Tionscadal Iompar Cathair na Gaillimhe

# N6 Galway City Ring Road

## Bat Derogation Licence Application

Volume 3 Appendices

April 2025

An Roinn Iompair
Department of Transport

Comhairle Cathrach na Gaillimhe
Galway City Council

ARUP

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# Appendix A

## Personnel 2018 and 2023

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

*Qualifications as of time of the surveying conducted:

2014 – 2018

Dr Daniel Buckley

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

Dr Isobel Abbott, Grad CIEEM

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

Brian Keeley, MCIEEM

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

Dr Caroline Shiel

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

Paul Scott CEcol, CEnv, MIEEM

Paul Scott is Director with Scott Cawley. He holds a first class honours degree in Environmental Biology from the University of Liverpool and a Masters in Pollution and Environmental Control from the University of Manchester. Paul is a Chartered Ecologist (CEcol), a Chartered Environmentalist (CEnv) and a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM). He is on the Council of Bat Conservation Ireland, leads the Dublin Bat Group and All Ireland Nathusius Pipistrelle Working Group and is a licenced and trained bat handler with experience of hand-netting, harp trapping and mist netting of bats in Ireland and the UK.

Paul is experienced in the assessment of impacts of major infrastructural developments on all Irish bat species. Paul has prepared ecological guidance notes designed for planners and developers on behalf of the four Dublin local authorities, including advice on compliance with legal protection for bats.

Geoffrey Billington

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

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

Tereza has over ten years' experience working with bats. Her experience includes trapping, ringing and radio-tagging bats in the UK and other European countries. She regularly participates in radio-tracking studies and examples of projects she has worked on include Hinkley Power Station in Somerset, Evergreen 3 between Oxford and Bicester in Oxfordshire and the Northern Distributor Road Scheme in Norfolk. She has provided training on advanced bat surveying techniques. She has extensive experience with sound analysis of bat recordings and work with frequency division/heterodyne and time expansion detectors as well as Batcorder and Anabat bat detectors, including analysis. She is experienced in programming and using static bat loggers (for monitoring radio-tagged bats).

Barbara McInerney

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

Colm Clarke, MCIEEM, Principal Ecologist

Colm Clarke is a Principal Ecologist with Scott Cawley and has over seven years' experience in ecological consultancy. He obtained an honours degree in Natural Sciences, with a specialisation in Botany, from Trinity College Dublin, and a Masters in Biodiversity and Conservation from the same institution. Colm is a full Member of the Chartered Institute of Ecology and Environmental Management (CIEEM), a member of the Irish Environmental Law Association (IELA), and chairperson of the Dublin Bat Group (an affiliate group of Bat Conservation Ireland (BCI)). He is part of the CIEEM's EcIA Accreditation Working Group, which is focused on driving quality standards in EcIA across Ireland and the UK. He keeps abreast of the latest developments in environmental case law and best practice in ecological assessment through attendance at training courses, and IELA events. Colm's principal specialisms are in botany (with experience in classification of habitats both to Fossitt (2000) categories and identification of EU Annex I habitats) and bats (including advanced survey techniques such as use of infrared night vision aids, and the capture and handling of bats), and he is Scott Cawley's lead bat specialist. Colm is also experienced in a range of other fauna surveys, including freshwater white-clawed crayfish, freshwater pearl mussel, amphibians, reptiles, marsh fritillary butterfly, and terrestrial mammals. Colm regularly completes Ecological Impact Assessment (EcIA), Biodiversity Chapters of Environmental Impact Assessment Reports (EIAR), Appropriate Assessment Screening reports, Natura Impacts Statements and Technical Review of AA reports on industrial, residential and large infrastructure projects.

2023

Daniel Connell, MCIEEM, Principal Ecologist

Daniel Connell is a Principal Ecologist with Scott Cawley Ltd. and has 11 years' combined experience in Ecology and Consultancy within Ireland, and more than 10 years' experience in Environmental Journalism for both ENGOs and National Press in Ireland and the UK. He has conducted Bat Surveys for large infrastructure projects within Ireland, as well as targeted species-specific and protect species surveys on behalf of private clients and ENGOs; from AA, NIS, EcIA, and EIAR ecology reports for construction, infrastructure, forestry, solar, and windfarm projects, to conservation initiatives for national wildlife groups and individual clients. He has also volunteered with Bat Conservation Ireland (BCI) and the Vincent Wildlife Trust (VWT), respectively, on a variety of Bat conservation initiatives, and has advised clients, local ENGOs and Citizen Scientists on Bat surveying techniques, appropriate Bat Box Schemes, and mitigation measures. He is currently coordinating the Bat Surveys for N6 GCRR (2023-Present).

Recent bat surveys Daniel has project-managed include, but are not limited to: Ballinasloe Strategic Housing Project (2022) on behalf of Limshill Ltd; (no. 9) Solar Farm projects in Cork, Meath, and Offaly, respectively, on behalf of Entrust Planning Services (2020-2022); N17/R320 Junction Upgrade at Lisduff to the southeast of Claremorris town in Co Mayo, on behalf of BAM (2021); and N59 Moycullen Bypass (2021 – 2022), on behalf of Wills Bros.; including applying for Bat Derogation licences with the NPWS Wildlife Licence Unit.

Síofra Quigley, MCIEEM, Senior Ecologist

Síofra is a Senior Ecologist at Scott Cawley. She has a Bachelor of Science degree in Zoology from the National University of Ireland, Galway, and a Masters in Wildlife Biology and Conservation from Edinburgh Napier University. Síofra has six years' experience working as an ecologist in Ireland and Scotland, most of which has involved various techniques of bat surveying on large and small infrastructure projects.

This includes; bat emergence and re-entry surveys, transect activity surveys, crossing point surveys, back-tracking surveys, deployment of static detectorautomated detectors and subsequent bat call analysis, radio-tracking surveys, building, structure and tree potential roost feature (PRF) surveys and winter hibernation inspections. Síofra is trained in endoscope use of PRFs in buildings, structures, and trees, and has carried out ECoW supervision of disturbance on bat roosts on road schemes. Síofra has carried out cave and mine winter hibernation inspections, and bat box checks under licenced supervision of David Dodds in Scotland. Siofra has completed a bat handling training course delivered by Neil Middleton of Batability in 2023, under licence from NPWS (Licence No. C72/2023). She has gained experience trapping and handling bats under the supervision of Paul Scott and under licence from the NPWS in Dublin Zoo (2023), and Johnstown Castle, Co. Wexford (2023). Siofra has undertaken a number of internal bat inspections across Ireland, and has identified roosts of various bat species including; pipistrelle sp., Leisler's bat, brown long-eared bat, Myotis sp. throughout her 6 six years of experience working as an ecologist. Siofra is also a member of BCI and a volunteer in the Wicklow Bat Group.

Kristie Watkins-Bourke

Kristie holds an honours degree in Geography from Swansea University, Wales, and obtained her Masters in Applied Environmental Science from University College Dublin specialising in water quality sampling and testing using habitat surveys, laboratory analysis, and macroinvertebrate identification. She is a Qualifying Member of CIEEM and has broad environmental expertise with skills that encompass both freshwater and terrestrial ecology. Kristie's experience in environmental consultancy has focused on the management of infrastructure projects and preparation of ecological assessments, including Ecological Impact Assessment (EcIA) Appropriate Assessment (AA) Screening reports, and Natura Impact Statements (NIS) for residential, commercial, and infrastructure projects across Ireland. Her field survey experience includes terrestrial mammal surveys (including bats, badgers and otters), bat roost suitability surveys, amphibian surveys, invasive species surveys, water quality assessments and fisheries potential, and licenced crayfish surveys and habitat suitability assessments, and has acted as an Ecological Clerk of Works role on construction projects. Kristie has confidence using a range of software's for habitat mapping (ArcGIS and QGIS) and conducting bat call analysis (Anabat Insight) to understand bat activity for EIA chapters. Kristie contributed to terrestrial ecology surveys and biodiversity chapter for the onshore aspect of a proposed windfarm and undertook bat activity surveys and a preliminary invasive species for cable route options.

Jamie Dempsey

Jamie Dempsey is a consultant ecologist with Scott Cawley Ltd. He holds a degree in Mechanical Engineering and a master's degree in Applied Environmental Science from University College Dublin. He has conducted activity, emergence, and automated detector surveys for bats on a range of projects, including large infrastructure projects and large residential developments. He has also completed bat surveys voluntarily with Bat Conservation Ireland (BCI). Jamie has received in-house training at Scott Cawley on building and tree based PRF identification, and best practice bat survey techniques.

*Alison Bourke*

Alison Bourke is a consultant ecologist with Scott Cawley Ltd. She hold a honours degree in Agricultural Environmental Science from University College Dublin. She has carried out multiple bat surveys with Bat Conservation Ireland (BCI) in 2020 and 2021 which contributed to the All-Ireland Daubenton Waterway Survey. Since joining, Alison has gained a large amount of bat surveying experience working on bat activity and emergence surveys, automated detector deployment, and the identification of possible roost features (PRFs) on trees and buildings. She has completed bat acoustic training and been involved in analysing the bat acoustic data from a number of large road projects. Alison has also been involved in a number of winter birds surveys and is continually growing her knowledge through training and survey work. She has also been gaining broader experience through in-house training with Scott Cawley completing habitat and mammals surveys while also gaining technical training on GIS.

*Cian O'Flaherty*

Cian O'Flaherty is a Qualifying CIEEM member with Scott Cawley Ltd. He possesses a BSc in Biology MU and an MSc in Wildlife Conservation and Management UCD. He has conducted a variety of Bat Surveys for large infrastructure projects across the country including the following road scheme projects, the N6 GCRR, the N4 Carrick-on-Shannon to Dromod road and the N24 Cahir to Limerick junction. Recent bat surveys conducted by Cian include the deployment of automated detectors (Boyne redevelopment project), tree and building roost emergence surveys (N6 GCRR), and bat activity transects (Carrick-on-Shannon to Dromod road). In his free time, Cian has attended talks given by Bat Conservation Ireland (BCI), also attending their recent annual conference held in March 2023.

Shane Brien

Shane Brien is a Senior Consultant Ecologist with Scott Cawley. Shane has been a valued member in BCI voluntary surveys which included Daubenton's survey, Pilot Woodland Monitoring Scheme and BATLAS 2020. He has professional experience in ecological consultancy in Ireland since 2018 and has worked with clients at both public and private levels. Shane has gained valuable experience in bat ecology, both voluntary and professionally, using best practice guidelines following Bat Survey for Professional Ecologists: Good Practice Guidelines (4$^{th}$ Edition) (Collins, 2023). He is experienced in bat roost inspections of buildings and emergence and re-entry surveys. Shane has been involved in conducting preliminary roost assessment of structures for bats, presence/absence surveys, undertaking walked survey transects in both woodland & structural settings, recording bat activity using specialist equipment (handheld bat detectors and automated bat detectors). Previous projects include TII projects of internal/external surveys in Dublin area (2019-2022); internal inspections for refurbishment works Dún Laoghaire (2020); internal and external building inspections at proposed light changes Kilternan (2019). Ecological clerk of works includes: DER/BAT 2022-38 – Roof removal at Kilmainham Mills, Kilmainham, Co. Dublin (2022). Supervision of works under licence to remove roof tiles; DER/BAT 2020-73 & DER/BAT 2022-45 – Roost disturbance, Emo Court, Emo, Co. Laois. Included supervision of enabling works at basement level Emo Court, an active brown long-eared roost. And he holds a full licence to capture all bat species (except lesser horseshoe bat) with hand net by hand (Licence No. C227/2023).

Jared Bennett

Jared Bennett is a Consultant Ecologist with Scott Cawley Ltd. and has conducted Bat Surveys for large infrastructure projects within Ireland. He is a member of Bat Conservation Ireland (BCI) and has volunteered with their initiatives. In recent surveys Jared undertook bat activity transects and roost inspections, as well as supervising data management and leading the analysis of bat activity for N6 GCRR (2023).

Eoin Cussen

Eoin Cussen is a Senior Consultant Ecologist with Scott Cawley Ltd. Eoin holds a BSc (Hons) in Zoology from University College Cork and MSc (Hons) in Ecological Assessment from the same institution. Eoin is an experienced ecologist with over 6 years' professional postgraduate experience in ecological consultancy including planning related casework for state and non-governmental organisations within Ireland and the UK, input to and preparation of Appropriate Assessment (AA) screenings, Natura Impact Statements, Environmental Impact Assessment Reports and Ecological Impact Assessments, and a wide range of experience of ecological surveys for protected habitats and species including botany, mammals, bats and birds. Eoin is trained and licensed within Ireland to disturb bat roost sites and handle bats where necessary.

Cathal O'Brien

Cathal O'Brien is a Senior Consultant Ecologist with Scott Cawley Ltd, which he joined in 2020. He is also a Qualifying Member of the CIEEM. He has conducted bat activity surveys on large infrastructural road and rail schemes as well as emergence and re-entry surveys of structures associated with such projects (i.e. Dart North + and N6 GCRR - 2021 - 2023). Cathal has carried out internal and external surveys of structures to identify evidence of bat roosts and potential bat roost features (Nullamore EcIA AA Screening – 2021, Dart North + 2021-2022, DUB40 Amazon Substation SID - 2020, Killeen Castle Rose Cottage - 2022). Cathal has also conducted inspections of trees for the presence of potential bat roost features (PRFs) (i.e. Dart North + - 2022, Rathbourne ECoW - 2022, Merville Place ECoW - 2022, 230004 Cyrus One Dub 2.0 – 2023, N6 GCRR - 2023). He has acted as Ecological Clerk of Works (ECoW) in a number of residential and commercial projects (2020 - current). The scope of ECoW site visits for these projects has included, further inspection and examination of structures and trees identified as suitable bat roost features (PRFs) during initial inspections prior to felling to facilitate construction works (i.e. Rathbourne ECoW - 2022, Merville Place ECoW - 2022, Cyrus One Dub 2.0 - 2023).

Cathal has also examined structures which were identified as hosting roosts during initial pre-planning ecological surveys on successfully obtaining a derogation licence from the NPWS (2020 – 2023). As part of ECoW, he has also confirmed the implementation of mitigation measures as part of planning compliance conditions as stipulated in derogation licences and/or as per consented planning applications both prior to the commencement of construction works and post-construction for monitoring measures (DUB40 Amazon Substation SID – 2020 - current, Castle Park Planning Compliance 2023 - current). Monitoring measures include post-construction monitoring of alternative roosts in the form of bat boxes erected on sites prior to construction works where bat roosts were confirmed. Cathal routinely conducts analyses of bat data collected on dawn and dusk activity, emergence and/or re-entry surveys in which he is highly proficient in identification of recorded calls to species or genus level by visual and aural examination of sonogrammes in the software packages.

Conor McKinney - Senior Ecologist, Arup

Conor is a Full Member of CIEEM and has 15 years working as an ecologist and has a BSc in Environmental Science and a MSc in Ecological Management and Conservation Biology. He has undertaken a range of bat surveys in his time, including within the last year various bat activity surveys, dawn and dusk and dusk to dawn emergence and reentry surveys Daubenton's surveys and endoscoping for projects in Ireland including data centres, residential developments and trainline developments as well as numerous smaller developments. Conor has recently (2022) undertook CIEEM registered training on bat ecology, survey and impact assessment and mitigation. Conor also undertakes voluntary bat recording and nocturnal animal recording with his community group Wild Belfast.

Hannah Sheridan – Ecologist, Arup

Hannah has a BSc (Hons) in Marine Science and a MSc (Hons) in Marine Planning for Sustainable Development. Hannah is a Qualifying Member of CIEEM and worked as an ecologist for 3 years with Arup and prior with the National Parks and Wildlife Service. During that time she has undertaken major projects for Arup including the creation of over 20 conservation management plans for Special Areas of Conservation and a forestry strategies for DAFM. She has also undertaken a range of bat surveys for roads projects in Derry, Sustainable Urban Drainage Systems and various other major developments. She has supported efforts to identify acoustic recording of bats for various projects including those mentioned above.

Amy Sproule – Ecologist, Arup

Amy has a first class honours in Agri-Environmental Science and is a Qualifying Member of CIEEM and has 4years of experience undertaking bat surveys, not only on a professional basis where she has carried out bat activity surveys for development works ranging from Sustainable Urban Drainage Systems and for a major development at Diageo, but also on a voluntary basis for Bat Conservation Trust Ireland where she has been volunteering since 2019. Amy has recently various training workshops including Bat Ability an CIEEM help courses on bat impact assessment and mitigation. She has also been involved with bat projects in the UK and Australia identifying acoustic calls of bats and reporting.

Gemma Turner – Senior Ecologist, Arup

Gemma is a Senior Ecologist with over 15 years of experience working in consultancy. She has worked in the Arup London team since 2013 and previously worked as an ecologist within the Environmental Assessment team at URS Infrastructure and Environment Ltd (now part of AECOM). She is a full member of the Chartered Institute of Ecology and Environmental Management and has a BSc in Animal Behaviour and Wildlife Biology from Anglia Ruskin University. She has a Level 2 Natural England bat licence (2015-15889-CLS-CLS), which she has held since 2015. She is a bat specialist, with experience in managing and undertaking bat work on a variety of projects, including large scale masterplans and industrial, educational, commercial, rail and road projects. She is experienced in a range of surveys including preliminary roost assessment, internal inspections, emergence and re-entry surveys, transects, swarming, hibernation and trapping and tracking surveys, as well as bat sound analysis using BatExplorer and Kaleidoscope. She has volunteered with Surrey Bat Group, including bat box inspections and hibernation surveys.

Georgina Young – Ecologist, Arup

Georgina has over 8 years' experience working in the biodiversity field as a consultant ecologist and within the conservation sector. She has a BSc in Ecology and has recently applied to become a Full Member of CIEEM. Georgina is an experienced bat ecologist and holds level 1 and 2 Natural England survey licences for bats. She has experience undertaking and leading a range of bat survey types, including: preliminary bat roost assessment, activity surveys, hibernation, trapping and radio tracking. Her experience covers all breeding UK bat species. She has worked on numerous projects which may impact bat populations, including Nationally Significant Infrastructure Projects. Georgina is also a trustee for London Bat Group and regularly undertakes voluntary surveys to help monitor London's bat populations.

Gwen Brassine – Ecologist, Arup

Gwen has a BSc in Zoology and Entomology and BSc (Hons) in Geography from Rhodes University, South Africa. Gwen has over 6 years' experience in Ecological Consultancy and has experience working on large infrastructure projects, residential developments and numerous smaller developments in both England and Northern Ireland. She has designed and led a variety of bat surveys including bat crossing, emergence, re-entry, and transect activity surveys. Gwen additionally has experience undertaking and managing of the analysis of large datasets of bat calls, particularly from crossing point surveys. She has had training in bat handling and identification. Gwen undertakes voluntary bat recording, trapping and hibernation surveys with her local group in Surrey.

Rob Beer – Ecologist, Arup

Rob is an associate member of the Royal Society of Biology and is also working towards becoming an associate member of CIEEM. Rob has a BSc (Hons) in Environmental Management and Ecology and has been with Arup for 11 months and worked as an ecologist full time for 5 years with an additional 2 years prior to that as a sub-consultant. In that time Rob has worked extensively on projects with bat related components including bat activity surveys (both dawn and dusk), roost characterisation surveys, hibernation surveys, transect surveys and endoscoping surveys. Rob is also a member of his local county's bat group and has been involved in voluntary bat survey work with them. Rob is also a holder of a Natural England level 2 bat license.

Rachel Brown - Ecologist, Arup

Rachel has a first class BSc (Hons) in Biology and an MSc in Biodiversity and Conservation (distinction). Rachel is a graduate member of CIEEM and has one survey season of experience as an ecologist with a primary focus on bat surveys. Rachel carried out these surveys with infrared cameras and is knowledgeable on the correct set-up and positioning of the equipment. Rachel has attended multiple CIEEM-accredited bat surveying courses, including Introduction to Bat Ecology and Bat Surveys (2022), and has completed various training workshops with Bat Ability (online bat training resource), with a developing ability to identify acoustic recordings of bats, post-surveys.

Kellie Doyle – Ecologist, Arup

Kellie has a BSc (Hons) in Environmental Biology and a first-class MSc in Environmental Science, both from University College Dublin. She is an associate member of CIEEM and has practical experience working as part of multidisciplinary and dedicated ecological teams in both the U.K. and Ireland. She has seven years of experience in ecological consultancy, which includes experience in carrying out a range of bat survey types including dusk and dawn emergence and re-entry surveys (including the use of an infrared camera), transect surveys and preliminary roost assessments. This work was carried out across a range of sectors including for commercial developers, housing developments, carbon capture projects, road and rail projects, and Nationally Significant Infrastructure Projects (NSIP).

Matt Pollitt – Ecologist, Arup

Matt has a BSc in Biology from the University of Sheffield and an MSc in Biodiversity and Conservation from the University of Leeds. He is currently applying for Associate membership of CIEEM. Matt has six seasons of experience in ecological consultancy and has conducted a range of bat surveys including preliminary roost assessments, dusk emergence/dawn re-entry, walked transect, and Defra crossing point/transect surveys. Matt has conducted bat surveys on a range of different projects, including Nationally Significant Infrastructure Projects, road and rail projects, and housing developments. Matt is experienced in undertaking bat call analysis and is confident in identifying most common species of UK bat.

Hannah Brown – Ecologist, Arup

Hannah is in her second year of MSc study in Biodiversity, Wildlife and Ecosystem Health with the University of Edinburgh and is a student member of CIEEM. She has a year's experience working as an ecologist and was previously working in the planning team at Arup for two years. Hannah has undertaken bat roost suitability assessments, emergence/ re-entry surveys and has experience using infrared cameras and thermal imaging scopes. Hannah has attended various BatAbility webinars including the Bat Sound Analysis webinar and is developing this skill in a current project to analyse recorded bat calls.

David Feitschinger – Ecologist, Arup

David is an ecologist with a broad range of experience in ecology and biodiversity. David has over five years of experience in carrying out terrestrial protected species surveys, including bat roost suitability assessments, bat activity surveys (Emergence/return and transect), and other protected species surveys. David has extensive skill in quantitative data analysis, particularly within Natural Capital, Biodiversity, and ecosystem-based carbon sequestration and storage. Currently, David is working on a range of Biodiversity Net Gain projects, several Ecological Impact Assessments, a variety of natural capital assessments for UK-based and international projects, and wetland and peatland restoration projects requiring the calculation of ecosystem-based carbon sequestration and carbon stocks.

Livvy Cooper – Ecologist, Arup

Livvy Cooper (BSc, MRSB, ACIEEM) is an ecologist with a specialism in UK and international bat work. After three seasons of bat conservation research in Indonesia, which led to publications in regional and international journals, she has spent over seven years with Arup primarily planning, executing and reporting on bat surveys across England, Wales and Northern Ireland. Significant projects include the A120 Herts., identifying and mitigating for a nationally important maternity barbastelle colony; The Alexander Stadium, identifying and mitigating for a locally important colony of swarming noctules on a tight programme before the Commonwealth Games; and the A358 and A417 realignment projects which required trapping and tracking of several bat species. She is experienced in assessing trees and buildings for bat roosting potential; acoustic bat surveys including transects and static surveys; emergence and return surveys with and without assistive technology; crossing point surveys; harp trapping, mist netting and radio tracking surveys; endoscoping checks and roost entry checks. She holds a Level 2 bat licence in England and volunteers with West Yorkshire and Worcestershire Bat Groups. She has substantial further experience on projects including great crested newt, badger, reptile and barn owl surveys and mitigation.

Jordan Simpson - Ecologist, Arup

Jordan has a BSc (Hons) in Tropical Biology from the University of Nottingham and an MSc in Biodiversity and Conservation from Lancaster University. He is a qualifying member of CIEEM and has three seasons experience of conducting a wide variety of bat surveys, including activity surveys (both dawn and dusk), transect surveys, crossing point surveys, emergence and re-entry surveys, back-tracking surveys, and endoscope surveys. These were undertaken on a range of projects from old mills and farm buildings to data centres and utility sites. Jordan has also attended various training workshops with Bat Ability and has a developing knowledge in bat acoustic analysis.

Matthew Sanders – Ecologist, Arup

Matthew has a BSc (Hons) in Marine & Freshwater Biology and an MSc in Environmental Change, Management & Monitoring, both from the University of Hull. He is a qualifying member of CIEEM and has 5 years practical experience of carrying a range of bat surveys in including dusk/dawn re-entry and emergence (with and without infrared cameras), transect surveys, preliminary roost assessments and identifying placement of static detectors for activity surveys. These surveys were undertaking on a wide variety of projects including large-scale housing developments, large infrastructure (road and rail). urban regeneration and commercial developments. Clients have included Network Rail, Homes England, local authorities and private developers.

Madeleine Ambler- Graduate Ecologist, Arup

Madeleine is an ecologist, having graduated with an MSc in Wildlife Biology and Conservation and a BSc (Hons) in Animal Biology from Edinburgh Napier University. She is a qualifying member of CIEEM and has experience conducting preliminary roost assessments, activity surveys (both dawn and dusk) and tree/building scoping surveys. These surveys were undertaken across a range of projects from small-scale wind farm and hydrogen production and urban regeneration to larger offshore windfarm with associated onshore infrastructure. Madeleine has also attended various training workshops with Bat Ability and has experience undertaking bat acoustic analysis of large datasets of bat calls, particularly from static detector surveys. Prior to joining Arup, Madeleine worked as a field ecologist undertaking bat re-entry and emergence surveys across several sites in Scotland.

Ross Judge-Graduate Ecologist, Arup

Ross is an ecologist with a Bsc in Biological Sciences (Ecology) from the University of Edinburgh. He is currently a qualifying member of CIEEM and has extensive bat survey experience beginning from a summer job undertaken during university. Ross has undertaken a wide variety of bat surveys, including exit/re-entry activity surveys, walking transects, crossing point surveys, and potential roost assessments; these surveys were carried out across a wide variety of habitat types (both rural and urban) and involved natural and man-made structures. He also has experience in utilising infra-red and thermal cameras during activity surveys and setting up and monitoring static bat detectors. Ross has also undertaken hibernacula surveys while studying at university, as part of the National Bat Monitoring Programme at the disused Middleton quarry after bat-friendly access structures were built to encourage bat roosting at the site.

Outside of surveys, Ross has experience in analysing camera footage for bat activity and analysing bat calls using sound analysis software.

Barbara McInerney – profile as above (see 5.3.1 2014 – 2018)

Dr Caroline Shiel – profile as above (see 5.3.1 2014 – 2018)

# Appendix B

## Changes of Roost Types and Locations between 2018 and 2023

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR06 | High | Yes (based on 2014-2018 and 2023 data) | RhHi | Maternity Roost | 2014 | High | Yes | RhHi, MyDa | Maternity Roost | Y | Species Change - just Lesser Horseshoe bats, not Daubenton's bats |
| PBR112 | High | Yes (based on 2014-2018 and 2023 data) | RhHi | Day Roost, Night Roost, Hibernation Roost | 2014 | High | Yes | RhHi | Day Roost, Night Roost, Hibernation Roost | N | N/A |
| PBR114 | Low | No | None | No Evidence of Bats | 2014 | No Initial Assessment | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR115 | Low | No (former roost) | None | No Evidence of Bats | 2014 | Low | Yes | No_ID | Night Roost | Y | No longer a roost |
| PBR124 | Medium | No (former roost) | None | No Evidence of bats | 2014_2015 | Medium | Yes | RhHi | Night Roost | Y | No longer a roost |
| PBR128 | Low | Yes (based on 2014-2018 data) | RhHi | No Evidence of Bats | 2014 | Medium | Yes | RhHi | Night Roost | Y | Change in PRF from Medium to Low |
| PBR129 | High | Yes (based on 2014-2018 data) | RhHi | Night Roost | 2014 | Low | Yes | RhHi | Night Roost | Y | Change in PRF from Low to High |
| PBR130 | Low | No (former roost) | None | No Evidence of Bats | 2014 | Low | Yes | RhHi | Night Roost/ Day Roost | Y | No longer a roost |
| PBR133 | Low | No | None | No Evidence of Bats | 2014 | Low | Yes | MyDa | Maternity Roost | Y | No longer a roost |
| PBR134 | High | Yes (based on 2014-2018 and 2023 data) | PiPy, NyLe | Transitional Roost | 2014 | Low | Yes | Ny Le | Transitional Roost? | Y | Species Change - now Soprano Pipistrelles and Leisler's bats. Change in PRF from Low to High |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR139 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | NyLe | Transitional Roost | 2014 | No Initial Assessment | Yes | NyLe | Unknown/To be Completed | Y | Confirmed in 2023 as Transitional roost |
| PBR140 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | MyMys | Transitional Roost | 2014 | No Initial Assessment | Yes | MyMys | Unknown/To be Completed | N | N/A |
| PBR145 | Low | Yes (based on 2014-2018 and 2023 data) | PiPy | Maternity Roost | 2014 | No Initial Assessment | Yes | PlAu | Unknown/To be Completed | Y | Species Change - now Soprano Pipistrelles, not Brown Long-eared bats. Confirmation of PRF as Low |
| PBR146 | Access denied - Not Assessed | No (former roost) | None | No Evidence of Bats | 2014 | No Initial Assessment | Yes | NyLe | Unknown/To be Completed | Y | No longer a roost |
| PBR151 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | MyMys | Transitional Roost | 2014 | No Initial Assessment | Yes | MyMys | Unknown/To be Completed | N | N/A |
| PBR153 | High | Yes (based on 2014-2018 and 2023 data) | RhHi | Night Roost/ Day Roost | 2014 | No Initial Assessment | Yes | RhHi | Night Roost/Day Roost | Y | Confirmation of PRF as High |
| PBR154 | Medium | No (former roost) | None | No Evidence of Bats | 2014 | No Initial Assessment | Yes | RhHi | Night Roost/Day Roost | Y | No longer a roost |
| PBR156 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPi, RhHi | Night Roost/ Day Roost | 2014 | No Initial Assessment | Yes | RhHi, PlAu | Night Roost/Day Roost | Y | Species Change - now Soprano Pipistrelles and Lesser horseshoe bats, not Brown Long-eared bats and Lesser horseshoe bats. Confirmation of PRF as Moderate. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR157 | Medium | No (former roost) | None | No Evidence of Bats | 2014 | No Initial Assessment | Yes | RhHi | Night Roost | Y | No longer a roost |
| PBR158 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | RhHi | Day Roost | 2014 | No Initial Assessment | Yes | RhHi | Day Roost | N | N/A |
| PBR166 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR167 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR168 | Medium | No | None | No Evidence of Bats | 2016 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR169 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR170 | Low | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR171 | Low | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR172 | Medium | No | None | No Evidence of Bats | 2016 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR173 | Medium | Yes (based on 2014-2018 and 2023 data) | PlAu | Possible Maternity Roost | 2015_2016 | Medium | No | PlAu | Possible Maternity Roost | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR174 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR175 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR176 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR177 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPy | Transitional Roost | 2015_2016 | Medium | Yes | PiPy | Transitional Roost | N | N/A |
| PBR178 | High | Yes (based on 2014-2018 and 2023 data) | Myotis species, RhHi | Unknown | 2015_2016 | High | Yes | RhHi, PlAu | Possible Maternity Roost (Both Species) | Y | Species Change - now Myotis Species and Lesser horseshoe bats, not Brown long-eared and Lesser horseshoe bats. |
| PBR179 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPy | Unknown, possible maternity Roost for Ppyg | 2015_2016 | High | Yes | PiPy, PlAu | Unknown, possible maternity Roost for PiPy | Y | Species Change - now just Soprano Pipistrelle, not Brown long-eared and Soprano Pipistrelle. Change of PRF from High to Moderate. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR180 | Negligible | No | None | No Evidence of Bats | 2015 | High | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR181 | Low | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | N/A |
| PBR182 | Medium | No (former roost) | None | No Evidence of Bats | 2015, 2016 | Medium | Yes | PiSp | Unknown | N | N/A |
| PBR183 | Negligible | No (former roost) | None | No Evidence of Bats | 2015_2016 | Medium | Yes | PlAu | Unknown | Y | No longer a roost |
| PBR184 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR185 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR186 | Medium | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR187 | Negligible | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR188 | Low | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR189 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |

| Label | Overall_BR_2023 | Roost Confirmation_2023 | Species_2023 | Roost_Type_2023 | Previous Year Surveyed | Overall_BR_Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR190 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR191 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR192 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | PlAu | Unknown | 2015, 2016 | Medium | Yes | PlAu | Unknown | N | N/A |
| PBR193 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR194 | Negligible | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR195 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR196 | High | Yes (based on 2014-2018 and 2023 data) | NyLe | Night Roost/ Day Roost | 2015_2016 | High | Yes | PlAu, PiPy | Unknown | Y | Species Change - now just Liesler's bats, not Brown long-eared and Soprano Pipistrelle. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR197 | Negligible | No | None | No Evidence of Bats | 2015, 2016 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | Change of PRF from Low to Negligible. |
| PBR198 | Low | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR199 | Medium | Yes (based on 2023 data) | Myotis species | Night Roost/ Day Roost | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Myotis species roost. |
| PBR200 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR201 | Medium | No | None | No Evidence of Bats | 2015, 2016 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR202 | Low | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR203 | Medium | No | None | No Evidence of Bats | 2015 | High | No | No Evidence of Bats | No Evidence of Bats | Y | Change of PRF from High to Medium. |
| PBR204 | High | Yes (based on 2014-2018 and 2023 data) | PlAu | Night Roost/ Day Roost | 2014_2015_2016 | High | Yes | PlAu, RhHi | Night Roost/ Day Roost | Y | Species Change - now just Brown long-eared, not Brown Long-eared and Lesser horseshoe bats. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR205 | High | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | 2015_2016 | Medium | Yes | PiPi_PiPy | Unknown | Y | Change of PRF from Medium to High. Pipistrelle Species recorded in wider stable block area (sub-divided as below - PBR205_ST) |
| PBR205_ST1 | Low | Yes (based on 2014-2018 and 2023 data) | Pipistrellus species | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST10 | Medium | Yes (based on 2014-2018 and 2023 data) | Pipistrellus species | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST11 | Negligible | No | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST12 | Negligible | No | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST2 | Medium | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST3 | Medium | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST4 | Medium | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST5 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_ST6 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR205_S T7 | Negligible | No | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_S T8 | Negligible | No | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR205_S T9 | Medium | Yes (based on 2014-2018 and 2023 data) | Pipistrellus species | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR206 | Negligible | No | None | No Evidence of Bats | 2015 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | Change of PRF from Low to Negligible. |
| PBR207 | Low | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Change of PRF from Medium to Low. |
| PBR208 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR209 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR210 | Medium | Yes (based on 2014-2018 and 2023 data) | RhHi | Night Roost | 2015_2016 | Medium | Yes | RhHi | Night Roost | N | N/A |
| PBR211 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR212 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR213 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR214 | Medium | No | None | No Evidence of Bats | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR215 | Medium | Yes (based on 2023 data) | PlAu, Myotis species | Night Roost/ Day Roost | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Brown long-eared bat and Myotis species roost. |
| PBR216 | Medium | Yes (based on 2023 data) | PlAu | Night Roost/ Day Roost | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Brown long-eared bat roost. |
| PBR218 | High | Yes (based on 2014-2018 data) | RhHi | Day Roost | 2015 | High | Yes | RhHi | Day Roost | N | N/A |
| PBR219 | High | Yes (based on 2014-2018 data) | RhHi | No Evidence of Bats in 2023. Live bats identified in 2014 | 2015 | High | Yes | RhHi | Night Roost | N | N/A |
| PBR222 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | PiPy | Transitional roost of 1-2 bats based on evidence collected in 2014 | 2015 | High | Yes | PiPy | Unknown | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR225 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | PiPy | Possible Maternity Roost for PiPy | 2015_2016 | High | Yes | PiPy, PlAu | Possible Maternity Roost for PyPy | Y | Species change - now just Soprano Pipistrelle. |
| PBR226 | Medium | Yes (based on 2023 data) | NyLe | Night Roost/ Day Roost | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Leisler's bat roost. |
| PBR228 | High | No (former roost) | None | No Evidence of Bats | 2015 | Medium | Yes | PiPi | Unknown | Y | No longer a roost. PRF change from Medium to High. |
| PBR229 | High | Yes (based on 2023 data) | Pipistrellus species | Night Roost/ Day Roost | 2015 | High | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Pipistrelle species roost. |
| PBR230 | Low | No | None | No Evidence of Bats | 2015 | High | No | No Evidence of Bats | No Evidence of Bats | Y | Change of PRF from High to Low. |
| PBR234 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | 2015 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR235 | High | No | None | No Evidence of Bats | 2015 | High | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR236 | Medium | No | None | No Evidence of Bats | 2015_2016 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR237 | Medium | No (former roost) | None | No Evidence of Bats | 2015_2016 | Medium | Yes | PiPy | Unknown | Y | No longer a roost |
| PBR238 | Medium | Yes (based on 2023 data) | PiPy | Night Roost/ Day Roost | 2015_2016 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Soprano Pipistrelle bat roost. |
| PBR241 | High | Yes (based on 2014-2018 and 2023 data) | RhHi | Night Roost | 2014_2015_2016 | High | Yes | PiPy | PiPy foraging in the lee of mature trees beside house. | Y | Species change - now Lesser horseshoe bat roost not a Soprano Pipistrelle bat roost. |
| PBR242 | Low | No (former roost) | None | No Evidence of Bats | 2015_2016 | Low | Yes | PiSp | Unknown | Y | No longer a roost. |
| PBR243 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Medium | Unknown | | | N | N/A |
| PBR244 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Unknown | | | | N/A | N/A |
| PBR245 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Low | Unknown | | | N/A | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR246 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N/A | N/A |
| PBR247 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Low | Unknown | | | N/A | N/A |
| PBR248 | High | Yes (based on 2023 data) | PiPy | Unknown | 2016 | Medium | Unknown | | | Y | Change of PRF from Medium to High. |
| PBR249 | High | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | Y | Change of PRF from Low to High. |
| PBR250 | High | Yes (based on 2023 data) | PiPy | Night Roost/ Day Roost | 2016 | Medium | Unknown | | | Y | Change of PRF from Medium to High. |
| PBR251 | Medium | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | Y | Change of PRF from Low to Medium. |
| PBR252 | Low | Yes (based on 2023 data) | PiPi | Unknown | 2016 | Low | Unknown | | | Y | Now a Common Pipistrelle bat roost. |
| PBR253 | Negligible | No | None | No Evidence of Bats | 2016 | Medium | Unknown | | | Y | Change of PRF from Low to Negligible. |
| PBR254 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR255 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPy, NyLe | Unknown | 2016 | Medium | Yes | PiPy | Unknown | Y | Species change - now Leisler's bats and Soprano pipistrelle root, not just Soprano pipistrelle. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR256 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPy | Night Roost/ Day Roost | 2016 | Medium | Yes | PlAu | Maternity | Y | Species change - now Soprano pipistrelle root, not Brown long-eared bat. |
| PBR257 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR259 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | 2016 | Medium | Unknown | | | N | N/A |
| PBR260 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR261 | Low | Yes (based on 2023 data) | PiPy | Night Roost/ Day Roost | 2016 | Low | Unknown | | | Y | Now a Soprano Pipistrelle bat roost. |
| PBR262 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR263 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | 2016 | Low | Unknown | | | N | N/A |
| PBR264 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR265 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR266 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR267 | High | Yes (based on 2014-2018 and 2023 data) | PlAu, PiPy | Transitional Roost | 2016 | High | Yes | PlAu, PiPy | Unknown | N | N/A |
| PBR268 | Low | No | None | No Evidence of Bats | 2016 | Low | Unknown | | | N | N/A |
| PBR269 | Negligible | No | None | No Evidence of Bats | 2017 | Low | Unknown | | | N | N/A |
| PBR270 | Low | No (former roost) | None | No Evidence of Bats | 2017 | Low | Yes | Unidentified | Unknown, old roost | Y | No longer a roost. |
| PBR271 | Low | No | None | No Evidence of Bats | 2017 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR272 | Medium | No | None | No Evidence of Bats | 2017 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR273 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2017 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR274 | High | No | None | No Evidence of Bats | 2017 | Medium | No | No Evidence of Bats | No Evidence of Bats | Y | PRF change from Medium to High. |
| PBR275 | Negligible | No | None | Unknown | 2017 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | PRF change from Low to Negligible. |
| PBR276 | Negligible | No | None | None | 2017 | Low | No | No Evidence of Bats | None | Y | PRF change from Low to Negligible. |
| PBR277 | Negligible | No | None | No Evidence of Bats | 2017 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | PRF change from Low to Negligible. |
| PBR278 | Negligible | No | None | No Evidence of Bats | 2017 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | PRF change from Low to Negligible. |
| PBR279 | Negligible | No | None | No Evidence of Bats | 2017 | Low | No | No Evidence of Bats | No Evidence of Bats | Y | PRF change from Low to Negligible. |
| PBR280 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2017 | Unknown | No | No Evidence of Bats | No Evidence of Bats | N | N/A |

| Label | Overall_BR_2023 | Roost Confirmation_2023 | Species_2023 | Roost_Type_2023 | Previous Year Surveyed | Overall_BR_Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR281 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2017 | Unknown | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR283 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR284 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR285 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR286 | Negligible | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR287 | Low | No | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR288 | Low | Yes (based on 2023 data) | PiPy | Night Roost/ Day Roost | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR289 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR290 | Medium | No | None | Night Roost | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR291 | Low | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR292 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR293 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR294 | Negligible | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR295 | Low | No | None | No Evidence of Bats | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR296 | Unknown - Not Assessed in 2018 - external (visual) in 2023 | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR298 | Unknown - Not Assessed in 2018 - external (visual) in 2023 | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | New for 2023 - Not previously Surveyed | | | | | N/A | N/A |
| PBR299/PBR116 | Demolished - Previously PBR116 | No | None | Demolished | 2014 (PBR116) | High | Yes | RhHi | Night Roost | Y | Building has been demolished between 2018 - 2023 |
| PBR49 | High | No (former roost) | None | No Evidence of Bats | 2014 | High | Yes | PiPy, PlAu | Unknown/To be Completed | Y | No longer a roost |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR50 | High | Yes | Pipistrellus Species | Unknown | 2014 | Low | No | No Evidence of Bats | No Evidence of Bats | Yes | Now a Pipistrelle species roost. |
| PBR53 | High | Yes (based on 2023 data) | PiPy | Transitional Roost | 2014 | No Initial Assessment | No | No Evidence of Bats | No Evidence of Bats | Y | Now a Soprano Pipistrelle bat roost. |
| PBR54 | Negligible | No (former roost) | None | No Evidence of Bats | 2014 | High | Yes | RhHi | Satellite Roost | Y | No longer a roost. PRF change from High to Negligble |
| PBR62 | Low | No | None | No Evidence of Bats | 2014 | Low | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR63 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | Unknown | 2014 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR67 | High | No | None | No Evidence of Bats | 2014 | High | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR73 | Medium | Yes (based on 2014-2018 and 2023 data) | NyLe, MyNa | Unknown | 2014 | Low | Yes | MyNa | Unknown/To be Completed | Y | Species change - now Leisler's bat and Natterer's bat roost not just Natterer's bat. |
| PBR81 | Negligible | No | None | Unknown/To be Completed | 2014 | Medium | Unknown | Unknown/To be Completed | Unknown/To be Completed | Y | PRF change from Medium to Negligible. |

| Label | Overall_BR _2023 | Roost Confirmation _2023 | Species_2023 | Roost_Type _2023 | Previous Year Surveyed | Overall_BR _Pre-2018 | Roost Confirmation Pre-2018 | Species_Pre-2018 | Roost_Type_ Pre-2018 | Change Y/N | Details of change(s) between 2023 and 2018 - 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PBR82 | Medium | Yes (based on 2014-2018 data) | RhHi, PlAu, MyNa | Night Roost | 2014 | Medium | Yes | RhHi, PlAu, MyNa | Night Roost | N | N/A |
| PBR83 | Medium | Yes (based on 2014-2018 and 2023 data) | PiPi, RhHi | Transitional Roost | 2014 | Medium | Yes | RhHi | Night Roost | Y | Species change - now Common Pipistrelle and Lesser horseshoe bat roost not just Lesser horseshoe bat. |
| PBR84 | Access denied - Not Assessed | No - Likely absence cannot be confidently inferred due to survey limitations | None | No Evidence of Bats | 2014 | Medium | No | No Evidence of Bats | No Evidence of Bats | N | N/A |
| PBR85 | Access denied - Not Assessed | Yes (based on 2014-2018 data) | RhHi | Night Roost | 2014 | High | Yes | RhHi | Night Roost | N | N/A |

# Appendix C

## Greena Ecological Consultancy, Galway Bat Ringing Project Ringing Studies of Lesser Horseshoe Bats May and August 2023

*Greena Ecological Consultancy*

# Galway Bat Ringing Project

## Ringing studies of lesser horseshoe bats
## May & August 2023

*Photo by Isobel Abbott*

*Photo by Geoff Billington*

**DRAFT V1 December 2023**

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Cover photographs of Menlo Castle and Coopers Cave



Citation: **Billington, G. (2023)**. Galway bat ringing project. Ringing studies of lesser horseshoe bat species, May & August 2023. Greena Ecological Consultancy.

# Contents

## Executive summary

Greena Ecological Consultancy was commissioned by Scott Cawley Ltd to undertake a ringing study in Galway, Republic of Ireland, to inform the N6 Galway City Ring Road Project. The study was conducted to obtain information on where Lesser Horseshoe bats ("LHS") roost and the extent of their range in order to be able to determine the potential impacts of the proposed road development on the local bat populations. A baseline survey had previously been conducted in August and September 2014 and then further surveys in May 2015.

No previous ringing study covering Lesser horseshoe bats had been undertaken in the area of interest prior to 2014. Scott Cawley carried out monitoring of bat activity in combination with emergence surveys and roosts inspections prior to the 2014 & 2015 ringing and radio-tracking studies by Greena in order to provide information on bat colonies present in the area of interest. Monitoring of specific roost sites has been extended beyond the duration of the 2014 and 2015 study to provide additional data on linkage between sites.

This twin session ringing study was carried out by Greena Ecological Consultancy in May and August 2023. This session, together with the results from 2014 and 2015, 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).

In all sessions 2.4mm mammal society alloy rings were used. In 2014 and 2015 base silver coloured rings were used. In 2023 colour anodised rings were prepared and used, green at Menlo Castle and blue at Coopers Cave. Red rings were going to be used at Auchnacurra garage, but no bats were present on either session.

Greena Ecological Consultancy captured 11 Lesser horseshoes *(Rhinolophus hipposideros)* during the May session, eight at Menlo Castle and three at Coopers Cave, seven of them females and four males all 11 were ringed.
19 were captured in August all at Menlo Castle 11 were females and eight were males, 17 were ringed, 10 of them females and seven were males. The licence only permitted 30 bats in total to be handled so trapping ended once total was reached.
In August one male bat had previously been ringed at the castle in 2014 and four females ringed at the castle in May 2023 were recaught. The 2014 male had previously been radio tracked in August 2014 (bat no. 6).

All bats were captured at the castle in static mist nets stretched over two fireplace roost entrances and in a harp trap at Coppers Cave entrance, they were held for minimum time and released where caught, no other bats were captured.

Bats were of apparent good health, in May weights ranging from 4.80g to 6.60g and in August ranging from 4.86g to 6.91g lightest bats were males and lightest females were 5.30g in May and 5.74g in August.

# 1.0 Aims and Objectives

The overall aim of the study was to handle up to 30 Lesser horseshoe bats and ring as many of these as possible, spread over three roosting sites: Menlo Castle, Coopers Cave and Aughnacurra garage over two sessions in May and August 2023.This was to inform potential connections between these roosts and those in the wider region to inform studies for the N6 Galway City Ring Road project.

# 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 Birds and Natural 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 its integrity.

The Lesser horseshoe bat is one of the most endangered European bat species (Stebbings, 1988) it is listed under Annex II of the EC Habitats Directive. 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 bat populations 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 pressures impacting on Lesser horseshoe bats 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)

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

In 2014 and 2015 Lesser horseshoe bats were ringed (and some radio tracked) at Menlo Castle and Coopers Cave.

## 3.0 Study area

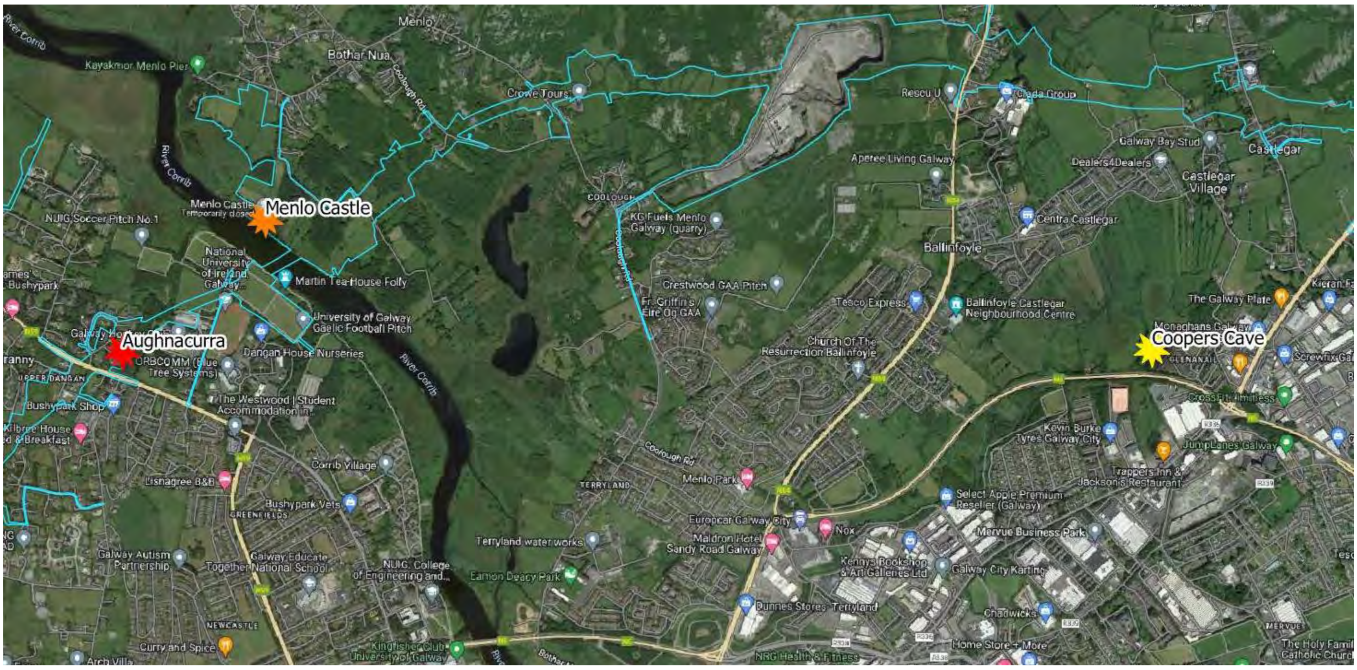
The study area comprises three sites as detailed in Figure 1.

Menlo Castle is the main known breeding roost of the area divided between two disused chimneys.

Coppers Cave is a short cave used by odd Lesser horseshoe bats as a day roost but also as a night gathering and swarming site.

Aughnacurra garage has been an occasional day roost of small numbers of Lesser horseshoe bats.

Figure 1 Study area of the N6 Galway City Ring Road




## 4.0 Methods

A licence to carry out bat trapping (licence to catch with harp/mist net/by hand no. no.C147/2023) plus a licence to disturb roosts (DER/BAT 2023-48) was obtained from the National Parks and Wildlife Service, Ireland and authorisation to access the land involved was obtained from landowners in advance of commencing fieldwork by Scott Cawley.

Six-metre wide BTO mist nets were set across the entrances to the chimney roosts on 8th May and 22nd August 2023 and an Austbat harp trap was used at Coopers Cave entrance on 10th May and 21st August 2023. No other trapping was undertaken.

In both sessions 2.4mm mammal society colour anodised rings were prepared and used, green at Menlo Castle and blue at Coopers Cave. Red rings were going to be used at Auchnacurra garage, but no bats were present on either session.

Greena Ecological Consultancy captured 11 Lesser horseshoe bats *(Rhinolophus hipposideros)* during the May session, eight at Menlo Castle and three at Coopers Cave, seven of them females and four males all 11 were ringed.

19 were captured in August all at Menlo Castle 11 were females and eight were males, 17 were ringed, 10 of them females and seven were males. The licence only permitted 30 bats in total to be handled so trapping ended once total was reached.

The surveyors carrying out the study were Geoff Billington and Stephen Davison on both sessions accompanied by Simon Brain in May and Rachel Denness in August.

Recording sheets were used to record biometric and ring data.

## 5.0 Survey constraints

Even though the aims were achieved, but as numbers were limited by the licence, other studies have found the more bats that are ringed the higher the effectiveness of relocation, so with limits on numbers less bats are likely to be refound.

## 6.0 Ethical Review

The level of existing knowledge of the bat population was used to determine that the surveys were necessary and justified in order to inform the impact assessment process. A maternity colony of Lesser horseshoe bats was previously identified at Menlo Castle and several smaller roosts were located in the area of study in 2014 and 2015 including in caves and buildings.

Survey techniques were appropriate to the objectives of the project.

Both surveyors of Greena Ecological Consultancy, conducting ring marking, hold Natural England, National Resources Wales and Greek ministry class 3 & 4 personal/project licences or equivalent and have extensive experience with handling, marking and tagging Lesser horseshoe bats. Both surveyors were also included in Derogation licences issued by the National Parks and Wildlife Service in 2023 and permitting the trapping and marking of bats for this project.

Mist nets or harp trap were set up just before sunset, mist nets were attended at all times.

Where bats were caught in a mist net, they were removed immediately to reduce potential stress. Where harp trap was used, trapped animals were removed as soon as practical.
The trapping took place during nights of suitable temperature and were all initially rainfall free though after an hour or so rain occurred at Coppers Cave in August.

The catching period avoided more sensitive seasons such as when they emerge from hibernation in early spring (March/April), later stage of pregnancy in summer (June), or when newly born young are supported for a couple of weeks in mid-summer (June/July).

All bats were released unharmed at the point of capture.

No injuries occurred during the trapping sessions. All bats were of good health and did not show any signs of distress when fitted with transmitters (and rings, where applicable).

The catching session at Menlo Castle in August was ceased when maximum number of allowed bats were caught.

# 7.0 Results

## *7.1 Previous records*

A maternity roost of Lesser horseshoe bats previously located in Menlo Castle, where peak count of bats in July 2009 reached 38 individuals and a repeat emergence count on 8$^{th}$ July 2014 revealed 27 individuals.

Coopers Cave was found to be a day roost, swarming and night roost of Lesser horseshoe bats in 2014.

Auchnacurra garage roost was identified by Scott Cawley during wider surveys for the project finding a small number of Lesser horseshoe bats day roosting there.

## *7.2 Bat captures*

Table 1 contains the captures made at Menlo Castle in May all rings were green.

**Table 1 Captures 08/05/2023, Menlo Castle**

| Time caught | species | sex | forearm (mm) | net weight (g) | ring number | Comments |
|---|---|---|---|---|---|---|
| 22:13 | LHS | F | 36.40 | 6.60 | L01109 | Adult |
| 22:20 | LHS | F | 36.8 | 6.10 | L01113 | Adult |
| 22:25 | LHS | F | 36.9 | 6.10 | L01061 | Adult |
| 22:55 | LHS | F | 39.6 | 6.10 | L01116 | Adult |
| 23:10 | LHS | F | 37.7 | 5.40 | L01094 | Adult |
| 23:20 | LHS | F | 38.5 | 6.60 | L01105 | Adult |
| 23:40 | LHS | M | 35.0 | 5.00 | L01065 | Adult |
| 23:40 | LHS | F | 37.2 | 5.30 | L01076 | Adult |

Abbreviations: **F – female; M – male; LHS – Lesser horseshoe**

Table 2 contains the captures made at Coopers Cave in May all rings were blue.

**Table 2 Captures 10/05/2023, Coopers Cave**

| Time caught | species | sex | forearm (mm) | net weight (g) | ring number | Comments |
|---|---|---|---|---|---|---|
| 22:30 | LHS | M | 38.2 | 5.90 | L01010 | Adult |

| Time caught | species | sex | forearm (mm) | net weight (g) | ring number | Comments |
|---|---|---|---|---|---|---|
| 22:30 | LHS | M | 35.2 | 4.80 | L01148 | Adult |
| 22:35 | LHS | M | 38.0 | 5.70 | L01131 | Adult |

Table 3 contains the captures made at Menlo Castle in August all rings were green.

**Table 3 Captures 22/08/2023, Menlo Castle**

| Time caught | species | sex | forearm (mm) | net weight (g) | ring number | Comments |
|---|---|---|---|---|---|---|
| 22:18 | LHS | F | | 6.30 | | Adult, not breeding |
| 22:27 | LHS | M | 35.2 | 4.86 | | Adult |
| 22:29 | LHS | F | 37.9 | 5.94 | L01062 | Adult, breeding |
| 22:32 | LHS | F | 37.0 | 6.23 | L01118 | Adult, breeding |
| 22:36 | LHS | F | 38.4 | 6.50 | L01116 | Adult, breeding, recapture ringed at Menlo Castle May23 |
| 22:44 | LHS | M | 35.2 | 5.10 | L01071 | Adult |
| 22:51 | LHS | M | 35.2 | 5.36 | L01103 | Juvenile |
| 22:51 | LHS | M | 36.4 | 5.74 | L01106 | Adult |
| 21:57 | LHS | M | 35.2 | 5.13 | L01082 | Adult |
| 22:02 | LHS | M | 36.3 | 5.14 | L01070 | Adult |
| 22:06 | LHS | F | 37.3 | 5.82 | L01094 | Adult, breeding, recapture ringed at Menlo Castle May23 |
| 22:12 | LHS | F | 38.4 | 6.91 | L01076 | Adult, breeding |
| 22:18 | LHS | M | 37.5 | 5.64 | L01606 | Adult, breeding, recapture ringed at Menlo Castle July14 |
| 22:23 | LHS | F | 37.5 | 6.39 | L01113 | Adult, bred before, recapture ringed at Menlo Castle May23 |
| 22:31 | LHS | F | 38.2 | 5.74 | L01107 | Juvenile |
| 22:33 | LHS | F | 38.1 | 6.08 | L01069 | Juvenile |
| 22:44 | LHS | F | 37.5 | 6.09 | L01084 | Adult, breeding |
| 22:49 | LHS | M | 36.0 | 4.85 | L01065 | Juvenile |
| 22:49 | LHS | F | 37.5 | 6.65 | L01062 | Adult, non breeding, recapture ringed at Menlo Castle May23 |

Abbreviations: **F – female; M – male; LHS – Lesser horseshoe**

## *7.3 Summary of Results*

This project successfully ringed 28 bats from two roosts in May & August 2023.

One male bat was recaught from our 2014 study and four bats were recaught in August from May 2023, as with studies of other Lesser horseshoe roosts bats swop between other roosts so each roost forming a meta population of the wider regional population.

The coloured rings will facilitate easy future relocation in other roosts without requirement to handle bats.

