2019

Bat Assessment

Dr Tina Aughney

Bat Eco Services

August 2019

Bat Eco Services, Ulex House, Drumheel, Lisduff, Virginia, Co. Cavan. A82 XW62.

Licenced Bat Specialist: Dr Tina Aughney (tina@batecoservices.com, 086 4049468)

NPWS licence C30/2017 (Licence to handle bats, expires 31st December 2019)

NPWS licence 33/2017 (Licence to photograph/film bats, expires 31st December 2019)

NPWS licence DER/BAT 2017-09 (Licence to disturb a roost, expires 29th March 2020)

Client: Drogheda Tidy Towns

Project Name & Location: Drogheda, Co. Louth

Report Revision History

Date of Issue	Draft Number	Issued To
4th August 2019	Draft 1	Drogheda Tidy Towns

Purpose

This document has been prepared as a Final Report for Drogheda Tidy Towns.

Bat Eco Service accepts no responsibility or liability for any use that is made of this document other than by the client for the purposes for which it was originally commissioned and prepared.

Carbon Footprint Policy

It is the policy of Bat Eco Services to provide documentation digitally in order to reduce carbon footprint. Printing of reports etc. is avoided, where possible.

Bat Record Submission Policy

It is the policy of Bat Eco Services to submit all bat records to Bat Conservation Ireland database one year post-surveying. This is to ensure that a high level bat database is available for future desktop reviews. This action will be automatically undertaken unless otherwise requested, where there is genuine justification.

Executive Summary

Project Name & Location: Bats of Drogheda, Co. Louth

Proposed work: General Bat Conservation Measures

Bat Survey Results - Summary

Bat Species	Roosts	Foraging	Commuting
Common pipistrelle *Pipistrellus pipistrellus*		√	√
Soprano pipistrelle *Pipistrellus pygmaeus*		√	√
Nathusius' pipistrelle *Pipistrellus nathusii*			
Leisler's bat *Nyctalus leisleri*		√	√
Brown long-eared bat *Plecotus auritus*			
Daubenton's bat *Myotis daubentonii*		√	√
Natterer's bat *Myotis nattereri*			
Whiskered bat *Myotis mystacinus*			
Lesser horseshoe bat *Rhinolophus hipposideros*			

Bat Survey Duties Completed

Tree PBR Survey	◯	Daytime Building Inspection	◯
Static Detector Survey	◯	Daytime Bridge Inspection	◯
Dusk Bat Survey	◯	Dawn Bat Survey	◯
Walking Transect	◯	Driving Transect	◯
Trapping / Mist Netting	◯	IR Camcorder filming	◯
Endoscope Inspection	◯	Other	◯

_____

Contents

1. Introduction

Bat Eco Services was commissioned by Drogheda Tidy Town to undertake a general bat survey of the town environs.

1.1 Relevant Legislation & Bat Species Status in Ireland

All Irish bat species are protected under the Wildlife Act (1976) and Wildlife Amendment Acts (2000 and 2010). Also, the EC Directive on The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive 1992), seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken. All Irish bats are listed in Annex IV of the Habitats Directive and the lesser horseshoe bat *Rhinolophus hipposideros* is further listed under Annex II. Across Europe, they are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

Also, under existing legislation, the destruction, alteration or evacuation of a known bat roost is a notifiable action and a derogation licence has to be obtained from the *National Parks and Wildlife Service* before works can commence. Any works interfering with bats and especially their roosts, may only be carried out under a licence to derogate from Regulation 23 of the Habitats Regulations 1997 and Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011 (which transposed the EU Habitats Directive into Irish law), issued by NPWS. The details with regards to appropriate assessments, the strict parameters within which derogation licences may be issued and the procedures by which and the order in relation to the planning and development regulations such licences should be obtained, are set out in Circular Letter NPWS 2/07 "*Guidance on Compliance with Regulation 23 of the Habitats Regulations 1997 - strict protection of certain species/applications for derogation licences*" issued on behalf of the Minister of the Environment, Heritage and Local Government on the 16th of May 2007.

There are eleven recorded bat species in Ireland, nine of which are considered resident. Eight resident bat species and one of the vagrant bat species are vesper bats and all vespertilionid bats have a tragus (cartilaginous structure inside the pinna of the ear). Vesper bats are distributed throughout the island. Nathusius' pipistrelle *Pipistrellus nathusii* is a recent addition while the Brandt's bat has only been recorded once to-date (Only record confirmed by DNA testing, all other records has not been genetically confirmed). The ninth resident species is the lesser horseshoe bat *Rhinolophus hipposideros*, which belongs to the Rhinolophidea and has a complex nose leaf structure on the face, distinguishing it from the vesper bats. This species' current distribution is confined to the western seaboard counties of Mayo, Galway, Clare, Limerick, Kerry and Cork. The eleventh bat species, the greater horseshoe bat, was only recorded for the first time in February 2013 in County Wexford and is therefore considered to be a vagrant species.

Irish bat species list (please see Appendices for more information in individual bat species) is presented in Table 1. The current status of the known bat species occurring in Ireland is given in the Table 1 below.

Table 1: Status of the Irish bat fauna (Marnell *et al.,* 2009).

Species: Common Name	Irish Status	European Status	Global Status
Resident Bat Species ^			
Daubenton's bat *Myotis daubentonii*	Least Concern	Least Concern	Least Concern
Whiskered bat *Myotis mystacinus*	Least Concern	Least Concern	Least Concern
Natterer's bat *Myotis nattereri*	Least Concern	Least Concern	Least Concern
Leisler's bat *Nyctalus leisleri*	Near threatened	Least Concern	Least Concern
Nathusius' pipistrelle *Pipistrellus nathusii*	Least Concern	Least Concern	Least Concern
Common pipistrelle *Pipistrellus pipistrellus*	Least Concern	Least Concern	Least Concern
Soprano pipistrelle *Pipistrellus pygmaeus*	Least Concern	Least Concern	Least Concern
Brown long-eared bat *Plecotus auritus*	Least Concern	Least Concern	Least Concern
Lesser horseshoe bat *Rhinolophus hipposideros*	Least Concern	Near threatened	Least Concern
Possible Vagrants ^			
Brandt's bat Myotis brandtii	Data deficient	Least Concern	Least Concern
Greater horseshoe bat *Rhinolophus ferrumequinum*	Data deficient	Near threatened	Near threatened

^ Roche *et al.,* 2014

1.2 Relevant Guidance Documents

This report will draw on guidelines already available in Europe and will use the following documents:

- National Roads Authority (2006) Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes
- Collins, J. (Editor) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edition). Bat Conservation Trust, London
- McAney, K. (2006) A conservation plan for Irish vesper bats, Irish Wildlife Manual No. 20 National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- Kelleher, C. & Marnell, F. (2006) Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.
- The status of EU protected habitats and species in Ireland: Conservation status in Ireland of habitats and species listed in the European Council Directive on the Conservation of

Habitats, Flora and Fauna 92/43/EEC. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.

