Appendix E

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)

E1

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

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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 (ºC)	Min Temp (ºC)	Survey Temp (ºC)	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 (ºC)	Min Temp (ºC)	Survey Temp (ºC)	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.

Abbreviations:
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

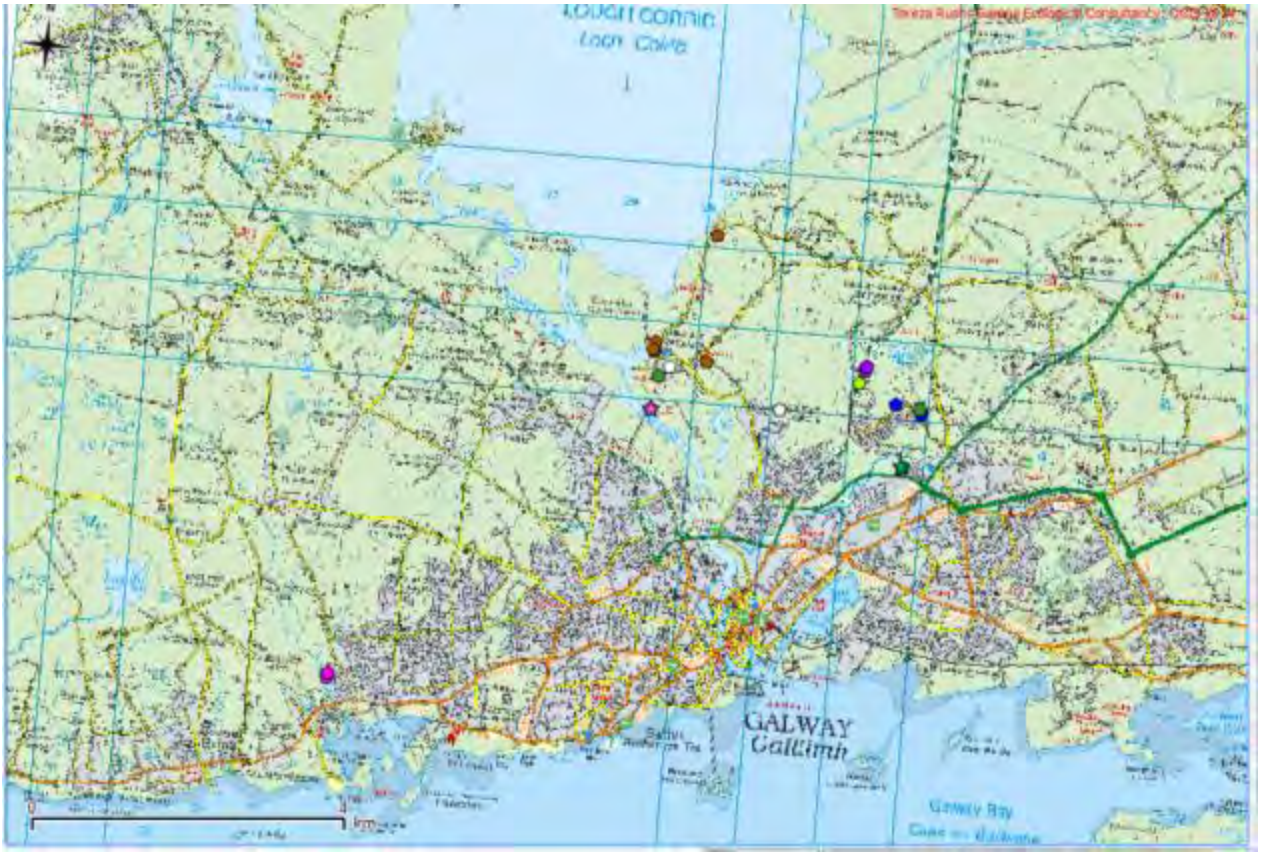
bat	30/08	31/08	01/09	02/09	03/09	04/09	05/09	06/09
1	/	/	/	/	/	/	/	/
2	/	/	/	/	/	/	/	/
3	/	/	/	/	/	/	/	/
4	/	C2	C2	C2	C2	C2	/	/
5	D2	D2	D2	D2	D2	D2	D2	/
6	/	F2	F2	F2	/	/	/	/
7	/	/	/	/	A2	A2	/	/
8	A2	A2	A2	A2	A2	A2	A2	/
9	/	/	/	/	/	/	/	/
10	/	/	/	/	/	/	/	/
11	/	/	/	/	/	/	/	/
12	/	/	B2	A2	B2	/	/	/
13	/	/	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)