## 8.0 Acknowledgements

Greena Ecological Consultancy would like to thank the following organisations and individuals for their help in the due course of this study:

- Scott Cawley Limited

- National Parks and Wildlife Service, Ireland

- Galway County Council

- Roost owners for allowing access

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# Appendix D

## Transect Survey Data 2023

| Label | Season | X_Start | Y_Start | X_End | Y_End |
|---|---|---|---|---|---|
| T1 | Spring | 521183 | 722569 | 521388 | 723153 |
| T1 | Spring | 521679 | 723393 | 521849 | 723843 |
| T1 | Summer | 521862 | 723839 | 521818 | 723844 |
| T1 | Summer | 521436 | 722572 | 521407 | 722572 |
| T1 | Autumn | 522003 | 723819 | 521974 | 723845 |
| | | | | | |
| T2 | Spring | 522792 | 723797 | 523101 | 723978 |
| T2 | Spring | 523517 | 724398 | 523525 | 724395 |
| T2 | Summer | 523646 | 724351 | 523754 | 724251 |
| T2 | Summer | 522689 | 724225 | 523523 | 724268 |
| T2 | Autumn | 522786 | 724171 | 522969 | 724436 |
| T2 | Autumn | 522003 | 723819 | 521974 | 723845 |
| | | | | | |
| T3 | Spring | 524829 | 725135 | 524843 | 725133 |
| T3 | Summer | 524903 | 725115 | 524510 | 724871 |
| T3 | Summer | 523646 | 724351 | 523754 | 724251 |
| T3 | Autumn | 524535 | 724877 | 524534 | 724893 |
| T3 | Autumn | 523631 | 724270 | 523739 | 724266 |
| | | | | | |
| T4 | Spring | 525027 | 725334 | 525038 | 725346 |
| T4 | Spring | 526191 | 725967 | 526658 | 726528 |
| T4 | Spring | 525435 | 725776 | 526191 | 725967 |
| T4 | Summer | 525034 | 725337 | 525036 | 725346 |
| T4 | Summer | 526250 | 725948 | 526332 | 725928 |
| T4 | Summer | 526308 | 725943 | 526307 | 725926 |
| T4 | Autumn | 526214 | 725960 | 526608 | 726738 |
| T4 | Autumn | 525368 | 725654 | 525759 | 725818 |
| T4 | Summer | 525472 | 725880 | 525380 | 725677 |
| T4 | Summer | 525511 | 725931 | 525517 | 725935 |
| | | | | | |
| T5 | Spring | 527835 | 727184 | 526803 | 726620 |
| T5 | Spring | 526191 | 725967 | 526658 | 726528 |
| T5 | Spring | 527088 | 726005 | 526933 | 725255 |
| T5 | Summer | 526308 | 725943 | 526307 | 725926 |
| T5 | Summer | 527079 | 725960 | 527086 | 726016 |
| T5 | Summer | 527030 | 726473 | 527198 | 726385 |
| T5 | Autumn | 527145 | 726481 | 526862 | 726585 |
| T5 | Autumn | 526214 | 725960 | 526608 | 726738 |
| T5 | Autumn | 526899 | 725047 | 526930 | 725215 |
| | | | | | |

| Label | Season | X_Start | Y_Start | X_End | Y_End |
|---|---|---|---|---|---|
| T6 | Spring | 527835 | 727184 | 526803 | 726620 |
| T6 | Summer | 527030 | 726473 | 527198 | 726385 |
| T6 | Summer | 527473 | 727019 | 527815 | 727337 |
| T6 | Autumn | 527145 | 726481 | 526862 | 726585 |
| T6 | Autumn | 526214 | 725960 | 526608 | 726738 |
| T6 | Autumn | 527495 | 727137 | 527709 | 727299 |
| | | | | | |
| T7 | Spring | 526948 | 727218 | 527357 | 727564 |
| T7 | Summer | 527192 | 727598 | 527095 | 727320 |
| T7 | Autumn | 527309 | 727686 | 527122 | 727326 |
| | | | | | |
| T8 | Spring | 528419 | 727559 | 528018 | 727471 |
| T8 | Summer | 527821 | 727536 | 527802 | 727382 |
| T8 | Summer | 528184 | 727366 | 528274 | 727575 |
| T8 | Autumn | 528052 | 727510 | 528048 | 727477 |
| T8 | Autumn | 528180 | 727331 | 528166 | 727514 |
| | | | | | |
| T9 | Spring | 528473 | 728025 | 528800 | 727947 |
| T9 | Spring | 528488 | 728169 | 528234 | 728343 |
| T9 | Summer | 528300 | 728317 | 528718 | 727822 |
| T9 | Autumn | 528484 | 728147 | 528476 | 728158 |
| T10 | Spring | 529563 | 728218 | 530014 | 728327 |
| T10 | Summer | 530012 | 728317 | 529968 | 728388 |
| T10 | Summer | 530013 | 728327 | 530014 | 728293 |
| T10 | Autumn | 529692 | 728352 | 530015 | 728341 |
| | | | | | |
| T11 | Spring | 530320 | 728288 | 529817 | 727973 |
| T11 | Spring | 530323 | 728288 | 529817 | 727973 |
| T11 | Summer | 530299 | 728297 | 529871 | 727442 |
| T11 | Summer | 530298 | 728296 | 529876 | 727430 |
| T11 | Autumn | 530109 | 728089 | 530051 | 728082 |
| | | | | | |
| T12 | Spring | 531970 | 728475 | 532034 | 728468 |
| T12 | Spring | 530981 | 728253 | 531075 | 728403 |
| T12 | Spring | 531847 | 728282 | 531840 | 728281 |
| T12 | Summer | 531054 | 728590 | 531067 | 728406 |
| T12 | Summer | 531509 | 728272 | 532041 | 728416 |
| T12 | Autumn | 532052 | 728414 | 532057 | 728235 |
| T12 | Autumn | 531021 | 728610 | 531056 | 728415 |

| Label | Season | X_Start | Y_Start | X_End | Y_End |
|---|---|---|---|---|---|
| T12 | Autumn | 532082 | 728287 | 532052 | 728410 |
| | | | | | |
| T13 | Spring | 533221 | 727252 | 533225 | 727236 |
| T13 | Spring | 532863 | 727565 | 532893 | 727635 |
| T13 | Spring | 532845 | 728017 | 532745 | 728085 |
| T13 | Spring | 531970 | 728475 | 532034 | 728468 |
| T13 | Spring | 532836 | 728021 | 532696 | 728335 |
| T13 | Spring | 532058 | 728373 | 532060 | 728372 |
| T13 | Summer | 532865 | 728003 | 532744 | 727628 |
| T13 | Summer | 532763 | 727473 | 532851 | 728020 |
| T13 | Summer | 531509 | 728272 | 532041 | 728416 |
| T13 | Summer | 533604 | 728111 | 533618 | 728104 |
| T13 | Autumn | 532052 | 728414 | 532057 | 728235 |
| T13 | Autumn | 532783 | 728189 | 532972 | 727907 |
| T13 | Autumn | 533053 | 727996 | 533086 | 728036 |
| T13 | Autumn | 532082 | 728287 | 532052 | 728410 |
| | | | | | |
| T14 | Spring | 534243 | 727433 | 534006 | 727942 |
| T14 | Summer | 533604 | 728111 | 533618 | 728104 |
| T14 | Autumn | 533927 | 727844 | 533922 | 727846 |
| T14 | Autumn | 533053 | 727996 | 533086 | 728036 |
| | | | | | |
| T15 | Spring | 535049 | 726759 | 535010 | 726132 |
| T15 | Spring | 534243 | 727433 | 534006 | 727942 |
| T15 | Summer | 534488 | 726933 | 534449 | 726950 |
| T15 | Autumn | 534256 | 727214 | 534273 | 727252 |
| T15 | Autumn | 534485 | 726895 | 534268 | 727215 |
| T15 | Autumn | 534869 | 726758 | 534869 | 726755 |

# Appendix E

## Auto-detector Results 2023

## Auto-detector locations and deployment dates in 2023

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| L1 | Spring | SMU09897 | 03/05/2023 | 08/05/2023 | 521346 | 723297 |
| L1 | Summer | SMU10125 | 19/06/2023 | 26/06/2023 | 521351 | 723304 |
| L1 | Autumn | SMU09901 | 29/08/2023 | 04/09/2023 | 521350 | 723304 |
| | | | | | | |
| L2 | Spring | SMU10128 | 03/05/2023 | 08/05/2023 | 522008 | 723848 |
| L2 | Summer | SMU10126 | 19/06/2023 | 26/06/2023 | 522013 | 723862 |
| L2 | Autumn | SMU09177 | 29/08/2023 | 04/09/2023 | 522009 | 723847 |
| | | | | | | |
| L3 | Spring | SMU09137 | 03/05/2023 | 08/05/2023 | 522614 | 724200 |
| L3 | Summer | SMU10070 | 19/06/2023 | 26/06/2023 | 522618 | 724205 |
| L3 | Autumn | SMU09137 | 29/08/2023 | 04/09/2023 | 522618 | 724204 |
| | | | | | | |
| L4 | Spring | SMU10071 | 03/05/2023 | 08/05/2023 | 523152 | 724180 |
| L4 | Summer | SMU09144 | 19/06/2023 | 26/06/2023 | 523139 | 724183 |
| L4 | Autumn | SMU09174 | 29/08/2023 | 04/09/2023 | 523142 | 724183 |
| | | | | | | |
| L5 | Spring | SMU10126 | 03/05/2023 | 08/05/2023 | 523667 | 724261 |
| L5 | Summer | SMU09901 | 19/06/2023 | 26/06/2023 | 523672 | 724258 |
| L5 | Autumn | SMU09176 | 29/08/2023 | 04/09/2023 | 523671 | 724260 |
| | | | | | | |
| L6 | Spring | SMU09137 | 09/05/2023 | 15/05/2023 | 524047 | 724753 |
| L6 | Summer | SMU09184 | 20/06/2023 | 27/06/2023 | 524048 | 724750 |
| L6 | Autumn | SMU10069 | 30/08/2023 | 05/09/2023 | 524078 | 724751 |
| | | | | | | |
| L7 | Spring | SMU10128 | 09/05/2023 | 15/05/2023 | 524206 | 724819 |
| L7 | Summer | SMU10071 | 20/06/2023 | 27/06/2023 | 524207 | 724821 |
| L7 | Autumn | SMU10128 | 30/08/2023 | 05/09/2023 | 524209 | 724822 |
| | | | | | | |
| L8 | Spring | SMU09897 | 09/05/2023 | 15/05/2023 | 524622 | 725053 |
| L8 | Summer | SMU10068 | 20/06/2023 | 27/06/2023 | 524632 | 725058 |
| L8 | Autumn | SMU10071 | 29/08/2023 | 04/09/2023 | 524634 | 725058 |
| | | | | | | |
| L9 | Spring | SMU10071 | 09/05/2023 | 15/05/2023 | 525025 | 725490 |
| L9 | Summer | SMU10128 | 20/06/2023 | 29/06/2023 | 525198 | 725467 |
| L9 | Autumn | SMU10070 | 30/08/2023 | 05/09/2023 | 525211 | 725467 |
| | | | | | | |
| L10 | Spring | SMU10126 | 09/05/2023 | 15/05/2023 | 525730 | 725842 |

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| L10 | Summer | SMU09174 | 20/06/2023 | 27/06/2023 | 525733 | 725827 |
| L10 | Autumn | SMU10060 | 30/08/2023 | 05/09/2023 | 525733 | 725827 |
| | | | | | | |
| L11 | Spring | SMU09176 | 10/05/2023 | 16/05/2023 | 526101 | 726090 |
| L11 | Summer | SMU09912 | 21/06/2023 | 27/06/2023 | 526100 | 726090 |
| L11 | Autumn | SMU09184 | 30/08/2023 | 05/09/2023 | 526102 | 726086 |
| | | | | | | |
| L12 | Spring | SMU09901 | 10/05/2023 | 16/05/2023 | 526387 | 726330 |
| L12 | Summer | SMU09176 | 21/06/2023 | 27/06/2023 | 526387 | 726325 |
| L12 | Autumn | SMU09850 | 30/08/2023 | 05/09/2023 | 526380 | 726324 |
| | | | | | | |
| L13 | Spring | SMU10070 | 10/05/2023 | 16/05/2023 | 526506 | 726443 |
| L13 | Summer | SMU10060 | 21/06/2023 | 28/06/2023 | 526506 | 726445 |
| L13 | Autumn | SMU10068 | 31/08/2023 | 05/09/2023 | 526512 | 726465 |
| | | | | | | |
| L14 | Spring | SMU09179 | 10/05/2023 | 16/05/2023 | 526614 | 726533 |
| L14 | Summer | SMU10123 | 21/06/2023 | 28/06/2023 | 526617 | 726531 |
| L14 | Autumn | SMU09144 | 31/08/2023 | 05/09/2023 | 526616 | 726531 |
| | | | | | | |
| L15 | Spring | SMU09174 | 10/05/2023 | 16/05/2023 | 526909 | 726712 |
| L15 | Summer | SMU09850 | 21/06/2023 | 27/06/2023 | 526911 | 726706 |
| L15 | Autumn | SMU10125 | 31/08/2023 | 05/09/2023 | 526909 | 726715 |
| | | | | | | |
| L16 | Spring | SMU10069 | 11/05/2023 | 17/05/2023 | 527230 | 727619 |
| L16 | Summer | SMU09912 | 28/06/2023 | 03/07/2023 | 527236 | 727618 |
| L16 | Autumn | SMU10060 | 06/09/2023 | 11/09/2023 | 527241 | 727623 |
| | | | | | | |
| L17 | Spring | SMU09144 | 11/05/2023 | 16/05/2023 | 527150 | 726866 |
| L17 | Summer | SMU09901 | 28/06/2023 | 03/07/2023 | 527120 | 726852 |
| L17 | Autumn | SMU09179 | 06/09/2023 | 12/09/2023 | 527125 | 726877 |
| | | | | | | |
| L18 | Spring | SMU09850 | 17/05/2023 | 22/05/2023 | 527146 | 726497 |
| L18 | Summer | SMU10068 | 28/06/2023 | 03/07/2023 | 527160 | 726494 |
| L18 | Autumn | SMU10071 | 06/09/2023 | 11/09/2023 | 527154 | 726496 |
| | | | | | | |
| L19 | Spring | SMU10068 | 11/05/2023 | 16/05/2023 | 527650 | 727217 |
| L19 | Summer | SMU09144 | 28/06/2023 | 03/07/2023 | 527652 | 727216 |
| L19 | Autumn | SMU09174 | 06/09/2023 | 11/09/2023 | 527659 | 727223 |

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| L19 | Autumn (Redeployment) | SMU10060 | 13/09/2023 | 18/09/2023 | 527654 | 727214 |
| | | | | | | |
| L20 | Spring | SMU09912 | 31/05/2023 | 07/06/2023 | 527962 | 727473 |
| L20 | Summer | SMU09850 | 30/06/2023 | 05/07/2023 | 527983 | 727480 |
| L20 | Autumn | SMU09912 | 06/09/2023 | 11/09/2023 | 527972 | 727463 |
| | | | | | | |
| L21 | Spring | SMU09897 | 31/05/2023 | 07/06/2023 | 528025 | 727524 |
| L21 | Summer | SMU10071 | 30/06/2023 | 05/07/2023 | 528036 | 727508 |
| L21 | Autumn | SMU10123 | 06/09/2023 | 11/09/2023 | 528022 | 727524 |
| | | | | | | |
| L22 | Spring | SMU09179 | 31/05/2023 | 07/06/2023 | 528283 | 727664 |
| L22 | Summer | SMU09174 | 30/06/2023 | 05/07/2023 | 528270 | 727658 |
| L22 | Autumn | SMU09897 | 06/09/2023 | 11/09/2023 | 528280 | 727670 |
| | | | | | | |
| L23 | Spring | SMU09177 | 18/05/2023 | 23/05/2023 | 528553 | 727780 |
| L23 | Summer | SMU10128 | 31/05/2023 | 06/06/2023 | 528552 | 727771 |
| L23 | Summer (Redeployment) | SMU10125 | 29/06/2023 | 04/07/2023 | 528561 | 727779 |
| L23 | Autumn | SMU10125 | 07/09/2023 | 12/09/2023 | 528558 | 727780 |
| | | | | | | |
| L24 | Spring | SMU09179 | 18/05/2023 | 23/05/2023 | 528613 | 727809 |
| L24 | Summer | SMU10125 | 07/06/2023 | 13/06/2023 | 528608 | 727811 |
| L24 | Summer (Redeployment) | SMU10070 | 29/06/2023 | 04/07/2023 | 528612 | 727810 |
| L24 | Autumn | SMU10069 | 07/09/2023 | 12/09/2023 | 528612 | 727821 |
| | | | | | | |
| L25 | Spring | SMU10070 | 18/05/2023 | 23/05/2023 | 528713 | 727879 |
| L25 | Summer | SMU09184 | 29/06/2023 | 04/07/2023 | 528707 | 727864 |
| L25 | Autumn | SMU10068 | 07/09/2023 | 12/09/2023 | 528705 | 727852 |
| | | | | | | |
| L26 | Spring | SMU09901 | 18/05/2023 | 23/05/2023 | 528799 | 727948 |
| L26 | Summer | SMU10060 | 29/06/2023 | 03/07/2023 | 528805 | 727951 |
| L26 | Autumn | SMU09901 | 07/09/2023 | 12/09/2023 | 528805 | 727952 |
| | | | | | | |
| L27 | Spring | SMU09174 | 18/05/2023 | 24/05/2023 | 529129 | 728167 |
| L27 | Summer | SMU10126 | 28/06/2023 | 04/07/2023 | 529130 | 728162 |
| L27 | Autumn | SMU09174 | 13/09/2023 | 18/09/2023 | 529137 | 728178 |

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| | | | | | | |
| L28 | Spring | SMU10128 | 18/05/2023 | 24/05/2023 | 529359 | 728310 |
| L28 | Summer | SMU10123 | 29/06/2023 | 04/07/2023 | 529359 | 728309 |
| L28 | Autumn | SMU09177 | 07/09/2023 | 12/09/2023 | 529359 | 728312 |
| | | | | | | |
| L29 | Spring | SMU09184 | 17/05/2023 | 22/05/2023 | 529697 | 728385 |
| L29 | Summer | SMU09184 | 06/07/2023 | 11/07/2023 | 529712 | 728448 |
| L29 | Autumn | SMU09850 | 07/09/2023 | 12/09/2023 | 529699 | 728384 |
| | | | | | | |
| L30 | Spring | SMU09912 | 17/05/2023 | 22/05/2023 | 529785 | 728414 |
| L30 | Summer | SMU10070 | 06/07/2023 | 11/07/2023 | 529791 | 728400 |
| L30 | Autumn | SMU09176 | 07/09/2023 | 12/09/2023 | 529785 | 728400 |
| | | | | | | |
| L31 | Spring | SMU10123 | 17/05/2023 | 22/05/2023 | 529799 | 728376 |
| L31 | Summer | SMU09176 | 06/07/2023 | 11/07/2023 | 529793 | 728377 |
| L31 | Autumn | SMU10070 | 07/09/2023 | 12/09/2023 | 529797 | 728376 |
| | | | | | | |
| L32 | Spring | SMU10126 | 18/05/2023 | 23/05/2023 | 530353 | 728451 |
| L32 | Summer | SMU10126 | 05/07/2023 | 10/07/2023 | 530351 | 728425 |
| L32 | Autumn | SMU09912 | 13/09/2023 | 18/09/2023 | 530347 | 728427 |
| | | | | | | |
| L33 | Spring | SMU09144 | 18/05/2023 | 23/05/2023 | 530717 | 728554 |
| L33 | Summer | SMU09897 | 05/07/2023 | 10/07/2023 | 530695 | 728559 |
| L33 | Autumn | SMU09897 | 13/09/2023 | 18/09/2023 | 530692 | 728560 |
| | | | | | | |
| L34 | Spring | SMU09137 | 18/05/2023 | 23/05/2023 | 530768 | 728461 |
| L34 | Summer | SMU10123 | 05/07/2023 | 10/07/2023 | 530768 | 728458 |
| L34 | Autumn | SMU10068 | 14/09/2023 | 19/09/2023 | 530772 | 728455 |
| | | | | | | |
| L35 | Spring | SMU10068 | 18/05/2023 | 23/05/2023 | 530951 | 728478 |
| L35 | Summer | SMU09177 | 30/06/2023 | 05/07/2023 | 530943 | 728477 |
| L35 | Autumn | SMU09850 | 13/09/2023 | 18/09/2023 | 530946 | 728476 |
| | | | | | | |
| L36 | Spring | SMU09176 | 18/05/2023 | 23/05/2023 | 531004 | 728471 |
| L36 | Summer | SMU09897 | 30/06/2023 | 05/07/2023 | 531005 | 728471 |
| L36 | Autumn | SMU10123 | 13/09/2023 | 18/09/2023 | 531005 | 728470 |
| | | | | | | |
| L37 | Spring | SMU09177 | 01/06/2023 | 06/06/2023 | 531165 | 728468 |
| L37 | Summer | SMU09177 | 05/07/2023 | 10/07/2023 | 531170 | 728466 |

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| L37 | Autumn | SMU09176 | 13/09/2023 | 18/09/2023 | 531170 | 728465 |
| | | | | | | |
| L38 | Spring | SMU09174 | 01/06/2023 | 06/06/2023 | 531213 | 728453 |
| L38 | Summer | SMU09144 | 05/07/2023 | 10/07/2023 | 531209 | 728449 |
| L38 | Autumn | SMU10071 | 13/09/2023 | 18/09/2023 | 531207 | 728454 |
| | | | | | | |
| L39 | Spring | SMU10060 | 01/06/2023 | 06/06/2023 | 531473 | 728378 |
| L39 | Summer | SMU09912 | 06/07/2023 | 11/07/2023 | 531477 | 728371 |
| L39 | Autumn | SMU10125 | 14/09/2023 | 19/09/2023 | 531487 | 728387 |
| | | | | | | |
| L40 | Spring | SMU10123 | 23/05/2023 | 29/05/2023 | 531622 | 728350 |
| L40 | Summer | SMU10071 | 06/07/2023 | 11/07/2023 | 531626 | 728346 |
| L40 | Autumn | SMU09184 | 14/09/2023 | 19/09/2023 | 531618 | 728350 |
| | | | | | | |
| L41 | Spring | SMU09850 | 23/05/2023 | 29/05/2023 | 531822 | 728375 |
| L41 | Summer | SMU10060 | 06/07/2023 | 11/07/2023 | 531823 | 728372 |
| L41 | Autumn | SMU09144 | 14/09/2023 | 19/09/2023 | 531820 | 728379 |
| | | | | | | |
| L42 | Spring | SMU09184 | 23/05/2023 | 31/05/2023 | 531963 | 728331 |
| L42 | Summer | SMU09174 | 06/07/2023 | 12/07/2023 | 531964 | 728333 |
| L42 | Autumn | SMU09179 | 14/09/2023 | 19/09/2023 | 531967 | 728336 |
| | | | | | | |
| L43 | Spring | SMU10070 | 24/05/2023 | 31/05/2023 | 532205 | 728331 |
| L43 | Summer | SMU09901 | 07/07/2023 | 12/07/2023 | 532206 | 728334 |
| L43 | Autumn | SMU09177 | 14/09/2023 | 19/09/2023 | 532200 | 728329 |
| | | | | | | |
| L44 | Spring | SMU10071 | 01/06/2023 | 06/06/2023 | 532351 | 728296 |
| L44 | Summer | SMU09137 | 07/07/2023 | 12/07/2023 | 532353 | 728290 |
| L44 | Autumn | SMU09174 | 20/09/2023 | 25/09/2023 | 532360 | 728294 |
| | | | | | | |
| L45 | Spring | SMU10126 | 24/05/2023 | 30/05/2023 | 532684 | 728220 |
| L45 | Summer | SMU10128 | 07/07/2023 | 17/07/2023 | 532688 | 728222 |
| L45 | Autumn | SMU09177 | 20/09/2023 | 25/09/2023 | 532679 | 728220 |
| | | | | | | |
| L46 | Spring | SMU10068 | 24/05/2023 | 30/05/2023 | 532853 | 727829 |
| L46 | Summer | SMU10071 | 12/07/2023 | 17/07/2023 | 532852 | 727828 |
| L46 | Autumn | SMU10068 | 20/09/2023 | 25/09/2023 | 532849 | 727836 |
| | | | | | | |
| L47 | Spring | SMU09901 | 24/05/2023 | 30/05/2023 | 533127 | 728311 |

| Label | Season | Device | Deployed | Collected | X | Y |
|---|---|---|---|---|---|---|
| L47 | Summer | SMU10125 | 12/07/2023 | 17/07/2023 | 533129 | 728317 |
| L47 | Autumn | SMU10071 | 20/09/2023 | 25/09/2023 | 533129 | 728311 |
| | | | | | | |
| L48 | Spring | SMU09144 | 24/05/2023 | 30/05/2023 | 533915 | 727847 |
| L48 | Summer | SMU10060 | 12/07/2023 | 17/07/2023 | 533911 | 727843 |
| L48 | Autumn | SMU10125 | 20/09/2023 | 25/09/2023 | 533903 | 727835 |
| | | | | | | |
| L49 | Spring | SMU09137 | 24/05/2023 | 30/05/2023 | 534461 | 727016 |
| L49 | Summer | SMU10069 | 12/07/2023 | 17/07/2023 | 534459 | 727010 |
| L49 | Autumn | SMU09176 | 20/09/2023 | 25/09/2023 | 534454 | 727010 |
| | | | | | | |
| L50 | Spring | SMU09176 | 24/05/2023 | 30/05/2023 | 534696 | 726664 |
| L50 | Summer | SMU09850 | 12/07/2023 | 17/07/2023 | 534669 | 726678 |
| L50 | Autumn | SMU09897 | 20/09/2023 | 25/09/2023 | 534664 | 726673 |

# Appendix F

## 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)

*Greena Ecological Consultancy*

# Galway Bat Radio-tracking Project

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

*Photo by Isobel Abbott*

## V3A October 2014

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# Contents

## Executive summary

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

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

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

Greena Ecological Consultancy captured 17 Lesser horseshoes *(Rhinolophus hipposideros)* during the first session, 13 females and four males. All bats were captured in a static mist net stretched over maternity roost entrance. Bats were of good health, weight ranging from 5.7g to 6.5g for females and from 5.3g to 6.0g for males. Ten bats were fitted with radio transmitters and ringed at the same time. The session at Menlo Castle (30/07/2014) was followed by another catching session at Cooper's Cave on the night of 1$^{st}$ 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 1$^{st}$ 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 2$^{nd}$ August 2014. The night temperature dropped considerably on 2$^{nd}$ August 2014 due to clear sky. All other nights of the August session were affected by rain. Bats still foraged most of the nights but their activity was limited and they were recorded returning to their roost of finding night roosts several times during the night with continuing foraging activity later during the same night.

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

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

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

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

## 6.0 Ethical Review

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

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

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

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

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

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

All bats were released at the point of capture.

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

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

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

# 7.0 Results

## *7.1 Previous records*

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

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

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

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

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

## *7.2 Weather data*

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

**Table 3A Weather data, August session**

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

*Data from Worldweatheronline.com, 2014 and survey records*

**Table 3B Weather data, September session**

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

*Data from Worldweatheronline.com, 2014 and survey records*

## *7.3 Bat captures*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

All bats ringed and tagged by Tereza Rush.

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

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

All bats ringed and tagged by Geoff Billington.

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

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

## *7.4 Roosting sites*

### 7.4.1 Daytime roosting sites

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

**Table 5 Identified daytime roosts in August 2014**

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

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

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

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

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

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

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

**Figure 2 Roost A, August and September, Menlo Castle**

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

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

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

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

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

**Table 7 Identified daytime roosts in September 2014**

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

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

**Figure 6 Roost C2 from the September session**

**Figure 7 Roost D2 from the September session**

**Figure 8 Roost E2 from the September session**

**Figure 9 Roost F2 from the September session**

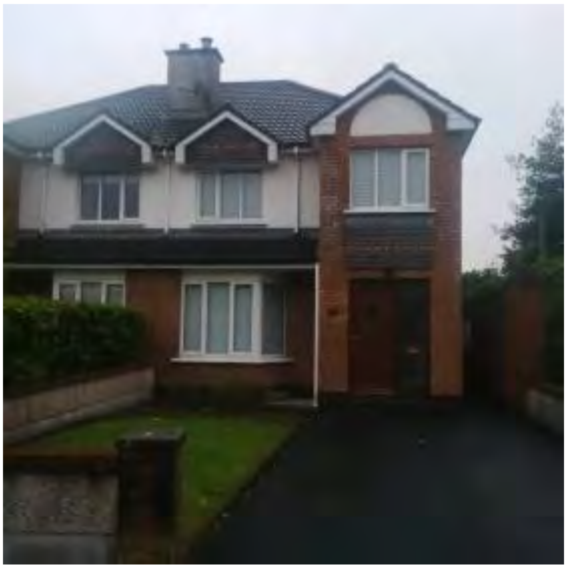


**Figure 10 Roost G2 from the September session**

**Figure 11 Roost H2 from the September session**

**Figure 12 Roost I2 from the September session**

**Figure 13 Location of all roosting sites identified in August**

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

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

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

**Table 8 Daytime roost usage during the monitored period in September**

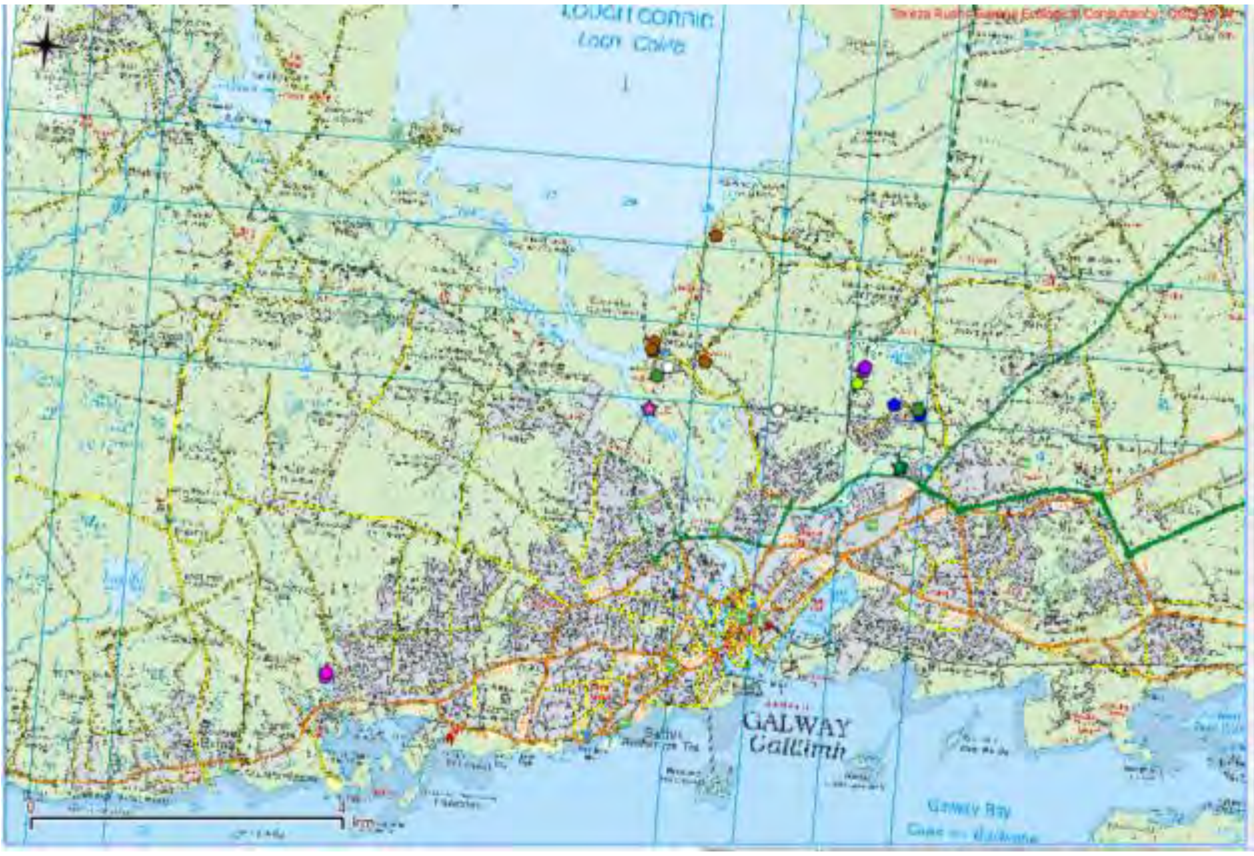
| bat | 30/08 | 31/08 | 01/09 | 02/09 | 03/09 | 04/09 | 05/09 | 06/09 |
|---|---|---|---|---|---|---|---|---|
| 1 | / | / | / | / | / | / | / | / |
| 2 | / | / | / | / | / | / | / | / |
| 3 | / | / | / | / | / | / | / | / |
| 4 | / | C2 | C2 | C2 | C2 | C2 | / | / |
| 5 | D2 | D2 | D2 | D2 | D2 | D2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

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

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

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

**Figure 14 Location of roosting sites located in September**



### 7.4.2 Night-time roosting sites

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

**Table 9 Night roosts of tagged bats in August**

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

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

**Figure 15 Night roost AN1 of bat 2 from August session**

**Figure 16 Night roost BN1 of bat 2 from August session**

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

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

**Figure 19 Night roost EN1 of bat 4 from August session**

**Figure 20 Night roost FN1 of bat 6 from August session**

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

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

**Figure 23 Night roost JN1 of bats 11 from August session**

**Figure 24 Night roost KN1 of bat 13 from August session**

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

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

**Table 10 Night roosts of tagged bats in September**

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

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

**Figure 25 Night roost AN2 of bat 17 from September session**

**Figure 26 Night roost BN2 of bat 17 from September session**

**Figure 27 Night roost CN2 of bat 17 from September session**

**Figure 28 Night roost FN2 of bat 5 from September session**

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

**Figure 30 Night roost HN2 of bat 17 from September session**

## *7.5 Foraging periods*

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

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

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

## *7.6 Foraging areas*

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

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

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

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

**Table 11 Results of radio tracking session in August 2014**

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

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

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

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

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

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

Table 12 shows results of the September radio tracking session.

**Table 12 Results of radio tracking session in September 2014**

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

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

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

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

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

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


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

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

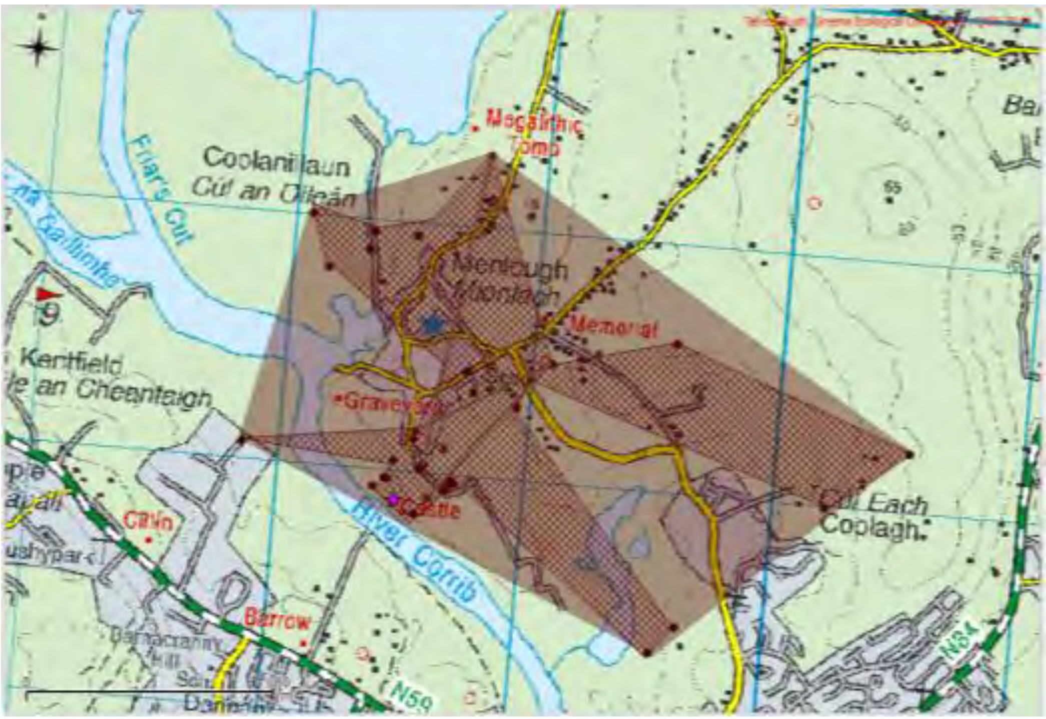



**Figure 36 Foraging area of bat 6 August (male Lesser horseshoe)**

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


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

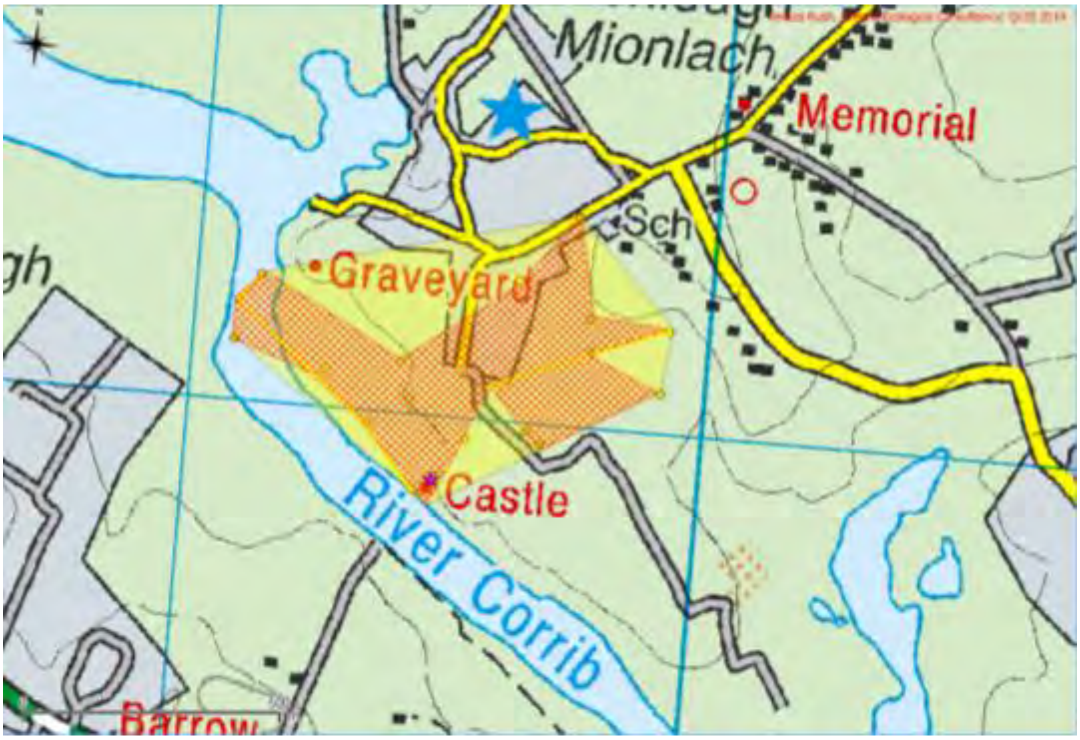


**Figure 39 Foraging area of bat 9 August (male Lesser horseshoe)**

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

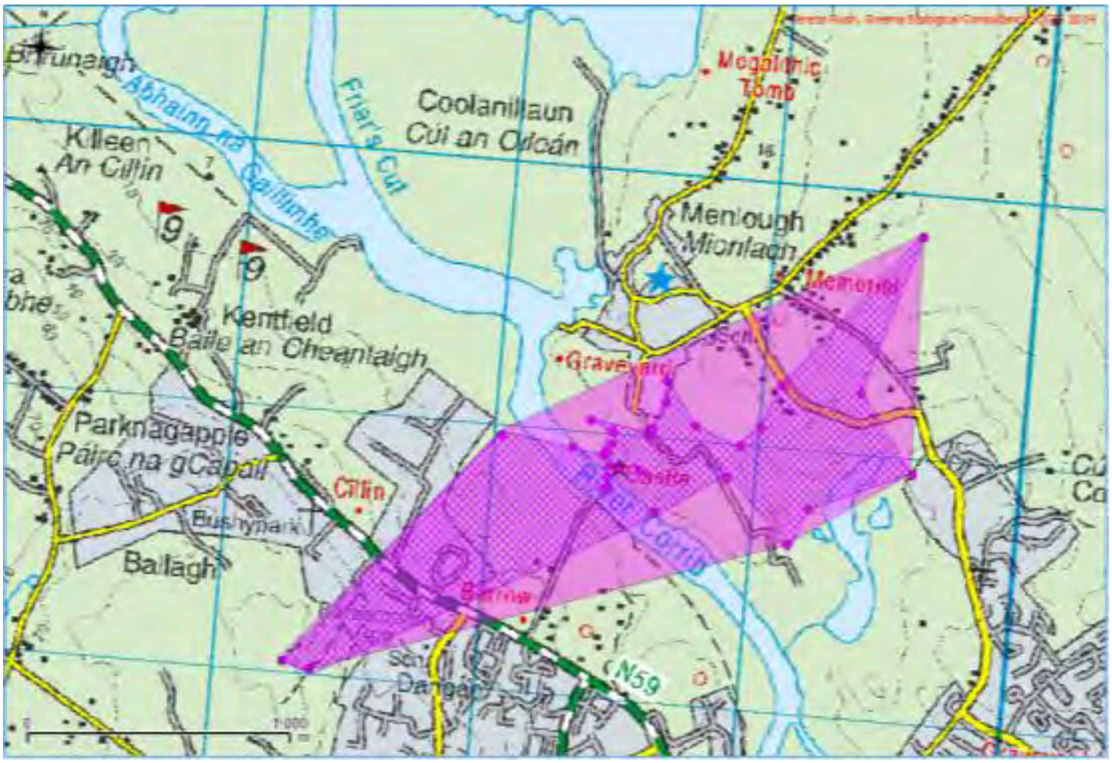


**Figure 41 Foraging area of bat 11 August (male Lesser horseshoe)**

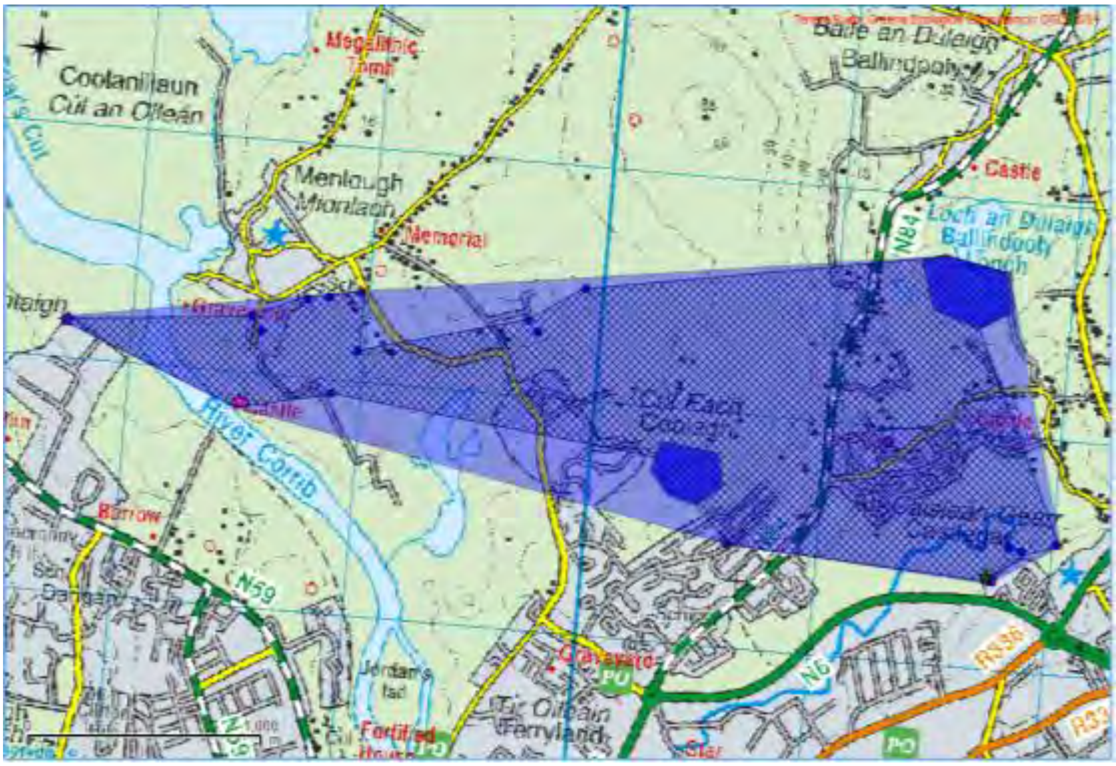



**Figure 42 Foraging area of bat 12 August (male Lesser horseshoe)**

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

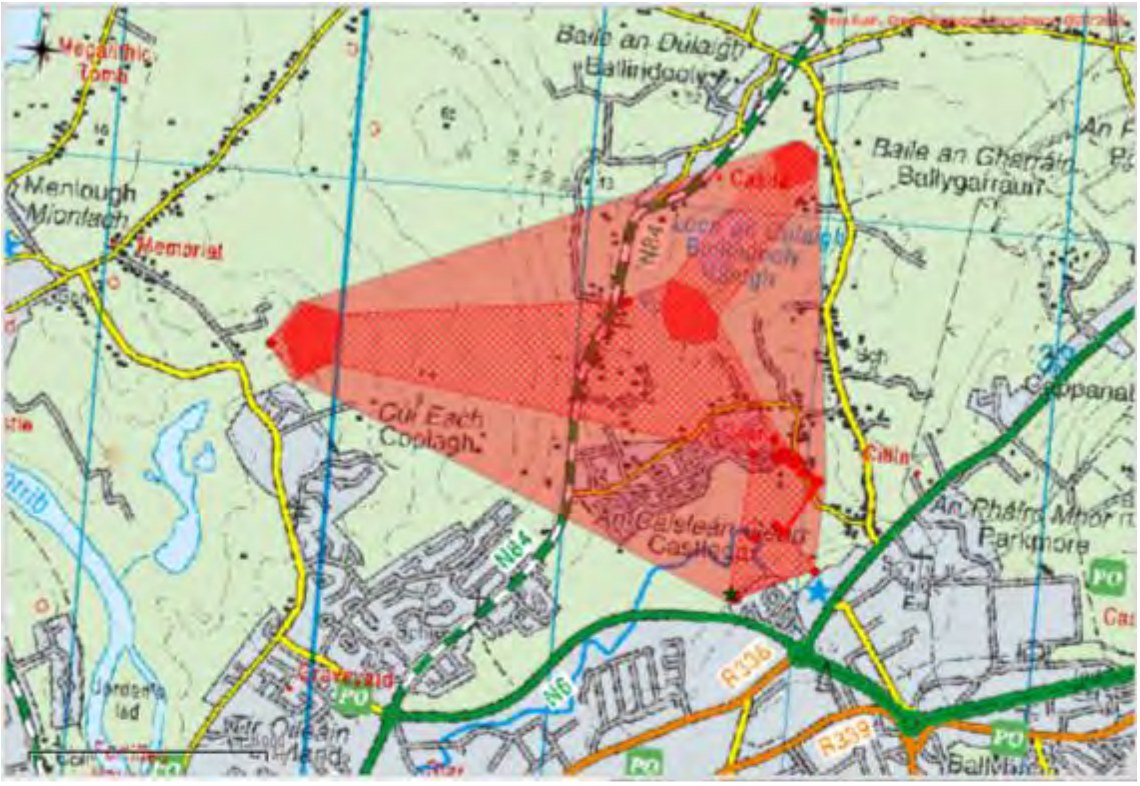



**Figure 44 Foraging area of bat 14 August (male Leisler's)**

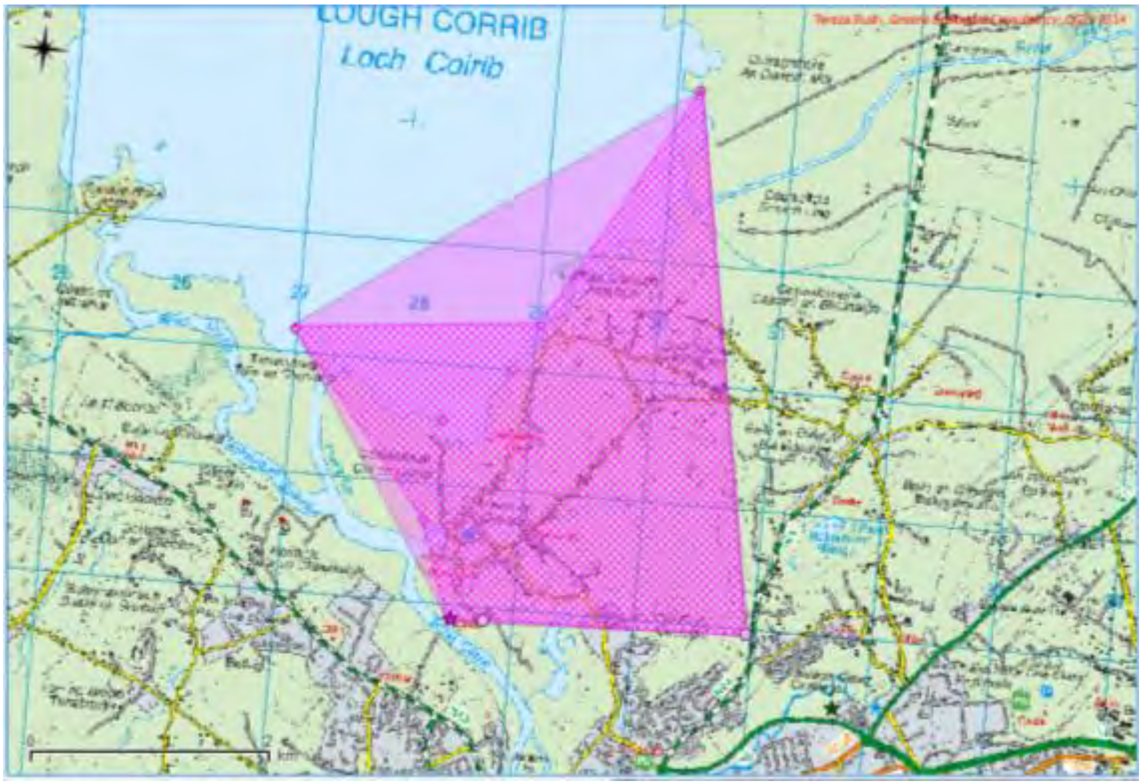


**Figure 45 Foraging area of bat 4 September (male Leisler's)**

**Figure 46 Foraging area of bat 5 September (female Brown long eared bat)**

**Figure 47 Foraging area of bat 6 September (Whiskered bat)**

**Figure 48 Foraging area of bat 7 September (male Daubenton's bat)**

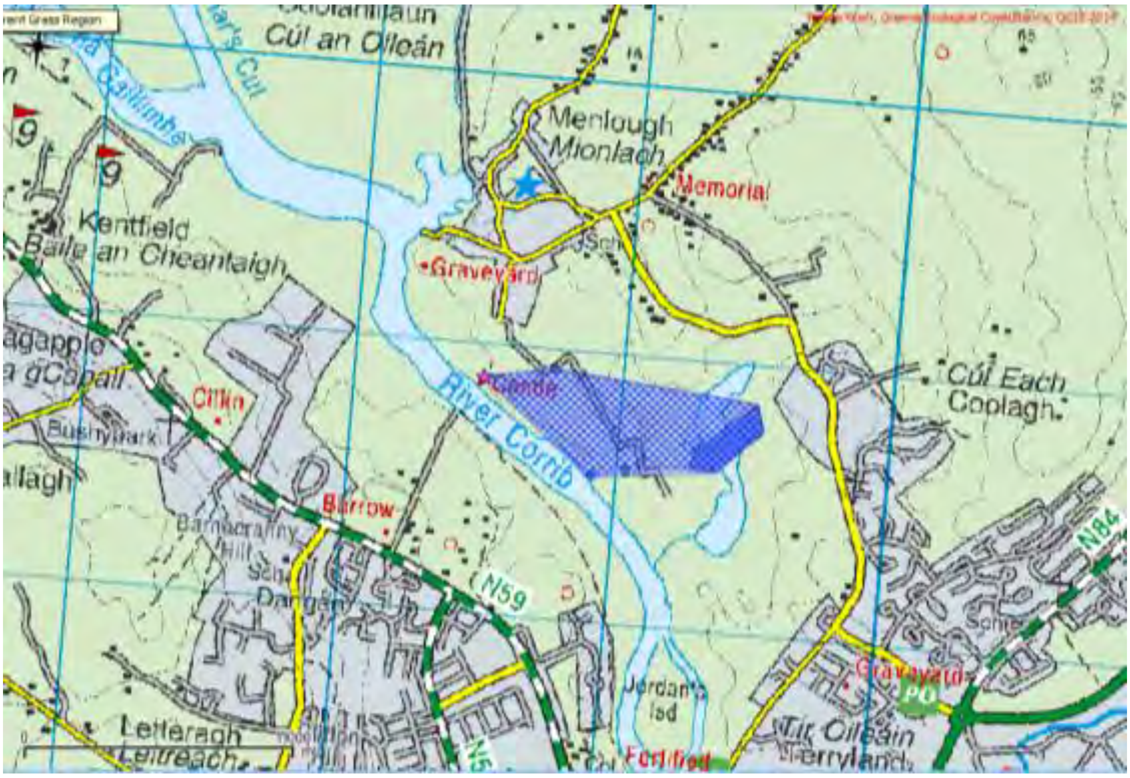


**Figure 49 Foraging area of bat 8 September (female Daubenton's bat)**


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

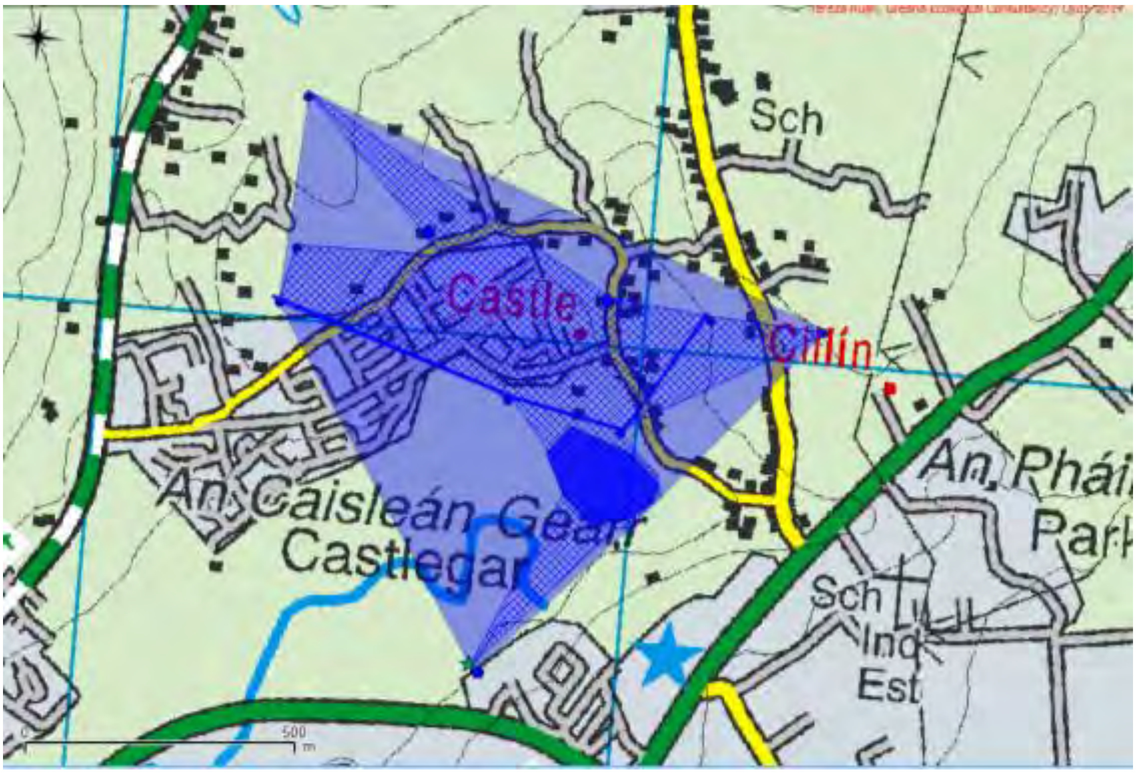


**Figure 51 Foraging area of bat 13 September (male Lesser horseshoe)**

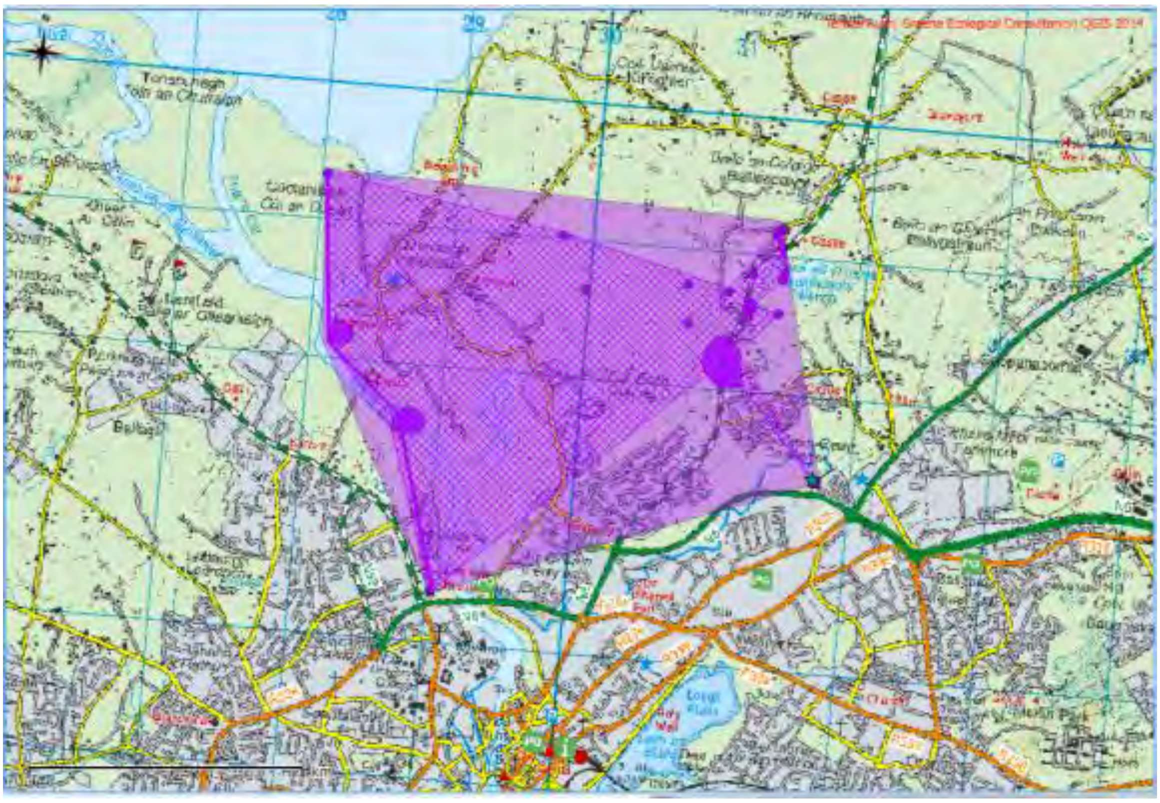


**Figure 52 Foraging area of bat 14 September (female Lesser horseshoe)**

**Figure 53 Foraging area of bat 15 September (male Lesser horseshoe)**


**Figure 54 Foraging area of bat 17 September ( female Lesser horseshoe)**

August foraging and roosting areas:

**Bat 1**

Bat 1, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Foraging area of bat 1 ranged from Menlo Castle in south-west, towards Ballinfoyle in south-east, over Ballindooly Lough to Ballindooly in north-east, then into the south part of Lough Corrib, covering Angliham Quarry and limestone pavement located north-east from Menlo Castle. Bat 1 covered the largest distance and foraging area of all Lesser horseshoe bats studied in August 2014.

**Bat 2**

Bat 2, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Bat 2 changed its roosting place throughout the duration of the radio tracking session, roosting not only at Menlo Castle but also in Menlough Village and near Kilroghter. Foraging area of Bat 2 ranged from Menlo Castle in north-eastern direction, following the south shore of Lough Corrib and covering Kilroghter limestone pavement. Foraging area of Bat 2 is comparable with the average foraging area calculated for females Lesser horseshoe bats during this study.

**Bat 3**

Bat 3, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. This bat later changed its roosting place and was found first night roosting and later also day roosting in Angliham Quarry before returning back to Menlo Castle. Limited amount of data was collected on Bat 3 because its radio-transmitter got detached before the end of the study. Foraging area of Bat 3 extended in the north-eastern direction from Menlo Castle, spreading over Menlough Village and towards the south shore of Lough Corrib but avoiding Kilroghter limestone pavement. The small extent of the foraging area of Bat 3 raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

**Bat 4**

Bat 4, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Its foraging area to large extent coincided with the foraging area recorded for Bat 3, covering Menlough Village and heading towards the south edge of Lough Corrib, yet avoiding foraging on the limestone pavement situated north-east from Menlo Castle. Bat 4 was also found first night roosting and later utilising the same roosting place in Angliham Quarry for day roosting. The overall foraging area of Bat 4 is comparable with the average foraging area recorded for male Lesser horseshoe bats during the August study.

**Bat 5**

Bat 5, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Its foraging area extended further west than those of previously mentioned bats, reaching over the west bank of the River Corrib. Bat 5 was foraging in Menlough Village but never ventured as far north as Angliham Quarry; however, covered the village of Coolagh, including Lackagh Quarry and feeding repeatedly around Coolagh lakes. The foraging area of Bat 5 corresponds with the average calculated for Lesser horseshoe females in August 2014.

**Bat 6**

Bat 6, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. It was recorded to move to the west bank of the River Corrib the first night after being tagged. There is utilised a roost in a block of stables on regular basis, although was also recorded to have returned to Menlo Castle, usually for night roosting, and as far east as in Cooper's Cave for both, day and night roosting. Its foraging area did not spread north like other bats from the same roost. Instead, it was situated in the east-west direction between stable roost on the west bank, covering Menlough Village and Coolagh lakes and reaching to the field system around Cooper's Cave and Ballinfoyle.