Based on the information collected during the desktop studies and bat surveys, the bat ecologist assigns an ecological value to each bat species recorded based on its conservation status at different geographical scales (Table 2). For example, a site may be of national ecological value for a given species if it supports a significant proportion (e.g. 5%) of the total national population of that species.

Table 2: The six-level ecological valuation scheme used in the CIEM Guidelines (2016) Ecological Value

Ecological Value	Geographical Scale of Importance
International	International or European scale
National	The Republic of Ireland or the island of Ireland scale (depending on the bat species)
Regional	Province scale: Leinster
County	County scale: Co. Louth
Local	Drogheda
Negligible	None, the feature is common and widespread

1.3 Project Description

1.3.1 Site Location

The bat survey was completed within the town of Drogheda, Co. Louth.

1.3.2 Proposed Project

Drogheda Tidy Towns requested a bat survey to determine what bat species are present within the town environs in order to undertake bat conservation measures as part of the wildlife works of the tidy town goals.

1.3.3 Bat Survey Aims

The aims of the bat survey at the proposed project site are as follows:

- Provide a species list;
- Provide a map of bat encounters;
- Make recommendations on bat conservation measures for the town.

- Walking transect: bat surveys completed on-foot where the surveyor(s) walk the survey site from 10 minutes prior to sunset to at least 120 minutes after sunset. Often this survey is completed post an emergence survey and therefore may be undertaken for a longer period of time after sunset.

- Driving transect: bat survey complete in a car and undertaken according to a strict survey protocol. Surveying is completed from 40 minutes after sunset till the end of the planned survey route. This is only undertaken for large survey area with a well-defined public road structure. Routes are planned and mapped prior to surveying.

2. Bat Survey Methodology

2.1 Night-time Bat Detector Surveys

2.1.1 Dusk Bat Survey

Dusk walking bat surveys are completed from 10 minutes before sunset to at least 120 minutes post sunset. Surveys are completed during mild and dry weather conditions with air temperature 8^{o}C or greater. All bat encounters are noted during surveys.

Walking transects involve the surveyor(s) walking the survey area, noting the time, location and bat species encountered. If the mapping facility is used on the Wildlife Acoustics Echo Meter Touch2 Pro (Android) connected to Samsung Galaxy Tab S3, this is mapped using Google Earth with a KLM file produced for mapping purposes. Validation of bat records is completed by the principal bat surveyor prior to mapping. Otherwise, Irish Grid references are recorded and an excel file of bat record locations is produced for mapping.

Driving transects are undertaken for large survey areas. The Wildlife Acoustics Echo Meter Touch2 Pro (Android) microphone is attached to a 5m extension microphone cable (attached to Samsung Galaxy Tab S3) and is located outside on the passenger side of a vehicle. The vehicle is driven at 24 km/hr following Bat Conservation Ireland's car-based bat monitoring methodology (Aughney *et al.,* 2018). The time, location (grid reference) and bat species encountered are recorded. These recordings are mapped using Google Earth with a KLM file produced for mapping purposes. Validation of bat records is completed by the principal bat surveyor prior to mapping.

The following equipment is used:

Wildlife Acoustics Echo Meter Touch2 Pro (Android) connected to Samsung Galaxy Tab S3 and Petersson D200 Heterodyne Bat Detector.

2.2 Desktop Review

2.2.1 Bat Conservation Ireland Database

A 1km and 10km search of bat records available for Drogheda area was requested from Bat Conservation Ireland. the Irish grid reference used for the data searches was O087754.

2.2.2 All Ireland Daubenton's Bat Waterways Survey

Bat Conservation Ireland manages the Irish Bat Monitoring Programme. As part of this programme is the All Ireland Daubenton's Bat Waterways survey, a monitoring scheme that records the distribution and activity levels of the Daubenton's bat along rivers and canals. This survey involves a walking transect of 1km stretches of linear waterways and is undertaken during the month of August annually. As the River Boyne flows through Drogheda, a request for information on potential 1km transects along the river within reach of Drogheda was requested from Bat Conservation Ireland.

2.2.3 Bat Conservation Landscape Favourability

Bat Conservation Ireland produced a landscape conservation guide for Irish bat species using their database of species records collated during the 2000-2009 survey seasons. An analysis of the habitat and landscape associations of all bat species deemed resident in Ireland was undertaken and reported in Lundy *et al.*, 2011. The geographical area suitable for individual species was used to identify the core favourable areas of each species. This was produced as a GIS layer for local authorities and planners in order to provide a guide to the consideration of bat conservation. The island is divided into 5km squares and the landscape favourability of each 5km square for each species of bat was modelled. The survey area of the proposed wind farm development is located, primarily, in 5 x 5km squares (See Map 1.2). A caveat is attached to the model and it is that the model is based on records held on the BCIreland database, while core areas have been identified, areas outside the core area should not be discounted as unimportant as bats are a landscape species and can travel many kilometres between roosts and foraging areas nightly and seasonally. This model was used as part of the desktop study for this report.

