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THE IRISH BAT MONITORING PROGRAMME 2015-2017

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An Roinn Cultúir,
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Front cover, small photographs from top row:

Coastal heath, Howth Head, Co. Dublin, Maurice Eakin; **Red Squirrel** *Sciurus vulgaris*, Eddie Dunne, NPWS Image Library; **Marsh Fritillary** *Euphydryas aurinia*, Brian Nelson; **Puffin** *Fratercula arctica*, Mike Brown, NPWS Image Library; **Long Range and Upper Lake**, Killarney National Park, NPWS Image Library; **Limestone pavement**, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott; **Barn Owl** *Tyto alba*, Mike Brown, NPWS Image Library; **A deep water fly trap anemone** *Phelliactis* sp., Yvonne Leahy; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson.

Main photograph:

Soprano Pipistrelle *Pipistrellus pygmaeus*, Tina Aughney.

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Executive Summary

The Irish Bat Monitoring Programme is comprised of four schemes currently under the management of Bat Conservation Ireland. This report communicates the results from these schemes from 2015-2017 along with long term trends in bat populations, where available. The surveys have been funded by the National Parks and Wildlife Service (NPWS) in the Republic of Ireland and the Northern Ireland Environment Agency (NIEA) in Northern Ireland.

Data for these schemes are collected in a standardized fashion by numerous volunteer citizen scientists across the island. The Car-based Bat Monitoring Scheme (2003-2017) collects data on Common and Soprano Pipistrelles as well as Leisler's Bat, while the All Ireland Daubenton's Bat Waterways Monitoring Scheme (2006-2014), the Brown Long-eared Bat Roost Monitoring Scheme (2007-2014) and the Lesser Horseshoe Bat Roost Monitoring Scheme are single species surveys. Different methods are used for sampling bat activity or occurrence – the Car-based Bat Monitoring Scheme uses driven transects and time expansion bat detectors, the Daubenton's survey uses stationary points along walked waterway transects and heterodyne/ tuneable detectors, the Brown Long-eared Bat is counted at summer roosts either externally using detectors during emergence or internally during daylight hours and the Lesser Horseshoe Bat survey is a dual season programme whereby the bats are counted in summer either externally using detectors or video cameras, or internally in the roost, and in winter in hibernacula.

All four schemes collect sufficient data to allow detection of red or amber alert declines in their target species. Additional information for other species such as Nathusius' Pipistrelle is also gathered by the Car-based Bat Monitoring Scheme but at an insufficient level of detail to be certain of trends.

The news for bats in Ireland over the past 12+ years has been largely positive with significant increases seen in several species such as Common Pipistrelle, Soprano Pipistrelle and the Annex II listed Lesser Horseshoe Bat. Based on present estimates of roadside Soprano Pipistrelle activity levels, this species is thought to have roughly doubled between 2006 and 2017. Both the Brown Long-eared Bat and Daubenton's Bat appear to be reasonably stable or slightly increasing.

As part of the monitoring schemes Bat Conservation Ireland continues to target participation by members of the public. Well-attended Daubenton's Bat training courses are run by Bat Conservation Ireland every year, thus improving awareness and encouraging citizen science across the island – over 1,500 people have participated in this scheme to-date. Encouragingly, volunteer uptake continues to increase year-on-year.

Equipment upgrades are ongoing, for example full spectrum Batlogger detectors which are in the testing phase for the Car-based Bat Monitoring Scheme and the use of camcorders with infra-red lamps to improve accuracy of Brown Long-eared Bat counts. Other research has been carried out as part of the monitoring programme, including radio tracking of Brown Long-eared Bat at three roosts, which is the first time this species has been studied in detail in Ireland. Ancillary data such as records collected for other vertebrates during the Car-based Bat Monitoring Scheme and Daubenton's surveys are also discussed.

Acknowledgements

The authors sincerely regret that it is not possible to individually name all surveyors involved in the four bat monitoring schemes from 2015-2017. However, we fully acknowledge that these surveys would be impossible without their hard work, dedication and enthusiasm. We hope they derive satisfaction and pride in seeing their survey work contribute to the results presented in this report. We would also like to thank all of the bat groups across the island for their continued support and participation.

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1 Introduction

Nine species of bat are known to be resident in Ireland and they form almost one third of Ireland's land mammal fauna. Bats are a species rich group widely distributed throughout the range of habitat types in the Irish landscape. Due to their reliance on insect populations, specialist feeding behaviour and habitat requirements, they are considered to be valuable environmental indicators of the wider countryside (Walsh *et al.*, 2001).

Irish bats are protected under domestic and EU legislation. Under the Republic of Ireland's Wildlife Act (1976) and Wildlife (Amendment) Act (2000) it is an offence to intentionally harm a bat or disturb its resting place. Bats in Northern Ireland are similarly protected under the Wildlife (Northern Ireland) Order 1985.

The EU Habitats Directive (92/43/EEC) lists all Irish bat species in Annex IV and one Irish species, the Lesser Horseshoe Bat (*Rhinolophus hipposideros*), in Annex II. Annex II includes animal species of community interest whose conservation requires the designation of Special Areas of Conservation (SACs) because they are, for example, endangered, rare, vulnerable or endemic. Annex IV lists various species that require strict protection. Article 11 of the Habitats Directive requires member states to monitor all species listed in the Habitats Directive and Article 17 requires States to report to the EU on the findings of monitoring schemes.

Ireland and the UK are also signatories to a number of conservation agreements pertaining to bats such as the Bern and Bonn Conventions. The Agreement on the Conservation of Populations of European Bats (EUROBATS) is an agreement under the Bonn Convention and the Republic of Ireland and the UK are two of the 36 signatories. EUROBATS has an Action Plan with priorities for implementation. Best practice guidelines are also developed and published. In one such publication the standardised methods for the surveillance and monitoring of all bat species across Europe was reviewed (Battersby, 2010).

The Red Data List for Mammals in Ireland (Marnell, Kingston, & Looney, 2009) lists most of the bat species, including Common Pipistrelle (*Pipistrellus pipistrellus*), Soprano Pipistrelle (*P. pygmaeus*), Daubenton's Bat (*Myotis daubentonii*) and Brown Long-eared Bat (*Plecotus auritus*) as Least Concern. All of these species are monitored using one of the BCIreland monitoring schemes included in the present report. One of the species included in BCIreland's monitoring, Leisler's Bat (*Nyctalus leisleri*), is, however, considered Near Threatened. It has been assigned this threat status because Ireland is considered a world stronghold for the species (Mitchell-Jones *et al.*, 1999). The status of the European Leisler's Bat population is Least Concern (Temple & Terry, 2009). This species is still, however, infrequent in the rest of Europe compared with Ireland where it is quite common.

1.1 Alert Levels

There are no precise biological definitions of when a population becomes vulnerable to extinction but the British Trust for Ornithology (BTO) has produced Alert levels based on IUCN-developed criteria for measured population declines. Species are considered of high conservation priority (Red Alert) if their population has declined by 50% or greater over 25 years and of medium conservation priority (Amber Alert) if their populations have declined by 25-49% over 25 years (Marchant, Wilson, Chamberlain, Gregory, & Baillie, 1997). These Alerts are based on evidence of declines that have already occurred but if Alerts are *predicted* to occur based on existing rates of decline in a shorter time period then the species should be given the relevant Alert status e.g. if a species has declined by 2.73% per annum over a 10-year period then it is predicted to decline by 50% over 25 years and should be given Red Alert status after 10 years. Monitoring data should be of sufficient statistical sensitivity (and better, if possible) to meet these Alert levels. In addition, the data should also be able to pinpoint population increases should these occur (for more details on power analysis, i.e. assessment of how robust the data is at detecting increases or declines, for example see Roche *et al.* (2009) and Aughney *et al.* (2009, 2011).

1.2 Developing the Irish Bat Monitoring Programme

The first bat species to be regularly monitored in Ireland was the Lesser Horseshoe Bat. While some roost counts for this species were carried out as early as 1987, regular and systematic counting at sites began in the mid-late 1990s. Counts are carried out at winter sites in January and February each year, while summer roost counts are carried out from 23 May to 7 July. These counts are mainly conducted by staff of the NPWS and the Vincent Wildlife Trust (VWT).

The Car-based Bat Monitoring Scheme was first piloted in 2003; it targets the two most abundant pipistrelle species (Common and Soprano Pipistrelle) and Leisler's Bat (Catto, Russ & Langton, 2004). These species are relatively easy to detect and distinguish from each other on the basis of echolocation calls. The car-based survey makes use of a broadband bat detector that picks up a range of ultrasound, this is recorded in the field and analysed post-survey. This method therefore allows survey work to be carried out by individuals with little or no experience in bat identification since identification is completed post survey work.

The Car-based Bat Monitoring Scheme was followed in 2006 by the All Ireland Daubenton's Bat Waterways Monitoring Scheme (Aughney *et al.*, 2009). This scheme follows a survey methodology devised by the Bat Conservation Trust (BCT) in the UK. Narrow band, heterodyne detectors are used so volunteers who conduct the survey are trained in the identification of Daubenton's Bat prior to field work. Surveyors count the number 'bat passes' of this bat species for four minutes at each of 10 fixed points on linear waterways. The onset of this scheme was a very significant development in bat monitoring here since it represented the first large-scale recruitment of members of the Irish public to bat conservation-related work.

The Brown Long-eared Bat Roost Monitoring Scheme was piloted and developed in 2007 (Aughney *et al.*, 2011). This project concentrates on counts of Brown Long-eared Bat at its roosts and is conducted by individuals with a greater level of experience in bat identification than is necessary for Daubenton's or car-based surveys. This survey protocol involves at least two counts per annum (May to September) using three potential survey methods depending on the structure, access and location of bats within, and emerging from, the roost.

The Car-based Bat Monitoring Scheme and All Ireland Daubenton's Bat Waterway surveys are all-Ireland schemes. Lesser Horseshoe Bat roost counts are carried out within the known distribution of the species, in counties along the western seaboard from Mayo to Cork. Brown Long-eared Roost Monitoring has, so far, been based in the Republic of Ireland only. Regular monitoring under BCIreland management is, therefore, in process for six bat species in the Republic of Ireland, and for four species in Northern Ireland. Additional BCT Field Surveys are also undertaken in Northern Ireland. Data collected from those surveys feed into the BCT's UK reporting mechanisms.

1.3 Factors Impacting Measured Bat Population Trends

Many factors including climate, foraging habitat quality, roost availability, disturbance at hibernacula, landscape connectivity, artificial lighting, predation and competition, among others, combine to regulate the local and national population of a given bat species. The possibility that monitoring schemes may themselves introduce bias or error resulting in erroneous trends was discussed in a recent publication by Buckland & Johnston (2017) who reviewed the principles and possible pitfalls when monitoring biodiversity and determining trends in different species including bats. The authors specified five essential components to any monitoring scheme

1. representative sampling
2. sufficient sample size
3. sufficient detection of target species
4. representative sample of species
5. temporal sampling scheme designed to aid valid inference

We have addressed many of these issues by ensuring we carry out power analysis on data from the schemes, targeting minimum numbers of sites, random sampling where possible, carrying out counts before young are flying etc. Where we have reservations with regard to specific schemes we have addressed them in the relevant sections.

1.4 Weather 2015-2017

In 2015 the survey season kicked off in January with counts at Lesser Horseshoe Bat hibernacula. Weather was variable that month with rainfall of up to 150% of the long term average (LTA) in many parts of the bat's range. Temperatures were generally at, or slightly below, the 30 year average. January was also very windy. February was a cooler month, with less wind, and it was for the most part drier than January. County Mayo was the exception; it recorded very high rainfall levels.

Summer surveying began in May 2015 with Brown Long-eared and Lesser Horseshoe Bat counts. Rainfall totals in this month were almost all above the LTA. Parts of the North-west, midlands and southern Atlantic coasts experienced up to 200% LTA for the month. Eastern parts of the country experienced drier weather in the second half of the month. May temperatures were low. Weather in June continued in the same vein, although rainfall eased off in the west somewhat. Temperatures remained low and many parts of the east experienced a 'dry spell' (i.e. 15+ days without rain). Temperatures in July were again below normal with some stations even recording ground frosts while rainfall was up – most stations recorded levels above the LTA. Some high winds were also recorded in July. August did not see much improvement in the weather with temperatures continuing below average. Rainfall was variable but generally above average and gale force winds were recorded in the west early in the month. September saw some of the sunniest weather of the survey season and a consistent dry spell, although night time temperatures continued very cool.

For 2016 the survey season kicked off in January with dull, wet and windy conditions for much of the month but quite mild overall. Rainfall levels were generally above the long term average. The unsettled pattern continued in February, albeit somewhat cooler.

In May 2016 rainfall levels were generally below long term averages for most stations while temperatures were generally on or above long term averages. June began settled and dry, with warm daytime temperatures but night time ground frosts were recorded early in the month. Unsettled dull weather followed although temperatures remained mild. Rainfall was above average in many locations. July began with cool changeable weather with rain and showers. High pressure brought short-lived warmer dry weather in the third week. Changeable weather prevailed again by the end of the month. Some areas of Counties Wexford and Wicklow had very low rainfall in July, while above average rainfall was recorded in parts of Counties Mayo and Louth. August continued in a similar changeable vein although temperatures were generally quite warm. Unsettled weather brought widespread rain and strong winds. Most stations recorded below average rainfall for August with some exceptions, in particular in some of the Kerry mountains. September was more unsettled than usual but also warm. Wet and windy, sometimes gale force, conditions prevailed in the first couple of weeks. Dull settled weather followed in the fourth week but the month ended with more unsettled weather.

2017 began mild and mainly dry but became unsettled at the end of January. January rainfall was mainly below the LTA with stations in the east and east midlands reporting particularly low levels. Temperatures in January were generally higher than LTA. February was quite unsettled but overall very mild. Storm Doris brought widespread gales and disruption on 23rd February.

Into spring 2017 and May saw a good deal of dry weather but also some wetter interludes. The first half of June was changeable, with warm mostly dry weather for the second half of the month. July and August were unsettled and noticeably cool, brief high pressure ridges brought some fine days – especially to the south and east, while severe thundery downpours occurred in the North towards the end of the month. The cool unsettled pattern continued during September. In general the first half of the year had higher than normal temperatures while the second half had lower than normal temperatures.

In summary all three survey seasons witnessed a mixed bag of unsettled weather making for unpredictable field work conditions.

2 Car-based Bat Monitoring

2.1 Method

Training of surveyors is carried out in June and early July each year. Survey teams are provided with all equipment needed for the survey including: a time expansion bat detector (Courtpan Electronic, Tranquility Transect), HTC Android smart phone with memory card, pre-stamped envelopes to return the data, instruction manuals, recording sheets, batteries, flashing beacon, thermometer and a first aid kit.

Each year survey teams carry out surveys of a mapped route within a defined 30km ***Survey Square***. Every route covers 15 x 1.609km (1 mile) monitoring ***Transects*** each of which is separated by a minimum distance of 3.2km (2 miles). Surveyors are asked to carry out the survey on two dates, one in mid to late July (Survey 1, S1) and one in early to mid-August (Survey 2, S2). Transect coverage begins 45 minutes after sundown. Each of the 1.609km transects is driven at 24km (15 miles) per hour while continuously recording from a time expansion bat detector, set to x10 time expansion, on to a smart phone. Purpose built adaptor leads from NHBS (www.nhbs.com), are used to connect the 3.5mm TRS jack lead from the detector into the phone's 3.5mm TRRS jack socket.

The time expansion detector is clamped to the passenger door window and set to record for 320ms, and it then replays sounds at x10 time expansion so that, in effect, each recording consists of a series of 0.32 second intervals with no sound, followed by 3.2 seconds of time expanded sound. To record the survey, a purpose-built smart phone Android app (AudioAndLocationRecorder) was developed for the survey in 2011 based on Hertz the Wav recorder. The AudioAndLocationRecorder app simultaneously records GPS geo-locational data and sound at a 44,100Hz sampling speed. Sound is stored as .wav files and locational data, which includes latitude, longitude, altitude, error and speed, are stored in .csv files.

An additional app, Spectral Pro-Analyszer, is used by surveyors to check the detector and phone are connected correctly. This app creates a visible display of the sound being recorded by the phones in real time. It was kindly provided to Bat Conservation Ireland free of charge by its developers RadonSoft. This app is used at the beginning of each survey so that volunteers can visually check that the sound coming into the phone is correct. It cannot be used simultaneously with the AudioAndLocationRecorder, however.

In 2013 three training videos were also uploaded to YouTube and to the Car monitoring Facebook page in 2015 to provide further back-up information on how to use the smart phones and apps for the survey.

- http://www.youtube.com/watch?v=0vt_KhB9IWA
- http://www.youtube.com/watch?v=BKiK8ApwXPo
- http://www.youtube.com/watch?v=lRzcjf2Kmnk

Following survey completion, phone mini-SD cards and hard copy recording sheets are forwarded (in pre-stamped and addressed envelopes) to BCIreland or uploaded to a shared Dropbox folder following survey completion. From 2016, teams were strongly advised to make a backup copy prior to posting the SD card or to upload the data to a Dropbox folder which was provided to them for the survey. In this way, we hoped to prevent loss of survey data due to SD cards becoming corrupted or lost in the post.

2.1.1 Sound Analysis & Data Handling

Smart phone sound recordings are downloaded directly using a smart phone connected to PC. For those surveys where GPS data is successfully recorded using the Audio and Location Recorder App, a .csv file corresponding to each .wav file (transect) is also available. Csv files are also downloaded to computer.

For bat call analysis each .wav file is opened in Bat Sound™ and calls are identified to species level where possible. Species that can be identified accurately using this method are the Common Pipistrelle, Soprano Pipistrelle, and Nathusius' Pipistrelle (*Pipistrellus nathusii*). Pipistrelle calls with a peak in echolocation between 48kHz and 52kHz are recorded as 'Pipistrelle unknown' because they could be either Common or Soprano Pipistrelle. Leisler's Bat, a low frequency echolocating species, can also be easily identified using this method. Occasional calls of *Myotis* bats are recorded but these are noted as *Myotis* spp. since they could belong to one of a number of similar species – Daubenton's, Whiskered or Natterer's (*Myotis daubentonii, M. mystacinus* or *M. nattereri*). Occasional social calls of Brown Long-eared Bats are also recorded. Various publications (Russ, 2012; Russo & Jones, 2002; Vaughan, Jones, & Harris, 1997) are used for sonogram identification reference.

For quality control purposes approximately 10% of the .wav files are forwarded each year to Dr Jon Russ for comparative analysis.

Information for each survey (Tranquility data) is entered to a tailor made MySQL database. Once analysis is complete, smart phone .csv files with date and time stamps, latitude and longitude are linked to the MySQL database bat records. Links are created based on the duration of the transect and the time that each bat was recorded at. It is usually possible to geo-reference each bat recorded on a smart phone survey transect that has a corresponding .csv GPS file. We also take into account the fact that GPS data and bats are not always recorded simultaneously so the programme also calculates the time difference between GPS location point and the time a bat was recorded.

For the purposes of providing volunteer feedback, spreadsheets listing bat species, date, time, location and accuracy are uploaded to Google Maps using Fusion Tables

- http://www.google.com/drive/start/apps.html#fusiontables

and bat locations are pinned to a map for each route, with icons of differing colour and shape denoting a particular bat species.

Each year following analysis, data from the Car-based Bat Monitoring MySQL database is synchronised with the Bat Conservation Ireland Bat Records Database to ensure that the data becomes widely available when uploaded to the NDBC website.

The Facebook page (IrishCarBats) is used to communicate ongoing progress with Facebook users and surveyors. Training videos were also uploaded to this Facebook page.

2.1.2 Methodology Changes

On the first year of the survey, 2003, surveys were carried out on later dates than in the following years and the survey began 30 minutes after sunset rather than the later start time of 45 minutes after sunset. An additional change was made to the methodology in 2009; where each route had originally consisted of 20 transects, the final five transects for each route was omitted, due to safety and driver tiredness concerns. These changes to the method are taken into account in the statistical analysis.

2.1.3 Statistical Analysis

As in previous years, we used the full GAM approach described by Fewster *et al.* (2000). The response variable is the number of passes per survey, using the log of total number of 0.32s recordings per survey as an offset, which effectively does something very similar to analysing the passes per minute, but allows use of a Poisson error distribution. The analysis was carried out using the first 15 mile transects only of the surveys from 2003-2008, so that results are comparable with the reduced sampling plan used from 2009. The spline curves have four degrees of freedom, which is the default recommended by Fewster *et al.* (2000) for this length of data. Surveys with less than 650 0.32s snapshots (or equivalent sonogram length) are excluded.

In this report 2006 is used as the base year, reflecting the advice in Buckland & Johnston (2017) that it is best to select a year with more data.

Smoothed trends are constructed using the Generalised Additive Model (GAM) approach described by with confidence limits generated by bootstrapping at the Survey Square level. The log of the total number of recording intervals is fitted as an offset to adjust for different recording lengths. A fully saturated GAM model, which is equivalent to a conventional GLM with estimates for each year, is also fitted to indicate the year-to-year variation about the smoothed curve.

For Nathusius' Pipistrelle and Brown Long-eared Bat trends, models are constructed based on a binomial distribution. This is because the species sometimes occur in the same transect on multiple occasions but there are, much more often, transects with no occurrences of these species and, therefore, a large number of zeros in the dataset. Otherwise the same methodology is applied, with confidence limits constructed by bootstrapping at the square level. Since no Nathusius' Pipistrelle were recorded in 2004, the base year for other species' trends, for the present report the Nathusius' Pipistrelle baseline is set to the last year of the survey minus one (i.e. 2016).

Buckland and Johnston (2017) recently examined the design and analytical issues surrounding monitoring biodiversity trends and raised a point that we felt required some in-depth consideration in the context of the car-based bat monitoring scheme. Buckland and Johnston list five criteria for effective biodiversity monitoring as discussed in Section 1.3. For the car-based bat monitoring scheme we have addressed most of their points, for example by ensuring that widely dispersed sites were randomly selected in the early years of the survey, and that routes cover such large areas that many habitat types are sampled. We have also carried out various tests of power of the data and rechecked the sample sizes needed to achieve 80% power to detect both decreases and increase of all three target species. The same detector type has been used for the surveys each year thus ensuring there is no bias caused by improved microphones. The fifth point made by Buckland *et al.* (2017) addresses timing and the risk that, by sampling at certain times of year, rapid change may be taking place, such as young becoming volant or migration occurring. This then also ties in with the possibility that phenological changes, for example earlier births due to climate change, may mimic population increases. With this in mind we decided to carry out a further analysis of our car survey data to attempt to elicit whether phenological changes may be impacting on observed trends.

Analysis was also carried out using Met Éireann data from weather stations across the Republic of Ireland and the car transect bat pass data. A detailed description of these analyses and results will be the subject of a scientific paper but in summary we examined monthly average temperatures and rainfall data as quarterly figures (conforming to the meteorological definitions of the seasons) and relationships with bat passes at various spatial and temporal scales.

2.1.4 Batlogger Trial

The detector stock for the survey is ageing; some of the detectors are now over 12 years old. Full spectrum detectors that include GPS chips and SD cards are now widely available on the market. These devices remove the need for separate recording hardware (minidisc/smartphone). The connection leads between detector and recorder are the most common source of equipment failure during the surveys.

A number of Elekon Batlogger M full spectrum detectors were purchased by the NPWS in 2016 and first tested in May and June 2016 on night time car surveys in Counties Meath and Kildare. Batlogger M detectors record in real time and have a GPS chip. Sound and location data files are recorded onto an SD card in the detector. In 2016 five car survey teams were trained up in their use and data was available from nine surveys where the Tranquility and Batlogger systems were used in tandem, with the detectors both attached to the same window clamp. By 2017, 11 Batlogger detectors had been provided by the NPWS. Training for the new bat detector system was provided in 2017 for four additional teams in different localities of the island. The detectors were deployed across the country and 20 car-based surveys were carried out with the two systems in tandem in 2017.

In 2016, data from Batloggers was analysed using Bat Sound as well as BatClassifyIreland. BatClassifyIreland software was developed by Chris Scott and the University of Leeds for a woodland monitoring project and was modified in 2016 and 2017 for Irish bats during the Pilot Woodland Bat Survey (Boston *et al.*, 2017). In 2017, data from Batloggers was analysed using both the automated and manual identification features of Kaleidoscope Pro (Wildlife Acoustics) as well as BatClassifyIreland.

Batlogger data were inputted to Excel spreadsheets. Increasing use of Batloggers will require modifications to the existing MySQL database, or its redevelopment, in the future.

2.2 Results

Seven teams participated in the 2003 car-based pilot scheme and 17 survey routes were surveyed in 2004. Twenty one squares were surveyed in 2005. An additional five squares were surveyed in 2006, bringing the total number of surveyed squares to 26 throughout the island. Equipment for 28 squares was disseminated from 2007 onwards (Figure 1). The survey represents a considerable input of voluntary time - taking approximately three hours to complete (mean = 181 minutes for 2017), and each team typically consists of two people.

In total, surveyors contributed 312 hours to the survey in 2017 and similar numbers in previous years, Table 1 shows number of squares and transects surveyed each year. In 2017, 60 individuals participated in surveys of 28 squares around the island (Figure 1). Data from 52 surveys were available to contribute to bat species trend modelling.

Table 1 Numbers of squares and transects surveyed each year since 2003, along with total number of bats "passes" recorded.

Year	Squares	Transects	Total Number of Bat "Passes"
2003	7	180	378
2004	17	576	2031
2005	21	608	1691
2006	26	887	3212
2007	27	889	3014
2008	27	927	3280
2009	27	787	2147
2010	28	816	2672
2011	28	763	2748
2012	28	664	2266
2013	26	704	2529
2014	28	754	3464
2015	28	786	3406
2016	28	744	3692
2017	28	758	3945
	TOTAL	**10,843**	**40,475**

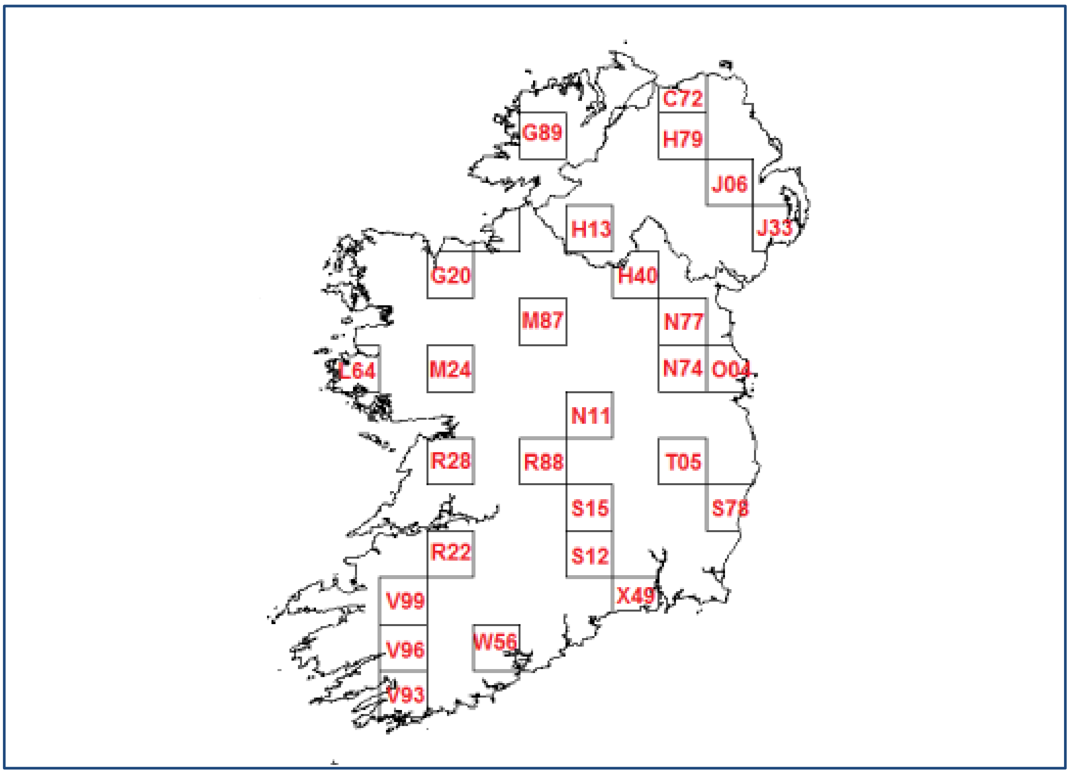

Figure 1 Locations of the 30km squares where surveys are carried out in both July and August each year.

Over 40,000 bat passes have been recorded during the 15 years of the survey. The highest number of bats was recorded in 2017 when, on average, 5.2 bat passes were detected on each 1.6km transect.

2.2.1 Bat Dataset Generated

Since the Irish data is analysed by the same person every year the results are very consistent. Table 2 below shows raw bat encounter data, per 1.6km transect.

Table 2 Raw bat encounter data, per 1.609km/1 mile transect, not corrected to encounters per km or per hour, Car-based Bat Monitoring Scheme 2003-2017. Average number of bats reflects the average number of bat passes observed during each 1.609km/1 mile transect travelled. Note that the detector records for just 1/11th of the time spent surveying so to determine the actual number of bat encounters per km this must be divided by 0.146 (the total distance sampled for each 1.609km transect).

Year	No. Transects	Common Pipistrelle	Soprano Pipistrelle	Pipistrelle unid.	Nath. Pip.	Leisler's Bat	*Myotis* spp.	Brown Long-eared	Total Bats
2003	190	1.294	0.478	N/a	0	0.289	0.039	n/a	2.1
2004	5771	1.905	0.695	0.443	0	0.511	0.05	n/a	3.621
2005	608	1.344	0.574	0.266	0.001	0.544	0.035	n/a	2.781
2006	887	1.701	0.652	0.271	0.033	0.892	0.029	0.024	3.62
2007	889	1.77	0.639	0.253	0.015	0.631	0.036	0.019	3.39
2008	927	1.686	0.768	0.294	0.006	0.739	0.029	0.002	3.537
2009	787	1.212	0.714	0.221	0.032	0.492	0.032	0.011	2.728
2010	816	1.442	0.668	0.241	0.069	0.809	0.023	0.012	3.275
2011	763	1.56	0.8	0.36	0.022	0.79	0.038	0.02	3.602
2012	663.5	1.399	0.799	0.353	0.048	0.754	0.027	0.026	3.415
2013	704	1.550	0.847	0.324	0.021	0.807	0.011	0.028	3.592
2014	754	1.985	1.085	0.424	0.044	1.001	0.025	0.017	4.594
2015	786	1.944	1.033	0.403	0.014	0.877	0.047	0.009	4.333
2016	744	2.141	1.227	0.555	0.040	0.952	0.027	0.009	4.962
2017	758	2.379	1.314	0.562	0.032	0.875	0.022	0.009	5.204
Mean Per Transect S.E.		**1.687** ±0.087	**0.819** ±0.062	**0.355** ±0.029	**0.025** ±0.005	**0.731** ±0.051	**0.031** ±0.003	**0.016** ±0.002	**3.650** ±0.216

The mean total number of bat encounters per 1.6km transect is 3.65 for all years of the survey. Numbers encountered per survey have gradually increased to 2017 when over 5 bat passes were recorded per transect. In the two most recent years of the survey more than two Common Pipistrelle passes were recorded per transect. Unknown pipistrelles echolocating between 48 and 52kHz account for between 10% and 14% of Common/Soprano/unknown pipistrelle calls in any given year of the survey.

Figure 2, a pie-chart, shows proportions of each species or species group encountered, from 2003 to 2017. The Common Pipistrelle is the most abundant species. Soprano Pipistrelle and Leisler's Bat are fairly equally represented with 20-23% each of the total bat encounters. Bat encounters that cannot be ascribed to either the Common Pipistrelle or Soprano Pipistrelle are recorded as 'Pipistrelle unknown'.

Myotis spp., Nathusius' Pipistrelle and Brown Long-eared Bat are rarely encountered. Note that Figure 2 is not meant to give an impression of the actual relative abundance of each species along Irish roadsides since each species differs in its detectability and flight style which influences detection. Leisler's Bat, for example, has loud, low frequency calls with much greater long-range detectability than either of the two pipistrelles, but would not necessarily fly close to hedgerows along roadsides, unlike the pipistrelles. So, while they are more detectable, their occurrence in the landscape would preclude detection if they had quiet short range calls. It is not possible, therefore, to directly compare detectability between the species. In addition, the pie-chart illustrates results of the sampled dataset with social calls of Leisler's Bat and Brown Long-eared Bat included, but excluding social calls of the pipistrelles. Pipistrelle social calls are excluded because they can be difficult to distinguish, with confidence, to species level.

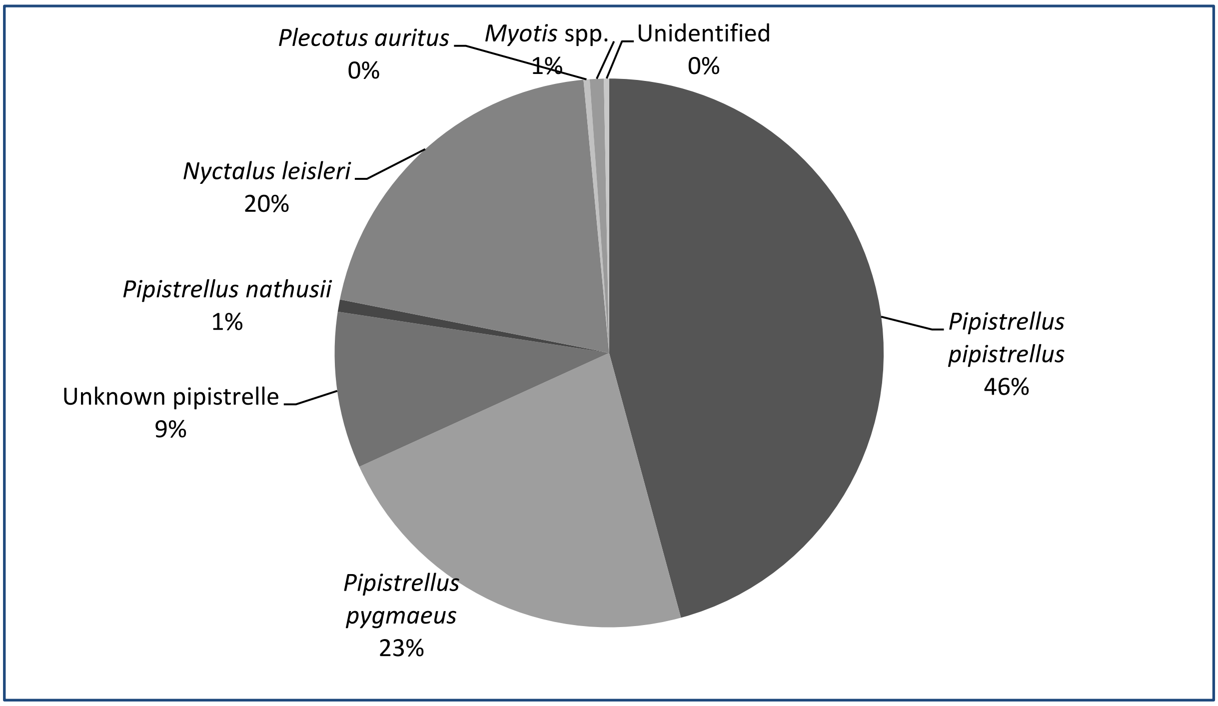

Figure 2 Proportions of bat species recorded during car-based bat monitoring surveys 2003-2017, n=40,474.

Figure 3 Survey squares colour coded according to mean bat encounter rates (per hour) 2012-2014 (left) and 2015-2017 (right), includes all bat species so results are somewhat biased by the high abundance of Common Pipistrelle in the south.

Encounter rate $>0\leq40hr^{-1}$
Encounter rate $>40\leq70hr^{-1}$
Encounter rate $>70hr^{-1}$

2.2.2 Common Pipistrelle

Common Pipistrelle has been the most frequently encountered species during the monitoring scheme in all survey years to-date. In L64, Connemara, Common Pipistrelle was confirmed for the first time in 2014. The species tends to show a southern bias, occurring with greater frequency in the south west and east of the country than in the north and north west. Figure 4 compares the mean encounter rate per hour for each square in two x three year intervals, the first from 2012-2014 and the second from 2015-2017. A greater number of high encounter rate squares are apparent in the second time interval, all in the south of the island.

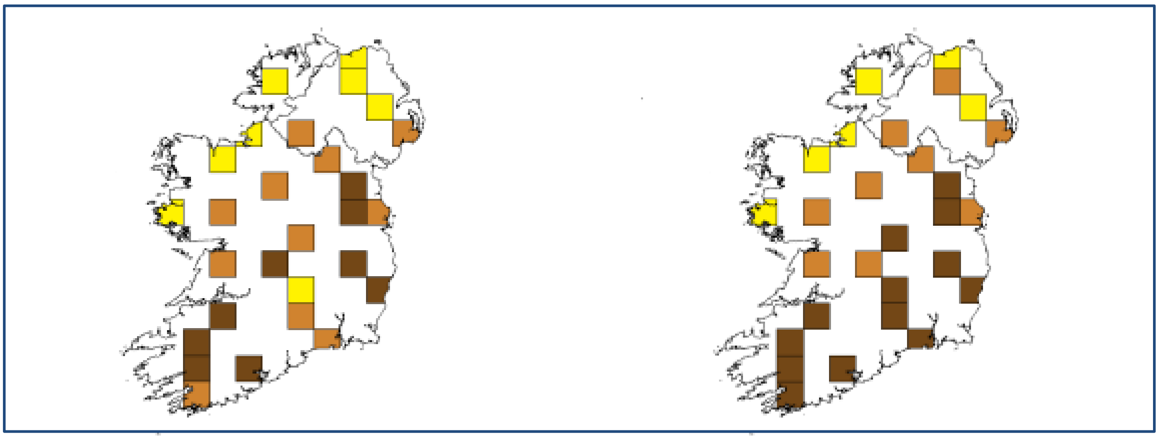

Figure 4 Survey squares colour coded according to mean Common Pipistrelle encounter rates (per hour) from 2012-2014 (left) and from 2015-2017 (right). The overall average rate of Common Pipistrelle encounters for all squares from 2012-2014 was 24hr^{-1} compared with 27.1hr^{-1} from 2015-2017.

- Encounter rate >0≤15hr^{-1}
- Encounter rate >15≤30hr^{-1}
- Encounter rate >30hr^{-1}

2.2.2.1 Common Pipistrelle Trend

Common Pipistrelle showed a significant increase from the survey start until 2017, despite the fact that the trend levelled out a little between 2008 and 2012. The lower 95% confidence interval currently exceeds the 2006 baseline index (Figure 5, Table 3). The highest yearly estimate for the Common Pipistrelle was in 2017. In the past twelve years (2006-2017) this species has increased by 37.5% in total, equivalent to a per annum increase of 2.7%.

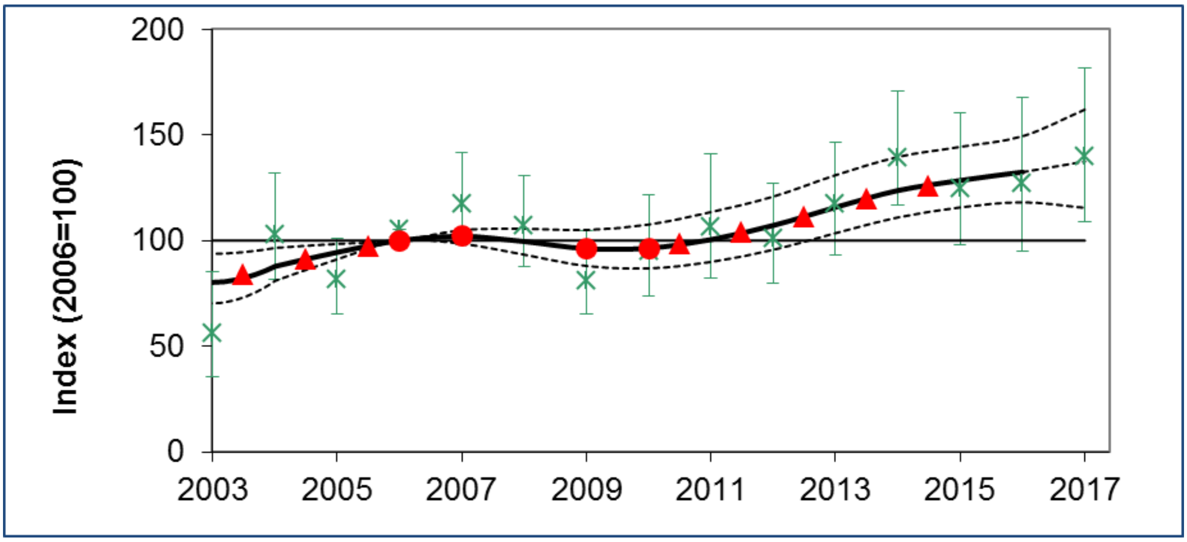

Figure 5 Results of the GAM/GLM model for Common Pipistrelle data. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$).

Table 3 GAM results for Common Pipistrelles with 95% confidence limits (using first 15 transects from the 2003-2008 dataset).

Year	Sites	Surveys	Mean Passes	Smoothed (GAM) Estimate	S.E.	Conf. Interval (lower 95%)	Conf. Interval (upper 95%)	Unsmoothed Estimate	S.E.
2003	7	9	16.44	80.23	6.08	70.34	93.80	55.94	12.01
2004	17	27	25.63	87.80	4.04	80.96	96.55	103.12	12.97
2005	17	31	21.29	94.48	1.89	91.16	98.44	81.382	9.11
2006	25	45	24.33	100.00	0.00	100.00	100.00	105.39	0.00
2007	26	46	25.72	102.05	1.63	98.53	104.98	117.26	11.00
2008	23	42	24.14	99.58	3.08	93.37	105.60	107.03	10.76
2009	28	52	18.04	96.21	4.23	88.02	105.05	81.26	9.73
2010	27	53	20.92	96.43	5.22	86.88	107.62	94.78	12.20
2011	28	53	22.47	100.50	6.00	89.93	113.52	106.56	15.14
2012	26	44	20.02	107.19	6.56	95.69	120.84	100.83	11.79
2013	25	46	22.43	115.80	7.07	103.56	130.99	117.11	13.55
2014	27	49	29.69	123.72	7.38	110.98	139.62	139.49	13.46
2015	28	53	28.51	128.48	7.47	115.72	144.39	124.88	15.68
2016	28	51	31.08	132.45	8.27	118.16	149.43	127.27	18.27
2017	28	52	34.58	137.46	11.82	115.53	162.04	140.10	18.61

2.2.3 Soprano Pipistrelle

Soprano Pipistrelles have been the second most frequently encountered species during the monitoring scheme in most survey years to-date. Abundance of this species is variable across the island, unlike the Common Pipistrelle this species shows no particular southern bias, see Figure 2.6.

Figure 6 compares the mean encounter rate per hour for each square in two, three year intervals, the first from 2012-2014 and the second from 2015-2017. A greater number of high encounter rate squares were apparent in the second time interval, mainly in coastal counties of the Republic of Ireland. In the North, encounter rates appeared to be lower in the most recent three years of the survey compared with the three previous years.

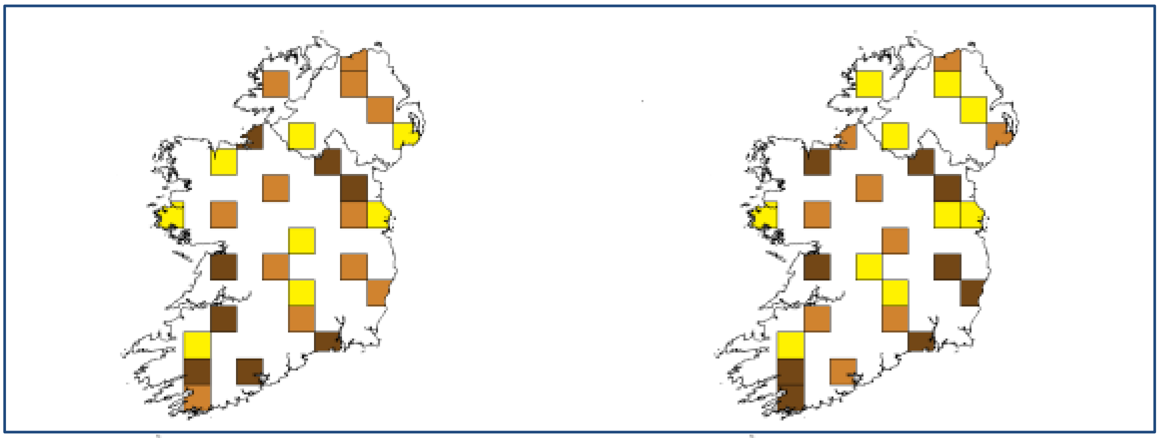

Figure 6 Survey squares colour coded according to mean Soprano Pipistrelle encounter rates (per hour) from 2012-2014 (left) and from 2015-2017 (right). The overall average rate of Soprano Pipistrelle encounters for all squares from 2012-2014 was 12.6hr^{-1} compared with 15.0hr^{-1} from 2015-2017.

Encounter rate >0≤10hr^{-1}
Encounter rate >10≤20hr^{-1}
Encounter rate >20hr^{-1}

2.2.3.1 Soprano Pipistrelle Trend

Soprano Pipistrelles showed a significant increase from the survey start until 2017. The lower 95% confidence interval around the smoothed trend currently exceeds the 2006 baseline index (Figure 7, Table 4). The highest yearly estimate in the trend series was in 2017 (Figure 7). In the past twelve years (2006-2017) this species has increased by 105.8% in total, equivalent to a per annum increase of 6.2%, see Table 2.4.

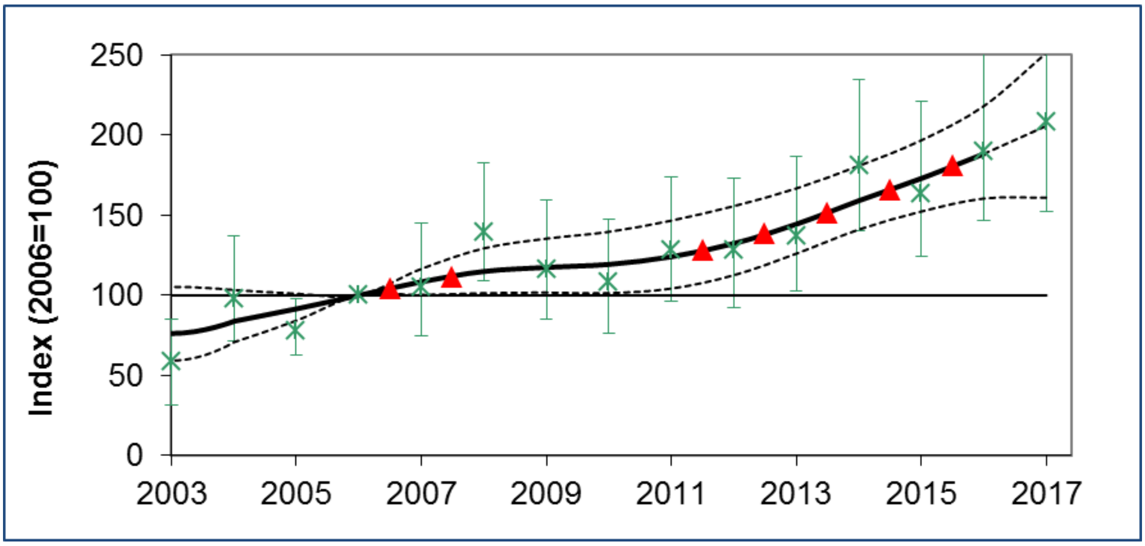

Figure 7 Results of the GAM/GLM model for Soprano Pipistrelle data. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant (p<0.05) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant (p<0.05).

Table 4 GAM results for Soprano Pipistrelles with 95% confidence limits (using first 15 transects from the 2003-2008 dataset).

Year	Sites	Surveys	Mean Passes	Smoothed (GAM) Estimate	S.E.	Conf. Interval (lower 95%)	Conf. Interval (upper 95%)	Unsmoothed Estimate	S.E.
2003	7	9	6.78	76.12	11.88	59.07	105.27	58.28	13.81
2004	17	27	10.30	83.78	8.41	70.71	103.30	98.155	17.14
2005	17	31	7.58	91.52	4.29	84.20	101.01	77.55	9.27
2006	25	45	9.69	100.00	0.00	100.00	100.00	100.59	0.00
2007	26	46	9.15	108.45	4.08	100.28	116.55	104.88	18.20
2008	23	42	12.05	114.92	7.03	101.34	129.34	139.63	18.70
2009	28	52	10.75	117.45	8.64	101.75	135.41	116.25	18.78
2010	27	53	10.09	119.32	9.71	101.34	139.67	107.90	18.00
2011	28	53	11.53	124.12	10.60	104.22	146.69	128.04	19.80
2012	26	44	11.86	132.35	10.81	112.58	155.72	128.36	20.42
2013	25	46	12.70	144.46	10.36	126.07	166.81	136.68	21.11
2014	27	49	16.29	159.15	10.24	141.11	180.92	181.07	24.49
2015	28	53	15.23	173.04	11.35	152.37	196.89	163.52	24.73
2016	28	51	17.82	188.42	14.87	160.49	218.31	190.05	26.18
2017	28	52	19.10	205.88	22.52	161.01	251.49	208.02	34.17

2.2.4 Leisler's Bat

Leisler's Bat has been the third most frequently encountered species during the monitoring scheme in most survey years to-date. Like the Common Pipistrelle, this species tends to show some southern bias in its abundance with more squares with high numbers of passes found in the south and east. Figure 8 compares the mean encounter rate per hour for Leisler's Bat for each square in two, three year intervals, the first from 2012-2014 and the second from 2015-2017. Fewer high encounter rate squares in the past three years can be seen compared with the 2012-2014 interval. In the northern half of the island, encounter rates appear to be lower in the most recent three years of the survey compared with the three previous years.