**Bat 7**

Bat 7, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio tracking session. Its foraging area was located east from Menlo Castle , covering Menlough Village, Lackagh Quarry and the village of Coolagh. The overall foraging area of Bat 7 is comparable with average area calculated for Lesser horseshoe females in August 2014.

**Bat 8**

Bat 8, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio-tracking session. Limited amount of data was collected on foraging behaviours of Bat 8 in August. Its foraging area was very small and located in close vicinity of Menlo Castle and in Menlo Woods. It raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

**Bat 9**

Bat 9, a male Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle. Similarly to Bat 6, this bat was also switching roosts between Menlo Castle and Cooper's Cave. Bat 9 was recorded to forage on the west bank of the River Corrib, over Menlough Village, in the area of Coolagh lakes and towards Ballinfoyle, as well as in the field system in proximity of Cooper's Cave. Foraging area of Bat 9 was considered larger than the average foraging area calculated for males Lesser horseshoe bat in August 2014.

**Bat 10**

Bat 8, a female Lesser horseshoe bat, was captured on 30th July 2014 from the maternity roost at Menlo Castle and did not change its roosting place throughout the duration of the radio-tracking session. Foraging area of this bat spread south-west from Menlo Castle as far as Bearnacranny, over Menlough Village, in Menlo Woods and the northern edge of Coolagh lakes but did not reach Lackagh Quarry in east. Foraging area of Bat 10 is considered smaller than the average foraging area of females Lesser Horseshoe bats studied in August, despite the fact that relatively large amount of data was collected. It raises the question whether bats 3, 8 and 10 could have had dependent young in the maternity roost at Menlo Castle in early August 2014.

**Bat 11**

Bat 11, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It used the cave as a day roost all through the duration of the August radio-tracking study; however, was recorded night roosting on the west bank of the River Corrib. Its foraging area included the field system in proximity of Cooper's Cave, Ballinfoyle, Coolagh, the northern part of Coolagh lakes, Menlo Castle and Menlo Woods. Bat 11 was also recorded night-roosting in the maternity roost at Menlo Castle.

**Bat 12**

Bat 12, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It was recorded roosting in the cave and later in two sheds in Coolagh. Limited amount of data was collected on Bat 12; this bat stopped foraging on the 4th August 2014 and was later found dead in its roost in Coolagh. Its foraging area included Ballindooly lake and field systems around it as well as the field systems between Ballinfoyle and Coolagh.

**Bat 13**

Bat 13, a male Lesser horseshoe bat, was captured at Cooper's Cave on 1st August 2014. It was recorded roosting in Cooper's Cave on the night of tagging but then moved into a boarded derelict house in Castlegar where it remained roosting throughout the duration of the radio-tracking study. Bat 13 repeatedly used the same foraging area, located between Cooper's Cave, Ballindooly lake and Ballinfoyle. It was often recorded foraging around fields and following field boundaries.

**Bat 14**

Bat 14, a male Leisler's bat, was captured in Menlo Woods on 4th August 2014. It was not a target species of the August session and therefore limited amount of data was collected on its foraging area as well as roosting places. Scott Cawley located two roosts of Bat 14, one in an ash tree in Menlo Woods and one in a bungalow in Ballinfoyle. Recorded foraging area of Bat 14 included Menlough Village, Angliham Quarry and the south and south-east shore of Lough Corrib, flood area north of Angliham and reached south to Coolagh village.

<u>September foraging and roosting areas:</u>

Bats 1 – 11 in the September session were captured and fitted with radio-transmitters by Geckoella. Please refer to Geckoella report for details on physical measurements and weather conditions on trapping nights as well as exact trapping locations. Bats 1, 2, 3, 9, 10 and 11 could not be located during the September radio-tracking study led by Greena Ecological Consultancy.

**Bat 4**

Bat 4, male Leisler's bat, was captured in Bearna on 20th August 2014. It was changing roosts between two bungalows only located approximately 100 metres apart on Cappagh Road in Knocknacarra based on the evidence provided by Geckoella. Bat 4 did not change its roost during the study led by Greena Ecological Consultancy and utilised the same bungalow throughout the duration of the study. Bat 4 was using the same commuting route on regular basis, skimming the north-west edge of Galway City and then following the River Corrib north before spending prolonged periods foraging over the open water of Lough Corrib.

**Bat 5**

Bat 5, female Brown long eared bat, was captured by Cooper's Cave on 21st August 2014. It is not known to Greena Ecological Consultancy whether the bat was captured when entering / exiting the cave itself or while foraging nearby. Bat 5 did not change its day roost in Castlegar throughout the duration of the September study; however, was recorded night roosting in the stone arch between Menlough Village and Menlo Castle. It is possible that Bat 5 was forced to find a night roost due to adverse weather conditions on that night. Foraging area of Bat 5 was used repeatedly every night and was situated between Coolagh, Glenanail and Castlegar, extending north to Ballindooly.

**Bat 6**

Bat 6, male Whiskered bat, was captured on the grounds of National University of Ireland in Galway (NUIG) on 22nd August 2014. It was roosting in a residential house between Knocknacarra and Bearna and did not change its roosting place throughout the duration of the September study. The foraging area of Bat 6 spread westwards from its roost, utilising Bearna Woods, Moycullen Bogs and the area south of Lough Inch. It is possible that Bat 6 foraged further west, out of the study area, where it could not be followed during the radio-tracking study

**Bat 7**

Bat 7, male Daubenton's bat, was captured on the grounds of NUIG on 22nd August 2014. This bat was not located prior to the arrival of Greena Ecological Consultancy. The only confirmed roosting place of this bat was Menlo Castle, bat 7 visited maternity colony of Daubenton's bats located in the northern part of the castle for a single night in early September. Limited amount of data was therefore collected on Bat 7. It was recorded foraging in close vicinity of Menlo Castle, in Menlo Woods and in the area of Coolagh lakes.

**Bat 8**

Bat 8, female Daubenton's bat, was captured on the grounds of NUIG on 22nd August 2014. It was roosting in the maternity roost of Daubenton's bats in Menlo Castle and never changed the location of roost during the September radio-tracking study. It was recorded foraging along the River Corrib, mainly southwards from the roost, reaching Galway City centre but staying limited to the river.

**Bat 12**

Bat 12, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. Only limited amount of data was collected on Bat 12 because radio-transmitter got detached several days into the study. The foraging area of Bat 12 was very limited, spreading around Castlegar and field system in proximity of Cooper's Cave.

**Bat 13**

Bat 13, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in a house along the busy Headford Road, although returned to Cooper's Cave towards the end of the radio-tracking study conducted in September. The foraging area of Bat 13 was large, covering majority of the stretch of the River Corrib between the northern edge of Galway City and the southern shore of Lough Corrib, Menlough Village, Coolagh lakes and reaching east to Castlegar and Ballindooly.

**Bat 14**

Bat 14, female Lesser horseshoe bat, was captured from Menlo Castle maternity roost entrance on 1st September 2014. It did not change day roosting location throughout the duration of the September study. It was; however, recorded night roosting in Lackagh Quarry on regular basis, usually sharing the night roost with Bat 15. Foraging area of Bat 14 spread north reaching the southern shore of Lough Corrib, covering Menlough Village, Coolagh, Ballinfoyle and north part of Castlegar.

**Bat 15**

Bat 15, male Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in a house along the busy N84, although returned to Cooper's Cave towards the end of the radio-tracking study conducted in September. The foraging area of Bat 15 was limited to the field system in vicinity of Cooper's Cave and reaching north to Ballindooly, then west through Ballinfoyle and Coolagh to Menlo Woods and south of Menlough Village. Bat 15 regularly utilised a night roost in a quarry building in Lackagh Quarry.

**Bat 16**

Bat 16, male Natterer's bat, was captured in Menlo Woods on 1st September 2014. The bat was never located during the September radio-tracking study and it can be therefore concluded that it was an occasional visitor that never returned to the same area for the duration of the study or the radio-transmitter failed shortly after fitting.

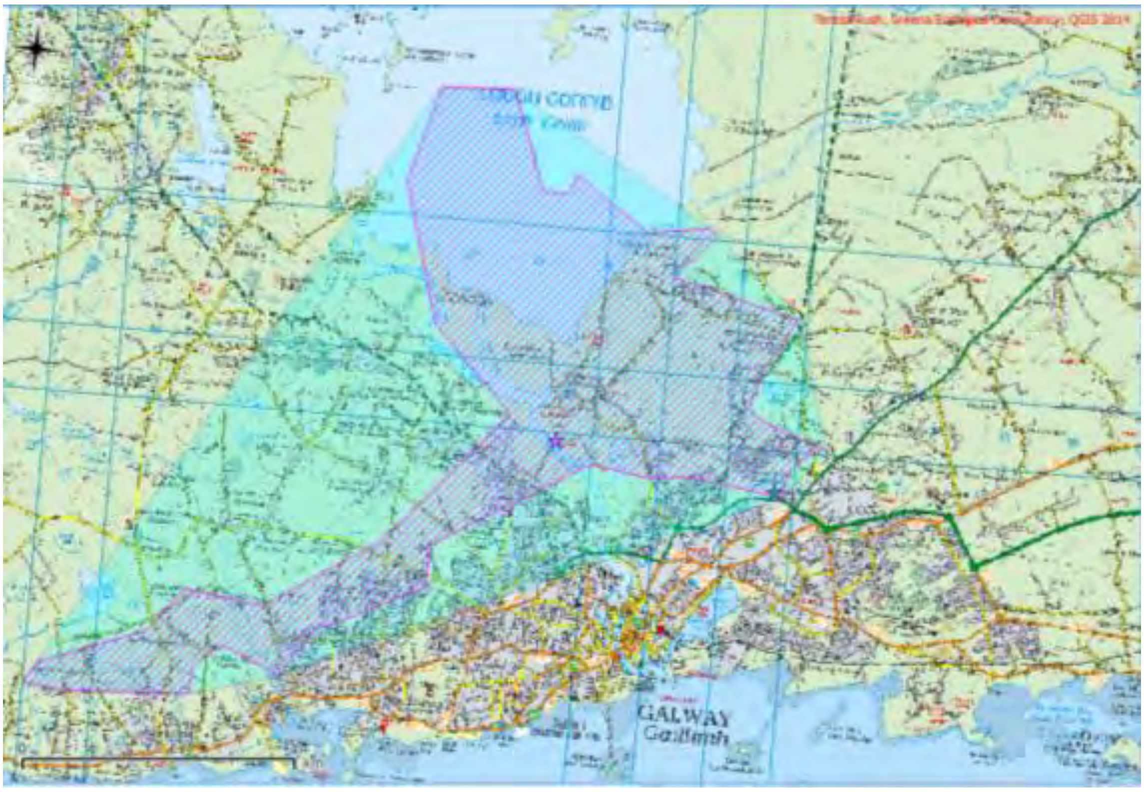
**Bat 17**

Bat 17, female Lesser horseshoe bat, was captured at Cooper's Cave entrance on 1st September 2014. It was regularly roosting in the maternity roost at Menlo Castle and is considered to be part of the maternity colony. Bat 17 utilised a large number of night roosts located in Menlough Village and Angliham Quarry as well as in Angliham. Cooper's Cave was also one of the confirmed night roosts of Bat 17. A large foraging area of this bat covered the limestone pavement between Ballindooly and Angliham Quarry as well as Menlo Woods, Lackagh Quarry, Ballinfoyle and field system in vicinity of Cooper's Cave.

Figures 55 and 56 overleaf show the combined overall foraging areas for all horseshoe bats in August and all bat species in September.

**Figure 55 Overall foraging area in August 2014**


**Figure 56 Overall foraging area in September 2014**



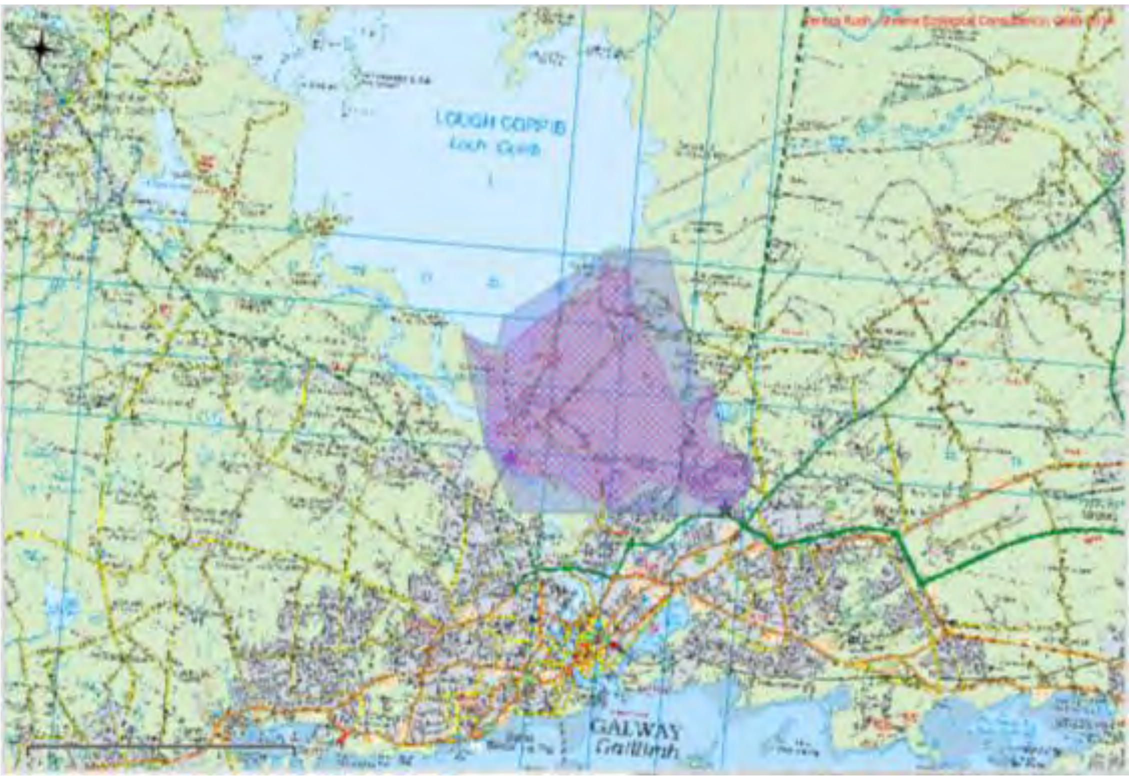
The overall foraging areas from both sessions overlapped in many places. The overall foraging area in August added up to 21.75km$^2$ (MCP) or 13.70km$^2$ (MLP), while it was 56.10km$^2$ (MCP) or 26.46km$^2$ (MLP) in September. Direct comparison of foraging areas in the August and the September session is not possible due to species variation. Comparison of foraging areas of Lesser horseshoe bats between August and September is shown in Figure 57.

**Figure 57 Overall August foraging area and September foraging area of Lesser horseshoe bats**

August MCP in solid yellow, August MLP in red vertical stripe, September MCP in solid pink, September MLP in horizontal blue stripe


Figure 58 overleaf shows the overlap of foraging areas in August and September for Lesser horseshoe bats. This area is crucial for the population of Lesser horseshoe bats in the Galway area because it is utilised during late maternity period in summer as well as for foraging in preparation for hibernation in late summer. The area of overlapping home-ranges of Lesser horseshoe bats from August and September measures 11.96sq.km (MCP) or 8.10sq.km (MLP).

**Figure 58 Overlap of foraging areas of Lesser horseshoe bats studied in August and in September 2014**



## *7.7 Summary of Results*

Greena Ecological Consultancy carried out two radio-tracking sessions in Galway in 2014, the first one commenced in late July and is referred to as the August session, the second one commenced in late August and is referred to as the September session.

Thirteen Lesser horseshoe bats were captured and fitted with radio-transmitters in the August session. In addition to that, Scott Cawley caught a male Leisler's bat and a male Daubenton's bat that were also tagged by Greena Ecological Consultancy but were not considered target species of the August session resulting in limited attention paid to them during night time radio-tracking. Out of all Lesser horseshoe bats tagged in August, ten were caught at Menlo Castle maternity roost (seven females and three males) and three were caught at Cooper's Cave (all males).

Vesper bats of five species – Whiskered bat, Leisler's bat, Daubenton's bat, Brown long eared bat and Common pipistrelle bat – were caught and fitted with radio-transmitters prior to the start of the September session. In addition to that, Greena Ecological Consultancy captured and tagged five Lesser horseshoe bats and one Natterer's bat. One female Lesser horseshoe was caught from the maternity roost at Menlo Castle, four remaining Lesser horseshoe bats (three males and one female) were caught by the entrance to Cooper's Cave. Natterer's bat was caught in Menlo Woods.

No juvenile or pregnant bats were subject to survey in either session carried out by Greena Ecological Consultancy.

Majority of foraging areas of Lesser horseshoe bats in August and in September overlapped in the area of Menlo castle, Menlo Woods, Menlough village, Coolagh, Castlegar in east and towards Angliham in the north. No foraging areas of Lesser horseshoe bats extended south towards Galway City.

The sample of vesper bats was not representative. Generally, Leisler's bat foraged in the south part of Lough Corrib and often utilised area of open water for foraging. Leisler's bats commuted relatively long distances from roost to foraging areas.

Daubenton's bats utilised the area of Menlo Wood and the immediate proximity of Menlo Castle. They were also recorded foraging along the River Corrib, with foraging areas and commuting routes extending south along to river to the city centre. The River Corrib forms an ideal bio-corridor in otherwise built up landscape affected by light pollution.

Only one Whiskered bat was radio-tracked. It foraged north and north-west of Bearna, opting for woodland and limestone pavement with scrub as a favourite foraging habitat.

Pipistrelle bats tagged by Geckoella in the second half of August could not be located and were therefore not subject to the radio-tracking studies.

One Natterer's bat was tagged in September but could not be located and is not included in the radio-tracking studies.

Six daytime roosts of Lesser horseshoe bats were identified during the August study, later two day roosts of Leisler's bat and one roost of Daubenton's bat were also identified as a part of the session.

Eleven night roosts of Lesser horseshoe bats were discovered in August.

Nine daytime roosts were identified in the September session of radio-tracking. These included roosts of Lesser horseshoe bats as well as vesper bats.

In the same session, eight further night roosts were discovered. Night roosts only relate to Lesser horseshoe bats, no night roosts of vesper bats was found.

Lesser horseshoe bat maximum foraging distance from the roost was 5.15km in August and 4.40km in September, with average maximum distances being approximately 2.93km and 3.39km, respectively.

Considering the proportion of the bat population monitored during the two radio-tracking sessions; it can be concluded that the area to the east of the River Corrib and north of Galway City is of high importance to commuting and foraging horseshoe bats and they use it on regular basis in summer.

Based on the results of the radio-tracking studies carried out in 2013, it can be concluded that both, Lesser horseshoe bat and vesper bat species utilize existing woodlands, field boundaries and watercourses for foraging and navigating. Areas of scrub on limestone pavement are often used as foraging areas for prolonged periods of time. Quarries in the Galway area are of particular importance to Lesser horseshoe bats.

Maternity roosts present at Menlo Castle has a strong link to roosting site at Cooper’s Cave; bats regularly commute between the roosts and have been confirmed to be a part of the same Lesser horseshoe bat population.

All evidence suggests that Cooper’s Cave is an important roosting site for males Lesser horseshoes in summer and an important mating site in the area. It would be beneficial if the site could be cleared under supervision and grilled to prevent access of general public in order to improve roosting and mating opportunities for the Galway Lesser horseshoe bat population.

## 8.0 Acknowledgements

Greena Ecological Consultancy would like to thank the following organisations and individuals for their help in the due course of this study:

- Scott Cawley Limited

- National Parks and Wildlife Service, Ireland

- Galway County Council

- Kate McAney for information on known local bat roosts.

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# Appendix G

## Galway City Transport Project – Bat Acoustic Surveys: Summer-Autumn 2014 (Geckoella Ltd., 2015a)

Consultants for ecology and geology

# Galway City Transport Project
# Bat Acoustic Surveys
# Summer-Autumn 2014

| | |
|---|---|
| Report date: | 30th November 2014 |
| Survey dates: | 12th August to 4th November 2014 |
| Commissioned by: | Scott Cawley Ltd. |
| Version: | Final Report – June 2015 |
| Authorised by: | Andy King |
| Report author: | Kate Jeffreys |
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## Summary

Geckoella Ltd. were commissioned by Scott Cawley Ltd. to carry out an acoustic bat survey to inform the Galway City Transport Project. The objectives of the survey were to establish the distribution of different species and gain indices of relative abundance of bats within the study area, as well as gathering information in particular on rare and notable species such as lesser horseshoe bat and Nathusius's pipistrelle bat. The static detectors were first deployed on 12th August 2014. In total, to 4th November, 266,539 identified bat passes have been collected across 24 sites. Sonogram analysis has recorded 7 species, with lesser horseshoe bats present at 14 sites (58%), and Nathusius's pipistrelle bat present at 20 sites (83%). There is a large variation in levels of bat activity between some of the sites. As expected based on their abundance elsewhere in Ireland and the UK, the majority of bat calls recorded are from Pipistrelle bat species, with soprano pipistrelles accounting for 221,301 (83%) of identified calls.

## Acknowledgements

We thank the following contributors to the acoustic surveys, analysis and presentation: Dr. Fiona Mathews, Helen Saunders, Jana Prapotnikova, Tim Clark and the teams at Arup (Galway) and Scott Cawley Ltd.

## Contents

# 1 Introduction

1.1 Galway City Transport Project requires environmental baseline information in the scheme study area as part of the constraints study for the project. Information on bats is being collected as part of this process in accordance with local and European guidance and legislation (Kelleher & Marnell, 2006). Geckoella Ltd. was contracted by Scott Cawley Ltd. to carry out an acoustic bat survey to contribute to this baseline environmental information. This report presents findings to 4th November 2014.

1.2 Geckoella, in association with EcoPro and the University of Exeter, supplied static bat detectors, provided technical support, and carried out and presented the results of acoustic analyses including this report. Scott Cawley Ltd. and Arup carried out field deployment of the static bat detectors.

## 2 Methodology

2.1 The study area includes Galway and surrounding urban-fringe and farmland habitat, and totals approximately 6,350ha as shown in Figure 1.

2.2 Twenty-four sites for static detector deployment were selected across the site by Scott Cawley Ltd. to survey the bat species present at different locations, as well as to collect comparative data on species richness and general levels of bat activity (Figure 1). The static detectors used were SM2 or SM2+ bat detectors made by Wildlife Acoustics. They were set to record in .wac[1] format from ½ hour before dusk to ½ hour after dawn using settings as set out in Appendix B to determine when the unit would be triggered to record a potential bat call. The type of microphone (SMUX) was used for all detectors and they had all been calibrated within the previous 6 months to ensure that detector sensitivity and data collection was similar for all data included within the analysis.

2.3 'Bat passes' for the purposes of this survey are defined as a triggered recording of 2 or more bat pulses in a continuous sequence (Bat Conservation Trust, 2012). A single sound file can have bat passes from more than one species as well as calls from more than one bat of the same species. 'Survey nights' comprise the period beginning 30 minutes prior to sunset, and ending 30 minutes after sunrise during which a detector was deployed and recording bats at a particular site. Dates in this report relate to the date on which a survey night started, so that, for example, 17th September denotes the period from before sunset on the 17th through to past dawn on 18th September.

2.4 The sound files collected were converted from .wac format to .wav and zero crossing for sound analysis within Kaleidoscope Pro (KPro) software. This software can automatically sort sound files that contain only non-bat 'noise' from sound files that contain bat passes. The software can also 'tag' each call with a potential identification, according to similarities in call shape to archetypal call clusters within the database. This approach allows identification to genus level for *Myotis* species, and to species level for other bats found in Ireland[2]. Separation of *Myotis* species is complicated by the high degree of overlap between call characteristics. Appendix B summarises the accuracy levels of the sound analysis carried out both manually and through automatic classification for each species.

2.5 The call analysis was carried out using KPro by Mrs Kate Jeffreys MCIEEM CEnv, Ms Jana Prapotnikova MCIEEM and Mr Tim Clark GCIEEM with Dr. Fiona Mathews of Exeter University carrying out Quality Assurance (QA) for the data. This team is very experienced in the use of acoustic survey techniques for bats and has worked together, sharing files and experience in order to ensure consistency between analysis.

2.6 For species other than common or soprano pipistrelle, the tags were then checked and confirmed or corrected manually since automatic classification is not yet accurate enough to rely upon in isolation for most species (Waters & Barlow, 2013). The manual identification was carried out by comparison with call parameters as set out in Russ (2012) and Middleton et al. (2014). A quality assurance check by Dr Fiona Mathews of 3,540 calls found that the overall accuracy rate for manual identification of species

[1] .wac is a format for sound files developed by [Wildlife Acoustics]

[2] The calls of different species of *Myotis* bats have overlapping parameters and hence resolution to species level is usually to a lower level of confidence as compared to other genus. *Myotis* calls were identified to genus level only to ensure a consistency of confidence across the analysis.

was 97.3% (Appendix B).

2.7 A mix of automated and manual identification was adopted for common and soprano pipistrelle bats. Files tagged as common or soprano pipistrelle during session 1 (12th August to 14th September) were checked manually and subject to quality assurance as set out above.

2.8 Passes tagged by KPro as either common or soprano pipistrelle bats from 15th September to 4th November were not checked manually in order to streamline the analysis of the other bat calls. The accuracy rate for KPro for these 2 species for this study has been calculated as 99% and 94% respectively. Where KPro made a mistake, passes wrongly identified as soprano pipistrelle were most likely to be common pipistrelle, and *vice versa*. All other passes were checked manually. Appendix B sets out the detail.

2.9 Where identified manually, in some cases, separation between common and soprano pipistrelle was not possible, due to maximum peak energy of the lowest frequency call in a series being between 49.95 and 50.14 kHz. In these cases, calls were ascribed to Pipistrellus spp. (PIPI-PIPY).

2.10 The survey period ran from 12th August to 4th November. The survey period has been split into three separate sessions as described in Table 1. Dates within each session have broadly comparable night periods and represent broadly equivalent stages in terms of the seasonal changes that bats undergo. These sessions run inclusively from 12th August to 14th September, 15th September to 12th October, and 13th October to 4th November. Graphs and tables within this report indicate the number of survey nights recorded by each detector within each survey session as 'n' (sample size) as set out below in Table 1. The number of nights worth of data included for analysis (n) varied between sites and sessions. This reflects differences in deployment dates. In addition, any data collected under non-optimum conditions, for example with regard to equipment performance, was excluded. This ensured that the data included within the analysis was comparable between sites.

***Table 1 Bat acoustic survey dates for each site***

| Session / Site | 12Aug-14Sep (34 nights) | 15Sep-12Oct (28 nights) | 13Oct-3Nov (22 nights) | All |
|---|---|---|---|---|
| **S01** | 24 | 28 | 21 | 73 |
| **S02** | 14 | 28 | 21 | 63 |
| **S03** | 24 | 28 | 0 | 52 |
| **S04** | 31 | 28 | 21 | 80 |
| **S05** | 0 | 21 | 21 | 42 |
| **S06** | 0 | 14 | 21 | 35 |
| **S07** | 20 | 21 | 14 | 55 |
| **S08** | 26 | 25 | 14 | 65 |
| **S09** | 7 | 28 | 22 | 57 |
| **S10** | 28 | 28 | 21 | 77 |
| **S11** | 28 | 28 | 22 | 78 |
| **S12** | 34 | 28 | 21 | 83 |
| **S13** | 31 | 28 | 22 | 81 |
| **S14** | 14 | 28 | 22 | 64 |
| **S15** | 24 | 28 | 21 | 73 |
| **S16** | 34 | 28 | 21 | 83 |

| Site | Session 12Aug-14Sep (34 nights) | 15Sep-12Oct (28 nights) | 13Oct-3Nov (22 nights) | All |
|---|---|---|---|---|
| **S17** | 34 | 28 | 22 | 84 |
| **S18** | 7 | 28 | 22 | 57 |
| **S19** | 7 | 28 | 22 | 57 |
| **S20** | 33 | 28 | 21 | 82 |
| **S21** | 34 | 28 | 21 | 83 |
| **S22** | 0 | 21 | 21 | 42 |
| **S23** | 7 | 28 | 0 | 35 |
| **S24** | 7 | 24 | 21 | 52 |

2.11 Overall, the weather from 12th August to 4th November was similar to other years, and therefore suitable for collecting baseline data on bats in the Galway area. Appendix A provides more detail, with sub-optimal conditions for bat survey highlighted. Sub-optimal conditions for bat surveys are broadly described in BCT (2012). For the purposes of this study, they are definedby temperatures of less than $10^0$ C, wind speeds equivalent to Beaufort score of 5 or more (fresh breeze), and/or significant rainfall. Out of 84 survey nights, the weather was sub-optimal on 3 nights during the Aug-Sep session, 6 nights for the Sep-Oct session, and 4 nights for the Oct-Nov session.

2.12 The standardised settings, units and approach across the 24 sites in the study area, combined with careful attention paid to appropriate siting and deployment to maximise calls collected for each site, allows for comparison of the species recorded and the general bat activity levels between different sites. This takes into account the limitations as well as the advantages in acoustic bat survey techniques (Weller, 2007; Sowler & Middleton, 2013; Stahlschmidt & Brühl, 2012). The data from some sites on some dates could not be included in the comparative analysis of bat activity levels because the static detectors, on post-deloyment testing, were found to be not collecting data as effectively as other detectors . All species records contributed to overall species richness scores for different sites. Appendix B describes which sites contributed to which set of results on which dates. Figures and graphs include 'n' for sample size for each static. This gives the number of survey nights within each session that contributed to the data.

2.13 Acoustic surveys have inherent species-specific bias. For example, quiet bats such as brown long-eared bats may only be recorded if they pass close to the bat detector. The calls of horseshoe bats are not only quiet but also highly directional, further decreasing the probability of detection. Meanwhile, loud bats such as Leisler's may be recorded at some distance. For this reason, the number of calls of different species may not be indicative of relative abundance of those species at a single site.

2.14 The following measures are presented in the results:

- Species richness (Table 2)
- Relative levels and ranges of bat activity between different sites, and between different survey sessions (Figures 2A-2C)
- Relative levels of bat activity for different bat species between different sites, and between different survey sessions (Figures 3A-C, Figures 4A-C)
- Map showing relative levels of lesser horseshoe and Nathusius's pipistrelle bats at different sites (Figures 5A-B)

2.15 The following species abbreviations are used in this report:

| | |
|---|---|
| MYsp | a bat of the genus *Myotis* |
| NYLE | *Nyctalus leisleri* Leisler's bat |
| PLAUR | *Plecotus auritus* brown long-eared bat |
| PINA | *Pipistrellus nathusii* Nathusius's pipistrelle |
| PIPI | *Pipistrellus pipistrellus* common pipistrelle |
| PIPY | *Pipistrellus pygmaeus* soprano pipistrelle |
| PIPI-PIPY | a bat which is either PIPI or PIPY (call character does not allow further resolution) |
| RHHI | *Rhinolophus hipposideros* lesser horseshoe bat |

***Limitations to survey***

2.16 Data from survey-nights that last different lengths of time, have different weather, or are at a different time of year to each other may not be directly comparable since all these factors affect bat behaviour. The limitations that this introduces into the dataset in terms of making comparisons between sites was minimised by splitting the overall survey period into three survey sessions. The dates within each session would be sufficiently similar in night length and season to enable comparison. The number of survey nights within each session was maximised where practical, to reduce variation in the dataset due to changes in the weather, and to improve confidence in average values. A minimum of 7 nights per site was used for all comparisons in this report; usually much more data than this was collected. Table 1 gives the number of survey nights in each session for each detector.

2.17 Inter-site variation in the effectiveness of each bat detector was reduced through the standardisation of settings for data collection and analysis, and through chosing the best location for bats in each setting, to maximum the number of passes and species recorded. Detectors and the data they collected were checked weekly. Any data potentially compromised through equipment failure or other reasons was excluded from the comparative analysis. However, all bat passes contributed to species-richness counts for particular sites, because a 'positive' record is valid, even if the detector is not collecting data at its maximum potential.

# 3 Results

### *Species Richness*

3.1 Table 2 lists the species recorded at each site surveyed between 19th and 29th August. This shows that 9 sites had 7 species, 8 sites had 6 species, and 5 sites had 5 species recorded.

3.2 *Myotis*, Leisler's and common and soprano pipistrelle bats were recorded at every site. Brown long-eared bat was recorded at 18 sites (75%), but this common bat may be under-recorded due to its quiet calls. Lesser horseshoe bats were recorded at the fewest number of sites (14, 58%).

***Table 2. Species recorded at sites across Galway City***

| Site | n | MYsp | NYLE | PINA | PIPI | PIPY | PLAUR | RHHI | Total species |
|---|---|---|---|---|---|---|---|---|---|
| **S01** | 73 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S02** | 63 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S03** | 52 | Y | Y | N | Y | Y | Y | N | 5 |
| **S04** | 80 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S05** | 42 | Y | Y | Y | Y | Y | N | Y | 6 |
| **S06** | 35 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S07** | 55 | Y | Y | Y | Y | Y | Y | N | 6 |
| **S08** | 65 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S09** | 57 | Y | Y | Y | Y | Y | Y | N | 6 |
| **S10** | 77 | Y | Y | N | Y | Y | N | Y | 5 |
| **S11** | 78 | Y | Y | N | Y | Y | Y | Y | 6 |
| **S12** | 83 | Y | Y | Y | Y | Y | N | N | 5 |
| **S13** | 81 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S14** | 64 | Y | Y | Y | Y | Y | Y | N | 6 |
| **S15** | 73 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S16** | 83 | Y | Y | Y | Y | Y | Y | N | 6 |
| **S17** | 84 | Y | Y | Y | Y | Y | Y | N | 6 |
| **S18** | 57 | Y | Y | N | Y | Y | Y | N | 5 |
| **S19** | 57 | Y | Y | Y | Y | Y | N | Y | 6 |
| **S20** | 82 | Y | Y | Y | Y | Y | N | N | 5 |
| **S21** | 83 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S22** | 42 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **S23** | 35 | Y | Y | Y | Y | Y | N | N | 5 |
| **S24** | 52 | Y | Y | Y | Y | Y | Y | Y | 7 |
| **Total** | | 24 | 24 | 20 | 24 | 24 | 18 | 14 | |

***Bat Activity***

3.3 Figures 2A-2C show the average number of bat passes per site for each of the three sessions (Aug-Sep, Sep-Oct, Oct-Nov), as well as the inter-quartile and the full range of bat passes for each site. This illustrates the variation in bat passes between different nights at the same site, as well as general variation between different sites.

3.4 Box plots are created from a set of five numbers: the median, the 25th percentile or lower quartile, the 75th percentile or upper quartile, the minimum data value, and the maximum data value. The horizontal line in the middle of the box is the median of the measured values, the upper and lower sides of the box are the upper and lower quartiles, and the bars at the end of the vertical lines are the data minimum and maximum values.

3.5 Figures 2A-C show that some sites had generally more calls than other sites. For example, S06, S08, S20 and S21 have higher numbers of calls more often than other sites such as S09, S15 or S18. These sites often had occasional nights with very large numbers of calls, with S03, S06, S08, and S20 all having nights with over 2,000 bat passes.

***Species breakdown by site for each session***

3.6 Soprano pipistrelle bats were by far the most common species recorded, with 221,301(83%) of identified calls. Figures 3A-C show the number of common and soprano pipistrelle bat passes recorded on average per night for each site for each of the 3 sessions.

3.7 Site S06 had the highest average number of soprano pipistrelle calls. This in part is derived from occasional nights with extremely high numbers of calls as described in 3.5 above. Site S20 had the largest average number of common pipistrelle calls per night. S03 and S14 also had relatively higher levels of common pipistrelle activity.

3.8 Figures 4A-C show the number of bat passes for species other than soprano or common pipistrelle recorded on average per night for each site for each of the 3 sessions. This shows that S06 and S21 had regular activity from a range of species other than common and soprano pipistrelle bat. Conversely, sites S10 and S23 had relatively low levels of bat activity for these other species.

3.9 Rare and notable species comprise lesser horseshoe and Nathusius's pipistrelle bat. Figures 5A and 5B map the average number of passes per site for these two species, showing where these bats were most regularly recorded. Sites S6, S5 and S21 had the most lesser horseshoe bat records. Site with higher numbers of Nathusius's pipistrelle bat calls included S20, S16, S21 and S06. However, the species was also occasionally recorded at other sites across the proposed scheme area.

## 4 Discussion and Analysis of Results

4.1 Figure 1 shows the location of static detectors across the proposed scheme area. Comparing these with the graphs of relative activity (2A-C, 3A-C, 4A-C) suggests that sites close to the River Corrib have both high levels or bat acitivity, and a wide range of species. Figure 5B suggests that the River Corrib is of particular importance also for Nathusius's pipistrelle bat, although this species was also recorded away from the river.

4.2 There is a known maternity roost for lesser horseshoe bats at Menlo Castle. Sites close to this roost recorded relatively higher numbers of calls for this species (e.g. S06, S21, S05). A static at S02 picked up more lesser horseshoe calls per night in Oct-Nov than during the other survey sessions. This may possibly reflect a seasonal change in behaviour.

4.3 S20 regularly recorded the highest levels of activity and the widest range of species (with the exception of lesser horseshoe bat). The location within a 'green corridor' surrounded by the expanding city of Galway may well be of significance and worthy of further investigation.

4.4 Brown long-eared bats are common, but were not regularly recorded during the survey. This may be because they have relatively quiet calls, leading to under-recording. Sites which tended to have a higher average number of brown long-eared calls per night included S21, S15 and S4

4.5 *Myotis* bats were found across the proposed scheme area. S07 regularly had higher rates of *Myotis* passes than some of the other sites. S07 is located close to a known roost for Daubenton bats *Myotis daubentonii* (Geckoella, 2014). The relatively high numbers of *Myotis* calls at S14 may be indicative of a nearby roost. S21 also had a lot of *Myotis* calls, as well as calls of a range of other species indicating an important area for bats.

# 5 Bibliography

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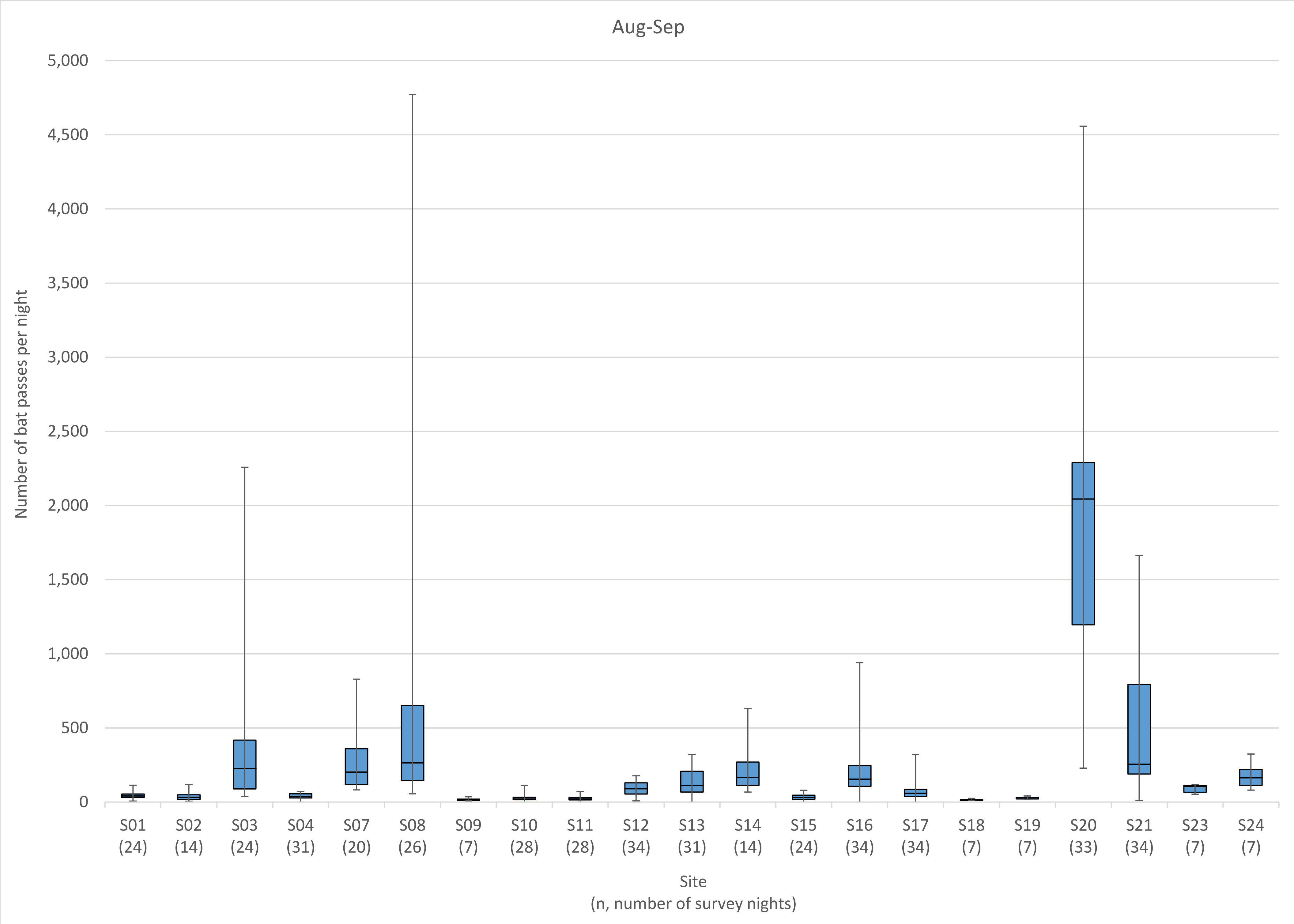
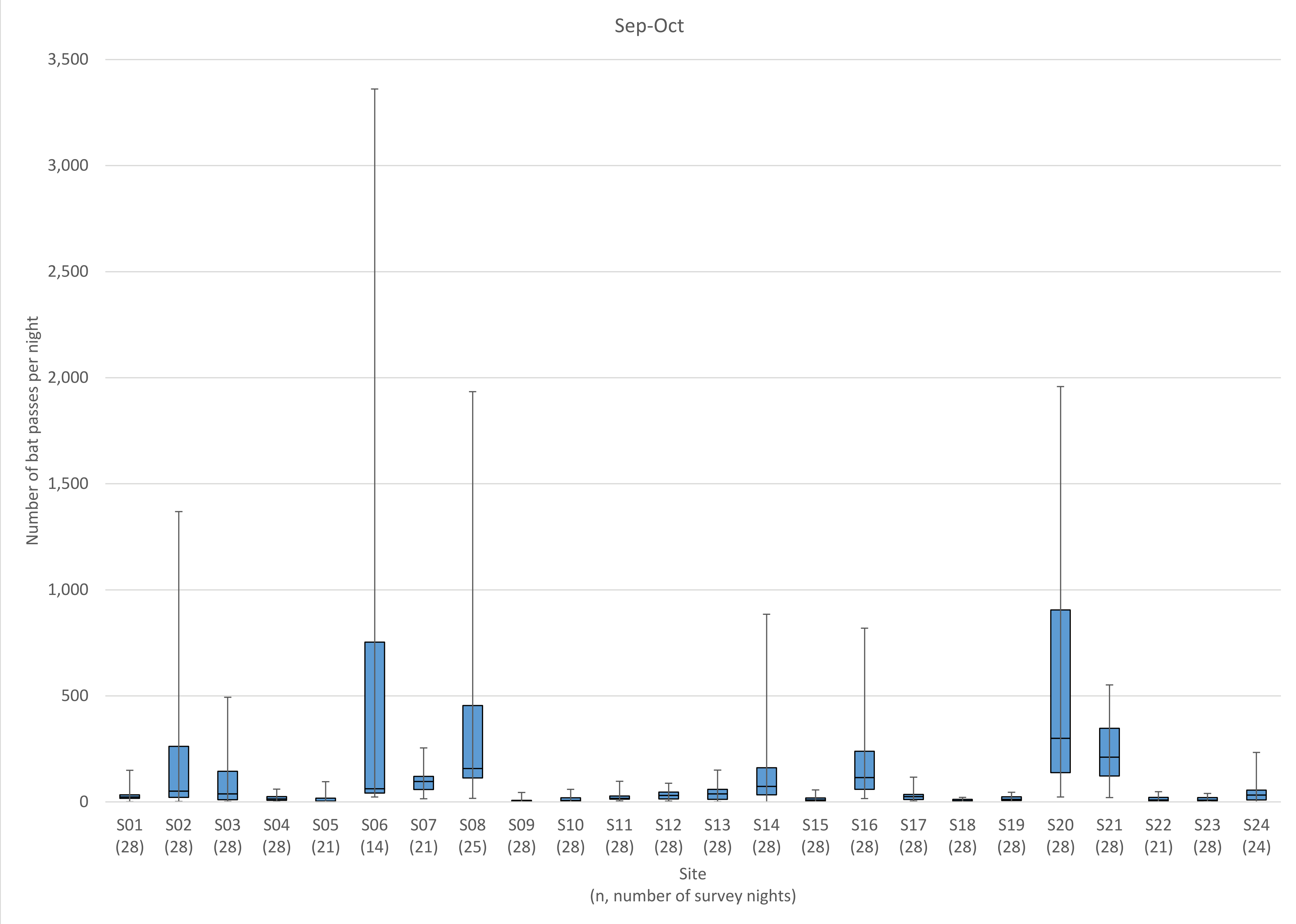
# Figure 1. Proposed Scheme Area and acoustic bat detector sites

Figure 2A Box plot showing bat passes per site



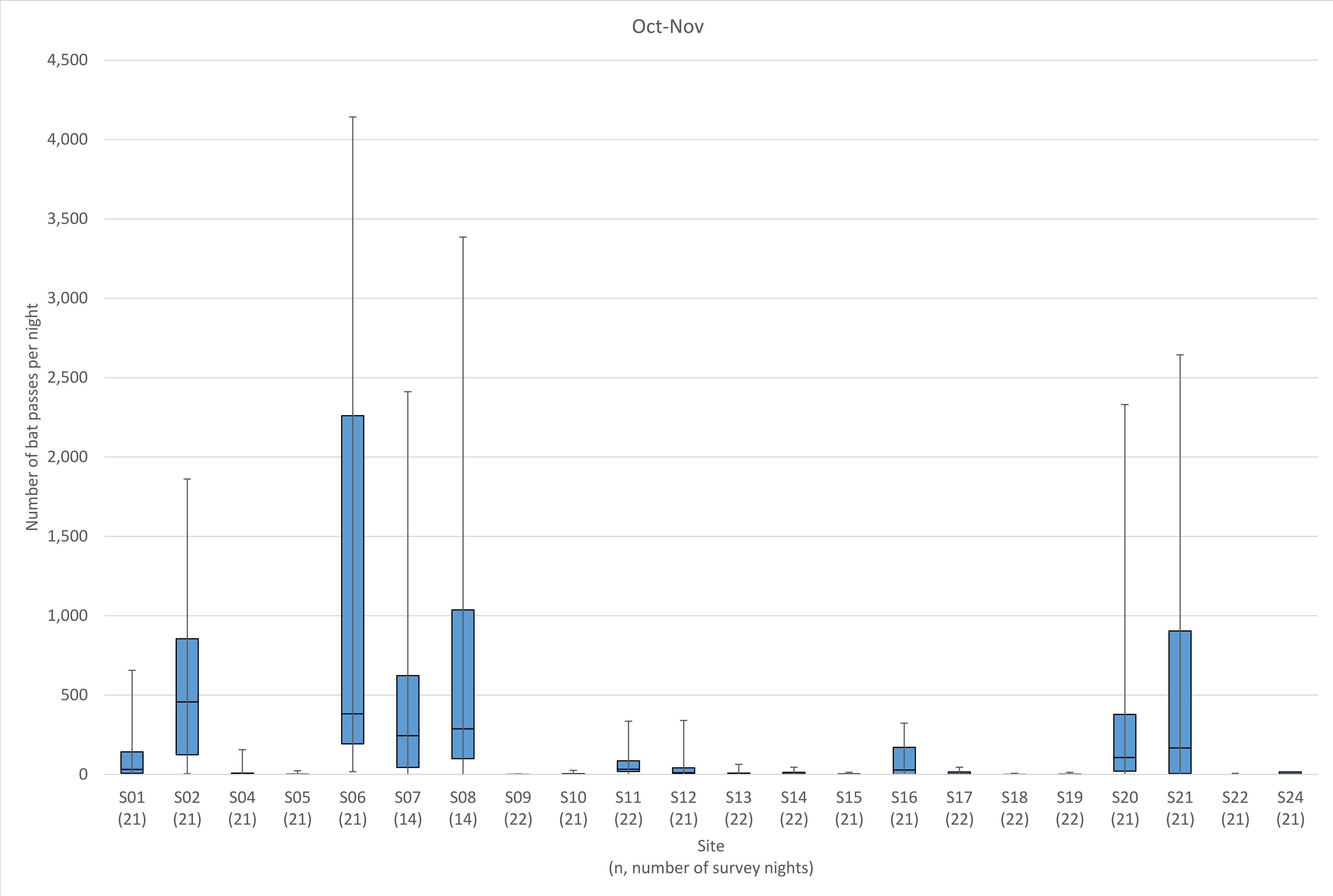

The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 2B Box plot showing bat passes per site




The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 2C Box plot showing bat passes per site




The box illustrates the median and inter-quartile rage; the vertical line shows the full range of the data.