3. Bat Survey Results

3.1 Night-time Bat Detector Surveys

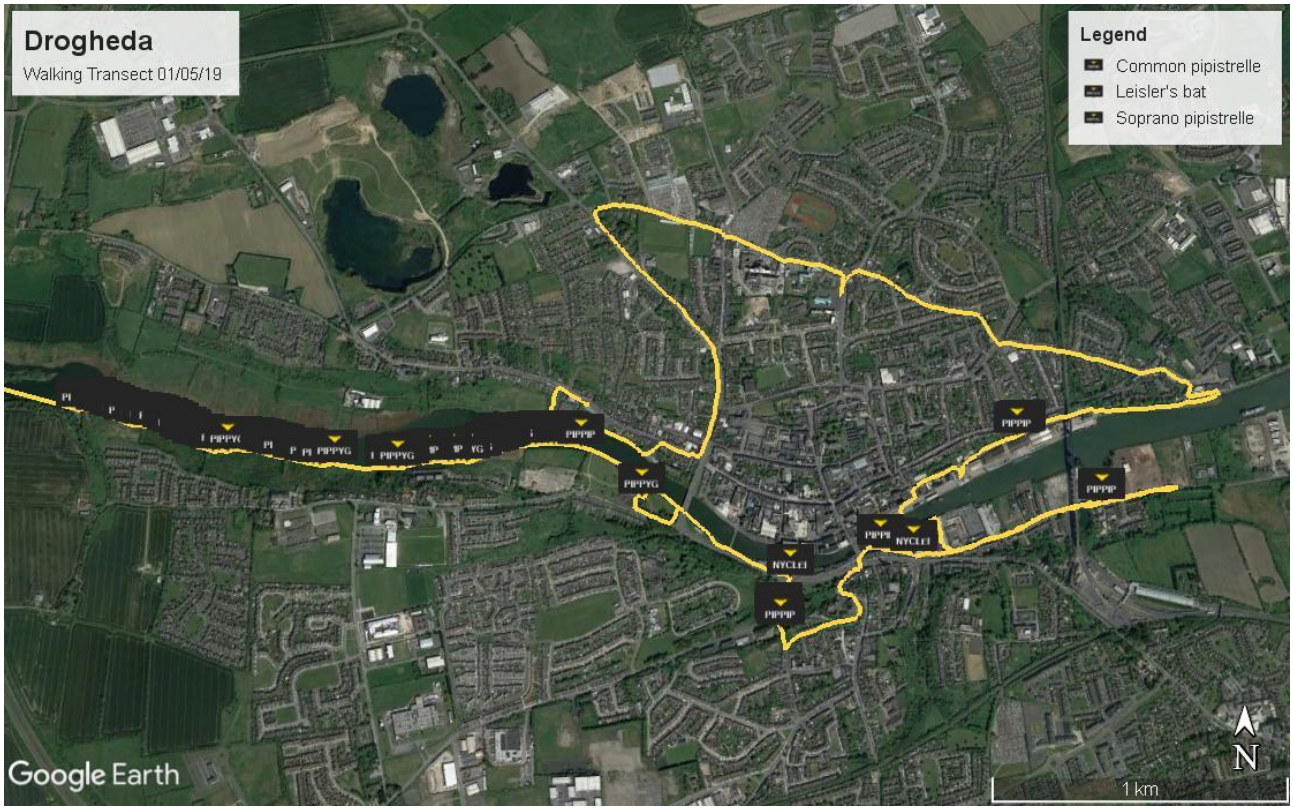
3.1.1 Dusk & Dawn Bat Survey

The following figures summarises the results of the bat detector surveys completed. A walking transect was undertaken on 1st May 2019 and the route walked is shown as a yellow line overlaid on the aerial photograph. A total of three bat species was recorded during the walking transects and the bat activity was generally confined to the areas adjacent to the River Boyne.

Soprano pipistrelles were the most commonly encountered bat species followed by common pipistrelles and Leisler's bats respectively. These three bat species are considered to be Ireland most common bat species.

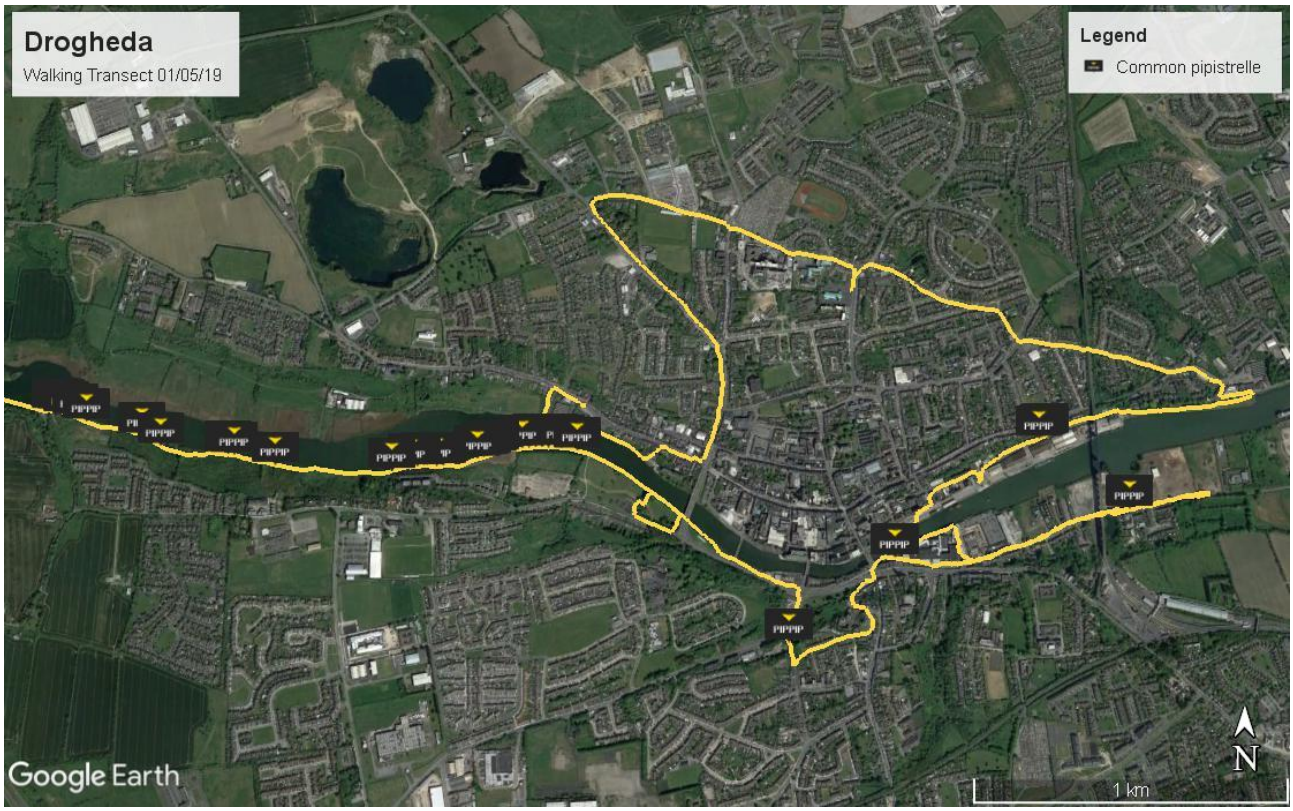
Figure 1: Walking Transect (1st May 2019)