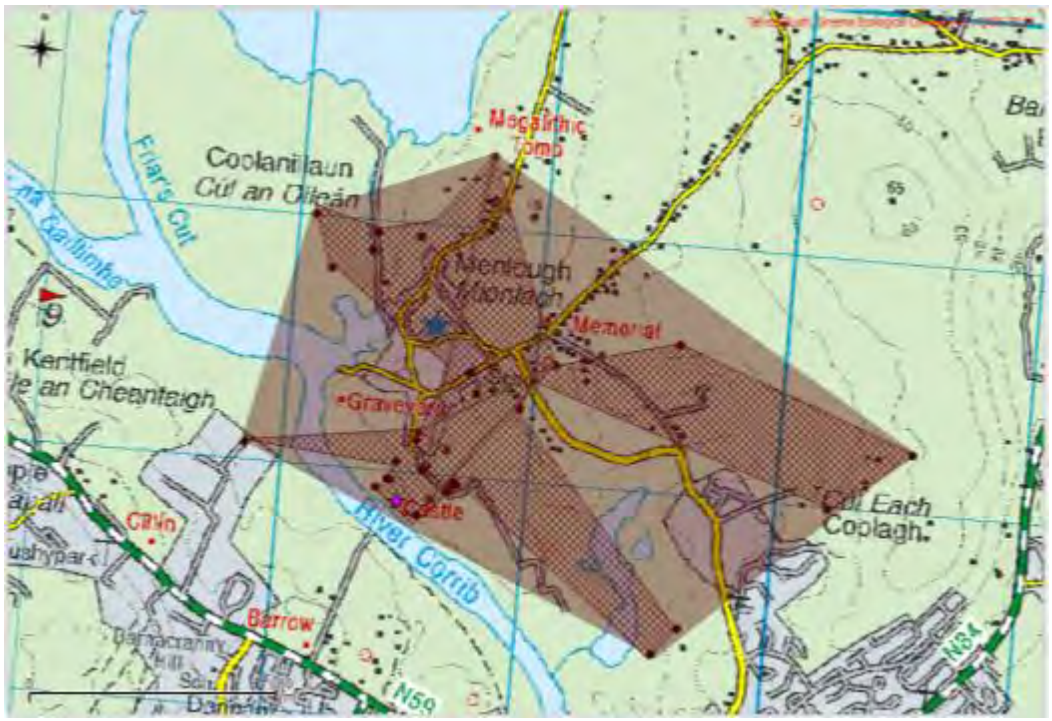


Figure 36 Foraging area of bat 6 August (male Lesser horseshoe)

Figure 37 Foraging area of bat 7 August (female Lesser horseshoe)

Figure 38 Foraging area of bat 8 August (female Lesser horseshoe)

