activity on the western side of the River Corrib at Daingean.

Surveys carried out for other EIAs recorded Lesser horseshoe bats at NUIG (McCarthy, Keville and O'Sullivan. (2014a) and Killarainy near Moycullen (RPS. (2013a).

The general lack of historical roost records and *ad-hoc* observations for this species did not necessarily suggest their low density or absence from specific areas. It is more likely to have been due to both the lack of targeted surveys for this species and the tendency for it to be overlooked due to its very quiet and narrowly-focused echolocation calls which allows it to be detected only at very close range.

5.2.1.2 Identification of locations used for winter hibernation

Unlike other Irish bat species, the Lesser horseshoe bat hibernates in the open, hanging from the ceiling from caves, cellars and other structures kept cool in winter. Therefore, it is much easier to find than other bat species at this time of year.

Following the collation of the historical data at the end of 2014, the examination of historical maps and records of caves and underground structures provided a list of locations that could be potential sites used for hibernation. These included:

- Menlo Castle
- Merlin Castle
- Ballybrit Castle
- Roscam Round Tower
- Cooper's Cave
- Newry's Cave
- Dangan Ice House
- Souterrain in the townland of Lydican

The interior of Ballybrit Castle and Merlin Castle were inaccessible for winter surveys that were undertaken in 2014 and therefore use of them by this species could not be ruled out. Of the others, the only evidence of Lesser horseshoe bats was found in Cooper's Cave near Castlegar, where a small number of fresh droppings characteristic of this species were recorded in the rear of the accessible part of the cave, suggesting recent use.

Daytime visual inspections of accessible locations were also undertaken in February and March 2015. Six Lesser horseshoe bats were recorded within Cooper's Cave on the February visit. All bats were in a state of hibernation. It was noted that two of the bats were ringed. The ring numbers (which could be read without disturbing the bats) corresponded to the following bats ringed as part of the bat surveys in summer 2014: one was a male bat ringed and radio-tracked at Menlo Castle on the 30 August 2014; the other, a male bat ringed and radio-tracked at Cooper's Cave on the 1 September 2014. This confirmed that some of the individuals using the Menlo Castle summer roost also used the cave as a hibernation site, and that bats using Cooper's Cave in summer months also used the cave as a hibernation site.

Cooper's Cave was also checked again on 24 February 2016 and four Lesser Horseshoe bats were recorded in a state of hibernation. None of these bats were ringed. Surveys in January 2018 recorded six hibernating Lesser horseshoe bats present on the 8 January and three on the 11 January (including one ringed bat).

No bats were seen or otherwise recorded within Newry's Cave in 2015 and 2016. It became evident in visits in 2015 that this site floods via underground springs up to ceiling level and therefore would be unsuitable for hibernating bats.

Since Lesser horseshoe bats are known to travel outside their summer ranges to reach hibernation sites, it was necessary to examine similar potential hibernation sites outside of the study area. Checks for bats (and particularly ringed bats) using other known underground sites, were carried out in February 2015. Five Lesser horseshoe bats (not ringed) were found hibernating in Cloonnabinnia Cave, outside Moycullen. A large pile of Lesser horseshoe bat droppings was also found in Moycullen Cave suggesting that it is used as a roosting site but this may be used at other times of year. In 2018, winter surveys at Moycullen Cave and at Cloonnabinnia Cave recorded three Lesser horseshoe bats which were found hibernating at each location.

Attempts were made to gain access to land where the cave curiously named "*Rhinolophus* Retreat" is located; however, entry to lands was not possible. A souterrain near Athenry was also visited but is probably unsuitable for use by Lesser horseshoe bats as the entrance was blocked.

The results of the surveys of potential hibernation sites for this species of bat indicated that Cooper's Cave and Menlo Castle provide winter hibernation conditions, for several individuals, in the vicinity of the proposed road development. However, both sites are vulnerable to human disturbance or changes within the roosts due to rockfall. There is also the possibility that other concealed voids in limestone features could also host hibernating bats.

5.2.1.3 Identification of locations used in Summer

Evidence of Lesser horseshoe bats was recorded at 15 structures, including Menlo Castle (PBR06) during the summer roost surveys in 2014 and 2015. Most roosts were located in the vicinity of Menlough and Castlegar. Outside these two areas, a day roost (PBR178) containing 9 bats including 5 juvenile bats was located in the garage of a house in the Aughnacurra residential estate on the western side of the River Corrib, adjacent to the NUIG Sporting Campus. In August 2018, two counts were undertaken at this roost: twelve Lesser horseshoe bats were recorded on the first night, and ten on the second night. Two of the Lesser horseshoe bats present at the Aughnacurra roost on the 28 August 2018 were ringed, confirming the link between the roost sites at Menlo Castle, Cooper's Cave and this satellite roost[12].

A night roost was also found in another garage in this estate (PBR210). Figure 8.18.1 of the EIA Report shows these locations.

Other Lesser horseshoe bat roosts found on the western side of the city and surrounding environs included two-night roosts in vicinity of Bearna Woods (PBR124, PBR115), north of Bearna (PBR217) and a roost in the townland of Aubwee just off the N59 Moycullen Road to the north west of the city (PBR44). All "night roosts" were confirmed as such, when Lesser horseshoe bat droppings were recorded but the structure was deemed to be unsuitable as a day roost and no bats were seen in-situ.

[12] To the best of the author's knowledge, at the time of writing, the only Lesser horseshoe bat ringing programme undertaken locally in recent years was that undertaken in 2014 and 2015 as part of the N6 GCRR surveys, where bats captured at Menlo Castle and Cooper's Cave were ringed (see Appendix A.8.1, Section 1.4.9). Therefore, the ringed Lesser horseshoe bats observed at Aughnacurra are individuals ringed during the 2014/2015 studies at Menlo Castle and Cooper's Cave

On the eastern side of the city and surrounding environs, one Lesser horseshoe bat night roost (PBR21) was located adjacent to the Corinthian's Rugby Club off the N83 Tuam Road to the north east of the city, while a day roost with a single bat was found in a disused bungalow adjacent to Ballindooley Lough (PBR25).

Lesser horseshoe bats at Menlo Castle (PBR06) were monitored from 2006-2017 by the NPWS and more recently by surveyors from Scott Cawley Ltd. Lesser horseshoe bats can be very difficult to count on emergence as they tend to fly in and out of the roost entrance. Monitoring of the roost in 2016, 2017 and 2018 used infra-red cameras and reflects the most accurate count for this roost.

Table 2: Numbers of Lesser horseshoe bats recorded emerging from Menlo Castle

Date	Count	Source	Comments
16/06/2006	2	NPWS	-
24/06/2009	26	NPWS	-
07/07/2009	38	NPWS	-
29/6/2012	23	NPWS	-
02/07/2012	27	NPWS	-
13/06/2013	21	NPWS	-
04/06/2014	18	NPWS	-
18/06/2014	35	NPWS	-
08/07/2014	27	Scott Cawley Ltd	-
18/05/2015	5	Scott Cawley Ltd	Disposable barbeque found in fireplace suggesting disturbance
21/05/2015	12	Scott Cawley Ltd	-
29/06/2015	32	Scott Cawley Ltd / NPWS	-
09/07/2015	29	Scott Cawley Ltd/NPWS	Inclement weather
20/08/2015	28	Scott Cawley Ltd / NPWS	Two bats did not emerge
29/08/2016	35	Scott Cawley Ltd	Counted from infra-red video camera footage. 2-3 bats may have remained in the roost
11/08/2017	43	Scott Cawley Ltd	Counted from infra-red video camera footage. 1 bat exited from small chimney
22/08/2018	20	Scott Cawley Ltd	Counted from infra-red video camera footage.
27/08/2018	15	Scott Cawley Ltd	Counted from infra-red video camera footage.

The roost numbers showed variability in the counts but have averaged 27 bats over the last ten years. This variability may be explained by bats using different (unknown) exit points on some nights, difficulties in counting in low light conditions and weather conditions in preceding nights which may have forced some bats to use alternative roosts. Infra-red footage in 2016 suggested that bats fly out quickly at very low levels and could have been easily overlooked by conventional emergence monitoring techniques.

Additional data on the roosts used by this species was collected during the radio-tracking in 2014 and 2015. 13 Lesser horseshoe bats were captured and fitted with radio-transmitters in the first radio-tracking session in August 2014. Ten of these (seven females and three males) were caught at the Menlo Castle roost (PBR06) and three (all males) were caught at Cooper's Cave (PBR). Five bats were captured and fitted with radio-transmitters in the September session; one (female) was caught in Menlough Woods and four (three males and one female) were captured at Cooper's Cave (PBR112). The radio-tracking in August 2014 resulted in the identification of six day roosts and 11 night roosts for this species (Figure 8.18.1 of the EIA Report shows these locations). Three of the six daytime roosts and seven of the night roosts had already been identified as Lesser horseshoe roosts from the building inspections undertaken in 2014. Nine additional daytime roosts and eight additional night roosts were subsequently identified in the September 2014 session of radio-tracking. Only three roosts (Menlo Castle PBR06, Cooper's cave PBR112 and a shed in Angliham Quarry PBR126) were used by bats during both tracking sessions. All roosts used by radio-tracked bats were located in the vicinity of Menlough Village, Coolagh, Castlegar and Angliham Quarry.

To conclude, the surveys found Lesser horseshoe bats using several roosts in the daytime in summer including those consistently used such as Menlo Castle and Cooper's Cave. Inspections of other structures and radio-tracking recorded other day roosts and a network of night roosts.

Eborhall House and Ballymaglancy Cave, located to the north of Lough Corrib, are both important roost sites for breeding and hibernating Lesser horseshoe bats respectively. Eborhall House is the "qualifying" roost for the Lough Corrib cSAC whilst the nearby Ballymaglancy Cave is a cSAC in its own right (No. 000474) and is thought to provide hibernation roosts for the bats from Eborhall House.

As part of the assessment of the potential movement of this bat species across the landscape, it was deemed important to determine if any of the ringed bats[13] that were roosting near the proposed road development were also using these "qualifying" roosts, even though they are located a considerable distance to the north (more than 30km).

Surveys were undertaken at Eborhall House and Ballymaglancy Cave to determine the presence of Lesser horseshoe bats that were ringed at roosts within the study area. These were undertaken under licence DER/BAT 2015-03, DER/BAT 2016-09, DER/BAT 2016-28 and DER/BAT 2017-06) on 21 October 2015, 23 August 2016 and 14 July 2017. Surveys in 2015 were undertaken by Paul Scott (Scott Cawley Ltd) with Mr John Higgins (NPWS Local Conservation Ranger) and in 2016 by Dr Daniel Buckley and in 2017 by Paul Scott. Daytime visual surveys were undertaken to count and identify any marked bats. Only the October 2015 surveys included Ballymaglancy Cave. No ringed bats from the study area were recorded during these visits.

[13] See the species accounts in this section for details on bats that were ringed.

5.2.1.4 Evidence of bat activity

This section summarises the results of the various surveys that recorded Lesser horseshoe bat activity across the study area. Survey methods include vehicle transects, walked transects and use of static detectors at fixed locations in 2014 and 2015 covering both summer, autumn and winter seasons. The results of the radio-tracking are also summarised separately in this section.

Lesser horseshoe bats were not recorded during the vehicle transect surveys but would not normally be expected to be easily detected due to their quiet and directional echolocation calls. However, the walked transect surveys recorded this species at Menlo Castle and Cooper's Cave. Static bat detectors deployed during the walked transects recorded this species by a culvert on the existing N6 (where the Terryland River flows under the road), by the Coolagh Lakes and by Ballindooley Lough.

The static bat detectors deployed in 2014 (Figure 8.18.1 of the EIA Report), recorded Lesser horseshoe bats at 14 (out of a total of 24) locations. Static detectors S5, S6 and S21 recorded the highest amount of activity for this species, which reflects their proximity to Menlo Castle (see summary of radio-tracking studies below). Beyond the Menlough area, Lesser horseshoe bats were also recorded at a woodland edge in the Ballindooley area (S2), close to a known roost identified during the building surveys, in the hazel scrub-limestone pavement complex east of Menlough (S4 and S22), within the grounds of Glenlo Abbey Hotel (S8), in Castlegar Valley (S10), on three sites on the north western edge of Galway City (S11, S13 and S15), the outskirts of Bearna Village (S19), and two sites on the north eastern edge of Galway City just to the north of Galway Technology Park (S1, S24).

The static detectors deployed in 2015 along the alignment of the proposed road development (at that time) recorded Lesser horseshoe bats at 15 locations. Activity was recorded within the known foraging area of the Menlo Castle roost as indicated by the radio-tracking results (see below), including along the woodland edges, south of Menlo Castle, within the limestone pavement area of Lough Corrib cSAC, Lackagh quarry and on field boundaries north of Castlegar Village, into the area south of Castlegar Village near Cooper's Cave.

Lesser horseshoe bat activity was also recorded within the grounds of NUIG, east of Galway Racecourse at Ballybrit and on the Bearna Stream, north of Bearna Woods.

For the crossing point surveys, possible recordings of Lesser horseshoe bats that were made on both microphones, that could suggest bats flying across the proposed road development, were recorded at 2 (out of a total of 21) sites for Lesser horseshoe bat: CP7 and CP9. CP7 had one potential crossing record, while CP9 had 35 potential crossing records.

In order to record and assess bat activity within the lands proposed for habitat enhancement, four SM2BAT+ ultrasound detectors were placed along hedgerows from 28 July - 11 August 2017. Detectors were also placed in hedgerows on the bóithrín at Menlo which is crossed by the proposed road development. Lesser horseshoe bats were recorded at both locations with 132 recordings made in the proposed habitat enhancement lands and 81 recording made along the bóithrín. An

SM2BAT+ detector was also deployed from 2 – 15 May 2018 at one of the same locations within the lands proposed for habitat enhancement and two detectors were also deployed in the field to the south toward the River Corrib in order to measure usage of different areas over the same time period. On this second occasion, Lesser horseshoe bats were recorded at all three locations with 102 recordings made by the two detectors in the fields to the south and only 12 recordings in the proposed habitat enhancement lands.

These results demonstrated that the proposed habitat enhancement area was accessible for Lesser horseshoe bats and is a suitable area for increasing the amount of foraging habitat within it.

Monitoring of bat activity at Cooper's Cave, Newry's Cave and the City Centre Railway Tunnel took place in the autumn of 2014 and late winter in 2015. A small number of Lesser horseshoe bat calls were recorded on the 26 and 28 September 2014 in Newry's Cave. A large number of Lesser horseshoe calls were recorded throughout September 2014 and October 2014 in Cooper's Cave, which would suggest that Cooper's Cave is used in the mating season for this species. Lesser horseshoe bat activity was recorded at Cooper's Cave and Menlo Castle during the late winter activity seasons in 2015. Therefore, based on these activity surveys undertaken after the radio-tracking studies it was concluded overall that Lesser horseshoe bats use Menlo Castle and Cooper's cave throughout the year – Menlo Castle for breeding and hibernation and Cooper's Cave for mating and hibernation.

The radio-tracking surveys allowed the patterns of foraging and flight paths to be identified for this species. In August 2014, the maximum foraging distance from Menlo Castle ranged from 0.59km up to 5.15km, with the average maximum distance of foraging area from the roost being 2.93km. On average, males foraged slightly further afield, with the average maximum distance from the roost 3.68km, while females averaged a maximum distance of 2.29km. See **Figure 57** in **Annex A**.

In September 2014, the maximum foraging distance from the roost ranged from 1.11km up to 4.40km with the average maximum distance of foraging from the roost being 3.39km. On average, males foraged a maximum distance from the roost of 2.88km, while females averaged a maximum distance of 4.16km. See **Figure 58** in **Annex A**.

The overall foraging area in August comprised 21.75km^2 (MCP) or 13.70km^2 (MLP)[14], whilst it was 56.10km^2 (MCP) or 26.46km^2 (MLP) in September. Foraging areas recorded in both August and September, overlapped in woodland and field boundaries in the Menlo Castle and Menlough Village areas; suggesting that these areas were core foraging areas. The area of overlapping areas from August and September was 11.96km^2 (MCP) or 8.1km^2 (MLP). Field systems and quarries north-east and east of Menlo Castle and field systems north of Cooper's Cave also served as foraging areas. See **Figures 57** and **58** in **Annex A**. The majority of Lesser horseshoe bat foraging areas in August and September overlapped in the area of the River Corrib, field boundaries and woodland around

[14] A MCP is defined as an animal's home range size, with the shape, and position represented by joining the outermost fixes (Mohr, 1947). A MLP is defined as the minimal area between all confirmed points of an animal's occurrence during a radio-tracking session.

Menlo Castle and Menlough Village, limestone pavement, woodland, scrub and lake around Coolagh and Menlough Village, field boundaries and scrub around Castlegar and Ballindooley Lough, and a disused quarry in Angliham.

None of the foraging areas recorded in 2014 extended south of the existing N6, towards Galway City.

In May 2015, four Lesser horseshoe bats were captured and tagged. Two of the bats had been captured, tagged and ringed in 2014. Rings were placed on the new bats.

Three day roosts were identified during the radio-tracking session in 2015. Three out of the four bats consistently used the maternity roost in Menlo Castle (PBR06). One bat utilised a previously-unknown roost in a boulder field located in an abandoned quarry just south of Coolagh Lakes (PBR218) over several days before returning back to Menlo Castle (PBR06) Another bat used a void within a natural limestone structure located within Menlough Woods (PBR219) to roost. All of these daytime roosts were also used in the night for short periods of resting at night.

The overall foraging area of Lesser horseshoe bats tracked in 2015 covered 16 km^2 (MCP) or 10.22km^2 (MLP). The core foraging area of all bats extended over 1.25km^2. The majority of foraging areas overlapped in the area of Menlo Castle, Menlough Woods and Menlough Village in a similar pattern recorded in 2014. This was considered to be the core foraging area from where bats travelled both north towards Lough Corrib and south following the River Corrib. See **Figure 11** in **Annex B**.

The overall foraging area in May 2015 was smaller than recorded in the late summer /early autumn tracking periods in 2014. It is possible that the low night-time temperatures in May 2015 resulted in shorter foraging periods and shorter travel distances.

Based on the results of the radio-tracking studies carried out in 2014 and 2015, it was concluded that Lesser horseshoe bats utilised existing woodlands, field boundaries and watercourses for foraging and navigating during this period. Areas of scrub over limestone pavement were often used as foraging areas for prolonged periods of time. Quarries in the local area (including Lackagh Quarry and Angliham Quarry) appeared to be of importance to Lesser horseshoe bats with records of bats spending time both feeding and night roosting there. Areas used both during the late maternity period in summer as well as for foraging in preparation for hibernation in late summer are regarded to be crucial in supporting the local Lesser horseshoe bat population.

The radio-tracking studies confirmed a strong link between the maternity roost present at Menlo Castle (PBR06) and Cooper’s Cave (PBR112). Although there is a direct connection between both sites via the River Corrib and Terryland River, the radio-tracked bats tended not to utilise this potential commuting route and instead travelled overland via Lackagh quarry to the Terryland River Valley, via a small area of green space around Castlegar Village. Bats were regularly recorded commuting between these two sites and have been confirmed to be a part of the same Lesser horseshoe bat population.

Radio-tracking data also suggested that Cooper's Cave (PBR112) is an important roosting site for male Lesser horseshoe bats in summer and an important autumn mating site in the area as well as a hibernation site for this species.

5.2.2 Leisler's bat *Nyctalus leisleri*

5.2.2.1 Historical records

Leisler's bats have been recorded across the study area as bat detector records and have also been recorded using bat boxes in Rusheen Bay, which are the only previous roost records for this species. Detector records include for NUIG (A.P. McCarthy Planning Consultants (2007a), McCarthy, Keville & O'Sullivan (2014a) McCarthy, Keville & O'Sullivan (2014b)) Moycullen and Ballycuirke Lough (Galway County Council/Roscommon National Roads Design Office (2011). Since this bat can travel long distances from its roost each night, detector records do not necessarily suggest that bats are roosting nearby.

5.2.2.2 Identification of Roosts

No winter roost sites were recorded in any of the surveys for the proposed road development. Radio-tracking of three bats captured in 2014 and 2015 provided locations of four day roosts (PTR45, PB134, PBR139, PBR146). See Figure 8.19.1 of the EIA Report for locations of these roosts for this species.

In 2014, a single male Leisler's bat was captured and tagged in Menlough Woods. Radio-tracking indicated that the maximum distance that this individual was recorded travelling was 4.85km over a foraging area of 8.96km^2 that encompassed the southern area of Lough Corrib, the River Corrib and the Menlough area. Two roosts used by this individual were also located; a large modern house along the N84 Headford Road near Ballinfoyle (PBR134) and an ash tree at the edge of Menlough Woods (PTR45) (within the footprint of the proposed road development). See **Figure 44** in **Annex A**.

Another two male Leisler's bats were captured, ringed and tagged in Bearna Woods in the second radio-tracking session in 2014. However, data was only collected for one of these bats as the second could not be located. The bat that could be tracked was found to roost during the day at two modern dwelling houses on the Cappagh Road (PBR139, PBR146). Refer to **Figure 3l** in **Annex C**. This bat had a recorded foraging area of 13.62km^2 (MCP) that encompassed the southern area of Lough Corrib, along the River Corrib corridor and Menlough area.

5.2.2.3 Evidence of bat activity

Leisler's bats were recorded widely across the study area during the walked and vehicle transect surveys. However, few calls were recorded within the urban habitats within the more developed areas in Galway City. The species was recorded at every static detector location which reflects this widespread and far-ranging species during its foraging activities.

The static detectors deployed in 2015 recorded Leisler's bats at 32 (out of a total of 42) locations along the route of the proposed road development. The highest levels of activity were recorded over the River Corrib and Lackagh Quarry (see Figure 8.22.1 in the EIA Report).

During the crossing point surveys, indications of potential crossings were recorded at 6 (out of a total of 21) sites for Leisler's bat; CP5, CP6, CP8, CP10, CP14, CP15. It is reasonable to assume that the approach taken for detecting bat crossings is not effective for this species. The Leisler's bat loud echolocation calls would be received by both microphones simultaneously and therefore crossings could not be confirmed. However, since this is a fast and high-flying bat it is regarded to be less impeded by severance of features at ground level (an "open airspace species" according to Elmeros et al, 2016).

5.2.3 Common pipistrelle bat *Pipistrellus*

5.2.3.1 Historical records

Common pipistrelle bats have been recorded across the study area including the grounds of NUIG (A.P. McCarthy Planning Consultants (2007a), McCarthy, Keville & O'Sullivan (2014a) McCarthy, Keville & O'Sullivan (2014b)). None of these observations would appear to be records of roost sites and are records from bat detector surveys.

5.2.3.2 Identification of locations used in Summer

Building inspections carried out in 2014 and 2015 identified four roosts used by Common pipistrelle bats. One was located in an outbuilding in the Ballindooley area (PBR07), a small roost of 3-4 bats was found in a large shed adjacent to the N83 Tuam Road in Cappanabornia (PBR228) and single bats were observed at the stable block in Galway Racecourse in Ballybrit (PBR205) and an abandoned bungalow to the north of Bearna Village (PBR220). Refer to Figure 8.21.1 of the EIA Report).

Six common pipistrelle bats were captured during the radio-tracking session in 2014; two at NUIG, two at the NUIG Sporting Campus, and two at Menlough Woods. The male and female bats captured in NUIG were tagged, ringed and tracked to their day roosts. The female was found to roost in two modern buildings in a housing estate at Ballymoneen (PBR141, PBR147,) on the north-western edge of the city, while the male was found to roost in two modern agricultural barns in Cloonacauneen (PBR148, PBR149), to the north of the Roadstone Quarry. Refer to **Figure 3F**, **3G** in **Annex C**.

No winter roosts for this species have been recorded.

5.2.3.3 Evidence of bat activity

Common pipistrelle bats were recorded widely across the study area during the walked and vehicle transect surveys. However, very few calls were recorded within the more developed areas within Galway City apart from areas adjacent to the River

Corrib. The species was recorded at all 24 static detector locations in 2014. Refer to Figure 8.21.1 of the EIA Report for these locations.

The static detectors deployed along the proposed road development recorded Common pipistrelle bats at 34 (out of a total of 42) locations. The highest level of activity was recorded in Lackagh Quarry (RS13), a hedgerow in a field adjacent the N83 Tuam Road (RS26), a hedgerow adjacent to the Coolagh Roundabout (RS29) and along a hedgerow bordering the Aille Road, north of Bearna Village (RS40). Refer to Figure 8.21.1 of the EIA Report for the locations of these transects.

During the crossing point surveys, possible crossing records were recorded at 16 (out of a total of 21) sites for common pipistrelle bats. Seven sites recorded more than 10 possible crossings for this species; CP6, CP9, CP10, CP11, CP14, CP15, CP16. Relatively high number of possible crossings were recorded at CP9 (88 possible crossings) and CP10 (630 possible crossing records). Refer to Figure 8.21.1 of the EIA Report for the locations of these records.

5.2.4 Soprano pipistrelle bat *Pipistrellus pygmaeus*

5.2.4.1 Historical records

This species has been previously recorded across the study area and include records at Daingean, (A.P. McCarthy Planning Consultants, 2007a), Merlin Park (Browne and Fuller, 2009), Bearna Woods (Browne et al, 2009), Ballyquirke (Galway County Council/Roscommon National Roads Design Office, 2011) and NUIG (McCarthy, Keville and O'Sullivan, 2009a, 2014a, 2014b). A historical record was also provided by the NPWS of a roost from Menlough Village in 2014 (R. Teasdale, pers. comm, 2015) a single bat was known to roost in Menlo Castle in 2000 (RPS, 2006).

5.2.4.2 Identification of locations used in Summer

Building inspections carried out in 2014, 2015 and 2016 identified 13 roosts of this species. These were located in Aubwee, Ballybrit, Ballindooley, Letteragh, Gortacleva, Roscam, Bearna Woods, Bearr Aile, Truskey West, Aughnacurra and Coolagh. Seven of these roost sites were at locations with unoccupied farm buildings and houses (PBR196, PBR205, PBR237, PBR241, PBR42, PBR44, PBR49), and roosts were found in occupied buildings in Bearna Woods (PBR222), Aughnacurra residential estate (PBR177, PBR255) and Coolagh (PBR179).

A single soprano pipistrelle bat was observed emerging from an oak tree (PTR40) in a field located to the south of Menlo Castle in the summer of 2015.

Refer to Figure 8.21.1 of the EIA Report for locations referred to above.

5.2.4.3 Evidence for bat activity

Soprano pipistrelle bats were recorded widely across the study area during the walked and vehicle transect surveys. However, very few calls were recorded within the more developed areas within Galway City apart from areas adjacent to the River

Corrib. This species was recorded at all 24 static detector locations deployed in 2014.

The static detectors deployed in 2015 recorded soprano pipistrelle bats at 37 (out of a total of 42) locations along the route of the proposed road development. The highest levels of activity were recorded near the River Corrib (RS1 and RS2), in proximity to a confirmed roost in Aughnacurra Housing Estate (RS8) and a hedgerow adjacent to the existing Coolagh Roundabout (RS29). Figure 8.4.1 and 8.4.2 of the EIA Report shows the locations of these surveys.

During the crossing point surveys, bat activity suggesting possible crossings was recorded at all 21 survey locations for soprano pipistrelle bats. Thirteen sites along the route of the proposed road development recorded more than 10 possible crossing records for this species.

Refer to Figure 8.21.1 of the EIA Report for locations referred to above.

5.2.5 Nathusius' pipistrelle bat *Pipistrellus nathusii*

5.2.5.1 Historical records

This is the only bat species that has not been previously recorded in the study area. Only one record exists at a county level for an ad-hoc observation made in Oughterard in 2007 according to the Bat Conservation Ireland database.

5.2.5.2 Evidence for bat activity

Nathusius' pipistrelle bats were recorded during the walked and vehicle transect surveys in 2014 but on a much rarer basis than the other two *Pipistrellus* species. They were recorded in an area of farmland east of Galway Technology Park, Bearna Woods, Coolagh Lakes and Letteragh.

The species was recorded at 20 (out of a total of 24) static detector locations in 2014, although they again were much less frequent than the other *Pipistrellus* species but suggested that the species was more widespread than was shown by the walked and vehicle transects. Sites with highest numbers of calls included S20, S16, S21 and S06, which were located around the River Corrib. See Figure 8.20.1 of the EIA Report for the locations of these records.

The static detectors deployed in 2015 along the route of the proposed road development recorded Nathusius' pipistrelle bats at one (out of a total of 42) location, in Lackagh Quarry (RS13), where two calls were recorded.

During the crossing point surveys, evidence for Nathusius' pipistrelle bats crossing the route of the proposed road development were recorded at CP14 and CP20 (2 out of a total of 21). Only single "passes" were recorded.

See Figure 8.20.1 of the EIA Report for the locations of these records.

No roosts for this species have been recorded.

5.2.6 Unidentified Pipistrelle Species *Pipistrellus* sp.

Common pipistrelle bats have their peak echolocation call strength at 45kHz and soprano pipistrelle bats at 55kHz. Pipistrelle bat species that echolocate between 48 and 52kHz cannot be accurately identified by their calls and are described as "unidentified" Pipistrelle bat species.

5.2.6.1 Identification of locations used in Summer

No winter roosts for this species were recorded.

Two unidentified Pipistrelle bat roosts were recorded during building inspections in 2014 and 2015. A roost of unknown number was found in a farm house to the west of Bearna Village (PBR224) during an internal survey whilst an old unidentified Pipistrelle bat dropping was found in a bungalow within the grounds of Galway Racecourse in Ballybrit (PBR242).

An unidentified Pipistrelle bat was observed with an endoscope in a crevice in an ash tree (PTR54) in hazel scrub on limestone pavement located to the north of Coolagh Lakes in 2015.

Figure 8.21.1 of the EIA Report shows the locations of these records.

5.2.6.2 Evidence for bat activity

Bat calls that could not be assigned to either common or soprano pipistrelle bats were recorded widely across the study area during the walked and vehicle transects undertaken in 2014. The highest activity was recorded near the River Corrib (RS1), Lackagh Quarry (RS13) and along a hedgerow near Castlegar Village (RS19). See Figure 8.21.1 of the EIA Report for the locations of these records.

The static detectors deployed in 2015 recorded unidentified Pipistrelle bats at 32 (out of a total of 42) locations along the route of the proposed road development. During the crossing point surveys, bat activity suggesting possible crossings were recorded at 14 (out of a total of 21) sites for unidentified Pipistrelle bat species. Two sites recorded more than 10 possible crossing records for this species group: CP9 and CP10.

Figure 8.21.1 of the EIA Report shows the locations of these records.

5.2.7 Brown long-eared bat *Plecotus auritus*

5.2.7.1 Historical records

Baseline data presented in documentation supporting planning applications in the study area have recorded a Brown-long eared bat roost of more than 20 bats in Menlo Castle (RPS, 2006) although this was not recorded during the current series of surveys. This commonly-occurring and widespread species is known to occur in Merlin Woods (Browne and Fuller 2009), NUIG campus (McCarthy, Keville and O'Sullivan. (2014a)), Clydagh Bridge and Ballyquirke (north of the study area) (Galway County Council/Roscommon National Roads Design Office. (2011). Bat

Conservation Ireland records for this species show a small number of records in the study area.

5.2.7.2 Identification of locations used in Summer

27 roosts of this species were recorded during the building inspections in 2014-2017. Seven of the roosts could support maternity colonies; a period house on the Letteragh Road (PBR49), Merlin Castle (PBR51), an abandoned bungalow on the R338 to Oranmore (PBR89), a barn on the R399 east of Ballybrit (PBR100), the attic of two houses in Aughnacurra Housing Estate (PBR178, PBR256) and a modern house in the Heath Housing Estate (PBR173).

Twelve additional roosts were also classified as night roosts, while the remaining were not classified. The night roosts were found in the following locations; an abandoned house adjacent to the Corinthians RFC (PBR21), an abandoned house in Rockmount (PBR15), an abandoned three outbuildings near Ballindooley Lough (PBR17, PBR25, PBR111), an outbuilding and archway in Menlough (PBR82, PBR156), an unfinished modern house in Gortacleva (PBR138), a shed in Barr Aile (PBR217), and a shed in Garraun (PBR194), cottage in Ballintemple (PBR105).

During the radio-tracking in August 2014, four brown long-eared bats were captured; two bats at Bearna Woods, one bat at Menlough Woods, and one bat at Cooper's Cave. The female brown long-eared captured at Cooper's Cave was fitted with a radio transmitter and tracked to its daytime roost; a bungalow in Castlegar (PBR145). An emergence count carried out on this building observed six bats leaving the roost. As this bat was an adult female it is likely that this building was being used as a maternity roost. This bat was also tracked during the September radio-tracking session and was found to repeatedly roost in the same bungalow. On one night the bat was recorded night roosting in a stone arch between Menlough Village and Menlo Castle (PBR156) during heavy rain. The maximum commuting distance recorded for this individual in a single night was approximately 4.07km. The foraging area of 2.18km^2 (MCP) mainly encompassed the valley where Cooper's Cave was located but also around Ballindooley Lough. Refer to **Figure 3A** in **Annex C** and **Figure 46** in **Annex A**.

Figure 8.20.1 of the EIA Report shows the locations of these roost records.

5.2.7.3 Evidence for bat activity

Brown long-eared bats were only recorded at two locations during the walked and vehicle transects but these results are typical for this bat species which echolocates very quietly and is therefore difficult to pick up on a heterodyne bat detector on a moving transect. However, they were recorded at 18 (out of a total of 24) static detector locations in 2014, indicating that the species is quite widespread in the study area, consistent with the findings of the summer roost surveys.

The static detectors deployed in 2015 recorded brown long-eared bats at only two (out of a total of 42) sites along the route of the proposed road development, adjacent to the River Corrib (RS1 and RS7).

Figure 8.20.1 of the EIA Report shows the locations of these records.

5.2.8 Myotis bat species

The *Myotis* genus includes three bat species resident in Ireland: Daubenton's bat *Myotis daubentonii*, Natterer's bat *M. nattereri* and the Whiskered bat *M. mystacinus*. There can be difficulty in differentiating between these species of bats using their echolocations calls as there can be similarity between them. Therefore, they have been grouped together for the purposes for reporting these results.

5.2.8.1 Historical records

Previous bat studies have reported in excess of 20 Daubenton's bats recorded roosting in the southern façade of Menlo Castle in 2000. There was no roost recorded in 2005 and 2006 (RPS, 2006), but bats were recorded foraging nearby. Less than 30 Natterer's bats were recorded roosting in outbuildings of Menlo Castle in 2000 but no roost was recorded in 2005 and 2006 ((RPS, 2006). *Myotis* bats were recorded on the NUIG Sporting Campus (McCarthy, Keville & O'Sullivan (2014). There was also a historical record of a roost of Natterer's bats at St James's Church, Bushypark. Natterer's bats were also recorded as part of the surveys carried out for the proposed R336 to N59 Road Scheme (RPS, 2013a). Daubenton's bats have been recorded on the River Corrib from the NUIG lands (McCarthy, Keville and O'Sullivan. (2014a, 2014b)) and also in most watercourses within the city and around its environs. This species is regularly sighted around the Galway Cathedral during bat walks by Galway Bat Group (C. Carlin, pers comm 2015).

Whiskered bats have rarely been recorded across the study area and only *ad-hoc* records from Bat Conservation Ireland exist.

5.2.8.2 Identification of locations used in Summer

Four Natterer's bat roosts were recorded during the inspections of buildings in 2015 (PBR17, PBR20, PBR64, PBR82). These roosts were confirmed based on the presence of droppings, which were analysed using DNA sequencing to confirm the species identity. Locations are shown on Figure 8.19.1 of the EIA Report.

An emergence survey of Menlo Castle (PBR06) carried out on the 8 July 2014 found Daubenton's bats to be still roosting in the castle. Numbers of bats were estimated to be less than 20 bats.

During the radio-tracking in August 2014, nine Daubenton's bats (one female and eight males) were captured in Menlough Woods and a single male Daubenton's bat was captured at Cooper's Cave. One of the male Daubenton's bats captured in Menlough Woods was tagged and tracked. It was found to roost in a stonewall structure on the eastern bank of the River Corrib (PBR133). An emergence count undertaken shortly after recorded 25 Daubenton's bats to be roosting in the wall, suggesting that this was likely to be a maternity roost for this species.

During the second radio-tracking session in August, ten Daubenton's bats were captured (one from Merlin Wood, three from NUIG, and six from Menlough Woods) and four were tagged (one female from Merlin Wood, two females and one male from NUIG). Roosting information was recorded for three of the Daubenton's bats tracked during the second August session. They were found to roost in three buildings (PBR142, PBR143, PBR144) and two bridges (PBR150, PBR152) in Galway City Centre. Foraging data was recorded in the September tracking session for two Daubenton's bats that were captured during the second August session. One bat travelled a maximum distance of 1.06km and had foraging areas of 0.26km^2 (MCP) encompassing Merlin Woods and the Coolagh lakes. The other had a maximum distance of 2.48km and had a foraging area of 0.55km^2 (MCP) encompassing the River Corrib from Menlo Castle into Galway City Centre. Refer to **Figures 48, 49 I Annex A** and **Figure 2, 3B, 3D**, **3E** of **Annex C**.

Two male whiskered bats were captured and tagged during the second radio-tracking session in August 2014 (one from NUIG and one from Merlin Woods). However, the bat caught in Merlin Woods could not be relocated after tagging. The other Whiskered bat was found to roost in two modern dwelling houses (PBR140, PBR151) in a residential estate by the Sports Centre, near Bearna Woods. Foraging data for this individual was gathered during the September radio-tracking session. The maximum distance this bat travelled was 3.71km and had a foraging area of 2.02km^2, encompassing areas of scrub and rough grassland in the Bearna area. Refer to **Figure 47** in **Annex A** and **Figures 2** and **3C** in **Annex C**.

A Natterer's bat was captured in Menlough Woods in August 2014 but was not prioritised for tracking at that time and hence not fitted with a radio-tag. Another male Natterer's bat was captured, ringed and tagged in Menlough Woods during the September radio-tracking session; however, no data was recorded from this bat, possibly due to the bat leaving the area, or transmitter failure.

Figure 8.19.1 of the EIA Report shows the locations of these roost records.

5.2.8.3 Evidence of bat activity

During the walked and vehicle transect surveys and the static detector surveys in 2014 and 2015, the majority of *Myotis* calls were not identified by species due to the overlap in call characteristics between species when analysed. However, on a number of occasions, *Myotis* species were confirmed by visual observations coinciding with echolocation calls. Natterer's bats were recorded at Bearna Woods and Daubenton's bats were seen foraging on the River Corrib and the Terryland River. The majority of *Myotis* bat calls were recorded along the River Corrib and Terryland River during the walked and vehicle transects but were infrequently recorded across the rest of the study area. Figure 8.19.1 of the EIA Report shows the locations of these detector records.

Myotis calls were recorded across all 24 static detector locations in 2014, although at a lower frequency than pipistrelle species. Location S07 recorded the highest amount of *Myotis* activity. This site was close to the River Corrib and the known Daubenton's maternity roost.

The static detectors deployed in 2015 along the route of the proposed road development recorded *Myotis* bats at 25 (out of a total of 42) locations. Activity levels for this species at static locations along the route of the proposed road development was low for this species group but the highest activity was recorded along the River Corrib (RS1), Lackagh Quarry (RS13), an area of woodland adjacent to the N84 Headford Road near Ballindooley and along a stream surrounded by fields and scrub in Ballard East.

During the crossing point surveys, possible crossing records were recorded at 7 (out of a total of 21) sites for *Myotis* bat species, with 1-3 possible crossings recorded at each of these sites.

Figure 8.19.1 of the EIA Report shows the locations of these detector records.

5.3 Personnel

The following personnel carried out the surveys of bat roosts, activity surveys, radio-tracking surveys and all other types of surveys relating to bats include the following:

<u>Dr Daniel Buckley</u>

Daniel has worked in ecological consultancy in Ireland since 2011. He holds a BSc in Applied Ecology from University College Cork and a PhD in bat conservation genetics and ecology from University College Dublin and has published a number of scientific papers relating to Irish mammal ecology and conservation. Daniel has worked as an ecologist on a diverse range of projects including large scale infrastructure projects, industrial and residential developments. He holds a general derogation licence to disturb bat roosts for the purpose of environmental surveys across the Republic of Ireland and a licence to capture and handle bats across the Republic of Ireland. Daniel has served on the board of directors for both Bat Conservation Ireland and the Irish Wildlife Trust and was chairperson of the Irish Wildlife Trust from 2012 to 2015.

<u>Dr Isobel Abbott, Grad CIEEM</u>

Isobel has worked as a freelance ecological consultant specialising in bat surveys since 2012. She graduated first in class in 2007 with a Bachelor of Science degree (BSc) in Zoology, and in 2012 with a PhD in bat ecology and mitigation from University College Cork. She has published a number of scientific papers relating to bat ecology and conservation. Isobel has worked on a wide variety of projects including national bat monitoring surveys, wind farms, roads, rail, industrial and residential developments. She has considerable experience of designing bat surveys, evaluating potential impacts, and designing appropriate mitigation for a range of bat species.

<u>Brian Keeley, MCIEEM</u>

Brian Keeley is an ecological consultant providing mammal surveys for all aspects of bat conservation including biodiversity assessments, development, building repair or demolition, bridge repair by County Council’s Tidy Town nature trails. Brian was the principal author of the TII (formerly NRA) documents on the treatment of bats in road planning and construction. He has surveyed throughout Ireland and has been involved in bat surveying since 1989. He was a founder of the Dublin Bat Group and Bat Conservation Ireland and is licenced to capture and handle bats and to enter bat roosts.

Dr Caroline Shiel

Dr Caroline Shiel has 29 years' experience in the field of bat research and in conducting bat surveys for local authorities, the Office of Public Works, the Heritage Council, private companies and private individuals. She was awarded a BSc in 1989 with first class honours in Zoology at University College Galway. Under the supervision of Professor James Fairley, she was awarded a Ph.D. in zoology in 1998. Her thesis was titled "Diet, foraging and activity at the roost of Leisler's bat (*Nyctalus leisleri*) with special reference to nursery colonies in south Co. Wexford, Ireland." This project included two full seasons of radio-tracking Leisler's bats. Since completion of her Ph.D. Dr Shiel has working as an independent mammal consultant, specialising in bat surveys. She also sets up and runs an online antiquarian book business "Owl Books" which specialises in natural history and Irish history titles. Dr Shiel is a founding member and director of Bat Conservation Ireland. She is a licenced and trained bat handler. She is the author of 9 scientific papers and a regular contributor of species accounts for various mammal atlases and books relating to bats.

Paul Scott CEcol, CEnv, MIEEM

Paul Scott is Director with Scott Cawley. He holds a first class honours degree in Environmental Biology from the University of Liverpool and a Masters in Pollution and Environmental Control from the University of Manchester. Paul is a Chartered Ecologist (CEcol), a Chartered Environmentalist (CEnv) and a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). He is on the Council of Bat Conservation Ireland, leads the Dublin Bat Group and All Ireland Nathusius Pipistrelle Working Group and is a licenced and trained bat handler with experience of hand-netting, harp trapping and mist netting of bats in Ireland and the UK. Paul is experienced in the assessment of impacts of major infrastructural developments on all Irish bat species. Paul has prepared ecological guidance notes designed for planners and developers on behalf of the four Dublin local authorities, including advice on compliance with legal protection for bats.

Geoffrey Billington

Geoffrey Billington founded Greena Ecological Consultancy in 1999, carrying out bat surveys and impact assessments for charity and nature conservation bodies. He has carried out regular contracts for the Countryside Council for Wales, English Nature/Natural England, the National Trust, Scottish Natural Heritage, Bat Conservation Trust, the Vincent Wildlife Trust, and Bristol and Leeds Universities. Geoff has a wealth of experience in working with bats and has been called on to act as specialist witness for public enquiries. He is experienced in designing and carrying out radio-tracking studies of bats. His experience includes academic research and he has provided training on advanced bat surveying techniques including radio-tracking.

Tereza Rush, Ph.D., MSc. (Hons.)

Tereza has over ten years' experience working with bats. Her experience includes trapping, ringing and radio-tagging bats in the UK and other European countries. She regularly participates in radio-tracking studies and examples of projects she has worked on include Hinkley Power Station in Somerset, Evergreen 3 between

Oxford and Bicester in Oxfordshire and the Northern Distributor Road Scheme in Norfolk. She has provided training on advanced bat surveying techniques. She has extensive experience with sound analysis of bat recordings and work with frequency division/heterodyne and time expansion detectors as well as Batcorder and Anabat bat detectors, including analysis. She is experienced in programming and using static bat loggers (for monitoring radio-tagged bats).

Barbara McInerney

Barbara McInerney is a self-employed ecologist, carrying out a variety of habitat, bird and mammal surveys. She initially studied Applied Biology in the Institute of Sligo and later studied Field Ecology in University College Cork. She carries out bat surveys for a variety of developments and is experienced in using a range of bat detectors and software. She is a member of Bat Conservation Ireland and participates in five of their monitoring schemes of bat species on a yearly basis. She studied the use of riparian habitat by bats, researched swarming sites in the North West of Ireland, delivers talks and walks to the general public and has rescued and rehabilitated bats for house owners. She has monitored Brown long-eared bat roosts over the last five years in Co. Sligo and is undertaking the tracking of some of these bats in the North West in 2017. In 2016, she recorded the first evidence of Nathusius Pipistrelle *Pipistrellus nathusii* in Co. Sligo and is committed to researching their presence in the area. She has a bat licence to capture, disturb and photograph bats in Ireland (C88/2017, DER/BAT 2017-74 and 063/2017).

5.4 Interpretation and evaluation

5.4.1 Population size class assessment

The *Bat Mitigation Guidelines for Ireland* (NPWS, 2006) refer to the population size class assessment as being the numbers of bats using a site. The guidelines acknowledge that it can be difficult to estimate the size of the bat population in a local context for a variety of factors including sampling and survey efficiency, population dynamics, seasonal occupation of roosts and gender-specific preferences at each roost site. There is also a wide range of variability in effectiveness in using bat activity data as an indication of density of individuals. The data on local bat populations is most available for Lesser horseshoe bats as the populations of this species has been monitored for several years in Ireland. Other species have varying ranges of data available and subsequently it was not deemed possible to apply the same level of analysis to the other bat species. In the context of the limited distribution of Lesser horseshoe bats in Ireland this species has been given a more detailed level of analysis than other species.

5.4.1.1 Lesser horseshoe bat

Counts of Lesser horseshoe bats made at Menlo Castle were compared to other roost counts to determine the level of importance of Menlo Castle in a county and national context. Based on counts from 2006 - 2016, the maternity roost at Menlo Castle makes up 0.6% (min 0.1%-max 0.6% (38 bats)) of the summer population of Lesser horseshoe bats for the national population of this species and 6% (min

2%-max 6%) of the County Galway summer population. Therefore, while the roost at Menlo Castle does not meet the threshold of representing 1% of the national population to make it of national importance (NRA, 2009), it does exceed this threshold at the County level and therefore would be regarded to be at least of County-importance.

However, based on the distribution of maternity roosts in the range of this species in Ireland, the Menlo Castle maternity roost and the local population it supports, meets the criteria of being of national importance, whereby "a smaller population may qualify as nationally-important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle." (NRA, 2009).

There are only six known maternity roosts in and around Lough Corrib, with the majority of roosts concentrated on the northern shores near Cong (including Eborhall House, the qualifying roost for the Lough Corrib cSAC). Only two maternity roosts are known to be located on the southern end: Ross Lake Gatehouse and Menlo Castle. These southern roosts may be an important stepping-stone for long-term movements and gene flow between bat populations in North Galway and Mayo and populations in South Galway and Clare. Recent counts from Ross Lake Gatehouse have shown that this roost has undergone significant deterioration resulting in decline in numbers from 150 bats in 1994 to five bats in 2011 ((Rebecca Teesdale pers. comm., 2014 and p44 in Roche et al, (2015)). A decline in the Ross Lake roost could potentially increase the relative importance of the roost at Menlo Castle as a stepping stone roost as it is now the only significant maternity colony at the southern end of Lough Corrib. There is no evidence to suggest that Menlo Castle Lesser horseshoe bat population is connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population, nor the QI Lesser horseshoe bat populations of any other European sites.

The numbers of bats using Cooper's Cave is very hard to quantify due to the lack of access to roosting areas underground and the seasonal and gender specific variability in its use. It clearly is used by males and females some of which roost there in summer and also use it for mating. The cave system also supported a small population of hibernating Lesser horseshoe bats (usually averaging 4 bats) although the cave system could not be accessed in its entirety so more bats could have been present underground. The surveys have indicated that Menlo Castle and Cooper's Cave provide hibernation conditions for the local population although since both locations cannot be fully accessed to count individuals, the population size cannot be fully determined. Given the lack of other maternity roosts in the locality which could otherwise be a source of additional bats to occupy hibernacula, it is very unlikely that the winter roost population differs from the summer roost population in the Menlo Castle-Cooper's Cave complex.

Populations of all other bat species are regarded to be important at a local geographic scale since they are regarded to be widespread across the study area, County Galway and at a national scale. Less common bat species, particularly Natterer's and Whiskered bat, were represented within the study area and at a low encounter rate that would suggest a population density comparable to the rest of the country. Nathusius's pipistrelle was recorded flying through the study area but, much like available data on the species for the rest of the country, no roosts were encountered.

5.4.1.2 Numbers of bats

Table 3 presents the nature of each bat roost and the numbers of bats recorded at the roosts identified during the baseline surveys which are the subject of this derogation licence application. This may be as a result of the direct loss of roosts, risk of disturbance caused by construction, the effects of fragmentation of flight paths during construction and operation (residual effects) and loss of foraging habitats closest to these roosts.

The roost locations are shown in Figures 8.18.1-8.21.1 of the EIA Report.

Table 3: Confirmed bat roosts of relevance to the derogation licence application

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
ROOSTS WITHIN THE PROPOSED DEVELOPMENT BOUNDARY			
PBR177	Soprano pipistrelle bat	Emergence and Re-Entry of Bats	12 bats
PBR178	Lesser horseshoe bat Brown long-eared bat	Live bats, Droppings (confirmed by DNA sequencing)	9 Lesser horseshoe bats seen in 2015, 10 Lesser horseshoe bats recorded emerging in 2016. Unknown number of Brown Long-eared bats
PBR179	Soprano pipistrelle bat, Brown long-eared bat	Droppings (confirmed by DNA sequencing)	4 bats emerged in 2015, none in 2016. Possible former maternity roost
PBR182	Pipistrelle species	Old Droppings	Single or small numbers (thought to be unused)
PBR183	Brown long-eared bat	Old Droppings (confirmed by DNA sequencing)	Single or small numbers
PBR196	Brown long-eared bat Soprano pipistrelle bat	Droppings (confirmed by DNA sequencing). Feeding Remains	Single or small numbers. Single Soprano pipistrelle bat emerged
PBR205	Common pipistrelle bat Soprano pipistrelle bat	Bats seen on emergence	4 bats (2016)
PBR210	Lesser horseshoe bat	Droppings in Garage (confirmed by DNA sequencing), night roost	Small numbers

Roost Code	**Species**	**Evidence for bats**	**Number of bats recorded (or likely population)**
PBR241	Soprano pipistrelle bat	Bats recorded during emergent/re-entry surveys.	1-2
PBR253	Unknown	Unknown species. Not re-encountered in 2017	Minimum 1
PBR255	Soprano pipistrelle bat	Bats recorded during emergent/re-entry surveys	1-3 (2016)
PBR256	Brown long-eared bat	Bats seen *in-situ* and during emergent/re-entry surveys (maternity roost)	14 bats seen
PBR204	Brown long-eared bat, Lesser horseshoe bat	Live Bat radio-tracked to roost and droppings	Brown long-eared bat (unknown numbers), Lesser horseshoe bat (minimum 1)
PBR267	Brown long-eared bat Soprano pipistrelle bat	Bats recorded during emergent/re-entry surveys	Single Brown long-eared bat Single Soprano pipistrelle bat
PBR270	Unknown	Single dropping found, old	Minimum 1. Not in active use
ROOSTS ADJACENT TO THE PROPOSED DEVELOPMENT BOUNDARY (<100M)			
PBR139	Leisler’s bat	Live Bat radio-tracked to bungalow	Minimum 1
PBR145	Brown long-eared bat	Live Bat radio-tracked to bungalow at Castlegar	Minimum 1
PBR146	Leisler’s bat	Live Bat radio-tracked to residence at Cappagh Road	Minimum 1
PBR49	Soprano pipistrelle bat, Brown long-eared bat	Droppings in Attic (Pipistrellus species), (confirmed by DNA sequencing). Anecdotal evidence from house owner of Brown long-eared bat	Unknown

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
PBR173	Brown long-eared bat	Droppings (confirmed by DNA sequencing)/large amount suspected maternity roost	Unknown
PBR192	Brown long-eared bat	Droppings (confirmed by DNA sequencing)	Unknown
PBR219	Lesser horseshoe bat	Live Bat radio-tracked to day/night roost in limestone outcrop	1
PBR228	Common pipistrelle bat	Bat recorded during emergence/re-entry	3-4 bats
PBR154	Lesser horseshoe bat	Live Bat radio-tracked to night roost/occasional day roost at Lake View house on N84 Headford Road	1
PBR73	Natterer's bat	Historical Record of bats in St James's Church	Unknown/To be Completed
PBR225	Soprano pipistrelle bat, Brown long-eared bat	Droppings and anecdotal records from owner	Unknown, possible former maternity roost
ROOSTS AWAY FROM THE PROPOSED DEVELOPMENT BOUNDARY (>100M)			
PBR237	Soprano pipistrelle bat	Bat recorded during emergence/re-entry	1-2 bats
PBR06	Lesser horseshoe bat, Daubenton's bats.	Live Bats recorded during emergence from Menlo Castle Maternity roost	35 Lesser horseshoe bats (highest count in 2016) 20-30 Daubenton's bats
PBR07	Common pipistrelle bat	Droppings (confirmed by DNA sequencing)	1-5 (estimated from dropping numbers)
PBR100	Brown long-eared bat	Droppings (confirmed by	10-20 estimated

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
		DNA sequencing)	
PBR112	Lesser horseshoe bat	Droppings and live bats seen in hibernation in Cooper's Cave	4-6 minimum
PBR111	Brown long-eared bat	Feeding Remains	Unknown
PBR105	Brown long-eared bat	Droppings (confirmed by DNA sequencing)	1-5 (estimated from dropping numbers)
PBR115	Unknown	Feeding Remains (night roost)	Unknown
PBR116	Lesser horseshoe bat	Ultrasound recordings made inside night roost	Unknown
PBR125	Lesser horseshoe bat	Live Bats (radio-tracked), Droppings in concrete tube in quarry	Minimum 2 bats (radio-tracked bats) from PBR06
PBR126	Lesser horseshoe bat	Live Bats in night roost, Droppings in shed in quarry	Minimum 1 from PBR06
PBR127	Lesser horseshoe bat	Live Bat radio-tracked to night roost fissure in quarry face	1 from PBR06
PBR128	Lesser horseshoe bat	Live Bat radio-tracked to night roost in bungalow	1 from PBR06
PBR129	Lesser horseshoe bat	Live Bat radio-tracked to night roost in old shed	1 from PBR06
PBR130	Lesser horseshoe bat	Live Bat radio-tracked to night roost in stable	Minimum 1 from PBR06
PBR133	Daubenton's bat	Live Bats radio-tracked to maternity roost in old quay wall	25 bats counted on emergence
PBR134	Leisler's bat	Live Bat radio-tracked to roost in dwelling house	Minimum 1
PBR136	Unidentified	Droppings not capable of being	Unknown

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
		analysed further due to deteriorated condition	
PBR138	Brown long-eared bat Pipistrelle bat	Droppings suggesting day and/or night roost for both species	Minimum 1
PBR140	Whiskered bat	Live Bat radio-tracked to dwelling house	Minimum 1
PBR141	Common pipistrelle bat	Live Bat radio-tracked to dwelling house, Ballymoneen	Minimum 1
PBR142	Daubenton’s’ bat	Live Bat radio-tracked to dwelling house, Killeen	Minimum 1
PBR143	Daubenton’s bat	Live Bat radio-tracked to Women’s Study Centre	Minimum 1
PBR144	Daubenton’s bat	Live Bat radio-tracked to St Joseph’s	Minimum 1
PBR147	Common pipistrelle bat	Live Bat radio-tracked to dwelling house at Ballymoneen	Minimum 1
PBR148	Common pipistrelle bat	Live Bat radio-tracked to Cluanacauneen	Minimum 1
PBR149	Common pipistrelle bat	Live Bat radio-tracked to barn near Cluanacauneen	Minimum 1
PBR15	Brown long-eared bat	Droppings found at suspected night roost	1-5 (estimated)
PBR150	Daubenton’s bat	Live Bat radio-tracked to Cathedral footbridge	Minimum 1
PBR151	Whiskered bat	Live Bat radiotracked to residence behind Sport's centre	Minimum 1

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
PBR152	Daubenton’s bat	Live Bat radio-tracked to Salmon Weir Bridge	Minimum 1
PBR153	Lesser horseshoe bat	Live Bat radio-tracked to night roost/occasional day roost at Castlegar	1
PBR156	Lesser horseshoe bat, Brown long-eared bat	Live Bat, Droppings recorded at Castle entrance arch	1
PBR157	Lesser horseshoe bat	Live Bat radio-tracked to night roost shed at Menlo	1
PBR158	Lesser horseshoe bat	Live Bat radio-tracked to day roost at Monument road	Minimum 1
PBR165	Common pipistrelle bat	Live Bat radio-tracked to roost at Ballymoneen	Unknown
PBR17	Brown long-eared bat, Natterer’s bat	Droppings (confirmed by DNA sequencing)	1-5 (Estimated)
PBR18	Lesser horseshoe bat	Droppings and live bat radio-tracked to roost at old house	1-10 (Estimated)
PBR20	Natterer’s bat	Droppings (confirmed by DNA sequencing)	1-5 (Estimated)
PBR21	Lesser horseshoe bat Brown long-eared bat	Droppings (confirmed by DNA sequencing)	1-5 (Estimated)
PBR25	Lesser horseshoe bat Brown long-eared bat	Live Bat (Lesser horseshoe) seen during daytime. Droppings (Lesser horseshoe and Brown long-eared bat confirmed by	Lesser horseshoe bat x 1 1-5 Brown long-eared bat (estimated)

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
		DNA sequencing)	
PBR42	Soprano pipistrelle bat	Droppings (confirmed by DNA sequencing). Likely night roost	1-5 (estimated)
PBR44	Lesser horseshoe bat, Soprano pipistrelle bat	Live Bats seen in situ, Droppings (confirmed by DNA sequencing)	Unknown
PBR47	Unidentified	Feeding Remains	Unknown
PBR51	Brown long-eared bat	Live bats seen *in-situ*	5
PBR54	Lesser horseshoe bat	Recordings made on static bat detector. Droppings and live sighting of one bat	1-5 (One seen, estimated from droppings)
PBR64	Natterer's bat	Droppings (confirmed by DNA sequencing)	Minimum 1
PBR82	Lesser horseshoe bat, Brown long-eared bat Natterer's bat	Used by radio-tracked Lesser horseshoe bat as a night roost and droppings (confirmed by DNA sequencing)	1 Lesser horseshoe bat
PBR83	Lesser horseshoe bat	Live Bat radio-tracked to night roost at Menlo	1
PBR85	Lesser horseshoe bat	Live Bat radio-tracked to night roost shed at Coolagh	1
PBR89	Brown long-eared bat	Droppings recorded at possible maternity roost	10-20 (estimated)
PBR92	Brown long-eared bat	Droppings (confirmed by DNA sequencing)	Minimum 1

Roost Code	Species	Evidence for bats	Number of bats recorded (or likely population)
PBR94	Brown long-eared bat	Droppings recorded in upper floor. Potential night roost	Minimum 1
PBR159	Lesser horseshoe bat	Droppings in Moycullen Cave, probably night roost	Unknown
PBR160	Lesser horseshoe bat	Live bats recorded hibernating in Cloonbinna cave	5
PBR217	Lesser horseshoe bat, Brown long-eared bat	Static detector recordings, live bats	1-2 Lesser horseshoe bats (estimated), Up to 5 brown long-eared bats seen
PBR218	Lesser horseshoe bat	Live Bat radio-tracked to day/night roost in boulder field	1
PBR220	Common pipistrelle bat	Bat recorded during emergence/re-entry	1
PBR222	Soprano pipistrelle bat	Bat recorded during emergence/re-entry	1
PBR224	Pipistrelle bat	Droppings	Unknown
PBR242	Pipistrelle bat	Droppings	1
PBR124	Lesser horseshoe bat	Live Bat, Droppings found at day/night roost in alcove	1

Table 4 presents total numbers of bats of each species in structures that may be removed or not removed as a result of the proposed road development.

Table 4: Estimated [15]numbers of bats affected by removal of roosts

Bat Species	Approximate population size of bats in properties to be removed	Approximate population size of bat in properties not removed
Lesser horseshoe bat	10	49
Common pipistrelle bat	8	9
Soprano pipistrelle bat	25	6
Brown long-eared bat	16	63
Daubenton's bat	0	30
Leisler's bat	1	3
Whiskered	0	2
Natterer's bat	0	5
Unidentified bat	2	0

As can be inferred from **Table 4** above, the species that is potentially incurring the greatest potential loss of roosting is the Soprano pipistrelle bat population, which also happens to be the most commonly occurring bat in the country and recorded at almost all recording locations in the study area.

Just less than half of these bats come from one roost to be demolished (PBR177).

The population of Lesser horseshoe bats lost as a result of demolitions comes from the loss of one property at Aughnacurra (PBR178), a satellite roost to Menlo Castle (PBR06) (which itself will not be affected by the demolition works).

5.4.2 Assessment of the status of the overall study area

The overall study area includes 8 bat species out of the 9 species that are known to breed on the island of Ireland. The only species for which a roost was not recorded is Nathusius's pipistrelle bat, but this species was recorded flying in the study area by the static detectors in several locations.

The status of the population of Lesser horseshoe bats as discussed in Section 2.4.1 is deemed to be of important at a national geographic scale. As discussed in Section 2.4.1 populations of all other bat species are regarded to be important at a local geographic scale.

5.4.3 Survey Limitations

A total of 230 structures and 62 trees were assessed as part of the collection of baseline data on the bat population in the area of the proposed road development. This unprecedented level of surveying allowed a detailed picture of the species assemblage present in the study area and informed the constraints and route

[15] "Estimated", since the numbers may be based on a small number of counts or estimates of bat numbers by bat workers based on volumes of droppings recorded. Actual numbers are not likely to deviate significantly from those quoted above.

selection studies, the design of the proposed road development and the preparation of the EIA Report.

All structures within the proposed development boundary which may be affected either directly or indirectly were surveyed to record potential usage by bats. In most cases it was possible to carry out internal and external checks for signs of bats in daytime as well as dusk and/or dawn surveys. Inevitably in a few cases, access to inside the structure was not possible. In such cases, surveys at night were undertaken to record any bats emerging from or returning to the structure.

Some surveys (e.g. radio-tracking surveys in 2015) may have been affected by cool night time temperatures and may have forced bats to reduce foraging time. Overall, the repeated surveys carried out since 2014 have allowed bats to be surveyed over multiple seasons which reduce the bias caused by suboptimal weather conditions.

6 Impact assessment

6.1 Overview of activities to be covered by this derogation licence

As noted in Section 1, this application relates to specific residual impacts on bats arising from the construction and operation of the proposed road development, and its potential impact on bat (*Chirpotera*) species. Potential impacts have been mitigated as far as possible during the design phase and the residual impacts are those that cannot be ruled out despite applying best practice techniques.

Only activities that may give rise to offences under Regulations 51, 52 and 53 of the 2011 Regulations are within the scope of this application. There may be other potential ecological impacts of the proposed road development that are not relevant to this application and therefore are not discussed further. Other potential impacts, which are not relevant to Regulations 51, 52 and 53 of the 2011 Regulations are set out and considered in Chapter 8, Biodiversity of the EIA Report.

The works that are to be covered by this derogation licence are outlined below.

Construction phase

- Removal of structures and trees which may cause direct loss of roosting sites
- Removal of vegetation, which may cause:
  - Direct loss of bat foraging habitat
  - Fragmentation of foraging habitat and commuting routes and areas used by bats for other non-roosting activities[16]
- Installation of temporary lighting during construction and at site compounds which may cause indirect disturbance of flight patterns

Operational phase

- Use of the proposed road development by vehicular traffic which may cause:
  - Mortality of bats due to vehicular collision
  - Loss of foraging resources either by residual impact of severance of /barriers across features assisting bats in reaching them during the operation of the proposed road development
  - Indirect disturbance of flight patterns due to operational lighting proposed development and proposed lighting at NUIG sports pitches and periods of construction works at night

This derogation licence application applies to those aspects of the proposed road development whereby there is a residual risk of adverse impacts e.g. removal of roosts within a structure, residual risk of bat mortality because of vehicular collision and the unavoidable fragmentation of foraging habitats.

[16] as fragmentation of feeding habitat has the potential to disturb normal bat behavioural patterns, and thus adversely affect the ability of local bat populations to persist and reproduce, impacting on their local distribution and/or abundance and thereby conflicting with Regulation 51(b) of S.I. 477.

A significant amount of data collection and analysis has been carried out in respect of potential impacts to bat species from the proposed road development. This analysis has enabled the project team to conclusively rule out potential impacts on bat species from certain aspects of the proposed road development, such as proposed lighting design and the provision of passage under and over the proposed road development. These aspects, therefore, are not included in the application for a derogation under Article 54 as there will be no potential impact on bat species from these aspects.

6.2 Construction Phase

The following impacts are relevant to this derogation licence application (i.e. those that could constitute an offence under the European Communities (Bird and Natural Habitats) Regulations, 2011):

- Removal of structures and tree which may cause direct loss of roosting sites
- Removal of vegetation, which may cause:
    - Direct loss of bat foraging habitat
    - Fragmentation of foraging habitat and commuting routes and areas used by bats for other non-roosting activities[17]
- Installation of temporary working and site compound lighting which may cause indirect disturbance of flight patterns

The nature of each of these impacts is described below.

6.2.1 Removal of structures and trees which may cause direct loss of roosting sites

15 buildings supporting 20 bat roosts are within the proposed development boundary (6 Soprano pipistrelle roosts (PBR177, 179, 196, 205, 255, 267), 1 Common pipistrelle roost (PBR205), 1 unidentified pipistrelle bat roost (PBR182), 7 Brown long-eared bats roosts (PBR 183, 178, 179, 196, 204, 256, 267), 3 Lesser horseshoe bat roosts (PBR178, 204, 210) and two unidentified species bat roosts (253, 270). Six of these are structures used by more than one bat species. Figures 8.18.1-8.21.1 of the EIA Report show the locations of these roosts.

Fourteen of these structures are proposed for demolition (see **Table 8.28 below**), with one of the structures (PBR241) to be retained, protected from adverse impacts and bat roost features fitted to the structure, this is discussed further in this derogation licence application as a compensation measure[18]. One (PBR183) will be

[17] as fragmentation of feeding habitat has the potential to disturb normal bat behavioural patterns, and thus adversely affect the ability of local bat populations to persist and reproduce, impacting on their local distribution and/or abundance and thereby conflicting with Regulation 51(b) of S.I. 477.

[18] Note that the term “compensation” is used in this application refers to addressing impacts which cannot be mitigated. These impacts will have no impact on any European Site and the term “compensation” as used in this application does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive.

demolished but an outbuilding will be retained for the purposes of compensation for loss of other roosts.

Two trees will be felled (PTR48, PTR 43) that have been confirmed as supporting bats (Leisler's bat and Soprano pipistrelle bat respectively) and an additional 13 trees have high (category 1) potential to support bats and will also be felled. Figure 8.16.1 - 8.16.15 of the EIA Report show the locations of these trees.

The potential impacts of the permanent loss of these 14 roost structures, apart from the Lesser horseshoe bat roosts, and the two trees are deemed to be significant at a local level as they are valued as important at the local geographic level, almost all had a low number of bats using them and were recorded using other roost sites across the study area which will not be impacted by the proposed road development.

The impacts of the loss of the Lesser horseshoe bat roosts are potentially significant at a national level in the absence of mitigation measures. Evidence confirms that the roost at Aughnacurra (PBR178) is a satellite roost linked to Menlo Castle. Given that the physical structure of the Menlo Castle roost may be deteriorating, the Aughnacurra roost could be a relatively new addition to their network of roosts. The Aughnacurra satellite roost (PBR178) is within a sub-optimal building in terms of the preferred building type for this species and its occupation by bats may be a reflection of the lack of availability of better roost opportunities in the area.

Therefore, the loss of the satellite Lesser horseshoe bat roost at Aughnacurra (PBR178) and the loss of other Lesser horseshoe bat night roosts (PBR204, PBR210) within their foraging area could result in an impact on the Lesser horseshoe bat at a national geographic scale, in the absence of any measures to address this impact.

In the context of the potential impact on the Lough Corrib cSAC, of which Lesser horseshoe bats are a QI, although this species is present within the study area, the roost that forms the QI population for this European site (Eborhall House) is more than 30km away from the proposed road development, on the northern shore of Lough Corrib. This distance would be regarded to be beyond the normal core foraging range of the Eborhall House population and beyond the normal commuting range of this species except on exceptional occasions or over long periods of time – for example, bats dispersing and moving between areas in the wider landscape over a period of many years/generations. Furthermore, radio-tracking surveys of the Menlough population of bats (which were identified within the study area) undertaken for this project in 2014 and 2015 (*N6 Galway City Transport Project Route Selection Report*, Arup, 2016) did not suggest any evidence of movement between that population and the Eborhall House roost. Given the lack of any linkage between the study area and the roosts that are the reason for designation of this European site, likely significant effects on the Lough Corrib cSAC's Lesser horseshoe bat population have been ruled out.

Twelve other bat roosts were deemed to be in proximity to the proposed road development (within 100m) of the proposed development boundary. Potential direct impacts are predicted on these roosts as a result of disturbance during the construction phase, although it is acknowledged that in some areas this impact may be of a lower magnitude than others as the boundary is set back from the actual construction footprint.

These roosts include night roosts for Lesser horseshoe bats, day roosts for Soprano and Common pipistrelle bats, Leisler's bats and a possible maternity roost for Brown long-eared bats. This is predicted to result in impacts regarded to be significant at a local level in the absence of mitigation for all of these species.

Only PBR173 and PBR154 are suspected to be vulnerable to a significant level of construction impacts. PBR173 is a suspected maternity roost for Brown long-eared bats and PBR154 is a known night and occasional day roost for small numbers of Lesser horseshoe bats alongside the N84 Headford Road. All other roosts are set back from the proposed development boundary or are in locations where the construction works for the proposed road development are less likely to be as intrusive.

The species that is potentially incurring the greatest potential loss of roosting is the Soprano pipistrelle bat population, which also happens to be the most commonly occurring bat in the country and recorded at almost all recording locations in the study area.

The impact on population of Lesser horseshoe bats lost as a result of demolition comes from the loss of one property at Aughnacurra (PBR178), a satellite roost to Menlo Castle (PBR06) (which itself will not be affected by the demolition works).

6.2.2 Removal of vegetation, including tree felling

6.2.2.1 Direct loss of bat foraging habitat

The proposed road development will result in loss of foraging habitat for all bat species recorded. There are few areas that are deemed unsuitable for bats or where the baseline data collection has not recorded bat activity.

For Lesser horseshoe bats, the radio-tracking studies have revealed areas proved to be used for feeding but for other bat species, their foraging areas have been inferred from predicted theoretical "core sustenance zones" (CSZ) taken from best practice guidance (UK Bat Conservation Trust, 2016). 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.

Due to the large number of bat roosts recorded in the study area, all parts of the proposed road development overlap with at least one CSZ for a bat roost.

The level of significance of the loss of these foraging habitats can be described in terms of impacts on individual roosts in terms of the proportion of loss of the CSZ as a result of the proposed road development. It is important to note that the percentage loss of area within the CSZ does not account for any additional barrier effects provided by the proposed road development which could prevent bats reaching foraging areas on the other side of the proposed road development.

There is also evidence (Berthinussen and Altringham, 2012[19]) that there is displacement of bats from the margins of the road corridor which extends the impact zone well outside of the construction area. However, it should be noted that these displacement effects have only been investigated and detected in relatively open landscapes away from woodland and large water bodies. Certain sections of the proposed road development where woodland is being retained close to the edge of the proposed road development, may exhibit less of an adverse effect.

Theoretical core sustenance zones (CSZs) for the Irish bat species are listed below with an indication of the level of confidence attached to the CSZ size. Unidentified bats have been given a CSZ radius of 3km which represents the average of the above CSZ radii.

Table 5: Theoretical core sustenance zones for each bat species (based on UK Bat Conservation Trust, 2016)

Species	CSZ radius (km)	Confidence in CSZ size (text taken from Bat Conservation Trust, 2016)
Lesser horseshoe bat	2-3	Good. The CSZ in the context of the roost at Menlo Castle and at Cooper's Cave is regarded to be 3km (mean maximum foraging distance 2.93km in August 2014, 3.39km in August 2014, 2.86km in May 2015). This has been calculated using the same approaches as outlined in the BCT guidance. In the context of other day roosts, the CSZ of 2km has been applied.
Brown long-eared bat	3	Poor. No data on mean-maximum distance between roost and foraging areas available from the literature. In addition, the calculated weighted (based on the number of bats used to calculate the CSZ) average (3.45km) lies just below the threshold where it was rounded down to give a CSZ size of 3km. The CSZ of the Brown Long-eared bat that was studied during radio-tracking in 2014 is regarded to be approximately less than 4km radius (maximum foraging distance was 4.07km but data collection only took place over 2 days). Since only one bat was tracked, the BCT recommended CSZ distance of 3km has been used.
Daubenton's bat	4	Poor. No data on mean-maximum distance between roost and foraging areas available from the literature. In addition, the calculated weighted (based on the number of bats used to calculate the CSZ) average (3.5001km) lies just above the threshold where it was rounded up to give a CSZ size of 4km. The maximum foraging distances of the Daubenton's bats that were studied has shown a limited feeding area within the River Corrib corridor up to 2.5km from the roost. Due to the low numbers of bats that were analysed the BCT recommended CSZ distance of 4km has been used.
Natterer's bat	4	Good. Calculation based on a reasonable sample size from multiple colonies and studies. The BCT recommended CSZ distance of 4km has been used.

[19] Berthinussen A. and Altringham J. (2012) *The effect of a major road on bat activity and diversity*. Journal of Applied Ecology 2012, **49**, 82–89.

Species	CSZ radius (km)	Confidence in CSZ size (text taken from Bat Conservation Trust, 2016)
Whiskered bat	1	Poor. Data available from multiple colonies but only for a single study for this species. The BCT recommended CSZ distance of 1km has been used.
Common pipistrelle bat	2	Moderate. Data available from multiple colonies but only from a single study. The BCT recommended CSZ distance of 2km has been used.
Soprano pipistrelle bat	2	Good. Calculation based on a reasonable sample size from multiple colonies and studies. The BCT recommended CSZ distance of 2km has been used.
Nathusius's Pipistrelle bat	3	Poor. Calculation based on small sample size. The BCT recommended CSZ distance of 3km has been used.
Leisler's bat	4	Poor. Calculation based on small sample size. The BCT recommended CSZ distance of 4km has been used.

For all confirmed roosts that were identified during the field surveys, the proportion of the CSZ that will be lost as a result of the proposed road development was calculated (refer to **Annex E** for details). Whilst the CSZ is a generic radial distance from the roost, in some cases not all of this habitat would be regarded to be suitable foraging habitat for bats as it included built land with little suitable habitat to provide foraging resources. Bats will therefore not use all of the CSZ; they will selectively feed in the most resource rich areas. However, such potentially unsuitable areas within the footprint of the proposed road development were not deducted from the CSZs for each roost, thereby giving a worst-case scenario for the assessment of impacts. CSZs around night roosts have not been included in this analysis as theoretically these roosts occur within the CSZ of the associated day roost.

The proportion of habitat loss relating to each roost being lost is less than 7% of the CSZ in all cases except for PBR225 (stable block at Galway Racecourse) and less than 5% of the CSZ in the majority of cases. In the case of PBR225 the majority of the "real" CSZ is likely to extend to the quarry to the north west and agricultural land as foraging opportunities are more limited in the urban landscapes to the south. Much of the "real" CSZ is not affected by the proposed road development.

For Pipistrelle bat species which are adapted to feeding in a wide variety of landscape types[20], the impact of habitat loss during construction is not predicted to be significant since these bats will be able to utilise the majority of suitable habitat in their CSZ that is currently available to them and are not reliant on having to cross the construction area to reach foraging areas. This applies particularly to roosts to the north of the proposed road development as the majority of optimal feeding areas are outside of the urban city core which lies to the south.

[20] In the CEDR guidelines they are in Group C: Bats with medium manoeuvrability. They often hunt and commute along vegetation or structures at variable heights, but rarely close to or within the vegetation. May also hunt in open areas. Commuting over open stretches generally takes place at low to medium heights (typically 2 – 10m) with no clear tendency to lower flight.

For Lesser horseshoe bats which show a greater preference for following linear landscape features between roosts and foraging areas[21], the potential impact of habitat loss is compounded by the barrier effect which may prevent bats using suitable habitats on the other side of the proposed road development or moving between day and night roosts or between different roosts used at other times of year. Impacts are regarded to be potentially significant at a county level if the foraging range is affected (e.g. by not being able to reach night roosts) or national-scale where the fecundity or mortality rates are affected due to lack of feeding resources as a result of loss of feeding habitat and barrier effects. Significant efforts have been made to provide effective methods to getting bats across the construction areas and underneath or over the proposed road development so that they can avail of habitats on both sides of the proposed road development.

The magnitude of habitat loss for Lesser horseshoe bats has been measured in terms of the physical loss of the most important habitat as a result of the proposed road development. The area deemed to be of highest importance for Lesser horseshoe bats is regarded to be the core foraging area used by Menlo Castle (PBR06) radio-tracked bats in summer 2015. Prior to the birthing period in mid-June, female bats will utilise the best foraging habitats closest to the roost and research in at least one study (Bontadina et al, 2002[22]) has highlighted the importance of habitat within 600m of the roost. Approximately 7ha of woodland, scrub, hedgerows and grassland will be lost in the area from the River Corrib to the Bothár Nua which spans the core foraging area for the Menlo Castle roost (PBR06). The loss of this 7ha equates to 5.6% of the core foraging area (125ha) recorded in 2015 which is regarded to be the area of highest importance for the roost[23], although not all of the core foraging area is used equally by bats. The loss of habitat within the core foraging area for the Menlo Castle Lesser horseshoe roost (PBR06) is deemed to be a potentially significant factor threatening the viability of the roost there. If bats cannot feed close to the roost, especially close to the birthing period, then fecundity may be reduced. When compounded by other potential effects of the proposed road development (collision, barrier effects) this relatively small loss of habitat might have a significant impact on the population.

Other bat roosts in proximity along the proposed road development are unlikely to be associated with such optimum bat habitats. The loss of woodland in the Menlough area is unavoidable as the belt of woody vegetation on the northeast bank of the river stretches from the Quincentenary Bridge in the city all the way to Menlough Village and therefore the proposed road development will inevitably cross it at some location.

In order to prevent the loss of foraging habitats resulting in an adverse impact on bat species at either a local, county or national geographic scale, design measures

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[21] In the CEDR guidelines they are in Group A: Extremely manoeuvrable bats, which often fly within foliage, or close to vegetation, surfaces and structures at variable flight heights. When commuting, they often follow linear and longitudinal landscape elements. Low-flying (typically < 2m) when commuting over open gaps.

[22] Bontadina, F., Schofield H. and Naef-Daenzer B. (2002) *Radio-tracking reveals that Lesser horseshoe bats (Rhinolophus hipposideros) forage in woodland*. J. Zool., Lond. 258, 281-290.

[23] This differs from the 98ha of land within the proposed development boundary which is within the 2925ha of CSZ for the roost at Menlo Castle as per the table in **Annex E.**

have been incorporated into the design of the proposed road development. This derogation licence application therefore only addresses those impacts which cannot be fully mitigated by design.

