Irish Bat Monitoring Schemes

Annual Report for 2024

Roche N., Clarke, D., Healy, K., & Langton S. (2025)

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1.0 EXECUTIVE SUMMARY

This annual report provides information on monitoring schemes managed by Bat Conservation Ireland:

● Car-Based Bat Monitoring (All Ireland)
● All Ireland Daubenton's Bat Waterway Monitoring
● Brown Long-eared Bat Roost Monitoring
● Lesser Horseshoe Bat Monitoring

While rainfall was below average at most stations in 2024 it was a dull year for most of the country. Even though the summer seemed cool, on average temperatures were above the long-term average for the year. There were seven named storms during the year.

For the Car-Based Bat Monitoring Scheme 56 individuals participated in surveys of 27 squares around the island. Online training courses were provided in 2024 for seven new teams, and revision training was provided to two teams, also via Zoom. Data from 51 surveys, all of which had >10 completed transects, were available. In total 12,740 bat passes were recorded, 47% of which were common pipistrelles. The soprano pipistrelle was second most frequently recorded bat species and Leisler's the third most common.

Trends were analysed using a combination of data from both Tranquility (which were used up to 2019) and Batlogger detectors (which were used from 2017 onwards), using a covariate to account for differences in the two. Although yearly estimates of most species were slightly lower in 2024, trends of the three target species continued to increase. Confidence intervals of the common pipistrelle, soprano pipistrelle and Leisler's bats are all well above their baseline indices indicating they each show a significantly increasing trend.

Nathusius' pipistrelle trends are still unclear but increased a little in 2024. The brown long-eared roadside trend has been increasing slightly since 2020, although confidence intervals still indicate a reasonably stable trend. Numbers of observations of both these species are extremely low using the car-based method, leading to wide error bars.

The yearly estimate for the *Myotis* spp. group increased in 2023 and 2024 and the upper confidence interval is again above the baseline index. This may indicate that the consistent downward trend observed from 2015 to 2021 has begun to level out.

Training courses were online as part of the All-Ireland Daubenton's Bat Waterway Monitoring Scheme in 2024. Two hundred and fifty waterway sites were surveyed by 210 teams in 2024. Of these 250 sites, 216 (86.4%) were surveyed twice in the month of August. A total of 18,294 'Sure' Daubenton's bat passes were recorded on 217 waterway sites (86.8%). The trend line for Daubenton's bat across the island appears to be fairly steady from year to year with error bars consistently encompassing the baseline.

For Brown Long-eared Bat Roost Monitoring, 37 volunteers participated in 2024, which included two roost owners. Volunteers provided count data for 29 roost sites while an additional 9 roosts were surveyed by the coordinator. One roost was surveyed by the coordinator and a team of volunteers. In total, 110 monitoring surveys were carried out at 41 roosts. Using the highest results for each roost monitored in 2024, the total number of brown long-eared bats counted was 1,555 individuals. Average counts in 2024 were almost identical to 2023. The smoothed GAM curve remains roughly level, slightly above the baseline 2009 value, but not significantly different to it, as has been the case for the last ten years. Nonetheless, the error bars encompass the baseline so the population is, overall, considered to be stable.

NPWS and VWT regional staff forwarded count data from 121 lesser horseshoe bat sites in winter 2024 and 143 sites in summer 2024. In winter 2024 9,800 bats were counted, and 12,117 bats were counted in summer 2024. From 2012 onwards there has been excellent consistency in counts at lesser horseshoe sites, which improves the robustness of the monitoring dataset. Over the past 20 years this species has increased in winter by an average of 3.15% per annum. Summer trends mirror this, slightly less steeply (2.84% per annum since 2004). A high number of new sites have been found by local NPWS staff in the past few years, in 2024 alone, 26 new sites were added to the roost database.

2.0 GENERAL INTRODUCTION

2.1 Why Monitor Ireland's Bats?

Bats constitute a large proportion of the mammalian biodiversity in Ireland. Nine species of bat are known to be resident in Ireland and 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. The Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019 ensured that this legislation remained in place in Northern Ireland upon the exit of the UK from the EU.

Ireland and the UK are 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 Republic of Ireland and the UK are two of the 39 parties to the Agreement. The Agreement has an Action Plan with priorities for implementation. One of the current priorities is to produce guidelines on standardised bat monitoring methods across Europe. Battersby (2010), in a EUROBATS publication outlined various methods for surveillance and monitoring of bats. This publication is currently being updated by a Eurobats Advisory Committee.

The Red Data List for Mammals in Ireland (Marnell *et al.*, 2019) lists all the Irish bat species and, therefore all of the bat species monitored by the Irish Bat Monitoring Programme, as Least Concern. One of the species included in BCIreland's monitoring, Leisler's bat (*Nyctalus leisleri*), was previously listed as considered Near Threatened (Marnell *et al.,* 2009). It had been assigned this threat status because Ireland is considered a world stronghold for the species (Mitchell-Jones *et al.*, 1999). However, the status of the European Leisler's bat population is also Least Concern (Temple and Terry 2007). This species is still, however, infrequent in the rest of Europe compared with Ireland where it is quite common.

2.2 Red and Amber Alerts

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 *et al.*, 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 for Car-Based Bat Monitoring see Roche *et al*., 2009 and for the Daubenton's Waterways Survey see Aughney *et al.,* 2009).

2.3 The Monitoring Schemes

Despite high levels of legal protection for all species, until 2003 there was no systematic monitoring of any species apart from the lesser horseshoe bat in Ireland. To redress this imbalance, The Car-Based Bat Monitoring Scheme was first piloted in 2003 and targets the two most abundant pipistrelle species (common and soprano pipistrelles) and Leisler's bat (Catto *et al*., 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 full spectrum bat detector which picks up a range of ultrasound which can be 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 this is completed post survey work.

The car-based monitoring scheme was followed in 2006 by the All-Ireland Daubenton's Bat Waterways Monitoring Scheme (e.g. Aughney *et al.,* 2007). This scheme follows a survey methodology devised by the Bat Conservation Trust (BCT 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 of 'bat passes' of this bat species for four minutes at each of the 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 public to bat conservation-related work.

In 2007, a brown long-eared bat monitoring scheme was piloted (Aughney *et al.*, 2011). This project concentrates on counts of brown long-eared bats at their 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. A full report on the brown long-eared roost monitoring scheme is provided in Aughney *et al.,* 2011.

BCIreland took over management of the lesser horseshoe bat monitoring dataset in November 2013. Surveys for this scheme are mainly carried out by staff of the NPWS and VWT, along with a small number of volunteers and ecological consultants. Each year counts are carried out at specific lesser horseshoe sites. Surveys take place in summer at dusk and are usually carried out using bat detectors, although video cameras and/or internal counts are also sometimes carried out depending on site characteristics and staff availability. The dates for surveying in summer are May 23rd to July 7th. Winter surveys are carried out in January and February each year using internal counts, sometimes aided by still photography.

The Car-Based Bat Monitoring Scheme and All-Ireland Daubenton's Bat Waterway surveys are all-Ireland schemes. The brown long-eared roost monitoring has, so far, been based in the Republic of Ireland only. The lesser horseshoe bat is confined to the Republic of Ireland. Regular monitoring under BCIreland management is, therefore, in process for six bat species for the Republic of Ireland, one of which is the only resident Annex II species on the island, and for four bat species in Northern Ireland. Additional BCT UK Field Surveys are also undertaken in Northern Ireland. Data collected from those surveys feed into the BCT's UK reporting mechanisms.

2.4 Weather in 2024

While rainfall was below average at most stations in 2024 it was a dull year for most of the country. Sunniest conditions were recorded in the eastern half of the country. Overall temperatures were higher than the long term average. There were seven named storms in 2024.

The survey season kicked off in January with counts at lesser horseshoe hibernacula. Weather-wise, January was cold, dry and sunny. High pressure was in control for the second week bringing dry and cool weather. The third week saw an Arctic air mass cause widespread frosts. Milder weather arrived towards the end of the month, along with two named storms Joceyln and Isha. The second half of the January was much drier, especially in the east. February was mild and wet with a dip in temperatures towards the end of the month. Rainfall was above average in February.

Summer surveying began in May with brown long-eared bat and lesser horseshoe bat counts. This month was reasonably dry and was the warmest May on record in many places. In contrast the summer of 2024 began in the first half of June with a cool northerly airflow. The second half of the month was wetter and milder but this was followed in early July by a return to cool north-westerlies. The month of July gradually warmed up and was followed by a mixed August. Low pressure fronts bringing rain kept the west and northwest cool while the South and East experienced a drier warmer August. Overall temperatures in the summer of 2024 were below average in many places.

All weather data derived from www.meteireann.ie.

3.0 CAR-BASED BAT MONITORING

3.1 Methods

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 Batlogger M detector (Elekon Electronics), two SD cards, instruction manuals, recording sheets, batteries, flashing beacon, thermometer and a first aid kit. Surveyors are also provided with a Dropbox link to share data, and a return postal label so the box can be posted back to BCIreland at the end of the season.

The Batlogger M detectors were used on their own for the first time in 2020. For details of the trial phasing in their use, see Aughney et al. (2020). 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, thus there is no need for recording hardware or connecting leads, which were, at times, a source of equipment failure with the former equipment set up for the survey.

In 2020 a new training video was uploaded to YouTube and to the Car monitoring Facebook page to provide further information on how to use the detector and other equipment for the survey.

- https://www.youtube.com/watch?v=09_x6dylqE8

Each year survey teams complete surveys of a mapped route within a defined 30km Survey Square. Routes cover 15 x 1.609km (1 mile) Monitoring Transects each separated by a minimum distance of 3.2km (2 miles).

Surveyors are asked to undertake 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 (at night) while continuously recording on the Batlogger detector.
The Batloggers are pre-loaded with parameters for the survey. Surveyors are asked to affix the detector to the window clamp so that the microphone is facing out of the window and slightly to the rear of the car. The Batlogger records audio and GPS location data to the device's SD card. Surveyors switch the Batlogger on to record at the start of each transect and switch it off at the end. The result is a folder containing multiple matched audio (.wav) and GPS (.xml) files for each survey evening.

On completion of surveys, data is forwarded to BCIreland for analysis. In 2024 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.

Data from Batloggers were analysed using Wildlife Acoustics Kaleidoscope Pro software (both automated and manual settings). At present manually identified bat calls are used to create trends although we plan to check automated identification methods against manual identification as identification algorithms continue to improve.

Calls are identified to species level where possible. Species that can be identified accurately using this method are the common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), 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 pipistrelles. Leisler's bat (*Nyctalus leisleri*), 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 species in the genus –

Daubenton's, whiskered or Natterer's (*Myotis daubentonii, M. mystacinus* or *M. nattereri*). Occasional social calls of brown long-eared bats (*Plecotus auritus*) are also recorded.

Data for each survey were gathered into Excel spreadsheets and imported to the tailor-made MySQL database.

For the purposes of providing volunteer feedback, data listing bat species, date, time and location were uploaded to Google Maps and bat locations were pinned to a map for each route, with icons of differing colour and shape denoting a particular bat species.

3.1.1 Statistical Analysis

3.1.1.1 Routine Yearly Trend Analysis

In previous years, when the detector used was a Tranquility time expansion detector the response variable was the number of passes per survey. From 2020 when we changed to Batlogger M full spectrum detectors, we switched to the number of sound files with the species present and we do not account for multiple passes when analyzing the data. In practice this change makes very little difference to the trend since the vast majority of the former Tranquility detector snapshots only had a single pass anyway.

For overall yearly trends as in previous years, the full GAM approach has been used as described by Fewster *et al*. (2000). Both Tranquility and Batlogger data are included, with a covariate for detector, to adjust for their different sensitivities. The response variable is the number of snapshots/soundfiles with the species present. The log of total survey time (based on number of 0.32s recordings per survey, sonogram length or the actual survey time) is used as an offset, which effectively does something very similar to analysing the passes per minute, but allows use of a Poisson error distribution.