a) All bat encounters (yellow line = walking route)



b) Common pipistrelle encounters along River Boyne

c) Common pipistrelle encounters in all areas of Drogheda walked



d) Soprano pipistrelle encounters along River Boyne

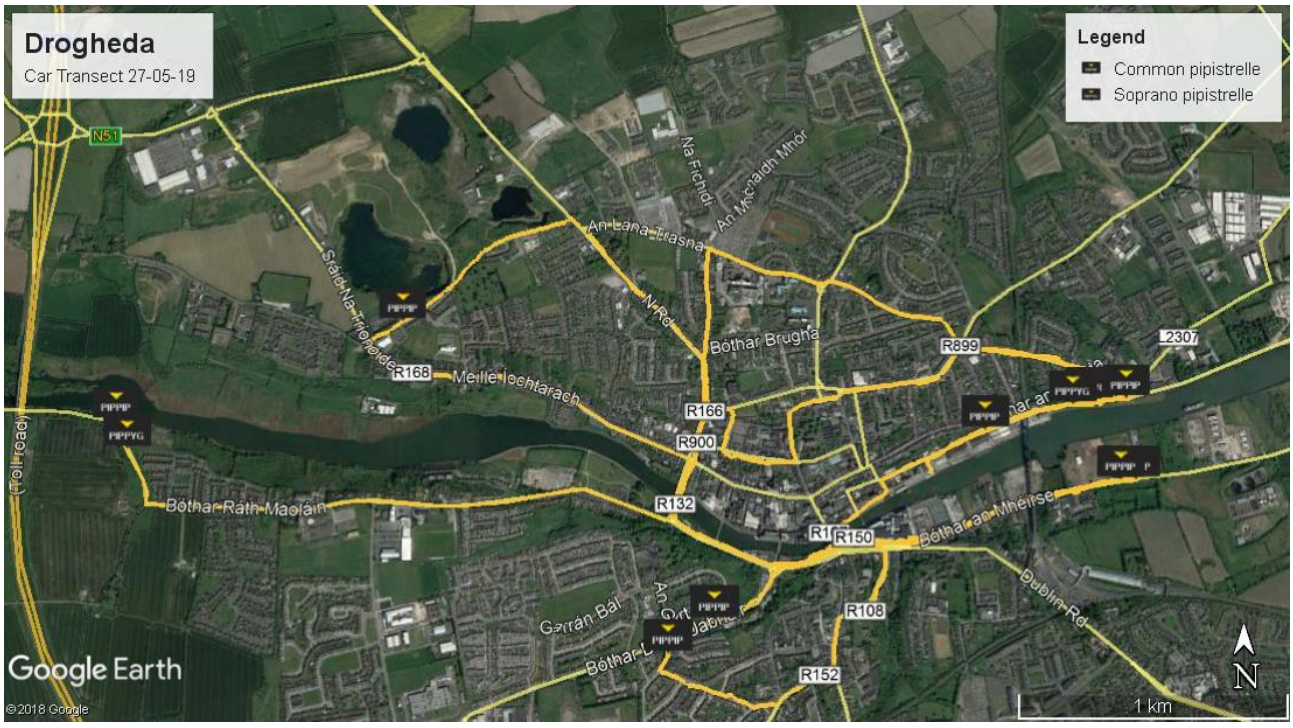
e) Soprano pipistrelle encounters in all areas of Drogheda walked

f) Leisler's bat encounters in all areas of Drogheda walked

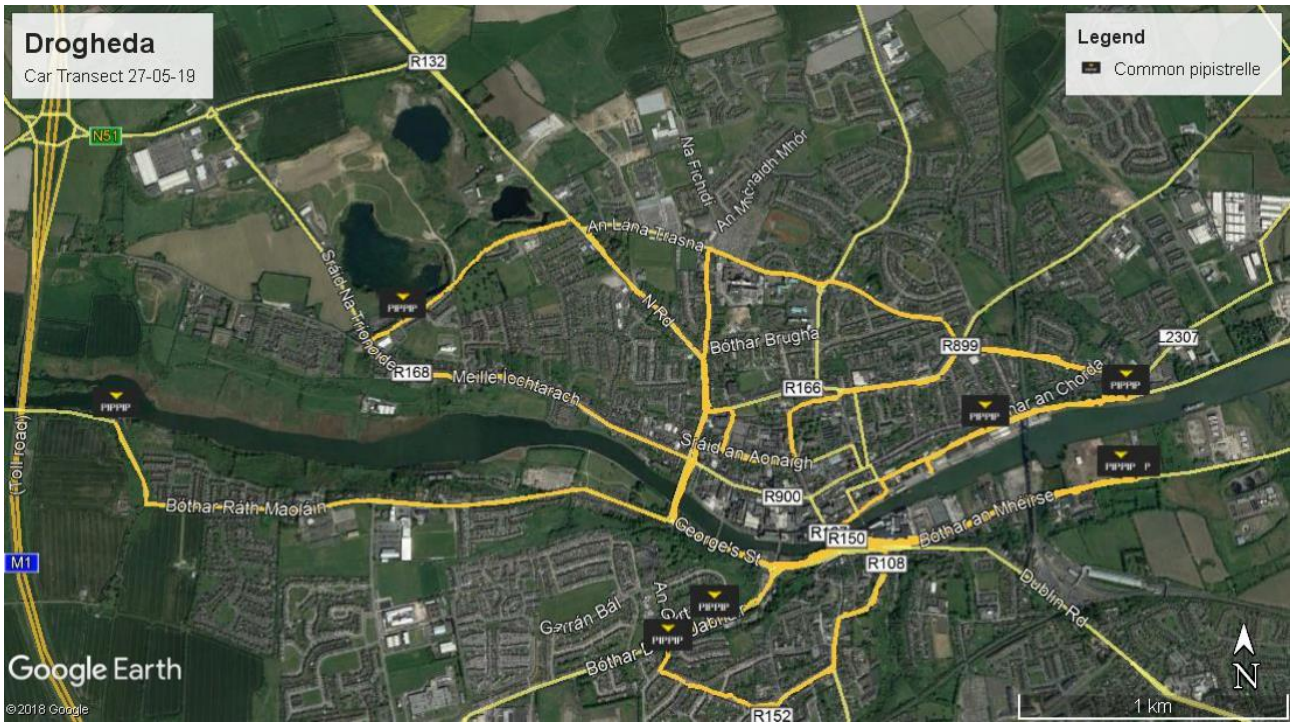
To supplement information on the local bat populations of Drogheda, a driving transect was completed on the 29th June 2019. Only two species of bat was encountered during the driving transect: common pipistrelle and soprano pipistrelle.