Figure 3A Average numbers of common or soprano bat passes per site

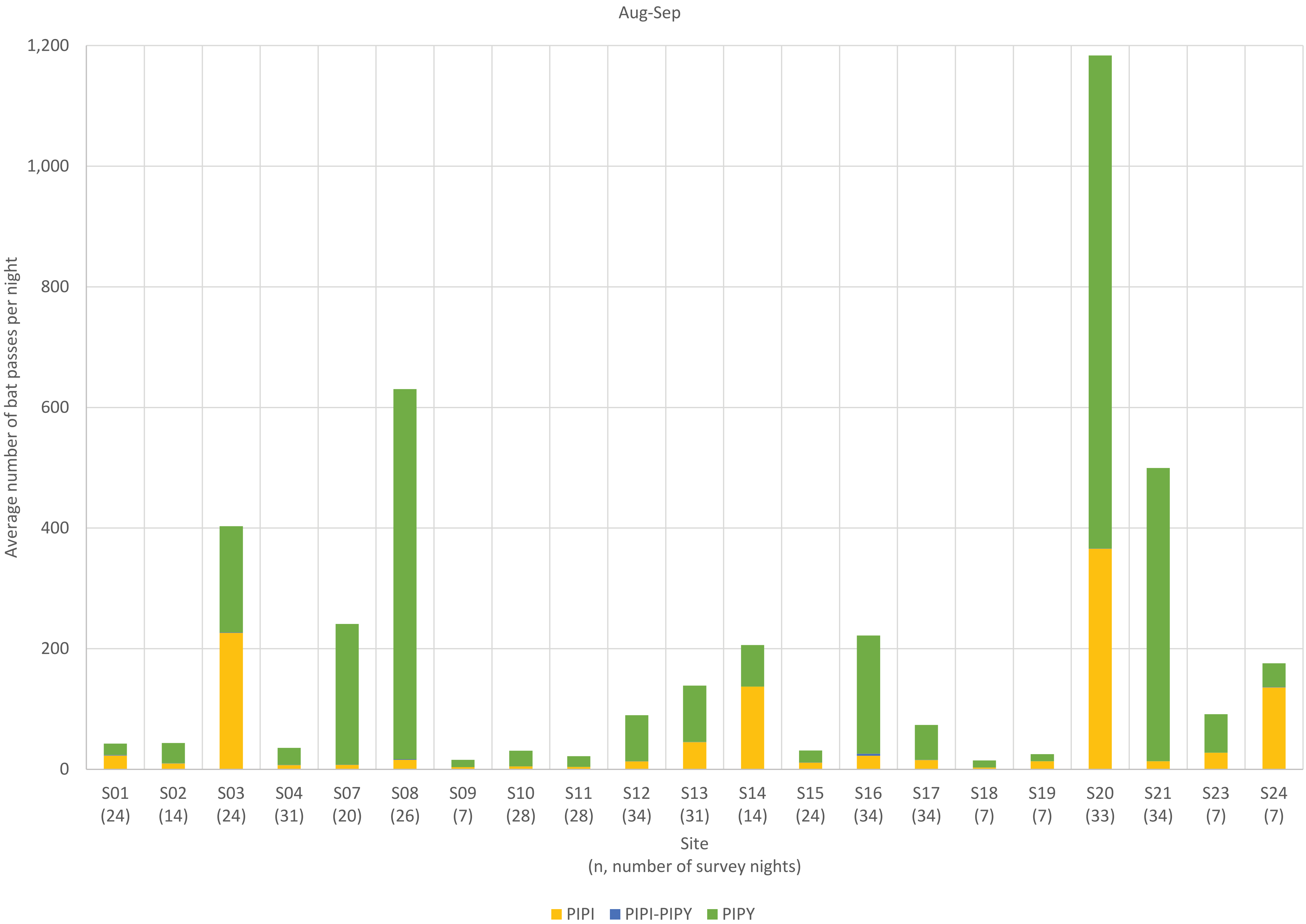


Figure 3B Average numbers of common or soprano pipistrelle bat passes per site

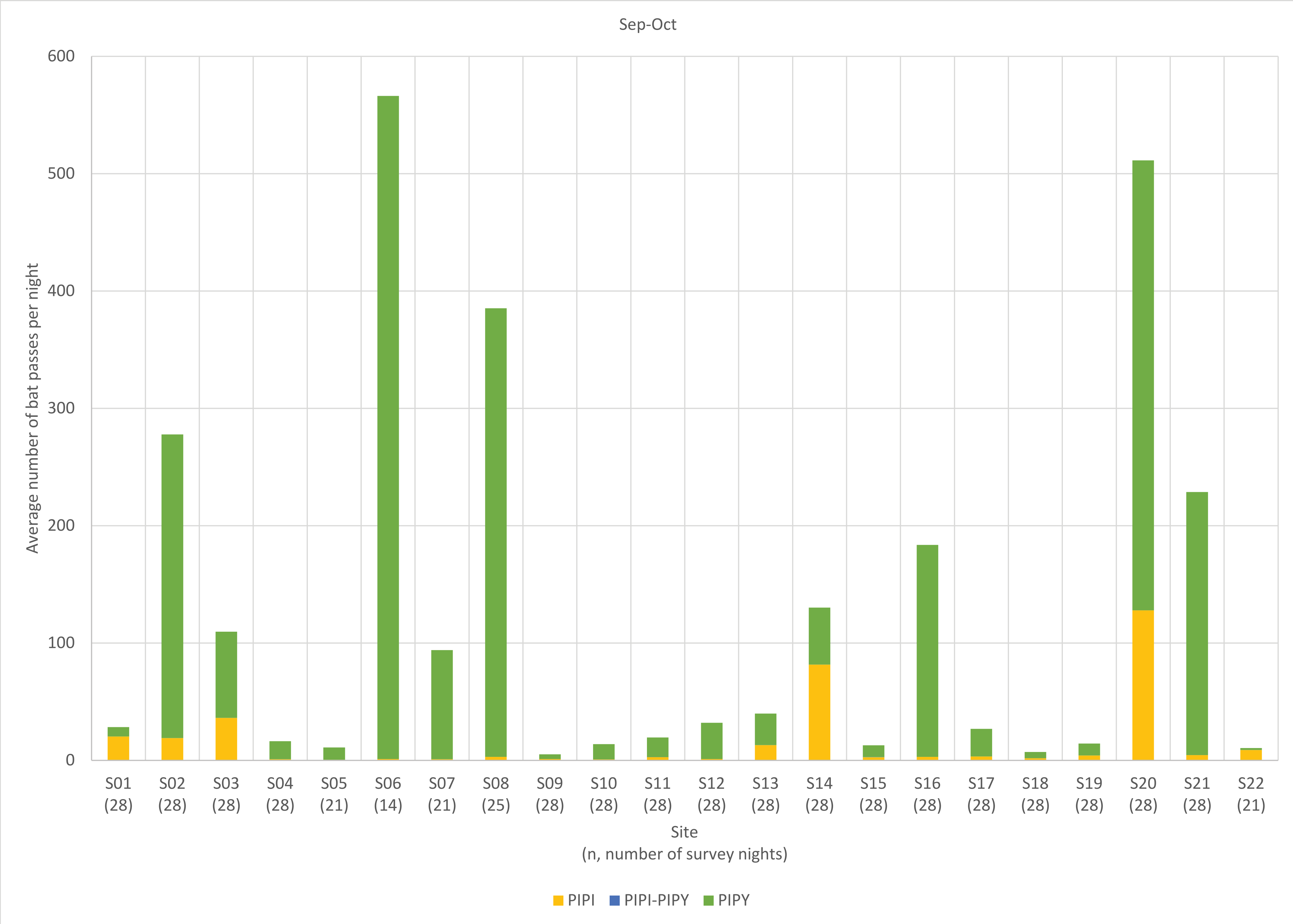


Figure 3C Average numbers of common or soprano pipistrelle bat passes per site

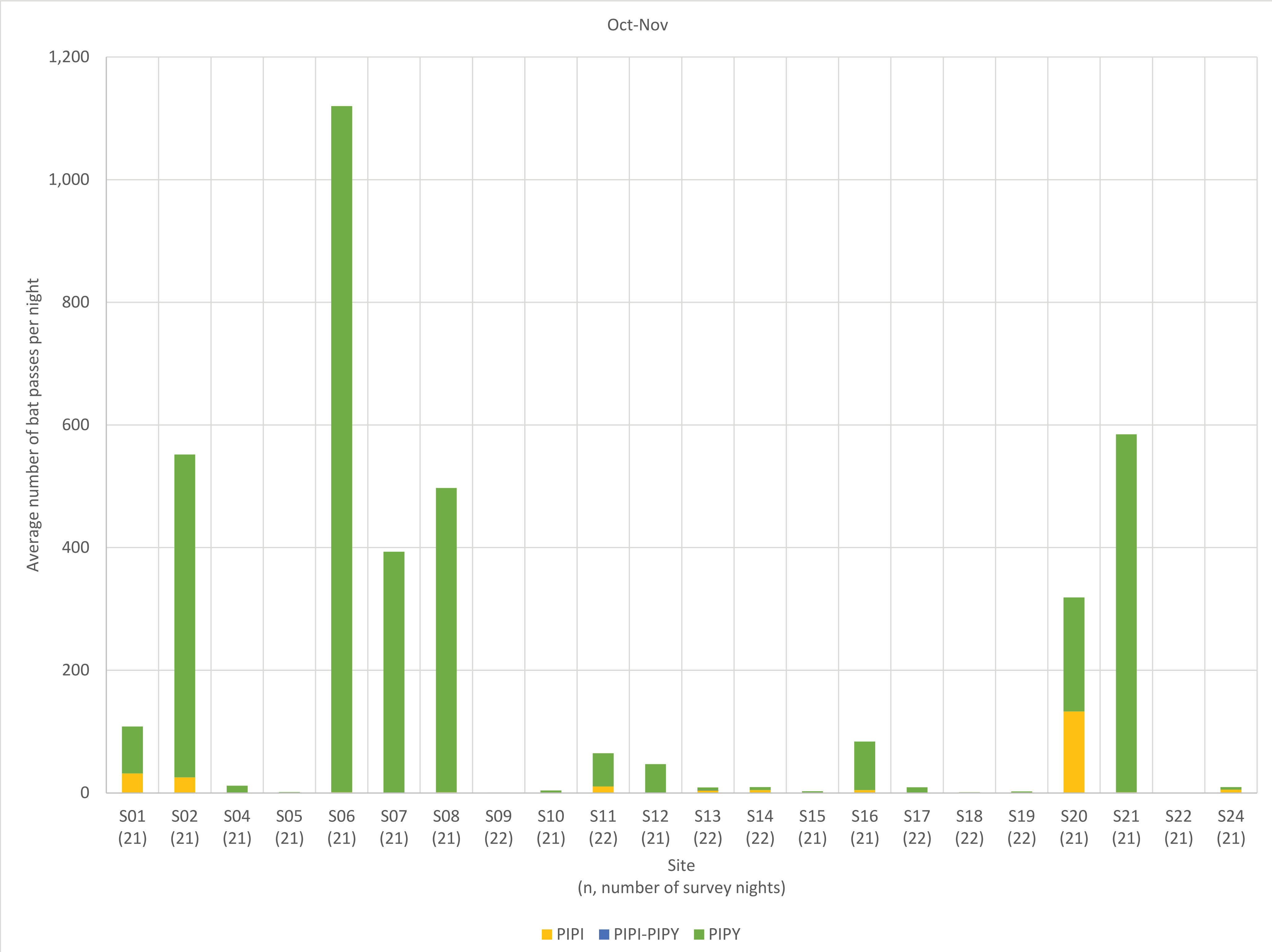


Figure 4A Average numbers of other bat passes per site

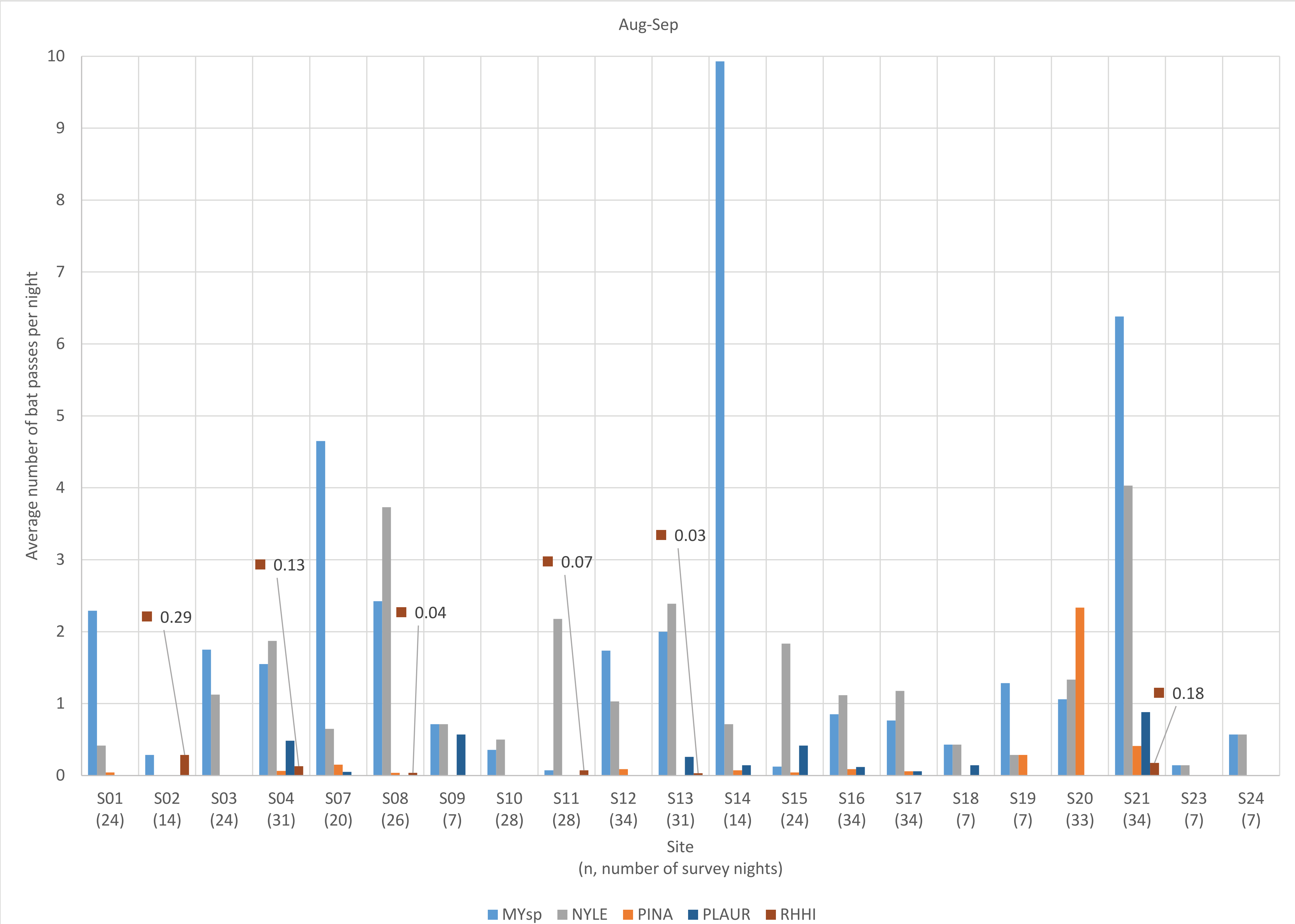


Figure 4B Average numbers of other bat passes per site

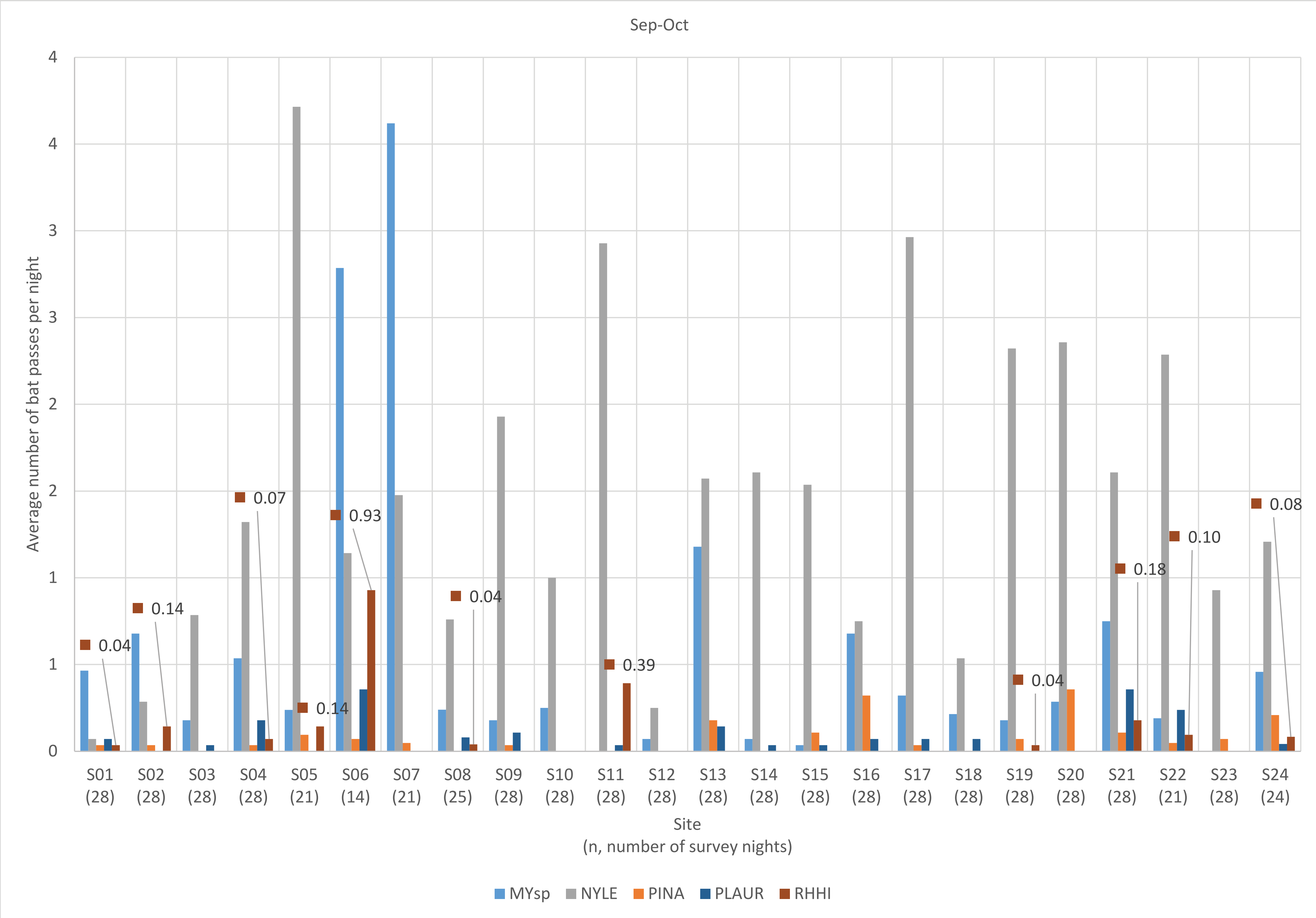
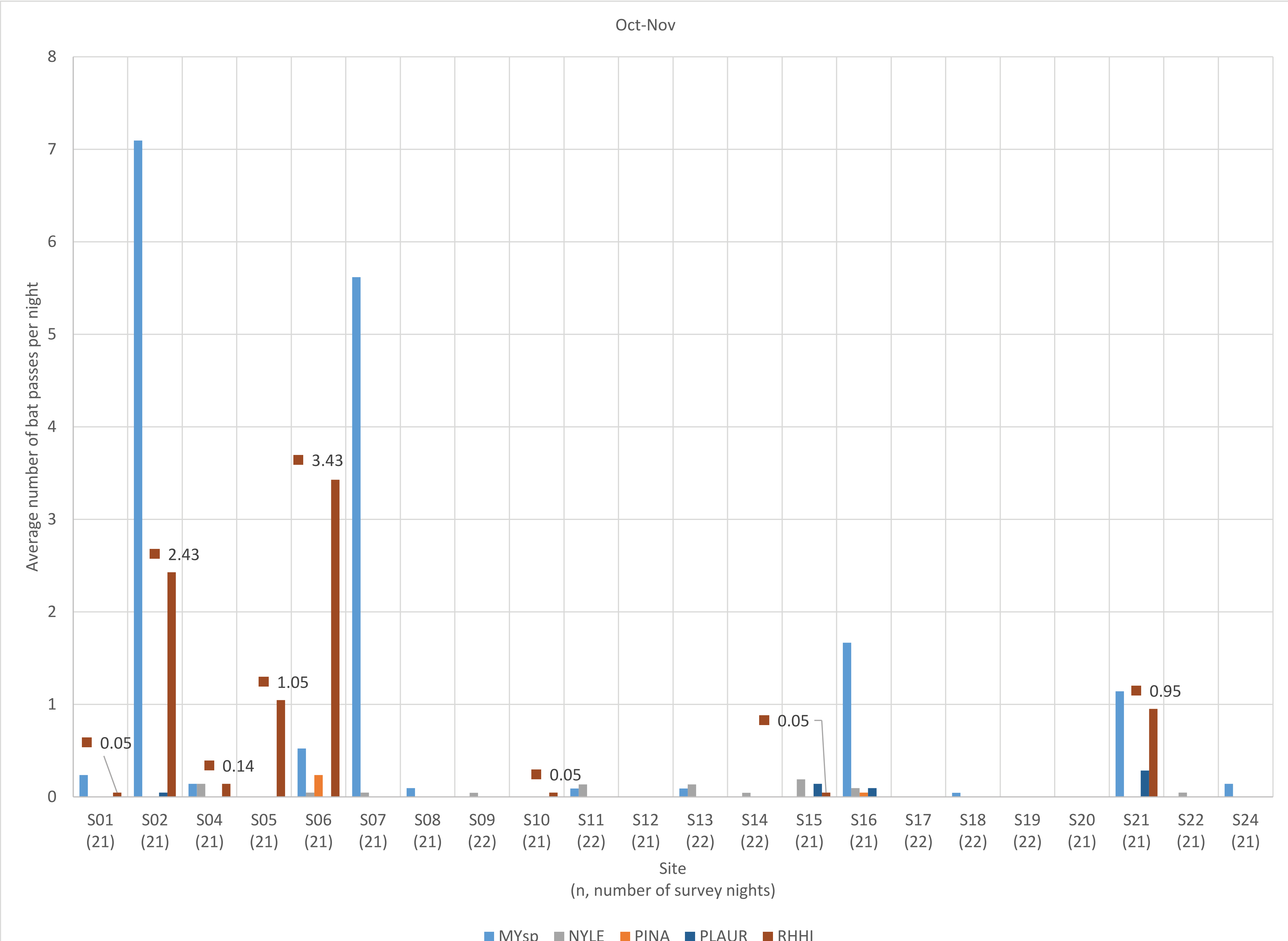
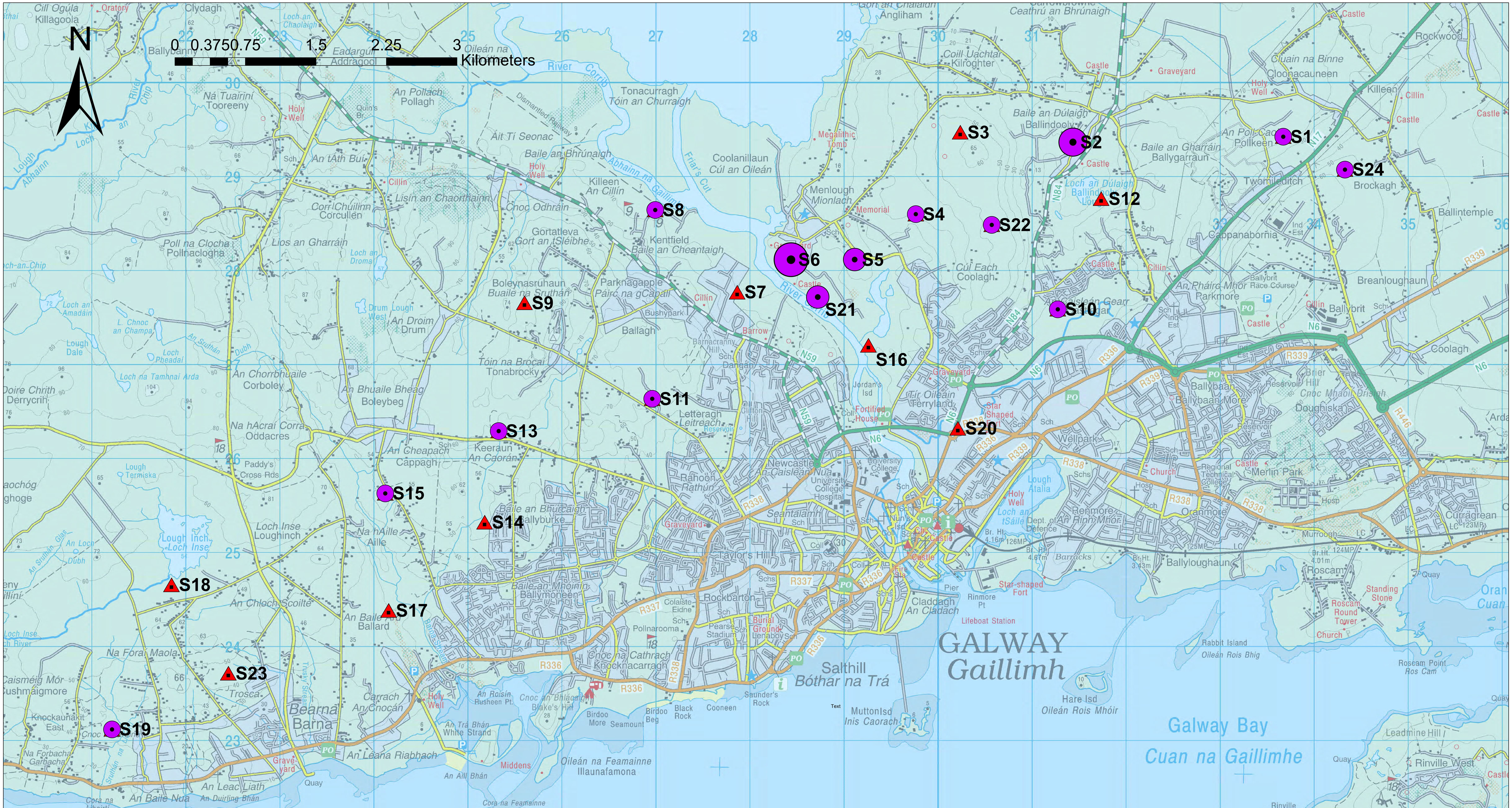


Figure 4C Average numbers of other bat passes per site



# Figure 5a. Map: Lesser horseshoe bat passes per night at each site




## Key

Statics where Lesser Horseshoe Bats detected

Site of Other Static Bat Detector

**Mean No. of Passes per Night**

Less than 0.17

0.17 to 0.60

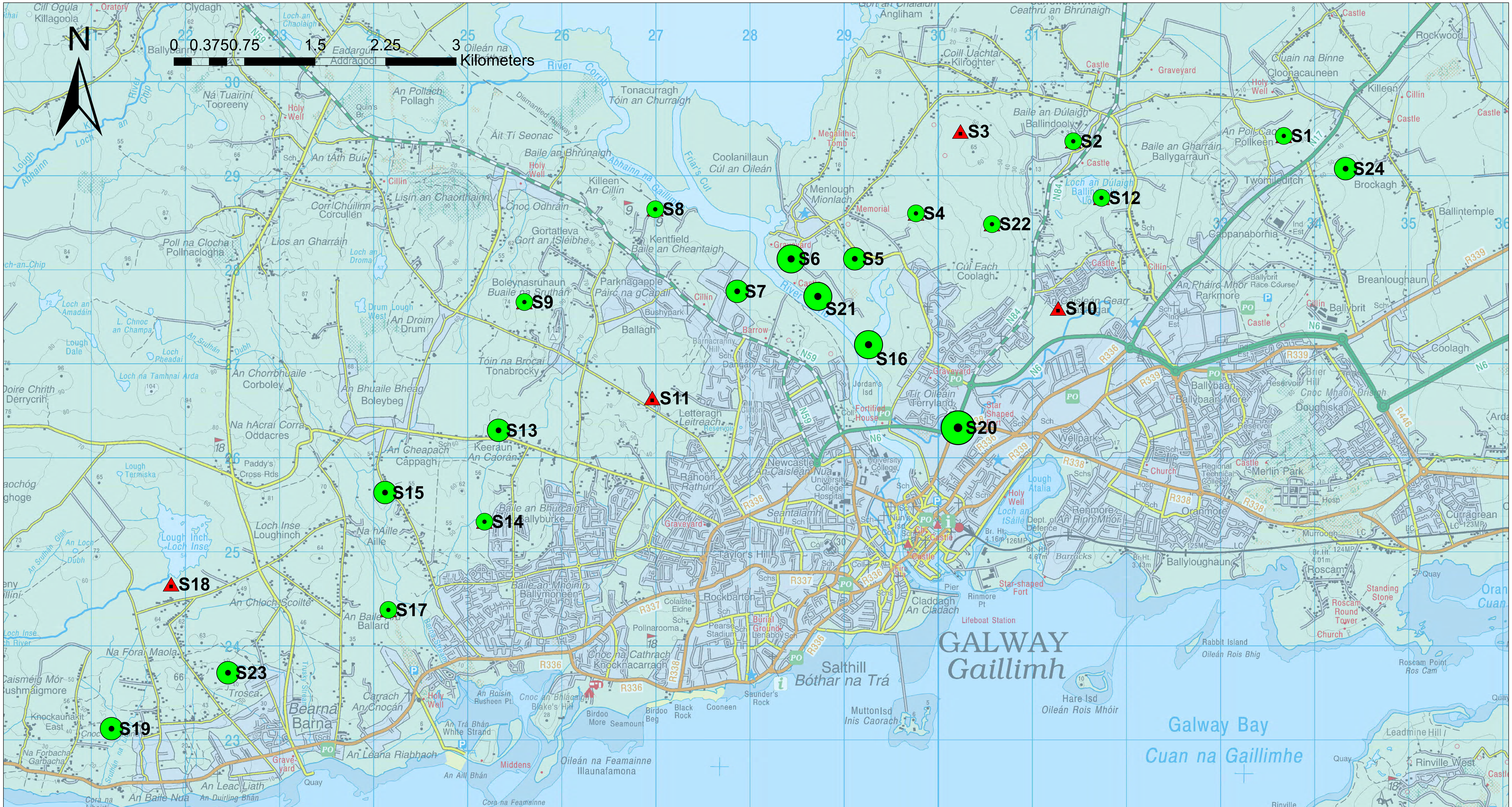
0.61 to 0.94

More than 0.94

Ecology and Geology

Values provided are mean average bat passes per survey nights.
Surveys took place between 12th August and 4th November.
(Number of survey nights varied between sites, see Figures 2A-C and Appendix B).

# Figure 5b. Map: Nathusius's pipistrelle bat passes per night at each site




## Key

Statics where Nathusius's Pipistrelles detected

Site of Other Static Bat Detector

**Mean No. of Passes per Night**

- Less than 0.04
- 0.04 to 0.10
- 0.11 to 0.20
- More than 0.20

Values provided are mean average bat passes per survey nights.
Surveys took place between 12th August and 4th November.
(Number of survey nights varied between sites, see Figures 2A-C and Appendix B).

Ecology and Geology

# Appendix A: Bat acoustic survey session dates and weather

The weather from August – November 2014 was broadly typical for Galway and did not pose a significant constraint to survey. Warm, humid, calm weather is good for flying invertebrates and hence good for bat foraging. Data highlighted in blue represents sub-optimal conditions, comprising temperatures of less than 10ºC, wind speeds equivalent to Beaufort score of 5 or more (Fresh breeze), and/or significant rainfall.

| AUGUST - SEPTEMBER | | | | | | |
|---|---|---|---|---|---|---|
| S | M | T | W | T | F | S |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | | | | | | |

34 nights

3 sub-optimal

| SEPTEMBER - OCTOBER | | | | | | |
|---|---|---|---|---|---|---|
| S | M | T | W | T | F | S |
| | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | | | | | | |

28 nights

6 sub-optimal

| OCTOBER - NOVEMBER | | | | | | |
|---|---|---|---|---|---|---|
| S | M | T | W | T | F | S |
| | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | 31 | 1 |
| 2 | 3 | 4 | | | | |

22 nights

4 sub-optimal

Survey nights' run from dusk til dawn, whereas the weather data represents 24hr periods from midnight til midnight. None-the-less this data gives an indication of general weather conditions at the time of survey.

Data on General Weather during 24hr period produced under license from Weather Underground.

http://www.wunderground.com/personal-weather-station/dashboard?ID=ICOGALWA2#history/s20140805/e20140812/mweek

Weather Station ID: ICOGALWA2. Station Name: Oranmore
Latitude / Longitude: N 53 ° 16 ' 28 '', W 8 ° 55 ' 45 '', Elevation: 0. City: Oranmore, State: Co.Galway
Hardware: Davis VP2(24h FARS), Software: meteohub, Owner: Private

## Details of static acoustic bat detector deployment location and dates

| Site | Serial number | Model | Microphone | Date deployment | Date collection | Easting | Northing | Habitat | Picture ref |
|---|---|---|---|---|---|---|---|---|---|
| **S01** | G14373 | SM2BAT+ | SMX-US | 15/08/2014 | 03/11/2014 | 533677 | 729426 | Woodland edge, Hawthorn | 100-0062 |
| **S02** | 10495 | SM2BAT+ | SMX-US | 12/08/2014 | 03/11/2014 | 531440 | 729368 | Woodland edge, field boundary | S2.jpg |
| **S03** | 13775 | SM2BAT+ | SMX-US | 15/08/2014 | 03/11/2014 | 530241 | 729475 | Hedgerow adjacent to limestone pavement, Ash tree | 100-0063 |
| **S04** | 6810 | SM2BAT | SMX-US | 15/08/2014 | 03/11/2014 | 529768 | 728602 | Hedgerow, woodlan edge, Hazel tree | 100-0060 |
| **S05** | 6364 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 529118 | 728118 | Edge of woodland, on tree beside grassland | S5.jpg |
| **S06** | 6337 | SM2BAT | SMX-US | 15/08/2014 | 29/09/2014 | 528441 | 728118 | Woodland edge, Ash tree | 100-0061 |
| **S06** | TBC | TBC | SMX-US | 29/09/2014 | 03/11/2014 | 528441 | 728118 | Woodland edge, Ash tree | 20140929_161131_S6 |
| **S07** | 6343 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 527869 | 727772 | Woodland edge, Sw corner of field, through bushes into clearing on left | 100-0049 |
| **S08** | 16688 | SM2BAT+ | SMX-US | 08/09/2014 | 03/11/2014 | 527015 | 728644 | Woodland edge, by pond | [similar] |
| **S08** | 12995 | SM2BAT | SMX-US | 20/08/2014 | 08/09/2014 | 527015 | 728644 | Woodland edge, by pond | 20.08.14.18.01 |
| **S09** | 17003 | SM2BAT+ | SMX-US | 08/09/2014 | 04/11/2014 | 529824 | 727484 | Rough grassland | [similar] |
| **S09** | 6215 | SM2BAT | SMX-US | 21/08/2014 | 08/09/2014 | 529824 | 727484 | Rough grassland | 21.08.14.17.17 |
| **S10** | 9617 | SM2BAT+ | SMX-US | 12/08/2014 | 03/11/2014 | 531278 | 727590 | Hawthorn hedgerow field boundary (part) | 100-0052 |
| **S11** | 6359 | SM2BAT | SMX-US | 12/08/2014 | 04/11/2014 | 526966 | 726637 | Hedgerow, edge of path | 100-0048 |
| **S12** | 3609 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 531740 | 728766 | Edge of scrub, field boundary | 100-0051 |
| **S13** | 13110 | SM2BAT+ | SMX-US | 15/08/2014 | 04/11/2014 | 525332 | 726294 | Lough edge, Willow tree | 100-0059 |
| **S14** | 16769 | SM2BAT+ | SMX-US | 08/09/2014 | 04/11/2014 | 525182 | 725328 | Scrub, pasture | [similar] |
| **S14** | 11737 | SM2BAT | SMX-US | 21/08/2014 | 08/09/2014 | 525182 | 725328 | Scrub, pasture | 21.08.14.16.44 |
| **S15** | 6335 | SM2BAT | SMX-US | 15/08/2014 | 03/11/2014 | 524126 | 725632 | Edge of lake, Hawthorn tree | 100-0058 |
| **S16** | 6570 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 529264 | 727206 | Hedgerow. Hawthorn tree, end of hedge | 100-0055, 100-0056 |
| **S17** | 6283 | SM2BAT | SMX-US | 12/08/2014 | 04/11/2014 | 524162 | 724385 | Woodland edge | 100-0047 |
| **S18** | 16724 | SM2BAT+ | SMX-US | 08/09/2014 | 04/11/2014 | 521872 | 724606 | Lake, bog/heath | [similar] |
| **S18** | 6115 | SM2BAT | SMX-US | 20/08/2014 | 08/09/2014 | 521872 | 724606 | Lake, bog/heath | 20.08.14.18.49 |
| **S19** | 16975 | SM2BAT+ | SMX-US | 03/09/2014 | 04/11/2014 | 521372 | 723143 | Small field with gorse and fern, pockets of exposed rock. Hedgerow, scrub and rough grassland. | IMG_7885 - S19 |
| **S20** | 6198 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 530216 | 726323 | River bank, Ash tree | 100-0053, 100-0054 |
| **S21** | 6330 | SM2BAT | SMX-US | 12/08/2014 | 03/11/2014 | 521372 | 723143 | Hazel tree in hedgerow | S21.jpg |
| **S22** | 16753 | SM2BAT+ | SMX-US | 08/09/2014 | 03/11/2014 | 530424 | 728432 | Back of Lackagh Quarry, limestone | 20141006_123325_S22 |
| **S23** | 17004 | SM2BAT+ | SMX-US | 03/09/2014 | 04/11/2014 | 522419 | 723682 | Small field with gorse, pockets of exposed rock. Scrub, rough grassland. | IMG_7911 - S23 |
| **S24** | 6131 | SM2BAT | SMX-US | 20/08/2014 | 08/09/2014 | 534339 | 724082 | Scrub / plantation | 20.08.14.16.43 |
| **S24** | 16675 | SM2BAT+ | SMX-US | 08/09/2014 | 03/11/2014 | 534339 | 724082 | Scrub / plantation | 20140929_100947_S24 |

## Total number of bat passes for each static acoustic bat detector across 24 sites in Galway

| Site | MYsp | NYLE | PINA | PIPI | PIPI-PIPY | PIPY | PLAUR | RHHI | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| **S01** | 73 | 12 | 2 | 1,785 | 24 | 2,281 | 2 | 2 | 4,181 |
| **S02** | 172 | 8 | 1 | 1,199 | 4 | 18,774 | 1 | 59 | 20,218 |
| **S03** | 47 | 49 | | 6,440 | 16 | 6,288 | 1 | | 12,841 |
| **S04** | 66 | 98 | 3 | 249 | 9 | 1,551 | 20 | 9 | 2,005 |
| **S05** | 5 | 78 | 2 | 10 | | 253 | | 25 | 373 |
| **S06** | 50 | 17 | 6 | 39 | | 31,408 | 5 | 85 | 31,610 |
| **S07** | 287 | 45 | 4 | 169 | 9 | 14,881 | 1 | | 15,396 |
| **S08** | 71 | 116 | 1 | 499 | 29 | 35,940 | 2 | 2 | 36,660 |
| **S09** | 10 | 60 | 1 | 65 | | 202 | 7 | | 345 |
| **S10** | 17 | 42 | | 172 | 2 | 1,162 | | 1 | 1,396 |
| **S11** | 4 | 146 | | 424 | 1 | 2,149 | 1 | 13 | 2,738 |
| **S12** | 61 | 42 | 3 | 486 | 12 | 4,441 | | | 5,045 |
| **S13** | 97 | 121 | 5 | 1,848 | 12 | 3,756 | 12 | 1 | 5,852 |
| **S14** | 141 | 56 | 1 | 4,305 | | 2,430 | 3 | | 6,936 |
| **S15** | 4 | 91 | 4 | 344 | 7 | 816 | 14 | 1 | 1,281 |
| **S16** | 83 | 61 | 13 | 943 | 119 | 13,386 | 8 | | 14,613 |
| **S17** | 35 | 123 | 3 | 633 | 11 | 2,812 | 4 | | 3,621 |
| **S18** | 10 | 18 | | 74 | | 252 | 3 | | 357 |
| **S19** | 14 | 67 | 4 | 225 | | 399 | | 1 | 710 |
| **S20** | 43 | 110 | 87 | 18,448 | 4 | 41,616 | | | 60,308 |
| **S21** | 262 | 182 | 17 | 606 | | 35,067 | 46 | 31 | 36,211 |
| **S22** | 4 | 49 | 1 | 188 | | 40 | 5 | 2 | 289 |
| **S23** | 1 | 27 | 2 | 250 | | 730 | | | 1,010 |
| **S24** | 18 | 33 | 5 | 1,811 | 6 | 667 | 1 | 2 | 2,543 |
| **Grand Total** | 1,575 | 1,651 | 165 | 41,212 | 265 | 221,301 | 136 | 234 | 266,539 |

## Quality Assurance Results for bat acoustic surveys, Galway.

Comparing results of original ID of 3,540 bat passes with identification by Dr. Fiona Mathews, Exeter University

| | Original ID: columns | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FM ID: rows | Column Labels | | | | | | | | | | | | | | | | | |
| Row Labels | MY-PL | MYsp | noise | NYLE | NYLE-EPSE | PINA | PIPI | PIPI-PIPY | PIPI-PIPY-PIPY | PIPY | PIPY, query PLAUR | PIPY-Mysp | PIPY-NYLE | PIPYsoc | query | RHHI192 | soc | Grand Total |
| MY-PL | 1 | | | | | | | | | | | | | | | | | 1 |
| MYsp | | 19 | | | | | | | | | | | | | | | | 19 |
| NoID | | | | | | | | | | | | | | | | | 1 | 1 |
| noise | | | 3 | | | | | | | | | | | | | | | 3 |
| NYLE | | | | 52 | 1 | | | | | | | | | | 1 | | | 54 |
| PINA | | | | | | 4 | | | | | | | | | | | | 4 |
| PIPI | | | | | | | 107 | 9 | | 1 | | | | | | | | 117 |
| PIPI-PIPY | | | | | | | 3 | 60 | 6 | 33 | | | | 1 | | | | 103 |
| PIPY | | | | | | | 2 | 30 | | 3184 | | 1 | 1 | 1 | | | | 3219 |
| PIPY-Mysp | | | | | | | | | | 2 | 1 | 2 | | | | | | 5 |
| PIPY-Mysp, NYLE | | | | | | | | | | 1 | | | | | | | | 1 |
| PIPY-NYLE | | | | | | | | | | 2 | | | 8 | | | | | 10 |
| RHHI192 | | | | | | | | | | | | | | | | 3 | | 3 |
| **Grand Total** | **1** | **19** | **3** | **52** | **1** | **4** | **112** | **99** | **6** | **3223** | **1** | **3** | **9** | **2** | **1** | **3** | **1** | **3540** |

| Category | | % |
|---|---|---|
| Agreed | 3443 | 97.3% |
| during final check would | 8 | 0.2% |
| Mis-identified as PIPY when PIPI, or vice versa | 80 | 2.3% |
| Mis-identified to different species | 9 | 0.3% |

## Accuracy measures for Common and Soprano Pipistrelle ID by Kaleidoscope Pro.

This study carried out manual identification of Common and Soprano Pipistrelle calls for the survey session Aug-Sep 2014.
For the survey sessions Sep-Oct and Oct-Nov, Kaleidoscope Pro was relied upon without manual checking for calls tagged as either common or soprano pipistrelle.
Data published by the manufacturers of the acoustic bat detectors (Wildlife Acoustics, www.wildlifeacoustics.com) is reproduced below.
These illustrate the accuracy of the programme and hence the implications for the Galway study of relying on KPro for tagging common and soprano pipistrelle calls.
**99% and 94% of calls tagged by KPro as common and soprano pipistrelle are tagged correctly. Where tagged incorrectly, 0% were tagged as a species other than common or soprano pipistrelle.**

Kaleidoscope 2.0.5 United Kingdom Classifiers - Wildlife Acoustics Test Results. Published by Wildlife Acoustics (www.wildlifeacoustics.com).

| | UNITED KINGDOM CLASSIFIERS 2.0.5 (sensitive setting) | | | | | | | | | | | | | | | | Testing | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RECORDINGS | BABA | EPSE | MYBR | MYDA | MYNA | NYLE | NYNO | PINA | PIPI | PIPY | PLAUR | RHFE | RHHI | HHI192 | NoID | Correct | N Files | N Calls |
| BABA | 52% | 3% | | 1% | | | | 1% | 5% | 8% | 2% | | | | 28% | 72% | 93 | 676 |
| EPSE | | 81% | | 2% | | 4% | 3% | | | | 2% | | | | 8% | 88% | 128 | 2,177 |
| MYBR | | | 57% | 14% | | | | | | | 21% | | | | 7% | 62% | 14 | 132 |
| MYDA | 2% | | 8% | 64% | | | | 5% | 3% | 2% | 3% | | | | 14% | 75% | 64 | 1,040 |
| MYNA | 1% | 1% | 3% | 5% | 28% | | 5% | | 3% | | 4% | | | | 49% | 55% | 75 | 662 |
| NYLE | | 7% | | | | 52% | 14% | | | | 1% | | | | 26% | 71% | 92 | 1,058 |
| NYNO | | 11% | | | | 10% | 52% | | | | | | | | 27% | 71% | 1,904 | 20,420 |
| PINA | 1% | | | | | | | 93% | | 2% | | | | | 4% | 96% | 139 | 2,147 |
| PIPI | | | | | | | | | 84% | 1% | | | | | 15% | 99% | 16,774 | 187,743 |
| PIPY | | | | | | | | | 5% | 79% | | | | | 17% | 94% | 4,349 | 45,101 |
| PLAUR | | 4% | | | 1% | | | | 1% | | 30% | | | | 63% | 81% | 145 | 396 |
| RHFE | | | | | | | | | | | | 85% | | 10% | 6% | 90% | 317 | 4,678 |
| RHHI | | | | | | | | | | | | | 78% | | 22% | 100% | 859 | 4,848 |
| RHHI192 | | | | | | | | | | 9% | | 15% | | 63% | 14% | 73% | 2,332 | 24,765 |
| | | | | | | | | | | | | | | | Mean correct | 80% | 27,285 | 295,843 |
| True Positive Rate | 52% | 81% | 57% | 64% | 28% | 52% | 52% | 93% | 84% | 79% | 30% | 85% | 78% | 63% | Mean TPR | 64% | | |
| Positive Predictive Value | 92% | 76% | 85% | 74% | 95% | 79% | 70% | 94% | 83% | 79% | 46% | 85% | 100% | 86% | Mean PPV | 82% | | |

# Appendix H

## N6 Galway City Transport Project – Bat Radio-tracking and Roost Surveys 19 to 29 August 2014 (Geckoella Ltd., 2015b)

Consultants for ecology and geology

# N6 Galway City Transport Project
# Bat Radio-tracking and Roost Surveys
# 19th to 29th August 2014

| | |
|---|---|
| Report date: | 28th November 2014 |
| Survey dates: | 19th to 29th August 2014 (incl.) |
| Commissioned by: | Scott Cawley Ltd. |
| Version: | Final Report_March 15 amendments |
| Authorised by: | Dr. Andy King |
| Report authors: | Kate Jeffreys<br>Dr. Andy King (Annex A) |
| NPWS License numbers: | C098/2014, 027/2014, C009/2014, DER/BAT 2014-39 |

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## Summary

Geckoella Ltd. were commissioned by Scott Cawley Ltd. to radiotrack bats to inform the environmental baseline of the N6 Galway City Transport Project. The specific objectives of the project were to find out more about the vesper bats that are present within the proposed scheme area, especially their roost locations, as well to gather data on lesser horseshoe bats outside the home range of the lesser horseshoe bats of Menlo Castle. The survey took place between $19^{th}$ and $29^{th}$ August 2014 (incl.) and 181 bats were caught from 6 sites on 6 nights. Of these, 11 bats of 5 species were tagged. Daytime positioning was used to identify roost locations. Roosts were found for 8 of the bats. Five of these individuals moved roosts within the survey period, and a total of 16 bat roosts were identified.

## Acknowledgements

We thank the following contributors to the radio-tracking surveys and analysis:
Dr. Fiona Mathews, Dr. Elizabeth Bradshaw, Alison Johnston, Iain Hysom, Dan Buckley, Helen Saunders, and Kevin Hamel.

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***Annex***

# 1 Introduction

1.1 N6 Galway City Transport Project requires environmental baseline information in the scheme study area as part of the constraints study for the project. Information on bats is being collected as part of this process in accordance with local and European guidance and legislation (Kelleher & Marnell, 2006). A consortium led by Geckoella Ltd., with Helix Ecology and EcoPro was contracted by Scott Cawley Ltd. to carry out radio-tracking and other bat survey work to contribute to this baseline environmental information.

1.2 The specific objectives of the radio-tracking and other survey work carried out between 19th and the 29th August 2014 (incl.) were to:

- Gather data on vesper [1]bats across the 6,350 ha proposed scheme area, centred on the city of Galway.
- Gather data on lesser horseshoe bats *Rhinolophus hipposideros* across the proposed scheme area, excluding the home range of the lesser horseshoe bats of Menlo Castle.

1.3 The approach used was to catch bats using harp traps and mist nets and collect biometric data on all trapped bats. A subset of bats, most likely to provide information of relevance to the environmental baseline for the scheme, were fitted with small radio-transmitters. The tagged bats were re-found during the following days using radio-receivers, to establish their daytime roosting habits. Supplementary information on these roosts was also collected. The survey work was carried out under licence numbers C098/2014, 027/2014, C009/2014 and DER/BAT 2014-39 from the National Parks and Wildlife Service of Ireland.

[1] Vesper bats are of the family Vespertilionidae, and in Ireland include bats of the genera *Pipistrellus*, *Myotis*, *Plecotus* and *Nyctalus*.

## 2 Methodology

2.1 The proposed scheme area is located at Galway city on the west coast of Ireland and includes approximately 6,350ha as shown in Figure 1.

2.2 Six sites for trapping were selected using advice from local surveyors (Scott Cawley Ltd., pers. comm.), aerial photo interpretation and site visits. The best sites for trapping bats in late August are generally sheltered locations close to likely good feeding habitat and roost sites. This increases the potential for a large number of bats of a wide range of species to be present in a relatively enclosed environment which is suitable for trapping. Figure 1 shows the trapping locations selected across the site.

2.3 Harp traps and mist nets were set up at each site. Bat lures emitting ultrasound calls similar to bat calls were placed adjacent to the harp traps, to help attract bats and increase the catch rate (Sussex Autobat, and AT100 ultrasound speaker).

2.4 The species and sex of every bat caught was recorded. Additional biometric data was collected for species other than soprano pipistrelle, comprising forearm length, weight and reproductive status. Where practical, all trapped bats were fur-clipped, as a temporary marker (agitated or stressed bats were not fur-clipped). This reduced the likelihood of double-counting, since bats re-caught with clipped-fur could be excluded from the data-set.

2.5 Supplementary information on presence / absence of bat species at trapping locations was collected through the use of hand-held detectors during the trapping sessions. The detectors record sound files for subsequent analysis using specialist software (Kaleidoscope Pro), which can identify species found to genus level for *Myotis* species, and species level for other bats found in Ireland.

2.6 Captured bats most likely to provide information of relevance to the environmental baseline of the proposed scheme area, determined according to criteria defined by Scott Cawley Ltd., were tagged with 0.29g or 0.35g radio transmitters (Holohil Ltd. Canada and Biotrack UK). Breeding females of any species were tagged as first preference. Tags were then applied to bats in order to obtain results from both males and females, adult and juvenile, and from a range of species. Bats of the genus *Myotis* were of particular interest. Each tag was less than 7% of the bat's body weight, as a condition of the survey license from the National Parks and Wildlife Service. Most of the bats tagged were also ringed with a unique long-term identification number in case re-found at a later date.

2.7 Each tag emitted a pulse of a specific frequency that could be re-found using a radio-receiver. This enabled the identification of any re-found bats to individual level. Tagged bats were tracked using Australis, SIKA and Regal radio-receivers during the day to identify daytime roosts, using a combination of omni-directional and directional Yagi antennae. Bats were sought first of all close to their trapped location, with the search area increasing until a systematic city-wide sweep was carried out. Data from within 24hrs of trapping was disregarded as potentially non-representative of typical behaviour.

2.8 The detailed location of each roost was found by homing-in where close approach to the roost was practical. For daytime roosts, this involved simply following the direction of strongest signal until the source of the signal was found and is a recognised best-practice approach for a static signal (Amelon, et al., 2009). Where close approach to the roost was impractical, then triangulation was used. This involves taking readings from three or more locations around the likely source of the signal, and plotting their intersection. The roost locations presented in this report, including the ITM[2] values, represent the actual likely locations of the roosts of the tagged bats; with confidences indicated to compensate for potential sources of bias and error (Bartolommei, et al., 2012).

2.9 A systematic search of the proposed scheme area was carried out on 27th and 28th August 2014 in order to try to find any additional roosts. Each kilometre square in the area was checked for any tag frequencies that had not already been found elsewhere on that day.

2.10 Failure to find a tagged bat would have been most likely due to the following reasons:

- the bat was roosting outside the proposed scheme area,
- the bat was roosting in locations that made detection of the signal difficult (for example in dense woodland or cellars),
- the surveyors missed a clear signal inside the proposed scheme area (the likelihood of this would be reduced due to the systematic approach to search – see 2.8),
- the tag was no longer working (could be discounted for bats found again later in the survey).

2.11 The survey team comprised Mrs Kate Jeffreys MCIEEM CEnv, Dr. Fiona Mathews, Dr Elizabeth Bradshaw, Ms Alison Johnston, Mr Iain Hysom and Dr Andy King. This team is very experienced in the use of radio-tracking survey techniques for bats.

2.12 The findings in this report are described using the CIEEM categorisation of confidence (CIEEM, 2006) as set out below:

- Certain/near-Certain: probability estimated at 95% chance or higher.
- Probable: probability estimated above 50% but below 95%.
- Unlikely: probability estimated above 5% but less than 50%.
- Extremely Unlikely: probability estimated at less than 5%

2.13 Weather conditions for Galway during the survey period are summarised in Appendix A, with site specific data collected for trapping sites and times. The likely effects of the weather on the confidence of the survey findings are indicated where appropriate, the main impact being on limiting the number of suitable trapping evenings during the survey period.

[2] Irish Transverse Mercator grid reference

# 3 Results

3.1 Overall, 181 bats of 7 species were trapped at 6 sites. Of these, 11 bats of 5 species were tagged, 9 of which were also ringed. Most of the bats caught were soprano pipistrelles (151, 83.4%). followed by common pipistrelle (11, 6.1%) and Daubenton's (10, 5.5%). Trapping sites, with numbers of bats captured and tagged are listed in Table 3.1, with the detail provided in Appendix B. Figure 1 shows the locations of each trapping site. The following species abbreviations apply to all tables in these results:

| | | |
|---|---|---|
| Md | *Myotis daubentonii* | Daubenton's bat |
| Mmy | *Myotis mystacinus* | whiskered bat |
| Mn | *Myotis nattereri* | Natterer's bat |
| Msp | *Myotis sp.* | a bat of the Myotis genera |
| Nl | *Nyctalus leisleri* | Leisler's bat |
| Paur | *Plecotus auritus* | brown long-eared bat |
| Pn | *Pipistrellus nathusii* | Nathusius's pipistrelle |
| Ppi | *Pipistrellus pipistrellus* | common pipistrelle |
| Ppy | *Pipistrellus pygmaeus* | soprano pipistrelle |
| Rh | *Rhinolophus hipposideros* | lesser horseshoe bat |

3.2 Supplementary information on the presence of bat species at trapping locations was collected through the use of hand-held detectors during some of the trapping sessions. The detectors record sound files for subsequent analysis using specialist software (Kaleidoscope Pro), which can identify species found to genus level for *Myotis* species, and species level for other bats found in Ireland. Table 3.1 also lists the additional species recorded at each trapping site.

3.3 Trapping rates tended to be higher in sheltered, woodland locations. It was difficult to find suitable areas to trap bats in the area west of Lough Corrib. This area includes open bog and heath, too exposed for trapping bats. Elsewhere, for example around Tonabrocky, the patchwork of small fields, overgrown hedges and impenetrable woodland patches offered a few suitable locations for trapping, but these were still likely to experience a rapid drop in temperature in August, and also had access issues.

3.4 The eleven tagged bats comprised 5 species: whiskered, Daubenton's, Leisler's, brown long-eared and common pipistrelle bats. Six were adult bats, of which 4 were in breeding condition, including one post-lactating female brown long-eared bat. Table 3.2 lists the tagged bats in detail. No bats were tagged from the Sport's Ground because no target species were caught – the cool weather conditions led to a very low catch-rate; equipment issues prevented the tagging of bats from Menlo Woods although biometric data on trapped bats is presented.

3.5 Sixteen roost locations were identified for 8 of the tagged bats and are listed in Table 3.3, with the detail provided in Appendix B. Figures 2A to 2P show and describe each roost. Ten roosts (62.5%) were modern houses or bungalows built in the 20th or 21st centuries.

3.6 An emergence survey carried out at The Women's Study Centre (Roost F) on 22nd August, found that 3 bats, including the tagged male Daubenton's bat tracked to this roost, emerged from the eastern aspect of the building )and flew east towards the River Corrib, using the vegetated dark road-bank corridor between the Kingfisher Centre and the N6.

3.7 An emergence survey carried out at Menlo Castle (Roost E) on 26th August found that 11 lesser horseshoe bats emerged from the maternity roost in the chimney at this site. These bats and this roost are described in other bat reports for the GCTP.

3.8 An emergence survey carried out at Salmon Weir Bridge (Roost O) on 29th August 2014, found that the male Daubenton's bat using this roost emerged at 21:30 and foraged south of the Salmon Weir Bridge until the end of survey. Large numbers of soprano pipistrelles were using the stream/culvert between Roosts M (Cathedral Footbridge) and Roost O (Salmon Weir Bridge). soprano and common pipistrelle bats were also regularly and constantly foraging over the River Corrib, passing under the arches of Salmon Weir Bridge. Leisler's bats and more *Myotis* bats were also recorded constantly foraging over the river.

3.9 No roost was found for one of the male Leisler's bats caught and tagged at Barna Woods (frequency 173.438, Appendix B).There was a weak daytime signal to the north-east of Castlegar on 25th August, but this signal faded and was not found again during subsequent searches, suggesting a day roost with thick walls or some other impediment to signal transmission. This bat was recorded foraging north-west of the Sport's Field on the 23rd August (bearing 314º from ITM 528250 727680), and east of Oranmore (3 bearings) on the evening of the 25th August, suggesting a large home range including areas west, north and east of Galway city.

**Table 3.1. Trapping sites in Galway**

| Location | Date | ITM | Species captured | Total Captured | Number ringed | Number Tagged | Species recorded by acoustic surveys at trap site |
|---|---|---|---|---|---|---|---|
| Merlin Woods | 19-Aug | 0533450 0725600 | 1xMmy, 1xMd, 25xPpy | 27 | none | 1xMmy, 1xMd | Ppy, Ppi, Msp |
| Barna Woods | 20-Aug | 524400 723800 | 2 x Paur, 2xNl, 31 x Ppy | 35 | 2xNl | 2xNl | - |
| Cooper's Cave | 21-Aug | 531729 727476 | 1xPaur, 3xPpy | 4 | 1x Paur | 1x Paur | Ppi, Ppy, Msp |
| NUIG[3] | 22-Aug | 529178 726369 | 61xPpy, 1xMmy, 3xMd, 2xPpi | 67 | 1xMmy, 3xMd, 2xPpi | 1xMmy, 3xMd, 2xPpi | Ppy, Ppi, Paur, Msp, Nl |
| Sports fields | 23-Aug | 528250 727680 | 7xPpy, 2xPpi | 9 | none | none | Ppy, Ppi, Nl, Msp |
| Menlo Woods | 26-Aug | 528530 728000 | 29xPpy, 2xPpi, 1xMn, 6xMd 1xPaur | 39 | none | none | - |
| **6 sites** | | | **7 species** | **181** | **9 ringed, 5 species** | **11 tagged, 5 species** | |

[3] National University of Ireland: Galway

**Table 3.2. Bats tagged at sites in Galway**

| Tagging location | Date tagged | Species | Arm mm | Sex M/F | Age | Breeding condition[4] Y/N | Weight g | Ring N/number | Frequency of tag MHz 173.xxx | Roosts found |
|---|---|---|---|---|---|---|---|---|---|---|
| Merlin | 19-Aug | Mmy | 31.6 | M | A | N | 4.75 | N | 231 | not found |
| Merlin | 19-Aug | Md | 38.2 | F | J | N | 8.5 | N | 459 | D |
| Barna | 20-Aug | Nl | 44.1 | M | A | Y | 15.5 | 131726 | 438 | Single, weak signal NW of Galway, foraging data |
| Barna | 20-Aug | Nl | 44.2 | M | A | Y | 15 | 131727 | 535 | A, I |
| Cooper's Cave | 21-Aug | Paur | 38.8 | F | A | Y | 8.5 | A4260 | 395 | H |
| NUIG | 22-Aug | Mmy | 32.7 | M | J | N | 5 | A4261 | 414 | B, N |
| NUIG | 22-Aug | Md | 37.8 | M | A | Y | 8 | A4262 | 513 | not found |
| NUIG | 22-Aug | Md | 39.6 | F | J | N | 10 | A4263 | 252 | E |
| NUIG | 22-Aug | Md | 37.7 | M | J | N | 8 | A4264 | 297 | F, G, M, O |
| NUIG | 22-Aug | Ppi | - | F | J | N | 5 | L00391 | 361 | C, J, P |
| NUIG | 22-Aug | Ppi | 31.5 | M | A | N | 4.5 | L00393 | 323 | K, L |
| **6 sites** | | **11 tagged 5 species** | | **7 M, 4 F** | **6 A, 5 J** | **4 in breeding condition** | | **9 ringed, 5 species** | | |

[4] 'Y' for breeding condition indicates post-lactating females or reproductively active males respectively.

**Table 3.3. Bat roosts found through radio-tracking in Galway**

| Roost name | Roost ITM Easting / Northing | Dates in August | Bat Species / F[5] | Bat sex (M/F) age (A/J), breeding (Y/N) | Trapping site | Distance from trapping site (km) | Description | Confidence |
|---|---|---|---|---|---|---|---|---|
| A. Bungalow, Cappagh Road | 524485 725124 | 24th, 25, 27th | Nl / 535 | M/A/Y | Barna | 1.2 | Modern bungalow | High |
| B. Residence behind Sport's centre | 524614 724182 | 24th, 25th, 26th | Mmy / 414 | M/J/N | NUIG | 5.0 | Modern house | Moderate – location backs onto Roost N. Unlikely but possible that roost is at the back of Roost N. |
| C. Ballymoneen | 526356 725344 | 24th, 25th | Ppi / 361 | F/J/N | NUIG | 3.0 | Modern house | High |
| D. Killeen House | 526370 728692 | 25th, 26th, 27th | Md / 459 | F/J/N | Merlin | 7.9 | Farmhouse complex | Roost is within farm complex, but not sure which building. Tracked from road. |
| E. Menlo Castle | 0528431 0727907 | 24th-29th | Md / 252 | F/J/N | NUIG | 1.7 | Ruined castle | High |
| F. Women's Study Centre | 528996 726229 | 24th | Md / 297 | M/J/N | NUIG | 0.3 | 1970s house | High |
| G. 51 St. Joseph's | 529130 726060 | 25th | Md / 297 | M/J/N | NUIG | 0.4 | Study centre | High |

[5] F = frequency of bat tag, 173.xxx, to help indicate the specific bat.

| Roost name | Roost ITM Easting / Northing | Dates in August | Bat Species / F[5] | Bat sex (M/F) age (A/J), breeding (Y/N) | Trapping site | Distance from trapping site (km) | Description | Confidence |
|---|---|---|---|---|---|---|---|---|
| H. Bungalow at Castle Gar | 531925 728152 | 24th-29th | Paur / 395 | F/A/Y | Coopers | 0.8 | Modern bungalow | High |
| I. Residence. Cappagh Road | 524391 725205 | 26th | NI / 535 | M/A/Y | Barna | 1.3 | Modern bungalow | High |
| J. Residence. Ballymoneen. Sli Na Sruchan | 526439 725313 | 26th, 27th | Ppi / 361 | F/J/N | NUIG | 3.0 | Modern house | Moderate – dense housing estate, signal may bounce, houses close together. Judgement made on best indication from signal strength. |
| K. Cluanacauneen | 533542 730077 | 25th, 26th | Ppi / 323 | M/A/N | NUIG | 5.7 | Modern agricultural barn | High |
| L. barn nr roost K | 0533503 0730071 | 28th | Ppi / 323 | M/A/N | NUIG | 5.7 | Modern agricultural barn | High |
| M. Cathedral footbridge | 0529520 0725588 | 28th | Md / 297 | M/J/N | NUIG | 0.9 | Stone footbridge | Moderate – cluttered environment including thick stone structures. Possible bouncing signal. |
| N. Ard Na Coille. Residence behind Sport's centre | 524591 724159 | 29th | Mmy / 414 | M/J/N | NUIG | 5.1 | Modern house | Moderate – see notes on Roost B. |

| Roost name | Roost ITM Easting / Northing | Dates in August | Bat Species / F[5] | Bat sex (M/F) age (A/J), breeding (Y/N) | Trapping site | Distance from trapping site (km) | Description | Confidence |
|---|---|---|---|---|---|---|---|---|
| O. Salmon Weir Bridge | 0529532 0725541 | 29th | Md / 297 | M/J/N | NUIG | 1.0 | Stone roadbridge | High |
| P. Residence. Ballymoneen. Sli Na Sruchan | 526324 725235 | 29th | Ppi / 361 | F/J/N | NUIG | 3.1 | Modern house | Moderate – dense housing estate, signal may bounce, houses close together. Judgement made on best indication from signal strength. |
| **16 bat roosts** | | | | | | **Mean distance 2.9km** | | |

# 4 Discussion and Analysis of Results

4.1 In total, 16 different roosts were identified by the surveys. Twelve of the 16 roosts (75%) were found in modern buildings; 5 roosts (31%) were likely to have been constructed within the last 10 years. This contrasts with suggestions that bats are more likely to be found in old buildings, especially those with multiple access spaces and different types of voids, and low levels of disturbance (Bat Conservation Trust, 2012).This difference may be due to one, or a combination of, the following reasons:

1) A general scarcity in the area of roosting sites with optimal features for bats.
2) A rapid change in the character and extent of Galway, changing the nature and availability of roost sites. The bats of Galway may be adapting to these changes, with unknown implications for population dynamics.
3) Local bat population preference. Mammal populations in different areas can have different habits. The findings from elsewhere in Europe with regard to roost preference and roost use by bats may not apply in Galway.
4) This survey was conducted outside the maternity season. Therefore a higher proportion of roosts would be expected in sites that would be suboptimal for maternity colonies (e.g. sites used by breeding males).

4.2 All roosts were located within 500m of open countryside, and/or close to the expansive natural watercourse and fringing habitat that comprises the River Corrib and which provides a 'blue corridor' flightpath and foraging area for bats which links the centre of Galway to open countryside.The roosts in Ballymoneen (C, J and P) were the most urban in location. No roosts were found within the heavily built-up areas of central Galway, despite a thorough city-wide sweep carried out by the team on 28th and 29th August 2014. Additional data would be required by other survey techniques to further evaluate the relative value of city-edge to city-centre locations for bats. However, the locations favoured for roosting by the bats tagged during this study suggests that roosts with good access to areas suitable for foraging are more likely to be used by bats.

4.3 Five of the 8 bats (63%) for which roosts were found moved roosts at least once during the period tracked. A male juvenile Daubenton's bat tagged at National University of Ireland Galway (NUIG) moved the most, occupying 4 different roosts over 6 days. In contrast, a post-breeding female brown long-eared bat was faithful to a single roost (H) over 6 days.

4.4 The roosts found during the surveys that had high potential to host maternity bat roosts were the bungalow (roost H) faithfully occupied by the post-lactating female brown long-eared bat (frequency 173.395), and Menlo Castle (Roost E) which was faithfully occupied by a female juvenile Daubenton's bat (frequency 173.252) for the duration of the survey and is a known maternity roost for at least one other species (lesser horseshoe bat). The farm complex (D) regularly occupied by another juvenile female Daubenton's bat (frequency 173.297) is also highly suitable for bats and well located to excellent foraging habitat and may well host a maternity roost. The extremely large numbers of soprano pipistrelle bats recorded at dusk during an emergence survey at Salmon Weir bridge, and a nearby stone footbridge (Roosts O and M) suggest a possible large maternity roost for this species somewhere in the vicinity of the old stone waterway that links these two features. A dawn track-back survey could help to clarify the exact roost location.

4.5 The location with low potential for a maternity roost comprised The modern agricultural barns (Roosts K and L) regularly occupied during the survey period by a juvenile female common pipistrelle bat, had low potential as maternity roosts, since the corrugated iron and other modern materials could lead to rapid changes in internal temperature in the structure. Other roosts found during the survey, comprising houses and bungalows, many modern, were of moderate potential for maternity roosts.

4.6 Rates of roost changing may be relatively high due to one, or a combination of, the following reasons, although further research would be required in order to test these theories:

- The time of year (August) is a period when the summer roosts of bats are breaking up, and bats are generally moving around more (Dietz, 2009).
- The area under study, comprising the fringes of Galway, have rapidly changed in the last few years. For example, a comparison of the area around roost F (Women's Study Centre, behind the Kingfisher complex) now with Google Maps aerial photographs dated 2012, shows substantial redevelopment in this area, including the removal of buildings. Bats may be adjusting to this changing environment by checking and exploring new roosts.
- The tagged bats including juvenile, non-breeding and male bats as a high proportion of the total tagged (5 out of 8 bats for which roosts were found were juveniles, 63%). These bats may tend to move roost more often than breeding female bats.
- Changes in bat behaviour due to fitting a tag. For this reason, data collected on tagged bats within 24hours of the tag being fitted was treated with caution.

4.7 Lesser horseshoe bats were present in the known roost at Menlo Castle and a survey carried out on this site counted 11 emerging lesser horseshoe bats. No lesser horseshoe bats were captured or detected acoustically at any of the trapping sites. Even taking into account species-specific bias against capturing lesser horseshoe bats, this low encounter rate is in line with the suggestion that lesser horseshoe bats are uncommon in the area. Acoustic survey data presented elsewhere also supports this suggestion (Geckoella, 2014).

4.8 There are substantial parts of the proposed scheme area which are generally open in character, and may be subject to low temperatures at night. Areas with open character also offer practical challenges to the use of mist nets and harp traps with regard to finding locations where bats are 'funnelled' into smaller areas. This makes other survey methods, such as acoustic techniques, potentially more appropriate in these areas. Trapping success improved in sheltered and warm areas.