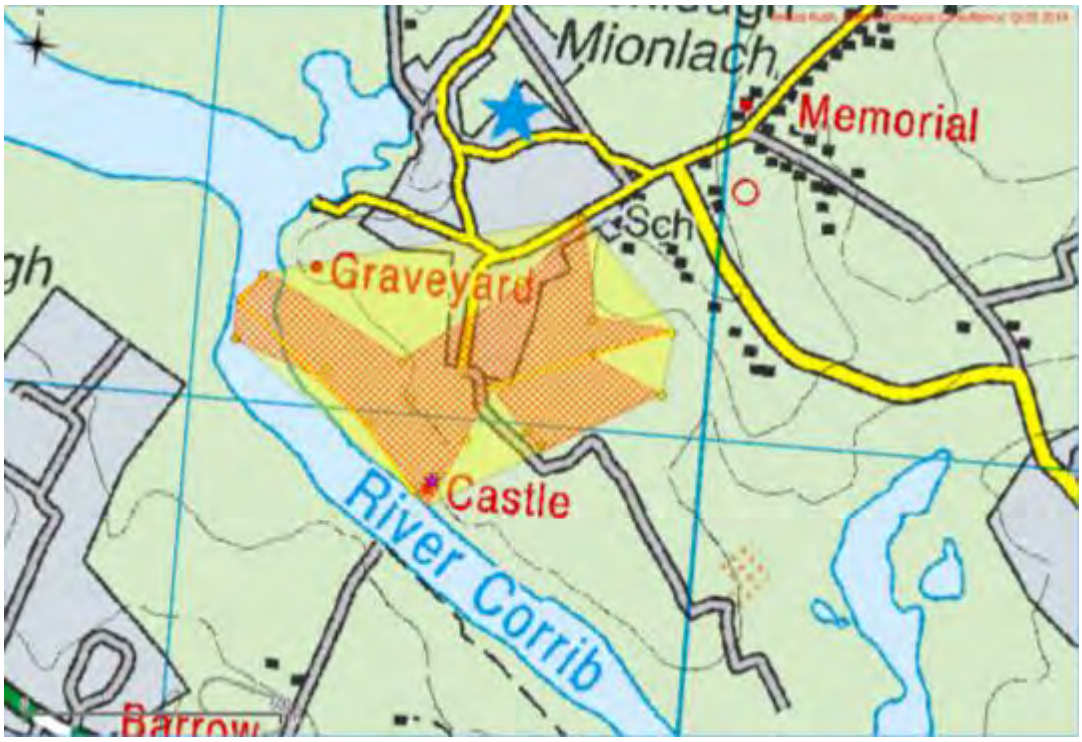


Figure 39 Foraging area of bat 9 August (male Lesser horseshoe)

Figure 40 Foraging area of bat 10 August (female Lesser horseshoe)

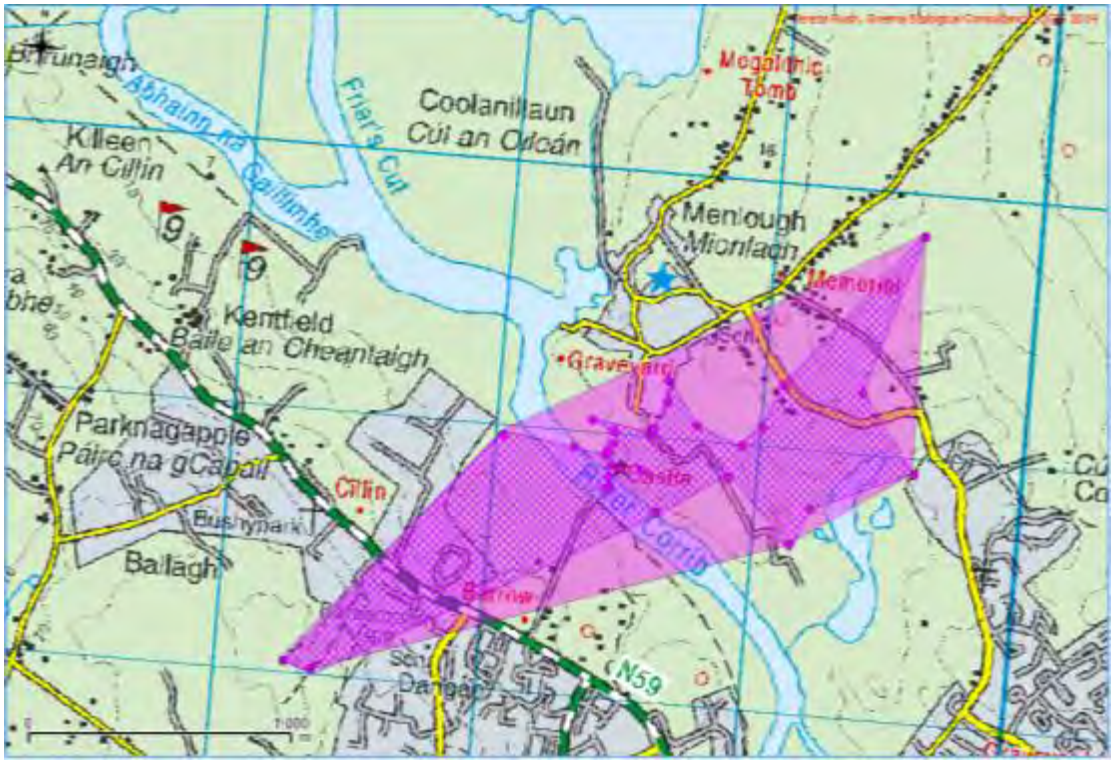


Figure 41 Foraging area of bat 11 August (male Lesser horseshoe)