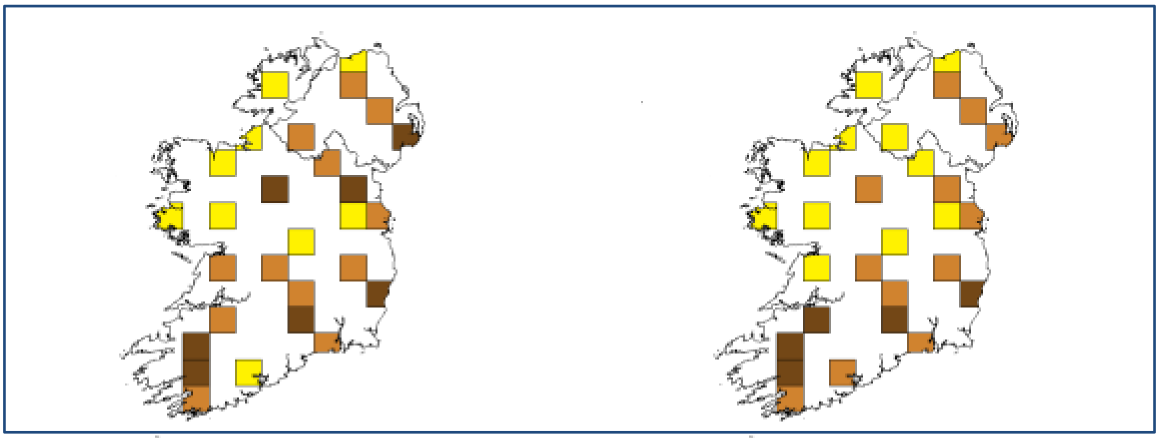

Figure 8 Survey squares colour coded according to mean Leisler's Bat encounter rates (per hour) from 2012-2014 (left) and from 2015-2017 (right). The overall average rate of Leisler's Bat encounters for all squares from 2012-2014 was 12.1hr^{-1} compared with 11.2hr^{-1} from 2015-2017.

Encounter rate $>0\leq 8hr^{-1}$
Encounter rate $>8\leq 16hr^{-1}$
Encounter rate $>16hr^{-1}$

2.2.4.1 Leisler's Bat Trend

Leisler's Bat showed a significant increase from the survey start until 2014 when the trend turned downwards. The lower 95% confidence interval around the smoothed trend currently overlaps the 2006 baseline index (Figure 9, Table 5). The highest yearly estimate in the trend series was in 2014 (Figure 9). In the past twelve years (2006-2017) this species has increased by 29.7% in total, equivalent to a per annum increase of 2.2%.

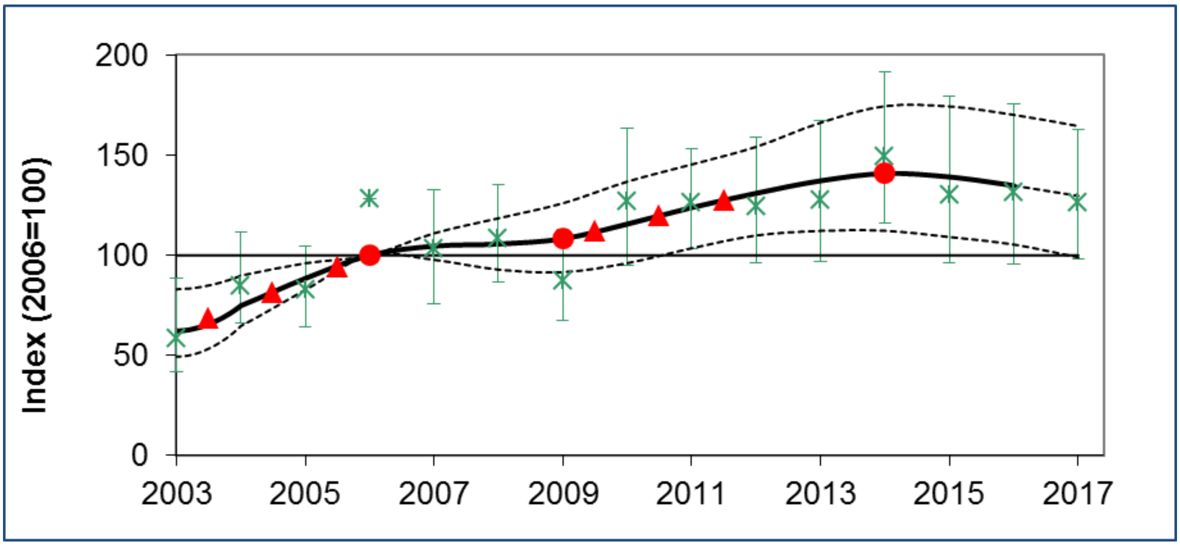

Figure 9 Results of the GAM/GLM model for Leisler's Bat data. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$).

Table 5 GAM results for Leisler's Bat with 95% confidence limits (using first 15 transects from the 2003-2008 dataset).

Year	Sites	Surveys	Mean Passes	Smoothed (GAM) Estimate	S.E.	Conf. Interval (lower 95%)	Conf. Interval (upper 95%)	Unsmoothed Estimate	S.E.
2003	7	9	5.11	62.17	8.54	49.34	83.02	30.27	12.17
2004	17	28	7.71	74.81	6.35	64.69	89.84	56.46	11.38
2005	17	31	7.68	88.43	3.32	82.69	96.03	54.46	10.18
2006	25	45	13.33	100.00	0.00	100.00	100.00	100.00	0.00
2007	26	46	9.07	104.56	3.44	97.72	111.02	75.07	14.53
2008	23	42	9.93	105.59	6.51	92.85	118.52	80.15	12.32
2009	28	52	7.35	108.26	8.89	91.59	125.99	58.77	11.48
2010	27	53	12.23	115.62	10.29	96.09	136.84	98.51	18.24
2011	28	53	11.43	123.84	10.43	103.54	145.43	98.13	12.72
2012	26	44	11.32	131.02	11.42	109.91	154.23	96.19	16.36
2013	25	46	11.46	137.25	13.82	112.21	166.30	99.41	17.85
2014	27	49	15.00	140.89	16.07	112.27	174.55	120.93	19.31
2015	28	53	12.96	139.17	16.71	109.12	174.42	101.57	21.26
2016	28	51	13.76	134.84	16.45	105.37	170.22	103.20	20.82
2017	28	52	12.73	129.72	17.24	98.98	164.61	98.13	16.83

2.2.5 Nathusius' Pipistrelle

Nathusius' Pipistrelle remains one of the least encountered species from the survey. It has been recorded just 292 times since 2005. Records from the Car-based Bat Monitoring Scheme to 2011 were published in the Irish Naturalists' Journal (Roche, Aughney, Kingston, Lynn, & Marnell, 2015). Over the past three years (2015-2017) the species has been recorded in a larger number of survey squares than the previous three year interval (2012-2014), see Figure 10.

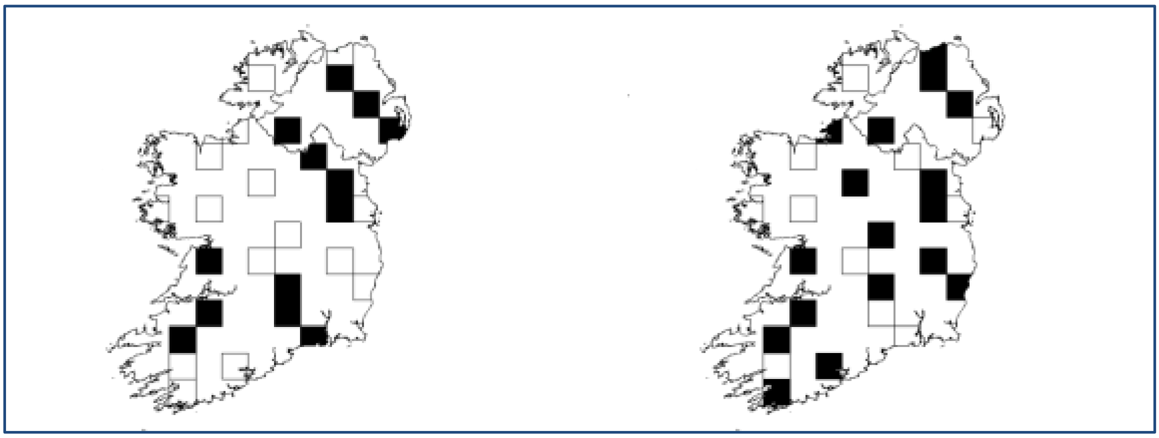

Figure 10 Survey squares indicating presence (black) or absence (white) of Nathusius' Pipistrelle records from the Car-based Bat Monitoring Scheme 2012-2014 (left) and 2015-2017 (right). The species was detected in a greater number of squares during the more recent three year interval.

2.2.5.1 Nathusius' Pipistrelle Trend

Due to its rarity there is considerable uncertainty about the trend for this species, as indicated by the very wide confidence intervals (Figure 11, Table 6). However, as far as can be determined at present, the species may be slightly increasing. Interpretation of trends should be treated with caution due to the very large variability between years and wide error bars.

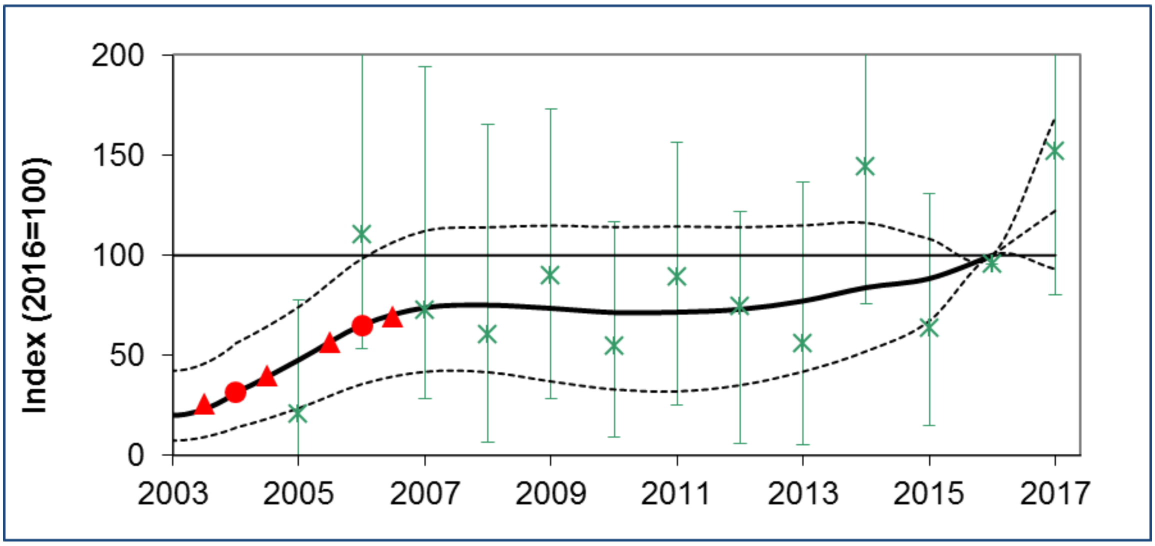

Figure 11 Results of the binomial GAM/GLM model for proportion of 1.6km transects with Nathusius' Pipistrelle passes. Green points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$). The baseline is taken as 2016.

Table 6 GAM results for Nathusius' Pipistrelle with 95% confidence limits (using first 15 transects from the 2003-2008 dataset).

Year	Sites	Surveys	Mean Passes	Smoothed (GAM) Estimate	S.E.	Conf. Interval (lower 95%)	Conf. Interval (upper 95%)	Unsmoothed Estimate	S.E.
2003	7	9	0.00	19.99	9.48	7.35	42.30	0.03	0.02
2004	17	28	0.00	31.43	11.25	13.81	56.02	0.05	0.03
2005	17	31	0.00	47.76	13.22	23.56	74.24	24.70	25.53
2006	25	45	0.02	65.05	16.04	35.60	98.30	114.97	41.66
2007	26	46	0.02	73.80	18.37	41.79	112.18	76.74	47.86
2008	25	44	0.01	75.04	18.88	41.56	113.98	64.83	47.81
2009	28	53	0.01	73.50	20.09	36.92	114.85	94.15	37.88
2010	28	54	0.01	71.38	21.33	32.91	114.08	59.09	28.65
2011	28	53	0.02	71.53	21.59	31.98	114.40	93.62	34.36
2012	27	45	0.02	72.97	20.47	35.03	114.04	79.07	31.69
2013	26	49	0.01	77.16	18.71	41.88	114.90	60.32	35.83
2014	28	50	0.03	83.88	16.07	52.03	116.20	148.43	42.35
2015	28	53	0.01	88.34	10.26	67.16	108.18	68.25	30.62
2016	28	51	0.02	100.00	0.00	100.00	100.00	100.00	0.00
2017	28	52	0.02	122.32	19.57	93.10	169.30	156.59	70.65

2.2.6 *Myotis* bat species

Occasional records for *Myotis* species are collected by the Car-based Bat Monitoring Scheme. These records are widespread but infrequent across the island. *Myotis* sp. bat passes could be Natterer's, Daubenton's or Whiskered Bat but it is not possible to definitively identify them to species level.

The trend graph (Figure 12) for *Myotis* species based on the car monitoring data shows evidence of a downward trend. As well as the very wide error bars, which express uncertainty about the trend, the result for *Myotis* bats is likely to comprise a number of species so must be interpreted with added caution

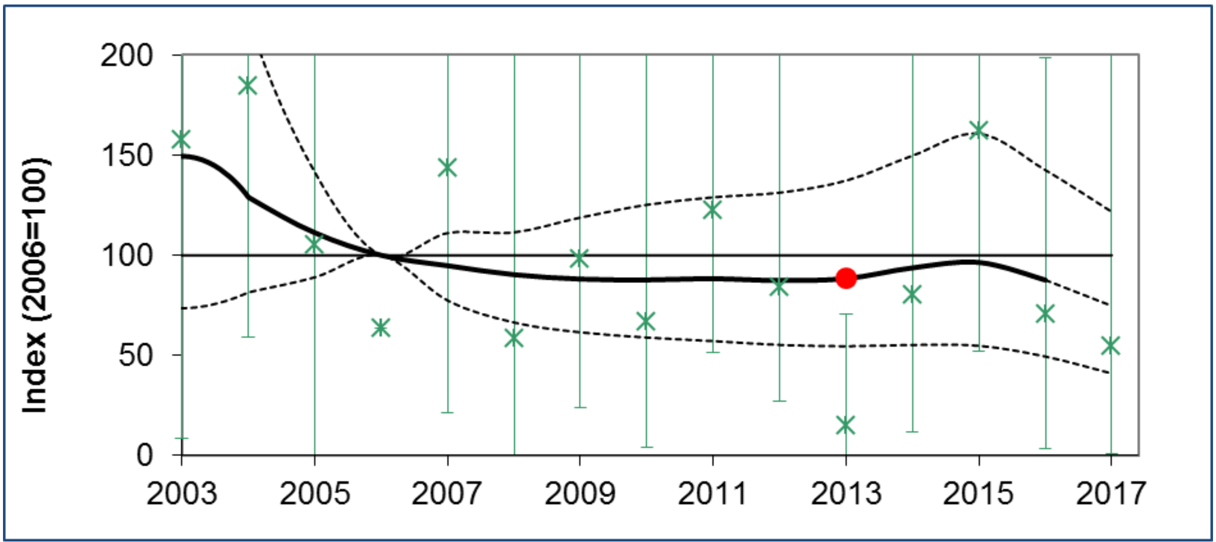

Figure 12 Results of the binomial GAM/GLM model for proportion of 1.6km transects with *Myotis* spp. passes. Green points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. The baseline is taken as 2016.

Table 7 GAM results for *Myotis* spp. with 95% confidence limits (using first 15 transects from the 2003-2008 dataset).

Year	Sites	Surveys	Mean Passes	Smoothed (GAM) Estimate	S.E.	Conf. Interval (lower 95%)	Conf. Interval (upper 95%)	Unsmoothed Estimate	S.E.
2003	7	9	0.78	149.53	72.49	73.49	350.27	194.16	167.42
2004	17	27	0.78	129.02	35.63	81.47	218.83	221.04	143.88
2005	17	31	0.52	111.25	13.71	89.00	141.57	141.67	103.34
2006	25	45	0.38	100.00	0.00	100.00	100.00	100.00	0.00
2007	26	46	0.59	94.78	8.40	77.39	111.09	179.62	126.21
2008	23	42	0.31	90.31	11.51	66.39	111.44	94.36	61.43
2009	28	52	0.48	88.11	14.31	61.48	118.87	134.31	71.11
2010	27	53	0.36	87.69	16.75	58.88	125.22	103.14	67.78
2011	28	53	0.53	88.30	18.42	57.11	129.00	158.89	68.50
2012	26	44	0.41	87.37	18.93	55.21	131.33	119.93	56.06
2013	25	46	0.17	88.33	20.48	54.53	137.31	50.75	22.76
2014	27	49	0.39	93.73	24.55	55.14	149.83	116.35	74.14
2015	28	53	0.70	96.45	27.38	54.74	160.82	198.58	112.77
2016	28	51	0.39	87.62	23.93	49.39	142.59	106.98	51.43
2017	28	52	0.33	74.69	20.89	40.89	121.72	90.63	56.97

2.2.7 Brown Long-eared Bat

This species was encountered for the first time by the Car-based Bat Monitoring Scheme in 2007. It is largely undetectable during the car surveys due to its quiet echolocation calls. However, it does occasionally produce social calls of higher amplitude (loudness) that may be recorded. When occurrences are examined by site and year, there is little sign of a consistent pattern; which is exactly what would be expected from a widely distributed species with low detection rate. It is interesting to compare results from the Car-based Monitoring Scheme with the more robust Brown Long-eared Bat Roost Monitoring Scheme where the current trend for this species is stable (Section 4).

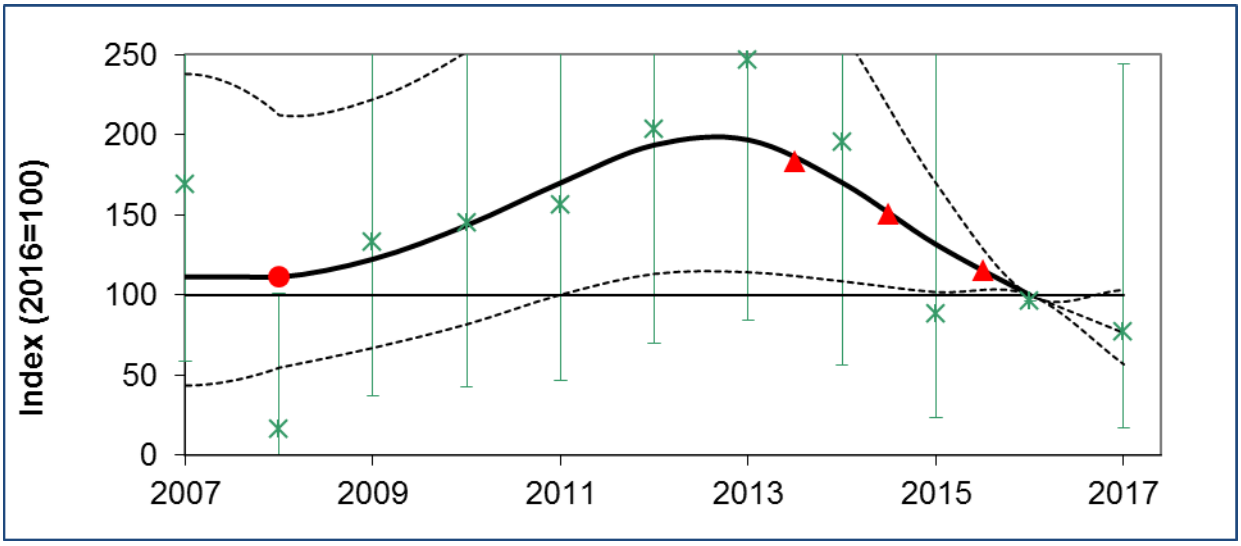

Figure 13 Results of the binomial GAM/GLM model for proportion of 1.6km transects with Brown Long-eared Bat passes. Green points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$). The baseline is taken as 2016.

2.2.8 Phenological Changes

Buckland & Johnston (2017) suggested that climate change impacts on the timing of births may affect observed trends by increasing the numbers of young flying earlier in the year. It might be expected that any such effect would impact differently on the two months of the car survey so we compared the trends of the target species just using Survey 1 (usually July) and just using Survey 2 (August). Results are shown in Figures 14 – 16 with the July trend lines for each species shown in red and the August line in blue.

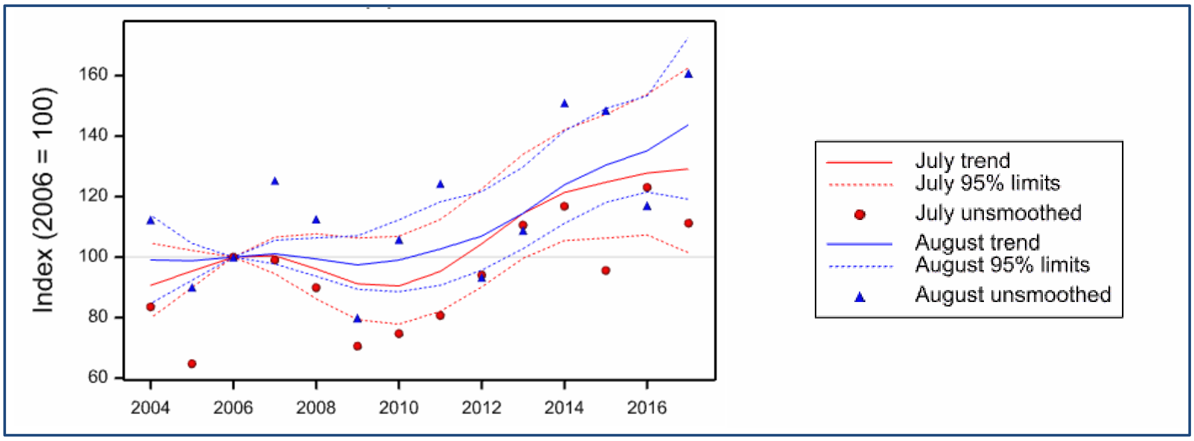

Figure 14 Trend lines for the Common Pipistrelle in July and in August.

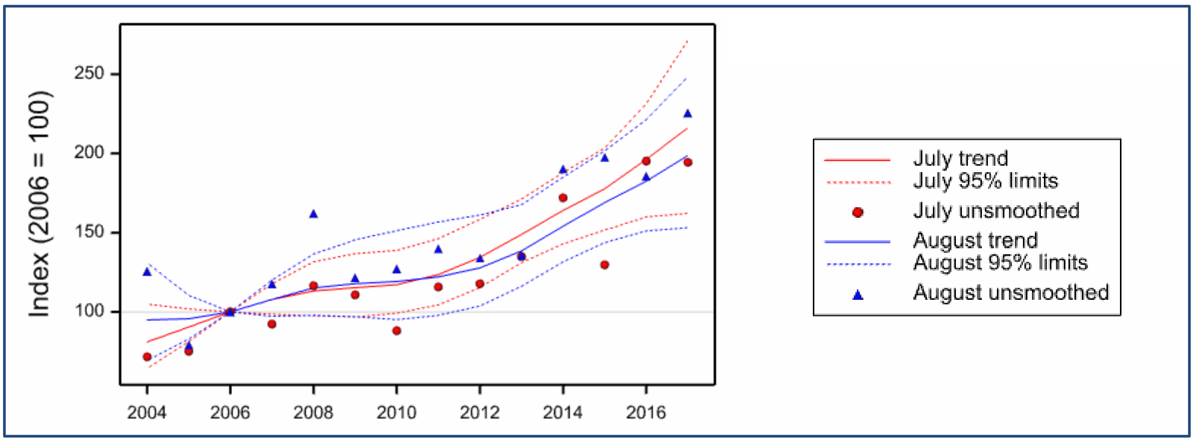

Figure 15 Trend lines for the Soprano Pipistrelle in July and in August.

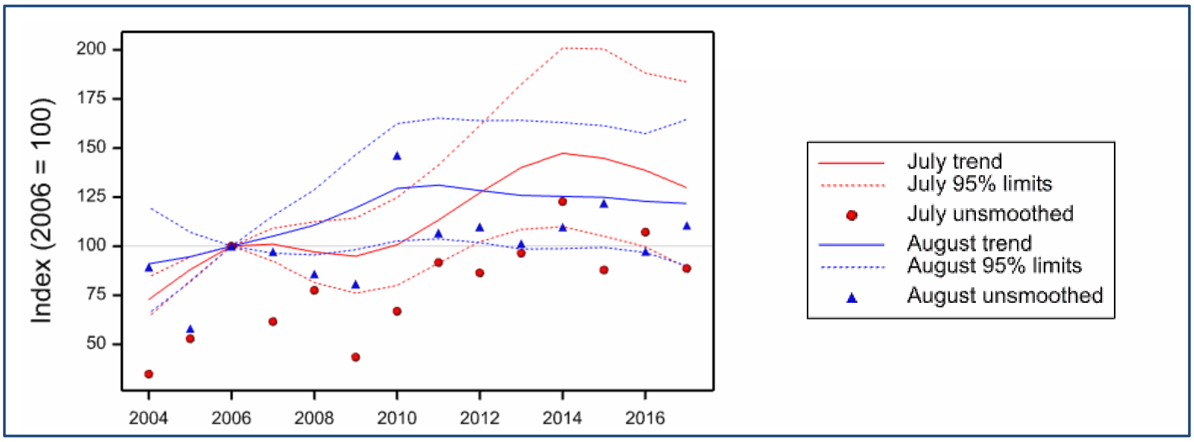

Figure 16 Trend lines for Leisler's Bat in July and in August

Differences between the trend lines are small relative to their confidence intervals (indicated by the dotted lines), although there are some signs of temporal differences for Leisler's Bat, with the main increase happening a few years earlier for the August counts. However, both trend lines show an increase over the duration of the scheme.

The other interesting thing about these graphs is the lack of strong correlation between the two sets of unsmoothed estimates for each species. For example, for Common Pipistrelle the 2015 point is very low in July but very high in August. This suggests that the year-to-year effects might owe more to factors such as weather than true annual differences. It might therefore be worth considering a further look at the use of covariates in the models to see whether these can lead to a reduction in the width of confidence limits.

2.2.9 Batlogger Trial

Six Batlogger M (Elekon) units were trialled in 2016 in tandem with the traditional Tranquility Transect detectors. Following the purchase of more Batloggers in 2017, data from both detectors were collected from 19 surveys in total.

In 2016 Batlogger data from the nine surveys were analysed using Bat Sound by hand. The results of the analysis from 2016 are available in Aughney, Roche, & Langton (2017). Bat Sound is too time-consuming to be a feasible method for analysing the extensive datasets that will arise when Batloggers are in use in all 28 squares. In 2017 data from Batloggers were instead analysed using Kaleidoscope Pro (by Wildlife Acoustics), with both the auto identification and manual identification functions, thus providing two separate results datasets. In addition, Batlogger data were analysed using BatClassifyIreland (2017 version). This automatic identification software was developed initially at University of Leeds for a pilot woodland scheme in the UK. The software was updated for using with Batloggers in Ireland in 2016 and 2017 by Chris Scott and using a bat call library provided by Emma Boston and Bat Conservation Ireland as part of the woodland bat pilot survey (Boston, Roche, Aughney & Langton, 2017). BatClassifyIreland outputs a probability estimate rather than a definitive identification. Identifications with a probability of >0.8 are considered positive for a species.

We examined the results from the 2017 Batlogger trial for the present report, looking at correlations between Tranquility data analysed using Bat Sound, and Batlogger data analysed using each of the three following methods

- Kaleidoscope Pro: Automatic
- Kaleidoscope Pro: Manual
- Bat Classify Ireland (2017 version) (positive identifications >0.8 probability)

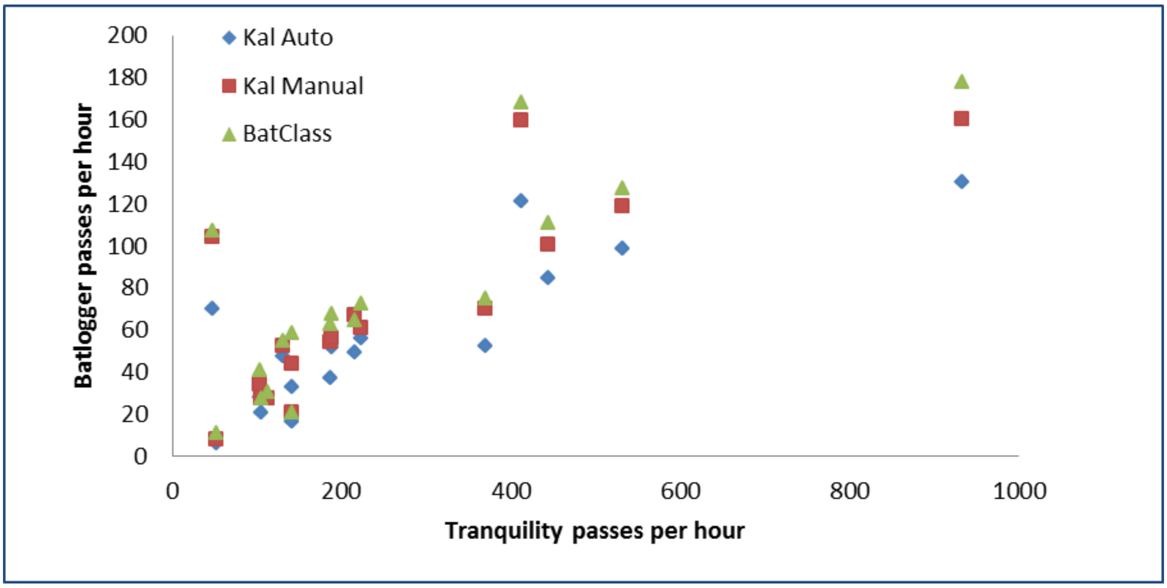

Figure 17 Common Pipistrelle passes per hour 2017. Each point represents one survey. X-axis shows Tranquility detector results analysed using Bat Sound, Y-axis shows Batlogger results analysed by each of the different analysis methods.

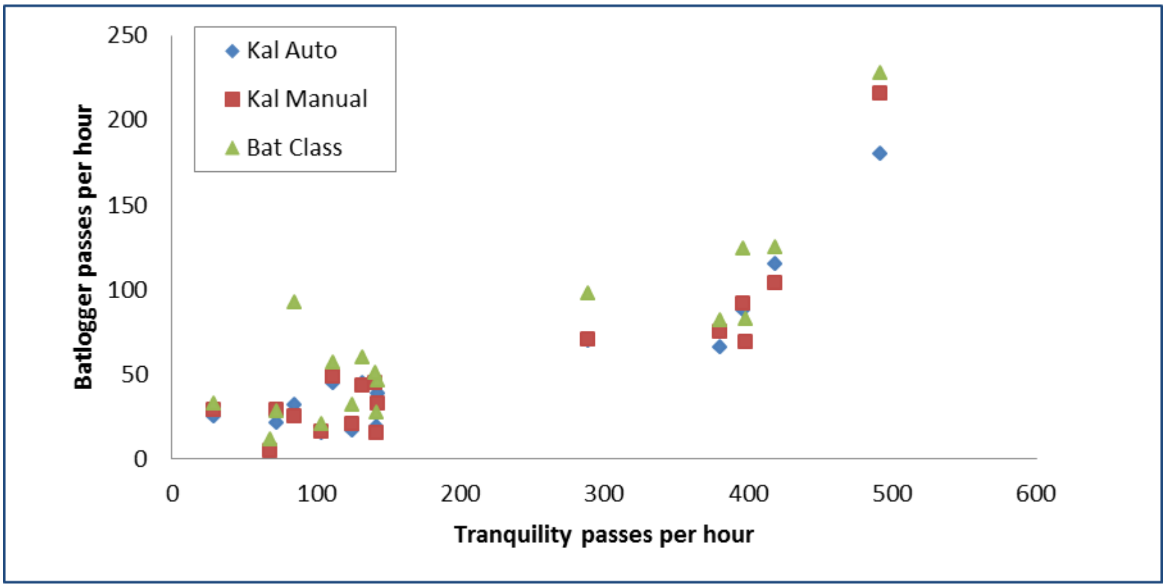

Figure 18 Soprano Pipistrelle passes per hour 2017. Each point represents one survey. X-axis shows Tranquility detector results analysed using Bat Sound, Y-axis shows Batlogger results analysed by each of the different analysis methods.

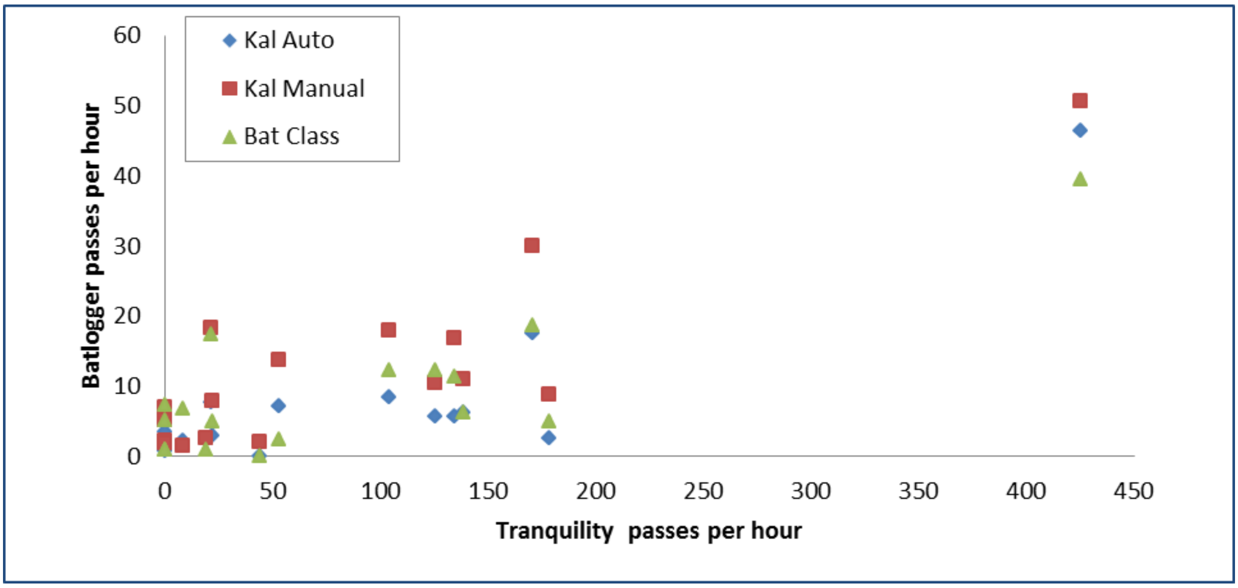

Figure 19 Leisler's Bat passes per hour 2017. Each point represents one survey. X-axis shows Tranquility detector results analysed using Bat Sound, Y-axis shows Batlogger results analysed by each of the different analysis methods.

Table 8 Correlation (r value) between Batlogger and Tranquility passes per minute, per survey (n=17).

Species	Tranquility Bat Sound *Compared with* Batlogger Kaleidoscope Manual	Tranquility Bat Sound *Compared with* Batlogger Kaleidoscope Auto	Tranquility Bat Sound *Compared with* Batlogger Bat Classify Ireland
Common Pipistrelle	0.80	0.84	0.81
Soprano Pipistrelle	0.85	0.88	0.83
Pipistrelle unknown	0.75	n/a	n/a
Nathusius' Pipistrelle	0.34	0.00	0.17
Leisler's Bat	0.87	0.88	0.82
Myotis	0.37	0.60	0.14

Correlation in detection of rarer species is very poor. Both types of automated ID software regularly misidentify Nathusius' Pipistrelle. In Aughney *et al.* (2017) we discussed the fact that BatClassifyIreland tends to misidentify Common Pipistrelle calls as Nathusius' Pipistrelle. The best correlation between analysis types for this species was between Batlogger with manual Kaleidoscope and Tranquility with Bat Sound. But the correlation is still far from ideal with an r value of just 0.34. The best method for *Myotis* species may be Kaleidoscope Auto.

While the correlation co-efficients are reasonably similar for the three target species between methods (+0.8), Kaleidoscope Auto and Manual show slightly higher correlation compared with BatClassifyIreland. The facility to manually verify calls using Kaleidoscope is a distinct advantage over BatClassifyIreland.

Results from the two R22 surveys in 2017 deviated very considerably from the trend. In fact, the results from Batlogger and Tranquility detectors in the two surveys from square R22 varied so greatly that the data was omitted from the above graphs. For surveys in N74 the Common Pipistrelle datapoints were also somewhat anomalous but not to as great an extent. The most likely explanation for this kind of variation is that some Tranquility detectors' microphones have degenerated and are now less sensitive, possibly at specific frequencies. Variability in the original detector stock may make the changeover from one method to the other slightly more complicated and may have to be accounted-for in the analysis.

2.2.10 Analysis of Weather Data

Some of these results were presented at the 14th European Bat Research Symposium in Donostia in 2017. Among the findings was a significant positive correlation between overall percentage annual change in the Common Pipistrelle index and temperature the previous summer. We found that warm temperatures the previous summer were also likely to correlate with higher numbers of bats the following year at the 30km survey square level (all three target species). We are currently compiling these results and further analyses in a paper for submission to a peer-reviewed journal.

2.2.11 Other Vertebrates

2.2.11.1 Other Vertebrates: Living

Surveyors are asked to record living and dead vertebrates that they encounter during the surveys, within and between transects. This resulted in the collection of 3,965 records of living vertebrates (apart from bats) from 2006 to 2017. Figure 20 is a pie chart illustrating proportions of living vertebrate records attributed to species or species groups. In all survey years the records for living vertebrates have been dominated by cats. In most years, these accounted for over 50% of the records collected. Dogs and rabbits are the second most frequently encountered species with 407 and 383 records collected, respectively. Foxes are the next most common (327 records). A number of species of conservation interest have been recorded by surveyors including otter, pine marten and owls.

All 'other vertebrate' data to 2015 was provided to the National Biodiversity Data Centre.

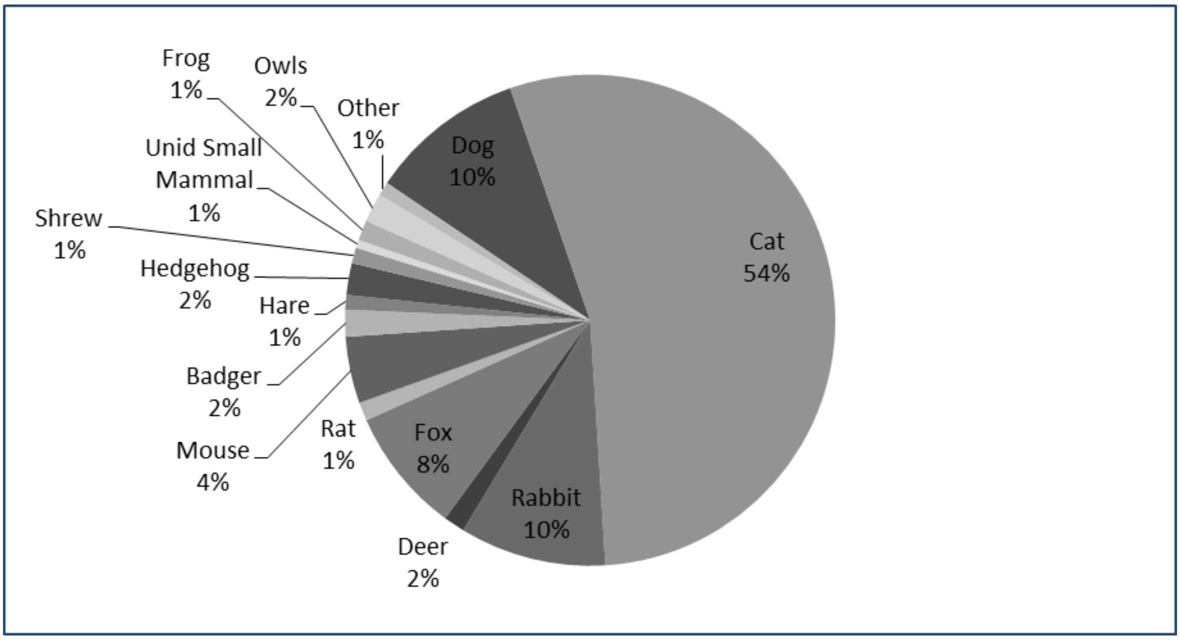

Figure 20 Living vertebrates, other than bats, recorded 2006-2017, n=3965

Records for living cats, foxes, rabbits and hedgehogs were analysed further using TRIM (Trends and Indices for Monitoring Data, Statistics Netherlands). It is important to note, however, that these 'other vertebrate' data are not central to the Car-based Bat Monitoring Scheme and the survey was not designed with collection of these data in mind. Detection of cats, or any other non-Chiropteran species, is not necessarily standardised across the dataset so the trends reported below may be subject to error. In addition, the dataset for hedgehogs, which was examined for the first time as part of the present report, includes very high numbers of zeros which further reduces the reliability of the trend results.

The total number of each species counted in each survey square each year was calculated and the time taken to complete the surveys in each square was included as a weighting factor (to account for the differences in time spent). For the trend analysis we used a linear model with default stepwise detection of change points. The base year for these analyses is taken as 2007, the second year in which 'other vertebrates' were consistently recorded during the surveys.

All the species, with the exception of hedgehogs, showed significant moderate declines from 2007 to 2017 according to our roadside count data. All four models are plotted together in Figure 21. Foxes and rabbits show very similar trends. The trend for hedgehogs is currently unclear but appears more stable than other species.

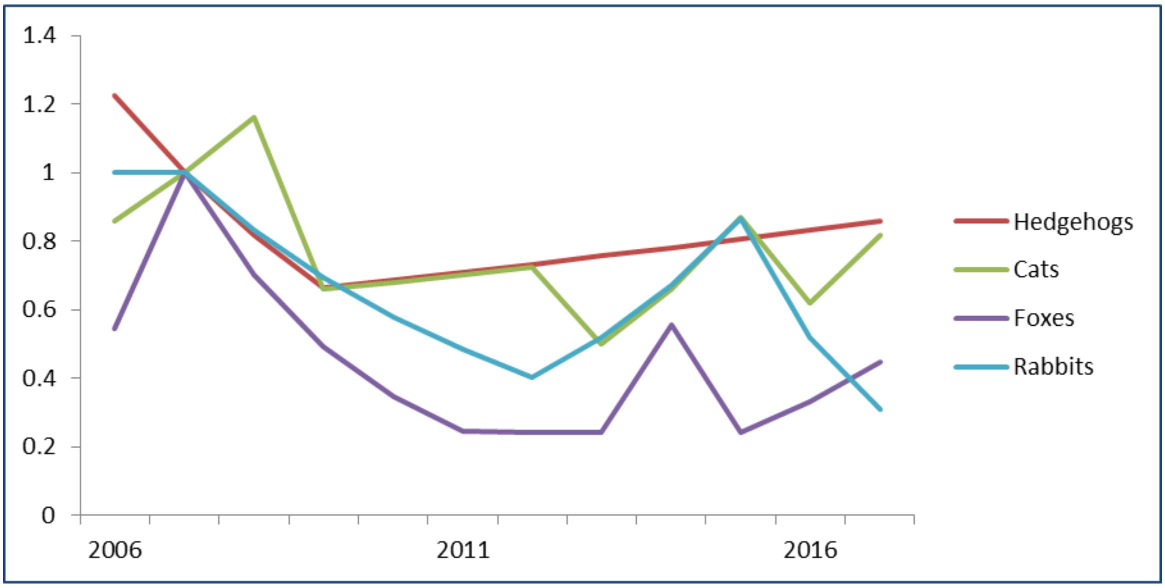

Figure 21 Roadside hedgehog, cat, fox and rabbit trends analysed using TRIM. Indices are based on yearly estimates with a linear trend; change points are selected using the default stepwise method. The baseline year was taken as 2007, time spent surveying was included as a weighting factor.

2.2.11.2 Other Vertebrates: Dead

Dead vertebrates tend to be recorded in differing proportions to live ones (see Figure 22). Over 260 dead vertebrates other than bats were recorded by surveyors from 2006 to 2017. Despite the high numbers of living cats observed during the car surveys, cats are infrequently observed as road kill, relative to the proportion of live sightings, but still constitute the second most frequently recorded dead vertebrate. The most frequently recorded dead species is the rabbit, while rats, hedgehogs, badgers and foxes are observed less often.

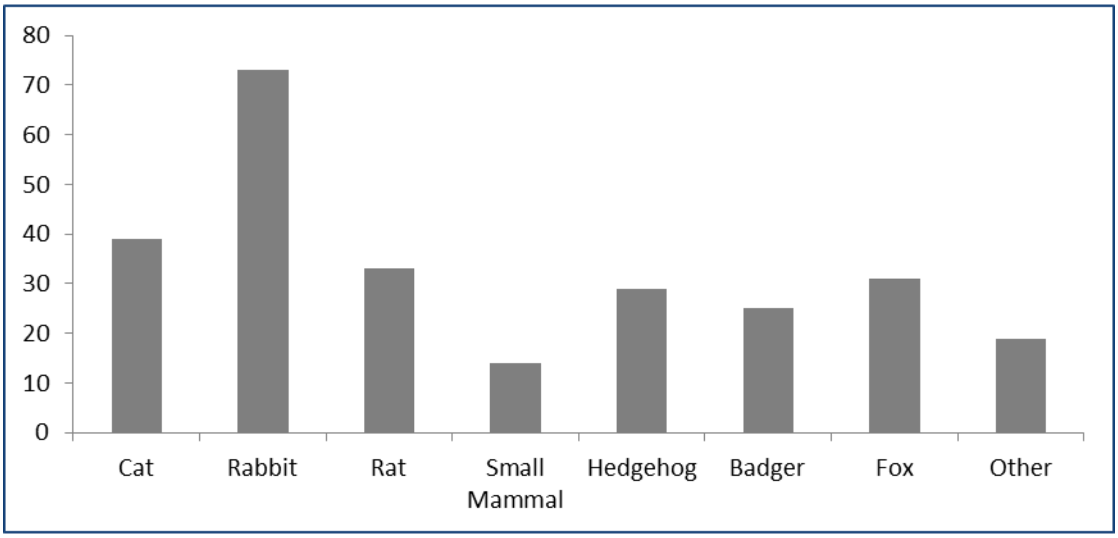

Figure 22 Number of records of dead vertebrates collected during car-based bat monitoring surveys 2006-2017. N=263.

2.2.12 Oral and Poster Presentations & Scientific Papers

The following conference presentations were completed using data from the Car-based Bat Monitoring Surveys:

1. 9th Irish Bat Conference 2017

   Oral Presentation Title: The Impact of Climate on Trends in Common Bat Species

2. 14th European Bat Symposium 2017

   Oral Presentation Title: The Impact of Climate on Trends in Common Bat Species

   Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

3. Inaugural Irish Ecological Association Ecology & Evolution Conference 2016

   Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

4. All Ireland Mammal Symposium 2015

   Oral Presentation Title: Population trends of Irish bat species.

5. Peer Reviewed Paper

   Records for Nathusius' Pipistrelle (*Pipistrellus nathusii*) in Ireland from a car-based bat monitoring scheme (Roche, Aughney, Kingston, Lynn, & Marnell, 2015). Published in the Irish Naturalists' Journal.

6. Peer Reviewed Paper

   Google Earth and Google Street View reveal differences in *Pipistrellus pipstrellus* and *Pipistrellus pygmaeus* roadside habitat use in Ireland (Dick & Roche, 2017) published in the Irish Naturalists' Journal.

3 Daubenton's Bat Waterways Monitoring

The All Ireland Daubenton's Bat Waterway Monitoring Scheme is a project funded by the National Parks and Wildlife Service (NPWS) of the Department of Culture, Heritage and Gaeltacht, Republic of Ireland and the Northern Ireland Environment Agency (NIEA) through the Environment Fund. This scheme aims to be the primary tool for monitoring Daubenton's Bat in the Republic of Ireland and Northern Ireland. This monitoring protocol was devised the Bat Conservation Trust (BCT) in 1997 and introduced in Ireland by BCIreland in 2006 and has been managed by BCIreland since then.

This section of the report presents a synthesis of results for the twelve years (2006-2017) of monitoring in the Republic of Ireland and Northern Ireland under the management of BCIreland and follows earlier reports produced by BCIreland e.g. Aughney *et al.* (2009; 2015; 2012).

3.1 Method

The All-Ireland Daubenton's Bat Waterway Monitoring Survey methodology is based on that currently used in BCT's UK National Bat Monitoring Programme (NBMP) (Walsh *et al.*, 2001). Newly recruited surveyors are assigned a choice of starting points located within 10km of their home address or preferred survey area. Seasoned surveyors are reassigned starting points surveyed in previous years. Starting points, where possible, are linked the EPA's National Rivers Monitoring Programme in the Republic of Ireland and the Water Quality Management Unit dataset under the NIEA, Northern Ireland. However, volunteer teams are also given the opportunity to choose sites close to their own home address or preferred survey area (e.g. Tidy Town committees' survey sites within their management boundaries).

Surveyors undertake a daytime survey of their allocated sites to determine its safety and suitability for surveying. At the chosen site, ten points (i.e. survey spots) approximately 100m apart are marked out along a 1km stretch of waterway. The surveyors then revisit the site on two evenings in August and start surveying 40 minutes after sunset. At each of the ten survey spots, the surveyor records Daubenton's Bat activity as bat passes for four minutes using a heterodyne bat detector and torchlight (Walsh *et al.*, 2001). Surveyors are asked to undertake the survey on two dates, one between the dates of 1st to 15th August (Survey 1, S1) and the repeat survey between the dates of 16 to 30 August (Survey 2, S2).

Bat passes are either identified as 'Sure' Daubenton's Bat passes or 'Unsure' Daubenton's Bat passes. A 'Sure' Daubenton's Bat pass is where the surveyor, using a heterodyne detector, has heard the typical rapid clicking echolocation calls of a *Myotis* species and has also clearly seen the bat skimming the water surface. Bat passes that are heard and sound like *Myotis* species but are not seen skimming the water surface may be another *Myotis* species. Therefore, these bat passes are identified as 'Unsure'. Bat passes are counted for the duration of four minutes. Counting bat passes is a measure of activity and results are quoted as the number of bat passes per total survey period (No. of bat passes/40 minutes).