Figure 2: Driving Transect (27th May 2019)

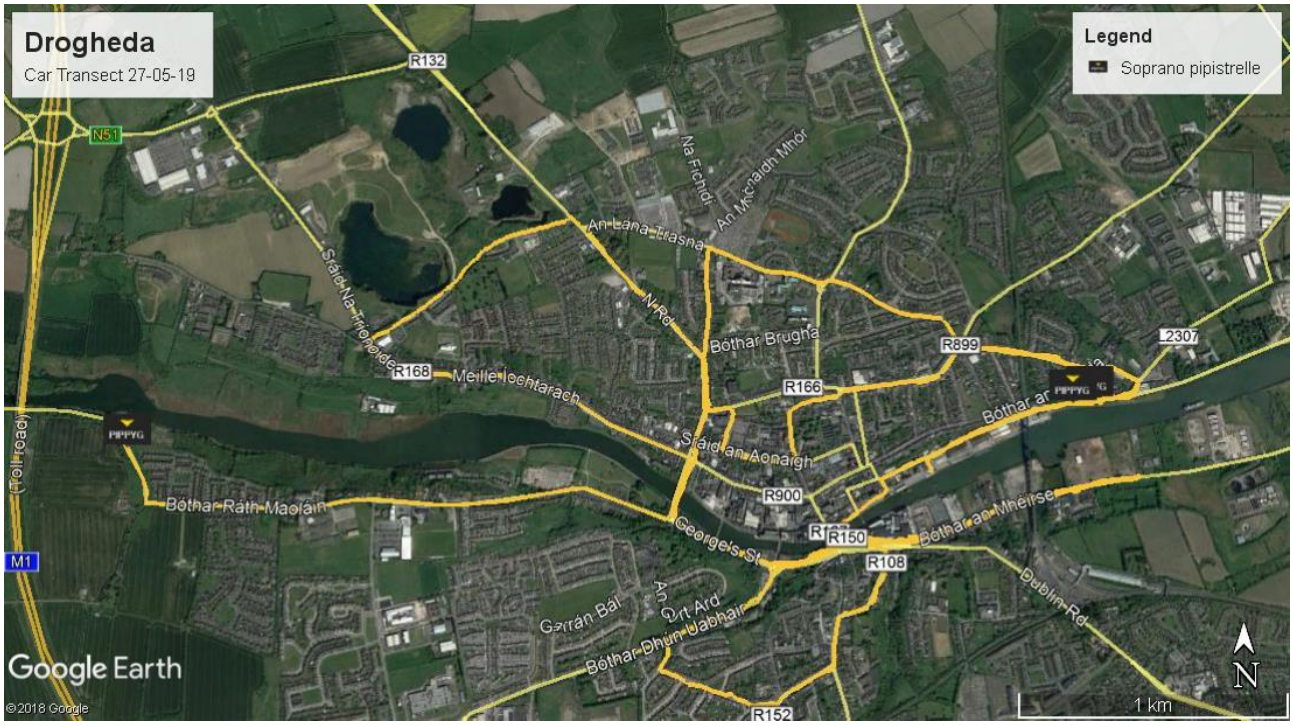
a) All bat encounters (yellow line = driving route)



b) Common pipistrelle encounters (yellow line = driving route)



c) Soprano pipistrelle encounters



3.2 Desktop Review

3.2.1 Bat Conservation Ireland Database

At a 1km data search level, four roosts (Common pipistrelle and soprano pipistrelle), one transect (Daubenton's bat, Leisler's bat, common pipistrelle and soprano pipistrelle) and two Ad Hoc records (*Myotis* species, Leisler's bat, common pipistrelle and soprano pipistrelle are known to exist.

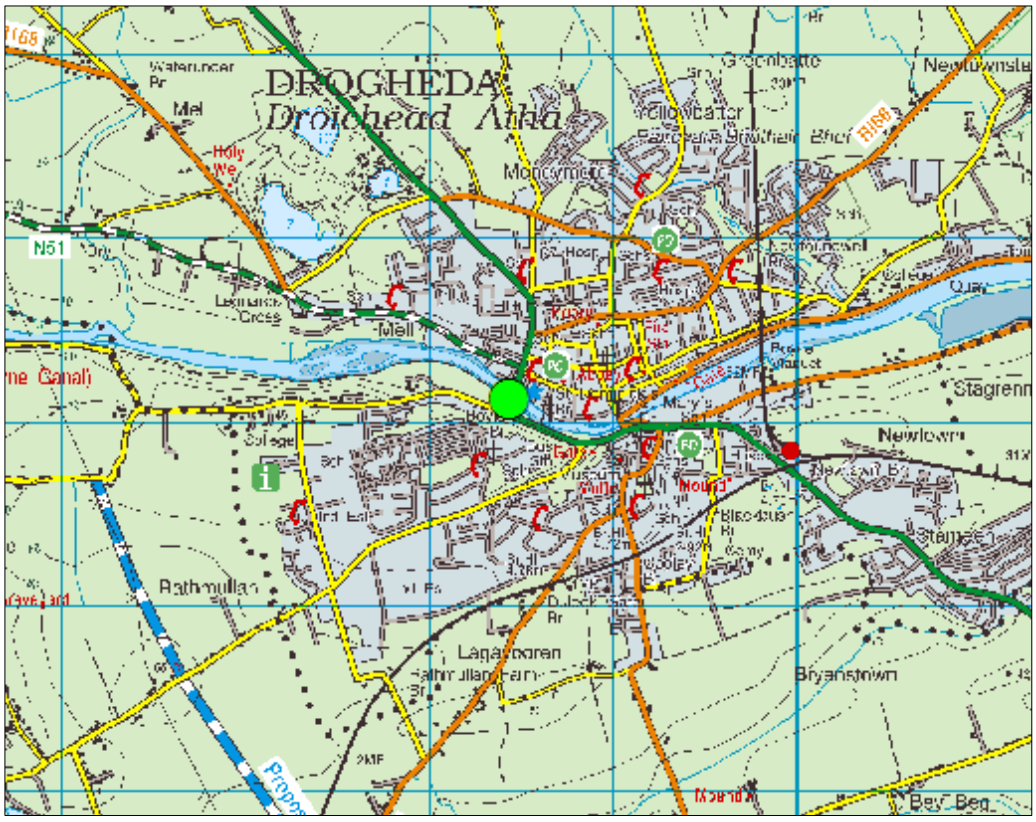
At the 10km level additional records are known for brown long-eared bat and Natterer's bat.