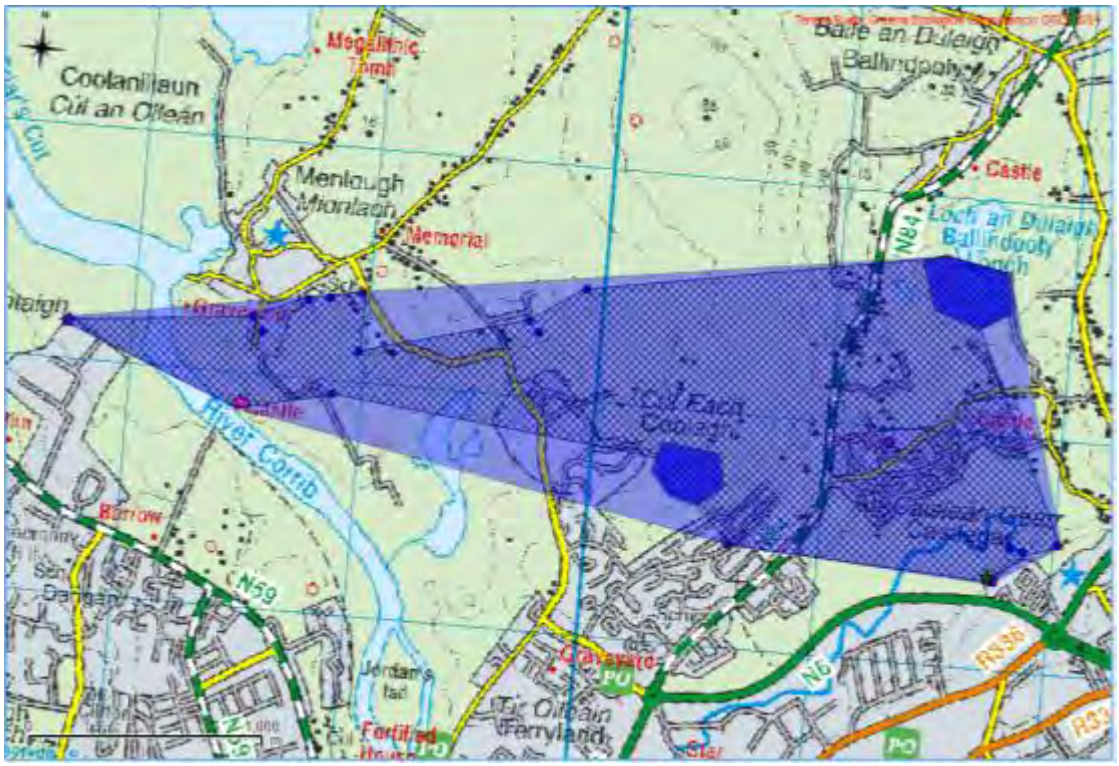


Figure 42 Foraging area of bat 12 August (male Lesser horseshoe)

Figure 43 Foraging area of bat 13 August (male Lesser horseshoe)