6.2.2.2 Fragmentation of foraging habitat and commuting routes and areas used by bats for other non-roosting activities[24]

Given that there is evidence of bats crossing the proposed road development in multiple locations and that all parts of the proposed road development are within the theoretical or proven CSZ of at least one bat roost, there is the potential for the proposed road development to act as a barrier to flight paths for all species (except Leisler's bats which have been shown to fly at greater altitudes so as not to be affected by ground level features) and in all locations.

The barrier effect can manifest itself as soon as the site clearance phase commences and the barrier itself is in the form of the cleared lands. Removal of hedgerows, treelines, woodland and scrub will take place across the length of the proposed road development. Whilst it is not proposed to remove all the vegetation within the proposed development boundary, it has been assumed that intervention of some kind in the landscape may occur within the boundary to the extent that it could affect bat behaviour, thereby assessing the worst-case scenario.

Interpretation of the patterns of bat activity records has indicated that potential barrier effects would be most significant at the following locations:

1. Bats flying to/from Bearna Woods – The woods were one of the few sites where Natterer's bats were recorded and also support a small/dispersed population of Lesser horseshoe bats. The relatively open, heathy landscape to the north of the woods would be regarded to offer less suitable opportunities for bat foraging so the woods are likely to be important for local populations of several bat species.
2. Aughnacurra (including Chestnut Avenue and Upper Dangan) – the potential barrier effect posed by the proposed road development here is somewhat reduced by the proximity of the River Corrib which bats use as a flight corridor. The barrier effect would be likely to supress movements at a very localised scale.
3. Barrier effects in the area spanned by Menlo Castle-Coolagh-Castlegar are potentially the most significant as it is the known core foraging area/CSZ for the nationally-important Menlo Castle population of Lesser horseshoe bats as well as for roosts of other bat species close to the proposed development boundary. Severance of Lesser horseshoe flight paths between Menlo Castle and Cooper's Cave in particular could have significant adverse effects on the ability of the breeding population to mate and hibernate in suitable roosts. Severance of flight paths between day and night roosts also could affect the

[24] as fragmentation of feeding habitat has the potential to disturb normal bat behavioural patterns, and thus adversely affect the ability of local bat populations to persist and reproduce, impacting on their local distribution and/or abundance and thereby conflicting with Regulation 51(b) of S.I. 477.

ability of bats to reach suitable foraging areas further away by using the night roosts as stepping-stones.

4. The location of the Menlo Castle roost is regarded to be at a key location in the national distribution of Lesser horseshoe bats. The main strongholds for this species are in south Mayo, mid-Clare/south Galway, Kerry and West Cork but the species is present all along the west coast counties from Cork to Leitrim. Analysis of the genetic and echolocation differences has revealed that the Irish population is made up of differentiated north and south populations (Dool et al, 2016[25]). Factors such as habitat connectivity were identified as being one of the reasons why this species is subject to population fragmentation at a national scale. Dool et al (2016) describe the "Limerick gap" as an area where there has been a separation of lesser horseshoe bat populations, leading to genetic isolation in these areas. As can be seen in **Plate 1**, the Menlo Castle roost is in an area of similarly low densities of roost records and the loss of the population could create a new gap in in the natural range of the species in Ireland.

[25] Dool S.E., Puechmaille S.J., Kelleher C., McAney K., and Teeling E. (2016) *The effects of human-mediated habitat fragmentation on a sedentary woodland-associated species (Rhinolophus hipposideros) at its range margin.* Acta Chiropterologica, 18(2): 377–393, 2016.

Plate 6.1: Lesser horseshoe bat population distribution (taken from Bat Conservation Ireland distribution maps)

5. Based on the distribution of maternity roosts in the range of this species in Ireland, the Menlo Castle maternity roost and the local population it supports are of national importance, as defined in NRA (2009) “a smaller population may qualify as nationally-important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle”. However, the roost size falls well below the threshold for designation as a Special Area of Conservation (100 bats in maternity roost) and it has been confirmed by the NPWS as not being part of the Lough Corrib cSAC’s qualifying interest population.

6. There are only six known maternity roosts in and around Lough Corrib, with the majority of roosts concentrated on the northern shores near Cong. Only two roosts are located on the southern end: Ross Lake Gatehouse and Menlo Castle. These southern roosts may be stepping-stones for long-term

movements and gene flow between bats at the northern shore of Lough Corrib, Lough Mask and Lough Carra and populations in South Galway and Clare. Recent counts from Ross Lake Gatehouse have shown that this roost has undergone significant deterioration resulting in decline in numbers from 150 bats in 1994 to five bats in 2011 (Rebecca Teesdale pers. Comm., 2014 and p44 in Roche et al, (2015)). A decline in the Ross Lake roost could potentially increase the relative importance of the roost at Menlo Castle as a stepping stone roost, as it would be the only significant maternity colony at the southern end of Lough Corrib. Menlo Castle itself would not appear to be in a structurally-stable condition and the bat roost is vulnerable to rock fall, vandalism and blockage within the chimney flue. If bats were not able to reach the foraging areas and Cooper's Cave due to a barrier effect, then it would add another impact which might put the viability of this population at risk. There is no evidence to suggest that Menlo Castle Lesser horseshoe bat population is connected to the Eborhall Lesser horseshoe bat population, which is the qualifying interest (QI) population for Lough Corrib cSAC. Any predicted impacts on Lesser horseshoe bats associated with the proposed road development will not affect the conservation objectives of the Lough Corrib cSACs QI Lesser horseshoe bat population, nor the QI Lesser horseshoe bat populations of any other European sites.

The numbers of Lesser horseshoe bats recorded using Cooper's Cave for hibernation has been relatively small (around 10% of the estimated roost size at Menlo Castle) but much of the cave is not accessible and there may be higher numbers present. The only other hibernation site known for this population is Menlo Castle and the roost site is not accessible for counting. A wildlife overpass has been included as part of the design of the proposed road development to allow bats to reach the cave for hibernation and to avoid them being forced to use less suitable locations. While Cooper's Cave is under ongoing pressures from fly tipping and disturbance, it is likely that bats will continue to use it unless the entrance is blocked altogether.

The western portion of the proposed road development (from Bearna to Upper Dangan) has a lower distribution density of bats and has less-suitable habitats for foraging but a barrier effect is still predicted in the absence of any effective mitigation. Such potential impacts are regarded to be significant at a local geographic scale as the bat populations have been valued as being important at a local geographic scale, there are few roosts known in this area, and no important landscape features (such as major watercourses, areas of woodland or hedgerow networks) are predicted to be severed.

The potential impacts of the barrier effect have been addressed through the design measures described in Section 8 of this derogation licence application.

6.2.3 Installation of temporary working and site compound lighting which may cause indirect disturbance of flight patterns

As construction works will typically be undertaken during normal daylight working hours, the requirement for lighting for construction works during night time will be limited.

Over the expected 36-month construction phase there will be up to a total of 10 weeks of night time working. Temporary night-time closure of existing local roads may be required where overbridges are to be constructed at locations such as the Rahoon Road, Letteragh Road, N59 Moycullen Road, Menlo Castle Bóthrín, Bóthar Nua, Seanbóthar, N84 Headford Road, N83 Tuam Road, Briarhill Business Park Road and R339 Monivea Road.

Nightime working requiring the use of floodlighting to permit safe working have the potential to displace bats from the illuminated area. This will be particularly sensitive at the following locations:

- N59 Moycullen Road near the Aughnacurra satellite roost (PBR178) and a proposed replacement roost structure
- Menlo Castle Bóthrín which is an important flight path for Lesser horseshoe bats and other bat species
- Bóthar Nua which is an important flight path for Lesser horseshoe bats and other bat species
- Seanbóthar which is an important flight path for Lesser horseshoe bats and other bat species
- N84 Headford Road which is an important crossing point for Lesser horseshoe bats and close to known night/occasional day roosts for this species and is also close to a proposed replacement roost structure

In all cases where lighting may cause disturbance, it will be temporary in nature but may last over several consecutive nights and this could result in temporarily lower bat diversity in these areas. Such displacement (which would be a matter of metres) could prevent bats from accessing foraging areas or roosts, or result in bats taking more circuitous routes to get to foraging areas and hence potentially depleting energy reserves. It cannot be predicted precisely when these works will take place during the year but it could be a significant disturbance if affecting bats pre-parturition (birth) or pre-hibernation when energy reserves are essential for survival. However, the potential impact only arises during months when bats are most active (April to September) and during these months the need for night lighting is likely to be limited as daylight hours are longer.

6.3 Operational Phase

The following potential impacts are relevant to this derogation licence application (i.e. those that could constitute an offence under the European Communities (Bird and Natural Habitats) Regulations, 2011):

- Mortality of bats due to vehicular collision
- Loss of foraging resources either by residual impact of severance or barriers across features assisting bats in reaching them during the operation of the proposed road development
- Indirect disturbance of flight patterns due to noise and operational lighting and periods of working at night

The nature of each of these impacts is described below.

6.3.1 Mortality of bats due to vehicular collision

Research (Sparks and Choate, 2000; Butchkowski and Hassinger, 2002; Dodd et al., 2004; Capo et al., 2006; Choquene, 2006; Glista and DeVault, 2008; Russell et al., 2008; Hein et al.,2009; Whitaker and Mumford, 2009)) has provided evidence that mortality of bats due to road collisions can reach an annual mortality of 5% of the bats in local roosts. Altringham (2008) arrived at a similar estimate, based on conservative calculations for a road in the UK crossed by Lesser horseshoe bats from a large roost (data from Billington 2001 - 2006).

Theoretical studies (e.g. Lande 1987, With and King 1999, Carr and Fahrig 2001) “show that populations of animal species with low reproductive rates and high intrinsic mobility, such as bats, are more susceptible to decline and ultimately extinction by the additional mortality caused by road” (taken from **Annex A**, WC1060 main report).

Lesiński (2007) recorded mortality highest where roads approached tree stands (up to 6.8 per km/year) or crossed a forest (2.7 per km/year) and lowest within densely built-up areas (0.3 ind./km/year). If the highest rates were applied to the Lesser horseshoe bat roost at Menlo Castle (PBR06) then this could equate to 34 deaths per year based on the maximum roost foraging area being bisected by c. 5km of the proposed road development (based on radio-tracking in 2014). The lower rate for mortality near forests would result in 13 deaths per year. Whilst the long-term population fluctuations are not known for this population, in a worst-case scenario such mortality rates could cause the entire roost to become extinct in less than two years, assuming that all of the bats in the roost are exposed to the same level of mortality risk and that all of the bats killed per km were of this species. The loss of this roost would be regarded to be a significant potential impact at a national geographic scale, assuming a worst-case scenario and in the absence of any mitigation.

Similar mortality rates could be applied to similar low-flying gleaning species of bats such as Brown long-eared bats and some *Myotis* species such as Daubenton’s bats. Since this would have an adverse effect on these species, a complex mitigation strategy has been developed and is presented in this application.

Measures that have been incorporated into the design of the proposed road development including underpasses, culverts and a wildlife overpass at Castlegar, will reduce the percentage of the local bat population flying over the proposed road development (and) being at risk of collision. The risk cannot be removed entirely as not all measures are 100% effective at a population level, so this derogation application is seeking to permit the residual mortality incidents which may occur.

6.3.2 Loss of foraging resources either by residual impact of severance or barriers across features assisting bats in reaching them during the operation of the proposed road development

In a similar manner to the barrier effect resulting from clearance of the proposed road development corridor, the completed road will act as a potential barrier to bats moving across the landscape. This will affect bats roosting close to the proposed road development as potentially a larger area of their CSZs will be on the opposite side of the proposed road development. However, each roost may react differently to the barrier posed by the proposed road development and the topography and surrounding habitats may result in a range of impacts occurring, not all of which will be significant.

6.3.3 Indirect disturbance of flight patterns due to operational lighting

The barrier effect can be compounded by light spill associated with the illumination of the corridor of the proposed road development. Lighting will also be provided for the proposed NUIG Sporting Pitches. Whilst there is planning permission to light the existing pitches adjacent to the river, they are currently unlit.

Examination of light spill modelling has identified potential light spill impacts on bats (where light levels exceed 1 lux) at the following locations:

- Ch. 2+850: Lighting at the Bearna East Roundabout may impact on the movement of bats in the locality and prevent them using the proposed culvert CO2/01b. However, proposed landscape planting and retained woody vegetation near the mouth of the culvert entrances will help in shading the flight paths approaching the culvert at this location to allow bats to fly through
- Ch. 4+300 - Ch. 4+550: Lighting at the Cappagh Road junction is close to PBR139 and PBR146 (both Leisler's bat roosts) and Soprano pipistrelle activity has been recorded nearby. Localised displacement may occur in this area although the presence of roadside scrub and garden shrubs and trees will provide shaded area which may be used by bats to avoid lit areas
- N59 Link Road North and South: This will be illuminated over a length of 2.4km across open agricultural and heath landscape. Light spill may cause a localised barrier to movements in an east-west direction although there are only two roosts (PBR49 and PBR237) which are parallel to the N59 Link Road North and South and neither are in the light spill of the proposed lighting design
- Ch. 9+150 – Ch. 9+250: Lighting will be provided as part of the proposed NUIG Sporting Pitches. Whilst there is planning permission to flood the existing pitches adjacent to the river, they are currently unlit. There are a number of roosts in this general area (for Lesser horseshoe bat, Daubenton's bat, Soprano pipistrelle bat and Brown long-eared bats) however none of them are located

within the area of light spill from the proposed lighting design. The closest roost is Menlo Castle PRB06 which is approximately 375m from the proposed sporting pitches at their closest point. No roosts will be directly impacted. The light spill will not impede bats from using the River Corrib for feeding or commuting. There may be a displacement effect locally from the sports pitches themselves due to light spill, however the bat survey results did not record significant levels of usage of these fields by any species

- Ch. 11+050 – Ch. 11+150: Lighting at western entrance to Lackagh Tunnel. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux
- Ch. 11+380 – Ch. 11+500: Lighting at eastern entrance to Lackagh Tunnel. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. There is bat activity data collected for this location including feeding and resting Lesser horseshoe bats and it is likely to be used by several other species of bats for feeding and commuting
- Ch. 11+975 – Ch.14+500: The N84 Headford Road at this location is currently unlit and the proposed new lighting will introduce approximately 8ha of illuminated area. This area is used by several species including Lesser horseshoe bats and will result in a displacement from this area. PBR154 (a Lesser horseshoe bat night roost and occasional day roost) will be impacted upon by light spill to the roost. However, the entry to the roost will still remain unlit and well shielded from the lighting as it faces to the east and is at a lower elevation than the N84 Headford Road and the proposed road development. Light spill from lighting columns in the area of Ballindooley-Castlegar (Ch. 12+600 to Ch. 13+600) will generally be contained within the immediate vicinity of the proposed road development which, at this location, is sunken below the level of the surrounding landscape. Light spill here will help to deter bats from crossing the road and reduce the risk of vehicle collision, whilst the Castlegar Wildlife Overpass will be in darkness and provide a safe crossing point
- Lighting in the area around the N83 Tuam Road Junction, the City North Business Park Link and the Parkmore Link Road will increase from the current levels and may have localised impacts on the flight paths of Pipistrelle species recorded nearby
- Ch. 14+850 – Ch. 15+000: Eastern end of Galway Racecourse Tunnel entrance. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. This may lead to localised impacts on the flight paths of Pipistrelle species recorded nearby
- Ch. 15+150 – Ch. 15+300: Western end of Galway Racecourse Tunnel entrance. This will be localised and will not affect roosts but is likely to have a displacement effect on bats over an area of circa 150m x 50m where light levels exceed 1 lux. This may lead to localised impacts on the flight paths of Pipistrelle species recorded nearby

- Ch. 15+500 – Ch. 17+483 (end of proposed road development): Scattered records of Pipistrelle species and Leisler's bats in this location suggest that the widened illuminated corridor in this location will result in localised displacement. This impact is not regarded to be significant as most of the bat records suggest activity is focused to the north east away from the proposed road development

The potential impact of vehicle lighting has been assessed in the context of the potential illumination of Menlo Castle (PBR06) from the proposed road development. This would have particularly high sensitivity due to the absence of any notable lighting at present and the presence of both a maternity roost and hibernacula for Lesser horseshoe bats, a maternity roost for Daubenton's bat and a former Brown long-eared roost; all species which would be susceptible to lighting impacts. In a worst-case scenario, the cumulative impact of many vehicles on the River Corrib Bridge on Menlo Castle is less than 0.01 lux and this would only result on the top section of the castle. Given that the Lesser horseshoe bats generally flew at heights of 1-3m above the ground at and near the roost location this is not predicted to affect their flight paths. This level of illumination is also well within the tolerance range for this species.[26].

There are no roosts that will be directly illuminated by the proposed operational lighting to the extent that any adverse impacts are predicted.

[26] Average light levels recorded along preferred commuting routes of *Rhinolophus hipposideros* under natural unlit conditions were 0.04 lux across eight sites. Stone E.L. (2011) *Bats and development: with a particular focus on the impacts of artificial lighting.* (Ph.D. Thesis) University of Bristol, UK (2011).

7 Summary of Potential Impacts

The potential impacts of the proposed road development (prior to the implementation of the mitigation measures included in the design and roost compensation measures[27]) are summarised as follows:

- Demolition of 14 buildings within the proposed development boundary which will affect local populations of Soprano pipistrelle bats, Common pipistrelle bats, Brown long-eared bats and Lesser horseshoe bats including:
  - One maternity roost which will be demolished, a Brown long-eared roost at Aughnacurra (PBR256)
  - One satellite roost for Lesser horseshoe bats which will be demolished at Aughnacurra (PBR178) (a satellite roost for the Menlo Castle (PBR06) Lesser horseshoe maternity roost)
- Loss of foraging habitat is less than 7% of the theoretical CSZ for all roosts impacted by the proposed road development. Most of the roosts are losing less than 5% of the theoretical CSZ. Loss of foraging habitat is regarded to be most significant in the Menlough area where approximately 7ha of woodland-pasture-hedgerow habitat is being lost and is within the CSZ for the nationally-important population of Lesser horseshoe bats
- Inevitable elevated mortality rates due to vehicle collisions
- Barrier and severance effects are predicted to occur (in the absence of mitigation) along most of the proposed road development but is particularly significant in the Bearna Woods, Aughnacurra, Menlough and Castlegar areas
- Construction and operational light spill impacts are likely to compound the barrier effect to landscape-scale movements (as opposed to directly affecting any specific roosts). No roosts are predicted to be directly illuminated to the extent that adverse impacts are predicted and only one roost (PBR154; a Lesser horseshoe night and occasional day roost) is within an area of operational light spill. Night time construction works are predicted to cause localised temporary displacement of bats of various species including Lesser horseshoe bats. No mitigation measures are required in terms of alteration of the lighting design.

[27] Note that the term "compensation" is used in this application refers to addressing impacts which cannot be mitigated. These impacts will have no impact on any European Site and the term "compensation" as used in this application does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive.

8 Mitigation and Compensation[28] Strategy

8.1 Protection of bats within roosts proposed for removal

The following mitigation measures are proposed in relation to structures either confirmed as supporting bat roosts or considered to have the potential to support roosting bats:

- Prior to demolition of the 14 structures containing confirmed bat roosts, replacement artificial roosts (as set out in **Section 8.2** below) will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity
- Where possible, buildings with the confirmed bat roosts will not be demolished during the breeding period or hibernation period (April to mid-August and November-March) as the risk of accidental death or injury is higher at this time. Bats may use roosts in smaller numbers in winter but may nevertheless be present. Outside of these periods, the approach to demolition of bat roosts will determined on a case-by-case basis and subject to relevant licence conditions
- Buildings confirmed as bat roosts proposed for demolition will be marked on the ground with agreed paint marking to permit identification by Contractors
- Prior to demolitions, all structures that were confirmed as either having bats or having high potential for bats will be re-examined immediately prior to demolition to assess whether bats are present at the time of demolition. This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolitions unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture. For structures which have not been confirmed as bat roosts but regarded to have high potential for bats, a bat detector assessment of the property to be demolished will be carried out, if demolitions are proposed during the period May – August (note this time period will not be permitted in the case of the confirmed bat roosts to be demolished). This will be an all-night examination to determine if bats enter the building during the night or early morning. This will provide adequate information to proceed with demolition unless weather conditions were unsuitable for feeding bats. If bats are present, then they will require exclusion from the property over several nights or if possible physical removal by hand by a licenced bat specialist to be placed in a bat box or similar for release in the evening after capture

[28] Note that the term “compensation” is used in this application refers to addressing impacts which cannot be mitigated. These impacts will have no impact on any European site and the term “compensation” as used in this application does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive.

- Once structures containing roosts are deemed to be clear of bats, the bat specialist will be on site to supervise the demolition procedure until the structure is no longer deemed able to support a bat roost. Bats may re-enter a partially demolished structure overnight so the bat specialist may be required to be present during demolition works until they are completed

The following mitigation measures are proposed in relation to those trees identified as having high potential to support roosting bats. These include the two trees confirmed to have had bats present (PBR43, PBR48) or the 13 other trees to have high suitability, where either obvious potential roosting features are present, or where obscured by dense ivy cover, the tree is of an age and condition that there is a high chance that roosting features are present. Figure 8.16.1 - 8.16.15 of the EIA Report show the locations of these trees but a more detailed drawing will be provided to the contractor prior to any felling works. Bats could occupy suitable roosting features at any time prior to the commencement of works. Therefore, there is an inherent risk that bats could be affected by the proposed felling works. The proposed mitigation measures for this potential impact are as follows:

- Felling of confirmed and potential tree roosts will be undertaken during the period September – October as during this period bats are capable of flight and may avoid the risks from tree felling if proper measures are undertaken, but also are neither breeding or in hibernation
- Use of detectors alone may not be sufficient to record bat emergence and re-entry in darkness. Therefore, prior to felling of confirmed and potential tree roosts, an emergence survey using infra-red illumination and video camera(s) and bat detectors will be carried out on the night immediately preceding the felling operation to determine if bats are present
- Where it is safe and appropriate to do so for both bats and humans, such trees may be felled using heavy plant to push over the tree. In order to ensure the optimum warning for any roosting bats that may still be present, the tree will be pushed lightly two to three times, with a pause of approximately 30 seconds between each nudge to allow bats to become active. The tree should then be pushed to the ground slowly and should remain in place until it is inspected by a bat specialist
- Trees should only be felled "in section" or "soft felled" where the sections can be rigged to avoid sudden movements or jarring of the sections
- Where remedial works (e.g. pruning of limbs) are to be undertaken to trees deemed to be suitable for bats, the affected sections of the tree will be checked by a bat specialist (using endoscope under a separate derogation licence held by that individual) for potential roost features before removal. For limbs containing potential roost features high in the tree canopy, this will necessitate the rigging and lowering of the limb to the ground (with the potential roost feature intact) for inspection by the bat specialist before it is cut up or mulched. If bats are found to be present, they will be removed by a bat specialist licenced to handle bats and released in the area in the evening following capture

Prior to felling the two confirmed tree roosts (PTR43 and PTR48) replacement bat boxes (as set out in **Section 8.2.6** below) will be in place to ensure that bats are able to access alternative resting places at the earliest opportunity. The location of the bat boxes in these instances will be within the proposed development boundary but will be decided by the bat specialist. If any additional bat tree roosts are confirmed, and will be removed by the proposed felling works, then appropriate alternative roosting sites will be provided in the form of replacement bat boxes as set out in **Section 8.2.6** below.

8.2 Compensation for loss of roosts

Loss of the more “significant” roosts (e.g. maternity roosts or roosts used by Lesser horseshoe bats) will be mitigated by the erection of replacement structures (artificial roosts) in locations close to the original roost.

There is a dual purpose to the artificial roosts. Firstly, to ensure that there is no net loss of roosting opportunities for the bats confirmed to be roosting within the proposed development boundary. Secondly, it has been recognised that there will be an inevitable increase in mortality rates due to road collisions as suggested by scientific evidence as described in **Section 6.3.1** of this application. The second function of the replacement roosts is to create improved conditions for bats to breed and to offset the increase in mortality.

Four artificial roost structures are proposed as set out below. The detailed specifications of these artificial roosts will follow the recommendations of an experienced bat ecologist and further consultation with the Vincent Wildlife Trust will take place to ensure that their experiences in these techniques are taken into account.

There will be a need to screen structures from the effects of construction phase disturbance by means of solid hoarding or brushwood screens with an appropriate buffer zone around the roost. The dimensions of the planting will depend on the local topography and surrounding landscape and will be decided on a case-by-case basis by the bat ecologist.

It should be noted that the mitigation strategy has included ensuring that passage underneath the proposed road development in the vicinity of the roosts has been facilitated by including culverts underneath the proposed road development in locations as close to the roosts as possible.

8.2.1 Proposed Aughnacurra maternity/hibernation roost for Lesser horseshoe bats and Brown long-eared bats

The proposed replacement roost will be located close to the existing Aughnacurra roost (PBR178) structure.

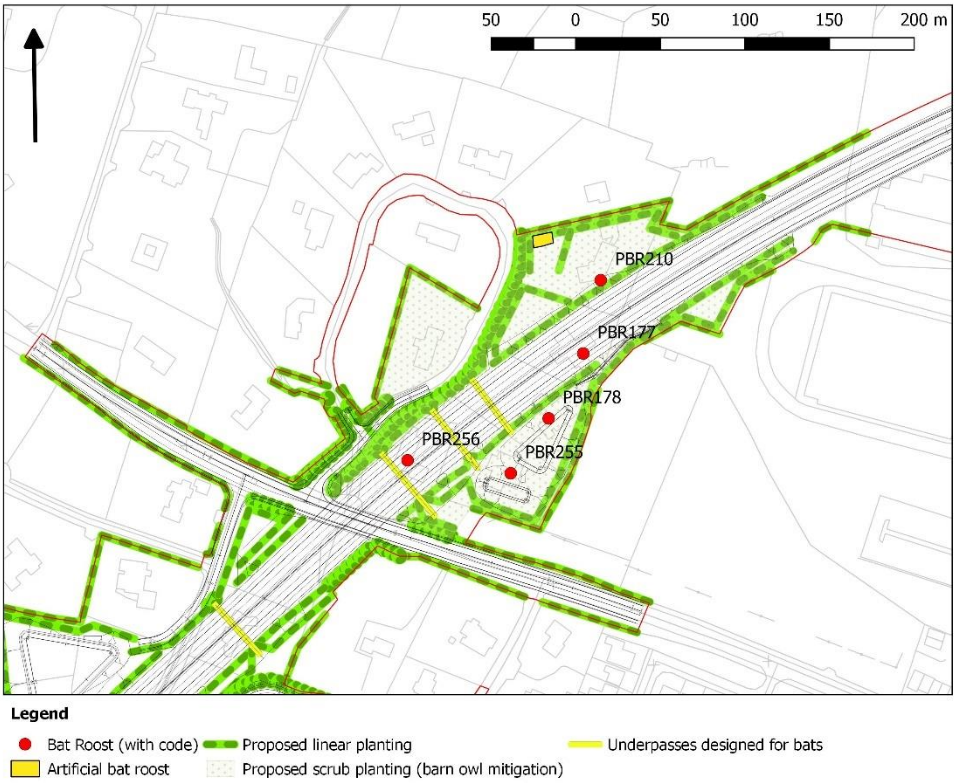
The proposed roost within the proposed development boundary will be temporarily screened with brushwood fencing or similar semi-solid screens c. 2m high for the construction stage and will also be planted up around it as soon as the roost is constructed to provide long-term screening during the operation of the proposed road development. Non-native ornamental species may be used to provide screening in this case as it is in keeping with the suburban setting.

The design of the roost will take account of the with the Vincent Wildlife Trust (VWT) guidance[29] and will follow the following design parameters (as shown in drawing GCOB-3000-D-001 in **Annex F**).

- The template for the design has be taken from the roost at Garryland, Co. Galway constructed for the N18 Oranmore to Gort road development which has been shown to have worked successfully since its completion in 2011
- Single storey structure with southwest orientation for maximum solar gain on the pitched roof
- Location as set out in **Plate 8.1** below in corner of garden to be acquired
- Rendered block wall structure with natural slate roof. The exterior walls can be clad with rough stone or a material designed to have no adverse visual impact
- The building will have a footprint of c.10m x 8m with a steep pitched slate roof, partitions in the ground floor and roof space and an attic floor laid down with an open hatch for access for bats
- Plywood partitions will be installed within the roof voids to create bat "hotboxes" and separate roosting spaces for different species so that the brown long-eared bat roost can also be accommodated in the same building
- The interior of the roof will be lined with BS747 bituminous felt. All ceilings on the ground floor will be fitted with rough wood
- The entry point for bats shall be on the western side away from the proposed road development and close to the vegetation on the eastern perimeter which will be retained and enhanced. The entry point will be c. 500mm x 300mm with bars set 125mm apart and lead flashing to be placed over the window sill under the hatch to prevent predator entry
- The northern corner will include a hibernation room at ground level which will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering will be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed
- No water or electricity services are required
- Access for surveyors will be via a door on the southern side. Bats will be allowed to fly around the ground floor via an open hatch in the attic floor near the entry point
- The proposed location (within the proposed development boundary) is close to vegetation which is important cover for bats entering and leaving. Additional planting is proposed to link the roost to the perimeter and to connecting features in the wider landscape

[29] Vincent Wildlife Trust (2015) *Lesser Horseshoe Bat: Conservation Handbook.*

Plate 8.1: Proposed location of Aughnacurra artificial roost structure (not to scale)



8.2.2 Menlo Castle alternative roost - Lesser Horseshoe maternity/hibernation roost

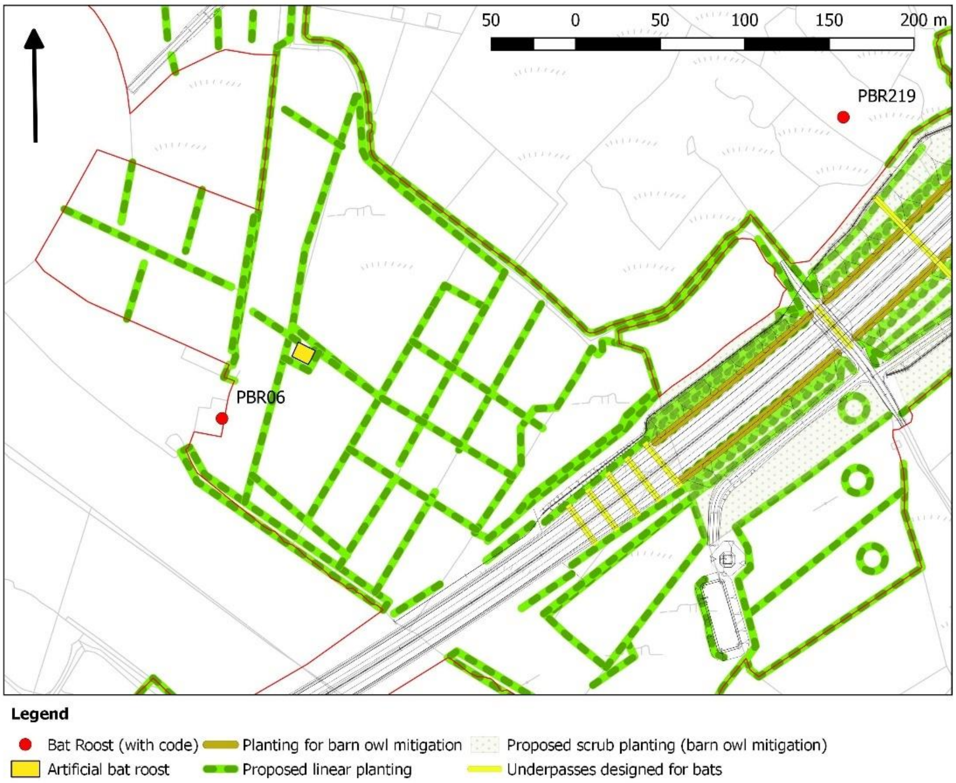
This roost is not replacing any specific loss of roost but is a critical part of the bat mitigation strategy. It will assist to increase the recruitment in the local Lesser horseshoe bat population so as to offset any increases in mortality as a result of the potential impacts of the proposed road development. The current roost in the chimney of the castle (PBR06) is likely to be unstable, inadequate and vulnerable to being lost if the castle falls into further disrepair. The new Menlo Castle roost would be better in design and aim to increase natural birth rates and thereby neutralise or overturn any negative impacts of the proposed road development. The preferred location is in a field to the east of the castle. The key design parameters will include:

The design of the roost has taken account of the Vincent Wildlife Trust (VWT) guidance and following consultation with Dr Kate McAney and Ruth Hanniffy (VWT) and will follow the following design parameters (and as shown in drawing GCOB-3000-D-001 in **Annex F**):

- The template for the design will be taken from the roost at Garryland, Co. Galway constructed for the N18 Oranmore to Gort road development which has been shown to have worked successfully since its completion in 2011
- Single storey structure with southern orientation for maximum solar gain on the pitched roof

- Location as set out in Plate 8.2 below in the northwest corner of the field close to Menlo Castle (PBR06)
- Rendered block wall structure with natural slate roof. The exterior walls can be clad with rough stone or a material designed to have no adverse visual impact. Additional planting around the perimeter of the building will also screen it from view
- The building will have a footprint of c.10m x 8m with a steep pitched slate roof, partitions in the ground floor and roof space and an attic floor laid down with an open hatch for access for bats. All ceilings on the ground floor will be fitted with rough wood
- Plywood partitions will be installed within the roof voids to create bat "hotboxes" and separate roosting spaces for different species so that other bat species roost can also be accommodated in the same building
- 4 no. wooden Kent bat boxes will be erected on the gable end of the structure to provide roosting opportunities for Daubenton's and Pipistrelle bat species. See: http://www.bats.org.uk/publications_download.php/938/Kent_Bat_Box_Jul2013_copy.pdf
- The interior of the roof will be lined with BS747 bituminous felt or equivalent bituminous felt
- The entry point for bats shall be on the west gable end sides away from the proposed road development and close to the vegetation on the eastern perimeter which will be retained and enhanced. The entry point will be c. 500mm x 300mm with bars set 125mm apart and lead flashing to be placed over the window sill under the hatch to prevent predator entry
- The northern corner will include a hibernation room at ground level. This will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed
- No water or electricity services are required
- Access for surveyors will be via a door on the southern side. Bats will be allowed to fly around the ground floor via an open hatch in the attic floor near the entry point
- The proposed location within the proposed development boundary is close to vegetation which is important cover for bats entering and leaving. Additional planting is proposed to link the roost to the perimeter and to connecting features in the wider landscape

Plate 8.2: Proposed location of Menlo Castle artificial roost structure



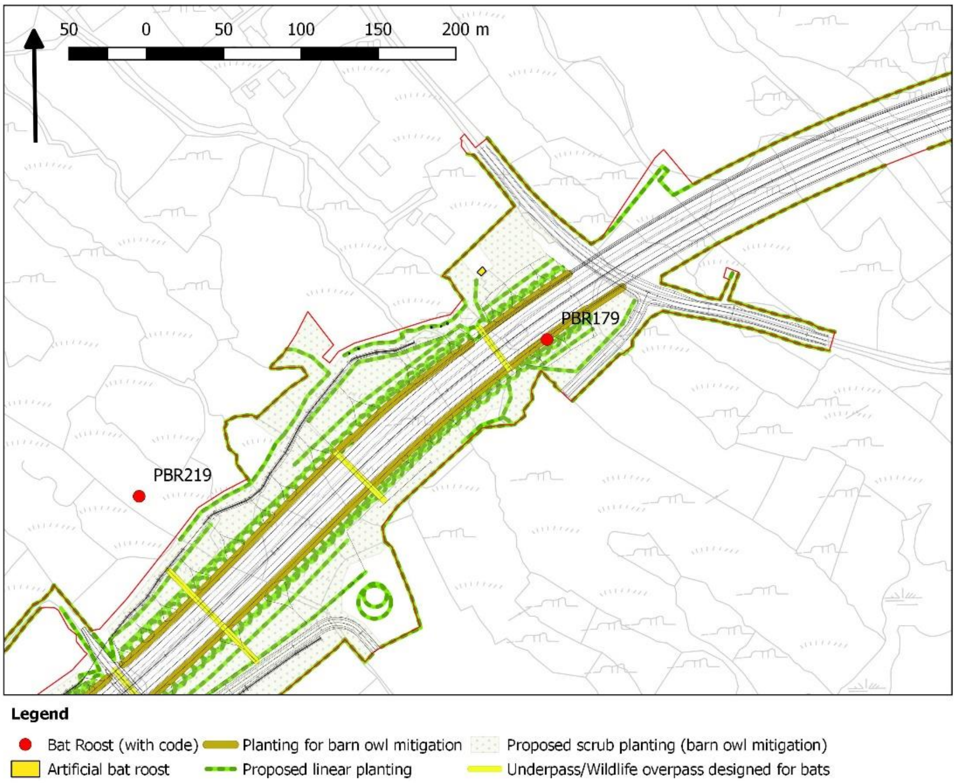
8.2.3 Menlough Woods Replacement Night roost for Lesser horseshoe bats and Soprano pipistrelle and Brown long-eared bats roosts

This is to replace a night roost for Lesser horseshoe bats (PBR219) and Brown long-eared bats (PBR179). It will be located near the edge of the proposed development boundary west of Bothár Nua and will be a simple wooden shed type structure (1m wide, 2.5m high, 2m deep) modelled on the Vincent Wildlife Trust design[30] and is shown in drawing GCOB-3000-D-002 in **Annex F**. The footprint will be much smaller than the area symbol indicated in Plate 8.3 below. The design parameters include:

- Steep pitched slate roof facing southeast
- Plywood “ceiling” with access open hatch 300mm x 300mm for bats
- Access for bats via gap over access door 500mm x 500mm
- Access for birds prevented by installing plywood baffle 1m behind access gap
- Roof lined with BS747 bituminous felt

[30] http://www.vwt.org.uk/wp-content/uploads/2015/04/lesser-horseshoe-night-roost-design.pdf

Plate 8.3: Proposed location of Menlough Woods artificial night roost structure



8.2.4 Ballindooley Night/Day roost for Brown long-eared and Pipistrelle bat and night/day/hibernation roost for Lesser horseshoe bats

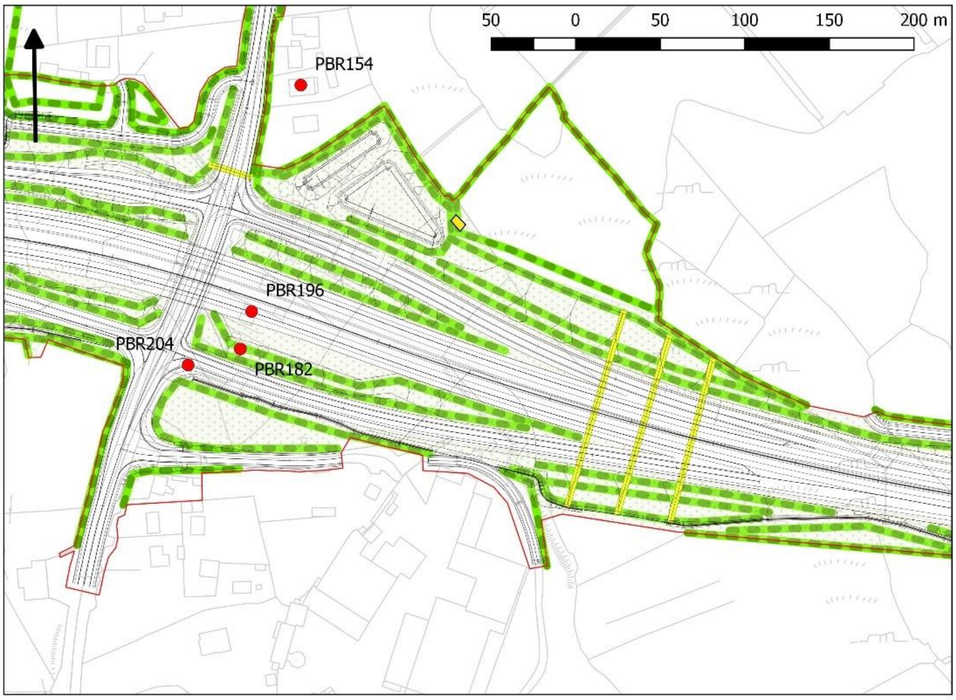
This roost is to replace a Lesser horseshoe day/night roost on the N84 Headford Road (PBR and to replace roosts for Pipistrelle and Brown long-eared bats (PBR204, PBR182, PBR196). The structure will be a small block building (e.g. 6m x 8m footprint) with natural slate roof and some external features e.g. Kent bat boxes for use by other bats species. Drawing ref GCOB-3000-D-002 in **Annex F** shows the design of this roost.

The design parameters include:

- Single storey structure with southwest orientation for maximum solar gain
- Location as set out in **Plate 8.4** below abutting the vegetation for good connections to foraging and shelter
- Rendered block wall structure with natural slate roof and can be clad and designed so as to have no adverse visual impact

- The building would have a footprint in the region of 6m x 8m with a steep pitched slate roof, partition wall in the ground floor and roof space and an attic floor laid down with an open hatch for access for bats[31]
- Plywood partitions may be installed within the roof voids to create bat "hotboxes" and separate roosting spaces for different species
- The interior of the roof should be lined with BS747 bituminous felt
- Entry points for bats shall be on the north-east facing sides away from the proposed road development and close to vegetation which will be retained and enhanced
- The northern corner will include a hibernation room at ground level which will be lined with concrete blocks and insulated to provide suitable conditions for hibernation. Plywood partitions will hang down from the ceiling to provide sheltered pockets at ceiling level. An earth floor will maintain humidity and some of the guttering will be piped inside to create an optional water-filled trough along one wall so that humidity levels can be adjusted if needed
- No water or electricity services are required
- Access for surveyors will be via a door on the southern side

Plate 8.4: Proposed location of Ballindooley artificial night roost structure options



Legend

- Bat Roost (with code)
- Proposed linear planting
- Underpasses designed for bats
- Artificial bat roost
- Proposed scrub planting (barn owl mitigation)

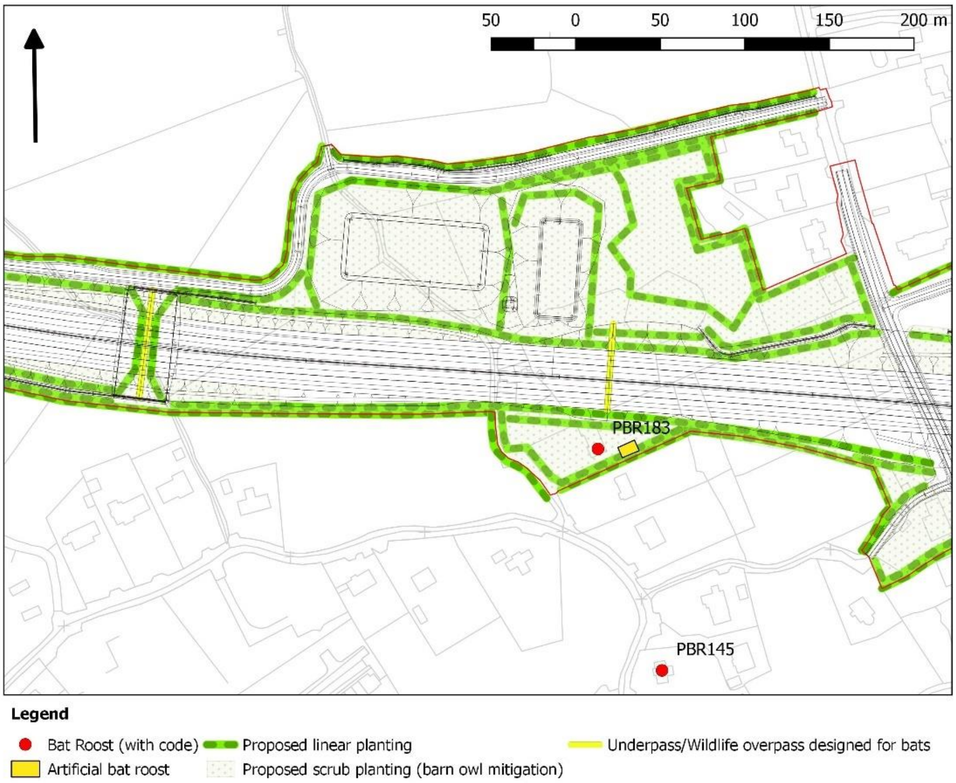
[31] Vincent Wildlife Trust (2015) *Lesser Horseshoe Bat: Conservation Handbook*.

8.2.5 Retrofitting Retained Buildings for Bats

At Ch. 12+960, the detached converted garage (next to PBR183) to the south of the proposed road development to be retained and converted for use by several species including Brown long-eared bats and Lesser horseshoe bats. This building is in a strategically-important location as it will connect to the linear planting on the south side of the proposed road development and is just c.250m from the proposed wildlife overpass in Castlegar and within a local ecological corridor leading to Cooper’s Cave, a proven hibernation and mating site for Lesser horseshoe bats. This structure will undergo minor interior and exterior modifications to create warm areas in the roof space for summer roosting and breeding and also cold conditions for hibernation. These modifications are shown in drawing GCOB-3000-D-003 in **Annex F**.

Plate 8.5 shows this location below:

Plate 8.5: Retrofitted roost near PBR183, Castlegar



8.2.6 Bat Boxes

Bat boxes will be located near the roosts to be lost but not immediately adjacent to the proposed road development where risk of collision with vehicles is highest.

Bat boxes will be erected by, or under the supervision of, a bat specialist.

These bat boxes will target Common and Soprano pipistrelle bats and Brown long-eared bats and will consist of Schwegler Type 1FF and 2FN bat boxes (or equivalent) mounted on wooden poles set into concrete bases adjacent to treelines and hedgerows as these have been demonstrated as being successful for these species in Ireland[32]. Mounting boxes on poles close to the edge of tree canopies will also allow the long-term retention of the boxes, as opposed to mounting boxes on small trees which have limited longevity.

A rocket box (as shown on Drawing GCOB-3000-D-002 in **Annex F**) will be installed at Ch. 3+320 near the roost at PBR241, rather than a bat box fixed to the building itself, so as not to detract from its cultural heritage value.

Box locations, as shown on **Plates 8.6-8.9** will include the following:

- Ch. 3+320: Rocket box to be erected to west of the building PBR241
- Ch. 10+050: 5 boxes to be erected along the edge of the tree canopy near the underpass
- Ch. 11+400: 5 boxes to be erected on the entrance road into Lackagh Quarry
- Ch. 15+100: 5 bat boxes to be erected south of Galway Racecourse

[32] McAney K. and Hanniffy, R. (2015) *The Vincent Wildlife Trust's Irish Bat Box Schemes* http://www.mammals-in-ireland.ie/wp-content/uploads/2015/11/Ireland-Bat-Box-Project-Report-WEB.pdf

Plate 8.6: Rocket box location at Ch. 3+320 near PBR241

Plate 8.7: Bat box locations near Ch. 10+050

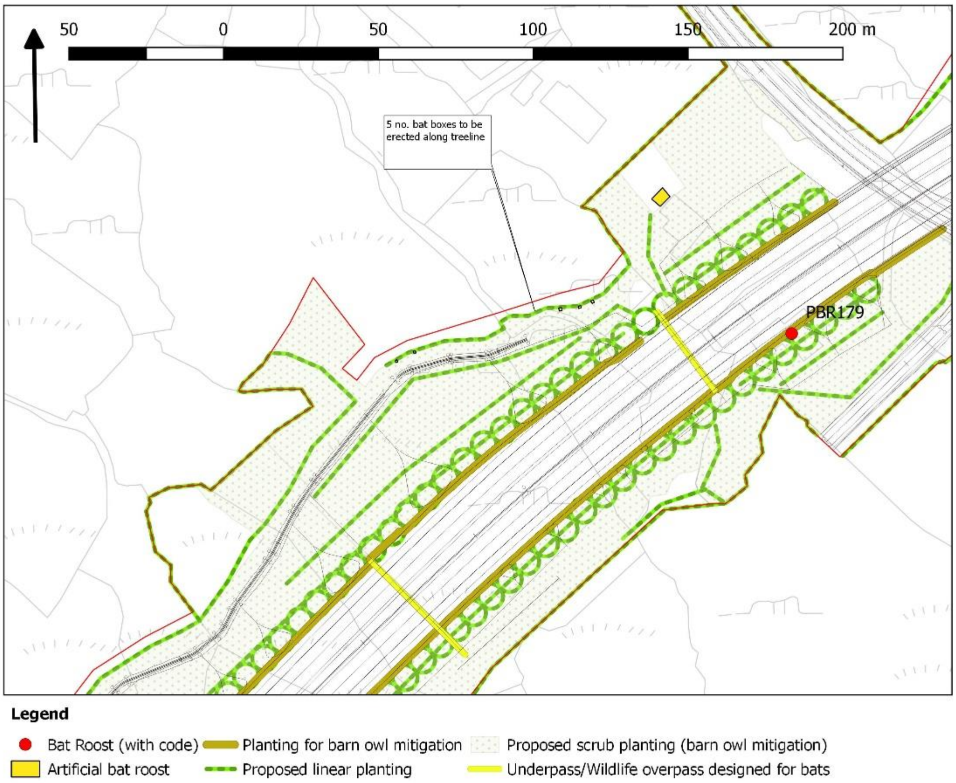


Plate 8.8: Bat boxes locations near Ch. 11+400

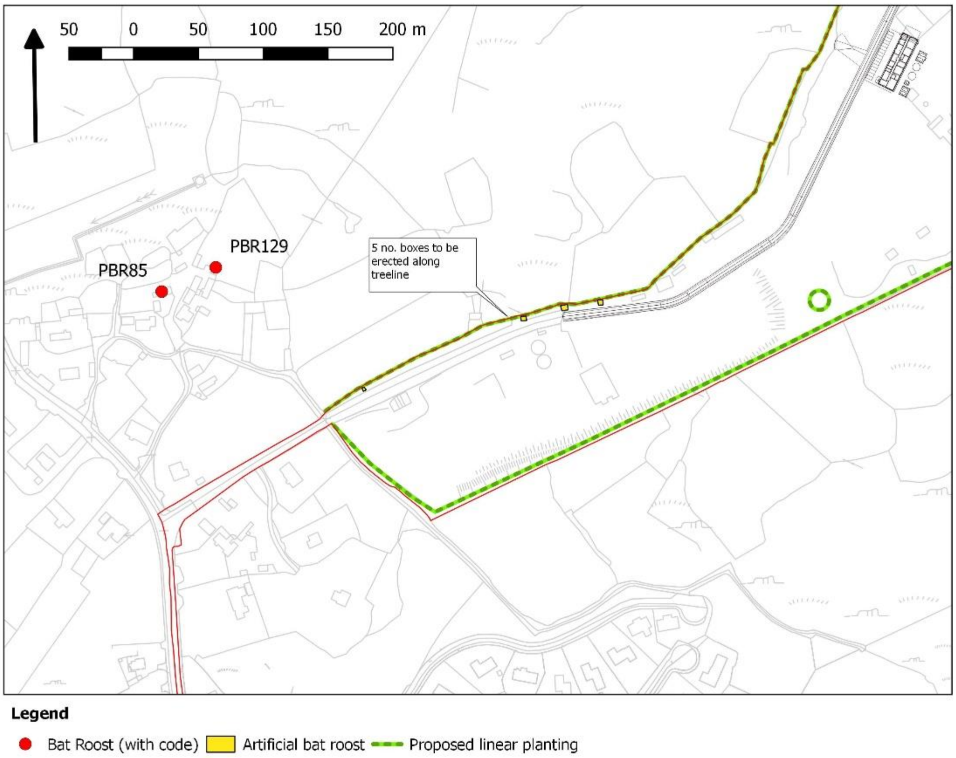
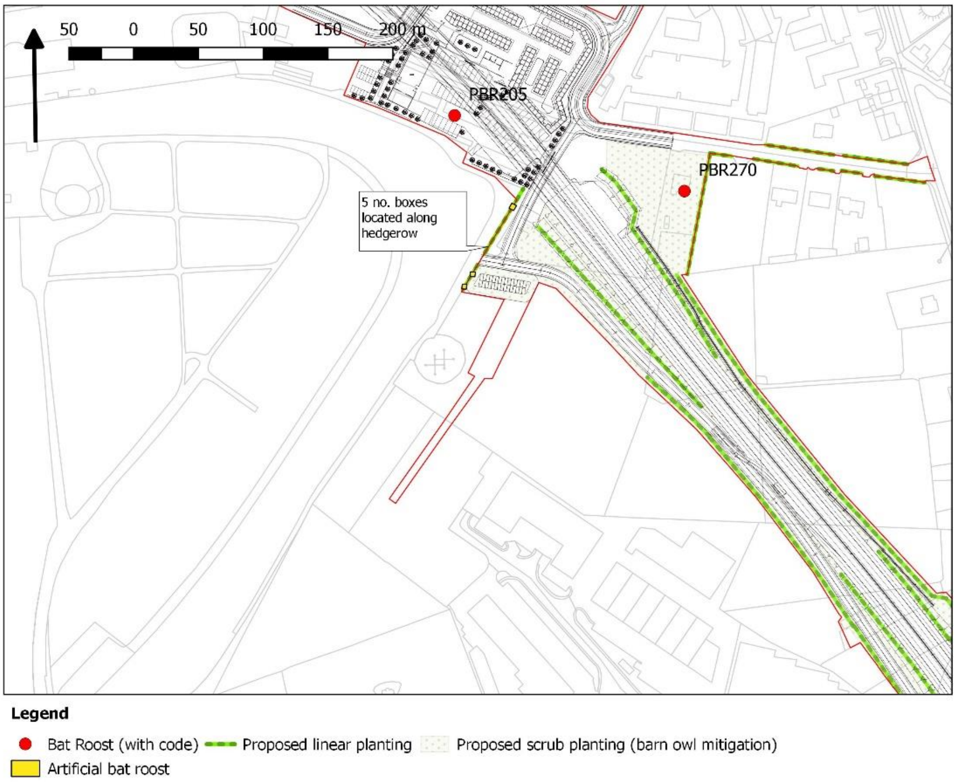


Plate 8.9: Bat boxes locations near Ch. 15+100



In the case of bat boxes provided as replacements for bat tree roosts to be felled, boxes will be Schwegler Type 1F bat boxes (or equivalent) erected on suitable trees or structures retained within the proposed development boundary in the vicinity of the tree to be lost where possible. The type and siting of any bat boxes required will be determined by the bat specialist at that time but preliminary areas for bat boxes have been identified in the areas of woodland around Menlough, Coolagh, on retained structures and the quarry walls at Lackagh Quarry and in areas near attenuation ponds.

All new roosts, retrofitted structures and bat boxes will be erected in advance of the commencement of site clearance so that replacement roosts are available to bats and that there is reasonable chance that they will have discovered them prior to loss of the existing roost. Boxes can be erected at any time of year and preferably as soon as the necessary consents are in place for the proposed road development.

8.3 Protection of proposed artificial roosts during construction works

- Newly-created roosts and bat boxes within the proposed development boundary will require protection from the adverse effects of noise and lighting during the construction phase. It is an essential element of the mitigation strategy that they are accessible and usable by bats during this time
- All existing and proposed artificial roosts retained within the proposed development boundary will be surrounded with wooden panels to a height that allows shading and shelter of key roost access features
- Planting around the existing and proposed artificial roosts retained within the proposed road development will include fast growing shrub species or fast-growing willow if the ground conditions permit. Planting will aim to guide bats away from the open construction zone toward linear features. Use of non-native species may be appropriate in some locations where it is important to get vegetation established
- All structures will be locked and not used for other purposes such as storage of materials or shelter without agreement from the Ecological Clerk of Works
- The maintenance of the existing and proposed artificial roosts retained within the proposed development boundary, in a state that they are accessible and usable by bats, will be carried out by the Contractor until the completion of the proposed road development whereby it will be taken in charge by the local authority. Maintenance will include standard building repairs over time and responding to the results of the roost monitoring (e.g. increasing or reducing humidity)

8.4 Reducing barrier effects after site clearance during the construction phase

The construction of the proposed road development will require removal of treelines, hedgerows, areas of woodland and other landscape features that bats use to provide shelter, foraging and visual cues for their movements between roosts and feeding areas. The approach to mitigation will include reconnecting some of these important features across the landscape.

The installation of temporary fencing across sites to replace connecting features has been used and appears to have only been monitored and shown to be successful as part of one project in Switzerland (Britschgi et al, 2004)[33] . In this study, a 1m wide x 1.5-2m high artificial hedgerow was recorded to be followed by a proportion of the bats in a roost. It is proposed to apply similar measures in key locations to ensure

[33] Britschgi A., Theiler A. & Bontadina F. (2004) *Wirkungskontrolle von Verbindungsstrukturen. Teilbericht innerhalb der Sonderuntersuchung zur Wochenstube der Kleinen Hufeisennase in Friedrichswalde-Ottendorf / Sachsen.*

that there are linear features to connect habitats across the construction footprint of the proposed road development.

In order to inform siting of mitigation measures, including the temporary fencing described above during the construction phase, a series of infra-red/thermal camera surveys using a series of cameras and bat detectors along linear features in the following locations will be carried out in the optimum activity season. This will help to identify the preferred crossing points, immediately prior to construction, at the following sections:

- Area 1: North of Bearna Woods
- Area 2: Aughnacurra
- Area 3: River Corrib to Bothár Nua
- Area 4: West of N84 Headford Road
- Area 5: Ballindooley to Castlegar

Each area will be surveyed three times to record bats in flight in these locations with the precise vantage points for cameras to be determined during daytime surveys.

Any existing features that are identified as preferred crossing points and are scheduled for removal at the construction stage will be retained until the last moment and a portable artificial crossing structure put alongside it prior to its removal, so at no stage there is a gap across the construction site at night. The use of the temporary fence as artificial crossing structures will be monitored three times over two weeks following installation. If the artificial crossing structure is not at the same location as a proposed permanent crossing point (e.g. the wildlife overpass at Castlegar) then it shall be moved gradually over several nights to realign it with the permanent crossing point.

The nature of the artificial crossing structure may comprise lengths of camouflage netting, recycled Christmas trees roped together, portable planters or artificial plants that can be easily moved at morning and evening to ensure that the crossing is in place each night.

Plate 14: Example of portable crossing structure, Switzerland (from Britschgi et al, 2004)

8.5 Reducing mortality risk and barrier effects within the design and operation of the proposed road development

The mitigation to address significant barrier effects has been designed to reflect current best practice. The last 10 years has seen an improvement in the monitoring of the effectiveness of bat mitigation measures for roads and there is considerable evidence that whilst bats may "use" measures designed to get them over or under a road, in the context of the overall population these measures may not be "effective" as they are often in the wrong place or simply not attractive to bats to use. Measuring bat mortality as a result of collisions has also been studied in greater detail in recent years.

The two main approaches employed for the proposed road development include underpasses of a suitable size where the road design is on embankment and a wildlife overpass where it is in cut. These two measures are the only options that have been demonstrated to be effective at a population level (CEDR, 2016, (Elmeros and Dekker, 2016, Abbot et al 2012a, 2012b).

Underpasses are proposed in important crossing point areas and are aligned with existing landscape features that are known to be used by bats as a result of the surveys. Underpasses in the Menlough - Bothár Nua area and N84 Headford Road areas are regarded to be of critical importance for Lesser horseshoe bat and other bat movements across this landscape.

The section from the N84 Headford Road to N83 Tuam Road is almost entirely in cut and installing underpasses is not possible, therefore the only effective option is a wildlife overpass (referred to throughout this report as the Castlegar wildlife overpass).

The Castlegar wildlife overpass is a critical component of the strategy. It will allow bats to fly across the proposed road development between the roosts and foraging habitats on the north side and Coopers Cave and foraging areas to the south at this location.

From 2013-2015 bats were recorded using hedgerows at many locations in places between the N84 Headford Road and the N83 Tuam Road – a distance of 1750m. The western section of the proposed road development in the vicinity of the N84 Headford Road includes for underpasses which would be used by Lesser horseshoe bats and other bat species in areas where they have been recorded, (approximately 400m in length) whilst the remainder of the proposed road development is in a cutting or it is not possible to include such underpasses.

In the absence of the Castlegar Wildlife Overpass, it is possible that bats would attempt to cross the proposed road development at the location of the existing crossing points[34]. This would increase the risk of collisions with vehicles at this key location and for Lesser horseshoe bats this could have an adverse impact that could deplete the population to an unsustainably low level.

In the absence of the Castlegar wildlife overpass the Lesser horseshoe bats would not be able to use Cooper's Cave for mating in late summer and as a result they could be forced to use less suitable locations (no other mating roosts were recorded). Mating sites that are accessible to a geographically wide population and mixes of males and females from different roosts is an essential attribute to ensure genetic heterogeneity in the local bat population. At present, bats are able to get to Cooper's Cave from a variety of directions.

A potential worst-case scenario barrier effect isolating the Menlo Castle roost would therefore lead to reduced genetic diversity and possible reduced reproductive rates in that population. Similarly, the bats using Cooper's Cave would be confined to sub-optimal habitats and it is not unreasonable to conclude that, in a worst-case-scenario, the cave would cease to be used by Lesser horseshoe bats.

The location of the Castlegar wildlife overpass is crucial to its success. Research published since 2008 by Berthinussen & Altringham (2015[35]) and evidence presented in the CEDR Safe Bat Paths reports (2016[36]) and Natural England (2015[37]) reports have identified that bats will cross a road along existing known flight paths in preference to new artificial crossings at alternative locations. Whilst this may be truer of species that are known to fly across open spaces such as Pipistrelle species, it is not known if Lesser horseshoe bats would also act in the same way. In the absence of data to the contrary, the precautionary principle has been applied and the wildlife overpass has been located at known Lesser horseshoe bat crossing points. The proposed location at Ch. 12+690 – Ch. 12+720 ties in with

[34] Lighting of the proposed road development at this location may create a barrier effect, making crossing the proposed road development even more problematic for bats.
[35] *WC1060 Development of a Cost-Effective Method for Monitoring the Effectiveness of Mitigation for Bats crossing Linear Transport Infrastructure*. Final Report 2015. Anna Berthinussen & John Altringham. School of Biology, University of Leeds, Leeds LS2 9JT/
[36] http://bios.au.dk/om-instituttet/organisation/faunaoekologi/projekter/safe-bat-paths/documents/
[37] http://publications.naturalengland.org.uk/publication/6312886965108736

records of Lesser horseshoe bats, Common and Soprano pipistrelle bats recorded by static bat detectors in 2015. It will be essential to quantify the number of bats using each crossing point (especially the Castlegar wildlife overpass) immediately prior to construction in order to provide data against which post-construction surveys can be compared (see **Sections 7** and **8** below for details on monitoring).

The width and design of the Castlegar wildlife overpass has followed simple assumptions that are based on the target species ecology and has followed best available knowledge and information as outlined below.

Guidance from Natural England (2015) can be summarised as follows:

- The COST 341 handbook (2003) identifies four types of 'over structure' to provide faunal passage; landscape bridges, wildlife bridges, modified bridges/ multi use bridges and tree top overpasses. A clear distinction between landscape bridges and wildlife bridges is not given, but in terms of design this appears to be based on scale aspects, with landscape bridges being larger structures over 80m wide and wildlife bridges being small in width with a recommendation of between 40 and 50m. The handbook does not use the term 'green bridge' to describe these structures
- A width below 20m is not recommended as although evidence shows that species will still use these bridges, the frequency of use is reduced. The proposed overpass bridge at Castlegar is 30m wide

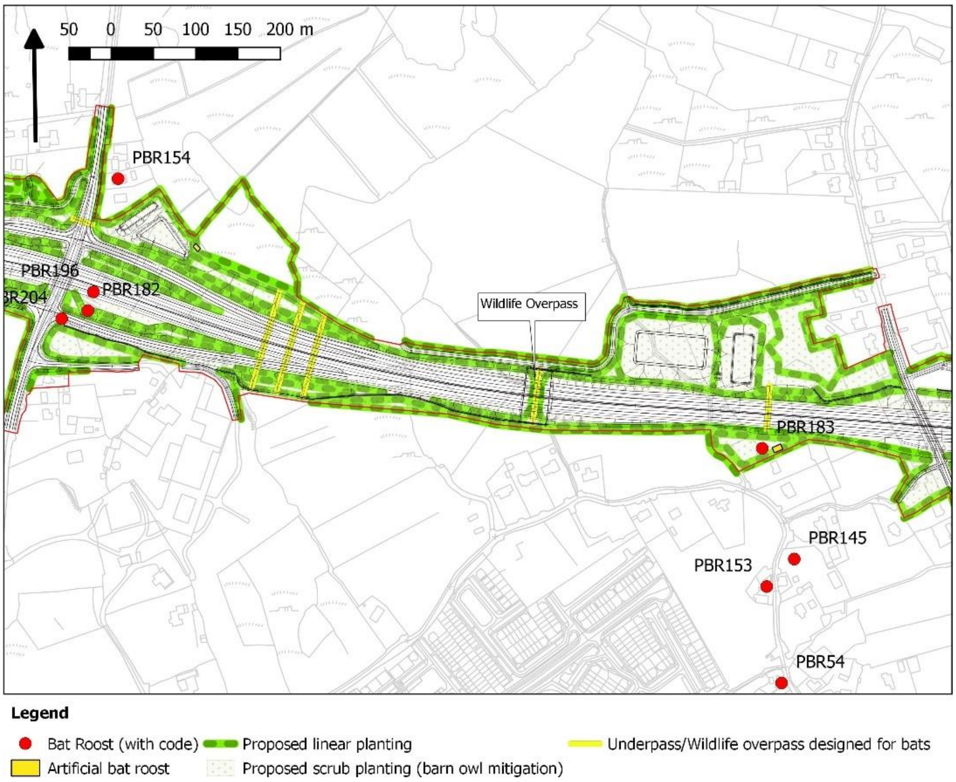
Findings of the WC1060 Report (Berthinussen & Altringham, 2015) can be summarised as follows:

- Although green bridges have the potential to be effective crossing structures for bats over infrastructure, there are other issues that also need to be considered such as the cost, the land take required for construction of the bridge and the detrimental effects there may be on bats while it is being constructed. However, one expensive yet effective structure will always make more sense than cheaper structures that do not work: mitigation structures must be cost effective and functional. Green bridges may also provide mitigation for other wildlife. Eight mammal species have been found to use Scotney Castle landscape bridge, including deer, badger and breeding dormice (National Trust, 2012), and similar structures are commonly built throughout Europe and North America for large mammals. Combining mitigation for a range of wildlife may be a cost-effective solution, but would require careful planning, project management and monitoring
- The two most widespread forms of wire bat bridge do not provide effective mitigation and should not be built, particularly since there is evidence that bats do not adapt to them with time. Our results suggest that green bridges and underpasses have the greatest potential but they must be designed correctly and many factors are important such as size, position, connectivity, topography, and the density and maturity of vegetation. Green bridges should be of sufficient width
- Best practice principles for bat mitigation along linear transport infrastructure include that in addition to being vegetated, green bridges should be as wide as possible, to provide a large area for bats to commute across. Further research is

needed to determine exact dimensions. A 30m wide green bridge was found to be effective in this study

The planting design comprises of a double hedgerow in the middle section of the overpass (to mimic a 4m wide bóithrín). Each of the hedgerows will then diverge out to create a "mouth" at the entrance to the overpass on both sides of the proposed road development to funnel bats in to the centre of the overpass. **Plate 8.10** shows the schematic design and location of the proposed overpass.

Plate 8.10: Wildlife overpass at Castlegar



No lighting will be provided at or on any of the structures which have been designed to provide bat passage, with the exception of S06/01 where lighting will be provided to allow for safe use by pedestrians. All of the bat underpasses (as well as artificial roosts) that are designed for Lesser horseshoe bats will have connecting woody vegetation features. Other bats species are not as reliant[38] on hedgerows and woodland edges. Whilst there are many existing landscape features outside of the proposed development boundary, the bat mitigation strategy cannot rely on these in the long term as they may be subject to interventions by third parties. In effect, what will be created is a hedgerow corridor leading up to underpasses in the section of the proposed road development between Aughnacurra and Castlegar. This planting provides a guaranteed green corridor connecting up the underpasses/overpasses and will allow bats to adapt more easily to any future landscape scale losses of connecting habitat features.

[38] Although it is noted that Lesser horseshoe bats cross the River Corrib over 120m of open water at Menlo Castle.

Table 6 below sets out the schedule of structures which provide bat passage and states the function that they serve in terms of mitigating the potential barrier effect. The size and location of the underpasses and culverts took into account the research carried out by Abbott (2012a, b) and the advice provided in the CEDR, COST341 and WC1060 reports. Design parameters included:

- Identifying where roosts are close to the proposed road development or where bat activity has been identified close to the proposed road development
- Identifying where the proposed vertical profile of the proposed road development (i.e. in cut, on fill or at grade) can permit bat passage underneath the proposed road development
- Where river culverts and minor roads pass under the proposed road development, it was considered if these can fulfil a role in conveying bats underneath the proposed road development
- New underpasses provided should be a minimum of 2.5m high to permit the passage of bats. Research by Abbott showed that this height would allow 90% of the bats to pass through an underpass 2.5m to 3.1m high as seen in the except from her research below

Plate 16: Results of surveys carried out by Abbott (2012c)

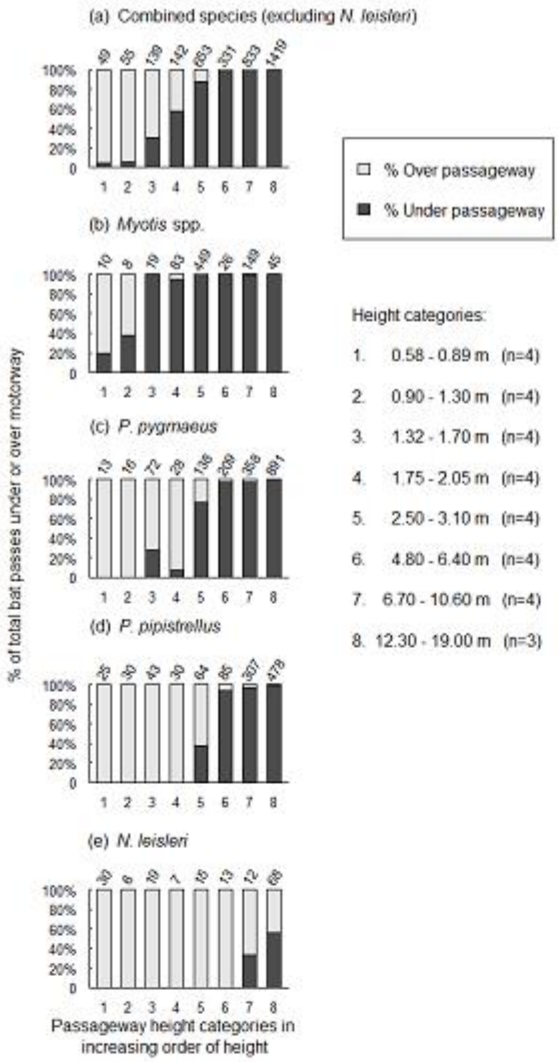


Fig. 4.17 Percentage of bat passes for **(a)** combined species (excluding *N. leisleri*), **(b)** *Myotis* spp., **(c)** *P. pygmaeus*, **(d)** *P. pipistrellus* and **(e)** *N. leisleri* (**b - e** in order of decreasing degree of clutter-adaptation) detected flying through underpasses (% Under) compared to flying over the traffic lanes of the motorway directly above underpasses (% Over) during simultaneously paired recordings. Bat pass counts (Over + Under) per height category (see legend) are shown above each bar for each species

Table 6: Schedule of structures designed to serve for bat passage

Structure	Description	Mitigation Function
Culvert C00/01	A 2.5m wide by 1.35m high culvert designed to provide bat passage beneath the proposed road development	Six species of bats recorded near this location. A combined hydraulic and wildlife culvert which will cater for Lesser horseshoe and Myotis species of bats which have been recorded here.
Culvert C02/01b	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	A combined hydraulic and wildlife culvert which will cater for Pipistrelle species which were recorded nearby.
Culvert C03/01	A 2.5m wide by 1.2m high culvert designed to provide for bat passage beneath the proposed road development	A combined hydraulic and wildlife culvert which will cater for Pipistrelle species which were recorded nearby.
Culvert C03/03	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats species nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods.
Culvert C03/04	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods.
Culvert C04/01	A 5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Lesser horseshoe and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats and will also cater for the commuting route for Lesser horseshoe bats to Bearna Woods.
Culvert C04/02	A 3.1m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Records of Pipistrelle, Brown-long eared and Myotis species of bats nearby. A combined hydraulic and wildlife culvert which will cater for bats.
Underbridge S06/01	Proposed road underbridge	The existing Rahoon Road will allow continued bat passage underneath the proposed road development. Records of Pipistrelle species of bat nearby. There will be lighting to allow safe pedestrian access.
Culvert C06/00	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will convey bats underneath proposed road development as the proposed road development severs the existing road which is used by Pipistrelle species. Records of Pipistrelle species of bat nearby, culvert connects linear feature each side of the proposed road development.
Culvert C06/01	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert allows passage across proposed road development in area of fill whereas there are no areas for underpasses to the west for c.500m. Connects to attenuation ponds which may be used for foraging.

Structure	Description	Mitigation Function
Culvert C07/00	A 2.5m wide by 2m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will connect across landscape used by Pipistrelle and Brown long-eared bats. Roosts to the east which will be surrounded by the proposed road development will be reconnected via this culvert and also culverts to the north.
Culvert C07/02A	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	Culvert will connect across landscape used by Pipistrelle and Brown long-eared bats. Roosts to the east which will be surrounded by the proposed road development will be reconnected via this culvert and also culverts to the north. The culvert carries a small stream and ties into a ditch and hedgerow on the eastern side and will join a proposed landscaped strip on the western side, to connect it to the existing Rahoon Road.
Culvert C08/01A	A 2.5m wide by 2.5m high culvert designed to provide for bat passage beneath the proposed road development	This culvert is in an area of fill west of the N59 Moycullen Road and offers an opportunity for bats to cross under the proposed road development in this section. Pipistrelle and Lesser horseshoe bats have been recorded in the surrounding area.
Culvert C08/05	2.5m wide by 2.5m high culverts will provide for bat passage beneath the proposed road development	These culverts are close to the artificial roost proposed to address the loss of the bat roosts at Aughnacurra (PBR178, 256, 255, 177, 210). As such it is essential to maximise permeability of the proposed road development in this section. Brown long-eared and Lesser horseshoe bats will be facilitated by this culvert. Proposed landscape planting strips will connect the culvert to retained vegetation at the perimeter.
Culvert C08/04		
Culvert C08/02		
Culvert C09/01	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	Series of five culverts providing permeability underneath the proposed road development for Lesser horseshoe, Pipistrelle, Brown long-eared and other bat species. The culverts will open into the retained edges of Menlough woods with additional planting provided.
Culvert C09/02	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Culvert C09/03	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Culvert C09/04	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	
Culvert C09/05	A 5m wide by 4m high culvert will provide for bat passage beneath the proposed road development	

Structure	Description	Mitigation Function
Road Underbridge S09/01	Proposed road underbridge (9.6m wide 5.3m high) Menlo Castle Bóithrín will provide for bat passage beneath the proposed road development	Key crossing point in the landscape for Lesser horseshoe bats permitting flights between Menlo Castle roost (and future new roost) and foraging areas near the Coolagh Lakes. Proven by radio-tracking data. The unlit existing road will allow continued bat passage underneath the proposed road development. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings.
Culvert C09/06	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	This culvert connects woodland edges that will be retained at the edge of the culvert. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings.
Culvert C09/07	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	In low area in local topography within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings.
Underpass C10/01	A 18m wide by 4.5m high underpass will provide for bat passage beneath the proposed road development	This underpass connects woodland edges that will be retained at the edge of the culvert. Records of several species of bat nearby including being within the recorded foraging area for Lesser horseshoe bats and being in an important area for crossings as proven by radio-tracking data.
Road Underbridge S10/02	Proposed road underbridge (9.6m wide by 5.3m high)	The proposed underbridge will allow continued bat passage beneath the proposed road development. Records of several species of bat nearby including Lesser horseshoe bats and being in an important area for crossings as proven by radio-tracking data.
Culvert C12/02	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the proposed road development	Series of 3 culverts, each 25m apart, connects lands north and south and allows bats to cross. A key crossing point for Lesser horseshoe bats, Brown long-eared bats and roosts for both species are nearby.
Culvert C12/03	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the road	
Culvert C12/04	A 2.5m wide by 2.5m high culvert will provide for bat passage beneath the road	
Castlegar Wildlife Overbridge S12/02	The Castlegar Wildlife Overbridge (60m long x 30m wide) will provide for bat passage over the proposed road development	Key crossing point in the landscape for Lesser horseshoe bats permitting flights between Castlegar and Ballindooley/Menlough areas. See text above this table for rationale for wildlife overpass location and design.
Structure S08/04	River Corrib bridge will provide for bat passage	An important crossing point for all bat species especially Lesser horseshoe and Daubenton’s bats as

Structure	Description	Mitigation Function
	under the proposed road development	proven by radio-tracking data. Roosts for both species are nearby.

In addition to the structures specifically designed for bat passage, there are other structures such as where minor roads pass underneath the proposed road development which will be used by bats as safe crossing points.

8.6 Compensation[39] for loss of foraging habitat

Approximately 7ha of woodland-pasture-hedgerow-scrub habitat will be removed from the area between the River Corrib and Bothár Nua in Menlough. This habitat is used by the Lesser horseshoe bat population and therefore there is a risk that there may be reduced breeding success if replacement planting is not made available.

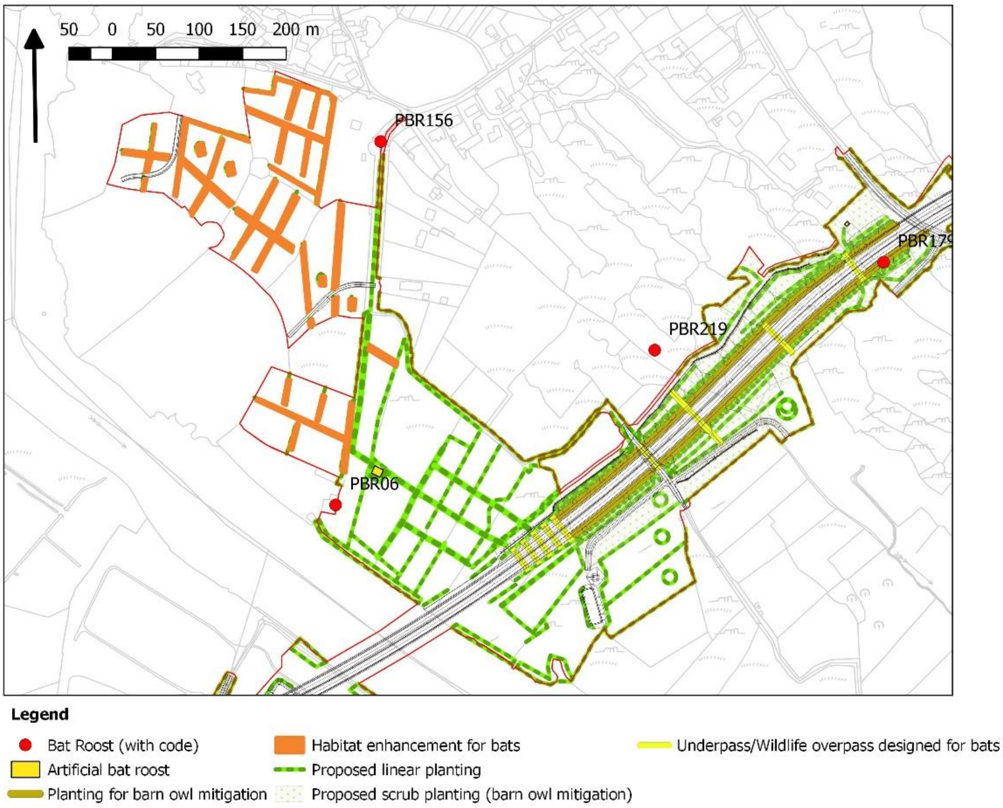
Lands within the known core foraging area of the Menlo Castle roost (PBR06), but not optimal feeding habitat, will be used to provide compensation for loss of foraging habitat. Hedgerows in this area will be augmented and thickets of hazel, hawthorn, holly and oak will be provided in several of the fields to create pockets of wood and grassland habitat. Grazing will continue on the lands as it has been shown that foraging over grazed land is preferred to ungrazed lands (Downes et al, 2016). Connectivity to foraging areas will also be secured through tying the proposed planting strips to hedgerows and woodland edges.