For Nathusius' pipistrelle and brown long-eared bats, trend models were constructed based on a binomial distribution. This is because both species sometimes occur in the same transect on multiple occasions but there are, much more often, transects with no occurrences and, therefore, a large number of zeros in the dataset. We have previously fitted these trends 'backwards', with the penultimate year used as the base year. However, now that there is a reasonably long timeline of data, it is possible to do a more conventional approach, with the base year near the start.

The analyses have been carried out using the first 15 x 1.6km transects only, from 2003-2008, so that results are comparable with the reduced 2009-present sampling plan.

The spline curves have five degrees of freedom, which is the default recommended by Fewster for this length of data. Surveys with less than 650 0.32s snapshots (or equivalent sonogram length) or less than eight one mile transects are excluded. 2006 is used as the base year as this was the first year with more than 20 survey sites (squares).

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.

3.2 Results

Training via Zoom was provided to new surveyors in Antrim (H79), Down (J33), Mayo (G20), Westmeath (N11), Offaly/Tipperary (R88) & Limerick (R88). A number of surveyors who were carrying out the survey for the second year also attended these sessions.

Additional telephone and Whatsapp support conversations were held with several teams to address queries about the surveys in 2024.

All equipment was posted to surveyors.

Survey work in 2024 was carried out from mid to end July and a repeat survey was carried out in early to mid-August. The median date of the first survey in 2024 was 25th July. The median date of the second survey was 20th August.

Twenty six squares were surveyed in July 2024. All of these yielded usable data. Twenty seven squares were surveyed in August 2024 (see Figure 3.1). All of these, bar one, yielded usable data. In total 1,230km of monitoring transects were surveyed and approximately 360hrs of survey time was spent on the scheme by the volunteers.

Overall, the quality of data collected in 2024 was excellent. No errors arose with data being lost due to faulty cards in 2024. One survey was driven in the wrong direction to usual because the Google maps for start and stop points provided to the surveyor did not include transect numbers. This error will be corrected in future when providing data to new surveyors.

Squares that were surveyed in 2024 cover the length and breadth of the island with squares in the north, west, south and east of the island included, along with a good spread of squares in the midlands (see Figure 3.1).

The total number of bat passes recorded in 2024 was 12,740.

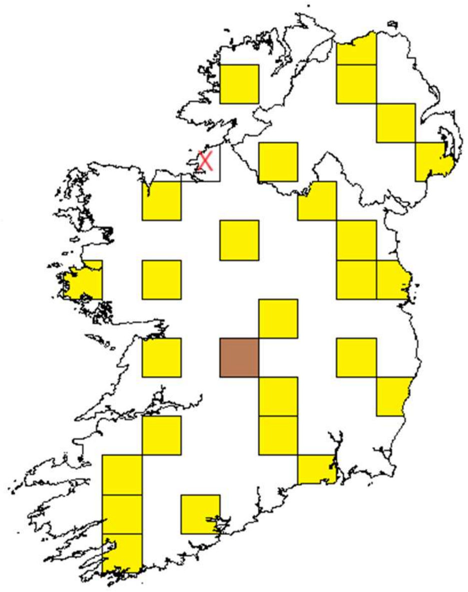


Figure 3.1: Location of 30km Survey Squares, yellow squares were surveyed twice, brown squares were surveyed once and square G53 (with X) was not surveyed.

Table 3.1: Mean bat encounter data (**Tranquility** detector), per 1.609km/1 mile transect, not corrected to encounters per km or per hour, Car-Based Bat Monitoring Scheme 2003-2019. Average number of bats reflects the average number of bat encounters observed during each 1.609km/1 mile transect travelled*.

Year	No. Transects	Common pipistrelle	Soprano pipistrelle	Pipistrelle unid.	Nath. Pip.	Leisler's bat	Myotis spp.	Brown long-eared
2003	173	1.25	0.474	0.453	0.000	0.301	0.040	
2004	543	1.94	0.707	0.267	0.000	0.524	0.052	
2005	596	1.36	0.559	0.272	0.002	0.527	0.035	
2006	879	1.71	0.652	0.256	0.033	0.895	0.030	
2007	878	1.78	0.645	0.308	0.015	0.634	0.036	0.019
2008	853	1.80	0.816	0.222	0.007	0.649	0.030	0.002
2009	781	1.22	0.717	0.243	0.032	0.490	0.032	0.010
2010	798	1.42	0.680	0.350	0.070	0.811	0.024	0.013
2011	780	1.53	0.783	0.343	0.022	0.777	0.037	0.017
2012	677	1.34	0.783	0.310	0.047	0.768	0.027	0.027
2013	730	1.46	0.811	0.417	0.021	0.749	0.011	0.027
2014	745	1.98	1.083	0.398	0.043	0.997	0.026	0.017
2015	796	1.92	1.018	0.544	0.014	0.867	0.046	0.009
2016	759	2.10	1.203	0.529	0.040	0.926	0.026	0.009
2017	801	2.25	1.242	0.610	0.030	0.828	0.021	0.009
2018	790	2.34	1.262	0.576	0.023	0.780	0.018	0.011
2019	733	2.08	1.209	0.453	0.083	0.969	0.005	0.007
Mean Per Transect		**1.76**	**0.884**	**0.379**	**0.030**	**0.761**	**0.028**	**0.013**

* 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).

Table 3.2: Mean bat encounter data (**Batlogger** detector), per 1.609km/1 mile transect, not corrected to encounters per km or per hour, Car-Based Bat Monitoring Scheme 2016-2024. Average number of bats reflects the average number of bat encounters observed per kilometre travelled*.

Year	No. Transects	Common pipistrelle	Soprano pipistrelle	Pipistrelle unid.	Nath. Pip.	Leisler's bat	Myotis spp.	Brown long-eared
2016	114	4.97	4.27	1.47	0.05	1.09	0.193	0.009
2017	265	5.88	4.732	0.977	0.117	1.049	0.128	0.011
2018	445	5.26	3.497	1.097	0.022	1.097	0.072	0.011
2019	636	5.36	3.931	1.299	0.200	1.456	0.069	0.031
2020	645	6.82	4.132	1.464	0.183	1.423	0.127	0.020
2021	809	7.121	4.005	1.319	0.119	1.771	0.068	0.031
2022	695	6.738	4.132	1.353	0.191	2.144	0.086	0.036
2023	781	8.661	5.941	1.539	0.062	1.729	0.047	0.047
2024	796	7.858	5.264	1.105	0.187	1.936	0.150	0.043
Mean Per Transect		**6.910**	**4.525**	**1.314**	**0.139**	**1.650**	**0.107**	**0.032**

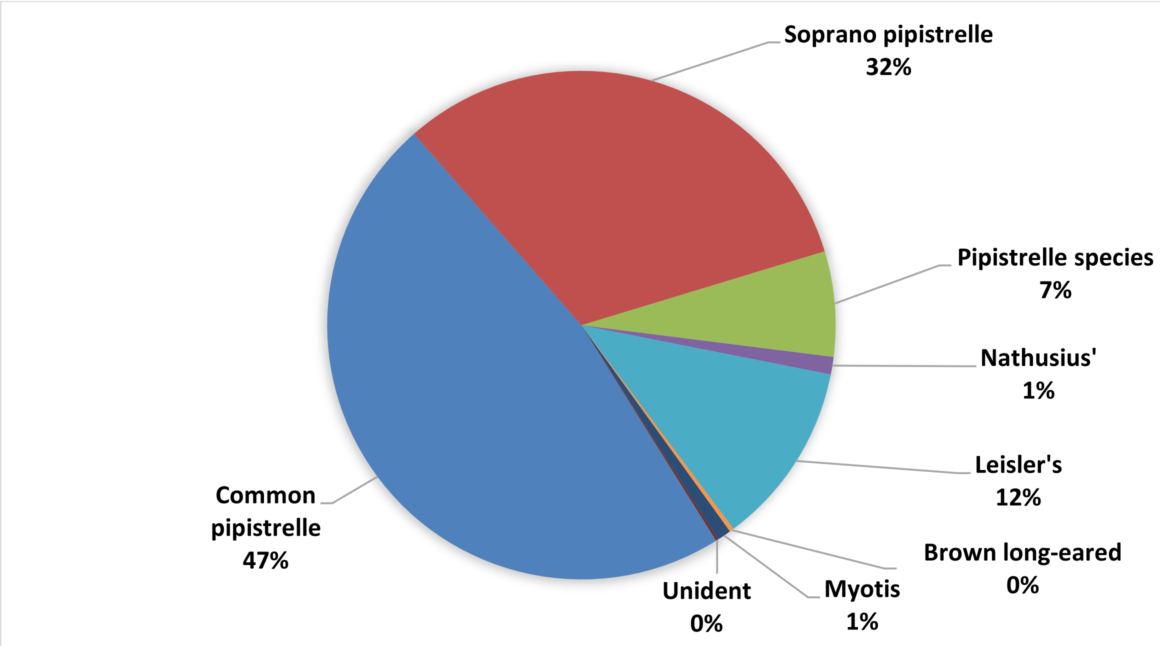


Figure 3.2: Proportion of bat species encountered (Batlogger Detectors) during the survey in 2024. Total number of bat encounters, n=12740. Excepting social calls of Leisler's bats and brown long-eared bats, which are unlikely to be mistaken for those of other species, bat social calls were noted during sonogram analysis but are not included in the above pie chart or in any statistical analyses. 'Pipistrelle species' refers to pipistrelle bat passes between 48 and 52kHz that cannot be assigned to a specific species.

Overall encounter rates varied between squares and between surveys. In general, the squares with highest encounter rates were found in the east/midlands and south of the island. These included squares W56 and N11 where over 400 bat encounters each were recorded during at least one survey night. Encounter rates per hour for each survey in each square (Batlogger) are shown in Appendix 1, Tables A1.1 and A1.2 with the overall average shown in Table 3.2 below.

Table 3.2: Average number of bat encounters per hour for all surveys (Batlogger), 2024. Total = total number of encounters for all species per hour. Means derived from total number of encounters divided by total time spent sampling by the detector corrected to 1 hour.

All Surveys 2024	**Common pipistrelle**	**Soprano pipistrelle**	**Pipistrelle unknown**	**Nathusius' pipistrelle**	**Leisler's bat**	**Brown long-eared**	**Myotis spp.**	**Total/hr**
Overall Mean	**102.58**	**67.99**	**14.32**	**2.12**	**24.89**	**0.56**	**1.93**	**214.70**
Standard Deviation	±65.63	±28.96	±7.55	±7.74	±19.89	±0.72	±2.40	±88.29
Minimum	0.00	18.24	0.94	0.00	0.00	0.00	0.00	54.73
Maximum	221.75	134.06	37.75	54.20	75.70	2.79	10.33	403.84

3.2.1 Common pipistrelle, *Pipistrellus pipistrellus*

3.2.1.1 2024 Results

The overall average number of common pipistrelle encounters per hour was 103.9 during Survey 1 and 101.3 in Survey 2 in 2024. The overall average number of common pipistrelle encounters per hour for both survey periods was 102.6 (see Table 3.2). The square with the highest number of records for the species was S15 (Tipperary, Survey 1).

Common pipistrelles were the most frequently encountered species during the monitoring scheme in 2024 and in all survey years to-date. Figure 3.3 illustrates low, medium and high encounter rate squares for common pipistrelles in 2024 for each of the surveyed 30km squares. As in previous years this map shows lower common pipistrelle encounter rates in the north and north-west while squares with the highest encounter rates are located in the south and east of the country. Common pipistrelles are often absent from surveys in L64 (Connemara) although the species is increasingly recorded there – this may be because batlogger detectors record for most of the survey time, unlike the old Tranquility detectors that just recorded for 1/11th of the survey time, thus increasing the chances of detecting the species where it occurs.

3.2.1.2 Trends

Figure 3.4 shows the results of a Generalised Linear Model (GLM) applied to the Car-based Bat Monitoring data for the common pipistrelle, along with Generalised Additive Model (GAM) smoothed curves. Common pipistrelles showed increases in the early years and error bars around the trend have now well exceeded the baseline. This means that the common pipistrelle increased significantly since the start of the car-based bat monitoring scheme. While the increase has not been continuous year on year, and both 2022 and 2024 saw a slight drops in the yearly estimates, the trend is still continuing upward.