## 5 References

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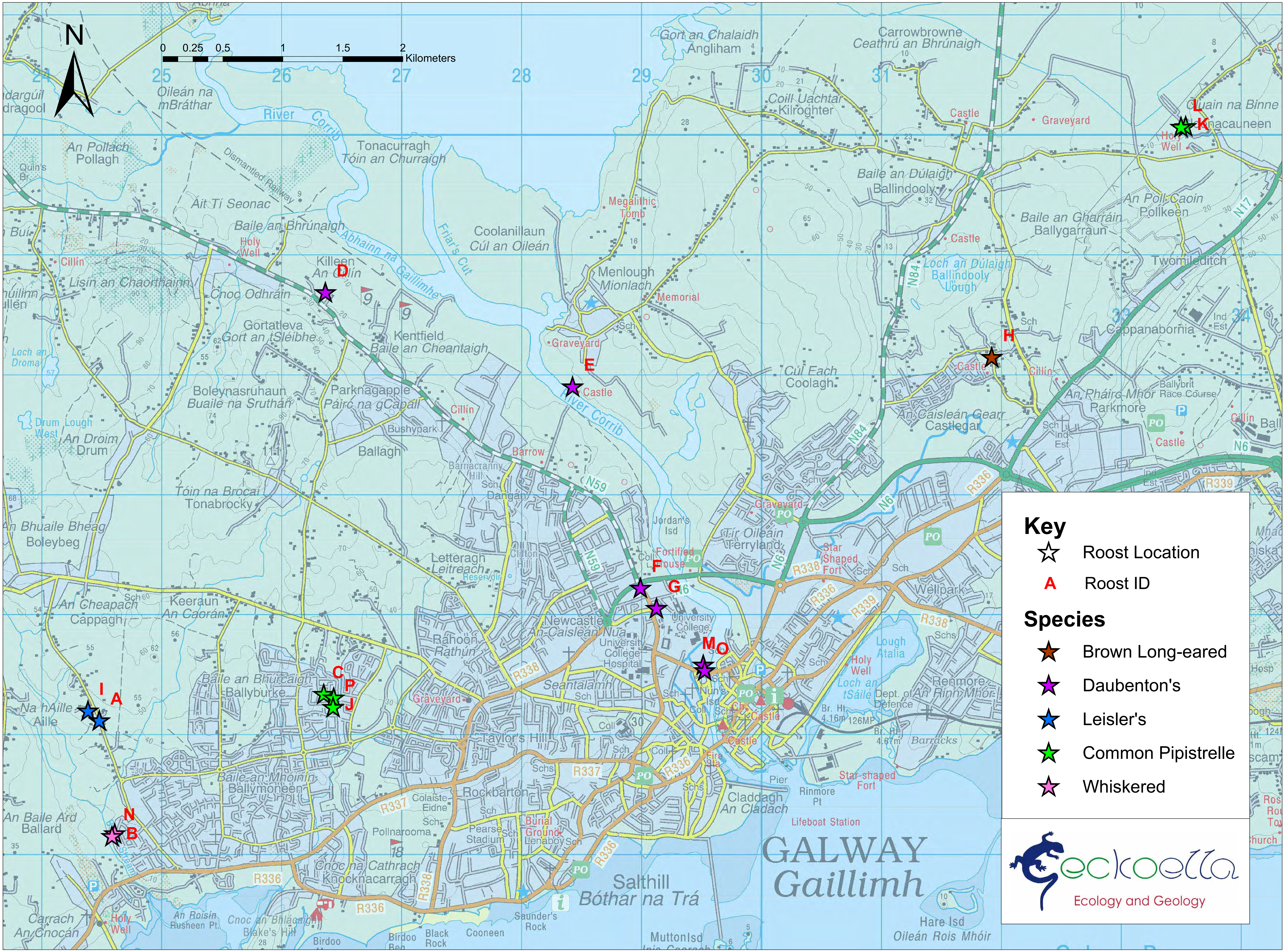
# Figure 1. Trapping Sites and Proposed Scheme Area

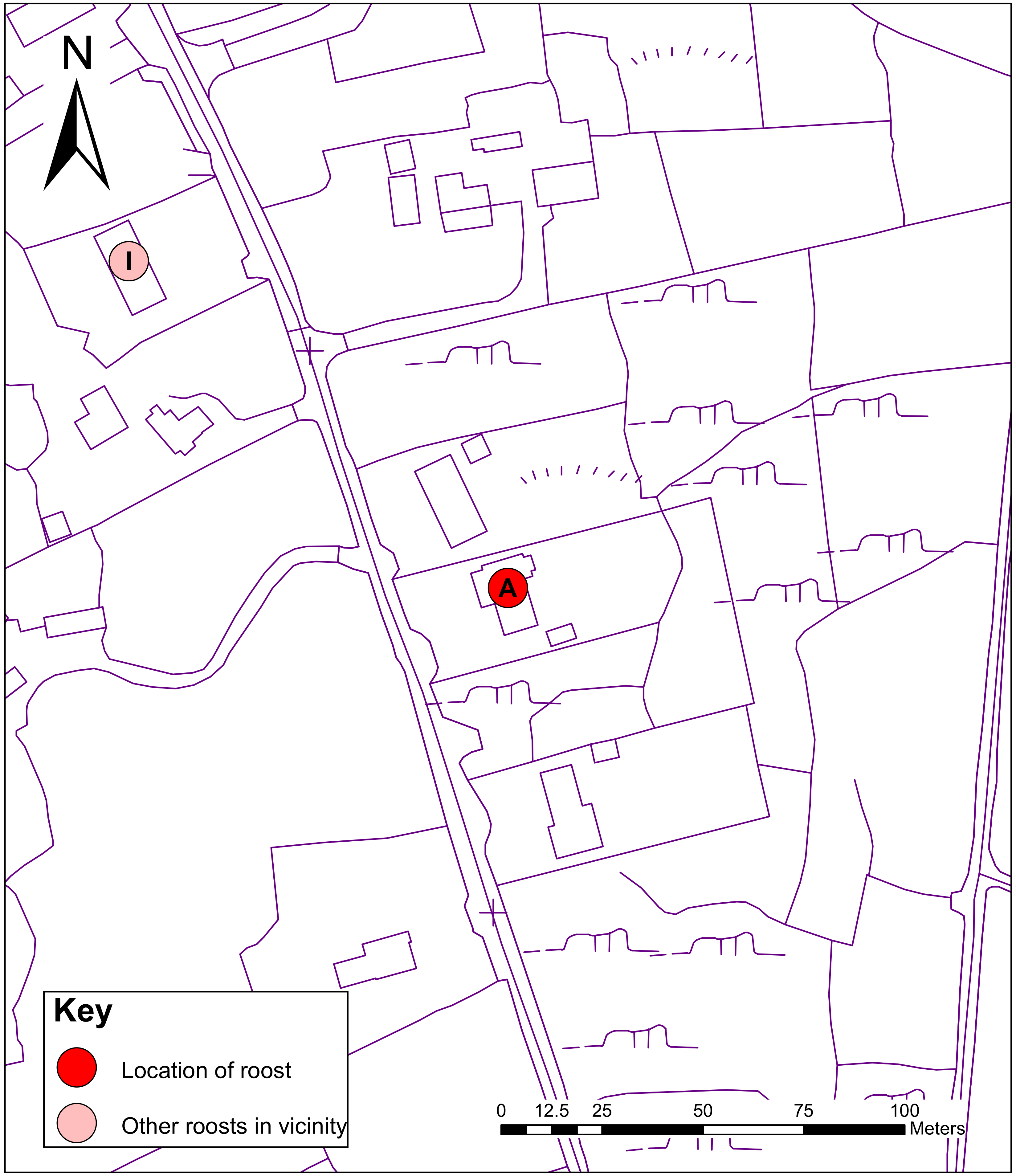
# Figure 2. Roost Locations From Radiotracking: Overview



## GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology





# Roost A

**GCTP Radiotracking**
**August 2014**

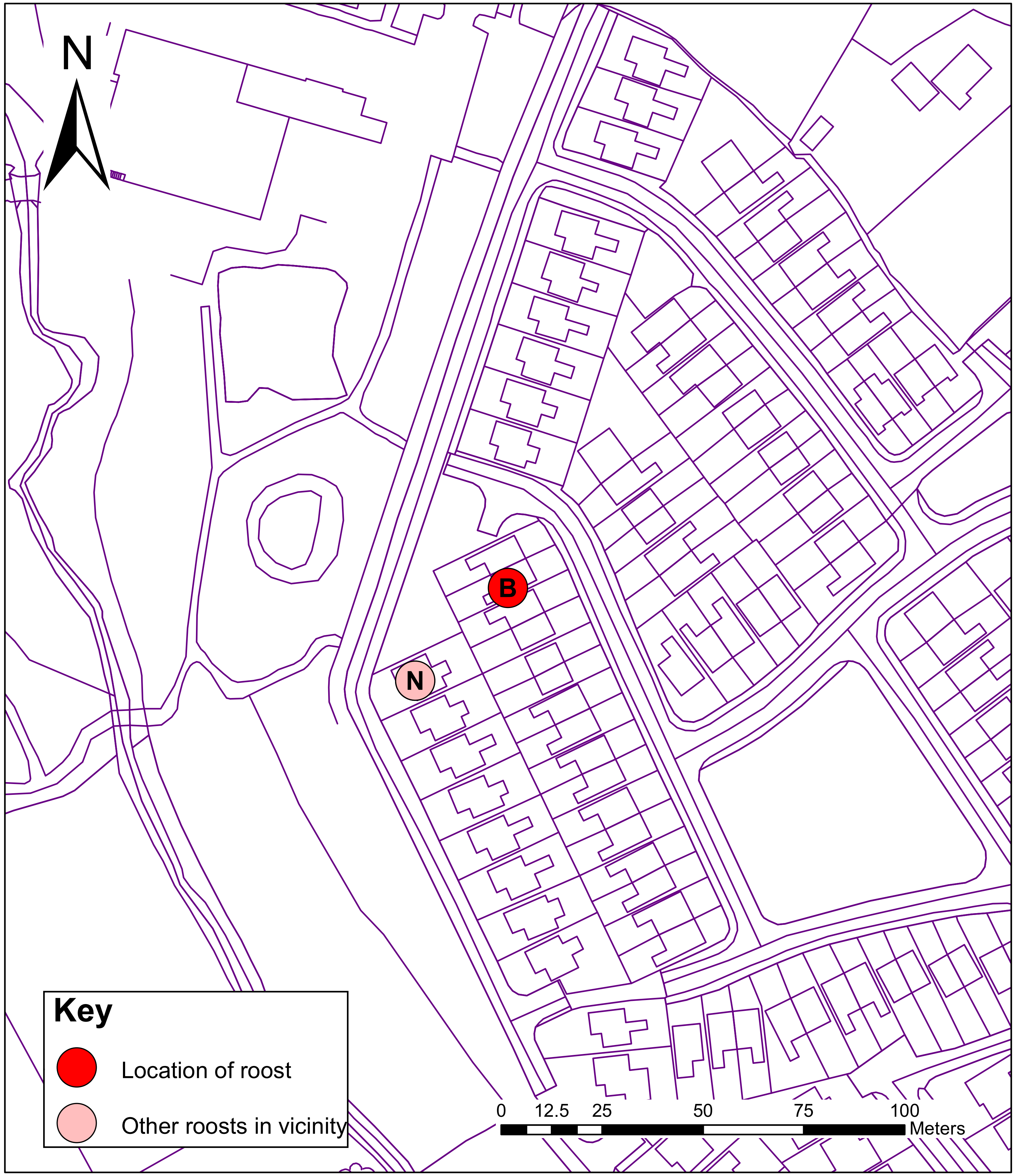
**ITM: 524485 725124**
**Location: Bungalow, Cappagh Road**

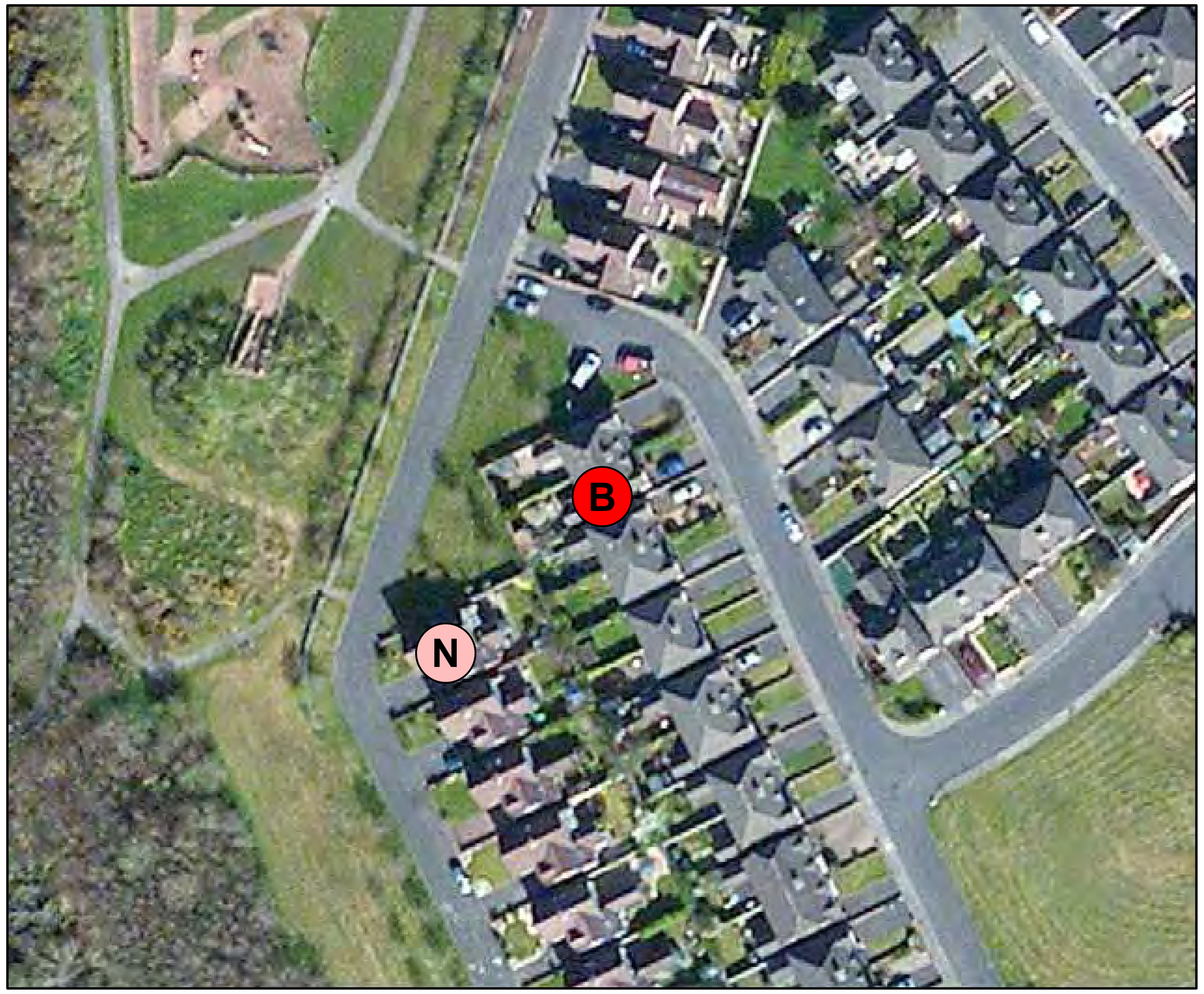
**Species: Leisler's Sex: Male**
**Dates bats confirmed resident: 22nd, 24th, 25th, 27th**

**Sheet 1 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost B

GCTP Radiotracking
August 2014

**ITM:** 524614 724182
**Location:** Residence behind Sport's centre

**Species:** Whiskered **Sex:** Male
**Dates bats confirmed resident:** 24th, 25th, 26th

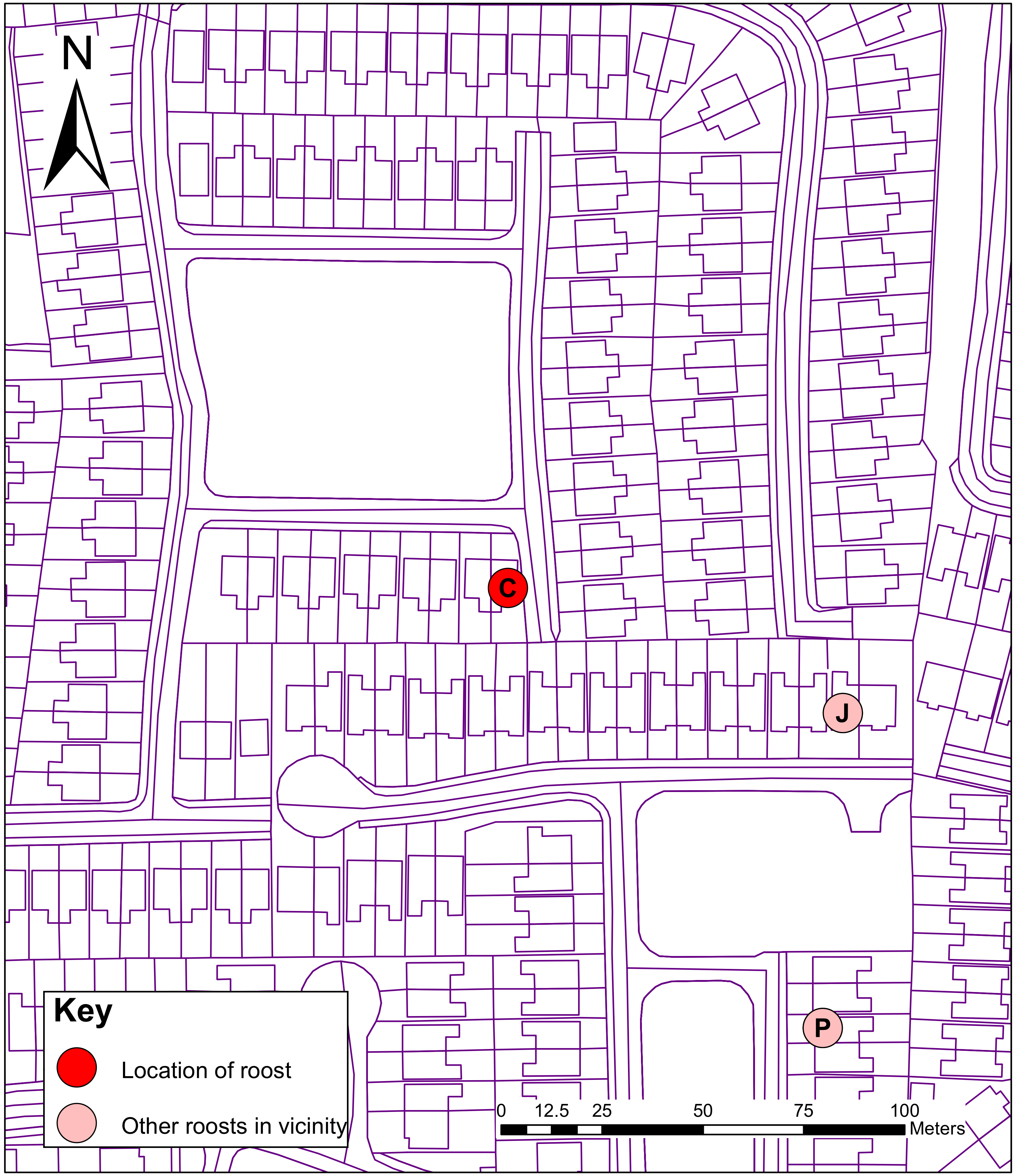
**Note: Roost B backs on to Roost N. Although signal strength indicates separate roosts, would need to be between buildings to be certain.**

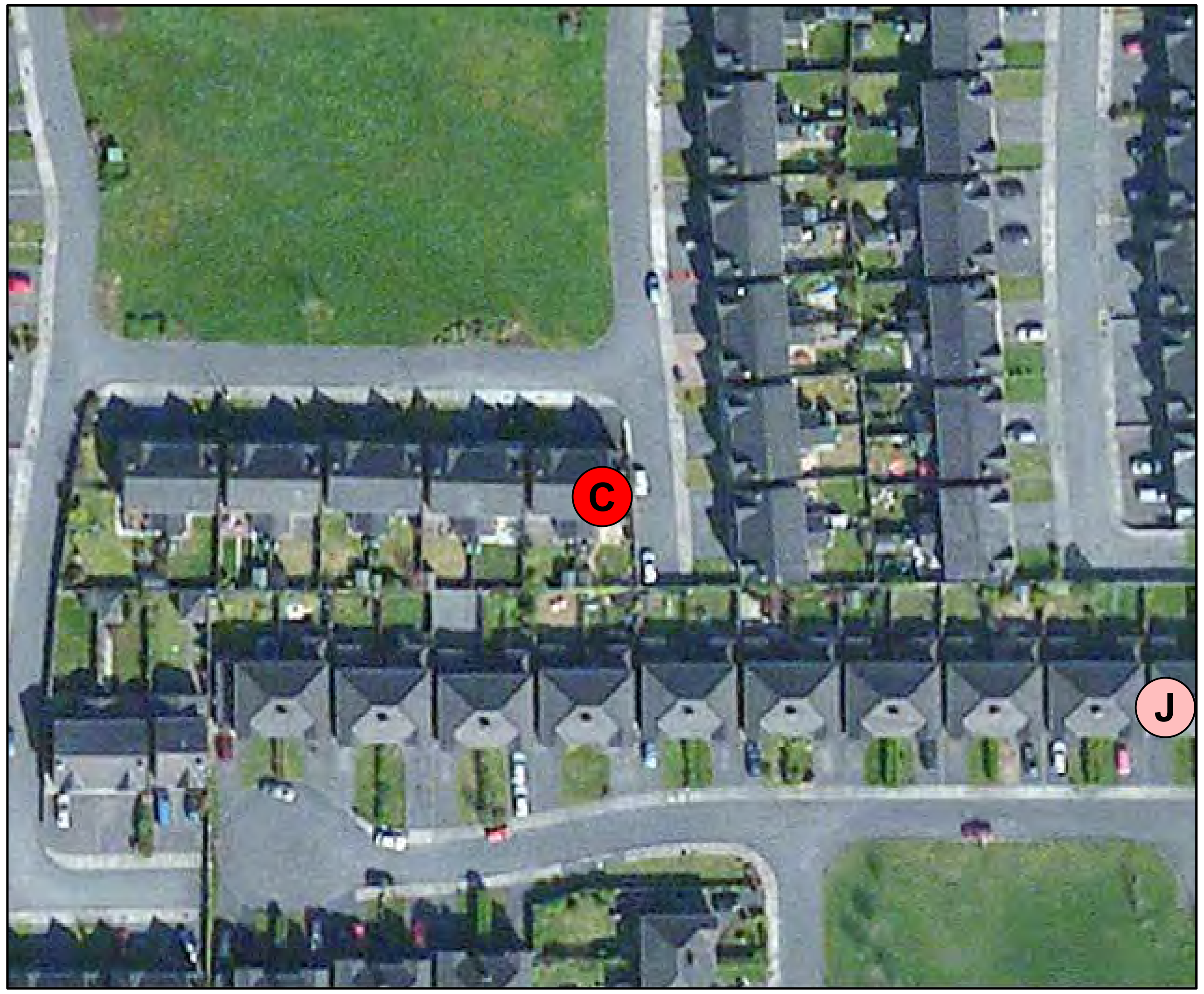
Sheet 2 of 16

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology




## Roost C

GCTP Radiotracking
August 2014

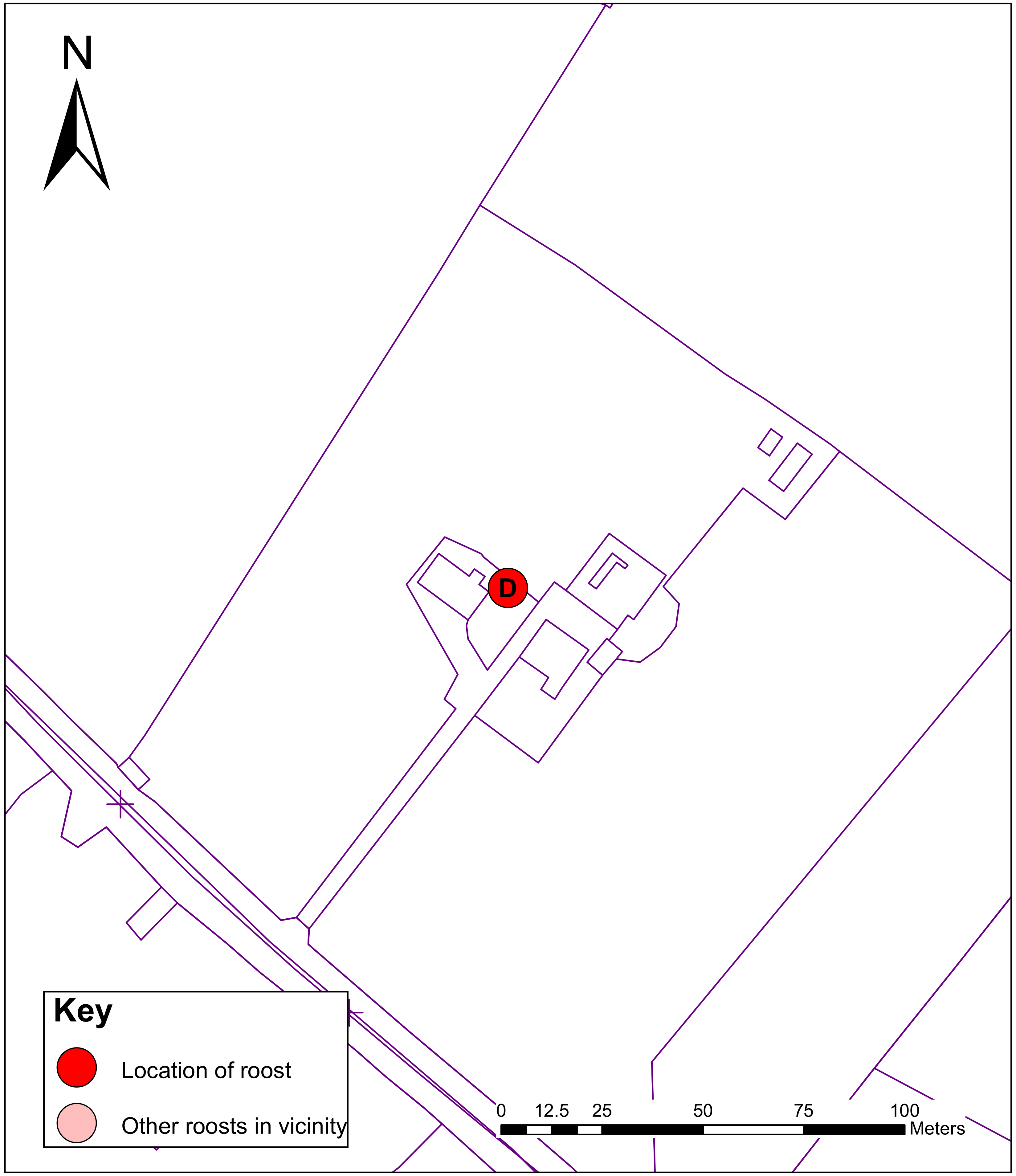
**ITM: 526356 725344**
**Location: Ballymoneen**

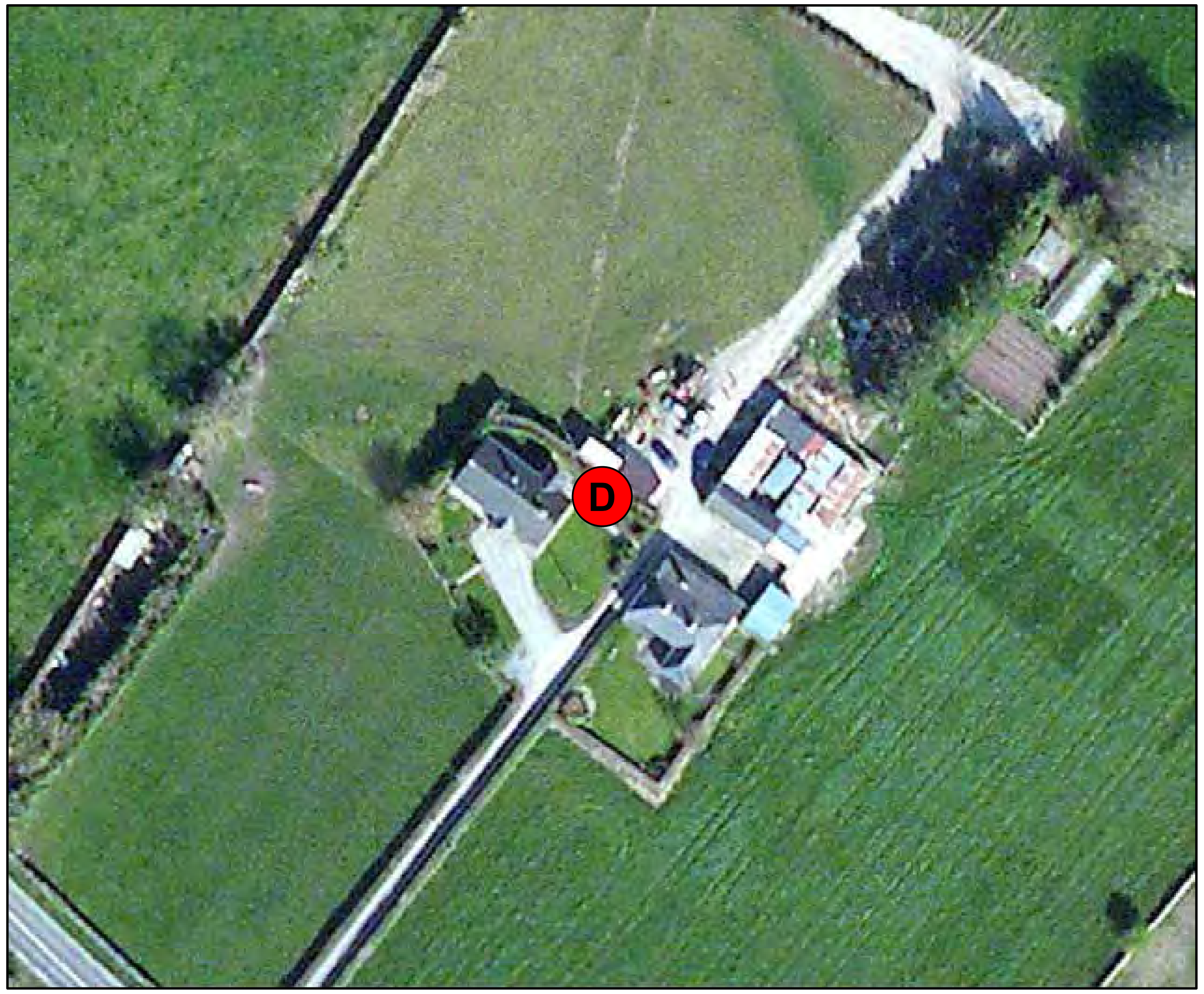
**Species: Common Pipistrelle Sex: Female**
**Dates bats confirmed resident: 24th, 25th**

**Sheet 3 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost D

**GCTP Radiotracking**
**August 2014**

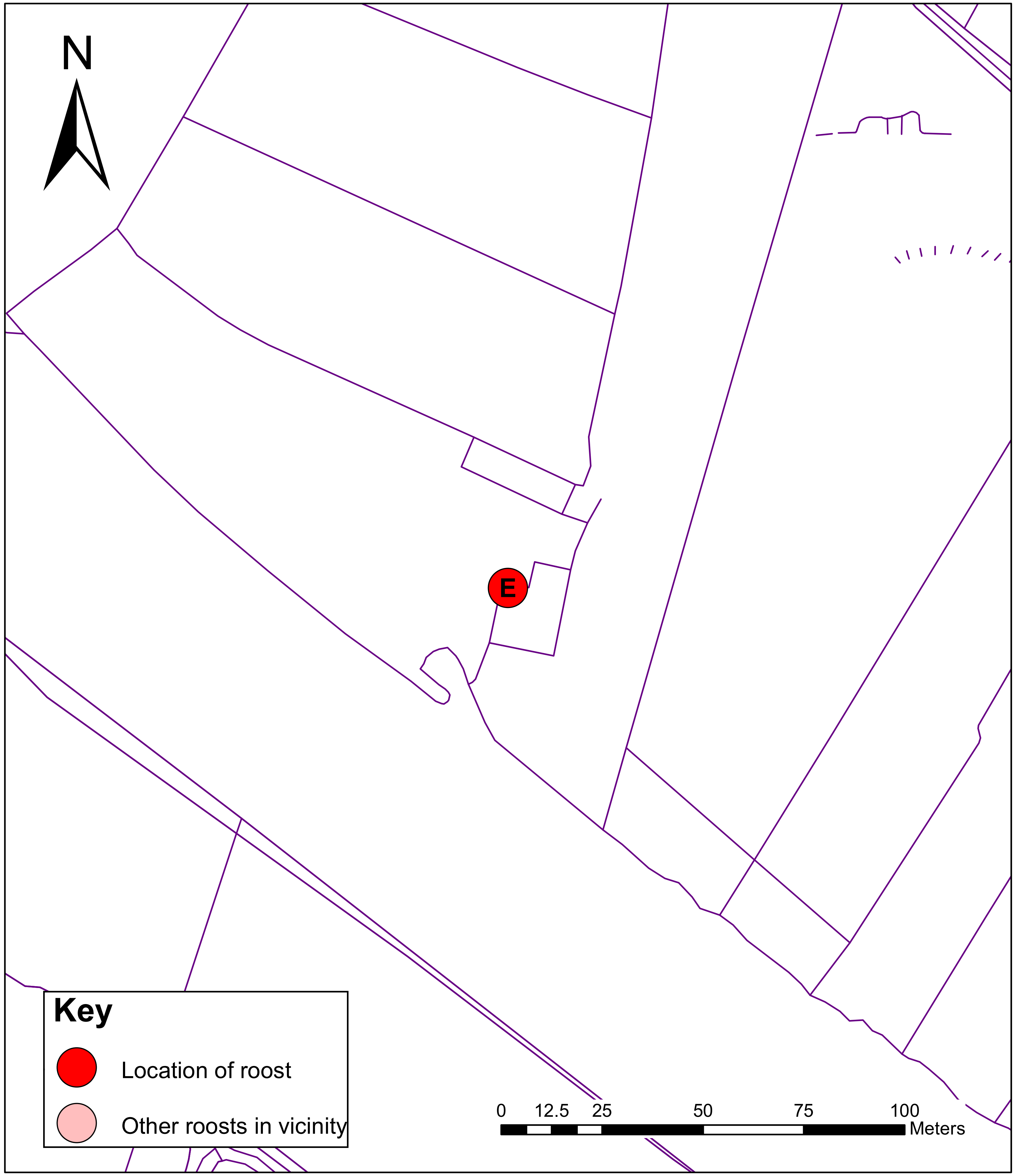
**ITM: 526370 728692**
**Location: Killeen House**

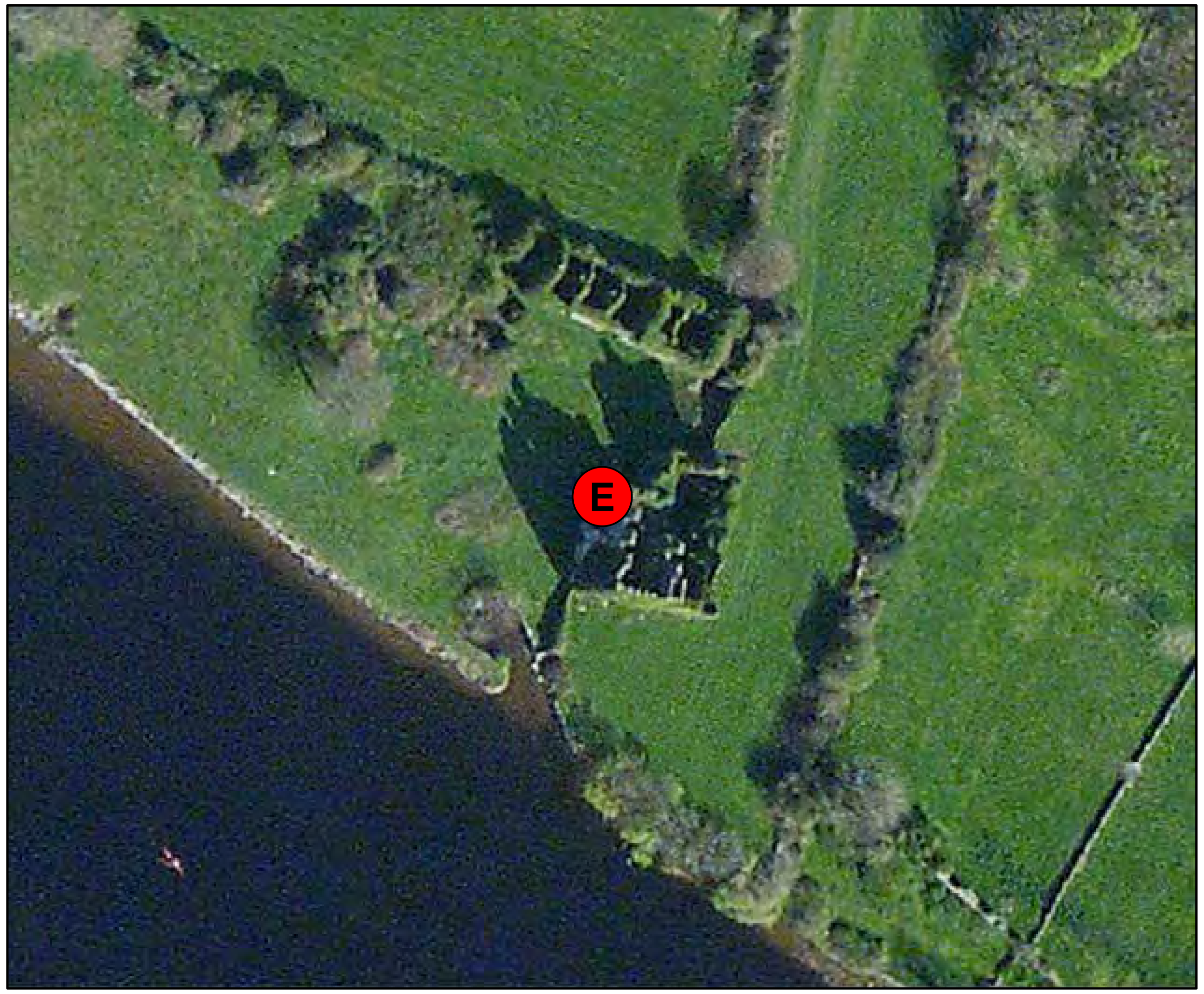
**Species: Daubenton's Sex: Female**
**Dates bats confirmed resident: 25th, 26th, 27th**

**Sheet 4 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost E

GCTP Radiotracking
August 2014

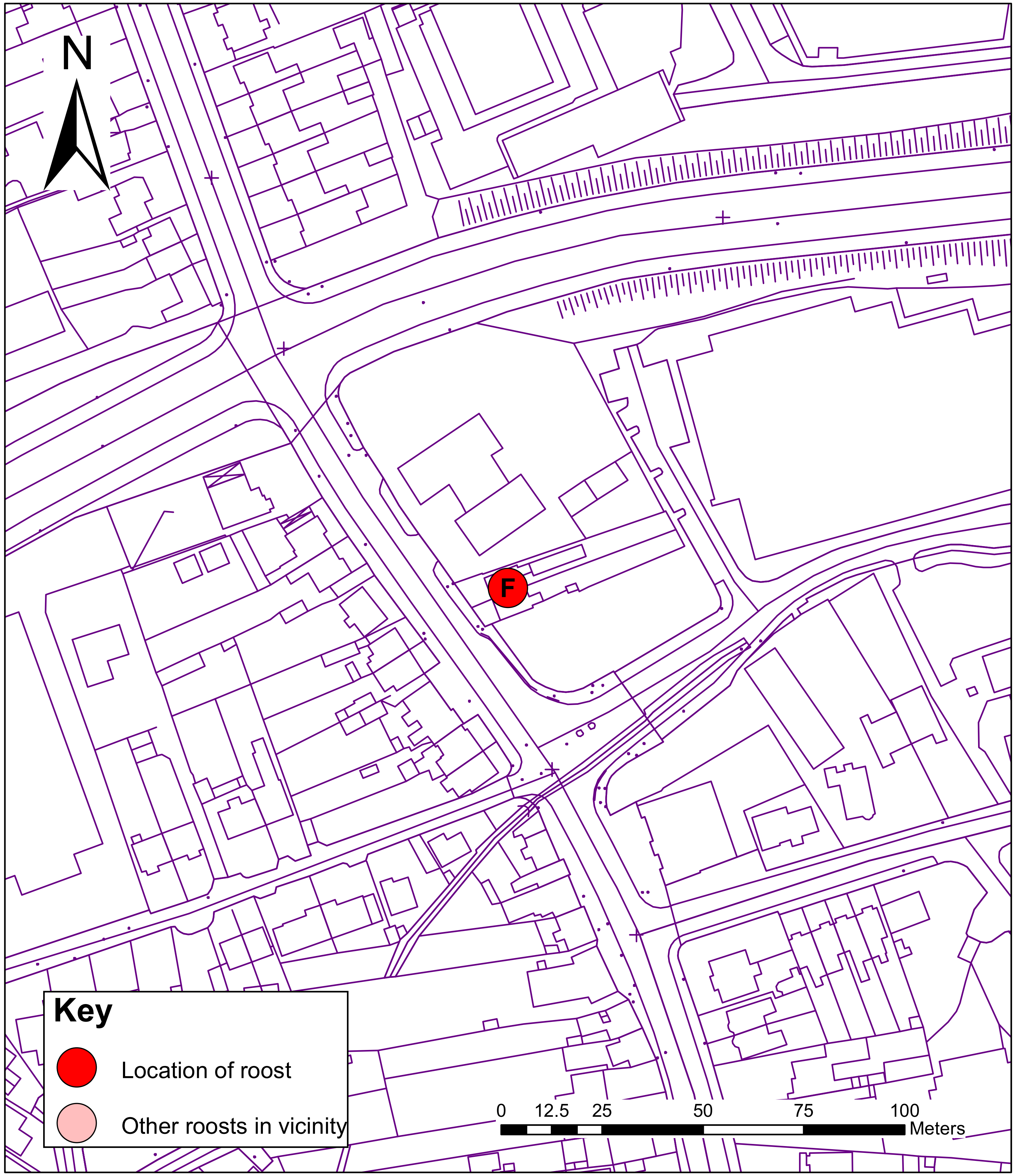
**ITM:** 528431 727907
**Location:** Menlo Castle

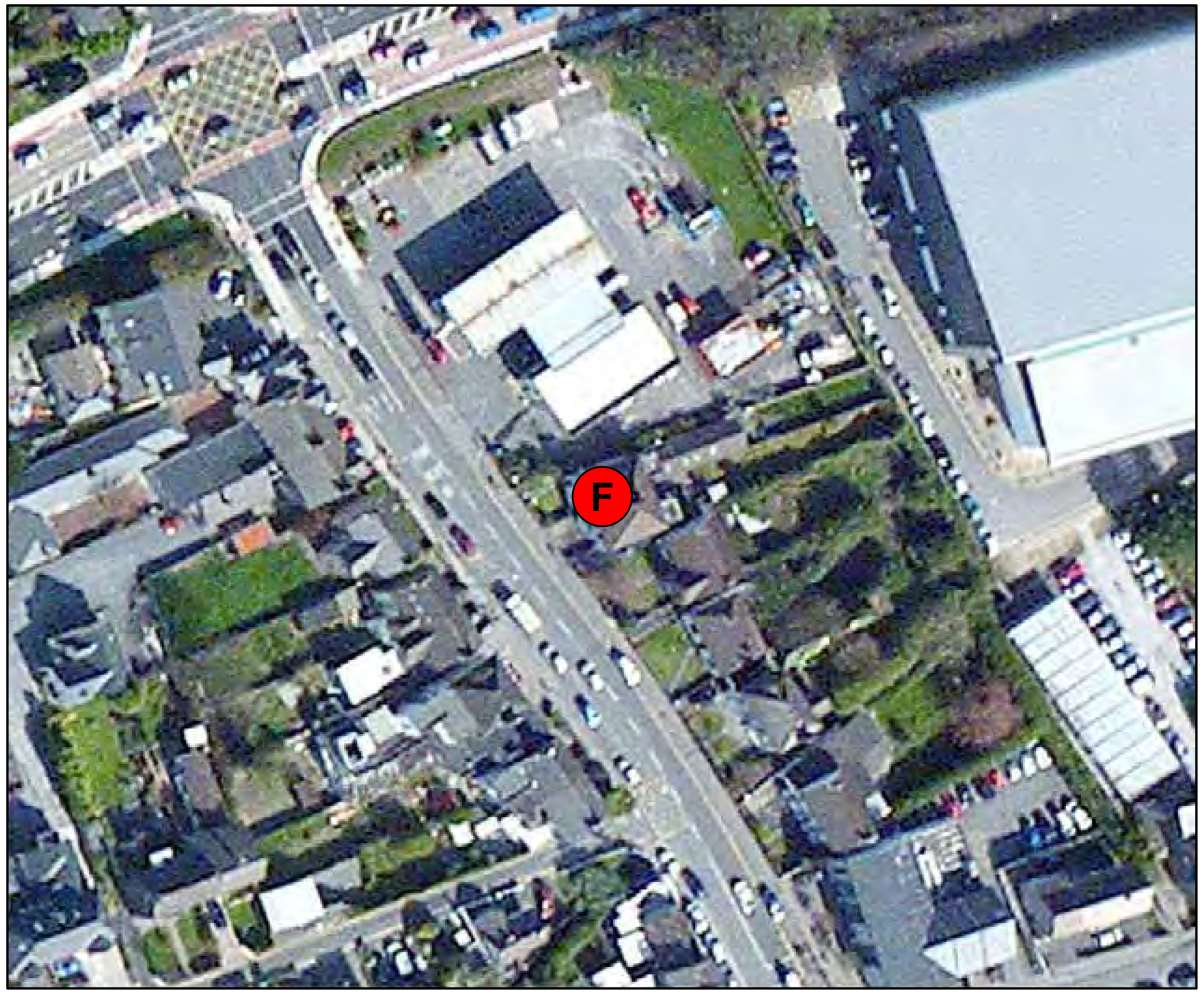
**Species:** Daubenton's **Sex:** Female
**Dates bats confirmed resident:** 24th, 25th, 26th, 27th, 28th, 29th

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology




## Roost F

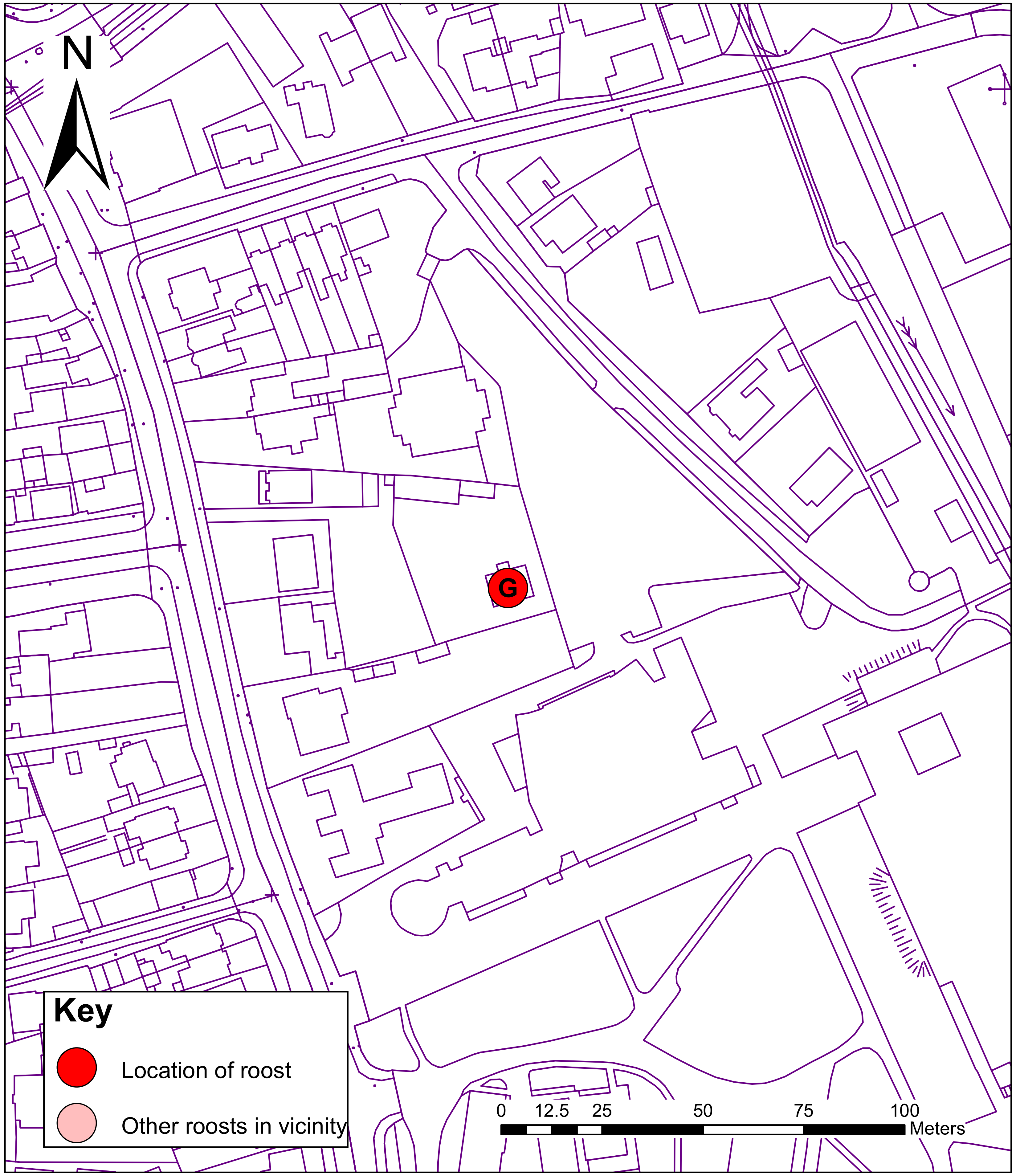
GCTP Radiotracking
August 2014

**ITM:** 528996 726229
**Location:** Women's Study Centre

**Species:** Daubenton's **Sex:** Male
**Dates bats confirmed resident:** 23rd, 24th

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





## Roost G

GCTP Radiotracking
August 2014

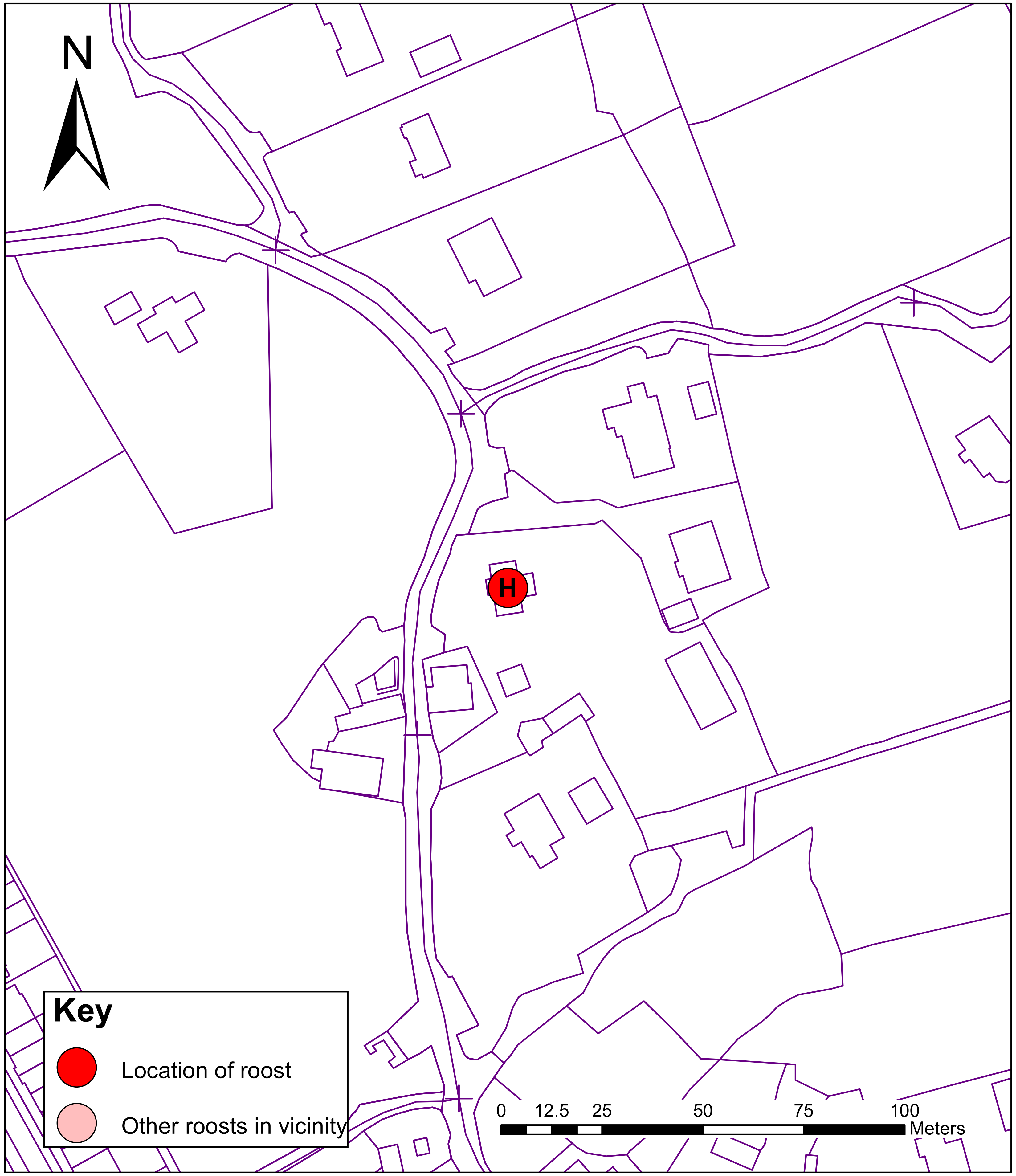
**ITM:** 529130 726060
**Location:** 51 St. Joseph's

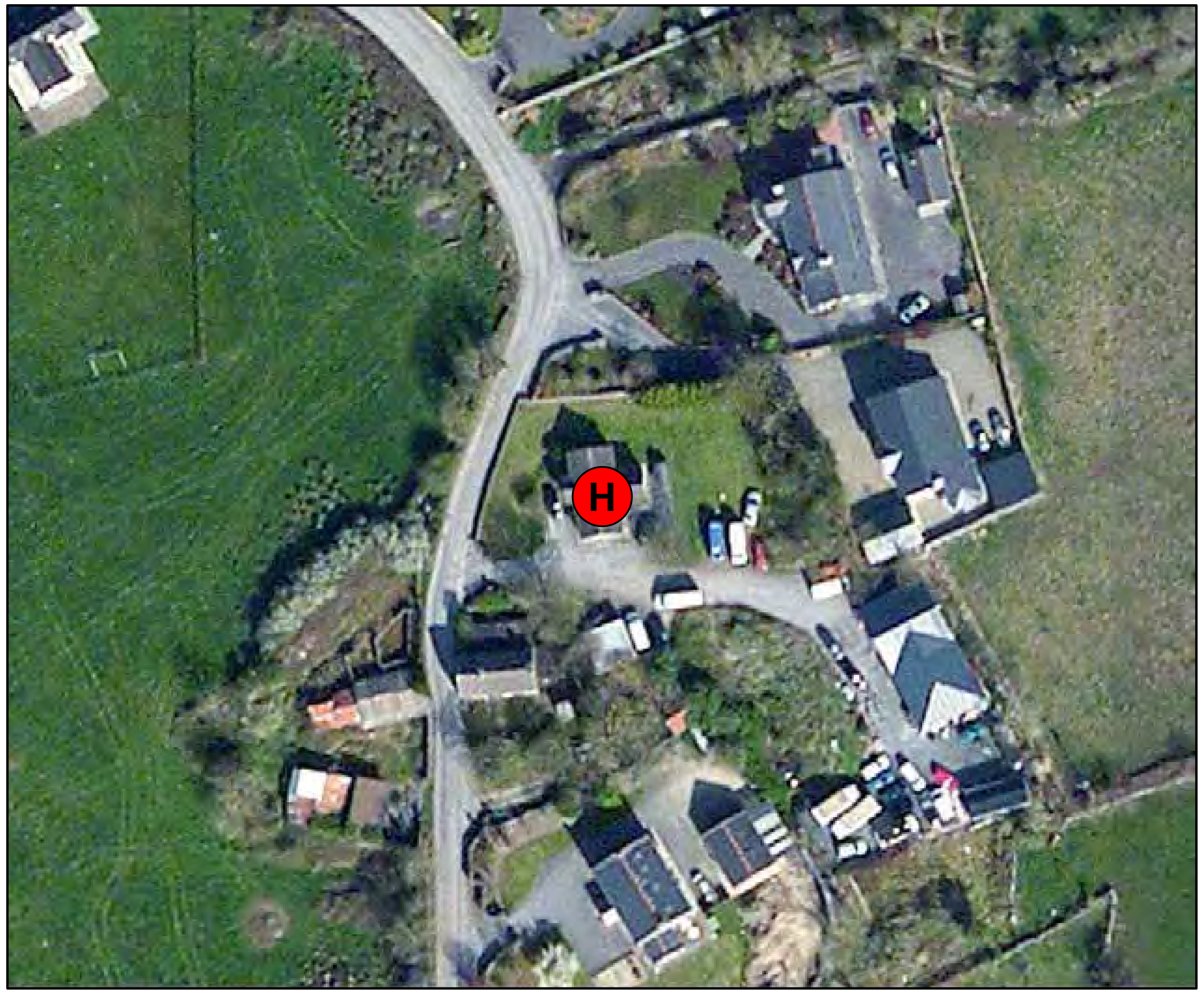
**Species:** Daubenton's **Sex:** Male
**Dates bats confirmed resident:** 25th

Sheet 7 of 16

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost H

GCTP Radiotracking
August 2014

**ITM:** 531925 728152
**Location:** Bungalow at Castle Gar

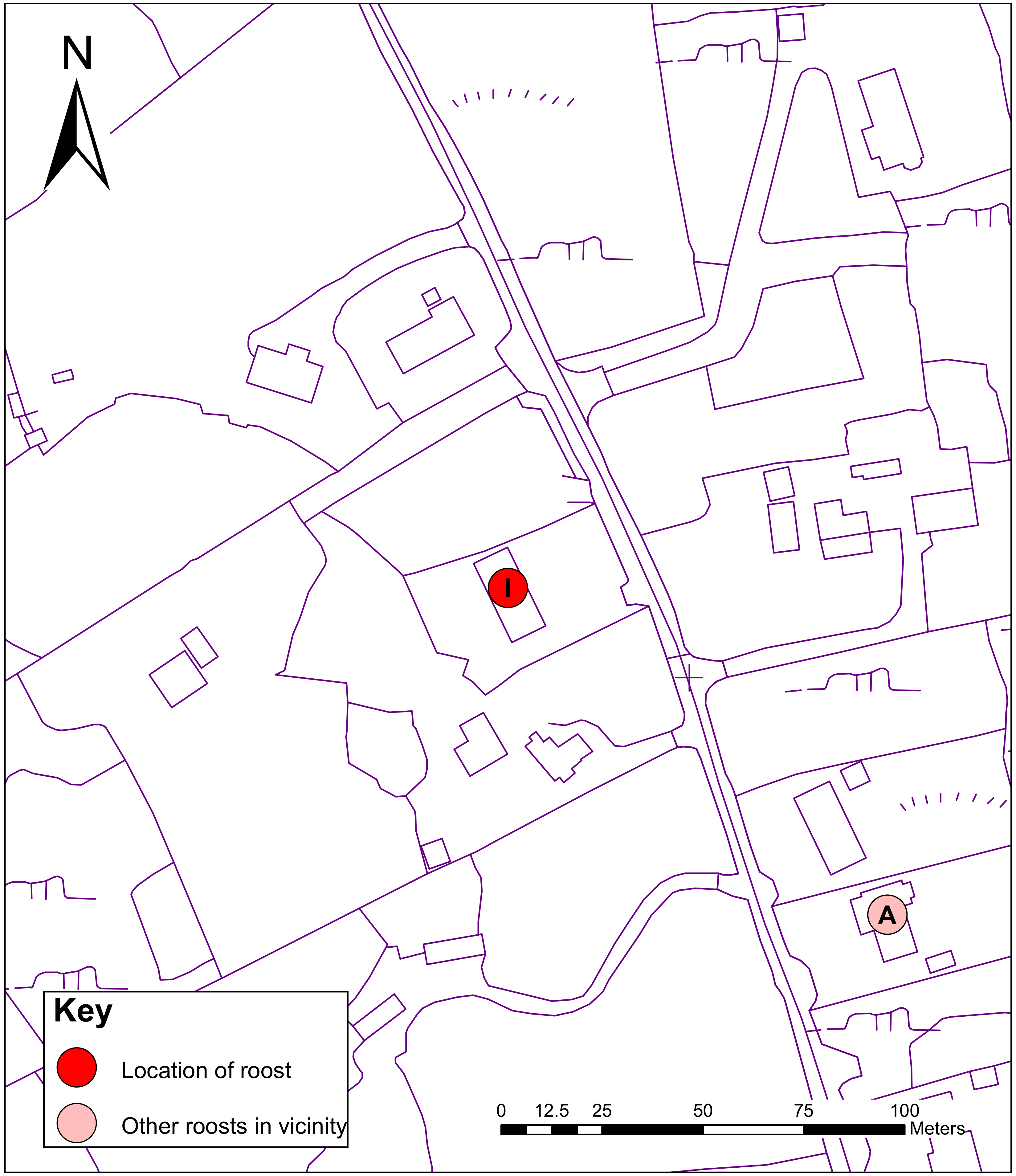
**Species:** Brown Long-eared **Sex:** Female
**Dates bats confirmed resident:** 24th, 25th, 26th, 27th, 28th, 29th