Planting of new hedgerows in fields between the proposed road development and Menlo Castle will improve the foraging resources of this core foraging area (**Plate 8.11**) and provide connectivity underneath the proposed road development. Such planting will include additional native hedgerows planted across the existing fields to increase the lengths of hedgerows close to the proposed new roost for Lesser horseshoe bats near Menlo Castle. The fields will still be grazed and the hedgerows can be fitted with field gates as required providing gaps are kept to a minimum.

The area of habitat enhancement for the purposes of offsetting the loss of suitable bat foraging habitat and landscape connectivity due to the proposed road development amounts to approximately 8ha.

[39] Note that the term "compensation" is used in this application refers to addressing impacts which cannot be mitigated. These impacts will have no impact on any European Site and the term "compensation" as used in this application does not in any way infer the same meaning as used in Article 6(4) of the E.C. Habitats Directive.

Plate 8.11: Proposed habitat enhancement at Menlo Castle (not to scale)



9 Residual Impacts

9.1 Residual Impacts on bat species and effect on conservation status

Potential impacts are predicted to occur to all bat species that were recorded in the study area although the magnitude and significance of the impact will vary between species and locations.

This section summarises the potential impact of the proposed road development on the local bat population, the approach to addressing these impacts and the resultant predicted impact on the conservation status of each species. The activities that require the derogation are also summarised.

9.1.1 Lesser horseshoe bat

The construction of the proposed road development will result in the loss of one satellite roost (PBR178) and several night roosts used by this species. The maternity roost at Menlo Castle will not be affected by the construction or operation of the proposed road development. Due to the isolated nature of the location of the eight roosts within the natural range of the species in Ireland and the lack of other maternity roosts known to occur nearby the impact would be of national-scale importance and threaten the conservation status of this species. In order to address this impact, four artificial bat roosts will be constructed and an existing building retrofitted to provide roosting opportunities for Lesser horseshoe bats during all stages of their life cycle. Procedures following best practice to ensure bats are protected during roost demolition will be adhered to, but a derogation is still required to permit the removal of these roosts.

The construction phase will also lead to loss of foraging habitat within proposed development boundary and fragmentation of flight paths between roosts and between roosts and foraging areas. It is proposed to enhance 8ha of agricultural lands to compensate for loss of 7ha of woodland, scrub and pasture in the area of Menlough, close to the maternity roost.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

Following the implementation of these mitigation measures, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The combined effect of providing new roosting with better conditions for breeding and habitats managed to maximise foraging resources will aim to consolidate and increase the existing population. Promoting an increase in the resident population as a result of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range. The residual impact of the proposed road development on Lesser horseshoe bat is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.2 Soprano pipistrelle bat

The construction of the proposed road development will result in the loss of six Soprano pipistrelle roosts, none of which are deemed to be maternity roost as all contained small numbers of bats. There will also be loss of foraging habitat within proposed development boundary and fragmentation of flight paths between alternative roosts and between roosts and foraging areas.

Due to the high frequency of occurrence of this species in the study area and the widespread natural range of the species in Ireland, the impact would be of local-scale importance and the loss of these small roosts is not expected to threaten the conservation status of this species. Nevertheless, procedures following best practice to ensure bats are protected during roost demolition will be adhered to and a derogation is still required to permit the removal of these roosts.

Bat boxes and installation of bat-roost features in the artificial roost structures will provide replacement roosting opportunities.

8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range. The residual impact of the proposed road development on Soprano pipistrelle bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.3 Common pipistrelle bat

The construction of the proposed road development will result in the loss of one roost (PBR205) of this species. There will also be loss of foraging habitat within proposed development boundary and fragmentation of flight paths between alternative roosts and between roosts and foraging areas.

Due to the high frequency of occurrence of this species in the study area and the widespread natural range of the species in Ireland, the impact would be of local-scale importance and the loss of these small roosts is not expected to threaten the conservation status of this species. Nevertheless, procedures following best practice to ensure bats are protected during roost demolition will be adhered to and a derogation is still required to permit the removal of these roosts. Bat boxes and installation of bat-roost features in the artificial roost structures will provide replacement roosting opportunities.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Common pipistrelle bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.4 Natterer’s bat

No known Natterer’s bat roosts are to be demolished or directly impacted upon as a result of the proposed road development. However, there will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

Due to the low frequency of occurrence of this species in the study area but the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Natterer's bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.5 Daubenton's bat

No Daubenton's bat roosts are to be demolished or directly impacted upon as a result of the proposed road development. However, there will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species. The maintenance of a dark corridor along the Corrib underneath the proposed road development will also permit foraging and connectivity between landscapes used by this species.

Due to the low frequency of occurrence of this species in the study area but the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Daubenton's bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.6 Whiskered bat

No Whiskered bat roosts are to be demolished or directly impacted upon as a result of the proposed road development. However, there will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

Due to the low frequency of occurrence of this species in the study area but the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Whiskered bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.7 Nathusius pipistrelle bat

No Nathusius's pipistrelle bat roosts were found during the surveys but it was recorded across the study area at a low density. There will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

Due to the low frequency of occurrence of this species in the study area but the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Nathusius pipistrelle bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.8 Brown Long eared bat

Seven Brown long-eared bat roosts are to be demolished, one of which are regarded to maternity roosts. Bat boxes and installation of bat-roost features in the artificial roost structures will provide replacement roosting opportunities. All the artificial roost structures will be designed to accommodate this species. Nevertheless, procedures following best practice to ensure bats are protected during roost demolition will be adhered to and a derogation is still required to permit the removal of these roosts. Bat boxes and installation of bat-roost features in the artificial roost structures will provide replacement roosting opportunities.

There will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

Due to the widespread occurrence of this species in the study area and the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species. There are also several other roosts known to occur nearby.

The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. The wildlife overpass has been located and designed in accordance with good practice and this is likely to be used by this species. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Brown long-eared bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.9 Leisler's bat

One tree (PTR48) used by one individual of this species for roosting will be removed. Bat boxes provide replacement roosting opportunities. All the artificial roost structures will be designed to accommodate this species. Nevertheless, procedures following best practice to ensure bats are protected during roost demolition will be adhered to and a derogation is still required to permit the removal of the roost site in the tree. Bat boxes and installation of bat-roost features in the artificial roost structures will provide replacement roosting opportunities.

There will be loss of foraging habitat within proposed development boundary. 8ha of agricultural lands to be planted and managed to compensate for loss of 7ha of woodland, scrub and pasture in Menlough which, although designed for Lesser horseshoe bats, will also benefit this species.

Due to the widespread occurrence of this species in the study area and the widespread natural range of the species in Ireland, the impact would be of local-scale importance not and threaten the conservation status of this species. There are also several other roosts known to occur nearby.

The proposed road development is less likely to pose an adverse impact on this species compared to the other Irish bat species. The impact on bat flight paths and the connectivity across the landscape has been addressed by design of underpass locations, size and proposed landscape planting. These measures will minimise the effect of fragmentation and barrier to movements across the landscape.

However, there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the road although since Leisler's bat often fly at height above the zone of potential collision, this risk is deemed to be very low. The proposed measures aim to protect the existing population using tested methods and approaches. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The residual impact of the proposed road development on Leisler's bats is predicted to be imperceptible above the scale of impacts on individual bats due to vehicle collision.

9.1.10 Overall Residual Impact

For all bat species there is a residual risk of mortality due to collisions with vehicles as a small proportion of the population will still fly over the proposed road development. The combined effect of these measures will ensure that there will be no reduction in the natural range or population of the species and hence there will be no detrimental effect to the maintenance of the populations of the species at a favourable conservation status in their natural range.

The overall residual effect on all bat species will be regarded to be significant, at the local geographic scale, due to the presence of the proposed road development within their foraging areas.

10 Proposed monitoring programme

10.1 Pre- construction monitoring

Pre-construction monitoring is required to provide data against which the post-construction monitoring can be compared. Parameters will include:

- Occupancy levels in roosts (Menlo Castle, proposed artificial roost buildings including retrofitted retained buildings, bat boxes)
- Bat passage structures (culverts, underpasses and the Castlegar Wildlife Overpass)
- Diversity of bat species and abundance of bat activity adjacent to the proposed road development

Occupancy levels in Menlo Castle will be measured by emergence surveys using infra-red video camera recording monthly from mid-April to September in the year of or immediately prior to construction commencing (whichever of the two is closer to the construction commencement).

The pre-construction baseline monitoring for bat usage of proposed bat passage structures will focus on recording bats using existing flight paths at proposed underpasses near Menlo Castle, the N59 Letteragh Junction and the proposed Castlegar Wildlife Overpass. Pre-construction baseline data is required on numbers of bats and flight height so that this can be compared to a post-construction scenario. Such data will be collected using focused infra-red camera and detector surveys carried out at least on three separate occasions at each location in the optimum survey period. In accordance with CEDR (2016) guidance it is proposed that this pre-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.

The risk of adverse effects on bat diversity and abundance adjacent to the proposed road development can never be ruled out completely; but not all populations will be affected in the same location in the same way and therefore ongoing monitoring is regarded to be good practice to enhance our understanding of the effects of road developments and the effectiveness of mitigation measures. Diversity of bat species and abundance of bat activity adjacent to the proposed road development will be monitored using standardised survey transects from the edge of the proposed road development outwards as described by Berthinussen & Altringham (2015). These transects will be used to record bat activity across the lands flanking the corridor of the proposed road development. It is proposed that six transects are surveyed pre-construction in locations of high bat activity where underpasses or an overpass are proposed.

10.2 During and post-construction monitoring

10.2.1 Roost monitoring

Monitoring of occupancy of the artificial roost buildings (including retrofitted retained buildings) and bat boxes will commence immediately after their installation to determine how soon they are used. They will be installed prior to the main site clearance phase; therefore, all monitoring can be by visual inspection according to the following schedule:

- Emergence counts at Menlo Castle roost: emergence counts will be undertaken during the construction works and in 5 years following construction in May, July and August. These counts will be made using infra-red video camera recording at the same time as visual inspections of bats using the proposed new roost site adjacent to Menlo Castle in order to get an overall count of bats at this location
- Artificial roost buildings: Occupancy of the proposed artificial roost buildings (including retrofitted structures) during the works and post-construction will be undertaken in the 5 years following completion of construction. Surveys will be undertaken in mid-winter for hibernation use and in May and July for use during breeding season. Surveys will include checks for individuals and also for droppings (where necessary using DNA analysis). Droppings will be removed after each check to ensure that the subsequent survey only records usage in the interim period. The roosts will be monitored annually for Lesser horseshoe bats and counts sent to the NPWS as part of the national Lesser horseshoe bat monitoring programme. This monitoring may be undertaken by NPWS staff, Galway bat group or others to be decided by the local authority. Remote modes of monitoring using new technology may mean that visits to the roosts are not always required and that infra-red images inside the roost can be sent wirelessly. Should the monitoring of the roosts suggest that bats are not using them, additional focused surveys will be undertaken to try to understand bat movements in the locality and aim to address any issues. Any changes that may be deemed necessary will be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in this report. Temperature and humidity probes coupled with data loggers will be installed in the roosts for two years post construction of the roost and measures taken (e.g. fitting vents, increasing period of water tanks in the hibernation roost area) to address any issues arising
- Bat boxes: The authors are not aware of any minimum or recommended standard for bat box monitoring. After installation, boxes will be visually inspected quarterly per year for the first two years. Research into the effectiveness of mitigation measures has indicated that occupancy of bat boxes averages 50%[40] since bats may prefer existing alternative roost sites in the locality. Any boxes not showing signs of occupancy after that time may be relocated to alternative locations within the proposed development boundary nearby where they may be of benefit to the local bat population. In years 3-5

[40] Paul Lynott, pers. comm 2017.

after installation the boxes will be checked in late March and September to record usage in winter and summer and to avoid disturbance during the sensitive hibernation times

- Bat boxes will be checked for a minimum of 5 years after erection

10.2.2 Monitoring crossing points

Monitoring will comprise acoustic detector and infra-red camera recording at the culverts at the four locations previously surveyed pre-construction referred to in Section 8.4, namely:

- Area 1: North of Bearna Woods
- Area 2: Aughnacurra
- Area 3: River Corrib to Bothár Nua
- Area 4: West of N84 Headford Road
- Area 5: Ballindooley to Castlegar, including the Castlegar wildlife overpass

This will quantify the usage by bats compared to non-usage (e.g. using other flight paths). This will allow a determination as to whether the bat passage structures are being effective at a population level (where it is assumed that 90% of the bats are able to pass underneath the proposed road development). Monitoring will be repeated at all locations to provide a robust dataset. In the event that the proposed bat passage structures including the Castlegar wildlife overpass are not deemed to be effective, then further focused surveys will be required to determine the causes and address them in a reasonable manner where possible (for example, controlling lighting, addressing local landscape changes). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in the EIA or Appropriate Assessment documentation.

In accordance with CEDR (2016) guidance it is proposed that this post-construction monitoring involves a minimum of two separate surveys in the breeding season and two separate (in time) surveys in mid-August to late-September, to reflect periods of landscape-scale movements, and that these surveys take place for two bat activity seasons (May-August) following completion of the construction of the proposed road development.

10.2.3 Diversity and abundance adjacent to the proposed road development corridor

Transects of bat activity will be taken across the same locations as the pre-construction transects in order to identify any displacement effects caused by disturbance impacts during construction and operation. Whilst the application of the Berthinussen & Altringham (2015) methodology is not without its limitations as it has only been applied to open agricultural landscapes, it is nevertheless a foundation for a reproducible survey method that is appropriate to the proposed road development. If a displacement effect is detected (decreased abundance and diversity close to the proposed road development) then further focused surveys will be required to determine the causes and address them where possible (for example, controlling lighting, addressing local landscape changes through additional planting). Any changes that may be deemed necessary will need to be coordinated and communicated to ensure that they do not conflict with any of the impact predictions or mitigation measures prescribed in the EIA Report or Natura Impact Statement. It is proposed that monitoring takes place during construction and two bat activity seasons following completion of the construction of the proposed road development.

11 Conclusions

Galway County Council are submitting this application under Regulation 54 of the European Communities (Birds and Habitats) Regulations 2011 (S.I. 477 of 2011) for a derogation licence from complying with the requirements of the provisions of Regulations 51, 52 and 53 of the same Regulations.

The application relates to specific residual impacts on bats arising from the construction and operation of the proposed road development, and its potential impact on bat (Chirpotera) species. Potential impacts have been mitigated as far as possible during the design phase and the residual impacts are those that cannot be ruled out despite applying best practice techniques.

Each of the following conditions as set out in the requirements of Articles 51, 52 and 53 have been addressed in this application in detail:

- there is no satisfactory alternative
- the proposed derogation will not be detrimental to the maintenance of the species at a favourable conservation status in their natural range
- one of the requirements set out in Article 54(2)(a) to (e) applies. In this case the requirement that applies *is "(c) in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment."*

It has been concluded by the applicant that the proposed design-based mitigation measures, compensatory roosting and foraging habitat and adopting best practice to protect bats during construction activities demonstrates full compliance with the Regulations.

12 References

Abbott I.M., Butler F. and Harrison S. (2012a) *When flyways meet highways - The relative permeability of different motorway crossing sites to functionally diverse bat species.* Landscape and Urban Planning 106, 293-302.

Abbott I.M., Harrison S. and Butler F. (2012b). *Clutter-adaptation of bat species predicts their use of under-motorway passageways of contrasting sizes – a natural experiment.* Journal of Zoology 287, 124-132.

Abbott, I. M. (2012c) *Assessment of the effectiveness of mitigation measures employed on Irish national road schemes for the conservation of bats***.** PhD thesis, University College Cork, Ireland.

Baagoe, H. J. (1987) *The Scandinavian bat fauna—adaptive wing morphology and free flight in the field. 57–74.* in Recent advances in the study of bats. Fenton, M. B., P. A. Racey, and J. M. V. Rayner. Cambridge University Press. Cambridge, United Kingdom.

Bat Conservation Trust. (2016) *Core Sustenance Zones: Determining zone size.* http://www.bats.org.uk/data/files/Core_Sustenance_Zones_Explained_-_04.02.16.pdf

Berthinussen, A. and Altringham, J. (2012) *The effect of a major road on bat activity and diversity*. Journal of Applied Ecology, 49: 82–89.

Berthinussen, A. and Altringham, J. (2012a) *Do bat gantries and underpasses help bats cross roads safely?* PLoS ONE, 7.

Berthinussen, A. and Altringham, J. (2015) *WC1060 Development of a Cost-Effective Method for Monitoring the Effectiveness of Mitigations for Bats crossing linear transport infrastructure. Final report 2015*. School of Biology, University of Leeds, Leeds.

Billington G. (2001-2006) *A487 Llanwnda to South Llanllyfni Improvement. Bat Surveys*. Greena Ecological Consultancy, Devon UK.

Bontadina, F., Schofield H. and Naef-Daenzer B. (2002) *Radio-tracking reveals that lesser horseshoe bats (Rhinolophus hipposideros) forage in woodland*. J. Zool., Lond. 258, 281-290.

Downes, N.C., Cresswell, W., Reason P., Sutton, G. Wells, D., and Wray, S. (2016). *Sex-Specific Habitat Preferences of Foraging and Commuting Lesser Horseshoe Bats Rhinolophus hipposideros (Borkhausen, 1797) in Lowland England.* Acta Chiropterologica 18, 451-465.

Britschgi A., Theiler A. and Bontadina F. (2004) *Wirkungskontrolle von Verbindungsstrukturen. Teilbericht innerhalb der Sonderuntersuchung zur Wochenstube der Kleinen Hufeisennase* in Friedrichswalde-Ottendorf /Sachsen.

Butchkowski, C. M., and J. M. Hassinger. (2002). *Ecology of a maternity colony roosting in a building.* Pp. 130–142, in The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas, 253 pp.

Capo G.J. J. Chaut and A.Laurent**.** (2006). *Quatre ans d'etude de mortalite des Chiropteres sur deux kilometres routiers proches d'un site d'hibernation. [Four years of bat mortality study along two kilometres of road near to a hibernation site]*. Symbioses 15:45–46.

Carr LW, Fahrig L. (2001) *Impact of road traffic on two amphibian species of different vagility*. Conservation Biology 15, 1071-1078.

Choquene, G. L. **(**2006) *Mortalité de chauves-souris suite à des collisions avec des véhicules routiers en Bretagne*. [Mortality of bats due to collisions with road vehicles in Brittany]. *Symbioses*, 15: 43–44.

Collins, J. (ed.) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn). The Bat Conservation Trust, London. ISBN-13 978-1-872745-96-1

Drew, D. (2004) *Cave Database for the Republic of Ireland*. Geography Department, Trinity College, Dublin, 2004. http://www.ubss.org.uk/irishcaves/irishcaves.php

Elmeros M. and Dekker J. (2016) SafeBatPaths. *Fumbling in the dark - effectiveness of bat mitigation measures on roads*: Final report.

Elmeros M., Dekker, J., Garin, I. Christensen, M. Fjederholt E.T., Moller J., Baagoe, J. (2016) *Bat mitigation measures on roads – a guideline: Fumbling in the dark – effectiveness of bat mitigation measures on roads.* CEDR Transnational Road Research Programme. Conference of European Directors of Roads.

Glista, D. J., and T. L. DeVault. (2008) Road mortality of terrestrial vertebrates in Indiana. *Proceedings of the Indiana Academy of Science*, 117: 55–62.

Hein, C. D., S. B. Castleberry, and K. V. Miller. (2009) *Site-occupancy of bats in relation to forested corridors.* Forest Ecology and Management, 257: 1200–1207.

Iuell B. (Eds.) (2003) *Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions.* COST 341 Habitat Fragmentation due to Transportation Infrastructure.

Kelleher C. and Marnell F. (2006) *Bat Mitigation Guidelines for Ireland.* National Parks and Wildlife Service.

Lande R. (1987) *Extinction thresholds in demographic models of territorial populations*. American Naturalist 130, 624-635.

Lesiński G. (2007) *Bat road casualties and factors determining their number.* Mammalia 20, 138-142.

Luo, J., Siemers, I. M., and Kosel, K. (2015) *How anthropogenic noise affects foraging.* Global Change Biology 21: 3278-3289.

Mitchell-Jones A. J., and McLeish A. P. (1999) *The Bat Workers' Manual, 2nd Edition*. Joint Nature Conservation Committee.

NRA. (2006) Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes. National Roads Authority.

Reiter, G., Polzer, E., Mixanig, H., Bontadina, F., and Huttmeir, U. (2012) *Impact of landscape fragmentation on a specialised woodland bat, Rhinolophus hipposideros.* Mammalian Biology - Zeitschrift fur Saugetierkunde · December 2012.

Russell A.L., Butchkoski C.M., Saidak L., McCracken G.F. (2009) *Road-killed bats, highway design, and the commuting ecology of bats.* Endangered Species Research 8, 49-60.

West E.W.W. (2016) *Technical Guidance for the Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Bats.* CALTRANS.

Whitaker, J. O., Jr., and R. E. Mumford. (2009) *Mammals of Indiana.* Indiana University Press, Bloomington, Indiana, 661 pp.

With K.A., King A.W. (1999) *Extinction thresholds for species in fractal landscapes*. Conservation Biology 13, 314-326.

Zurcher A.A., Sparks D.W., Bennett V.J. (2010) *Why the bat did not cross the road?* Acta Chiropterologica, 12, 337-340

Annex A

Galway Bat Radio-tracking Project - Bat Radio-tracking surveys. Radio-tracking studies of Lesser horseshoe and vesper bat species, August and September 2014 (Rush & Billington, 2014)

A1

Greena Ecological Consultancy

Galway Bat Radio-tracking Project

Radio tracking studies of lesser horseshoe and vesper bat species, August and September 2014

Photo by Isobel Abbott

V3A October 2014

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Contents

Executive summary

Greena Ecological Consultancy has been commissioned by Scott Cawley Ltd to undertake two radio-tracking studies in Galway, Republic of Ireland, to inform the N6 Galway City Transport Project. The study was conducted to obtain information on where the bats roost, breed, forage and the extent of their range in order to be able to determine the potential impacts of the proposed Scheme on the local bat populations.

No previous radio-tracking study covering Lesser horseshoe bats as well as vesper bats is known to have been undertaken in the area of interest. Scott Cawley carried out static monitoring in combination with emergence surveys and roosts inspections prior to the radio-tracking study in order to provide basic information on bat colonies present in the area of interest.

Three radio-tracking sessions were scheduled for 2014; Greena Ecological Consultancy conducted the first and the third. The first study took place in late July and early August 2014 ("August session") and the third one during the last days of August and in early September 2014 ("September session"). The two sessions aimed to help understand potential seasonal shift in activity patterns of Lesser horseshoe bats while avoiding interference during the most sensitive period of bat life cycle when females give birth and lactate (suckle their young), the latter session then added information on a sample of vesper bat population in Galway. One session, not undertaken by Greena Ecological Consultancy, took place in mid-August and aimed to find roosts of vesper bats. The second study partially overlapped with Greena Ecological Consultancy September study.

Greena Ecological Consultancy captured 17 Lesser horseshoes *(Rhinolophus hipposideros)* during the first session, 13 females and four males. All bats were captured in a static mist net stretched over maternity roost entrance. Bats were of good health, weight ranging from 5.7g to 6.5g for females and from 5.3g to 6.0g for males. Ten bats were fitted with radio transmitters and ringed at the same time. The session at Menlo Castle (30/07/2014) was followed by another catching session at Cooper's Cave on the night of 1st August 2014. Three males Lesser horseshoe (LHS) bats were captured in a double bank harp trap, together with a single male Daubenton's bat *(Myotis daubentonii)* and a single male Natterer's bat *(Myotis nattereri)*. All three males LHS were fitted with a radio-transmitter and ringed.

The September radio-tracking study carried out by Greena Ecological Consultancy commenced by surveying bats previously tagged in August. The total of 11 bats of five species was tagged prior to the arrival of Greena. These included Daubenton's bat (both sexes), Common pipistrelle *(Pipistrellus pipistrellus)* (both sexes), Brown long eared bat *(Plecotus auritus)* (female), Whiskered bat *(Myotis mystacinus)* (males) and Leisler's bat *(Nyctalus leisleri)* (males).

Several previously tagged bats could not be located due to combination of radio- frequencies fluctuating with temperature and the change not being recorded during tagging and possible tag failure. Bats that could be surveyed during the September session included one male Leisler's bat, one Brown long eared female bat, one male Whiskered bat and one male as well as one female Daubenton's bats.

Greena Ecological Consultancy carried out a catching session on 1st September 2014, during which 5 LHS were captured from Menlo Castle maternity roosting site and 11 LHS from Cooper's Cave site. One female LHS from Menlo Castle was fitted with a radio transmitter, together with three males LHS and one female LHS from Cooper's Cave. In addition to that, a male Natterer's bat was also tagged in Menlo Woods. Other bats captured in mist nets at Menlo Woods included five Soprano pipistrelle bats *(Pipistrellus pygmaeus)* (three females and two males) and a male Daubenton's bat. Other bats captured at Cooper's Cave included three male Daubenton's bats, one of them recaptured twice. All bats captured on 1st September with the exception of Pipistrelles were ringed.

In both sessions, bats were tracked wherever they ranged and were found as far south as Galway City, west by Knocknagreana, north over large proportion of Lough Corrib and east towards Oranmore (where roosts of tagged Pipistrelle bats were located, based on the evidence supplied by Geckoella, but no foraging area was determined).

During the August session, LHS foraged up to 5.15km from their roost, with majority of bats utilising the immediate area of Menlo Castle, Menlough Village, Kilrogher and Ballindooly. Hedgerow systems in Coolagh area were very popular. Bats tagged at Cooper's Cave utilised hedgerow systems near Castlegar and in vicinity of the cave but one of them was also recorded visiting Menlo Castle and similarly, male LHS from Menlo Castle was recorded roosting in Cooper's Cave. Both sites showed strong connection and importance for the local population of LHS. Foraging areas of bats captured at Cooper's Cave overlapped largely. While all bats from Menlo Castle used the immediate area for foraging, with the most heavily used being Menlo Woods and 1km radius from the maternity roost, each individual seemed to use a selected area and return to forage there every night.

Bats were foraging in adverse weather and did not seem to be influenced by rain or strong wind. The weather conditions in August were mainly wet and this may have influenced the extent of the overall foraging area.

Several night roosts were found during the August radio-tracking session. These included farm buildings, quarries, and old quarry buildings. Quarries of particular interest included Angliham Quarry, off Quarry Rd, north-east of Menlo and Lackagh Quarry, off Coolagh Road, east of Menlo.

The west-most record of a LHS occurrence was less than 2km west of Menlo Castle, the north-most record lies 2.7km away from the roost. East boundary of foraging area corresponded with foraging areas of bats captured at Cooper's Cave. LHS avoided Galway City completely during the August session and the south extreme of the overall foraging area was located 0.75km south of Menlo Castle.

Scott Cawley continued catching sessions while radio tracking was under way, resulting in large numbers of Soprano pipistrelles caught in Menlo Woods, together with a juvenile female Leisler's bat, male Leisler's bat and female Daubenton's bat. Male Leisler's bat and Daubenton's bat were added to the list of surveyed bats for the last two nights of the radio tracking session and limited data on Leisler's bat were obtained.

As in the previous session, a strong link between Menlo Castle and Cooper's Cave was soon established in the behaviour of LHS. All males and female captured at Cooper's Cave were recorded roosting at Menlo Castle at some point during the September session. All bats captured at Cooper's Cave were at some point recorded roosting at Menlo Castle. Females in particular were often switching night roosts, utilising a different one each night. Males tended to use the same night roost or several night roosts over the entire radio-tracking period. The maximum commuting distance of LHS in September was 4.40km in a single night. Areas of Menlough Village as well as field systems around Castlegar were of great importance to foraging and commuting bats. Quarries were sought in the September session, too, mainly the Lackagh Quarry which was used for foraging and night roosting on daily basis.

Leisler's bat was recorded covering large distances from its roost north-east of Bearna, heading east, avoiding Galway City and turning north, following the River Corrib and foraging over Lough Corrib, often over open water. A commuting distance up to 8.46km was recorded for this bat in a single night.

Brown Long eared bat displayed great fidelity to its roost and foraging area. Field systems around Castlegar were used on daily basis and the overall feeding area of this female remained rather small, suggesting sufficient food sources there. The maximum commuting distance recorded for this Long eared bat in a single night was approximately 4.07km.

Whiskered bat roosted north-east of Bearna and its foraging area extended westwards. It was covering relatively large distance over scrubby area, commuting up to 3.71km in a single night. The foraging area extended beyond the area of interest and it is possible this bat covered larger commuting distances beyond being surveyed.

Both Daubenton's bats remained in the vicinity of Menlo Castle where both of them were recorded to roost. Female Daubenton's bat foraged on the River Corrib, often heading south, while the male utilised Menlo Woods. Limited information was obtained on the male Daubenton's bat.

The male Natterer's bat was never successfully located during the September radio tracking session. It is possible that the male commuted long distance perhaps in search of a swarming site or only visited the area of interest briefly on the night it was caught. Another possible explanation would be tag failure.

All bats in September session displayed foraging behaviour for two to four hours after dusk most of the nights, after that they returned to roosts or found a night roost where they spent a large part of the night. The behaviour was not a result of adverse weather conditions and can only be explained by food sources abundance meaning no need to forage any longer.

An important link between the maternity roost at Menlo Castle and the roost at Cooper's Cave was established during the two radio-tracking studies.

1.0 Aims and Objectives

The overall aim of the study was to effectively preserve the availability of foraging areas, flight routes and roosting sites of bats and to provide detailed information to inform the project.

The objectives of this study were to identify the principal feeding areas and commuting routes of various colonies or parts of the population of Lesser horseshoe and vesper bats in the Galway area, and to determine the night and day roosts used. While the first session aimed to gain information during the peak maternity roosting period and focused on Lesser horseshoe bats, the later study aimed to gain information on Lesser horseshoe bats and vesper bats during the time they disperse to mating, swarming and winter roosts sites. The radio tracking sessions carried out during the bat active season whilst avoiding the sensitive period of late stages of pregnancy, birth and first emergence of newly born bats, aimed to form an understanding of seasonal shifts in foraging areas and commuting routes of Lesser horseshoe bats in the Galway area depending on prey availability.

Special attention was paid to the area of the proposed development, in order to accurately and correctly assess the potential impacts of the development.

Main objectives can be summarised as:

- Trapping within the study area to catch Lesser horseshoe bats (both sessions) and vesper bats (second session of Greena Ecological Consultancy) and follow-up radio-tracking survey in order to provide an understanding of foraging areas and/or commuting routes, either to foraging areas or to other night/satellite/day roosts.
- Identification and mapping of bat movements to mating sites or winter roosts (September session)
- Processing the data to determine proportional use of different sites and compilation of maps of roosts, foraging areas and flight routes

2.0 Background

In Europe there has been a decline in abundance and contraction in the distribution range of several species of bat over the last century. Bats their roosts, foraging habitats and flight routes are protected under the Wildlife Acts 1976 as amended and the European Communities (Birds and Natural Habitats) Regulations 2011. Bats are also protected from disturbance when they are in their roosts, and their roosts are protected even if they are unoccupied.

Where developments have the potential to result in significant effects on the features of European Sites, the Habitats Regulations require a thorough assessment of the implications of the development on the ability of the site to meets its conservation objectives and therefore it's integrity.

Lesser horseshoe is one of the most endangered European bat species (Stebbings, 1988) it is an annex II species. It was once widespread and common in most countries of Western and Central Europe, e.g. the Netherlands (Voute, Sluiter & van Heerdt, 1980), south Poland (Kokurewicz, 1990), Germany (Rudolph, 1990) and Switzerland (Stutz & Haffner, 1984). A dramatic population decline occurred in the 1950s and 1960s, which led to the loss of large areas of its former distribution.

Suggested causes for the decline of Lesser Horseshoe population include roost destruction, pesticide contamination of both, prey and roosts, habitat alterations and competition with other bat species (Stebbings, 1988, Kulzer, 1995, Arlettaz, Godat & Meyer, 2000).

Main pressure impacting on Lesser horseshoe bats identified in Ireland include renovation/demolition of buildings used as summer roosts, human disturbance in cave roosts and inundation – a particular issue in Karst caves of Clare / south Galway. (NPWS, 2013)

Vesper bats are affected in a similar way.

In order to protect suitable foraging habitat as well as roosting and mating sites, detailed knowledge of population ecology is required.

Linear infrastructures are known to have major negative impact on species and ecosystems dynamics, modifying landscape structure through artificialisation, habitat changes, alteration and fragmentation. (Vandevelde, Bouhours et al., 2014). The construction of roads has the potential to negatively affect bat populations, through loss of roosts, foraging habitats and by severing landscape elements used as commuting routes by bats. Roads create an open space, which most bat species are reluctant to cross. Traffic further increases the barrier effect due to sudden movement, noise, light and the risk of collision. Recent research shows that roads have a major negative impact on bat foraging activity and diversity. (Berthinusses, Altringham, 2011)

Since the 1980s, radio tracking has developed as one of the main techniques for studying many aspects of bat ecology (Kenward, 1992). Advances in transmitter technology have reduced the mass of radio-tags and it is now possible to effectively radio-track even the smallest species of bats without exceeding the justifiable surplus weight transmitters add to the weight of the animal.

In both of the radio-tracking studies, we investigated the behaviour of individuals by tracking two or more bats simultaneously. In the August session of the study the movements of fourteen bats (13 LHS and 1 Leisler's bat) were examined to record the distribution and behaviour of the populations Lesser horseshoe bats during maternity period of 2014. The September study anticipated radio tracking of 17 bats (4 LHS and 13 vesper bats). This report presents results of both radio tracking sessions conducted 2014.

3.0 Study area

Galway is a vibrant city in west Ireland, located on the River Corrib between Lough Corrib in the north and Galway Bay.

The main roads intersecting the area include the N59 (Thomas Hynes Road) in north-west, the N6 (Bóthar na dTreabh) in east and the N84 (Headford Road) as well as the N17 (Tuam Road) in north-east.

The city is surrounded by parks, field systems and small woodlands forming ideal foraging habitat for all species of bats. Areas of good habitat consist of Merlin Woods Park in east, Beechwood Park and Castle Park, fields around Castlegar, Ballindooly Lake, field systems and limestone pavement with scrub between Ballindooly and Lough Corrib, Menlo Woods, immediate surroundings of the River Corrib, woodland between Oranswell and Lisheenakeeran, Moycullen Bogs, Lough Inch and Bearna Woods. Galway City centre is built up and lit up in the night; however, the River Corrib forms a suitable commuting corridor and connects good quality habitats in north with green areas within the city, such as the National University of Ireland (Galway) campus.

The River Corrib forms a natural division line between the west and the east side of the study area. Menlo Castle was not only the main bat roost within the area of interest but also a centre point of large proportion of bat activity.

Several areas within the extent of the project have been classified as habitats of high conservation importance. These include Bearna Woods – a part of Special Area of Conservation (SAC) Galway Bay Complex, Lough Corrib that is SAC as well as Ramsar site and Moycullen Bogs, a natural heritage area. Conservation objectives for Lough Corrib include Lesser horseshoe bats (1303) (NPWS.ie, 2014).

The location of the study area is shown in Figure 1.

Some of the radio-tracked bats ventured out of the study area and were followed where possible in order to obtain the full picture of bat activity.

Figure 1 Scheme Study area of the N6 Galway City Transport Project

4.0 Methods

A valid licence to carry out bat trapping (licence to catch with harp/mist net/by hand no. C098/2014) and radio tracking (licence to mark no.C009/2014) had been obtained from National Parks and Wildlife Service, Ireland and authorisation to access the land involved was obtained from landowners in advance of commencing fieldwork. Licences to use lure (C027/2014) and to enter roosts (2014-39) were also obtained.

Because of working at night, the police were notified of each session of the activities, personnel.

Scott Cawley and Greena Ecological Consultancy reviewed existing data, aerial photographs, maps, and carried out a site visit to determine possible trapping places, first in Menlo Castle, later around Cooper's Cave and in Menlo Woods. The area of interest consists of field systems with mature hedgerows and stonewalls, a continuous area of limestone pavement with scrub, small areas of woodland and urban areas. The potential for successful catching horseshoes in mist nets and/or harp traps was assessed as being low in the open landscape; however, catching directly from the maternity roost in Menlo Castle proved very productive. A six-metre wide Avinet mist net was stretched across the entrance to the maternity roost, further mist nets were placed strategically in window / door openings in the castle and one double bank harp trap was used in the south-eastern part of the castle during the catching session on 30th July 2014. All bats (17 LHS in total) were caught while emerging from the roost in the net placed over the roost entrance. No bats were caught elsewhere around the castle on the night of 30th July. Ten LHS, seven females and three males, were fitted with a 0.3g Biotrack radio- transmitter with various battery life (see Table 1A). Six out of the seven females were assessed as post-lactating; one female did not breed in 2014.

Second catching exercise of the first radio tracking session took place at Cooper's Cave on 1st August 2014. A double bank harp trap was used in the entrance of Cooper's Cave. Shield netting blocked gaps on sides of the harp trap to maximise the catch. Five bats were caught at the cave on the night of 1st August. Three LHS, all males, were fitted with Holohil radio-transmitters, first two with 0.32g with a 7-day battery life and the last one with a 0.47g one with 11-day battery life. All three of them were ringed. Other bats captured that night included a male Daubenton's bat and a male Natterer's bat. Both were ringed.

Scott Cawley later conducted another catching session in Menlo Wood. The catching session took place on the 4th August 2014 and resulted in large numbers of Soprano pipistrelles *(Pipistrellus pygmaeus)* being caught in a harp trap and mist net, together with a juvenile female Leisler's bat, male Leisler's bat and female Daubenton's bat. The male Leisler's bat as well as the male Daubenton's bat were fitted with Holohil radio-transmitters. The transmitter used on the Leisler's bat weighed 0.75g with 14 days battery life while the Daubenton's radio-transmitter weighed 0.32g with 7-day battery life.

The first radio tracking study took place between the 31st July and the 7th August 2014. All juveniles were born by the time. No juvenile Lesser horseshoe bats were caught at either site and no females were pregnant.

The September session conducted by Greena Ecological Consultancy started on 30th August 2014 and ended on 7th August 2014. The radio-tracking study commenced by tracking bats previously tagged by Geckoella in August. The total of 11 bats of five species was tagged prior to the arrival of Greena. These included Daubenton's bat (both sexes), Common pipistrelle

(Pipistrellus pipistrellus) (both sexes), Brown long eared bat *(Plecotus auritus)* (female), Whiskered bat *(Myotis mystacinus)* (males) and Leisler's bat *(Nyctalus leisleri)* (males).
Several previously tagged bats could not be located due to combination of radio- frequencies fluctuating from original with temperature and the change not being recorded during tagging and possible tag failure. Bats that could be surveyed during the September session included one male Leisler's bat, one Brown long eared female bat, one male Whiskered bat and one male and one female Daubenton's bats.

Greena Ecological Consultancy carried out a catching session on 1st September 2014, during which five LHS were captured from Menlo Castle maternity roosting site and 11 LHS from Cooper's Cave site. A six-metre wide Avinet mist net was secured over the egress point from the maternity roost, just like during the August session. No other catching methods were used in Menlo Caste in September.

A double bank harp trap was used at Cooper's Cave together with shield netting. Catching methods in Menlo Woods included one double bank harp trap with lure and two Avinet mist nets, one nine-metre and one twelve-metre wide. One female LHS from Menlo Castle was fitted with a radio transmitter, together with three males LHS and one female LHS from Cooper's Cave. In addition to that, a male Natterer's bat was also tagged in Menlo Woods. Three LHS were fitted with Biotrack radio-transmitters of 0.35g, 10-day battery life and two LHS were fitted with Holohil 0.36g weight and 11-day battery life. Natterer's bat was fitted with a Holohil 0.47g radio-transmitter of 11 days battery life (see Table 1B for details). Other bats captures in mist nets at Menlo Woods included five Soprano pipistrelle bats (*Pipistrellus pygmaeus*) (three females and two males) and a male Daubenton's bat. Other bats captured at Cooper's Cave three males Daubenton's bats, one of them recaptured twice. All bats captured on 1st September with the exception of Pipistrelles were ringed.

Despite several other efforts by Scott Cawley, only two more Soprano pipistrelles were captured but not ringed neither fitted with radio-transmitters.

Two different approaches to radio tracking bats give different results. Tracking individual bats by at least one surveyor can determine complete behaviour and proportional habitat use; but this is limited to small numbers of animals. The second approach that has been used in these studies is to track larger numbers of bats that determines a higher proportion of the overall home range of the local population. Higher sample number of animals increases data gathering on roosting sites, numbers of animals visiting feeding areas and going through corridors.

Tables 1A (for August session) and 1B (for September session) below show details of transmitters used, duration of tag battery is stated in days, bpm is the number of pulse transmissions per minute

Table 1A Transmitters used during the first radio tracking session in August 2014

bat	species	supplier	weight	bpm	duration
1	LHS	Biotrack	0.3g	50	12
2	LHS	Biotrack	0.3g	50	11
3	LHS	Biotrack	0.3g	50	12
4	LHS	Biotrack	0.3g	50	14

bat	species	supplier	weight	bpm	duration
5	LHS	Biotrack	0.3g	50	10
6	LHS	Biotrack	0.3g	50	10
7	LHS	Biotrack	0.3g	50	13
8	LHS	Biotrack	0.3g	50	11
9	LHS	Biotrack	0.3g	50	13
10	LHS	Biotrack	0.3g	50	14
11	LHS	Holohil	0.32g	60	7
12	LHS	Holohil	0.32g	60	7
13	LHS	Holohil	0.47g	37	11
14	Leisler's	Holohil	0.75g	38	14
15	Daubenton's	Holohil	0.32g	60	7

Table 1B Transmitters used during the first radio tracking session in September 2014

bat	species	supplier	weight	bpm	duration
12	LHS	Biotrack	0.35g	60	10
13	LHS	Biotrack	0.35g	60	10
14	LHS	Holohil	0.36g	58	11
15	LHS	Biotrack	0.35g	60	10
16	Natterer's	Holohil	0.47g	37	11
17	LHS	Holohil	0.36g	58	11

Radio transmitters were glued between the fur-clipped shoulder blades of the bats a using latex adhesive and come off frequently within 2 weeks of being attached.

Up to five fieldworkers in August and three fieldworkers in September used *Australis 26K* and *Sika UHF* radio receivers with *Yaggi* rigid aerials to track bats. Omni directional antennas were used to search for bats by vehicle. Both receivers are able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any time. The surveyors carrying out the August study were Geoff Billington, Tereza Rush, Alison Johnston; Isobel Abbott and Daniel Buckley; in August Geoff Billington, Tereza Rush, Alison Johnston and Isobel Abbott. Assistants were involved during both sessions. Their role often included checking roosts and finding new night roosts, additional catching sessions or assistance with radio tracking. Assistants included Paul Scott, Conor Kelleher and Brian Keely in August and Isobel Abbott, Daniel Buckley and Paul Scott in September.

Tailor made recording sheets were used to record data and a combination of radio sets and mobile phones were used for two-way communication. Accurate bearings of bat locations were taken from hand held sighting Silva Expedition 54 compasses by two or more surveyor at the time. Bearings of 1^0 accuracy were obtained. The data used in this report were obtained by using joint bearings (positive contact) of two or more surveyors at the same time. Global Positioning Systems were used to increase the speed and accuracy of the surveyors to continuous supply of their location.

For all tagged bats, the following data was recorded:

- Observer location
- Bat ID number
- Triangulation bearings with other surveyor(s)
- Apparent location, route and behaviour
- Roost location and details when located

Whenever bats were commuting from roosts or at their first foraging sites of the evening, they were observed from fixed (often elevated) points chosen where good radio reception was available, such as at high or other suitable vantage points. Where possible surveyors made close approaches to bats, to ascertain the exact foraging area and behaviour or to attempt pursuit if the bat was moving away.

Over survey nights surveyors gradually built up a picture of routes bats use for commuting and of bat foraging areas. Surveyors positioned themselves strategically in the area of roosting sites to determine which direction the bats head away from the roost and move out into the wider survey area.

Location of observation points and number of times they were used is shown in Table 2A and 2B below:

Table 2A Location of observation points used in August 2014

location	grid reference	number of times used
Menlo Castle	M 28270 28381	6
Menlough Village	M 28852 28492	4
Quarry Road	M 29334 30300	3
Coolagh	M 29583 28167	4
The Mount	M 29583 28167	4
Ballygarraun	M 31413 29242	2
Castlegar	M 31961 27990	3
Ballindooly	M 32040 29119	2
Lackagh Quarry	M 29941 27996	2
Cooper's Cave	M 31718 27388	2

Table 2B Location of observation points used in September 2014

location	grid reference	number of times used
Menlo Castle	M 28270 28381	7
Menlough Village	M 28852 28492	4
Quarry Road	M 29334 30300	4
Coolagh	M 29583 28167	6
The Mount	M 29583 28167	2
Ballygarraun	M 31413 29242	4
Castlegar	M 31961 27990	4
Ballindooly	M 32040 29119	2
School Road	M 32034 28645	2
Lackagh Quarry	M 29941 27996	5
Bóthar na dTreabh	M 31745 27302	2
Cooper's Cave	M 31718 27388	2

Tracking ended either when the fieldwork period ended (generally half an hour before dawn), or when all bats had returned to the roost and were static or poor weather (strong wind, rain or drop of temperature) prevented bats from flying or make them return early to their roosts.

At the start of each survey night, estimations of environmental conditions were noted: wind strength and direction, rainfall, cloud cover and air temperature measured. Any significant changes in weather throughout the survey period were also noted.

Daytime work included located and verifying roost occupation, recording and plotting out results and investigation of any night roosting sites discovered during the tracking sessions.

Results are presented using the traditional method of minimum convex polygons (MCP). This method is compared with the method of multilateral polygons (MLP) drawn around all confirmed areas or points of occurrence of individual bats. An animal's home range size, shape, and position are traditionally represented by joining the outermost fixes for that animal to form a minimum convex polygon (Mohr 1947). Outlying fixes (representing rare excursions) may unduly influence the polygon's shape and size to produce a misrepresentation of the space actually used by the animal (McNay et al., 1994). Minimum convex polygons (convex hulls) are an internationally accepted, standard method for estimating species' ranges, particularly in circumstances in which presence-only data are the only kind of spatially explicit data available. One of their main strengths is their simplicity. They are used to make area statements and to assess trends in occupied habitat, and are an important part of the assessment of the conservation status of species; these estimates are, however, biased. The bias increases with sample size, and is affected by the underlying shape of the species habitat, the magnitude of errors in locations, and the spatial and temporal distribution of sampling effort. The method using MLP often results in much larger and less accurate area coverage. Using MLP is based on minimal area between all confirmed points of animal's occurrence during the radio-tracking session. It is obvious that while MCP overestimates potential occurrence of a tagged bat, MLP might underestimate this. The difference in results obtained using the traditional method and the method of multilateral polygons are shown on maps of foraging areas.

When habitat is to be lost to development, it appears sensible to slightly over-estimate the real foraging area utilising the method of MCP. Where study determines population dynamics and interaction, MLP is a more suitable approach to take.

MCP are represented by solid coloured area in maps while MLP are represented by checked overlay.

5.0 Survey constraints

These radio tracking studies were only carried out in short periods of the year so bats may use different areas at other times of year. This limitation is partially resolved through conducting the second radio tracking session resulting in a more complete picture of the behaviour of Lesser horseshoe bat populations in the Galway area. Ideally, both, horseshoe and vesper bats would be tracked in spring (early May), late July/August and in September to form a more complete picture of seasonal activity. The overall information on vesper bats is very limited due to the timing of the study and constrains related to problems including not tuning individual receivers to the real radio tag frequency after fitting them onto bats during the middle session when majority of vesper bats were tagged in August. Another explanation may include tagged bats leaving the study area and travelling long distances, which would consequently make locating them less likely. Surveyors in the September session searched extensive area and while particularly male Myotis bats are known to travel long distances in a single night, it is not considered the case with Pipistrelle bats and these would likely have been found if the adjusted tag frequency was recorded and radio-transmitters had functioned correctly.

A total of 11 bats, of five species, were tagged prior to the arrival of Greena Ecological Consultancy. These included Daubenton's bat (both sexes), Common pipistrelle *(Pipistrellus pipistrellus)* (both sexes), Brown long eared bat *(Plecotus auritus)* (female), Whiskered bat *(Myotis mystacinus)* (males) and Leisler's bat *(Nyctalus leisleri)* (males).

Several previously tagged bats could not be located due to combination of radio frequencies fluctuating with temperature and the change not being recorded during tagging and possible tag failure. Bats that could be surveyed during the September session included one male Leisler's bat, one Brown long eared female bat, one male Whiskered bat and one male and one female Daubenton's bats, the remaining six bats were not located.

The amount of gathered data was subject to correctly functioning radio-transmitters. Radio-transmitters may fail and this is rather common towards the end of their expected battery life. Bats, and in particular in maternity colonies tend to groom radio-transmitters off. We encountered the complication related to radio-transmitters being detached prior to the end of their battery life in three bats during the August radio-tracking session (bats 1, 3 and 5). Their transmitters got detached at various times during the study and the amount of data collected was affected by the time of transmitter staying attached. September session was also influenced by this constraint although to much lesser extent. Bat 12 in the September session detached the transmitter after several days of radio tracking.

A male Lesser horseshoe bat (bat 12) died after several days of activity following the attachment of its radio-transmitter and ring during the August session. The death was not a result of poor health at the time of bat handling and the bat did not display any signs of excessive distress or parasitic infestation. It was considered reasonably active for the following two nights and alive during daytime inspection of its roost following the two nights of activity. We cannot provide any explanation of the death without post-mortem expert examination. No obvious injuries were found on the carcass. The fact that bat 12 was not active for the remaining nights of the radio tracking study resulted in limitation in data collection.

Adverse weather conditions and the overall weather trend in 2014 affected the amount of data collected, too.

Rain, ranging from light drizzle to heavy showers or prolonged periods of rain occurred on regular basis during the August radio-tracking session. Only the first night of the session was rain-free and so was the night of 2nd August 2014. The night temperature dropped considerably on 2nd August 2014 due to clear sky. All other nights of the August session were affected by rain. Bats still foraged most of the nights but their activity was limited and they were recorded returning to their roost of finding night roosts several times during the night with continuing foraging activity later during the same night.

A different pattern was observed in September when only one of the survey nights was affected by rain. The remaining nights were dry and often starting with unusually high temperature for the time of the year. Bats foraged early and the tendency was to return in the roost after 3-4 hours or to find a night roost after the first period of feeding. After that bats rarely re-emerged, alternatively switched roosts in early morning hours. The possible explanation could be excess of food sources and no need to forage throughout the night despite suitable foraging conditions.

Without previous detailed knowledge of seasonality in behaviour of bats in the Galway area, it cannot be concluded if the weather conditions in combination with sufficient prey in September modified normal behaviour of the bat population.

The accuracy of a radio-location can be affected by habitat structure and may result in biased estimates of observed habitat use. A common source of error is signal bounce. Signal bounce occurs most frequently in undulated terrain where a signal is deflected by a hill, resulting in potential errors. The most effective way to overcome signal bounce during ground tracking is to take many bearings from several different places. When all signals appear to be coming from the same point then there is a good chance that the animal has been located correctly. However, if the signals are coming from a number of different points then signal bounce is likely still occurring (White, Garrott, 1990).

Signal deflection was apparent within Menlo Woods and often in proximity of quarries. It is possible that other areas were also affected to a lesser extent.

6.0 Ethical Review

Existing knowledge of bat population was used to determine that the surveys were necessary and justified. Maternity colony of Lesser horseshoe bats was identified at Menlo Castle and several smaller roosts were located in the area of study. Vesper bats were proved to use the area based on transect surveys.

Bats used for these studies could not be replaced by other species or non-living objects, a sufficient number of bats had to be used to determine the foraging areas and behavioural patterns of the colony as representatively as possible.

Survey techniques were appropriate to the objectives of the project. Radio-tracking is highly effective in determining animal's home range, commuting routes and favoured foraging areas as well as crossing points over man-made barriers in the natural habitat.

Both surveyors of Greena Ecological Consultancy, conducting ring marking and fitting of radio-transmitters, hold Natural England class 1 – 4 personal licences and have extensive experience with marking and tagging Lesser horseshoe bats as well as vespers.

Mist nets were set up either after dark or prepared in daytime and opened after dusk to avoid catching birds. Mist nets were attended at all times.

Where bats were caught in a mist net, they were removed immediately to reduce potential suffering. Where harp trap was used, animals were removed as soon as practical. Catching periods avoided times of high stress, such as pregnancy period in bats or the time when newly born young must be supported. Catching took place during nights of suitable temperature and rain-free.

All bats were released at the point of capture.

Weight of radio-transmitters used for these studies did not exceed 7% of bat body weight in any case. All ring fitted by Greena Ecological Consultancy were fitted by experienced ringers.

No injury occurred during trapping sessions; however, one Lesser horseshoe bat caught in a double bank harp trap at Cooper's Cave on 1st September 2014 probably suffered shock that resulted in death. The carcass will be subject to investigation to determine if there was any other underlying condition contributing to the death of the animal.

One Lesser horseshoe bat died during the first radio-tracking session in August. Bat was not showing any signs of distress and was of healthy weight when ringed and tagged. It continued foraging for two nights following its capture, and then died in a roost. This carcass will also be examined to determine the cause of death.

7.0 Results

7.1 Previous records

Scott Cawley undertook an extensive survey work in the Galway area prior to the radio-tracking sessions.

Static bat detectors were placed in suitable habitat and in expected roosting as well as mating places and along expected commuting routes.

A maternity roost of Lesser horseshoe bats was located in Menlo Castle, where peak count of bats in July 2009 reached 38 individuals and a repeat emergence count on 8th July 2014 revealed 27 individuals. Six night roosts (or roosts used on occasional basis by a limited number of bats) were identified mainly in farm buildings in the study area. Night roosts were usually identified based on an internal building inspection during which signs of bat presence in form of droppings or feeding remains were found. Scott Cawley identified Lesser horseshoe night / satellite / transition roosts between 3 and 6.5km from Menlo Castle.

Vesper bats were surveyed using the transect survey method. Scott Cawley carried out walked or car based transects along the shores of Lough Corrib and in Galway City. A maternity roost of Soprano pipistrelles was identified in a bungalow in the Coolagh area. The roost contained an excess of 100 individuals in 2005.

To our knowledge, no comparable radio tracking study has been previously conducted on bat population in the Galway area.

7.2 Weather data

Weather conditions were recorded for all nights of radio tracking. Maximum temperature refers to maximum day temperature while minimum temperature refers to minimum night temperature. The range of temperature recorded during radio tracking is shown as survey temperature. Precipitation was recorded during 24 hours; strength of wind was recorded during survey nights. Weather conditions are provided in Tables 3A and 3B overleaf.

Table 3A Weather data, August session

Date	Max Temp (°C)	Min Temp (°C)	Survey Temp (°C)	Precipitation (mm)	Wind (B)
30/07/2014	19	13	14 - 19	0	2
31/07/2014	20	14	14 - 18	0.2	3
01/08/2014	21	13	12 - 18	0.8	2
02/08/2014	18	8	7 - 16	0	2
03/08/2014	19	10	10 - 16	0.8	1
04/08/2014	23	9	9 - 17	1.6	1
05/08/2014	23	13	13 - 18	0.2	1
06/08/2014	20	12	12 - 16	1.0	2
07/08/2014	19	10	10 - 15	0	1

Data from Worldweatheronline.com, 2014 and survey records

Table 3B Weather data, September session

Date	Max Temp (°C)	Min Temp (°C)	Survey Temp (°C)	Precipitation (mm)	Wind (B)
30/08/2014	18	12	14 - 17	0	2
31/08/2014	19	10	11 - 17	0	1
01/09/2014	18	9	9 - 15	0	1
02/09/2014	19	7	7 - 14	0	1
03/09/2014	20	9	10 - 18	0	1
04/09/2014	23	14	14 - 19	0.1	1
05/09/2014	19	13	13 - 17	0.5	1
06/09/2014	17	7	8 - 15	0	1

Data from Worldweatheronline.com, 2014 and survey records

7.3 Bat captures

All bats were captured in a mist net or a double bank harp trap. All Lesser horseshoe bats captured at Menlo Castle were caught in a six-metre mist net stretched over the entrance to the maternity roost, all bats captured at Cooper's Cave were caught in harp trap fitted with shield netting to block the entire entrance to the cave. Bats captured in Menlo Woods were caught either in double bank harp trap with lure (Sussex Autobat, mixed calls) or in a mist net. Tables 4A to 4E below provide details of the bat captures in both radio-tracking sessions.

Bats 1 – 11 in the September session were captured, measured and fitted with rings and radio-transmitters by Geckoella. Greena Ecological Consultancy holds information on species and sex of these bats but not ring numbers, capture variables or physical measurements.

Two bats from August session were re-captured in September. Both were previously recorded to use Cooper's Cave where they were captured repeatedly. Bat 11 from the August session lost weight between 1st August and 1st September (5.6g comparing to 5.3g in September), bat 6 from the August session could not be measured.

<u>Abbreviations:</u>
M – male, F – female
LHS – Lesser horseshoe *(Rhinolophus hipposideros)*
Daub – Daubenton's bat *(Myotis daubentonii)*
Natt – Natterer's bat *(Myotis nattereri)*
Leis – Leisler's bat *(Nyctalus leisleri)*
BLE – Brown long eared bat *(Plecotus auritus)*
SP – Soprano pipistrelle *(Pipistrellus pygmaeus)*

Table 4A Captures 30/07/2014, Menlo Castle, August session

All bats ringed and fitted with radio-transmitters by Tereza Rush

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
21:27	LHS	F	39.7	6.3	L01601	Adult, post-lactating, **Bat 1**
21:30	LHS	F	38.3	6.1	N/A	Adult, post-lactating
21:36	LHS	F	39.6	6.5	L01602	Adult, post-lactating, **Bat 2**
21:38	LHS	F	38.2	6.4	L01603	Adult, post-lactating, **Bat 3**
21:41	LHS	M	37.0	5.7	L01604	Adult, **Bat 4**
21:43	LHS	F	37.4	5.8	N/A	Adult, post-lactating
21:44	LHS	F	38.7	6.3	L01605	Adult, post-lactating, **Bat 5**
21:47	LHS	M	38.0	6.0	L01606	Adult, **Bat 6**
21:51	LHS	F	38.8	6.3	L01607	Adult, non-breeding, **Bat 7**

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
21:53	LHS	F	37.0	5.9	N/A	Adult, post-lactating
21:56	LHS	F	39.6	6.2	N/A	Adult, post-lactating
21:57	LHS	F	35.7	6.1	L01608	Adult, post-lactating, **Bat 8**
22:00	LHS	M	37.0	5.3	N/A	Adult
22:02	LHS	F	37.3	5.7	N/A	Adult, post-lactating
22:03	LHS	M	37.8	5.8	L01609	Adult, **Bat 9**
22:04	LHS	F	39.2	6.2	N/A	Adult, post-lactating
22:10	LHS	F	39.5	6.4	L01610	Adult, post-lactating, **Bat 10**

Table 4B Captures 01/08/2014, Cooper's Cave, August session

Bats 11 and 12 ringed and tagged by Geoff Billington, bat 13 ringed and tagged by Tereza Rush.
Bats 11 and 12 ringed and tagged by Geoff Billington, bat 13 ringed and tagged by Tereza Rush.

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
22:50	LHS	M	36.2	5.6	L01577	Adult, **Bat 11**
22:50	LHS	M	37.5	5.1	L01578	Adult, **Bat 12**
23:15	Daub	M	36.4	8.3	N/A	Adult
02:00	LHS	M	37.0	5.1	L01579	Adult, **Bat 13**
02:01	Natt	M	40.7	7.4	N/A	Adult

Table 4C Captures 04/08/2014, Menlo Woods, August session

Leisler's bats and Daubenton's bat were tagged by Tereza Rush.

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
23:00	Leis	M	42.7	13.5	N/A	Adult, breeding, **Bat 14**
23:00	Daub	M	38.2	9.5	N/A	Adult, **Bat 15**

In addition to these two bats, Scott Cawley caught 41 Soprano pipistrelles (8 females, 3 males and 30 not sexed), 9 Daubenton's bats (1 female and 8 males), 1 male Natterer's bat, 4 males Brown long eared bats and 1 female Leisler's bat.

Table 4D Captures 01/09/2014, Menlo Woods, September session

All bats ringed and tagged by Tereza Rush.

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
22:30	LHS	F	37.9	5.4	L01615	Adult
22:30	LHS	F	37.5	6.0	L01611	Adult
22:30	LHS	F	34.4	4.8	L01612	Adult
22:30	LHS	F	38.8	6.1	L01613	Adult, **Bat 14**
22:30	LHS	F	38.3	5.6	L01614	Adult
23:10	SP	F	N/A	N/A	N/A	Adult, fur clipped
23:10	SP	F	N/A	N/A	N/A	Adult, fur clipped
23:10	SP	M	N/A	N/A	N/A	Adult, not in breeding condition, fur clipped
23:10	SP	M	N/A	N/A	N/A	Adult, breeding condition, fur clipped
23:10	SP	F	N/A	N/A	N/A	Adult, fur clipped
23:45	Daub	M	N/A	N/A	L01641	Adult, breeding condition
23:45	Natt	M	39.9	7.0	L01640	Adult, breeding condition, **Bat 16**

Table 4E Captures 01/09/2014, Cooper's Cave, September session

All bats ringed and tagged by Geoff Billington.

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
21:40	LHS	M	36.3	5.4	L01577	Adult, already ringed, bat 11 in August session
22:05	Daub	M	38.6	7.2	T8952	Adult
22:12	LHS	M	36.9	5.3	L01586**?**	Adult, **Bat 12**
22:30	LHS	M	36.7	4.9	L01591	Adult

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
22:38	LHS	M	36.7	5.1	L01900	Adult, **Bat 13**
22:47	LHS	M	N/A	N/A	L01580	Released before measuring
23:03	LHS	M	N/A	N/A	L01606	Adult, already ringed, bat 6 in August session
23:05	Daub	M	38.3	9.1	T8955	Adult, breeding condition
23:05	Daub	M	38.7	7.7	T8956	Adult, breeding condition
23:30	Daub	M			T8956	Recaptured in the same evening
23:58	LHS	M	37.4	5.3	L01581	Adult, **Bat 15**
00:36	LHS	M	37.9	5.4	L01582	Adult
01:13	LHS	F	37.2	5.7	L01583	Adult, non-breeding
01:30	LHS	F	38.8	6.8	L01585	Adult, non-breeding
01:32	LHS	F	38.5	6.8	L01584	Adult, non-breeding, **Bat 17**

7.4 Roosting sites

7.4.1 Daytime roosting sites

Six daytime roosting places were identified during the first radio tracking session conducted in August 2014. Table 5 shows details of daytime roosts from the August session. This table includes Menlo Castle and Cooper's Cave where bats were caught for tagging. Both day roosts were consequently used by a number of Lesser horseshoe bats during the study. No other bat species were recorded roosting in the same place of Menlo Castle; however, a small maternity roost of Daubenton's bats has been previously identified in different part of the castle by Scott Cawley. Records of Natterer's bats and Long eared bats roosting in the castle were also reported (Scott Cawley, personal comment, 2014). A male Daubenton's bat and a male Natterer's bat were recorded roosting in Cooper's Cave together with Lesser horseshoe bats.

Table 5 Identified daytime roosts in August 2014

roost	bats using	grid reference	location	description
A1	1,2,3,4,5,6,7,8,9,10	M 28491 27872	Menlo Castle	castle wall
B1	6, 11, 12, 13	M 31747 27380	Cooper's Cave	cave

roost	bats using	grid reference	location	description
C1	3, 4	M 29146 30144	Angliham Quarry	quarry building
D1	9, 13	M 31953 27979	Castlegar	boarded house
E1	6	M 27773 28141	Chestnut Lane	outbuilding
F1	12	M 29783 28069	Coolagh Road	shed

Roost A1 from the August and September session, Menlo Castle, is shown in Figure 2, roost B1 from August and September session, Cooper's Cave, in Figure 19, roost C1, quarry building in Angliham Quarry in Figure 15, roost D1 in Figure 22, roost E1, shed near Chestnut Lane in Figure 18 and roost F1 is depicted in Figure 20.

Table 6 below shows usage of daytime roosts by individual bats. It demonstrates that while some bats (1, 2, 5, 7, 8, 10 and 11) never changed their day roost – or were not identified to change roost – in the due course of the August radio tracking study and kept using the roost where they were captured, other bats changed day roost up to three times (bat 6). Fidelity to a roosting site correlates with sex; all bats staying in the same roost were females with the exception of bat 11. Six of the seven females caught at Menlo Castle maternity roost did not change their day roosting site in the duration of the radio tracking study.

Table 6 Daytime roost usage during the monitored period in August 2014

bat	31/07	01/08	02/08	03/08	04/08	05/08	06/08	07/08
1	A1	A1	A1	A1	A1	A1	N/A	N/A
2	A1	A1	A1	A1	A1	A1	A1	A1
3	A1	A1	A1	C1	A1	C1	N/A	N/A
4	A1	A1	C1	A1	A1	A1	C1	A1
5	A1	A1	A1	A1	A1	A1	A1	N/A
6	A1	E1	E1	A1	B1	E1	E1	E1
7	A1	A1	A1	A1	A1	A1	A1	A1
8	A1	A1	A1	A1	A1	A1	A1	A1
9	A1	A1	A1	B1	A1	A1	B1	B1
bat	31/07	01/08	02/08	03/08	04/08	05/08	06/08	07/08
10	A1	A1	A1	A1	A1	A1	A1	A1
11	/	B1	B1	B1	B1	B1	B1	B1

bat	31/07	01/08	02/08	03/08	04/08	05/08	06/08	07/08
12	/	B1	B1	C1	F1	F1	N/A	N/A
13	/	B1	D1	D1	D1	D1	D1	D1
14	/	/	/	/	/	/	/	/
15	/	/	/	/	/	/	Wall	Wall

Figure 2 Roost A, August and September, Menlo Castle

Bat 14 from the August session was found roosting in a mature ash tree at the grid reference of M 28749 27888, another day roost was located in a house on Headford Road, at the grid reference of M 30955 27953. Roost in the ash tree is shown in Figure 3, roost in the house is depicted in Figure 4. Bat 15 from the August session, male Daubenton's bat, was found roosting in a walled enclosure at the grid reference of M 29267 27908. This roost is shown in Figure 5.

Figure 3, Ash tree, day roost of male Leisler's bat during the August session

Figure 4, House on Headford Road, day roost of male Leisler's bat during the August session

Figure 5 Walled enclosure, day roost of male Daubenton's bat during the August session

Nine daytime roosting places were identified during the second radio tracking session conducted in September 2014. Table 7 shows details of daytime roosts from the September session. Roosts from which bats were first caught are included in this table because they were regularly used after the catching ceased. No other bat species were recorded to be using the same roosts with the exception of Cooper's Cave with the record of Brown long eared bat and at least three Daubenton's bats day roosting within.

Table 7 Identified daytime roosts in September 2014

roost	bats using	grid reference	location	description
A2	7, 8, 12, 14, 17	M 28491 27872	Menlo Castle	castle wall
B2	5, 12, 13, 15, 17	M 31747 27380	Cooper's Cave	cave
C2	4	M 24222 25094	Cappagh Road	bungalow
D2	5	M 31963 28203	Castlegar village	bungalow
E2	12	M 31590 28182	Castlegar village	shed
F2	6	M 24654 24161	60A Liosmor	house
G2	13, 15	M 31181 28622	Clearview	house
H2	15	M 31107 28421	Headford Road	house
I2	17	M 29140 28526	Monument Road	shed

Roost C2 from the September session is shown in Figure 6, roost D2 in Figure 7, roost E2 can be seen in Figure 8, roost F2 in Figure 9, roost G2 in Figure 10, roost H2 in Figure 11 and roost I2 is shown in Figure 12.

Figure 6 Roost C2 from the September session

Figure 7 Roost D2 from the September session

Figure 8 Roost E2 from the September session

Figure 9 Roost F2 from the September session

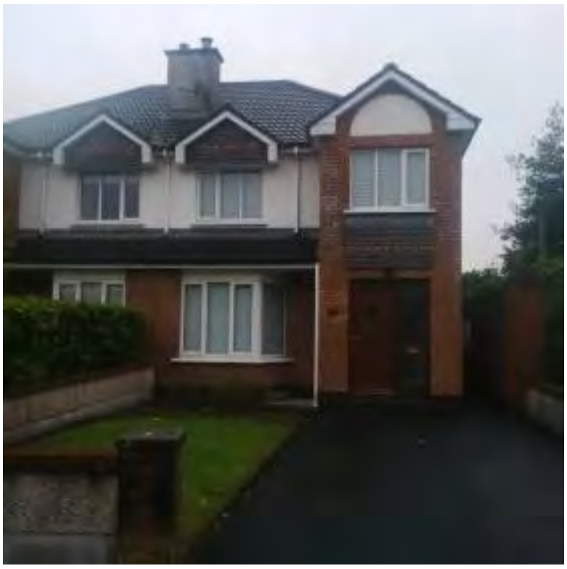


Figure 10 Roost G2 from the September session

Figure 11 Roost H2 from the September session

Figure 12 Roost I2 from the September session

Figure 13 Location of all roosting sites identified in August

Table 8 shows usage of daytime roosts by individual bats in September. It demonstrates that while some bats (4, 5, 6, 7, 8, 14) never changed day roost during the study conducted by Greena Ecological Consultancy. Fidelity to a roosting site in September does not correlate with sex; although interestingly both, female Daubenton's bat and female LHS captured at Menlo Castle were not recorded day-roosting elsewhere and it is likely that both were parts of the dispersing maternity colonies previously located in Menlo Castle.

Similarly to the August session, LHS roost was located in the central part of Menlo castle while Daubenton's roost was located in the northern part.

Some bats fitted with radio-transmitters prior to the arrival of Greena Ecological Consultancy were not located during the September session although their roosts may have been known in the session immediately before (refer to Geckoella Report for this session).

Table 8 Daytime roost usage during the monitored period in September

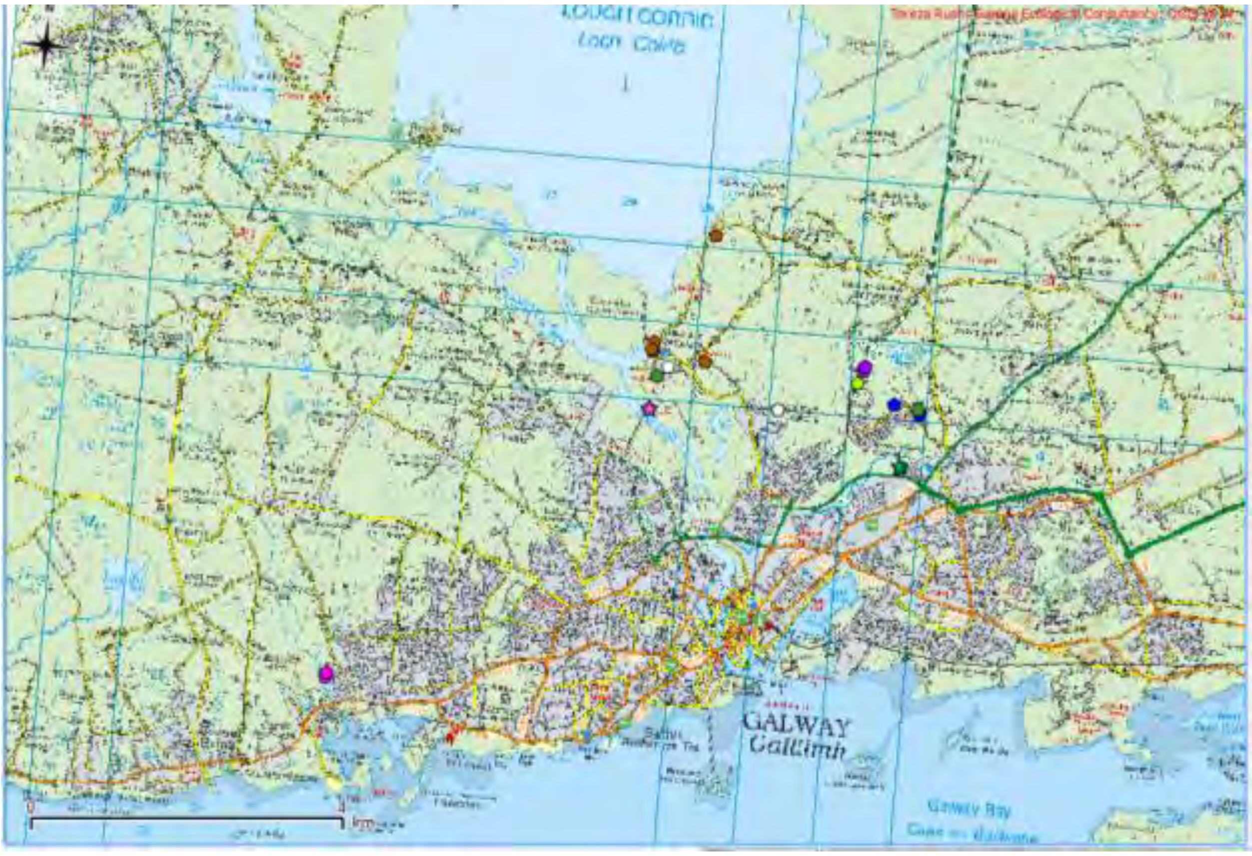
bat	30/08	31/08	01/09	02/09	03/09	04/09	05/09	06/09
1	/	/	/	/	/	/	/	/
2	/	/	/	/	/	/	/	/
3	/	/	/	/	/	/	/	/
4	/	C2	C2	C2	C2	C2	/	/
5	D2	D2	D2	D2	D2	D2	D2	/
6	/	F2	F2	F2	/	/	/	/
7	/	/	/	/	A2	A2	/	/
8	A2	A2	A2	A2	A2	A2	A2	/
9	/	/	/	/	/	/	/	/
10	/	/	/	/	/	/	/	/
11	/	/	/	/	/	/	/	/
12	/	/	B2	A2	B2	/	/	/
13	/	/	B2	B2	G2	G2	G2	B2
14	/	/	A2	A2	A2	A2	A2	A2
15	/	/	B2	B2	H2	H2	G2	B2
16	/	/	/	/	/	/	/	/
17	/	/	B2	A2	A2	A2	I2	I2

A single maternity roost of Lesser horseshoe bats was confirmed during the radio tracking studies in 2014. No young were captured or observed but the colony composition suggested maternity use. The roost was located in Menlo Castle.

A single swarming site was confirmed in the study area during the September study. All evidence suggested that Cooper's Cave serves as a swarming site (mating place for bats) because a small number of males day-roosted there and females were arriving later during the night before returning to their roost at Menlo Castle. Males LHS were also recoded visiting Menlo Castle and usually returning back to their roost at Cooper's Cave. Males of other bat species, Daubenton's and Natterer's bats, also used Cooper's Cave as a day roost and it is possible that these would mate there, too.

Figure 14 shows location of all roosting sites located in September.

Figure 14 Location of roosting sites located in September



7.4.2 Night-time roosting sites

Eleven night roost were identified during the August radio-tracking study. These only included night roosts of tagged bats subject to the study. Several roosts served as night roosts and were later used by the same or different bats as day roosting sites, too. These are listed in both spreadsheets. Menlo Castle was occasionally used as night roost but predominantly served as a day roost and is not included in the list of night roosts. Table 9 shows the location and description of the identified night roosts in August 2014.

Table 9 Night roosts of tagged bats in August

roost	bats using	grid reference	location	description
AN1	2	M 29756 30257	Angliham	derelict house
BN1	2	M 28463 28605	Quarry Road	shed
CN1	3, 4	M 29146 30144	Angliham Quarry	quarry building
DN1	3, 4	M 29091 30179	Angliham Quarry	quarry building
EN1	4	M 29136 30046	Angliham Quarry	quarry wall
FN1	6	M 27773 28140	Chestnut Lane	stables
GN1	6,11,12,13	M 31747 27380	Cooper's Cave	cave
HN1	12	M 29788 28079	Coolagh Road	shed
IN1	12	M 29782 28068	Coolagh Road	shed
JN1	11	M 31312 27908	Castlegar village	derelict house
KN1	13	M 31952 27981	Castlegar village	boarded house

Night roosts from the August sessions are shown in Figures 15 – 24.

Figure 15 Night roost AN1 of bat 2 from August session

Figure 16 Night roost BN1 of bat 2 from August session

Figure 17 Night roost CN1 of bat 3 and bat 4 from August session

Figure 18 Night roost DN1 of bat 3 and bat 4 from August session

Figure 19 Night roost EN1 of bat 4 from August session

Figure 20 Night roost FN1 of bat 6 from August session

Figure 21 Night roost GN1 of bats 6, 11, 12 and 13 from August session

Figure 22 Night roost of bat 12, HN1 (left), IN1 (right) from August session

Figure 23 Night roost JN1 of bats 11 from August session

Figure 24 Night roost KN1 of bat 13 from August session

Eight night roosts were identified during the radio tracking session in September 2014. Bat 17 was recorded in four different night roosts, in addition to Menlo Castle and roost on Monument Road, both recorded to be day and night roosts. Bats 14 and 15 in September used Lackagh Quarry for night roosting on regular basis and approximately at the same time every night.

Table 10 shows the location and description of the identified night roosts in September.

Table 10 Night roosts of tagged bats in September

roost	bats using	grid reference	location	description
AN2	17	M 29638 30424	Angliham	shed
BN2	17	M 28478 28718	Quarry Road	modern house
CN2	17	M 28463 28611	Quarry Road	shed
DN2	17	M 28458 28621	Quarry Road	shed
EN2	14	M 28674 28417	Menlo Park	house
FN2	5	M 28542 28297	Arch, The Avenue	stone arch
GN2	14, 15	M 30128 27995	Lackagh Quarry	quarry building
HN2	17	M 29146 30144	Angliham Quarry	shed

Night roosts discovered in September are shown in Figures 25 – 30. No photographs of roosts DN2 or EN2 were taken.

Figure 25 Night roost AN2 of bat 17 from September session

Figure 26 Night roost BN2 of bat 17 from September session

Figure 27 Night roost CN2 of bat 17 from September session

Figure 28 Night roost FN2 of bat 5 from September session

Figure 29 Night roost GN2 of bat 14 and bat 15 from September session

Figure 30 Night roost HN2 of bat 17 from September session

7.5 Foraging periods

All Lesser horseshoe bats radio-tracked in the August session were displaying similar foraging pattern. They emerged approximately 15-20 minutes after sunset and foraged for 3-4 hours before returning to the roost or finding a night roost. After the first period of foraging, they remained in the roost for 20-40 minutes before emerging for another prolonged period of foraging activity. If the temperature dropped below 10^0C, which only happened twice during the August radio-tracking session, bats foraged in shorter periods and remained in the roost longer. Bat activity was monitored until 15 minutes before sunrise on several occasions. Bats emerged to forage even in stronger wind and rain ranging from light drizzle to heavy shower.

Foraging activity recorded in the September session was species dependent. Leisler's male bat emerged within half an hour after sunset and commuted long distance in order to feed over Lough Corrib for several hours before moving further north or returning back to its roost. A Brown long-eared female bat emerged within 40 minutes after sunset and foraged in close proximity of its roost for up to 2 hours before returning to the roost and emerging for at least another session of foraging shortly after. Whiskered male bat emerged shortly after sunset and foraged for 6 – 7 hours, covering large distance overall but only moving several hundred meters from one foraging site to another. The bat then spent up to 45 minutes foraging in a particular area before moving further west. Daubenton's bats emerged within 40 minutes after sunset and their activity varied from one evening to another. This was obvious in the female Daubenton's bat that either covered large distance swiftly heading south along the river from the roost or spent majority of the night foraging on a limited stretch of the River Corrib only covering several hundred meters repeatedly. The behavioural pattern seemed to be dependent on wind, with stronger wind probably dispersing prey normally found very close to the roost at Menlo Castle. All Lesser horseshoe radio-tracked in the September study usually emerged shortly after sunset and foraged for 2.5 – 4 hours before returning to the roost or finding a night roost. If they returned to their day-roost, they rarely re-emerged to forage later. If they found a night roost, they would only leave it briefly as the night progressed or remained in the roost for prolonged periods of time (over 2 hours) after which surveyors usually stopped radio tracking for the night.