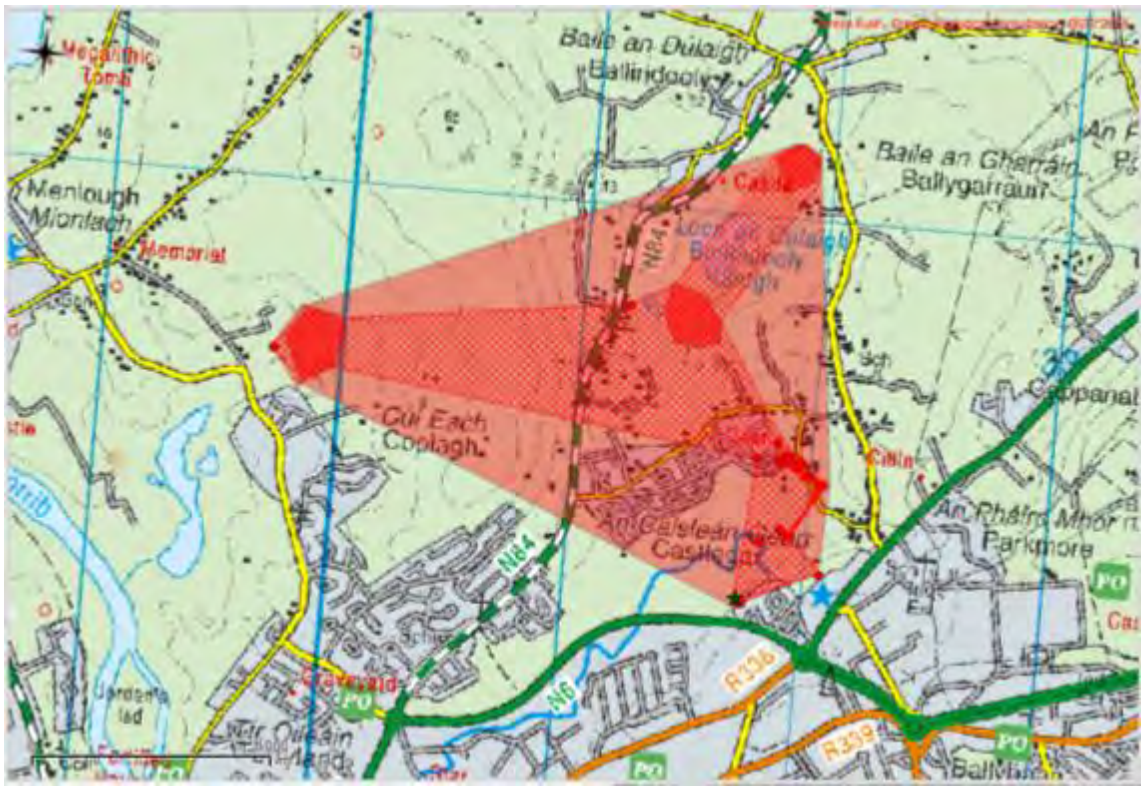


Figure 44 Foraging area of bat 14 August (male Leisler's)

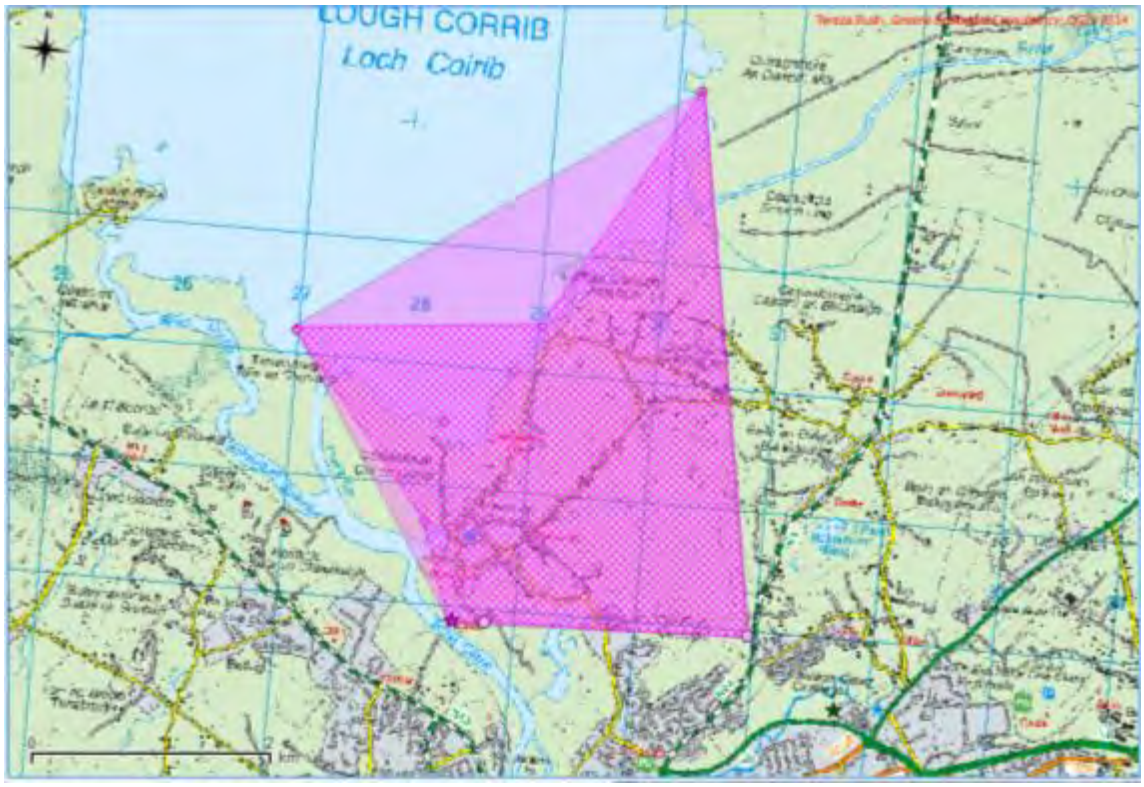


Figure 45 Foraging area of bat 4 September (male Leisler's)