Surveyors are also requested to record a number of parameters including air temperature, weather data and waterway characteristics, such as width and smoothness. Volunteers are required to survey in pairs for safety reasons. One member of the team is designated as Surveyor 1 and uses the bat detector and torch while Surveyor 2 documents the number of bat passes and other information required for the recording sheets. Information on the bat detection skills of Surveyor 1 and model of bat detector is requested for incorporation into analyses. On completion of both nights, surveyors return completed recording sheets and map (with the ten survey spots marked out) to BCIreland for analysis and reporting.

Volunteers are also encouraged to record any other wildlife species encountered during their surveys.

3.1.1 Volunteer Recruitment

The All Ireland Daubenton's Bat Waterway Monitoring Scheme relies on the participation of volunteers to survey the large number of waterway sites required to detect Red and Amber Alert declines and to calculate population trends. A recruitment drive is undertaken annually. An on-line registration system was set up on the BCIreland website to facilitate volunteer participation. BCIreland also works closely with Heritage Officers and Biodiversity Officers in local authorities to facilitate development of local volunteer networks.

Prior to the allocation of sites, all surveyors are contacted by email to determine their participation in the coming year's surveys. All newly recruited surveyors are invited to attend an evening training course; these are organised for the months of June and July. These training courses are advertised through social media, BCIreland website (events section) and by email. Local hosts of training courses are provided with posters to advertise in their area. The training course consists of a one hour PowerPoint presentation followed by a discussion of potential survey areas. An outdoor practical session on a local river or canal to demonstrate the survey methodology is then completed. An information pack consisting of a detailed description of the methodology, maps, survey forms and online training details are provided for each survey team. Heterodyne bat detectors are also available for loan for the duration of the summer months.

All volunteers registered for the summer surveying receive an email prior to the month of August with the following information:

- Digital copies of survey sheets, survey methodology, Landowner Letter and sunset times;
- Weblinks to video clips of foraging Daubenton's Bat
- BCIreland's bat echolocation call audio library

Volunteers receive regular updates by email and through newsletters on the progress of the monitoring scheme.

A word document for each waterway site, detailing the survey history and results and comparing the trend for the individual site to the All-Ireland trend, is emailed to the relevant survey teams. Thus detailed feedback is provided ensuring that participants are kept fully informed of their contribution to the survey.

3.1.2 Statistical Analysis

The data from each survey form is entered onto a MySQL database designed purposely for the All Ireland Daubenton's scheme. This database stores all data collated since 2011. This database is then converted to MS Access and combined with the 2006-2010 Excel file for statistical analysis.

For statistical analysis, a log-transformation is carried out on data at the ten individual points within each survey; this effectively calculates the mean of passes for the survey and helps to reduce the influence of the very high counts sometimes recorded due to one or two bats repeatedly passing the observation point. In previous years bat pass counts were used in a REML model (log-transformed) to investigate the potential relationships with collected variables. Since 2010, the dataset (2006-2017) has been entered into a model looking at the impact of the various covariates on the probability of observing bats at a given spot i.e. a binomial model (Binomial GLMM/GAM model).

Analyses are based on data from survey dates between day numbers 205-250 (i.e. 24 July and 7 September, if not a leap year) which is designed to give approximately one week either side of the official survey period to maximise the amount of data available. As a consequence, the majority of submitted surveys are included in the model as only a few surveys from the second week in September are excluded.

For analyses based on bat passes, both counts excluding and including 'Unsure' Daubenton's Bat passes are used. For binomial analyses, the presence of both 'Sure' and 'Unsure' Daubenton's Bat passes at each survey spot are used. Surveys where no bat passes were recorded are also included in the analysis.

To assess trends, two different methods are used. One is a Generalised Linear Model (GLM) with a Poisson error distribution which is applied to the entire dataset (i.e. 2006-2014) and the other is a GLM with a binomial distribution. The first is undertaken in order to compare the trends with the BCT waterways survey (Barlow *et al.*, 2015) while the latter is also reported since presence/absence models such as this are considered to more effectively deal with the issue of multiple encounters with the same bats, a problem common to static detector surveys. The trend datasets only include waterway sites surveyed for two or more years as waterway sites surveyed in a single year do not contribute to information on trends.

For the GLM with Poisson distribution Daubenton's Bat activity per annum was modelled using four different measures ('Sure' passes only, 'Unsure' and 'Sure' passes combined, a maximum of 48 passes per survey, a maximum of 48 passes with covariates included in the model). The model with the maximum number of bat passes per survey spot is set to 48 passes (both Sure and Unsure) (i.e. one pass per 5 seconds) because it is considered that volunteers differ greatly in how they record continuous activity and this truncation reduces the uncertainty associated with higher counts. This approach is similar to the approach used for assessing Daubenton's trend in Britain in the National Bat Monitoring Programme (NBMP) undertaken by the BCT and also for trends in bird populations. Recent work for the NBMP has suggested that precision may be improved, at the risk of some bias, by using a logistic regression model for the number of observation points with bats present (pers. comm. S. Langton).

The binomial (presence/absence) model uses the proportion of survey spots with bats present at each waterway site (e.g. 0.7 if Daubenton's Bat was observed at seven of the ten survey spots). Bootstrapping is used to find standard errors using logistic regression (a GLM with a logit link function) (Fewster *et al.*, 2000). A smoothed GAM trend is also fitted (to highlight the change in trend) to the results both with and without co-variates to give a general indication of the trend. The co-variates were determined using the binomial GLMM model.

The default degrees of freedom have been increased to five, compared to the usual default value of 3 for this length of data, as the oscillating pattern of the unsmoothed values is too complex to be modelled with 3 degrees of freedom. The increase in degrees of freedom was applied to both trend models.

3.2 Results

3.2.1 Volunteer Participation

Approximately 180 volunteer survey teams have participated in the All Ireland Daubenton's Bat Waterway Monitoring Scheme each year since 2009. A small number of teams survey more than one site annually but the majority survey one waterway site. In addition a small number of survey teams (e.g. n=2 in 2017, excluding the scheme co-ordinator) received remuneration to ensure that a sub-set of core-waterway sites are surveyed annually. The number of waterway sites surveyed by these teams varied from year to year (e.g. n=11 in 2017, excluding the scheme co-ordinator surveys). Over the 12 years of the operation of the scheme, the scheme co-ordinator has surveyed 45 different waterway sites across Counties Cork, Galway, Westmeath, Longford, Roscommon, Antrim, Fermanagh, Armagh, Down, Donegal, Cavan, Meath, Mayo, Louth, Kildare, Monaghan, Kilkenny and Leitrim.

There is a high turnover of survey teams with approximately 30 new survey teams recruited annually. Three hundred and eighty (50.6%) survey teams participated for one year only while 93 (12.4%) survey teams have participated for 7 years or more (see Figure 23). The average survey team participates in the scheme for 2.9 years.

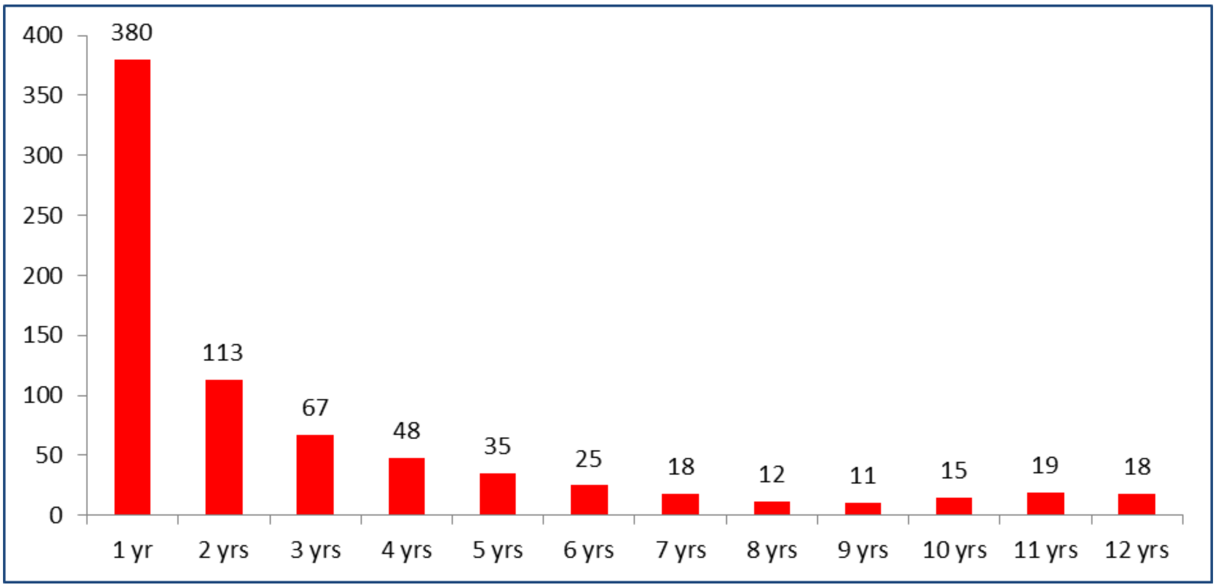

Figure 23 Total number of years each survey team has participated in the scheme in 2006-2017 monitoring period. Note: Survey team refers to lead surveyor and principal contact person.

Over the twelve years of the scheme to-date, a total of the 599 waterway sites were surveyed by 751 teams. Some waterway sites have been surveyed by a number of different teams over the monitoring period while other volunteer teams have taken on different waterway sites depending on where they reside from year to year. The majority of waterway sites have been surveyed by one team only (n=363 waterway sites (60.6%), note this figure includes 158 waterway sites surveyed for one year only) while ten waterways sites have been surveyed by five or more different survey teams (Table 9) over the 12 years. These ten waterways sites are located in Dublin city (n=5), Belfast (n=1), County Limerick (n=1), Galway City (n=1) and County Kildare (n=2).

Table 9 Total number of different survey teams that have surveyed waterway sites for the duration of the monitoring scheme 2006-2017.

No. Waterway Sites	No. of Survey Teams
363 sites	1 team
152 sites	2 teams
54 sites	3 teams
20 sites	4 teams
8 sites	5 teams
2 sites	6 teams

Of the waterway sites surveyed for two or more years (n=441), 53.5% (n=236) were surveyed by two or more different survey teams over the duration of the monitoring scheme (2006-2017). Only 2.5% (n=15) of waterway sites have been surveyed by the same survey team for each of the 12 years of the scheme (Table 10).

Table 10 Total number of survey teams involved in surveying registered waterway sites surveyed for the duration of the monitoring scheme 2006-2017.

Waterway Site surveyed for:	1 Survey Team only	2 Survey Teams	3 Survey Teams	4 Survey Teams	5 Survey Teams	6 Survey Teams	**Total**
1 yr	158						**158**
2 yrs	51	35					**86**
3 yrs	30	29	11				**70**
4 yrs	22	17	11	5			**55**
5 yrs	16	20	4	2	0		**42**
6 yrs	9	7	3	3	2	0	**24**
7 yrs	16	14	7	4	1	2	**44**
8 yrs	11	8	9	3	3	0	**34**
9 yrs	9	7	3	1	0	0	**20**
10 yrs	8	7	2	1	1	0	**19**
11 yrs	18	5	4	1	0	0	**28**
12 yrs	15	3	0	0	1	0	**19**
TOTAL	**363**	**152**	**54**	**20**	**8**	**2**	**599**

3.2.2 Volunteer Recruitment, Training & Support

The training schedule consists of at least 13 evening training courses per year. The courses are usually organised in conjunction with Heritage Officers, Biodiversity Officers, NPWS education units, National Parks, local environmental and community groups and other government agencies (e.g. NPWS and NIEA staff). As a consequence, the training events have developed into a regular feature of the summer calendar events for Heritage Officers and Biodiversity Officers' education programmes. Since 2006, a total of 167 training courses have been organized and have provided training for over 2,500 people.

Heterodyne bat detectors are loaned to volunteers teams, where required. Since 2006 180 bat detectors have been purchased by BCIreland for volunteer teams participating in the All Ireland Daubenton's Bat Waterways Scheme. The models purchased by BCIreland tend to be cheaper models available on the market.

In 2017 a YouTube training video was produced to assist new volunteers and the weblink to this was emailed to all participating volunteer teams

- https://www.youtube.com/watch?v=Dwh66QHqlM4

During the 2017 survey season, this training video was viewed 144 times.

The BCIreland Facebook page was used from 2015 to 2017 to communicate training courses, training dates and ongoing progress with Facebook users and surveyors. The training video was also uploaded to this Facebook page.

3.2.3 Bat Detector Models

Volunteer teams are asked to provide details of the type of bat detector they use. Detector models have changed considerably since 2006 (Figure 24). In the early years BCIreland purchased Magenta III detectors while detectors more recently purchased for this scheme are Magenta 4 models. As a result, the detector model most frequently used by volunteer teams tends to be the models loaned out by BCIreland. Therefore, in the early years, Magenta Mark III was the most used bat detector model but this was replaced by Magenta Bat 4 detector from 2011 onwards, while Stag Electronics Bat Box III detector or Bat Box 3D detector (in later years) has been consistently used throughout the monitoring period (Figure 24).

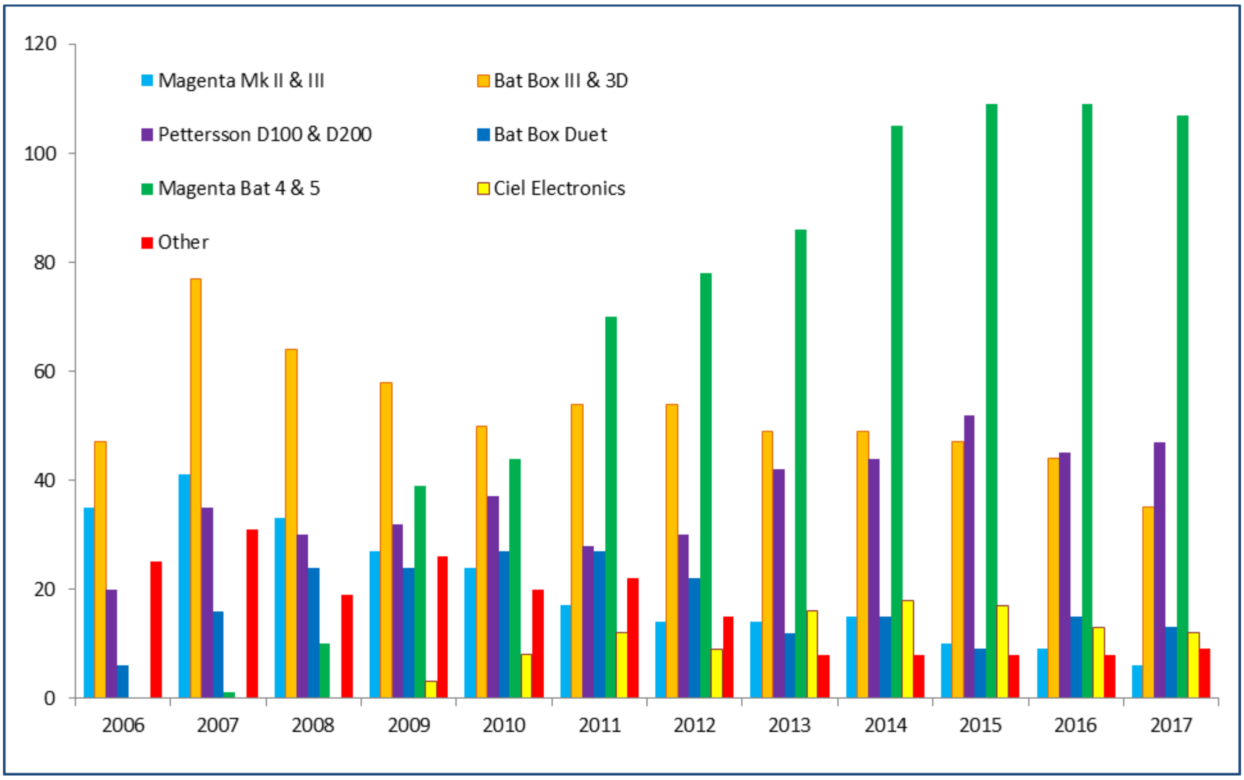

Figure 24 Percentage of detector model type used by survey teams for each year of the 2006-2017 monitoring period.

3.2.4 Waterway Sites Surveyed

A total of 599 waterway sites were surveyed across the island from 2006 to 2017 (Table 11 and see Appendix 2 for a full list of all of the waterway sites surveyed to-date). Ninety three of the waterway sites surveyed are located in Northern Ireland and 506 are located in the Republic of Ireland (Figure 25). The greatest number of waterway sites surveyed over the 12 years are located in the province of Leinster (n=244) while the highest number of waterway sites per county are found in County Cork (n=45) (Figure 26).

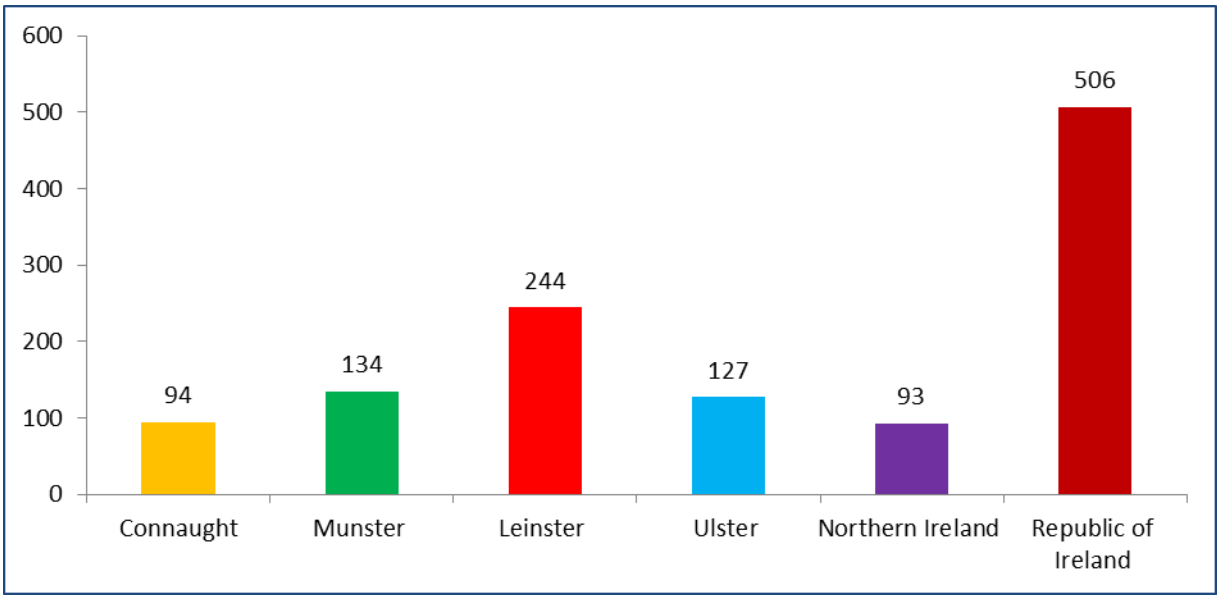

Figure 24 Total number of waterway sites surveyed in 2006-2017 in each province and country.

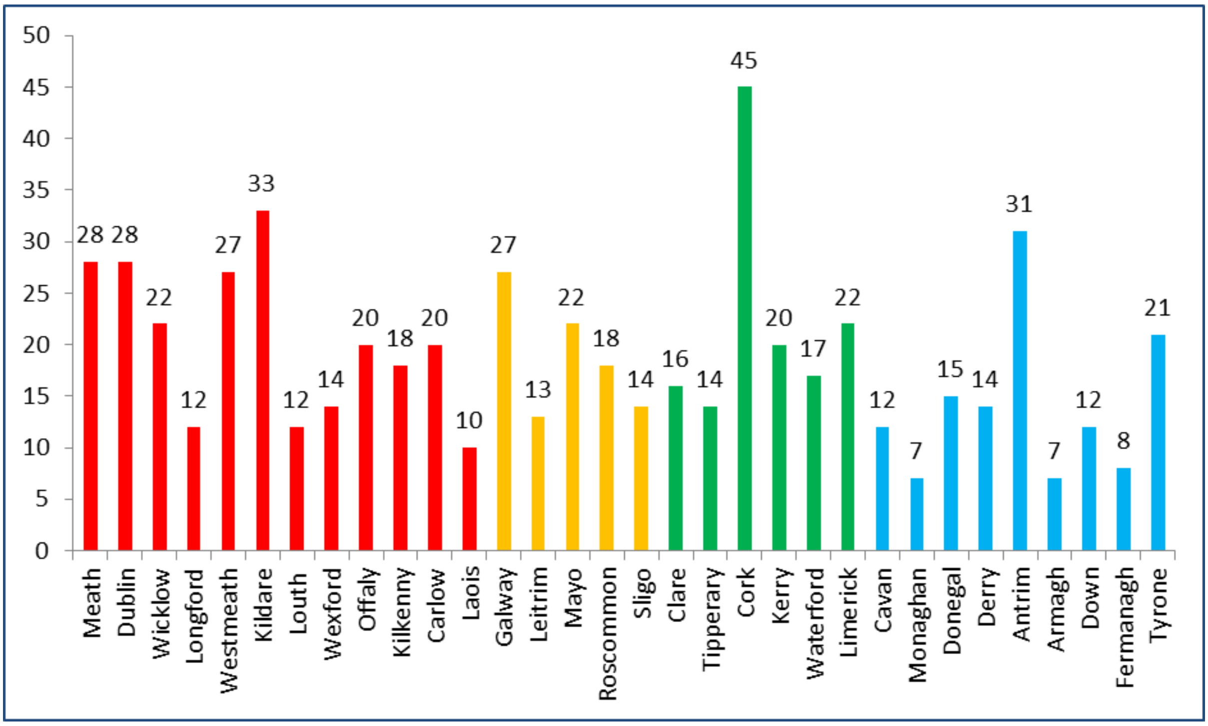

Figure 25 Total number of waterway sites surveyed in 2006-2017 in each county across the island.

A total of 84 waterway sites are along canals, four waterway sites are along channels and 511 waterway sites are along rivers (Figure 26). Lake shores and coastlines are not included in this monitoring scheme. Sites are located along 307 discrete waterways; 21 canals, 3 channels and 283 rivers. Multiple Daubenton's waterway sites may be situated at different locations along the same river. For example, the Royal Canal and Grand Canal have 27 and 28 surveyed waterway sites, respectively while the rivers Boyne, Shannon and Barrow have 16 waterway sites each.

Table 11 Total number of waterway sites surveyed per year according to province and country for the duration of the monitoring scheme 2006-2017.

Year	Connaught	Munster	Leinster	Ulster	Northern Ireland	Republic of Ireland	**Total**
2006	27	35	53	19	14	120	**134**
2007	31	42	103	26	20	182	**202**
2008	29	38	77	37	31	150	**181**
2009	30	46	89	44	35	174	**209**
2010	30	40	96	48	36	178	**214**
2011	33	48	97	54	46	186	**232**
2012	32	46	95	47	36	184	**220**
2013	26	46	109	47	34	194	**228**
2014	36	46	113	60	36	219	**255**
2015	40	56	103	51	36	214	**250**
2016	36	56	103	50	32	213	**245**
2017	29	54	101	44	33	196	**229**

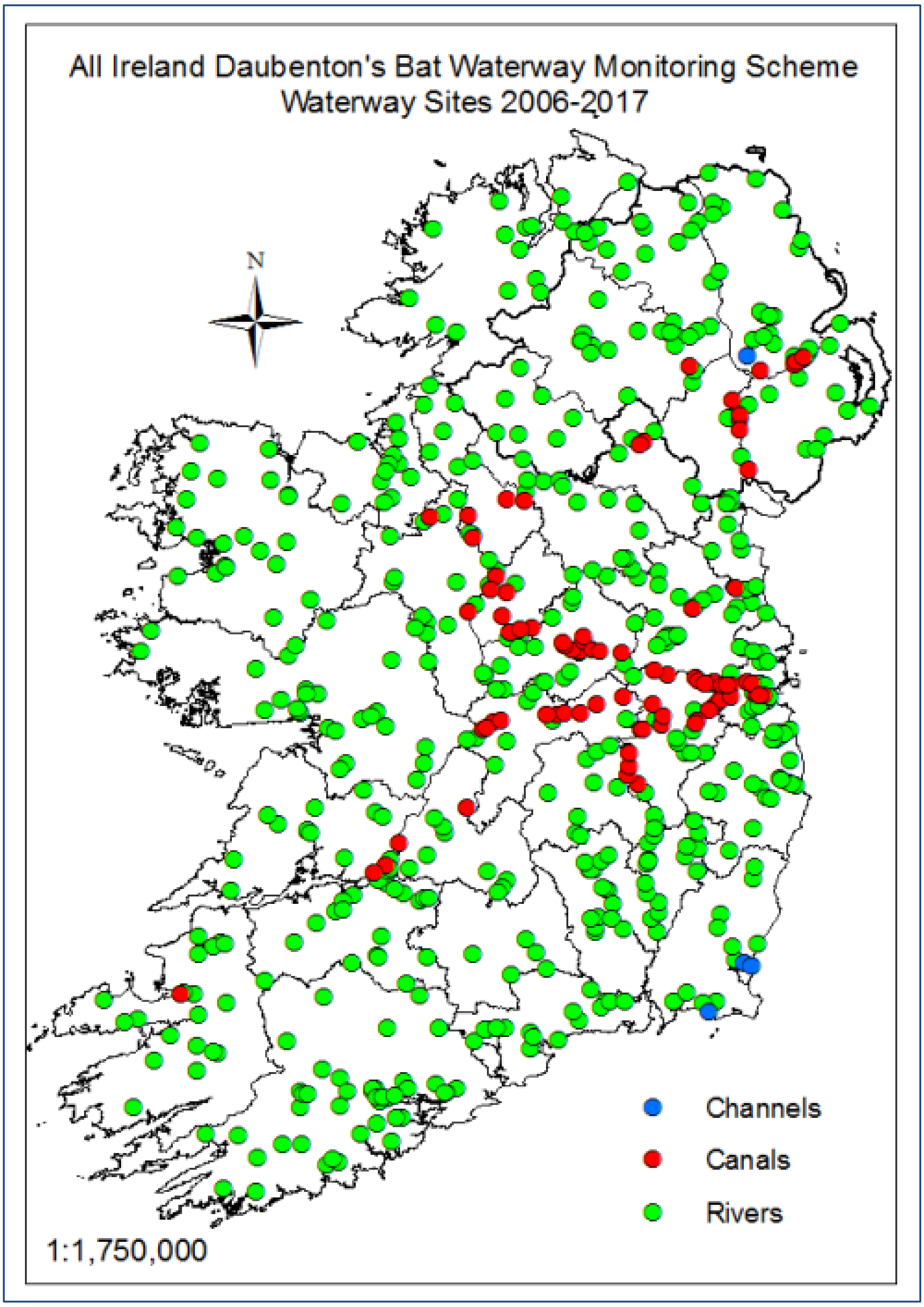

Figure 26 Location of waterway sites surveyed in 2006-2017 in each county and according to type of waterway.

The highest number of waterways sites surveyed in any one year for Northern Ireland was in 2011 (n=46) and for Republic of Ireland was in 2014 (n=219). Overall, the highest number of waterway sites surveyed in a particular year was in 2014 (n=255).

Of the 599 waterway sites surveyed, only 6.4% (n=19) were surveyed for all twelve years while 26.4% (n=158) of waterway sites were surveyed only once (Figure 27).

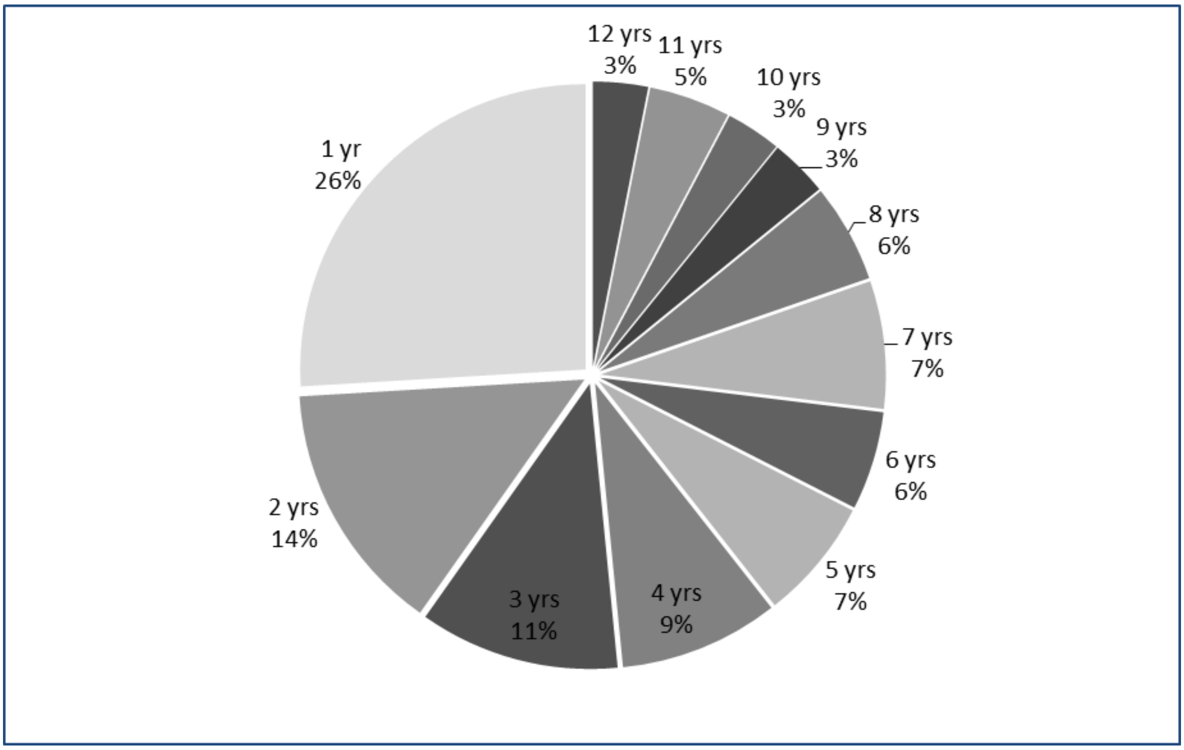

Figure 27 Number of years each waterway site was surveyed in 2006-2017 monitoring period.

During the 12 years of monitoring, Daubenton's Bat 'passes' were recorded on 85.5% (n=512) of the waterways sites surveyed (Figure 28).

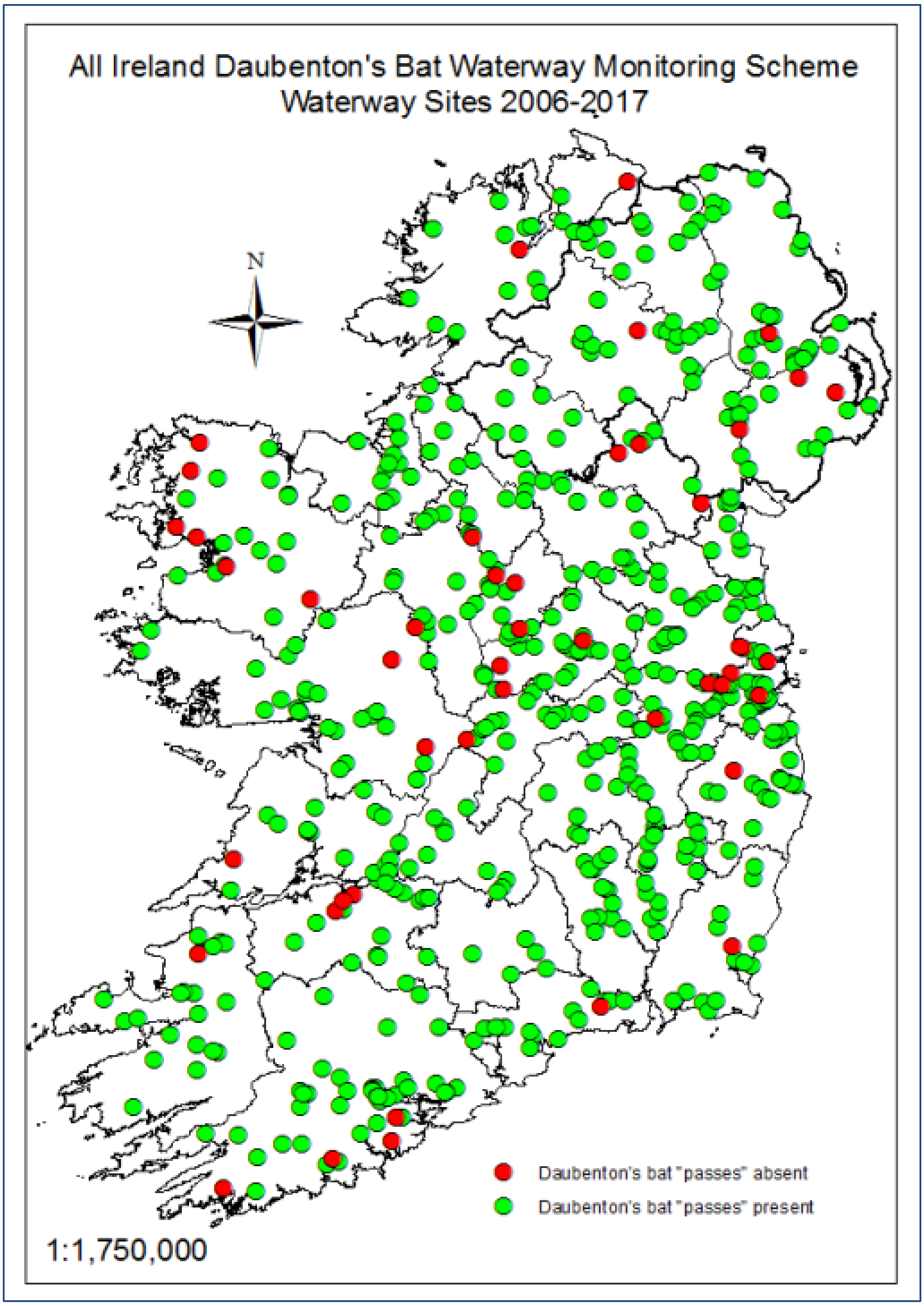

Figure 28 Location of waterway sites where Daubenton's Bat 'passes' were recorded during at least one survey in the 2006-2017 monitoring period.

However, 132 (25%) of these positive sites were only surveyed for one year during the monitoring period (see Figure 29). For those waterway sites positive for Daubenton's Bat and surveyed for two years or more, 77 waterway sites had at least one survey year where Daubenton's Bat 'passes' were not recorded (see Figure 29). Two hundred and eighty-one waterways sites surveyed for two years or more had Daubenton's Bat recorded consistently during each survey year.

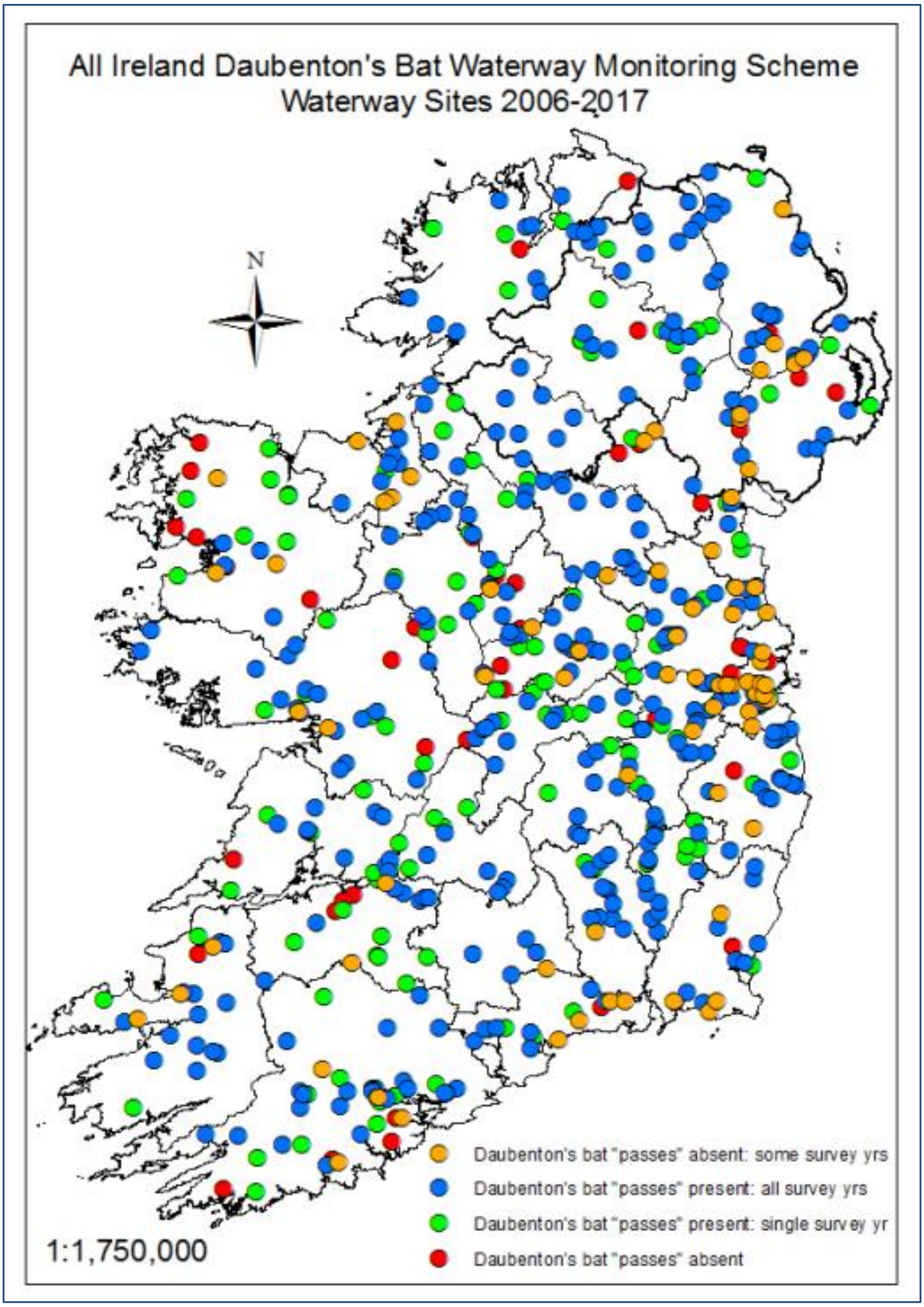

Figure 29 Location of waterway sites where Daubenton's Bat 'passes' were recorded during 2006-2017 monitoring period.

Of the 47 waterway sites where no Daubenton's Bat 'passes' were ever recorded during the survey period, nine of these are along canals and the remainder are along rivers. The majority of these waterway sites were, however, only surveyed once during the monitoring period 2006-2017 (n=27, 66%) and two of these for the first time in 2017.

3.2.5 Number of Completed Surveys

The highest number of surveys was completed in 2014 (n=473 surveys) (Table 12). Overall, 4,729 surveys were returned to BCIreland for the 2006-2017 monitoring period and this amounts to 3,152 hours and 40 minutes of observation time (four minutes per survey spot, 10 survey spots= 40 minutes per survey). Survey teams were requested to complete two surveys, if possible, per year as this provides more robust data for monitoring. The month of August was split into two sampling periods: Survey 1 (1 August to 15 August) and Survey 2 (16 August to 31 August). Of the completed surveys, 1,572 were repeats (i.e. both Survey 1 and Survey 2 were completed - 91.5%). The year with the highest proportion of repeat surveys was 2007 (95% of waterway sites with repeat surveys for that year).

Table 12 Total number of completed surveys for the duration of the monitoring scheme 2006-2017.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
S1 & S2	122	185	133	171	193	179	183	187	221	213	197	181
Single Survey	12	17	47	37	19	51	37	40	31	37	48	48
TOTAL	**256**	**387**	**313**	**379**	**405**	**409**	**403**	**414**	**473**	**463**	**442**	**410**

In total, 256,476 bat passes were recorded from all completed surveys 2006-2017, 82.6% of which were noted as 'Sure' Daubenton's Bat passes (Table 13). The proportion of 'Unsure' Daubenton's Bat passes was highest in 2006 (33%) when the scheme first started and lowest in 2009 and 2015 (15%).

Table 13 Total number of bat passes recorded for the duration of the monitoring scheme 2006-2017.

Year	Sure Daubenton's Bat pass	Unsure Daubenton's Bat pass	TOTAL	% of Unsure of Total No. of bat passes
2006	11,985	5,916	17,901	33%
2007	15,951	3,971	19,922	20%
2008	11,735	2,173	13,908	15.6%
2009	17,018	2,998	20,016	15%
2010	20,775	3,731	24,506	15.2%
2011	20,828	3,899	24,727	15.8%
2012	17,866	3,922	21,788	18%
2013	17,409	3,426	20,835	16.4%
2014	18,508	3,844	22,352	17.2%
2015	19,558	3,452	23,010	15%
2016	20,635	3,826	24,461	15.6%
2017	19,492	3,558	23,050	15.4%
TOTAL	**211,760**	**44,716**	**256,476**	**17.4%**

The mean number of 'Sure' Daubenton's Bat passes recorded for all 12 years was 44.9 per survey with the highest mean recorded in 2010 (51.7 'Sure' Daubenton's Bat passes per survey). The province of Connaught shows a consistently high mean number of 'Sure' Daubenton's Bat passes (All years: 56 'Sure' Daubenton's Bat passes per survey) (Figure 30). The percentage of surveys with bat 'passes' recorded for all nine years was 92.5% while the province of Munster had the highest percentage of surveys with bat passes (All years: 93%) compared to all other provinces. A full breakdown of these statistics is presented in Appendix 2.

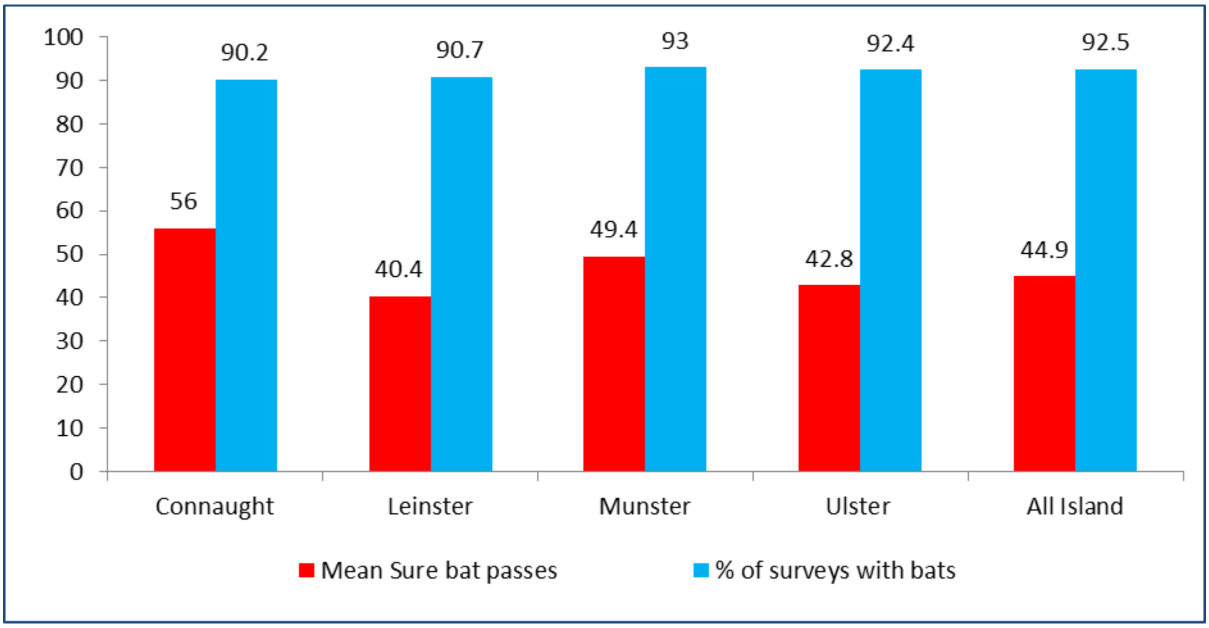

Figure 30 Mean number of 'Sure' Daubenton's Bat passes per survey in each province and for the island and percentage of surveys with bats in the 2006-2017 monitoring period.

3.2.6 Trend Analysis 2006-2017

To assess trends, a Poisson Generalised Linear Model (GLM) was applied to the data with the results expressed as an index and 2007 used as the base year. Just one of the models is reported here, the model that includes both sure and unsure and with the maximum number of passes set to 48 with covariates. This particular model is chosen to facilitate comparison with British data from the BCT. Data from a total of 430 waterway sites that were surveyed for two years or more are included in this analysis. Waterway sites only surveyed for one year do not contribute to information on trends and are therefore omitted.

Bat counts (bat passes) were relatively low in from 2012 to 2014, with the result that a downward trend first noted in 2011 continued till 2014. However a recovery was then noted in 2015. Results for the Poisson GAM models confirmed that the upward trend reported in 2015 continued in 2016 and 2017. The smoothed 2017 value is significantly above the 2007 baseline value. Even when unsure passes are included, the 2017 smoothed line is very nearly significantly different to the baseline (dotted line only just below 100). There is a very obvious sinusoidal pattern to the trend (Figure 31).

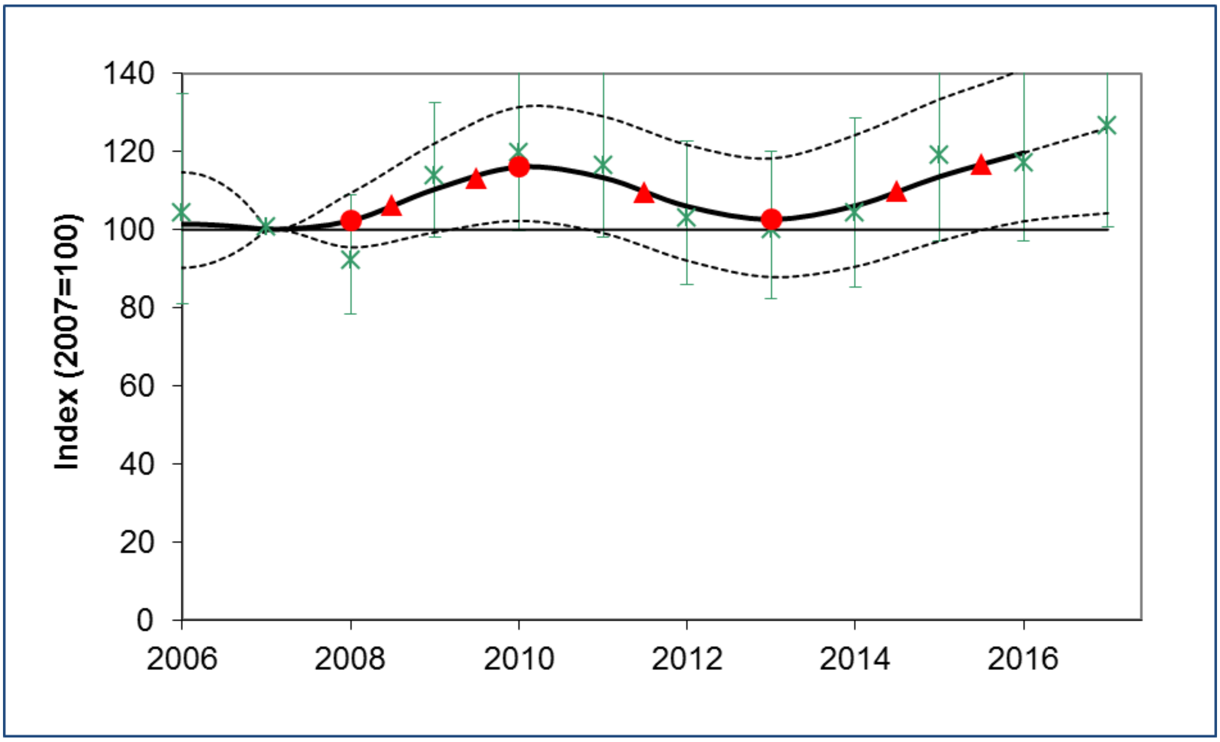

Figure 31 All Ireland results of Poisson GAM model (max 48 'sure' and 'unsure' passes) with 95% confidence limits. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 14 Poisson GAM results with 95% confidence limits for Daubenton's Bat (2006-2017). Covariates include survey start time, surveyor skills and degree of smooth water as recorded by survey teams.

		Index 2007 = 100							
		Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	Sites	Index	s.e.	Lower	Upper	Fitted	s.e.	Lower	Upper
2006	106	101.40	6.35	90.22	114.68	103.62	13.78	80.08	134.12
2007	164	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	164	102.28	3.63	95.45	109.37	91.24	7.46	77.76	108.15
2009	179	110.33	5.78	99.29	122.08	113.17	8.84	97.41	131.82
2010	199	116.00	7.36	102.27	131.37	118.93	11.12	98.81	142.22
2011	207	113.31	7.70	99.11	128.97	115.81	11.05	97.17	140.45
2012	207	105.96	7.49	92.05	121.69	102.12	9.07	85.16	121.78
2013	213	102.61	7.82	87.85	118.21	99.27	9.68	81.57	119.40
2014	228	106.11	8.61	90.53	124.23	103.67	10.72	84.50	127.70
2015	229	113.57	9.33	97.06	133.37	118.15	12.23	96.21	144.32
2016	226	119.66	10.03	102.13	141.34	116.44	11.25	96.47	141.01
2017	199	126.07	13.10	104.20	154.64	125.88	15.36	99.78	161.84
TOTAL	**430**								

Based on the Poisson model with covariates, Daubenton's Bat has fluctuated over the duration of the monitoring scheme. The smoothed trend indicates a total increase of 26.07%, which represents a yearly increase of 2.34% (baseline year is 2007). The increase is close to significant since the lower confidence interval is just above the 100 baseline.

Using the Poisson model an exploratory analysis using geographically weighted regression suggested that the change from 2007 to 2017 was more positive in the northern part of the island, an area roughly corresponding to Northern Ireland and the north of Donegal. Fitting separate trends to Northern Ireland and the Republic of Ireland confirms that the 2017 level is significantly above the 2007 baseline for Northern Ireland, despite the wide confidence limits resulting from the relatively small sample size (Figure 32). By contrast, the trend for the Republic of Ireland is slightly increasing, but is not significantly higher than the baseline value (Figure 33). However, a randomisation test indicates that the difference between the two countries is not statistically significant (P=0.230).