The weather conditions were mostly suitable for bat emergence and foraging during all nights in both sessions. Heavy rain slightly postponed bat emergence but never fully prevented it.

7.6 Foraging areas

Foraging areas for the purpose of this report were expressed in the standard form of minimum convex polygons as well as the form of multi-lateral polygons. Areas have been designated by the use bats made of them as combined areas of roosting sites, commuting and foraging areas of individual bats.

In August, the Lesser horseshoe bat maximum foraging distance from the roost ranged from 0.59km up to 5.15km with the average maximum distance of foraging area from the roost being 2.93km. This calculation included both, males and females. On average, males foraged slightly further afield, with the average maximum distance from the roost 3.68km, while females averaged the maximum distance of 2.29km.

A male Leisler's bat foraged in the maximum distance of 4.85km from its roost. No data on foraging areas or distance from the roost were gained on male Daubenton's bat fitted with a radio-transmitter in early August 2014.

Table 11 shows a summary of results of the first radio tracking session, including the number of fixes taken on each bat and the number of days a positive contact (joint bearings of two or more surveyors) was made.

Table 11 Results of radio tracking session in August 2014

bat	species	sex	foraging area MCP (sq.km)	foraging area MLP (sq.km)	maximum distance from roost (km)	fixes taken	over days
1	LHS	F	10.25	5.63	4.23	39	6
2	LHS	F	3.09	2.19	2.96	30	7
3	LHS	F	1.33	0.51	2.54	13	3
4	LHS	M	2.20	1.90	3.02	19	6
5	LHS	F	3.03	1.39	2.10	33	4
6	LHS	M	3.60	1.08	5.15	35	5
7	LHS	F	2.16	1.30	2.10	35	5
8	LHS	F	0.30	0.17	0.59	18	5
9	LHS	M	4.96	2.96	4.74	29	6
10	LHS	F	1.70	0.96	1.49	30	6
11	LHS	M	3.63	2.86	4.38	14	4
12	LHS	M	2.54	1.28	2.50	6	2
13	LHS	M	2.71	1.16	2.27	13	2
14	Leisler's	M	11.33	8.96	4.85	7	2

The Lesser horseshoe bat maximum foraging distance from the roost in September ranged from 1.11km up to 4.40km with the average maximum distance of foraging area from the roost being 3.39km. This calculation included both, males and females. On average, males foraged the maximum distance from the roost 2.88km, while females averaged the maximum distance of 4.16km. Maximum foraging distances of males and females of Lesser horseshoe bats were comparable. The difference in average maximum distance may be caused by limited data collected on Bat 12 (male LHS) before its radio transmitter got detached. The Lesser horseshoe population sample was much smaller than in the August session and average foraging distances can be biased by this fact.

A single Leisler's male bat foraged the maximum distance of 8.46km from the roost, single female Brown long eared bat foraged the maximum distance of 4.07km from its roost and the single male Whiskered bat was recorded up to 3.71km away from its roost.

Male Daubenton's bat foraged up to 1.06km from its known roost and the female Daubenton's bat was recorded up to 2,48km away from the roost. Very limited number of fixes were taken on the male Daubenton's bat and conclusions of its behaviour are therefore not indicative of the normal Daubenton's bat behavioural pattern.

No record was obtained on the male Natterer's bat fitted with a radio-transmitter during the September session. It is likely that the bat was only ad hoc visitor to the area and perhaps travelled large distance in search of breeding site when caught. Another possible explanation would be defective radio-transmitter.

No data were obtained for Bat 1, male Whiskered, Bat 2, female Daubenton's bat, Bat 3, male Leisler's bat, Bat 9, male Daubenton's bat, Bat 10, female Common pipistrelle or Bat 11, male Common pipistrelle, all tagged in the second half of August by Geckoella.

Table 12 shows results of the September radio tracking session.

Table 12 Results of radio tracking session in September 2014

bat	species	sex	foraging area MCP (sq.km)	foraging area MLP (sq.km)	maximum distance from roost	fixes taken	over days
4	Leisler's	M	24.49	13.62	8.46	29	3
5	Brown long eared bat	F	5.71	2.18	4.07	24	2
6	Whiskered	M	4.55	2.02	3.71	19	1
7	Daubenton's	M	0.27	0.26	1.06	3	1
8	Daubenton's	F	1.01	0.55	2.48	23	1
12	LHS	M	0.54	0.26	1.11	7	1
13	LHS	M	8.27	5.38	4.22	16	1
14	LHS	F	5.07	1.54	3.91	55	4
15	LHS	M	3.16	1.85	3.30	15	2
17	LHS	F	9.39	6.19	4.40	37	4

The majority of foraging areas obtained in both, August and September, overlapped in the Menlo Caste and Menlough Village area; meaning this was a key foraging area. Field systems and quarries north-east and east of Menlo Castle, as well as farm buildings in proximity of Menlough, proved to be crucial for Lesser horseshoe bats. Field systems north of Cooper's Cave served as foraging areas not only for Lesser Horsehoes but also Brown long eared bat. Daubenton's bats utilised the River Corrib as an ideal foraging habitat. Leisler's bats in both sessions covered relatively large distances and foraged in the southern part of Lough Corrib.

The following figures show forging areas (home ranges) of all bats successfully radio-tracked. Shaded area represent MCP traditional method, while checked area represents MLP method. Commuting routes, where they could beconfirmed, are shown with lines, confirmed foraging areas are marked with darker shaded areas. Figures 31 – 44 represent the August radio-tracking session whilst Figures 45 – 54 represent September 2014.

Figure 31 Foraging area of bat 1 August (female Lesser horseshoe)

Figure 32 Foraging area of bat 2 August (female Lesser horseshoe)

Figure 33 Foraging area of bat 3 August (female Lesser horseshoe)

Figure 34 Foraging area of bat 4 August (male Lesser horseshoe)

Figure 35 Foraging area of bat 5 August (female Lesser horseshoe)

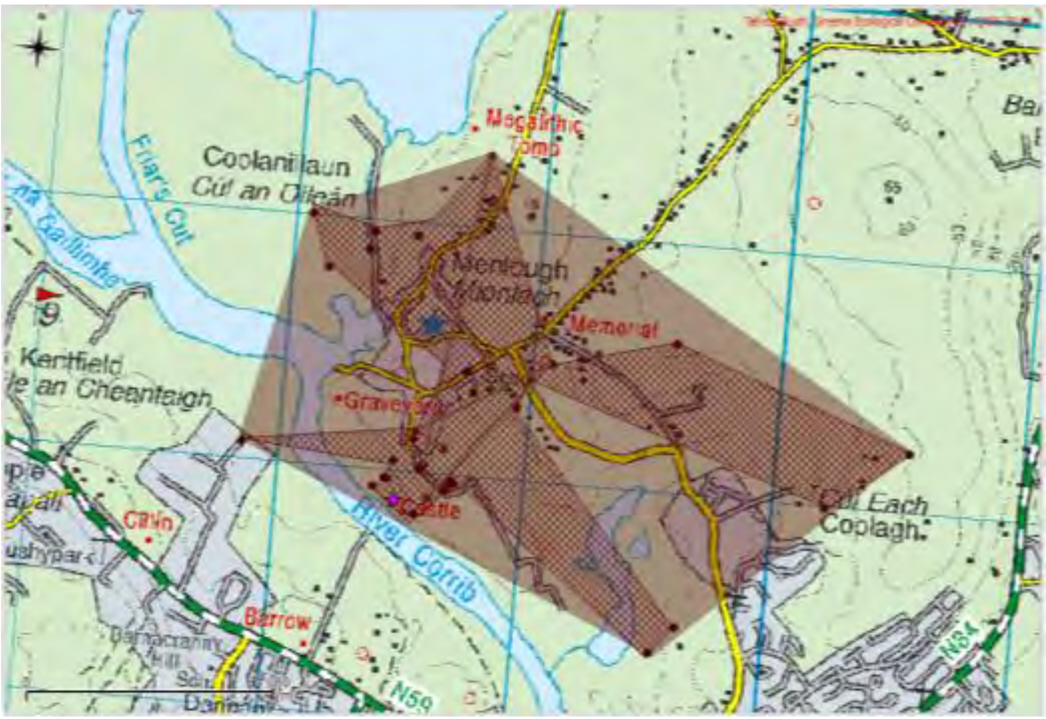


Figure 36 Foraging area of bat 6 August (male Lesser horseshoe)

Figure 37 Foraging area of bat 7 August (female Lesser horseshoe)

Figure 38 Foraging area of bat 8 August (female Lesser horseshoe)

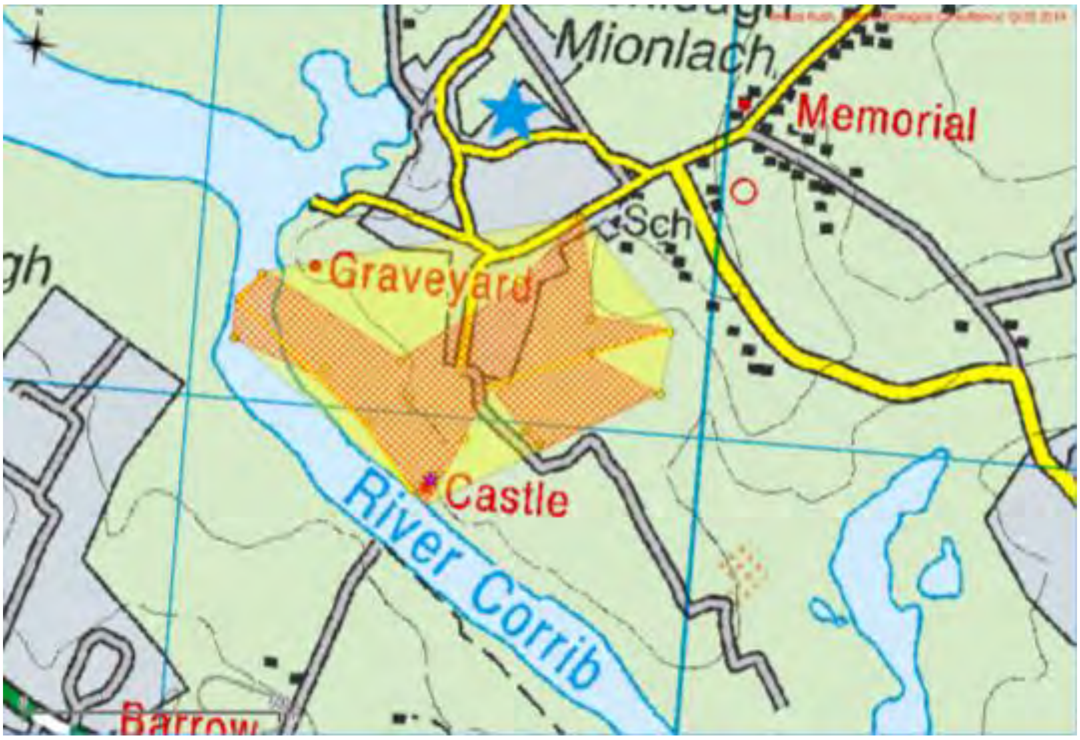


Figure 39 Foraging area of bat 9 August (male Lesser horseshoe)

Figure 40 Foraging area of bat 10 August (female Lesser horseshoe)

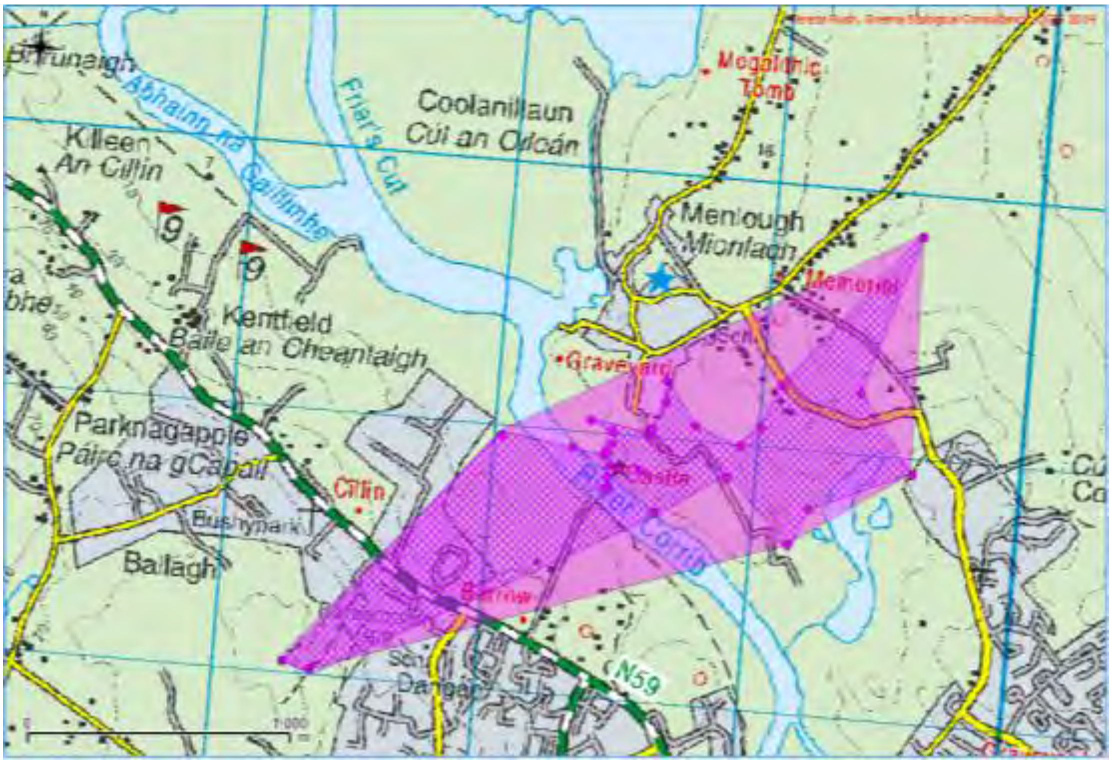


Figure 41 Foraging area of bat 11 August (male Lesser horseshoe)

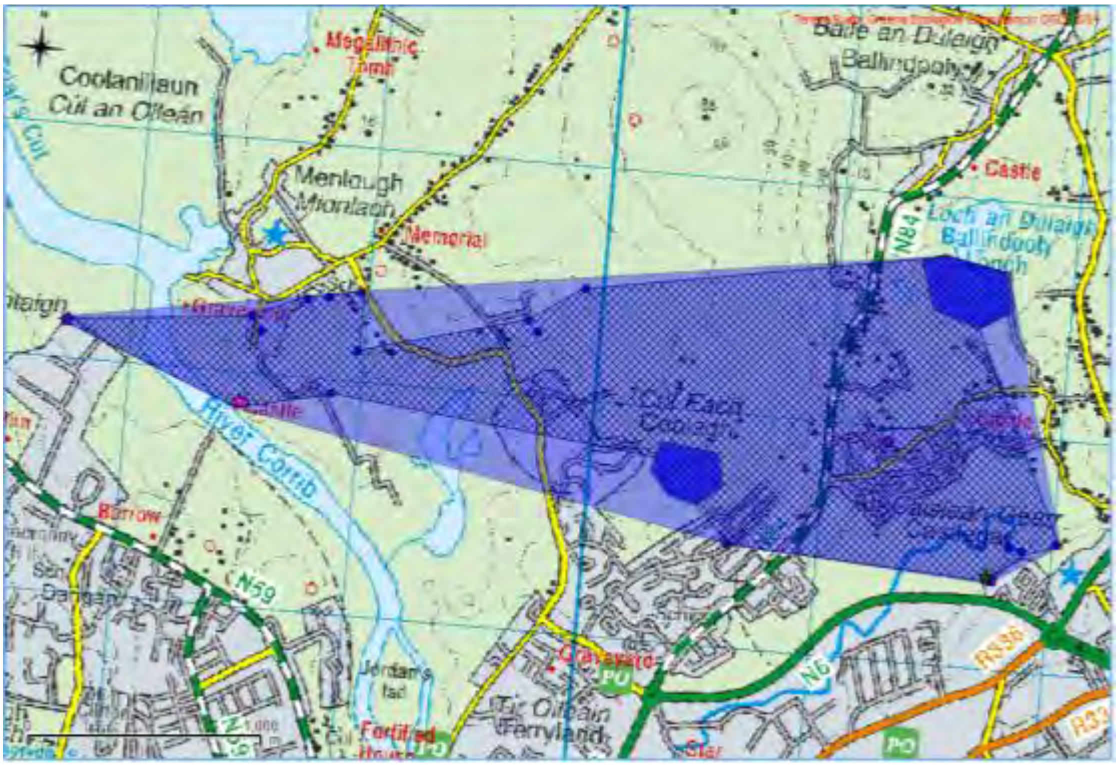


Figure 42 Foraging area of bat 12 August (male Lesser horseshoe)

Figure 43 Foraging area of bat 13 August (male Lesser horseshoe)

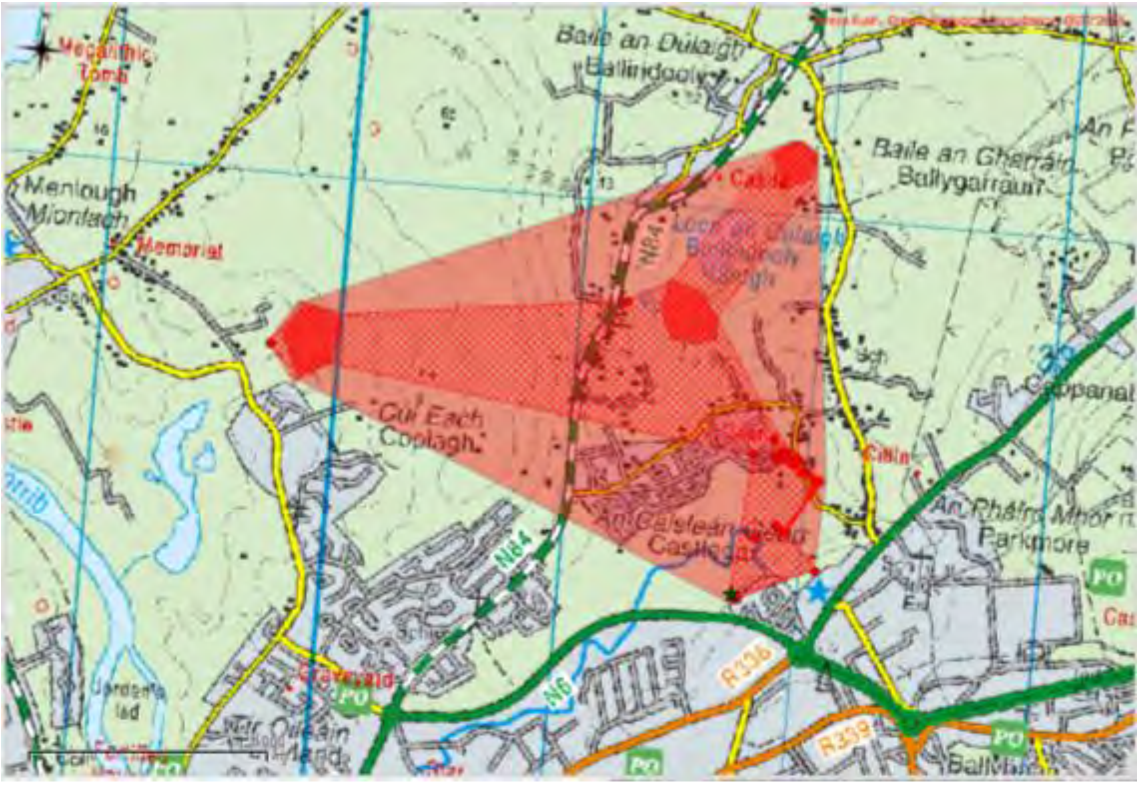


Figure 44 Foraging area of bat 14 August (male Leisler's)

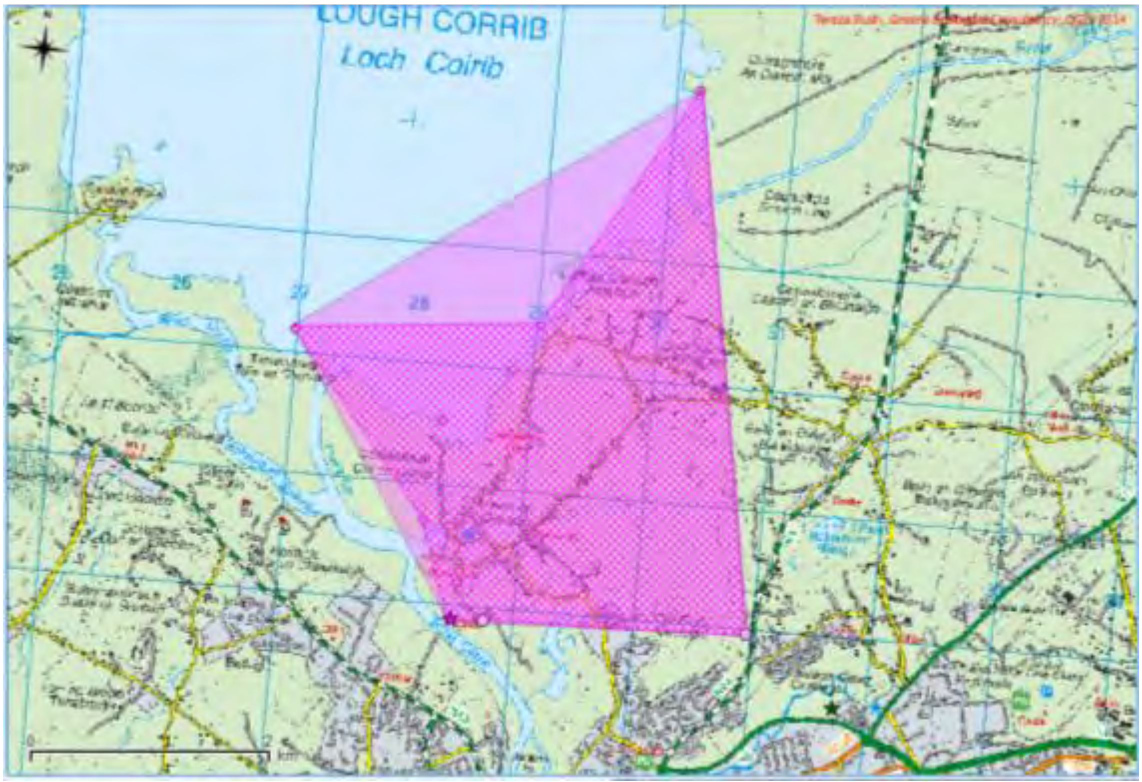


Figure 45 Foraging area of bat 4 September (male Leisler's)

Figure 46 Foraging area of bat 5 September (female Brown long eared bat)

Figure 47 Foraging area of bat 6 September (Whiskered bat)

Figure 48 Foraging area of bat 7 September (male Daubenton's bat)

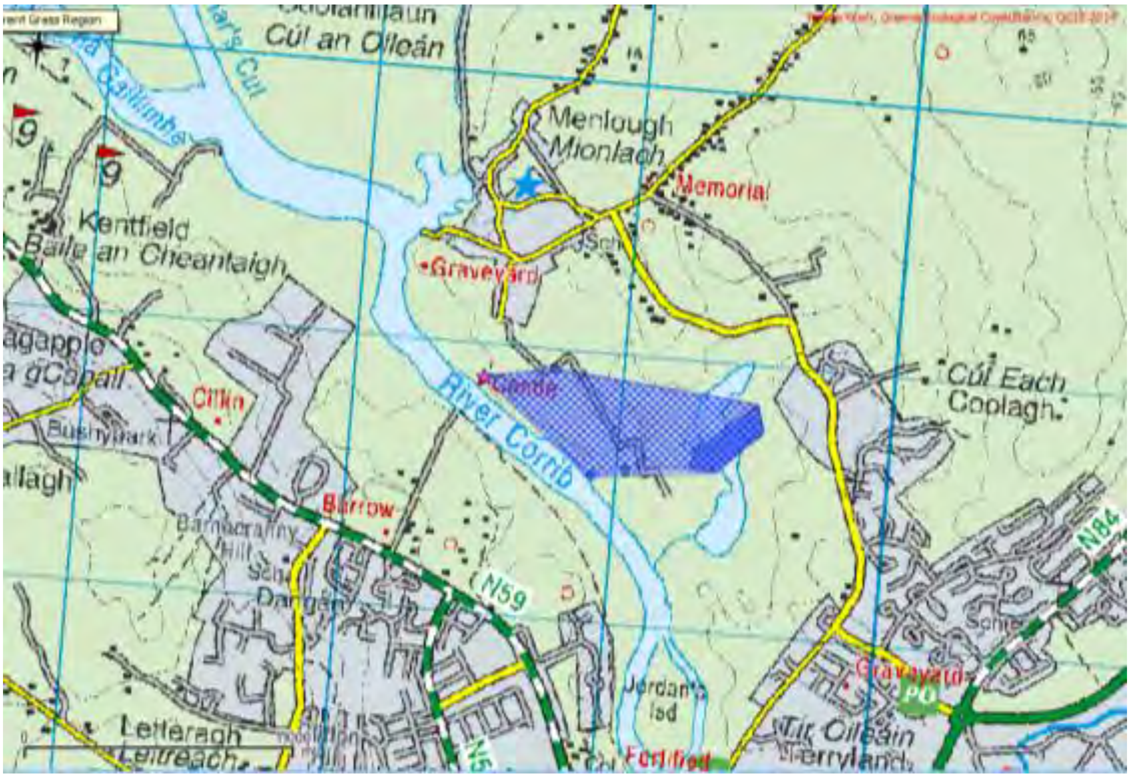


Figure 49 Foraging area of bat 8 September (female Daubenton's bat)

Figure 50 Foraging area of bat 12 September (male Lesser horseshoe)

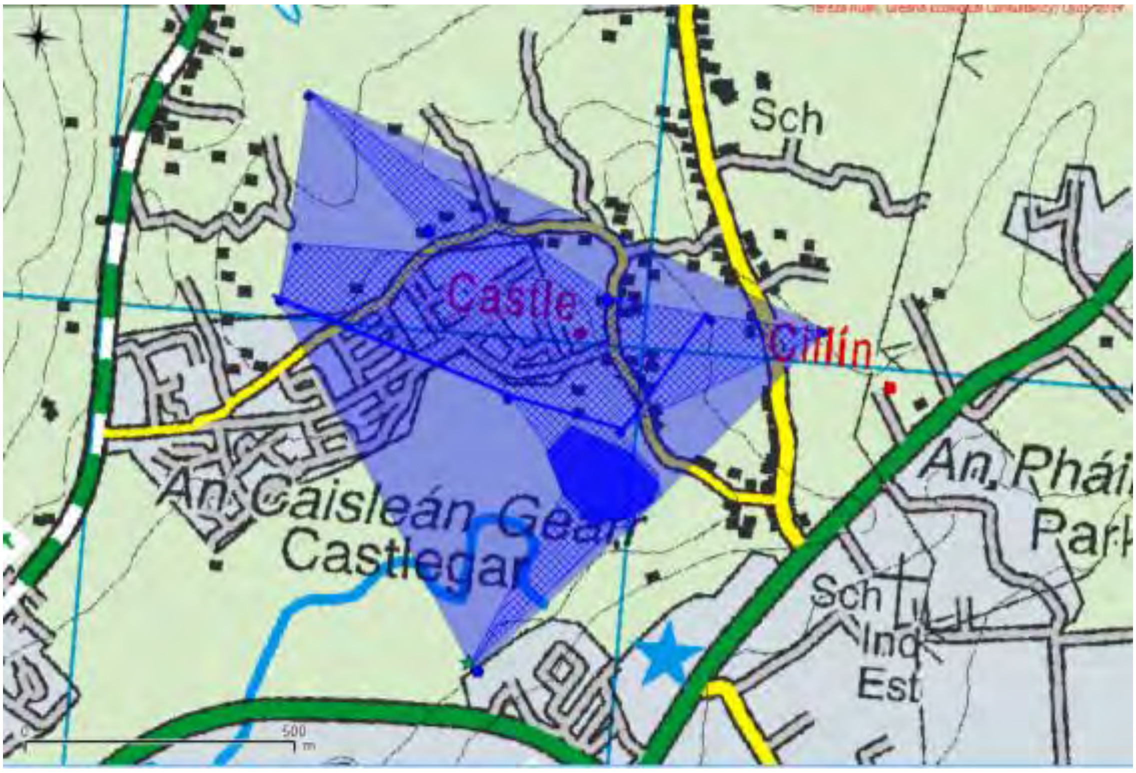


Figure 51 Foraging area of bat 13 September (male Lesser horseshoe)

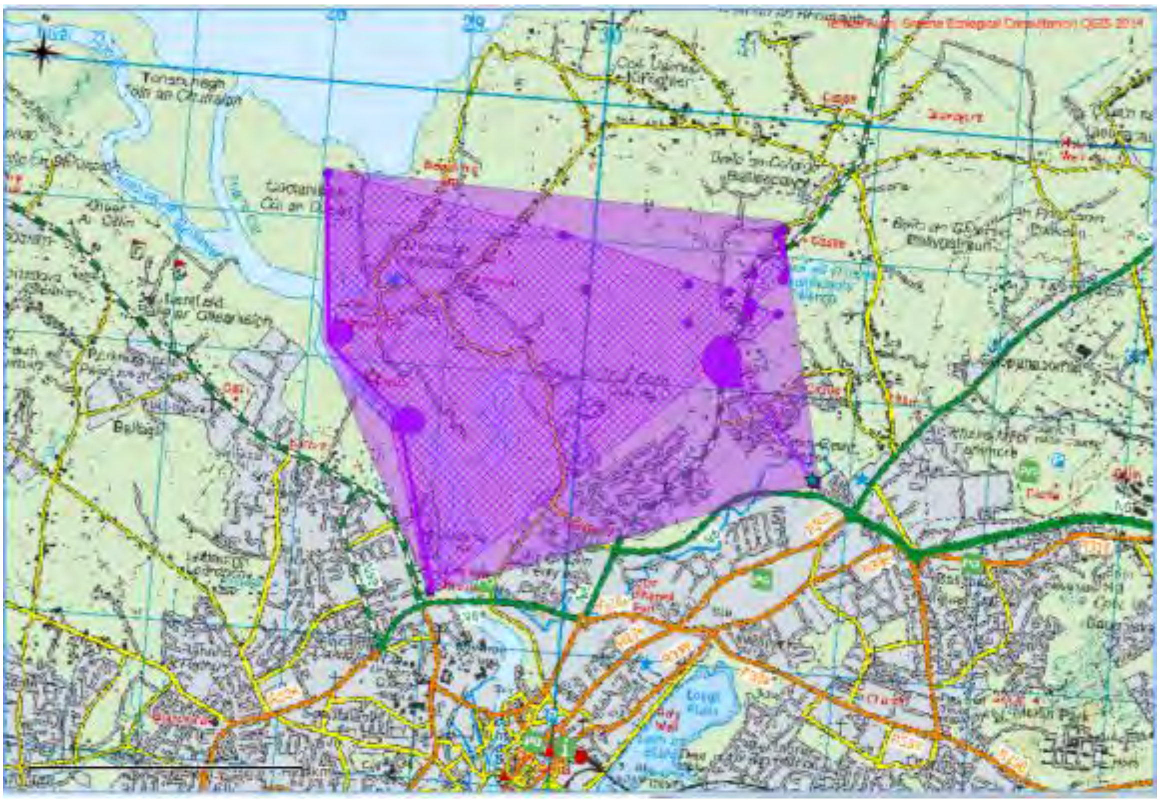


Figure 52 Foraging area of bat 14 September (female Lesser horseshoe)

Figure 53 Foraging area of bat 15 September (male Lesser horseshoe)

Figure 54 Foraging area of bat 17 September (female Lesser horseshoe)

August foraging and roosting areas:

Bat 1

Bat 1, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Foraging area of bat 1 ranged from Menlo Castle in south-west, towards Ballinfoyle in south-east, over Ballindooly Lough to Ballindooly in north-east, then into the south part of Lough Corrib, covering Angliham Quarry and limestone pavement located north-east from Menlo Castle. Bat 1 covered the largest distance and foraging area of all Lesser horseshoe bats studied in August 2014.

Bat 2

Bat 2, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Bat 2 changed its roosting place throughout the duration of the radio tracking session, roosting not only at Menlo Castle but also in Menlough Village and near Kilroghter. Foraging area of Bat 2 ranged from Menlo Castle in north-eastern direction, following the south shore of Lough Corrib and covering Kilroghter limestone pavement. Foraging area of Bat 2 is comparable with the average foraging area calculated for females Lesser horseshoe bats during this study.

Bat 3

Bat 3, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. This bat later changed its roosting place and was found first night roosting and later also day roosting in Angliham Quarry before returning back to Menlo Castle. Limited amount of data was collected on Bat 3 because its radio-transmitter got detached before the end of the study. Foraging area of Bat 3 extended in the north-eastern direction from Menlo Castle, spreading over Menlough Village and towards the south shore of Lough Corrib but avoiding Kilroghter limestone pavement. The small extent of the foraging area of Bat 3 raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

Bat 4

Bat 4, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Its foraging area to large extent coincided with the foraging area recorded for Bat 3, covering Menlough Village and heading towards the south edge of Lough Corrib, yet avoiding foraging on the limestone pavement situated north-east from Menlo Castle. Bat 4 was also found first night roosting and later utilising the same roosting place in Angliham Quarry for day roosting. The overall foraging area of Bat 4 is comparable with the average foraging area recorded for male Lesser horseshoe bats during the August study.

Bat 5

Bat 5, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Its foraging area extended further west than those of previously mentioned bats, reaching over the west bank of the River Corrib. Bat 5 was foraging in Menlough Village but never ventured as far north as Angliham Quarry; however, covered the village of Coolagh, including Lackagh Quarry and feeding repeatedly around Coolagh lakes. The foraging area of Bat 5 corresponds with the average calculated for Lesser horseshoe females in August 2014.

Bat 6

Bat 6, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. It was recorded to move to the west bank of the River Corrib the first night after being tagged. There is utilised a roost in a block of stables on regular basis, although was also recorded to have returned to Menlo Castle, usually for night roosting, and as far east as in Cooper's Cave for both, day and night roosting. Its foraging area did not spread north like other bats from the same roost. Instead, it was situated in the east-west direction between stable roost on the west bank, covering Menlough Village and Coolagh lakes and reaching to the field system around Cooper's Cave and Ballinfoyle.

Bat 7

Bat 7, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Its foraging area was located east from Menlo Castle , covering Menlough Village, Lackagh Quarry and the village of Coolagh. The overall foraging area of Bat 7 is comparable with average area calculated for Lesser horseshoe females in August 2014.

Bat 8

Bat 8, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio-tracking session. Limited amount of data was collected on foraging behaviours of Bat 8 in August. Its foraging area was very small and located in close vicinity of Menlo Castle and in Menlo Woods. It raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

Bat 9

Bat 9, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Similarly to Bat 6, this bat was also switching roosts between Menlo Castle and Cooper's Cave. Bat 9 was recorded to forage on the west bank of the River Corrib, over Menlough Village, in the area of Coolagh lakes and towards Ballinfoyle, as well as in the field system in proximity of Cooper's Cave. Foraging area of Bat 9 was considered larger than the average foraging area calculated for males Lesser horseshoe bat in August 2014.

Bat 10

Bat 8, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio-tracking session. Foraging area of this bat spread south-west from Menlo Castle as far as Bearnacranny, over Menlough Village, in Menlo Woods and the northern edge of Coolagh lakes but did not reach Lackagh Quarry in east. Foraging area of Bat 10 is considered smaller than the average foraging area of females Lesser Horseshoe bats studied in August, despite the fact that relatively large amount of data was collected. It raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

Bat 11

Bat 11, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It used the cave as a day roost all through the duration of the August radio-tracking study; however, was recorded night roosting on the west bank of the River Corrib. Its foraging area included the field system in proximity of Cooper's Cave, Ballinfoyle, Coolagh, the northern part of Coolagh lakes, Menlo Castle and Menlo Woods. Bat 11 was also recorded night-roosting in the maternity roost at Menlo Castle.

Bat 12

Bat 12, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It was recorded roosting in the cave and later in two sheds in Coolagh. Limited amount of data was collected on Bat 12; this bat stopped foraging on the 4th August 2014 and was later found dead in its roost in Coolagh. Its foraging area included Ballindooly lake and field systems around it as well as the field systems between Ballinfoyle and Coolagh.

Bat 13

Bat 13, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It was recorded roosting in Cooper's Cave on the night of tagging but then moved into a boarded derelict house in Castlegar where it remained roosting throughout the duration of the radio-tracking study. Bat 13 repeatedly used the same foraging area, located between Cooper's Cave, Ballindooly lake and Ballinfoyle. It was often recorded foraging around fields and following field boundaries.

Bat 14

Bat 14, a male Leisler's bat, was captured in Menlo Woods on 4th August 2014. It was not a target species of the August session and therefore limited amount of data was collected on its foraging area as well as roosting places. Scott Cawley located two roosts of Bat 14, one in an ash tree in Menlo Woods and one in a bungalow in Ballinfoyle. Recorded foraging area of Bat 14 included Menlough Village, Angliham Quarry and the south and south-east shore of Lough Corrib, flood area north of Angliham and reached south to Coolagh village.

<u>September foraging and roosting areas:</u>

Bats 1 – 11 in the September session were captured and fitted with radio-transmitters by Geckoella. Please refer to Geckoella report for details on physical measurements and weather conditions on trapping nights as well as exact trapping locations. Bats 1, 2, 3, 9, 10 and 11 could not be located during the September radio-tracking study led by Greena Ecological Consultancy.

Bat 4

Bat 4, male Leisler's bat, was captured in Bearna on 20th August 2014. It was changing roosts between two bungalows only located approximately 100 metres apart on Cappagh Road in Knocknacarra based on the evidence provided by Geckoella. Bat 4 did not change its roost during the study led by Greena Ecological Consultancy and utilised the same bungalow throughout the duration of the study. Bat 4 was using the same commuting route on regular basis, skimming the north-west edge of Galway City and then following the River Corrib north before spending prolonged periods foraging over the open water of Lough Corrib.

Bat 5

Bat 5, female Brown long eared bat, was captured by Cooper's Cave on 21st August 2014. It is not known to Greena Ecological Consultancy whether the bat was captured when entering / exiting the cave itself or while foraging nearby. Bat 5 did not change its day roost in Castlegar throughout the duration of the September study; however, was recorded night roosting in the stone arch between Menlough Village and Menlo Castle. It is possible that Bat 5 was forced to find a night roost due to adverse weather conditions on that night. Foraging area of Bat 5 was used repeatedly every night and was situated between Coolagh, Glenanail and Castlegar, extending north to Ballindooly.

Bat 6

Bat 6, male Whiskered bat, was captured on the grounds of National University of Ireland in Galway (NUIG) on 22nd August 2014. It was roosting in a residential house between Knocknacarra and Bearna and did not change its roosting place throughout the duration of the September study. The foraging area of Bat 6 spread westwards from its roost, utilising Bearna Woods, Moycullen Bogs and the area south of Lough Inch. It is possible that Bat 6 foraged further west, out of the study area, where it could not be followed during the radio-tracking study

Bat 7

Bat 7, male Daubenton's bat, was captured on the grounds of NUIG on 22nd August 2014. This bat was not located prior to the arrival of Greena Ecological Consultancy. The only confirmed roosting place of this bat was Menlo Castle, bat 7 visited maternity colony of Daubenton's bats located in the northern part of the castle for a single night in early September. Limited amount of data was therefore collected on Bat 7. It was recorded foraging in close vicinity of Menlo Castle, in Menlo Woods and in the area of Coolagh lakes.

Bat 8

Bat 8, female Daubenton's bat, was captured on the grounds of NUIG on 22nd August 2014. It was roosting in the maternity roost of Daubenton's bats in Menlo Castle and never changed the location of roost during the September radio-tracking study. It was recorded foraging along the River Corrib, mainly southwards from the roost, reaching Galway City centre but staying limited to the river.

Bat 12

Bat 12, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. Only limited amount of data was collected on Bat 12 because radio-transmitter got detached several days into the study. The foraging area of Bat 12 was very limited, spreading around Castlegar and field system in proximity of Cooper's Cave.

Bat 13

Bat 13, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in a house along the busy Headford Road, although returned to Cooper's Cave towards the end of the radio-tracking study conducted in September. The foraging area of Bat 13 was large, covering majority of the stretch of the River Corrib between the northern edge of Galway City and the southern shore of Lough Corrib, Menlough Village, Coolagh lakes and reaching east to Castlegar and Ballindooly.

Bat 14

Bat 14, female Lesser horseshoe bat, was captured from Menlo Castle maternity roost entrance on 1st September 2014. It did not change day roosting location throughout the duration of the September study. It was; however, recorded night roosting in Lackagh Quarry on regular basis, usually sharing the night roost with Bat 15. Foraging area of Bat 14 spread north reaching the southern shore of Lough Corrib, covering Menlough Village, Coolagh, Ballinfoyle and north part of Castlegar.

Bat 15

Bat 15, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in a house along the busy N84, although returned to Cooper's Cave towards the end of the radio-tracking study conducted in September. The foraging area of Bat 15 was limited to the field system in vicinity of Cooper's Cave and reaching north to Ballindooly, then west through Ballinfoyle and Coolagh to Menlo Woods and south of Menlough Village. Bat 15 regularly utilised a night roost in a quarry building in Lackagh Quarry.

Bat 16

Bat 16, male Natterer's bat, was captured in Menlo Woods on 1st September 2014. The bat was never located during the September radio-tracking study and it can be therefore concluded that it was an occasional visitor that never returned to the same area for the duration of the study or the radio-transmitter failed shortly after fitting.

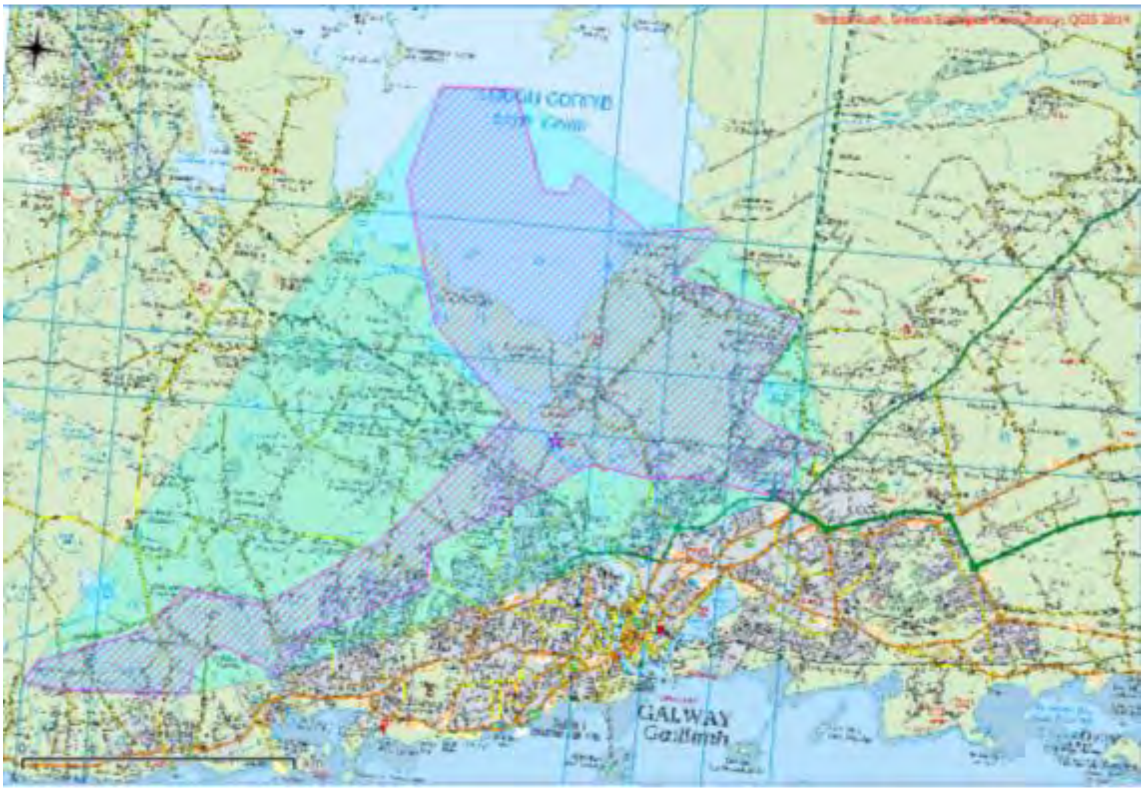
Bat 17

Bat 17, female Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in the maternity roost at Menlo Castle and is considered to be part of the maternity colony. Bat 17 utilised a large number of night roosts located in Menlough Village and Angliham Quarry as well as in Angliham. Cooper's Cave was also one of the confirmed night roosts of Bat 17. A large foraging area of this bat covered the limestone pavement between Ballindooly and Angliham Quarry as well as Menlo Woods, Lackagh Quarry, Ballinfoyle and field system in vicinity of Cooper's Cave.

Figures 55 and 56 overleaf show the combined overall foraging areas for all horseshoe bats in August and all bat species in September.

Figure 55 Overall foraging area in August 2014

Figure 56 Overall foraging area in September 2014



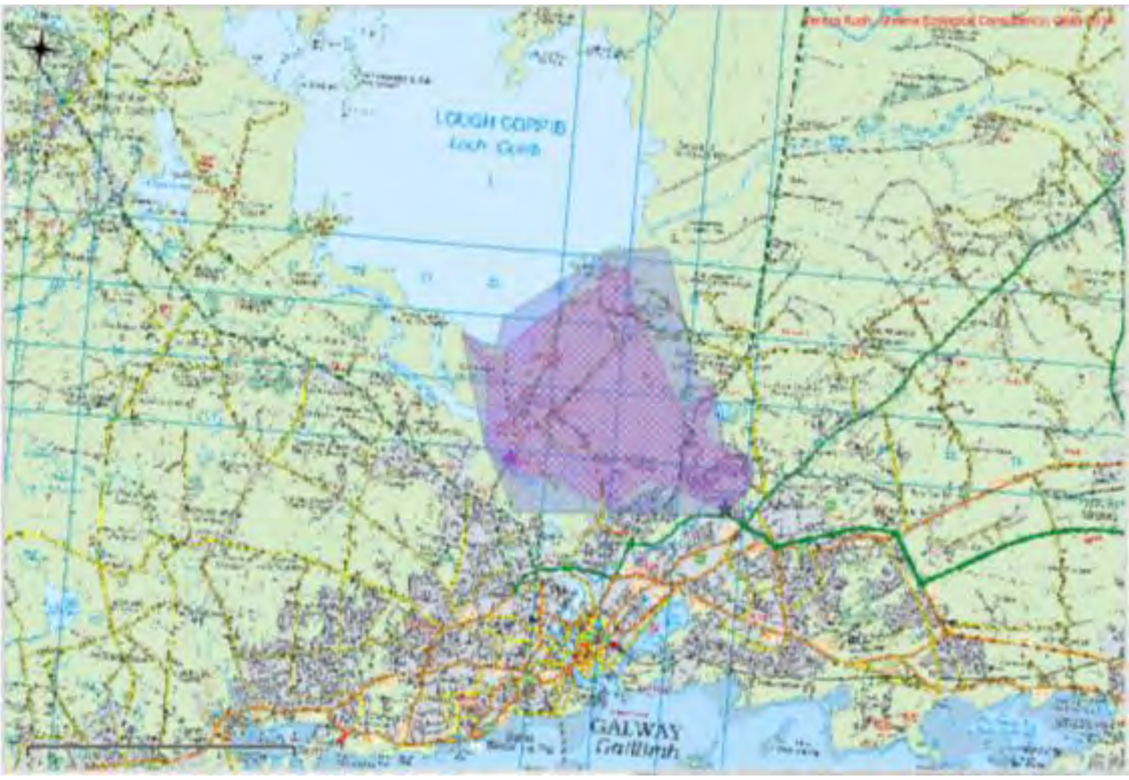
The overall foraging areas from both sessions overlapped in many places. The overall foraging area in August added up to 21.75km^2 (MCP) or 13.70km^2 (MLP), while it was 56.10km^2 (MCP) or 26.46km^2 (MLP) in September. Direct comparison of foraging areas in the August and the September session is not possible due to species variation. Comparison of foraging areas of Lesser horseshoe bats between August and September is shown in Figure 57.

Figure 57 Overall August foraging area and September foraging area of Lesser horseshoe bats

August MCP in solid yellow, August MLP in red vertical stripe, September MCP in solid pink, September MLP in horizontal blue stripe

Figure 58 overleaf shows the overlap of foraging areas in August and September for Lesser horseshoe bats. This area is crucial for the population of Lesser horseshoe bats in the Galway area because it is utilised during late maternity period in summer as well as for foraging in preparation for hibernation in late summer. The area of overlapping home-ranges of Lesser horseshoe bats from August and September measures 11.96sq.km (MCP) or 8.10sq.km (MLP).

Figure 58 Overlap of foraging areas of Lesser horseshoe bats studied in August and in September 2014



7.7 Summary of Results

Greena Ecological Consultancy carried out two radio-tracking sessions in Galway in 2014, the first one commenced in late July and is referred to as the August session, the second one commenced in late August and is referred to as the September session.

Thirteen Lesser horseshoe bats were captured and fitted with radio-transmitters in the August session. In addition to that, Scott Cawley caught a male Leisler's bat and a male Daubenton's bat that were also tagged by Greena Ecological Consultancy but were not considered target species of the August session resulting in limited attention paid to them during night time radio-tracking. Out of all Lesser horseshoe bats tagged in August, ten were caught at Menlo Castle maternity roost (seven females and three males) and three were caught at Cooper's Cave (all males).

Vesper bats of five species – Whiskered bat, Leisler's bat, Daubenton's bat, Brown long eared bat and Common pipistrelle bat – were caught and fitted with radio-transmitters prior to the start of the September session. In addition to that, Greena Ecological Consultancy captured and tagged five Lesser horseshoe bats and one Natterer's bat. One female Lesser horseshoe was caught from the maternity roost at Menlo Castle, four remaining Lesser horseshoe bats (three males and one female) were caught by the entrance to Cooper's Cave. Natterer's bat was caught in Menlo Woods.

No juvenile or pregnant bats were subject to survey in either session carried out by Greena Ecological Consultancy.

Majority of foraging areas of Lesser horseshoe bats in August and in September overlapped in the area of Menlo castle, Menlo Woods, Menlough village, Coolagh, Castlegar in east and towards Angliham in the north. No foraging areas of Lesser horseshoe bats extended south towards Galway City.

The sample of vesper bats was not representative. Generally, Leisler's bat foraged in the south part of Lough Corrib and often utilised area of open water for foraging. Leisler's bats commuted relatively long distances from roost to foraging areas.

Daubenton's bats utilised the area of Menlo Wood and the immediate proximity of Menlo Castle. They were also recorded foraging along the River Corrib, with foraging areas and commuting routes extending south along to river to the city centre. The River Corrib forms an ideal bio-corridor in otherwise built up landscape affected by light pollution.

Only one Whiskered bat was radio-tracked. It foraged north and north-west of Bearna, opting for woodland and limestone pavement with scrub as a favourite foraging habitat.

Pipistrelle bats tagged by Geckoella in the second half of August could not be located and were therefore not subject to the radio-tracking studies.

One Natterer's bat was tagged in September but could not be located and is not included in the radio-tracking studies.

Six daytime roosts of Lesser horseshoe bats were identified during the August study, later two day roosts of Leisler's bat and one roost of Daubenton's bat were also identified as a part of the session.

Eleven night roosts of Lesser horseshoe bats were discovered in August.

Nine daytime roosts were identified in the September session of radio-tracking. These included roosts of Lesser horseshoe bats as well as vesper bats.

In the same session, eight further night roosts were discovered. Night roosts only relate to Lesser horseshoe bats, no night roosts of vesper bats was found.

Lesser horseshoe bat maximum foraging distance from the roost was 5.15km in August and 4.40km in September, with average maximum distances being approximately 2.93km and 3.39km, respectively.

Considering the proportion of the bat population monitored during the two radio-tracking sessions; it can be concluded that the area to the east of the River Corrib and north of Galway City is of high importance to commuting and foraging horseshoe bats and they use it on regular basis in summer.

Based on the results of the radio-tracking studies carried out in 2013, it can be concluded that both, Lesser horseshoe bat and vesper bat species utilize existing woodlands, field boundaries and watercourses for foraging and navigating. Areas of scrub on limestone pavement are often used as foraging areas for prolonged periods of time. Quarries in the Galway area are of particular importance to Lesser horseshoe bats.

Maternity roosts present at Menlo Castle has a strong link to roosting site at Cooper's Cave; bats regularly commute between the roosts and have been confirmed to be a part of the same Lesser horseshoe bat population.

All evidence suggests that Cooper's Cave is an important roosting site for males Lesser horseshoes in summer and an important mating site in the area. It would be beneficial if the site could be cleared under supervision and grilled to prevent access of general public in order to improve roosting and mating opportunities for the Galway Lesser horseshoe bat population.

8.0 Acknowledgements

Greena Ecological Consultancy would like to thank the following organisations and individuals for their help in the due course of this study:

- Scott Cawley Limited

- National Parks and Wildlife Service, Ireland

- Galway County Council

- Kate McAney for information on known local bat roosts.

9.0 References

Altringham, J.D., (2001). Bats, Biology and Behaviour. Oxford University Press. Reprint.

Berthinussen, A., Altringham, J. (2011). The effect of a major road on bat activity and diversity. Journal of Applied Ecology 49 (1), pp. 82-89

Kenward, R. E. (1992). Quantity versus quality: programmed collection and analysis of radio-tracking data in Wildlife telemetry. Remote monitoring and tracking of animals: 231-245. Priede, I. G. & Swift, S. M. (Eds). Chichester: Ellis Horwood.

Kokurewicz, T. (1990). The decrease in abundance of the lesser horseshoe bat Rhinolophus hipposideros Bechstein, 1800 (Chiroptera: Rhinolophidae) in winter quarters in Poland. Myotis 28: pp.109-118.

Irishstatutebook.ie, (2014). Wildlife Act, 1976. [online] available at: http://www.irishstatutebook.ie/1976/en/act/pub/0039/index.html [accessed on 21st October 2014]

McNay, R. S., Morgan, J. A. and Bunnel, F. L.,(1994). *South Dakota Agricultural Experiment Station, Characterizing independence of oband the National Rifle Association.* Support was observations in movements of Columbian black provided by South Dakota Co-operative Fish and tailed deer. The Journal of Wildlife Management, Wildlife Research Unit, South Dakota State University- 58, 422–429.

Mohr, C.O., (1947). *Table of equivalent populations of North American small mammals*. Am Midl Nat 37: pp.223–249

NPWS (2013) The Status of EU Protected Habitats and Species in Ireland. Species Assessments Volume 3. Version 1.0. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

NPWS.ie (2014) *Protected sites – National Parks & Wildlife Service.* [online] available at: http://www.npws.ie/protectedsites/ [accessed on 11th October 2014]

Park, K.J. (1998) Roosting ecology and behaviour of four temperate species of bat. University of Bristol

Rudolph, B.-U. (1990). Fruhere Bestandesdichte und heutige Bestandessituation der Kleinen Hufeisennase Rhinolophus hipposideros in Nordbayern. Myotis 28: pp.101-108.

Stebbings, R. E. (1988). Conservation of European bats. London: Christopher Helm

Stutz, H. P., Haffner, M. (1984). Arealverlust und Bestandesruckgang der Kleinen Hufeisennase (Rhinolophus hipposideros) (Bechstein 1800) (Mammalia: Chiroptera) in Schweiz. Jahresber. Naturforsch. Ges. Graubuenden Neue Folge 101: pp.169-178

Vandevelde, J.-C, Bouhours, A., Julien J.-F, Couvet, D., Kerbiriou, C. (2014) *Activity of European bats along railway verges*. Ecological Engineering. Vol 64, pp 49-56.

Voute, A. M., Sluiter, J. W. & van Heerdt, P. F. (1980). Devleermuizenstand in enige Zuidlimburgse groeven sedert 1942.Lutra 22(1-3): pp.18-34.

White, G. C., and R. A. Garrott. (1990). Analysis of wildlife radio-tracking data. Academic Press, New York, New York, USA.

Worldweatheronline.com (2014). Galway, Ireland historic weather, RSS Feed, Weather Charts, Weather Averages and Weather Widget for website and blog. WorldWeatherOnline.com [online] available at: http://www.worldweatheronline.com/v2/historical-weather.aspx?q=Galway,%20Ireland [accessed on 12th October 2014]

Annex B

Galway City Transport Project - Bat Acoustic Surveys: Summer-Autumn 2014 (Geckoella Ltd., 2015a)

B1

Galway City Transport Project
Bat Acoustic Surveys
Summer-Autumn 2014

Report date:	30th November 2014
Survey dates:	12th August to 4th November 2014
Commissioned by:	Scott Cawley Ltd.
Version:	Final Report – June 2015
Authorised by:	Andy King
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Summary

Geckoella Ltd. were commissioned by Scott Cawley Ltd. to carry out an acoustic bat survey to inform the Galway City Transport Project. The objectives of the survey were to establish the distribution of different species and gain indices of relative abundance of bats within the study area, as well as gathering information in particular on rare and notable species such as lesser horseshoe bat and Nathusius's pipistrelle bat. The static detectors were first deployed on 12th August 2014. In total, to 4th November, 266,539 identified bat passes have been collected across 24 sites. Sonogram analysis has recorded 7 species, with lesser horseshoe bats present at 14 sites (58%), and Nathusius's pipistrelle bat present at 20 sites (83%). There is a large variation in levels of bat activity between some of the sites. As expected based on their abundance elsewhere in Ireland and the UK, the majority of bat calls recorded are from Pipistrelle bat species, with soprano pipistrelles accounting for 221,301 (83%) of identified calls.

Acknowledgements

We thank the following contributors to the acoustic surveys, analysis and presentation: Dr. Fiona Mathews, Helen Saunders, Jana Prapotnikova, Tim Clark and the teams at Arup (Galway) and Scott Cawley Ltd.

Contents

Tables

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Appendices

1 Introduction

1.1 Galway City Transport Project requires environmental baseline information in the scheme study area as part of the constraints study for the project. Information on bats is being collected as part of this process in accordance with local and European guidance and legislation (Kelleher & Marnell, 2006). Geckoella Ltd. was contracted by Scott Cawley Ltd. to carry out an acoustic bat survey to contribute to this baseline environmental information. This report presents findings to 4th November 2014.

1.2 Geckoella, in association with EcoPro and the University of Exeter, supplied static bat detectors, provided technical support, and carried out and presented the results of acoustic analyses including this report. Scott Cawley Ltd. and Arup carried out field deployment of the static bat detectors.

2 Methodology

2.1 The study area includes Galway and surrounding urban-fringe and farmland habitat, and totals approximately 6,350ha as shown in Figure 1.

2.2 Twenty-four sites for static detector deployment were selected across the site by Scott Cawley Ltd. to survey the bat species present at different locations, as well as to collect comparative data on species richness and general levels of bat activity (Figure 1). The static detectors used were SM2 or SM2+ bat detectors made by Wildlife Acoustics. They were set to record in .wac[1] format from ½ hour before dusk to ½ hour after dawn using settings as set out in Appendix B to determine when the unit would be triggered to record a potential bat call. The type of microphone (SMUX) was used for all detectors and they had all been calibrated within the previous 6 months to ensure that detector sensitivity and data collection was similar for all data included within the analysis.

2.3 'Bat passes' for the purposes of this survey are defined as a triggered recording of 2 or more bat pulses in a continuous sequence (Bat Conservation Trust, 2012). A single sound file can have bat passes from more than one species as well as calls from more than one bat of the same species. 'Survey nights' comprise the period beginning 30 minutes prior to sunset, and ending 30 minutes after sunrise during which a detector was deployed and recording bats at a particular site. Dates in this report relate to the date on which a survey night started, so that, for example, 17th September denotes the period from before sunset on the 17th through to past dawn on 18th September.

2.4 The sound files collected were converted from .wac format to .wav and zero crossing for sound analysis within Kaleidoscope Pro (KPro) software. This software can automatically sort sound files that contain only non-bat 'noise' from sound files that contain bat passes. The software can also 'tag' each call with a potential identification, according to similarities in call shape to archetypal call clusters within the database. This approach allows identification to genus level for *Myotis* species, and to species level for other bats found in Ireland[2]. Separation of *Myotis* species is complicated by the high degree of overlap between call characteristics. Appendix B summarises the accuracy levels of the sound analysis carried out both manually and through automatic classification for each species.

2.5 The call analysis was carried out using KPro by Mrs Kate Jeffreys MCIEEM CEnv, Ms Jana Prapotnikova MCIEEM and Mr Tim Clark GCIEEM with Dr. Fiona Mathews of Exeter University carrying out Quality Assurance (QA) for the data. This team is very experienced in the use of acoustic survey techniques for bats and has worked together, sharing files and experience in order to ensure consistency between analysis.

2.6 For species other than common or soprano pipistrelle, the tags were then checked and confirmed or corrected manually since automatic classification is not yet accurate enough to rely upon in isolation for most species (Waters & Barlow, 2013). The manual identification was carried out by comparison with call parameters as set out in Russ (2012) and Middleton et al. (2014). A quality assurance check by Dr Fiona Mathews of 3,540 calls found that the overall accuracy rate for manual identification of species

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[1] .wac is a format for sound files developed by Wildlife Acoustics

[2] The calls of different species of *Myotis* bats have overlapping parameters and hence resolution to species level is usually to a lower level of confidence as compared to other genus. *Myotis* calls were identified to genus level only to ensure a consistency of confidence across the analysis.

was 97.3% (Appendix B).

2.7 A mix of automated and manual identification was adopted for common and soprano pipistrelle bats. Files tagged as common or soprano pipistrelle during session 1 (12th August to 14th September) were checked manually and subject to quality assurance as set out above.

2.8 Passes tagged by KPro as either common or soprano pipistrelle bats from 15th September to 4th November were not checked manually in order to streamline the analysis of the other bat calls. The accuracy rate for KPro for these 2 species for this study has been calculated as 99% and 94% respectively. Where KPro made a mistake, passes wrongly identified as soprano pipistrelle were most likely to be common pipistrelle, and *vice versa*. All other passes were checked manually. Appendix B sets out the detail.

2.9 Where identified manually, in some cases, separation between common and soprano pipistrelle was not possible, due to maximum peak energy of the lowest frequency call in a series being between 49.95 and 50.14 kHz. In these cases, calls were ascribed to Pipistrellus spp. (PIPI-PIPY).

2.10 The survey period ran from 12th August to 4th November. The survey period has been split into three separate sessions as described in Table 1. Dates within each session have broadly comparable night periods and represent broadly equivalent stages in terms of the seasonal changes that bats undergo. These sessions run inclusively from 12th August to 14th September, 15th September to 12th October, and 13th October to 4th November. Graphs and tables within this report indicate the number of survey nights recorded by each detector within each survey session as 'n' (sample size) as set out below in Table 1. The number of nights worth of data included for analysis (n) varied between sites and sessions. This reflects differences in deployment dates. In addition, any data collected under non-optimum conditions, for example with regard to equipment performance, was excluded. This ensured that the data included within the analysis was comparable between sites.

Table 1 Bat acoustic survey dates for each site

Session Site	12Aug-14Sep (34 nights)	15Sep-12Oct (28 nights)	13Oct-3Nov (22 nights)	All
S01	24	28	21	73
S02	14	28	21	63
S03	24	28	0	52
S04	31	28	21	80
S05	0	21	21	42
S06	0	14	21	35
S07	20	21	14	55
S08	26	25	14	65
S09	7	28	22	57
S10	28	28	21	77
S11	28	28	22	78
S12	34	28	21	83
S13	31	28	22	81
S14	14	28	22	64
S15	24	28	21	73
S16	34	28	21	83

Site	Session 12Aug-14Sep (34 nights)	15Sep-12Oct (28 nights)	13Oct-3Nov (22 nights)	All
S17	34	28	22	84
S18	7	28	22	57
S19	7	28	22	57
S20	33	28	21	82
S21	34	28	21	83
S22	0	21	21	42
S23	7	28	0	35
S24	7	24	21	52

2.11 Overall, the weather from 12th August to 4th November was similar to other years, and therefore suitable for collecting baseline data on bats in the Galway area. Appendix A provides more detail, with sub-optimal conditions for bat survey highlighted. Sub-optimal conditions for bat surveys are broadly described in BCT (2012). For the purposes of this study, they are definedby temperatures of less than 10^{0} C, wind speeds equivalent to Beaufort score of 5 or more (fresh breeze), and/or significant rainfall. Out of 84 survey nights, the weather was sub-optimal on 3 nights during the Aug-Sep session, 6 nights for the Sep-Oct session, and 4 nights for the Oct-Nov session.

2.12 The standardised settings, units and approach across the 24 sites in the study area, combined with careful attention paid to appropriate siting and deployment to maximise calls collected for each site, allows for comparison of the species recorded and the general bat activity levels between different sites. This takes into account the limitations as well as the advantages in acoustic bat survey techniques (Weller, 2007; Sowler & Middleton, 2013; Stahlschmidt & Brühl, 2012). The data from some sites on some dates could not be included in the comparative analysis of bat activity levels because the static detectors, on post-deloyment testing, were found to be not collecting data as effectively as other detectors . All species records contributed to overall species richness scores for different sites. Appendix B describes which sites contributed to which set of results on which dates. Figures and graphs include 'n' for sample size for each static. This gives the number of survey nights within each session that contributed to the data.

2.13 Acoustic surveys have inherent species-specific bias. For example, quiet bats such as brown long-eared bats may only be recorded if they pass close to the bat detector. The calls of horseshoe bats are not only quiet but also highly directional, further decreasing the probability of detection. Meanwhile, loud bats such as Leisler's may be recorded at some distance. For this reason, the number of calls of different species may not be indicative of relative abundance of those species at a single site.

2.14 The following measures are presented in the results:

- Species richness (Table 2)
- Relative levels and ranges of bat activity between different sites, and between different survey sessions (Figures 2A-2C)
- Relative levels of bat activity for different bat species between different sites, and between different survey sessions (Figures 3A-C, Figures 4A-C)
- Map showing relative levels of lesser horseshoe and Nathusius's pipistrelle bats at different sites (Figures 5A-B)

2.15 The following species abbreviations are used in this report:

MYsp	a bat of the genus *Myotis*
NYLE	*Nyctalus leisleri* Leisler's bat
PLAUR	*Plecotus auritus* brown long-eared bat
PINA	*Pipistrellus nathusii* Nathusius's pipistrelle
PIPI	*Pipistrellus pipistrellus* common pipistrelle
PIPY	*Pipistrellus pygmaeus* soprano pipistrelle
PIPI-PIPY	a bat which is either PIPI or PIPY (call character does not allow further resolution)
RHHI	*Rhinolophus hipposideros* lesser horseshoe bat

Limitations to survey

2.16 Data from survey-nights that last different lengths of time, have different weather, or are at a different time of year to each other may not be directly comparable since all these factors affect bat behaviour. The limitations that this introduces into the dataset in terms of making comparisons between sites was minimised by splitting the overall survey period into three survey sessions. The dates within each session would be sufficiently similar in night length and season to enable comparison. The number of survey nights within each session was maximised where practical, to reduce variation in the dataset due to changes in the weather, and to improve confidence in average values. A minimum of 7 nights per site was used for all comparisons in this report; usually much more data than this was collected. Table 1 gives the number of survey nights in each session for each detector.

2.17 Inter-site variation in the effectiveness of each bat detector was reduced through the standardisation of settings for data collection and analysis, and through chosing the best location for bats in each setting, to maximum the number of passes and species recorded. Detectors and the data they collected were checked weekly. Any data potentially compromised through equipment failure or other reasons was excluded from the comparative analysis. However, all bat passes contributed to species-richness counts for particular sites, because a 'positive' record is valid, even if the detector is not collecting data at its maximum potential.

3 Results

Species Richness

3.1 Table 2 lists the species recorded at each site surveyed between 19th and 29th August. This shows that 9 sites had 7 species, 8 sites had 6 species, and 5 sites had 5 species recorded.

3.2 *Myotis*, Leisler's and common and soprano pipistrelle bats were recorded at every site. Brown long-eared bat was recorded at 18 sites (75%), but this common bat may be under-recorded due to its quiet calls. Lesser horseshoe bats were recorded at the fewest number of sites (14, 58%).

Table 2. Species recorded at sites across Galway City

Site	n	MYsp	NYLE	PINA	PIPI	PIPY	PLAUR	RHHI	Total species
S01	73	Y	Y	Y	Y	Y	Y	Y	7
S02	63	Y	Y	Y	Y	Y	Y	Y	7
S03	52	Y	Y	N	Y	Y	Y	N	5
S04	80	Y	Y	Y	Y	Y	Y	Y	7
S05	42	Y	Y	Y	Y	Y	N	Y	6
S06	35	Y	Y	Y	Y	Y	Y	Y	7
S07	55	Y	Y	Y	Y	Y	Y	N	6
S08	65	Y	Y	Y	Y	Y	Y	Y	7
S09	57	Y	Y	Y	Y	Y	Y	N	6
S10	77	Y	Y	N	Y	Y	N	Y	5
S11	78	Y	Y	N	Y	Y	Y	Y	6
S12	83	Y	Y	Y	Y	Y	N	N	5
S13	81	Y	Y	Y	Y	Y	Y	Y	7
S14	64	Y	Y	Y	Y	Y	Y	N	6
S15	73	Y	Y	Y	Y	Y	Y	Y	7
S16	83	Y	Y	Y	Y	Y	Y	N	6
S17	84	Y	Y	Y	Y	Y	Y	N	6
S18	57	Y	Y	N	Y	Y	Y	N	5
S19	57	Y	Y	Y	Y	Y	N	Y	6
S20	82	Y	Y	Y	Y	Y	N	N	5
S21	83	Y	Y	Y	Y	Y	Y	Y	7
S22	42	Y	Y	Y	Y	Y	Y	Y	7
S23	35	Y	Y	Y	Y	Y	N	N	5
S24	52	Y	Y	Y	Y	Y	Y	Y	7
Total		24	24	20	24	24	18	14	

Bat Activity

3.3 Figures 2A-2C show the average number of bat passes per site for each of the three sessions (Aug-Sep, Sep-Oct, Oct-Nov), as well as the inter-quartile and the full range of bat passes for each site. This illustrates the variation in bat passes between different nights at the same site, as well as general variation between different sites.

3.4 Box plots are created from a set of five numbers: the median, the 25th percentile or lower quartile, the 75th percentile or upper quartile, the minimum data value, and the maximum data value. The horizontal line in the middle of the box is the median of the measured values, the upper and lower sides of the box are the upper and lower quartiles, and the bars at the end of the vertical lines are the data minimum and maximum values.

3.5 Figures 2A-C show that some sites had generally more calls than other sites. For example, S06, S08, S20 and S21 have higher numbers of calls more often than other sites such as S09, S15 or S18. These sites often had occasional nights with very large numbers of calls, with S03, S06, S08, and S20 all having nights with over 2,000 bat passes.

Species breakdown by site for each session

3.6 Soprano pipistrelle bats were by far the most common species recorded, with 221,301(83%) of identified calls. Figures 3A-C show the number of common and soprano pipistrelle bat passes recorded on average per night for each site for each of the 3 sessions.

3.7 Site S06 had the highest average number of soprano pipistrelle calls. This in part is derived from occasional nights with extremely high numbers of calls as described in 3.5 above. Site S20 had the largest average number of common pipistrelle calls per night. S03 and S14 also had relatively higher levels of common pipistrelle activity.

3.8 Figures 4A-C show the number of bat passes for species other than soprano or common pipistrelle recorded on average per night for each site for each of the 3 sessions. This shows that S06 and S21 had regular activity from a range of species other than common and soprano pipistrelle bat. Conversely, sites S10 and S23 had relatively low levels of bat activity for these other species.

3.9 Rare and notable species comprise lesser horseshoe and Nathusius's pipistrelle bat. Figures 5A and 5B map the average number of passes per site for these two species, showing where these bats were most regularly recorded. Sites S6, S5 and S21 had the most lesser horseshoe bat records. Site with higher numbers of Nathusius's pipistrelle bat calls included S20, S16, S21 and S06. However, the species was also occasionally recorded at other sites across the proposed scheme area.

4 Discussion and Analysis of Results

4.1 Figure 1 shows the location of static detectors across the proposed scheme area. Comparing these with the graphs of relative activity (2A-C, 3A-C, 4A-C) suggests that sites close to the River Corrib have both high levels or bat acitivity, and a wide range of species. Figure 5B suggests that the River Corrib is of particular importance also for Nathusius's pipistrelle bat, although this species was also recorded away from the river.

4.2 There is a known maternity roost for lesser horseshoe bats at Menlo Castle. Sites close to this roost recorded relatively higher numbers of calls for this species (e.g. S06, S21, S05). A static at S02 picked up more lesser horseshoe calls per night in Oct-Nov than during the other survey sessions. This may possibly reflect a seasonal change in behaviour.

4.3 S20 regularly recorded the highest levels of activity and the widest range of species (with the exception of lesser horseshoe bat). The location within a 'green corridor' surrounded by the expanding city of Galway may well be of significance and worthy of further investigation.

4.4 Brown long-eared bats are common, but were not regularly recorded during the survey. This may be because they have relatively quiet calls, leading to under-recording. Sites which tended to have a higher average number of brown long-eared calls per night included S21, S15 and S4

4.5 *Myotis* bats were found across the proposed scheme area. S07 regularly had higher rates of *Myotis* passes than some of the other sites. S07 is located close to a known roost for Daubenton bats *Myotis daubentonii* (Geckoella, 2014). The relatively high numbers of *Myotis* calls at S14 may be indicative of a nearby roost. S21 also had a lot of *Myotis* calls, as well as calls of a range of other species indicating an important area for bats.

5 Bibliography

Bat Conservation Trust, 2012. *Bat Surveys: Good Practice Guidelines.* 2nd ed. London: Bat Conservation Trust.

Geckoella, 2014. *Galway City Transport Project Bat Radiotracking Surveys 19th to 29th August 2014,* Taunton, UK: Geckoella.

Kelleher, C. & Marnell, F., 2006. *Bat Mitigation Guidelines for Ireland (Irish Wildlife Manuals, No. 25.),* Dublin, Ireland: National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

Middleton, N., Froud, A. & French, K., 2014. *Social Calls of the Bats of Britain and Ireland.* Exeter: Pelagic Publishing.

Russ, J., 2012. *British Bat Calls: A Guide to Species Identification.* Exeter: Pelagic Publishing.

Sowler, S. & Middleton, N., 2013. 'Bat Passes' - Redundant or Still Useful? An Alternative Approach to the Analysis and INterpretation of Large Amounts of Data. *In Practice,* Volume 79, pp. 16-18.

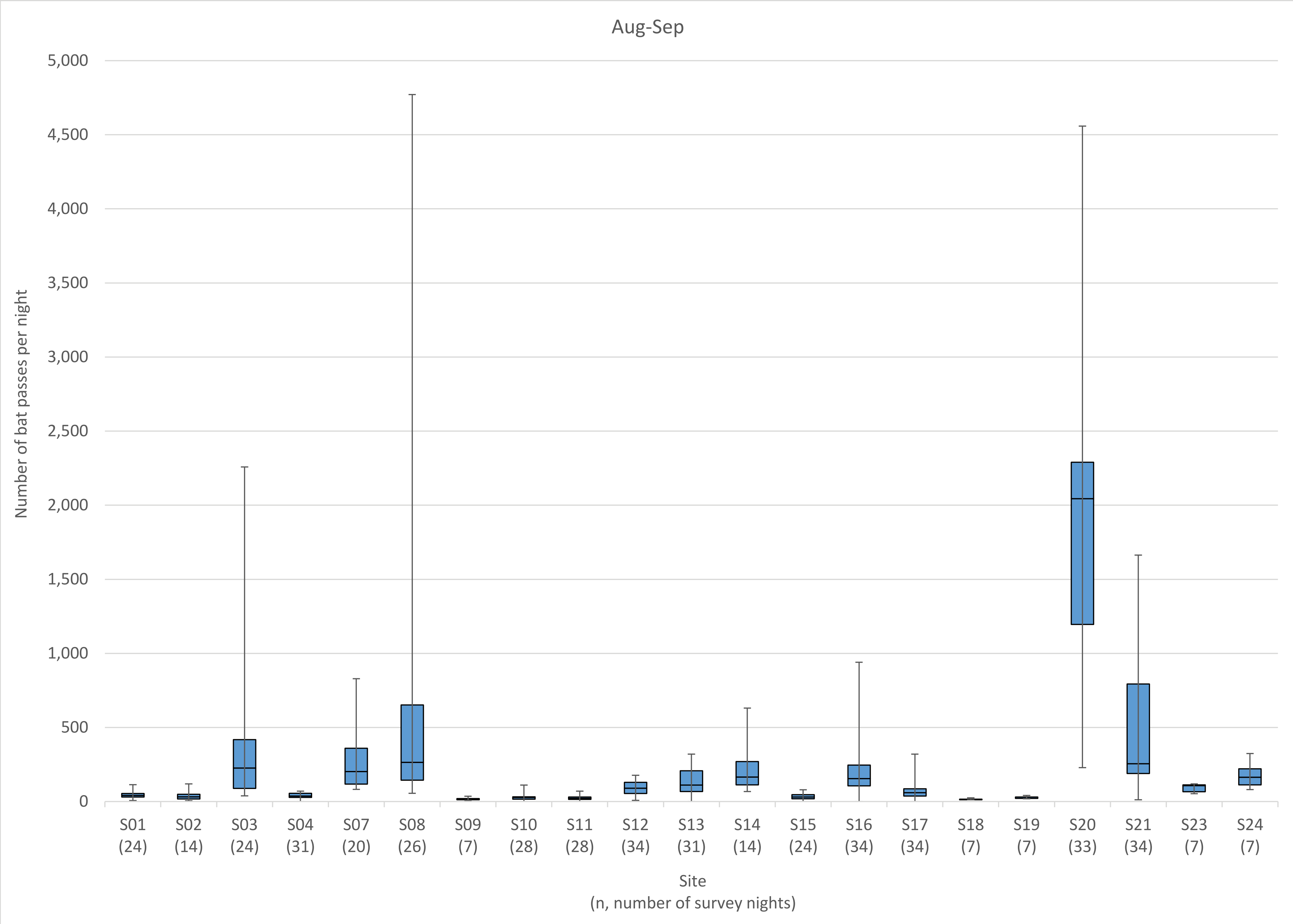
Stahlschmidt, P. & Brühl, C., 2012. Bats as bioindicators - the need of a standardized method for acoustic bat activity surveys. *Methods Ecol. Evol.,* Volume 3, p. 503–508.

Waters, D. & Barlow, K., 2013. Automatic Recognition Systems for Bat Call Identification. *In Practice,* Volume 79.

Weller, T. J., 2007. Assessing population status of bats in forests: challenges and opportunities. In: M. J. Lacki, J. P. Hayes & K. Allen, eds. *Bats in forests: conservation and management.* Baltimore: USA: Johns Hopkins University, pp. 263-291.