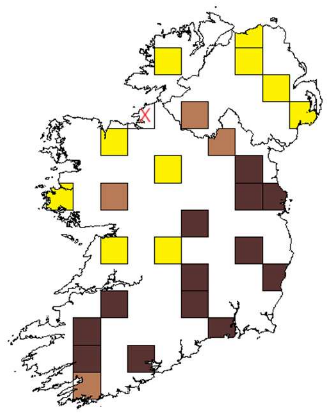


Figure 3.3: Survey squares colour coded according to common pipistrelle encounter rates (per hour) in 2024. The overall average rate of common pipistrelle encounters for all squares in 2024 was 102.6hr^{-1}. Square G53 (with X) was not surveyed.

No data
Encounter rate >0≤60hr^{-1}
Encounter rate >60≤120hr^{-1}
Encounter rate >120hr^{-1}

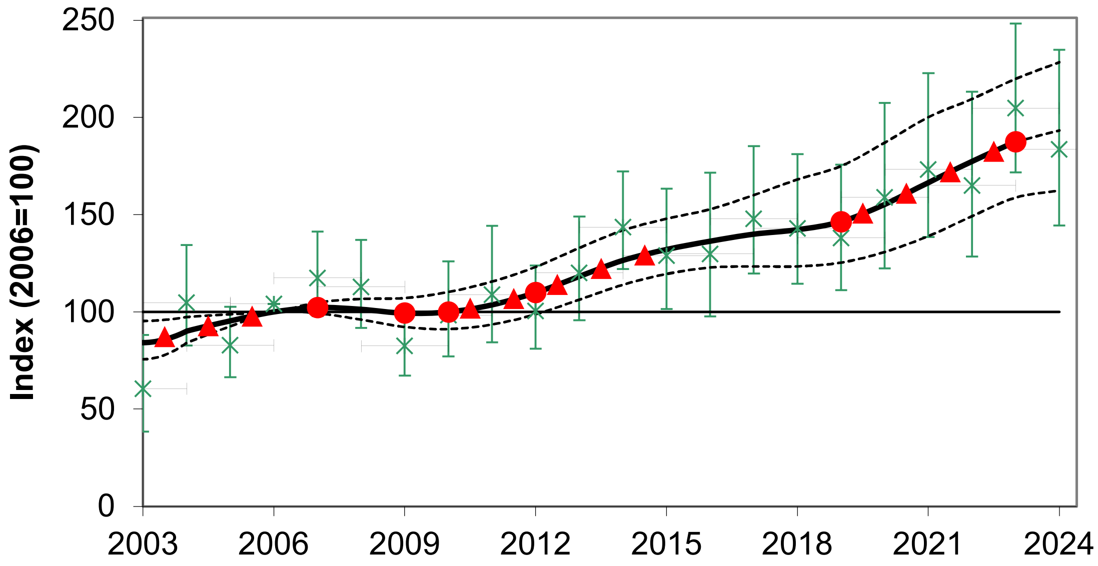


Figure 3.4: Results of the GAM/GLM model for common pipistrelle passes per survey, All-Ireland. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. All estimates are adjusted to 1,125 0.32s snapshots or equivalent time recording on a Batlogger. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2023-2024 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 3.4: GAM results for common pipistrelles with 95% confidence limits (using first 15 transects only 2003-2008). Values are modeled estimates adjusted to 1,125 snapshots per survey or equivalent time recording on a Batlogger.

			Smoothed		95% limits		unsmoothed	
Year	***Sites***	***Counts***	***index***	***s.e.***	***lower***	***Upper***	***fit***	***s.e.***
2003	7	9	84.25	5.14	75.64	95.34	56.36	11.95
2004	17	27	90.16	3.40	84.17	97.37	100.64	13.00
2005	17	31	95.45	1.60	92.60	98.80	78.63	9.24
2006	25	45	100.00	0.00	100.00	100.00	100.00	0.00
2007	26	46	102.27	1.43	99.28	104.86	113.30	11.05
2008	23	42	101.31	2.71	96.02	106.68	108.73	11.36
2009	28	53	99.35	3.82	92.26	107.10	78.32	9.15
2010	27	53	99.97	4.84	91.16	110.23	94.22	12.70
2011	28	53	103.68	5.62	93.50	115.62	104.64	15.13
2012	27	45	109.92	6.21	98.79	123.13	96.32	10.81
2013	26	49	118.26	6.78	106.30	132.92	115.84	13.62
2014	27	49	126.44	7.15	113.96	141.95	139.42	13.25
2015	28	53	132.13	7.33	119.54	147.90	124.87	15.67
2016	28	51	136.38	7.84	122.83	152.82	125.59	18.69
2017	28	70	139.93	9.38	123.40	160.11	143.66	16.49
2018	28	81	142.24	11.21	123.41	168.10	138.73	17.01
2019	28	92	146.39	12.50	125.37	175.05	133.92	16.33
2020	25	45	155.34	14.01	130.83	187.08	154.81	21.22
2021	28	54	166.53	15.20	138.98	200.16	169.04	20.94
2022	27	47	177.43	15.51	149.24	209.52	160.87	21.34
2023	27	53	187.55	15.54	158.80	219.86	200.68	19.60
2024	27	52	193.32	16.78	162.46	228.40	179.50	22.67

3.2.2 Soprano pipistrelle, *Pipistrellus pygmaeus*

3.2.2.1 2024 Results

The overall average number of soprano pipistrelle encounters per hour was 64.4 during Survey 1 in 2024 and 71.6 during Survey 2; see Tables A1.1 and A1.2 (Appendix). The overall average number of soprano pipistrelle encounters per hour for both survey periods was 68.

The highest number of discrete soprano pipistrelle passes was recorded from Survey 2 in G20 (County Mayo). When corrected for time spent surveying the highest encounter rates per hour were recorded from Survey 2 in V93 (west Cork) and H40 (Cavan), 134.1 and 129.0 per hour, respectively.

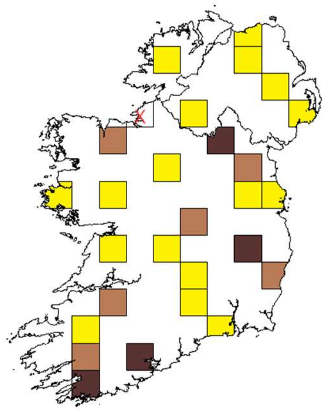


Figure 3.5: Survey squares colour coded according to soprano pipistrelle encounter rates (per hour) in 2024. The overall average rate of soprano pipistrelle encounters for all squares in 2024 was 68hr^{-1}. Square G53 (with X) was not surveyed.

No data
Encounter rate >0≤70hr^{-1}
Encounter rate >70≤100hr^{-1}
Encounter rate >100hr^{-1}

Figure 3.5 illustrates low, medium and high encounter rate squares for soprano pipistrelles in 2024. As in previous years, the pattern of activity levels across the island are more difficult to distinguish than for common pipistrelles. In 2024 the highest encounter rate squares were found along the south and east coasts. Soprano pipistrelles were recorded on all survey routes in 2024.

3.2.2.2 Trends

Figure 3.6 shows the results of a Generalised Linear Model (GLM) applied to Car-based Bat Monitoring data for the soprano pipistrelle, along with Generalised Additive Model (GAM) smoothed curves. Confidence intervals remain well above the baseline value indicating that the species has significantly increased over the duration of the monitoring scheme. While 2018 and 2019 saw a slight decrease, the upward trend resumed in 2020. In 2023 the trendline veered sharply upwards, and although the 2024 estimate dropped slightly, it still remained higher than any year up to 2022.

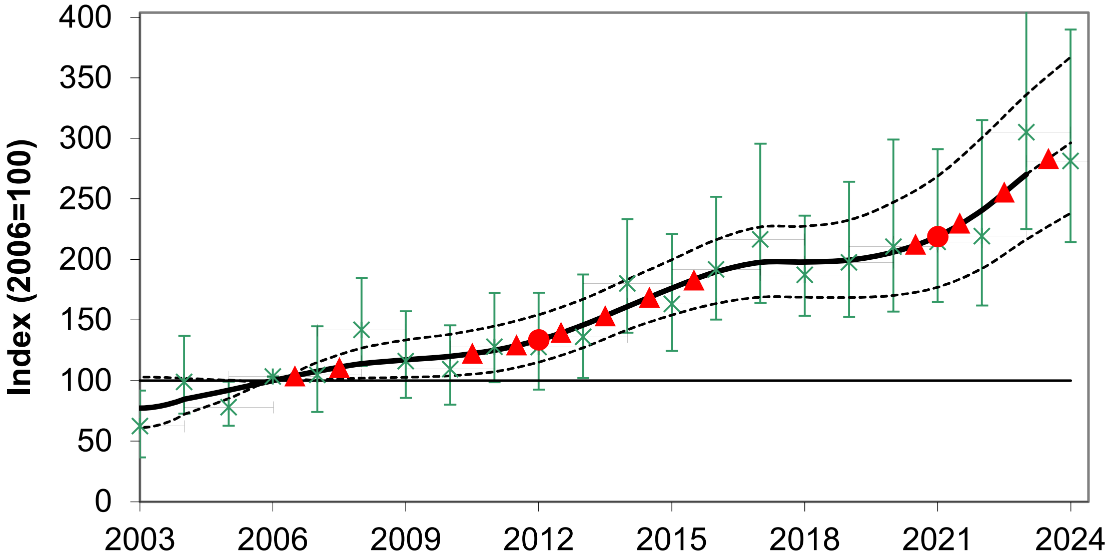


Figure 3.6: Results of the GAM/GLM model for soprano pipistrelle passes per survey, all-Ireland. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. All estimates are adjusted to 1,125 0.32s snapshots or equivalent time recording on a Batlogger. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2023-2024 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 3.5: GAM results for soprano pipistrelles with 95% confidence limits (using first 15 transects only 2003-2008). Figures are modeled estimates adjusted to 1,125 snapshots per survey or equivalent time recording on a Batlogger.

			Smoothed		95% limits		Unsmoothed	
Year	***Sites***	***Counts***	***index***	***s.e.***	***Lower***	***Upper***	***fit***	***s.e.***
2003	7	9	77.37	10.61	61.15	102.97	58.95	14.65
2004	17	27	84.57	7.49	72.29	101.85	95.49	16.75
2005	17	31	92.02	3.84	85.23	100.39	74.58	9.05
2006	25	45	100.00	0.00	100.00	100.00	100.00	0.00
2007	26	46	107.74	3.64	100.60	115.06	101.16	18.40
2008	23	42	113.87	6.35	102.08	126.84	138.43	19.00
2009	28	53	117.12	7.91	102.73	133.55	112.69	18.10
2010	27	53	119.94	8.92	104.00	138.29	106.03	17.30
2011	28	53	125.11	9.72	107.40	145.04	124.60	19.24
2012	27	45	133.54	10.14	115.22	154.53	124.26	20.05
2013	26	49	145.90	10.19	127.19	167.31	132.65	21.47
2014	27	49	161.23	10.40	142.03	183.61	176.90	23.97
2015	28	53	176.28	11.48	154.18	199.82	159.85	24.60
2016	28	51	189.77	13.29	163.66	216.43	188.44	25.46
2017	28	70	197.60	14.73	168.96	226.90	213.19	33.34
2018	28	81	197.93	14.95	168.84	227.50	183.80	20.56
2019	28	92	199.54	16.32	168.64	232.62	194.34	28.80
2020	25	45	206.21	19.64	170.40	247.30	207.11	36.82
2021	28	54	219.02	23.59	177.14	268.88	211.14	32.27
2022	27	47	240.85	27.50	192.68	300.70	215.82	39.46
2023	27	53	270.42	30.35	216.55	336.12	301.56	53.32
2024	27	52	296.38	32.74	238.40	367.27	278.03	45.04

3.2.3 Leisler's bat, *Nyctalus leisleri*

3.2.3.1 2024 Results

The overall average number of Leisler's bat encounters per hour was 30.4 during Survey 1 in 2024 and 19.4 during Survey 2, (see Appendix Tables A1.1 and A1.2) bringing the overall average number of Leisler's bat encounters per hour for both surveys to 24.9.