Based on the Poisson model with covariates, Daubenton's Bat in Northern Ireland has gone from stable to increasing to slightly decreasing to increasing again over the duration of the monitoring scheme. The smoothed trend indicates a total increase of 87.35%, which represents a yearly increase of 6.48% (baseline year is 2007). The increase is considered to be significant since the lower confidence interval is above the 100 baseline. However caution is required as the error bars are wide.

Based on the Poisson model with covariates, Daubenton's Bat in the Republic of Ireland has a less obvious sinusoidal pattern to the trend compared to both the All Ireland trend and the Northern Ireland trend. The smoothed trend indicates a total increase of 10.91%, which represents a yearly increase of 1.04% (baseline year is 2007).

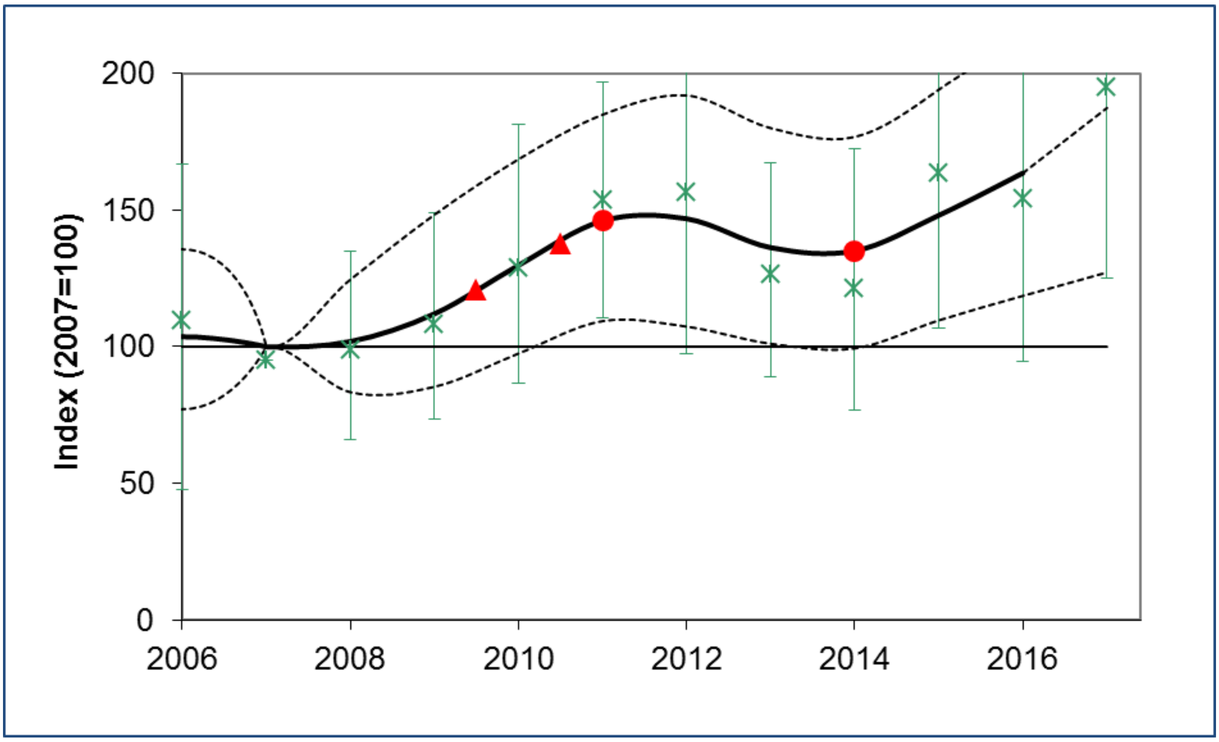

Figure 32 Northern Ireland Poisson GAM model with 95% confidence limits. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 15 Northern Ireland Poisson GAM results with 95% confidence limits for Daubenton's Bat (2006-2017). Covariates include survey start time, surveyor skills and degree of smooth water as recorded by survey teams.

		Index 2007 = 100							
		Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	Sites	Index	s.e.	Lower	Upper	Fitted	s.e.	Lower	Upper
2006	10	103.66	15.31	77.17	135.66	114.76	30.96	52.71	172.07
2007	13	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	25	101.93	10.33	83.40	124.58	103.71	18.35	71.20	140.16
2009	30	112.07	16.16	85.38	148.32	113.19	18.54	78.65	154.13
2010	35	129.81	18.83	97.56	168.57	134.13	25.47	91.96	186.44
2011	39	146.07	19.18	109.41	184.89	158.60	22.29	115.74	201.92
2012	33	146.84	20.63	107.38	191.92	161.51	26.95	102.46	208.64
2013	30	136.28	19.52	101.12	179.97	131.49	20.66	94.01	172.31
2014	33	135.08	19.80	99.44	176.74	126.62	24.79	81.92	177.57
2015	33	148.09	22.60	109.69	194.04	168.46	32.71	111.78	242.09
2016	31	163.53	26.54	118.63	220.16	159.08	27.81	99.75	214.63
2017	31	187.35	40.45	127.18	280.35	200.16	44.16	130.01	300.69
TOTAL	**71**								

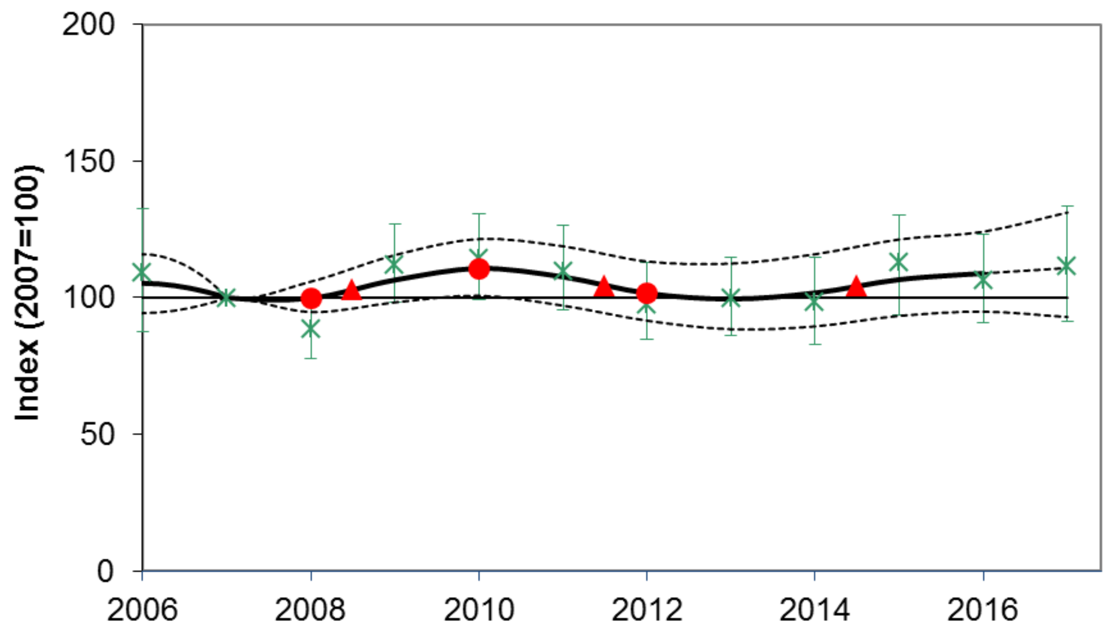

Figure 33 Republic of Ireland Poisson GAM model with 95% confidence limits. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 16 Republic of Ireland Poisson GAM results with 95% confidence limits for Daubenton's Bat (2006-2017). Covariates include survey start time, surveyor skills and degree of smooth water as recorded by survey teams.

Index 2007 = 100

		Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	Sites	Index	s.e.	Lower	Upper	Fitted	s.e.	Lower	Upper
2006	96	105.50	5.40	94.39	115.93	109.46	11.71	87.77	132.75
2007	151	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	140	99.87	2.83	94.80	105.92	88.54	5.81	77.92	101.22
2009	149	106.50	4.36	98.35	115.63	112.06	7.61	98.48	127.21
2010	164	110.73	5.23	100.78	121.47	114.62	7.90	99.75	130.80
2011	168	107.65	5.44	97.13	118.86	110.02	7.66	95.68	126.69
2012	174	101.65	5.54	91.63	113.29	97.65	7.18	85.21	113.09
2013	183	99.56	6.00	88.49	112.51	100.22	7.41	86.29	114.92
2014	194	101.81	6.68	89.55	115.95	98.73	8.38	83.33	115.20
2015	196	106.66	7.12	93.41	121.35	113.05	9.43	93.83	130.65
2016	195	108.95	7.60	94.93	124.18	106.50	8.56	91.27	123.50
2017	171	110.91	9.71	92.99	131.21	111.64	10.99	91.34	133.89
TOTAL	**359**								

Binomial GAM modelling was completed using the percentage of survey spots with bats present. The response variable in the analysis is, for example, 0.7 if Daubenton's Bat passes (both 'Sures' and 'Unsures' bat passes combined) were observed at seven of the ten survey spots. A similar modelling approach to that for the counts was followed, with bootstrapping used to find standard errors, but this time logistic regression (a GLM with a logit link function) rather than a Poisson GLM was used. Results of the binomial model with covariates for All Ireland are shown in Figure 34 and Table 17. A smoothed GAM trend was also applied to the results. The results also suggested a series of decreases and increase similar to the Poisson model (Figure 31) but changes are subtler and quite small relative to the width of the confidence limits and must, therefore, be treated with caution. Based on the binomial model with covariates, over the duration of the monitoring scheme Daubenton's Bat can be considered to have gone from stable or slightly decreasing in the early years of the monitoring scheme to increasing in the latter years with the smoothed estimate having increased by 11.47% since the baseline year of 2007. This represents a yearly increase of 1.09%. Like the Poisson model, the increase is close to significant since the lower confidence interval is just above the 100 baseline.

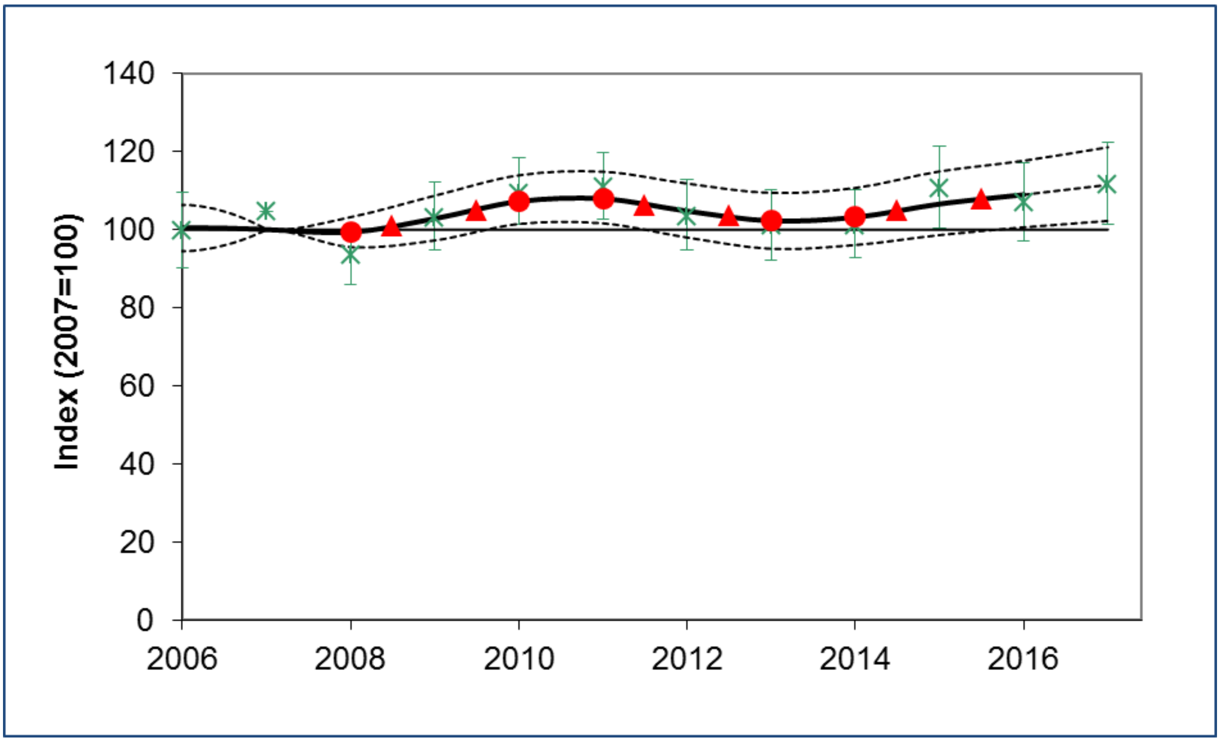

Figure 34 All Ireland results of Binomial GAM model with 95% confidence limits. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 17 Binomial GAM results with 95% confidence limits for Daubenton's Bat (2006-2017). Covariates include survey start time, surveyor skills and degree of smooth water as recorded by survey teams.

		Index 2007 = 100							
		Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	Sites	Index	s.e.	Lower	Upper	Fitted	s.e.	Lower	Upper
2006	108	100.48	3.03	94.46	106.35	95.15	5.10	85.35	104.89
2007	168	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	167	99.33	1.92	95.54	103.20	88.77	3.82	81.23	96.55
2009	186	102.82	2.82	97.24	108.70	98.34	4.45	90.12	107.63
2010	200	107.20	3.21	101.45	113.91	104.50	4.33	96.69	113.58
2011	208	107.9	3.43	101.60	114.82	106.01	4.45	97.79	114.87
2012	209	104.73	3.54	97.96	111.79	98.46	4.56	90.02	108.07
2013	214	102.24	3.66	95.09	109.39	96.26	4.59	87.60	105.61
2014	230	103.16	3.81	96.07	110.68	96.21	4.49	88.11	105.50
2015	231	106.56	4.09	98.61	114.90	105.87	5.19	95.79	116.57
2016	229	108.94	4.30	100.59	117.62	102.19	5.06	92.54	112.55
2017	203	111.47	4.75	102.24	121.08	106.85	5.27	96.59	117.66
TOTAL	**432**								

3.2.7 Relationship with Other Variables 2006-2017

To investigate the impact of covariates on the probability of observing bats at a survey spot, a binomial model was applied to the data (2006-2017). Results are based on a model containing terms for waterway width, smooth water, survey start time after sunset, temperature, time taken to complete the survey and rain plus terms for survey experience, model of bat detector used and day number in year (survey date).

Surveyors are asked to record data on a number of parameters including to estimate the width of the waterways, determine the percentage of smooth water according to three categories (none or up to 50% or greater than 50%), note the time the survey is started at and finished at, air temperature at the start of the survey, weather conditions for three parameters according to three categories (Wind: calm or light or breezy; Cloud: clear or patchy or full and Rain: dry or drizzle or light rain), determine their bat identification skills (Poor or Ok or Good or Very Good) and record the length of field experience using a bat detector (Less than 1 yr or 2-3 yrs or >3 yrs).While the model is a complex one, two parameters, in particular, show signs of influencing the percentage of survey spots where bat passes were detected: observer experience and detector model type.

The data show signs of a positive association between the proportion of survey spots with bats present and observer experience. However, the model estimates, adjusting for the other factors in the model, suggest the reverse, with the percentage of spots with bats highest for observers with one year or less of experience. If a model is fitted to “Sure” Daubenton’s Bat passes only experience is not significant, but ID skills are, with observers rating their skills highly (i.e. very good) observing sure passes at a higher proportion of spots.

Table 18 Results of Binomial model for the percentage of survey spots with bats present: observer experience (F=3.19 with 4 and 1800 d.f., P=0.013).

Surveyor experience	No. of surveys	Raw Data		Model Estimates		
		% with spots	s.e.	logit	s.e.	% with
Less than 1 year	597	54.9%	0.64	0.51	0.113	62.5
1 year	605	57.6%	0.64	0.51	0.116	62.5
2-3 years	916	60.4%	0.51	0.40	0.115	59.8
>3 years	2184	56.8%	0.34	0.25	0.116	56.2
Not noted	8	53.7%	5.58	0.03	0.784	50.9

In relation to the different bat detector models used the overall F-test is close to significant (P=0.091) indicating that the type of bat detector model used may influence the rate of bat passes detected.

Table 19 Results of Binomial model for the percentage of survey spots with bats present: bat detector model (F=1.58 with 12 and 2000 d.f., P=0.091).

Surveyor experience	No. of surveys	Raw Data		Model Estimates		
		% with spots	s.e.	logit	s.e.	% with
Bat Box III	896	58.8	0.52	0.23	0.119	55.6
Bat Box Duet	363	58.4	0.82	0.21	0.147	55.2
Bat Box IIId	245	65.0	0.96	0.11	0.161	52.7
Ciel Electronics	208	53.0	1.09	0.05	0.168	51.3
Magenta Bat 4	999	59.1	0.49	0.25	0.116	56.2
Magenta Bat 5	258	58.8	0.97	0.42	0.165	60.3
Magenta Mk II	77	63.9	1.73	0.27	0.266	56.8
Magenta Mk III	328	61.4	0.85	0.37	0.148	59.1
Mini-3	69	33.6	1.80	0.60	0.230	64.5
Petersson D230	44	74.5	2.05	0.37	0.336	59.1
Petersson D240x	112	60.4	1.46	0.09	0.197	52.2
Pettersson D100	336	50.1	0.86	0.08	0.155	52.1
Pettersson D200	375	48.8	0.82	0.07	0.135	48.3

3.2.8 Oral and Poster Presentations

The following conference presentations were completed using data collated from the All Ireland Daubenton's Bat Waterways Surveys:

1. 14th European Bat Symposium 2017

   Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

2. Inaugural Irish Ecological Association Ecology & Evolution Conference 2016

   Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

3. All Ireland Mammal Symposium 2015

   Oral Presentation Title: Population trends of Irish bat species.

3.2.9 Data Handling

Each year following analysis, data from the All Ireland Daubenton's Bat Waterways Survey MySQL database is synchronised with the Bat Conservation Ireland Bat Records Database to ensure that the data becomes widely available when uploaded to the NDBC website.

Data for Northern Ireland is also issued to the BCT for their analysis and to CeDAR for their database.

3.2.10 Additional Wildlife Records

Approximately 80 additional records of other species of wildlife, including otters, owls, foxes etc. are submitted annually by the surveyors. These are currently the subject of a paper in preparation on the value added by citizen scientists participating in monitoring programmes.

4 Brown Long-eared Roost Monitoring

The Brown Long-eared Roost Monitoring Scheme is a project funded by The National Parks and Wildlife Service (NPWS) of the Department of Culture, Heritage and Gaeltacht, Republic of Ireland. This scheme aims to be the primary tool for monitoring Brown Long-eared Bat in the Republic of Ireland. This monitoring protocol was devised and piloted by BCIreland in 2007 and has been managed by BCIreland since then.

This report presents results for the first eight years (2007-2017) of Brown Long-eared Bat (*Plecotus auritus*) monitoring in the Republic of Ireland and follows earlier reports produced by BCIreland (Aughney *et al.*, 2011).

4.1 Method

4.1.1 Survey Methods

Roosts deemed suitable for the monitoring scheme are monitored yearly by either Internal counts (2 counts) or External Emergence Dusk Counts (2-3 counts) during the specified survey periods (see Appendix 3). In general, buildings with no access to the roof space are surveyed by Emergence Dusk Counts only. Buildings with exit points too high to clearly see emerging bats (i.e. greater than two floors high) are monitored using Internal Counts if the roof space is accessible. Not all individual Brown Long-eared Bats leave the roost site every night, especially during poor weather conditions (Entwistle, Racey, & Speakman, 1996) therefore internal validation is completed post emergence survey where possible. Buildings with both access to roof space and visible exit points are assessed by whichever method can be used with greatest ease and that results in reliable roost numbers.

Dates for survey periods are as follows: Survey 1: 16 May to 15 June; Survey 2: 16 June to 31 July & Survey Period 3: 1 August to 30 August. Volunteer survey teams are encouraged to adhere to these survey dates, where possible. Internal counts are undertaken by a licensed surveyor and counts are completed during the day using a red-light torch. The entire internal space of the roost is examined and individual Brown Long-eared Bats are counted. Emergence Dusk Surveys are completed using bat detectors with surveyors located at all known exit points from the roost. Surveys begin 20 minutes after sunset and continue until no bats exit the building for a full ten minutes of surveying. On completion of surveys, survey forms are returned to BCIreland for analysis and reporting.

4.1.2 Methodology Changes

On the first year of the survey, 2007, surveys began 30 minutes after sunset. As a result of statistical analysis and surveyor feedback expressing the likelihood of missing early emerging bats, the start time was changed to 20 minutes after sunset from 2011. This change to the survey methodology is taken into account in the statistical analysis.

4.1.3 Statistical Analysis

The effects of Northings and Eastings, day number (i.e. survey date), weather data, start time, and internal/external counts were examined using a Generalised Linear Mixed Model (GLMM). To assess trends a Generalised Linear Model (GLM), with confidence limits based on bootstrapping at the site level, was applied to the 2007-2014 data. To allow for differences between Internal Counts and external Dusk Emergence Counts, and between the different survey periods (S1, S2 and S3), all counts for roosts monitored for at least two years, are included in the model. The trend was smoothed using GAM smoothing and the yearly estimates were expressed as an index with 2008 as the base year. The models use a negative binomial distribution, rather than the Poisson distribution previously used (and as used for the GLMM), as it fitted the data better and gave slightly more precise results. The models were completed with and without covariates for drizzle/rain, for internal counts before mid-May and for external counts after mid-September.

The relationship between bat counts and emergence times was explored by adding the emergence time variables to over-dispersed Poisson GLMMs for the number of bats counted. The GLMM model included random terms for roosts and years within roosts, and fixed terms for years, survey period and rain. The effect of meteorological variables on emergence times was estimated using a Restricted Maximum Likelihood (REML) model, again with random terms for roosts and years within roosts.

4.1.4 Additional Technology

Sony HandyCam FDR-AX33 and FDR-AX53 cameras with night-shot capability along with infrared illuminators (30° and 60° spread, two of each type) were deployed to assist with emergence surveys in 2016 and 2017. The camcorder was positioned on a tripod (1.5m high) while the IR illuminators were erected on a separate tripod (1m high, two per roost site). Illuminators (2 units per survey) were shone onto the building in the general vicinity of known exit points. Filming started 20 minutes after sunset and the 10 minute intervals were marked by vocalising "10 minutes" during recording session to aid counting post filming with reference to Emergence Count surveys undertaken simultaneously. Recordings were saved on SD Cards (64MB) and filming was completed in high resolution to aid counting. Recordings were analysed post surveying.

4.1.5 Radio Tracking

Telemetry (radio-tracking) is defined as any method of obtaining information on free-ranging animals by remote means but is more often associated with the use of radio tags. The first telemetry studies were completed on Brown Long-eared Bats in the early 1990s when radio tags were finally light enough to be used on bats (0.65 g Holohil tags). But advances in technology means that even smaller tags are now available with reasonable long-life to enable telemetry studies.

A transmitter consists of circuitry, a battery and an antenna. The size of the battery is crucial to the weight. A pulse is emitted via the antenna in a narrow frequency range that can be picked up with radio receivers.

A radio tracking project was carried out in north-west Ireland in July and August 2017. Radio tracking on Brown Long-eared Bats was completed using BioTrack Sika receivers (four units) set to 148-152 MHz and Yagi antennas (four units). All of the receivers were checked in June 2017. One receiver was sent to BioTrack to be set to 148-152 MHz range as it was set for the UK setting of 170-174MHz. A training course was organised for 16 July 2017 for the radio tracking team to familiarise themselves with the equipment and to undertake a full equipment check.

Ten Biotrack PicoPip Ag337 (battery) transmitters (maximum weight: ~0.3 g) were purchased from Biotrack and set for the 148-152 MHz (pulse length: 21, mode pulse rate: 50), with 20cm antenna length and battery life for approximately 10 days.

Individual bats were hand netted from three roosts. All bats caught were weight, aged and sexed. Adult male and female bats were selected based on weight, condition and forearm length to ensure that the heavier (tags to be less than 5% of the body weight of the bats), healthiest and strongest bats were chosen to carry the transmitters. Wing membranes were examined to ensure that there were no tears or holes and parasite loading of individuals was checked to ensure the health of the individual bats.

Once the bat was caught and selected for tagging, it was held in a cotton bag and removed from the roost and the cotton bag was hung in a parked vehicle for processing. Transmitters were attached between the shoulder blades (mid-dorsally) of individual bats using Torbot Skin Bond latex adhesive. Using an adhesive is considered to have the advantage of causing the least amount of stress to the bat and it also adds little weight to the overall tag. The transmitter was mounted with the antennae pointing backwards. Tagging was undertaken away from the roost in order to minimise disturbance to the colony. The tagged bat was either returned to the roost post-tagging to reduce stress or released directly outside the roost structure.

The frequencies of the transmitters were loaded into the receivers and stored on individual channels. Each receiver was loaded with all of the active transmitter's frequencies for the appropriate tagging period (e.g. three active transmitters for Period 1).

Radio-tracking was undertaken using a combination of "searching" and triangulation. Field work was undertaken from dusk to dawn, where weather conditions were suitable. At the start of each night, the tagged bats were located and field work started from these locations. If the tagged bats did not return to main roost at dawn, a search was undertaken during the daytime to locate its night roost. The frequency of each individual active transmitter was checked prior to a night's field work and if drifting of the transmitter frequency was noted, the frequency value of the transmitter was corrected to the new value. The bats, on emerging from the roost, were followed on-foot or by car and their foraging locations were recorded using a hand held GPS unit. Aerial photographs and OS Discovery Series maps were used to mark locations of the individual bats.

4.1.6 Habitat Mapping & Roost Profiles

For five roosts currently in the monitoring scheme were selected to represent the different types of buildings monitored, their locations were digitised and concentric circles were created at 0.5 km radius from the roost and at a distance of 2.5km radius using ArcView GIS 9.2 to determine the extent of woodland cover within each radius. Forest information from the NPWS Native Woodland Inventory (NWI) and the Forest Service Forest Information Planning Service (FIPS) datasets were used. FIPS data includes scrub and woodland blocks >0.5ha. Native Woodland Survey data includes areas of native woodland >1ha. Within 0.5 km radius of the roosts, tall vegetation categories such as hedgerows, treelines, small woodlands and parkland trees were digitised using aerial photographs to determine their total cover.

Information was collated in relation to the structure of the five roosts including age, wall construction, roofing material etc. Together with the broad habitat information, a roost profile was compiled. The five roosts are representative of the different types of buildings survey for Brown Long-eared Bats i.e. churches and large buildings.

4.2 Results

4.2.1 Volunteer Participation 2007-2017

Volunteer teams are a vital component of the monitoring scheme and support is provided by on-site training whereby the scheme co-ordinator and new volunteer teams complete the first count together. Bat detectors and torches are also provided by BCIreland, where required. In addition, the co-ordinator accompanied some volunteer team counts during the first survey of each new monitoring year to provide continued support, when requested. The number of volunteer teams participating annually varied from year to year. For example, forty-seven structures were surveyed in 2017, 33 of which were monitored by volunteer teams and/or roost owners. In total, 40 volunteers and four roost owners participated in the monitoring scheme in 2017. The survey teams are generally the same groups from year to year.

Both the Kildare Bat Group and Waterford Bat Group survey three roosts each annually. The Clare Bat Group, Cork County Bat Group and the Galway Bat Group monitored one roost annually. Four roost owners have participated in the scheme in the last three years. The Clare Bat Group assisted in the monitoring of a 2nd County Clare roost in 2017 and members of the Galway Bat Group assisted with surveying of a 2nd County Galway roost in 2016 and 2017. Two new survey teams were trained for monitoring in 2017 and all of the 2016 teams continued to participate in 2017.

In 2017 a video was prepared to assist volunteer teams with their prepared for surveying and surveying technique in relation to Emergence Count surveys. This was uploaded to the Bat Conservation Ireland You Tube channel for public access:

- https://www.youtube.com/watch?v=68Q4Tk0v9J0

This was viewed 274 times in 2017.

For the purposes of providing volunteer feedback, a graph is annually prepared for each roost sites detailing the survey history and results. This is emailed to each individual survey team in preparation for the next survey season.

4.2.2 Monitored Roosts 2007-2017

The Brown Long-eared Bat Roost Monitoring Scheme was introduced in 2007 and continued until 2010. There was no funding available in 2011 to implement the scheme, but during this survey season, volunteer teams undertook a minimum of one survey at 34 roosts to ensure continuity in the data until additional funding was sought. The scheme was reinstated in 2012.

Sixty-three Brown Long-eared Bat roosts distributed in 22 counties in the Republic of Ireland were monitored in 2007-2017. The highest number of roosts was located in County Cork (n=9) (Figure 35). The buildings surveyed were categorised into the following types: churches, houses, agricultural barns, large buildings/mansions and a category named “other” to represent two medieval towers and a 12th century stone structure (Figure 36, 36). The majority of the buildings surveyed over the duration of the monitoring scheme have been churches (n=28, 43.8%: Table 4.1). Over the 11 years, a total of 63 buildings were monitored while an additional 74 buildings were assessed and deemed unsuitable for monitoring. The highest number of roosts monitored in one year was in 2013 (n=49) while for the last three years, 47 roosts have been surveyed annually across 19 counties (Table 20).

Some buildings are no longer being monitored due to roost abandonment, roost renovation works and/or changes to the habitat adjacent to the building (e.g. removal of hedgerow preventing bats from commuting to/from the building) or no access to structure. There are currently 46 structures on the database that are suitable for monitoring going forward and eight structures that are recommended to be reassessed. One of the roosts surveyed in 2017 yielded zero bats with reductions in numbers noted since 2014. It is now considered abandoned.

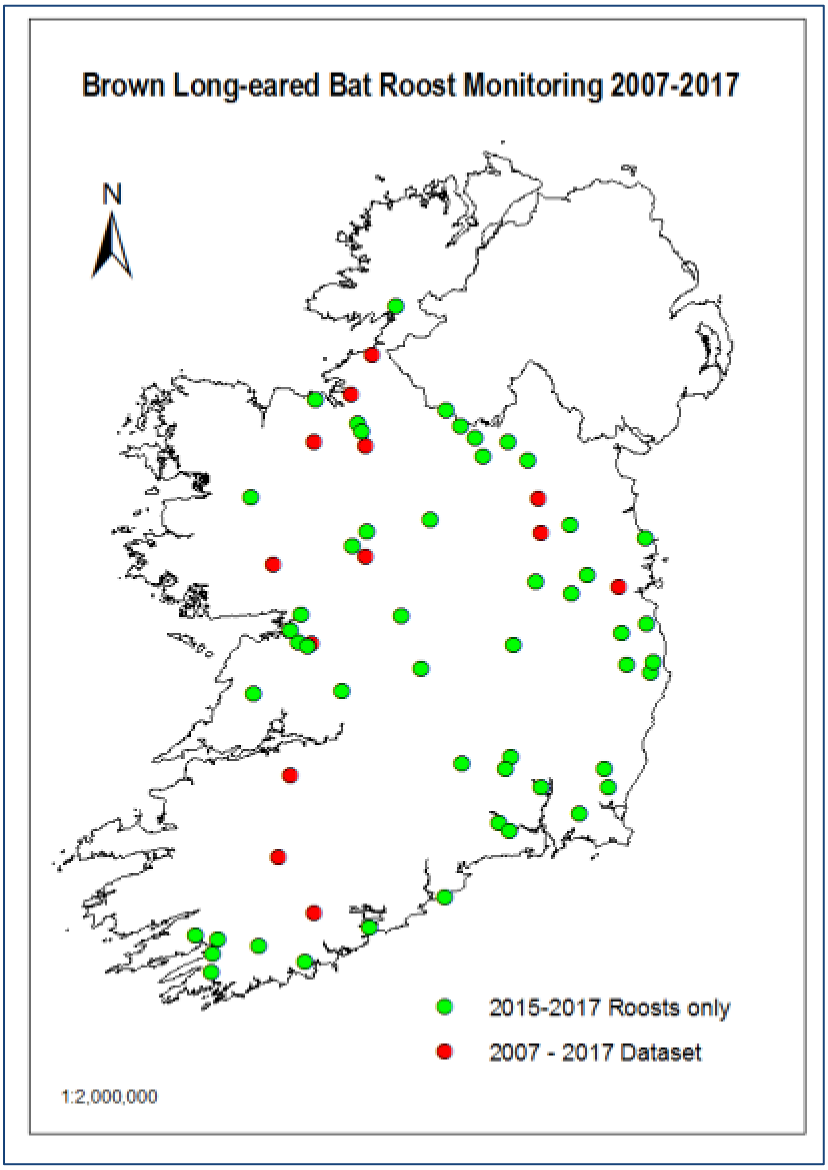

Figure 35 Location of all structures monitored as part of the Brown Long-eared Roost Monitoring Scheme from 2007-2017.

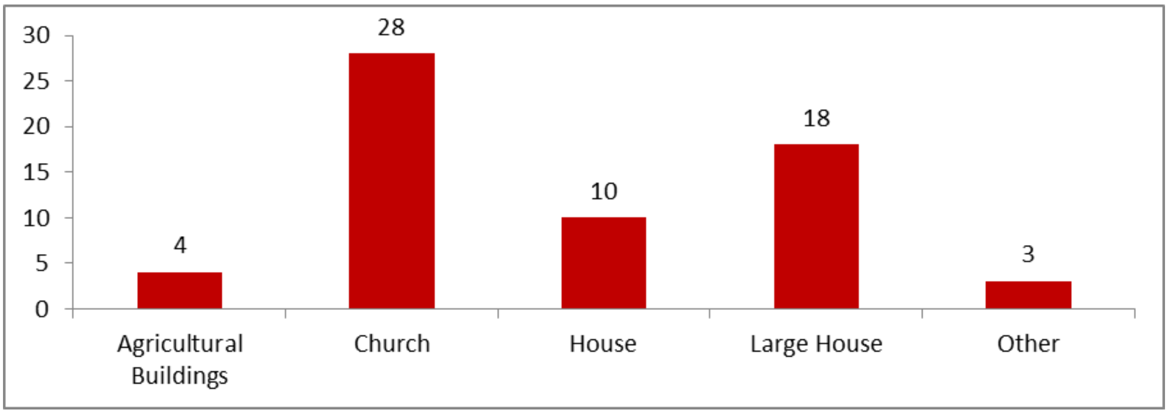

Figure 36 Number and types of structures monitored as part of the Brown Long-eared Roost Monitoring Scheme from 2007-2017.

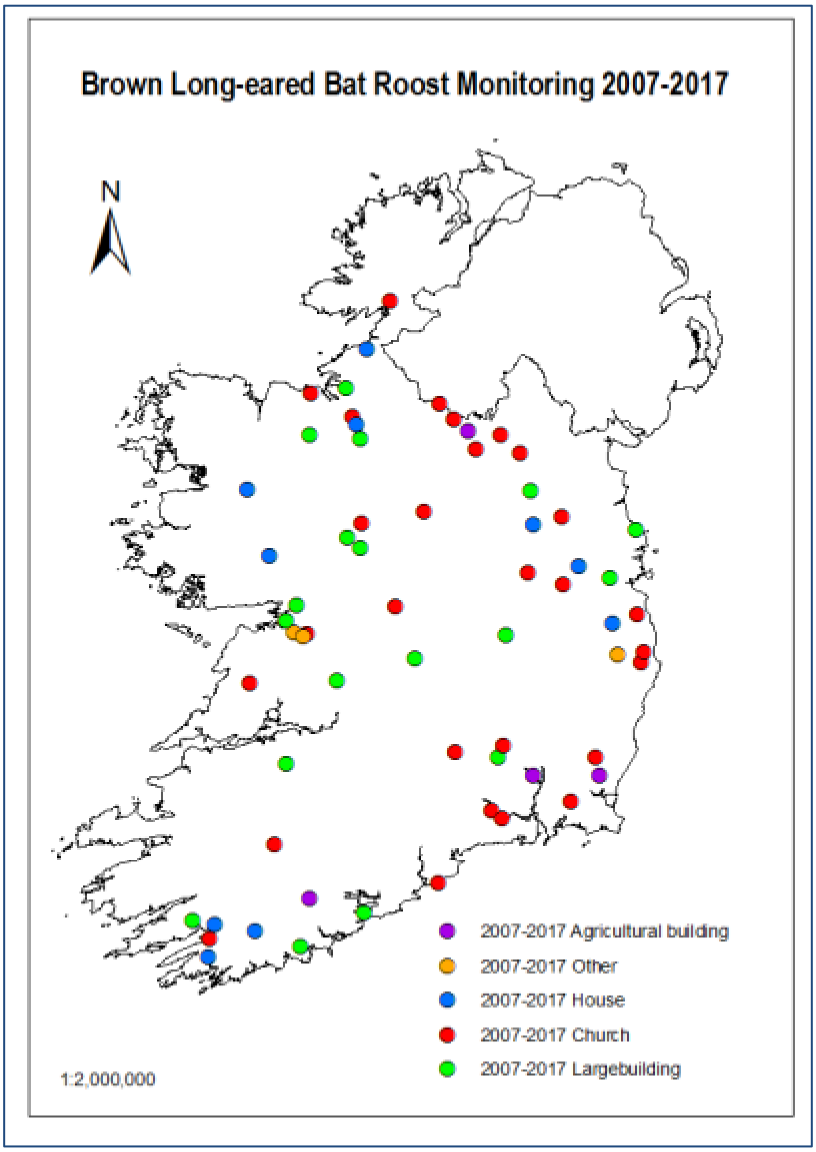

Figure 37 Location of all structures monitored as part of the Brown Long-eared Roost Monitoring Scheme from 2007-2017.

Table 20 The number of roost types surveyed per year for the duration of the monitoring scheme 2006-2017.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Barn	0	2	2	2	2	2	4	3	3	2	1	**3**
Church	5	11	19	18	16	19	24	24	26	26	26	**28**
House	3	5	5	7	3	6	7	7	7	8	8	**10**
Large bld/ mansion	6	11	8	12	12	12	12	11	8	8	9	**18**
Other	2	2	2	2	2	2	2	3	3	3	3	**4**
All types	**16**	**31**	**36**	**41**	**35**	**41**	**49**	**48**	**47**	**47**	**47**	**63**

The monitoring scheme has been in operation for eleven years and with each year new roost sites are investigated and added to the dataset. Thirty nine (62%) of the roost sites have been monitored for at least six years (Figure 38).

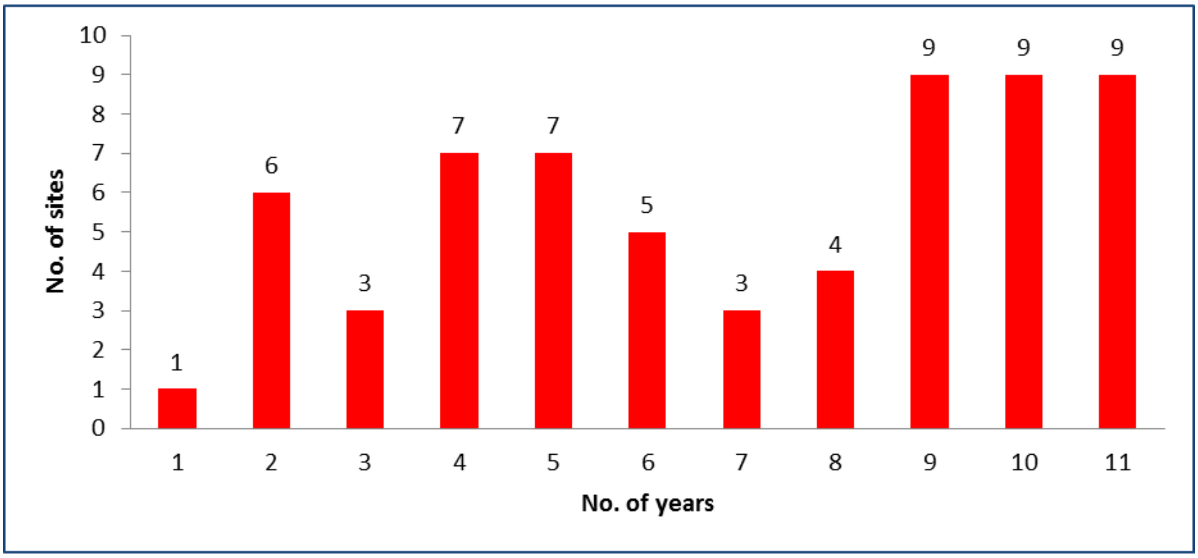

Figure 38 Number of years roosts sites were monitored as part of the Brown Long-eared Roost Monitoring Scheme in 2007-2017.

In general, the majority of roosts in the dataset are consistently surveyed from year to year, see Table 21. For example, 47 roost sites were monitored in 2017 and 43 of these roost sites were also monitored in 2014.

Table 21 The number of roosts surveyed per year, and surveyed again in subsequent years, for the duration of the monitoring scheme 2006-2017.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2007	16										
2008	16	31									
2009	11	24	36								
2010	13	26	35	41							
2011	11	22	31	34	35						
2012	10	22	32	34	33	41					
2013	11	25	33	36	34	40	49				
2014	10	22	31	33	32	40	46	48			
2015	9	20	29	31	29	37	43	45	47		
2016	10	20	29	30	28	36	42	44	45	47	
2017	10	20	29	30	28	36	41	43	44	46	47

In 2017, a total of 1,823 individual bats were counted in 47 roosts. This is the highest total over the eleven years of the scheme. The mean number of bats per roost in 2017 was 33.4 individuals and the median count was 29 individuals (Table 22).

Table 22 The number of roosts surveyed per year, and surveyed again in subsequent years, for the duration of the monitoring scheme 2006-2017.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. of individuals	342	644	1062	1455	1089	1523	1716	1648	1665	1772	1823
Mean Roost Count	18.32	18.6	25.6	31.7	31.1	32.3	29.5	29.63	30.2	34.1	33.4
Median Roost Count	18	15	21	29	26	29	26	23	28.5	30	29

4.2.3 Completed Surveys 2007-2017

A total of 920 monitoring surveys have been undertaken to-date with the highest number of surveys completed in 2016 (n=115 surveys) (see Table 23). Depending on the roost, monitoring is either completed by Internal Count or by an Emergence Count (dusk survey). Some roosts over the duration of the monitoring scheme were surveyed using a combination of these two methods. The majority of surveys completed were Emergence Count (n=694 surveys, 75.5%). Emergence Counts are the preferred method of survey as this was shown by statistical analysis to be a more reliable method for this monitoring scheme (Aughney *et al*., 2011). As a consequence, the proportion of roosts monitored by Internal Counts has reduced from year to year. For example, in 2007, 46% of surveys completed were Internal Counts compared to 18% in 2017. However some roost sites can only be accurately monitored by internal counts. A table is presented in Appendix 3 detailing all of the surveys completed for each roost and the recommended survey method for future monitoring.

Table 23 The number of surveys completed per year for the duration of the monitoring scheme 2006-2017.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Internal Count	12	26	24	25	7	24	25	27	18	20	18
Emergence Count	13	25	49	62	29	67	86	85	90	95	93
Total No. Surveys	**25**	**51**	**73**	**87**	**36**	**91**	**111**	**112**	**108**	**115**	**111**
Total No. Roosts	**16**	**31**	**36**	**41**	**35**	**41**	**49**	**48**	**47**	**47**	**47**

4.2.4 Statistical Analysis 2007-2016 Dataset

Additional analyses were carried out on the 2007-2016 dataset concerning effects of Northings and Eastings, building type, weather data and emergence times along with the methodology of the scheme. The results of these analyses are included in a paper currently in preparation for submission to a peer reviewed journal.

4.2.5 Trend Analysis 2007-2017

Results from a GAM model, expressing the trend as an index with 2008 as the base year, is shown in Figure 39 and Table 24. The models use a negative binomial distribution, rather than the Poisson distribution used previously (and as used for the GLMM), as this seemed to fit the data better and gave slightly more precise results.

The models have been fitted with and without covariates for drizzle/rain, for Internal Counts before mid-May and for external Dusk Emergence Counts after mid-September. The model with covariates is slightly more precise (i.e. narrower confidence limits). Other than the slight difference in precision, results are similar with and without covariates, with an initial increase followed by stable results for the last couple of years. The index is currently significantly above the baseline value for 2008, as indicated by the fact that the confidence limits on the smoothed curve do not enclose 100.

Overall the smoothed index using the model with covariates is currently 32.52% above the 2008 base year value which is equivalent to an average 3.18% annual increase.

In previous years the trend from the Irish roost monitoring surveys was similar to that derived from Car-based Bat Monitoring Scheme data. However, from 2015 to 2017 the Car-based Bat Monitoring Scheme indicated a decrease in Brown Long-eared Bat encounters (see Figure 12) while the trend from the roost monitoring was more stable or increasing. Error bars are much wider for Car-based Bat Monitoring data, however, since this scheme only picks up social calls of relatively few Brown Long-eared Bats during July and August roadside surveys. By way of comparison, just seven Brown Long-eared Bat passes were recorded from 790 x 1.6km transects across Ireland in 2015, compared with over 1600 individuals counted from 46 roosts during the Brown Long-eared Bat Roost Monitoring Scheme in the same year.

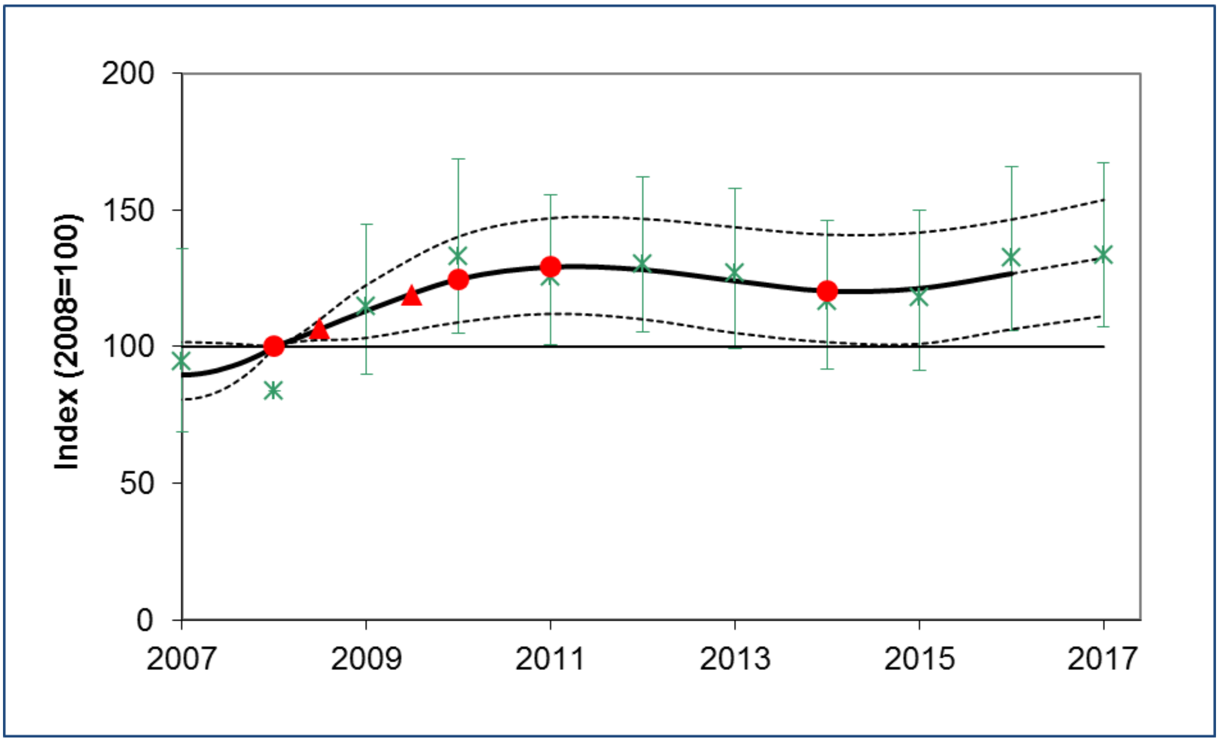

Figure 39 Results of Binomial GAM model with 95% confidence limits for the Brown Long-eared Roost Monitoring Scheme 2007-2017. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 24 Binomial GAM results with 95% confidence limits for Brown Long-eared Roost Monitoring Scheme (2007-2017). Covariates include drizzle/rain, for internal counts before mid-May and for external counts after mid-September.

		Index 2008 = 100							
		Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	Sites	Index	s.e.	Lower	Upper	Fitted	s.e.	Lower	Upper
2007	16	89.70	5.38	80.72	101.68	110.68	17.21	84.65	151.77
2008	31	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2009	36	113.23	4.97	103.26	122.64	130.63	13.75	105.74	160.77
2010	41	124.69	8.07	108.96	140.30	149.25	16.25	120.72	184.60
2011	35	129.17	8.95	112.09	147.04	141.55	14.01	116.94	171.43
2012	41	128.17	9.32	110.05	146.79	146.45	14.49	121.41	178.17
2013	49	124.10	9.80	105.03	143.75	142.97	15.35	115.30	174.06
2014	48	120.36	9.98	101.71	141.00	132.62	13.78	108.04	162.03
2015	47	121.34	10.07	101.07	141.76	134.10	14.83	107.43	165.89
2016	47	126.75	10.11	106.43	146.55	148.50	15.69	121.70	181.67
2017	46	132.52	10.72	111.24	153.72	149.68	15.09	123.47	183.36
TOTAL	**62**								

4.2.6 Additional Technology

Due to the difficulty of detecting Brown Long-eared Bats emerging from some roosts, filming with the aid of infra-red illuminators was investigated in 2016 and 2017. Sony HandyCam FDR-AX33 and FDR-AX53 with night-shot capability along with infrared illuminators were deployed at five roosts in 2016 and at eight roosts in 2017. These roosts were chosen due to the different heights that bats emerged from. The camcorder was positioned on a tripod (1.5m high) while the IR illuminators were on a separate tripod (1m high, two per roost site). Illuminators were shone onto the building in the general vicinity of known exit points.