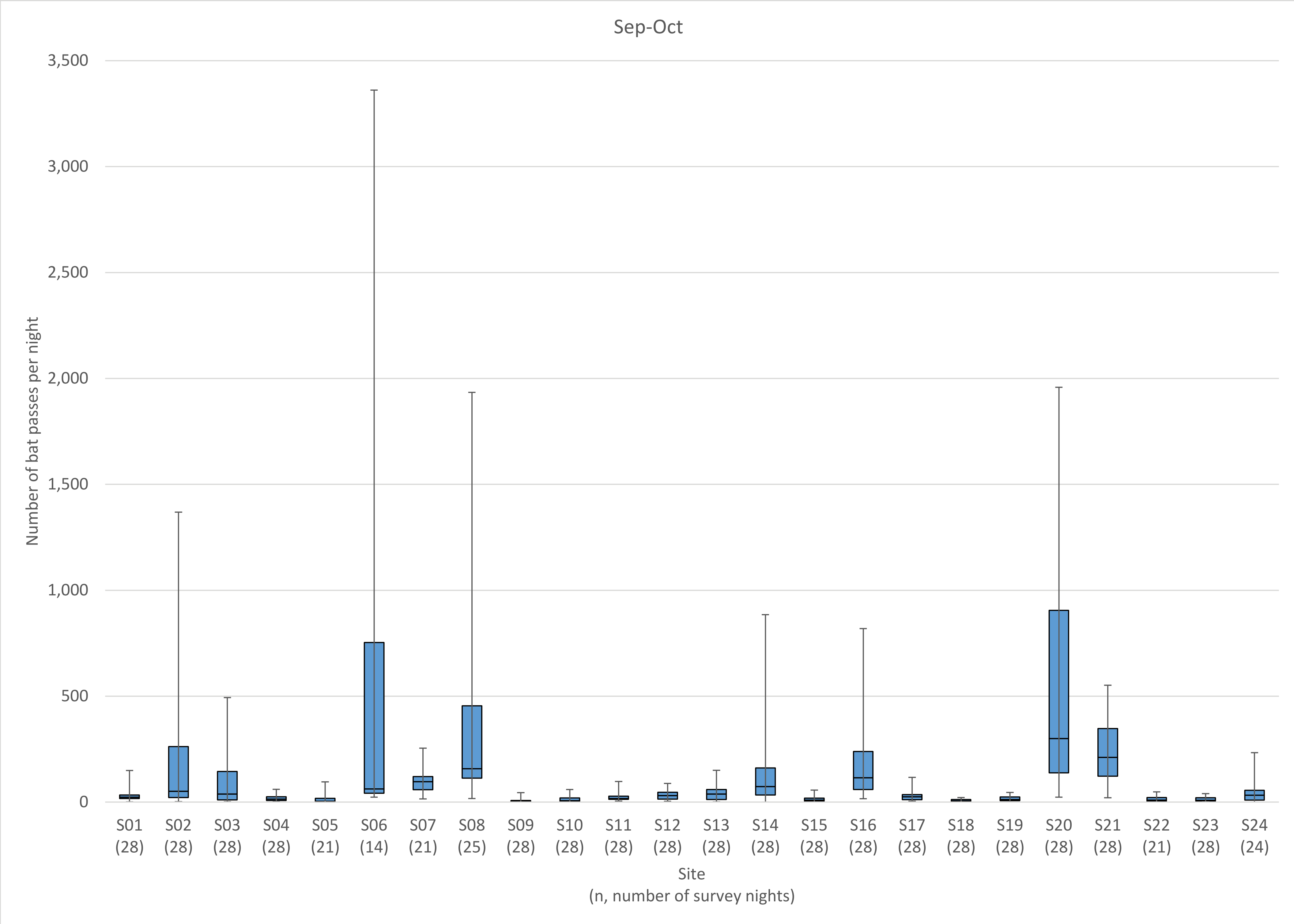
Figure 1. Proposed Scheme Area and acoustic bat detector sites

Figure 2A Box plot showing bat passes per site



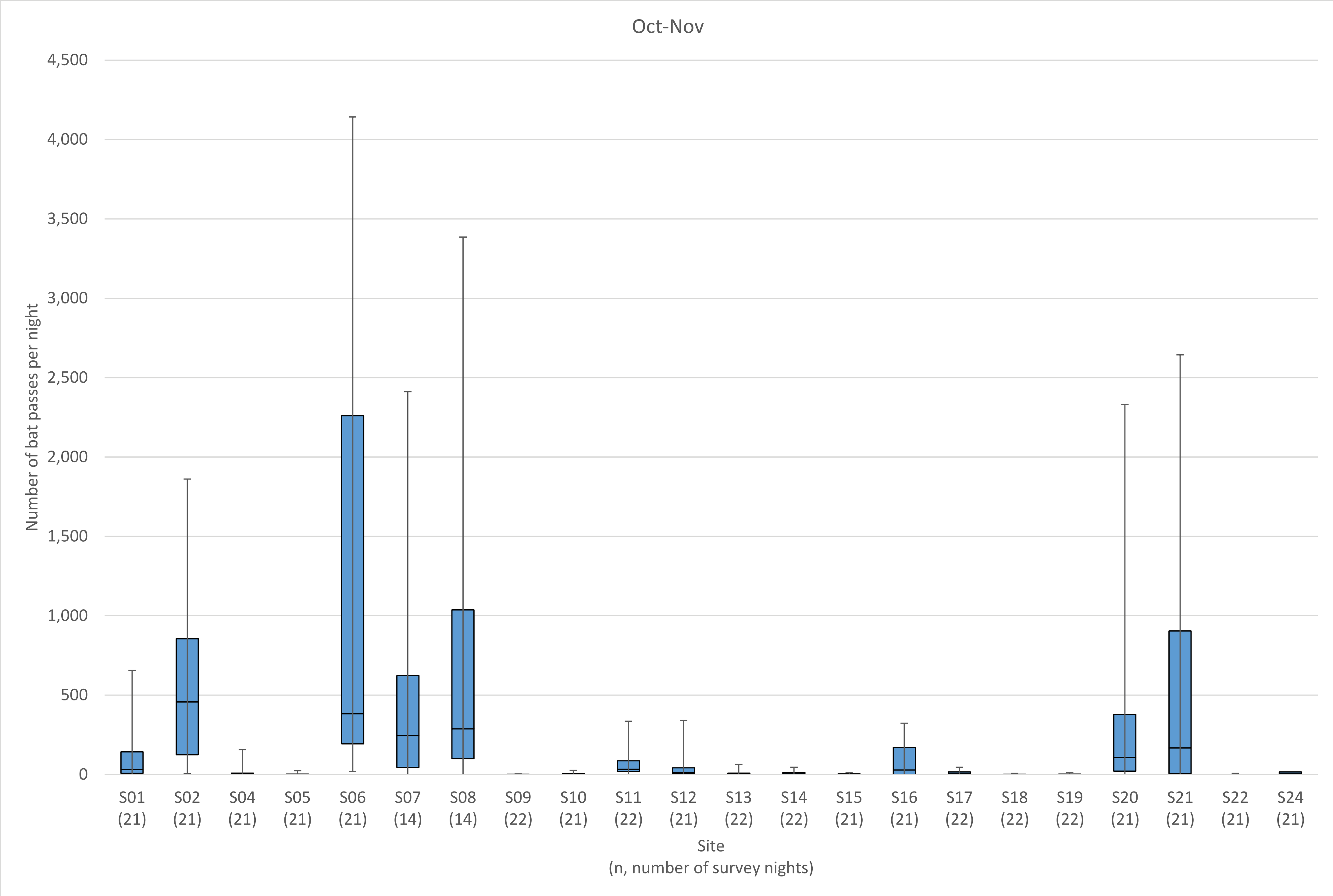
The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 2B Box plot showing bat passes per site



The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 2C Box plot showing bat passes per site



The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 3A Average numbers of common or soprano bat passes per site

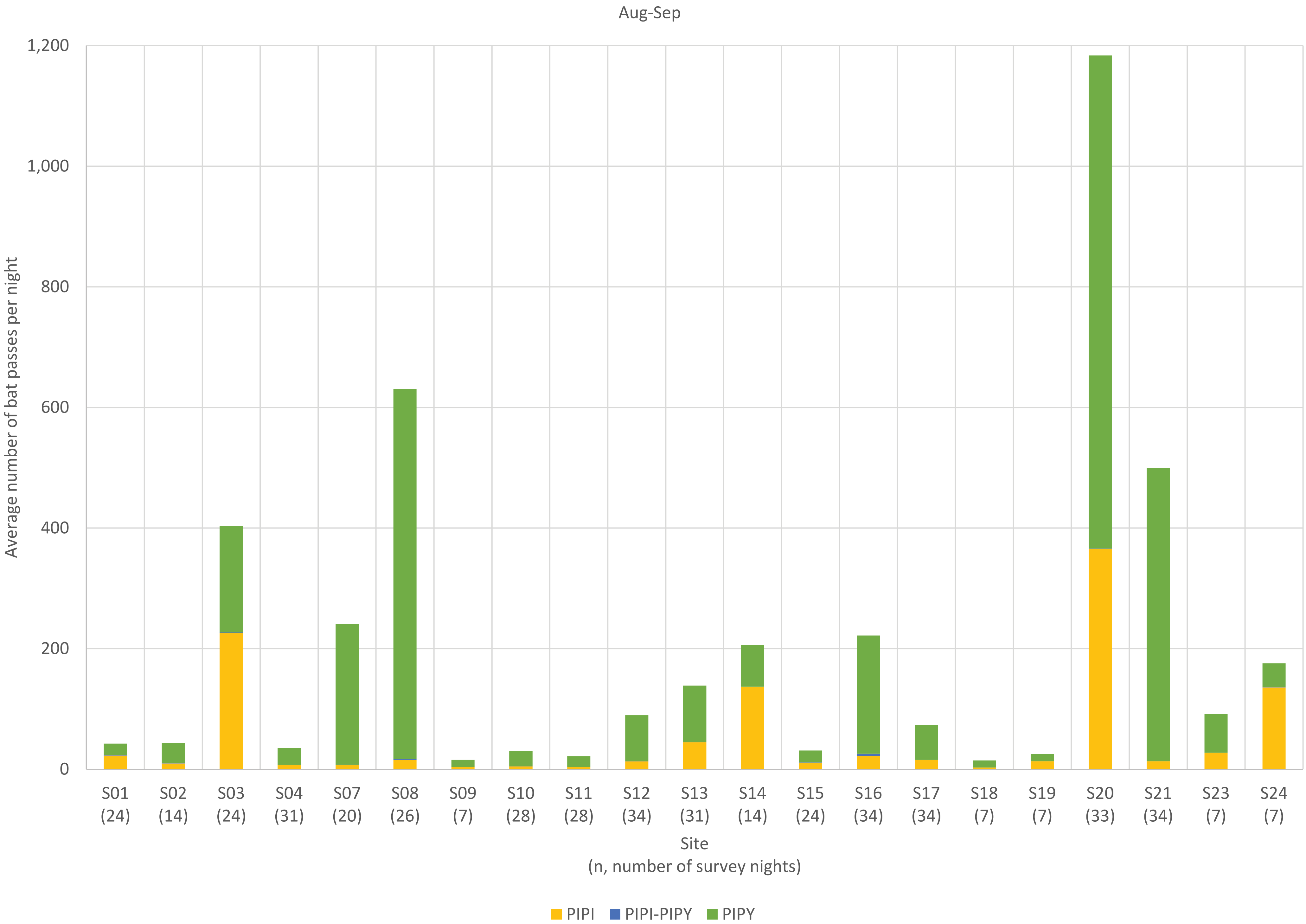


Figure 3B Average numbers of common or soprano pipistrelle bat passes per site

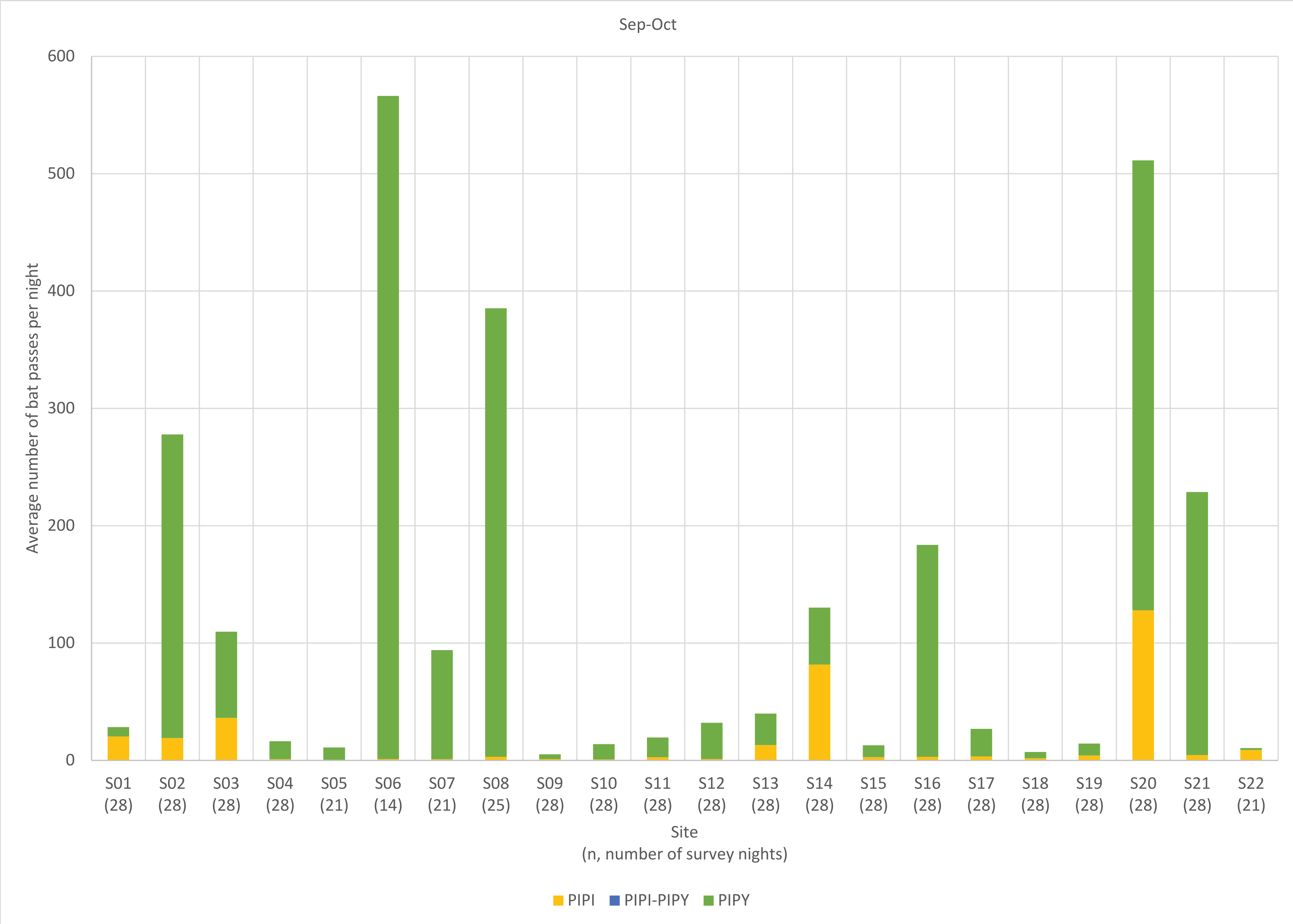


Figure 3C Average numbers of common or soprano pipistrelle bat passes per site

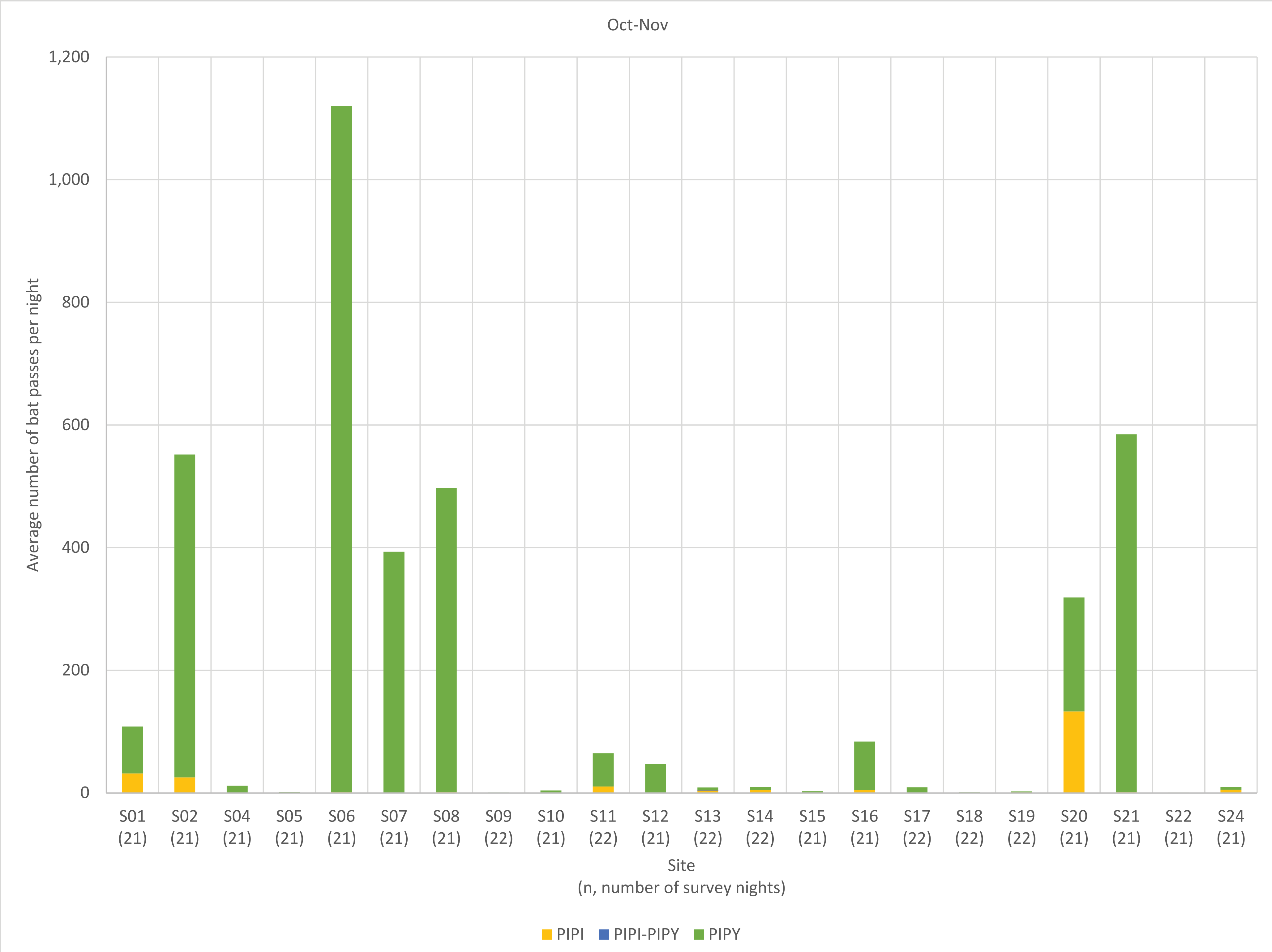


Figure 4A Average numbers of other bat passes per site

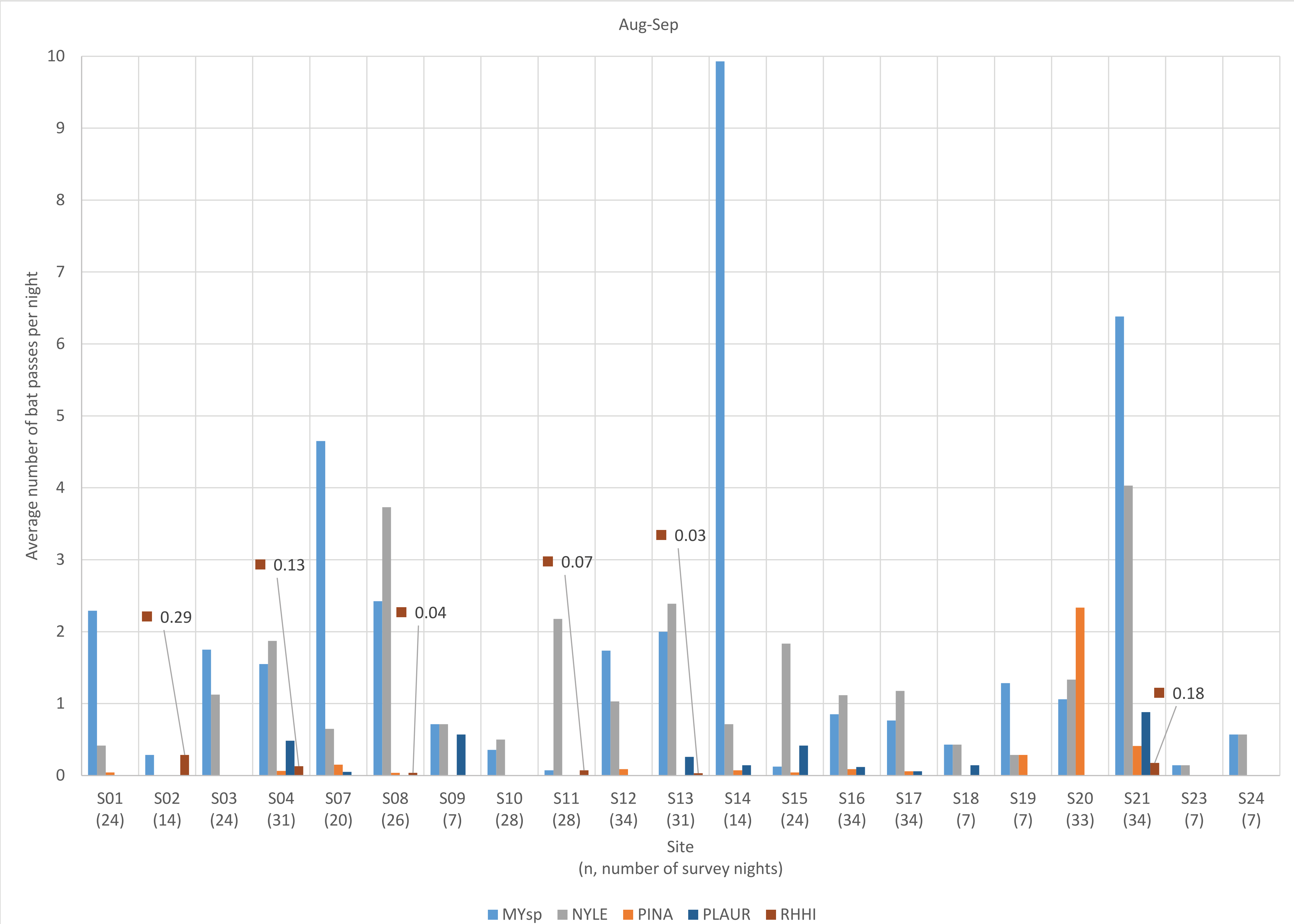


Figure 4B Average numbers of other bat passes per site

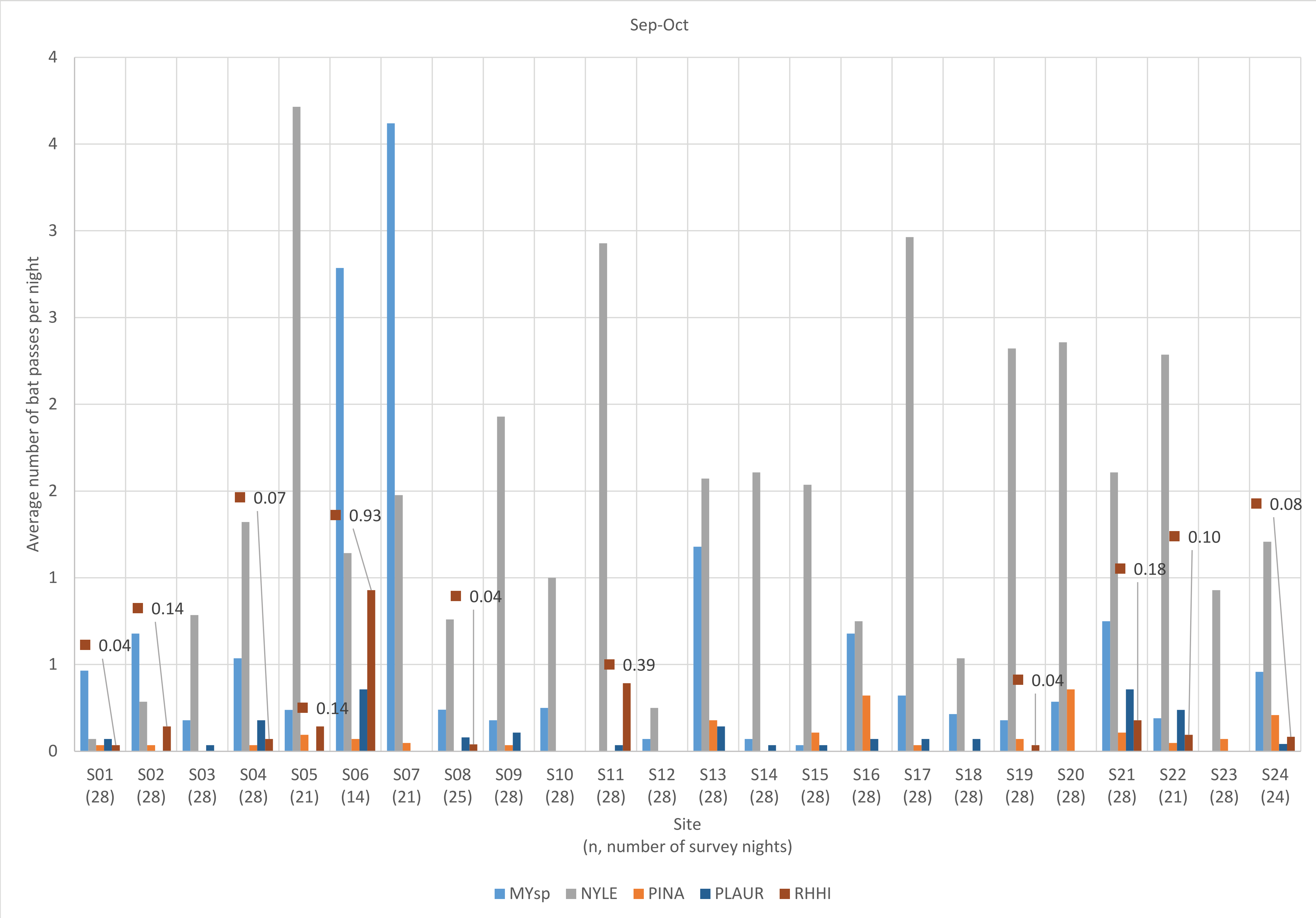


Figure 4C   Average numbers of other bat passes per site

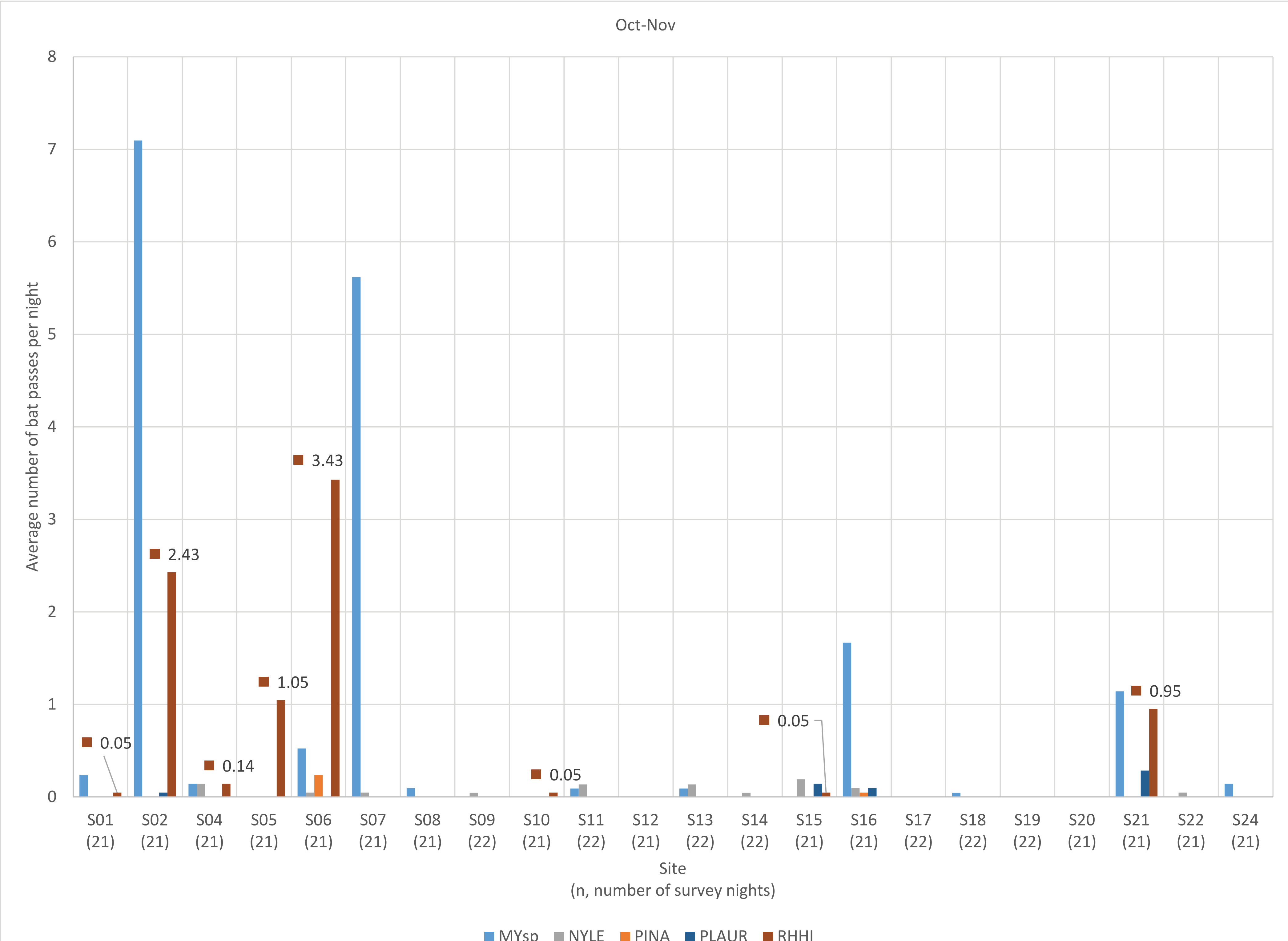
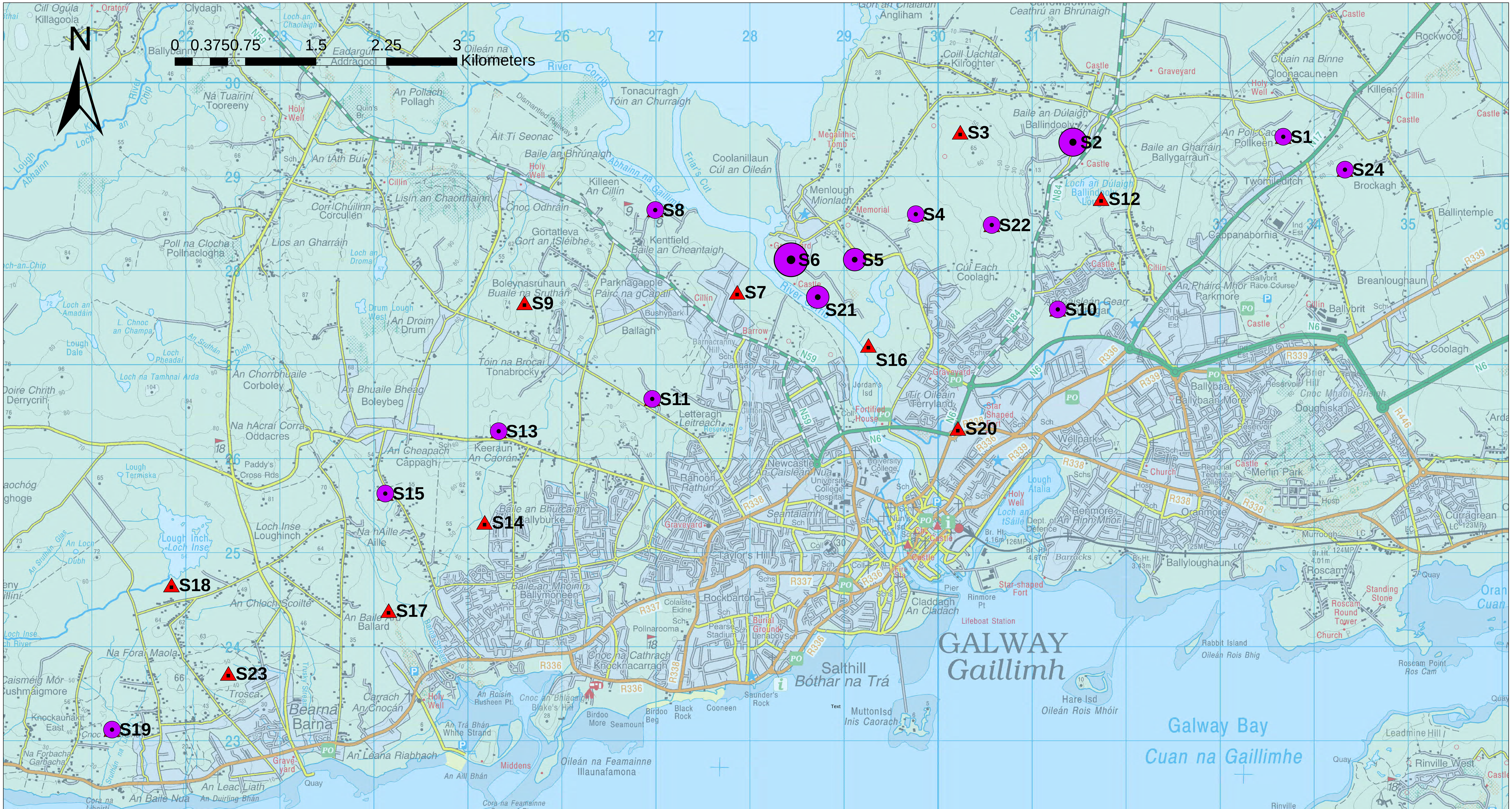


Figure 5a. Map: Lesser horseshoe bat passes per night at each site



Key

Statics where Lesser Horseshoe Bats detected

Site of Other Static Bat Detector

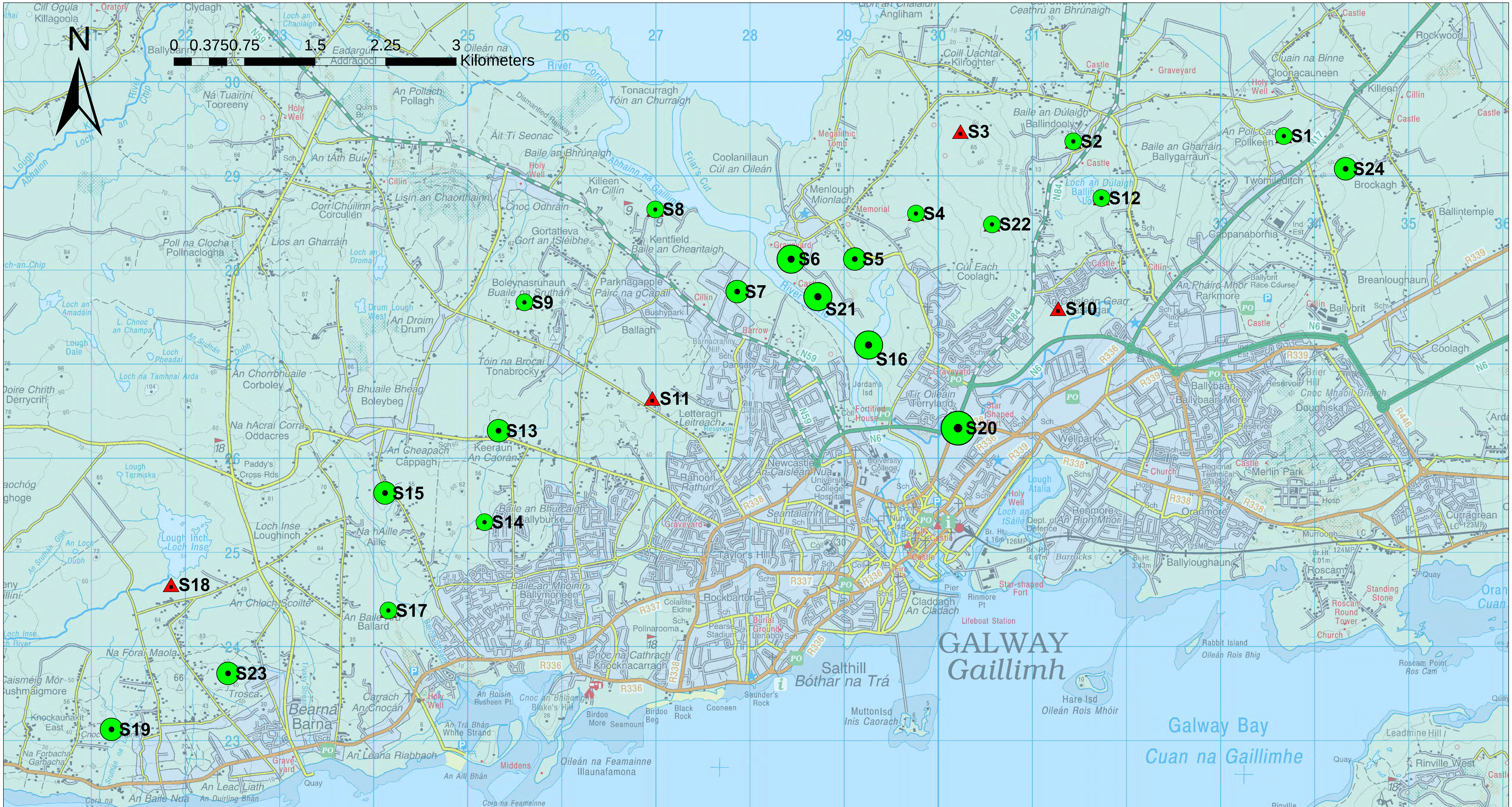
Mean No. of Passes per Night

- Less than 0.17
- 0.17 to 0.60
- 0.61 to 0.94
- More than 0.94

Ecology and Geology

Values provided are mean average bat passes per survey nights.
Surveys took place between 12th August and 4th November.
(Number of survey nights varied between sites, see Figures 2A-C and Appendix B).

Figure 5b. Map: Nathusius's pipistrelle bat passes per night at each site



Key

Statics where Nathusius's Pipistrelles detected

Site of Other Static Bat Detector

Mean No. of Passes per Night

- Less than 0.04
- 0.04 to 0.10
- 0.11 to 0.20
- More than 0.20

Values provided are mean average bat passes per survey nights.
Surveys took place between 12th August and 4th November.
(Number of survey nights varied between sites, see Figures 2A-C and Appendix B).

Ecology and Geology

Appendix A: Bat acoustic survey session dates and weather

The weather from August – November 2014 was broadly typical for Galway and did not pose a significant constraint to survey. Warm, humid, calm weather is good for flying invertebrates and hence good for bat foraging. Data highlighted in blue represents sub-optimal conditions, comprising temperatures of less than 10ºC, wind speeds equivalent to Beaufort score of 5 or more (Fresh breeze), and/or significant rainfall.

AUGUST - SEPTEMBER						
S	M	T	W	T	F	S
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14						

34 nights

3 sub-optimal

SEPTEMBER - OCTOBER						
S	M	T	W	T	F	S
	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12						

28 nights

6 sub-optimal

OCTOBER - NOVEMBER						
S	M	T	W	T	F	S
	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4				

22 nights

4 sub-optimal

Survey nights' run from dusk til dawn, whereas the weather data represents 24hr periods from midnight til midnight. None-the-less this data gives an indication of general weather conditions at the time of survey.

Data on General Weather during 24hr period produced under license from Weather Underground.

http://www.wunderground.com/personal-weather-station/dashboard?ID=ICOGALWA2#history/s20140805/e20140812/mweek

Weather Station ID: ICOGALWA2. Station Name: Oranmore
Latitude / Longitude: N 53 ° 16 ' 28 ", W 8 ° 55 ' 45 ", Elevation: 0. City: Oranmore, State: Co.Galway
Hardware: Davis VP2(24h FARS), Software: meteohub, Owner: Private

Details of static acoustic bat detector deployment location and dates

Site	Serial number	Model	Microphone	Date deployment	Date collection	Easting	Northing	Habitat	Picture ref
S01	G14373	SM2BAT+	SMX-US	15/08/2014	03/11/2014	533677	729426	Woodland edge, Hawthorn	100-0062
S02	10495	SM2BAT+	SMX-US	12/08/2014	03/11/2014	531440	729368	Woodland edge, field boundary	S2.jpg
S03	13775	SM2BAT+	SMX-US	15/08/2014	03/11/2014	530241	729475	Hedgerow adjacent to limestone pavement, Ash tree	100-0063
S04	6810	SM2BAT	SMX-US	15/08/2014	03/11/2014	529768	728602	Hedgerow, woodlan edge, Hazel tree	100-0060
S05	6364	SM2BAT	SMX-US	12/08/2014	03/11/2014	529118	728118	Edge of woodland, on tree beside grassland	S5.jpg
S06	6337	SM2BAT	SMX-US	15/08/2014	29/09/2014	528441	728118	Woodland edge, Ash tree	100-0061
S06	TBC	TBC	SMX-US	29/09/2014	03/11/2014	528441	728118	Woodland edge, Ash tree	20140929_161131_S6
S07	6343	SM2BAT	SMX-US	12/08/2014	03/11/2014	527869	727772	Woodland edge, Sw corner of field, through bushes into clearing on left	100-0049
S08	16688	SM2BAT+	SMX-US	08/09/2014	03/11/2014	527015	728644	Woodland edge, by pond	[similar]
S08	12995	SM2BAT	SMX-US	20/08/2014	08/09/2014	527015	728644	Woodland edge, by pond	20.08.14.18.01
S09	17003	SM2BAT+	SMX-US	08/09/2014	04/11/2014	529824	727484	Rough grassland	[similar]
S09	6215	SM2BAT	SMX-US	21/08/2014	08/09/2014	529824	727484	Rough grassland	21.08.14.17.17
S10	9617	SM2BAT+	SMX-US	12/08/2014	03/11/2014	531278	727590	Hawthorn hedgerow field boundary (part)	100-0052
S11	6359	SM2BAT	SMX-US	12/08/2014	04/11/2014	526966	726637	Hedgerow, edge of path	100-0048
S12	3609	SM2BAT	SMX-US	12/08/2014	03/11/2014	531740	728766	Edge of scrub, field boundary	100-0051
S13	13110	SM2BAT+	SMX-US	15/08/2014	04/11/2014	525332	726294	Lough edge, Willow tree	100-0059
S14	16769	SM2BAT+	SMX-US	08/09/2014	04/11/2014	525182	725328	Scrub, pasture	[similar]
S14	11737	SM2BAT	SMX-US	21/08/2014	08/09/2014	525182	725328	Scrub, pasture	21.08.14.16.44
S15	6335	SM2BAT	SMX-US	15/08/2014	03/11/2014	524126	725632	Edge of lake, Hawthorn tree	100-0058
S16	6570	SM2BAT	SMX-US	12/08/2014	03/11/2014	529264	727206	Hedgerow. Hawthorn tree, end of hedge	100-0055, 100-0056
S17	6283	SM2BAT	SMX-US	12/08/2014	04/11/2014	524162	724385	Woodland edge	100-0047
S18	16724	SM2BAT+	SMX-US	08/09/2014	04/11/2014	521872	724606	Lake, bog/heath	[similar]
S18	6115	SM2BAT	SMX-US	20/08/2014	08/09/2014	521872	724606	Lake, bog/heath	20.08.14.18.49
S19	16975	SM2BAT+	SMX-US	03/09/2014	04/11/2014	521372	723143	Small field with gorse and fern, pockets of exposed rock. Hedgerow, scrub and rough grassland.	IMG_7885 - S19
S20	6198	SM2BAT	SMX-US	12/08/2014	03/11/2014	530216	726323	River bank, Ash tree	100-0053, 100-0054
S21	6330	SM2BAT	SMX-US	12/08/2014	03/11/2014	521372	723143	Hazel tree in hedgerow	S21.jpg
S22	16753	SM2BAT+	SMX-US	08/09/2014	03/11/2014	530424	728432	Back of Lackagh Quarry, limestone	20141006_123325_S22
S23	17004	SM2BAT+	SMX-US	03/09/2014	04/11/2014	522419	723682	Small field with gorse, pockets of exposed rock. Scrub, rough grassland.	IMG_7911 - S23
S24	6131	SM2BAT	SMX-US	20/08/2014	08/09/2014	534339	724082	Scrub / plantation	20.08.14.16.43
S24	16675	SM2BAT+	SMX-US	08/09/2014	03/11/2014	534339	724082	Scrub / plantation	20140929_100947_S24

Total number of bat passes for each static acoustic bat detector across 24 sites in Galway

Site	MYsp	NYLE	PINA	PIPI	PIPI-PIPY	PIPY	PLAUR	RHHI	Grand Total
S01	73	12	2	1,785	24	2,281	2	2	4,181
S02	172	8	1	1,199	4	18,774	1	59	20,218
S03	47	49		6,440	16	6,288	1		12,841
S04	66	98	3	249	9	1,551	20	9	2,005
S05	5	78	2	10		253		25	373
S06	50	17	6	39		31,408	5	85	31,610
S07	287	45	4	169	9	14,881	1		15,396
S08	71	116	1	499	29	35,940	2	2	36,660
S09	10	60	1	65		202	7		345
S10	17	42		172	2	1,162		1	1,396
S11	4	146		424	1	2,149	1	13	2,738
S12	61	42	3	486	12	4,441			5,045
S13	97	121	5	1,848	12	3,756	12	1	5,852
S14	141	56	1	4,305		2,430	3		6,936
S15	4	91	4	344	7	816	14	1	1,281
S16	83	61	13	943	119	13,386	8		14,613
S17	35	123	3	633	11	2,812	4		3,621
S18	10	18		74		252	3		357
S19	14	67	4	225		399		1	710
S20	43	110	87	18,448	4	41,616			60,308
S21	262	182	17	606		35,067	46	31	36,211
S22	4	49	1	188		40	5	2	289
S23	1	27	2	250		730			1,010
S24	18	33	5	1,811	6	667	1	2	2,543
Grand Total	1,575	1,651	165	41,212	265	221,301	136	234	266,539

Quality Assurance Results for bat acoustic surveys, Galway.

Comparing results of original ID of 3,540 bat passes with identification by Dr. Fiona Mathews, Exeter University

FM ID: rows	Original ID: columns Column Labels																	
Row Labels	**MY-PL**	**MYsp**	**noise**	**NYLE**	**NYLE-EPSE**	**PINA**	**PIPI**	**PIPI-PIPY**	**PIPI-PIPY-PIPY**	**PIPY**	**PIPY, query PLAUR**	**PIPY-Mysp**	**PIPY-NYLE**	**PIPYsoc**	**query**	**RHHI192**	**soc**	**Grand Total**
MY-PL	1																	1
MYsp		19																19
NoID																	1	1
noise			3															3
NYLE				52	1										1			54
PINA						4												4
PIPI							107	9		1								117
PIPI-PIPY							3	60	6	33				1				103
PIPY							2	30		3184		1	1	1				3219
PIPY-Mysp										2	1	2						5
PIPY-Mysp, NYLE										1								1
PIPY-NYLE										2			8					10
RHHI192																3		3
Grand Total	**1**	**19**	**3**	**52**	**1**	**4**	**112**	**99**	**6**	**3223**	**1**	**3**	**9**	**2**	**1**	**3**	**1**	**3540**

Category		%
Agreed	3443	97.3%
during final check would	8	0.2%
Mis-identified as PIPY when PIPI, or vice versa	80	2.3%
Mis-identified to different species	9	0.3%

Accuracy measures for Common and Soprano Pipistrelle ID by Kaleidoscope Pro.

This study carried out manual identification of Common and Soprano Pipistrelle calls for the survey session Aug-Sep 2014.
For the survey sessions Sep-Oct and Oct-Nov, Kaleidoscope Pro was relied upon without manual checking for calls tagged as either common or soprano pipistrelle.
Data published by the manufacturers of the acoustic bat detectors (Wildlife Acoustics, www.wildlifeacoustics.com) is reproduced below.
These illustrate the accuracy of the programme and hence the implications for the Galway study of relying on KPro for tagging common and soprano pipistrelle calls.
99% and 94% of calls tagged by KPro as common and soprano pipistrelle are tagged correctly. Where tagged incorrectly, 0% were tagged as a species other than common or soprano pipistrelle.

Kaleidoscope 2.0.5 United Kingdom Classifiers - Wildlife Acoustics Test Results. Published by Wildlife Acoustics (www.wildlifeacoustics.com).

	UNITED KINGDOM CLASSIFIERS 2.0.5 (sensitive setting)																Testing	
RECORDINGS	BABA	EPSE	MYBR	MYDA	MYNA	NYLE	NYNO	PINA	PIPI	PIPY	PLAUR	RHFE	RHHI	RHHI192	NoID	Correct	N Files	N Calls
BABA	52%	3%		1%				1%	5%	8%	2%				28%	72%	93	676
EPSE		81%		2%		4%	3%				2%				8%	88%	128	2,177
MYBR			57%	14%							21%				7%	62%	14	132
MYDA	2%		8%	64%				5%	3%	2%	3%				14%	75%	64	1,040
MYNA	1%	1%	3%	5%	28%		5%		3%		4%				49%	55%	75	662
NYLE		7%				52%	14%				1%				26%	71%	92	1,058
NYNO		11%				10%	52%								27%	71%	1,904	20,420
PINA	1%							93%		2%					4%	96%	139	2,147
PIPI									84%	1%					15%	99%	16,774	187,743
PIPY									5%	79%					17%	94%	4,349	45,101
PLAUR		4%			1%				1%		30%				63%	81%	145	396
RHFE												85%		10%	6%	90%	317	4,678
RHHI													78%		22%	100%	859	4,848
RHHI192										9%		15%		63%	14%	73%	2,332	24,765
															Mean correct	80%	27,285	295,843
True Positive Rate	52%	81%	57%	64%	28%	52%	52%	93%	84%	79%	30%	85%	78%	63%	Mean TPR	64%		
Positive Predictive Value	92%	76%	85%	74%	95%	79%	70%	94%	83%	79%	46%	85%	100%	86%	Mean PPV	82%		

Annex C

N6 Galway City Transport Project - Bat Radio-tracking and Roost Surveys 19 to 29 August 2014 (Geckoella Ltd., 2015b)

C1

N6 Galway City Transport Project
Bat Radio-tracking and Roost Surveys
19th to 29th August 2014

Report date:	28th November 2014
Survey dates:	19th to 29th August 2014 (incl.)
Commissioned by:	Scott Cawley Ltd.
Version:	Final Report_March 15 amendments
Authorised by:	Dr. Andy King
Report authors:	Kate Jeffreys Dr. Andy King (Annex A)
NPWS License numbers:	C098/2014, 027/2014, C009/2014, DER/BAT 2014-39

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Summary

Geckoella Ltd. were commissioned by Scott Cawley Ltd. to radiotrack bats to inform the environmental baseline of the N6 Galway City Transport Project. The specific objectives of the project were to find out more about the vesper bats that are present within the proposed scheme area, especially their roost locations, as well to gather data on lesser horseshoe bats outside the home range of the lesser horseshoe bats of Menlo Castle. The survey took place between 19th and 29th August 2014 (incl.) and 181 bats were caught from 6 sites on 6 nights. Of these, 11 bats of 5 species were tagged. Daytime positioning was used to identify roost locations. Roosts were found for 8 of the bats. Five of these individuals moved roosts within the survey period, and a total of 16 bat roosts were identified.

Acknowledgements

We thank the following contributors to the radio-tracking surveys and analysis:
Dr. Fiona Mathews, Dr. Elizabeth Bradshaw, Alison Johnston, Iain Hysom, Dan Buckley, Helen Saunders, and Kevin Hamel.

Contents

Tables

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Annex

1 Introduction

1.1 N6 Galway City Transport Project requires environmental baseline information in the scheme study area as part of the constraints study for the project. Information on bats is being collected as part of this process in accordance with local and European guidance and legislation (Kelleher & Marnell, 2006). A consortium led by Geckoella Ltd., with Helix Ecology and EcoPro was contracted by Scott Cawley Ltd. to carry out radio-tracking and other bat survey work to contribute to this baseline environmental information.

1.2 The specific objectives of the radio-tracking and other survey work carried out between 19th and the 29th August 2014 (incl.) were to:

- Gather data on vesper [1]bats across the 6,350 ha proposed scheme area, centred on the city of Galway.
- Gather data on lesser horseshoe bats *Rhinolophus hipposideros* across the proposed scheme area, excluding the home range of the lesser horseshoe bats of Menlo Castle.

1.3 The approach used was to catch bats using harp traps and mist nets and collect biometric data on all trapped bats. A subset of bats, most likely to provide information of relevance to the environmental baseline for the scheme, were fitted with small radio-transmitters. The tagged bats were re-found during the following days using radio-receivers, to establish their daytime roosting habits. Supplementary information on these roosts was also collected. The survey work was carried out under licence numbers C098/2014, 027/2014, C009/2014 and DER/BAT 2014-39 from the National Parks and Wildlife Service of Ireland.

[1] Vesper bats are of the family Vespertilionidae, and in Ireland include bats of the genera *Pipistrellus*, *Myotis*, *Plecotus* and *Nyctalus*.

2 Methodology

2.1 The proposed scheme area is located at Galway city on the west coast of Ireland and includes approximately 6,350ha as shown in Figure 1.

2.2 Six sites for trapping were selected using advice from local surveyors (Scott Cawley Ltd., pers. comm.), aerial photo interpretation and site visits. The best sites for trapping bats in late August are generally sheltered locations close to likely good feeding habitat and roost sites. This increases the potential for a large number of bats of a wide range of species to be present in a relatively enclosed environment which is suitable for trapping. Figure 1 shows the trapping locations selected across the site.

2.3 Harp traps and mist nets were set up at each site. Bat lures emitting ultrasound calls similar to bat calls were placed adjacent to the harp traps, to help attract bats and increase the catch rate (Sussex Autobat, and AT100 ultrasound speaker).

2.4 The species and sex of every bat caught was recorded. Additional biometric data was collected for species other than soprano pipistrelle, comprising forearm length, weight and reproductive status. Where practical, all trapped bats were fur-clipped, as a temporary marker (agitated or stressed bats were not fur-clipped). This reduced the likelihood of double-counting, since bats re-caught with clipped-fur could be excluded from the data-set.

2.5 Supplementary information on presence / absence of bat species at trapping locations was collected through the use of hand-held detectors during the trapping sessions. The detectors record sound files for subsequent analysis using specialist software (Kaleidoscope Pro), which can identify species found to genus level for *Myotis* species, and species level for other bats found in Ireland.

2.6 Captured bats most likely to provide information of relevance to the environmental baseline of the proposed scheme area, determined according to criteria defined by Scott Cawley Ltd., were tagged with 0.29g or 0.35g radio transmitters (Holohil Ltd. Canada and Biotrack UK). Breeding females of any species were tagged as first preference. Tags were then applied to bats in order to obtain results from both males and females, adult and juvenile, and from a range of species. Bats of the genus *Myotis* were of particular interest. Each tag was less than 7% of the bat's body weight, as a condition of the survey license from the National Parks and Wildlife Service. Most of the bats tagged were also ringed with a unique long-term identification number in case re-found at a later date.

2.7 Each tag emitted a pulse of a specific frequency that could be re-found using a radio-receiver. This enabled the identification of any re-found bats to individual level. Tagged bats were tracked using Australis, SIKA and Regal radio-receivers during the day to identify daytime roosts, using a combination of omni-directional and directional Yagi antennae. Bats were sought first of all close to their trapped location, with the search area increasing until a systematic city-wide sweep was carried out. Data from within 24hrs of trapping was disregarded as potentially non-representative of typical behaviour.

2.8 The detailed location of each roost was found by homing-in where close approach to the roost was practical. For daytime roosts, this involved simply following the direction of strongest signal until the source of the signal was found and is a recognised best-practice approach for a static signal (Amelon, et al., 2009). Where close approach to the roost was impractical, then triangulation was used. This involves taking readings from three or more locations around the likely source of the signal, and plotting their intersection. The roost locations presented in this report, including the ITM[2] values, represent the actual likely locations of the roosts of the tagged bats; with confidences indicated to compensate for potential sources of bias and error (Bartolommei, et al., 2012).

2.9 A systematic search of the proposed scheme area was carried out on 27th and 28th August 2014 in order to try to find any additional roosts. Each kilometre square in the area was checked for any tag frequencies that had not already been found elsewhere on that day.

2.10 Failure to find a tagged bat would have been most likely due to the following reasons:

- the bat was roosting outside the proposed scheme area,
- the bat was roosting in locations that made detection of the signal difficult (for example in dense woodland or cellars),
- the surveyors missed a clear signal inside the proposed scheme area (the likelihood of this would be reduced due to the systematic approach to search – see 2.8),
- the tag was no longer working (could be discounted for bats found again later in the survey).

2.11 The survey team comprised Mrs Kate Jeffreys MCIEEM CEnv, Dr. Fiona Mathews, Dr Elizabeth Bradshaw, Ms Alison Johnston, Mr Iain Hysom and Dr Andy King. This team is very experienced in the use of radio-tracking survey techniques for bats.

2.12 The findings in this report are described using the CIEEM categorisation of confidence (CIEEM, 2006) as set out below:

- Certain/near-Certain: probability estimated at 95% chance or higher.
- Probable: probability estimated above 50% but below 95%.
- Unlikely: probability estimated above 5% but less than 50%.
- Extremely Unlikely: probability estimated at less than 5%

2.13 Weather conditions for Galway during the survey period are summarised in Appendix A, with site specific data collected for trapping sites and times. The likely effects of the weather on the confidence of the survey findings are indicated where appropriate, the main impact being on limiting the number of suitable trapping evenings during the survey period.

2 Irish Transverse Mercator grid reference

3 Results

3.1 Overall, 181 bats of 7 species were trapped at 6 sites. Of these, 11 bats of 5 species were tagged, 9 of which were also ringed. Most of the bats caught were soprano pipistrelles (151, 83.4%). followed by common pipistrelle (11, 6.1%) and Daubenton's (10, 5.5%). Trapping sites, with numbers of bats captured and tagged are listed in Table 3.1, with the detail provided in Appendix B. Figure 1 shows the locations of each trapping site. The following species abbreviations apply to all tables in these results:

Md	*Myotis daubentonii*	Daubenton's bat
Mmy	*Myotis mystacinus*	whiskered bat
Mn	*Myotis nattereri*	Natterer's bat
Msp	*Myotis sp.*	a bat of the Myotis genera
Nl	*Nyctalus leisleri*	Leisler's bat
Paur	*Plecotus auritus*	brown long-eared bat
Pn	*Pipistrellus nathusii*	Nathusius's pipistrelle
Ppi	*Pipistrellus pipistrellus*	common pipistrelle
Ppy	*Pipistrellus pygmaeus*	soprano pipistrelle
Rh	*Rhinolophus hipposideros*	lesser horseshoe bat

3.2 Supplementary information on the presence of bat species at trapping locations was collected through the use of hand-held detectors during some of the trapping sessions. The detectors record sound files for subsequent analysis using specialist software (Kaleidoscope Pro), which can identify species found to genus level for *Myotis* species, and species level for other bats found in Ireland. Table 3.1 also lists the additional species recorded at each trapping site.

3.3 Trapping rates tended to be higher in sheltered, woodland locations. It was difficult to find suitable areas to trap bats in the area west of Lough Corrib. This area includes open bog and heath, too exposed for trapping bats. Elsewhere, for example around Tonabrocky, the patchwork of small fields, overgrown hedges and impenetrable woodland patches offered a few suitable locations for trapping, but these were still likely to experience a rapid drop in temperature in August, and also had access issues.

3.4 The eleven tagged bats comprised 5 species: whiskered, Daubenton's, Leisler's, brown long-eared and common pipistrelle bats. Six were adult bats, of which 4 were in breeding condition, including one post-lactating female brown long-eared bat. Table 3.2 lists the tagged bats in detail. No bats were tagged from the Sport's Ground because no target species were caught – the cool weather conditions led to a very low catch-rate; equipment issues prevented the tagging of bats from Menlo Woods although biometric data on trapped bats is presented.

3.5 Sixteen roost locations were identified for 8 of the tagged bats and are listed in Table 3.3, with the detail provided in Appendix B. Figures 2A to 2P show and describe each roost. Ten roosts (62.5%) were modern houses or bungalows built in the 20th or 21st centuries.

3.6 An emergence survey carried out at The Women's Study Centre (Roost F) on 22nd August, found that 3 bats, including the tagged male Daubenton's bat tracked to this roost, emerged from the eastern aspect of the building)and flew east towards the River Corrib, using the vegetated dark road-bank corridor between the Kingfisher Centre and the N6.

3.7 An emergence survey carried out at Menlo Castle (Roost E) on 26th August found that 11 lesser horseshoe bats emerged from the maternity roost in the chimney at this site. These bats and this roost are described in other bat reports for the GCTP.

3.8 An emergence survey carried out at Salmon Weir Bridge (Roost O) on 29th August 2014, found that the male Daubenton's bat using this roost emerged at 21:30 and foraged south of the Salmon Weir Bridge until the end of survey. Large numbers of soprano pipistrelles were using the stream/culvert between Roosts M (Cathedral Footbridge) and Roost O (Salmon Weir Bridge). soprano and common pipistrelle bats were also regularly and constantly foraging over the River Corrib, passing under the arches of Salmon Weir Bridge. Leisler's bats and more *Myotis* bats were also recorded constantly foraging over the river.

3.9 No roost was found for one of the male Leisler's bats caught and tagged at Barna Woods (frequency 173.438, Appendix B).There was a weak daytime signal to the north-east of Castlegar on 25th August, but this signal faded and was not found again during subsequent searches, suggesting a day roost with thick walls or some other impediment to signal transmission. This bat was recorded foraging north-west of the Sport's Field on the 23rd August (bearing 314° from ITM 528250 727680), and east of Oranmore (3 bearings) on the evening of the 25th August, suggesting a large home range including areas west, north and east of Galway city.

Table 3.1. Trapping sites in Galway

Location	Date	ITM	Species captured	Total Captured	Number ringed	Number Tagged	Species recorded by acoustic surveys at trap site
Merlin Woods	19-Aug	0533450 0725600	1xMmy, 1xMd, 25xPpy	27	none	1xMmy, 1xMd	Ppy, Ppi, Msp
Barna Woods	20-Aug	524400 723800	2 x Paur, 2xNl, 31 x Ppy	35	2xNl	2xNl	-
Cooper's Cave	21-Aug	531729 727476	1xPaur, 3xPpy	4	1x Paur	1x Paur	Ppi, Ppy, Msp
NUIG[3]	22-Aug	529178 726369	61xPpy, 1xMmy, 3xMd, 2xPpi	67	1xMmy, 3xMd, 2xPpi	1xMmy, 3xMd, 2xPpi	Ppy, Ppi, Paur, Msp, Nl
Sports fields	23-Aug	528250 727680	7xPpy, 2xPpi	9	none	none	Ppy, Ppi, Nl, Msp
Menlo Woods	26-Aug	528530 728000	29xPpy, 2xPpi, 1xMn, 6xMd 1xPaur	39	none	none	-
6 sites			**7 species**	**181**	**9 ringed, 5 species**	**11 tagged, 5 species**	

[3] National University of Ireland: Galway

Table 3.2. Bats tagged at sites in Galway

Tagging location	Date tagged	Species	Arm mm	Sex M/F	Age	Breeding condition[4] Y/N	Weight g	Ring N/number	Frequency of tag MHz 173.xxx	Roosts found
Merlin	19-Aug	Mmy	31.6	M	A	N	4.75	N	231	not found
Merlin	19-Aug	Md	38.2	F	J	N	8.5	N	459	D
Barna	20-Aug	Nl	44.1	M	A	Y	15.5	131726	438	Single, weak signal NW of Galway, foraging data
Barna	20-Aug	Nl	44.2	M	A	Y	15	131727	535	A, I
Cooper's Cave	21-Aug	Paur	38.8	F	A	Y	8.5	A4260	395	H
NUIG	22-Aug	Mmy	32.7	M	J	N	5	A4261	414	B, N
NUIG	22-Aug	Md	37.8	M	A	Y	8	A4262	513	not found
NUIG	22-Aug	Md	39.6	F	J	N	10	A4263	252	E
NUIG	22-Aug	Md	37.7	M	J	N	8	A4264	297	F, G, M, O
NUIG	22-Aug	Ppi	-	F	J	N	5	L00391	361	C, J, P
NUIG	22-Aug	Ppi	31.5	M	A	N	4.5	L00393	323	K, L
6 sites		**11 tagged 5 species**		**7 M, 4 F**	**6 A, 5 J**	**4 in breeding condition**		**9 ringed, 5 species**		

[4] 'Y' for breeding condition indicates post-lactating females or reproductively active males respectively.

Table 3.3. Bat roosts found through radio-tracking in Galway

Roost name	Roost ITM Easting / Northing	Dates in August	Bat Species / F[5]	Bat sex (M/F) age (A/J), breeding (Y/N)	Trapping site	Distance from trapping site (km)	Description	Confidence
A. Bungalow, Cappagh Road	524485 725124	24th, 25, 27th	Nl / 535	M/A/Y	Barna	1.2	Modern bungalow	High
B. Residence behind Sport's centre	524614 724182	24th, 25th, 26th	Mmy / 414	M/J/N	NUIG	5.0	Modern house	Moderate – location backs onto Roost N. Unlikely but possible that roost is at the back of Roost N.
C. Ballymoneen	526356 725344	24th, 25th	Ppi / 361	F/J/N	NUIG	3.0	Modern house	High
D. Killeen House	526370 728692	25th, 26th, 27th	Md / 459	F/J/N	Merlin	7.9	Farmhouse complex	Roost is within farm complex, but not sure which building. Tracked from road.
E. Menlo Castle	0528431 0727907	24th-29th	Md / 252	F/J/N	NUIG	1.7	Ruined castle	High
F. Women's Study Centre	528996 726229	24th	Md / 297	M/J/N	NUIG	0.3	1970s house	High
G. 51 St. Joseph's	529130 726060	25th	Md / 297	M/J/N	NUIG	0.4	Study centre	High

[5] F = frequency of bat tag, 173.xxx, to help indicate the specific bat.

Roost name	Roost ITM Easting / Northing	Dates in August	Bat Species / F[5]	Bat sex (M/F) age (A/J), breeding (Y/N)	Trapping site	Distance from trapping site (km)	Description	Confidence
H. Bungalow at Castle Gar	531925 728152	24th-29th	Paur / 395	F/A/Y	Coopers	0.8	Modern bungalow	High
I. Residence. Cappagh Road	524391 725205	26th	NI / 535	M/A/Y	Barna	1.3	Modern bungalow	High
J. Residence. Ballymoneen. Sli Na Sruchan	526439 725313	26th, 27th	Ppi / 361	F/J/N	NUIG	3.0	Modern house	Moderate – dense housing estate, signal may bounce, houses close together. Judgement made on best indication from signal strength.
K. Cluanacauneen	533542 730077	25th, 26th	Ppi / 323	M/A/N	NUIG	5.7	Modern agricultural barn	High
L. barn nr roost K	0533503 0730071	28th	Ppi / 323	M/A/N	NUIG	5.7	Modern agricultural barn	High
M. Cathedral footbridge	0529520 0725588	28th	Md / 297	M/J/N	NUIG	0.9	Stone footbridge	Moderate – cluttered environment including thick stone structures. Possible bouncing signal.
N. Ard Na Coille. Residence behind Sport's centre	524591 724159	29th	Mmy / 414	M/J/N	NUIG	5.1	Modern house	Moderate – see notes on Roost B.

Roost name	**Roost ITM Easting / Northing**	**Dates in August**	**Bat Species / F[5]**	**Bat sex (M/F) age (A/J), breeding (Y/N)**	**Trapping site**	**Distance from trapping site (km)**	**Description**	**Confidence**
O. Salmon Weir Bridge	0529532 0725541	29th	Md / 297	M/J/N	NUIG	1.0	Stone roadbridge	High
P. Residence. Ballymoneen. Sli Na Sruchan	526324 725235	29th	Ppi / 361	F/J/N	NUIG	3.1	Modern house	Moderate – dense housing estate, signal may bounce, houses close together. Judgement made on best indication from signal strength.
16 bat roosts						**Mean distance 2.9km**		

4 Discussion and Analysis of Results

4.1 In total, 16 different roosts were identified by the surveys. Twelve of the 16 roosts (75%) were found in modern buildings; 5 roosts (31%) were likely to have been constructed within the last 10 years. This contrasts with suggestions that bats are more likely to be found in old buildings, especially those with multiple access spaces and different types of voids, and low levels of disturbance (Bat Conservation Trust, 2012).This difference may be due to one, or a combination of, the following reasons:

1) A general scarcity in the area of roosting sites with optimal features for bats.
2) A rapid change in the character and extent of Galway, changing the nature and availability of roost sites. The bats of Galway may be adapting to these changes, with unknown implications for population dynamics.
3) Local bat population preference. Mammal populations in different areas can have different habits. The findings from elsewhere in Europe with regard to roost preference and roost use by bats may not apply in Galway.
4) This survey was conducted outside the maternity season. Therefore a higher proportion of roosts would be expected in sites that would be suboptimal for maternity colonies (e.g. sites used by breeding males).

4.2 All roosts were located within 500m of open countryside, and/or close to the expansive natural watercourse and fringing habitat that comprises the River Corrib and which provides a 'blue corridor' flightpath and foraging area for bats which links the centre of Galway to open countryside.The roosts in Ballymoneen (C, J and P) were the most urban in location. No roosts were found within the heavily built-up areas of central Galway, despite a thorough city-wide sweep carried out by the team on 28th and 29th August 2014. Additional data would be required by other survey techniques to further evaluate the relative value of city-edge to city-centre locations for bats. However, the locations favoured for roosting by the bats tagged during this study suggests that roosts with good access to areas suitable for foraging are more likely to be used by bats.

4.3 Five of the 8 bats (63%) for which roosts were found moved roosts at least once during the period tracked. A male juvenile Daubenton's bat tagged at National University of Ireland Galway (NUIG) moved the most, occupying 4 different roosts over 6 days. In contrast, a post-breeding female brown long-eared bat was faithful to a single roost (H) over 6 days.

4.4 The roosts found during the surveys that had high potential to host maternity bat roosts were the bungalow (roost H) faithfully occupied by the post-lactating female brown long-eared bat (frequency 173.395), and Menlo Castle (Roost E) which was faithfully occupied by a female juvenile Daubenton's bat (frequency 173.252) for the duration of the survey and is a known maternity roost for at least one other species (lesser horseshoe bat). The farm complex (D) regularly occupied by another juvenile female Daubenton's bat (frequency 173.297) is also highly suitable for bats and well located to excellent foraging habitat and may well host a maternity roost. The extremely large numbers of soprano pipistrelle bats recorded at dusk during an emergence survey at Salmon Weir bridge, and a nearby stone footbridge (Roosts O and M) suggest a possible large maternity roost for this species somewhere in the vicinity of the old stone waterway that links these two features. A dawn track-back survey could help to clarify the exact roost location.

4.5 The location with low potential for a maternity roost comprised The modern agricultural barns (Roosts K and L) regularly occupied during the survey period by a juvenile female common pipistrelle bat, had low potential as maternity roosts, since the corrugated iron and other modern materials could lead to rapid changes in internal temperature in the structure. Other roosts found during the survey, comprising houses and bungalows, many modern, were of moderate potential for maternity roosts.

4.6 Rates of roost changing may be relatively high due to one, or a combination of, the following reasons, although further research would be required in order to test these theories:

- The time of year (August) is a period when the summer roosts of bats are breaking up, and bats are generally moving around more (Dietz, 2009).
- The area under study, comprising the fringes of Galway, have rapidly changed in the last few years. For example, a comparison of the area around roost F (Women's Study Centre, behind the Kingfisher complex) now with Google Maps aerial photographs dated 2012, shows substantial redevelopment in this area, including the removal of buildings. Bats may be adjusting to this changing environment by checking and exploring new roosts.
- The tagged bats including juvenile, non-breeding and male bats as a high proportion of the total tagged (5 out of 8 bats for which roosts were found were juveniles, 63%). These bats may tend to move roost more often than breeding female bats.
- Changes in bat behaviour due to fitting a tag. For this reason, data collected on tagged bats within 24hours of the tag being fitted was treated with caution.

4.7 Lesser horseshoe bats were present in the known roost at Menlo Castle and a survey carried out on this site counted 11 emerging lesser horseshoe bats. No lesser horseshoe bats were captured or detected acoustically at any of the trapping sites. Even taking into account species-specific bias against capturing lesser horseshoe bats, this low encounter rate is in line with the suggestion that lesser horseshoe bats are uncommon in the area. Acoustic survey data presented elsewhere also supports this suggestion (Geckoella, 2014).

4.8 There are substantial parts of the proposed scheme area which are generally open in character, and may be subject to low temperatures at night. Areas with open character also offer practical challenges to the use of mist nets and harp traps with regard to finding locations where bats are 'funnelled' into smaller areas. This makes other survey methods, such as acoustic techniques, potentially more appropriate in these areas. Trapping success improved in sheltered and warm areas.

5 References

Amelon, S. K., Dalton, D. C., Millspaugh, J. J. & Wolf, S. A., 2009. Radiotelemetry: Techniques and Analysis. In: T. H. Kunz & S. Parsons, eds. *Ecological and Behavioural Methods for the Study of Bats.* 2nd ed. Baltimore: The John Hopkins University Press, pp. 57-77.

Bartolommei, P., Francucci, S. & Pezzo, F., 2012. Accuracy of conventional radio telemetry estimates: A practical procedure of measurement. *Hystrix,* 23(2).

Bat Conservation Trust, 2012. *Bat Surveys: Good Practice Guidelines.* 2nd ed. London: Bat Conservation Trust.

CIEEM, 2006. *Guidelines for Ecological Impact Assessment in the United Kingdom,* Winchester: Chartered Institute for Ecology and Environmental Management.

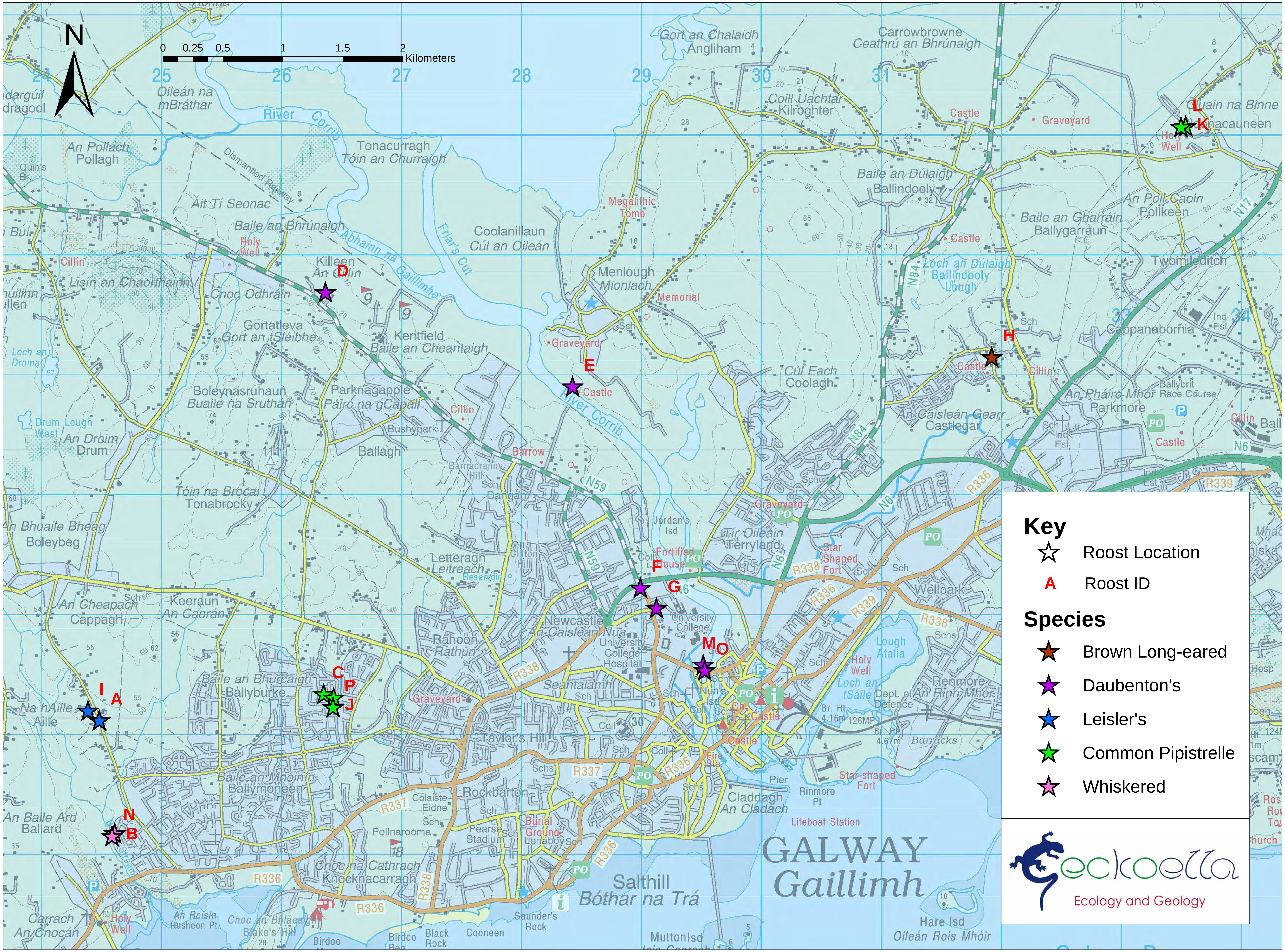
Dietz, C. O. v. H. &. D. H., 2009. *Bats of Britain, Europe and Northwest Africa.* www.acblack.com: A & C Black.

Geckoella, 2014. *Acoustic Survey of Bats in the Galway Area: Final Report,* Taunton, UK: Geckoella.