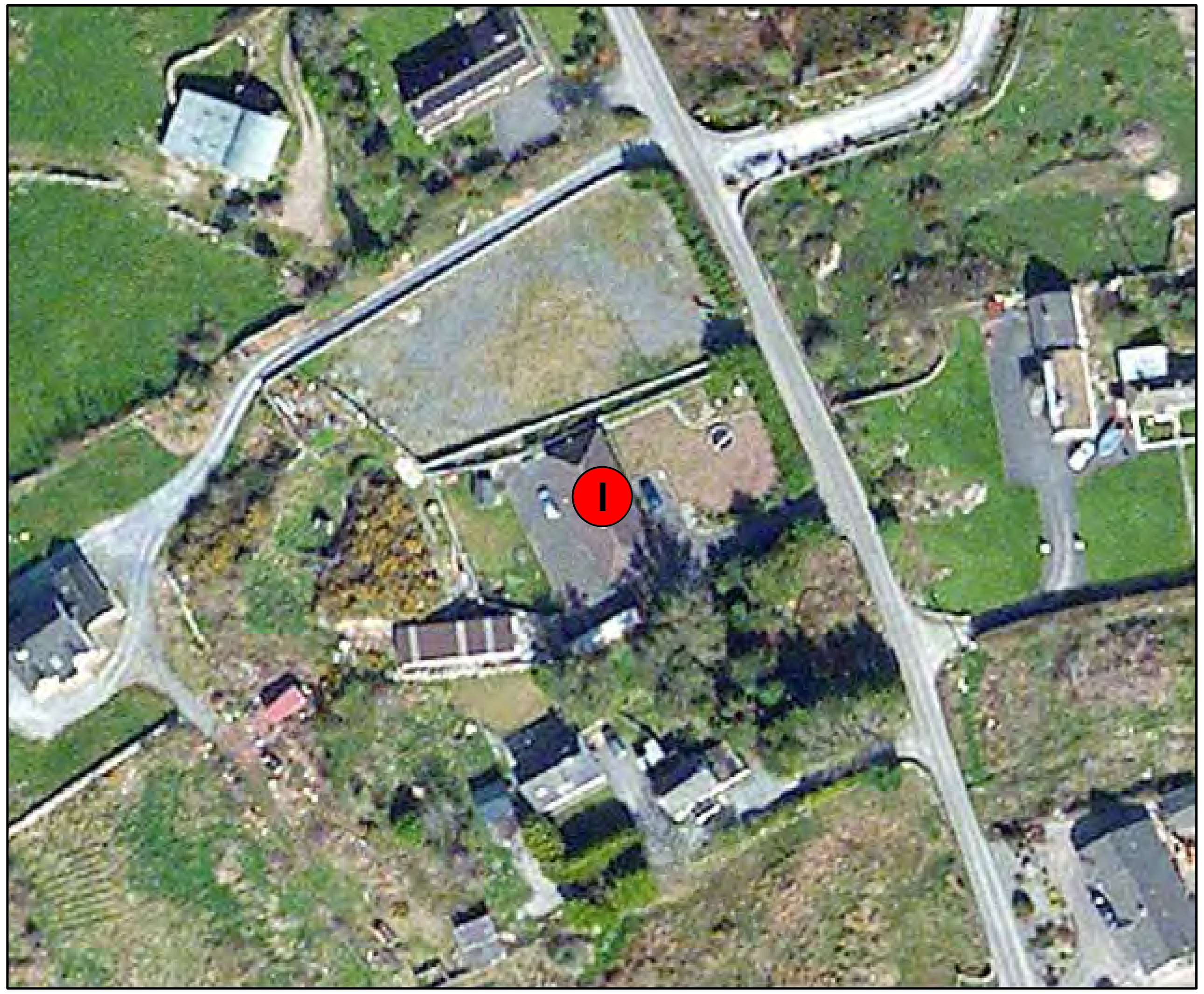
**Sheet 8 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology




## Roost I

GCTP Radiotracking
August 2014

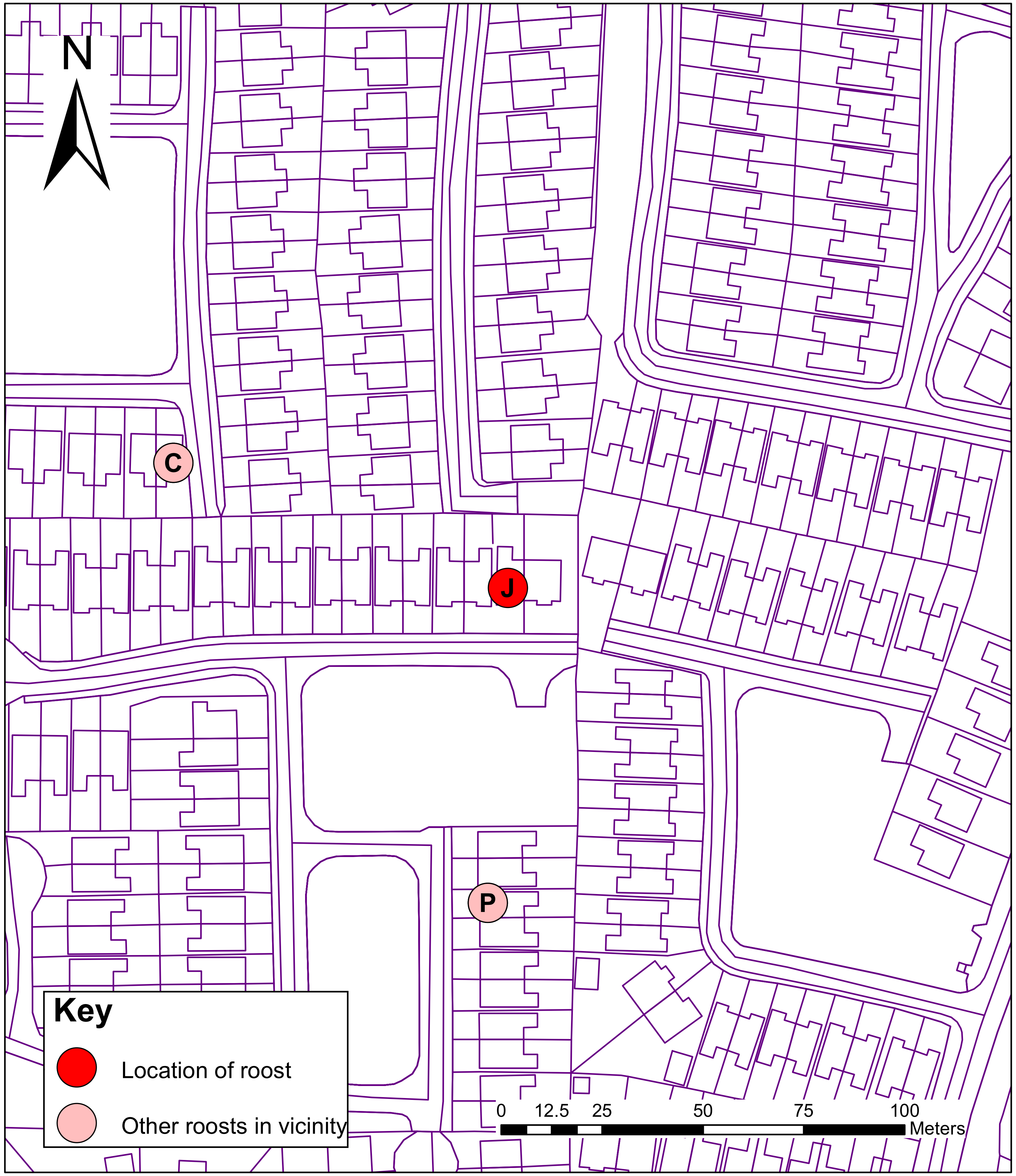
**ITM:** 524391 725205
**Location:** Residence. Cappagh Road

**Species:** Leisler's **Sex:** Male
**Dates bats confirmed resident:** 26th, 27th

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology





## Roost J

**GCTP Radiotracking**
**August 2014**

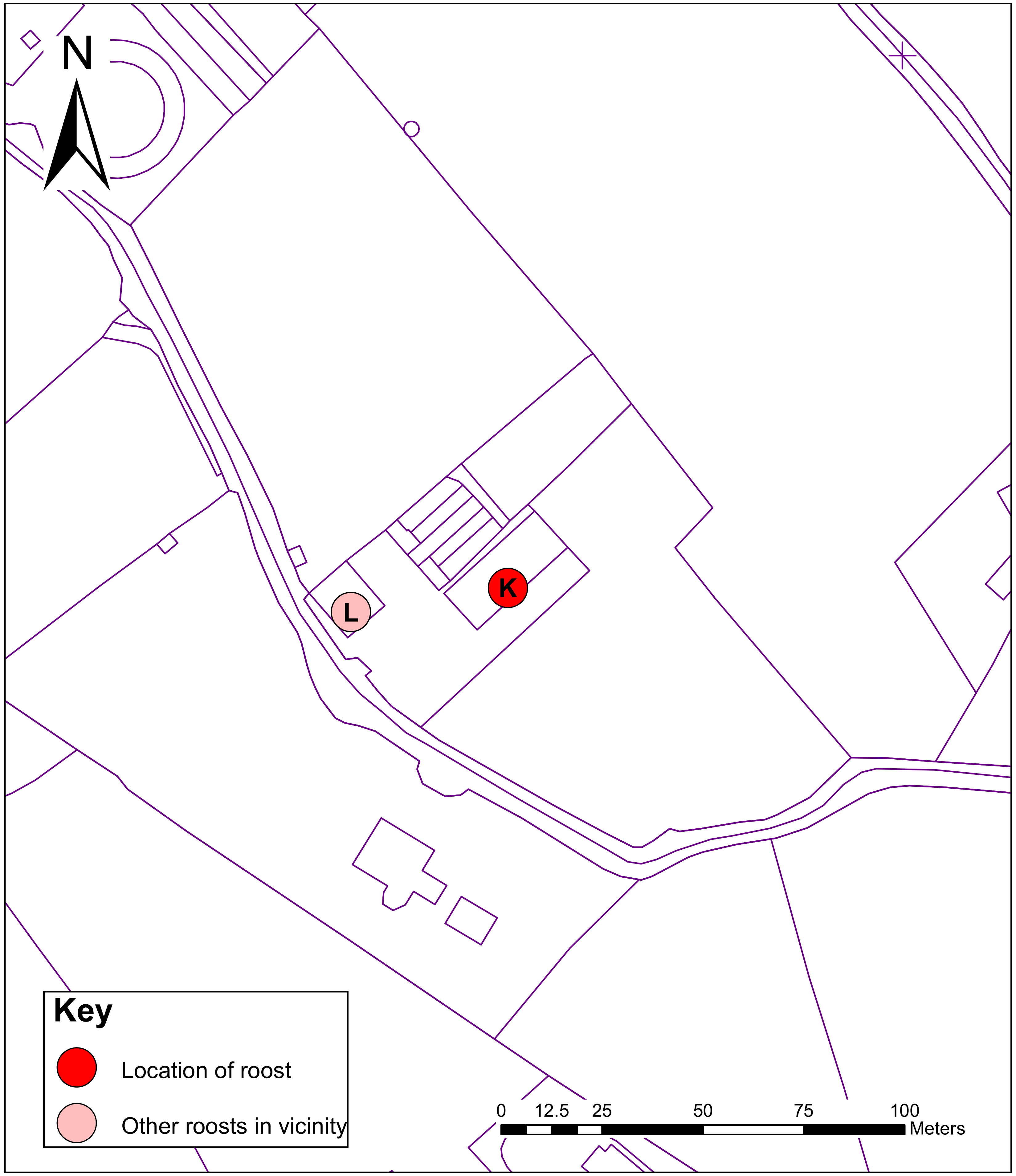
**ITM: 526439 725313**
**Location: Residence. Ballymoneen. 64 Sli Na Sruchan**

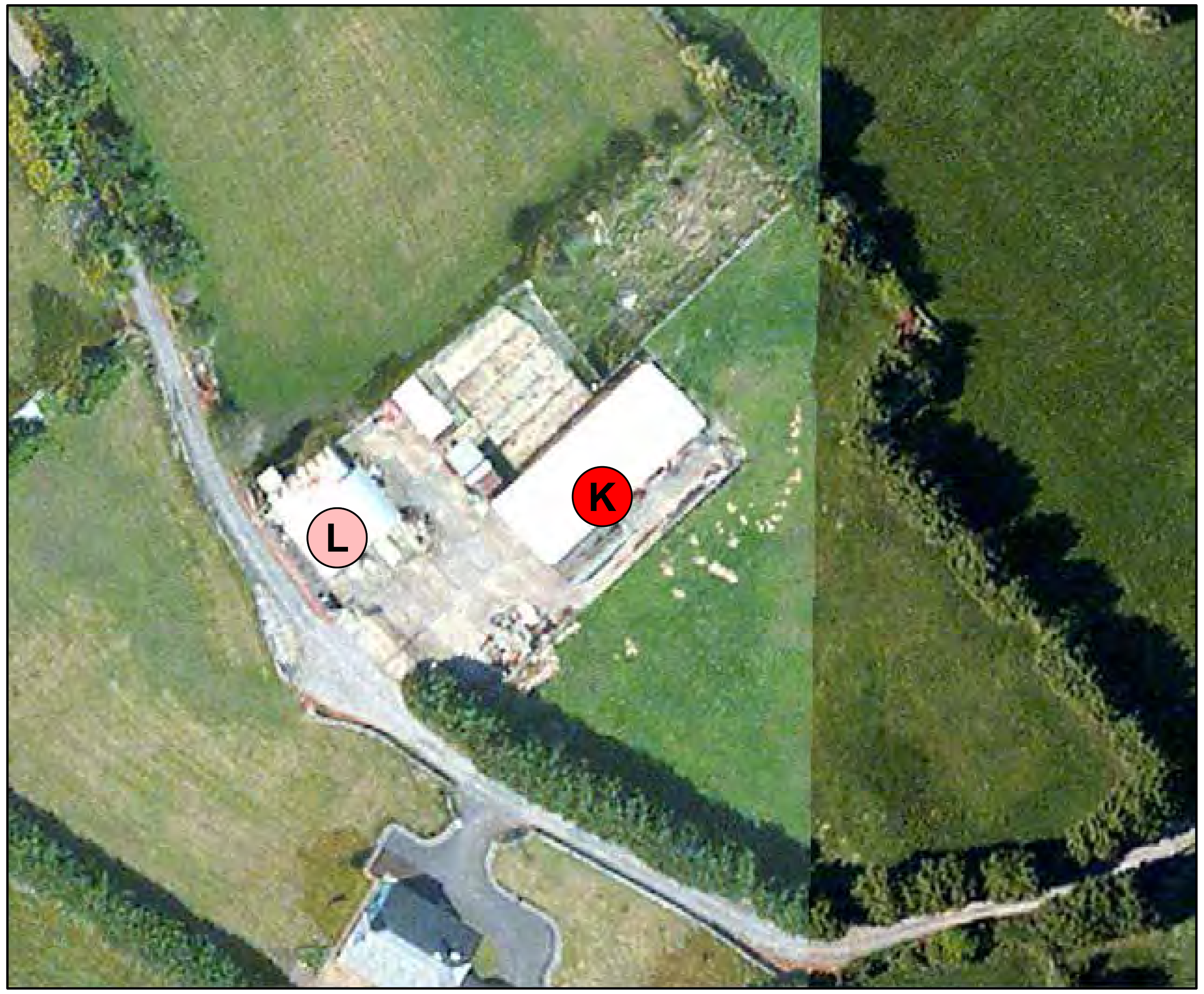
**Species: Common Pipistrelle Sex: Female**
**Dates bats confirmed resident: 26th, 27th**

**Sheet 10 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost K

GCTP Radiotracking
August 2014

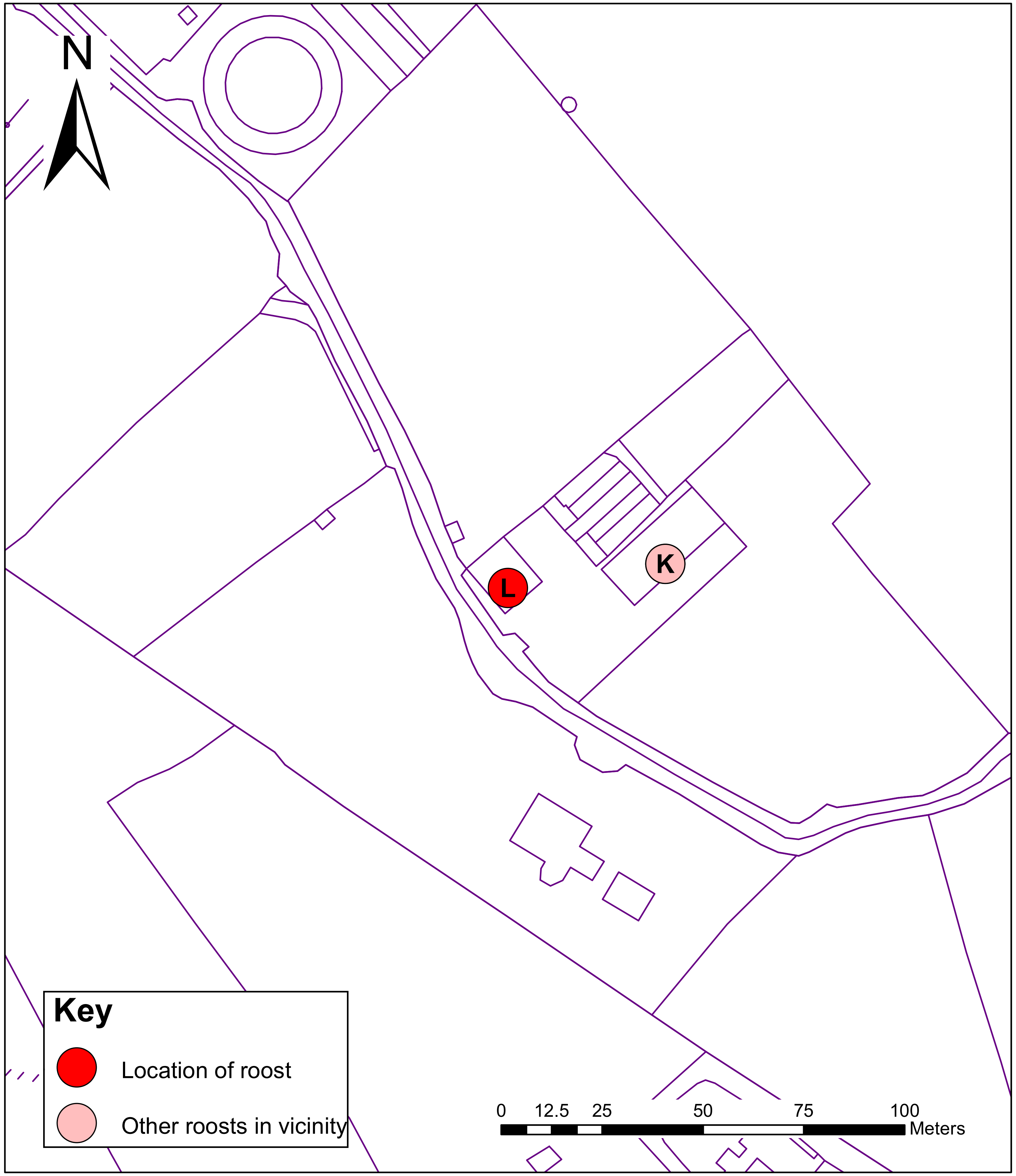
**ITM:** 533542 730077
**Location:** Cluanacauneen

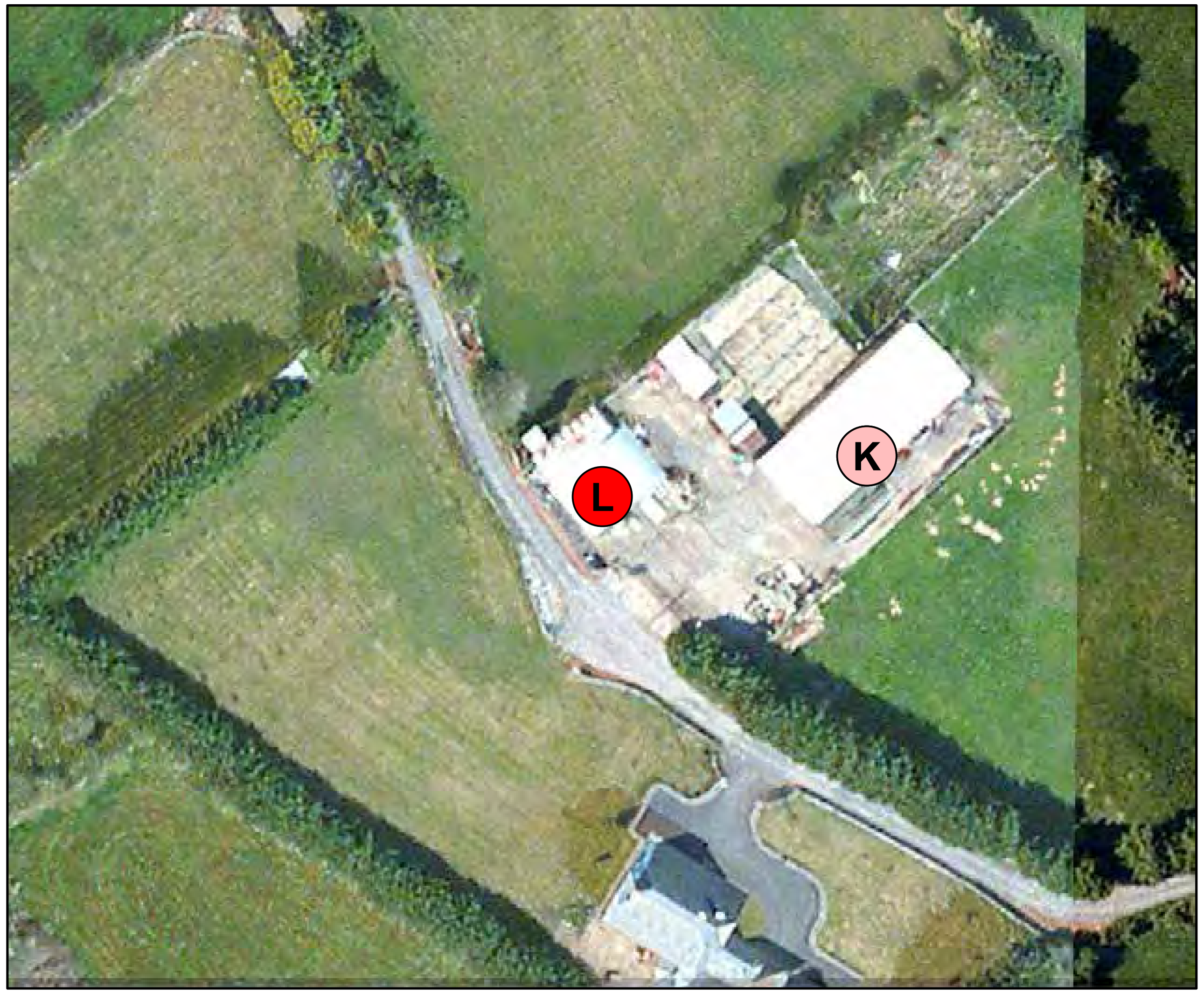
**Species:** Common Pipistrelle **Sex:** Male
**Dates bats confirmed resident:** 25th, 26th

**Sheet 11 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost L

GCTP Radiotracking
August 2014

**ITM:** 533503 730071
**Location:** barn nr roost K

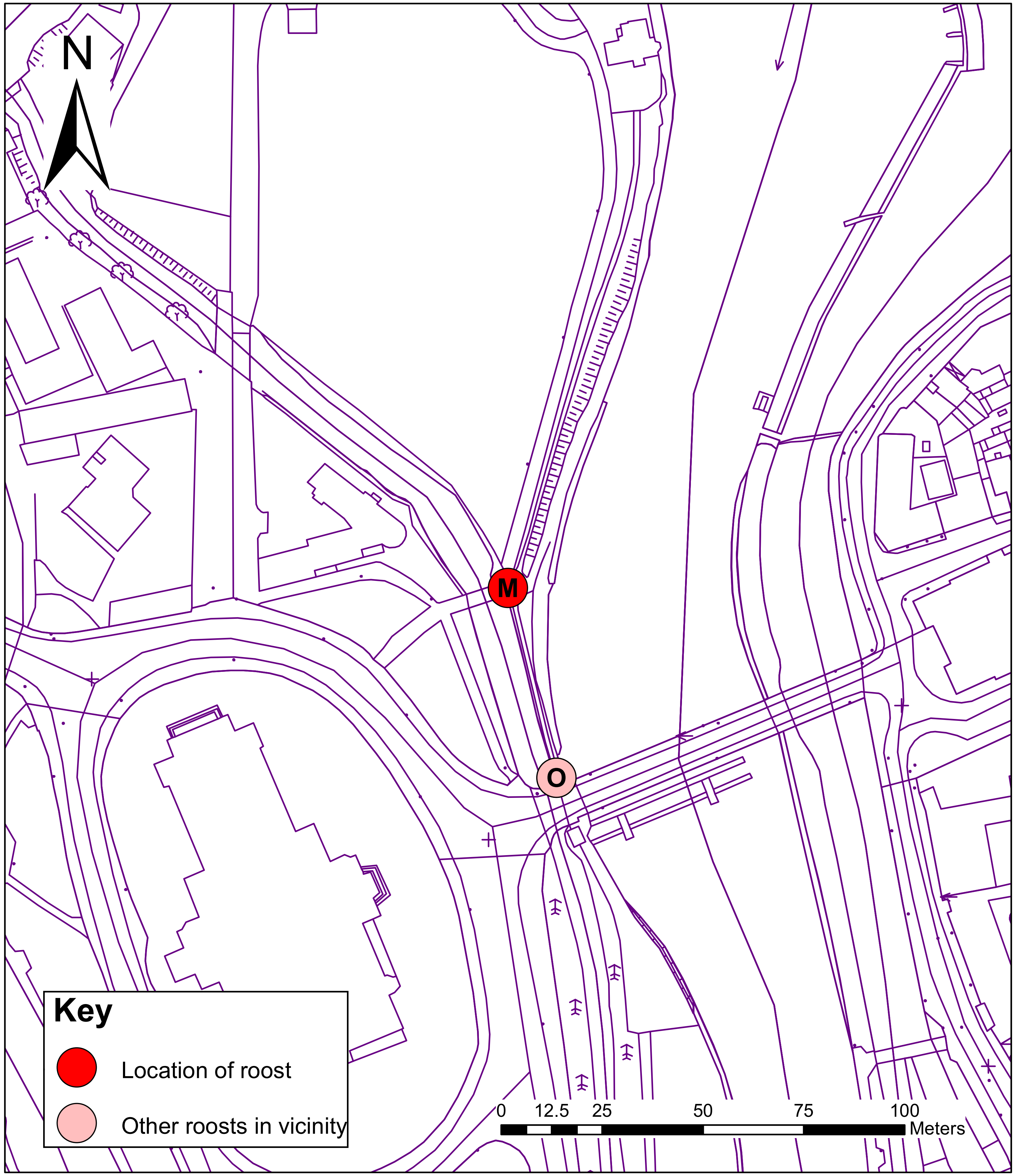
**Species:** Common Pipistrelle **Sex:** Male
**Dates bats confirmed resident:** 28th

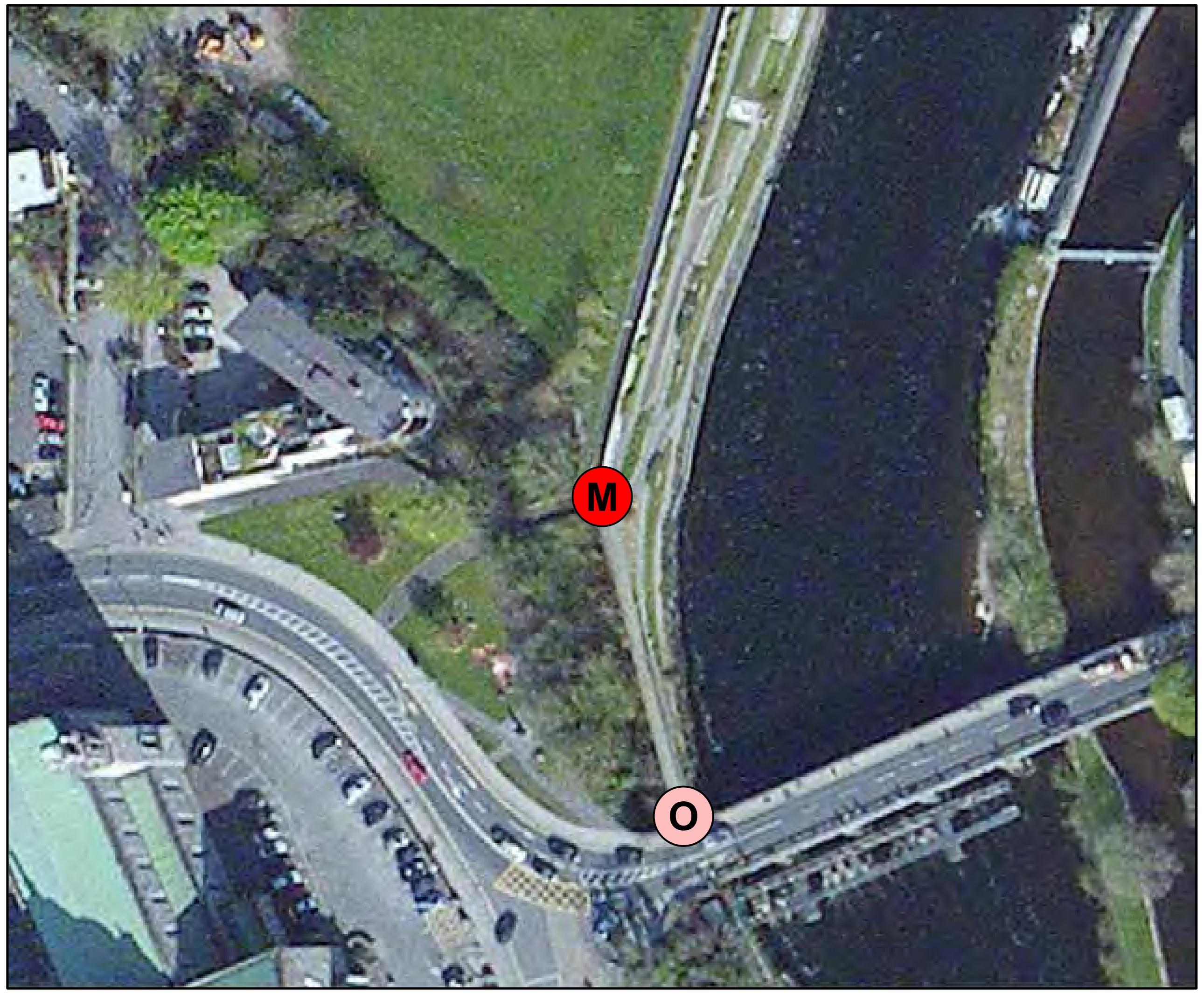
**Sheet 12 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology




## Roost M

GCTP Radiotracking
August 2014

**ITM:** 529520 725588
**Location:** Cathedral footbridge

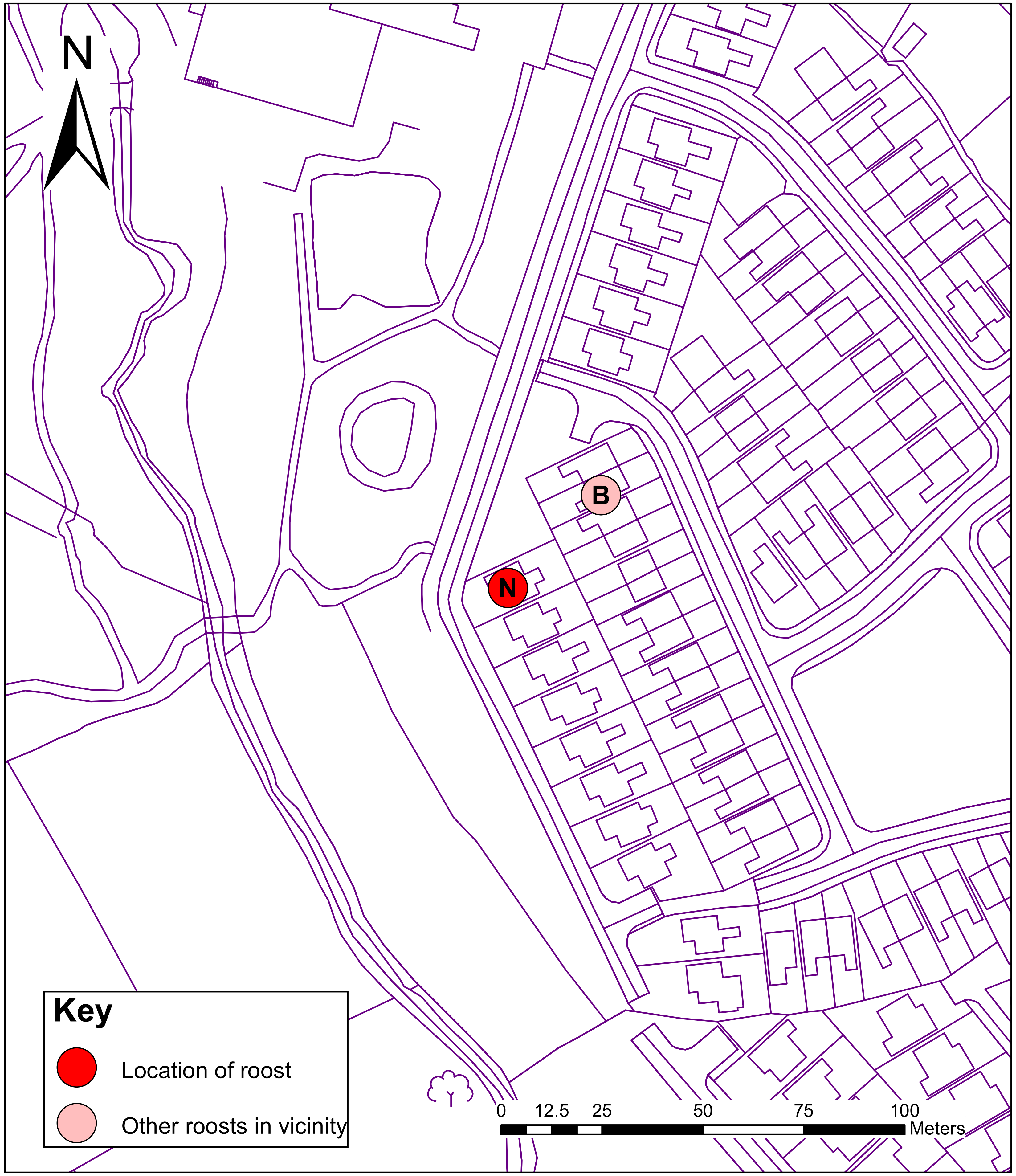
**Species:** Daubenton's **Sex:** Male
**Dates bats confirmed resident:** 28th

**Sheet 13 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P

Ecology and Geology





## Roost N

GCTP Radiotracking
August 2014

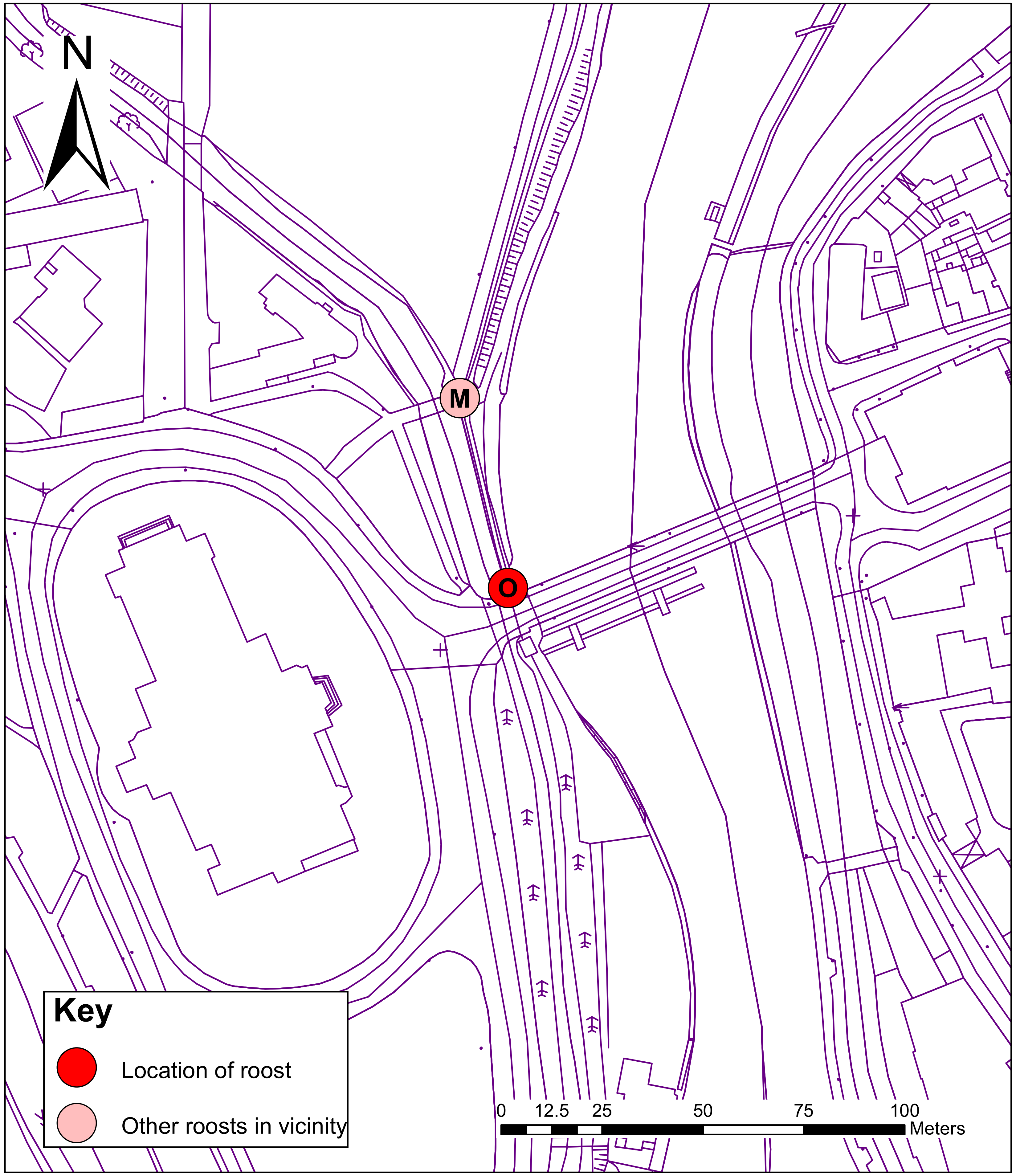
**ITM:** 524591 724159
**Location:** Ard Na Coille. Residence behind Sport's centre

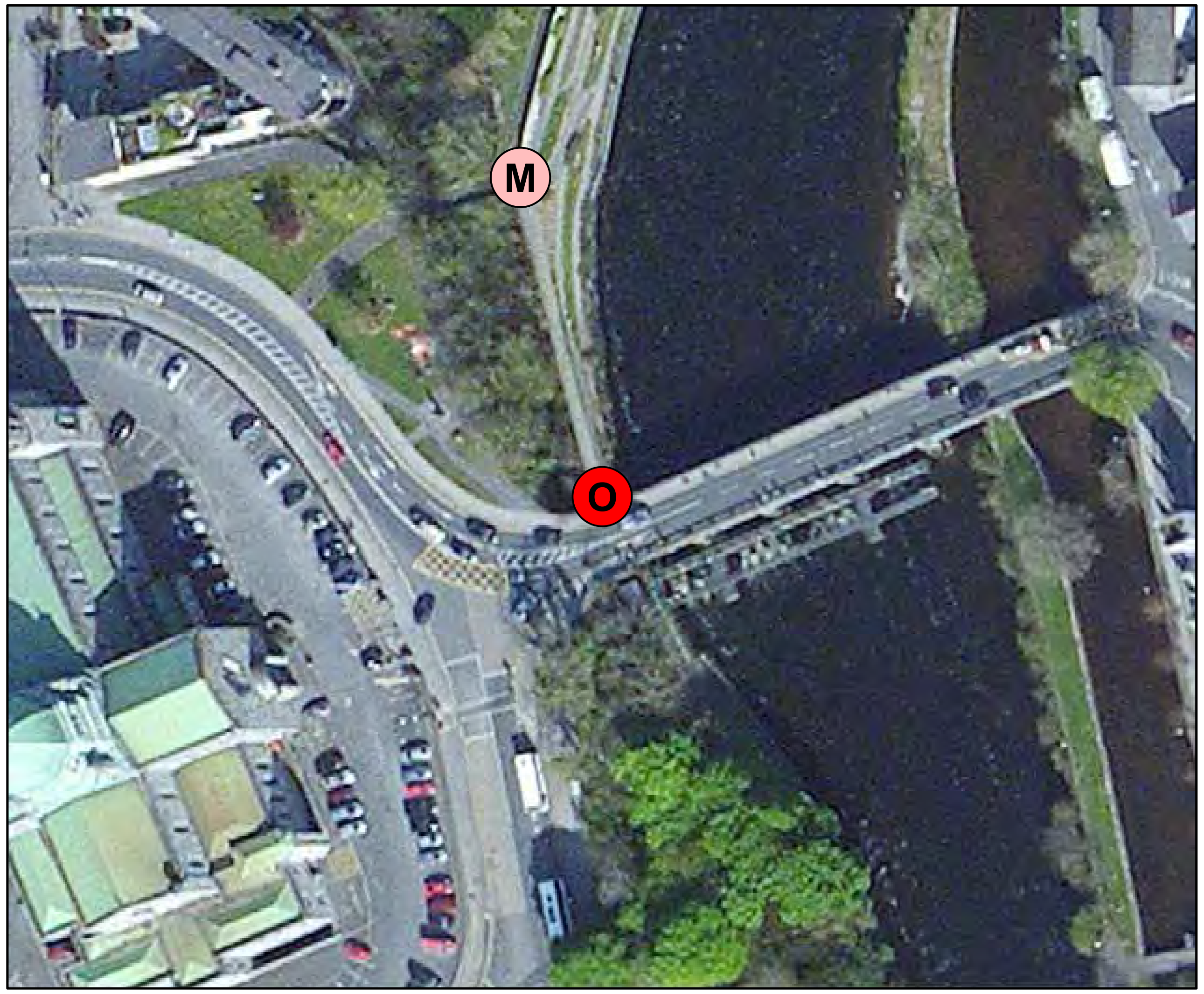
**Species:** Whiskered **Sex:** Male
**Dates bats confirmed resident:** 29th

**Note: Roost B backs on to Roost N. Although signal strength indicates separate roosts, would need to be between buildings to be certain.**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P




## Roost O

**GCTP Radiotracking**
**August 2014**

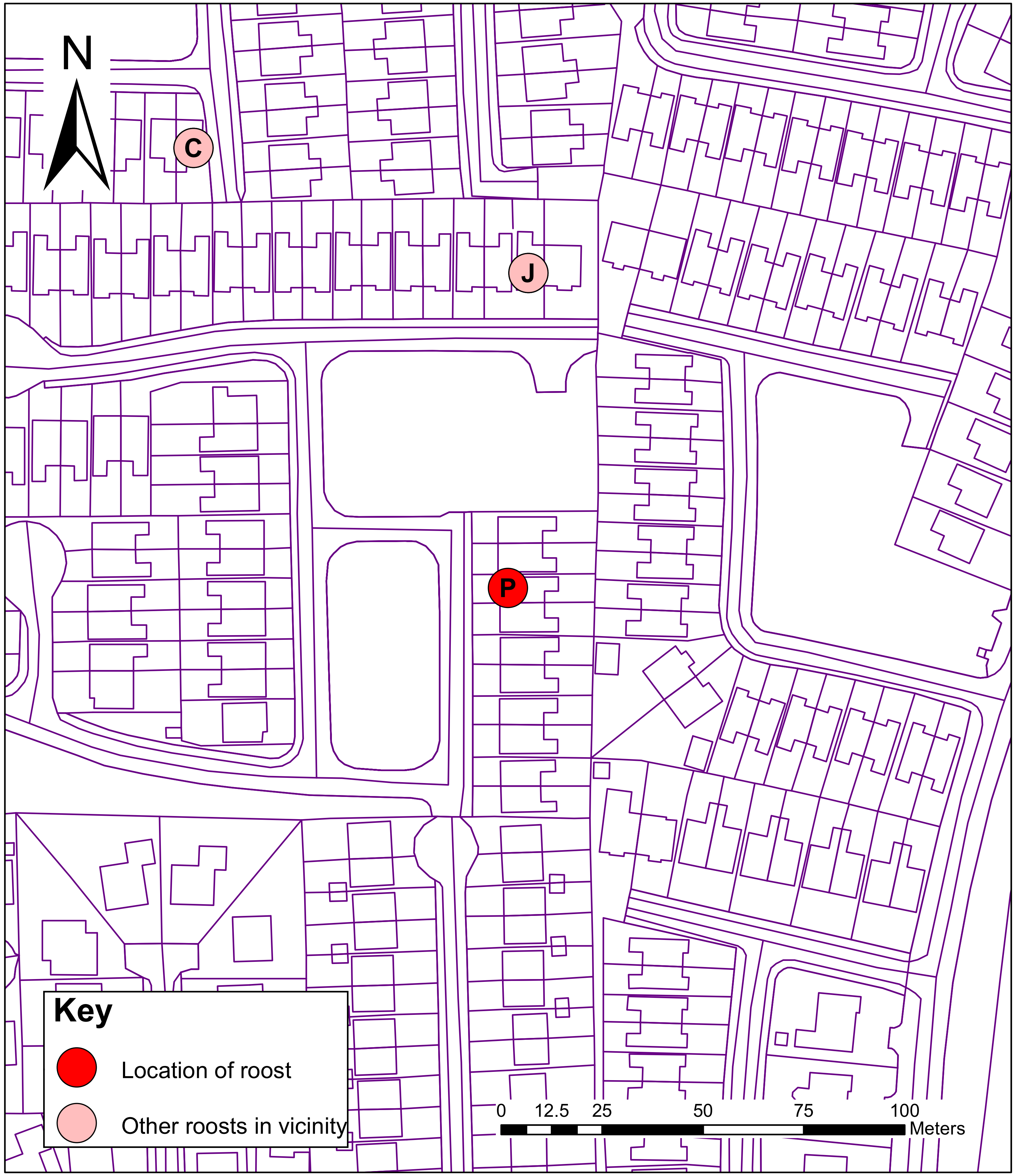
**ITM: 529532 725541**
**Location: Salmon Wier Bridge**

**Species: Daubenton's Sex: Male**
**Dates bats confirmed resident: 29th**

**Sheet 15 of 16**

# GCTP: Roost Locations From Radiotracking

Figs 2A to 2P





## Roost P

GCTP Radiotracking
August 2014

**ITM:** 526434 725235
**Location:** Residence. Ballymoneen. 68 Sli Na Sruchan

**Species:** Common Pipistrelle **Sex:** Female
**Dates bats confirmed resident:** 29th

**Sheet 16 of 16**

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

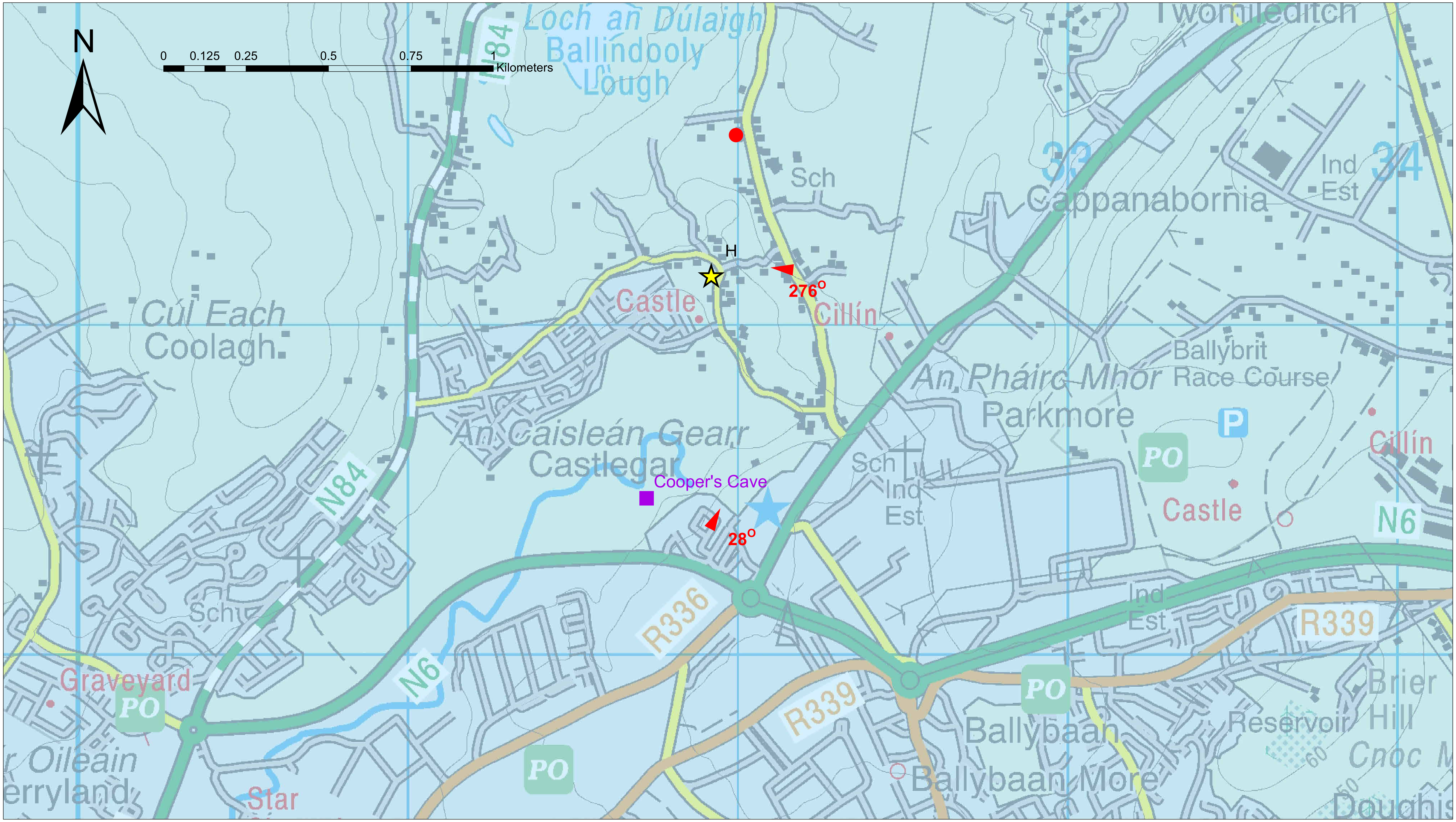



**Figure 3A**
Species: Brown Long-eared
Frequency: 173.395
Sex: Female    Breeding Condition: Y

Trapping Location:
Cooper's Cave, ITM 531729 727476, Date 21/08/2014
Roosts:
H. ITM 531925 728152. Dates resident: 24th, 25th, 26th, 27th, 28th, 29th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats


**Figure 3B**
Species: Daubenton's
Frequency: 173.459
Sex: Female    Breeding Condition: N

Trapping Location:
Merlin Woods, ITM 533450 725600, Date 19/08/2014
Roosts:
D. ITM 526370 728692. Dates resident: 25th, 26th, 27th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

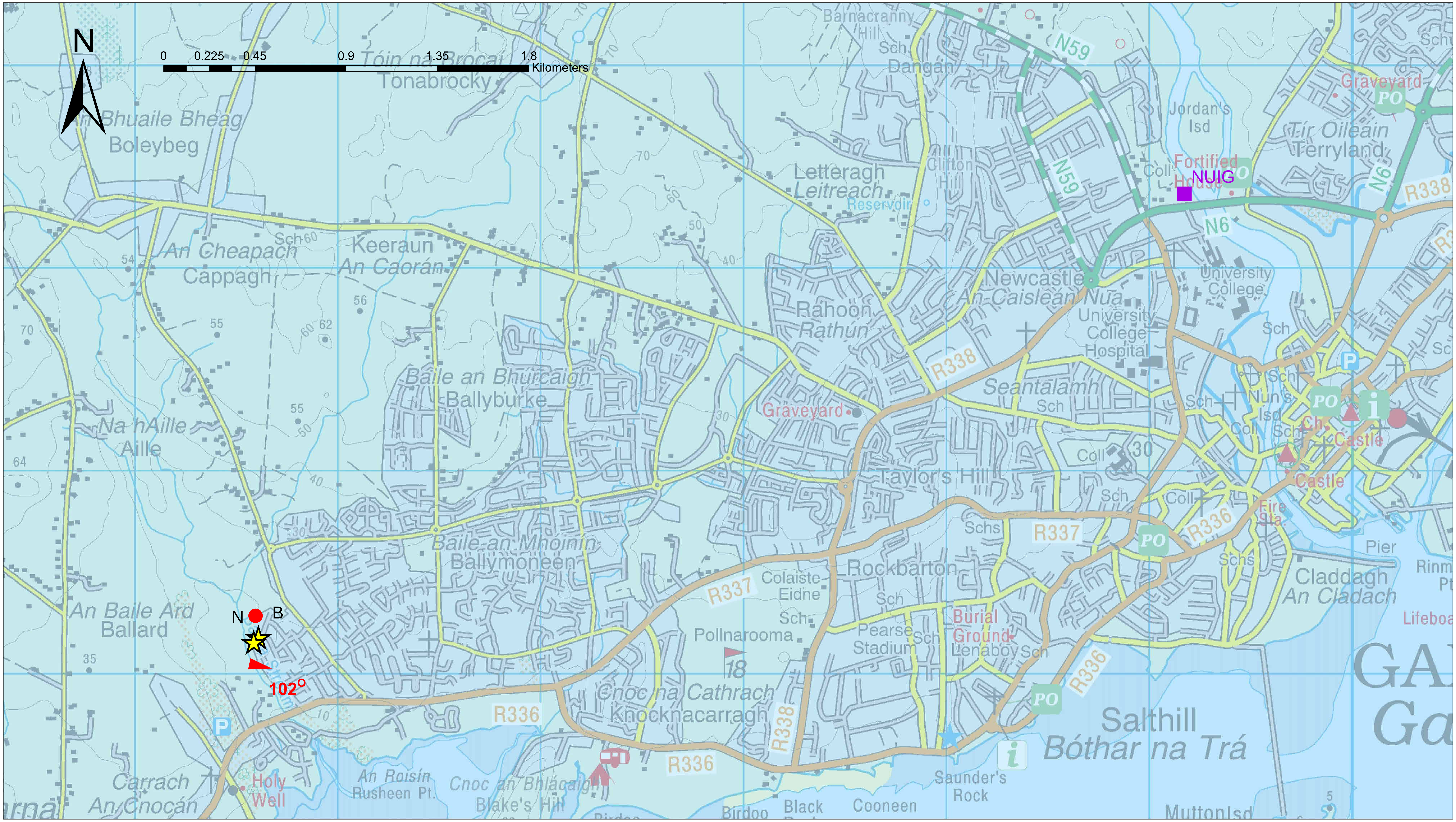



**Figure 3C**
Species: Whiskered
Frequency: 173.414
Sex: Male    Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
B. ITM 524614 724182. Dates resident: 24th, 25th, 26th
N. ITM 524591 724159. Dates resident: 29th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

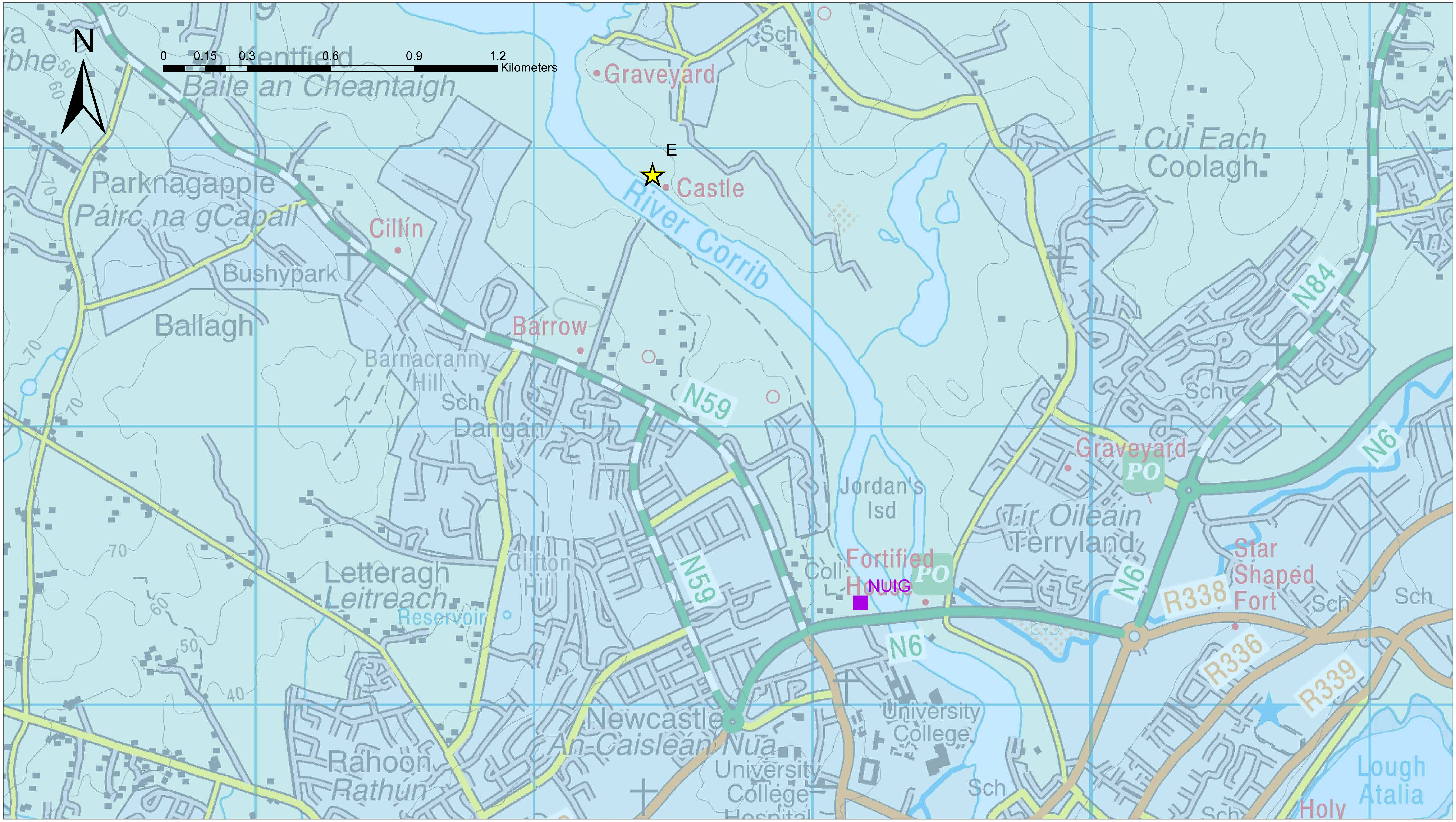



**Figure 3D**
Species: Daubenton's
Frequency: 173.252
Sex: Female    Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
E. ITM 528431 727907. Dates resident: 24th, 25th, 26th, 27th, 28th, 29th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Eckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