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)

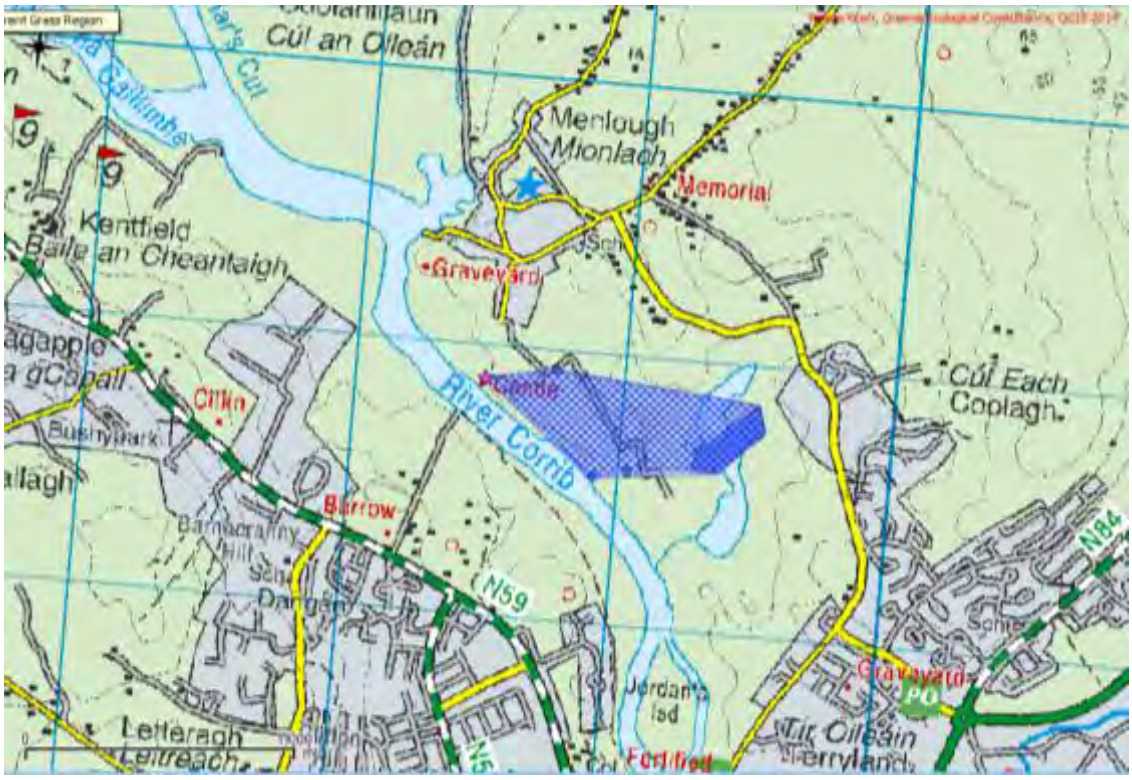


Figure 49 Foraging area of bat 8 September (female Daubenton's bat)

Figure 50 Foraging area of bat 12 September (male Lesser horseshoe)