The surveys with the highest number of Leisler's bat encounters, and encounters per hour, were the from the first survey in Kerry – Killarney (V96), and north Kerry (V99) Survey 2.

Leisler's bat was the third most frequently encountered species during the monitoring scheme in most years including 2024. Figure 3.7 illustrates low, medium and high encounter rate squares for Leisler's bat in 2024. While in some previous years, low encounter rate squares were typically more frequent in the western and north western half of the island, highest encounter rate squares in 2024 were in the south west and north east with a band of lower activity survey squares stretching from south east to the mid west.

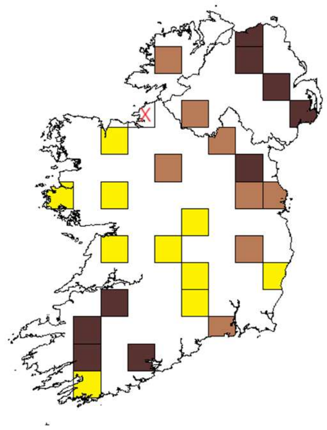


Figure 3.7: Survey squares colour coded according to Leisler's bat encounter rates (per hour) in 2024. The overall average rate of Leisler's encounters for all squares in 2024 was 24.9hr^{-1}. G53 (square with C) was not surveyed.

- No data
- Encounter rate >0≤15hr^{-1}
- Encounter rate >15≤30hr^{-1}
- Encounter rate >30hr^{-1}

3.2.3.2 Trends

Figure 3.8 shows the results of the Generalised Linear Model (GLM) applied to Car-based Bat Monitoring data for Leisler's bat, along with Generalised Additive Model (GAM) smoothed curves. The estimate for Leisler's bat rose significantly above the baseline in the first ten years of the survey. However, yearly estimates then dropped from 2015 to 2018. This was followed by an even steeper increase from 2019 to 2022. The estimate for both 2023 and 2024 were slightly lower and as a result, the trend line has levelled out this year. Nonetheless, lower confidence intervals have risen well above the baseline over the 20+ years of the survey, indicating a significant increase in the species in that time.

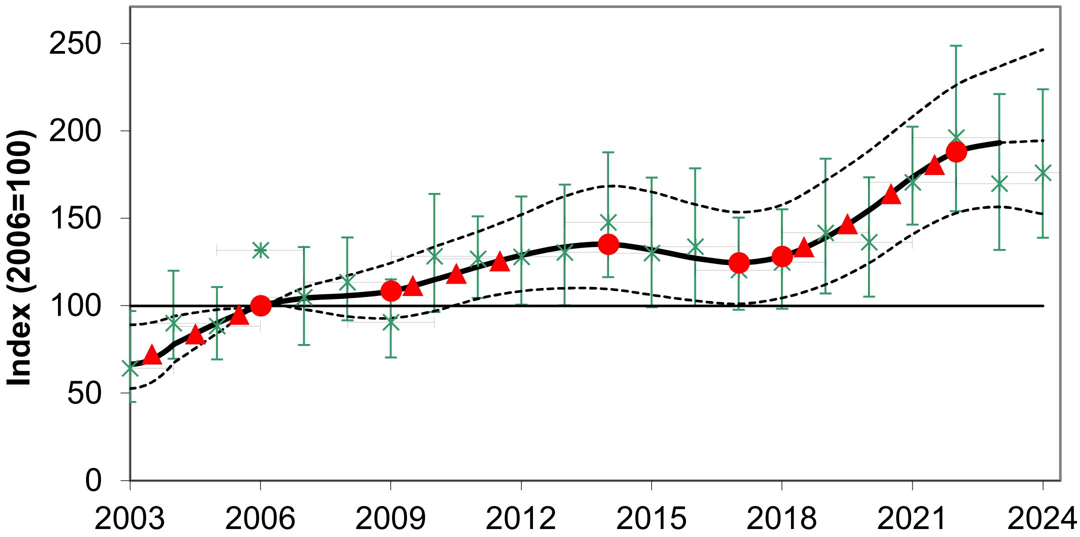


Figure 3.8: Results of the GAM/GLM model for Leisler's bat passes per survey. Points are estimated annual means derived from the Generalised Linear Model (GLM) and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model (GAM) curve with 95% confidence limits shown by the lighter black lines. All estimates are adjusted to 1,125 0.32s snapshots or equivalent time recording on a Batlogger. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2023-2024 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 3.6: GAM results for Leisler's bat with 95% confidence limits (using first 15 transects only 2003-2008). Figures are modelled estimates adjusted to 1,125 snapshots per survey or equivalent time recording on a Batlogger.

			smoothed		95% limits		Unsmoothed	
Year	*Sites*	*Counts*	*index*	*s.e.*	*lower*	*Upper*	*Fit*	*s.e.*
2003	7	9	66.60	9.31	52.74	89.09	32.46	13.46
2004	17	27	78.01	6.75	67.43	94.02	58.29	12.78
2005	17	31	90.00	3.46	84.18	97.81	56.63	10.74
2006	25	45	100.00	0.00	100.00	100.00	100.00	0.00
2007	26	46	104.25	3.31	97.88	110.34	73.03	14.16
2008	23	42	105.70	6.14	93.91	117.24	81.70	12.37
2009	28	53	108.34	8.27	92.93	124.52	58.74	11.54
2010	27	53	114.85	9.55	97.00	133.72	96.46	17.80
2011	28	53	122.29	9.92	104.03	142.33	95.01	12.03
2012	27	45	128.83	11.02	108.39	152.04	96.11	15.94
2013	26	49	133.66	13.14	110.05	162.61	98.70	17.59
2014	27	49	135.20	14.79	109.60	168.41	115.91	18.40
2015	28	53	132.00	14.88	106.21	165.07	98.24	19.75
2016	28	51	127.25	13.96	102.88	157.91	101.98	20.12
2017	28	70	124.60	12.99	101.11	153.53	88.54	13.32
2018	28	81	128.27	13.23	104.49	157.74	92.97	14.35
2019	28	92	139.02	14.83	112.15	171.66	109.79	19.41
2020	25	45	154.62	16.07	124.41	188.59	104.46	17.68
2021	28	54	173.39	17.15	140.86	208.16	138.75	14.06
2022	27	47	187.97	18.51	152.91	226.11	164.42	24.14
2023	27	53	193.22	20.22	156.54	236.80	137.98	22.51
2024	27	52	194.44	24.00	152.51	246.42	144.28	21.72

3.2.4 Nathusius' pipistrelle, *Pipistrellus nathusii*

3.2.4.1 2024 Results

The overall average number of Nathusius' pipistrelle encounters per hour increased from 2020 on account of the widespread use of Batloggers, which record continuously during each transect. The average encounter rate was 1.57hr^{-1} during Survey 1 and 2.68hr^{-1} during Survey 2, see Tables A1.1 and A1.2 (Appendix).

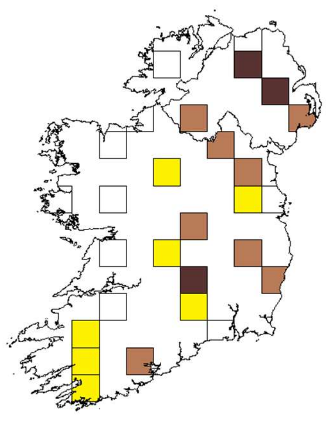


Figure 3.9: Survey squares indicating abundance of Nathusius' pipistrelle records from the 2024 car-based bat monitoring scheme. The overall average rate of Nathusius' encounters for all squares in 2024 was 2.12hr^{-1}.

No encounters
Encounter rate >0≤1hr^{-1}
Encounter rate >1≤2hr^{-1}
Encounter rate >2hr^{-1}

Figure 3.9 illustrates squares where the species was present in 2024 with the squares colour coded according to the species' activity levels. Most Nathusius' pipistrelle passes were recorded from square J06 (south Antrim), as in previous years. The overall average number of Nathusius' pipistrelle encounters per hour for both survey periods was 2.12, see Table 3.2.

3.2.4.2 Trends

Figure 3.10 shows the results of fitting a binomial GLM/GAM model for the proportion of one mile transects with Nathusius' pipistrelle passes, with a covariate for detector. Nathusius' pipistrelle increased from zero values recorded in the first two years of the monitoring scheme, although activity levels tend to fluctuate widely from year to year. The highest annual estimate to-date was recorded in 2020. The decline noted in 2022 has levelled out in 2023 and 2024, however, these results are clearly quite unstable with very large error bars, and so this trend should be treated with caution.

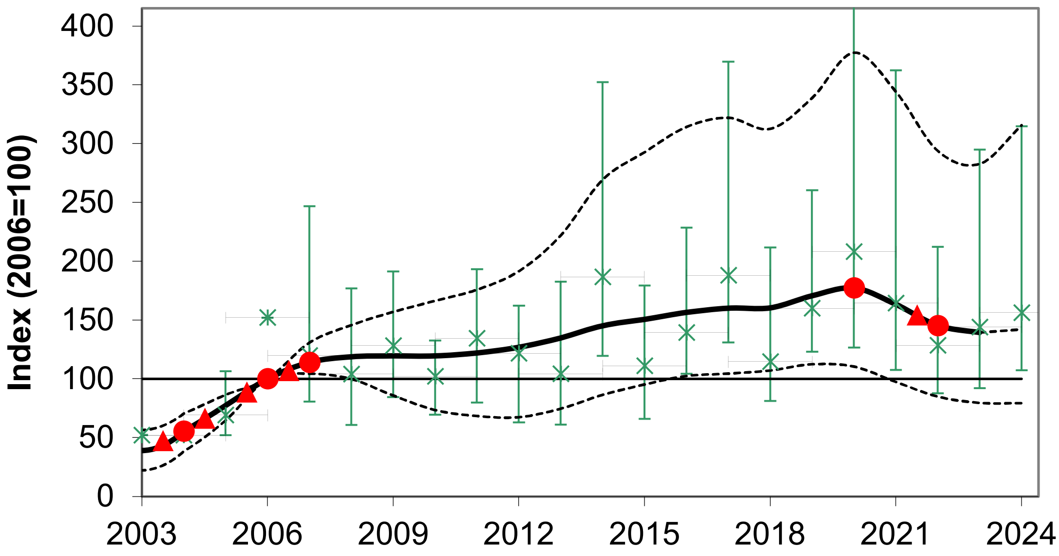


Figure 3.10: Results of a Binomial GLM modelling for the proportion of one mile (1.6km) transects with Nathusius' pipistrelle present, all-Ireland. The black line is the smoothed GAM curve, with 95% confidence limits shown by the lighter black lines. Points are estimated annual means and are shown to illustrate the variation about the fitted line. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2023-2024 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).

3.2.5 *Myotis* spp.

3.2.5.1 2024 Results

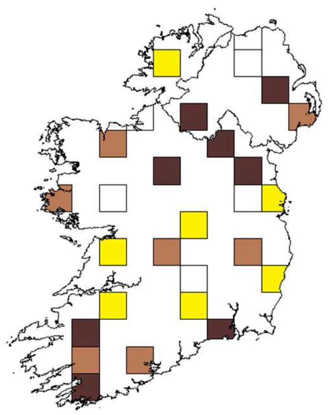


Figure 3.11: Survey squares indicating abundance of *Myotis* species records from the 2024 car-based bat monitoring scheme. The overall average rate of *Myotis* encounters for all squares in 2024 was 1.93hr^{-1}.

- No encounters
- Encounter rate >0≤1hr^{-1}
- Encounter rate >1≤2hr^{-1}
- Encounter rate >2hr^{-1}

The overall average number of *Myotis* species encounters per hour in 2024 was 1.93. On average, 2.1 *Myotis* bat passes were recorded per hour during Survey 1 and 1.76 during Survey 2 in 2024, see Tables A1.1 and A1.2 (Appendix 1).