In 2016 at buildings where the bats emerged at a height of 3m of less, the bats were successfully filmed (Table 25). While Site Code 2062 was successfully filmed for the first 20 minutes, the illuminators deployed were not bright enough to allow successful filming once it was fully dark. As a result two additional illuminators were purchased with a narrower beam of light (60° spread) for the 2017 filming. A similar result was recorded for Site Code 2133 in 2016. However, the additional IR illuminators tested in 2017, did not increase the illumination for Site Codes 2062 and 2133 enough to successfully film emerging bats due to the height the bats emerged at. An accurate count is achievable without the camera assistance at Site Code 2133, but not at Site Code 2062. In 2017, an additional five roosts were successfully filmed.

Another success of the filming exercise was that at Site Code 2064 and 2122, the locations of the roost exit points were pin pointed with great accuracy in 2016.

Filming was undertaken internally at Site Code 2124 in 2016 to determine where the bats were exiting from the sarking boards into the internal space of the church. This church is undergoing remedial works due to water damage and BCIreland worked closely with the church authorities and conservation architect to ensure that works were undertaken in a bat-sensitive manner. Monitoring continued at this site in 2017 to ensure that works did not impact on the colony and filming was successfully completed externally in 2017 to ensure that the bats continued to roost in the church post works.

Table 25 Results of filming of emergence counts in 2016 and 2017.

Site Code	Emergence Height	2016 Successful	2017 Successful
2062	approx 6m	No	No
2064	approx 3m	Yes	Yes
2122	2m	Yes	
2124	Internal in 2016 External in 2017 2m	Yes	Yes
2133	>10m	No	No
2003	3m		Yes
2066	3m		Yes
2122	2m		Yes
2128	1.5m		Yes
2129	3.5m		Yes

4.2.7 Radio Tracking of Brown Long-eared Bats

Three roosts, two churches and one house, were selected for this study and all were located in County Sligo (Figure 40). The three roosts are part of the Brown Long-eared Roost Monitoring Scheme (Roost 1 = Church of Ireland, Screen; Roost 2 = Private dwelling and Roost 3; Catholic Church, Riverstown). This study was undertaken to collate information on the individual colonies foraging preferences which could be linked to a better understanding of the colonies conservation requirements.

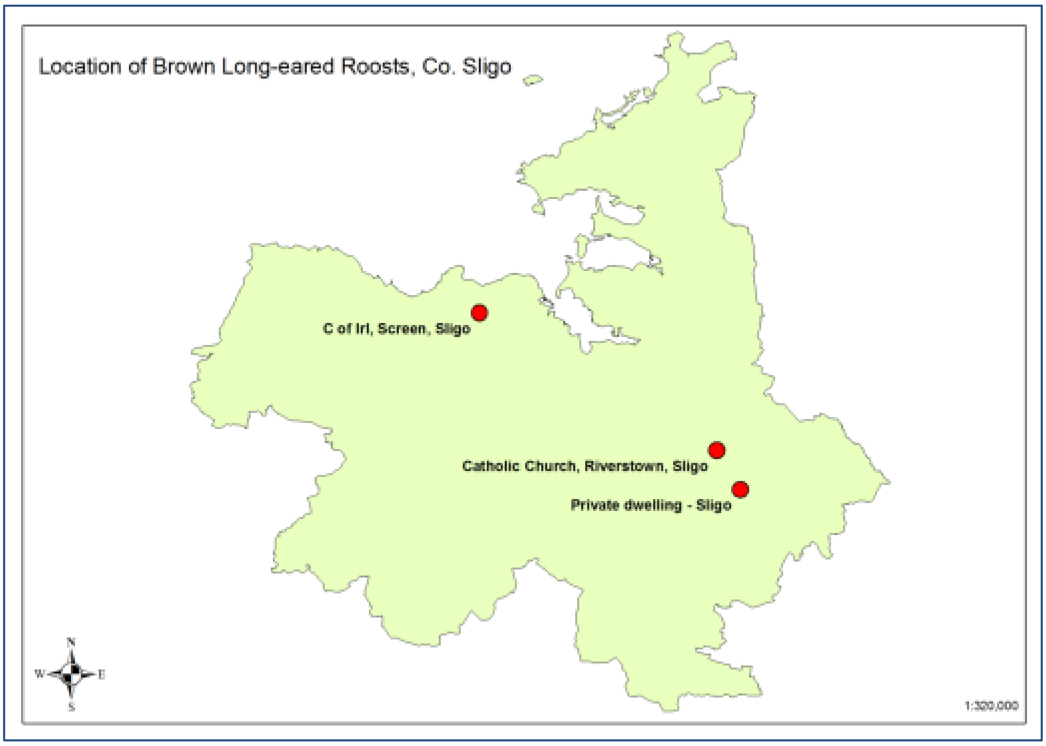

Figure 40 Location of Brown Long-eared Bat roosts radio-tracked in 2017 (Screen Church of Ireland = Roost 1; Private Dwelling = Roost 2 and Riverstown Catholic Church = Roost 3).

In 2017, an NPWS licence was received to radio track ten individual bats. Radio tracking was completed in July and August 2017 by a team of six surveyors. A total of ten bats were tagged (8 adult females and 2 adult males) during two separate tracking periods – one in late July 2017, Period 1 (3 bats) and one from mid to late August 2017, Period 2 (7 bats). These periods were selected to avoid disturbance to pregnant and lactating females.

For this report, a brief summary of the radio-tracking results is provided below. This will be further elaborated on in a separate paper to be written by the radio-tracking team.

Three bats (1 male, 2 females) were successfully tagged on the 23 July 2017. During the ten nights of radio tracking, the weather conditions were variable with wet and windy frequently recorded. In general, two of the bats foraged adjacent to the roost along treeline fields (mature sycamore tree) and occasionally foraged further east or north of the roost location. The third bat travelled the greater distance and more often foraged west and north-west of the roost along laneways lined with stonewall and hedgerows or in fields where dense treelines of sycamore trees were present. Much of this local landscape consisted of open farmland with little tall vegetation cover.

At Roost 2, three female bats were successfully tagged on 20 August 2017. The weather conditions were more favourable compared to Period 1. After release, one of the bats did not return to the roost at dawn or was not located within survey area at any point during the radio-tracking Period 2. The two remaining bats foraged primarily west of the River Unshin valley where the habitat consisted of wet grassland, dense hedgerows and pockets of mature trees. These bats roosted in a number of night roosts in this area as well as frequently returning to the main roost. One of the bats travelled 3km to the north of the roost to an area of river valley with woodland and treelines.

At Roost 3, four bats (1 male, 3 female) were successfully tagged on 23 August 2017. One of these was not recorded once released after the being tagged. Another bat removed her tag after 3 days and the tag was retrieved from the attic space of the roost. In the brief time before she removed her tag, she was recorded foraging 2km south of the roost and in the immediate vicinity around the roost. The immediate area around the roost consisted of deciduous woodland leading to the River Unshin alley. The 3rd bat was regularly recorded foraging along the river west and south-west of Riverstown where wetland grassland and large ditches lined with hedgerows were predominant. The male bat favoured a foraging area to the north-east of the town in a parkland area with large mature trees. He removed his tag after 7 days and this was found in a large mature tree in his foraging area.

Racey & Speakman (1996) reported that 92% of bats within their study area spent most of their time within 1.5km of the roost while the greatest distance flown by an individual (male bat) was 2.8km from the main roost. In this radio tracking study, the principal foraging areas were indeed within 1.5km for the majority of bats but some individuals flew up to 3km from the main roost.

During Period 2 (mid-late August) two individuals tagged were not located post-tagging. While a 10km radius of an area was surveyed by car to locate these two individuals, the search was unfruitful. It is possible that the timing of the tagging coincided with bats moving to swarming sites. Therefore it is recommended that any future radio tracking of maternity roosts should be completed earlier in the season. The timing of Period 1 was more successful.

4.2.8 Habitat Mapping & Roost Profiles

The broad habitat types surrounding five Brown Long-eared Bat roosts were mapped within two buffer zone scales to determine the percentage of foraging habitat available to Brown Long-eared Bats. In addition a profile of each roost's structure was compiled.

Site Code 2067 is a large church located on the edge of Riverstown, County Sligo and was one of the roosts where individuals of the colony were radio tracked in 2017. The immediate area adjacent to the church is characterised by extensive treelines (Figure 41a). The River Unshin flows through the town while the Douglas River flows north of the town where it joins the Unshin River. Lough Meharth is located south-east of the town and there are some large blocks of commercial forestry located to the north, east and south-east of the town (Figure 41b). Both the River Unshin and Lough Meharth are located within the 0.5km buffer zone while the forestry is within the 2.5km zone. This roost has been monitored since 2009 and the Brown Long-eared Bat colony counts yield a mean number of 56.2 bats (n=25 surveys, Table 26).

Table 26 Site Code 2067 Roost Profile and woodland habitats types within a 0.5km and 2.5km.

Site Code 2067 Profile	Details	Broad Habitats	0.5 km	2.5km
Age	<100 years old	Individual trees	0.1 ha	
Roof material	Slate roof, no felt	Hedgerows	1.7 ha	
Attic space	Yes - large attic space	Treelines	4.9 ha	
Wall construction	Natural stone	Scrub	2.0 ha	
Setting	Urban edge	Woodland	No	14.2 ha
1st year of monitoring	2009	Commercial Forestry	No	172 ha
Mean roost count	56.2 bats	Rivers	Yes	
Peak roost count	88 bats (2014)	Lakes	Yes	

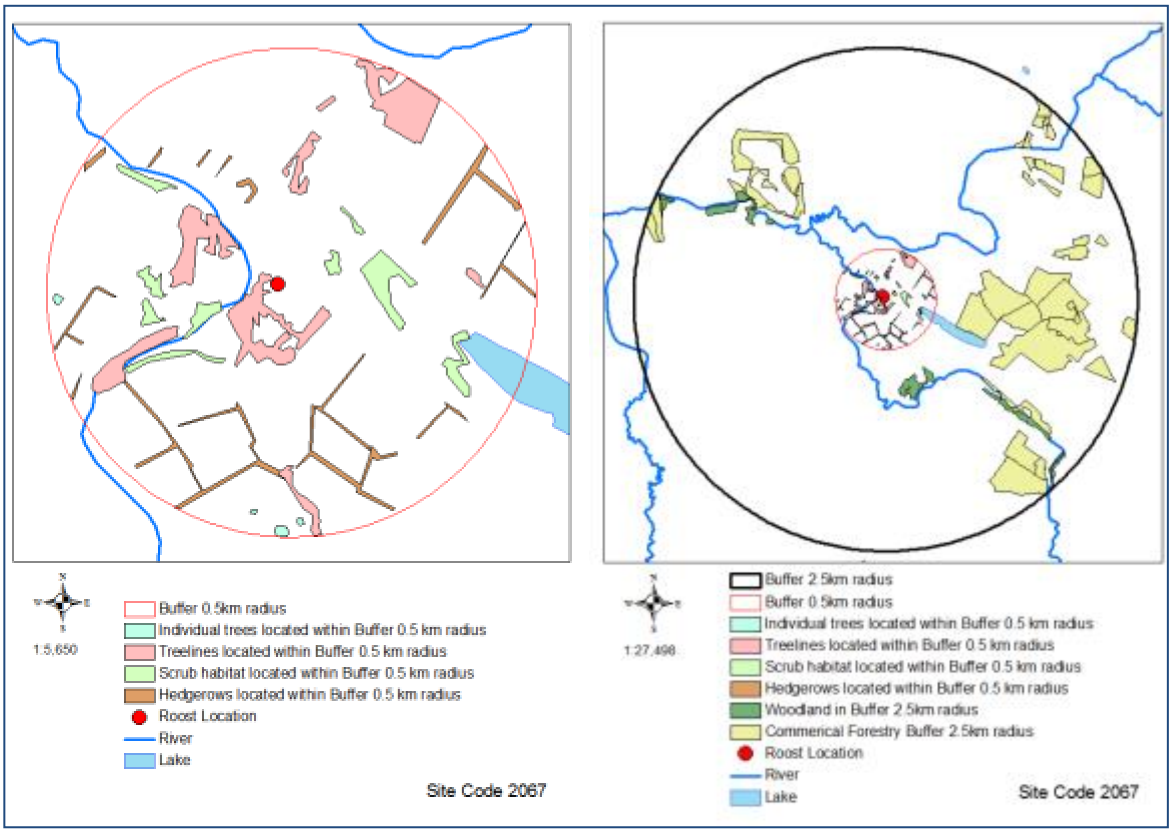

Figure 41a Site Code 2067 habitat mapping within 0.5km buffer zone.

Figure 41b Site Code 2067 habitat mapping within 2.5km buffer zone.

Site Code 2090 is a church located in a rural area of Co. Sligo and was one of the roosts where individuals of the colony were radio tracked in 2017. This area is characterised by upland to the south of the church with grassland grazed by sheep and stonewall field boundaries. The landscape immediately to the north of the roost location is characterised by large mature sycamore treelines with some individual mature trees and hedgerows (Figure 42a). The Ardglass River is situated to the north-east of the roost where it flows into Sligo Bay. There is some woodland to the east, south-east and south of the roost within the 2.5km buffer zone (Figure 42b). This roost has been monitored since 2009 and the Brown Long-eared colony counts yield a mean number of 15.7 bats (n=26 surveys, Table 27).

Table 27 Site Code 2090 Roost Profile and woodland habitats types within a 0.5km and 2.5km.

Site Code 2090 Profile	Details	Broad Habitats	0.5 km	2.5km
Age	>100 years old	Individual trees	0.3 ha	
Roof material	Slate roof, no felt	Hedgerows	1.2 ha	
Attic Space	Yes - large attic space	Treelines	2.9 ha	
Wall construction	Natural stone	Scrub	0.0 ha	
Setting	Rural	Woodland	No	54.6 ha
1st year of monitoring	2009	Commercial Forestry	No	No
Mean roost count	15.7 bats	Rivers	No	Yes
Peak roost count	35 bats (2009)	Lakes	No	

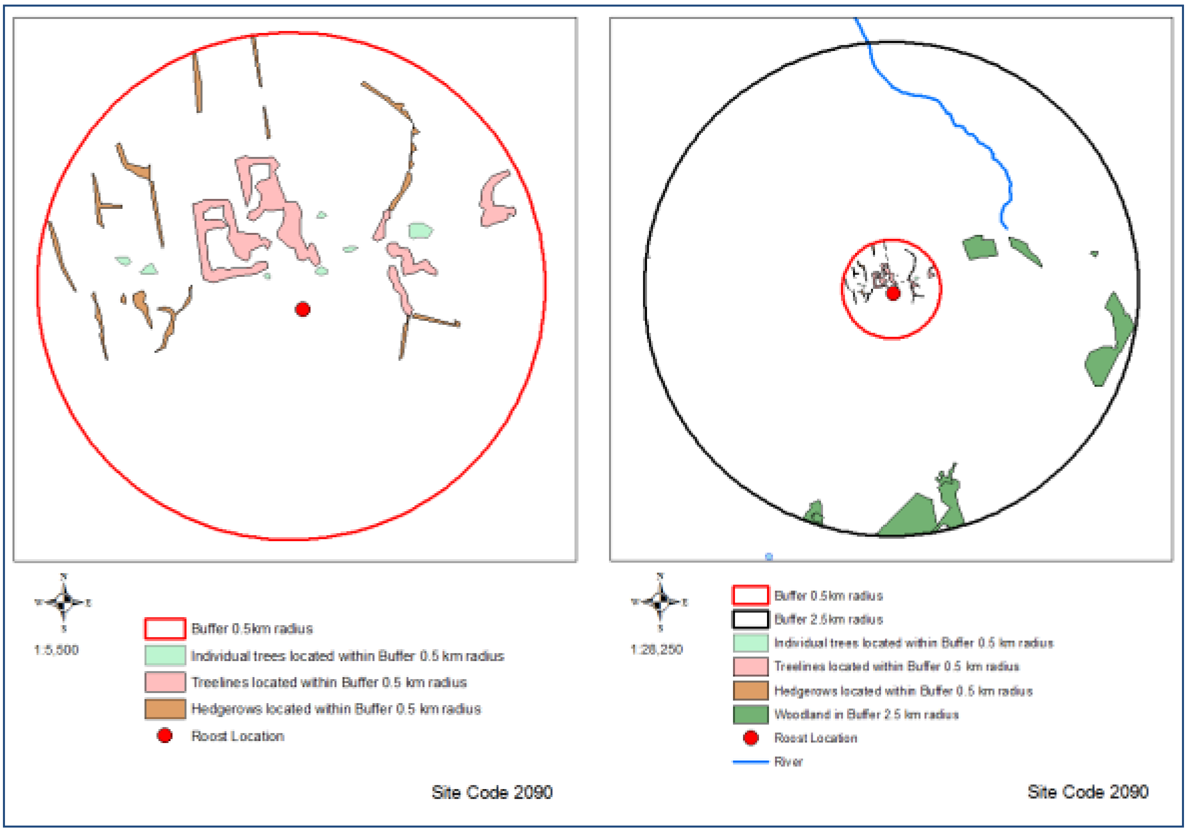

Figure 42a Site Code 2090 habitat mapping within 0.5km buffer zone.

Figure 42b Site Code 2090 habitat mapping within 2.5km buffer zone.

Site Code 2001 is a cathedral located in a rural area of Co. Cavan. The immediate surroundings of the roost are comprised of parkland habitat with large mature trees (Figure 43a). There are large areas of mature broadleaf woodland and conifer plantations. In the wider landscape, Lough Oughter complex is located to the west and north-west of the roost location and the Cavan River flows to the east. This roost has been monitored since 2007 and the Brown Long-eared Bat colony counts yield a mean number of 46.9 bats (n=24 surveys, Table 28).

Table 28 Site Code 2001 Roost Profile and woodland habitats types within a 0.5km and 2.5km.

Site Code 2001 Profile	Details	Broad Habitats	0.5 km	2.5km
Age	>100 years old	Individual trees	0.7 ha	
Roof material	Slate roof, felt	Hedgerows	1.6 ha	
Attic Space	Yes - large attic space	Treelines	2.8 ha	
Wall construction	Concrete / natural stone	Scrub	0.0 ha	
Setting	Rural	Woodland / Forestry	18.6 ha	111 ha
1st year of monitoring	2007			
Mean roost count	46.9 bats	Rivers	No	Yes
Peak roost count	64 bats (2013)	Lakes	No	Yes

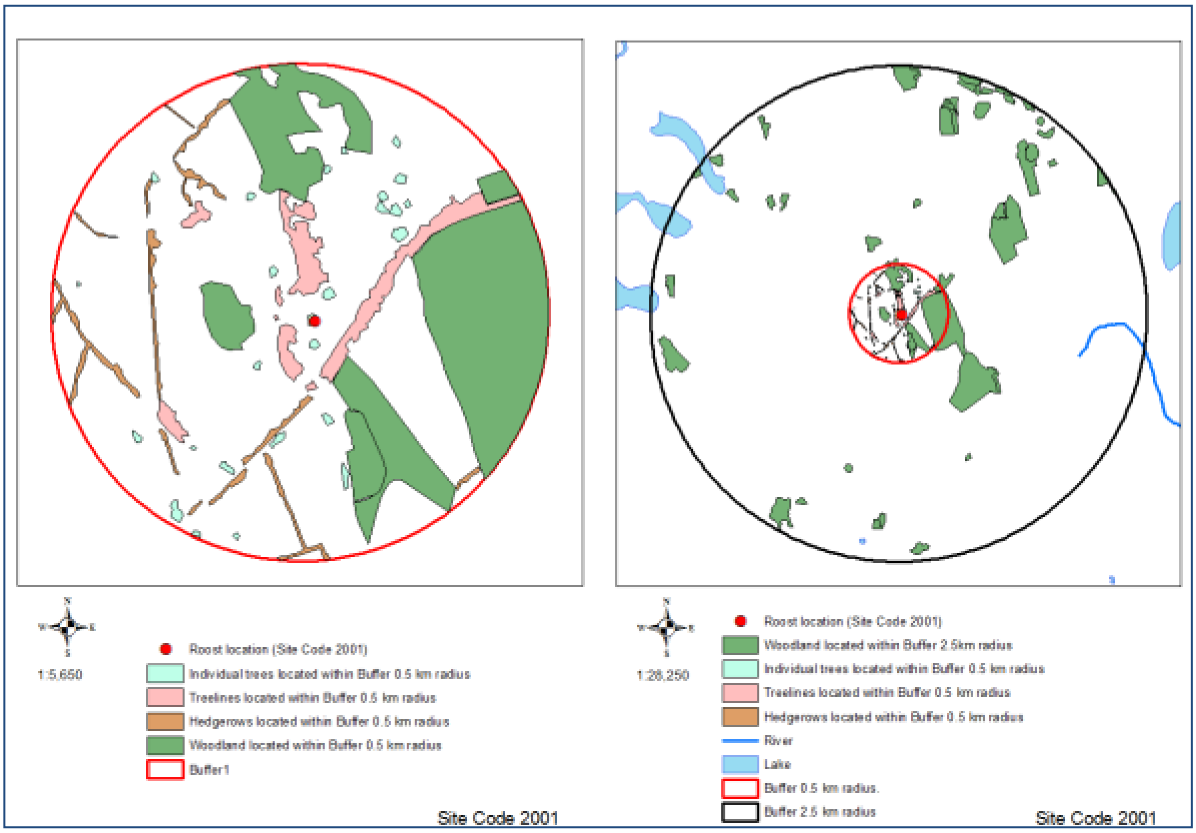

Figure 43a Site Code 2001 habitat mapping within 0.5km buffer zone.

Figure 43b Site Code 2001 habitat mapping within 2.5km buffer zone.

Site Code 2003 is an early Christian building located within the Wicklow Mountains National Park. The immediate surroundings of the roost are comprised of parkland habitat with large mature trees (Figure 44a). There are large areas of mature broadleaf woodland and conifer plantations. The Glendassan Rivers flows to the north of the roost location and enters the Lower and Upper Lakes of Glendalough. This roost has been monitored since 2007 and the Brown Long-eared Bat colony counts yield a mean number of 12.6 bats (n=18 surveys, Table 29).

Table 29 Site Code 2003 Roost Profile and woodland habitats types within a 0.5km and 2.5km.

Site Code 2003 Profile	Details	Broad Habitats	0.5 km	2.5km
Age	>100 years old	Individual trees	0.7 ha	
Roof material	Natural stone	Hedgerows	0.0 ha	
Attic Space	Yes - large attic space	Treelines	7.3 ha	
Wall construction	Natural stone	Scrub	4.5 ha	
Setting	Rural	Woodland / Forestry	36.0 ha	841.0 ha
1st year of monitoring	2007			
Mean roost count	12.6 bats	Rivers	Yes	Yes
Peak roost count	30 bats (2017)	Lakes	Yes	Yes

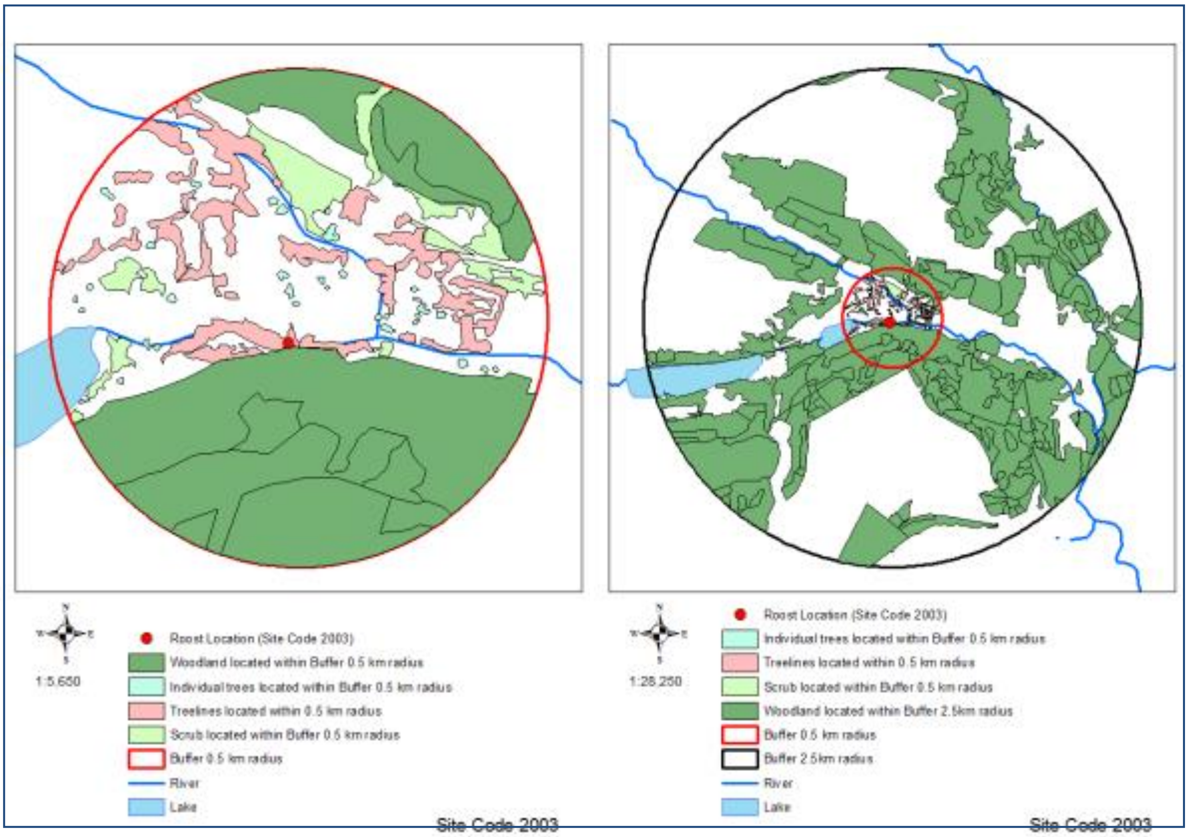

Figure 4.10a Site Code 2003 habitat mapping within 0.5km buffer zone.

Figure 4.10b Site Code 2003 habitat mapping within 2.5km buffer zone.

Site Code 2006 is a large house located on the coastline of Cork harbour, just south of Ringaskiddy. The immediate surroundings of the roost are comprised of Currabinny Wood, broadleaf woodland, to the west (Figure 45a). There are large areas of mature broadleaf woodland and conifer plantations. The Glendassan Rivers flows to the north of the roost location and enters the Lower and Upper Lakes of Glendalough. This roost has been monitored since 2007 and the Brown Long-eared Bat colony counts yield a mean number of 15.4 bats (n=21 surveys, Table 30).

Table 30 Site Code 2006 Roost Profile and woodland habitats types within 0.5km and 2.5km.

Site Code 2003 Profile	Details	Broad Habitats	0.5 km	2.5km
Age	>100 years old	Individual trees	0.1 ha	
Roof material	Natural stone	Hedgerows	0.0 ha	
Attic Space	Yes – medium size attic space	Treelines	0.2 ha	
Wall construction	Natural stone	Scrub	0.2 ha	
Setting	Urban edge	Woodland / Forestry	23.1 ha	115.0 ha
1st year of monitoring	2007			
Mean roost count	15.4 bats	Rivers	No	Yes
Peak roost count	42 bats (2013)	Lakes	No	No

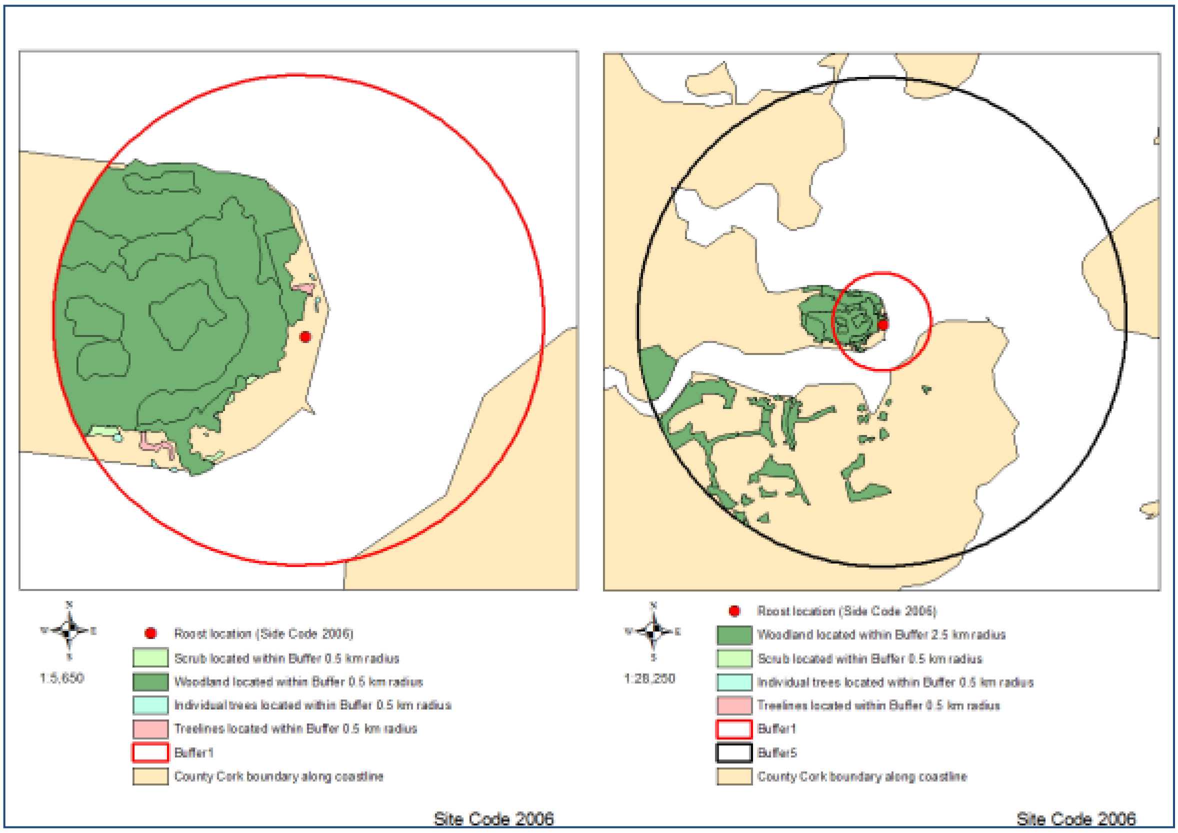

Figure 45a Site Code 2006 habitat mapping within 0.5km buffer zone.

Figure 45b Site Code 2006 habitat mapping within 2.5km buffer zone.

4.2.9 Oral & Poster Presentations

Results of work completed under the Brown Long-eared Roost Monitoring Scheme were presented at a number of conferences in 2015-2017 contract period:

1. 9th Irish Bat Conference 2017

Oral Presentation Title: Ten years of the Brown Long-eared Bat roost monitoring in Ireland

Oral Presentation Title: An investigation of activity patterns, commuting routes, foraging habitats and roost usage by Brown Long-eared Bat *Plecotus auritus* as revealed by radio-telemetry at three maternity roosts in Co. Sligo

2. 14th European Bat Symposium 2017

Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

3. Inaugural Irish Ecological Association Ecology & Evolution Conference 2016

Poster Presentation Title: The Irish Bat Monitoring Programme: lessons learned from 14 years of citizen science participation.

4. All Ireland Mammal Symposium 2015

Oral Presentation Title: Population trends of Irish bat species.

5 Lesser Horseshoe Bat Roost Monitoring

The Lesser Horseshoe Bat (*Rhinolophus hipposideros*) is mainly found in counties on Ireland's western seaboard Mayo, Galway, Clare, Limerick, Kerry and Cork although its strongholds are found in Kerry/west Cork and in Clare. The Lesser Horseshoe Bat is Ireland's only Annex II-listed bat species (as per EU Habitats Directive [92/43/EU]). This means that its population requires special protection measures and designation of Special Areas of Conservation within the Natura 2000 network. These designations are usually roost or hibernacula-centred and focus on large roosting sites for the species, usually with >50 individuals in winter or >100 individuals in summer.

BCIreland carried out analysis of the Lesser Horseshoe Bat database in 2012, see Roche *et al.* (2012). Initial results were encouraging and indicated that the species has increased for much of the duration of its monitoring scheme. However, concerns have been expressed about the state of deterioration of many of its roosting sites e.g. Roche, Aughney, & Langton (2015) and McAney (2014) as well as the finding that there are genetically distinct clusters within the Irish population (Dool *et al.*, 2013) that are likely to have arisen due to landscape connectivity constraints.

The present report details the ongoing seasonal monitoring of Lesser Horseshoe Bat summer and winter sites by National Parks and Wildlife Staff, staff of the Vincent Wildlife Trust and various independent ecological consultants. Using the summer roost and hibernacula count data we have analysed population trends for the species to winter and summer 2017.

5.1 Method

BCIreland's involvement in the scheme began in November 2013 when the MS Access database listing known roosts and roost records was provided by the NPWS.

Surveyors were trained in survey methodology prior to this handover. Surveyors are provided with equipment needed for the survey by the NPWS or Vincent Wildlife Trust (VWT) complete surveys of specific sites within their district each year. While some summer counts are carried out by counting emerging bats at dusk (emergence counts), many sites are counted internally during daylight hours. Emergence counts are generally carried out using bat detectors, with the Vincent Wildlife Trust also using video camera footage to ensure accuracy. The dates for surveying in summer are 23 May to 7 July, although counts outside these dates are included in the overall trend series because of the low sample sizes in early years of the time series should counts outside those dates be omitted. Winter surveys in hibernacula are carried out in January and February each year. For some of the larger hibernacula photographs of the hibernating bats are taken and are then counted ex situ to ensure accuracy of counts.

During the current contract data was provided in Excel spreadsheets by NPWS regional staff from summer 2015 to winter 2018. These data were cleaned, queried (where necessary) and imported to the database using the Excel to Access Import function in MS Access.

5.1.1 Statistical Analysis

For overall yearly trends, a Generalised Linear Model (GLM) with a Poisson error distribution was applied to the data. Confidence intervals are generated by bootstrapping (Fewster *et al*., 2000), as used in Generalised Additive Model (GAM) analysis. Generalised Additive Models (GAMs) have been fitted to the annual means to give a visual impression of the trend over time. Curved trend lines have been applied to the data.

5.1.1.1 Hibernation counts

The analysis includes data from 24 December to 7 March from 1986 to 2017 but the number of sites is very low in some years, particularly between 1989 and 1991. The y-variate is the count of bats present. Sites with no bats in any year in the survey period are excluded and sites with a record for only one year are also excluded because these contribute no information on trends. The winter 2017/2018 dataset was not included in the time series as all data had not been received at the time of analysis. Roche *et al*. (2012) highlighted the effect of day number during the survey period on mean winter counts with numbers falling off towards spring. In order to account for this, day number in the survey period is used as a covariate in the analysis. Data from surveys conducted between 26 December and 7 March are used, i.e. January and February ±1week.

Additional analysis of the winter dataset was carried out in October 2016 using the Dutch population monitoring software TRIM. This was done to facilitate its incorporation into the pan-European Bat Indicator. The TRIM analysis was run with serial correlation switched off in order for the models to converge. In addition, no covariates for day number (to adjust for survey date) were used as the software does not handle covariates in the same way as GLM. The results of this analysis was reported in Aughney *et al*. (2017).

5.1.1.2 Summer counts

The analysis includes data from May to August from 1992 to 2017 but the number of sites is very low in some years, particularly 1996 and early in the time series. The y-variate is the count of bats present. Sites with no bats in any year in the survey period are excluded and sites with a record for only one year are also excluded because these contribute no information on trends. There are a number of pairs of sites that are grouped for the analysis because the same bats use the two sites, for example the stables and cellars at Curragh Chase, Co. Limerick. Day number in the survey period is used as a covariate in the analysis.

5.1.1.3 Roosting Resource: Trends Within Sites

Counts for each site from the official monitoring period for winter and summer (±1 week) from two five year intervals; 2008 to 2012 and 2013 to 2017, were log transformed (+1 to account for zero counts). The slope of the trend line for each site for each five year period was calculated. Sites were included only when at least four of the five years had available count data. Sites were then categorised for each season according to whether they had undergone a 'large decrease', a 'decrease', 'no change', 'increase' or 'large increase'. The large increase and large decrease categories roughly equate to greater than 20% per annum change. The 'no change' category is approximately equivalent to a 0% to ±2% change per annum.

5.2 Results

5.2.1 Records submitted for 2015-2017

The number of records on the database currently stands at 4,739 but this includes some records for other species and data that cannot be used in trend analysis due, for example, to insufficient information in the Date field.

Table 31 Number of Lesser Horseshoe Bat records imported to Access database 2015-2017

Year	Winter	Summer
2015	122 (105 sites)	128 (94 sites)
2016	113 (89 sites)	141 (105 sites)
2017	119 (101 sites)	145 (115 sites)

These records include some null counts where no access was possible, some multiple counts in the same season at some sites, and some records for species other than the Lesser Horseshoe Bat. Some additional records outside the main survey dates or recently discovered historical records were also imported to the Access database.

In winter 2016, 116 counts were submitted from 112 sites. The sum of maximum counts for all sites in winter 2016 was 7,056, the mean count was 64.7 bats per site. This compares with 6,508 bats counted from 105 sites in winter 2015.

Table 32 Raw data for each season in the current reporting period (2015-2017 inclusive).

Year	Season	Total Bats	Mean count	Single Site Max Count	Median
2015	Summer	8805 (n=91)	97.8	460	57.5
2016	Summer	8737 (n=104)	84	661	37
2017	Summer	9655 (n=109)	88.6	489	42
2015	Winter	6510 (n=106)	61.4	962	12.5
2016	Winter	7056 (n=112)	64.7	1106	20
2017	Winter	7040 (n=105)	67.1	1010	12

In winter 2017, 118 counts were carried out at 105 sites. The sum of maximum counts for these sites in winter 2017 was 7,040. The maximum number of bats recorded in a single hibernaculum was 1,010 bats in Newgrove, Co. Clare and the second largest was 601 bats recorded at Moorehall, Co. Mayo.

In 2015, a maximum of 8,805 bats were counted during the summer monitoring period (±1 week) at 91 sites. The maximum count at any one site was of 460 bats at William King, Kilgarvan, a VWT site, (Site Code 522) on 15 June 2015. In summer 2015 the mean summer roost size was 97.8 and the median was 57.5. This compares with a mean summer roost size in 2014 of 86 and median roost size of 44.

For summer 2016, 130 discrete survey records from 104 sites were provided. At twelve of these, Lesser Horseshoe Bat was absent. In total, a maximum of 8,737 bats were counted during the summer monitoring period in 2016. The maximum count at any one site was of 661 bats at the VWT site Towerhill Cottage (Site Code 668) on 27 June 2016. Overall, the mean summer roost size was 84 and median roost size was 37 in summer 2016.

For the summer 2017 monitoring period (±1 week), 135 discrete survey records were provided. At 22 of these, Lesser Horseshoe Bat was absent or the count could not be carried out. Counts were carried out at 109 sites. In total, a maximum of 9,655 bats were counted during the summer in 2017 at these sites. This accounts for well over half the estimated population in the country which was last calculated as 14,010 in 2010-2011(Niamh Roche, Langton, & Aughney, 2012). The maximum count at any one site was of 489 bats at the VWT site Towerhill Cottage (Site Code 668) on 7 June 2017. Overall, the mean summer roost size was 88.6 and median roost size was 42 in 2017.

From summer 2015 to summer 2017 counts were carried out by 41 individuals including staff of NPWS and VWT, ecological consultants, and their assistants.

5.2.2 Winter trends

Counts at 143 sites contribute to the winter trend analysis. The trend has been increasing since the start of the survey with the exception of a five year period between 2007 and 2011 when numbers were stable. Between 1990 and 2017 the smoothed trend index increased by 100%. The baseline year is set as 2009, a year when a high number of hibernacula were counted. Since then, the trend index has increased quite steeply, by 44% in just nine years.

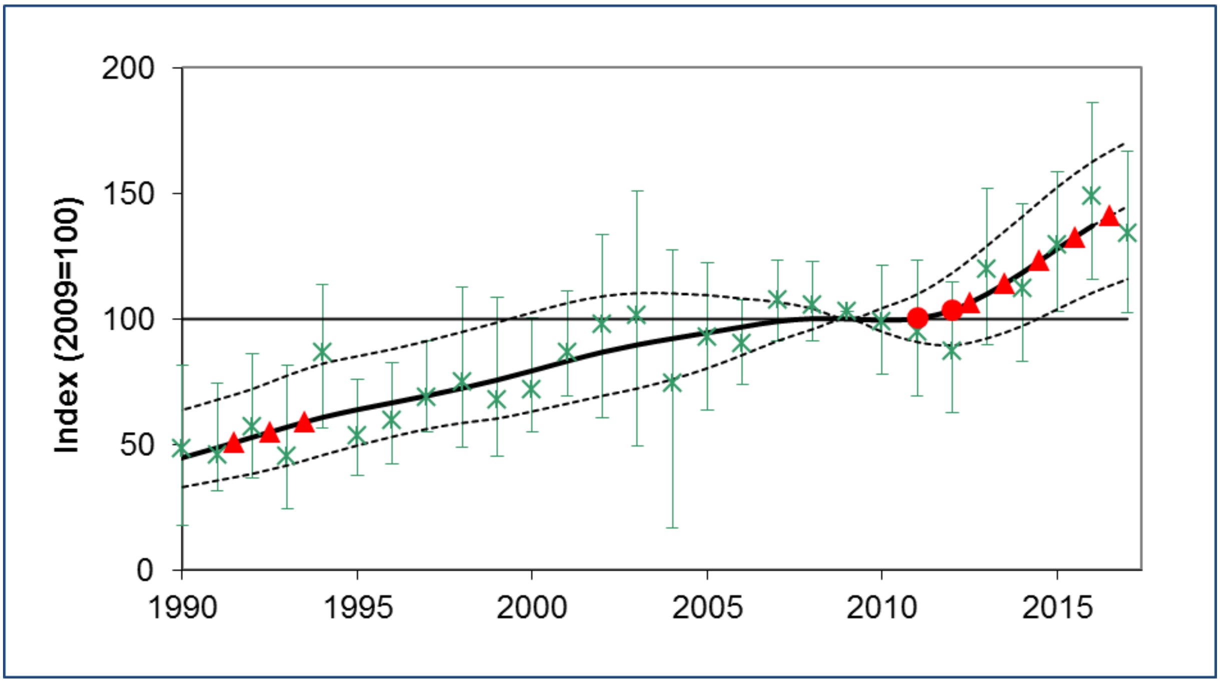

Figure 46 Results of the GAM/GLM model for Lesser Horseshoe Bat hibernation data. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$).

5.2.3 Summer trends

The results presented here use the full May to August period, with a covariate to adjust for the linear effect of day number in the year. A review of the data to 2017 showed that counts conducted internally differ substantially from those conducted during evening emergence. Since 2009, 524 summer counts in May, June and July have been categorized as evening emergence counts compared with 621 records of internal counts in the same timeframe. Fitting an over-dispersed Poisson model to data for 2009 onwards only for those sites with a mix of internal and emergence counts gives average counts of 45.0 (s.e. 1.71) for internal counts compared to 73.6 (s.e. 3.02) for other counts. A GLMM suggests that the difference varies between sites (presumably because bats are easier to count in some roosts), but the results suggest that it would be appropriate to conduct the analysis with a covariate for internal counts.

The results of the standard analysis (i.e. with a covariate for day number but without a covariate for internal counts) are shown in Figure 47. The results of analysis with covariates for both day number and internal counts are shown in Figure 48. The increase since 2009 is slightly greater than in the standard analysis and the confidence limits are slightly narrower (suggesting that the covariate has accounted for some otherwise unexplained variation). An analysis totally excluding internal counts suggests an even steeper increase (2017 index 132.2), although with wider confidence limits due to the much reduced sample size since 2009.

Results for the summer trend are similar to those from previous analyses e.g. Aughney, Roche, & Langton (2015). While there was a flattening of the increasing trend from summer 2007 to 2012 (both with and without a covariate for internal counts) it is again significantly increasing, in line with winter results.

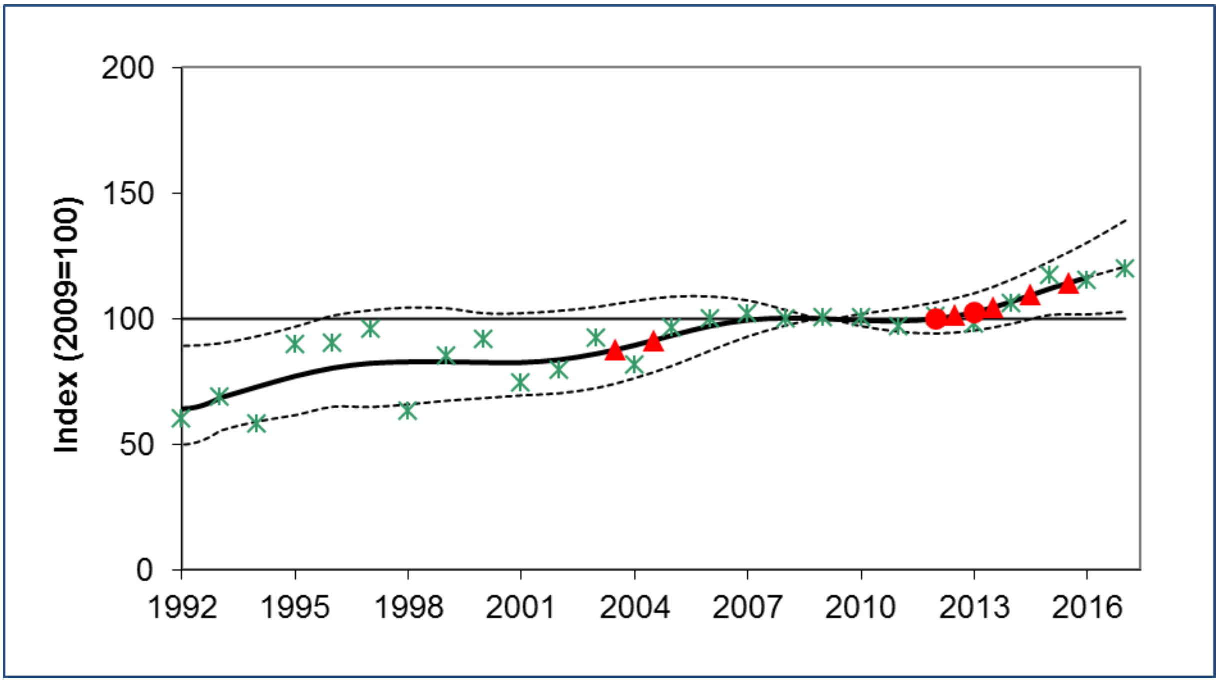

Figure 47 Results of the GAM/GLM model for Lesser Horseshoe Bat summer data with day number as a co-variate. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$).

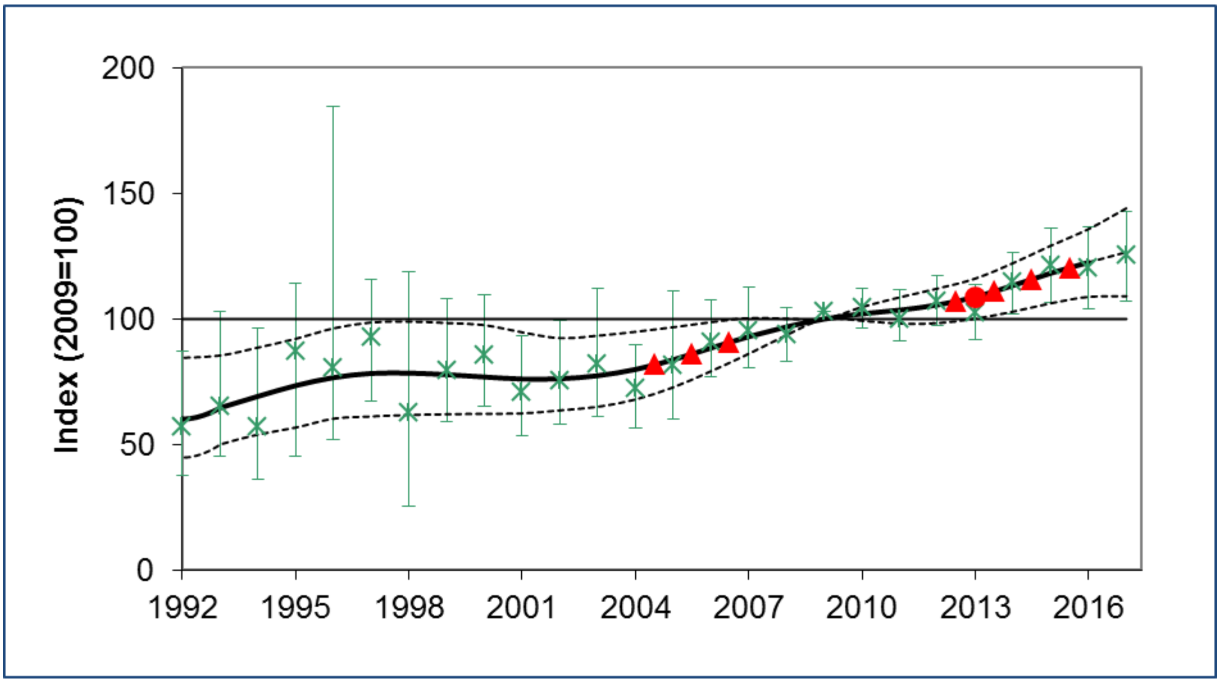

Figure 48 Results of the GAM/GLM model for Lesser Horseshoe Bat summer data with day number and internal counts as co-variates. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2016-2017 and the possibility that the slope will change with coming years' data. Red circles indicate significant ($p<0.05$) change points, where the slope of the smoothed trend line changes. Red triangles indicate that the difference in the smoothed index between consecutive years is statistically significant ($p<0.05$).

5.2.4 Roosting Resource: Trends Within Sites

In Roche *et al*. (2015) we examined the status of the roosting resource of the Lesser Horseshoe Bat and pointed out a number of locations where there were causes for concern within the species' range in Ireland where clusters of roosts or hibernacula appeared to have declined, for example the area around Galway City, south Clare, Limerick and parts of the Iveragh peninsula.