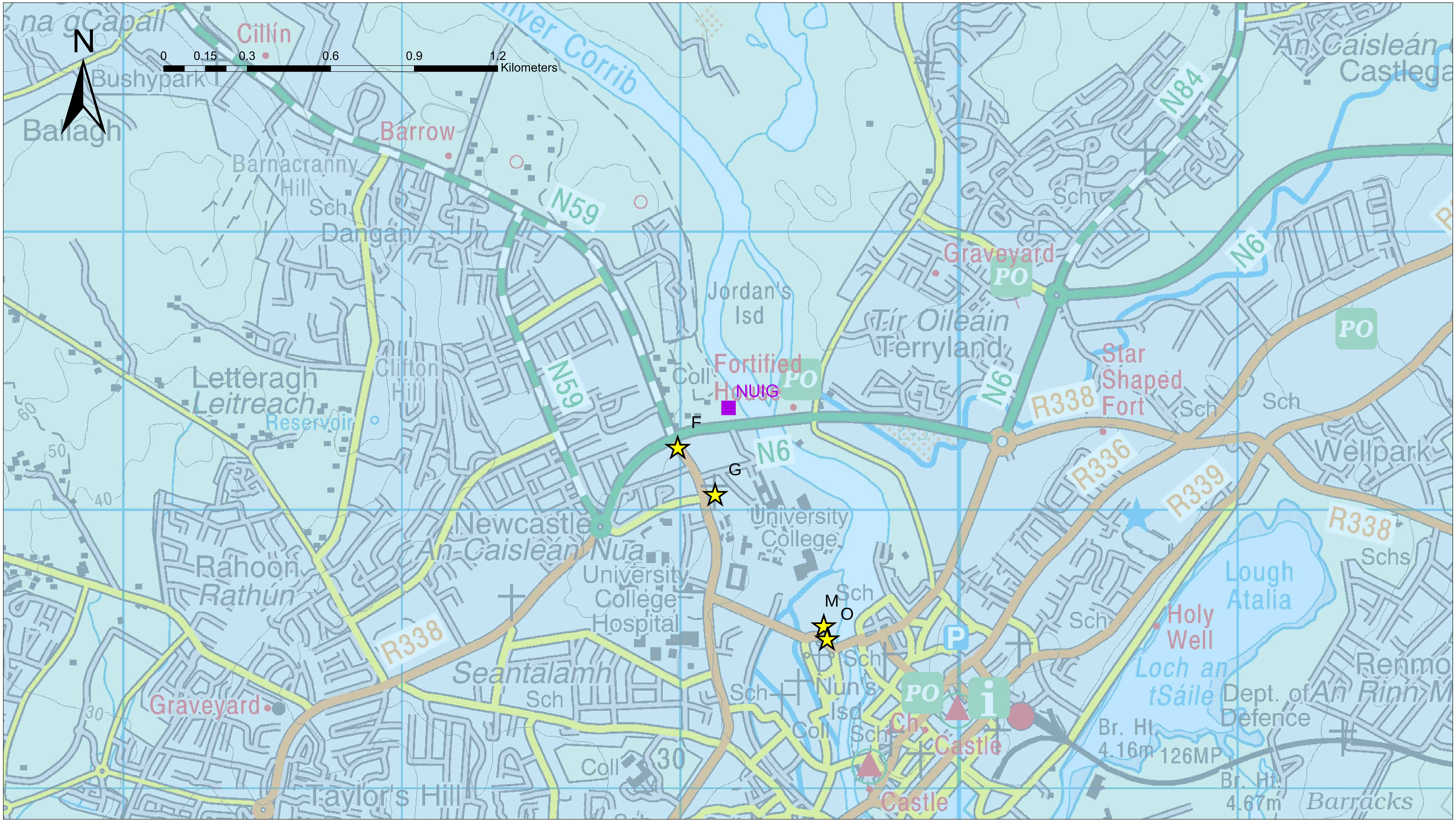



**Figure 3E**
Species: Daubenton's
Frequency: 173.297
Sex: Male    Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
F. ITM 528996 726229. Dates resident: 24th
G. ITM 529130 726060. Dates resident: 25th
M. ITM 529520 725588. Dates resident: 28th
O. ITM 529532 725541. Dates resident: 29th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

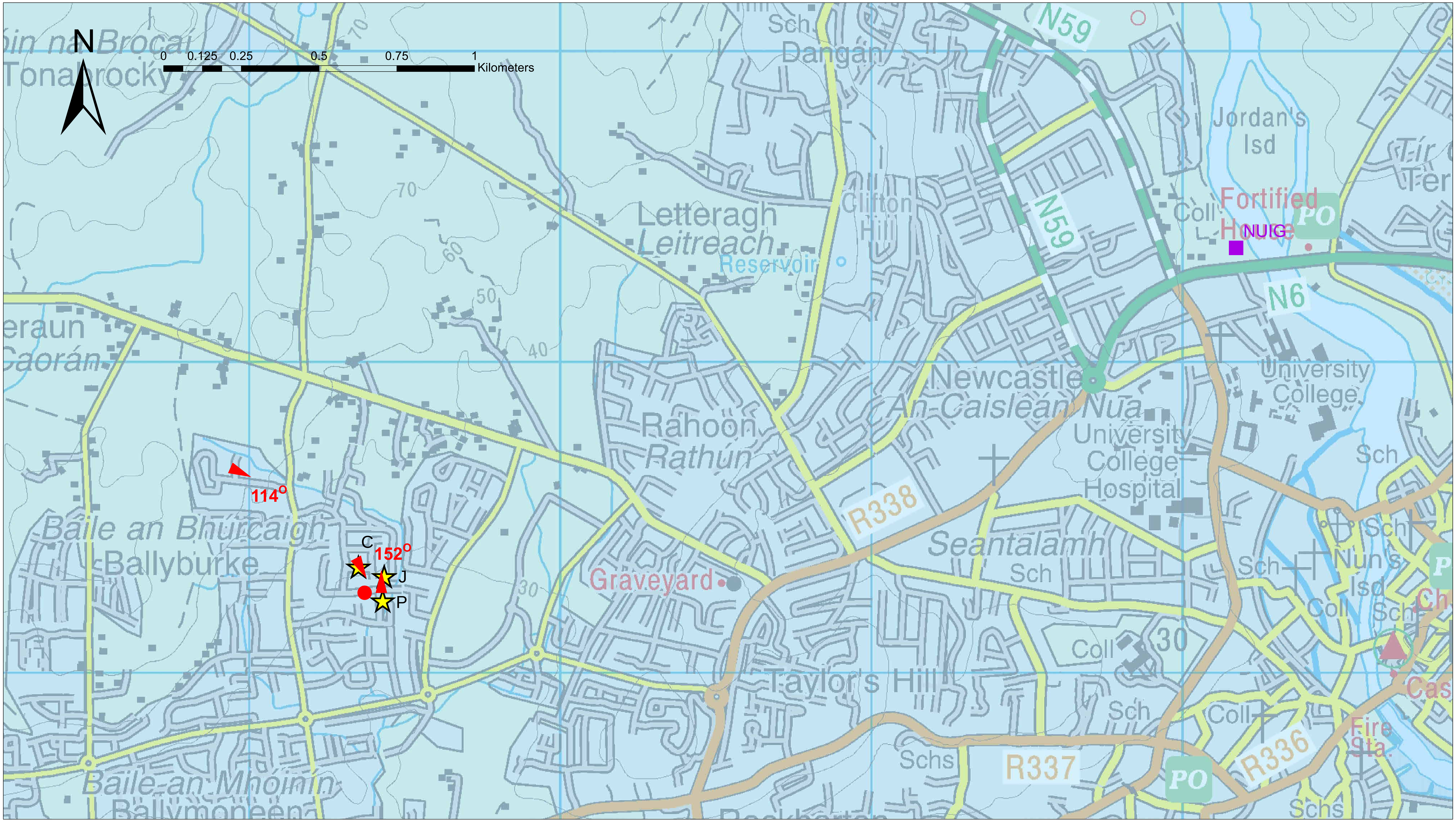



**Figure 3F**
Species: Common Pipistrelle
Frequency: 173.361
Sex: Femle    Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
C. ITM 526356 725344. Dates resident: 24th, 25th
J. ITM 526439 725313. Dates resident: 26th, 27th
P. ITM 526434 725235. Dates resident: 29th

**Key**
Fix with bearing
Fix without bearing
Tag Site
Roost

Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats

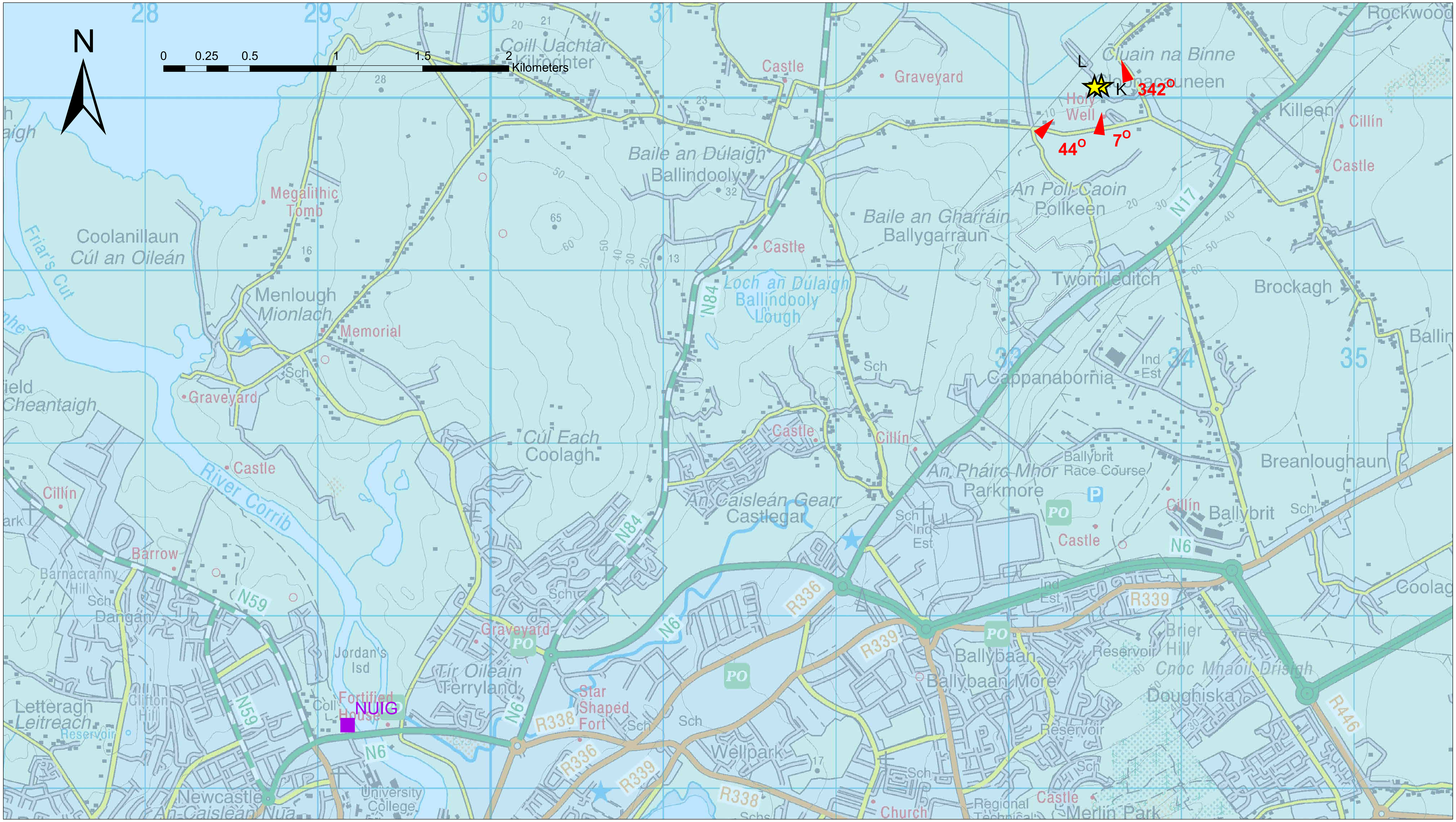



**Figure 3G**
Species: Common Pipistrelle
Frequency: 173.323
Sex: Male    Breeding Condition: N

Trapping Location:
NUIG, ITM 529178 726369, Date 22/08/2014
Roosts:
K. ITM 533542 730077. Dates resident: 25th, 26th
L. ITM 533503 730071. Dates resident: 28th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats


**Figure 3H**
Species: Leisler's
Frequency: 173.438
Sex: Male    Breeding Condition: Y

Trapping Location:
Barna Woods, ITM 524400 723800, Date 20/08/2014
Roosts:
Roost not located. Foraging data only

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Figures 3A-3I. Detailed Radiotracking: Individual Bats


**Figure 3I**
Species: Leisler's
Frequency: 173.535
Sex: Male    Breeding Condition: Y

Trapping Location:
Barna Woods, ITM 524400 723800, Date 20/08/2014
Roosts:
A. ITM 524485 725124. Dates resident: 24th, 25th, 28th
I. ITM 524391 725205. Dates resident: 26th, 27th

**Key**
- Fix with bearing
- Fix without bearing
- Tag Site
- Roost

Geckoella
Ecology and Geology

# Appendix A: Weather in Galway 15-29th August 2014

The weather in August 2014 was broadly typical for Galway in summertime and did not pose a significant constraint to survey. Warm, humid, calm weather is good for flying invertebrates and hence good for bat foraging. Data highlighted in blue represents sub-optimal temperatures of less than 10ºC, wind speeds equivalent to Beaufort score of 5 or more (Fresh breeze), and/or significant rainfall. Trapping was not carried out in the wet and windy conditions of the 27th and 28th August. Two trapping nights were slightly cooler than optimum (21st and 23rd August). Daytime roost checks were not affected by the weather. The surveys started on 19th August; the data from 15th to 19th are included to show that good conditions for bats were present also prior to the start of survey.

| | Weather during trapping | | | | | | General weather in Oranmore near Galway during 24hr period | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Site** | **Temp ºC** | **Humidity** | **Wind speed (Bft)** | **Cloud** | **Rain** | **Temp Max C** | **Temp Avg C** | **Temp Min C** | **Humidity Avg** | **Wind Speed Max km/h** | **Wind Speed Avg km/h** | **Precipitation Sum cm** |
| 15/08/2014 | | | | | | | 21 | 16 | 12 | 71 | 21 | 5 | 0 |
| 16/08/2014 | | | | | | | 17 | 15 | 14 | 80 | 27 | 6 | 0.03 |
| 17/08/2014 | | | | | | | 19 | 15 | 12 | 73 | 34 | 7 | 0.03 |
| 18/08/2014 | | | | | | | 18 | 14 | 11 | 73 | 27 | 6 | 0.05 |
| 19/08/2014 | Merlin Woods | 16 | moderate | 1to 2 | 4 | 0 | 18 | 14 | 10 | 71 | 24 | 4 | 0.1 |
| 20/08/2014 | Barna Woods | 13 | 81 | 1 | 4 | Slight shower | 18 | 13 | 9 | 73 | 19 | 3 | 0 |
| 21/08/2014 | Cooper's Cave | cool, dropped below 11 during survey | 75 | 2 to 3 | overcast | 0 | 19 | 14 | 12 | 76 | 26 | 5 | 0.05 |
| 22/08/2014 | NUIG | 12 | 70 | 2 | 0 | 0 | 18 | 14 | 11 | 71 | 27 | 5 | 0 |
| 23/08/2014 | Sports fields | 12 at start, dropped to 9 | 68 | 1 to 2 | clearing | | 19 | 14 | 9 | 68 | 24 | 3 | 0 |
| 24/08/2014 | | | | | | | 16 | 13 | 9 | 87 | 32 | 6 | 0.2 |

# Appendix A: Weather in Galway 15-29th August 2014

| | Weather during trapping | | | | | | General weather in Oranmore near Galway during 24hr period | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Site** | **Temp ºC** | **Humidity** | **Wind speed (Bft)** | **Cloud** | **Rain** | **Temp Max C** | **Temp Avg C** | **Temp Min C** | **Humidity Avg** | **Wind Speed Max km/h** | **Wind Speed Avg km/h** | **Precipitation Sum cm** |
| 25/08/2014 | | | | | | | 20 | 16 | 14 | 94 | 32 | 7 | 0.48 |
| 26/08/2014 | Menlo Woods | 15-16 | High | 1-2 | 4 to 8 | 0 | 18 | 16 | 15 | 89 | 31 | 7 | 0.03 |
| 27/08/2014 | | | | | | | 17 | 15 | 14 | 89 | 47 | 10 | 0.05 |
| 28/08/2014 | | | | | | | 19 | 15 | 11 | 86 | 43 | 8 | 1.27 |
| 29/08/2014 | | | | | | | 18 | 16 | 14 | 90 | 31 | 7 | 0.61 |

Data on General Weather during 24hr period produced under license from Weather Underground.

http://www.wunderground.com/personal-weather-station/dashboard?ID=ICOGALWA2#history/s20140805/e20140812/mweek

Weather Station ID: ICOGALWA2. Station Name: Oranmore
Latitude / Longitude: N 53 ° 16 ' 28 ", W 8 ° 55 ' 45 ", Elevation: 0. City: Oranmore, State: Co.Galway
Hardware: Davis VP2(24h FARS), Software: meteohub, Owner: Private

## Annex A: Summary notes on the geology of Galway, and its potential for bats and roosts

### Introduction

Underground sites can be extremely important roost sites for bats, offering in particular hibernation roosts for the winter and swarming roosts for social and mating behaviour in the Autumn. Locating underground sites in a limestone landscape can be challenging. These notes describe the geology of the area in order to narrow down the area of search for suitable features for bats in the limestone landscape around Galway.

### Geological setting of Galway

The geology of Galway and surrounding area is shown in Figure 1. To the east and south of the city, including the Inishmor isles, the area is dominated by Lower Carboniferous (Tournaisian and Viséan) sediments comprising limestones, calcitic mudstones and sandstones. Devonian-aged sandstones, conglomerates and mudstones (Old Red Sandstone) crop out to the south-west of the area between Loughrea and the border with County Clare. High ground west of Galway (including Moycullen Bog and Oughterard District Bog NHAs, and extending north-west towards Connemara) is formed mainly of igneous rocks, comprising a core of Silurian and Devonian granites and appinites, with fringing areas of Lower Palaeozoic gabbros and diorites, and occasional Ordovician-aged volcanic rocks.

### Geology of Galway City area

The bedrock geology of Galway City itself comprises three main lithologies:

i) Lower Palaeozoic gabbros and diorites, which occur in a roughly triangular-shaped central area extending from Dangan Heights/Galway Business Park southwards to Galway Bay (Cuan na Gaillimhe). The western side of the triangle runs via Shantallow (Seantalamn) to Salthill; the eastern side runs via Newcastle (An Caisleán Nu) and south of Townparks to Renmore Barracks (Dun Ui Mhaoiliosa)
ii) Lower Carboniferous (Viséan) limestones and calcitic mudstones, which occur east and north of the gabbros and diorites, and extend from Lough Corrib (Loch Coirib) eastwards beyond Claregalway (Baile Chláir) and Oranmore (Oran Mór)
iii) Siluro-Devonian granites and appinites, which occur west of the gabbros and diorites, and extend beyond Barna (Bearna) and Tonabrochy (Tóin na Brocai) to the highground of Moycullen Bogs NHA and further west.

The main lower Carboniferous limestones in and around Galway City are Viséan-aged (Upper Viséan, $D_1$-$D_2$ zones), and include strata now assigned to the Knockman Formation. Kinahan (1869, pp. 21-22) recorded quarries in the townlands of Angliham and Menlough on the south-east shore of Lough Corrib, three miles due north of Galway town. These quarries were formerly worked for their bands of dark limestone known as 'Galway black marble' which was formerly highly sought after and exported. Kinahan (loc. cit.) also reported quarries in the vicinity of Terryland village which were worked for general building stones. All these quarries contained numerous limestone crags, and sections in excessive of 12m height were worked.

Characteristically, the majority of limestones in the Galway City area are horizontally-bedded or exhibit very shallow dips (less that 10°), only locally does the dip reach up to 20-25°.

**Limestone features, and potential for bats and roosts**

The limestones exhibit considerable lithological variation and include:

- massive, compact varieties;
- other types which are more susceptible to water solution and form caves and other karstic features (such as 'mushroom rocks' and irregular limestone pavements);
- other limestone types which are more siliceous ('flinty') and shatter, providing tight crevices and fissures in quarry faces.

Interbedded within the limestone sequences are calcareous shales and calcitic mudstones which are relatively impervious and act as boundary layers along which surface and subsurface water may migrate and form cavities. This varied lithology is regarded here to offer considerable potential for a wide variety of possible roost sites for bats.

Table 1 provides a list of limestone quarries and cave/karst features identified within the Galway City area and signs of bat presence noted.

A case-example indicating the potential that geological features may have for identifying areas of possible interest for bat and roost sites is provided by Cooper's Cave at Castlegar; at least two species of bat (Lesser Horseshoe *Rhinolophus hipposideros* and *Myotis* sp.) are now recorded to use Cooper's Cave despite the cave showing signs of extensive human disturbance (litter) and smoke damage from fires lit within it.

Figure 2 is schematic, but demonstrates the principle that extrapolation of the generally horizontally-bedded limestones from Castlegar (including the limestone unit in which Cooper's Cave occurs) to the northwest indicates that the same limestone strata may crop out along the flanks of Cnoc an Ghearrtha. Several other quarries (including Angliham Quarry and old quarries along Route N84, see Table 1) are likely to have directly worked these strata, or to have excavated down to the levels of these limestone units.

Field observation and aerial photo analysis confirms that limestone faces are exposed in these quarries, and these faces are likely to include the same limestone features found at Castlegar which readily form caves and fissures, and, if present, these have considerable potential for use by bats. **Further investigation of these quarry sites to properly assess their potential use by bats is highly recommended, since the probability of further fissures and cave features within these geological beds is high.**

Conversely, limestone areas less likely to have roost features suitable for bats include the limestone pavement areas – these do not expose the type of limestone which is most likely to have fissures and caves.

Dr. Andy King, September 2014

**References**

Galway City Council, 2011-2017: SEA Environmental Report to Development Plan 2011-2017 (available at http://gis.galwaycity.ie/devplanflipbook/sea). 111pp.

Kinahan, G. H. 1869: Explanation to accompany Sheet 105 with that portion of Sheet 111 that lies on the North of Galway Bay of the Geological Survey of Ireland. Memoirs of the Geological Survey. Dublin & London. 63 pp.

OS Maps, 1842: Galway Six Inch OS maps (available at http://www.galway.ie/en/Services/Library/1842OSMaps)

| **Location** | **Northing**[1] | **Easting** | **Status** | **Bat observations** | **Notes**[1] |
|---|---|---|---|---|---|
| Cooper's Cave (Cooley's Cave), Castlegar | 131761 | 227409 | Cave | Lesser-horseshoe *Rhinolophus hipposideros* and *Myotis* sp. seen in cave (21 Aug 2014) | Limestones very shallowly dipping / horizontal. Smoke damage and litter, few cave decorations remaining |
| Newry's Cave, Merlin Park | 134345 | 225287 | Cave | Recent bat droppings found (28 Aug 2014), currently being analysed | County Geological Site, Galway 'black marble', Upper Viséan, brachiopod fossils, minor damage/disturbance , cave decorations present |
| Lackagh Quarry, Coolough | 130473 | 228383 | Active quarry | Not visited | Not visited |
| Roadstone Quarry, Tuam | 132893 | 229198 | Quarry in receivership | Not visited | Not visited. County Geological Site. Limestone aggregate quarry, Knockman Formation |
| Angliham Quarry, near Kilroghter | 129222 | 230119 | Disused quarry | Records of Lesser-horseshoe roosting at site, 2014 (SCA, pers. comm.) | Not visited. Galway 'black marble', Upper Viséan |
| Old quarry by N84, near Ballindooley | 130978 | 228163 | Disused quarry | Not visited | Not visited, access from Route N84 (locked gates) |
| Old quarry tips, Caireal Mór | 131114 | 228002 | Quarry tips | Not visited | Not visited, exposed quarry faces still remaining? |
| Old quarry tips, Ballygarruan | 131026 | 228838 | Quarry tips | Not visited | Not visited, exposed quarry faces still remaining? |

Table 1. Limestone quarries and cave/karst features identified within the Galway City area (during period of survey, 14th – 30th August 2014)

([1]Notes based on field observations where sites visited, and literature searches: Kinahan, 1869; OS Maps, 1842; Galway City Council 2011-17)

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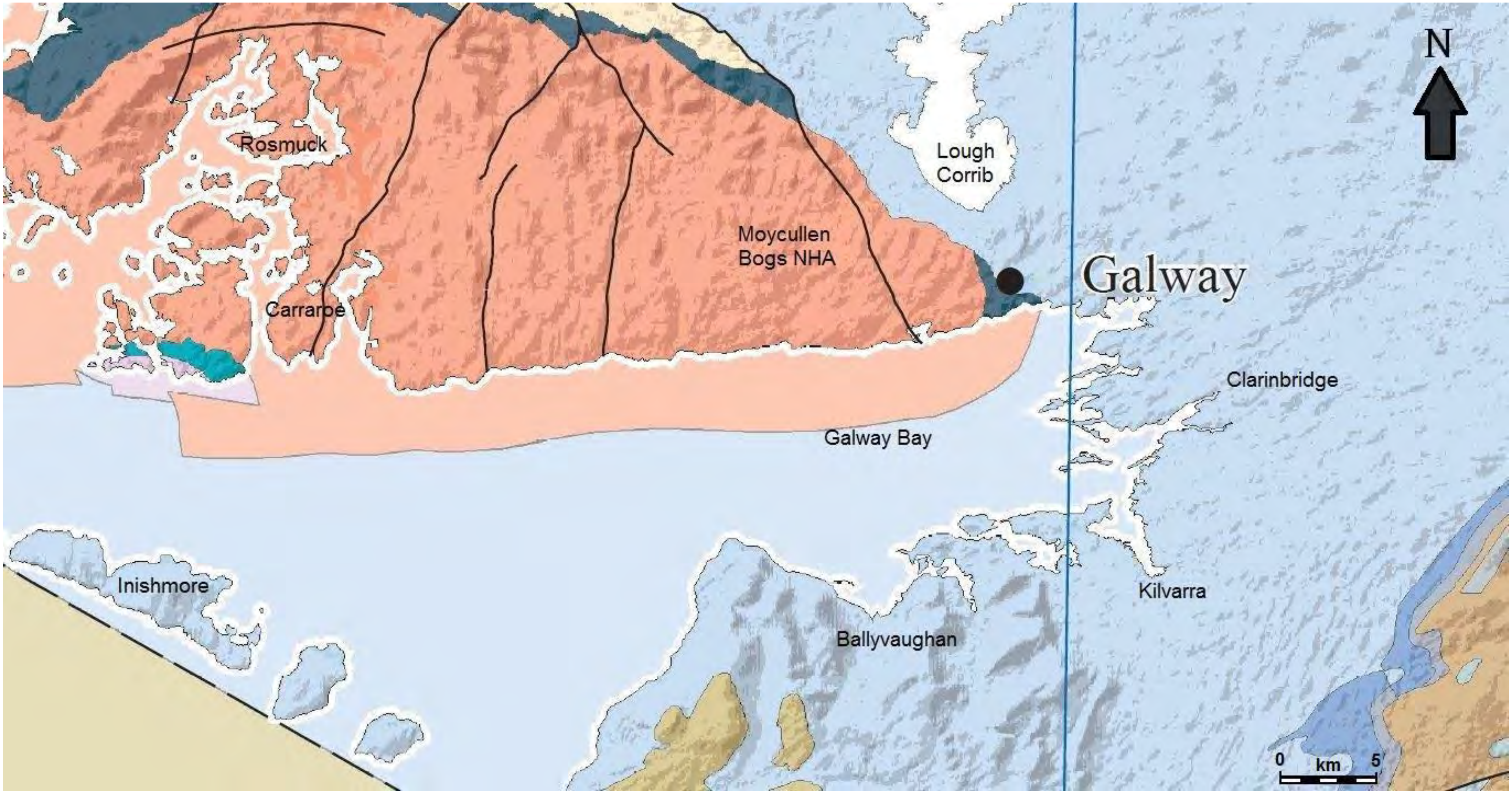
[1] Irish Grid coordinates




**Explanation of Bedrock Geology**

- Lower Carboniferous (Visean) limestones and calcareous mudstones
- Lower Carboniferous (Tournaisian) limestones, sandstones and mudstones
- Devonian (Old Red Sandstone) sandstones, conglomerates and mudstones
- Siluro-Devonian granitic rocks and appinites
- Lower Palaeozoic gabbroic-dioritic rocks
- Ordovician volcanic rocks

**Figure 1. Bedrock geology of Galway and environs**

Onshore geology derived from Bedrock geology of Ireland (Geological Survey of Ireland, 2014), 1:500,000 Bedrock geology map of Ireland, 1:100,000 Bedrock Map Series; Offshore geology derived from EMOD net project map compiled by GSI and INFOMAR, with materials from the British Geological Survey, NERC 1982, 1986, 2009.

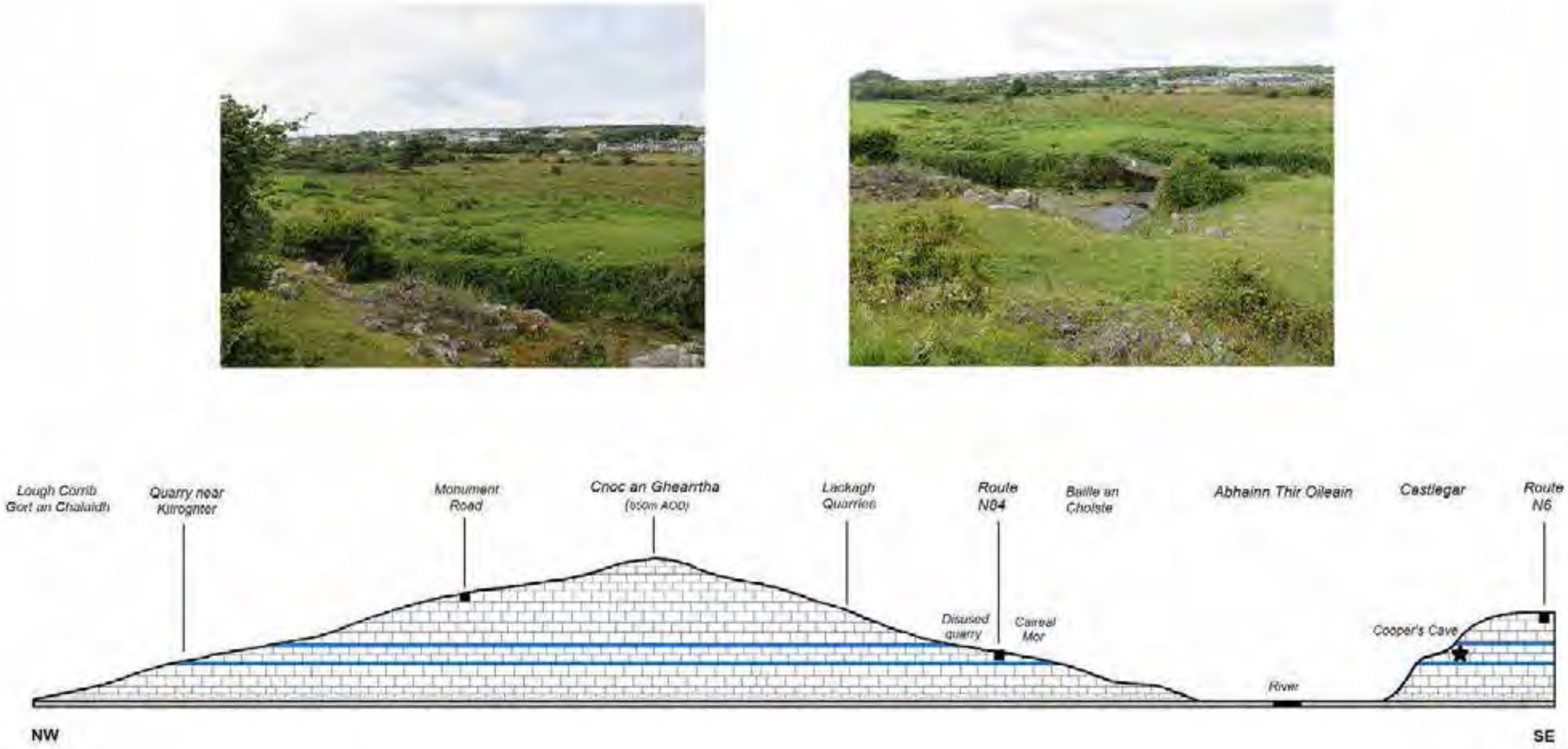



**Figure 2. Diagrammatic NW-SE cross-section from Lough Corrib (Gort and Chalaidh) to Castlegar (Glenburren Park and Route N6), distance 4.6km, vertical scale exaggerated.**

**(Inset photographs; views NW to Baille an Choiste and hillside quarries (towards Cnoc an Ghearrtha) from Castlegar ridge, near Cooper's Cave)**

# Appendix I

## Galway Bat Radio-tracking Project. Radio Tracking Studies of Lesser Horseshoe Bat Species, May 2015 (Rush & Billington, 2015)

*Greena Ecological Consultancy*

**Galway Bat Radio-tracking Project**

**Radio tracking studies of lesser horseshoe bat species, May 2015**

*Photo by Isobel Abbott*

**DRAFT V1A October 2015**

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# Contents

## Executive summary

Greena Ecological Consultancy was been commissioned by Scott Cawley Ltd to undertake a follow up radio-tracking studies in Galway, Republic of Ireland, to inform the N6 Galway City Transport Project. The study was conducted to obtain information on where the bats roost, breed, forage and the extent of their range in order to be able to determine the potential impacts of the proposed Scheme on the local bat populations. A baseline survey has previously been conducted in August and September 2014; however, spring session was not included due to the timing of agreements and permissions necessary for the work. This survey was; therefore carried out in order to provide a full picture of bat activity in the area throughout the year.

No previous radio-tracking study covering Lesser horseshoe bats as well as vesper bats had been undertaken in the area of interest prior to 2014. Scott Cawley carried out static monitoring in combination with emergence surveys and roosts inspections prior to the 2014 radio-tracking study in order to provide basic information on bat colonies present in the area of interest. Static monitoring was extended further beyond the duration of the 2014 study to provide additional data for the radio-tracking study proposed for 2015.

This single radio-tracking study was and carried out by Greena Ecological Consultancy in May 2015. This session, together with the results from 2014, aimed to help understand potential seasonal shift in activity patterns of Lesser horseshoe bats while avoiding interference during the most sensitive period of bat life cycle when females give birth and lactate (suckle their young).

Greena Ecological Consultancy captured four Lesser horseshoes *(Rhinolophus hipposideros)* during the May session, all of them females, three recognisably (but not heavily) pregnant, while one female was considered to be born the previous year so has not bred before nether did she show any signs of pregnancy when captured.
All bats were captured in a static mist net stretched over maternity roost entrance. Bats were of good health, weight ranging from 5.9g to 6.3g. Two of the females (Bat 1 and Bat 4 in this study) were captured and radio-tracked during the previous session in 2014 – their rings were identified as fitted by Greena Ecological Consultancy in August 2014. These bats were previously tracked as Bat 8 and Bat 3 respectively in the 2014 first session. Two females (Bat 2 and Bat 3) were not previously fitted with rings, suggesting they were not present in the roost during the summer session of 2014. These females were ringed in May 2015 at the same time all bats subject to this study were fitted with radio-transmitters. Despite efforts to catch Lesser horseshoe bats from previously identified night roosts west of Galway (excluding Coopers Cave), no other catching session was successful and, therefore, only four bats were studied in 2015, and no other bats were captured.

Between 16th May 2015 and 23rd May 2015, bats were tracked wherever they ranged and were found as far south as the Galway harbour and the area of University College Hospital; south of Ballagh in the west, north to Gort an Chalaidh Angliham and partially across the southern part of Lough Corrib and north of Coolagh in the east.

During the spring session, LHS foraged up to 3.56km from their roost, considerably less then was recorded later in the season in 2014, with majority of bats utilising the immediate area of

Menlo Castle, Menlough village and Menlo Woods. Hedgerow systems in Coolagh area as well as the area of woodland south of Menlough village were very popular. All four bats were utilising similar are for foraging; more than 62% of all recorded locations of each bat fell into the same foraging core area.
The west-most record of a LHS occurrence was less than 2km west of Menlo Castle, the north-most record lies 3.1km away from the roost. Surprisingly, LHS did not avoid Galway City and the south extreme of the overall foraging area was located 3.59km south of Menlo Castle. The eastern edge of foraging areas was located 1.56km away from the maternity roost.

Very limited number of night roosts were found during the 2015 radio-tracking session, majority of bats were returning back to Menlo Castle, their original roost, each night after foraging. The only exception was Bat 3, night- and day-roosting several days in a boulder field before returning back to day-roost in the castle. Bat 2 was also recorded to utilise a natural limestone formation for night-and day-roosting later in the due course of the radio-tracking study.

Bats were foraging in adverse weather and did not seem to be influenced by rain or strong wind. The weather conditions in May were mainly wet and this may have influenced the extent of the overall foraging area. The foraging area was generally smaller than recorded in August and September 2014 and all bats were recorded to forage in a core area largely overlapping between the studied females.

All bats in May session displayed foraging behaviour for two to three hours after dusk most of the nights, after that they returned to roosts or found a night roost where they spent a large part of the night. This behaviour was clearly associated with the sudden drop in temperature in the early evening and further decrease throughout the night.

# 1.0 Aims and Objectives

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

The objectives of this study were to identify the principal feeding areas and commuting routes of the main known Lesser horseshoe maternity colony in the Galway area, and to determine the night and day roosts used. While studies in 2014 aimed to gain information during the peak maternity roosting period and pre-hibernation behaviour of Lesser horseshoe bats, the study carried out in spring 2015 aimed to add to the complete picture of bat activity in the study area throughout the year. The radio tracking sessions carried out during the bat active season of 2014 and 2015, whilst avoiding the sensitive period of late stages of pregnancy, birth and first emergence of newly born bats, aimed to form an understanding of seasonal shifts in foraging areas and commuting routes of Lesser horseshoe bats in the Galway area depending on prey availability.

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

Main objectives can be summarised as:

- Trapping within the study area to catch and radio tag Lesser horseshoe bats and a follow-up radio-tracking survey in order to provide an understanding of foraging areas and/or commuting routes, either to foraging areas or to other night/satellite/day roosts.
- Processing the data to determine proportional use of different sites and compilation of maps of roosts, foraging areas and flight routes

This study focused solely on the spring part of bat active season, researching bat foraging behaviour during early pregnancy period of the females captured from the previously confirmed maternity roost in Menlo Castle.

# 2.0 Background

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

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

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

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

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

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

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

Since the 1980s, radio tracking has developed as one of the main techniques for studying many aspects of bat ecology (Kenward, 1992). Advances in transmitter technology have reduced the mass of radio-tags and it is now possible to effectively radio-track even the smallest species of bats without exceeding the justifiable surplus weight transmitters add to the weight of the animal. Researchers (International Berlin Bat Meeting consider bats can at times handle up to 25% of their weight without detriment, depending on sex, breeding status, season.

In the radio-tracking study, we investigated the behaviour of individuals by tracking two or more bats simultaneously. The movements of four bats (three breeding females and one non-breeding female) were examined to record the distribution and behaviour of the populations Lesser horseshoe bats during pre-maternity period of 2015.

## 3.0 Study area

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

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

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

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

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

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

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

## 4.0 Methods

A valid licence to carry out bat trapping (licence to catch with harp/mist net/by hand no. C085/2015) and radio tracking (licence to mark no.C004/2015) had been obtained from National Parks and Wildlife Service, Ireland and authorisation to access the land involved was obtained from landowners in advance of commencing fieldwork.
Licence to enter roosts (DER/BAT 2015-24) was also obtained.

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

Scott Cawley and Greena Ecological Consultancy reviewed existing data, aerial photographs, maps, and carried out a site visit to determine possible trapping places, first in Menlo Castle, later in previously identified night roosts of Lesser horseshoe bats in the area west of Galway. The area of interest consists of field systems with mature hedgerows and stone walls, a continuous area of limestone pavement with scrub, small areas of woodland and urban areas. The potential for successful catching horseshoes in mist nets and/or harp traps was assessed as being low in the open landscape; however, catching directly from the maternity roost in Menlo Castle proved very productive. A six-metre wide Avinet mist net was set across the entrance to the maternity roost on 16th May 2015. No other trapping attempts within the castle were undertaken. All bats (four LHS in total) were caught while emerging from the roost in the net placed over the roost entrance.
Further at least four bats were present in the roost on the night of catching; however, these bats stopped attempting emergence after they detected the fine netting and the net was removed 2 hours after the first recorded emergence in order not to allow the bats out to feed and so not to negatively affect them..
All captured females were fitted with a 0.35g Holohil radio- transmitter of 7 days battery life. Three out of the four captured bats were recognisably, but not heavily, pregnant. One female was assessed as being last year’s juvenile, and had not bred prior to the capture. Two of the four captured females had been ringed in the August 2014 season, the other two females were fitted with aluminium rings during the catching session in May 2015.

The radio tracking study took place between the 16th May and the 23rd May 2015. Two radio-transmitters fell off after this period, the remaining two were not possible to locate possibly they had run out of battery power.

A double bank harp trap was used at Bearna culvert together with shield netting. The culvert at the grid reference of M2477723800 beneath the R336 highway, this had previously been confirmed as a night roost for a single Lesser horseshoe bat; however, no bats were captured at this location on the two trapping nights (17th and 18th May 2015).

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

Table 1 below show details of transmitters used, duration of tag battery is stated in days, bpm is the number of pulse transmissions per minute.

**Table 1 Transmitters used during the radio tracking session in May 2015**

| bat | species | supplier | Tag weight | bpm | duration |
|---|---|---|---|---|---|
| 1 | LHS | Holohil | 0.32g | 60 | 7 |
| 2 | LHS | Holohil | 0.32g | 60 | 7 |
| 3 | LHS | Holohil | 0.32g | 60 | 7 |
| 4 | LHS | Holohil | 0.32g | 60 | 7 |

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

Up to four fieldworkers used *Australis 26K* and *Sika UHF* radio receivers with *Yaggi* rigid aerials to track bats. Both receivers are able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any time. Omni-directional antennas were used to search for bats by vehicle.
The surveyors carrying out the study were Geoff Billington, Tereza Rush, Isobel Abbott and Daniel Buckley.

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

From all tagged bats, the following data was recorded:

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

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

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

Location of frequent observation points and number of times that they were used are shown in Table 2 below, all of these points were on public roads.

**Table 2 Location of observation points used in May 2015**

| location | grid reference | number of times used |
|---|---|---|
| Menlo Castle | M 28270 28381 | 5 |
| Menlough Village | M 28852 28492 | 4 |
| Quarry Road | M 29334 30300 | 1 |
| Coolagh | M 29583 28167 | 2 |
| The Mount | M 29583 28167 | 1 |
| Lackagh Quarry | M 29941 27996 | 2 |

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

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

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

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

tagged bat, MLP might underestimate this. The difference in results obtained using the traditional method and the method of multilateral polygons are shown on maps of foraging areas.

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

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

## 5.0 Survey constraints

These radio tracking studies were only carried out in short periods of the year so bats may use different areas at other times of year. This limitation is partially resolved through previous studies conducted in 2014, later in the bat active season, resulting in a more complete picture of the behaviour of Lesser horseshoe bat populations in the Galway area.

Only four bats were captured and fitted with transmitters in the May session. At the time of the survey, this was estimated to be approximately 50% of the bats utilising the maternity roost at Menlo Castle. Ideally, more individuals would have been studied; however, the high proportion of overlap in the core foraging area suggests that the main characteristics of Lesser horseshoe foraging behaviour at the given time of the year were covered by the study of the selected four individuals.

The small numbers could be purely caused by the main part of the colony not having returned yet from winter/transition roosts. But also there were recent signs of small fires (e.g. a small group having a barbeque) having been lit in both on the ground under the chimney roost and within 3m of it. These may have caused some bats to move out as at this time of year, making our tracking task more difficult as few bats to catch and tag.

Catching attempts in other, previously identified, roosting structures proved non-productive, catching effective was liable to be very ineffective with multi access buildings. No other bats were captured in the May session despite the fact.
A single untagged Lesser horseshoe was observed to use a night roost in a culvert near Bearna, but with only a single bat a visiting once or twice a night not every night, makes catching extremely difficult.

The amount of gathered data was subject to correctly functioning radio-transmitters. Radio-transmitters may fail or batteries may not last the specified duration. Bats, and in particular in maternity colonies can groom radio-transmitters off. Two bats lost their tags prior to the end of their battery life and within the study period.

Adverse weather conditions and the overall weather trend in early 2015 affected the amount of data collected, too.

Rain, ranging from light drizzle to heavy brief showers occurred during the radio-tracking session. The night temperatures were relatively low on all survey nights; temperature dropped after dusk and continued decreasing throughout the night. Majority of bat activity was only recorded within the first two or three hours after dusk; activity ceased thereafter and bats usually returned back to their day-roost to spend the rest of the night there. It is considered likely that this is common spring weather pattern and the results from the study are; therefore, very valuable to add to last year's data.

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

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

## 6.0 Ethical Review

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

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

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

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

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

Where bats were caught in a mist net, they were removed immediately to reduce potential stress. Where harp trap was used, arrangements were made to removed potentially caught animals as soon as practical, though none were caught.
This took place/was attempted during nights of suitable temperature and rainfall free.
The catching period avoided more sensitive seasons such as, as when they emerge from hibernation in early spring, later stage of pregnancy in summer or when newly born young are supported for a couple of weeks in mid summer.

All bats were released unharmed at the point of capture.

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

No injuries occurred during trapping sessions, all bats were of good health and did not show any signs of distress when fitted with transmitters (and rings where applicable).

Catching session at Menlo Castle was ceased when it became obvious that four bats were still remaining in the roost after 2 hours, they were aware of the presence of the net and were reluctant to emerge. The decision to cease catching was in line to prioritise welfare of the remaining bats so they could emerge and forage that night.

In most intensive catching sessions at roosts you rarely catch half of the animals present.

# 7.0 Results

## *7.1 Previous records*

Scott Cawley undertook an extensive survey work in the Galway area prior to the radio-tracking session both for this one in 2015 and previous sessions in 2014.

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

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

An extensive study of Lesser horseshoe bat foraging behaviour in the Galway area was conducted in 2014. The same bat colony was subject to the survey. Night roosts previously used by bats were re-inspected.

Surveyors were already familiar with locations that were less shielded, providing good radio-tracking vantage points in the landscape.

## *7.2 Weather data*

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

**Table 3 Weather data, May session**

| Date | Max Temp (°C) | Min Temp (°C) | Survey Temp (°C) | Precipitation (mm) | Wind (B) |
|---|---|---|---|---|---|
| 16/05/2015 | 11 | 8 | 10 - 8 | 0.2 | 4 |
| 17/05/2015 | 13 | 7 | 10 - 7 | 0.4 | 4 |
| 18/05/2015 | 13 | 4 | 8 - 4 | 0.1 | 4 |
| 19/05/2015 | 11 | 4 | 8 - 4 | 0.3 | 4 |
| 20/05/2015 | 10 | 5 | 9 - 5 | 0 | 3 |
| 21/05/2015 | 14 | 7 | 9 - 7 | 0 | 3 |
| 22/05/2015 | 14 | 9 | 11 - 9 | 0 | 3 |
| 23/05/2015 | 17 | 9 | 13 - 9 | 0 | 2 |

*Data from Worldweatheronline.com, 2014 and survey records*

## *7.3 Bat captures*

All Lesser horseshoe bats were captured at Menlo Castle were caught in a six-metre mist net stretched over the entrance to the maternity roost in a chimney.

Two bats from the August session in 2014 were re-captured in May 2015. Their foraging areas could; therefore be compared with the 2014 session.

All bats fitted with radio-transmitters and ringed by Tereza Rush, bat 1 and bat 4 carried rings from previous season, bat 2 and bat 3 were ringed.

**Table 4 Captures 16/05/2015, Menlo Castle**

| Time caught | species | sex | forearm (mm) | net weight (g) | ring number | comments |
|---|---|---|---|---|---|---|
| 21:59 | LHS | F | 36.7 | 6.1 | L01608 | Adult, pregnant, **Bat 1,** Ring from 2014 |
| 22:16 | LHS | F | 38.2 | 5.9 | L01691 | Adult, not bred, **Bat 2** |
| 22:19 | LHS | F | 38.6 | 6.0 | L01690 | Adult, pregnant, **Bat 3** |
| 22:48 | LHS | F | 38.3 | 6.3 | L01603 | Adult, pregnant, **Bat 4,** Ring from 2014 |

Abbreviations: **F – female; LHS – Lesser horseshoe *(Rhinolophus hipposideros)***

## *7.4 Roosting sites*

### 7.4.1 Daytime roosting sites

Three daytime roosting places were identified during the radio-tracking session conducted in May 2015. Table 5 shows details of daytime roosts in this session. Three out of the four captured bats consistently used the maternity roost in Menlo Castle. One of them (bat 3) utilised a roost in a boulder field over several days before returning back to Menlo. Bat 2 moved to a natural limestone structure to roost by the end of the survey session and eventually lost its tag there. All of these daytime roosts were also used in the night for short periods of night roosting, although night roosting followed by extensive periods of foraging activity occurred very rarely during the spring radio-tracking session, compared to extensive night roosting being recorded in August and September 2014.

**Table 5 Identified daytime roosts in August 2014**

| roost | bats using | grid reference | location | description |
|---|---|---|---|---|
| A | 1,2,3,4 | M 28491 27872 | Menlo Castle | castle wall |
| B | 3 | M 29657 27130 | Boulder field | Cavity among large boulders |
| C | 2 | M 28865 28047 | Limestone structure | Cavity |

Roost A, Menlo Castle, is shown in Figure 2, roost B, the cavity among large boulders, in Figure 3, and roost C, the large cavity in the natural limestone structure can be seen in Figure 4.

Surprisingly, bat 3 was pregnant, yet did not stay in the maternity roost, possibly suggesting another maternity satellite roost is present. The roost in the boulder field did not appear to be suitable for maternity colony so it points towards bats still not having settled into maternity sites at this time of year in 2015.

though it could not be fully accessed for inspection nor was there access to be able to carry out multiple emergence counts. and an emergence survey carried out to count the number of bats utilising the location only revealed the usage by bat 3. Bat 3 eventually returned to Menlo Castle before the transmitter stopped working.

Menlo Castle was the only roost previously utilised in the 2014 season.

Table 6 below shows usage of daytime roosts by individual bats.

**Table 6 Daytime roost usage during the monitored period in May 2015**

| bat | 16/05 | 17/05 | 18/05 | 19/05 | 20/05 | 21/05 | 22/05 | 23/05 | 24/05 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | A | A | A | A | A | A | N/A | lost tag |
| 2 | A | A | A | A | A | A | N/A | N/A | C |
| 3 | A | A | B | B | B | B | B | A | A |
| 4 | A | A | A | A | A | A | N/A | N/A | N/A |

**Figure 2 Roost A, Menlo Castle**

**Figure 3 Roost B, boulder field**

**Figure 4 Roost C, natural limestone structure**

**Figure 5 Location of all roosting sites (marked with orange stars) identified in 2015**


### 7.4.2 Night roosting sites

All roosting places identified as daytime roosts were also used as night roosts during the night for short periods of time before further foraging commenced. No night roosting in terms of remaining in the structure between prolonged foraging periods occurred in the spring session.

No roosts only used at night were located in this session.

Foraging period were relatively short in duration and once the temperature dropped each night, bats returned to their roosts and rarely emerged again.

## 7.5 Foraging periods

All Lesser horseshoe bats radio-tracked in the May session were displaying similar foraging pattern. They emerged approximately 15-20 minutes after sunset and foraged for 2-3 hours before returning to the roost. Due to the night temperature drop, bats rarely re-emerged for further foraging. Very limited activity was recorded after 1.00am each day. Bats emerged to forage even in stronger wind and rain ranging from light drizzle to heavy shower, but temperature appeared to be the limiting factor of foraging behaviour in the spring.

## 7.6 Foraging areas

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

The Lesser horseshoe bat maximum foraging distance from the roost ranged from the immediate surroundings of Menlo Castle up to 3.56km with the average maximum distance of foraging area from the roost being 2.86km. The foraging areas of all studied bats were much less extensive than later in the bat active season, recorded in 2014. This, also, can be explained by the night temperature drop, leaving bats to utilise known close resources.

Table 7 shows a summary of results of the radio tracking session, including the number of fixes taken on each bat and the number of days a positive contact (joint bearings of two or more surveyors) was made.

**Table 7 Results of radio tracking session in May 2015**

| bat | species | sex | foraging area MCP (sq.km) | foraging area MLP (sq.km) | maximum distance from roost (km) | fixes taken | over days |
|---|---|---|---|---|---|---|---|
| 1 | LHS | F | 6.94 | 4.61 | 3.56 | 38 | 6 |
| 2 | LHS | F | 5.26 | 2.62 | 3.08 | 70 | 6 |
| 3 | LHS | F | 6.67 | 2.52 | 2.72 | 71 | 7 |
| 4 | LHS | F | 1.48 | 0.07 | 2.06 | 21 | 4 |

The majority of foraging areas obtained in May overlapped in the Menlo Castle and Menlough Village area, extending further across Menlo Woods; meaning this was a key foraging area. Field systems and quarries north-east and east of Menlo Castle proved to be crucial for Lesser horseshoe bats. This corresponded with the findings of 2014.

The following figures show forging areas (home ranges) of all bats successfully radio-tracked. Shaded area represent MCP traditional method, while checked area represents MLP method. Commuting routes, where they could beconfirmed, are shown with lines, confirmed foraging areas are marked with darker shaded areas.

**Figure 6 Foraging area of bat 1**

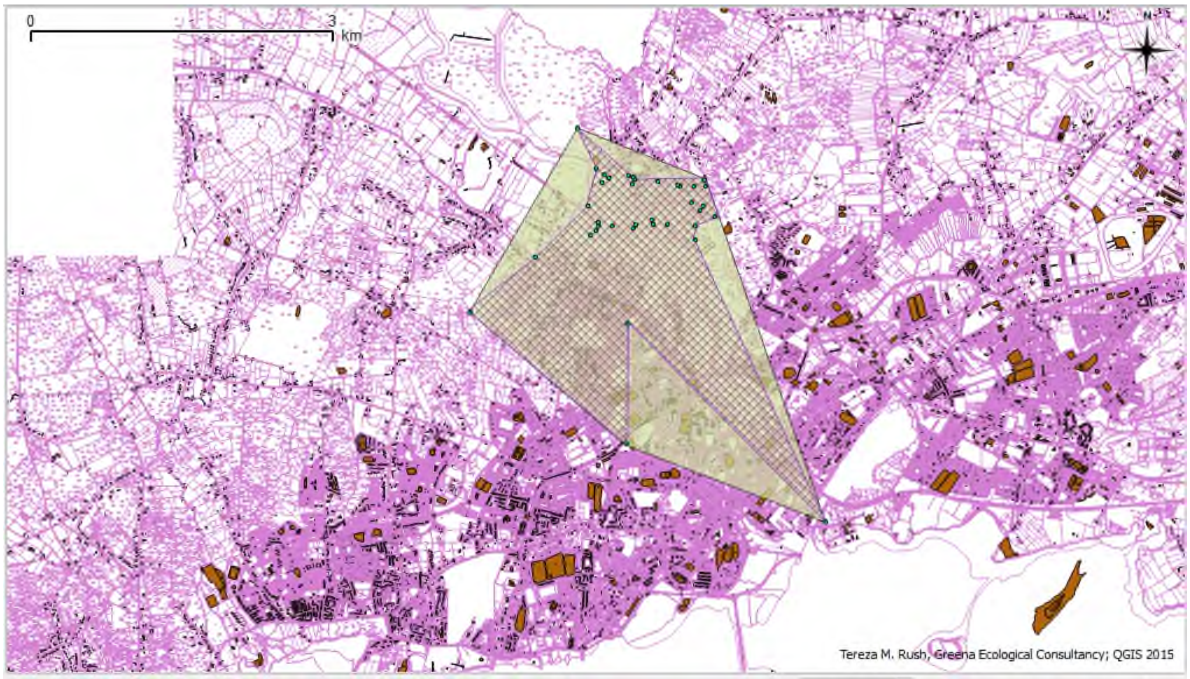



**Figure 7 Foraging area of bat 2**

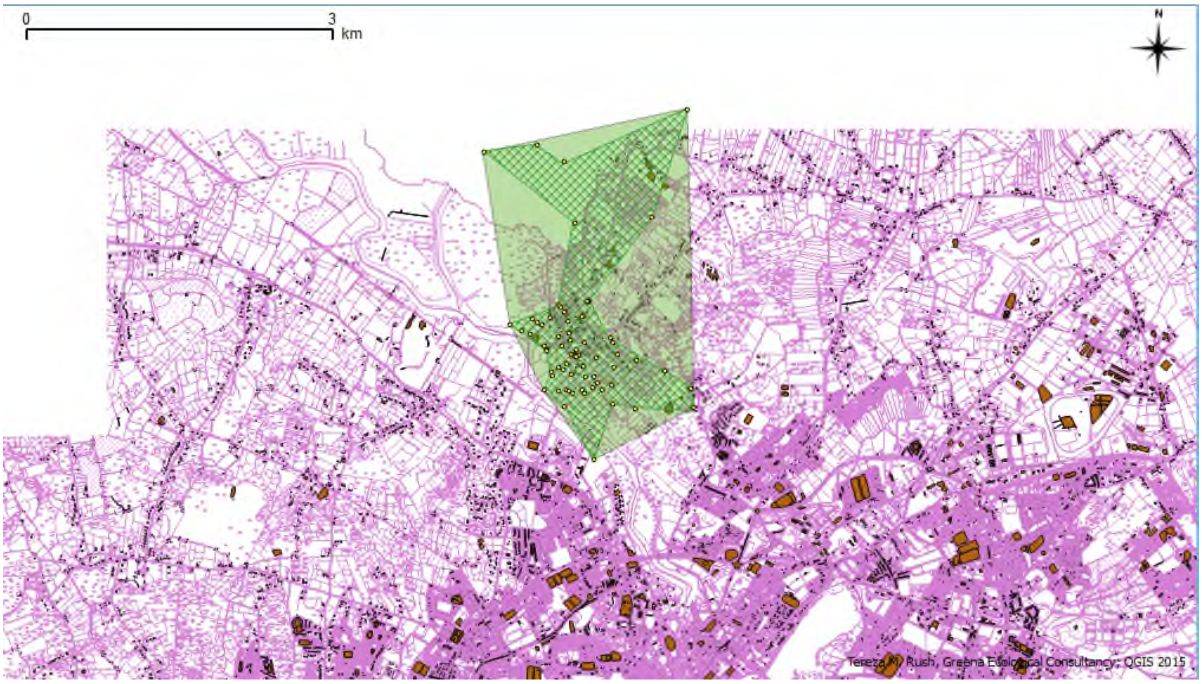


**Figure 8 Foraging area of bat 3**

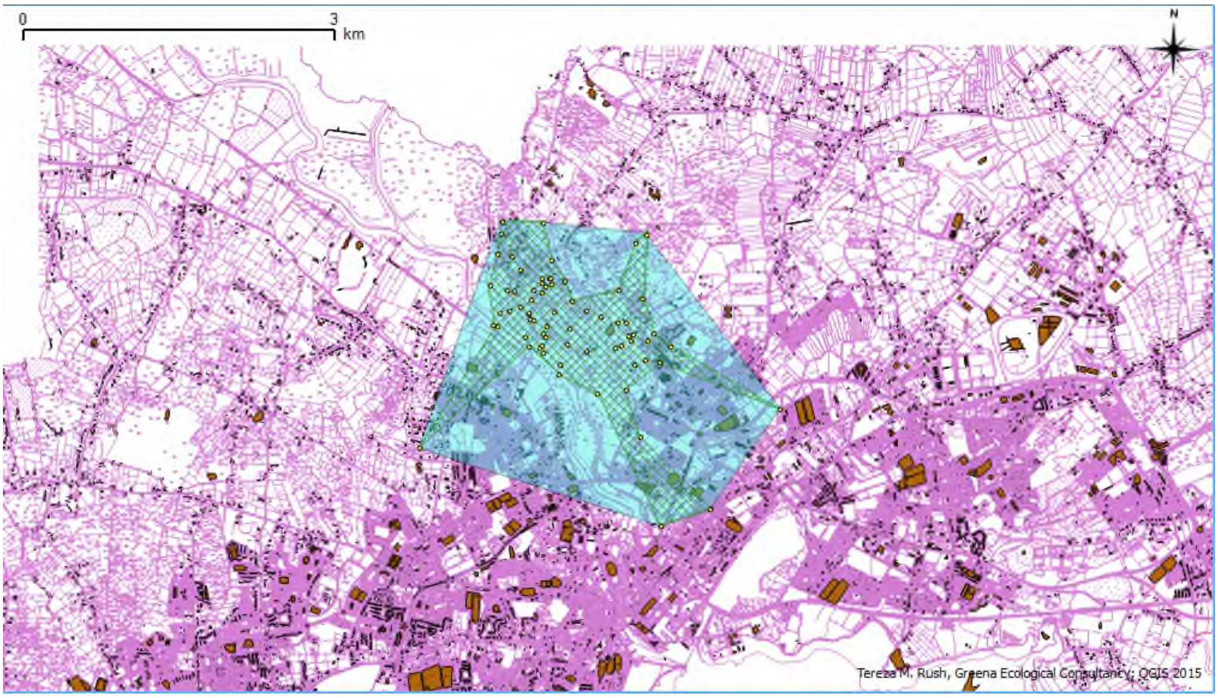



**Figure 9 Foraging area of bat 4**

Foraging and roosting areas:

**Bat 1**

Bat 1, a pregnant female Lesser horseshoe, was captured at the maternity roost in Menlo Castle and did not change her roosting place throughout the survey. This bat was previously captured and radio-tracked in 2014 (Bat 8 in the August 2014 session) and did not change roost during the summer study either. Last year this bat utilised a small area in vicinity of Menlo Castle and in Menlo Woods, returning to the roost on regular basis throughout the night suggesting a dependent young to care for. Bat 1 covered the largest foraging area of all bats studied in 2015 – 6.94km$^2$ in total, and travelled the longest distance from the roost, up to 3.56km. Its foraging area included the core area of Menlo Castle, Menlough Village and Menlo Woods, with 71% of all fixes on this bat located in the core area, but extended south and west across the River Corrib and onto Galway coast. It is likely that Bat 1 followed the River Corrib through Galway city down to Galway harbour.