Figure 3.11 illustrates squares where this species group was recorded in 2024, and colour coded according to the species group's activity levels.

3.2.5.2 Trends

Myotis spp. yearly estimates are highly variable. On the whole, they showed reasonably constant year-year levels until 2013 (see Figure 3.12) when they dropped considerably. Estimates then increased in 2014 and 2015. However, each year subsequently saw a decrease until 2020. 2021/2022. Higher estimates in 2023 and 2024 mean that the trend has shifted slightly upwards and the upper confidence intervals are again slightly above the baseline.

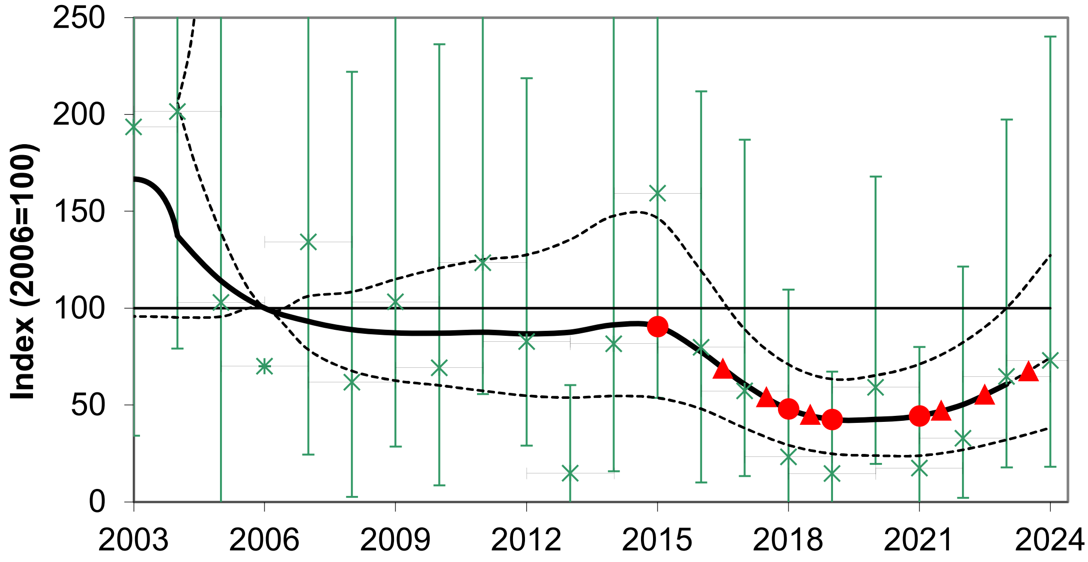


Figure 3.12: Results of the GAM/GLM model for *Myotis* spp. passes per survey. Points are estimated annual means derived from the Generalised Linear Model and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model curve with 95% confidence limits shown by the lighter black lines. All estimates are adjusted to 1,125 0.32s snapshots or the equivalent time recording on Batlogger detectors. The end of the smoothed trend is shown with a broken line to illustrate uncertainty for 2023-2024 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.

3.2.6 Brown long-eared bat, *Plecotus auritus*

3.2.6.1 2024 Results

The overall average number of brown long-eared encounters per hour for both months was 0.56 in 2024, see Table 3.2 and Appendix 1 Tables A1.1 and A1.2.

Figure 3.13 illustrates squares where this species was recorded in 2024.

Of all the species encountered during the monitoring scheme, the brown long-eared bat is typically the least common. The methodology of this monitoring scheme means that encounter rate for this species is expected to be low and therefore it is not a target species.

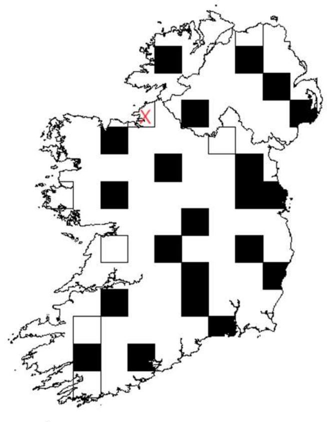


Figure 3.13: Survey squares indicating presence (black) or absence (white) of brown long-eared bat records from the 2024 Car-based Bat Monitoring Scheme. G53 (square with X) was not surveyed.

3.2.6.2 Trends

This species is recorded in very low numbers by the Car-based Bat Monitoring Scheme. The annual trend has been analysed using a binomial model, the results are shown in Section 5 alongside trends derived from the dedicated Brown Long-eared Bat Roost monitoring surveys.

3.2.7 Other Vertebrates

As in previous years, surveyors were asked to record living and dead vertebrates that they encountered while surveying, during and between transects. This resulted in the collection of 260 records of living vertebrates (apart from bats) and 6 records of dead vertebrates in 2024 from 45 surveys. Figure 3.14 is a pie chart illustrating proportions of living vertebrate observations attributed to species or species groups. As in previous years, records are dominated by cats, which in 2024 accounted for 57% of all records collected. Foxes were the second most commonly recorded 'other vertebrate'. Small mammals including mice, rats and shrews accounted for the next highest number of records (20 records).

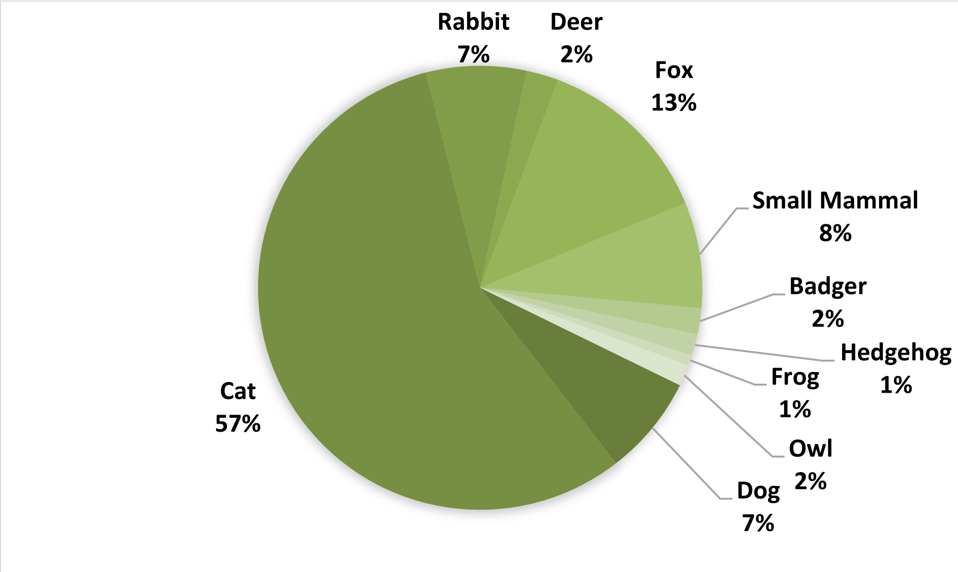


Figure 3.14: Living vertebrates, other than bats, observed during 2024, n=260. The category 'Owl' includes four unidentified owls. Small mammals includes 17 mice, two rats and one shrew.

3.2.7.1 Dead vertebrates

The number of dead specimens recorded from roadsides totalled six in 2024, a substantially lower number than previous years. Two rats, two foxes a hedgehog and mink were the only recorded dead specimens.

3.3 Discussion

3.3.1 Volunteer uptake

Fifty six individuals undertook the survey in 2024. Seven new teams were trained in. All teams used only Batloggers to detect bats. Results were excellent overall with few equipment errors, although the results of one survey went missing. All data was incorporated into existing trends using a covariate for detector type.

3.3.2 Survey Coverage in 2024

Usable data was available for 52 complete surveys thereby exceeding the target for achieving sufficient power to detect trends. Twenty seven out of 28 squares were surveyed at least once.

3.3.3 Dataset

The dataset consisted of 12,740 bat encounters in 2024. This is roughly three to four times the number of bat records we typically gathered from the survey using Tranquility detectors prior to 2020.

The common pipistrelle was the most frequently encountered species, as in all previous years. It constituted 47% of all the bat observations. Soprano pipistrelles accounted for 32% of observations. Leisler's bat accounted for 12% of total bat encounters.

3.3.4 Species Abundance and Yearly Trends

Definite conclusions from a monitoring project based on the road network, such as a Car-based Bat Monitoring Scheme, can only be made in relation to roadside habitats. Inferences from the roadside monitoring to wider bat populations can be made but are based on the assumption that population trend data collected from the roadside will mirror that of the wider population. Some caution is needed in doing this since population trends in a non-random subsample of available habitats will not necessarily be representative of the population as a whole (Buckland *et al.* 2005). Along roads various threats, pressures and biases may be acting to impact on bat activity there. Artificial light at night is particularly important because the extent and type of roadside lighting is currently undergoing a change to LED-based lanterns across Ireland. Bat Conservation Ireland worked with a Masters student from the University of Ulster in 2023/24 who is carrying out a new analysis of roadside lighting types and its impacts on bat activity along the car monitoring transects. His work will be presented at the International Artificial Light at Night conference in Westport in 2025.

3.3.4.1 Common pipistrelles

The activity distribution of this species followed its usual pattern with higher encounter rate squares located in the southern half of the country.

According to the trend model this species has increased slowly but significantly since 2003. Overall, since the first year of the survey in 2003, there has been a year on year increase of 4.03%, representing a total change of +129%. The more recent, six year, trend has been for a slightly more rapid increase, at 5.25% per annum.

3.3.4.2 Soprano pipistrelles

The pattern of activity distribution for the soprano pipistrelle has never been as clear as for common pipistrelles although this species shows some western bias in some years

The highest yearly estimate for the species was recorded in 2023 and the trend line showed a particularly steep increase between 2022 and 2023. There has been an overall significant year on year increase of 6.1%, representing a total increase of +283% since 2003.

3.3.4.3 Leisler's Bat

This species tends to show an eastern and southern bias. While this is not always discernible from a single year of surveys, in 2024 the higher occurrence squares were in the south west and north east. There has been a particularly steep increase in the species in Northern Ireland in the past six years of 15% per annum (Clarke et al. (2025)), compared with 7.2% per annum across the island of Ireland. This possible disparity in trends between Northern Ireland and the rest of the island be investigated further in next year's statistical analysis.

Overall, Leisler's bat increased by 191% from 2003 to 2024. This represents a yearly increase of 5.2% per annum over the 21 years.

3.3.4.4 Nathusius' Pipistrelle

Nathusius' pipistrelle increased from zero values in the first two years of the monitoring scheme. However, it should be noted, that squares in Northern Ireland, where this species has a stronghold, were not surveyed for the first few years of the survey.

The use of Batloggers, which record constantly during the transects rather than for 1/11th of the time (Tranquility detectors), means that more records for the species were picked up from 2020 onwards.

Trend analysis for this species is carried out using presence-absence (binomial) rather than count data. Despite the use of a binomial model, error bars around the trend are still very wide due to the low number of records for the species picked up during the survey.

Results indicate that the species increased since the start of the survey, on average by 6.3% per annum. However, the trend has dipped in recent years with a change of -2.1% per annum noted for the past six years. The large error bars for this species means that the trend should be treated with caution.

3.3.4.5 *Myotis* spp.

Confidence limits for this species grouping are quite wide due to the low encounter rates. While there is considerable year-to-year variation in estimates, the net trend has been downwards since the start of the survey – year on year the index dropped by -3.8% per annum over 21 years. This decline has recently changed direction, however, with the trend in the last six years showing a year on year increase of 7.6%. In 2024, the upper confidence intervals were above the baseline index.

3.3.4.6 Brown Long-eared Bat

This species is the least frequently observed by the Car-based Bat Monitoring Scheme. Results from the Brown Long-eared Bat Roost Monitoring Scheme are described in Section 5.

3.3.5 Other Vertebrates

Other vertebrates were recorded in 2024 as in previous years, and again, cats were the most commonly observed animal. In decreasing order foxes, rabbits and dogs and small mammals and were the next most common roadside species/species group. Four owls were observed in 2024.