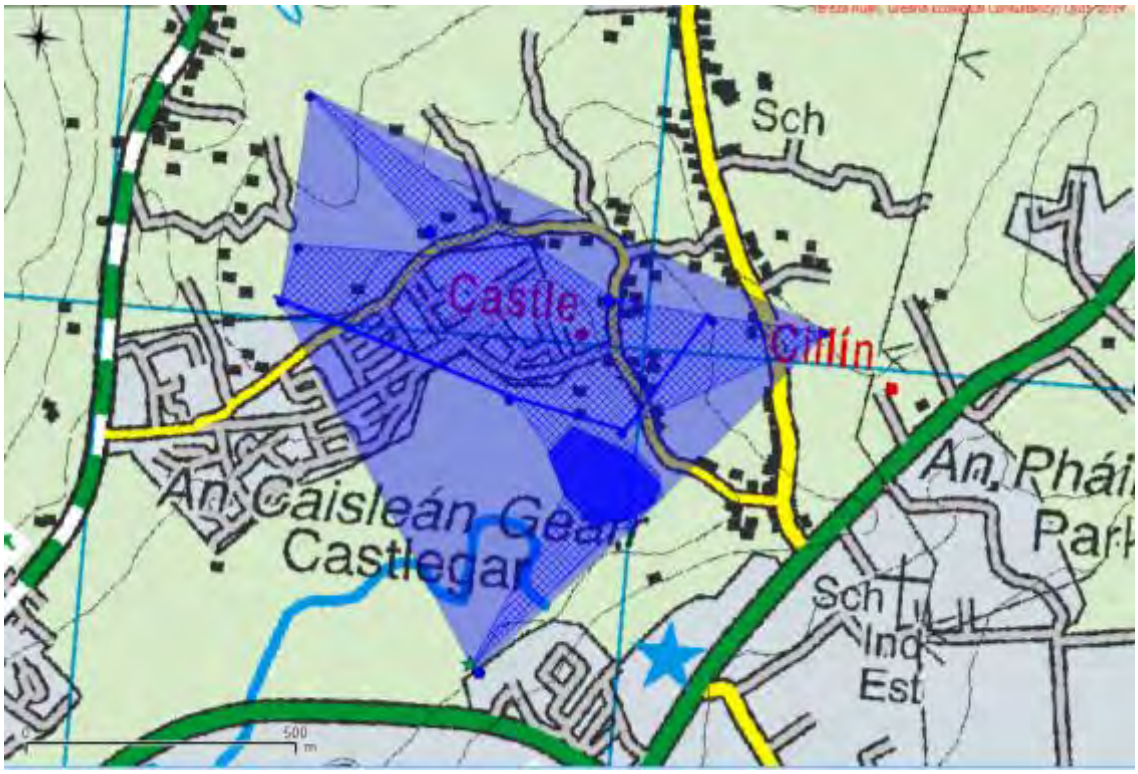


Figure 51 Foraging area of bat 13 September (male Lesser horseshoe)