**Bat 2**

Bat 2, a young female Lesser horseshoe bat, was captured from the maternity roost at Menlo Castle and continued using the roost for several days into the radio-tracking study, until moving into a new roost in a natural limestone structure in Menlo Woods, north-east of the castle, around the grid reference number of M 28865 28047 on 24$^{th}$ May 2015. This change corresponded with the time Bat 2 lost its tag, which was eventually located near the limestone structure. The foraging area of Bat 2 covered 5.26km$^2$ and the female travelled up to 3.08km from the roost. 78.6% of all fixes were recorded within the core foraging area of all bats, but also extended north across the southern part of Lough Corrib and towards Gort an Chalaidh Angliham. Bat 2 usually returned to the roost shortly after the night temperature drop.

**Bat 3**

Bat 3, a pregnant female Lesser horseshoe bat, was captured from the maternity roost in Menlo Castle, but after two days left the roost and spend several days in a new roosting place in the boulder field around grid reference of M 29598 27171, south-east from the castle and south of Coolough Lake. Towards the end of the radio-tracking study, Bat 3 returned to the maternity roost in Menlo Castle before the signal from its transmitter got lost. The foraging area of Bat 3 extended over 6.67 km$^2$ and the maximum-recorded foraging distance from its roost was 2.72km. Approximately 62% of all fixes on this bat were recorded within the core foraging area of Menlo Castle, Menlough Village and Menlo Woods; however, Bat 3 also foraged to the south-eats and south-west of the core area, covering the northern part of Galway City, Coolough and crossing the River Corrib.

**Bat 4**

Bat 4, a pregnant female Lesser horseshoe, was captured from the maternity roost in Menlo Castle and did not change her roosting place until 22$^{nd}$ May when her signal was lost. This bat was previously studied in August 2014 (Bat 3 then) when its foraging area covered the limestone pavement and quarries to the north-east of the castle, all the way towards Coil Uachtar Kilroghter. This bat was also known to roost in the quarries for prolonged periods of time. Bat 4 was considered to have a dependent young in the maternity roost in Menlo Castle in 2014.

Only limited data were collected on this bat in 2015, it was difficult to locate during the survey nights and the signal was lost before the end of the radio-tracking session. This may be due to a fault in the transmitter or due to the fact that Bat 4 covered large distances in the night and was regularly leaving the study area. The recorded foraging area extended over 1.48 km$^2$ with the maximum recorded foraging distance of 2.06km from the maternity roost. 71.4% of all recorded fixes on this bat fell into the core foraging area of all studied bats, but Bat 4 also ventured north and north-west of the Castle, crossing the River Corrib and foraging along the southern coast of Lough Corrib.

Figure 10 shows the combined overall foraging areas for all horseshoe bats in May 2015, Figure 11 depicts the extent of the core foraging area of all studied bats. The overall foraging area of all bats covered 16 km$^2$ (MCP – shaded in Figure 10) or 10.22 km$^2$ (MLP – checked in Figure 10). The core foraging area of all bats extended over 1.25 km$^2$.

**Figure 10 Overall foraging area in May 2015**

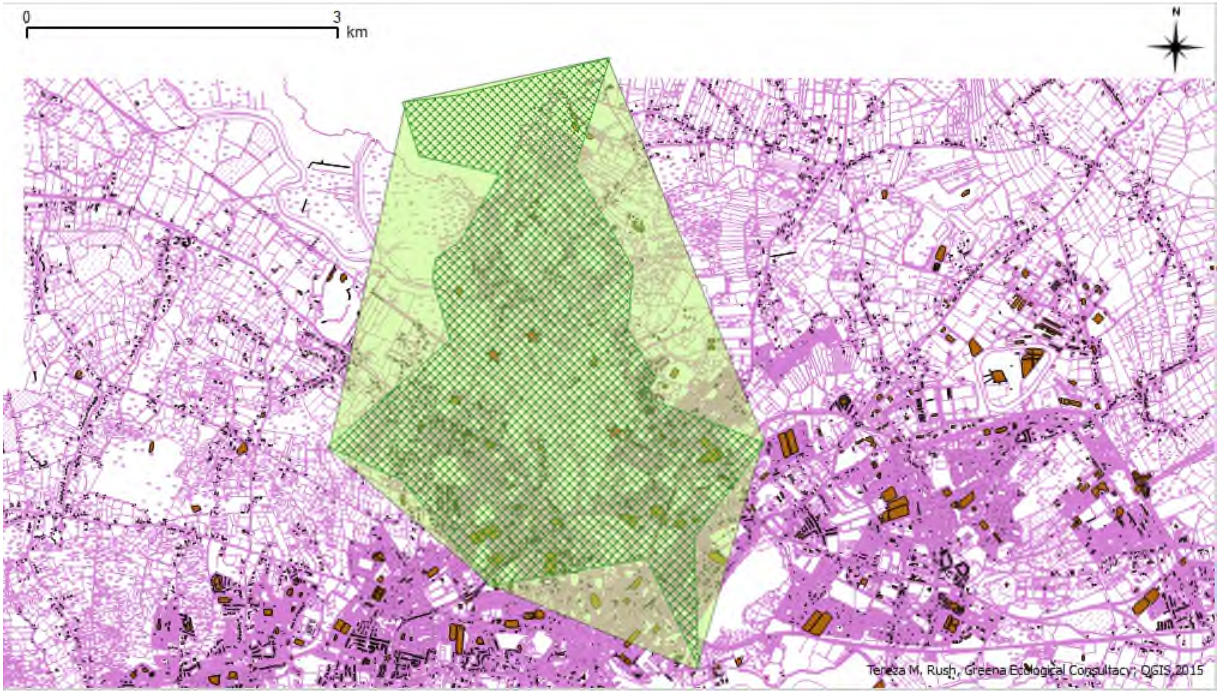
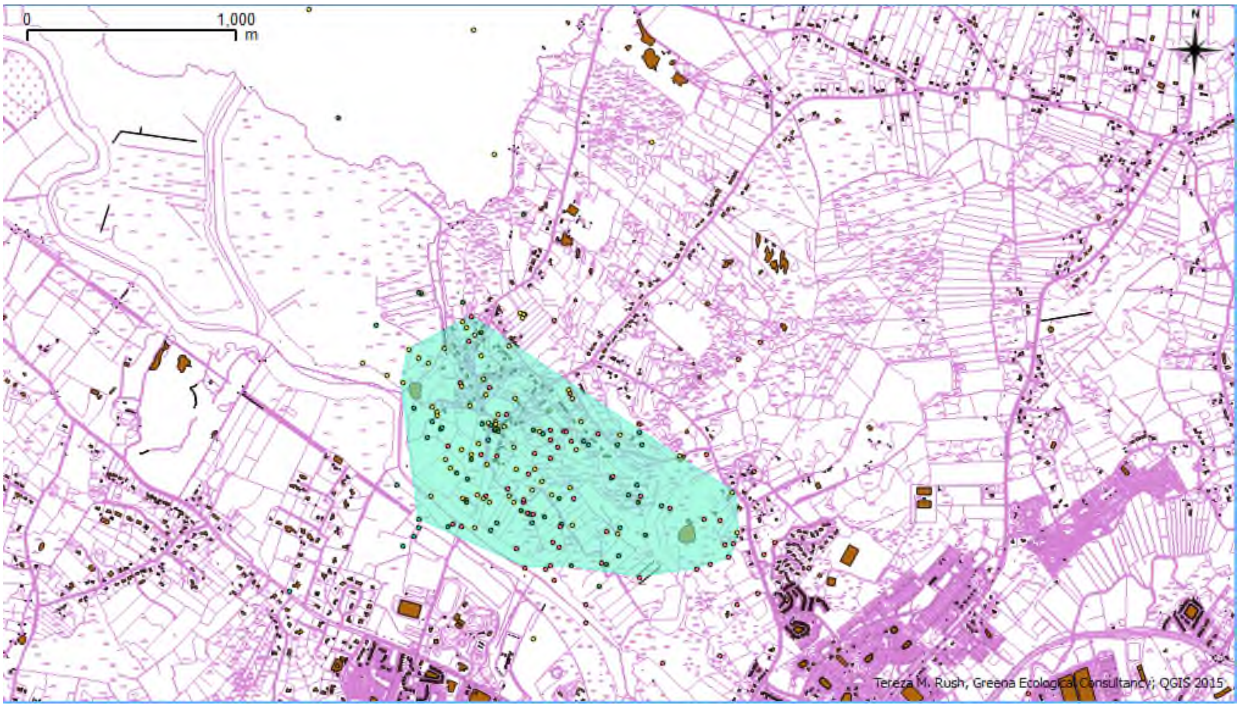


**Figure 11 Core foraging area in May 2015**




## *7.7 Summary of Results*

Greena Ecological Consultancy carried out an additional radio-tracking session in Galway in 2015 in order to complete the full picture of bat activity in the area throughout the year. Previous sessions covered the summer maternity season and the autumn pre-hibernation activity and took place between late July and August, followed by the second one commencing in late August and is extending into September 2014.

Four Lesser horseshoe bats, all females, were captured and fitted with radio-transmitters. All bats were caught at the known maternity roost at Menlo Castle. Further four or five bats were present in the roost on the night of catching but these could not be part of the study to preserve welfare of the colony.

No other bats were captured from Menlo Castle neither other locations in May 2015.

Two of the females captured in May 2015 were previously studied in August 2014 and the results from 2015 provided an interesting comparison of foraging activity of these individuals.

No juvenile bats were subject to survey carried out by Greena Ecological Consultancy. Three of the studied female bats were recognisably, but not heavily, pregnant; one bat was considered to be a young from 2014 that did not show any signs of pregnancy at the time of the capture on 16th May 2015.

Majority of foraging areas of all studied Lesser horseshoe bats overlapped in the area of Menlo castle, Menlo Woods and Menlough village. This was considered to be the core foraging area from where bats travelled both, north towards Lough Corrib and south following the River Corrib all the way to the coast of Galway. Bat foraging area was smaller than recorded in the previous year. It is likely that the obvious night temperature drop was to blame for shorter foraging periods and shorter travel distances of all studied bat in spring 2015.

Only three roosts of Lesser horseshoe bats were confirmed during the May 2015 study. These included the maternity roost of Menlo Castle and two new sites, not utilised by bats in the radio-tracking studies of 2014. The new roosting sites included a boulder field with large gaps among the boulders around the grid reference of M 29598 27171 and a natural limestone structure located at the grid reference of M 28865 28047.

Night roosting was common in the summer and autumn sessions in 2014 but rarely occurred in the spring session in May 2015. Bats usually foraged for 2 – 3 hours after dusk, then returned into their roosts to remain there for the rest of the night, perhaps due to low night temperatures. When further foraging occurred, it was only brief and in vicinity of the roosting places. For this reason all located roosts could also be considered night roosts.

Lesser horseshoe bat maximum foraging distance from the roost was 3.56km in May 2015, much less comparing too both, summer and autumn session of 2014. The average maximum foraging distance of bats in this study was 2.86km from the roost.

The importance of the maternity roost in Menlo Castle as well as the immediate area of Menlough Village and Menlo Woods was highlighted in this study, reinforcing the results of previous sessions.

## 8.0 Acknowledgements

Greena Ecological Consultancy would like to thank the following organisations and individuals for their help in the due course of this study:

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- Galway County Council

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# Appendix J

## Proportion of Core Sustenance Zone within the Proposed N6 GCRR Boundary

## Proportion of Core Sustenance Zone within the Assessment Boundary

| PBR Ref. | Species | CSZ (km)[61] | CSZ (ha) | Area of CSZ within Assessment boundary (ha) | Deductions for habitat retention within CSZ at Menlough (ha) | % loss |
|---|---|---|---|---|---|---|
| **Roosts within Assessment Boundary** | | | | | | |
| PBR177 | PiPy | 3 | 2827 | 113.00 | 10 | 3.64 |
| PBR178 | MySp | 4 | 5027 | 137.59 | 10 | 2.54 |
| PBR178 | RhHi | 2 | 1257 | 75.95 | 10 | 5.25 |
| PBR179 | PiPy | 3 | 2827 | 117.28 | 10 | 3.79 |
| PBR196 | NyLe | 3 | 2827 | 126.84 | 10 | 4.13 |
| PBR199 | MySp | 4 | 5027 | 160.65 | 10 | 3.00 |
| PBR204 | PlAu | 3 | 2827 | 126.48 | 10 | 4.12 |
| PBR205_ST1 | PiSp | 3 | 2827 | 110.97 | N/A | 3.93 |
| PBR205_ST10 | PiSp | 3 | 2827 | 111.84 | N/A | 3.96 |
| PBR205_ST9 | PiSp | 3 | 2827 | 111.47 | N/A | 3.94 |
| PBR210 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR215 | PlAu | 3 | 2827 | 44.54 | N/A | 1.58 |
| PBR215 | MySp | 4 | 5027 | 52.88 | N/A | 1.05 |
| PBR241 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR248 | PiPy | 3 | 2827 | 117.72 | N/A | 4.16 |
| PBR250 | PiPy | 3 | 2827 | 126.66 | 10 | 4.13 |
| PBR252 | PiPi | 2 | 1257 | 77.40 | 10 | 5.36 |
| PBR255 | PiPy | 3 | 2827 | 112.33 | 10 | 3.62 |
| PBR255 | NyLe | 3 | 2827 | 112.33 | 10 | 3.62 |
| PBR256 | PiPy | 3 | 2827 | 111.51 | 10 | 3.59 |
| PBR261 | PiPy | 3 | 2827 | 38.47 | 10 | 1.01 |
| PBR267 | PiPy | 3 | 2827 | 79.88 | N/A | 2.83 |
| PBR267 | PlAu | 3 | 2827 | 79.88 | N/A | 2.83 |
| **Roost Adjacent to the Assessment Boundary (<100m)** | | | | | | |
| PBR73 | MyNa | 4 | 5027 | 133.25 | 10 | 2.45 |
| PBR73 | NyLe | 3 | 2827 | 99.64 | 10 | 3.17 |
| PBR139 | NyLe | 3 | 2827 | 64.13 | N/A | 2.27 |
| PBR145 | PiPy | 3 | 2827 | 120.77 | N/A | 4.27 |
| PBR173 | PlAu | 3 | 2827 | 103.07 | 10 | 3.29 |
| PBR192 | PlAu | 3 | 2827 | 133.64 | N/A | 4.73 |

[61] BCT (2020) *Core Sustenance Zones and habitats of importance for designing Biodiversity Net Gain for bats*. Bat Conservation Trust, London.

| PBR Ref. | Species | CSZ (km)[61] | CSZ (ha) | Area of CSZ within Assessment boundary (ha) | Deductions for habitat retention within CSZ at Menlough (ha) | % loss |
|---|---|---|---|---|---|---|
| PBR219 | RhHi | 2 | Night roost | N/A (76.84) | N/A | N/A |
| PBR216 | PlAu | 3 | 2827 | 44.52 | N/A | 1.57 |
| PBR225 | PiPy | 3 | 2827 | 44.52 | N/A | 1.57 |
| PBR226 | NyLe | 3 | 2827 | 114.01 | 10 | 3.68 |
| PBR229 | PiSp | 3 | 2827 | 136.52 | N/A | 4.83 |
| PBR238 | PiPy | 3 | 2827 | 81.36 | N/A | 2.88 |
| PBR250 | PiPy | 3 | 2827 | 126.66 | 10 | 4.13 |
| PBR252 | PiPi | 2 | 1257 | 77.40 | 10 | 5.36 |
| PBR288 | PiPy | 3 | 2827 | 50.03 | N/A | 1.77 |
| **Roosts away from Assessment Boundary (>100m)** | | | | | | |
| PBR6 | MyDa | 2 | 1257 | 78.18 | 10 | 5.42 |
| PBR6 | RhHi | footnote 2 | 2625[62] | 98 | 10 | 3.35 |
| PBR7 | PiPi | 2 | 1257 | 60.87 | N/A | 4.84 |
| PBR15 | PlAu | 3 | 2827 | 0 | N/A | N/A |
| PBR112 | RhHi | 2 | 1257 | 84.90 | N/A | 6.75 |
| PBR17 | PlAu | 3 | 2827 | 102.85 | N/A | 3.64 |
| PBR17 | MyNa | 4 | 5027 | 141.83 | 10 | 2.62 |
| PBR18 | RhHi | 2 | 1257 | 17.18 | 10 | 0.57 |
| PBR20 | MyNa | 4 | 5027 | 130.86 | 10 | 2.40 |
| PBR21 | PlAu | 3 | 2827 | 49.90 | N/A | 1.77 |
| PBR21 | RhHi | 2 | 1257 | 0.03 | N/A | 0.00 |
| PBR25 | PlAu | 3 | 2827 | 106.67 | 10 | 3.42 |
| PBR25 | RhHi | 2 | 1257 | 71.44 | 10 | 4.89 |
| PBR42 | PiPy | 3 | 2827 | 45.40 | N/A | 1.61 |
| PBR44 | RhHi | 2 | 1257 | 0 | N/A | N/A |
| PBR44 | PiPy | 3 | 2827 | 0 | N/A | N/A |
| PBR47 | Unid. | 4 | 5027 | 115.40 | 10 | 2.10 |
| PBR51 | PlAu | 3 | 2827 | 100.23 | N/A | 3.55 |
| PBR54 | RhHi | 2 | 1257 | 90.32 | N/A | 7.19 |
| PBR64 | MyNa | 4 | 5027 | 41.76 | N/A | 0.83 |
| PBR82 | PlAu | 3 | 2827 | 110.20 | 10 | 3.54 |
| PBR82 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR82 | MyNa | 4 | 5027 | 136.77 | 10 | 2.52 |
| PBR83 | RhHi | 2 | Night roost | N/A | N/A | N/A |

[62] Based on the MCP for the 2015 radio-tracking surveys.

| PBR Ref. | Species | CSZ (km)[61] | CSZ (ha) | Area of CSZ within Assessment boundary (ha) | Deductions for habitat retention within CSZ at Menlough (ha) | % loss |
|---|---|---|---|---|---|---|
| PBR85 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR89 | PlAu | 3 | 2827 | 41.93 | N/A | 1.48 |
| PBR92 | PlAu | 3 | 2827 | 29.44 | N/A | 1.04 |
| PBR94 | PlAu | 3 | 2827 | 48.11 | N/A | 1.70 |
| PBR100 | PlAu | 3 | 2827 | 90.97 | N/A | 3.22 |
| PBR105 | PlAu | 3 | 2827 | 91.82 | N/A | 3.25 |
| PBR111 | PlAu | 3 | 2827 | 106.79 | N/A | 3.78 |
| PBR124 | RhHi | 2 | 1257 | 27.46 | N/A | 2.18 |
| PBR125 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR126 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR127 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR128 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR129 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR130 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR133 | MyDa | 2 | 1257 | 68.13 | 10 | 4.62 |
| PBR134 | NyLe | 3 | 2827 | 125.69 | N/A | 4.45 |
| PBR136 | Unid. | 4 | 5027 | 97.65 | N/A | 1.94 |
| PBR138 | PlAu | 3 | 2827 | 84.28 | 10 | 2.63 |
| PBR140 | MyMy | 1 | 314 | 12.38 | N/A | 3.94 |
| PBR141 | PiPi | 2 | 1257 | 51.19 | N/A | 4.07 |
| PBR142 | MyDa | 2 | 1257 | 24.70 | 10 | 1.17 |
| PBR143 | MyDa | 2 | 1257 | 44.51 | 10 | 2.75 |
| PBR144 | MyDa | 2 | 1257 | 26.67 | 10 | 1.33 |
| PBR147 | PiPi | 2 | 1257 | 51.00 | N/A | 4.06 |
| PBR148 | PiPi | 2 | 1257 | 23.15 | N/A | 1.84 |
| PBR149 | PiPi | 2 | 1257 | 24.09 | N/A | 1.92 |
| PBR150 | MyDa | 2 | 1257 | 0.05 | N/A | 0.00 |
| PBR151 | MyMy | 1 | 314 | 12.55 | N/A | 4.00 |
| PBR152 | MyDa | 2 | 1257 | 0.03 | 10 | N/A |
| PBR153 | RhHi | 2 | 1257 | 90.28 | N/A | 7.18 |
| PBR156 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR156 | PlAu | 3 | Night roost | N/A | N/A | N/A |

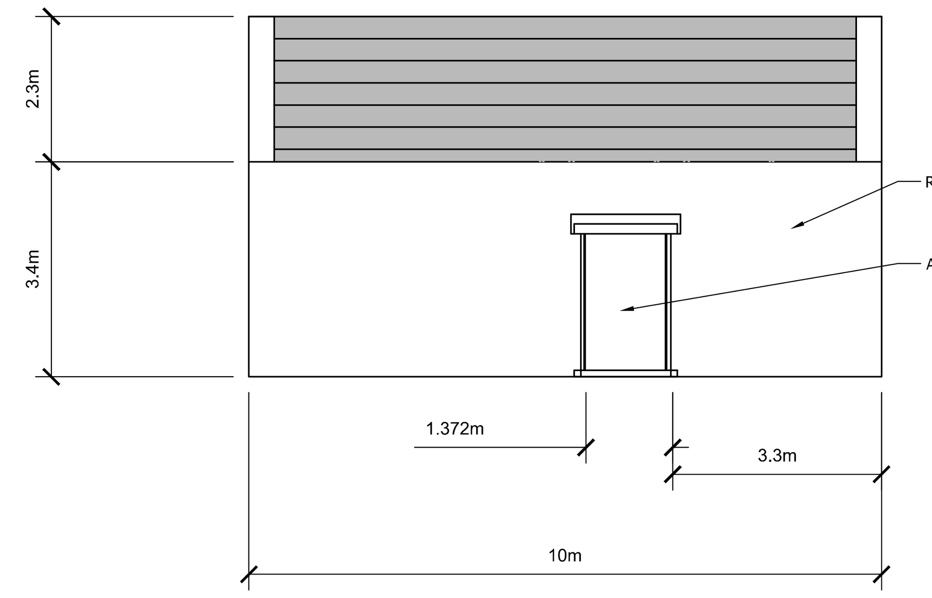
| PBR Ref. | Species | CSZ (km)[61] | CSZ (ha) | Area of CSZ within Assessment boundary (ha) | Deductions for habitat retention within CSZ at Menlough (ha) | % loss |
|---|---|---|---|---|---|---|
| PBR157 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR158 | RhHi | 2 | 1257 | 70.96 | 10 | 4.85 |
| PBR159 | RhHi | 2 | 1257 | 0 | N/A | N/A |
| PBR160 | RhHi | 2 | 1257 | 0 | N/A | N/A |
| PBR165 | PiPi | 2 | 1257 | 50.74 | N/A | 4.04 |
| PBR217 | RhHi | 2 | 1257 | 26.49 | N/A | 2.11 |
| PBR217 | PlAu | 3 | 2827 | 49.93 | N/A | 1.77 |
| PBR218 | RhHi | 2 | Night roost | N/A | N/A | N/A |
| PBR220 | PiPi | 2 | 1257 | 34.13 | N/A | 2.72 |
| PBR222 | PiPy | 3 | 2827 | 53.80 | N/A | 1.90 |
| PBR224 | PiSp | 3 | 2827 | 53.23 | N/A | 1.88 |
| PBR242 | PiSp | 3 | 2827 | 128.36 | N/A | 4.54 |

# Appendix K

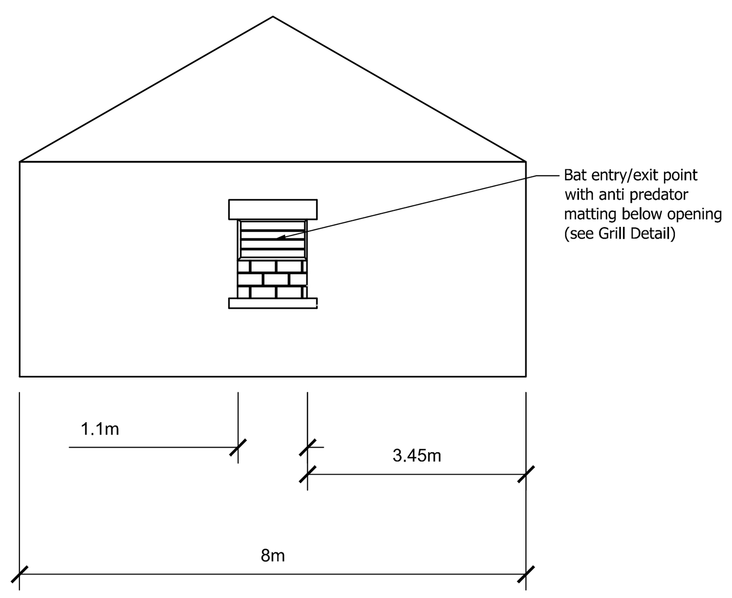
## Artificial Bat Roost Drawings

FOR INFORMATION

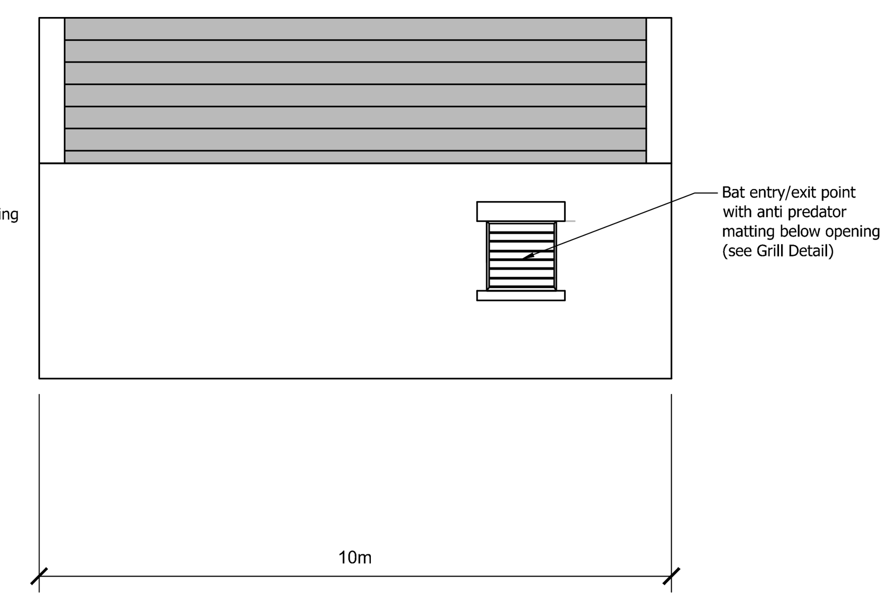
Notes:
1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.



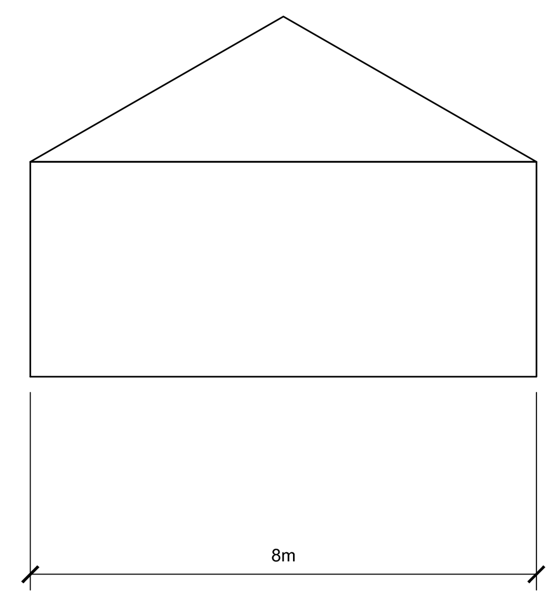

Proposed Front Elevation
Scale 1:100



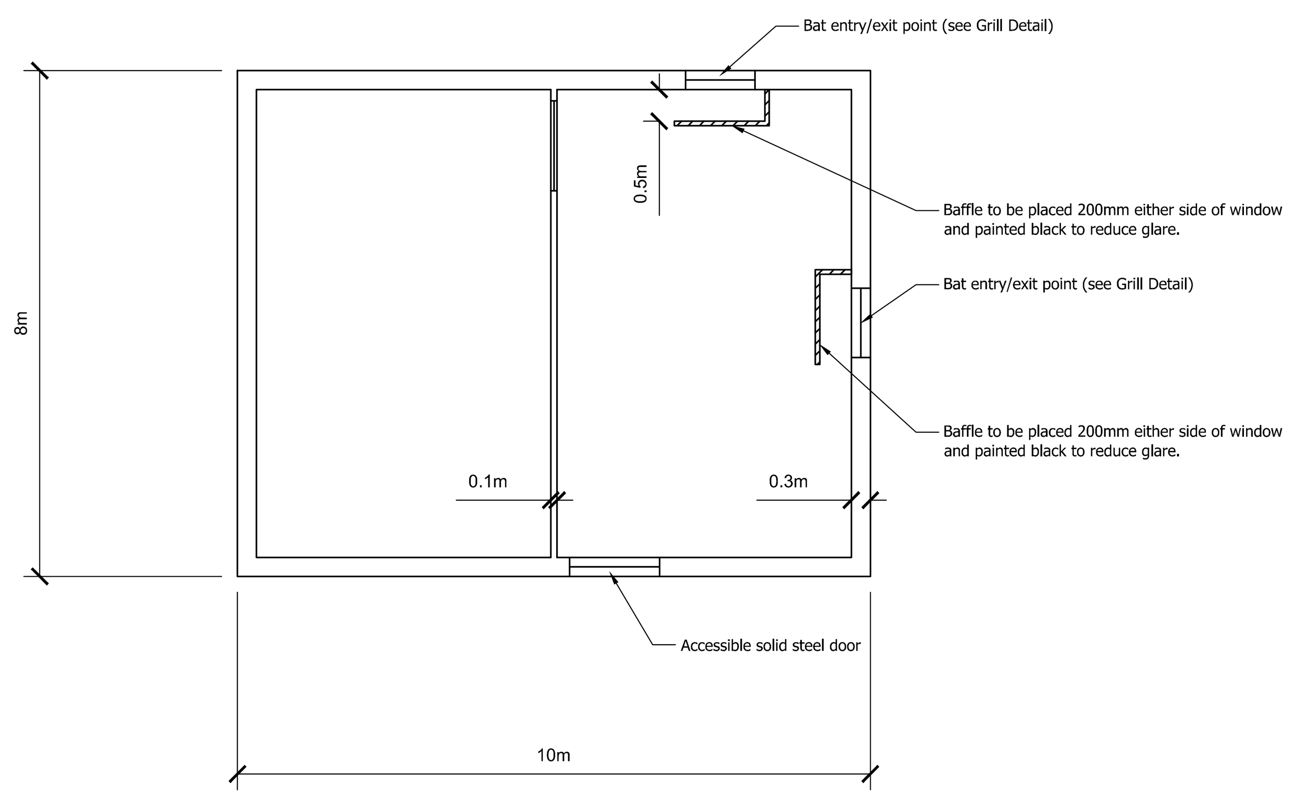

Proposed Side Elevation 1
Scale 1:100



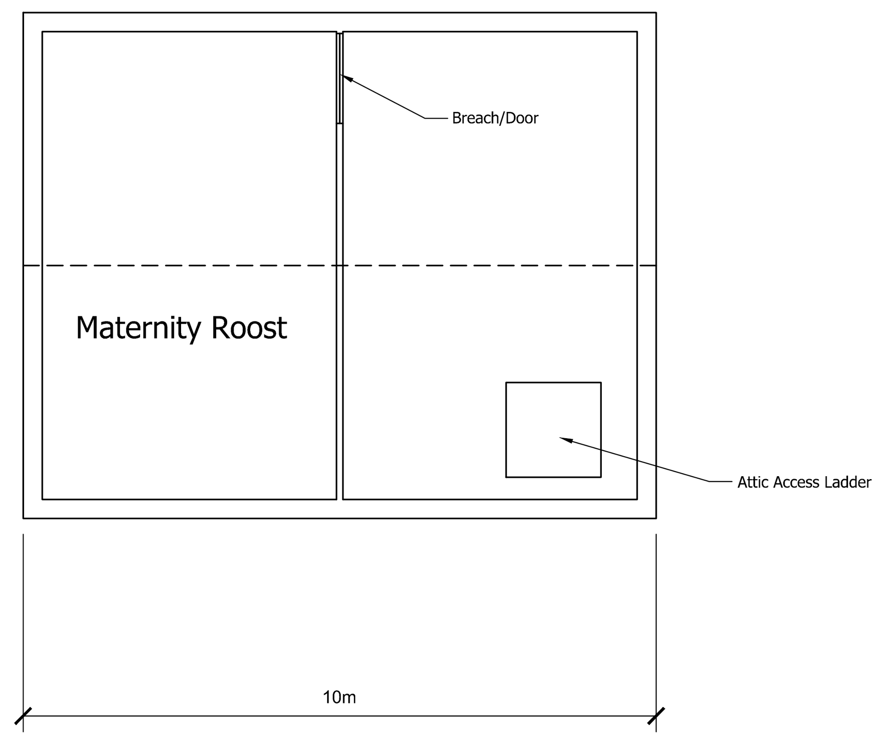

Proposed Rear Elevation
Scale 1:100




Proposed Side Elevation 2
Scale 1:100

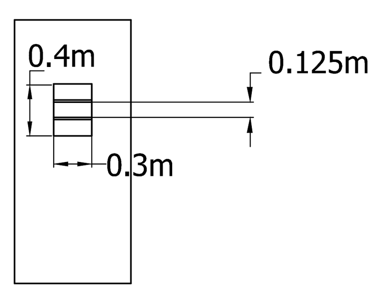



Proposed Ground Floor Plan
Scale 1:100

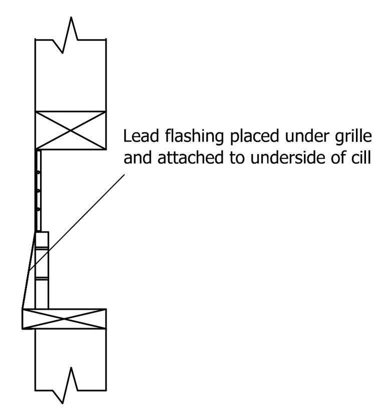



Proposed Attic Space Plan
Scale 1:100

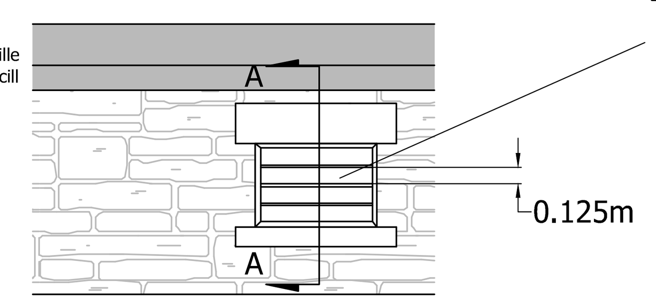
## Maternity/Hibernation Roost




Proposed Internal Door Detail
Scale 1:50




Section A-A
Scale 1:50




Proposed Grille Detail
Scale 1:100

Notes on Grille Detail

1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mmø Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.
4. Lead flashing to be placed over window cill.

Clients

Comhairle Chontae na Gaillimhe
Galway County Council

N6 Galway City Transport Project

An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport

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Scale: As Shown @A1

Date: February 2018

| Issue | Date | By | Chkd | Appd |
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| I2 | 23/03/2018 | AG | HK | EMC |
| I1 | 22/02/2018 | KJ | HK | EMC |

Drawing Title
Proposed Bat Roots

Sheet 1 of 3

Drawing Status
For Information

| Job No | Drawing No | Issue |
| --- | --- | --- |
| 233985 | GCOB-3000-D-001 | I2 |

Do not scale

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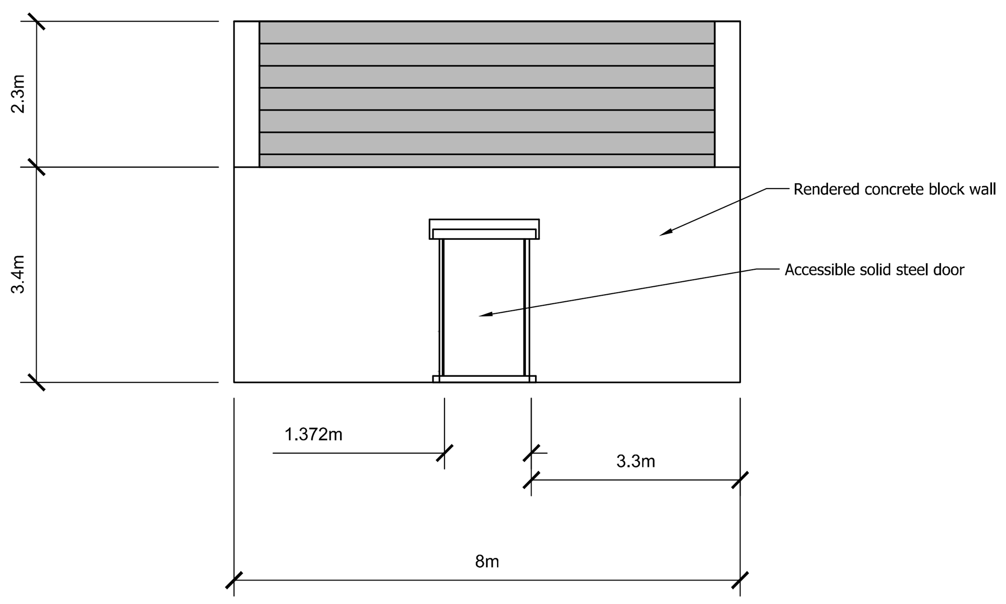
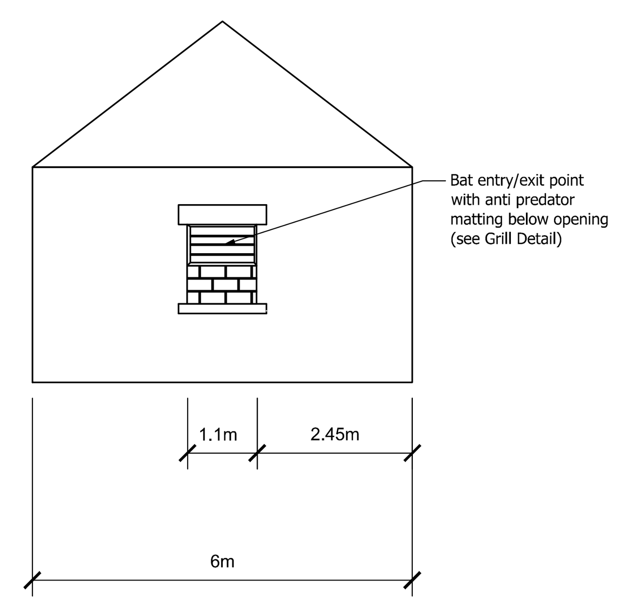
FOR INFORMATION

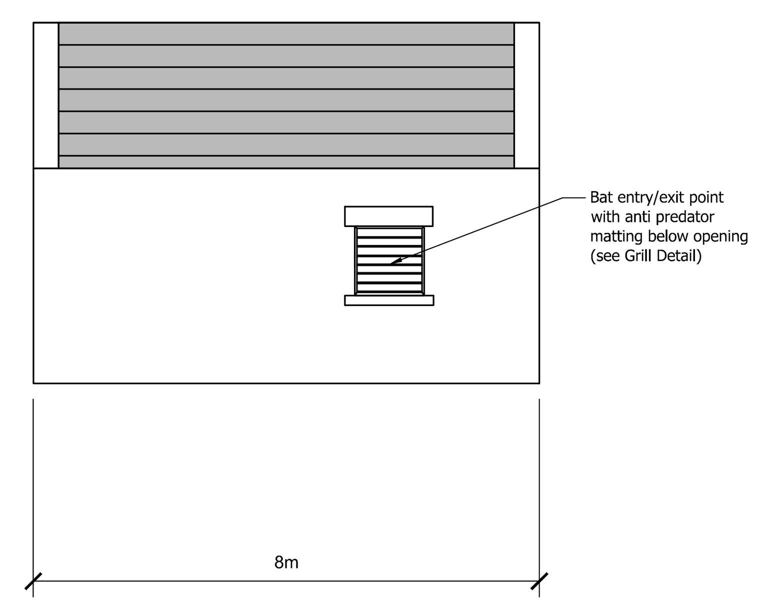
Notes:
1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.



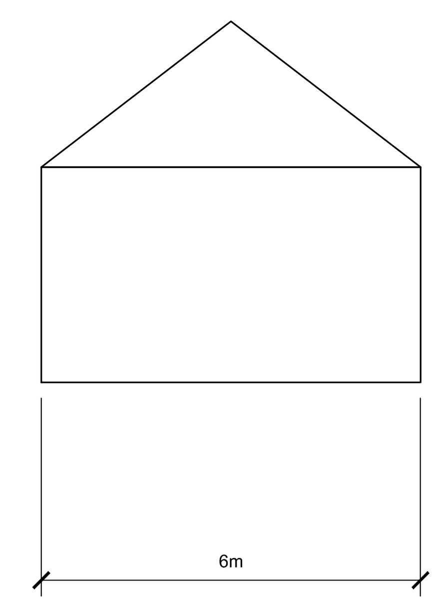

Proposed Front Elevation
Scale 1:100



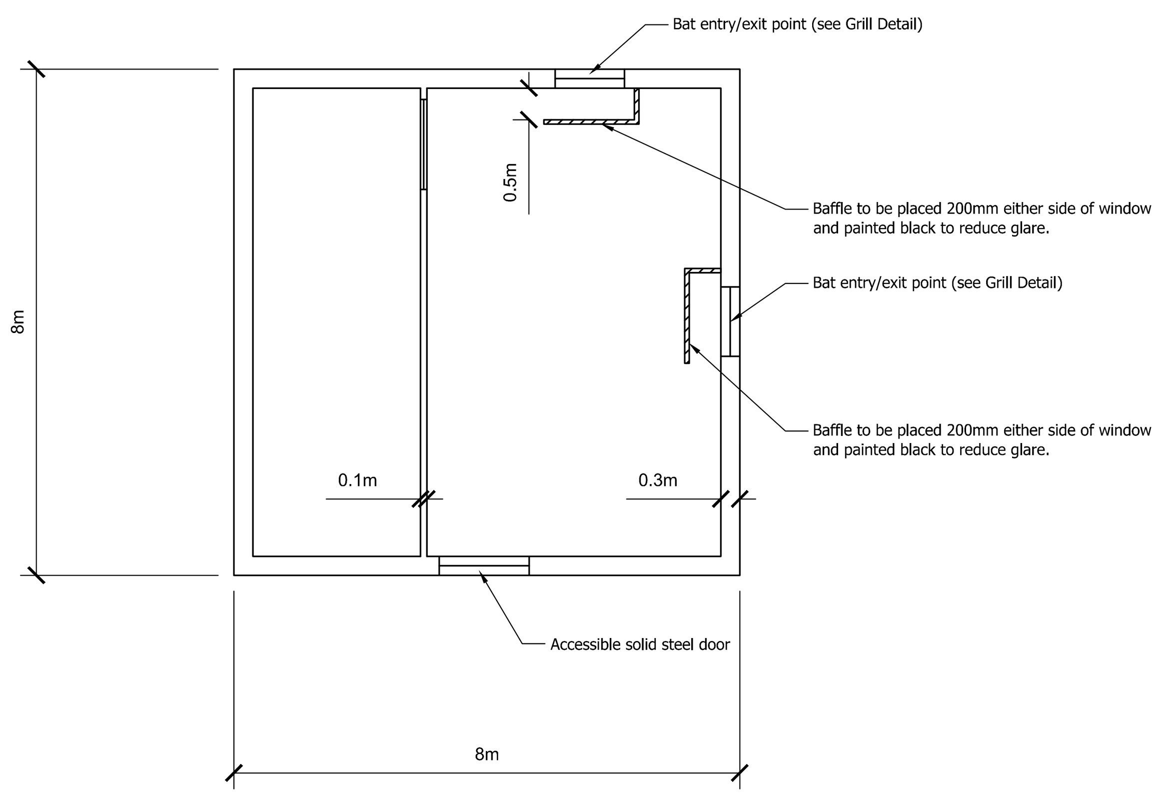

Proposed Side Elevation 1
Scale 1:100



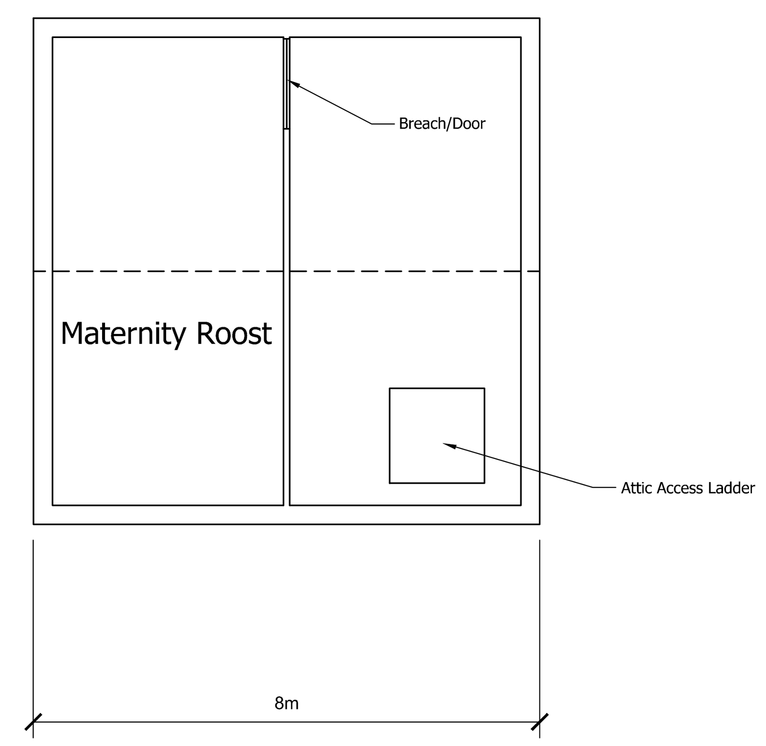

Proposed Rear Elevation
Scale 1:100




Proposed Side Elevation 2
Scale 1:100

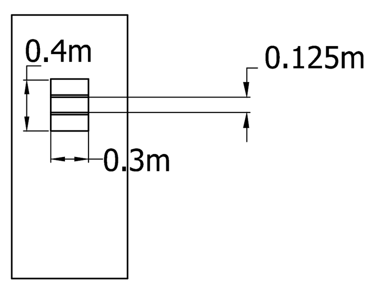



Proposed Ground Floor Plan
Scale 1:100

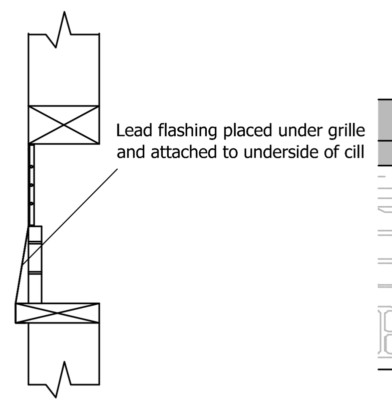



Proposed Attic Space Plan
Scale 1:100

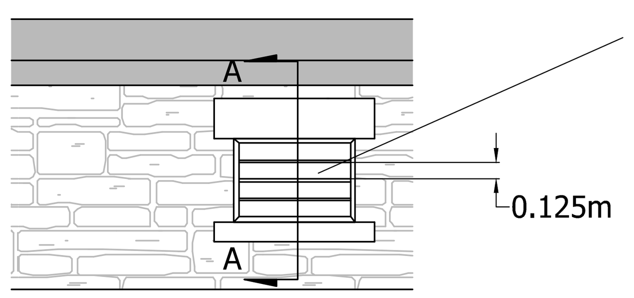
## Balliondooley Day/Night Roost




Proposed Internal Door Detail
Scale 1:50



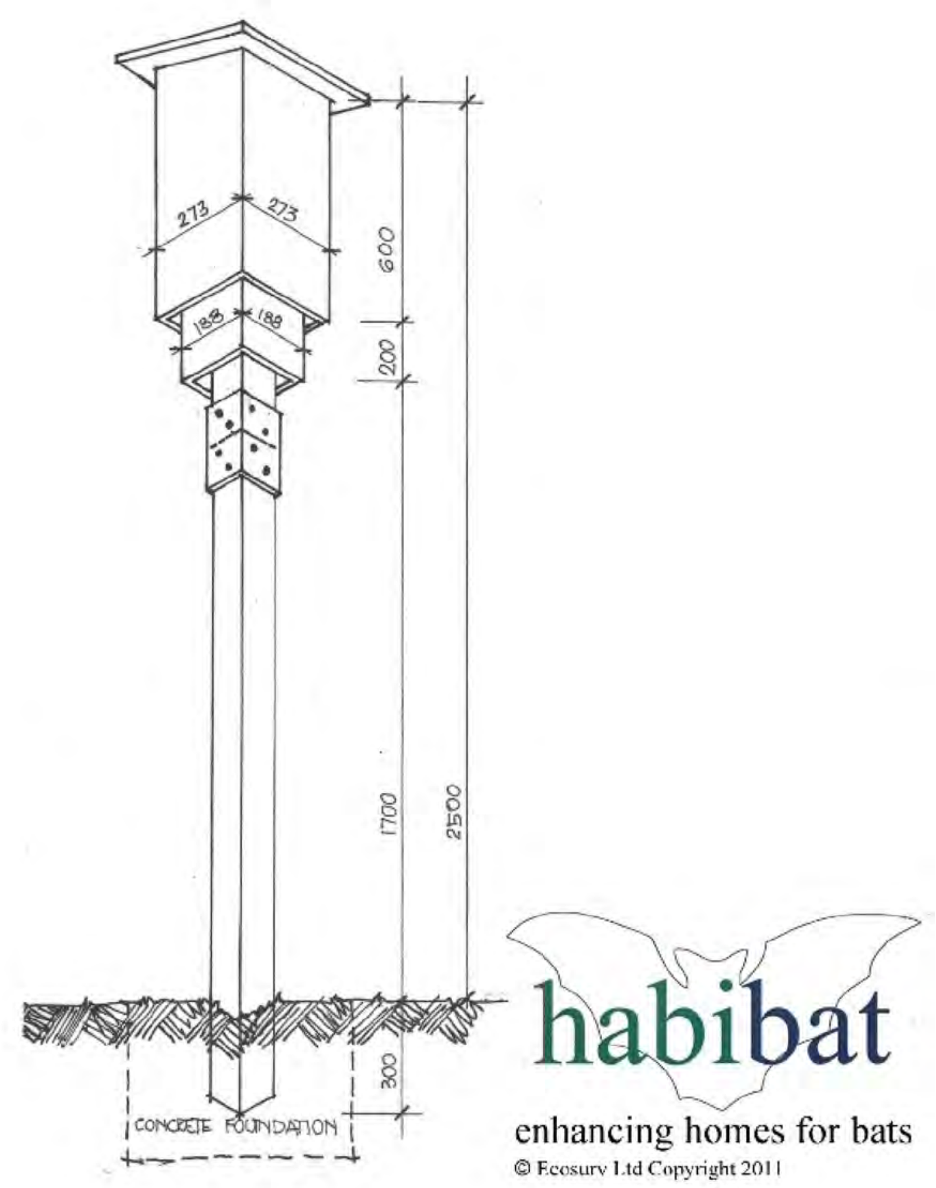

Section A-A
Scale 1:50



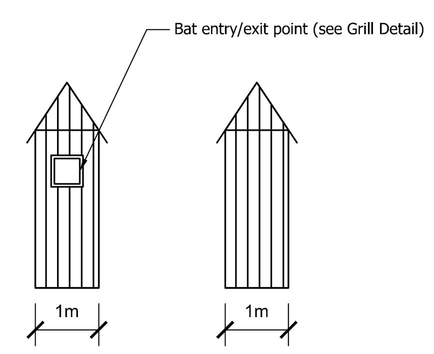

Proposed Grille Detail
Scale 1:100

Notes on Grille Detail

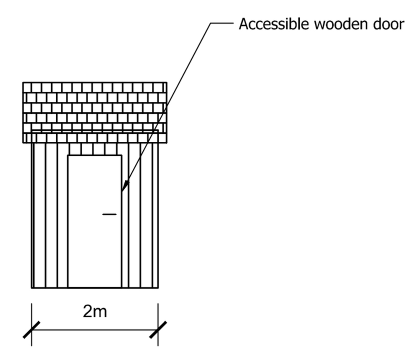
1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mmø Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.
4. Lead flashing to be placed over window cill.



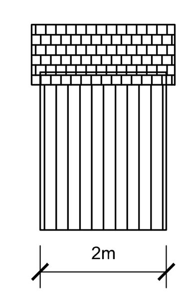

Typical Detail Double Chambered Rocket Box



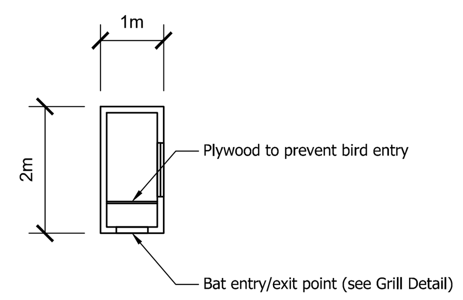

Proposed Side Elevations
Scale 1:100



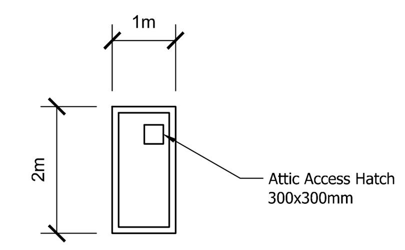

Proposed Front Elevation
Scale 1:100




Proposed Front Elevation
Scale 1:100




Proposed Ground Floor Plan
Scale 1:100




Proposed Attic Space Plan
Scale 1:100

## Menlough Woods Night Roost

Clients
Comhairle Chontae na Gaillimhe
Galway County Council
N6 Galway City Transport Project
An Roinn Iompair Turasóireachta agus Spóirt
Department Transport, Tourism and Sport
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Job Title
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Scale: As Shown @A1
Date: February 2018

| Issue | Date | By | Chkd | Appd |
|---|---|---|---|---|
| I2 | 23/03/2018 | AG | HK | EMC |
| I1 | 22/02/2018 | KJ | HK | EMC |

Drawing Title
Proposed Bat Roots
Sheet 2 of 3

Drawing Status
For Information

| Job No | Drawing No | Issue |
|---|---|---|
| 233985 | GCOB-3000-D-002 | I2 |

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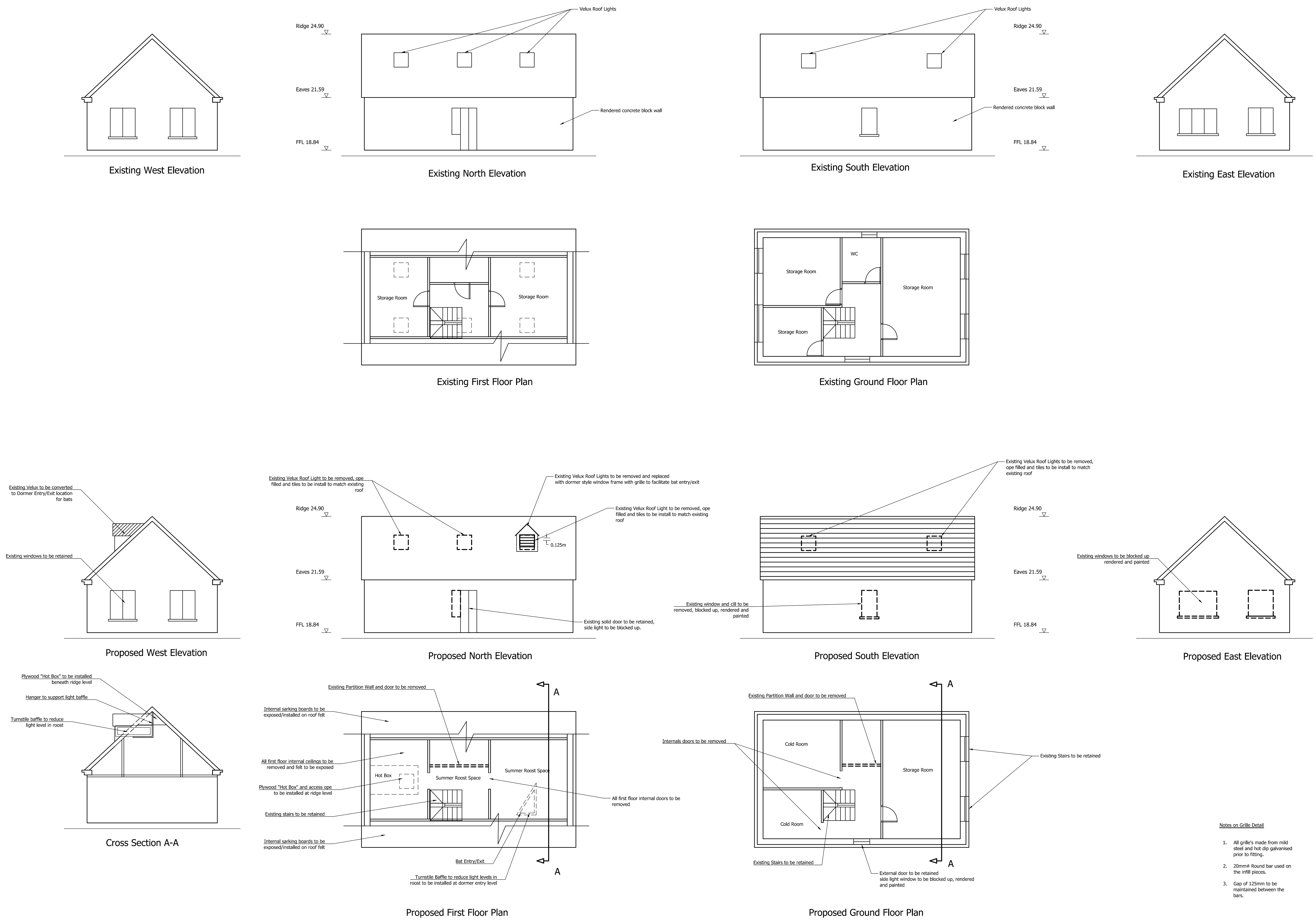


# Castlegar Garage Retrofit Details

FOR INFORMATION

Notes:

1. Main access for monitoring will be through front door. Access to Maternity Roost for monitoring via Fixed Ladder.
2. All cellings on ground floor should be fitted with rough wood.

Notes on Grille Detail

1. All grille's made from mild steel and hot dip galvanised prior to fitting.
2. 20mm⌀ Round bar used on the infill pieces.
3. Gap of 125mm to be maintained between the bars.

Clients: Comhairle Chontae na Gaillimhe Galway County Council; N6 Galway City Transport Project; An Roinn Iompair Turasóireachta agus Spóirt Department Transport, Tourism and Sport; TII Bonneagar Iompair Éireann Transport Infrastructure Ireland

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Scale: N.T.S.

Date: February 2018

| Issue | Date | By | Chkd | Appd |
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| I2 | 23/03/2018 | AG | HK | EMC |
| I1 | 22/02/2018 | KJ | HK | EMC |

Drawing Title: Proposed Bat Roots

Sheet 3 of 3

Drawing Status: **For Information**

Job No: 233985 | Drawing No: GCOB-3000-D-003 | Issue: I2

Do not scale

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