4.0 ALL-IRELAND DAUBENTON'S BAT WATERWAY MONITORING SCHEME

4.1 Methods

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) (Anon, 2004).

Prior to the allocation of sites, all surveyors are contacted by email to determine their willingness to participate in the coming year's surveys. An information pack consisting of a detailed description of the methodology, maps, survey forms and online training facilities are provided for each survey team. Heterodyne bat detectors are also available to loan for the duration of the summer months. In 2024 training took place virtually using the Zoom platform (four training sessions) and additional training videos were made available through the BCIreland YouTube channel.

Newly recruited surveyors are provided with an interactive Google Map that provided details of all waterway sites (both assigned and free) for volunteers to query. Volunteers were requested to choose 2-3 "Free" waterway sites (in order of preference) and submit these by email to the scheme co-ordinator. Details (i.e. maps, survey spot descriptions etc.) are then emailed to the volunteer so that they can check the waterway site during the daytime to determine if it is suitable to survey. The surveyor confirms which waterway site is to be surveyed and this waterway site is deemed "Assigned". Experienced surveyors are reassigned 1km transects surveyed in previous years.

Surveyors undertake a daytime survey of their allocated site 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).

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'. The number of times that a bat passes the surveyor is counted for the duration of the four minutes. Therefore, counting bat passes is a measure of activity and results are quoted as the number of bat passes per survey period (No. of bat passes/40 minutes).

Surveyors are also requested to record several other parameters including air temperature, weather data and waterway characteristics, such as the width of the waterway and the smoothness of the surface water.

Surveyors are asked to undertake the survey on two dates, one between the 1st and 15th August (Survey 1, S1) and the repeat survey between the 16th and 30th August (Survey 2, S2). On completion of surveys, survey forms are returned to BCIreland for analysis and reporting.

4.1.1 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 number 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 recorded variables. Since 2010, the dataset (2006-2024) 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 dates between day numbers 205-250 (i.e. 24th July and 7th 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. Consequently, 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 were used. For binomial analyses, the presence of both 'Sure' and 'Unsure' Daubenton's bat passes at each survey spot were 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. 2006-2024) 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 (e.g. Barlow *et al.*, 2015) while the latter is also reported since presence/absence models such as this are considered to be more effective in dealing with the issue of multiple encounters with the same individual 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 modeled 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 trends in Britain in the National Bat Monitoring Programme (NBMP) undertaken by the BCT and also for trends in bird populations.

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 bats were 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 without co-variates to give a general indication of the trend.

4.1.2 Online Training in 2024

No in-person training courses were organised in 2024. BCIreland ran four online training sessions for volunteers virtually using the Zoom platform. BCIreland also produced online training videos in 2020 and these were uploaded to the BCIreland YouTube channel.

4.2 Results

4.2.1 Training and Volunteer Participation

A total of 252 potential new volunteer teams registered in 2024 to participate in the monitoring survey. These volunteers were invited to attend one of the Zoom training sessions and 217 people registered to receive training. Four live Zoom sessions were organised for volunteers to participate in on the following dates: 16th, 18th, 20th, and 23rd July 2024.

All bat detectors to be loaned to volunteers were sterilized using disinfectant wipes and were posted to surveyors. Since 2020, it has been a BCIreland policy to discourage the sharing of bat detectors between survey teams. In preparation for 2024, additional bat detectors were purchased to ensure that there were enough detectors available for volunteers.

A total of 250 waterway sites were surveyed by 210 survey teams in 2024. Fifty-seven new survey teams participated in 2024 surveying 65 waterway sites. Overall, twenty-seven teams surveyed two or more waterway sites (n=64).

A total of 19 different bat detector models were used by survey teams in 2024. The Bat Magenta Bat 4 heterodyne bat detector was the most common model (n=131 surveys, 52.4%) (see Table A2.1 & A2.2, Appendix 2), principally because this is the detector model provided by BCIreland for volunteers.

4.2.2 Waterway Sites Surveyed

A total of 645 waterway sites were registered in 2024, which included two new waterway sites set up in 2023. Results of 250 surveyed waterway sites were received in time for statistical analysis.

Nine (1.4%) of the waterway sites surveyed in 2024 have been surveyed each year since 2006 while 84 (13%) of the waterway sites have been surveyed for only one year between 2006 and 2024 (Table 4.1). BCIreland encourages new survey teams to take on "Free" sites with a particular emphasis on waterways sites previously only surveyed once in order to further reduce the dataset of single survey waterway sites. In 2024, 16 waterway sites with only one previous survey were targeted and successfully surveyed.

Table 4.1: Number of years each waterway site across the island was surveyed during 2006-2024 as part of the All Ireland Daubenton's Bat Monitoring Scheme.

No. of Yrs	No. of Waterways	No. of Yrs	No. of Waterways
1	84	11	24
2	73	12	25
3	73	13	15
4	60	14	21
5	51	15	18
6	36	16	15
7	39	17	14
8	28	18	10
9	26	19	9
10	23		

Of the 250 sites surveyed (Figure 4.1), 31 were located in Northern Ireland and 219 in the Republic of Ireland. Sites surveyed in 2024 were distributed throughout the island with every county on the island of Ireland represented.

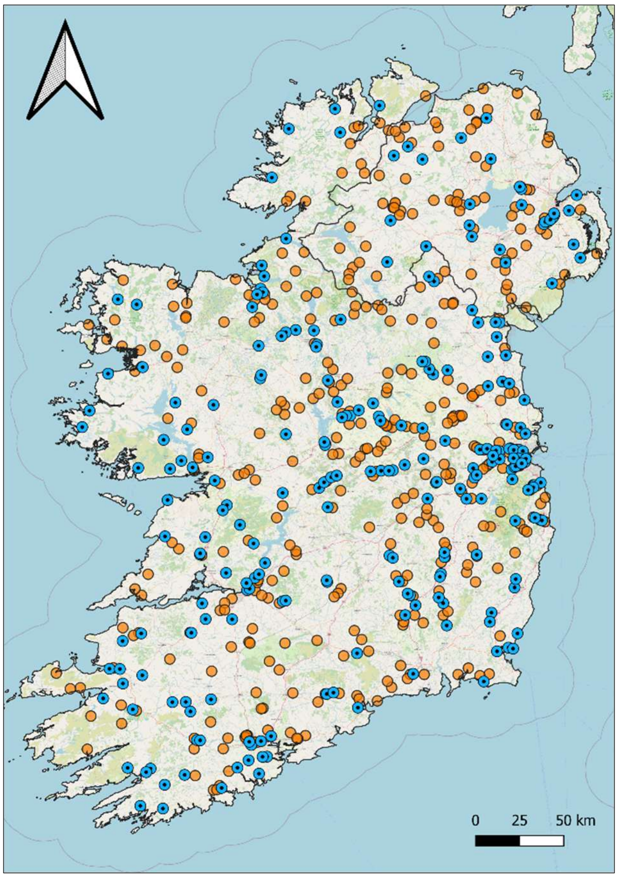


Figure 4.1: Location of all waterway sites surveyed across the island from 2006-2024 as part of the All Ireland Daubenton's Bat Monitoring Scheme. Blue circles with dot: 2024 waterway sites only (n = 250), Orange circles: all other registered waterway sites 2006-2024 (n = 395).

In 2024 a total of 14 canals (49 waterway sites), 3 channels and 120 rivers (198 waterway sites) were surveyed. In 2024 the Grand Canal had 20 sites surveyed along its length while the Royal Canal had 12 sites surveyed. The River Dodder had the most waterways sites surveyed with ten along its length, the Shannon and the Barrow rivers both had seven sites, the Liffey had six sites, while the Nore and the Lagan both had five sites surveyed (Figure 4.2).

Overall, for the 2006-2024 dataset there are 548 waterways sites located on rivers (n=295 rivers), 93 waterway sites on canals (n=23 canals) and the remaining four waterway sites are channels, such as the North Slobs in Co. Wexford (n=4 channels).

Of the four provinces, the highest number of waterway sites surveyed in 2024 were surveyed in Leinster (n=108, Figure 4.3), whereas Counties Cork and Kildare had the highest number of waterway sites surveyed in a single county (n=21 in each). Co. Dublin had 18 waterway sites and Co. Antrim had 14 sites. For a more detailed breakdown of country and provincial results, see Table A2.1 in the Appendices.

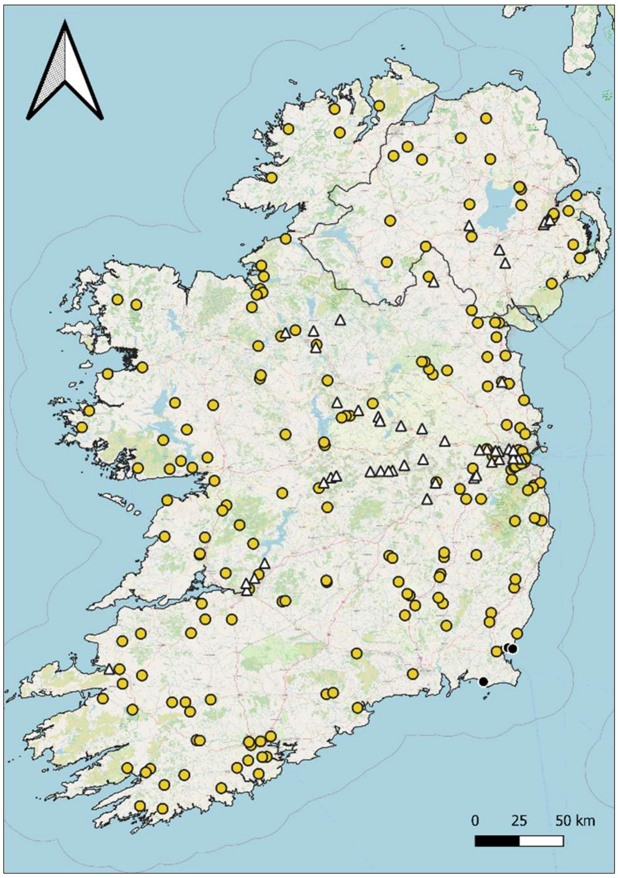


Figure 4.2: Different type of waterways surveyed in 2024 as part of the All-Ireland Daubenton's Bat Monitoring Scheme. Gold circles = River sites (n = 198), White triangles = Canals (n = 49), Black circles = Channels (n = 3).

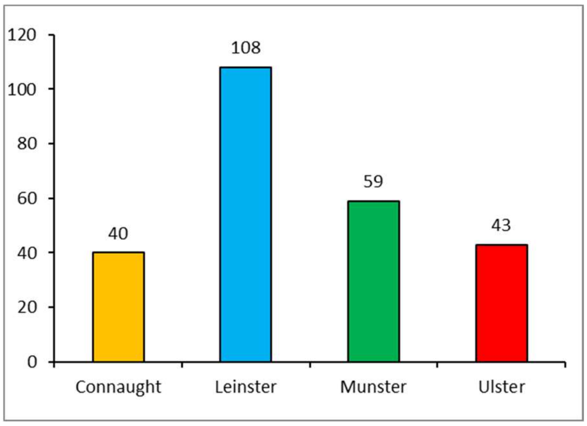


Figure 4.3: Number of waterway sites surveyed in each province in 2024 as part of the All-Ireland Daubenton's Bat Monitoring Scheme.

4.2.3 Completed Surveys

A total of 466 completed surveys from 250 waterway sites were returned to BCIreland in 2024. Two hundred and twenty-five surveys were completed in the first survey period (Survey 1: 1st – 15th August) while 241 surveys were completed in the second survey period (Survey 2: 16th – 30th August).

Waterway sites with repeated surveys (i.e. surveys completed in both sampling periods S1 and S2) provide more robust data for monitoring. In 2024, a total of 216 repeated surveys (86.4% of waterway sites) were completed while 34 single surveys were completed (see Figure 4.4) which was an improvement on more recent years. The years 2007 and 2010 had the highest rates of repeat surveys of all survey years to-date (95% and 93% respectively).