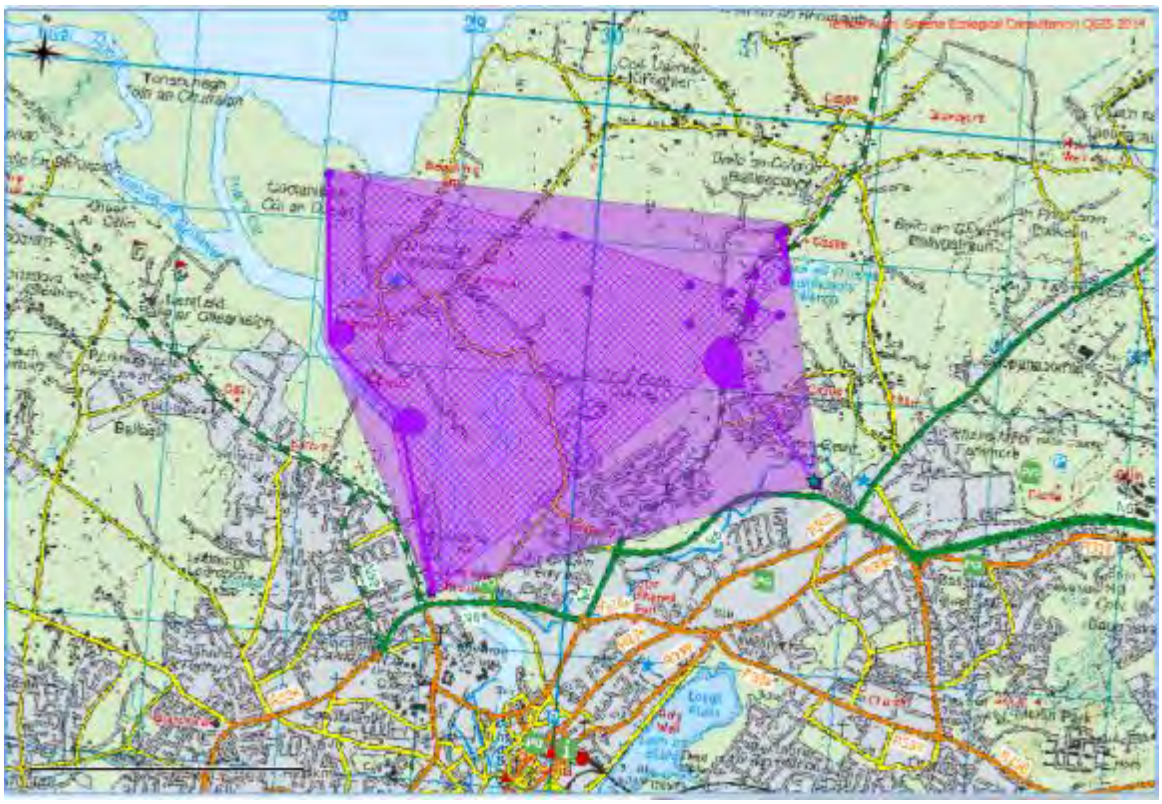


Figure 52 Foraging area of bat 14 September (female Lesser horseshoe)

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

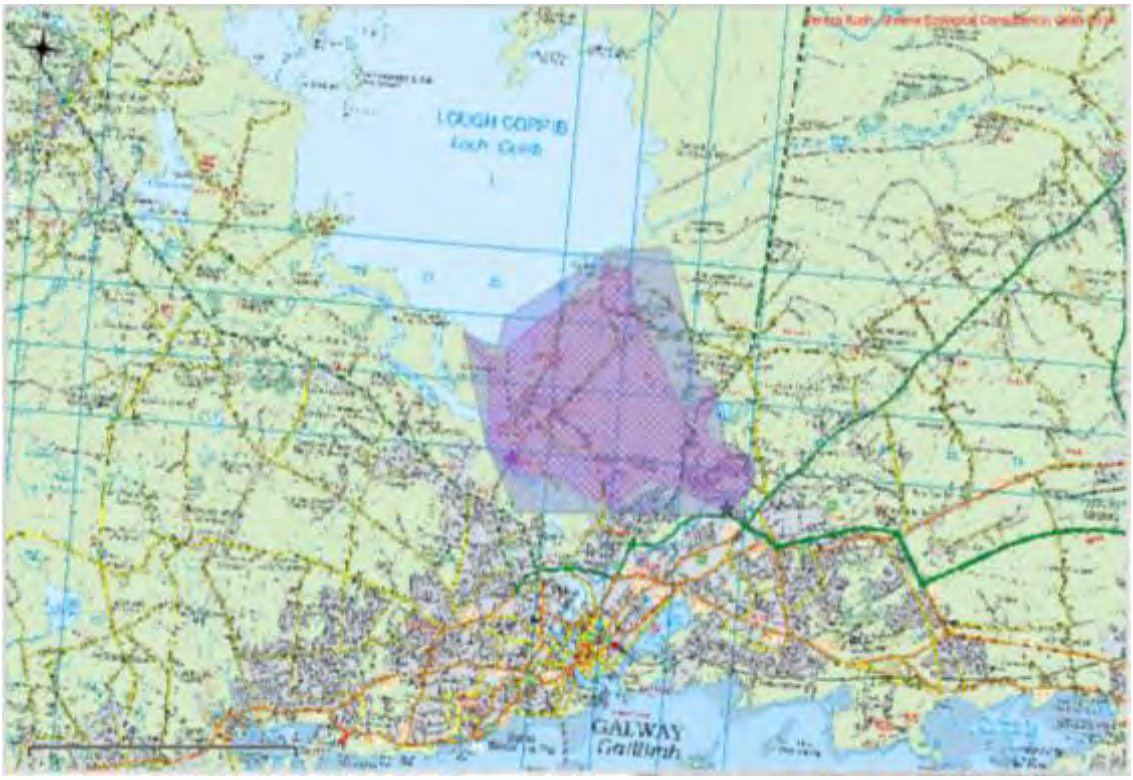
The overall foraging areas from both sessions overlapped in many places. The overall foraging area in August added up to 21.75km^2 (MCP) or 13.70km^2 (MLP), while it was 56.10km^2 (MCP) or 26.46km^2 (MLP) in September. Direct comparison of foraging areas in the August and the September session is not 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.

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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]