For this report we re-examined trends within sites across five year intervals (see 5.1.1.3). For summer counts, 65 sites had sufficient data to carry out slope analysis in 2008-2012. For the later period, 2013-2017, 91 sites had four or more counts. Among the winter sites 73 had sufficient data to carry out slope analysis in 2008-2012, while 83 sites had four or more counts from 2013-2017.

The proportion of sites with either a declining or increasing trend in summer or in winter changed very little from one five year interval to the next, see Figures 49 and 50. In summer during both five year intervals, a greater proportion of sites were increasing than decreasing while the opposite was true of the winter sites. The proportion of sites moderately increasing was higher in the winter 2013-2017 period than during the previous five years, however.

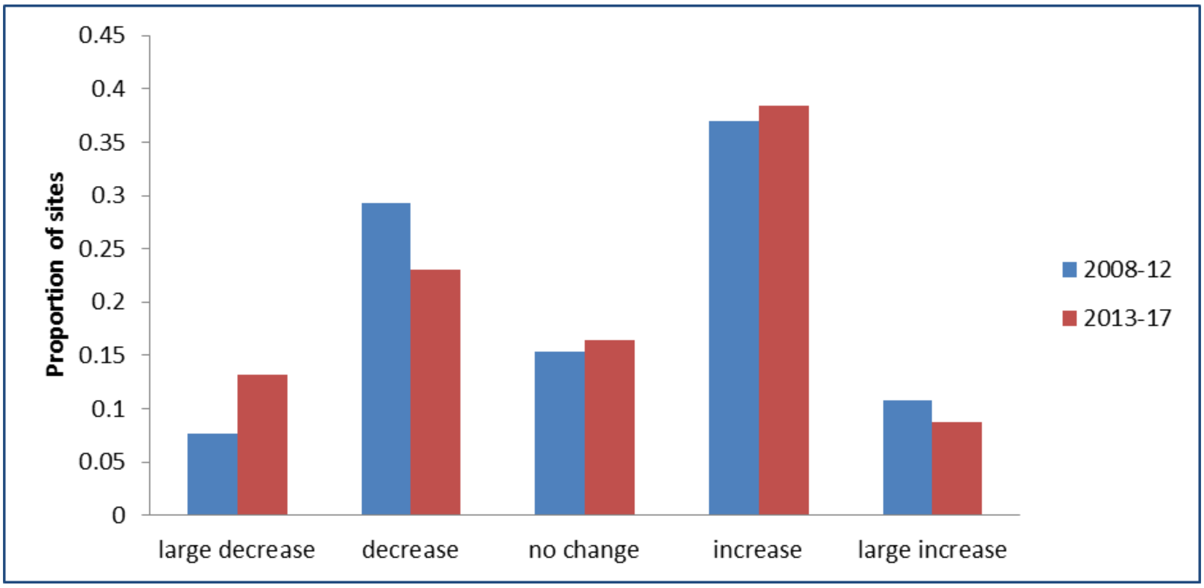

Figure 49 The proportion of summer sites assigned to each trend category in each five year interval, 2008-2012 n=65, 2013-2017 n=91.

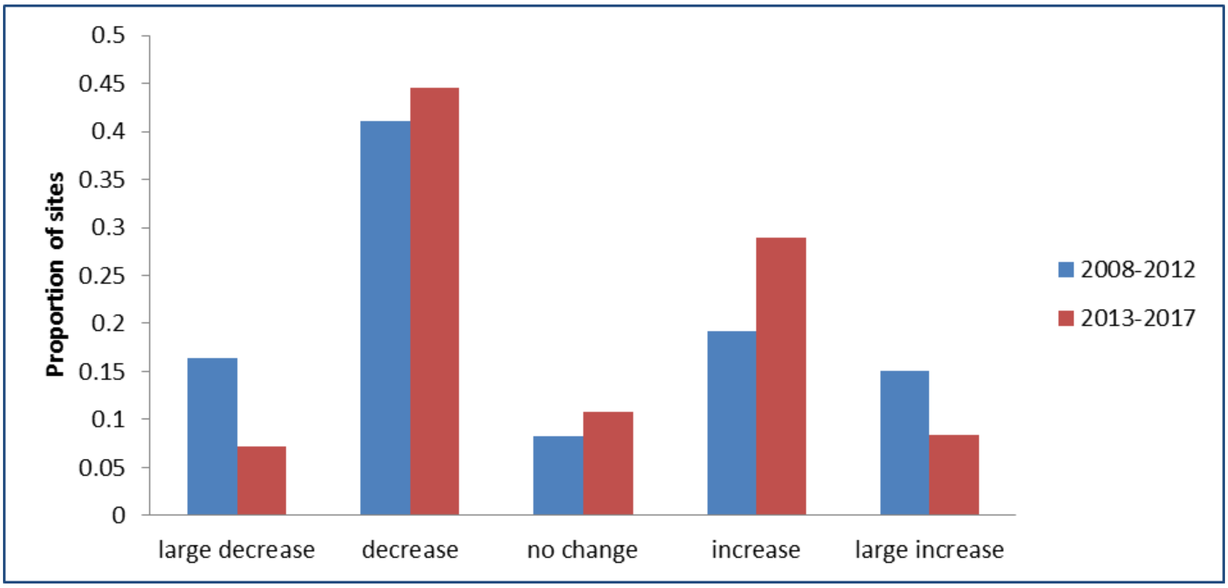

Figure 50 The proportion of winter sites assigned to each trend category in each five year interval, 2008-2012 n=73, 2013-2017 n=83.

We also examined average numbers of bats in sites categorised as decreasing (both 'decrease' and 'large decrease') compared with numbers of bats per site in the increasing categories (both 'increase' and 'large increase'). For both summer and winter sites, the number of bats in decreasing sites was lower in the latter five years of the survey while the number of bats per increasing site was higher in the latter five years, although note the widely overlapping error bars, see Figure 51 and 52. This may indicate the general trend for deteriorating sites becoming abandoned while good sites continue to increase. In general, there tends to be a lower number of bats per site where the trend is downwards, as may be expected.

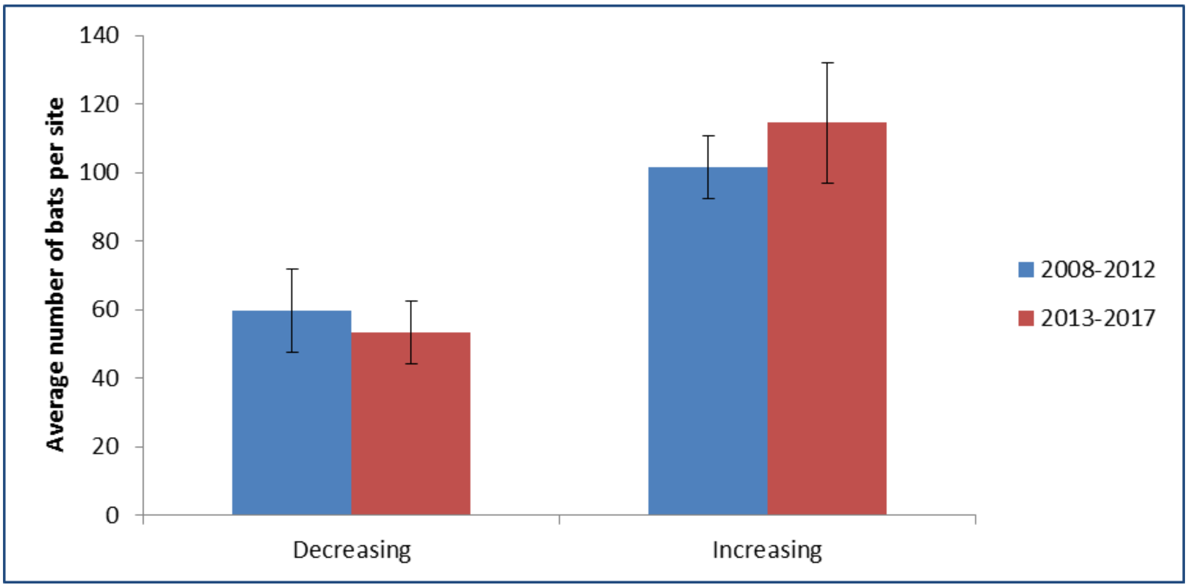

Figure 51 The mean number (and S.E.) of bats per summer site in each five year interval assigned to decreasing or increasing trend categories.

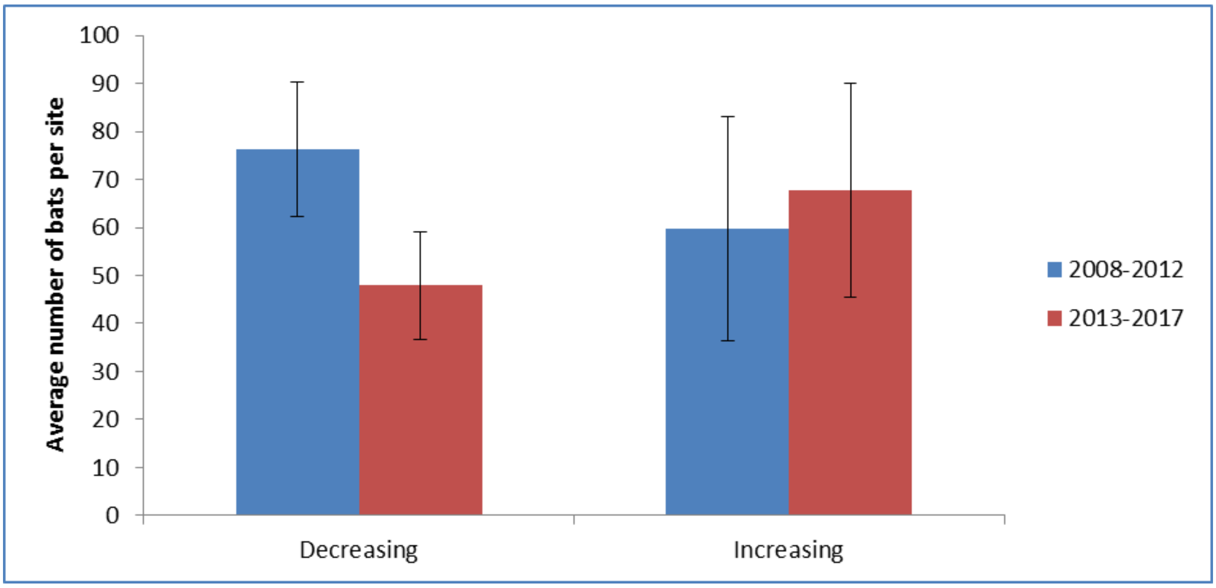

Figure 52 The mean number (and S.E.) of bats per winter site in each five year interval assigned to decreasing or increasing trend categories.

In 2015 we found that both declining and increasing sites were scattered across the distribution range for the species. In the intervening three years there has been no evidence of any major changes in any areas (see Figures 53-56). In the summer sites of south Clare there appears to have been a slight upswing in trends, as well as in winter sites around Kenmare Bay. In contrast, winter sites in south Galway and east Burren appear to be continuing to decline, however. This phenomenon was mentioned in Roche *et al.* (2015) and may be related to the high numbers of bats using Newgrove, an artificial underground structure, for hibernation. Also of interest is the slight increase in winter numbers in Limerick, this location is key to ensuring connectivity between populations in the north and south. Winter sites around Galway City continue to cause concern with declines recorded in the most recent five years of the survey.

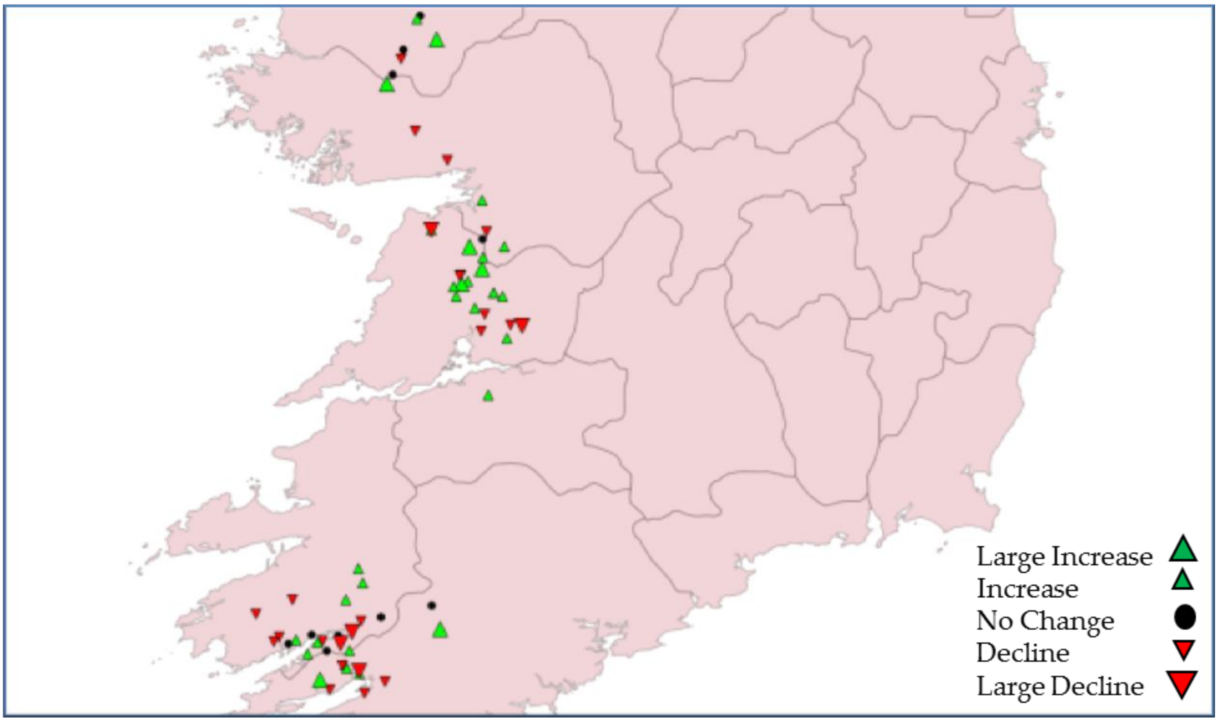

Figure 53 Changes in summer roost numbers per site 2008-2012.

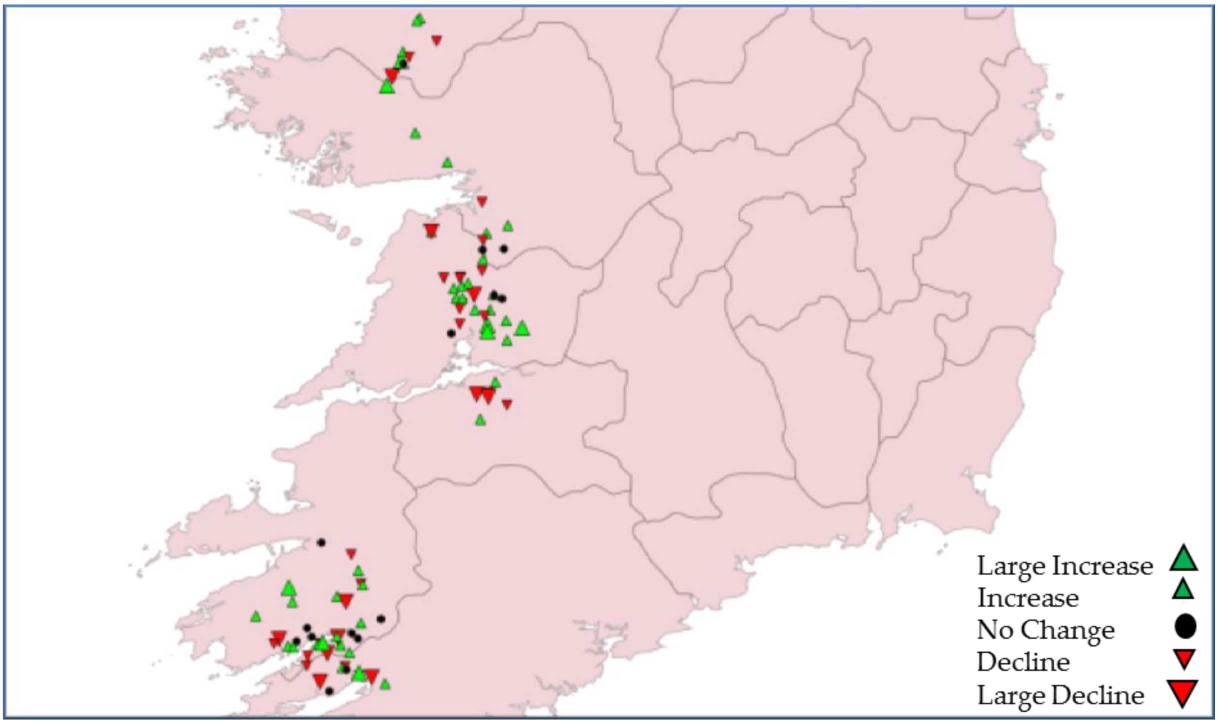

Figure 54 Changes in summer roost numbers per site 2013-2017.

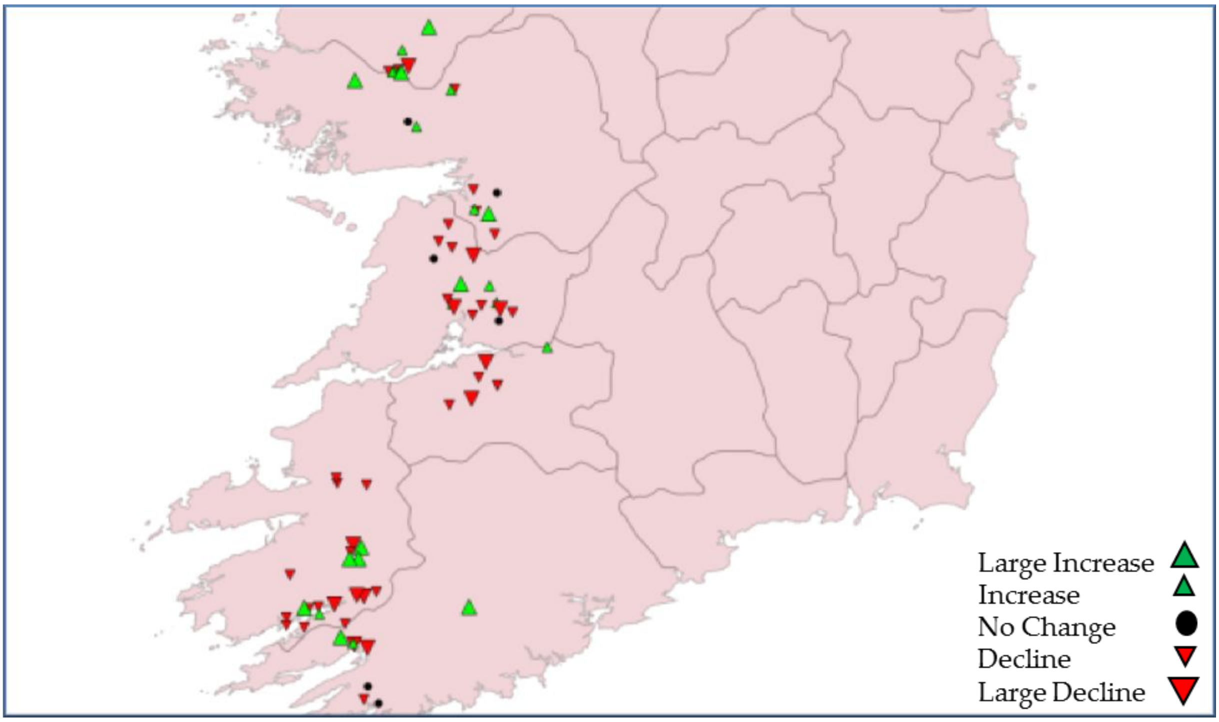

Figure 55 Changes in winter hibernacula numbers per site 2008-2012.

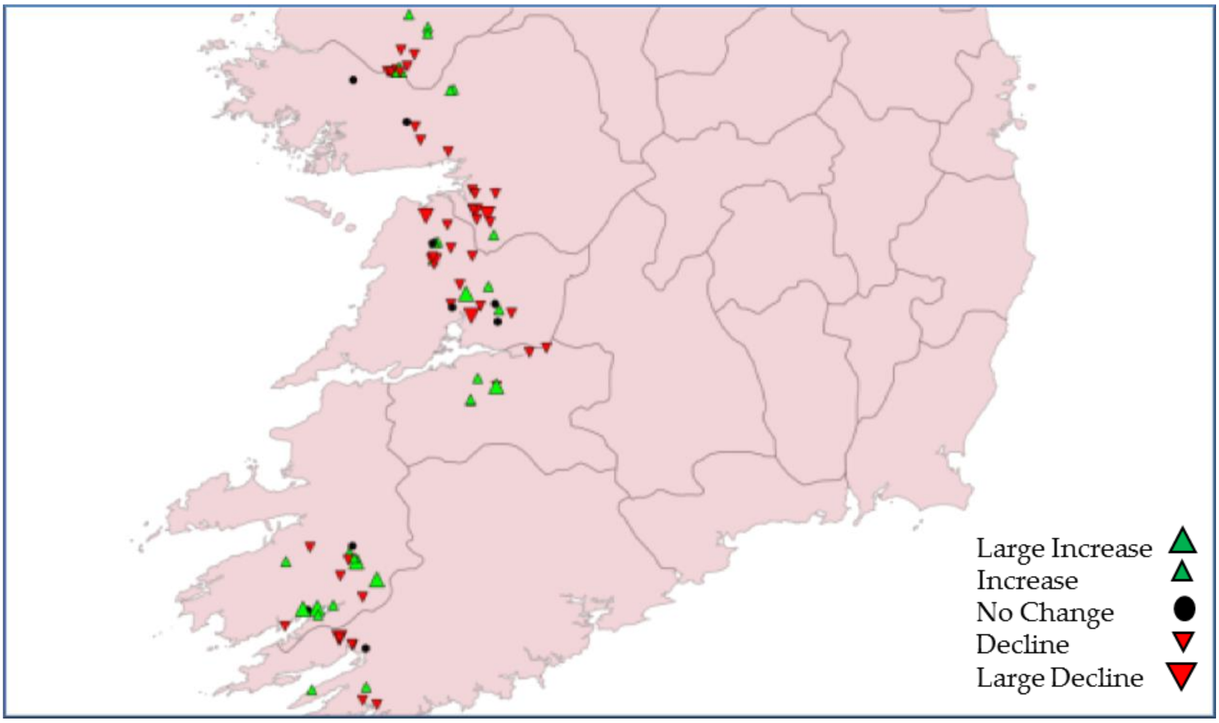

Figure 56 Changes in winter hibernacula numbers per site 2013-2017.

6 Discussion

6.1 Volunteer Participation

Citizen Science is a term used to describe the collaboration between scientists and members of the public in collecting essential information on a topic and it has increased in popularity over the last few decades (Silvertown, 2009). Much of Irish Bat Monitoring Programme involves participation by citizen scientists. There are a number of benefits from members of the public participating in citizen science programmes including increasing scientific knowledge and involvement in local issues (Conrad & Hilchey, 2011).

The Car-based Bat Monitoring Scheme continued to run successfully from 2015 to 2017 with considerable input from volunteer citizen scientists. Smartphones were fully phased in by the start of the contract although the leads used to connect the detectors to phones still cause problems during one or two surveys every year. Surveyors show a very high level of commitment to the scheme by completing surveys in their designated squares year after year. Without their expertise and time input it would not be possible to run the scheme. In general the turnover of volunteers on this scheme is quite low. This has reduced the need for training and recruiting in recent years of the survey, with the exception of training in the use of the new Batlogger units.

In exchange for training and equipment, members of the public are encouraged to survey their local waterway for Daubenton's Bat. The All Ireland Daubenton's Bat Waterway Monitoring Scheme was the first large-scale recruitment programme of the Irish public to bat conservation-related work (Roche *et al.*, 2014). Over the 12 years of the scheme, 751 teams have surveyed for Daubenton's Bat equating to at least 1,502 people. The waterways survey is a very valuable tool for raising awareness about the conservation needs of Irish bats but it also demonstrates the considerable volunteer force that exists in Ireland. Building on this positive result, additional citizen science bat-related programmes have been rolled out including BATLAS 2010 and 2020.

However 50% of the waterways survey teams have only participated for one year which means that there is a need for an annual recruitment drive since a certain percentage of volunteers are lost to the survey every year. The recruitment drive involves approximately 13 training courses per year along with providing on-going support for volunteer teams in the form of bat detectors, training aids and feedback. A considerable amount of work is involved in organising and running courses. When these are run in conjunction with local heritage or biodiversity officers in individual counties, the effort required on the part of BCIreland staff is greatly reduced and the benefit of running the event as part of the county heritage forum greatly increases their value for positive promotion of bats and wildlife conservation in local areas.

In order to monitor the population trends of Daubenton's Bat using the waterways survey method, a minimum of 180 waterways are required to be surveyed twice annually; without the large number of participating volunteer teams, this would be very difficult to achieve. Therefore, the managing body (i.e. BCIreland and the scheme co-ordinator) needs to continue to encourage volunteers to participate for more than one year. Retaining volunteers and keeping them interested is a challenge for citizen science programmes (Conrad & Daoust, 2008). There is genuine interest and willingness on behalf of the public to be involved (Miller-Rushing, Primack, & Bonney, 2012) but the scheme managers need to demonstrate that each volunteer's contribution is valued. In feedback to BCIreland, volunteer teams have requested greater explanation of how their data is used and how important it is. In addition, more training tools and opportunities to increase skill sets have also been requested. A communication plan is one of the recommended steps to feeding back results and managing recommendations for citizen science programmes (Conrad & Daoust, 2008).

For trend population models, only waterways sites surveyed for two or more years are used. Therefore it is important to ensure that waterways sites are surveyed as often as possible when survey teams are available. It is also preferable that the same survey team surveys the same waterway site from year to year. While BCIreland encourages new team members to take on "old" waterways sites, many new teams prefer to have their "local waterway" to survey. Further work needs to go into showing the benefits of taking on "old" waterway sites and repeating surveys. In addition, survey teams are disappointed if they survey waterways where there are no Daubenton's Bats. While we do explain that these "null" waterway sites are important, to retain volunteer teams, it may be more important to offer a different waterway site where Daubenton's Bat has been previously recorded and that the scheme co-ordinator surveys the "null" sites where possible.

For the Brown Long-eared Roost Monitoring Scheme volunteers need to have some experience in identifying bats using bat detectors. There is a smaller potential pool of volunteers within the country with sufficient expertise available to participate in the scheme, compared with Daubenton's waterways surveys, for example. However, the majority of the roosts in the scheme are now monitored by volunteer survey teams. In addition, the majority of teams participating in the scheme have done so since 2007 and this has greatly increased the robustness of the data. Teams to-date have carried out the counts very successfully, especially when they have been trained in situ by the co-ordinator and a team leader is assigned to organise survey dates, collate survey results and return datasheets to BCIreland. Working closely with local bat groups has also proven to be very effective and should continue for any future monitoring of Brown Long-eared Bats. The participation of roost owners in the monitoring scheme has also proven to be a very successful way of gathering data. It encourages roost owners to take a greater interest in their bat roosts and to contribute to the conservation of this species. It has also provided BCIreland with a valuable opportunity to answer queries with regard to bats roosting in housing. BCIreland will continue to encourage and assist roost owners with monitoring of their own roosts and to support current teams and new teams that entered the programme in 2018-2020. We will also continue to ensure that volunteers seeking to upgrade their bat detection skills are provided the opportunity to do so. Due to the success of the current YouTube video, additional videos will be produced to provide additional training and support.

6.2 Survey Coverage

Excellent coverage was achieved by all four monitoring schemes over the three years of the current contract. All schemes achieved the number of surveys required to achieve 80% power to detect Red and Amber Alert declines in the target species.

The car-based bat monitoring survey continued in all 28 squares across the island with at least 50 successful survey returns provided each year from 2015 to 2017.

For Daubenton's Bat a total of 599 waterway sites were surveyed across the island in 2006-2017. These waterway sites are located along 307 discrete waterways; 21 canals, 3 channels and 283 rivers. Coverage is considered to representative of the many different linear waterways on the island. During the twelve years of monitoring, Daubenton's Bat 'passes' were recorded on 85.5% (n=512) of the waterways sites surveyed. Daubenton's Bat has been recorded in every county thus re-confirming the species' wide distribution across the island. This monitoring scheme is, therefore, making a considerable contribution to our knowledge of the distribution range of the Daubenton's Bat. A similarly widespread distribution of this species was reported by the BCT NBMP where Daubenton's Bat was recorded from northern Scotland to southern England (www.bats.org.uk).

A consistently high number of completed surveys were achieved in 2015-2017 survey period for the Brown Long-eared Bat. Currently, there are roosts being monitored in 19 counties across the country. BCIreland aims to reassess roosts previously surveyed in Counties Limerick, Dublin, Wexford, Galway, Sligo, Cavan and Kildare. This will potentially increase coverage to 22 counties. However, four counties are still not represented in the national distribution and this should be addressed in the next 3-year monitoring period. While some roosts become unfavourable to monitor or to access, more than half the roosts in the current dataset have been monitored for at least seven years. Of the 46 roosts surveyed in 2017, 20 were also surveyed in the baseline year of 2008. This is an important factor in ensuring robust population trend analysis. There are currently 46 structures on the database that are suitable for monitoring going forward and five structures that are recommended for reassessment.

For the Lesser Horseshoe Bat a very high number of surveys were completed in both survey seasons 2015-2017 with more than 110 count records provided from at least 89 sites each season. These stretch across the distribution range for the species and account for well over half the entire population on the island in summer and up to half the population in winter. NPWS and VWT staff members are highly dedicated, visiting and reviewing the sites in their areas, providing count information, feedback and information on any new sites that come to light.

6.3 Possible Sources of Bias

Potential sources of bias in the car-based survey have been discussed in previous work. It is accepted that the survey can only provide an assessment of trends for roadside bat activity which may possibly not reflect the countryside as a whole. Other potential confounding factors such as use of detector types have been addressed in this survey by using just one detector type for the entire island. The planned change to Batloggers will only take place when sufficient surveys have been carried out with the two detector systems used simultaneously so that its impact can be fully understood and accounted-for in advance. We examined the possibility of phenological effects on our survey date ranges and for both pipistrelle species the trends in July and August were very similar. With Leisler's Bat increases in the trend index appeared to show up in August earlier in the time series and in July more recently suggesting that young may be volant earlier in more recent years. However, the two trends are not wholly dissimilar. Also, the comparison of July and August trends for all three species shows that unsmoothed estimates in each month are not particularly correlated. This suggests that the year-to-year effects might owe more to factors such as weather than true annual differences. We plan to take a further look at the use of covariates in the models to see whether these can lead to a reduction in the width of confidence limits.

For the Daubenton's survey an array of bat detector models is used by participating volunteer teams. Many of the volunteer teams also borrow a bat detector from BCIreland for the duration of the survey. Ten bat detector models have regularly been used by volunteer teams. However bat detector models have changed considerably since 2006. In the early years, Magenta Mark III was favoured but this was replaced by Magenta Bat 4 detector from 2011 onwards, while Stag Electronics Bat Box III detector or Bat Box 3D detector (in later years) has been frequently used throughout the monitoring period. As different bat detector models have different microphones, the capacity of the model to pick up different bat species can vary. Cheaper models tend to have poorer quality microphones and bat echolocation calls can often sound different from one model to another. Buckland and Johnston (2017) highlight the technological advances in bat detectors as one potential bias in bat monitoring schemes. One method to reduce to bias is to include the type of detector in the models of trends. While the potential impact of bat detector model has always been included in the Daubenton's Bat trend model, closer consideration of this potential bias is required as a precaution. BCIreland purchases the cheaper bat detector models for the waterways survey, principally because the detector is not the main tool for identification of Daubenton's Bat. It can be considered a tool to alert the volunteer team to bats nearing to their survey spot. A positive recording of a Daubenton's Bat is confirmed by seeing the bat as it flies across the surface of the waterway through the beam of torch light. As a consequence, the potential bias of changing bat detectors is not as much of a problem in this survey scheme as for other bat monitoring schemes that rely solely on bat detectors. However, BCIreland recommends the continued documentation of bat detector model type on survey forms.

Buckland and Johnston (2017) consider that the monitoring of roosts is inherently biased from the start because sites are usually selected based on known colonies. This was the case for the Brown Long-eared roost monitoring programme and continues to be the situation as new sites are added when BCIreland is alerted to a colony being identified. Over the years, colonies that have become abandoned are still included in the dataset but are no longer being surveyed. As a result, this can lead to negatively biased estimates in population trend models. However this is more of a concern for bat species that are known "roost switchers" such *Pipistrellus* species. Roost faithful species such as Brown Long-eared Bat, tend not to be such a problem. However, to reduce any negative bias, it is recommended that roosts previously surveyed for the scheme but not included should be reassessed for future inclusion in the survey scheme. Five such roosts have been identified and are listed in Appendix 3.

Discussions with regard to bias arising from the use of different bat detector models in the waterways survey has highlighted the need to closely look at this for other monitoring schemes, including the Brown Long-eared Bat roost counts. BCIreland have a pool of heterodyne bat detectors that are loaned to volunteer teams when requested. Due to the fact that this species is quieter and more difficult to detect, the models loaned to volunteers are of higher quality compared to those used by the waterway surveyors (e.g. Pettersson D200 and Bat Box Duet models compared to Magenta 4 for waterway surveys). In addition, volunteer teams are requested to use particular models of detectors for the roost surveys. However, volunteers have not been asked to-date to note the bat detector model used for the roost monitoring surveys and as a consequence, the potential impact of bat detector model has not been included in the trend model. Therefore, closer consideration of this potential bias is required as a precaution for the future operation of the scheme. On the positive side, it may be considered that the potential bias of changing bat detectors or using different models is not as much of a problem during roost emergence as for some bat monitoring schemes that rely solely on bat detectors because there is a visual element involved in the emergence counts and that there is no bias in relation to internal counts. However, BCIreland recommends the documentation of bat detector model type on survey forms for 2018-2020.

The accuracy of roost counts can also be increased by the use of filming. While this is an expensive option and cannot be used for all emergence surveys, BCIreland have two high quality camcorders with night-shot capability and filming has been successfully deployed in 2016 and 2017 at a small number of roosts. The use of filming has also resulted in more accurate location of exit points. Structures can change over time and as a result, the usage of the structure by bats changes; the deployment of cameras periodically at roosts will help ensure that roosts are surveyed correctly. It can also boost confidence for volunteer survey teams. Therefore it is recommended that for the 2018-2020 survey period, that the deployment of cameras is undertaken at all roosts where the exit point is <4m high at least once as part of a validation protocol. This validation is also an important process for citizen science programmes (Conrad & Hilchey, 2011) and for trend analysis (Buckland and Johnston, 2017).

6.4 Bat Species Trends

In the last reporting round the baseline year for trend analysis for the Car-based Bat Monitoring Scheme target species had been set to 2004 but this has been revised to 2006 in light of suggestions by Buckland and Johnston (2017). Common Pipistrelle trends have fluctuated somewhat but highest encounters to date were recorded in 2017. Overall the trend has been upwards. Since the baseline year of monitoring, 2006, the index has increased by an estimated 37.5% which amounts to a per annum increase of 2.7%. In Britain an increase was been recorded for the same species from foot-based field surveys carried out by the Bat Conservation Trust from 1999 to 2016 and it is now 82% above the 1999 baseline (Bat Conservation Trust and Joint Nature Conservation Committee, 2018).

Highest Soprano Pipistrelle encounter rates were also recorded by the Car-based Bat Monitoring Scheme in 2017. Since the baseline year of monitoring in 2006, the index for the species has more than doubled (+105%) representing a yearly change of +6.2%. In Britain this species increased to 2008 and declined thereafter to 2012. More recently the trend has been upwards again. In Britain it has not increased to the same extent as its sibling species, the Common Pipistrelle, with the 2016 index currently 58% above the 1999 baseline (BCT and JNCC, 2018).

The highest Leisler's Bat encounter rates were recorded by the Car-based Bat Monitoring Scheme in 2014. Since the baseline year of monitoring in 2006 the index for the species has increased by 30% representing a yearly change of +2.2%. However, error bars currently encompass the baseline so this trend should be treated with caution.

For all three species, therefore, Car-based Bat Monitoring Scheme data indicates that they are increasing or at the very least, stable. However, any current increases in Irish bat species must be placed within the context of widespread historical habitat loss across the island over past centuries.

While no other species are encountered by the Car-based Bat Monitoring Scheme in sufficient numbers to allow robust analysis of trends, a binomial analysis of Nathusius' Pipistrelle tentatively indicates that the species remains stable or may be slightly increasing. The records collected for this species from Car-based Bat Monitoring Scheme confirm that the species is a summer resident within the Republic of Ireland, as well as Northern Ireland, even though no maternity roosts have been found in the Republic of Ireland to-date. In the past three years the species was recorded from a higher number of survey squares than the previous three years of the scheme, which lends further credence to the suggestion that it is currently increasing on the island.

In 2009 we examined trends in Daubenton's Bat using a binomial method. This is a more effective way to establish trends since the impact of bat detector model on observed passes is diminished and other effects such as surveyor skill are likely to have less of an impact on overall trends (MacKenzie *et al*, 2006). As a result, the binomial model was again used in 2017 and can be compared with the Poisson model which has wider error bars and a slightly more fluctuating trend. However, the Poisson method is also reported as it is comparable with BCT reporting and considering the potential bias from advances in detector model (as discussed in Section 3.3.2), retaining the Poisson method is recommended.

Overall the smoothed index (Poisson Model) is currently 26.07% above the 2007 base year value which is equivalent to an average 2.34% annual increase. Overall the smoothed index for the binomial model is currently 11.47% above the 2007 base year value which is equivalent to an average 1.09% annual increase. This is comparable to the trend data from the BCT National Bat Monitoring Scheme. The smoothed index reported by the BCT is currently 4.6% above the 1999 base year value, equivalent to an average annual increase of 0.3%. The trend has remained stable since monitoring began in 1999.

Trend models were also run for Daubenton's Bat in Northern Ireland and the Republic of Ireland separately. Overall the smoothed index (Poisson Model) for Northern Ireland is currently 87.35% above the 2007 base year value which is equivalent to an average 6.48% annual increase. However caution is required as the error bars are wide. For the Republic of Ireland the increase is more reserved and may be a reflection of a more robust dataset due to over four times the number of waterway sites surveyed compared to Northern Ireland. Overall the smoothed index (Possion Model) is currently 10.91%above the 2007 base year value which is equivalent to an average 1.04% annual increase.

The smoothed index for Brown Long-eared Bat from roost counts, using the model with covariates, is currently 32.52% above the 2008 base year value, which is equivalent to an average 3.18% annual increase. The Irish Brown Long-eared Batmodelled trend is comparable to the trend data from the BCT National Bat Monitoring Scheme. The smoothed index reported by the BCT for Brown Long-eared Bat roost counts (n=157 roosts) is currently 28.2% above the 2001 base year value, equivalent to an average annual increase of 1.8%. The trend has fluctuated since monitoring started, and is currently increasing.

However the confidence intervals of the BCT trend have always overlapped with the index value of the base year meaning that **the change has not been significant**.

The Lesser Horseshoe Bat increased significantly from the early years of the survey in the early 1990s. While some caution is needed when interpreting trends from early years due to low sample sizes, we can be reassured by the fact that summer and winter trends converge, increasing up to the early 2000s, levelling out somewhat in the mid-2000s and more recently increasing again. Further investigations into the dataset have shown that summer counts carried out by internally checking buildings may be inclined to underestimate numbers of bats present. To account for this we analysed the summer data with a co-variate for internal counts. The results of this analysis show steeper increases. Overall in Ireland over the past 20 years (1998-2017) the species increased by between 100% in winter and 62% in summer, from the GAM smoothed models. The UK NBMP has also reported a difference in the extent of increase recorded by winter versus summer counts (BCT and JNCC, 2018). Between 1999 and 2016 the population change in the UK was 158% from winter counts and 80.4% from summer counts. The short term change in the UK from 2010 to 2015 was 22.7% in winter and 11.8% in summer (BCT and JNCC, 2018). These compare with higher recent increases in Ireland of 39.9% in winter and 19.9% in summer (2012-2017). The yearly trend over the past six years (2012-2017) in Ireland has been for a 5.8% annual increase in winter sites and a 3.8% yearly increase in summer sites.

6.5 Room for Improvement

Trials to facilitate the roll out of Batlogger M detectors on the car transect surveys took place in 2016 and 2017. Results are encouraging with a high degree of correlation between results from Batloggers and Tranquility detectors suggesting that it should be possible to account for the equipment changeover using a covariate with little loss in precision. However, results from the 2017 surveys also suggest that there may be some variability in sensitivity of the Tranquility detectors which may have to be accounted-for, if possible, in the roll out of the new detectors.

For Daubenton’s Bat the trend datasets only include waterway sites surveyed for two or more years. The 2006-2017 dataset contains 158 waterway sites that have only one year of data. To increase the robustness of the dataset, particular counties will need to be further targeted for surveying to decrease the number of single surveyed waterway sites. Overall the aim should be to include at least 80% of waterways sites in the dataset for trend analysis. At the moment this stands at 74.6%.

There are 599 waterway sites in the dataset and on average only 40% are surveyed annually. While the methodology used in the trend analysis can, in theory, form a trend from short runs of data, results will be more convincing, and less susceptible to bias, when many of the sites have been surveyed in most years. It is therefore worth working at trying to improve these figures, for example by encouraging new volunteers to take on sites that were regularly visited in the past, but which are no longer being surveyed.

Volunteers are encouraged to take on sites that have no volunteer teams but this is dependent on their location. Volunteers prefer to have waterway sites that are in close proximity to their home address to reduce travel. We have found that the further volunteers are required to travel the less likely they are to complete their surveys.

Therefore in 2018-2020, counties with a high proportion of single year surveyed waterway sites should be targeted for training courses and waterway sites that have not been surveyed in the last five years should be identified and promoted to new volunteer teams.

On an annual basis to ensure that surveys are wholly representative of the island greater targeting of volunteer recruitment and surveying is required for counties where participation is low, and this should be assessed prior to the start of each survey season. BCIreland has tried to ensure this in the past and the scheme co-ordinator has set up waterways sites to be surveyed annually by her in counties that have little volunteer participation (e.g. Co. Monaghan). In addition, training courses tend to be organised in counties where recruitment is required.

For the Brown Long-eared Bat counts, many of the roosts have been surveyed since the early years of the operation of the scheme. It is important that an intensive re-survey of such structures is periodically undertaken to ensure that exit points previously used by the bat colony have not changed. Therefore, the scheme co-ordinator will identify such roosts to determine the continued suitability of these roosts for counting as part of the scheme. These roosts will also be targeted for surveying using camcorders and IR illuminators to help identify any issues potentially present.

6.6 Ancillary Data

The data for vertebrates other than bats are not collected in a standardised fashion during the Car-based Bat Monitoring Survey and may be influenced by factors such as driving speed (which is variable between transects), car headlight beam intensity, and roadside verge vegetation density and height among others. We have no available estimates of detectability for the other vertebrates that are recorded during the car-based survey. Using the raw data with time as a weighting factor it is of interest that fox and rabbit trends in Ireland have shown similar patterns in roadside activity levels to-date with both species having shown moderate declines from 2007 to 2017. However, bearing in mind the potential sources of error in these data it may be that issues impacting detectability (such as roadside vegetation) may affect counts of both species equally and therefore result in similar, but possibly erroneous, trends.

Testing of methodologies and statistical methods, as well as additional analyses are carried out as routine. In the current three year contract, work on Nathusius' Pipistrelle records and Common and Soprano Pipistrelle habitat use along roadsides was published in two papers in the Irish Naturalists' Journal (Dick & Roche, 2017; N. Roche *et al.*, 2015). In-depth research on the impacts of weather on trends has now been carried out and is the subject of a new paper, currently in preparation and due for submission to a peer reviewed journal in spring 2018.

The large number of bat records generated by the monitoring schemes will feed into Article 17 reporting for Ireland in the coming months and has also been used for various publications such as the Atlas of Mammals in Ireland (Lysaght & Marnell, 2016).

Additional data is also recorded by All Ireland Daubenton's Bat Waterways surveyors and including sightings of owls, otters to name but a few. This data is submitted to both Bird Watch Ireland and the NBDC respectively has also been used for various publications such as the Atlas of Mammals in Ireland (Lysaght & Marnell, 2016).

7 Recommendations

7.1 Car-based Bat Monitoring

Recommendation 1	Continue to survey the 28 Survey Squares across the Republic of Ireland and Northern Ireland using the present survey protocol. Sites should continue to be surveyed twice per annum within the specified date ranges (see Appendix 1 for list of Squares and transect start and stop points).
Recommendation 2	Facilitate continued cooperation between agencies in Northern Ireland and the Republic of Ireland.
Recommendation 3	Continue to ensure equipment and software are fit for purpose by comprehensive testing in advance of dissemination in the summer and providing back up connector leads to account for possible lead failure during the survey season. Also, ensure survey teams are provided with sufficient training and support to carry out the surveys.
Recommendation 4	Continue Batlogger trials and testing and as part of this test the microphones of the existing Tranquility detectors. Seek funding for batloggers for Northern Ireland. Aim to have all squares changed over to Batloggers by summer 2021. Revise/update MySQL database to allow recording of dual system data and Batlogger only data.
Recommendation 5	Continue to provide “cloud-based” data sharing system such as Dropbox to facilitate online uploading of results.
Recommendation 6	Provide detailed feedback to surveyors in the form of overall bat numbers per survey, as well as detailed maps of bat records where sufficient GPS data is available.
Recommendation 7	Continue to share Republic of Ireland data with NBDC, and Northern Irish data with CEDaR and BCT and 3rd level researchers.
Recommendation 8	Continue to employ a professional statistician with experience of bat data interpretation to carry out analysis of the data.
Recommendation 9	Review phenological changes and possibility of improving trend estimates by including additional covariates in the trend models accounting for weather impacts on Survey 1/Survey 2.
Recommendation 10	Continue to carry out research based on the car monitoring dataset and publish research in peer-reviewed scientific journals, as well as presenting data at national and international scientific conferences.

7.2 Daubenton's Bat Waterways Monitoring

Recommendation 1	Continue to survey Daubenton's Bat using the current methodology. In particular, sites should continue to be surveyed twice in the month of August and start time should remain at 40 minutes after sunset.
Recommendation 2	Waterway sites surveyed in previous years should be re-surveyed from year to year to increase the robustness of the data.
Recommendation 3	Aim to survey a minimum of 200 sites, 170 in the Republic of Ireland and 30 in Northern Ireland. Aim to survey at least 80% of these twice annually. (See Appendix 2 for list of sites surveyed since 2006).
Recommendation 4	Strive to survey a minimum of 5 waterway sites per county with an aim of 50 waterway sites per province to allow for regional differences to be investigated.
Recommendation 5	Continue to provide annual training courses as a means to recruit new volunteers and as a means to provide education on the conservation of bats in general. Where necessary to ensure continuity of waterway sites, new volunteers should be deployed to cover waterway sites previously surveyed. Otherwise, continue to provide volunteers with three potential sites within 10km radius of their preferred survey area.
Recommendation 6	Improve technical support for volunteers. Produce additional survey videos to increase technical support for volunteers. Continue to provide volunteer support by email, Daubenton's Bat newsletters and training programmes. Consider the adoption of an online system for volunteers to return their survey forms. Continue to maintain a library of bat detectors for loan to volunteer teams.
Recommendation 7	Continue to utilise regional paid-surveyors to ensure that core sites are surveyed twice annually.
Recommendation 8	Continue to employ a professional statistician with experience of bat data interpretation to carry out analysis of the data. Future statistical analysis should concentrate on binomial analysis for assessing population trends, but models based on counts of bats should continue to be checked for any differences from the binomial model. Trend analysis should be undertaken annually and with the effectiveness of the design reviewed once every 3 years, for example by undertaking power analysis and by checking the coverage of sites and continuity of recording at sites.
Recommendation 9	Undertake the monitoring scheme on an all-island basis with continued cooperation between agencies in Northern Ireland and the Republic of Ireland. Encourage and sustain the involvement of NPWS and NIEA Regional Staff, Local Authorities' Heritage and Biodiversity Officers and Waterways Ireland in the organization of training courses and the surveying of waterway sites. Seek further partnership with Environmental Protection Agency, Republic of Ireland and Water Quality Unit, NIEA.
Recommendation 10	Continue to share data with BCT, UK, CeDAR, Northern Ireland and NBDC, Republic of Ireland.

7.3 Brown Long-eared Roost Monitoring

Recommendation 1	Brown Long-eared roost monitoring should continue with 2-3 counts completed for each monitored roost annually according to roost survey methodology (See Appendix 3, Table A3.1).
Recommendation 2	A minimum of 40 roosts should be monitored twice annually. Dates for survey periods should be changed to the following dates: Survey 1: 16 May to 15 June; Survey 2: 16 June to 31 July & Survey Period 3: 1 August to 30 August. (See Appendix 3, Table A3.2 for a list of sites recommended for monitoring in 2018-2020). Ensure that roosts are surveyed according to recommended survey method and that internal counts are completed by a licensed bat worker.
Recommendation 3	Continue to investigate potential roosts in counties Monaghan, Leitrim, Carlow and Westmeath in 2018-2020 to increase regional representation. All new sites should be assessed using the preliminary roost survey methodology (See Appendix 3, Table A3.1).
Recommendation 4	Continue to carry out volunteer recruitment with the aim of having greater than 70% of roosts monitored annually by volunteer teams and roost owners. Volunteers participating in other monitoring schemes and people who have attended bat detector workshops should be contacted to determine their interest in joining a local team to monitor a roost within their county. This will help ensure that the scheme can continue sustainably and cost effectively.
Recommendation 5	Continue to encourage and assist roost owners with monitoring of their own roosts.
Recommendation 6	Continue to keep in close communication with volunteers and to encourage those who are unable to carry out counts to inform us well in advance of the field season.
Recommendation 7	Continue to encourage volunteer surveyors to collect data in a standardised manner. Survey start time should continue to be 20 minutes after sunset. Provide volunteers with sunset time tables specific to their roosts to ensure that volunteer teams start surveys at an accurate time. Continue to emphasise the important of completing surveys on nights where the weather is forecasted to remain dry for the entire survey.
Recommendation 8	Change survey sheets to require volunteer survey teams to note the bat detector model used.
Recommendation 9	Investigate potential phenological effect on roost data collected over the 3 survey periods.
Recommendation 10	Complete broad habitat mapping within 0.5km radius distance from the roosts and a roost profile for each roost recommended for monitoring in 2018-2020.
Recommendation 11	Continue to employ a professional statistician with experience of bat data interpretation to carry out analysis of the data.
Recommendation 12	Reassess the five roost sites previously monitored and recommended for re-surveying (See Appendix 3, Table A3.2 for details).