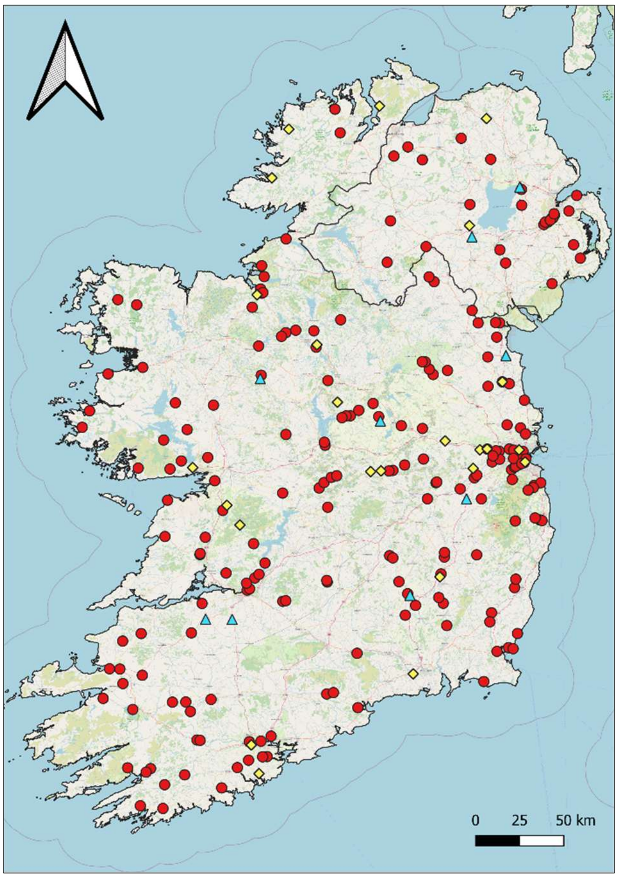


Figure 4.4: Waterways surveyed either twice (Survey 1 & Survey 2) or only once (Survey 1 only or Survey 2 only) in 2024 as part of the All-Ireland Daubenton's Bat Monitoring Scheme. Red circles = Survey 1 & Survey 2 (n = 216); Blue triangles = Survey 1 only (n = 10); Yellow diamonds = Survey 2 only (n = 24).

In 2024 'Sure' Daubenton's bat passes were recorded on 217 sites (86.8%) (Figure 4.5). At each of the 10 survey spots of each completed survey, volunteers recorded Daubenton's bat activity for four minutes generating 40 minutes of data per completed survey. In total, 18,294 'Sure' Daubenton's bat passes and 4,161 'Unsure' Daubenton's bat passes were recorded during 571 hours and 33 minutes of surveying in 2024. The number of Daubenton's bat passes recorded in 2024 is slightly higher than for 2023 (17,967) and higher than each of the survey years from 2019-2021.

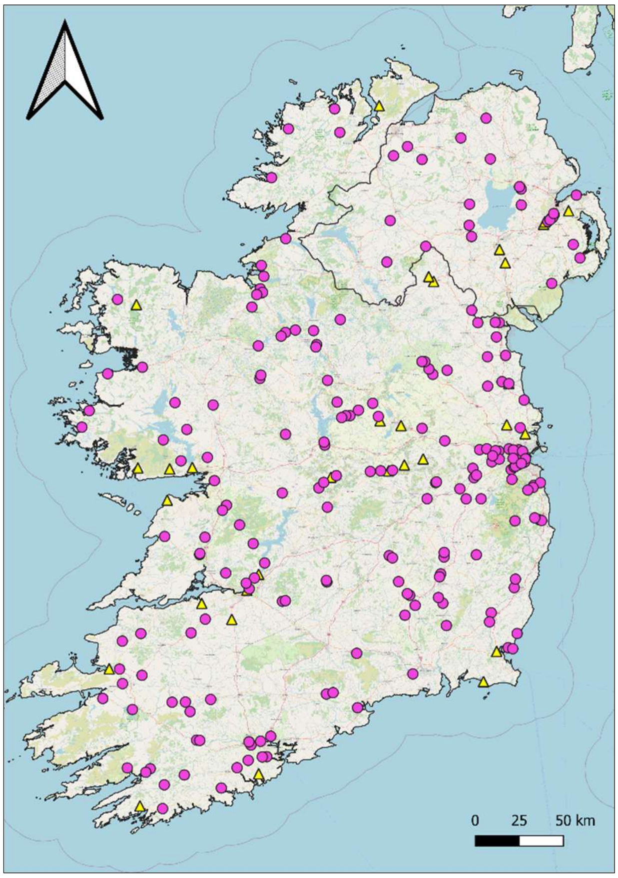


Figure 4.5: Location of waterways sites with Daubenton's bat recorded in 2024 as part of the All-Ireland Daubenton's Bat Monitoring Scheme. Pink circles: Daubenton's bat recorded; Yellow triangles: Daubenton's bat not recorded.

Taking the surveys that were returned in time for statistical analysis and were completed between Day 205 to 250 (n=466 surveys, See Table A2.3 in the Appendices) the mean number of 'Sure' Daubenton's bats passes per survey was 48.1 passes, which is the third highest mean number of sure passes recorded since the beginning and of the scheme 2006, and the highest since 2011. Daubenton's bats were recorded at 63.9% of survey spots in 2024, the highest percentage since the scheme began and greater than the mean percentage recorded in the nineteen years of the monitoring scheme (mean = 56.1%).

In 2024 waterway sites located in Munster recorded the highest mean number of bat passes (Mean no. = 59.6 'Sure' bat passes). Both Munster and Connaught tend to have the highest mean number of bat passes over all survey years, while Ulster tends to have the lowest number of bat passes over the years. However, in 2024 Leinster had a higher mean number of bat passes compared to Connaught (50.2 and 30.8. respectively) while Ulster recorded a mean number of 40.7 'sure' bat passes, which was the highest in Ulster since 2017. For a full break down of descriptive results for 2006-2024 see Table A2.3, Appendix 2.

4.2.4 Trends – Poisson GLM

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 passes. This particular model is chosen to facilitate comparison with British data from the BCT.

On an All-Ireland level, there has been a fluctuating trend since 2006, with levels having troughed in 2008 and again 2013-2014. A peak was observed in 2011 and then again 2015-2016. In the subsequent years until 2023 there was a slight dip in the trend, but in 2024 there was an upturn with the highest Daubenton's bat activity levels recorded since 2011. Overall, the species is showing a relatively stable trend. The smoothed index is currently 6.73% above the 2007 base year value which is equivalent to a mean 0.38% annual increase, although this increase is not considered significant as confidence intervals still encompasses the baseline index.

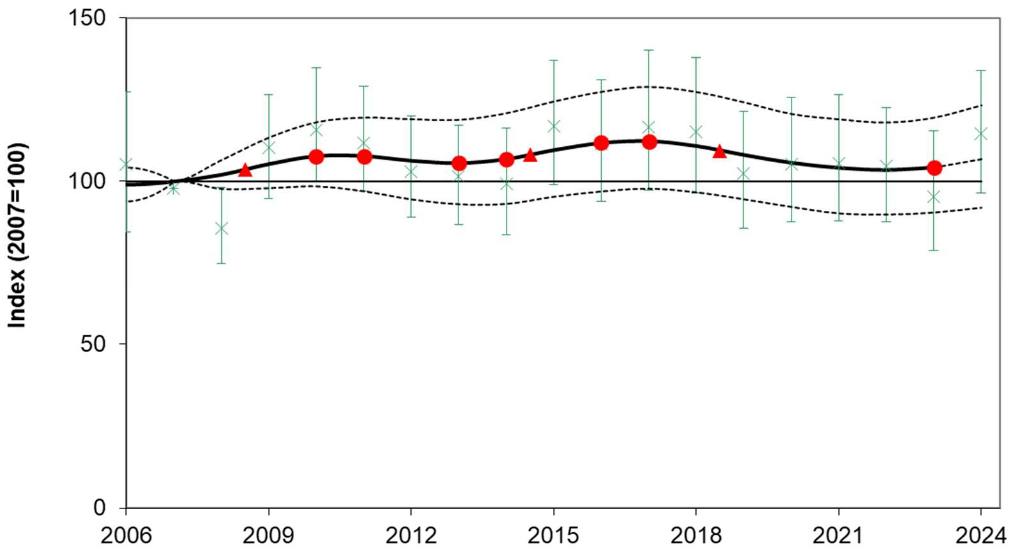
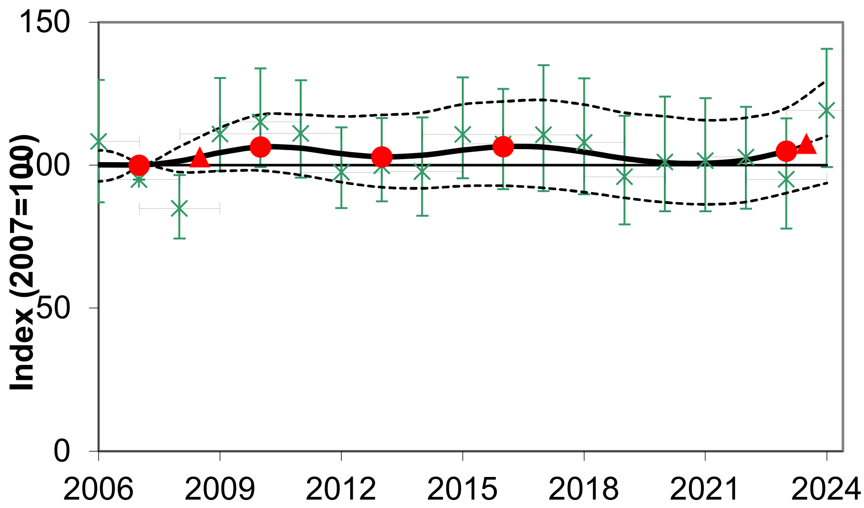


Figure 4.6: All Ireland results of the GAM (95% confidence interval) model for total number of Daubenton's 'All bat' passes (both 'Sure' and 'Unsure'). Green points are estimated annual means and are shown to illustrate the variation about the fitted line. Red circles indicate significant (P=<0.05) change 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). Please see appendices for the accompanying table.

4.2.5 Country Trend Models

There are 19 years of data available for analysis and therefore the trend models for Republic of Ireland and Northern Ireland were investigated separately. A total of 541 waterways sites are located in the Republic of Ireland and 104 waterway sites are located in Northern Ireland. Waterway sites with at least two years of data were used for trend models. Therefore, in 2024 there were 471 waterways sites available for Republic of Ireland and 87 waterway sites for Northern Ireland. In 2024, a total of 558 waterway sites (86.5%) were used for trend analysis.

Between 2023 and 2024, there was a significant increase in the mean number of Daubentons bat passes recorded in the Republic of Ireland (Figure 4.14., top chart). Conversely, in Northern Ireland there has been a downward trend over the last few monitoring seasons, with a significant year to year decrease observed in the mean number of bat passes recorded since 2020. over the (Figure 4.14, bottom chart). The Northern Ireland trend is continuing to head downwards, closing the gap between it and the Republic of Ireland trend which remains close to the baseline value. Confidence limits for Northern Ireland are wide due to the relatively small sample size and so differences are not significantly different using a randomisation test (P=0.330).