Kelleher, C. & Marnell, F., 2006. *Bat Mitigation Guidelines for Ireland (Irish Wildlife Manuals, No. 25.),* Dublin, Ireland: National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

Figure 1. Trapping Sites and Proposed Scheme Area

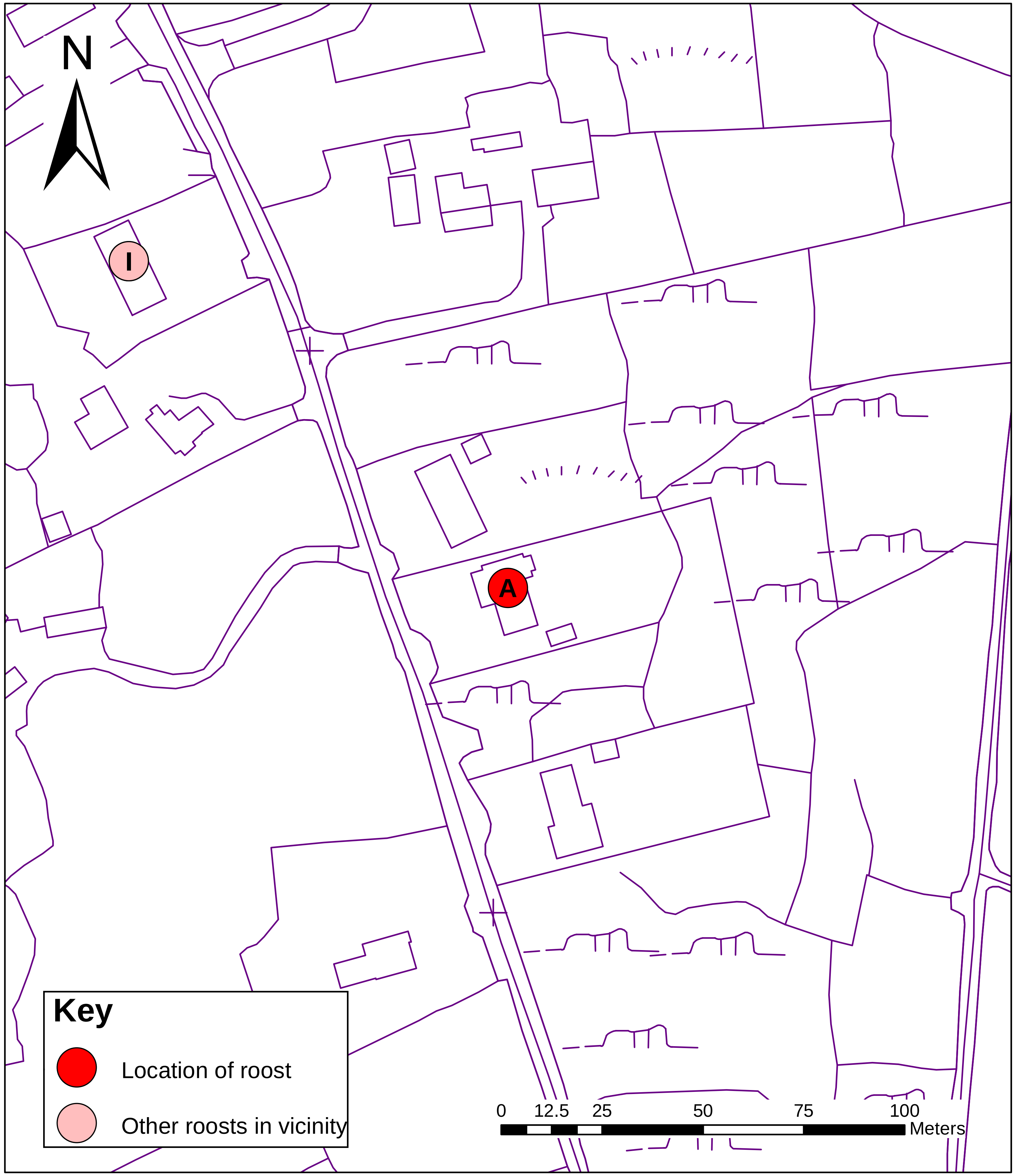
Figure 2. Roost Locations From Radiotracking: Overview



GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology



Roost A

GCTP Radiotracking
August 2014

ITM: 524485 725124
Location: Bungalow, Cappagh Road

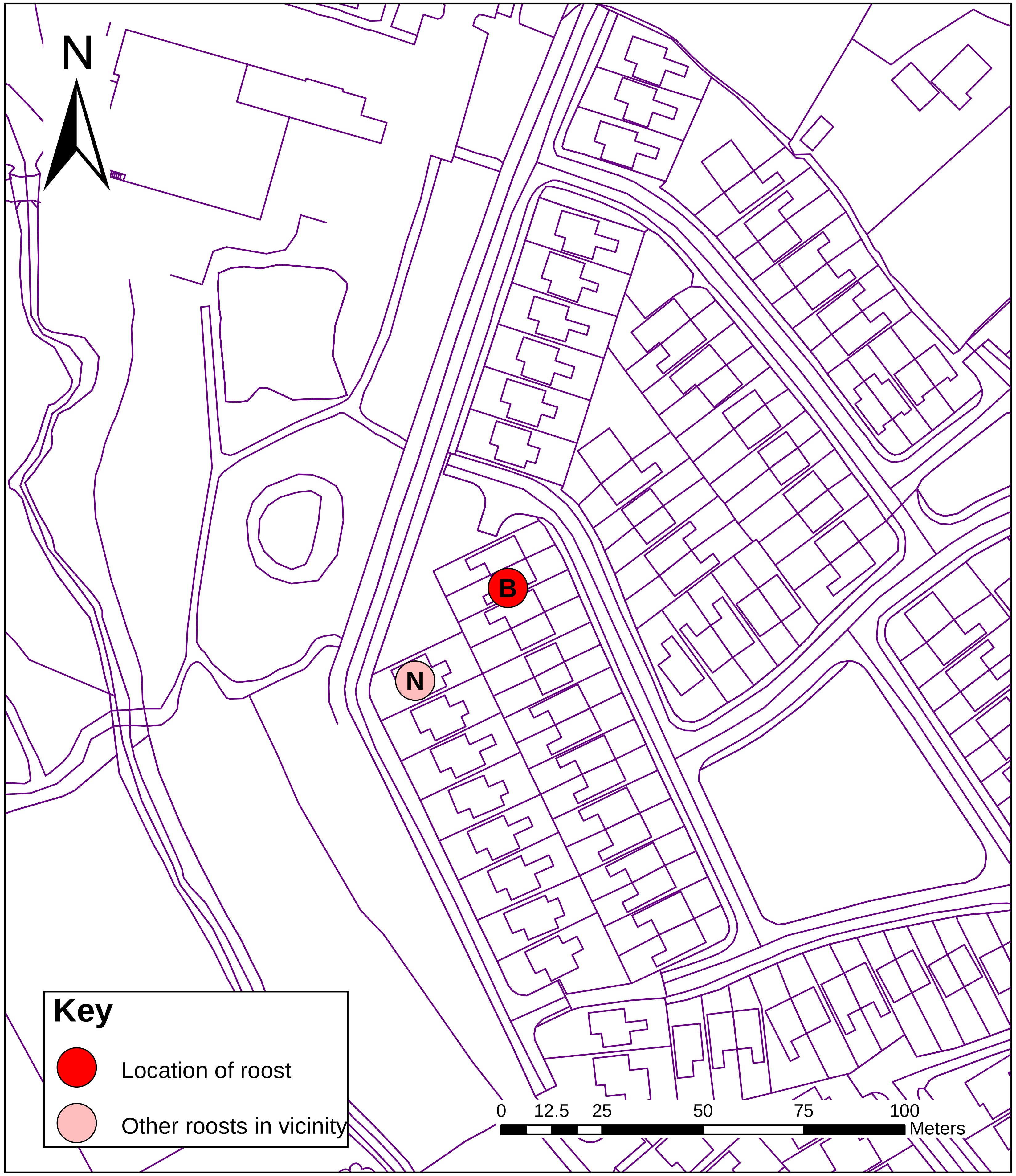
Species: Leisler's Sex: Male
Dates bats confirmed resident: 22nd, 24th, 25th, 27th

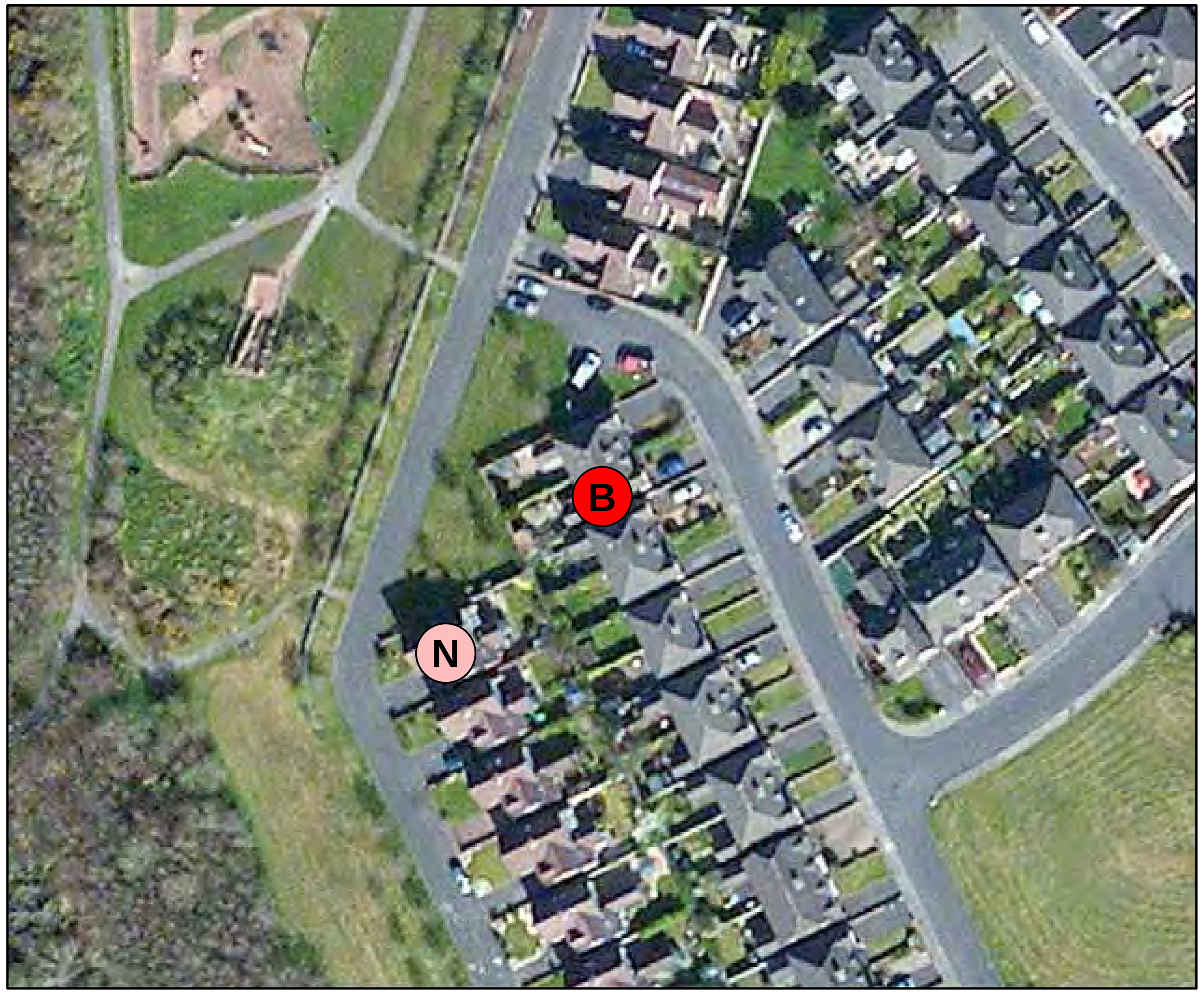
Sheet 1 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella
Ecology and Geology





Roost B

GCTP Radiotracking
August 2014

ITM: 524614 724182
Location: Residence behind Sport's centre

Species: Whiskered Sex: Male
Dates bats confirmed resident: 24th, 25th, 26th

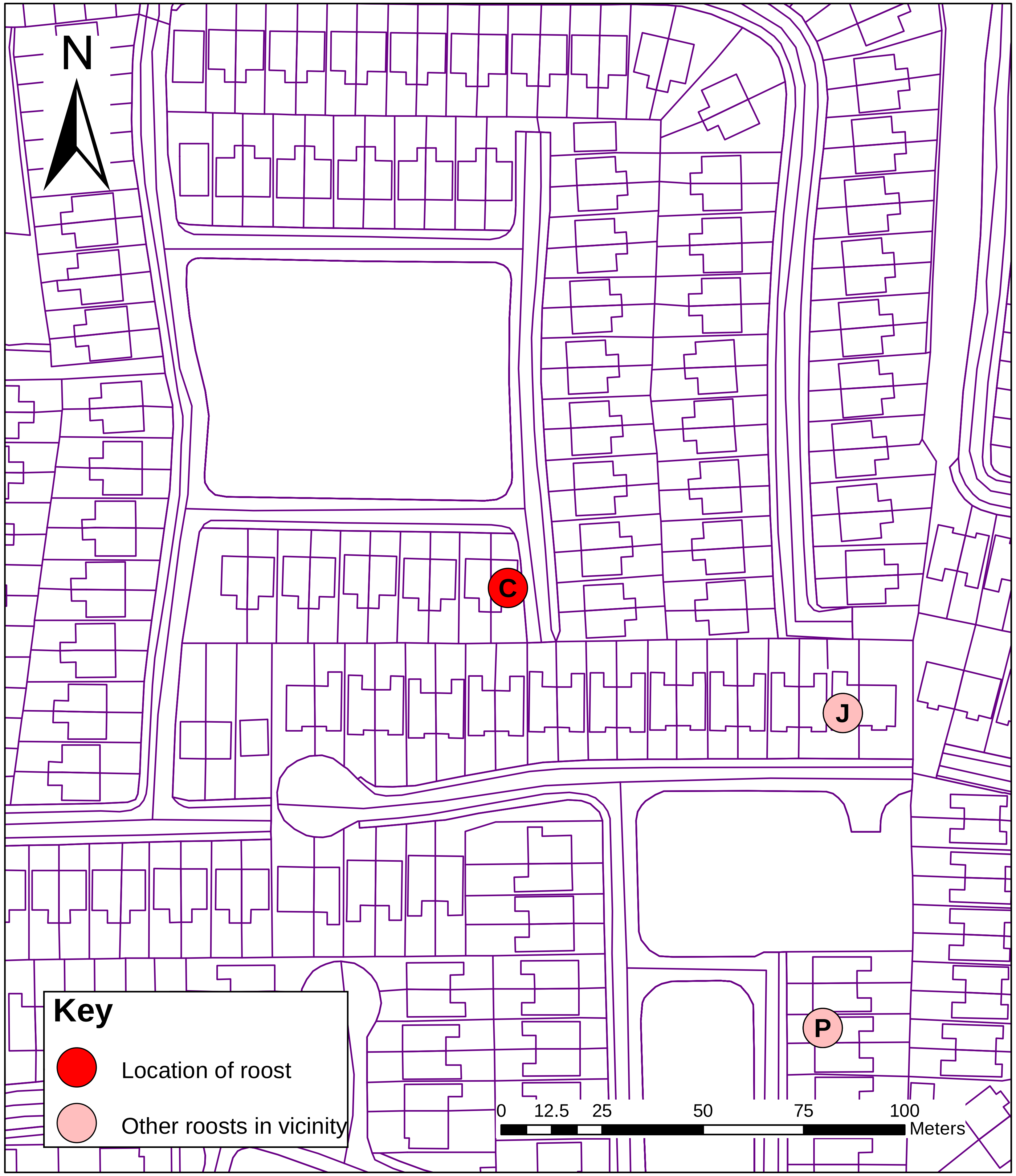
Note: Roost B backs on to Roost N. Although signal strength indicates separate roosts, would need to be between buildings to be certain.

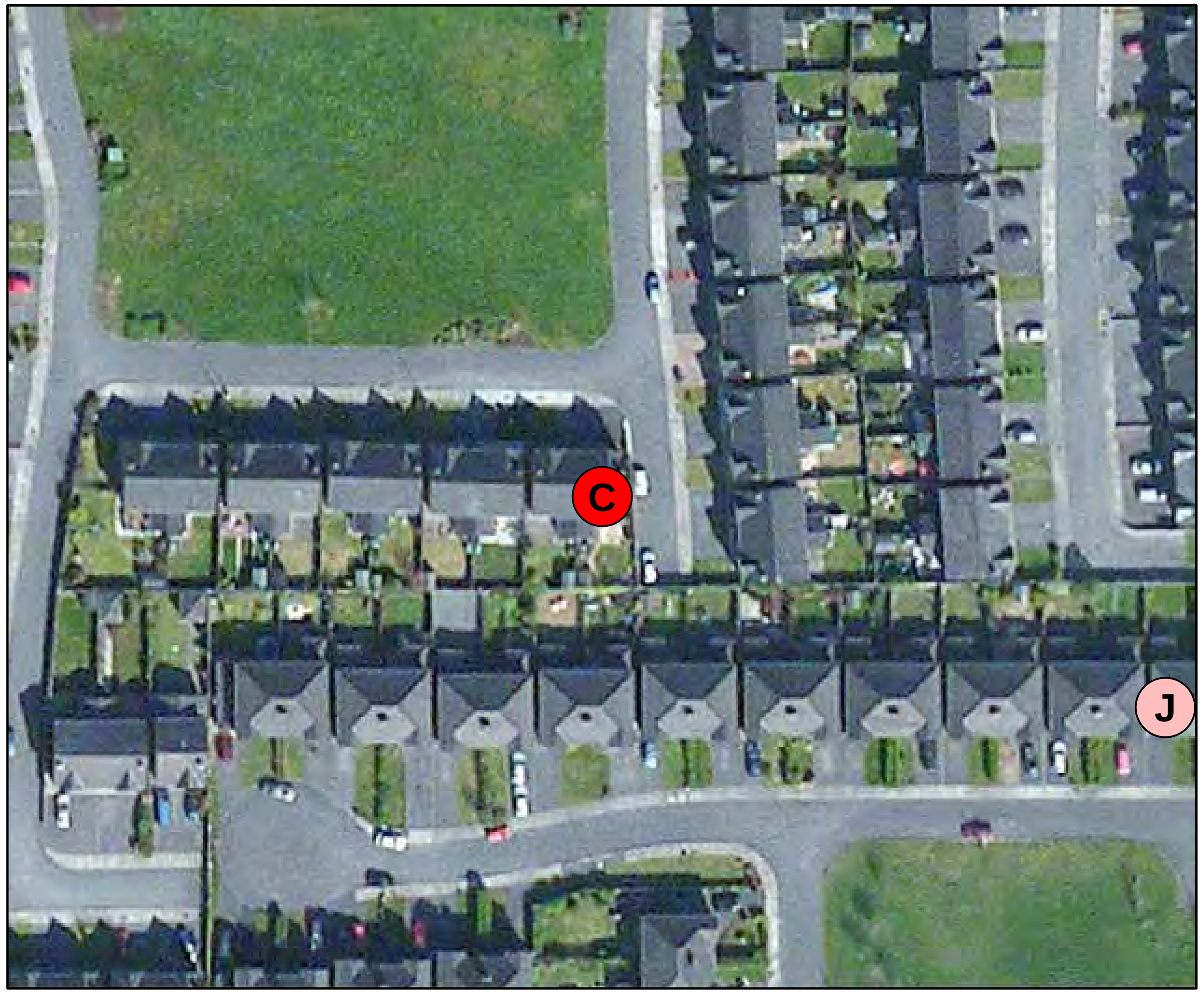
Sheet 2 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology





Roost C

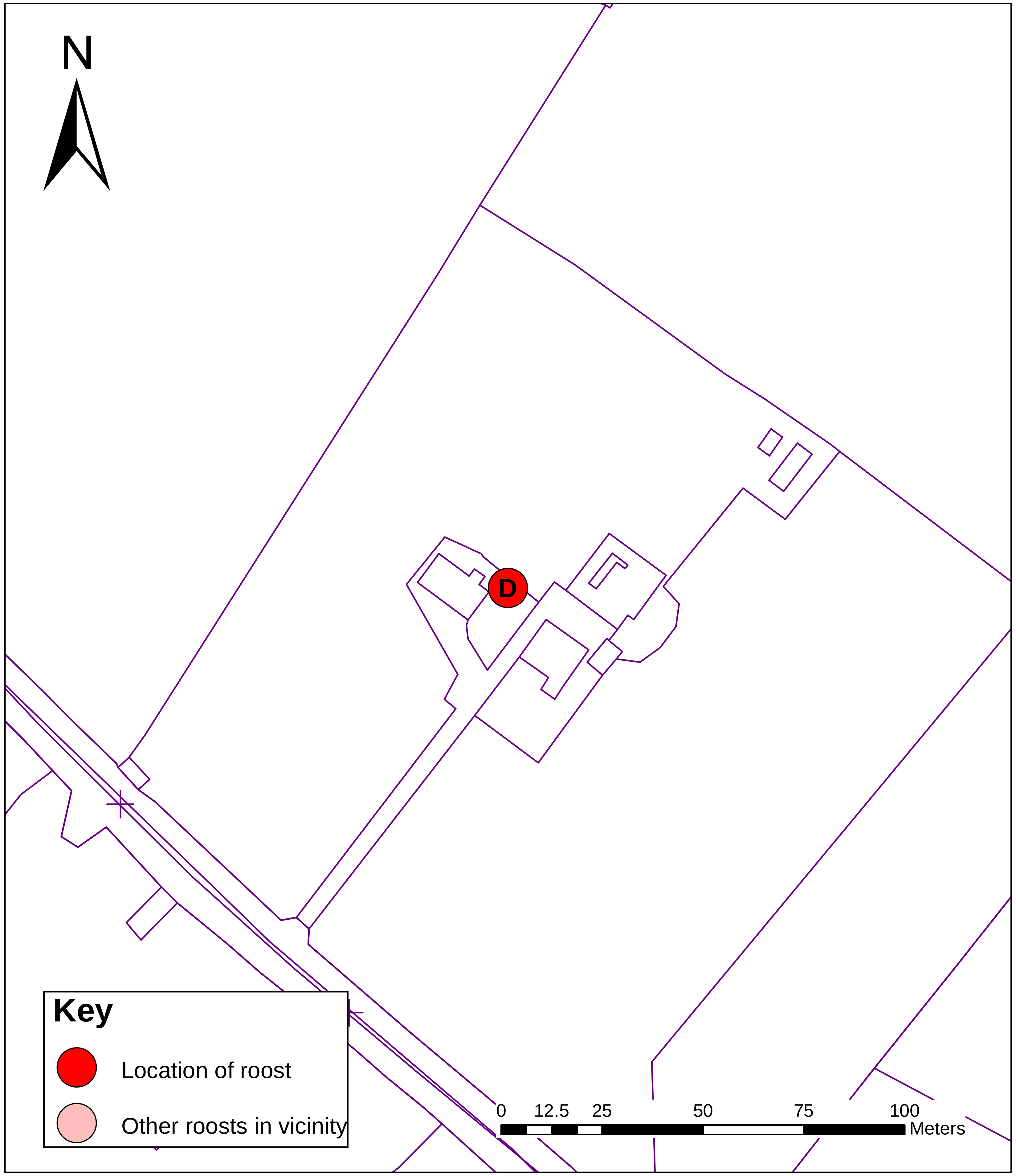
GCTP Radiotracking
August 2014

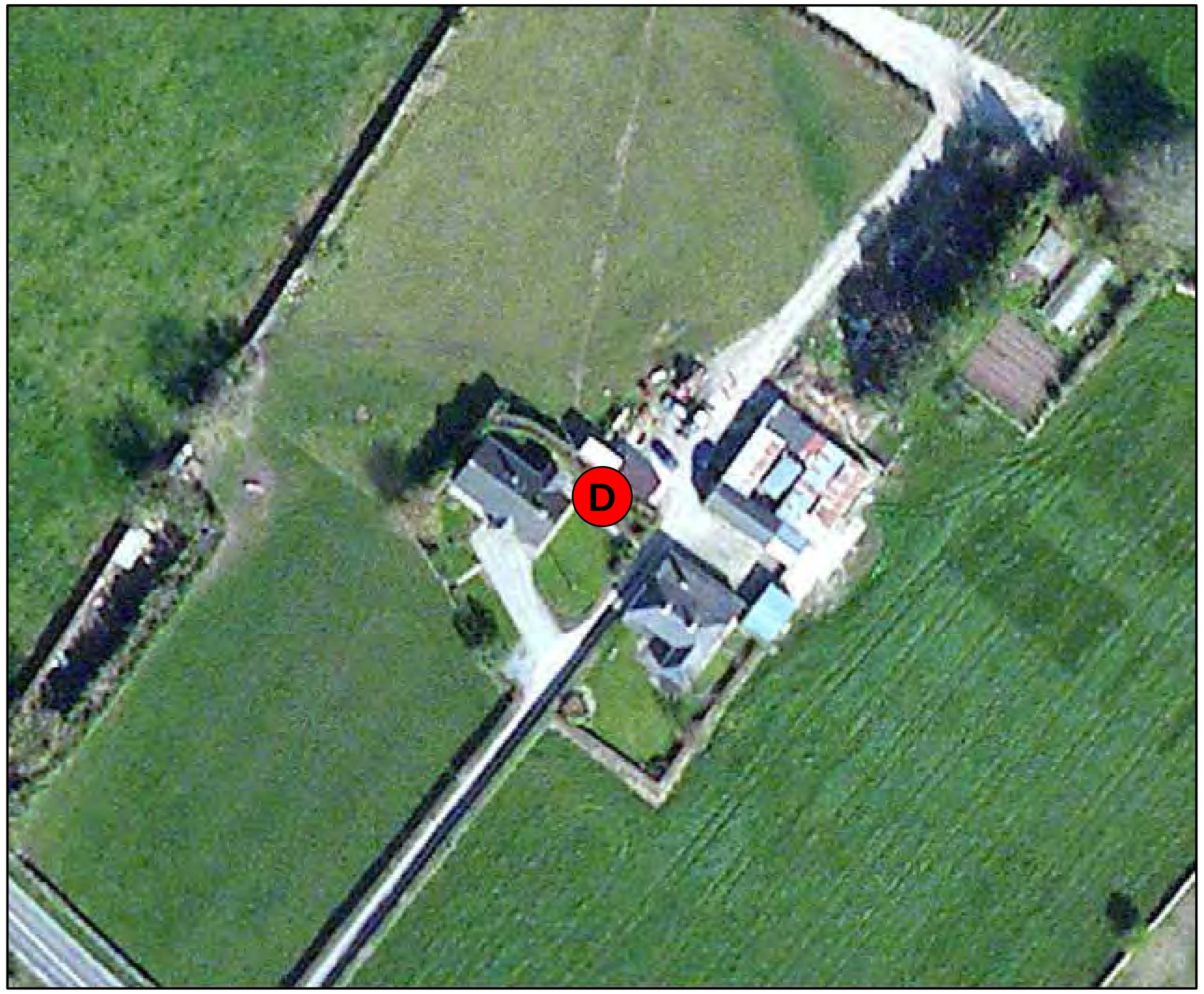
ITM: 526356 725344
Location: Ballymoneen

Species: Common Pipistrelle **Sex:** Female
Dates bats confirmed resident: 24th, 25th

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





Roost D

GCTP Radiotracking
August 2014

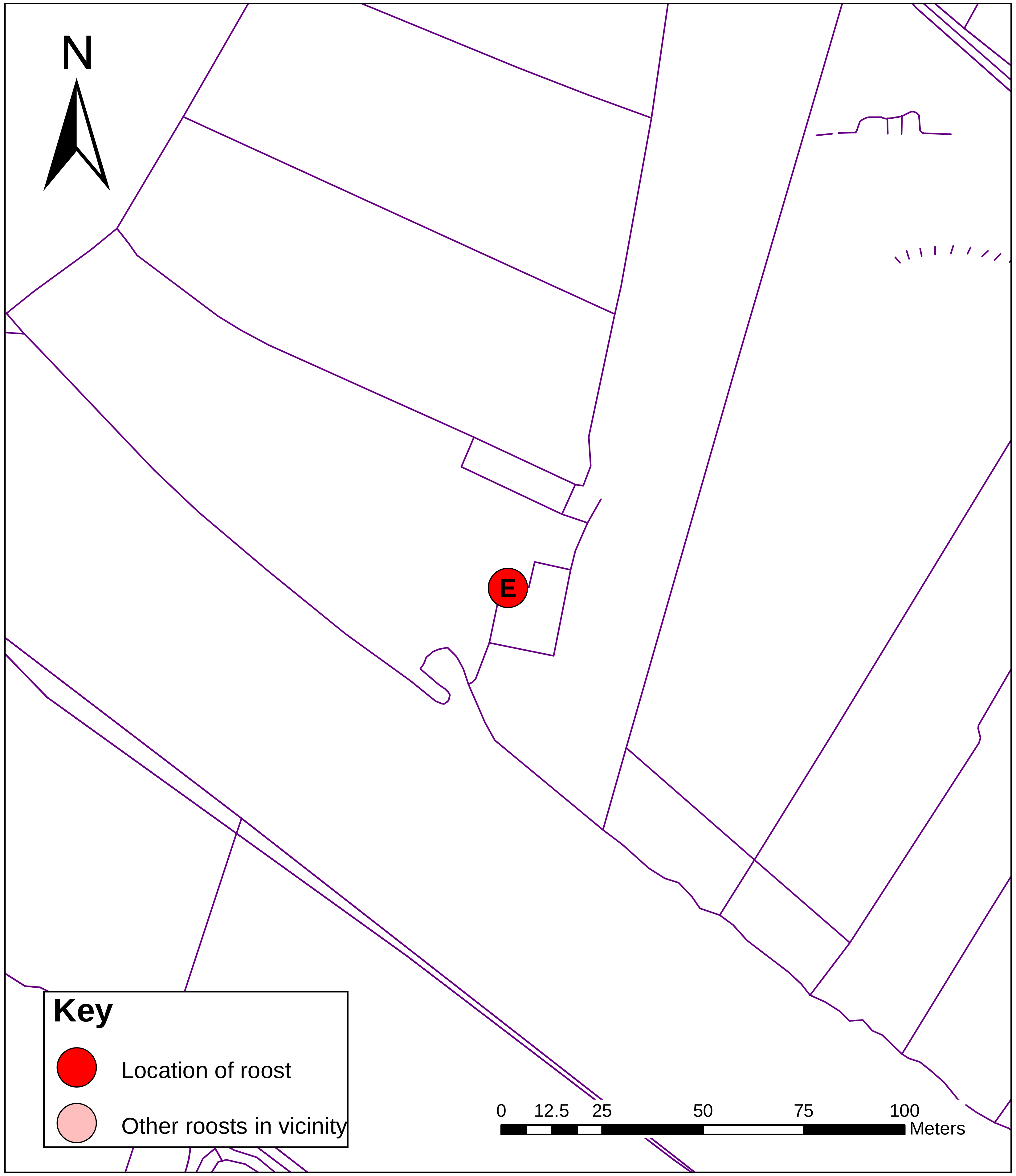
ITM: 526370 728692
Location: Killeen House

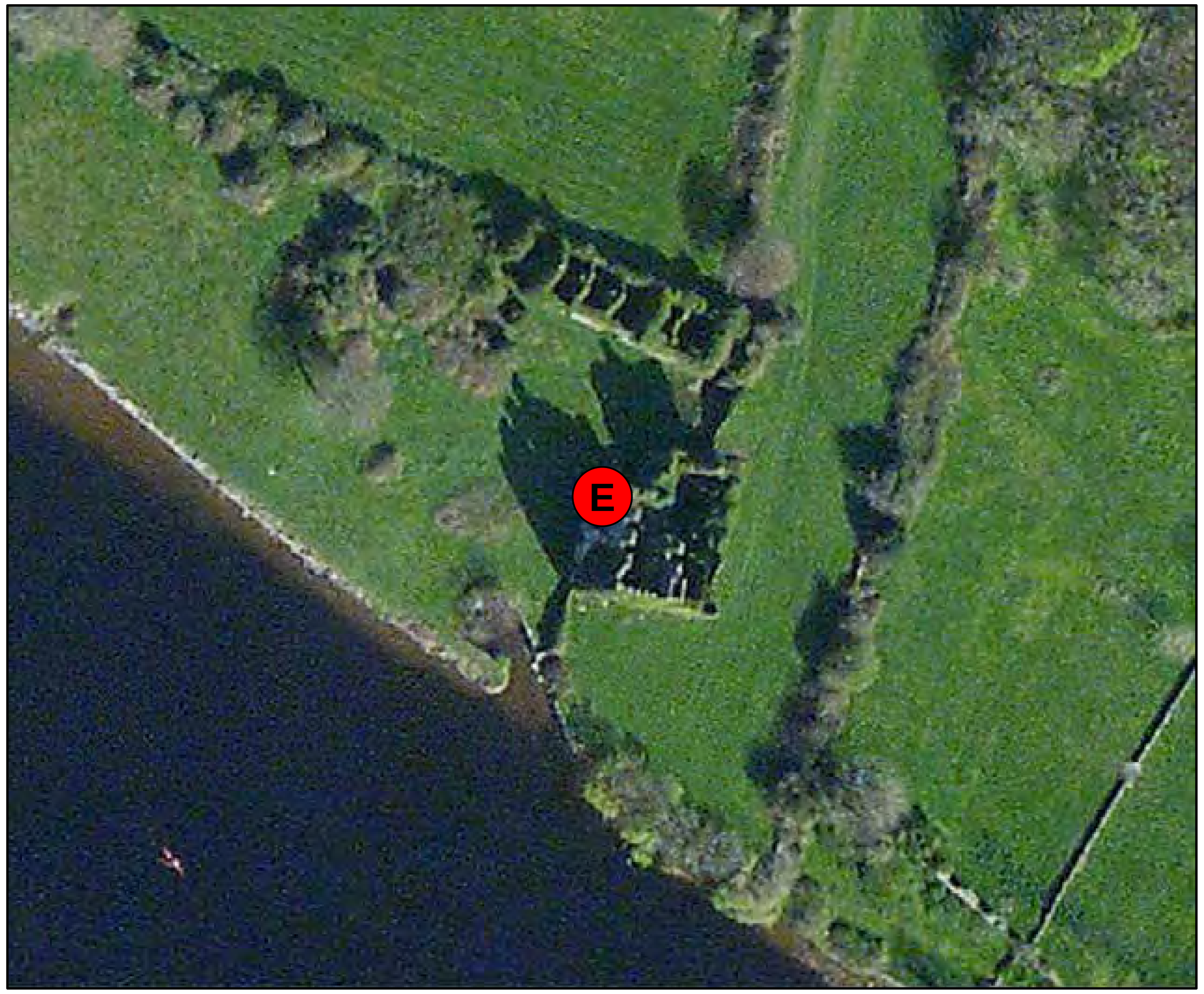
Species: Daubenton's Sex: Female
Dates bats confirmed resident: 25th, 26th, 27th

Sheet 4 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





Roost E

GCTP Radiotracking
August 2014

ITM: 528431 727907
Location: Menlo Castle

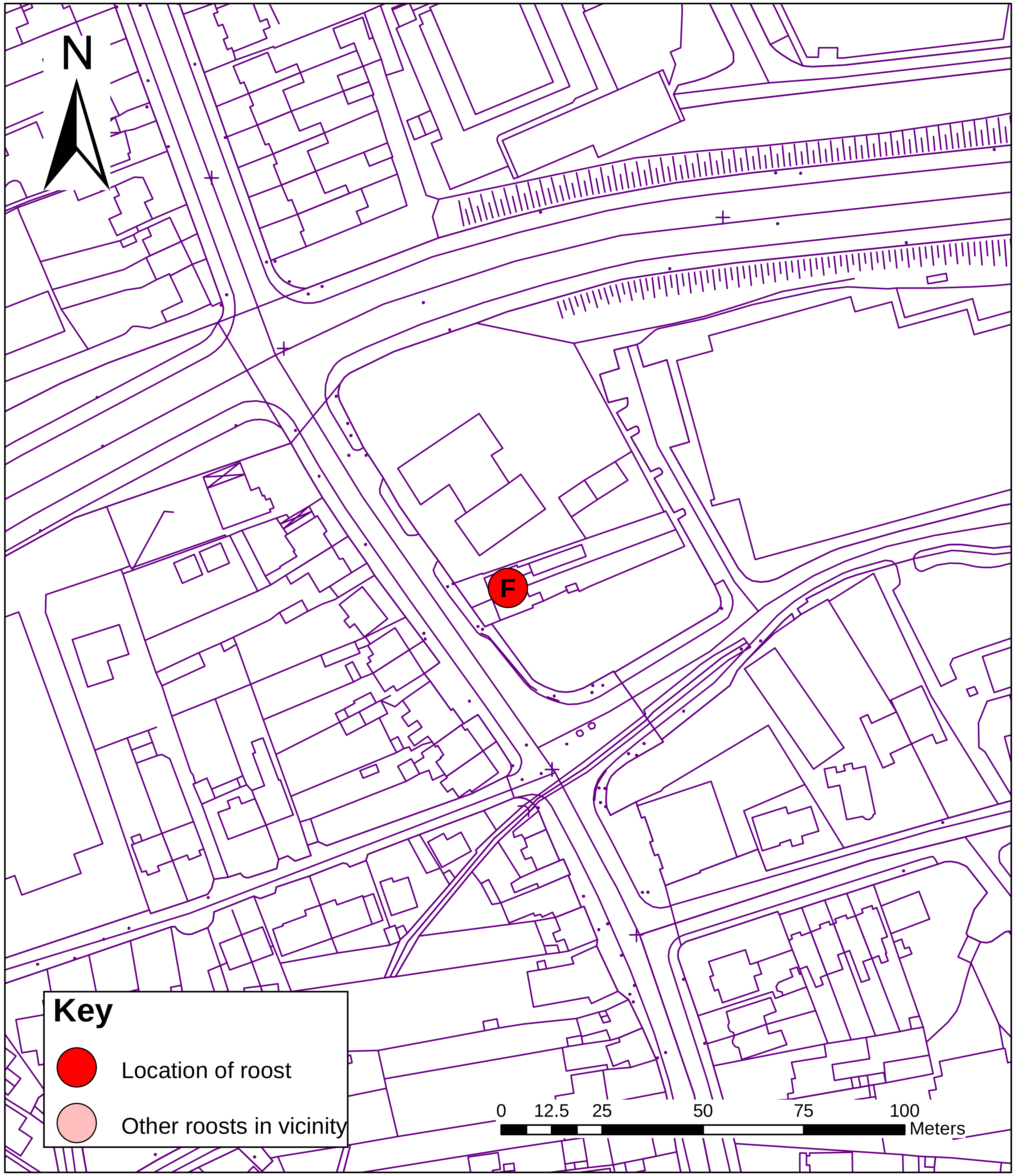
Species: Daubenton's Sex: Female
Dates bats confirmed resident: 24th, 25th, 26th, 27th, 28th, 29th

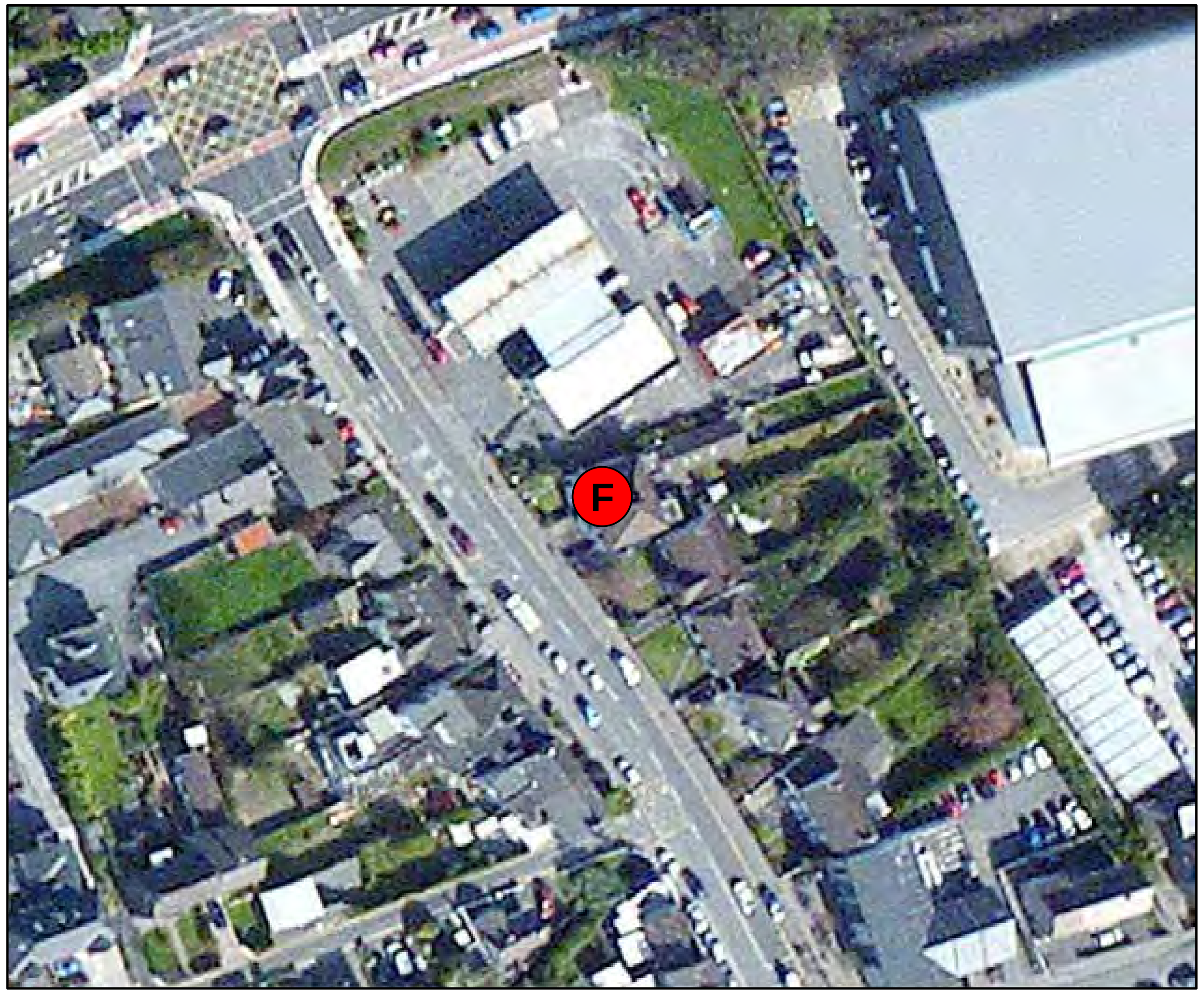
Sheet 5 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella
Ecology and Geology





Roost F

GCTP Radiotracking
August 2014

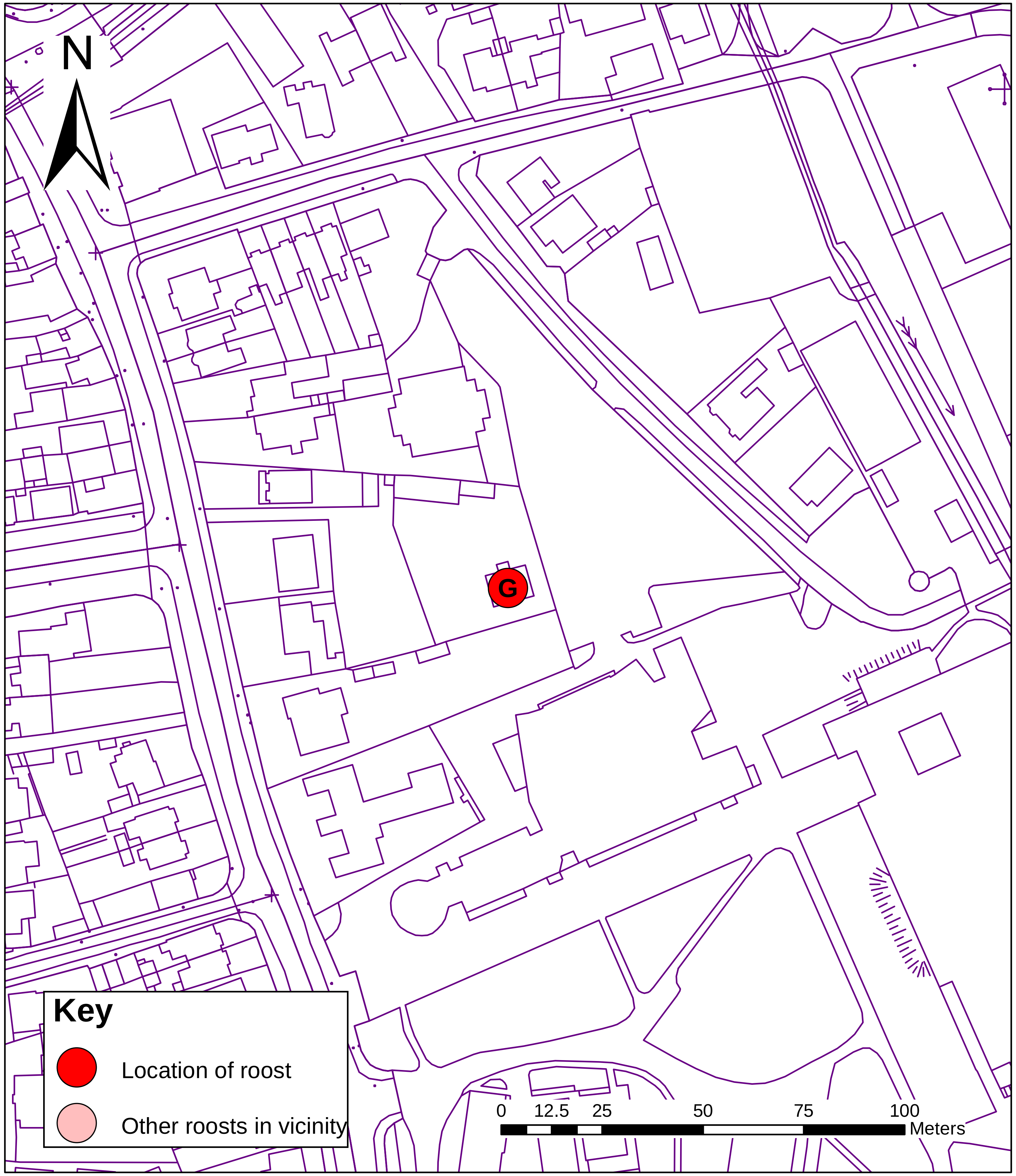
ITM: 528996 726229
Location: Women's Study Centre

Species: Daubenton's **Sex:** Male
Dates bats confirmed resident: 23rd, 24th

Sheet 6 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P



Roost G

GCTP Radiotracking
August 2014

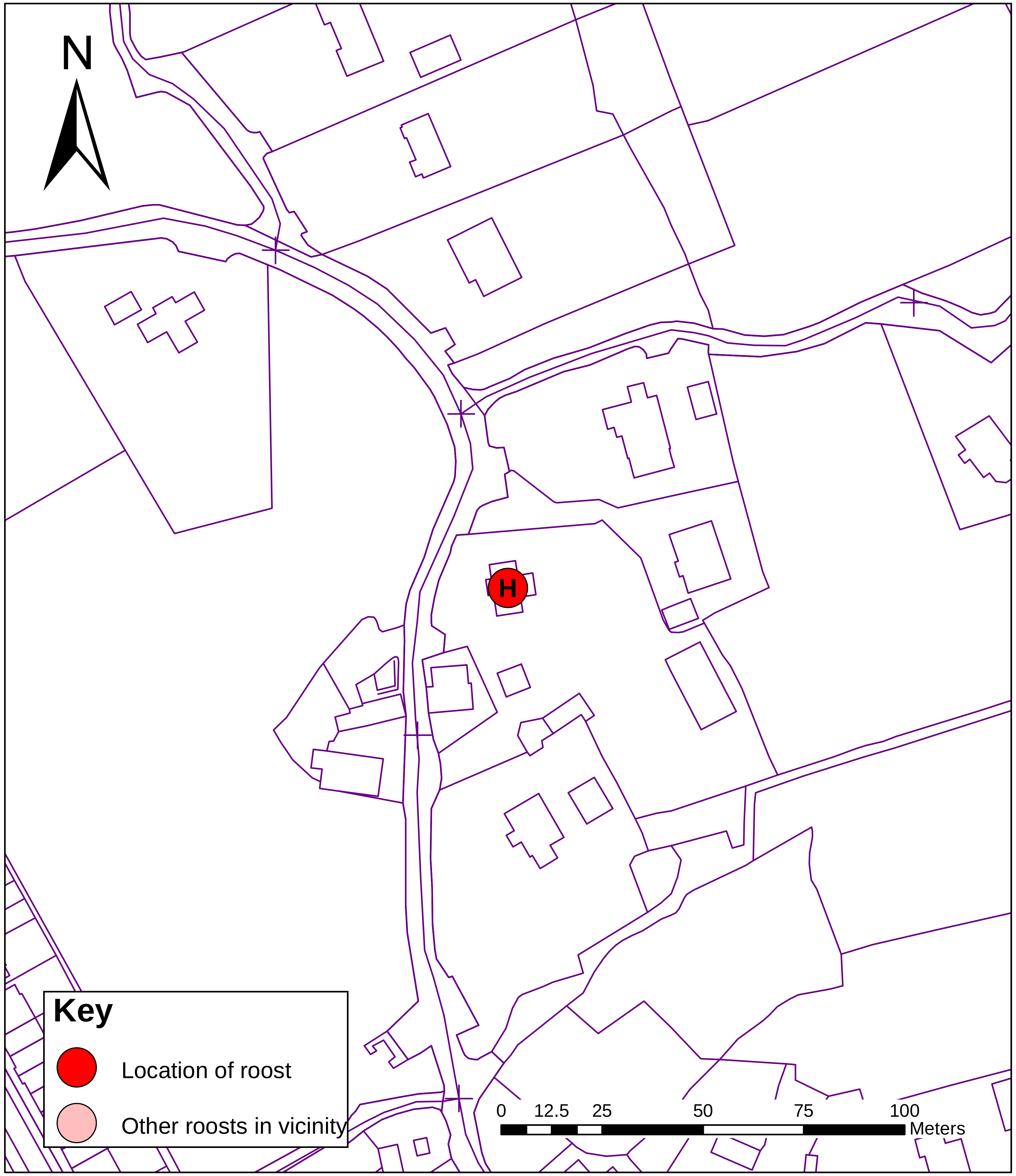
ITM: 529130 726060
Location: 51 St. Joseph's

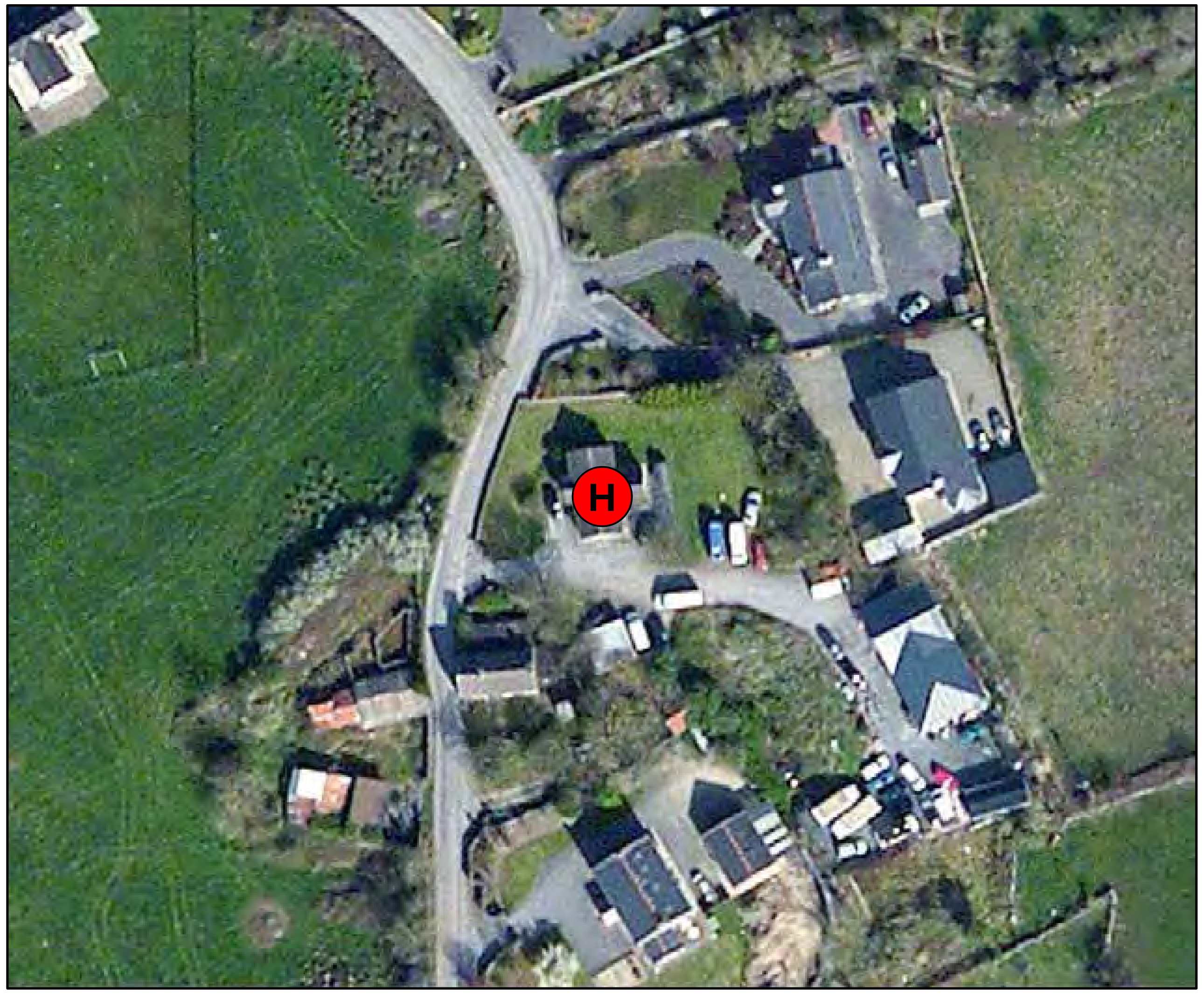
Species: Daubenton's Sex: Male
Dates bats confirmed resident: 25th

Sheet 7 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





Roost H

GCTP Radiotracking
August 2014

ITM: 531925 728152
Location: Bungalow at Castle Gar

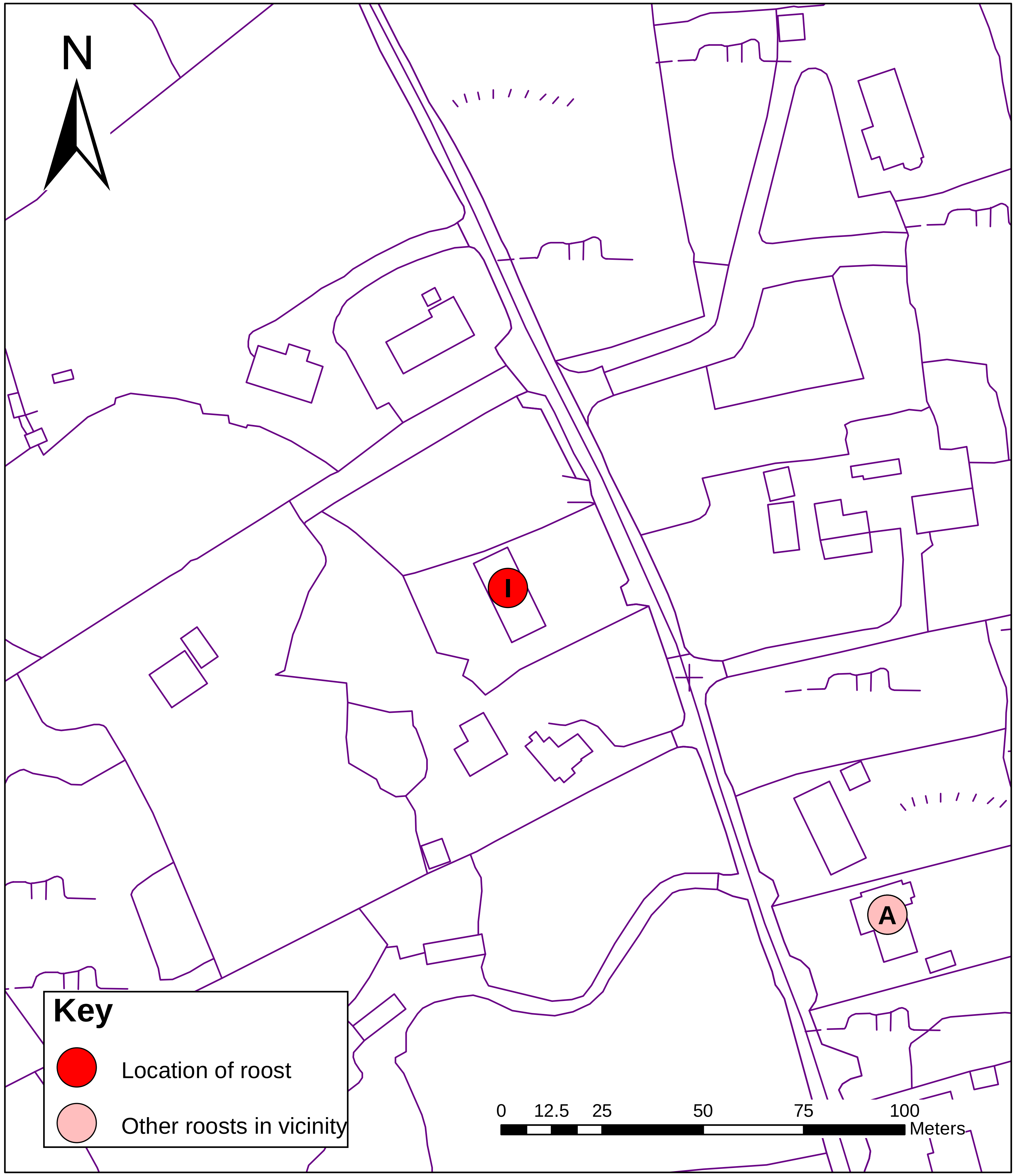
Species: Brown Long-eared Sex: Female
Dates bats confirmed resident: 24th, 25th, 26th, 27th, 28th, 29th

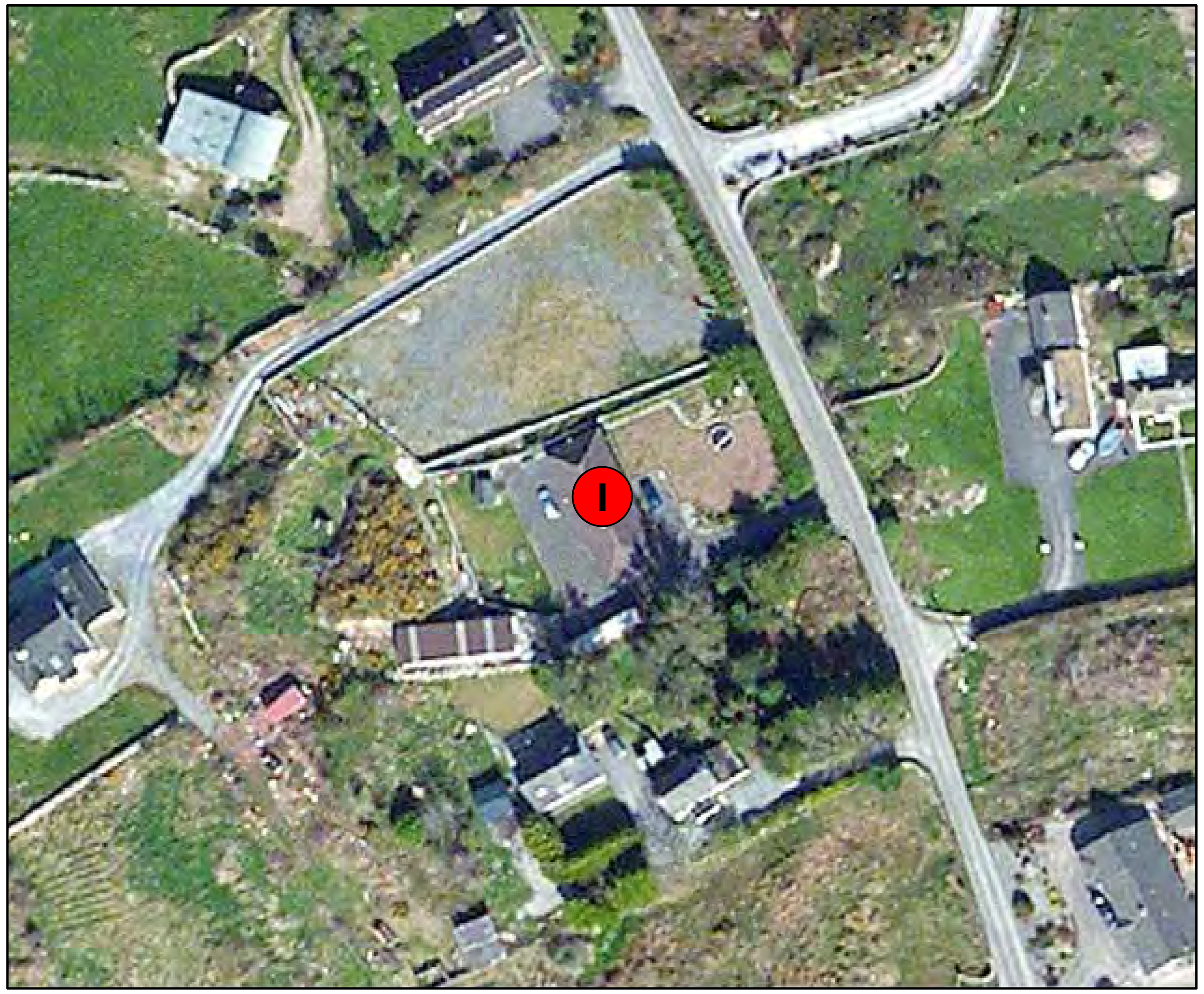
Sheet 8 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella
Ecology and Geology





Roost I

GCTP Radiotracking
August 2014

ITM: 524391 725205
Location: Residence. Cappagh Road

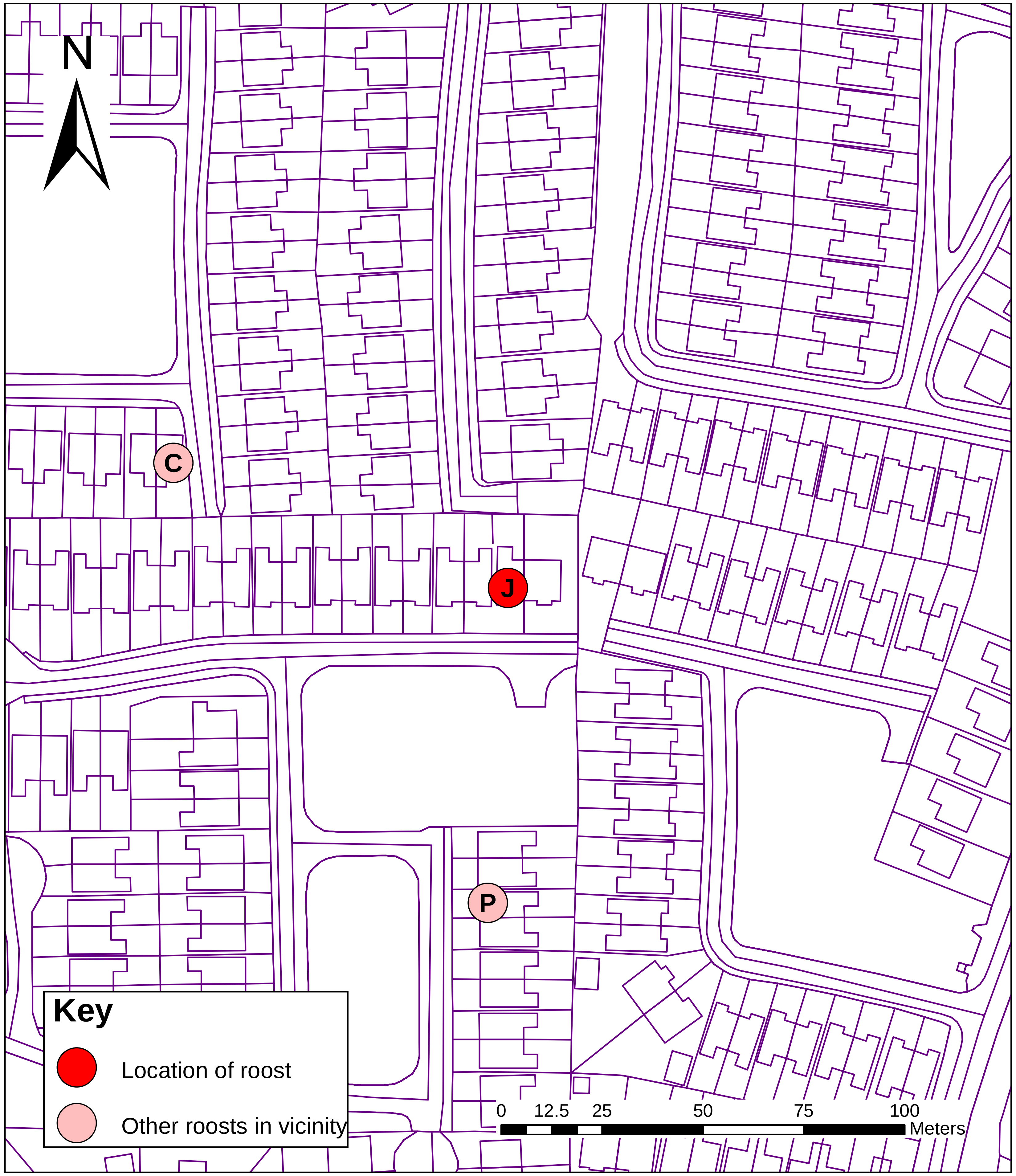
Species: Leisler's Sex: Male
Dates bats confirmed resident: 26th, 27th

Sheet 9 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella
Ecology and Geology



Roost J

GCTP Radiotracking
August 2014

ITM: 526439 725313
Location: Residence. Ballymoneen. 64 Sli Na Sruchan

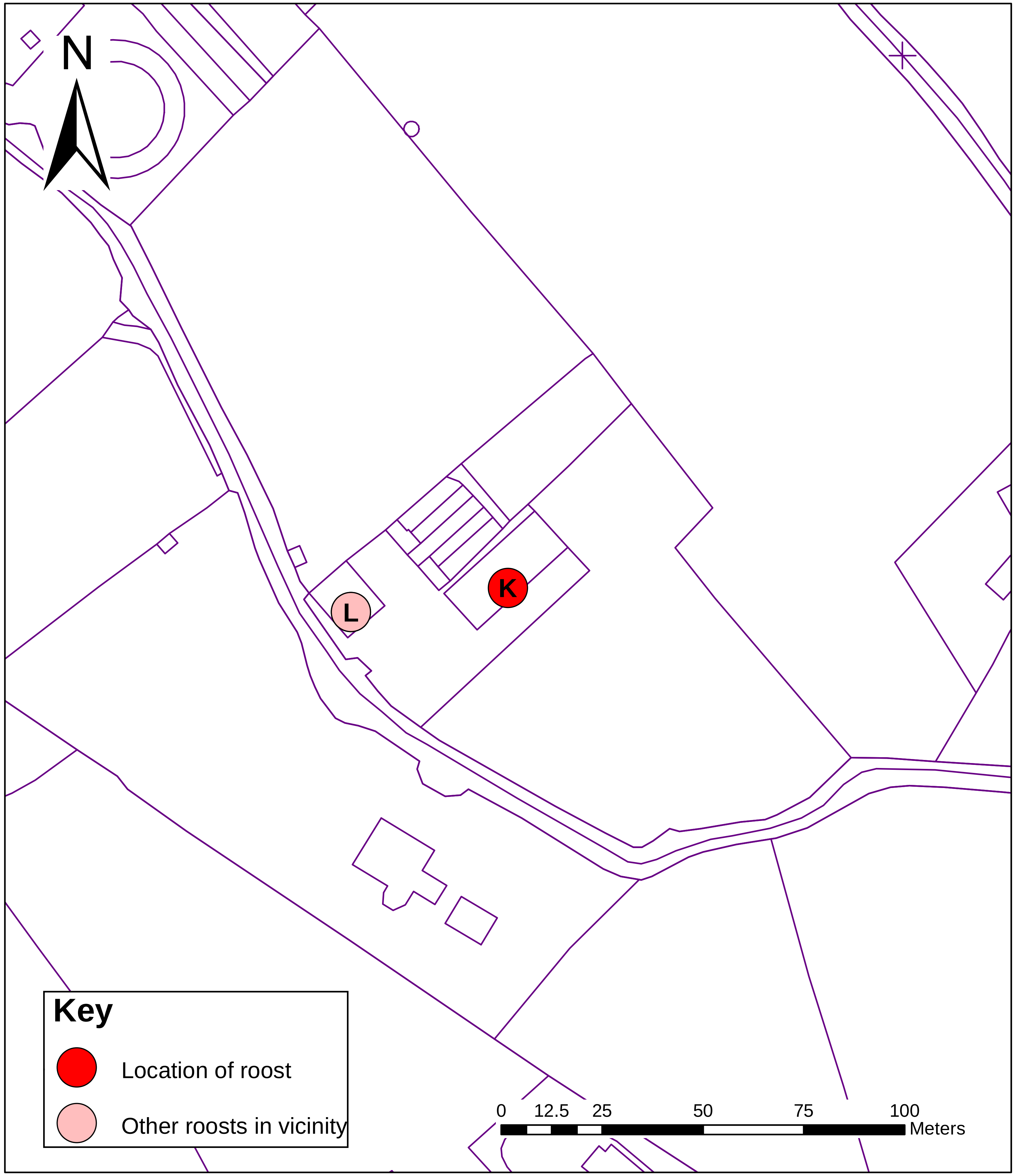
Species: Common Pipistrelle **Sex:** Female
Dates bats confirmed resident: 26th, 27th

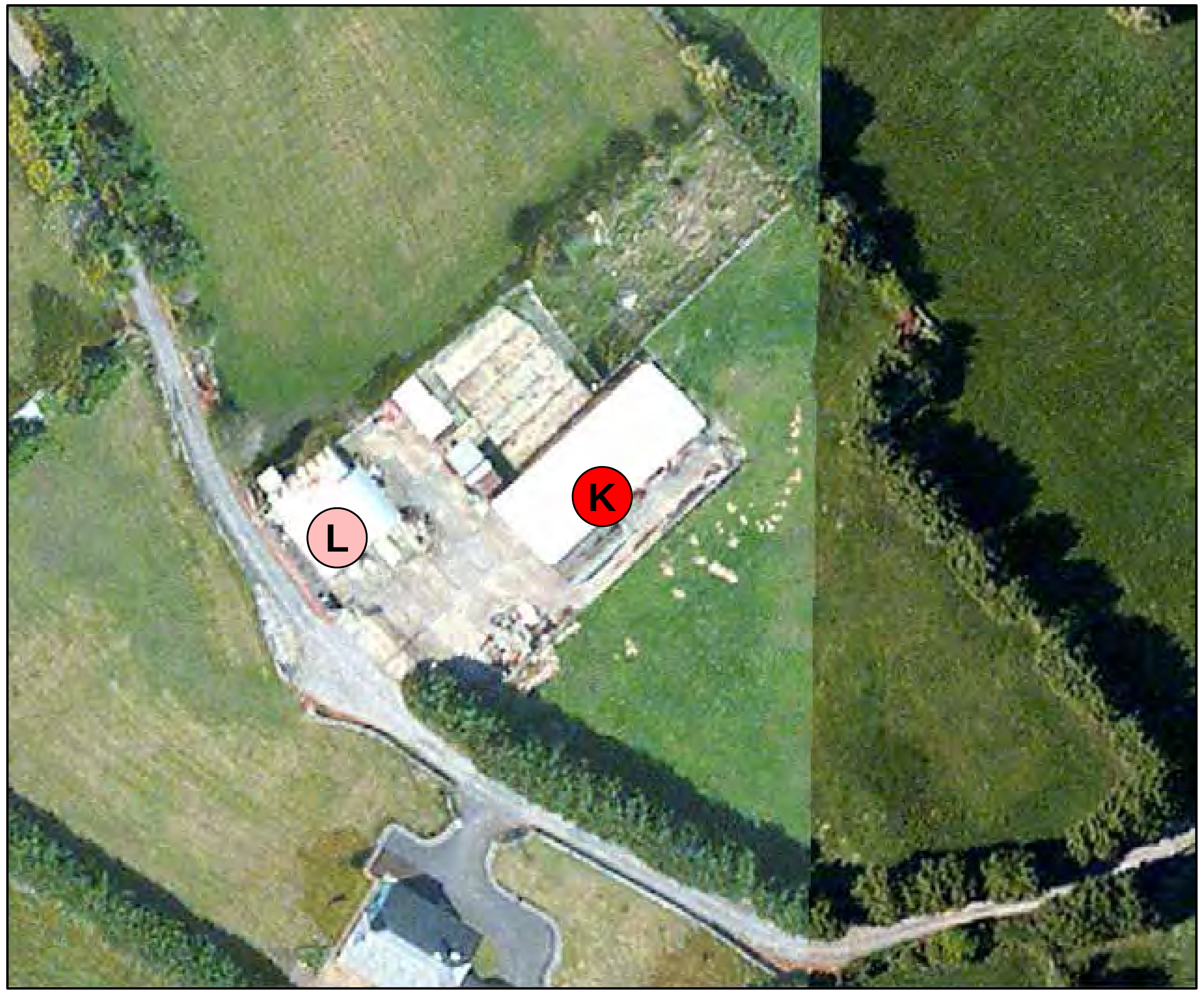
Sheet 10 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella Ecology and Geology





Roost K

GCTP Radiotracking
August 2014

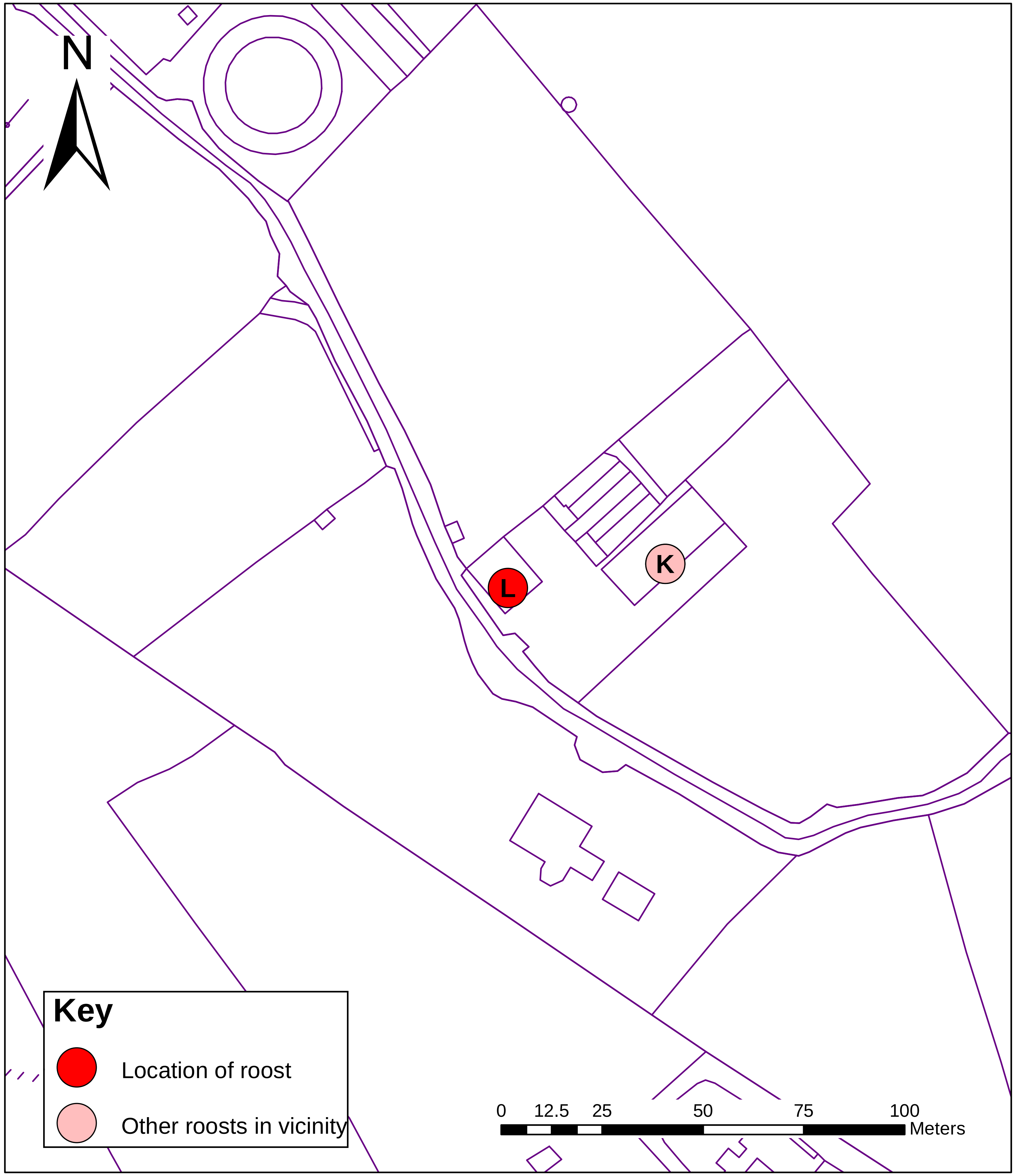
ITM: 533542 730077
Location: Cluanacauneen

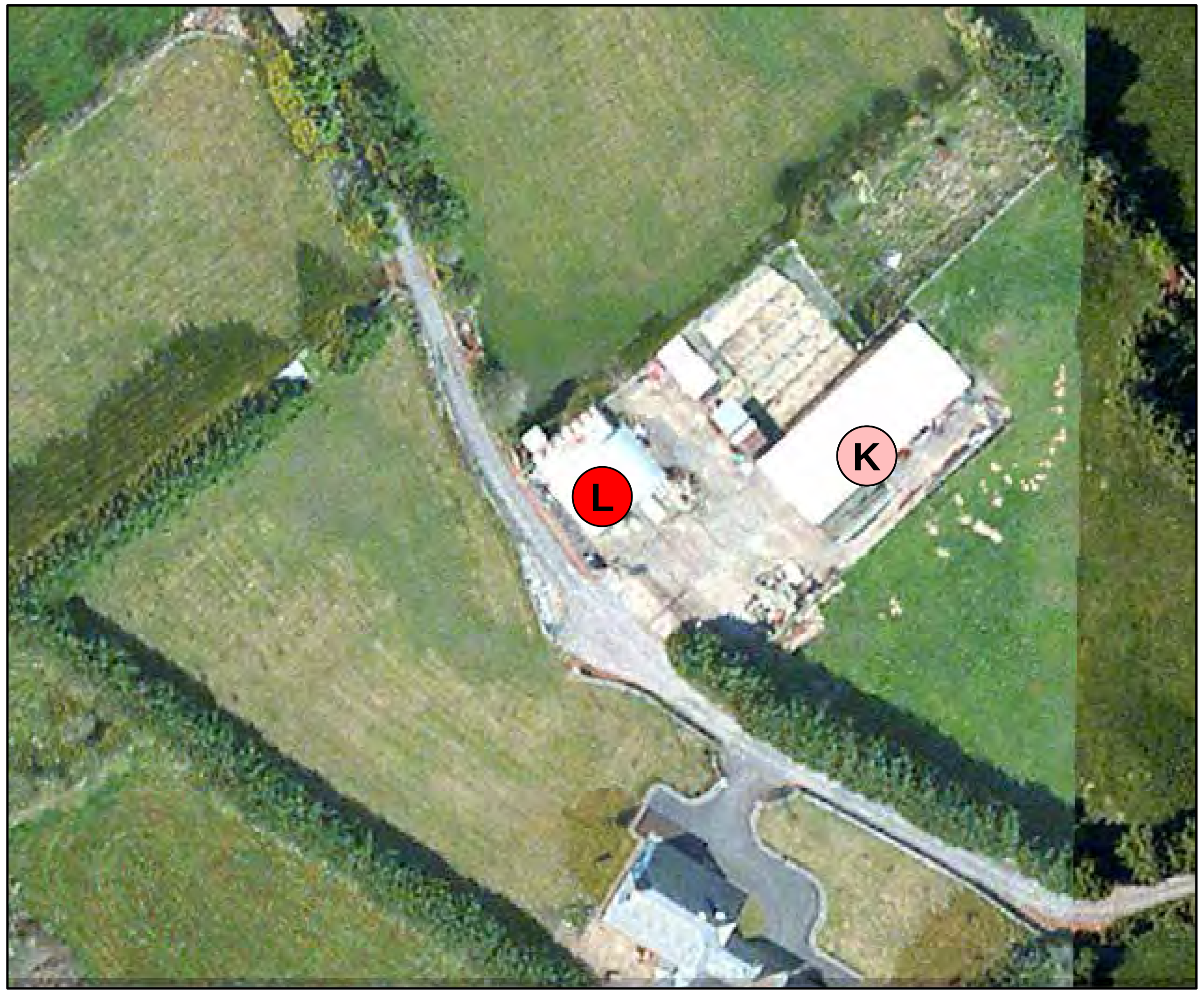
Species: Common Pipistrelle Sex: Male
Dates bats confirmed resident: 25th, 26th

Sheet 11 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





Roost L

GCTP Radiotracking
August 2014

ITM: 533503 730071
Location: barn nr roost K

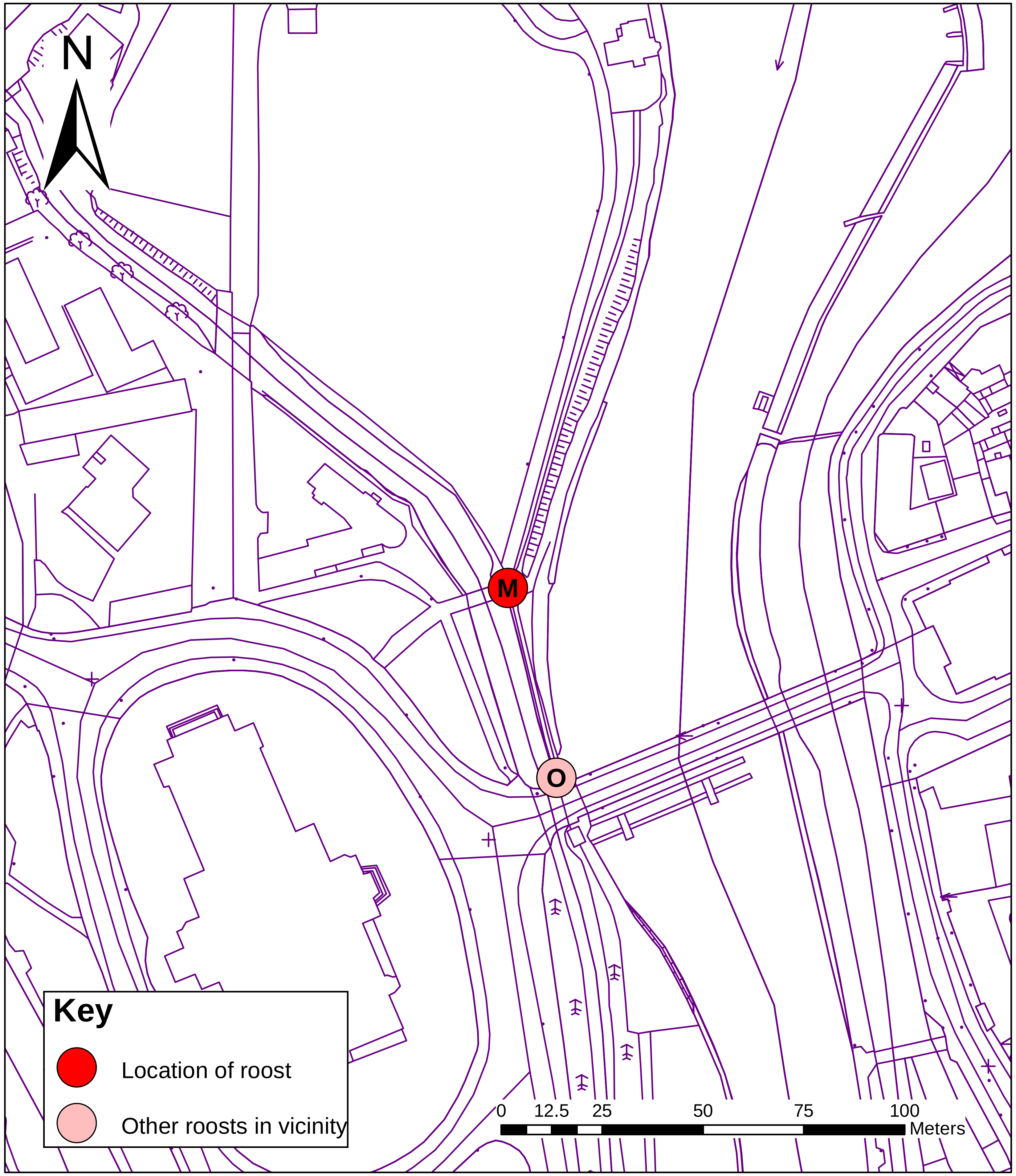
Species: Common Pipistrelle Sex: Male
Dates bats confirmed resident: 28th