3.2.2 All Ireland Daubenton's Bat Waterways Survey

Three 1km transects along the River Boyne and in vicinity of Drogheda are registered:

a) Site Code 1225 Beaulieu Bridge (running west towards town)
b) Site Code 1357 New Bridge (Town centre)
c) Site Code 1435 Boyne Estuary (running east).

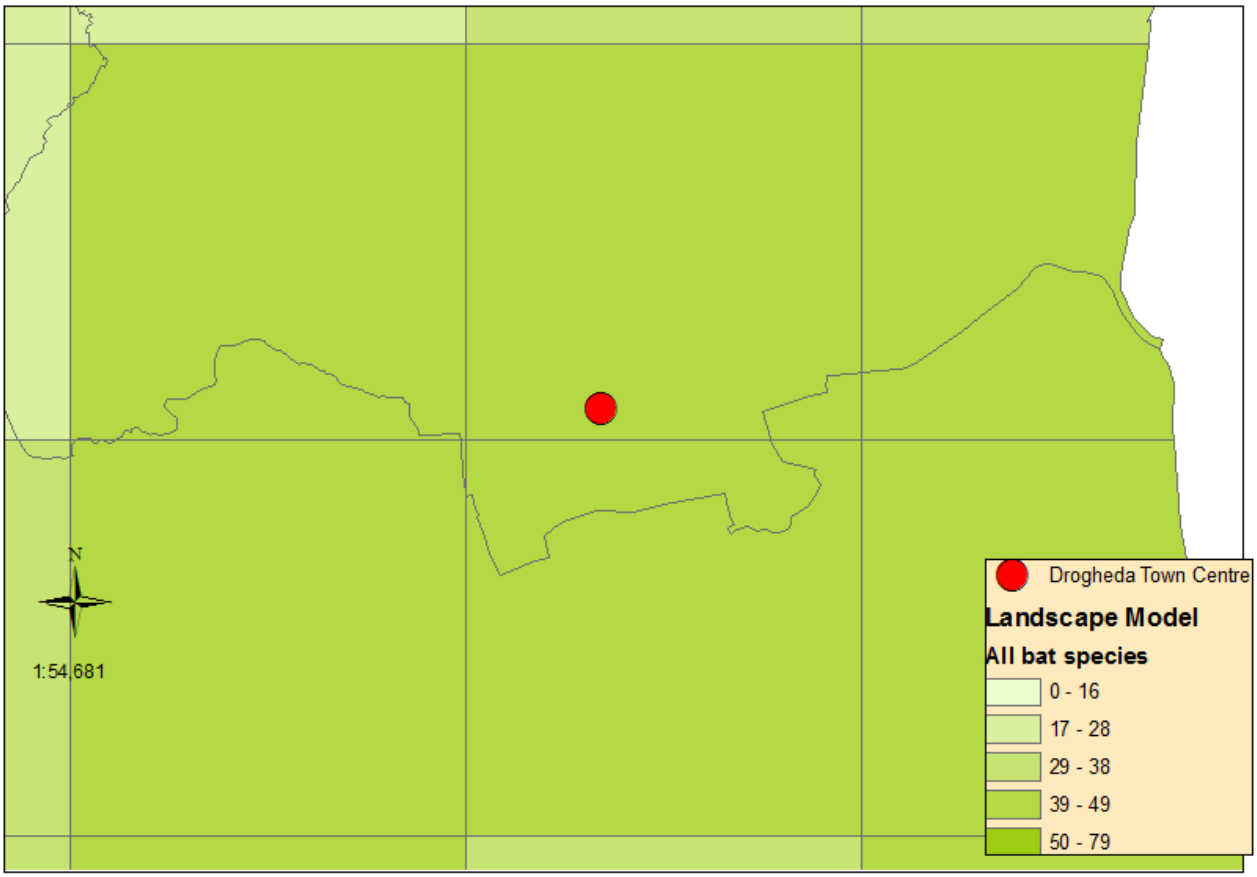
Site Code 1357 is surveyed by a member of the Tidy Town group annually. Daubenton's bats have been recorded on all three transects.



Map 1: Location of town centre All Ireland Daubenton's Bat Waterways Survey.

3.2.3 Bat Conservation Landscape Favourability

In general, the 5km squares of Drogheda Town and surrounding have 39-49% favourability for all Irish bat species.



Map 2: Landscape model for the surrounding 5km squares of Drogheda Town.

4. Bat Ecological Evaluation

4.1 Bat Species Recorded & Sensitivity

Three bat species were frequently recorded during these bat surveys: common pipistrelle, Leisler's bat and soprano pipistrelle. These three species are the three most common bat species recorded in Ireland. The All Ireland Daubenton's Bat Waterways Survey has been collecting data on this species of bat since 2006 and this species has been regularly recorded on the River Boyne.

The majority of the bat encounters recorded during the walking and driving transects were associated with the River Boyne. This reflects the importance of riverine habitats in our urban areas as commuting and foraging areas for nocturnal mammals such as bats.

Leisler's bat

This species was recorded primarily commuting through the survey area from the north to south direction during dusk surveys. Ireland's population is deemed of international importance and it is considered to be widespread across the island. The modelled Core Area for Leisler's bats is a relatively large area that covers much of the island of Ireland (52,820 km2). The Bat Conservation Ireland Irish Landscape Model indicated that the Leisler's bat habitat preference has been difficult to define in Ireland. Habitat modelling for Ireland shows an association with riparian habitats and woodlands (Roche *et al.,* 2014). The landscape model emphasised that this is a species that cannot be defined by habitats preference at a local scale compared to other Irish bat species but that it is a landscape species and has a habitat preference at a scale of 20.5km. In addition, of all Irish bat species, Leisler's bats have the most specific roosting requirements. It tends to select roosting habitat with areas of woodland and freshwater.