7.4 Lesser Horseshoe Bat Roost Monitoring

Recommendation 1	Lesser Horseshoe Bat roost and hibernacula monitoring should continue with counts completed annually in winter and summer.
Recommendation 2	A minimum of 70 roosts should be monitored annually in winter. While, for sufficient power just 50 core sites need to be counted in summer, ongoing deterioration of many summer sites means that problems are detected sooner when annual counts are carried out. Therefore, within constraints on available staff time as well as health and safety considerations, at least 50 and as many summer sites as possible should be recounted annually. Large sample sizes also reduce the potential for bias that is inherent in roost count monitoring schemes (see Discussion).
Recommendation 3	Selection of sites for monitoring should be based on the data available in the Lesser Horseshoe Bat MS Access Database in consultation with regional NPWS and VWT staff.
Recommendation 3	Dates for surveys: January and February for hibernacula, 23 May to 7 July for summer sites.
Recommendation 4	The subject of phenological changes to breeding times and climate impacts should be investigated with regard to the LHB dataset.
Recommendation 5	Continue to keep in close communication with NPWS and VWT staff.
Recommendation 6	Continue to encourage and assist NPWS staff with site visits.
Recommendation 7	Continue to encourage surveyors to collect data in a standardised manner.
Recommendation 8	Communicate the need to record whether sites have been surveyed using internal or external emergence counts, due to the impact this has on trend estimation error.
Recommendation 9	Continue to employ a professional statistician with experience of bat data interpretation to carry out analysis of the data.
Recommendation 10	Ensure yearly importation of site counts and site records to the Lesser Horseshoe Bat MS Access Database. Plan and execute a changeover to a GIS-based database.

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Appendix 1 Car-based Bat Monitoring

Table A1.1 Locations of Car-based Bat Monitoring Scheme Transects (2012 onwards)

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
C72	1	C989247	Finish	298900	424700
C72	2	C9260028500	Finish	292600	428500
C72	3	C9070025000	Finish	290700	425000
C72	4	C9350021700	Finish	293500	421700
C72	5	C8683919995	Finish	286839	419995
C72	6	C8430027100	Finish	284300	427100
C72	7	C8100026300	Finish	281000	426300
C72	8	C7350022500	Finish	273500	422500
C72	9	C7250026500	Finish	272500	426500
C72	10	C7470030500	Finish	274700	430500
C72	11	C7300034900	Finish	273000	434900
C72	12	C7760032400	Finish	277600	432400
C72	13	C8050029100	Finish	280500	429100
C72	14	C8300033300	Finish	283000	433300
C72	15	C8671130204	Finish	286711	430204
C72	1	C982261	Start	298200	426100
C72	2	C9360027000	Start	293600	427000
C72	3	C8970026600	Start	289700	426600
C72	4	C9560021900	Start	295600	421900
C72	5	C8808521262	Start	288085	421262
C72	6	C8550026200	Start	285500	426200
C72	7	C8000025000	Start	280000	425000
C72	8	C7330020600	Start	273300	420600
C72	9	C7130025600	Start	271300	425600
C72	10	C7450028900	Start	274500	428900
C72	11	C7170034100	Start	271700	434100
C72	12	C7840033800	Start	278400	433800
C72	13	C8010030600	Start	280100	430600
C72	14	C8170034400	Start	281700	434400
C72	15	C8552331053	Start	285523	431053
G20	1	G2296205204	Finish	122962	305204
G20	2	G2238408965	Finish	122384	308965
G20	3	G2054412525	Finish	120544	312525
G20	4	G2130516798	Finish	121305	316798
G20	5	G2575721619	Finish	125757	321619
G20	6	G2694225914	Finish	126942	325914
G20	7	G3164823879	Finish	131648	323879
G20	8	G3273919317	Finish	132739	319317
G20	9	G3195114782	Finish	131951	314782
G20	10	G3010810225	Finish	130108	310225
G20	11	G2921006284	Finish	129210	306284
G20	12	G3260904555	Finish	132609	304555
G20	13	G3580303486	Finish	135803	303486
G20	14	G3934905050	Finish	139349	305050

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
G20	15	G4078409862	Finish	140784	309862
G20	1	G2150504895	Start	121505	304895
G20	2	G2297407907	Start	122974	307907
G20	3	G2037610851	Start	120376	310851
G20	4	G2055616258	Start	120556	316258
G20	5	G2547019773	Start	125470	319773
G20	6	G2633124533	Start	126331	324533
G20	7	G2991324108	Start	129913	324108
G20	8	G3251420927	Start	132514	320927
G20	9	G3220616373	Start	132206	316373
G20	10	G3064811719	Start	130648	311719
G20	11	G2822607930	Start	128226	307930
G20	12	G3237602981	Start	132376	302981
G20	13	G3450603992	Start	134506	303992
G20	14	G3885903985	Start	138859	303985
G20	15	G4051108229	Start	140511	308229
G53	1	G6434443955	Finish	164344	343955
G53	2	G6012044439	Finish	160120	344439
G53	3	G6426548671	Finish	164265	348671
G53	4	G6957251405	Finish	169572	351405
G53	5	G7245656058	Finish	172456	356058
G53	6	G7690157581	Finish	176901	357581
G53	7	G7957254838	Finish	179572	354838
G53	8	G7879149723	Finish	178791	349723
G53	9	G7822642477	Finish	178226	342477
G53	10	G7338343132	Finish	173383	343132
G53	11	G7352539674	Finish	173525	339674
G53	12	G7612735886	Finish	176127	335886
G53	13	G7888333940	Finish	178883	333940
G53	14	G7828830371	Finish	178288	330371
G53	15	NULL	Finish		
G53	1	G6752243409	Start	165697	343431
G53	2	G6106945154	Start	161069	345154
G53	3	G6317347808	Start	163173	347808
G53	4	G6823250713	Start	168232	350713
G53	5	G7105455708	Start	171054	355708
G53	6	G7558457003	Start	175584	357003
G53	7	G7819454614	Start	178194	354614
G53	8	G7926951108	Start	179269	351108
G53	9	G7939741838	Start	179397	341838
G53	10	G7463643612	Start	174636	343612
G53	11	G7207439546	Start	172074	339546
G53	12	G7588837295	Start	175888	337295
G53	13	G7944734912	Start	179447	334912
G53	14	G7963230992	Start	179632	330992
G53	15	G741303	Start	174100	330300
G89	1	G82799289	End	182790	392890
G89	2	G86829401	End	186820	394010
G89	3	G91109531	End	191100	395310

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
G89	4	G95169683	End	195160	396830
G89	5	G9958597011	End	199585	397011
G89	6	H09289626	End	209289	389626
G89	7	C10300995	End	210300	409950
G89	8	C09321216	End	209320	412160
G89	9	C09971650	End	209970	416500
G89	10	C07241849	End	207240	418490
G89	11	C04491453	End	204490	414530
G89	12	C00451383	End	200450	413830
G89	13	B96561550	End	196560	415500
G89	14	B92951240	End	192950	412400
G89	15	B8957809171	End	189578	409171
G89	1	G8150093446	Start	181500	393446
G89	2	G85249393	Start	185240	393930
G89	3	G89719437	Start	189710	394370
G89	4	G93809699	Start	193800	396990
G89	5	G9806196714	Start	198061	396714
G89	6	H0669896354	Start	206698	396354
G89	7	C11610914	Start	211610	409140
G89	8	C08881072	Start	208880	410720
G89	9	C09241507	Start	209240	415070
G89	10	C08531836	Start	208530	418360
G89	11	C05951587	Start	205950	415870
G89	12	C02061344	Start	202060	413440
G89	13	B97911543	Start	197910	415430
G89	14	B94111356	Start	194110	413560
G89	15	B9092810230	Start	190928	410230
H13	1	H1169354820	Finish	211693	354820
H13	2	H1034551711	Finish	210345	351711
H13	3	H10184766	Finish	210180	347660
H13	4	H1108043184	Finish	211080	343184
H13	5	H1159239435	Finish	211592	339435
H13	6	H1159633650	Finish	211596	333650
H13	7	H2008230983	Finish	220082	330983
H13	8	H2817831032	Finish	228178	331032
H13	9	H3413933624	Finish	234139	333624
H13	10	H3933330479	Finish	239333	330479
H13	11	H384343	Finish	238400	334300
H13	12	H383403	Finish	238300	340300
H13	13	H387466	Finish	238700	346600
H13	14	H389522	Finish	238900	352200
H13	15	H3874157977	Finish	238741	357977
H13	1	H1098856297	Start	210988	356297
H13	2	H1169751985	Start	211697	351985
H13	3	H1120547467	Start	211205	347467
H13	4	H1235843947	Start	212358	343947
H13	5	H1002839359	Start	210028	339359
H13	6	H1027034280	Start	210270	334280
H13	7	H1991032562	Start	219910	332562

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
H13	8	H2673531038	Start	226735	331038
H13	9	H3551834742	Start	235518	334742
H13	10	H3808831278	Start	238088	331278
H13	11	H397355	Start	239700	335500
H13	12	H378387	Start	237800	338700
H13	13	H387450	Start	238700	345000
H13	14	H379509	Start	237900	350900
H13	15	H399569	Start	239900	356900
H40	1	H462018	Finish	246200	301800
H40	2	H504023	Finish	250400	302300
H40	3	H528023	Finish	252800	302300
H40	4	H569014	Finish	256900	301400
H40	5	H601031	Finish	260100	303100
H40	6	H643043	Finish	264300	304300
H40	7	H632083	Finish	263200	308300
H40	8	H615126	Finish	261500	312600
H40	9	H661164	Finish	266100	316400
H40	10	H648218	Finish	264800	321800
H40	11	H647275	Finish	264700	327500
H40	12	H617293	Finish	261700	329300
H40	13	H583266	Finish	258300	326600
H40	14	H540255	Finish	254000	325500
H40	15	H509235	Finish	250900	323500
H40	1	H445019	Start	244500	301900
H40	2	H492022	Start	249200	302200
H40	3	H515023	Start	251500	302300
H40	4	H555008	Start	255500	300800
H40	5	H587037	Start	258700	303700
H40	6	H628041	Start	262800	304100
H40	7	H631068	Start	263100	306800
H40	8	H623111	Start	262300	311100
H40	9	H647156	Start	264700	315600
H40	10	H653204	Start	265300	320400
H40	11	H656262	Start	265600	326200
H40	12	H626297	Start	262600	329700
H40	13	H596273	Start	259600	327300
H40	14	H554252	Start	255400	325200
H40	15	H516244	Start	251600	324400
H79	1	H7479097441	End	274790	397441
H79	2	H7810394838	End	278103	394838
H79	3	H8221496736	End	282214	396736
H79	4	H8450793531	End	284507	393531
H79	5	H8827491036	End	288274	391036
H79	6	H9197392934	End	291973	392934
H79	7	H9565094929	End	295650	394929
H79	8	H9345499120	End	293454	399120
H79	9	C9348402832	End	293484	402832
H79	10	C9546005564	End	295460	405564
H79	11	C9427510179	End	294275	410179

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
H79	12	C9090013233	End	290900	413233
H79	13	C8232716810	End	282327	416810
H79	14	C8137516359	End	281375	416359
H79	15	C7791216081	End	277912	416081
H79	1	H7385798756	Start	273857	398756
H79	2	H7694895498	Start	276948	395498
H79	3	H8066196677	Start	280661	396677
H79	4	H8378594847	Start	283785	394847
H79	5	H8669391407	Start	286693	391407
H79	6	H9086791922	Start	290867	391922
H79	7	H9510093896	Start	295100	393896
H79	8	H9439597686	Start	294395	397686
H79	9	C9239702748	Start	292397	402748
H79	10	C9527104354	Start	295271	404354
H79	11	C9468208610	Start	294682	408610
H79	12	C9208912577	Start	292089	412577
H79	13	C8640414753	Start	286404	414753
H79	14	C8232716810	Start	282327	416810
H79	15	C7949416140	Start	279494	416140
J06	1	J2525182316	Finish	325251	382316
J06	2	J2300085800	Finish	323000	385800
J06	3	J1950087300	Finish	319500	387300
J06	4	J1580089300	Finish	315800	389300
J06	5	J1330087400	Finish	313300	387400
J06	6	J1670085400	Finish	316700	385400
J06	7	J1720080900	Finish	317200	380900
J06	8	J1590076900	Finish	315900	376900
J06	9	J1400073800	Finish	314000	373800
J06	10	J1320068700	Finish	313200	368700
J06	11	J0970066700	Finish	309700	366700
J06	12	J0870064500	Finish	308700	364500
J06	13	J1290862794	Finish	312908	362794
J06	14	J1590061200	Finish	315900	361200
J06	15	J2020061300	Finish	320200	361300
J06	1	J2522281294	Start	325222	381294
J06	2	J2400085000	Start	324000	385000
J06	3	J2110087200	Start	321100	387200
J06	4	J1750089000	Start	317500	389000
J06	5	J1210088500	Start	312100	388500
J06	6	J1520085900	Start	315200	385900
J06	7	J1720082300	Start	317200	382300
J06	8	J1680078300	Start	316800	378300
J06	9	J1490074900	Start	314900	374900
J06	10	J1340070500	Start	313400	370500
J06	11	J1120067100	Start	311200	367100
J06	12	J0790065800	Start	307900	365800
J06	13	J1090062900	Start	310900	362900
J06	14	J1470061400	Start	314700	361400
J06	15	J1900061500	Start	319000	361500

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
J33	1	J3670041700	Finish	336700	341700
J33	2	J3660047500	Finish	336600	347500
J33	3	J4060054600	Finish	340600	354600
J33	4	J3760057900	Finish	337600	357900
J33	5	J3060056700	Finish	330600	356700
J33	6	J2550056300	Finish	325500	356300
J33	7	J2840051500	Finish	328400	351500
J33	8	J2730046000	Finish	327300	346000
J33	9	J2490039600	Finish	324900	339600
J33	10	J2380037000	Finish	323800	337000
J33	11	J3030034300	Finish	330300	334300
J33	12	J3890035300	Finish	338900	335300
J33	13	J4260041100	Finish	342600	341100
J33	14	J4560038000	Finish	345600	338000
J33	15	J5230034600	Finish	352300	334600
J33	1	J3573339994	Start	335733	339994
J33	2	J3730045500	Start	337300	345500
J33	3	J4130053200	Start	341300	353200
J33	4	J3890058300	Start	338900	358300
J33	5	J3170057400	Start	331700	357400
J33	6	J2610057800	Start	326100	357800
J33	7	J2760052700	Start	327600	352700
J33	8	J2820047600	Start	328200	347600
J33	9	J2580040900	Start	325800	340900
J33	10	J2240037600	Start	322400	337600
J33	11	J2880034600	Start	328800	334600
J33	12	J3760034500	Start	337600	334500
J33	13	J4120040600	Start	341200	340600
J33	14	J4570039700	Start	345700	339700
J33	15	J5140035700	Start	351400	335700
L64	1	L7014060091	Finish	70140	260091
L64	2	L7285062547	Finish	72850	262547
L64	3	L7689463240	Finish	76894	263240
L64	4	L8067860864	Finish	80678	260864
L64	5	L7917258908	Finish	79172	258908
L64	6	L8201556177	Finish	82015	256177
L64	7	L8504752677	Finish	85047	252677
L64	8	L8404448273	Finish	84044	248273
L64	9	L7992047290	Finish	79920	247290
L64	10	L7592346317	Finish	75923	246317
L64	11	L6520940384	Finish	65209	240384
L64	12	L6228343990	Finish	62283	243990
L64	13	L6500047481	Finish	65000	247481
L64	14	L6189649813	Finish	61896	249813
L64	15	L6594247763	Finish	65942	247763
L64	1	L7010258626	Start	70102	258626
L64	2	L7142562474	Start	71425	262474
L64	3	L7555263760	Start	75552	263760
L64	4	L7933361361	Start	79333	261361

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
L64	5	L8044659616	Start	80446	259616
L64	6	L8081857164	Start	80818	257164
L64	7	L8430854042	Start	84308	254042
L64	8	L8454149744	Start	84541	249744
L64	9	L8120246962	Start	81202	246962
L64	10	L7718046694	Start	77180	246694
L64	11	L6673340195	Start	66733	240195
L64	12	L6329642651	Start	63296	242651
L64	13	L6358046897	Start	63580	246897
L64	14	L6238148727	Start	62381	248727
L64	15	L6470248424	Start	64702	248424
M24	1	M215453	Finish	121500	245300
M24	2	M207486	Finish	120700	248600
M24	3	M202525	Finish	120200	252500
M24	4	M221557	Finish	122100	255700
M24	5	M252587	Finish	125200	258700
M24	6	M260629	Finish	126000	262900
M24	7	M264673	Finish	126400	267300
M24	8	M292682	Finish	129200	268200
M24	9	M325656	Finish	132500	265600
M24	10	M357618	Finish	135700	261800
M24	11	M393613	Finish	139300	261300
M24	12	M402583	Finish	140200	258300
M24	13	M424541	Finish	142400	254100
M24	14	M419526	Finish	141900	252600
M24	15	M375531	Finish	137500	253100
M24	1	M226462	Start	122600	246200
M24	2	M208472	Start	120800	247200
M24	3	M204512	Start	120400	251200
M24	4	M219542	Start	121900	254200
M24	5	M243574	Start	124300	257400
M24	6	M258613	Start	125800	261300
M24	7	M270659	Start	127000	265900
M24	8	M278688	Start	127800	268800
M24	9	M317662	Start	131700	266200
M24	10	M345633	Start	134500	263300
M24	11	M379613	Start	137900	261300
M24	12	M412594	Start	141200	259400
M24	13	M430553	Start	143000	255300
M24	14	M430517	Start	143000	251700
M24	15	M388534	Start	138800	253400
M87	1	N070826	End	207000	282600
M87	2	N055892	End	205500	289200
M87	3	N077920	End	207700	292000
M87	4	N104905	End	210400	290500
M87	5	N006862	End	200600	286200
M87	6	M976824	End	197600	282400
M87	7	M933800	End	193300	280000
M87	8	M915844	End	191500	284400

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
M87	9	M884876	End	188400	287600
M87	10	M892907	End	189200	290700
M87	11	M913948	End	191300	294800
M87	12	M930988	End	193000	298800
M87	13	M886921	End	188600	292100
M87	14	M847959	End	184700	295900
M87	15	M836933	End	183600	293300
M87	1	N082837	Start	208200	283700
M87	2	N054872	Start	205400	287200
M87	3	N081902	Start	208100	290200
M87	4	N095926	Start	209500	292600
M87	5	N021864	Start	202100	286400
M87	6	M984840	Start	198400	284000
M87	7	M947795	Start	194700	279500
M87	8	M924832	Start	192400	283200
M87	9	M898867	Start	189800	286700
M87	10	M882897	Start	188200	289700
M87	11	M903936	Start	190300	293600
M87	12	M925973	Start	192500	297300
M87	13	M902984	Start	190200	298400
M87	14	M857966	Start	185700	296600
M87	15	M833946	Start	183300	294600
N11	1	N3270039500	Finish	232700	239500
N11	2	N3330036400	Finish	233300	236400
N11	3	N3740034800	Finish	237400	234800
N11	4	N3890031900	Finish	238900	231900
N11	5	N3470029700	Finish	234700	229700
N11	6	N3100030300	Finish	231000	230300
N11	7	N2900027400	Finish	229000	227400
N11	8	N2950025000	Finish	229500	225000
N11	9	N3080020900	Finish	230800	220900
N11	10	N3170017900	Finish	231700	217900
N11	11	N3340015200	Finish	233400	215200
N11	12	N2950012700	Finish	229500	212700
N11	13	N2570015400	Finish	225700	215400
N11	14	N2510018700	Finish	225100	218700
N11	15	N2060022700	Finish	220600	222700
N11	1	N3440039300	Start	234400	239300
N11	2	N3250037400	Start	232500	237400
N11	3	N3570034700	Start	235700	234700
N11	4	N3980032900	Start	239800	232900
N11	5	N3630029800	Start	236300	229800
N11	6	N3130028700	Start	231300	228700
N11	7	N2910029000	Start	229100	229000
N11	8	N3090025400	Start	230900	225400
N11	9	N3060022500	Start	230600	222500
N11	10	N3000018600	Start	230000	218600
N11	11	N3420016500	Start	234200	216500
N11	12	N3070011600	Start	230700	211600

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
N11	13	N2730015000	Start	227300	215000
N11	14	N2380017400	Start	223800	217400
N11	15	N2030020900	Start	220300	220900
N74	1	N8372567918	Finish	283725	267918
N74	2	N7748167575	Finish	277481	267575
N74	3	N7339569390	Finish	273395	269390
N74	4	N7416162923	Finish	274161	262923
N74	5	N7305056178	Finish	273050	256178
N74	6	N7495453408	Finish	274954	253408
N74	7	N7874850695	Finish	278748	250695
N74	8	N7419048631	Finish	274190	248631
N74	9	N7401744007	Finish	274017	244007
N74	10	N8118345584	Finish	281183	245584
N74	11	N8475143102	Finish	284751	243102
N74	12	N8666647440	Finish	286666	247440
N74	13	N9250346917	Finish	292503	246917
N74	14	NULL	Finish		
N74	15	N9245957100	Finish	292459	257100
N74	1	N8533467628	Start	285334	267628
N74	2	N7904667407	Start	279046	267407
N74	3	N7473069181	Start	274730	269181
N74	4	N7357764382	Start	273577	264382
N74	5	N7327557662	Start	273275	257662
N74	6	N7332753266	Start	273327	253266
N74	7	N7758751343	Start	277587	251343
N74	8	N7559147955	Start	275591	247955
N74	9	N7273944501	Start	272739	244501
N74	10	N7962145702	Start	279621	245702
N74	11	N8389744378	Start	283897	244378
N74	12	N8562246404	Start	285622	246404
N74	13	N9328645525	Start	293286	245525
N74	14	N9391951701	Start	293919	251701
N74	15	N9166655757	Start	291666	255757
N77	1	N9593282437	Finish	295932	282437
N77	2	O0165482573	Finish	301654	282573
N77	3	O0095187002	Finish	300951	287002
N77	4	O0305890912	Finish	303058	290912
N77	5	O0213195540	Finish	302131	295540
N77	6	N9768596741	Finish	297685	296741
N77	7	N9437499650	Finish	294374	299650
N77	8	N9028497853	Finish	290284	297853
N77	9	N8632898074	Finish	286328	298074
N77	10	N8387295189	Finish	283872	295189
N77	11	N8079898753	Finish	280798	298753
N77	12	N7766498817	Finish	277664	298817
N77	13	N7869193046	Finish	278691	293046
N77	14	N7874588704	Finish	278745	288704
N77	15	N8114384759	Finish	281143	284759
N77	1	N9729381613	Start	297293	281613

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
N77	2	O0045182026	Start	300451	282026
N77	3	O0140185403	Start	301401	285403
N77	4	O0243989410	Start	302439	289410
N77	5	O0271494253	Start	302714	294253
N77	6	N9934596781	Start	299345	296781
N77	7	N9580699680	Start	295806	299680
N77	8	N9161298734	Start	291612	298734
N77	9	N8782898425	Start	287828	298425
N77	10	N8542894039	Start	285428	294039
N77	11	N8171597389	Start	281715	297389
N77	12	N7937398229	Start	279373	298229
N77	13	N7876394783	Start	278763	294783
N77	14	N7868590328	Start	278685	290328
N77	15	N8029286274	Start	280292	286274
O04	1	O2259	Finish	322000	259000
O04	2	O187616	Finish	318700	261600
O04	3	O171657	Finish	317100	265700
O04	4	O1368	Finish	313000	268000
O04	5	O087689	Finish	308700	268900
O04	6	O009694	Finish	300900	269400
O04	7	O0065	Finish	300000	265000
O04	8	O010598	Finish	301000	259800
O04	9	O067619	Finish	306700	261900
O04	10	O1162	Finish	311000	262000
O04	11	O115576	Finish	311500	257600
O04	12	O0558	Finish	305000	258000
O04	13	O024575	Finish	302400	257500
O04	14	O026540	Finish	302600	254000
O04	15	O0349	Finish	303000	249000
O04	1	O237594	Start	323700	259400
O04	2	O198613	Start	319800	261300
O04	3	O177643	Start	317700	264300
O04	4	O153685	Start	315300	268500
O04	5	O093676	Start	309300	267600
O04	6	O024688	Start	302400	268800
O04	7	O004670	Start	300400	267000
O04	8	O003614	Start	300300	261400
O04	9	O053613	Start	305300	261300
O04	10	O104614	Start	310400	261400
O04	11	O118593	Start	311800	259300
O04	12	O072587	Start	307200	258700
O04	13	O009583	Start	300900	258300
O04	14	O008542	Start	300800	254200
O04	15	O0351	Start	303000	251000
R22	1	R246279	End	124600	127900
R22	2	R243325	End	124300	132500
R22	3	R253368	End	125300	136800
R22	4	R293401	End	129300	140100
R22	5	R322431	End	132200	143100

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
R22	6	R341452	End	134100	145200
R22	7	R381467	End	138100	146700
R22	8	R409484	End	140900	148400
R22	9	R406455	End	140600	145500
R22	10	R422418	End	142200	141800
R22	11	R455401	End	145500	140100
R22	12	R464358	End	146400	135800
R22	13	R496356	End	149600	135600
R22	14	R457344	End	145700	134400
R22	15	R438303	End	143800	130300
R22	1	R244265	Start	124400	126500
R22	2	R245310	Start	124500	131000
R22	3	R255357	Start	125500	135700
R22	4	R282388	Start	128200	138800
R22	5	R310421	Start	131000	142100
R22	6	R331448	Start	133100	144800
R22	7	R374452	Start	137400	145200
R22	8	R399486	Start	139900	148600
R22	9	R406468	Start	140600	146800
R22	10	R412424	Start	141200	142400
R22	11	R450415	Start	145000	141500
R22	12	R464373	Start	146400	137300
R22	13	R489362	Start	148900	136200
R22	14	R474348	Start	147400	134800
R22	15	R447311	Start	144700	131100
R28	1	R302867	Finish	130200	186700
R28	2	R335854	Finish	133500	185400
R28	3	R357823	Finish	135700	182300
R28	4	R396805	Finish	139600	180500
R28	5	R425844	Finish	142500	184400
R28	6	R439887	Finish	143900	188700
R28	7	R462926	Finish	146200	192600
R28	8	R483962	Finish	148300	196200
R28	9	M496004	Finish	149600	200400
R28	10	M462043	Finish	146200	204300
R28	11	M437076	Finish	143700	207600
R28	12	M392092	Finish	139200	209200
R28	13	M357082	Finish	135700	208200
R28	14	M340026	Finish	134000	202600
R28	15	M303020	Finish	130300	202000
R28	1	R287873	Start	128700	187300
R28	2	R334869	Start	133400	186900
R28	3	R345827	Start	134500	182700
R28	4	R385805	Start	138500	180500
R28	5	R418830	Start	141800	183000
R28	6	R434873	Start	143400	187300
R28	7	R456912	Start	145600	191200
R28	8	R470963	Start	147000	196300
R28	9	R490991	Start	149000	199100

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
R28	10	M467030	Start	146700	203000
R28	11	M448073	Start	144800	207300
R28	12	M407085	Start	140700	208500
R28	13	M360096	Start	136000	209600
R28	14	M346052	Start	134600	205200
R28	15	M315026	Start	131500	202600
R88	1	N034066	Finish	203400	206600
R88	2	N004068	Finish	200400	206800
R88	3	M964082	Finish	196400	208200
R88	4	M926068	Finish	192600	206800
R88	5	M905027	Finish	190500	202700
R88	6	M876006	Finish	187600	200600
R88	7	R845984	Finish	184500	198400
R88	8	R848954	Finish	184800	195400
R88	9	R866923	Finish	186600	192300
R88	10	R870892	Finish	187000	189200
R88	11	R864855	Finish	186400	185500
R88	12	R889834	Finish	188900	183400
R88	13	R927824	Finish	192700	182400
R88	14	R969818	Finish	196900	181800
R88	15	R988849	Finish	198800	184900
R88	1	N046057	Start	204600	205700
R88	2	N008083	Start	200800	208300
R88	3	M979078	Start	197900	207800
R88	4	M935077	Start	193500	207700
R88	5	M914038	Start	191400	203800
R88	6	M889008	Start	188900	200800
R88	7	R845997	Start	184500	199700
R88	8	R863961	Start	186300	196100
R88	9	R849929	Start	184900	192900
R88	10	R873907	Start	187300	190700
R88	11	R858869	Start	185800	186900
R88	12	R883847	Start	188300	184700
R88	13	R914827	Start	191400	182700
R88	14	R957824	Start	195700	182400
R88	15	R993834	Start	199300	183400
S12	1	S377496	Finish	237700	149600
S12	2	S336494	Finish	233600	149400
S12	3	S296490	Finish	229600	149000
S12	4	S254492	Finish	225400	149200
S12	5	S211477	Finish	221100	147700
S12	6	S164461	Finish	216400	146100
S12	7	S125429	Finish	212500	142900
S12	8	S122399	Finish	212200	139900
S12	9	S124354	Finish	212400	135400
S12	10	S122316	Finish	212200	131600
S12	11	S129285	Finish	212900	128500
S12	12	S145271	Finish	214500	127100
S12	13	S185265	Finish	218500	126500

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
S12	14	S224277	Finish	222400	127700
S12	15	S252257	Finish	225200	125700
S12	1	S3936549954	Start	239365	149954
S12	2	S3521649021	Start	235216	149021
S12	3	S3086448520	Start	230864	148520
S12	4	S2684149223	Start	226841	149223
S12	5	S2248248585	Start	222482	148585
S12	6	S1781546755	Start	217815	146755
S12	7	S1306544297	Start	213065	144297
S12	8	S1065739913	Start	210657	139913
S12	9	S1258137199	Start	212581	137199
S12	10	S1366932201	Start	213669	132201
S12	11	S1406529038	Start	214065	129038
S12	12	S1369226197	Start	213692	126197
S12	13	S1764226017	Start	217642	126017
S12	14	S2112827563	Start	221128	127563
S12	15	S2394325933	Start	223943	125933
S15	1	S386635	Finish	238600	163500
S15	2	S344620	Finish	234400	162000
S15	3	S358592	Finish	235800	159200
S15	4	S333577	Finish	233300	157700
S15	5	S336545	Finish	233600	154500
S15	6	S310545	Finish	231000	154500
S15	7	S286553	Finish	228600	155300
S15	8	S285513	Finish	228500	151300
S15	9	S247514	Finish	224700	151400
S15	10	S207532	Finish	220700	153200
S15	11	S187567	Finish	218700	156700
S15	12	S177620	Finish	217700	162000
S15	13	S155640	Finish	215500	164000
S15	14	S182684	Finish	218200	168400
S15	15	S205718	Finish	220500	171800
S15	1	S393647	Start	239300	164700
S15	2	S354628	Start	235400	162800
S15	3	S354600	Start	235400	160000
S15	4	S345582	Start	234500	158200
S15	5	S350552	Start	235000	155200
S15	6	S306532	Start	230600	153200
S15	7	S286571	Start	228600	157100
S15	8	S280531	Start	228000	153100
S15	9	S253505	Start	225300	150500
S15	10	S220526	Start	222000	152600
S15	11	S189552	Start	218900	155200
S15	12	S190612	Start	219000	161200
S15	13	S153622	Start	215300	162200
S15	14	S174669	Start	217400	166900
S15	15	S191711	Start	219100	171100
S78	1	S744815	Finish	274400	181500
S78	2	S737846	Finish	273700	184600

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
S78	3	S721879	Finish	272100	187900
S78	4	S729910	Finish	272900	191000
S78	5	S737939	Finish	273700	193900
S78	6	S741970	Finish	274100	197000
S78	7	S785960	Finish	278500	196000
S78	8	S823979	Finish	282300	197900
S78	9	S858968	Finish	285800	196800
S78	10	S886967	Finish	288600	196700
S78	11	S909997	Finish	290900	199700
S78	12	S928964	Finish	292800	196400
S78	13	S937938	Finish	293700	193800
S78	14	S974918	Finish	297400	191800
S78	15	S994885	Finish	299400	188500
S78	1	S749804	Start	274900	180400
S78	2	S749839	Start	274900	183900
S78	3	S734876	Start	273400	187600
S78	4	S716903	Start	271600	190300
S78	5	S736927	Start	273600	192700
S78	6	S734963	Start	273400	196300
S78	7	S774966	Start	277400	196600
S78	8	S808977	Start	280800	197700
S78	9	S847978	Start	284700	197800
S78	10	S879953	Start	287900	195300
S78	11	S896996	Start	289600	199600
S78	12	S930977	Start	293000	197700
S78	13	S922940	Start	292200	194000
S78	14	S960924	Start	296000	192400
S78	15	S991898	Start	299100	189800
T05	1	T030790	Finish	303000	179000
T05	2	T060764	Finish	306000	176400
T05	3	T054727	Finish	305400	172700
T05	4	T088706	Finish	308800	170600
T05	5	T122676	Finish	312200	167600
T05	6	T138654	Finish	313800	165400
T05	7	T096644	Finish	309600	164400
T05	8	T063671	Finish	306300	167100
T05	9	T015659	Finish	301500	165900
T05	10	T016616	Finish	301600	161600
T05	11	T044596	Finish	304400	159600
T05	12	T081589	Finish	308100	158900
T05	13	T049559	Finish	304900	155900
T05	14	T017514	Finish	301700	151400
T05	15	T045503	Finish	304500	150300
T05	1	T018788	Start	301800	178800
T05	2	T053772	Start	305300	177200
T05	3	T053737	Start	305300	173700
T05	4	T077717	Start	307700	171700
T05	5	T111687	Start	311100	168700
T05	6	T153661	Start	315300	166100

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
T05	7	T112643	Start	311200	164300
T05	8	T076664	Start	307600	166400
T05	9	T030663	Start	303000	166300
T05	10	T016630	Start	301600	163000
T05	11	T029590	Start	302900	159000
T05	12	T072598	Start	307200	159800
T05	13	T061572	Start	306100	157200
T05	14	T017528	Start	301700	152800
T05	15	T032495	Start	303200	149500
V93	1	W180479	Finish	118000	47900
V93	2	W136465	Finish	113600	46500
V93	3	W147438	Finish	114700	43800
V93	4	W184422	Finish	118400	42200
V93	5	W165388	Finish	116500	38800
V93	6	W137354	Finish	113700	35400
V93	7	W106338	Finish	110600	33800
V93	8	W062329	Finish	106200	32900
V93	9	W025347	Finish	102500	34700
V93	10	V984354	Finish	98400	35400
V93	11	V945374	Finish	94500	37400
V93	12	V904382	Finish	90400	38200
V93	13	V939407	Finish	93900	40700
V93	14	V969438	Finish	96900	43800
V93	15	V978473	Finish	97800	47300
V93	1	W194488	Start	119400	48800
V93	2	W150469	Start	115000	46900
V93	3	W136449	Start	113600	44900
V93	4	W169425	Start	116900	42500
V93	5	W167403	Start	116700	40300
V93	6	W146366	Start	114600	36600
V93	7	W119337	Start	111900	33700
V93	8	W077335	Start	107700	33500
V93	9	W039347	Start	103900	34700
V93	10	V998352	Start	99800	35200
V93	11	V958369	Start	95800	36900
V93	12	V917374	Start	91700	37400
V93	13	V926398	Start	92600	39800
V93	14	V954433	Start	95400	43300
V93	15	V984460	Start	98400	46000
V96	1	W0109288464	Finish	101092	88464
V96	2	W0514486283	Finish	105144	86283
V96	3	W0838083085	Finish	108380	83085
V96	4	W1213381995	Finish	112133	81995
V96	5	W152794	Finish	115200	79400
V96	6	W1952977674	Finish	119529	77674
V96	7	W163757	Finish	116300	75700
V96	8	W140760	Finish	114000	76000
V96	9	W1158473385	Finish	111584	73385
V96	10	W076740	Finish	107600	74000

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
V96	11	W042745	Finish	104200	74500
V96	12	V999733	Finish	99900	73300
V96	13	V955724	Finish	95500	72400
V96	14	V912707	Finish	91200	70700
V96	15	V9142380395	Finish	91423	80395
V96	1	W002898	Start	100200	89800
V96	2	W040876	Start	104000	87600
V96	3	W075844	Start	107500	84400
V96	4	W112826	Start	111200	82600
V96	5	W142801	Start	114200	80100
V96	6	W183788	Start	118300	78800
V96	7	W177763	Start	117700	76300
V96	8	W139774	Start	113900	77400
V96	9	W130738	Start	113000	73800
V96	10	W089734	Start	108900	73400
V96	11	W051754	Start	105100	75400
V96	12	W015735	Start	101500	73500
V96	13	V968728	Start	96800	72800
V96	14	V926716	Start	92600	71600
V96	15	V902804	Start	90200	80400
W56	1	W7684061298	Finish	176840	61298
W56	2	W7257062125	Finish	172570	62125
W56	3	W6836561344	Finish	168365	61344
W56	4	W6595262741	Finish	165952	62741
W56	5	W6135261747	Finish	161352	61747
W56	6	W5688661278	Finish	156886	61278
W56	7	W5209061187	Finish	152090	61187
W56	8	W5221365493	Finish	152213	65493
W56	9	W5120068841	Finish	151200	68841
W56	10	W5154271172	Finish	151542	71172
W56	11	W5562671786	Finish	155626	71786
W56	12	W5599572063	Finish	155995	72063
W56	13	W5463575580	Finish	154635	75580
W56	14	W5565079580	Finish	155650	79580
W56	15	W5613784083	Finish	156137	84083
W56	1	W7814861380	Start	178148	61380
W56	2	W7398262175	Start	173982	62175
W56	3	W6974261868	Start	169742	61868
W56	4	W6618661559	Start	166186	61559
W56	5	W6285762305	Start	162857	62305
W56	6	W5853561113	Start	158535	61113
W56	7	W5390560804	Start	153905	60804
W56	8	W5265363954	Start	152653	63954
W56	9	W5086167396	Start	150861	67396
W56	10	W5020170701	Start	150201	70701
W56	11	W5404171385	Start	154041	71385
W56	12	W5710571286	Start	157105	71286
W56	13	W5576274531	Start	155762	74531
W56	14	W5499278092	Start	154992	78092

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
W56	15	W5610482525	Start	156104	82525
X49	1	S470183	End	247000	118300
X49	2	S453151	End	245300	115100
X49	3	S425124	End	242500	112400
X49	4	S449085	End	244900	108500
X49	5	S429056	End	242900	105600
X49	6	S442015	End	244200	101500
X49	7	S464005	End	246400	100500
X49	8	S501017	End	250100	101700
X49	9	S545032	End	254500	103200
X49	10	S571072	End	257100	107200
X49	11	S609067	End	260900	106700
X49	12	S642013	End	264200	101300
X49	13	S675097	End	267500	109700
X49	14	S669056	End	266900	105600
X49	15	S644086	End	264400	108600
X49	1	S465197	Start	246500	119700
X49	2	S467147	Start	246700	114700
X49	3	S412131	Start	241200	113100
X49	4	S454104	Start	245400	110400
X49	5	S414067	Start	241400	106700
X49	6	S440030	Start	244000	103000
X49	7	X466990	Start	246600	99000
X49	8	S491027	Start	249100	102700
X49	9	S537021	Start	253700	102100
X49	10	S562060	Start	256200	106000
X49	11	S606082	Start	260600	108200
X49	12	S636025	Start	263600	102500
X49	13	S688007	Start	268800	100700
X49	14	S663041	Start	266300	104100
X49	15	S656078	Start	265600	107800
V99	1	W0064389816	Start	100643	89816
V99	2	W0609890220	Start	106098	90220
V99	3	W1049291274	Start	110492	91274
V99	4	W1478792932	Start	114787	92932
V99	5	W1731295862	Start	117312	95862
V99	6	R1557901008	Start	115579	101008
V99	7	R1640005100	Start	116400	105100
V99	8	R1701809907	Start	117018	109907
V99	9	R1693214456	Start	116932	114456
V99	10	R1412818391	Start	114128	118391
V99	11	R0890919424	Start	108909	119424
V99	12	R0595920519	Start	105959	120519
V99	13	R0004519451	Start	100045	119451
V99	14	Q9702816633	Start	97028	116633
V99	15	Q9897712228	Start	98977	112228
V99	1	W0217589654	End	102175	89654
V99	2	W0764890605	End	107648	90605
V99	3	W1206991703	End	112069	91703

SurveySquare	TransectNumber	Grid Ref	Point	X	Y
V99	4	W1624493153	End	116244	93153
V99	5	W1720197406	End	117201	97406
V99	6	R1595202481	End	115952	102481
V99	7	R1755706079	End	117557	106079
V99	8	R1663811076	End	116638	111076
V99	9	R1727915767	End	117279	115767
V99	10	R1262518508	End	112625	118508
V99	11	R0834320080	End	108343	120080
V99	12	R0447420237	End	104474	120237
V99	13	Q9851419153	End	98514	119153
V99	14	Q9734515170	End	97345	115170
V99	15	Q9950210840	End	99502	110840

Appendix 2 All-Ireland Daubenton's Bat Waterways Survey

Table A2.1 Locations of All Ireland Daubenton's Bat Waterway Sites 2006-2017.

Site Code	Waterway	Site Name	Grid Ref	Country	County
1001	River Boyne	Slane Bridge	N9640073610	RoI	Meath
1002	River Blackwater (L)	O'Dalys Bridge	N6530080320	RoI	Meath
1003	Borora River	Moynalty Bridge	N7352082560	RoI	Meath
1004	Ward River	Bridge nth of Killeek	O1453046397	RoI	Dublin
1005	Vartry River	Newrath Bridge	T2860096800	RoI	Wicklow
1006	Kings River	Ballinagree Bridge	O0364002380	RoI	Wicklow
1007	Avonmore River	Ballard Bridge	T1442095670	RoI	Wicklow
1008	Glencullen River	Knocksink Bridge / Knocksink	O2190017900	RoI	Wicklow
1009	Vartry River	Nun's Cross	T2560097900	RoI	Wicklow
1010	River Ow	Roddenagh Bridge	T1170079200	RoI	Wicklow
1011	Camlin River	The Mall Bridge	N0610075700	RoI	Longford
1012	Dargle River	Bray Bridge	O2640118895	RoI	Wicklow
1013	River Slaney	Seskin Bridge	S9770093900	RoI	Wicklow
1014	Streamstown River	Interpretative Centre	M4807005685	RoI	Galway
1015	Clarinbridge River	Clarin Bridge	M4123420005	RoI	Galway
1016	Black River	Moyne Bridge	M2500049000	RoI	Galway
1017	Lough Kip River	Dr. Chlaidhdi	M2221531223	RoI	Galway
1018	Owenriff River	Glan Road Bridge	M1224443146	RoI	Galway
1019	River Corrib	Salmon Weir Bridge	M2959225666	RoI	Galway
1020	Kilcolgan River	Dunkellin Bridge	M4420218423	RoI	Galway
1021	Cregg River	Addergoole Bridge	M3228334994	RoI	Galway
1022	Clare River	Claregalway Bridge	M3717933228	RoI	Galway
1023	Royal Canal	Aghnaskea Bridge	N0860080500	RoI	Longford
1024	Inny River	Newcastle Bridge	N1830057000	RoI	Longford
1025	Inagh River	Inagh Bridge	R2082081290	RoI	Clare
1026	Inagh River	Moananagh Bridge	R1703084900	RoI	Clare
1027	Mulkear River	Bridge Nth of Coolruntha	R8060068700	RoI	Tipperary
1028	River Moy	Mount Falcon Fisheries S1	G2494413324	RoI	Mayo
1029	River Boyne	Ramparts	N8740067400	RoI	Meath
1030	Blackwater River (L)	Donaghpatrick Bridge	N8194072310	RoI	Meath
1031	Athboy River	Athboy Bridge	N7169064260	RoI	Meath
1032	Brosna River	Ballinagore Bridge	N3560039600	RoI	Westmeath
1033	Coalisland Canal	Moor Bridge	H8590065000	NI	Tyrone
1034	Inny River	Ballymanhon Bridge	N1520056500	RoI	Longford
1035	Delvin River	Gormanstown Bridge	O1707665774	RoI	Dublin
1036	River Liffey	Leixlip Bridge	O0075035810	RoI	Kildare
1037	Tolka River	Cardiff Bridge	O1260037700	RoI	Dublin
1038	Tolka River	Dunboyne-Loughsallagh Br	O0280041700	RoI	Meath
1039	Tolka River	Abbotstown Bridge	O0930038300	RoI	Dublin
1040	River Dodder	Oldbawn Bridge	O0975026300	RoI	Dublin
1041	River Dodder	Bridge on Spring Avenue	O1361028910	RoI	Dublin
1042	Grand Canal	Henry Bridge	N9560028200	RoI	Kildare
1043	Rafford River	Ratty's Bridge	M5473423259	RoI	Galway
1044	Royal Canal	Farranyoogan	N1300074200	RoI	Longford
1045	River Rinn	Cloonart Bridge	N0830083200	RoI	Leitrim
1046	Royal Canal	Collins Bridge	O0280036750	RoI	Dublin
1047	Royal Canal	Granard Bridge, Castleknock	O0940038100	RoI	Dublin
1048	Grand Canal	Kilmainham Section	O1280033200	RoI	Dublin
1049	River Lee	Bannon Bridge	W6131671632	RoI	Cork
1050	Martin River	Bawnafinny Bridge	W5979075412	RoI	Cork
1051	Unshin River	Colloney	G6793026563	RoI	Sligo
1052	Owenboy River	Priests Bar	W6049161227	RoI	Cork
1053	River Foherish	Carrigaphooca Bridge	W2963673766	RoI	Cork
1054	Glashaboy River	Upper Glanmire Bridge	W7146478294	RoI	Cork
1055	Shournagh River	Tower Bridge	W5862074551	RoI	Cork

Site Code	Waterway	Site Name	Grid Ref	Country	County
1056	Laney River	Carrigagulla Bridge	W3894683016	RoI	Cork
1057	River Bride	Coolmucky Bridge	W4603767916	RoI	Cork
1058	River Lee	Drumcarra Bridge	W2955867786	RoI	Cork
1059	River Sullane	Linnamilla Bridge	W3113972814	RoI	Cork
1060	River Blackwater (M)	Charles bridge	W2481194404	RoI	Cork
1061	Argideen River	Lisselane Bridge	W4059944400	RoI	Cork
1062	Owenreagh River	Br u/s of Upper Lake (Gearhamneen)	V8842282104	RoI	Kerry
1063	River Suir	Knocklofty Bridge	S1450020628	RoI	Tipperary
1064	River Suir	Thurles Bridge	S1295758635	RoI	Tipperary
1065	River Feale	Racecourse Footbridge	Q9808433646	RoI	Kerry
1066	River Flesk	Flesk Bridge	V9672589468	RoI	Kerry
1067	River Fane	Stephenstown Bridge	J0139001610	RoI	Louth
1068	River Nanny	Dardistown Bridge	O1114070200	RoI	Meath
1069	Nenagh River	Tyone Bridge	R8770077900	RoI	Tipperary
1070	Moyola River	Curran Bridge	H9520089500	NI	Derry
1071	Sow River	Poulsack Bridge	T0480027000	RoI	Wexford
1072	Suir River	Kilsheelan Bridge	S2862023234	RoI	Tipperary
1073	Suir River	Cabragh Bridge	S1119956062	RoI	Tipperary
1074	Tintern Abbey Stream	Tintern Abbey	S7940010000	RoI	Wexford
1075	Dawn River	Whelan's Bridge, Kilmeadan	S5220009900	RoI	Waterford
1076	River Shannon	Banagher Bridge	N0050015800	RoI	Offaly
1077	River Sow	Kilmallock Bridge	T0327031910	RoI	Wexford
1078	River Nore	Knockanore	S5469643591	RoI	Kilkenny
1079	River Nore	NE of Warrington	S5373654466	RoI	Kilkenny
1080	River Nore	Threecastles Bridge	S4582162709	RoI	Kilkenny
1081	River Barrow	Saint Mullins	S7295037800	RoI	Carlow
1082	River Barrow	Graiguenamanagh Bridge	S7072443544	RoI	Kilkenny
1083	Avonmore River	Clara Bridge	T1690092100	RoI	Wicklow
1084	Owennashad River	Br u/s Blackwater R. confl.	X0482098940	RoI	Waterford
1085	Clashawley River	Fethard	S2050034900	RoI	Tipperary
1086	Royal Canal	Bellmount Bridge	N3950051100	RoI	Westmeath
1087	Dripsey River	Dripsey Bridge Lower	W4612279628	RoI	Cork
1088	Brosna River	Newell's Bridge	N3830042300	RoI	Westmeath
1089	River Aherlow	Cappa Old Bridge	R9935429318	RoI	Tipperary
1090	Derry River	Tomnafinoge Wood	T0190070300	RoI	Wicklow
1091	Glengarrif River	Footbridge NW of Glengarrif	V9178756970	RoI	Cork
1092	River Shannon	Lusmagh	M9666915225	RoI	Offaly
1093	Tributray of Boyne	Ballivor Road Bridge	N6030345270	RoI	Westmeath
1094	River Dodder	Newbridge Firhouse	O1145027750	RoI	Dublin
1095	Cartron River	Carran	F8001100176	RoI	Mayo
1096	River Feale	Finuge Bridge	Q9511132113	RoI	Kerry
1097	Sneem River	Br u/s Ardsheelhane R. confl.	V6291667562	RoI	Kerry
1098	River Moy	Mount Falcon Fisheries S2	G2484212404	RoI	Mayo
1099	River Blackwater (M)	Careyville	W8558399508	RoI	Cork
1100	Inny River	Shrule Bridge	N1350055900	RoI	Longford
1101	Arigideen River	Kilmaloda Bridge	W4519545566	RoI	Cork
1102	River Lagan	Shaws Bridge	J3250069000	NI	Antrim
1103	Maigue River	Fort Bridge	R5060025700	RoI	Limerick
1104	Mascosquin River	Ree Bridge	C8981628667	NI	Antrim
1105	River Roe	Dog Leap	C6790020300	NI	Derry
1106	River Roe	Dungiven Bridge	C6830009800	NI	Derry
1107	Whelan's Br River	Br West of Carrickduston	S5075007600	RoI	Waterford
1108	Glenarm River	Glenarm Estate	D3012511916	NI	Antrim
1109	Cusher River	Clare Glen Bridge	J0140043900	NI	Armagh
1110	Bann (Newry) Canal	Moneypennys Lock	J0330051200	NI	Armagh
1111	Bann (Newry) Canal	Scarva Heritage Centre	J0640043700	NI	Armagh
1112	Moneycarragh River	Moneylane	J3990036900	NI	Down
1113	Ravernet River	Legacurry Bridge	J2970060100	NI	Down
1114	Owenmore River	Rathmullan Big Bridge	G6662412322	RoI	Sligo