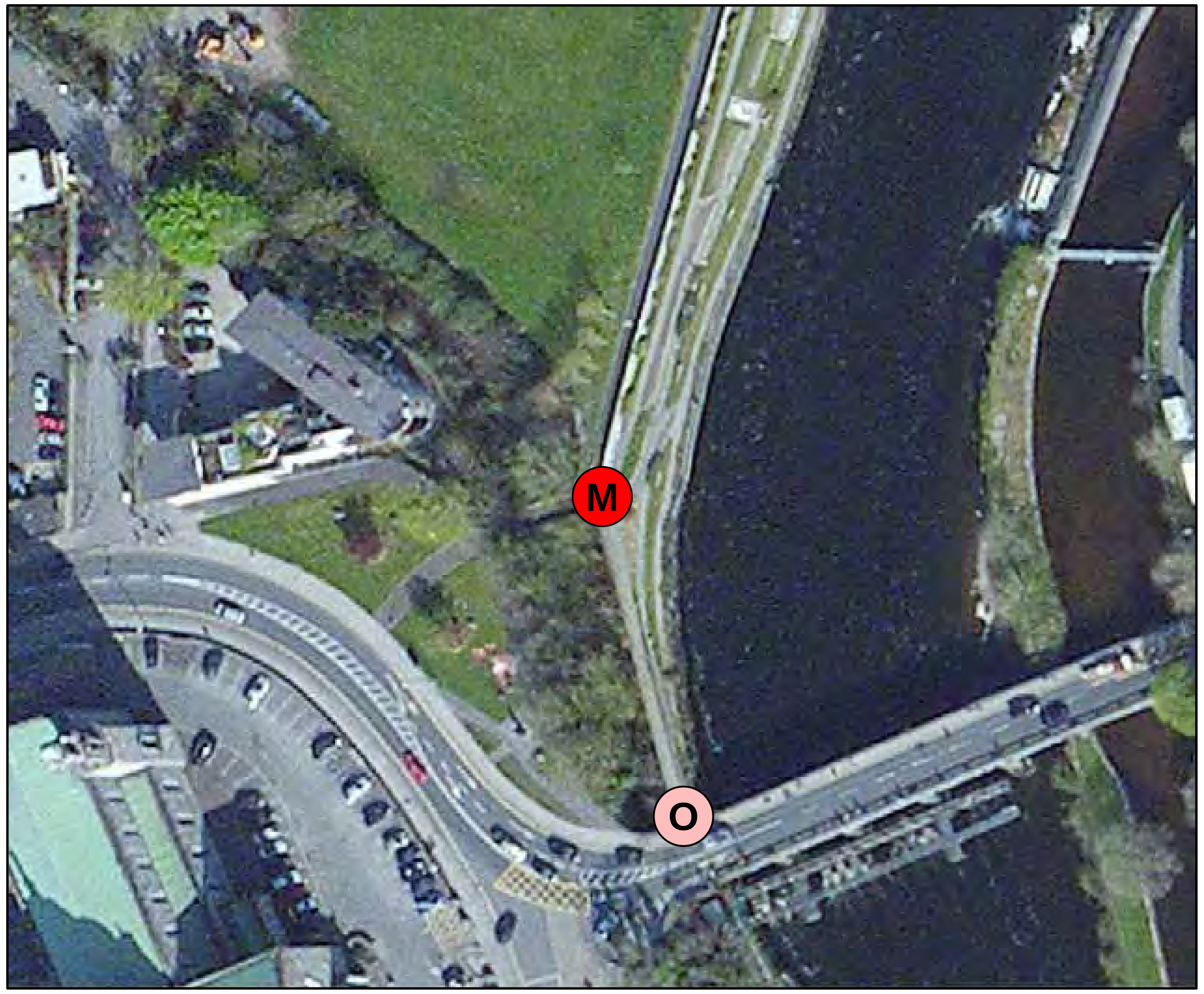
Sheet 12 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella Ecology and Geology





Roost M

GCTP Radiotracking
August 2014

ITM: 529520 725588
Location: Cathedral footbridge

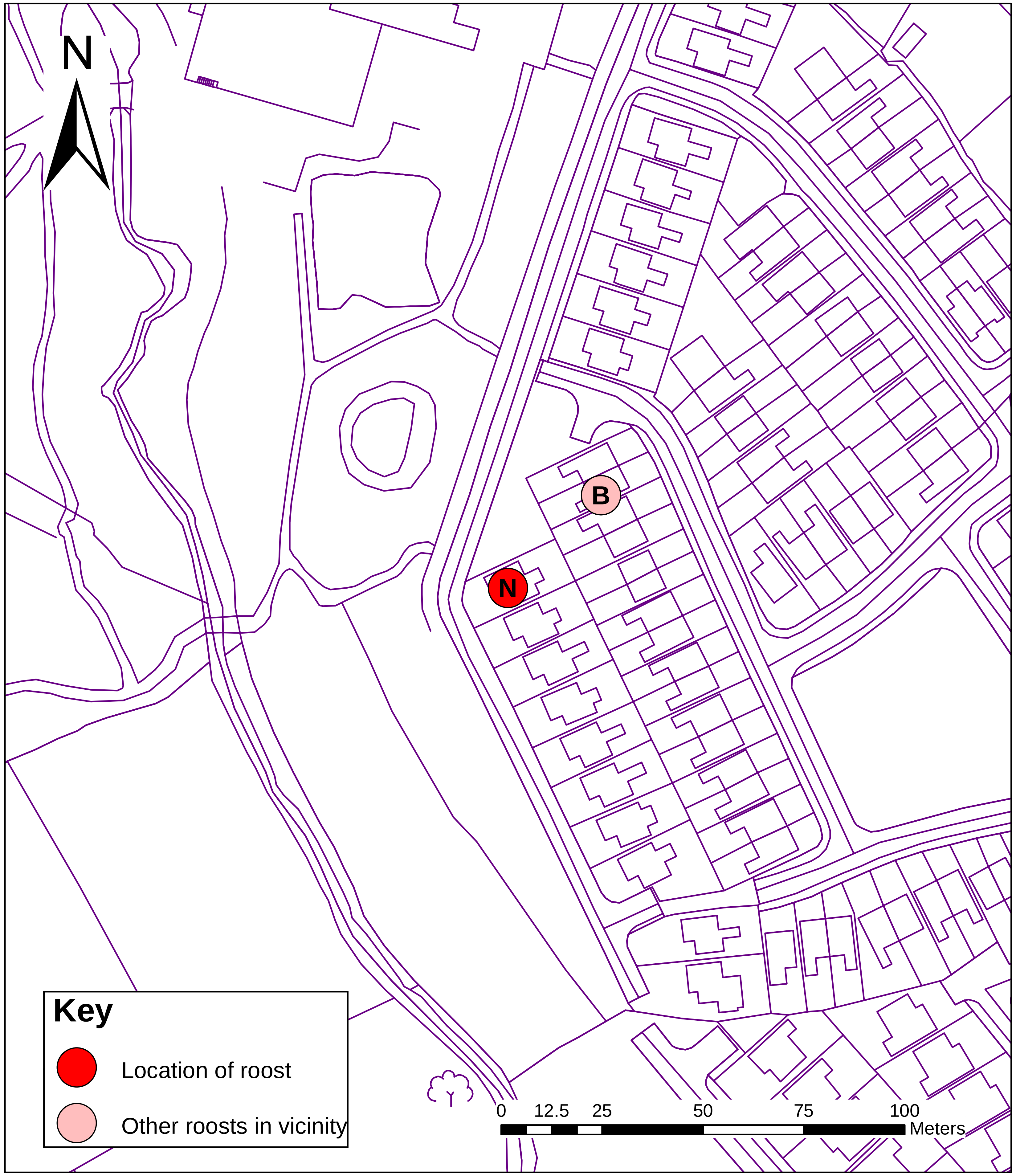
Species: Daubenton's **Sex:** Male
Dates bats confirmed resident: 28th

Sheet 13 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Geckoella
Ecology and Geology



Roost N

GCTP Radiotracking
August 2014

ITM: 524591 724159
Location: Ard Na Coille. Residence behind Sport's centre

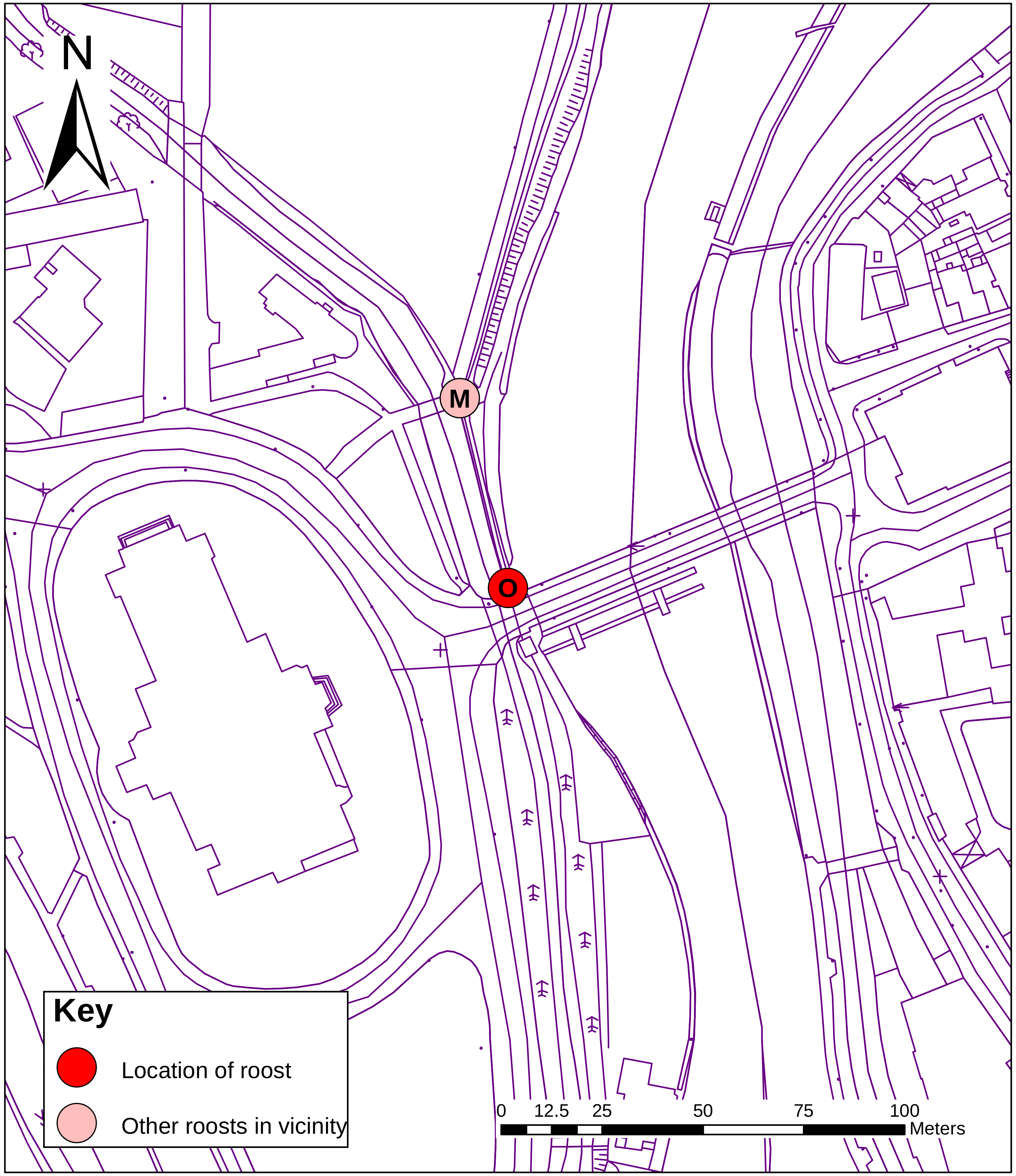
Species: Whiskered **Sex:** Male
Dates bats confirmed resident: 29th

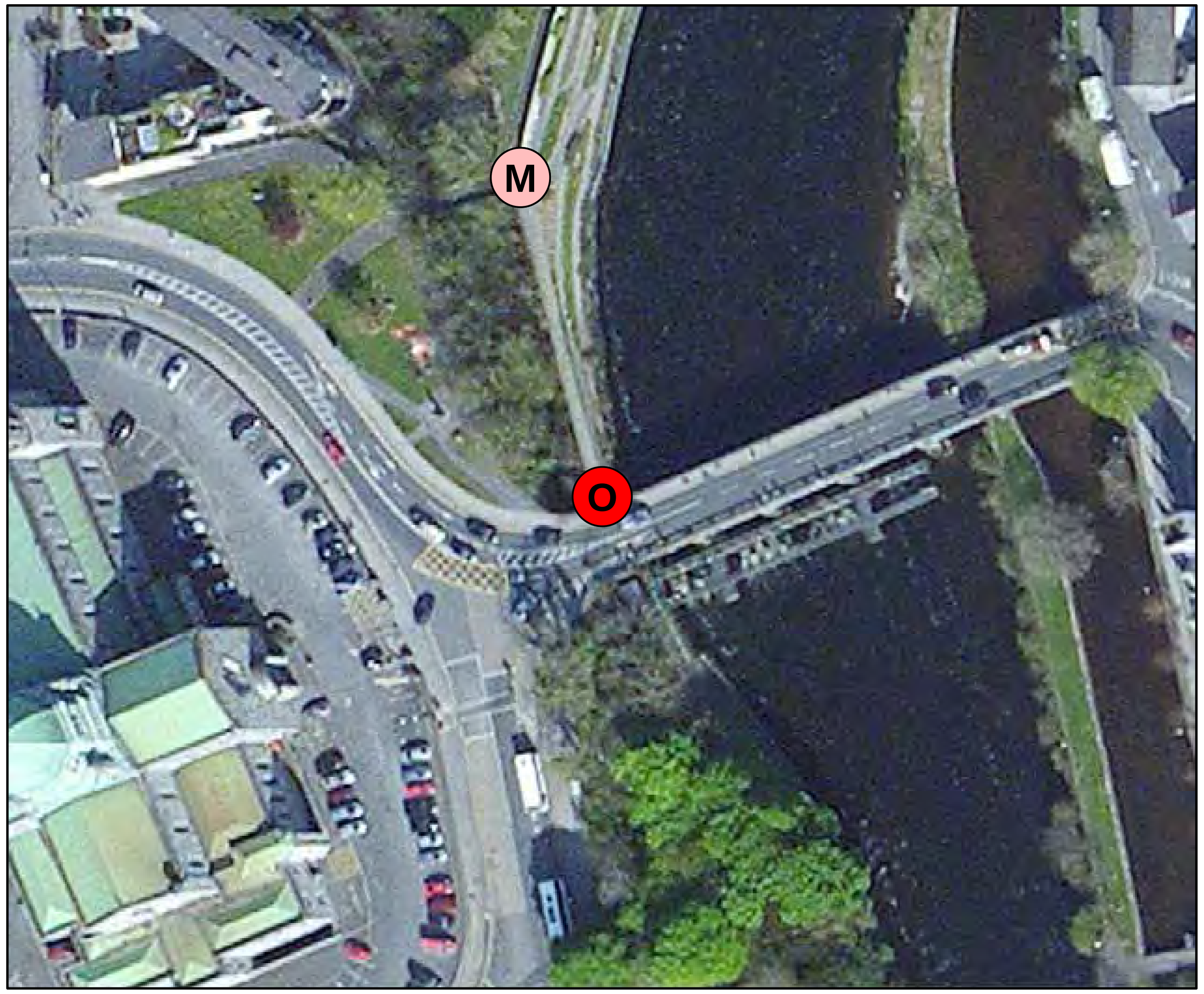
Note: Roost B backs on to Roost N. Although signal strength indicates separate roosts, would need to be between buildings to be certain.

Sheet 14 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





Roost O

GCTP Radiotracking
August 2014

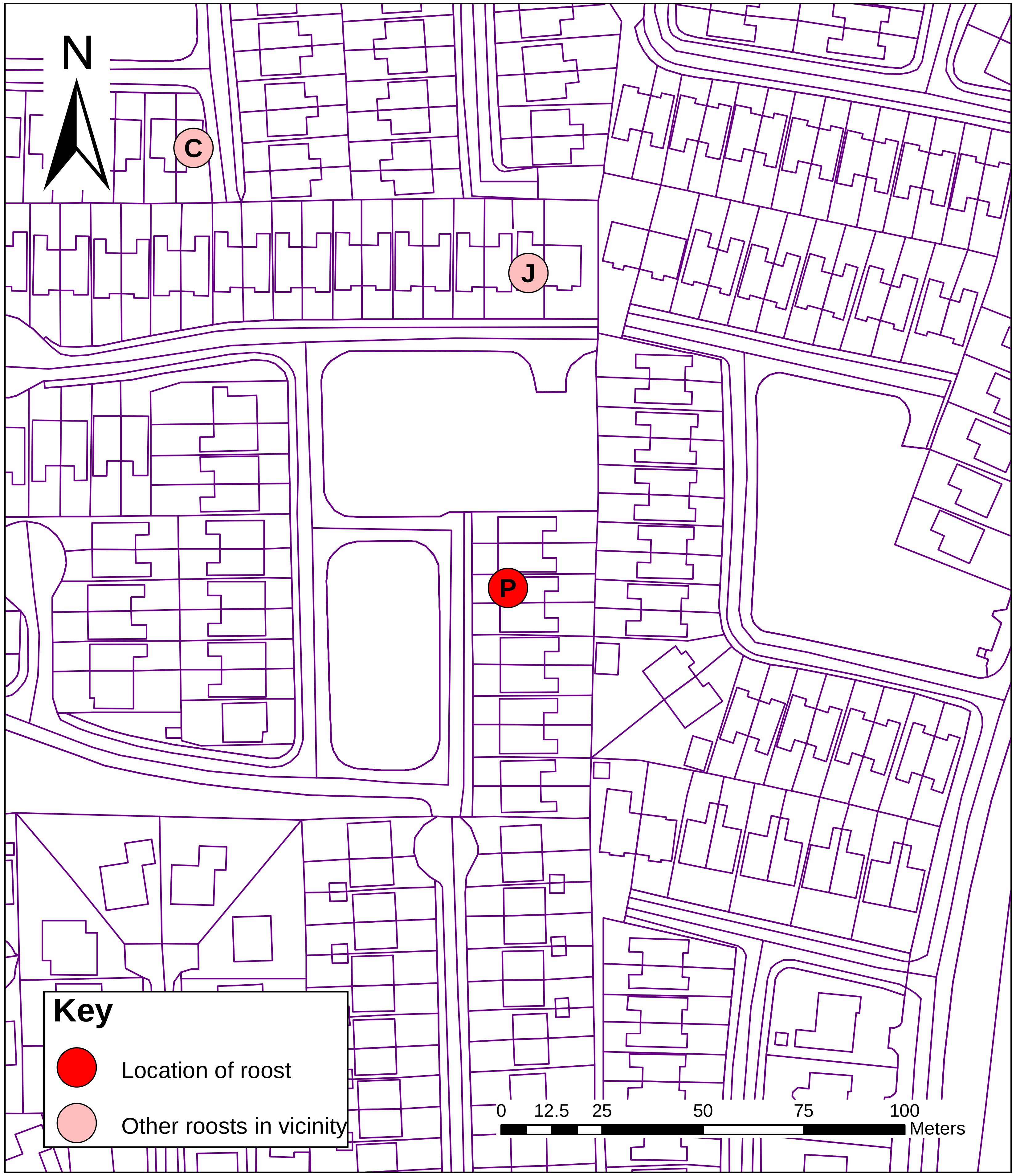
ITM: 529532 725541
Location: Salmon Wier Bridge

Species: Daubenton's **Sex:** Male
Dates bats confirmed resident: 29th

Sheet 15 of 16

GCTP: Roost Locations From Radiotracking

Figs 2A to 2P



Roost P

GCTP Radiotracking
August 2014

ITM: 526434 725235
Location: Residence. Ballymoneen. 68 Sli Na Sruchan

Species: Common Pipistrelle **Sex:** Female
Dates bats confirmed resident: 29th

Sheet 16 of 16

Figures 3A-3I. Detailed Radiotracking: Individual Bats

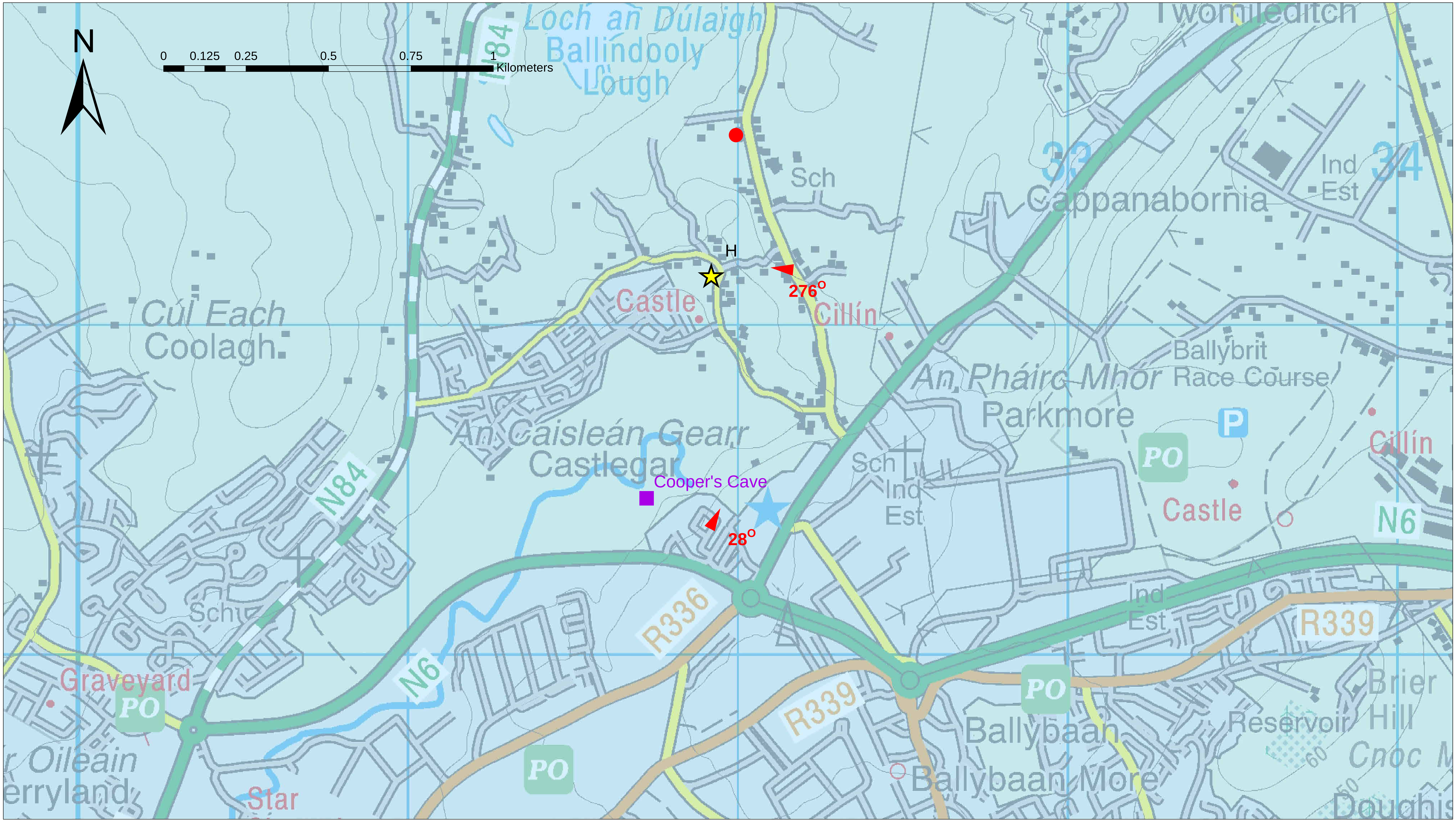


Figure 3A
Species: Brown Long-eared
Frequency: 173.395
Sex: Female   Breeding Condition: Y

Trapping Location:
Cooper's Cave, ITM 531729 727476, Date 21/08/2014
Roosts:
H. ITM 531925 728152. Dates resident: 24th, 25th, 26th, 27th, 28th, 29th

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

Figure 3B
Species: Daubenton's
Frequency: 173.459
Sex: Female   Breeding Condition: N

Trapping Location:
Merlin Woods, ITM 533450 725600, Date 19/08/2014
Roosts:
D. ITM 526370 728692. Dates resident: 25th, 26th, 27th

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

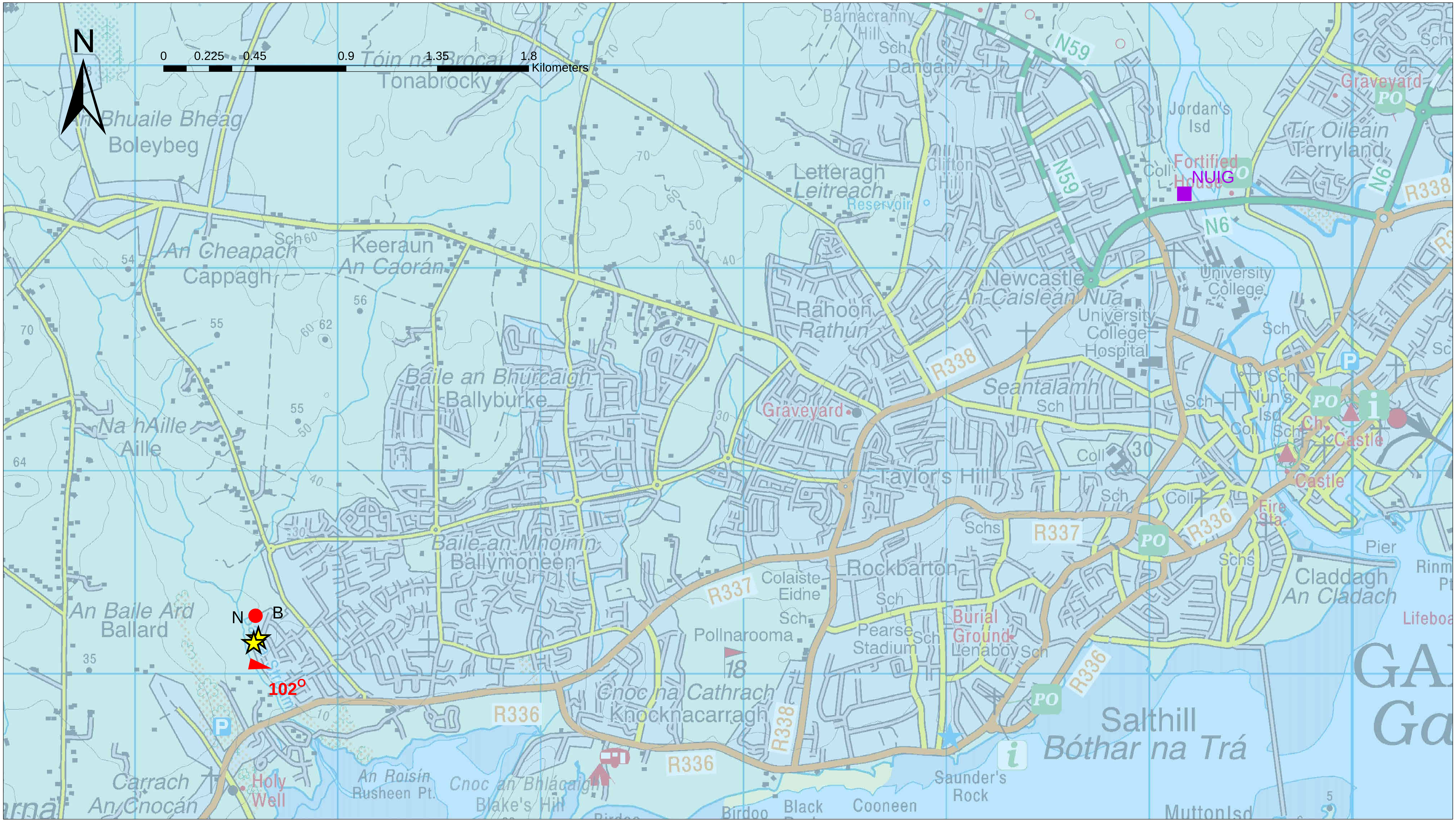


Figure 3C
Species: Whiskered
Frequency: 173.414
Sex: Male   Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
B. ITM 524614 724182. Dates resident: 24th, 25th, 26th
N. ITM 524591 724159. Dates resident: 29th

Geckoella Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

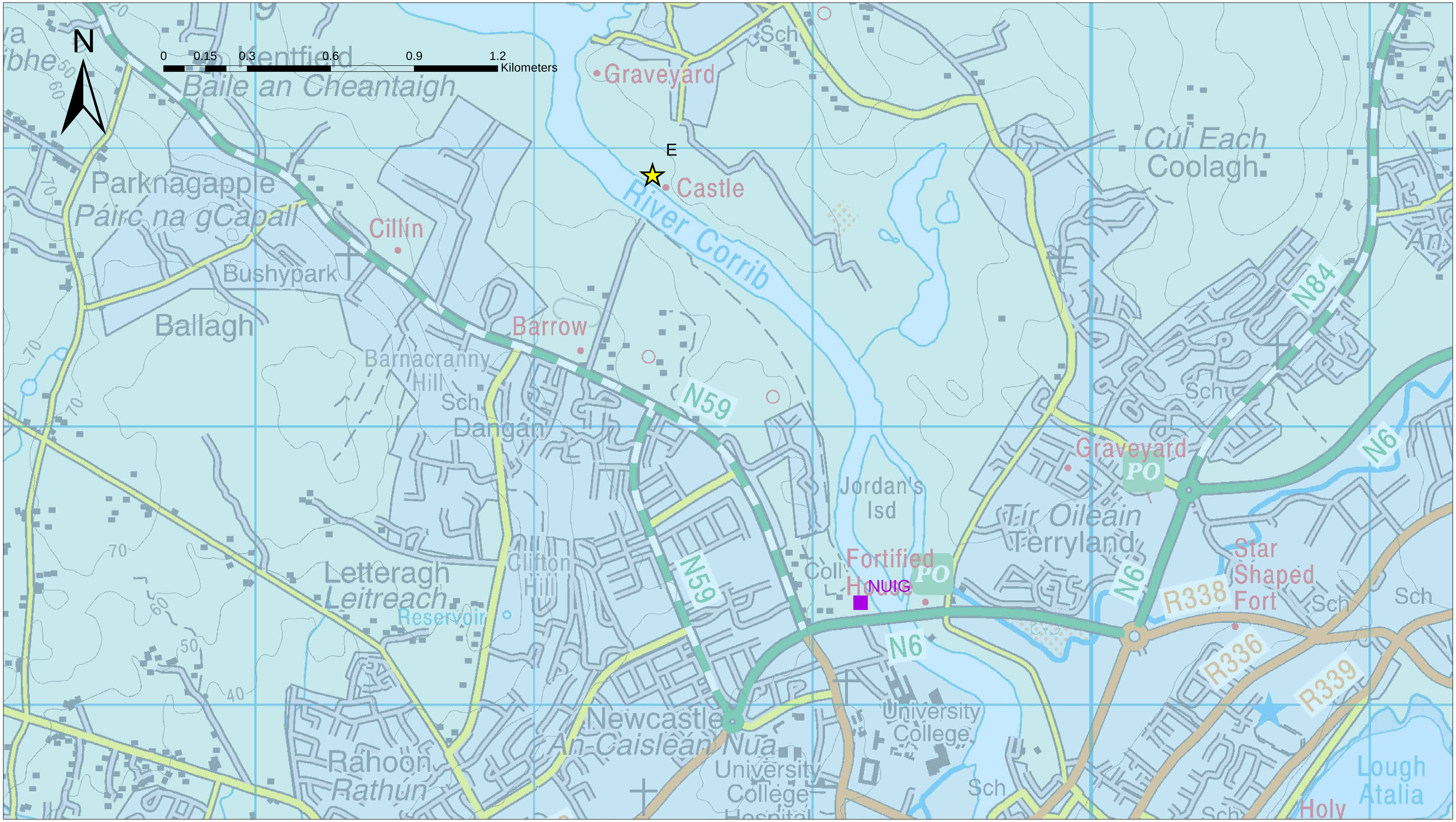


Figure 3D
Species: Daubenton's
Frequency: 173.252
Sex: Female   Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
E. ITM 528431 727907. Dates resident: 24th, 25th, 26th, 27th, 28th, 29th

Key
Fix with bearing
Fix without bearing
Tag Site
Roost

Geckoella
Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

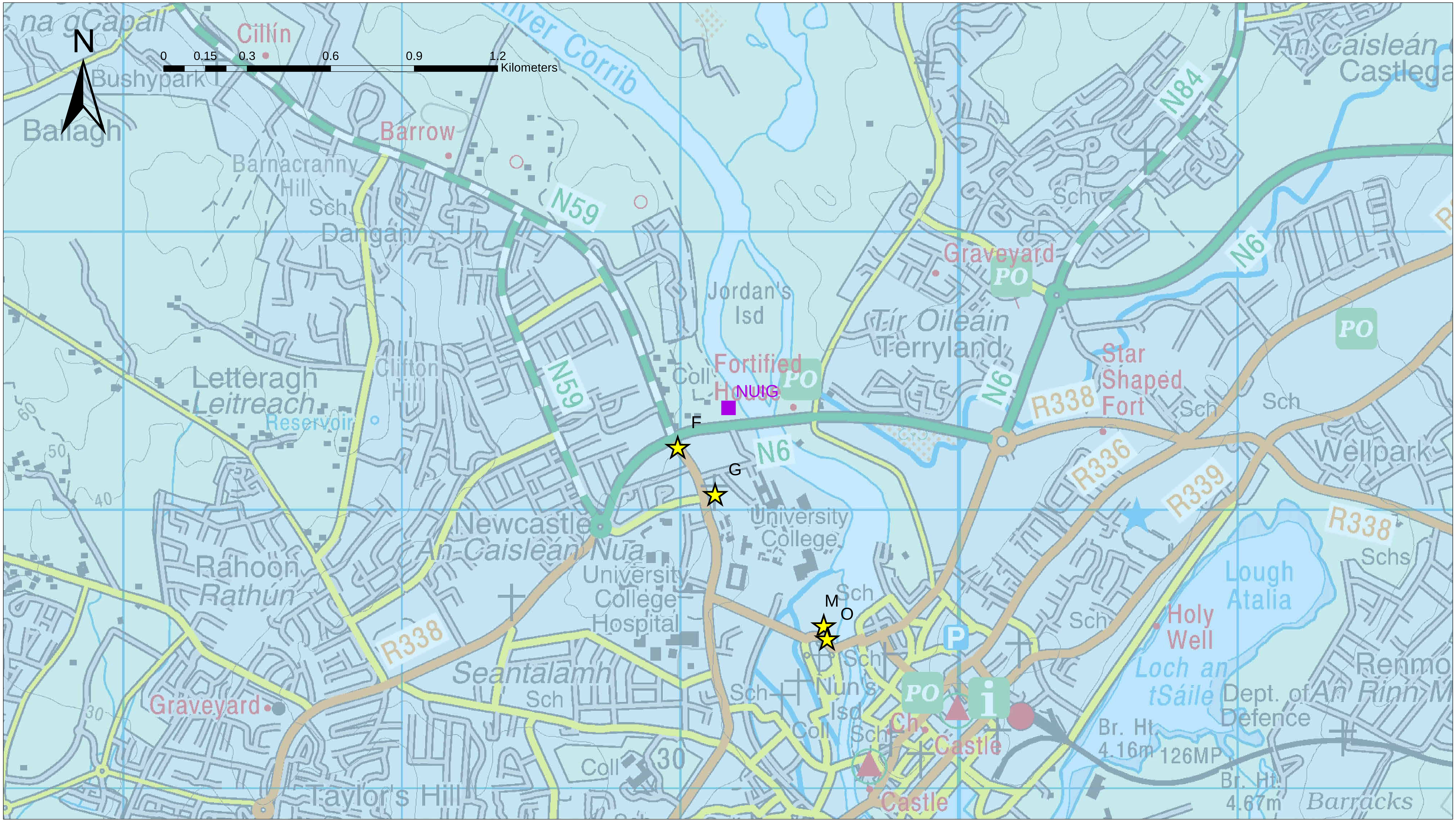


Figure 3E
Species: Daubenton's
Frequency: 173.297
Sex: Male   Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
F. ITM 528996 726229. Dates resident: 24th
G. ITM 529130 726060. Dates resident: 25th
M. ITM 529520 725588. Dates resident: 28th
O. ITM 529532 725541. Dates resident: 29th

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Eckoella
Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

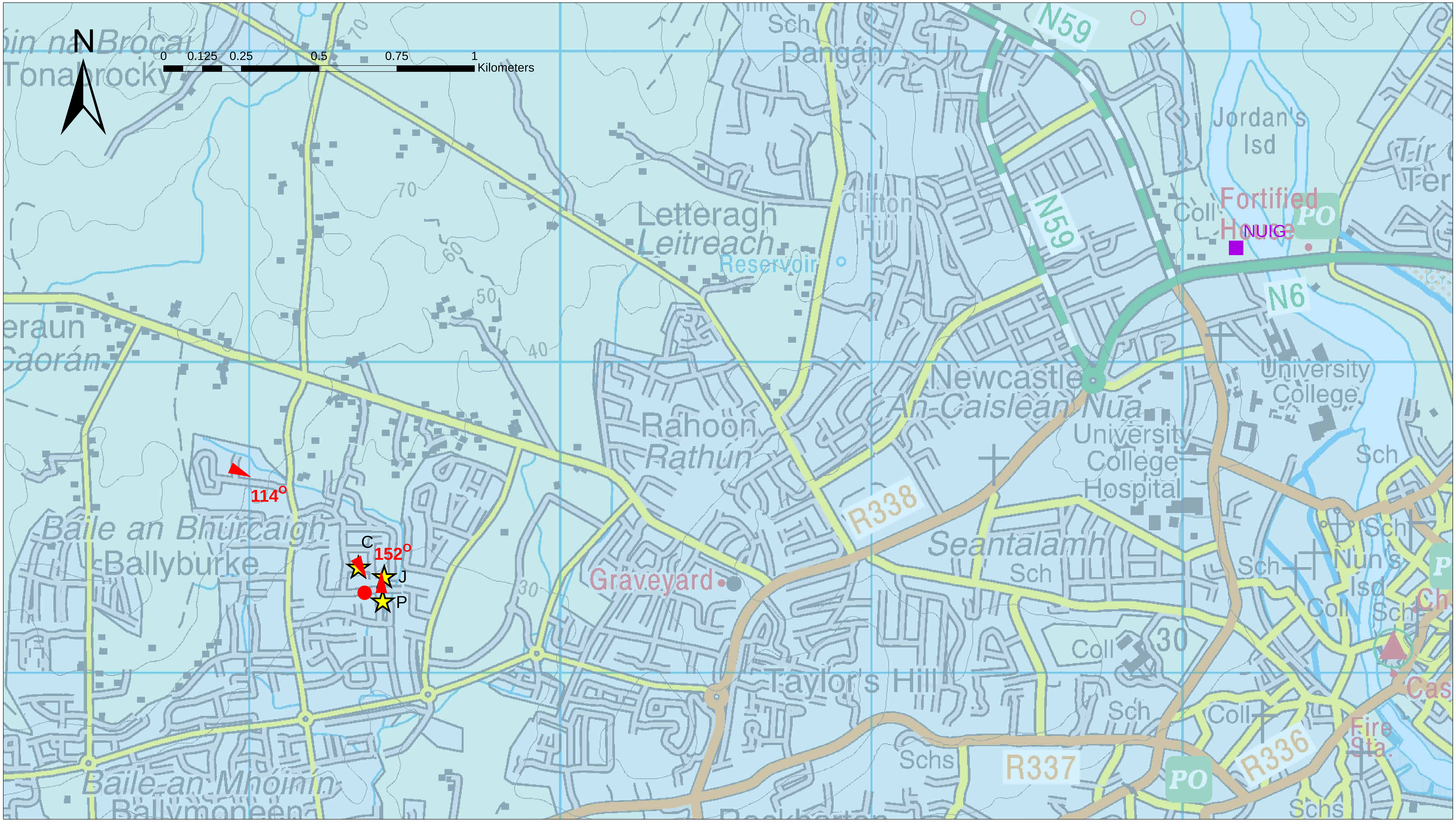


Figure 3F
Species: Common Pipistrelle
Frequency: 173.361
Sex: Femle   Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
C. ITM 526356 725344. Dates resident: 24th, 25th
J. ITM 526439 725313. Dates resident: 26th, 27th
P. ITM 526434 725235. Dates resident: 29th

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

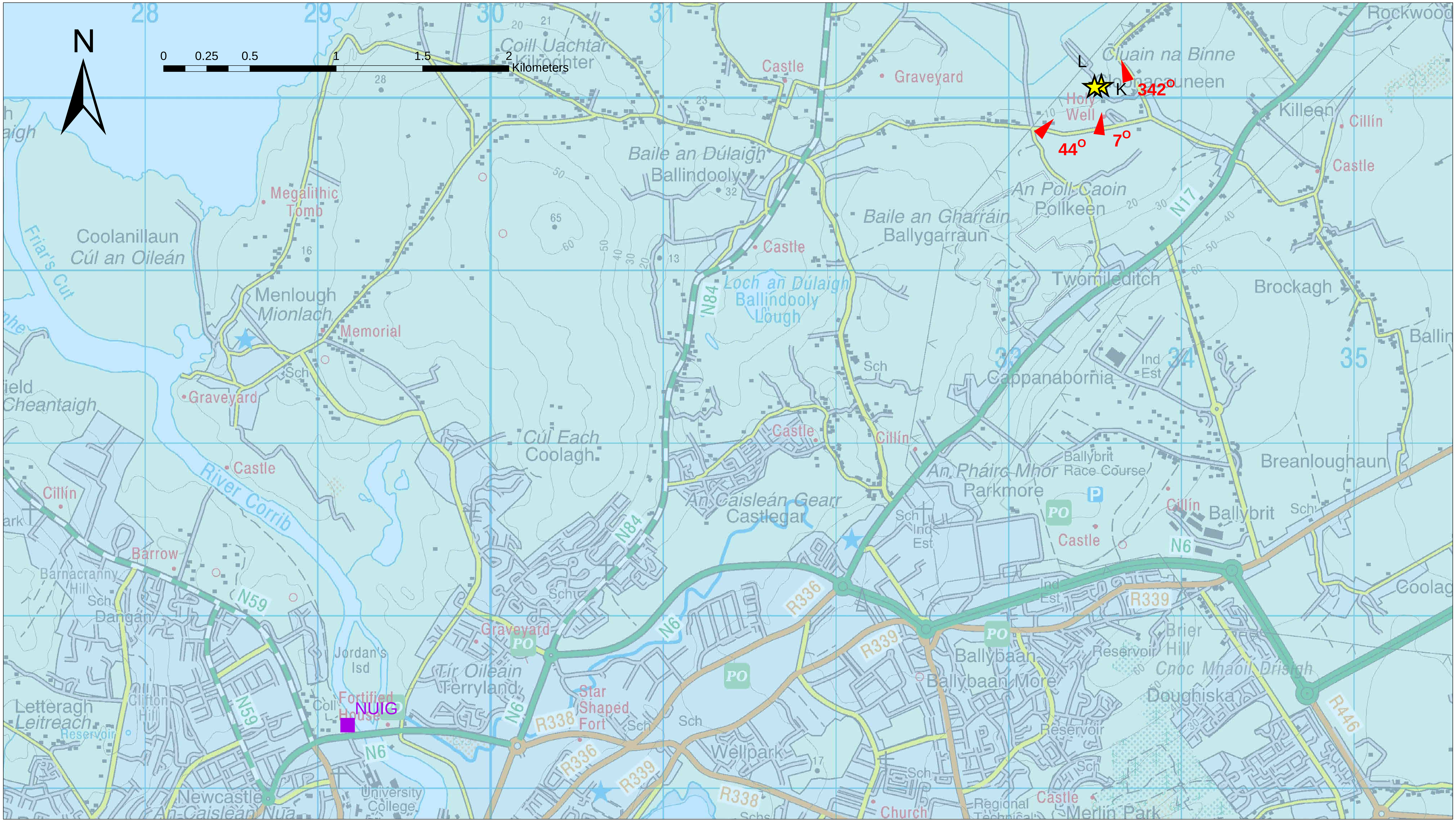


Figure 3G
Species: Common Pipistrelle
Frequency: 173.323
Sex: Male   Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
K. ITM 533542 730077. Dates resident: 25th, 26th
L. ITM 533503 730071. Dates resident: 28th

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

Figure 3H
Species: Leisler's
Frequency: 173.438
Sex: Male   Breeding Condition: Y

Trapping Location:
Barna Woods, ITM 524400 723800, Date 20/08/2014
Roosts:
Roost not located. Foraging data only

Key
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Eckoella
Ecology and Geology

Figures 3A-3I. Detailed Radiotracking: Individual Bats

Figure 3I
Species: Leisler's
Frequency: 173.535
Sex: Male   Breeding Condition: Y

Trapping Location:
Barna Woods, ITM 524400 723800, Date 20/08/2014
Roosts:
A. ITM 524485 725124. Dates resident: 24th, 25th, 28th
I. ITM 524391 725205. Dates resident: 26th, 27th

Key
Fix with bearing
Fix without bearing
Tag Site
Roost

Eckoella
Ecology and Geology

Appendix A: Weather in Galway 15-29th August 2014

The weather in August 2014 was broadly typical for Galway in summertime and did not pose a significant constraint to survey. Warm, humid, calm weather is good for flying invertebrates and hence good for bat foraging. Data highlighted in blue represents sub-optimal temperatures of less than 10ºC, wind speeds equivalent to Beaufort score of 5 or more (Fresh breeze), and/or significant rainfall. Trapping was not carried out in the wet and windy conditions of the 27th and 28th August. Two trapping nights were slightly cooler than optimum (21st and 23rd August). Daytime roost checks were not affected by the weather. The surveys started on 19th August; the data from 15th to 19th are included to show that good conditions for bats were present also prior to the start of survey.

	Weather during trapping						General weather in Oranmore near Galway during 24hr period						
Date	Site	Temp ºC	Humidity	Wind speed (Bft)	Cloud	Rain	Temp Max C	Temp Avg C	Temp Min C	Humidity Avg	Wind Speed Max km/h	Wind Speed Avg km/h	Precipitation Sum cm
15/08/2014							21	16	12	71	21	5	0
16/08/2014							17	15	14	80	27	6	0.03
17/08/2014							19	15	12	73	34	7	0.03
18/08/2014							18	14	11	73	27	6	0.05
19/08/2014	Merlin Woods	16	moderate	1to 2	4	0	18	14	10	71	24	4	0.1
20/08/2014	Barna Woods	13	81	1	4	Slight shower	18	13	9	73	19	3	0
21/08/2014	Cooper's Cave	cool, dropped below 11 during survey	75	2 to 3	overcast	0	19	14	12	76	26	5	0.05
22/08/2014	NUIG	12	70	2	0	0	18	14	11	71	27	5	0
23/08/2014	Sports fields	12 at start, dropped to 9	68	1 to 2	clearing		19	14	9	68	24	3	0
24/08/2014							16	13	9	87	32	6	0.2

Appendix A: Weather in Galway 15-29th August 2014

	Weather during trapping						General weather in Oranmore near Galway during 24hr period						
Date	Site	Temp ºC	Humidity	Wind speed (Bft)	Cloud	Rain	Temp Max C	Temp Avg C	Temp Min C	Humidity Avg	Wind Speed Max km/h	Wind Speed Avg km/h	Precipitation Sum cm
25/08/2014							20	16	14	94	32	7	0.48
26/08/2014	Menlo Woods	15-16	High	1-2	4 to 8	0	18	16	15	89	31	7	0.03
27/08/2014							17	15	14	89	47	10	0.05
28/08/2014							19	15	11	86	43	8	1.27
29/08/2014							18	16	14	90	31	7	0.61

Data on General Weather during 24hr period produced under license from Weather Underground.

http://www.wunderground.com/personal-weather-station/dashboard?ID=ICOGALWA2#history/s20140805/e20140812/mweek

Weather Station ID: ICOGALWA2. Station Name: Oranmore
Latitude / Longitude: N 53 ° 16 ' 28 ", W 8 ° 55 ' 45 ", Elevation: 0. City: Oranmore, State: Co.Galway
Hardware: Davis VP2(24h FARS), Software: meteohub, Owner: Private

Annex A: Summary notes on the geology of Galway, and its potential for bats and roosts

Introduction

Underground sites can be extremely important roost sites for bats, offering in particular hibernation roosts for the winter and swarming roosts for social and mating behaviour in the Autumn. Locating underground sites in a limestone landscape can be challenging. These notes describe the geology of the area in order to narrow down the area of search for suitable features for bats in the limestone landscape around Galway.

Geological setting of Galway

The geology of Galway and surrounding area is shown in Figure 1. To the east and south of the city, including the Inishmor isles, the area is dominated by Lower Carboniferous (Tournaisian and Viséan) sediments comprising limestones, calcitic mudstones and sandstones. Devonian-aged sandstones, conglomerates and mudstones (Old Red Sandstone) crop out to the south-west of the area between Loughrea and the border with County Clare. High ground west of Galway (including Moycullen Bog and Oughterard District Bog NHAs, and extending north-west towards Connemara) is formed mainly of igneous rocks, comprising a core of Silurian and Devonian granites and appinites, with fringing areas of Lower Palaeozoic gabbros and diorites, and occasional Ordovician-aged volcanic rocks.

Geology of Galway City area

The bedrock geology of Galway City itself comprises three main lithologies:

i) Lower Palaeozoic gabbros and diorites, which occur in a roughly triangular-shaped central area extending from Dangan Heights/Galway Business Park southwards to Galway Bay (Cuan na Gaillimhe). The western side of the triangle runs via Shantallow (Seantalamn) to Salthill; the eastern side runs via Newcastle (An Caisleán Nu) and south of Townparks to Renmore Barracks (Dun Ui Mhaoiliosa)

ii) Lower Carboniferous (Viséan) limestones and calcitic mudstones, which occur east and north of the gabbros and diorites, and extend from Lough Corrib (Loch Coirib) eastwards beyond Claregalway (Baile Chláir) and Oranmore (Oran Mór)

iii) Siluro-Devonian granites and appinites, which occur west of the gabbros and diorites, and extend beyond Barna (Bearna) and Tonabrochy (Tóin na Brocai) to the highground of Moycullen Bogs NHA and further west.

The main lower Carboniferous limestones in and around Galway City are Viséan-aged (Upper Viséan, D_1-D_2 zones), and include strata now assigned to the Knockman Formation. Kinahan (1869, pp. 21-22) recorded quarries in the townlands of Angliham and Menlough on the south-east shore of Lough Corrib, three miles due north of Galway town. These quarries were formerly worked for their bands of dark limestone known as 'Galway black marble' which was formerly highly sought after and exported. Kinahan (loc. cit.) also reported quarries in the vicinity of Terryland village which were worked for general building stones. All these quarries contained numerous limestone crags, and sections in excessive of 12m height were worked.

Characteristically, the majority of limestones in the Galway City area are horizontally-bedded or exhibit very shallow dips (less that 10°), only locally does the dip reach up to 20-25°.

Limestone features, and potential for bats and roosts

The limestones exhibit considerable lithological variation and include:

- massive, compact varieties;
- other types which are more susceptible to water solution and form caves and other karstic features (such as 'mushroom rocks' and irregular limestone pavements);
- other limestone types which are more siliceous ('flinty') and shatter, providing tight crevices and fissures in quarry faces.

Interbedded within the limestone sequences are calcareous shales and calcitic mudstones which are relatively impervious and act as boundary layers along which surface and subsurface water may migrate and form cavities. This varied lithology is regarded here to offer considerable potential for a wide variety of possible roost sites for bats.

Table 1 provides a list of limestone quarries and cave/karst features identified within the Galway City area and signs of bat presence noted.

A case-example indicating the potential that geological features may have for identifying areas of possible interest for bat and roost sites is provided by Cooper's Cave at Castlegar; at least two species of bat (Lesser Horseshoe *Rhinolophus hipposideros* and *Myotis* sp.) are now recorded to use Cooper's Cave despite the cave showing signs of extensive human disturbance (litter) and smoke damage from fires lit within it.

Figure 2 is schematic, but demonstrates the principle that extrapolation of the generally horizontally-bedded limestones from Castlegar (including the limestone unit in which Cooper's Cave occurs) to the northwest indicates that the same limestone strata may crop out along the flanks of Cnoc an Ghearrtha. Several other quarries (including Angliham Quarry and old quarries along Route N84, see Table 1) are likely to have directly worked these strata, or to have excavated down to the levels of these limestone units.

Field observation and aerial photo analysis confirms that limestone faces are exposed in these quarries, and these faces are likely to include the same limestone features found at Castlegar which readily form caves and fissures, and, if present, these have considerable potential for use by bats. **Further investigation of these quarry sites to properly assess their potential use by bats is highly recommended, since the probability of further fissures and cave features within these geological beds is high.**

Conversely, limestone areas less likely to have roost features suitable for bats include the limestone pavement areas – these do not expose the type of limestone which is most likely to have fissures and caves.

Dr. Andy King, September 2014

References

Galway City Council, 2011-2017: SEA Environmental Report to Development Plan 2011-2017 (available at http://gis.galwaycity.ie/devplanflipbook/sea). 111pp.

Kinahan, G. H. 1869: Explanation to accompany Sheet 105 with that portion of Sheet 111 that lies on the North of Galway Bay of the Geological Survey of Ireland. Memoirs of the Geological Survey. Dublin & London. 63 pp.

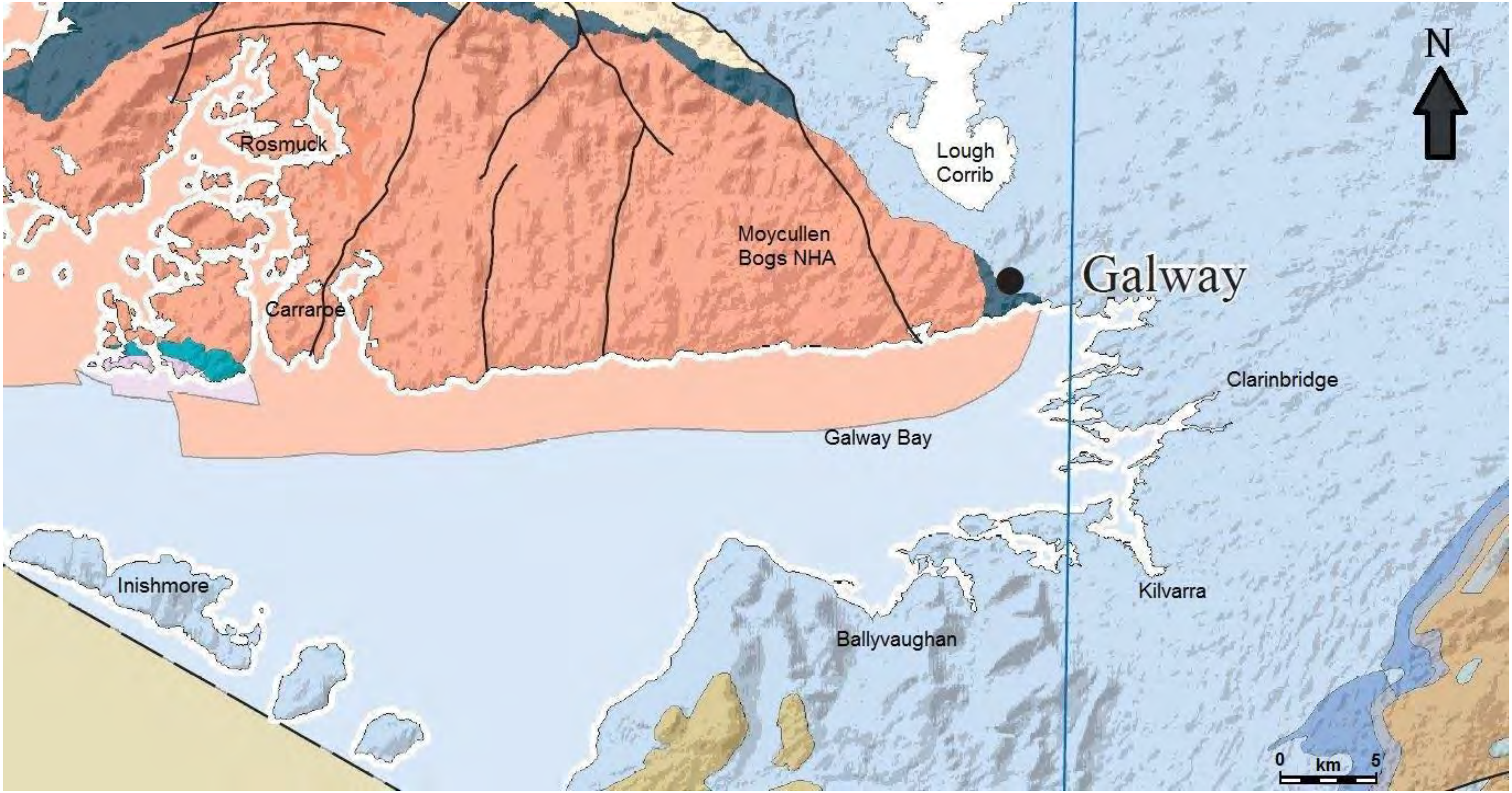
OS Maps, 1842: Galway Six Inch OS maps (available at http://www.galway.ie/en/Services/Library/1842OSMaps)

Location	**Northing**[1]	**Easting**	**Status**	**Bat observations**	**Notes**[1]
Cooper's Cave (Cooley's Cave), Castlegar	131761	227409	Cave	Lesser-horseshoe *Rhinolophus hipposideros* and *Myotis* sp. seen in cave (21 Aug 2014)	Limestones very shallowly dipping / horizontal. Smoke damage and litter, few cave decorations remaining
Newry's Cave, Merlin Park	134345	225287	Cave	Recent bat droppings found (28 Aug 2014), currently being analysed	County Geological Site, Galway 'black marble', Upper Viséan, brachiopod fossils, minor damage/disturbance , cave decorations present
Lackagh Quarry, Coolough	130473	228383	Active quarry	Not visited	Not visited
Roadstone Quarry, Tuam	132893	229198	Quarry in receivership	Not visited	Not visited. County Geological Site. Limestone aggregate quarry, Knockman Formation
Angliham Quarry, near Kilroghter	129222	230119	Disused quarry	Records of Lesser-horseshoe roosting at site, 2014 (SCA, pers. comm.)	Not visited. Galway 'black marble', Upper Viséan
Old quarry by N84, near Ballindooley	130978	228163	Disused quarry	Not visited	Not visited, access from Route N84 (locked gates)
Old quarry tips, Caireal Mór	131114	228002	Quarry tips	Not visited	Not visited, exposed quarry faces still remaining?
Old quarry tips, Ballygarruan	131026	228838	Quarry tips	Not visited	Not visited, exposed quarry faces still remaining?

Table 1. Limestone quarries and cave/karst features identified within the Galway City area (during period of survey, 14th – 30th August 2014)

([1]Notes based on field observations where sites visited, and literature searches: Kinahan, 1869; OS Maps, 1842; Galway City Council 2011-17)

[1] Irish Grid coordinates



Explanation of Bedrock Geology

- Lower Carboniferous (Visean) limestones and calcareous mudstones
- Lower Carboniferous (Tournaisian) limestones, sandstones and mudstones
- Devonian (Old Red Sandstone) sandstones, conglomerates and mudstones
- Siluro-Devonian granitic rocks and appinites
- Lower Palaeozoic gabbroic-dioritic rocks
- Ordovician volcanic rocks

Figure 1. Bedrock geology of Galway and environs

Onshore geology derived from Bedrock geology of Ireland (Geological Survey of Ireland, 2014), 1:500,000 Bedrock geology map of Ireland, 1:100,000 Bedrock Map Series; Offshore geology derived from EMOD net project map compiled by GSI and INFOMAR, with materials from the British Geological Survey, NERC 1982, 1986, 2009.

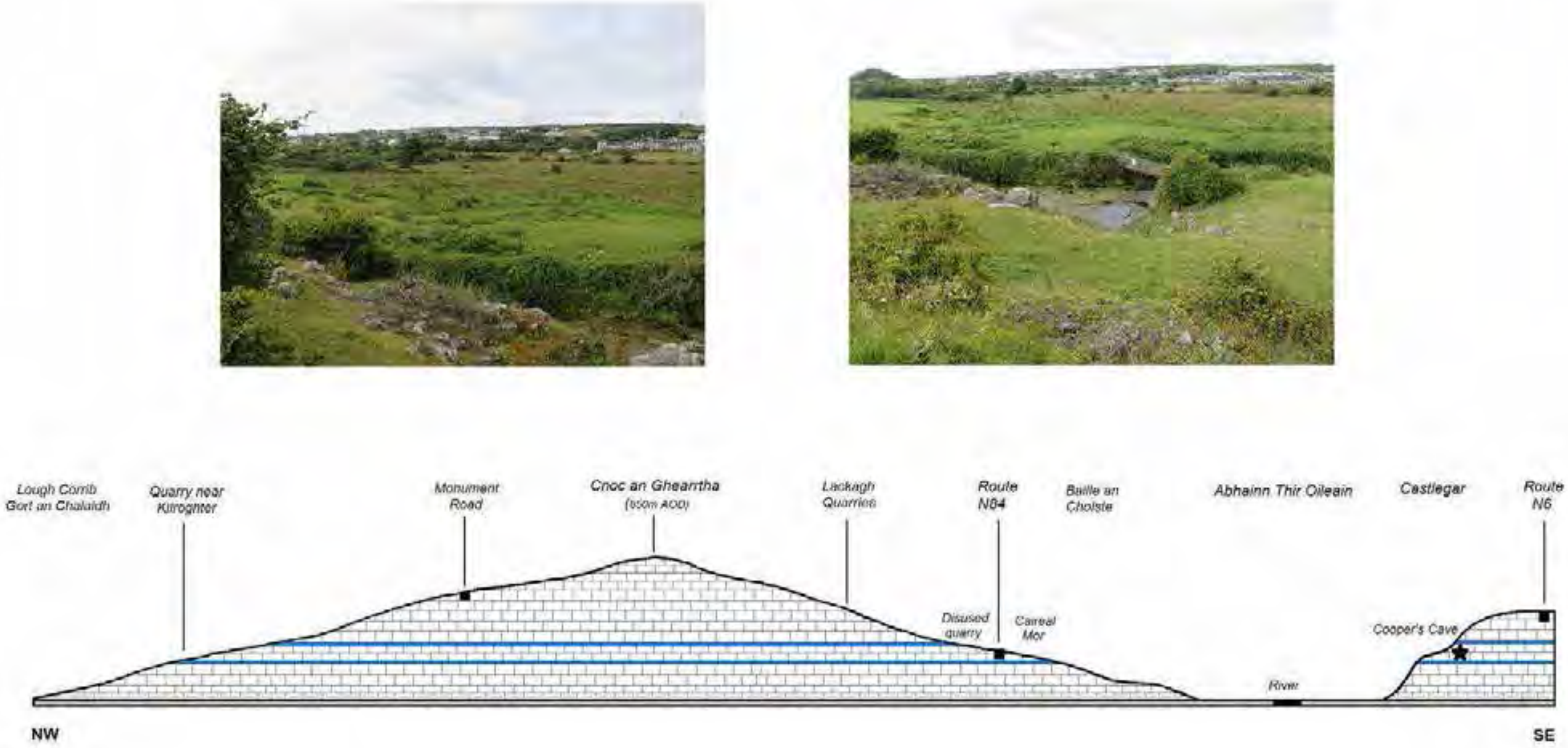


Figure 2. Diagrammatic NW-SE cross-section from Lough Corrib (Gort and Chalaidh) to Castlegar (Glenburren Park and Route N6), distance 4.6km, vertical scale exaggerated.

(Inset photographs; views NW to Baille an Choiste and hillside quarries (towards Cnoc an Ghearrtha) from Castlegar ridge, near Cooper's Cave)

Annex D

Galway bat radio-tracking project. Radio tracking studies of Lesser horseshoe bat species, May 2015 (Rush & Billington, 2015)

D1

Greena Ecological Consultancy

Galway Bat Radio-tracking Project

Radio tracking studies of lesser horseshoe bat species, May 2015

Photo by Isobel Abbott

DRAFT V1A October 2015

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Contents

Executive summary

Greena Ecological Consultancy was been commissioned by Scott Cawley Ltd to undertake a follow up radio-tracking studies in Galway, Republic of Ireland, to inform the N6 Galway City Transport Project. The study was conducted to obtain information on where the bats roost, breed, forage and the extent of their range in order to be able to determine the potential impacts of the proposed Scheme on the local bat populations. A baseline survey has previously been conducted in August and September 2014; however, spring session was not included due to the timing of agreements and permissions necessary for the work. This survey was; therefore carried out in order to provide a full picture of bat activity in the area throughout the year.

No previous radio-tracking study covering Lesser horseshoe bats as well as vesper bats had been undertaken in the area of interest prior to 2014. Scott Cawley carried out static monitoring in combination with emergence surveys and roosts inspections prior to the 2014 radio-tracking study in order to provide basic information on bat colonies present in the area of interest. Static monitoring was extended further beyond the duration of the 2014 study to provide additional data for the radio-tracking study proposed for 2015.

This single radio-tracking study was and carried out by Greena Ecological Consultancy in May 2015. This session, together with the results from 2014, aimed to help understand potential seasonal shift in activity patterns of Lesser horseshoe bats while avoiding interference during the most sensitive period of bat life cycle when females give birth and lactate (suckle their young).

Greena Ecological Consultancy captured four Lesser horseshoes *(Rhinolophus hipposideros)* during the May session, all of them females, three recognisably (but not heavily) pregnant, while one female was considered to be born the previous year so has not bred before nether did she show any signs of pregnancy when captured.
All bats were captured in a static mist net stretched over maternity roost entrance. Bats were of good health, weight ranging from 5.9g to 6.3g. Two of the females (Bat 1 and Bat 4 in this study) were captured and radio-tracked during the previous session in 2014 – their rings were identified as fitted by Greena Ecological Consultancy in August 2014. These bats were previously tracked as Bat 8 and Bat 3 respectively in the 2014 first session. Two females (Bat 2 and Bat 3) were not previously fitted with rings, suggesting they were not present in the roost during the summer session of 2014. These females were ringed in May 2015 at the same time all bats subject to this study were fitted with radio-transmitters. Despite efforts to catch Lesser horseshoe bats from previously identified night roosts west of Galway (excluding Coopers Cave), no other catching session was successful and, therefore, only four bats were studied in 2015, and no other bats were captured.

Between 16th May 2015 and 23rd May 2015, bats were tracked wherever they ranged and were found as far south as the Galway harbour and the area of University College Hospital; south of Ballagh in the west, north to Gort an Chalaidh Angliham and partially across the southern part of Lough Corrib and north of Coolagh in the east.

During the spring session, LHS foraged up to 3.56km from their roost, considerably less then was recorded later in the season in 2014, with majority of bats utilising the immediate area of

Menlo Castle, Menlough village and Menlo Woods. Hedgerow systems in Coolagh area as well as the area of woodland south of Menlough village were very popular. All four bats were utilising similar are for foraging; more than 62% of all recorded locations of each bat fell into the same foraging core area.
The west-most record of a LHS occurrence was less than 2km west of Menlo Castle, the north-most record lies 3.1km away from the roost. Surprisingly, LHS did not avoid Galway City and the south extreme of the overall foraging area was located 3.59km south of Menlo Castle. The eastern edge of foraging areas was located 1.56km away from the maternity roost.

Very limited number of night roosts were found during the 2015 radio-tracking session, majority of bats were returning back to Menlo Castle, their original roost, each night after foraging. The only exception was Bat 3, night- and day-roosting several days in a boulder field before returning back to day-roost in the castle. Bat 2 was also recorded to utilise a natural limestone formation for night-and day-roosting later in the due course of the radio-tracking study.

Bats were foraging in adverse weather and did not seem to be influenced by rain or strong wind. The weather conditions in May were mainly wet and this may have influenced the extent of the overall foraging area. The foraging area was generally smaller than recorded in August and September 2014 and all bats were recorded to forage in a core area largely overlapping between the studied females.

All bats in May session displayed foraging behaviour for two to three hours after dusk most of the nights, after that they returned to roosts or found a night roost where they spent a large part of the night. This behaviour was clearly associated with the sudden drop in temperature in the early evening and further decrease throughout the night.

1.0 Aims and Objectives

The overall aim of the study was to effectively preserve the availability of foraging areas, flight routes and roosting sites of bats and to provide detailed information to inform the project.

The objectives of this study were to identify the principal feeding areas and commuting routes of the main known Lesser horseshoe maternity colony in the Galway area, and to determine the night and day roosts used. While studies in 2014 aimed to gain information during the peak maternity roosting period and pre-hibernation behaviour of Lesser horseshoe bats, the study carried out in spring 2015 aimed to add to the complete picture of bat activity in the study area throughout the year. The radio tracking sessions carried out during the bat active season of 2014 and 2015, whilst avoiding the sensitive period of late stages of pregnancy, birth and first emergence of newly born bats, aimed to form an understanding of seasonal shifts in foraging areas and commuting routes of Lesser horseshoe bats in the Galway area depending on prey availability.

Special attention was paid to the area of the proposed development, in order to accurately and correctly assess the potential impacts of the development on this species.

Main objectives can be summarised as:

- Trapping within the study area to catch and radio tag Lesser horseshoe bats and a follow-up radio-tracking survey in order to provide an understanding of foraging areas and/or commuting routes, either to foraging areas or to other night/satellite/day roosts.
- Processing the data to determine proportional use of different sites and compilation of maps of roosts, foraging areas and flight routes

This study focused solely on the spring part of bat active season, researching bat foraging behaviour during early pregnancy period of the females captured from the previously confirmed maternity roost in Menlo Castle.

2.0 Background

In Europe there has been a decline in abundance and contraction in the distribution range of several species of bat over the last century. Bats their roosts, foraging habitats and flight routes are protected under the Wildlife Acts 1976 as amended and the European Communities (Birds and Natural Habitats) Regulations 2011. Bats are also protected from disturbance when they are in their roosts, and their roosts are protected even if they are unoccupied.

Where developments have the potential to result in significant effects on the features of European Sites, the Habitats Regulations require a thorough assessment of the implications of the development on the ability of the site to meets its conservation objectives and therefore it integrity.

Lesser horseshoe is one of the most endangered European bat species (Stebbings, 1988) it is an annex II species. It was once widespread and common in most countries of Western and Central Europe, e.g. the Netherlands (Voute, Sluiter & van Heerdt, 1980), south Poland (Kokurewicz, 1990), Germany (Rudolph, 1990) and Switzerland (Stutz & Haffner, 1984). A dramatic population decline occurred in the 1950s and 1960s, which led to the loss of large areas of its former distribution.

Suggested causes for the decline of Lesser Horseshoe population include roost destruction, pesticide contamination of both, prey and roosts, habitat alterations and competition with other bat species (Stebbings, 1988, Kulzer, 1995, Arlettaz, Godat & Meyer, 2000).

Main pressure impacting on Lesser horseshoe bats identified in Ireland include renovation/demolition of buildings used as summer roosts, human disturbance in cave roosts and inundation – a particular issue in Karst caves of Clare / south Galway. (NPWS, 2013)

In order to protect suitable foraging habitat as well as roosting and mating sites, detailed knowledge of population ecology is required.

Linear infrastructures are known to have major negative impact on species and ecosystems dynamics, modifying landscape structure through artificialisation, habitat changes, alteration and fragmentation. (Vandevelde, Bouhours et al., 2014). The construction of roads has the potential to negatively affect bat populations, through loss of roosts, foraging habitats and by severing landscape elements used as commuting routes by bats. Roads create an open space, which some bat species are reluctant to cross. Traffic further increases the barrier effect due to sudden movement, noise, light and the risk of collision. Recent research shows that roads have a major negative impact on bat foraging activity and diversity. (Berthinusses, Altringham, 2011)

Since the 1980s, radio tracking has developed as one of the main techniques for studying many aspects of bat ecology (Kenward, 1992). Advances in transmitter technology have reduced the mass of radio-tags and it is now possible to effectively radio-track even the smallest species of bats without exceeding the justifiable surplus weight transmitters add to the weight of the animal. Researchers (International Berlin Bat Meeting consider bats can at times handle up to 25% of their weight without detriment, depending on sex, breeding status, season.

In the radio-tracking study, we investigated the behaviour of individuals by tracking two or more bats simultaneously. The movements of four bats (three breeding females and one non-breeding female) were examined to record the distribution and behaviour of the populations Lesser horseshoe bats during pre-maternity period of 2015.

3.0 Study area

Galway is a vibrant city in west Ireland, located on the River Corrib between Lough Corrib in the north and Galway Bay.

The main roads intersecting the area include the N59 (Thomas Hynes Road) in north-west, the N6 (Bóthar na dTreabh) in east and the N84 (Headford Road) as well as the N17 (Tuam Road) in north-east.

The city is surrounded by parks, field systems and small woodlands forming ideal foraging habitat for all species of bats. Areas of good habitat consist of Merlin Woods Park in east, Beechwood Park and Castle Park, fields around Castlegar, Ballindooly Lake, field systems and limestone pavement with scrub between Ballindooly and Lough Corrib, Menlo Woods, immediate surroundings of the River Corrib, woodland between Oranswell and Lisheenakeeran, Moycullen Bogs, Lough Inch and Bearna Woods. Galway City centre is built up and lit up in the night; however, the River Corrib forms a suitable commuting corridor and connects good quality habitats in north with green areas within the city, such as the National University of Ireland (Galway) campus.

The River Corrib forms a natural division line between the west and the east side of the study area. Menlo Castle was not only the main bat roost within the area of interest but also a centre point of large proportion of bat activity.

Several areas within the extent of the project have been classified as habitats of high conservation importance. These include Bearna Woods – a part of Special Area of Conservation (SAC) Galway Bay Complex, Lough Corrib that is SAC as well as Ramsar site and Moycullen Bogs, a natural heritage area. Conservation objectives for Lough Corrib include Lesser horseshoe bats (1303) (NPWS.ie, 2014).

The location of the study area is shown in Figure 1.

Figure 1 Scheme Study area of the N6 Galway City Transport Project

4.0 Methods

A valid licence to carry out bat trapping (licence to catch with harp/mist net/by hand no. C085/2015) and radio tracking (licence to mark no.C004/2015) had been obtained from National Parks and Wildlife Service, Ireland and authorisation to access the land involved was obtained from landowners in advance of commencing fieldwork.
Licence to enter roosts (DER/BAT 2015-24) was also obtained.

Because of working at night, the police were notified of the session of the activities and personnel.

Scott Cawley and Greena Ecological Consultancy reviewed existing data, aerial photographs, maps, and carried out a site visit to determine possible trapping places, first in Menlo Castle, later in previously identified night roosts of Lesser horseshoe bats in the area west of Galway. The area of interest consists of field systems with mature hedgerows and stone walls, a continuous area of limestone pavement with scrub, small areas of woodland and urban areas. The potential for successful catching horseshoes in mist nets and/or harp traps was assessed as being low in the open landscape; however, catching directly from the maternity roost in Menlo Castle proved very productive. A six-metre wide Avinet mist net was set across the entrance to the maternity roost on 16th May 2015. No other trapping attempts within the castle were undertaken. All bats (four LHS in total) were caught while emerging from the roost in the net placed over the roost entrance.
Further at least four bats were present in the roost on the night of catching; however, these bats stopped attempting emergence after they detected the fine netting and the net was removed 2 hours after the first recorded emergence in order not to allow the bats out to feed and so not to negatively affect them..
All captured females were fitted with a 0.35g Holohil radio- transmitter of 7 days battery life. Three out of the four captured bats were recognisably, but not heavily, pregnant. One female was assessed as being last year's juvenile, and had not bred prior to the capture. Two of the four captured females had been ringed in the August 2014 season, the other two females were fitted with aluminium rings during the catching session in May 2015.

The radio tracking study took place between the 16th May and the 23rd May 2015. Two radio-transmitters fell off after this period, the remaining two were not possible to locate possibly they had run out of battery power.

A double bank harp trap was used at Bearna culvert together with shield netting. The culvert at the grid reference of M2477723800 beneath the R336 highway, this had previously been confirmed as a night roost for a single Lesser horseshoe bat; however, no bats were captured at this location on the two trapping nights (17th and 18th May 2015).

Two different approaches to radio tracking bats give different results. Tracking individual bats by at least one surveyor can determine complete behaviour and proportional habitat use; but this is limited to small numbers of animals.
The second approach that was used in these study was to track larger numbers of bats that determines a higher proportion of the overall home range of the local population. Higher sample number of animals increases data gathering on roosting sites, numbers of animals visiting feeding areas and going through corridors.

Table 1 below show details of transmitters used, duration of tag battery is stated in days, bpm is the number of pulse transmissions per minute.

Table 1 Transmitters used during the radio tracking session in May 2015

bat	species	supplier	Tag weight	bpm	duration
1	LHS	Holohil	0.32g	60	7
2	LHS	Holohil	0.32g	60	7
3	LHS	Holohil	0.32g	60	7
4	LHS	Holohil	0.32g	60	7

Radio transmitters were glued between the fur-clipped shoulder blades of the bats a using latex adhesive these come off within 2 weeks of being attached.

Up to four fieldworkers used *Australis 26K* and *Sika UHF* radio receivers with *Yaggi* rigid aerials to track bats. Both receivers are able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any time. Omni-directional antennas were used to search for bats by vehicle.
The surveyors carrying out the study were Geoff Billington, Tereza Rush, Isobel Abbott and Daniel Buckley.

Tailor made recording sheets were used to record data and a combination of radio sets and mobile phones were used for two-way communication. Accurate bearings of bat locations were taken from hand held sighting Silva Expedition 54 compasses by two or more surveyor at the time. Bearings of up to 1^0 accuracy were obtained. The data used in this report were obtained by using joint bearings (positive contact) of two or more surveyors at the same time.
Global Positioning Systems were used to increase the speed and accuracy of the surveyors to continuous supply of their location.

From all tagged bats, the following data was recorded:

- Observer location
- Bat ID number
- Triangulation bearings with other surveyor(s)
- Apparent location, route and behaviour
- Roost location and details when located

Whenever bats were commuting from roosts or at their first foraging sites of the evening, they were observed from fixed (often elevated) points chosen where good radio reception was available, or other suitable vantage points viewing between buildings and other obstacles. Where possible surveyors made close approaches to bats, to ascertain the exact foraging area and behaviour or to attempt pursuit if the bat was moving away.