Irish Status	**Near Threatened**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	73,000 to 130,000 (2007-2013) Ireland is considered the world stronghold for this species
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011)*	52,820

Taken from *Roche et al., 2014*

The principal concerns for Leisler's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Tree felling
- Increasing urbanisation

Daubenton's bat

This species was recorded along a treeline/hedgerow within the survey area but outside the proposed development site. The modelled Core Area for Daubenton's bats is a relatively large area that covers much of the island of Ireland (41,285 km2) reflecting the distribution of sizeable river catchments. The Irish Landscape Model indicated that the Daubenton's bat habitat preference is for areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.,* 2014).

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	81,000 to 103,000 (2007-2012)
Irish Population Trend	2008-2013 Stable
Estimate Core Area (km2) (Lundy *et al. 2011)*	41,285

Taken from *Roche et al., 2014*

Principal concerns for Daubenton's bats are poorly known in Ireland but those that are relevant for this survey area are as follows:

- Loss of woodland, scrub and hedgerows
- Tree surgery and felling
- Increasing urbanisation
- Light pollution

Common pipistrelle

This species was the most recorded species within the survey area and it generally considered to be the most common bat species in Ireland. The species is widespread and is found in all provinces. The modelled Core Area for common pipistrelles is a large area that covers much of the island of Ireland (56,485 km2) which covers primarily the east and south east of the area (Roche *et al.,* 2014). The Bat Conservation Ireland Irish Landscape Model indicated that the common pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanization (<30%) (Roche *et al.,* 2014).

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	1.2 to 2.8 million (2007-2012)
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011)*	56,485

Taken from *Roche et al., 2014*

Principal concerns for common pipistrelles in Ireland that are relevant for this survey area are as follows:

- Renovation or demolition of derelict buildings.
- Tree felling
- Increasing urbanisation (e.g. increase in lighting)

Soprano pipistrelle

This species was the second most recorded species within the survey area and it generally considered to be the second most common bat species in Ireland. The species is widespread and is found in all provinces, with particular concentration along the western seaboard. The modelled Core Area for soprano pipistrelle is a large area that covers much of the island of Ireland (62,020 km2). The Bat Conservation Ireland Irish Landscape Model indicated that the soprano pipistrelle selects areas with broadleaf woodland, riparian habitats and low density urbanisation (Roche *et al.,* 2014).

Irish Status	**Least Concern**
European Status	Least Concern
Global Status	Least Concern
Estimated Irish Population Size	0.54 to 1.2 million (2007-2012)
Irish Population Trend	2003-2013 ↑
Estimate Core Area (km2) (Lundy *et al. 2011)*	62,020

(Taken from Roche *et al.,* 2014)

Principal concerns for soprano pipistrelles in Ireland that are relevant for this survey area are as follows:

- Renovation or demolition of structures
- Tree felling
- Increasing urbanisation (e.g. increase in lighting)

4.2 Bat Foraging Habitat & Commuting Routes

The majority of the bat encounters recorded during the walking and driving transects were associated with the River Boyne. This reflects the importance of riverine habitats in our urban areas as commuting and foraging areas for nocturnal mammals such as bats. Any enhancement works for local bat populations should involve connecting treelines, hedgerows and woodlands to the river boundaries in order to facilitate greater connectivity. Lighting can impede bat activity. Therefore sensitive planning with regards to street lighting is also important.

5. Conservation Recommendations

All bat species recorded during this Bat Survey are Annex IV species under the EU Habitats Directive and all have a Favourable Status in Ireland. There are many ways to increase favourable habitats for bat species. Some examples are provided below.

5.1 Landscaping

Providing increase areas of native tree and shrub vegetation, especially in parks and areas along the River Boyne will increase suitable foraging and commuting habitats for bats. The following principals could be followed:

- Plant additional native hedgerow and tree species
- Individual deciduous trees to allow mature trees to develop over time
- Where possible, pockets (field corners or park corners) of small groups of deciduous trees to provide shelter belts for foraging.
- Avoid the use of chemicals (weed killers, *etc*.) within the planting zones.
- Use planting to buffer important habitats such as the River Boyne for residual street lighting.

5.2 Lighting

Nocturnal mammals are impacted by lighting. Therefore it is important that lighting installed within the town, especially along the River Boyne, is completed with sensitivity for local wildlife while still providing the necessary lighting for human usage. The following principals should be followed:

- Artificial lights shining on bat roosts, their access points and the flight paths away from the roost **must always be avoided**. This includes alternative roosting sites such as bat boxes.

- Lighting design should be flexible and be able to fully take into account the presence of protected species. Therefore, appropriate lighting should be used within a proposed development and adjacent areas with more sensitive lighting regimes deployed in wildlife sensitive areas.

- Dark buffer zones can be used as a good way to separate habitats or features from lighting by forming a dark perimeter around them. This could be used for habitat features noted as foraging areas for bats.

- Buffer zones can be used to protect Dark buffer zones and rely on ensuring light levels (levels of illuminance measured in lux) within a certain distance of a feature do not exceed certain defined limits. The buffer zone can be further subdivided in to zones of increasing illuminance limit radiating away from the feature or habitat that requires to be protected.

- Luminaire design is extremely important to achieve an appropriate lighting regime. Luminaires come in a myriad of different styles, applications and specifications which a lighting professional can help to select. The following should be considered when choosing luminaires. This is taken from the most recent BCT Lighting Guidelines (BCT, 2018).

    - All luminaires used should lack UV/IR elements to reduce impact.

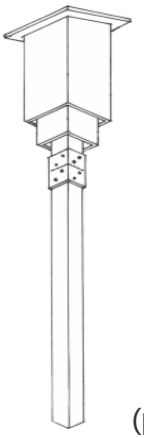
- LED luminaires should be used due to the fact that they are highly directional, lower intensity, good colour rendition and dimming capability.
- A warm white spectrum (<2700 Kelvins is recommended to reduce the blue light component of the LED spectrum).
- Luminaires should feature peak wavelengths higher than 550nm to avoid the component of light most disturbing to bats.
- The use of specialist bollard or low-level downward directional luminaires should be considered in bat sensitive areas to retain darkness above.
- Column heights should be carefully considered to minimise light spill. The shortest column height allowed should be used where possible.
- Only luminaires with an upward light ratio of 0% and with good optical control should be used.
- Luminaires should always be mounted on the horizontal, i.e. no upward tilt.
- Any external security lighting should be set on motion-sensors and short (1min) timers.
- As a last resort, accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed.

5.3 Alternative roosting sites

There is a bat box scheme currently located in the park beside the River Boyne. Additional bat boxes could be erected in other landscape areas within the town environs. The bat boxes a 1FF Schwegeler woodcrete bat boxes are suitable for the Irish weather (i.e. they last up to 20 years when erected on mature trees etc.