Site Code	Waterway	Site Name	Grid Ref	Country	County
1115	Drowse River	Lennox's Bridge	G8180857254	RoI	Leitrim
1116	Grand Canal	Spencer Bridge	N6680018900	RoI	Kildare
1117	River Suir	Suir Valley Railway	S5390010400	RoI	Waterford
1118	Owenmore River	Templehouse Bridge	G6250918568	RoI	Sligo
1119	Drumcliff River	Ford 500m u/s Drumcliff Bridge	G6823242240	RoI	Sligo
1120	North Slob Channel	Channel - Wildfowl Reserve	T0827525539	RoI	Wexford
1121	Duff River	Bridge at Drumacolla	G7960049100	RoI	Leitrim
1122	Boyle River	Knockvicar Bridge	G8728605541	RoI	Roscommon
1123	River Lee	Kennel's to Weir Stream	W5870071400	RoI	Cork
1124	Manulla River	Belcarra Walkway	M2010085400	RoI	Mayo
1125	Grand Canal	Corbally Line/Limerick Bridge	N8730018700	RoI	Kildare
1126	River Liffey	Kilcullen Bridge	N8424009730	RoI	Kildare
1127	River Liffey	Connell Ford	N8135013680	RoI	Kildare
1128	Royal Canal	Deey Bridge	N9790037000	RoI	Kildare
1129	Brosna River	Ballycumber Bridge	N2120030600	RoI	Offaly
1130	Royal Canal	Smullen Bridge	N9410037400	RoI	Kildare
1131	River Dodder	Milltown Bridge	O1698030410	RoI	Dublin
1132	River Blackwater (L)	Mabe's Bridge	N7361077290	RoI	Meath
1133	River Blackwater (L)	Nine Eyes Bridge	N6304083380	RoI	Cavan
1134	River Blackwater (U)	New Mills, Cornahoe	H7189838769	RoI	Monaghan
1135	Errina-plassey (Limerick/Killaloe)Canal	Errina Bridge	R6400064800	RoI	Clare
1136	Greanagh River	Coolah Bridge	R4434946357	RoI	Limerick
1137	Claureen River	Claureen Bridge	R3285978100	RoI	Clare
1138	River Fergus	Drehidnagower	R3301778654	RoI	Clare
1139	River Barnakyle	Old Forge Bridge	R5103853043	RoI	Limerick
1140	River Shannon	Burgess Park, Athlone	N0410041000	RoI	Westmeath
1141	River Blackwater (U)	Killryan Bridge	H2025014600	RoI	Cavan
1142	Grand Canal	Milltown Bridge	S6550097500	RoI	Kildare
1143	Grand Canal	Ayimer Bridge	N9730029500	RoI	Kildare
1144	Diffagher River	Cloonemeohe Bridge	G9345124542	RoI	Leitrim
1145	River Shannon	Dowra Bridge	G9910026700	RoI	Leitrim
1146	River Shannon	Mahanagh Bridge	G9557611687	RoI	Roscommon
1147	River Suck	Castlecoote Bridge	M8086362621	RoI	Roscommon
1148	Owenea River	Owenea Bridge	G7369092110	RoI	Donegal
1149	River Deele	Milltown Bridge	C2450099613	RoI	Donegal
1150	Owenwee River	Belclare Bridge	L9599882163	RoI	Mayo
1151	St. John's River	Kilbarry Walkway	S6015010000	RoI	Waterford
1152	Unshin River	Ballygrania Bridge	G6949725875	RoI	Sligo
1153	River Feale	Listowel Bridge	Q9952633292	RoI	Kerry
1154	Mulkear River	Annacotty Bridge	R6430057700	RoI	Limerick
1155	Owenocarney River	Annagore Bridge	R4768267717	RoI	Clare
1156	Bilboa River	Gortnagarde Bridge	R7800050500	RoI	Limerick
1157	Boyle Canal	Boyle Canal	G8200004300	RoI	Roscommon
1158	Lung River	Br u/s Lough Gara	M6614696681	RoI	Roscommon
1159	River Bann	Margerry's Bridge	T1144159337	RoI	Wexford
1160	Rafford River	Rafford House	M6083726048	RoI	Galway
1161	River Slaney	Scarawalsh Bridge	S9837545068	RoI	Wexford
1162	Colligan River	Colligan Bridge	X2195897983	RoI	Waterford
1163	Douglas River	Cunaberry Bridge	S8422067950	RoI	Carlow
1164	Crana River	Crana Park	C3480432892	RoI	Donegal
1165	River Liffey	Ballymore Eustace Bridge	N9262009790	RoI	Kildare
1166	River Fergus	Dromore Wood	R3592787828	RoI	Clare
1167	River Blickey	Twomile Bridge	X2250091200	RoI	Waterford
1168	Kesh River	Kesh	H1820064200	NI	Fermanagh
1169	River Erne	Enniskillen	H2700053000	NI	Fermanagh
1170	Colebrook River	Ballindarragh Bridge	H3310036000	NI	Fermanagh
1171	River Robe	Crossboyne Bridge	M3386170962	RoI	Mayo
1172	Grand Canal	Srah Castle	N3290025200	RoI	Offaly
1173	Boor River	Kilbillaghan Townland	N1180034950	RoI	Westmeath

Site Code	Waterway	Site Name	Grid Ref	Country	County
1174	Grand Canal	Griffith Bridge/Shannon Harbour	N0330019100	RoI	Offaly
1175	Lagan Canal	Hilden Bridge	J2810065500	NI	Antrim
1176	Clooneen River	Bridge NW of Kilavil	G6364110056	RoI	Sligo
1177	Grand Canal	Hazelhatch Bridge	N9880030700	RoI	Dublin
1178	River Feale	Mount Colums Creamery	R1575018700	RoI	Limerick
1179	River Erkina	Footbridge 0.5km u/s Durrow	S4050077500	RoI	Laois
1180	River Suck	Ballyforan Bridge	M8160046300	RoI	Galway
1181	River Nore	Waterloo Bridge	S4110084000	RoI	Laois
1182	Owenass River	Bridge Nth of Irishtown Hs	N4500007300	RoI	Laois
1183	Delour River	Annagh Bridge	S2910093500	RoI	Laois
1184	River Barrow	Clashganey Lock	S7360945865	RoI	Carlow
1185	Dinin River	Dinin Bridge	S4789062850	RoI	Kilkenny
1186	River Nore	Fennessys Mill	S5228754953	RoI	Kilkenny
1187	Owenboy River	Ballea Bridge	W7090063300	RoI	Cork
1188	Woodford River	Ballyconnell Bridge	H2729118609	RoI	Cavan
1189	Cladagh River	Swanlinbar Church of Irl	H1940027200	RoI	Cavan
1190	Owengarve River	Rosgalive Bridge	L8866096312	RoI	Mayo
1191	Carrowbeg River	2nd br u/s lake, Westport Hs	L9940484624	RoI	Mayo
1192	River Bush	Bush Golf Course	C9370042500	NI	Antrim
1193	Broadmeadow	Swords Golf Course	O1488150004	RoI	Dublin
1194	Unshin River	Riverstown Riverstown	G7399720147	RoI	Sligo
1195	Gort River	Castletown Mill	M4583303174	RoI	Galway
1196	River Barrow	Portnahinch Bridge	N4910010100	RoI	Laois
1197	River Dereen	Acaun Bridge	S9000077900	RoI	Carlow
1198	Castlebar River	Castlebar Town	M1400090500	RoI	Mayo
1199	Vicarstown Canal	Vicarstown	N6150000500	RoI	Laois
1200	Dalligan River	Ballyvoyle Bridge	X3359794997	RoI	Waterford
1201	Lacey's Canal	Butler's Bridge	N4200050300	RoI	Westmeath
1202	River Nore	Dysart	S5960039300	RoI	Kilkenny
1203	Royal Canal	County Meath Bridge	N8860039600	RoI	Kildare
1204	River Boyne	2km d/s Blackwater confl.	N8852069110	RoI	Meath
1205	River Knock	Knockadrohid Bridge	M1587926695	RoI	Galway
1206	River Lee	Lee Fields	W6484371393	RoI	Cork
1207	Clodiagh River	Muchlagh Bridge	N3100022800	RoI	Offaly
1208	Dripsey River	Dripsey Bridge	W4876073864	RoI	Cork
1209	Brosna River	Mill Race Coola Mills	N4200050200	RoI	Westmeath
1210	Silver River	Wooden Bridge	N1270014300	RoI	Offaly
1211	Castletown River	Toberona/St John's Bridge	J0300009700	RoI	Louth
1212	Kilcurry River	Bridge near Lurgankeel	J0272811980	RoI	Louth
1213	River Dereen	Ballykilduff Townland	S9000070900	RoI	Carlow
1214	River Dee	Bridge in Ardee	N9528590665	RoI	Louth
1215	Dee River	Drumcar Bridge	O0660091170	RoI	Louth
1216	Scarrif River	Cooleen Bridge	R6030086000	RoI	Clare
1217	River Dodder	Castlekelly Bridge	O1110020260	RoI	Dublin
1218	Scarrif River	1km u/s Scarrif Bridge	R6330084315	RoI	Clare
1219	Rye Water	Rye Bridge	O0040035800	RoI	Dublin
1220	Boyne Canal	Oldbridge	O0460076200	RoI	Louth
1221	River Boyne	Kilnagross Bridge	N7710056800	RoI	Meath
1222	River Glyde	Castlebellingham	O0600095100	RoI	Louth
1223	Newry Canal	Victoria Lock	J0960023400	NI	Armagh
1224	The Quoile	Quoile Pondage	J4960047000	NI	Down
1225	River Boyne	Beaulieu Bridge	N1250075900	RoI	Louth
1226	Emlagh River	Bridge west of Emlagh townland	Q6480003300	RoI	Kerry
1227	River Dargle	Ballinagee Bridge	O2040014700	RoI	Wicklow
1228	Stradbally River	Stradbally Bridge	S5720096300	RoI	Laois
1229	Glenarm River	Glenarm Castle	D3100015100	NI	Antrim
1230	Camowen River	Lover's Retreat Picnic Site	H4680072900	NI	Tyrone
1231	River Lagan	Drum Bridge	J3060067100	NI	Antrim
1232	Inny River	Coolnagon Bridge	N3872470037	RoI	Westmeath
1233	River Bride	Tallow Bridge	W9980094400	RoI	Waterford

Site Code	Waterway	Site Name	Grid Ref	Country	County
1234	Breensford River	Unknown	N1040044400	RoI	Westmeath
1235	Fairywater	Downstream of Poe's Bridge	H4250075000	NI	Tyrone
1236	Inny River	Ballycorkey Bridge	N3120063900	RoI	Westmeath
1237	Mahon River	Aughshemus Bridge	S4160002600	RoI	Waterford
1238	Glory River	Monachunna Townland	S4810038100	RoI	Kilkenny
1239	Kings River	Ballycloven	S4853939873	RoI	Kilkenny
1240	Royal Canal	Chambers Bridge	N9000038800	RoI	Kildare
1241	River Bush	Conagher Bridge	C9574930521	NI	Antrim
1242	Mountain River	Ballycoppigan Bridge	S7343549860	RoI	Carlow
1243	Camowen River	Bracky Bridge	H5350071400	NI	Tyrone
1244	River Faughan	Park Bridge	C5910002400	NI	Derry
1245	Sixmile Water	Loughshore Park	J1480086500	NI	Antrim
1246	Lower Bann	The Cuts	C8560030300	NI	Derry
1247	Glenelly River	Drumaspar	H4960091300	NI	Tyrone
1248	Annalee River	Rathkenny Bridge	H5350011600	RoI	Cavan
1249	Tolka River	Violet Hill Drive, Finglas	O1430037400	RoI	Dublin
1250	Grand Canal	Ponsonby Bridge	N9370026600	RoI	Kildare
1251	Broadmeadow	Milltown Bridge	O0721051770	RoI	Meath
1252	River Dargle	Tinehinch Bridge	O2212516160	RoI	Wicklow
1253	Aghadowney River	Agivey Bridge	C8980022900	NI	Derry
1254	Slaney River	Enniscorthy Bridge	S9742239898	RoI	Wexford
1255	Varty River	Ashford Bridge	T2704797405	RoI	Wicklow
1256	River Liffey	New Bridge	N8704009850	RoI	Kildare
1257	Royal Canal	Ballinea Bridge	N3850051100	RoI	Westmeath
1258	Slaney River	Kilcarry Bridge	S8940062500	RoI	Carlow
1259	River Barrow	Ballyteiglea Br (Lock)	S6920053200	RoI	Carlow
1260	Sixmilewater	Millrace Trail	J1550085500	NI	Antrim
1261	Ulster Canal	Monaghan Town	H6800034700	RoI	Monaghan
1262	River Corrib	Quincentennial Bridge	M2928726328	RoI	Galway
1263	River Laune	1/2km below Beaufort Bridge	V8816692633	RoI	Kerry
1264	River Strule	Stone Bridge	H4370077600	NI	Tyrone
1265	Sillees River	Glencunny Bridge	H0830038400	NI	Fermanagh
1266	River Lagan	Stranmillsweir to Lagan Meadows	J3410070900	NI	Antrim
1267	Sixmilewater	Castlefarm Bridge	J1440086800	NI	Antrim
1268	River Bann	Lawcencetown	J0990049200	NI	Down
1269	River Nore	Threecastles Bridge d/s	S4650062600	RoI	Kilkenny
1270	Dawros River	Derryinver Bridge	L7000059000	RoI	Galway
1271	River Dodder	Clonskeagh Bridge	O1750030700	RoI	Dublin
1272	River Roe	Roe Road Bridge	C6680022900	NI	Derry
1273	Annalee River	Butler's Bridge	H4094910499	RoI	Cavan
1274	Glencullen River	Knocksink Nature Reserve	O2190017900	RoI	Wicklow
1275	Avonmore River	Clara Vale Site 1	T1845591104	RoI	Wicklow
1276	Blennerville Canal	Blenerville	Q8164713313	RoI	Kerry
1277	Lackagh River	Lackagh Bridge	C0956930880	RoI	Donegal
1278	Crawsfordsburn River	Crawsfordsburn Country Park	J4670082000	NI	Down
1279	River Shrule	Stone Bridge u/s	H4369577631	NI	Tyrone
1280	River Faughan	Faughan Bridge u/s	C4930020600	NI	Derry
1281	Aigivey River	Errigal Bridge	C8130014500	NI	Derry
1282	Fairy Water	Omagh	H4290074900	NI	Tyrone
1283	River Boyne	Trim Walkway	N8069056480	RoI	Meath
1284	River Boyne	Trim Castle	N8019056889	RoI	Meath
1285	Glencullen River	Glencullen/Dargle confluence	O2430017200	RoI	Wicklow
1286	Vartry River	Annagolan Bridge	T2220099300	RoI	Wicklow
1287	Kings River	Kells Bridge	S4941543690	RoI	Kilkenny
1288	Drumragh River	Lissan Bridge	H4660070100	NI	Tyrone
1289	River Lagan	Wolfden's Bridge	J2847668805	NI	Antrim
1290	Agivey River	Moneycarrie Bridge	C8670019500	NI	Derry
1291	Lagan Canal	Ballyskeagh High Bridge	J2850066500	NI	Antrim
1292	Enler River	Dundonald Moat Park Transect	J4183574032	NI	Down
1293	Royal Canal	Sli na Canala, Enfield	N7750041300	RoI	Meath

Site Code	Waterway	Site Name	Grid Ref	Country	County
1294	Bann Upper	Laraheen	T1330064200	RoI	Wexford
1295	Upper Inny River	Jobson's Bridge	N5295480707	RoI	Meath
1296	Upper Inny River	Ross Bridge	N4729183034	RoI	Meath
1297	Clarebane River	Clarebane Bridge	H8740016800	RoI	Monaghan
1298	Owenascaul River	Anascaul Bridge	Q5920001900	RoI	Kerry
1299	Camlin River	Carrigglass Bridge	N1650078000	RoI	Longford
1300	River Boyne	Derryingdaly Bridge	N7660053950	RoI	Meath
1301	River Liffey	War Memorial Gardens	O1170034150	RoI	Dublin
1302	Arney River	Brochagh Bridge	H1750037500	NI	Fermanagh
1303	River Nore	Kilkenny City	S5150055500	RoI	Kilkenny
1304	River Nore	Bennetsbridge North	S5524349272	RoI	Kilkenny
1305	Gageborough River	John Halloway Farm	N2673337876	RoI	Offaly
1306	Royal Canal	D'Arcy's Bridge	N5920049800	RoI	Westmeath
1307	Grand Canal	Cartland Bridge	N5980032400	RoI	Offaly
1308	River Boyne	Ballyboggan Bridge	N6385040300	RoI	Meath
1309	Grand Canal	Courtwood Bridge	N6190004100	RoI	Laois
1310	River Boyne	Broadboyne Bridge	N9160071200	RoI	Meath
1311	Altidore River	Mountkennedy Wood	O2630906937	RoI	Wicklow
1312	Kilcrow River	Hearnesbrook Demesne	M7999011970	RoI	Galway
1313	River Lee (Kerry)	Ballyseedy Wood	Q8760113092	RoI	Kerry
1314	Grand Canal	Pike Bridge, Caron Gate	N9612637359	RoI	Kildare
1315	Broadmeadow	Ashbourne	O0639752231	RoI	Meath
1316	River Shannon	O'Brien's Bridge	R6610066800	RoI	Clare
1317	Ballyteige Channels	Ballteige	S9400006000	RoI	Wexford
1318	Virginia River	Handball Alley, Virginia	H6050087600	RoI	Cavan
1319	River Finn	Drumboe Woods	H1351294675	RoI	Donegal
1320	Garvogue River	Sligo Transect: Bridge Street, Sligo	G6930935969	RoI	Sligo
1321	Kings River	Newtown	S4640043500	RoI	Kilkenny
1322	Owenmore River	Knoxpark	G6735028950	RoI	Sligo
1323	Ardnaglass River	Ardnaglass Bridge	G5310034300	RoI	Sligo
1324	Mulkear River	Rockvale Bridge	R7381763391	RoI	Tipperary
1325	River Lagan	Moores Bridge	J3200068000	NI	Antrim
1326	River Lagan	Lock Keepers Cottage	J3300069100	NI	Antrim
1327	Hind River	South of Roscommon Town	M8935061350	RoI	Roscommon
1328	Maine River	Castleisland	R0015109561	RoI	Kerry
1329	River Suck	Dunamon Bridge	M7895064900	RoI	Roscommon
1330	River Suck	Rookwood Bridge	M8095057600	RoI	Roscommon
1331	Boyle River	Boyle Town	G7940502494	RoI	Roscommon
1332	Lecarrow Canal	Lecarrow	M9715055500	RoI	Roscommon
1333	River Suck	Cloondacarra Bridge	M6710078050	RoI	Roscommon
1334	River Shannon	Roosky	N0539787001	RoI	Roscommon
1335	River Scramogue	Carrowclogher	M9290078100	RoI	Roscommon
1336	Bleach River	Flagmount	R5555094900	RoI	Clare
1337	River Lee (Kerry)	Tralee Town	Q8371913759	RoI	Kerry
1338	Royal Canal	46th Lock	N0630075350	RoI	Longford
1339	River Shannon	Tharmonbarry	N0550076950	RoI	Roscommon
1340	Gageborough River	Ballyboughlin Bridge	N2365033800	RoI	Offaly
1341	Royal Canal	Scally's Bridge	N2300060100	RoI	Longford
1342	Mulkear River	Abington	R7157653428	RoI	Limerick
1343	Royal Canal	Ashtown Station	O1105037450	RoI	Dublin
1344	Royal Canal	Louisa Bridge	N9945036650	RoI	Kildare
1345	Butlerstown River	Glyntown Bridge	W7325075000	RoI	Cork
1346	Leannan River	Claragh Bridge	C2045020300	RoI	Donegal
1347	Shannon Bypass Canal	Bigmeadow, Athlone	N0391740202	RoI	Roscommon
1348	Glencree River	Wooden Bridge	O1920014700	RoI	Wicklow
1349	Killeenagarrif River	Barrington's Bridge	R6789054928	RoI	Limerick
1350	Baldwinstown River	Castle Bridge, Baldwinstown	S9705010250	RoI	Wexford
1351	River Nore	Limaine Bridge	S4410566004	RoI	Kilkenny
1352	River Dinan	Corelttstown	S5060066200	RoI	Kilkenny
1353	River Boyne	Bellewstown	N7620055800	RoI	Meath

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1354	Woodford River	George Mitchell Peace Bridge	H3395819357	NI	Fermanagh
1355	River Erne	Erne Bridge, Belturbet	H3514117039	RoI	Cavan
1356	River Boyne	Obelisk Bridge	O0455076250	RoI	Louth
1357	River Boyne	New Bridge, Drogheda	O0842675139	RoI	Louth
1358	River Bonet	Drumlease Fileds	G8184830233	RoI	Leitrim
1359	Blackwater River (U)	Favour Royal Bridge	H6121753031	NI	Tyrone
1360	Colebrook River	Scarford Bridge, Ashbrook	H3914144098	NI	Fermanagh
1361	Owenboy River	Bealahareach Bridge	W6846763224	RoI	Cork
1362	Newry Canal	Campbell's Lock	J0640045100	NI	Down
1363	River Coyle	Stoneyford	J5830048900	NI	Down
1364	Unknown River	Whitehouse, Ballymagrorthy	C3990018800	NI	Derry
1365	Unshin River	Union Wood, Colloney	G6859126898	RoI	Sligo
1366	Grand Canal	Belmont Village, Offaly	N0735921944	RoI	Offaly
1367	River Eske	Donegal Town	G9285878608	RoI	Donegal
1368	Maine River	Maine Bridge	Q8909004815	RoI	Kerry
1369	River Robe	Ballinarobe Town	M1903264544	RoI	Mayo
1370	Owenglin River	Andbear Old Bridge, Clifden	L6600050400	RoI	Galway
1371	River Nanny	Beamond Bridge (Bellewstown)	O0853369640	RoI	Meath
1372	Castletown River	Cort Rd Bridge	J0066509956	RoI	Louth
1373	Cashen River	Ferry Bridge	Q8890036500	RoI	Kerry
1374	Vartry River	Devils Glen	T2310098900	RoI	Wicklow
1375	River Boyne	Scurlockstown Bridge	N8158956837	RoI	Meath
1376	Newport River	Newport Town	L9900094000	RoI	Mayo
1377	River Bandon	Inisshannon Bridge	W5420057100	RoI	Cork
1378	Ballinderry River	Kildress AC	H7730078400	NI	Tyrone
1379	Royal Canal	Atchies Bridge	N1370058000	RoI	Longford
1380	Slate River	Bridge Street, Rathangan	N6725919354	RoI	Kildare
1381	River Liffey	Liffey Park, Clane	N8790027050	RoI	Kildare
1382	Leemara River	Leemara Wood	W8435076950	RoI	Cork
1383	Lerr River	Gotham Bridge	S7260082200	RoI	Carlow
1384	Ballinderry River	Cabinwood	H8160076500	NI	Tyrone
1385	Killymoon River	Tullylagan Manor	H8020073000	NI	Tyrone
1386	River Barrow	Maganey Bridge	S7175084650	RoI	Carlow
1387	River Barrow	Barrow Track, Carlow	S7173976826	RoI	Carlow
1388	Crumlin River	Lennymore Blue Bridge	J1190075300	NI	Antrim
1389	River Maigue	Ballycasey, Kildimo	R4690050600	RoI	Limerick
1390	River Barrow	Slyguff Townland	S6860057400	RoI	Carlow
1391	Ballinderry River	Scotstown Road	H9440080600	NI	Tyrone
1392	River Barrow	Milford Bridge	S6970067100	RoI	Carlow
1393	Lagan Canal	Broadwater	J1480062700	NI	Antrim
1394	Dungourney River	Bilberry	W9275875314	RoI	Cork
1395	Royal Canal	Jackson's Bridge	N9180037600	RoI	Kildare
1396	Lagan Canal	Gilchrest Bridge	J3172968037	NI	Antrim
1397	Shournagh River	Shournagh Cross Roads	W5910075400	RoI	Cork
1398	River Slaney	Tullow Bridge	S8490072200	RoI	Carlow
1399	River Cloughmore	Palmerstown	G1730031500	RoI	Mayo
1400	Owenmore River	Bangor Erris Village	F8610022800	RoI	Mayo
1401	Deel River	Deelcastle Townland	G1780018900	RoI	Mayo
1402	Allow River	Kilberrihert Metal Bridge	R3940011800	RoI	Cork
1403	Glasswater River	Glasswater Townland	J4495054050	NI	Down
1404	River Barrow	Barrow Br, Portarlington	N5400012700	RoI	Offaly
1405	Owenmore River	Bellacorick Bridge	F9690020000	RoI	Mayo
1406	River Barrow	Clogrennan Bridge	S6980073700	RoI	Carlow
1407	Sixmile Water	Dunadry Rd, Muckmore	J2010085000	NI	Antrim
1408	River Barrow	Leighlin Bridge	S6905065450	RoI	Carlow
1409	River Barrow	Rathvinden Lock	S6960066400	RoI	Carlow
1410	Shimna River	Tollymore Forest	J3270031900	NI	Down
1411	Ballinderry River	Coagh Village	H8920078700	NI	Tyrone
1412	Ballinderry River	Artrea Canoe Steps	H8609076900	NI	Tyrone
1413	Rye River	Carton Estate	N9590038100	RoI	Kildare

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1414	River Boyne	Scariff Bridge	N7340052600	RoI	Meath
1415	Kilcrow River	Ballyshrule Bridge	M7970005600	RoI	Galway
1416	River Bandon	Dunmanway	W2280053000	RoI	Cork
1417	Shannon Erne Waterway	Ballyduff Bridge	H1970010900	RoI	Leitrim
1418	River Slaney	Rathvilly Bridge	S8770082300	RoI	Carlow
1419	Grand Canal	Pluckerstown	N7470021000	RoI	Kildare
1420	Dooyertha River	Clougharevaun Bridge	M5830024400	RoI	Galway
1421	Unknown River	Lisduff Townland	M6440020400	RoI	Galway
1422	Grand Canal	Killeen Bridge, Daigean	N4900029000	RoI	Offaly
1423	Camcor River	Springfield Bridge, Birr	N0803704641	RoI	Offaly
1424	Laune River	Biannconi Car Park	V7790796335	RoI	Kerry
1425	River Blackwater (M)	Killavullen Bridge	W6477299756	RoI	Cork
1426	Shimna River	Islands Park, Newcastle	J3710031600	NI	Down
1427	Royal Supply Canal	Castlepollard Canal Bridge	N4350054500	RoI	Westmeath
1428	Grand Canal	Lock 34, McCartney Aqueduct	N0459519599	RoI	Offaly
1429	River Funshion	Killee Bridge	R7791912600	RoI	Cork
1430	River Moy	Banda	G4640009900	RoI	Sligo
1431	River Bonet	Cornstauk Bridge	G8720038900	RoI	Leitrim
1432	River Shannon	Drumsna Bridge	M9930597267	RoI	Leitrim
1433	Boor River	Kilgarvan Glebe Townland	N0830034900	RoI	Westmeath
1434	Castle Lough River	Castle Lough Woodlands	N6596999094	RoI	Cavan
1435	River Boyne	Boyne Estuary	O1254476333	RoI	Louth
1436	River Nanny	Annesbrook, Duleek	O0355565525	RoI	Meath
1437	Grand Canal	12th Lock, Lucan Road Br	O0298032236	RoI	Dublin
1438	Tunny Cut Channel	Lough Beg Tunny Cut Channel	J0910069100	NI	Antrim
1439	Cromogue River	Monroe, Bouladuff	S0507962531	RoI	Tipperary
1440	Owenbeg River	Kilnamonagh	G6527725618	RoI	Sligo
1441	Wee River	Madabawn Bridge	H6412209474	RoI	Cavan
1442	Rostrevor River	Rostrevor Town	J1800078000	NI	Antrim
1443	Grand Canal	Lock 26 to 27, Tullamore	N3565925606	RoI	Offaly
1444	River Sillees	Derryconnelly	H1220051900	NI	Fermanagh
1445	River Slaney	Glen of Imaal	S9360094200	RoI	Wicklow
1446	Royal Canal	Kildallan Bridge	N4333056440	RoI	Westmeath
1447	Royal Canal	Shandonagh Bridge	N3594052660	RoI	Westmeath
1448	Royal Canal	Baltrasna Bridge	N4718051300	RoI	Westmeath
1449	Deenagh River	Killarney National Park	V9473490149	RoI	Kerry
1450	Upper Caragh River	Blackstones Bridge	V7096486387	RoI	Kerry
1451	River Leannan	Dromore Bridge	C1240017700	RoI	Donegal
1452	River Suir	Holycross Village	S0903754106	RoI	Tipperary
1453	Jamestown Canal	Canal Tow Path	M9884595891	RoI	Roscommon
1454	Stoneyford/Glenavy River	Knockcairn Bridge	J1980073900	NI	Antrim
1455	Crumlin River	Crumlin Glen	J1560076500	NI	Antrim
1456	River Corrib	NUIGalway Playing Fields	M2872327513	RoI	Galway
1457	River Deele	Deel Bridge, Rathkeale	R3608041430	RoI	Limerick
1458	Glendasan River	Glendasan Valley	T1190097200	RoI	Wicklow
1459	River Owenmore	Slievadrehid	Q5126710759	RoI	Kerry
1460	Ulster Canal	Tom Young's Wood	H6574933103	RoI	Monaghan
1461	River Stick	Blegooly Village	W6655153637	RoI	Cork
1462	Duncorney River	Middleton Heritage Centre	W8845573376	RoI	Cork
1463	Owenacurra River	Cork Bridge, Midleton	W8793173755	RoI	Cork
1464	River Ilen	Poll na Carraighe Dubh	W1284047327	RoI	Cork
1465	River Bandon	Manch Estate, Dunmanway	W3017652606	RoI	Cork
1466	Grand Canal	Portobello, Dublin	O1568532465	RoI	Dublin
1467	River Faughan	Drumahoe A6 Road Bridge	C4604414749	NI	Derry
1468	Royal Canal	Moyvalley Bridge	N7220042600	RoI	Meath
1469	River Burren	Mill Race, Carlow Town	S7210476508	RoI	Carlow
1470	Royal Canal	Fowlards Bridge	N1790059300	RoI	Longford
1471	Royal Canal	Cope Bridge, Leixlip	O0079337067	RoI	Kildare
1472	River Shannon	Jamestown	M9791397804	RoI	Leitrim
1473	River Blackwater (M)	Castleislands, Lismore	X0400099000	RoI	Waterford

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1474	Royal Canal	The Downs, Kinnegad	N5008550707	RoI	Westmeath
1475	Stoneyford River	Coxtown	N6430061900	RoI	Westmeath
1476	Royal Canal	Coolnahinch Bridge	N1091464635	RoI	Longford
1477	River Barrow	Bestfield Lock Gates	S7170079284	RoI	Carlow
1478	Grand Canal	Sallins Village Centre	N8940022800	RoI	Kildare
1479	River Blackwater (M)	Salters Bridge	X0861799716	RoI	Waterford
1480	River Fergus	Ennis Town Center	R3387377672	RoI	Clare
1481	River Clodiagh	Portlaw Bridge	S4674115075	RoI	Waterford
1482	Glenshesk River	Magheratemple Townland	D1305039800	NI	Antrim
1483	Burntollet River	Ervey, Ness Wood	C5280011800	NI	Derry
1484	Grand Canal	Oberstown (M7 Bridge)	N8862121718	RoI	Kildare
1485	Grand Canal	Rathangan Bridge	N6740019300	RoI	Kildare
1486	River Blackwater	Deerpark Woodlands, Virginia	N5906587611	RoI	Cavan
1487	Anner River	Grangebeg Townland, Fethard	S2459829851	RoI	Tipperary
1488	Grand Canal	Bord Na Mona Factory Bridge, Lullymore	N7160029400	RoI	Kildare
1489	Bawnaknockane River	Ballydehob	V9893735109	RoI	Cork
1490	Royal Canal	Dolan Bridge (Coolnahay Harbour)	N3530954017	RoI	Westmeath
1491	River Blackwater	The Argory	H8730058500	NI	Armagh
1492	River Dodder	Rathfarnham Road (R114) Bridge	O1442429689	RoI	Dublin
1493	Sixmile Water	Summerhill Mill Section (Antrim Town)	J1836185182	NI	Antrim
1494	Manulla River	Laghtavarry, Ballyvarry (M5)	M2432894445	RoI	Mayo
1495	River Clare	Curraghmore Bridge (N84)	M3216733119	RoI	Galway
1496	River Blackwater (U)	Ballinode Village	H6291735826	RoI	Monaghan
1497	Woodford (Aughty) River	Clonco Townland (R135)	R7638199004	RoI	Galway
1498	River Barrow	Goresbridge Town	S5370068500	RoI	Kilkenny
1499	Curragheen River	Murphy's Farm (Bishopstown))	W6200070000	RoI	Cork
1500	River Finn (M)	Magherarny Village, Monaghan	H5788029835	RoI	Monaghan
1501	Bredagh River	Gulladuff, Moville	C6099438545	RoI	Donegal
1502	Swilly River	Milk Isle, Letterkenny (N14)	C1827811248	RoI	Donegal
1503	Owenmore River	Ardcree Bridge, SE Coolaney	G6403822638	RoI	Sligo
1504	Tolka River	Griffith Park to Drumcondra Park	O1618736725	RoI	Dublin
1505	Crolly (Gweedore) River	Crolly Bridge (NW of N56)	B8340019700	RoI	Donegal
1506	Skeoge River	Inch Widlfowl Reserve	C3500023000	RoI	Donegal
1507	Barrow Way Canal	Ballyteige Bridge	N7535124196	RoI	Kildare
1508	Castlegar River	Canavans Bridge, Mountbellew	M6669246852	RoI	Galway
1509	River Maigue	Adare Bridge, Adare Town	R4688946639	RoI	Limerick
1510	Glenaniff River	R281 Bridge, Rossinver	G9202149672	RoI	Leitrim
1511	Eany Water	Ballymacahill Bridge	G8410081500	RoI	Donegal
1512	River Liffey	Castletown Estate	N9920434119	RoI	Kildare
1513	Grand Canal	Clogheen Bridge 5th Monasteravin	N6201409766	RoI	Kildare
1514	Owenkeagh River	Mounteen Townland, Ballinascarthy	W4290046800	RoI	Cork
1515	Bessbrook River	Carrigmore Viaduct, Bessbrook	J0659928366	NI	Armagh
1516	River Nore	Tallyho Bridge, SE Durrow	S4235776207	RoI	Laois
1517	Newry Canal	PontzyPass, Nth Newry	J0600039400	NI	Armagh
1518	Leannan River	Ramelton Town Centre	C2280421180	RoI	Donegal
1519	Slate River	Drumsru Townland, Rathangan	N7252023529	RoI	Kildare
1520	River Inny	Float Bridge, Coole	N3924672511	RoI	Westmeath
1521	River Lagan	Governor's Bridge, Belfast	J3385471602	NI	Antrim
1522	Dungolman / Tang River	Galliaghstown	N1760052000	RoI	Westmeath
1523	Tributary of River Inny	Ballymacartan Townland (L5344)	N2410052500	RoI	Westmeath
1524	River Blackwater (Wexford)	Mooeny's Fields (East of Blackwater)	T1312033302	RoI	Wexford
1525	River Finn	R235 Road Bridge, Castlefinn	H2623794587	RoI	Donegal
1526	Broadmeadow	Fieldstown (R122), Rolestown	O1174450227	RoI	Dublin
1527	Torrent River	Reenaderny Road Bridge	H8821962848	NI	Tyrone
1528	River Lagan	Ballynaris Hill (W of Dunmore)	J1804153425	NI	Down
1529	River Lagan	Tullynacross Rd Bridge (Lisburn)	J2790366270	NI	Antrim
1530	Bilboa River	Blackboy Bridge	R7970051500	RoI	Limerick
1531	Bilboa River	Bilboa Bridge	R8160051800	RoI	Limerick
1532	Boyne Canal	Ramparts Foot Bridge	N8744767932	RoI	Meath

Site Code	Waterway	Site Name	Grid Ref	Country	County
1533	Killaloe Canal	Killaloe Town Centre	R6980073300	RoI	Clare
1534	Nenagh River	Kylerarr Bridge, Lower Bir Road	R8730580003	RoI	Tipperary
1535	Carrowbeg River	East of Viaduct, Westport	M0036684399	RoI	Mayo
1536	Francis River	Castlerea Town Park	M6764879937	RoI	Roscommon
1537	Muckanagh River	Knockbaun R312 Rd Bridge	M0729196721	RoI	Mayo
1538	Ballinamore/Ballyconnell Canal	Crossycarwill Bridge	G9749705203	RoI	Leitrim
1539	Lissan Water	Lissan House, Cookstown	H7943782418	NI	Tyrone
1540	Ballinderry River	Wellbrook Bridge, Cookstown	H7495379114	NI	Tyrone
1541	Owenduff River	Srahboy Confluence (Shean Lodge)	F8450011200	RoI	Mayo
1542	Owvane River	Carriganass Bridge (R584)	W0484656566	RoI	Cork
1543	Ballymoney River	Riverside park, Ballymoney	C9550025700	NI	Antrim
1544	River Shannon	Railway Bridge, Athlone	N0350041900	RoI	Westmeath
1545	River Foyle	Sainsbury, Strand Rd, Derry	C4384518292	NI	Derry
1546	Derryhippo River	Cregg Village Walkway	M7625660241	RoI	Galway
1547	Ballinderry Upper River	Baroney Road (West of Cookstown)	H6555379079	NI	Tyrone
1548	Glenamoy River	Glenamoy Bridge (R314)	F8931333817	RoI	Mayo
1549	Ilen River	Bridge by West Cork Hotel	W1185933916	RoI	Cork
1550	River Lee	Angler's Rest, Bandon	W6086671777	RoI	Cork
1551	River Liffey	Liffey Linear Park, Newbridge	N8060015400	RoI	Kildare
1552	Grand Canal	Lock 32 (Noggus)	N1045722884	RoI	Offaly
1553	Nenagh River	Ballyartella Bridge, Ballycommon	R8392783443	RoI	Tipperary
1554	Gageborough River	Train Station Field, Horseleap	N2789138297	RoI	Westmeath
1555	Ballinderry Upper River	Aughlish Townland	H7858778266	NI	Tyrone
1556	River Dall	Cushendall Town Centre Bridge	D2367927620	NI	Antrim
1557	Fane River	Blackstaff (Bridge on L3119)	H9079009691	RoI	Monaghan
1558	River Inny	Finea Village	N3952181091	RoI	Westmeath
1559	Ballinamore Canal	Ballinamore Town	H1273211448	RoI	Leitrim
1560	Canal Bank Plassey Walk	Lough Derg Way, Limerick City	R9657987576	RoI	Limerick
1561	River Glennafallid	Glenshelane River Walk	X1189799298	RoI	Waterford
1562	River Bann	Fisherman's Walk, Portglenone	C9789902575	NI	Antrim
1563	Colligan River	Killadangan Bridge, Killadangan	X2321396144	RoI	Waterford
1564	Clare River	Milltown Bridge, Milltown Village	M4054362970	RoI	Galway
1565	Curracloe Channel	Curracloe North Slob	T1074924246	RoI	Wexford
1566	Triogue River	Portlaoise South Central	S4752598083	RoI	Laois
1567	River Blackwater	Kitchen Hole to Huthole (N72)	X0863799736	RoI	Waterford
1568	River Barrow	Athy Railway Bridge	S6823793403	RoI	Kildare
1569	Grand Canal	Dolphins Barn, Dublin	O1368932684	RoI	Dublin
1570	Lixnaw Canal & River Brick	Cunnigar Townland	Q8898328977	RoI	Kerry
1571	River Shannon	Universtiy of Limerick	R6102158685	RoI	Limerick
1572	Black River	Shrule Village	M2799452633	RoI	Mayo
1573	River Shannon	Castleconnel (Castleoaks Hotel)	R6545362174	RoI	Limerick
1574	Bawnboy River	Bawnboy Bridge (Keepers Inn)	H2114719111	RoI	Cavan
1575	Bunowen River	Louisburgh Town Centre	L8067880692	RoI	Mayo
1576	River Mahon	Main Street Bridge, Kilmacthomas	S3934806187	RoI	Waterford
1577	Arra River	Cullinaghmore Bridge, Newcastle West	R2721233792	RoI	Limerick
1578	River Mock	Duncormick Bridge	S9177109309	RoI	Wexford
1579	Tributary of River Corock	Wellintonbridge, Wexford	S8523213601	RoI	Wexford
1580	River Shannon	Lanesborough Town Centre	N0049269385	RoI	Roscommon
1581	Aherlow River	Ballyhoura Way	R8100027800	RoI	Limerick
1582	River Shannon	World's End, Castleconnell	R6587763590	RoI	Limerick
1583	Creegh River	Creegh Bridge	R0337966892	RoI	Clare
1584	Ward River	Wards River Valley Park, Swords	O1769346634	RoI	Dublin
1585	River Sullane	Sullane Macroom Town Park	W3295072620	RoI	Cork
1586	The Loobagh	North Bridge, Kilmallock	R6060828469	RoI	Limerick
1587	Grand Canal	29th Lock, Tullamore	N2875125261	RoI	Offaly
1588	The Loobagh	Deebert Bridge (R515), Kilmallock	R6125727758	RoI	Limerick
1589	Owvane River	Perason's Bridge	W0231554545	RoI	Cork
1590	Figile River	Clonbullogue Bridge	N6091923513	RoI	Offaly
1591	River Morningstar	Bruff Village, Limerick	R6266835993	RoI	Limerick

Site Code	Waterway	Site Name	Grid Ref	Country	County
1592	Headrace Canal	Blackwater Bridge, Ardnacrusa (R463)	R5928761868	RoI	Clare
1593	Keale River	Darragh Bridge, Kilfinane	R7223717529	RoI	Clare
1594	Owendoher River	Ballyboden Road, Dublin	O1420028400	RoI	Dublin
1595	River Lee	Carrigohane (Beyond Lee Fields)	W6316371800	RoI	Cork
1596	Grand Canal	Ballycommon	N4239025893	RoI	Offaly
1597	River Dodder	Herbert Park, Ballsbridge	O1788032428	RoI	Dublin
1598	River Nore	Knockanore Townland	S5469643591	RoI	Kilkenny
1599	River Lee	Cork City Centre	W6748172150	RoI	Cork

Appendix 3 Brown Long-eared Bat Roost Monitoring

Preliminary Roost Assessment - Methodology

All new roosts, when first considered for inclusion in the monitoring scheme, were assessed by completing a daytime check of the building. This involved a survey of the roof space and when the building was accessible, safe, and Brown Long-eared Bat droppings or actual Brown Long-eared Bats were observed, then a preliminary assessment was undertaken. The preliminary assessment involved surveying the building by using at least two of the methods listed in Table A3.1 below. Once a site was deemed suitable for inclusion in the scheme (i.e. more than eight individuals were present and it was possible to safely count bats at the site by watching emerging bats or by entering the roof space), monitoring was then completed year-on-year using the most suitable method with an aim of counting the colony at each roost twice per year.

Table A3.1 Methods of assessing the most suitable protocol for counting Brown Long-eared Bats at each roost. The assessment is carried out using at least two of Methods A-C below. Dates for surveying: Survey 1, 1 May to 15 June 15; Survey 2, 16 June to 31 July; Survey 3, 1 August to 31 August.

	Method A	**Method B**	**Method C**
Description	Interior daytime count	Emergence Dusk Count	Interior Post Emergence Count
No. of counts per season	2	2 or 3	2 (usually in conjunction with Method B)
Dates when counts can be conducted	Survey Period1 & Survey Period 3	Survey Period 1 (preferred), Period 2 and Period 3 (preferred)	Survey Period 1 & Survey Period 3
Surveyor	Licensed	Licence not necessary	Licensed
Method	Count of bats present in roost.	Surveyors present at all known exit points, surveying starts 20 minutes after sunset. Count in 10min blocks. Count for 60mins or stop when no bats emerge for 10mins. Note if bats are seen or just heard. Direction of flight also noted.	Enter roost at start and end of emergence. Count bats present on both occasions. Numbers of bats before and after emergence are compared with total observed emerging.
Equipment	Red-light torch	Bat detector and red-light torch	Red-light torch
Other recorded details	Internal roof details, dimensions, presence of roof felt etc.	Weather conditions.	Weather conditions
Other info	Dead bats collected	Fine weather survey only.	Only undertaken in buildings with safe access in hours of darkness.

Table A3.2 Locations of Brown Long-eared Roost Monitoring Sites recommended for 2018-2020 monitoring period.

Code	Name	Grid Reference	Survey Type
2001	Kilmore Cathedral, Co. Cavan	H3840003547	Internal
2003	St. Kevin's Kitchen, Co. Wicklow	T1225996784	Emergence
2005	Private Residence, Timoleague, Co. Cork	W4672144156	Internal
2006	Private Residence, Currabinny, Co. Cork	W7985461938	Emergence
2009	Glenealy Catholic Church, Co. Wicklow	T2486692334	Emergence
2010	Ardgillan Castle, Co. Dublin	O2188861214	Emergence
2012	Lydacan Castle, Gort, CO. Galway	M4374507999	Emergence
2013	Church of Ireland, Ennistage, Co. Kilkenny	S5249648995	Emergence
2014	Church of Ireland, Clone, Co. Wexford	T0051943249	Emergence
2016	Private Residence, Rathkeale, Co. Limerick	R3967039242	To be reassessed
2019	Church of Ireland, Tomregan, Co. Cavan	H2699018836	Internal
2021	Private Residence, Birr, Co. Offaly	N1330200930	Emergence
2022	Private Residence, Pearson's Bridge, Co. Cork	W0217455591	Emergence
2023	Private Residence, Glengarriff, Co. Cork	V9102357423	Internal
2024	Catholic Church, Bantry, Co. Cork	V9988748189	Emergence
2027	Private Residence, Dunmanway, Co. Cork	W2358754713	Emergence
2029	Agricultural Building, Co. Wexford	T0265033650	To be reassessed
2035	Catholic Church, Inagh, Co. Clare	R2083081244	Emergence
2038	Church of Ireland, Portlaw, Co. Waterford	S465153	Emergence
2039	Church of Ireland, Kilmeadan, Co. Waterford	S516109	Emergence
2045	Emo Court, Co. Laois	N5376306596	Internal
2055	Private Residence, Kells, Co. Kilkenny	S4992842667	Emergence
2062	Clonfert Cathedral, Co. Galway	M9615021150	Emergence
2063	Church of Ireland, Ballycormack, Co. Longfrod	N116710	Emergence
2064	Church of Ireland, Horetown, Co. Wexford	S8751719690	Emergence
2065	Church of Ireland, Swanlinbar, Co. Cavan	H1922627024	Emergence
2066	Catholic Church, Baileboro, Co. Cavan	H6159401409	Emergence
2067	Catholic Church, Riverstown, Co. Sligo	G7411719996	Emergence
2072	Church of Ireland, Crohan, Co. Tipperary	S2783045640	Emergence
2086	Catholic Church, Peterswell, Galway	M507069	To be reassessed
2090	Church of Ireland, Screen, Co. Sligo	G524326	Internal
2092	Church of Ireland, Donnameade, Co. Kildare	N8336033058	Emergence
2100	Private Building, Cloughballymore, Co. Galway	M3977514075	Emergence
2101	Private Residence, Castlebar, Co. Mayo	M1895882258	Internal
2116	Private Residence, Castlebaldwin, Co. Sligo	G7629316392	Emergence
2119	Private Residence, Virginia, Co. Cavan	N6705181641	To be reassessed
2120	Private Building, Milltown, Co. Cavan	H3425913074	Internal
2121	Private Residence, Maynooth, Co. Kildare	N9211342496	To be reassessed
2122	Private Residence, Ballydehob, Co. Cork	V9870038800	Emergence
2123	Church of Ireland, Ardmore, Co. Waterford	X1888977468	Emergence
2124	Church of Ireland, Dunamon, Co. Roscommon	M7900664687	Emergence
2125	St Patrick's Church of Ireland, Powerscourt, Co. Wicklow	O2239517047	Emergence
2128	Private Building, Ballynabrock, Co. Wicklow	O0960012900	Emergence
2129	Ardbraccan Church, Navan, Co. Meath	N8283668243	Emergence
2130	Clogharinka Catholic Church, Co. Kildare	N6550039200	Emergence
2131	Nuns Cross Church of Ireland, Ashford, Co. Wicklow	T2577597975	Emergence
2132	Killymard Old Roman Catholic Church, Co. Donegal	G9339480438	Emergence
2133	Drung Roman Catholic Church, Co. Cavan	H5086510577	Emergence
2135	Private Building, Letterfrack, Co. Galway	L7105857545	Emergence
2136	Raheen Community Hospital, Raheen, Co. Clare	R6586982667	Emergence
2137	Private Building, Gort, Co. Galway	M4810206109	Emergence