Over survey nights surveyors gradually built up a picture of routes bats use for commuting and of bat foraging areas. Surveyors positioned themselves strategically in the area of roosting sites to determine which direction the bats head away from the roost and move out into the wider survey area.

Location of frequent observation points and number of times that they were used are shown in Table 2 below, all of these points were on public roads.

Table 2 Location of observation points used in May 2015

location	grid reference	number of times used
Menlo Castle	M 28270 28381	5
Menlough Village	M 28852 28492	4
Quarry Road	M 29334 30300	1
Coolagh	M 29583 28167	2
The Mount	M 29583 28167	1
Lackagh Quarry	M 29941 27996	2

Tracking ended either when the fieldwork period ended (which could be up to half an hour before dawn), or when all bats had returned to the roost and were static or poor weather (strong wind, rain or drop of temperature) prevented bats from foraging or make them return early to their roosts.

At the start of each survey night, estimations of environmental conditions were noted: wind strength and direction, rainfall, cloud cover and air temperature measured. Any significant changes in weather throughout the survey period were also noted.

Daytime work included located and verifying roost occupation, recording and plotting out results and investigation of any night roosting sites discovered during the tracking sessions.

Results are presented using the traditional method of minimum convex polygons (MCP). This method is compared with the method of multilateral polygons (MLP) drawn around all confirmed areas or points of occurrence of individual bats.
An animal's home range size, shape, and position are traditionally represented by joining the outermost fixes for that animal to form a minimum convex polygon (Mohr 1947). Outlying fixes (representing rare excursions) may unduly influence the polygon's shape and size to produce a misrepresentation of the space actually used by the animal (McNay et al., 1994). Minimum convex polygons (convex hulls) are an internationally accepted, standard method for estimating species' ranges, particularly in circumstances in which presence-only data are the only kind of spatially explicit data available. One of their main strengths is their simplicity, they are used to make area statements and to assess trends in occupied habitat, and are an important part of the assessment of the conservation status of species; these estimates are, however, biased. The bias increases with sample size, and is affected by the underlying shape of the species habitat, the magnitude of errors in locations, and the spatial and temporal distribution of sampling effort.
The method using MCP often results in much larger and less accurate area coverage. Using MLP is based on minimal area between all confirmed points of animal's occurrence during the radio-tracking session. It is obvious that while MCP overestimates potential occurrence of a

tagged bat, MLP might underestimate this. The difference in results obtained using the traditional method and the method of multilateral polygons are shown on maps of foraging areas.

When habitat is to be lost to development, it appears sensible to slightly over-estimate the real foraging area utilising the method of MCP. Where study determines population dynamics and interaction, MLP is a more suitable approach to take plus adding n relevant features within MCP boundary.

MCP are represented by solid coloured area in maps while MLP are represented by checked overlay.

5.0 Survey constraints

These radio tracking studies were only carried out in short periods of the year so bats may use different areas at other times of year. This limitation is partially resolved through previous studies conducted in 2014, later in the bat active season, resulting in a more complete picture of the behaviour of Lesser horseshoe bat populations in the Galway area.

Only four bats were captured and fitted with transmitters in the May session. At the time of the survey, this was estimated to be approximately 50% of the bats utilising the maternity roost at Menlo Castle. Ideally, more individuals would have been studied; however, the high proportion of overlap in the core foraging area suggests that the main characteristics of Lesser horseshoe foraging behaviour at the given time of the year were covered by the study of the selected four individuals.

The small numbers could be purely caused by the main part of the colony not having returned yet from winter/transition roosts. But also there were recent signs of small fires (e.g. a small group having a barbeque) having been lit in both on the ground under the chimney roost and within 3m of it. These may have caused some bats to move out as at this time of year, making our tracking task more difficult as few bats to catch and tag.

Catching attempts in other, previously identified, roosting structures proved non-productive, catching effective was liable to be very ineffective with multi access buildings. No other bats were captured in the May session despite the fact.
A single untagged Lesser horseshoe was observed to use a night roost in a culvert near Bearna, but with only a single bat a visiting once or twice a night not every night, makes catching extremely difficult.

The amount of gathered data was subject to correctly functioning radio-transmitters. Radio-transmitters may fail or batteries may not last the specified duration. Bats, and in particular in maternity colonies can groom radio-transmitters off. Two bats lost their tags prior to the end of their battery life and within the study period.

Adverse weather conditions and the overall weather trend in early 2015 affected the amount of data collected, too.

Rain, ranging from light drizzle to heavy brief showers occurred during the radio-tracking session. The night temperatures were relatively low on all survey nights; temperature dropped after dusk and continued decreasing throughout the night. Majority of bat activity was only recorded within the first two or three hours after dusk; activity ceased thereafter and bats usually returned back to their day-roost to spend the rest of the night there. It is considered likely that this is common spring weather pattern and the results from the study are; therefore, very valuable to add to last year's data.

The accuracy of a location determined by taking simultaneous bearings can be affected by habitat structure and may result in biased estimates of observed habitat use. A common source of error is signal bounce. Signal bounce occurs most frequently in undulated terrain where a signal is deflected by a hill, resulting in potential errors. The most effective way to overcome signal bounce during ground tracking is to take many bearings from several different places. When all signals appear to be coming from the same point then there is a good chance that the animal has been located correctly. However, if the signals are coming from a number of different points then signal bounce is likely still occurring (White, Garrott, 1990).

Signal deflection was apparent within Menlo Woods and often in proximity of quarries. It is possible that other areas were also affected to a lesser extent.

6.0 Ethical Review

Existing knowledge of bat population was used to determine that the surveys were necessary and justified. Maternity colony of Lesser horseshoe bats was identified at Menlo Castle and several smaller roosts were located in the area of study.

Bats used for these studies could not be replaced by other species or non-living objects, a sufficient number of bats had to be used to determine the foraging areas and behavioural patterns of the colony as representatively as possible.

Survey techniques were appropriate to the objectives of the project. Radio-tracking is highly effective in determining animal's home range, commuting routes and favoured foraging areas as well as crossing points over man-made barriers in the natural habitat.

Both surveyors of Greena Ecological Consultancy, conducting ring marking and fitting of radio-transmitters, hold Natural England class 1 – 4 personal licences and have extensive experience with marking and tagging Lesser horseshoe bats.

Mist nets were set up either after dark or prepared in daytime and opened after dusk to avoid catching birds. Mist nets were attended at all times.

Where bats were caught in a mist net, they were removed immediately to reduce potential stress. Where harp trap was used, arrangements were made to removed potentially caught animals as soon as practical, though none were caught.
This took place/was attempted during nights of suitable temperature and rainfall free.
The catching period avoided more sensitive seasons such as, as when they emerge from hibernation in early spring, later stage of pregnancy in summer or when newly born young are supported for a couple of weeks in mid summer.

All bats were released unharmed at the point of capture.

Weight of radio-transmitters used for these studies did not exceed 7% of bat body weight in any case. All rings fitted by Greena Ecological Consultancy experienced ringers.

No injuries occurred during trapping sessions, all bats were of good health and did not show any signs of distress when fitted with transmitters (and rings where applicable).

Catching session at Menlo Castle was ceased when it became obvious that four bats were still remaining in the roost after 2 hours, they were aware of the presence of the net and were reluctant to emerge. The decision to cease catching was in line to prioritise welfare of the remaining bats so they could emerge and forage that night.

In most intensive catching sessions at roosts you rarely catch half of the animals present.

7.0 Results

7.1 Previous records

Scott Cawley undertook an extensive survey work in the Galway area prior to the radio-tracking session both for this one in 2015 and previous sessions in 2014.

Static bat detectors were placed in suitable habitat and in expected roosting as well as mating places and along expected commuting routes.

A maternity roost of Lesser horseshoe bats was located in Menlo Castle, where peak count of bats in July 2009 reached 38 individuals and a repeat emergence count on 8th July 2014 revealed 27 individuals. Numerous night roosts (or roosts used on occasional basis by a limited number of bats) were identified mainly in farm buildings and culverts in the study area. Night roosts were usually identified based on an internal structural inspection during which signs of bat presence in form of droppings or feeding remains were found. Scott Cawley identified Lesser horseshoe night / satellite / transition roosts between 3 and 6.5km from Menlo Castle.

An extensive study of Lesser horseshoe bat foraging behaviour in the Galway area was conducted in 2014. The same bat colony was subject to the survey. Night roosts previously used by bats were re-inspected.

Surveyors were already familiar with locations that were less shielded, providing good radio-tracking vantage points in the landscape.

7.2 Weather data

Weather conditions were recorded for all nights of radio tracking. Maximum temperature refers to maximum day temperature while minimum temperature refers to minimum night temperature. The range of temperature recorded during radio tracking is shown as survey temperature. Precipitation was recorded during 24 hours; strength of wind was recorded during survey nights. Weather conditions are provided in Table 3 overleaf.

Table 3 Weather data, May session

Date	Max Temp (°C)	Min Temp (°C)	Survey Temp (°C)	Precipitation (mm)	Wind (B)
16/05/2015	11	8	10 - 8	0.2	4
17/05/2015	13	7	10 - 7	0.4	4
18/05/2015	13	4	8 - 4	0.1	4
19/05/2015	11	4	8 - 4	0.3	4
20/05/2015	10	5	9 - 5	0	3
21/05/2015	14	7	9 - 7	0	3
22/05/2015	14	9	11 - 9	0	3
23/05/2015	17	9	13 - 9	0	2

Data from Worldweatheronline.com, 2014 and survey records

7.3 Bat captures

All Lesser horseshoe bats were captured at Menlo Castle were caught in a six-metre mist net stretched over the entrance to the maternity roost in a chimney.

Two bats from the August session in 2014 were re-captured in May 2015. Their foraging areas could; therefore be compared with the 2014 session.

All bats fitted with radio-transmitters and ringed by Tereza Rush, bat 1 and bat 4 carried rings from previous season, bat 2 and bat 3 were ringed.

Table 4 Captures 16/05/2015, Menlo Castle

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
21:59	LHS	F	36.7	6.1	L01608	Adult, pregnant, **Bat 1,** Ring from 2014
22:16	LHS	F	38.2	5.9	L01691	Adult, not bred, **Bat 2**
22:19	LHS	F	38.6	6.0	L01690	Adult, pregnant, **Bat 3**
22:48	LHS	F	38.3	6.3	L01603	Adult, pregnant, **Bat 4,** Ring from 2014

Abbreviations: **F – female; LHS – Lesser horseshoe *(Rhinolophus hipposideros)***

7.4 Roosting sites

7.4.1 Daytime roosting sites

Three daytime roosting places were identified during the radio-tracking session conducted in May 2015. Table 5 shows details of daytime roosts in this session. Three out of the four captured bats consistently used the maternity roost in Menlo Castle. One of them (bat 3) utilised a roost in a boulder field over several days before returning back to Menlo. Bat 2 moved to a natural limestone structure to roost by the end of the survey session and eventually lost its tag there. All of these daytime roosts were also used in the night for short periods of night roosting, although night roosting followed by extensive periods of foraging activity occurred very rarely during the spring radio-tracking session, compared to extensive night roosting being recorded in August and September 2014.

Table 5 Identified daytime roosts in August 2014

roost	bats using	grid reference	location	description
A	1,2,3,4	M 28491 27872	Menlo Castle	castle wall
B	3	M 29657 27130	Boulder field	Cavity among large boulders
C	2	M 28865 28047	Limestone structure	Cavity

Roost A, Menlo Castle, is shown in Figure 2, roost B, the cavity among large boulders, in Figure 3, and roost C, the large cavity in the natural limestone structure can be seen in Figure 4.

Surprisingly, bat 3 was pregnant, yet did not stay in the maternity roost, possibly suggesting another maternity satellite roost is present. The roost in the boulder field did not appear to be suitable for maternity colony so it points towards bats still not having settled into maternity sites at this time of year in 2015.

though it could not be fully accessed for inspection nor was there access to be able to carry out multiple emergence counts. and an emergence survey carried out to count the number of bats utilising the location only revealed the usage by bat 3. Bat 3 eventually returned to Menlo Castle before the transmitter stopped working.

Menlo Castle was the only roost previously utilised in the 2014 season.

Table 6 below shows usage of daytime roosts by individual bats.

Table 6 Daytime roost usage during the monitored period in May 2015

bat	16/05	17/05	18/05	19/05	20/05	21/05	22/05	23/05	24/05
1	A	A	A	A	A	A	A	N/A	lost tag
2	A	A	A	A	A	A	N/A	N/A	C
3	A	A	B	B	B	B	B	A	A
4	A	A	A	A	A	A	N/A	N/A	N/A

Figure 2 Roost A, Menlo Castle

Figure 3 Roost B, boulder field

Figure 4 Roost C, natural limestone structure

Figure 5 Location of all roosting sites (marked with orange stars) identified in 2015

7.4.2 Night roosting sites

All roosting places identified as daytime roosts were also used as night roosts during the night for short periods of time before further foraging commenced. No night roosting in terms of remaining in the structure between prolonged foraging periods occurred in the spring session.

No roosts only used at night were located in this session.

Foraging period were relatively short in duration and once the temperature dropped each night, bats returned to their roosts and rarely emerged again.

7.5 Foraging periods

All Lesser horseshoe bats radio-tracked in the May session were displaying similar foraging pattern. They emerged approximately 15-20 minutes after sunset and foraged for 2-3 hours before returning to the roost. Due to the night temperature drop, bats rarely re-emerged for further foraging. Very limited activity was recorded after 1.00am each day. Bats emerged to forage even in stronger wind and rain ranging from light drizzle to heavy shower, but temperature appeared to be the limiting factor of foraging behaviour in the spring.

7.6 Foraging areas

Foraging areas for the purpose of this report were expressed in the standard form of minimum convex polygons as well as the form of multi-lateral polygons. Areas have been designated by the use bats made of them as combined areas of roosting sites, commuting and foraging areas of individual bats.

The Lesser horseshoe bat maximum foraging distance from the roost ranged from the immediate surroundings of Menlo Castle up to 3.56km with the average maximum distance of foraging area from the roost being 2.86km. The foraging areas of all studied bats were much less extensive than later in the bat active season, recorded in 2014. This, also, can be explained by the night temperature drop, leaving bats to utilise known close resources.

Table 7 shows a summary of results of the radio tracking session, including the number of fixes taken on each bat and the number of days a positive contact (joint bearings of two or more surveyors) was made.

Table 7 Results of radio tracking session in May 2015

bat	species	sex	foraging area MCP (sq.km)	foraging area MLP (sq.km)	maximum distance from roost (km)	fixes taken	over days
1	LHS	F	6.94	4.61	3.56	38	6
2	LHS	F	5.26	2.62	3.08	70	6
3	LHS	F	6.67	2.52	2.72	71	7
4	LHS	F	1.48	0.07	2.06	21	4

The majority of foraging areas obtained in May overlapped in the Menlo Castle and Menlough Village area, extending further across Menlo Woods; meaning this was a key foraging area. Field systems and quarries north-east and east of Menlo Castle proved to be crucial for Lesser horseshoe bats. This corresponded with the findings of 2014.

The following figures show forging areas (home ranges) of all bats successfully radio-tracked. Shaded area represent MCP traditional method, while checked area represents MLP method. Commuting routes, where they could beconfirmed, are shown with lines, confirmed foraging areas are marked with darker shaded areas.

Figure 6 Foraging area of bat 1

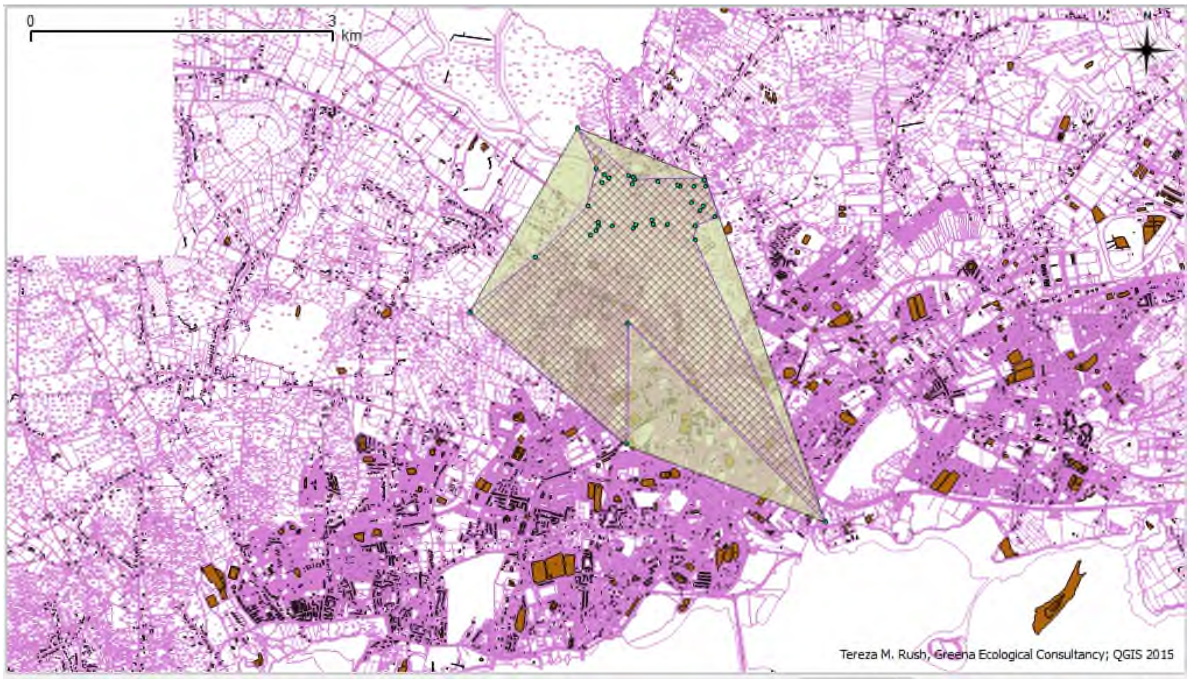


Figure 7 Foraging area of bat 2

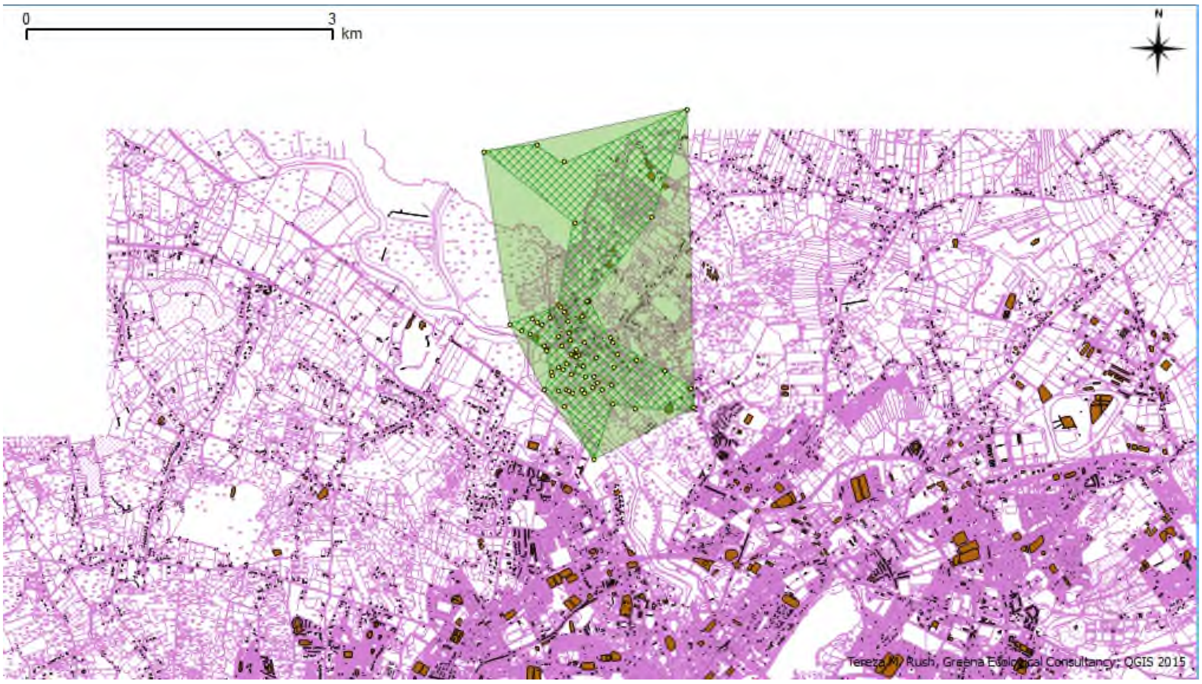


Figure 8 Foraging area of bat 3

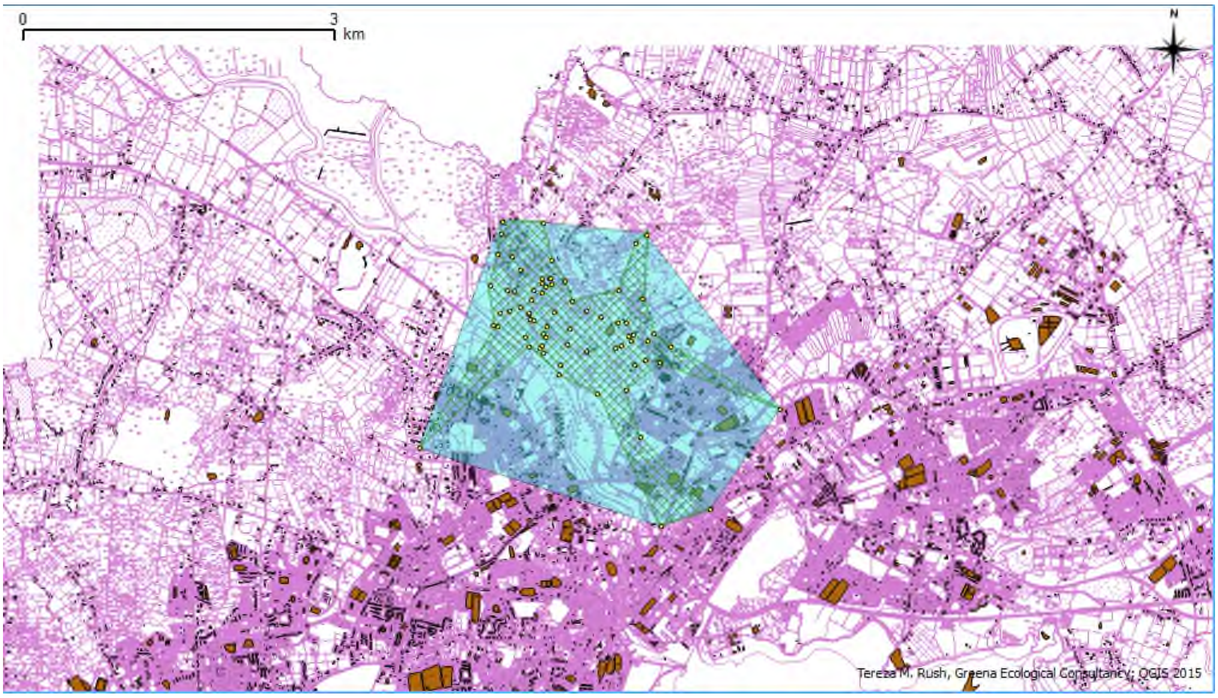


Figure 9 Foraging area of bat 4

Foraging and roosting areas:

Bat 1

Bat 1, a pregnant female Lesser horseshoe, was captured at the maternity roost in Menlo Castle and did not change her roosting place throughout the survey. This bat was previously captured and radio-tracked in 2014 (Bat 8 in the August 2014 session) and did not change roost during the summer study either. Last year this bat utilised a small area in vicinity of Menlo Castle and in Menlo Woods, returning to the roost on regular basis throughout the night suggesting a dependent young to care for. Bat 1 covered the largest foraging area of all bats studied in 2015 – 6.94km^2 in total, and travelled the longest distance from the roost, up to 3.56km. Its foraging area included the core area of Menlo Castle, Menlough Village and Menlo Woods, with 71% of all fixes on this bat located in the core area, but extended south and west across the River Corrib and onto Galway coast. It is likely that Bat 1 followed the River Corrib through Galway city down to Galway harbour.

Bat 2

Bat 2, a young female Lesser horseshoe bat, was captured from the maternity roost at Menlo Castle and continued using the roost for several days into the radio-tracking study, until moving into a new roost in a natural limestone structure in Menlo Woods, north-east of the castle, around the grid reference number of M 28865 28047 on 24th May 2015. This change corresponded with the time Bat 2 lost its tag, which was eventually located near the limestone structure. The foraging area of Bat 2 covered 5.26km^2 and the female travelled up to 3.08km from the roost. 78.6% of all fixes were recorded within the core foraging area of all bats, but also extended north across the southern part of Lough Corrib and towards Gort an Chalaidh Angliham. Bat 2 usually returned to the roost shortly after the night temperature drop.

Bat 3

Bat 3, a pregnant female Lesser horseshoe bat, was captured from the maternity roost in Menlo Castle, but after two days left the roost and spend several days in a new roosting place in the boulder field around grid reference of M 29598 27171, south-east from the castle and south of Coolough Lake. Towards the end of the radio-tracking study, Bat 3 returned to the maternity roost in Menlo Castle before the signal from its transmitter got lost. The foraging area of Bat 3 extended over 6.67 km^2 and the maximum-recorded foraging distance from its roost was 2.72km. Approximately 62% of all fixes on this bat were recorded within the core foraging area of Menlo Castle, Menlough Village and Menlo Woods; however, Bat 3 also foraged to the south-eats and south-west of the core area, covering the northern part of Galway City, Coolough and crossing the River Corrib.

Bat 4

Bat 4, a pregnant female Lesser horseshoe, was captured from the maternity roost in Menlo Castle and did not change her roosting place until 22nd May when her signal was lost. This bat was previously studied in August 2014 (Bat 3 then) when its foraging area covered the limestone pavement and quarries to the north-east of the castle, all the way towards Coil Uachtar Kilroghter. This bat was also known to roost in the quarries for prolonged periods of time. Bat 4 was considered to have a dependent young in the maternity roost in Menlo Castle in 2014.

Only limited data were collected on this bat in 2015, it was difficult to locate during the survey nights and the signal was lost before the end of the radio-tracking session. This may be due to a fault in the transmitter or due to the fact that Bat 4 covered large distances in the night and was regularly leaving the study area. The recorded foraging area extended over 1.48 km^2 with the maximum recorded foraging distance of 2.06km from the maternity roost. 71.4% of all recorded fixes on this bat fell into the core foraging area of all studied bats, but Bat 4 also ventured north and north-west of the Castle, crossing the River Corrib and foraging along the southern coast of Lough Corrib.

Figure 10 shows the combined overall foraging areas for all horseshoe bats in May 2015, Figure 11 depicts the extent of the core foraging area of all studied bats. The overall foraging area of all bats covered 16 km^2 (MCP – shaded in Figure 10) or 10.22 km^2 (MLP – checked in Figure 10). The core foraging area of all bats extended over 1.25 km^2.

Figure 10 Overall foraging area in May 2015

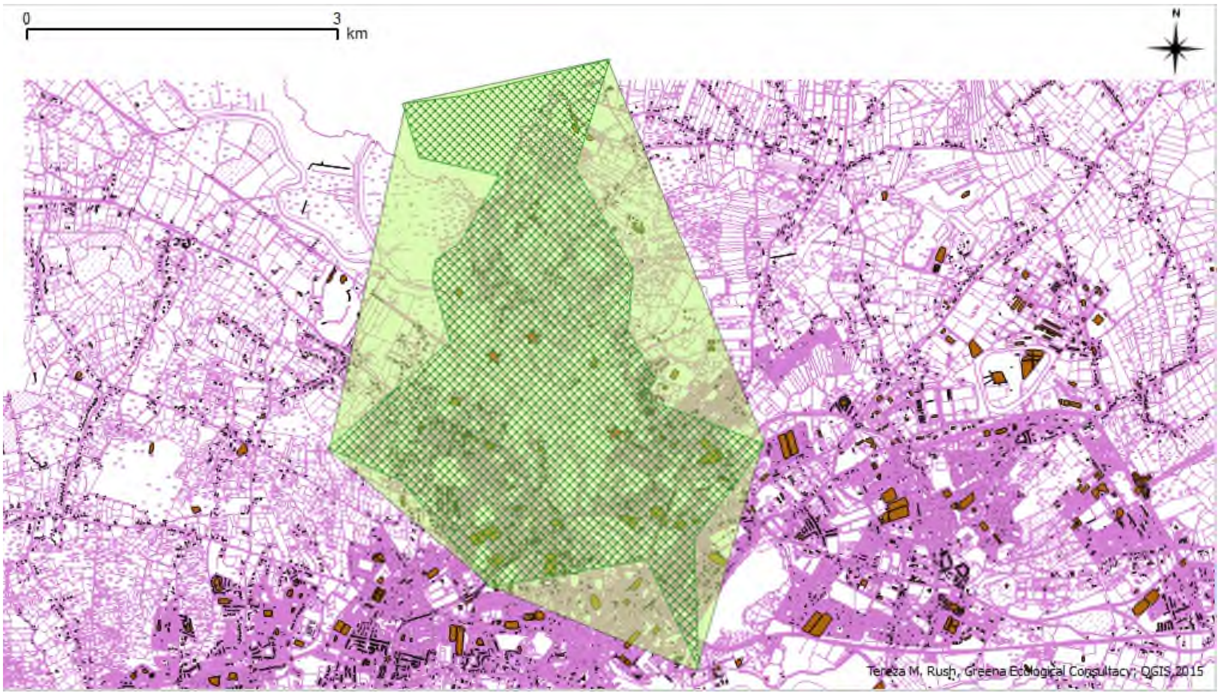
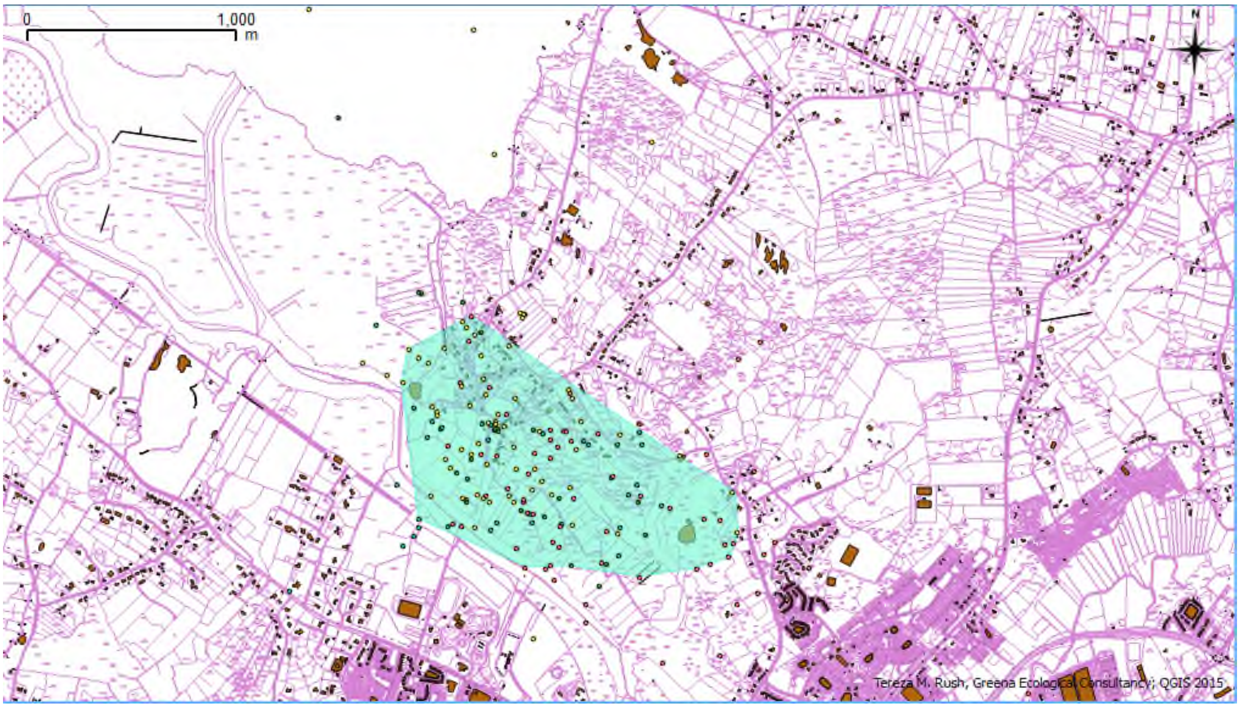


Figure 11 Core foraging area in May 2015



7.7 Summary of Results

Greena Ecological Consultancy carried out an additional radio-tracking session in Galway in 2015 in order to complete the full picture of bat activity in the area throughout the year. Previous sessions covered the summer maternity season and the autumn pre-hibernation activity and took place between late July and August, followed by the second one commencing in late August and is extending into September 2014.

Four Lesser horseshoe bats, all females, were captured and fitted with radio-transmitters. All bats were caught at the known maternity roost at Menlo Castle. Further four or five bats were present in the roost on the night of catching but these could not be part of the study to preserve welfare of the colony.

No other bats were captured from Menlo Castle neither other locations in May 2015.

Two of the females captured in May 2015 were previously studied in August 2014 and the results from 2015 provided an interesting comparison of foraging activity of these individuals.

No juvenile bats were subject to survey carried out by Greena Ecological Consultancy. Three of the studied female bats were recognisably, but not heavily, pregnant; one bat was considered to be a young from 2014 that did not show any signs of pregnancy at the time of the capture on 16th May 2015.

Majority of foraging areas of all studied Lesser horseshoe bats overlapped in the area of Menlo castle, Menlo Woods and Menlough village. This was considered to be the core foraging area from where bats travelled both, north towards Lough Corrib and south following the River Corrib all the way to the coast of Galway. Bat foraging area was smaller than recorded in the previous year. It is likely that the obvious night temperature drop was to blame for shorter foraging periods and shorter travel distances of all studied bat in spring 2015.

Only three roosts of Lesser horseshoe bats were confirmed during the May 2015 study. These included the maternity roost of Menlo Castle and two new sites, not utilised by bats in the radio-tracking studies of 2014. The new roosting sites included a boulder field with large gaps among the boulders around the grid reference of M 29598 27171 and a natural limestone structure located at the grid reference of M 28865 28047.

Night roosting was common in the summer and autumn sessions in 2014 but rarely occurred in the spring session in May 2015. Bats usually foraged for 2 – 3 hours after dusk, then returned into their roosts to remain there for the rest of the night, perhaps due to low night temperatures. When further foraging occurred, it was only brief and in vicinity of the roosting places. For this reason all located roosts could also be considered night roosts.

Lesser horseshoe bat maximum foraging distance from the roost was 3.56km in May 2015, much less comparing too both, summer and autumn session of 2014. The average maximum foraging distance of bats in this study was 2.86km from the roost.

The importance of the maternity roost in Menlo Castle as well as the immediate area of Menlough Village and Menlo Woods was highlighted in this study, reinforcing the results of previous sessions.

8.0 Acknowledgements

Greena Ecological Consultancy would like to thank the following organisations and individuals for their help in the due course of this study:

- Scott Cawley Limited

- National Parks and Wildlife Service, Ireland

- Galway County Council

- Kate McAney for information on known local bat roosts.

9.0 References

Altringham, J.D., (2001). Bats, Biology and Behaviour. Oxford University Press. Reprint.

Berthinussen, A., Altringham, J. (2011). The effect of a major road on bat activity and diversity. Journal of Applied Ecology 49 (1), pp. 82-89

Kenward, R. E. (1992). Quantity versus quality: programmed collection and analysis of radio-tracking data in Wildlife telemetry. Remote monitoring and tracking of animals: 231-245. Priede, I. G. & Swift, S. M. (Eds). Chichester: Ellis Horwood.

Kokurewicz, T. (1990). The decrease in abundance of the lesser horseshoe bat Rhinolophus hipposideros Bechstein, 1800 (Chiroptera: Rhinolophidae) in winter quarters in Poland. Myotis 28: pp.109-118.

Irishstatutebook.ie, (2014). Wildlife Act, 1976. [online] available at: http://www.irishstatutebook.ie/1976/en/act/pub/0039/index.html [accessed on 21st October 2014]

McNay, R. S., Morgan, J. A. and Bunnel, F. L.,(1994). *South Dakota Agricultural Experiment Station, Characterizing independence of oband the National Rifle Association.* Support was observations in movements of Columbian black provided by South Dakota Co-operative Fish and tailed deer. The Journal of Wildlife Management, Wildlife Research Unit, South Dakota State University- 58, 422–429.

Mohr, C.O., (1947). *Table of equivalent populations of North American small mammals*. Am Midl Nat 37: pp.223–249

NPWS (2013) The Status of EU Protected Habitats and Species in Ireland. Species Assessments Volume 3. Version 1.0. Unpublished Report, National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

NPWS.ie (2014) *Protected sites – National Parks & Wildlife Service.* [online] available at: http://www.npws.ie/protectedsites/ [accessed on 11th October 2014]

Park, K.J. (1998) Roosting ecology and behaviour of four temperate species of bat. University of Bristol

Rudolph, B.-U. (1990). Fruhere Bestandesdichte und heutige Bestandessituation der Kleinen Hufeisennase Rhinolophus hipposideros in Nordbayern. Myotis 28: pp.101-108.

Stebbings, R. E. (1988). Conservation of European bats. London: Christopher Helm

Stutz, H. P., Haffner, M. (1984). Arealverlust und Bestandesruckgang der Kleinen Hufeisennase (Rhinolophus hipposideros) (Bechstein 1800) (Mammalia: Chiroptera) in Schweiz. Jahresber. Naturforsch. Ges. Graubuenden Neue Folge 101: pp.169-178

Vandevelde, J.-C, Bouhours, A., Julien J.-F, Couvet, D., Kerbiriou, C. (2014) *Activity of European bats along railway verges*. Ecological Engineering. Vol 64, pp 49-56.

Voute, A. M., Sluiter, J. W. & van Heerdt, P. F. (1980). Devleermuizenstand in enige Zuidlimburgse groeven sedert 1942.Lutra 22(1-3): pp.18-34.

White, G. C., and R. A. Garrott. (1990). Analysis of wildlife radio-tracking data. Academic Press, New York, New York, USA.

Worldweatheronline.com (2014). Galway, Ireland historic weather, RSS Feed, Weather Charts, Weather Averages and Weather Widget for website and blog. WorldWeatherOnline.com [online] available at: http://www.worldweatheronline.com/v2/historical-weather.aspx?q=Galway,%20Ireland [accessed on 17th October 2015]

Annex E

Proportion of Core Sustenance Zone within the proposed road development boundary

E1

Proportion of Core Sustenance Zone within the proposed road development boundary

PBR Ref	CSZ (ha)	Area of CSZ within proposed road development boundary (ha)	Deductions for habitat retention within CSZ at Menlough (ha)	% loss
Roosts within Proposed Road Development Boundary				
PBR205	1256	92		7.32
PBR183	2827	118		4.17
PBR196Py	1256	78		6.21
PBR196Pa	2827	126		4.46
PBR182	2827	126		4.46
PBR204Rh	1256	76		6.05
PBR204Pa	2827	126		4.46
PBR253	2827	122		4.32
PBR179Py	1256	75		5.97
PBR179Pa	2827	116		4.10
PBR177	1256	75	10	5.18
PBR178Rh	1256	74	10	5.10
PBR178Pa	2827	111	10	3.57
PBR255	1256	74	10	5.10
PBR256	2827	110	10	3.54
PBR241	1256	37		2.95
PBR267Py	1256	46		3.66
PBR267Pa	2827	79		2.79
PBR210	Night roost	NA	NA	NA
PBR270	2816	106		3.76
Roost Adjacent to Development Boundary (<100m)				
PBR139	5026	100		1.99
PBR145	2827	120		4.24
PBR146	5026	100		1.99
PBR49Pa	2827	92	10	2.90
PBR49Py	1256	64		5.10
PBR173	2827	102	10	3.25
PBR192	2827	133		4.70

PBR Ref	CSZ (ha)	Area of CSZ within proposed road development boundary (ha)	Deductions for habitat retention within CSZ at Menlough (ha)	% loss
PBR219	night roost	NA	NA	NA
PBR228	1256	76		6.05
PBR154	night roost	Na	NA	Na
PBR73	5026	132	10	2.43
PBR237	1256	63		5.02
Roosts away from Proposed Road Development (>100m)				
PBR6Md	5026	139	10	2.57
PBR6Rh	2625[41]	98	10	3.35
PBR111	2827	106		3.75
PBR105	2827	100		3.54
PBR115	2827	60		2.12
PBR116	2827	59		2.09
PBR125	Night roost	NA	NA	NA
PBR126	Night roost	NA	NA	NA
PBR127	Night roost	NA	NA	NA
PBR128	Night roost	NA	NA	NA
PBR129	Night roost	NA	NA	NA
PBR130	Night roost	NA	NA	NA
PBR133	5026	157	10	2.92
PBR134	5026	167		3.32
PBR136	2827	56		1.98
PBR138Pa	2827	83	10	2.58
PBR138Pp	1256	41	2	3.11
PBR140	314	12		3.82
PBR141	1256	51		4.06
PBR142	5026	106	10	1.91
PBR143	5026	142	10	2.63
PBR144	5026	142	10	2.63
PBR147	1256	50		3.98
PBR148	1256	22		1.75
PBR149	1256	23		1.83
PBR15	2827	0		0.00

[41] Based on the MCP for the 2015 radio-tracking surveys.

PBR Ref	CSZ (ha)	Area of CSZ within proposed road development boundary (ha)	Deductions for habitat retention within CSZ at Menlough (ha)	% loss
PBR150	5026	141		2.81
PBR151	314	12		3.82
PBR152	5026	140	10	2.59
PBR153	2827	100		3.54
PBR156	Night roost	NA	NA	NA
PBR157	Night roost	NA	NA	NA
PBR158	2827	110	10	3.54
PBR165	1256	50		3.98
PBR17Pa	2827	100		3.54
PBR17Mn	5026	141	10	2.61
PBR18	2827	75	10	2.30
PBR20	5026	130	10	2.39
PBR21Pa	2827	49		1.73
PBR21Rh	2827	49		1.73
PBR25Pa	2827	143	10	4.70
PBR25Rh	2827	143	10	4.70
PBR42	1256	8		0.64
PBR44Rh	2827	0		0.00
PBR44	1256	0		0.00
PBR47	2827	92	10	2.90
PBR51	2827	99		3.50
PBR54	2827	122		4.32
PBR64	5026	41		0.82
PBR82Pa	2827	82	10	2.55
PBR82Rh	Night roost	NA	NA	NA
PBR82Mn	5026	135	10	2.49
PBR83	Night roost	NA	NA	NA
PBR85	Night roost	NA	NA	NA
PBR89	2827	41		1.45
PBR92	2827	28		0.99
PBR94	2827	47		1.66
PBR159	2827	0		0.00
PBR160	2827	0		0.00

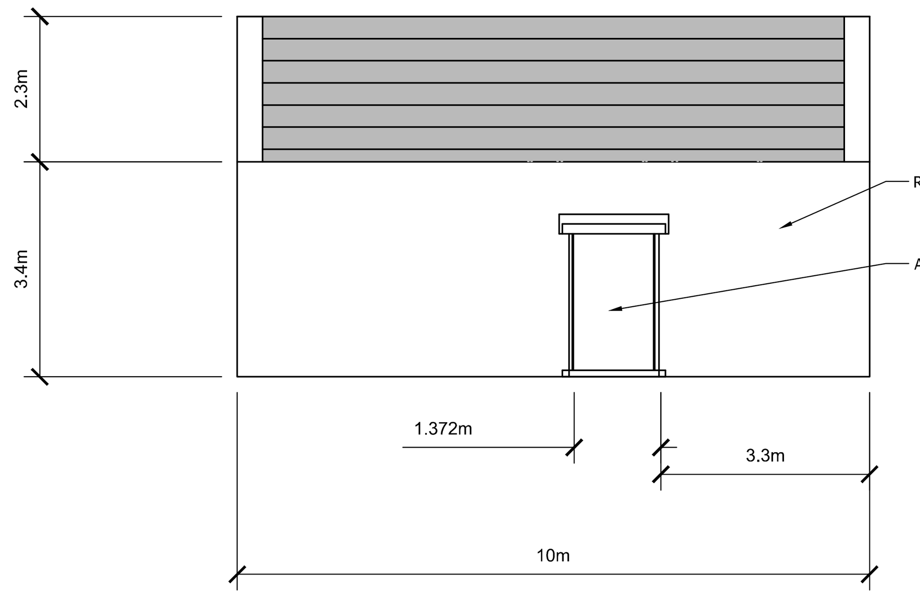
PBR Ref	CSZ (ha)	Area of CSZ within proposed road development boundary (ha)	Deductions for habitat retention within CSZ at Menlough (ha)	% loss
PBR217Rh	2827	49		1.73
PBR217Pa	2827	49		1.73
PBR218	Night roost	NA	NA	NA
PBR220	1256	34		2.71
PBR222	1256	29		2.31
PBR224	1256	26		2.07
PBR242	1256	82		6.53
PBR124	2827	51		1.80
PBR7	1256	60		4.78
PBR100	2827	100		3.54
PBR112	2827	124		4.39
PBR225Py	1256	35		2.79
PBR225Pa	2827	44		1.56

Annex F

Artificial Bat Roost Drawings

F1

FOR INFORMATION



Proposed Front Elevation
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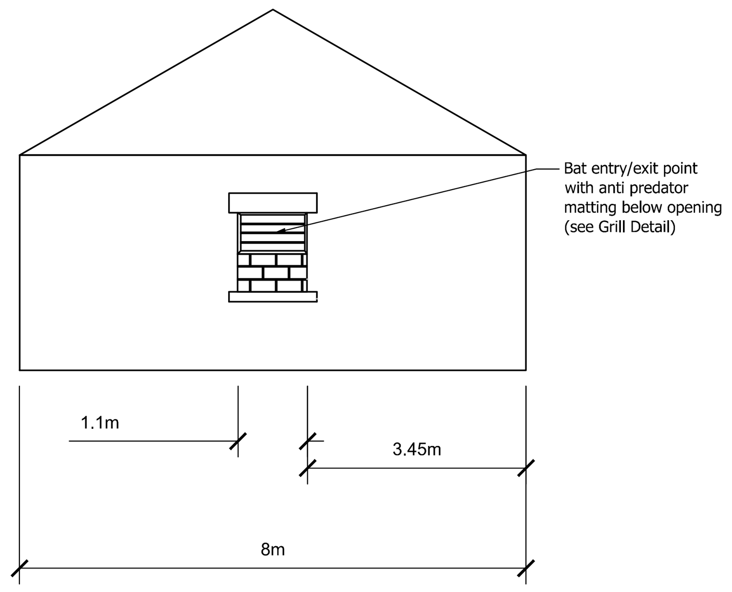

Proposed Side Elevation 1
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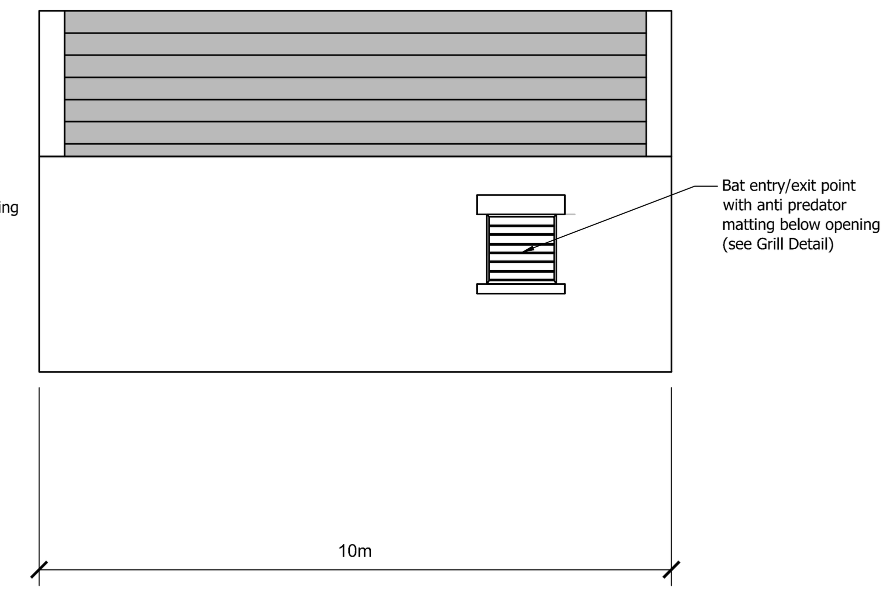

Proposed Rear Elevation
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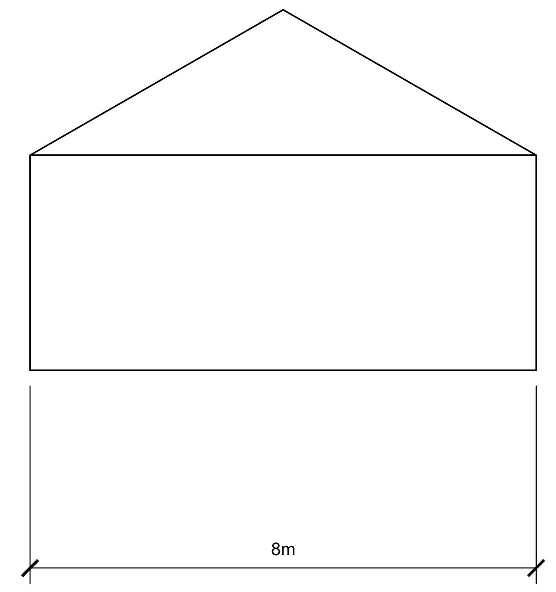

Proposed Side Elevation 2
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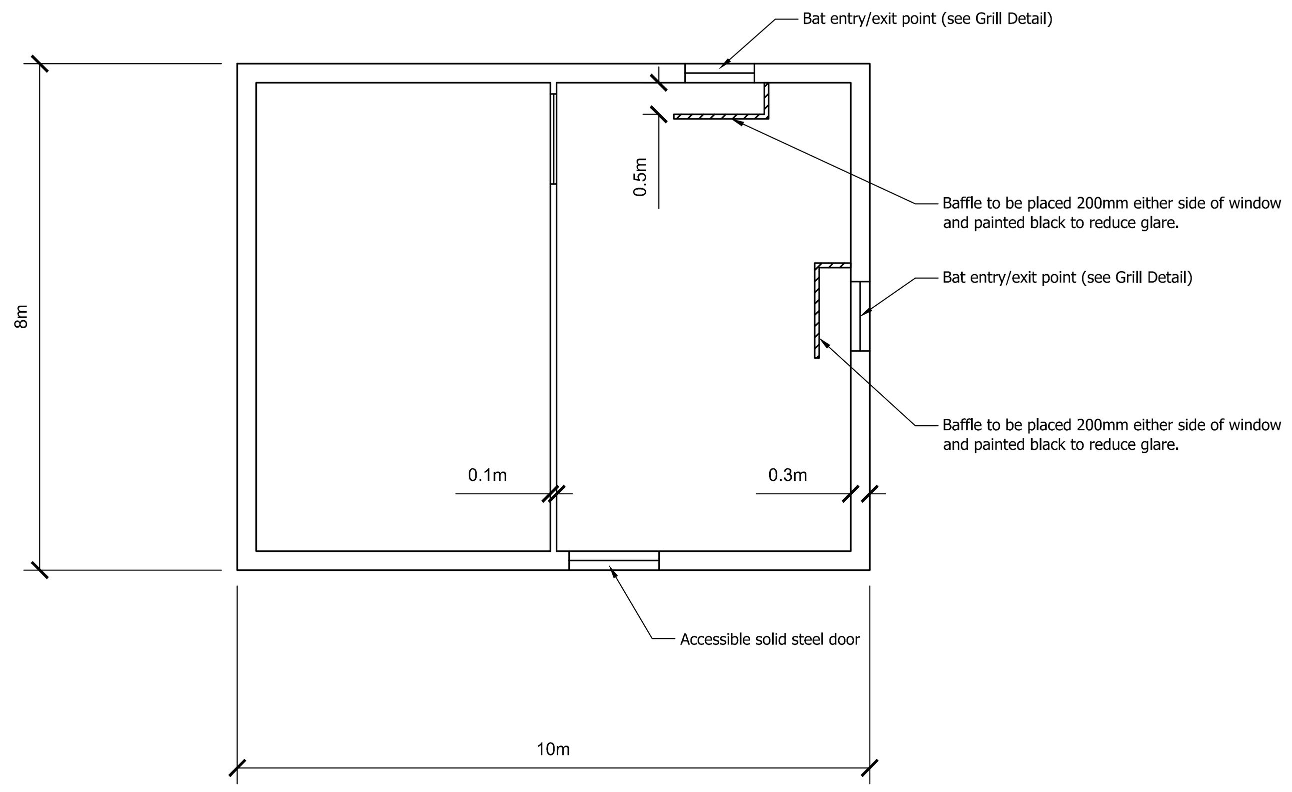

Proposed Ground Floor Plan
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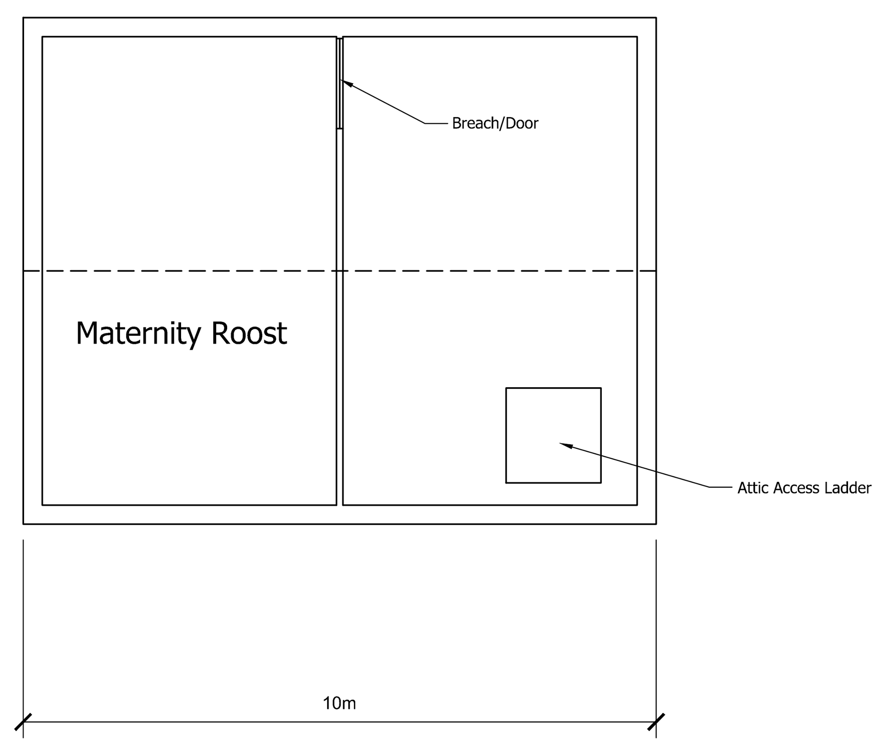

Proposed Attic Space Plan
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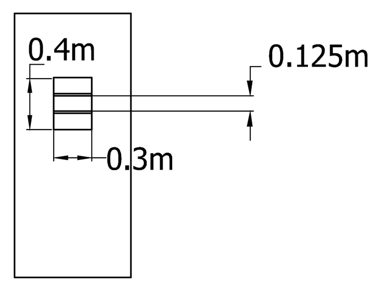
Maternity/Hibernation Roost



Proposed Internal Door Detail
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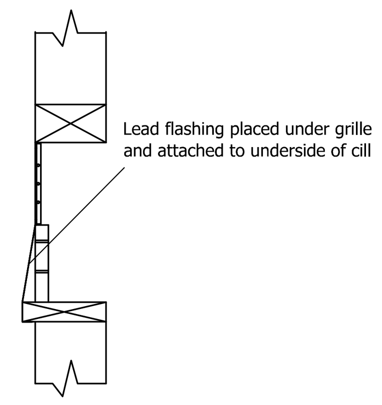

Section A-A
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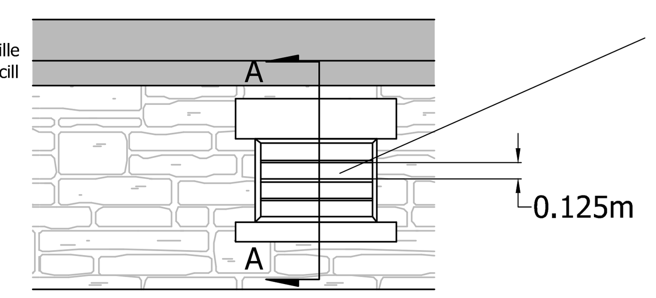

Proposed Grille Detail
Scale 1:100

Notes on Grille Detail

1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mmØ Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.
4. Lead flashing to be placed over window cill.

Notes:

1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.

Clients

Comhairle Chontae na Gaillimhe
Galway County Council

Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport

Bonneagar Iompair Éireann
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Consultant

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www.arup.ie

Job Title
N6 Galway City Ring Road

Scale: As Shown @A1
Date: February 2018

Issue	Date	By	Chkd	Appd
I2	23/03/2018	AG	HK	EMC
I1	22/02/2018	KJ	HK	EMC

Drawing Title
Proposed Bat Roots

Sheet 1 of 3

Drawing Status
For Information

Job No	Drawing No	Issue
233985	GCOB-3000-D-001	I2

Do not scale

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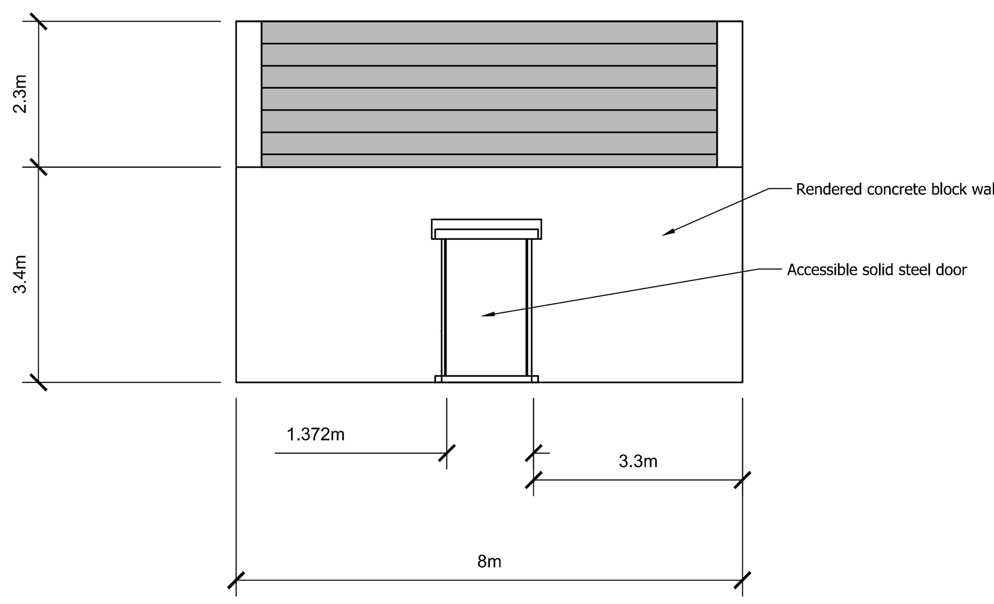
A1 | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P

FOR INFORMATION

Notes:
1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.



Proposed Front Elevation
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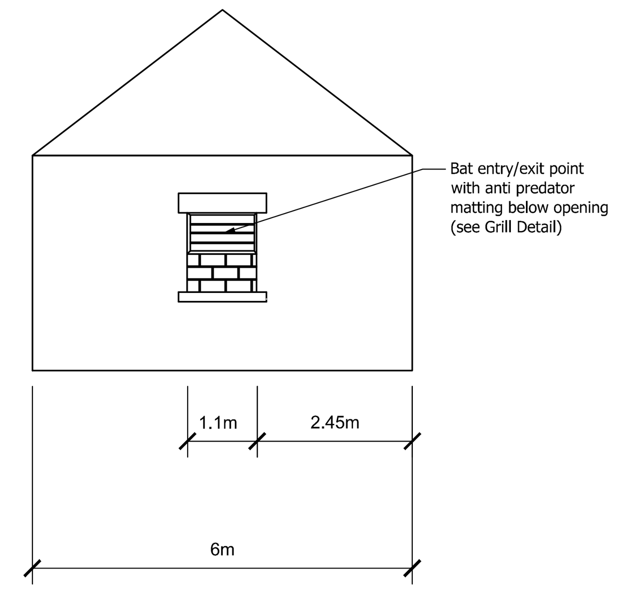

Proposed Side Elevation 1
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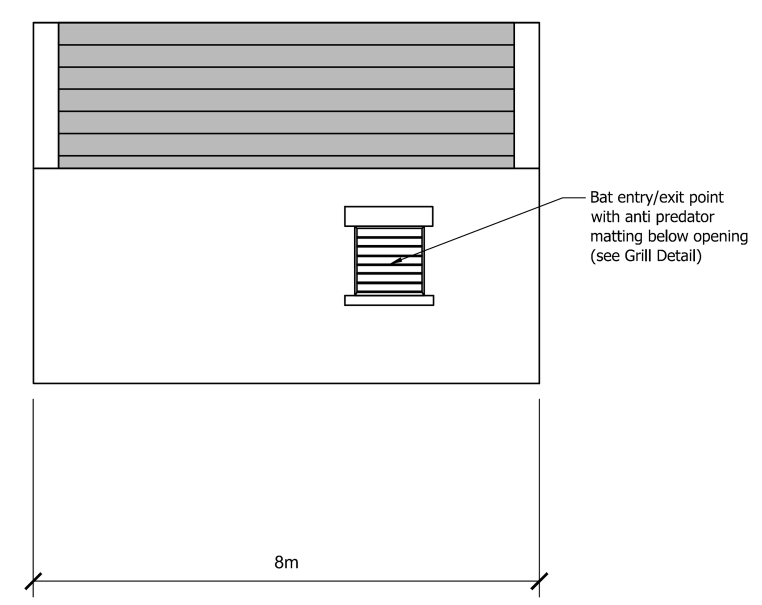

Proposed Rear Elevation
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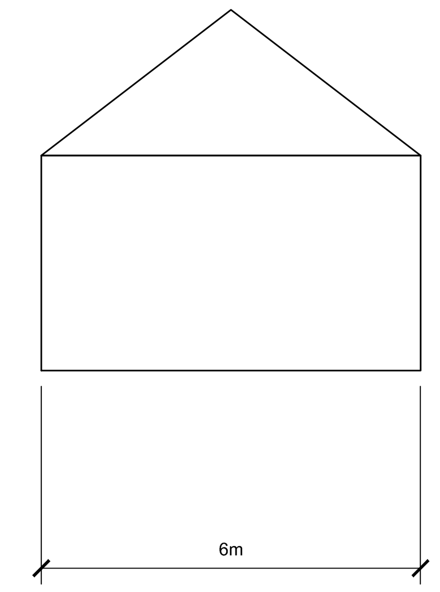

Proposed Side Elevation 2
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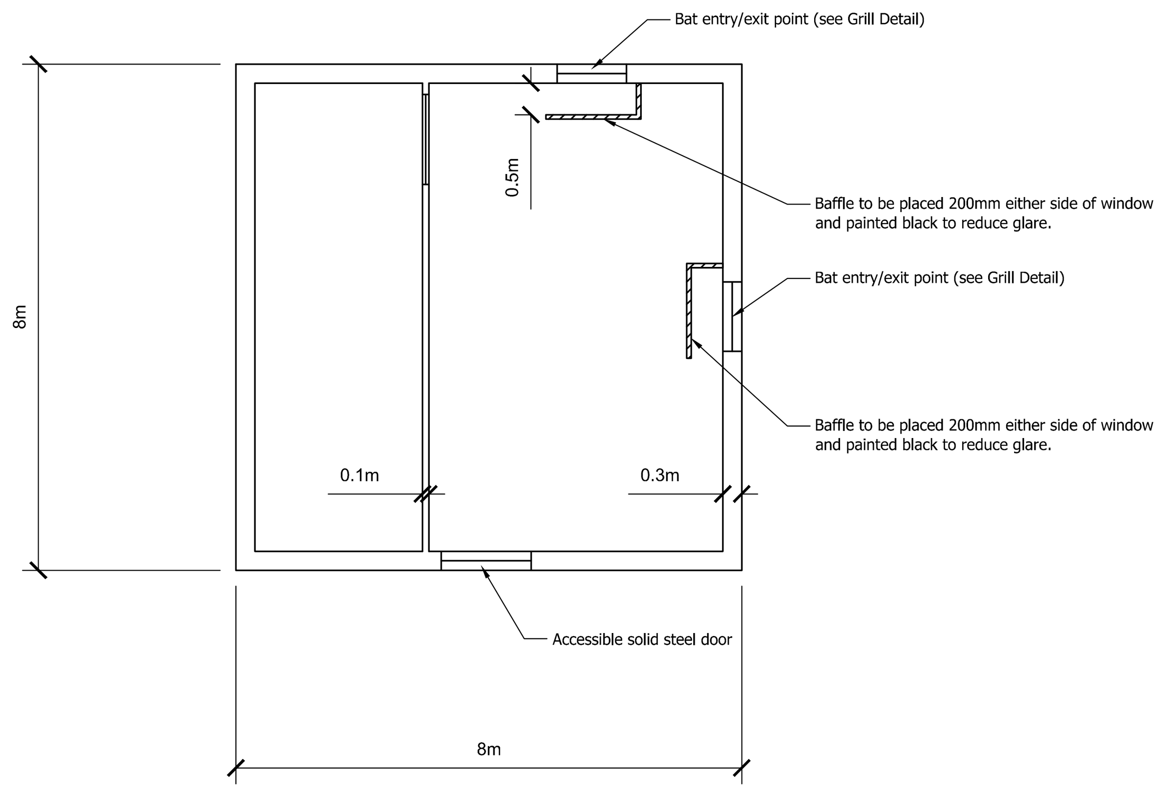
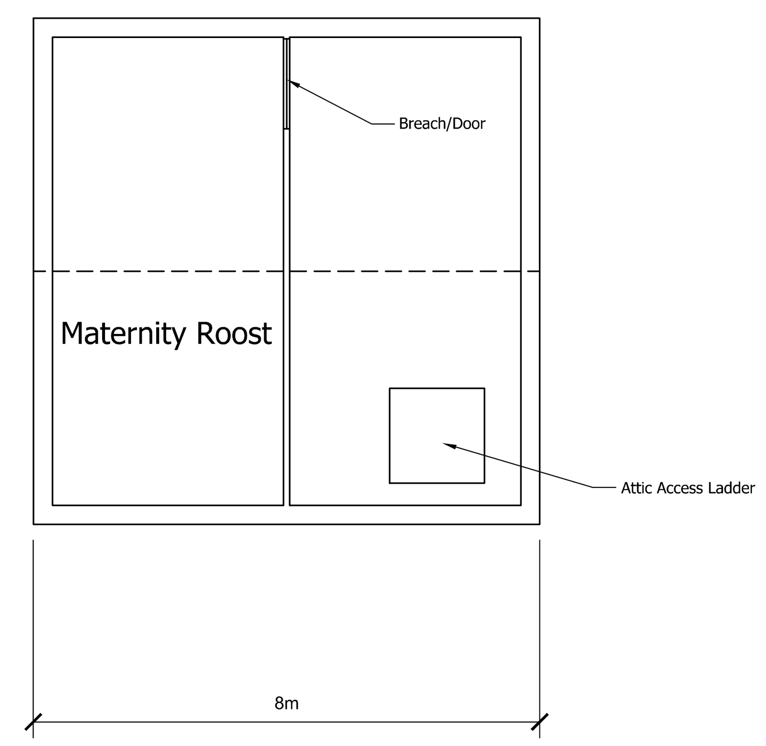
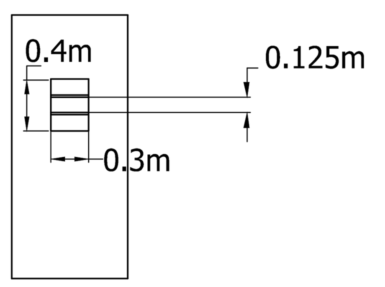


Proposed Ground Floor Plan
Scale 1:100

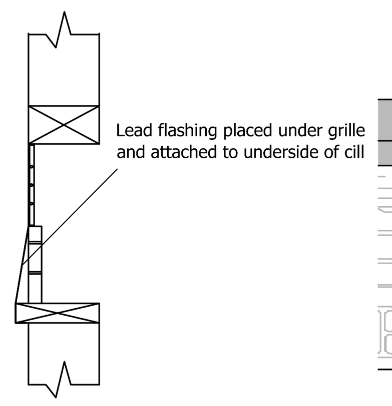


Proposed Attic Space Plan
Scale 1:100

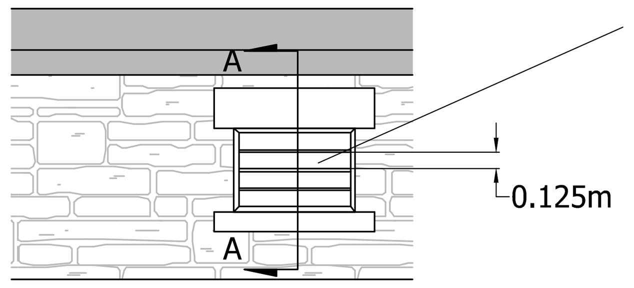
Balliondooley Day/Night Roost



Proposed Internal Door Detail
Scale 1:50

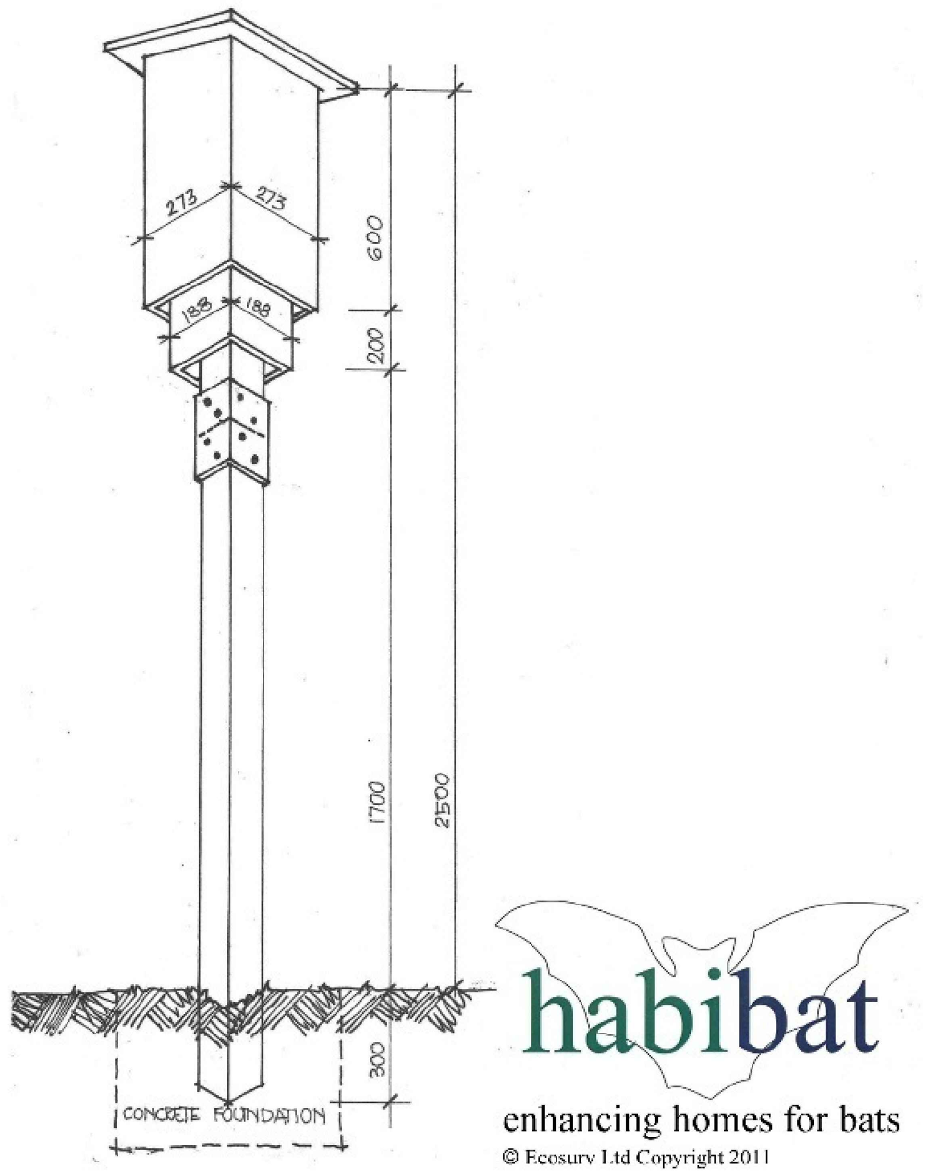


Section A-A
Scale 1:50

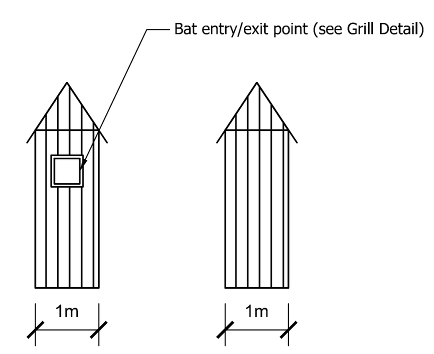


Proposed Grille Detail
Scale 1:100

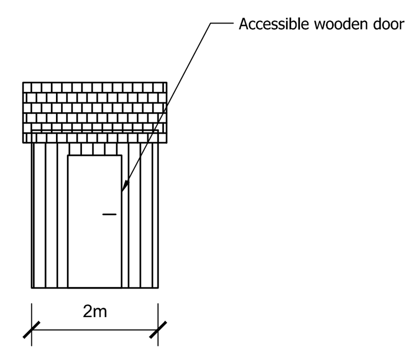
Notes on Grille Detail
1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mmØ Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.
4. Lead flashing to be placed over window cill.



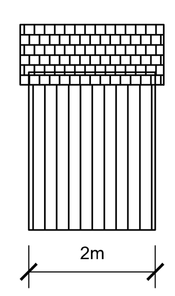
Typical Detail Double Chambered Rocket Box



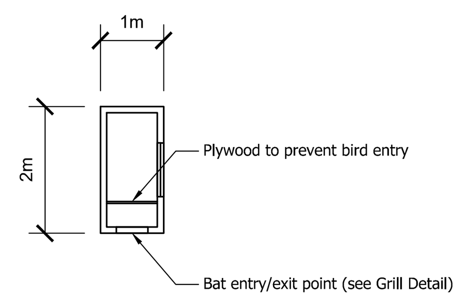
Proposed Side Elevations
Scale 1:100



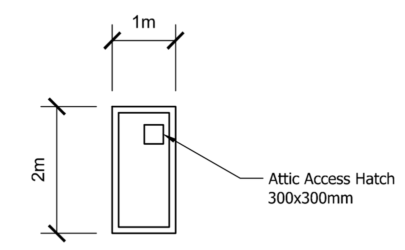
Proposed Front Elevation
Scale 1:100



Proposed Front Elevation
Scale 1:100



Proposed Ground Floor Plan
Scale 1:100



Proposed Attic Space Plan
Scale 1:100

Menlough Woods Night Roost

Clients
Comhairle Chontae na Gaillimhe
Galway County Council
N6 Galway City Transport Project
An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport
TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

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Job Title
N6 Galway City Ring Road

Scale: As Shown @A1
Date: February 2018

Issue	Date	By	Chkd	Appd
I2	23/03/2018	AG	HK	EMC
I1	22/02/2018	KJ	HK	EMC

Drawing Title
Proposed Bat Roots
Sheet 2 of 3

Drawing Status
For Information

Job No	Drawing No	Issue
233985	GCOB-3000-D-002	I2

Do not scale
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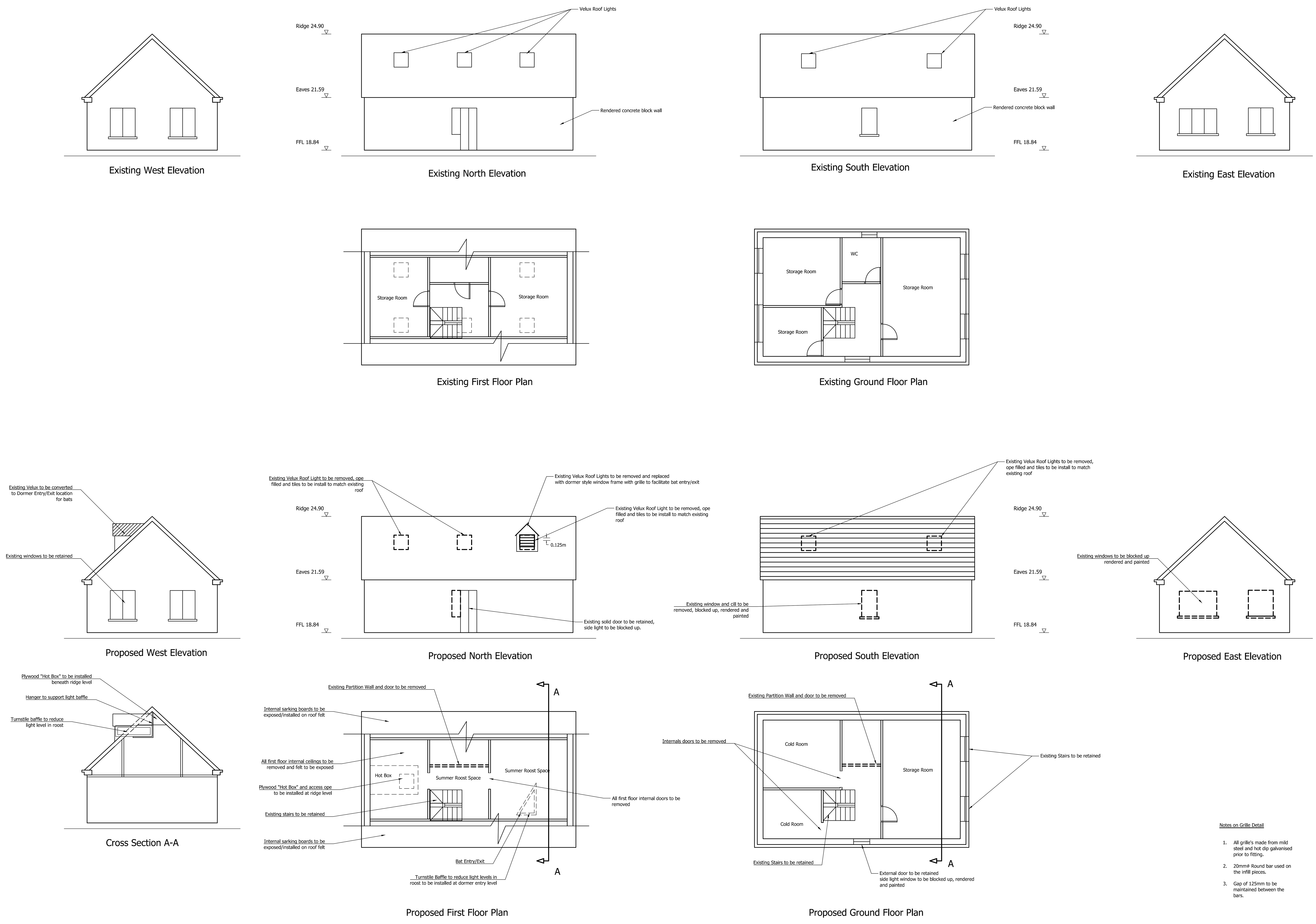

FOR INFORMATION

Notes:
1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.

Notes on Grille Detail

1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mmØ Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.

Castlegar Garage Retrofit Details

Clients
Comhairle Chontae na Gaillimhe
Galway County Council
N6 Galway City Transport Project
An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport
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Job Title
N6 Galway City Ring Road

Scale N.T.S.
Date: February 2018

Issue	Date	By	Chkd	Appd
I2	23/03/2018	AG	HK	EMC
I1	22/02/2018	KJ	HK	EMC

Drawing Title
Proposed Bat Roots
Sheet 3 of 3

Drawing Status
For Information

Job No	Drawing No	Issue
233985	GCOB-3000-D-003	I2

Do not scale
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