Alternatively or in combination Rocket bat boxes could also be erected in landscape areas. These are maternity spaces while he bat boxes described above a summer boxes and are suitable for smaller groups of bats.

Habibat Double Chambered Rocket Box
Pole-mountable bat box to provide extensive roosting space



(please view on www.nhbs.com)

6. Bibliography

Abbott, I. M., Butler, F. And Harrison, S. (2012) When flyways meet highways – the relative permeability of different motorway corssing sites to functionality diverse bat species. Landscape and Urban Planning 106 (4): 293-302.

Abbott, I. M., Berthinessen, A., Stone, E., Booman, M., Melber, M. and Altringham, J. (2015) Bats and Roads, Chapter 5, pp/ 290-299. In: Handbook of Road Ecology. Editors: R. Van der Ree., D. J. Smidt and C. Grilo. Wiley Blackwell.

Altringham, J. D. (2013) Biritah Bats. Collins New Naturalist Library, Volume 93. Haper Collins, London.

Altringham, J. And Kerth, G. (2016) Bats and Roads, Chapter 3. In: Bats in the Anthropocence: Conservation of Bats in a Changing World. Editors: C. C. Voigt and T. Kingston. Springer Open.

Aughney, T., Roche, N., & Langton, S (2018) The Irish Bat Monitoring Programme 2015-2017. *Irish Wildlife Manuals*, No. 103. National Parks and Wildlife Service, Department of Cultural heritage and the Gaeltacht, Ireland.

Barratt, E. M., Deauville, R., Burland, T. M., Bruford, M. W., Jones, G., Racey, P. A., & Wayne, R. K. (1997). DNA answers the call of pipistrelle bat species. *Nature* 387: 138 - 139.

Bat Conservation Ireland (2015) BATLAS 2020 Pilot Project 2015: Volunteer Survey Manual. Version 01. www.batconservationireland.org.

Bharddwaj, M., Soaner, K., Straka, T., Lahoz-Monfort, J., Lumsden, L. F. and van der Ree, R. (2017) Differential use of highway underpasses by bats. Biological Conservation 212: 22-28.

Billington, G. E. & Norman, G. M. (1997). A report on the survey and conservation of bat roosts in bridges in Cumbria, Kendal. English Nature.

BTHK (2018) Bat Roosts in Trees – A Guide to Identification and Assessment for Tree-Care and Ecology Professionals. Exeter: Pelagic Publishing.

CIEEM (2016) Guidelines for Ecological impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal (2nd Edition). CIEEM, Winchester.

Collins, J. (ed.) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd Edition). The Bat Conservation Trust, London.

Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1982.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.

Dietz, C., Helversen, O. and Dietmar, N. (2011) Bats of Britain, Europe & Northweat Africa. A&C Black, London.

EC Directive on The Conservation of Natural habitats and of Wild Fauna and Flora (Habitats Directive) 1992.

Gunnell, K., Grant, G. and Williams, C (2012) Landscape and urban design for bats and biodiversity. The Bat Conservation Trust, London.

Hundt, L. (2012) Bat Surveys: Good Practice Guidelines (2nd Edition). The Bat Conservation Trust, London.

Kelleher, C. & Marnell, F. (2006) Bat Mitigation Guidelines for Ireland. Irish Wildlife Manuals, No. 25. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Lundy, M.G., Montgomery, I.W., Roche, N. & Aughney, T. (2011). *Landscape Conservation for Irish Bats & Species Specific Roosting Characteristics* (Unpublished). Bat Conservation Ireland, Cavan, Ireland.

Lysaght, L. and Marnell, F. (eds) (2016) Atlas of Mammals in Ireland 2010-2015, National Biodiversity Data Centre, Waterford.

Marnell, F., Kingston, N. & Looney, D. (2009) *Ireland Red List No. 3: Terrestrial Mammals*, National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland.

Mathews, F., Roche, N., Aughney, T., Jones, N,m Day, J., Baker, J. and Langton, S. (2015) Barriers and benefits: implications of artificial night-lighting for the distribution of common bats in Britain and Ireland. *Philosphical Transactions of the Royal Society of London B* 370 (1667), doi: 10.1098/rstb.2014.0124.

McAney, K. (2006) A conservation plan for Irish vesper bats, Irish Wildlife Manual No. 20 National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland. McAney, K. (2014). An overview of Rhinolophus hipposideros in Ireland (1994-2014). *Vespertilio* **17**, 115–125.

McAney, K., O'Mahony, C., Kelleher, C., Taylor, A. & Biggane, S. (2013). *The Lesser Horseshoe Bat in Ireland: Surveys by The Vincent Wildlife Trust*. Belfast, Northern Ireland: Irish Naturalists' Journal.

Mullen, E. (2007). Brandt's Bat *Myotis brandtii* in Co. Wicklow. Irish Naturalists' Journal 28: 343.

O'Sullivan, P. (1994). *Bats in Ireland.* Special supplement to the Irish Naturalists' Journal.

Richardson, P. (2000). *Distribution atlas of bats in Britain and Ireland 1980 - 1999*. The Bat Conservation Trust, London, UK.

Roche, N., Aughney, T. & Langton, S. (2015). *Lesser Horseshoe Bat: population trends and status of its roosting resource* (No. 85). , Irish Wildlife Manuals. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

Roche, N., Langton, S. & Aughney, T. (2012). *Lesser Horseshoe Bat: Population, Trends and Threats 1986 to 2012* (Unpublished). Bat Conservation Ireland, Cavan, Ireland.

Roche, N., Aughney, T., Marnell, F. & Lundy, M. (2014). *Irish Bats in the 21st Century.* Bat Conservation Ireland, Cavan, Ireland.

Russ, J. (2012) British Bat Calls: A guide to species identification. Pelagic Publishing, Exeter.

Schofield, H. (2008). *The Lesser Horseshoe Bat Conservation Handbook*. Herefordshire, England: The Vincent Wildlife Trust.

Stebbings, R. E. & Walsh, S. T. (1991) *Bat Boxes: A guide to the history, function, construction and use in the conservation of bats.* The Bat Conservation Trust, 1991.

Whilde, A. (1993). *Threatened mammals, birds, amphibians and fish in Ireland. Irish Red Data Book 2: Vertebrates.* Belfast: HMSO.

Wildlife Act 1976 and Wildlife [Amendment] Act 2000. Government of Ireland.