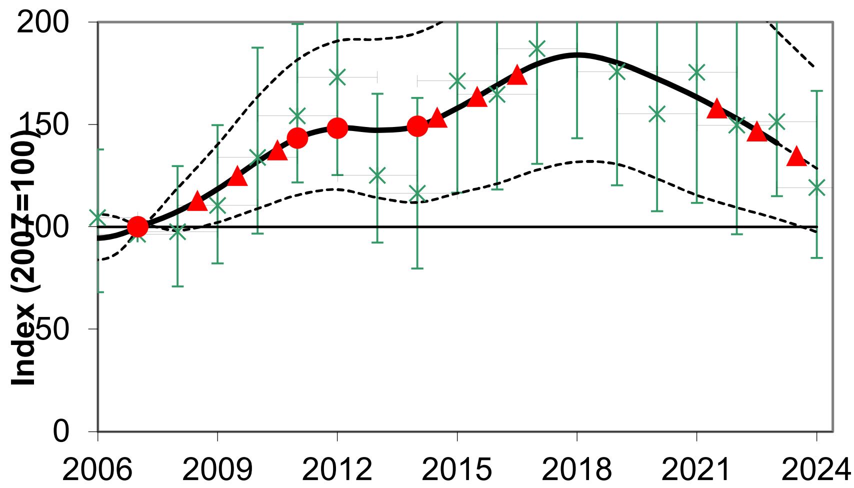


Figure 4.7 (previous page): Poisson GAM results for the Republic of Ireland (above) and Northern Ireland (below). Green points are unsmoothed means and the bars are 95% bootstrapped confidence limits. The black line is the fitted GAM curve with 95% confidence limits shown by the dotted lines. Red triangles show a significant year-to-year change and red circles a significant changepoint (where the slope changes). Please see appendices for accompanying tables.

4.2.6 Robustness of Dataset

BCIreland encourages new survey teams to take on "old" waterway sites in order to strengthen the data. In 2024 new survey teams were encouraged to take on previously registered waterway sites. This approach is reducing the number of single survey waterway sites and increasing the number of annual repeat surveys of registered waterway sites.

At the end of 2023, 100 (15.5%) of the waterway sites had been surveyed for only one year. In 2024 this has been reduced to 84 waterway sites (13%) (Figure 4.8). This is a 2.5% reduction of single survey waterway sites compared to 2023.

There are 645 waterway sites in the dataset and on average only 35-40% are surveyed annually. As a result, there is a large number of sites only surveyed for one to four years in the full dataset (n=290, 45%).

On a county-by-county basis, the five counties with the highest percentage of single year survey sites are Counties Westmeath (32.1%, n=9), Tyrone (32%, n=8), Mayo (32%, n=8), Monaghan (30%, n=3) and Carlow (25%, n=5).

Table 4.2 shows the number of years of data contributed by each waterway site surveyed in 2024. While there is a much larger number of waterway sites surveyed for just one, two or three years in the full dataset (i.e. 2006-2024, see Table A2.5 in the Appendices for details), the 2024 waterway site dataset shows a more even distribution.

Table 4.2: Number of years each waterway site surveyed in 2024 was surveyed as part of the All-Ireland Daubenton's Bat Monitoring Scheme.

	Sites Surveyed in 2024		
No. of Years	**N sites**	**% of Total**	**Cumulative %**
1	0	0.0	0.0
2	16	6.4	6.4
3	17	6.8	13.2
4	25	10	23.2
5	19	7.6	30.8
6	13	5.2	36.0
7	18	7.2	43.2
8	12	4.8	48.0
9	13	5.2	53.2
10	11	4.4	57.6
11	13	5.2	62.8
12	16	6.4	69.2
13	12	4.8	74.0
14	15	6.0	80.0
15	13	5.2	85.2
16	8	3.2	88.4
17	10	4.0	92.4
18	10	4.0	96.4
19	9	3.6	100.0

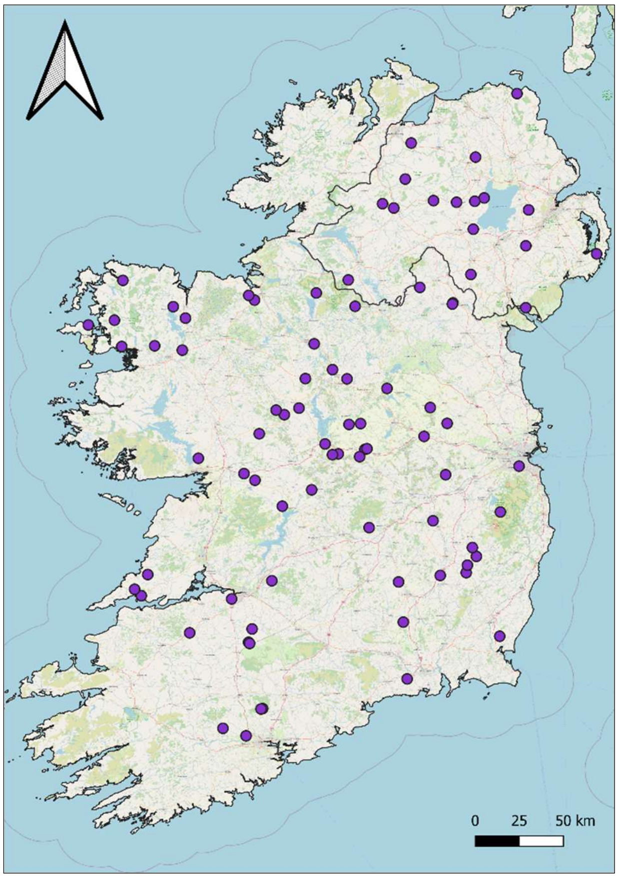


Figure 4.8: Waterways surveyed for one year only (2006-2024 dataset), n=84 (Purple circles).

4.3 Discussion

4.3.1 Volunteer Uptake 2024

A large number of volunteers continue to participate in the All-Ireland Daubenton's Bat Waterways Survey. A total of 252 potential new volunteer teams registered in 2024 to participate in the monitoring survey and 217 of these attended online training. Fifty-seven new survey teams were recruited in 2024 and successfully completed surveys along 65 waterway sites. This far exceeds our usual annual recruitment of 30-40 new survey teams, which is what is typically required to ensure that the target number of waterway sites are surveyed annually.

While a small core group of survey teams have participated in the programme for each of the nineteen years, there is still need for a recruitment drive each year since a certain percentage of volunteers are lost from the survey every year. Prior to COVID-19 this recruitment drive usually involved 3 -15 in-person training courses per year. However, since 2020, BCIreland has provided online training. This has reduced the amount of time required for training, allowing the scheme co-ordinator to undertake extra surveys to reduce the number of single surveyed waterway sites. This new type of training has also lowered the scheme's carbon footprint by reducing travel to training courses. While the lack of physical training reduced volunteer recruitment in 2020, online training course recruitment has increased every year since 2021, which is encouraging.

In future, we feel that a combination of physical and online training could be a good combination to optimise recruitment and training while leaving some time free to carry out additional surveys where we have poor uptake by volunteers. The feasibility of this will be assessed annually and will be determined by work commitments of the monitoring co-ordinators.

It has become a policy since 2020 to encourage volunteers to choose a waterway site from the list of available registered sites. This has resulted in a greater uptake of registered waterway sites by new volunteer teams compared to the survey years prior to 2020. This policy has increased the robustness of the dataset and therefore should continue to be the standard practice for future operational years.

4.3.2 Survey Coverage in 2024

Survey coverage was excellent in 2024. The number of surveyed waterway sites (250) was the third highest since the inception of the scheme and the highest number of surveyed sites since 2011, while the number of completed surveys (466) was the second highest of any survey year (the most being 474 in 2014). In relation to repeat surveys i.e. sites that were successfully surveyed twice during the designated survey windows in August, 2024 had 216 (86.4% of the total) which was the highest number of repeat surveys completed in the 19 years of the survey. Surveys were carried out in each of the 32 counties of the island in 2024. The highest coverage for a single county was Dublin with 25 surveyed waterways sites and was closely followed by Cork with 23 surveyed sites. A large number of sites are consistently surveyed in these two counties each year, owing mostly to the high number of volunteers located in Co. Dublin and the large number of registered waterways in Co. Cork.

4.3.3 Dataset & Distribution

The 2024 dataset consisted of 18,294 Daubenton's bat passes. Daubenton's bat was recorded on the majority of waterway sites surveyed in 2024 (86.8%), thus re-confirming this species' wide distribution on linear waterways across the island. Daubenton's bat was recorded in every county surveyed, from the most northerly waterway sites in Co. Antrim to waterway sites in south-west Co. Kerry and also at sites on the western seaboard in Co. Mayo. A similar widespread distribution of this species was reported by the BCT's National Bat Monitoring Programme where

Daubenton's bat has been recorded at sites spanning areas in northern Scotland to southern England (www.bats.org.uk). This monitoring scheme is, therefore, making a considerable contribution to our knowledge of the distribution range of Daubenton's bat on the island of Ireland.

4.3.4 Lighting & Habitats

Lighting and habitat data was last assessed in detail for data up to and including the survey of 2021 (Aughney, Roche & Langton, 2022). If lighting is present at a waterway site, this has a significant negative effect on the number of Daubenton's bats recorded. White lights, in particular, have the largest negative effects. This is an important issue particularly in urban areas, where waterways are often the last remaining dark conduits through a landscape of artificial surfaces and buildings. It is important that dark wildlife refuges are part of wider landscape management policies.

While our previous data has indicated that the presence of hedgerows and reeds at the survey spots of the waterways sites do not have a strong influence on the presence of bat passes, trees do have a significant positive impact. This fact could be used as a management tool to increase the wildlife value of linear waterways, particularly in urban areas. Trees can also be used to buffer lighting impacts as part of landscape tools (BCT, 2018).

4.3.5 Yearly Trends

From 2009-2022 we examined trends using both a Poisson Generalized Linear Model (GLM), which focusses on Daubenton's bat counts, and a binomial model, which focusses on presence/absence of Daubenton's bat at individual survey spots. The latter is considered to be an 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). However, over the years there has been very little difference in the trends when both models are compared. As with last year's report, for the 2024 report we decided to only use the Poisson model in our reporting of the Daubenton's survey data. Moreover, the Poisson method is more directly comparable with the BCT's reporting in the UK, since it is the same model used in their analyses. Although we will still continue to carry out the analysis on Daubenton's data using both Poisson and Binomial models to assess any differences, we will focus on only reporting the data using the Poisson model henceforth.

GLM/GAM analysis has shown evidence of declines and increases in Daubenton's bat activity throughout the duration of the monitoring scheme. The overall trend has fluctuated since 2006, and in some cases declines in particular years may have been attributable to poor weather (i.e. high rainfall and/or low temperatures) in August of that year but the overall trend since 2006 has been reasonably stable, with an increase in Daubenton's bat activity being observed in 2024.

In comparison with Ireland, the smoothed index for Daubenton's bats for the United Kingdom in 2023 was 4.3% above the 1999 base year value, however this change is not statistically significant (Bat Conservation Trust, 2024). It has been relatively stable since 1999, sitting close to or slightly above the baseline.

4.3.6 Robustness of Dataset

The trend datasets only include waterway sites surveyed for two or more years. The 2006-2024 dataset contains 84 waterway sites that have only one year of data. Due to our policy of targeting single surveyed waterways sites when recruiting new volunteers, this number has been steadily decreasing, with a 2.5% reduction in the number of single surveyed waterways sites since 2023.

To increase the robustness of the dataset, particular counties are targeted for surveying to decrease the number of single surveyed waterway sites. Since 2020 there, there has been an aim to include at least 80% of waterways sites in the dataset for trend analysis. This has been achieved.

For 2025, efforts to reduce single survey waterway sites will be continued. The five counties with the highest proportion of single year survey waterway sites will be targeted in 2025: they are Westmeath, Tyrone, Mayo, Monaghan and Carlow. In addition, BCIreland will also target waterway sites that have not been surveyed in the last five years. This dataset consists of 215 waterway sites, 31 in Northern Ireland and 184 in the Republic of Ireland.

There are 645 waterway sites in the dataset and on average only 35-40% are surveyed annually. The volunteer capacity achieved annually is a realistic value and therefore it is unlikely that a larger number of the registered waterway sites can be surveyed. Therefore, the policy of discouraging the establishment of new registered waterway sites is important and should continue for the operation of this monitoring survey.

Some changes to how the scheme will be run are planned for 2025. This will include recruiting volunteers through an online interactive map where waterways sites can be claimed, automatically signing up volunteers to the scheme after they choose a site and complete an online form. The process for submitting survey results will also be moving to an online format. These changes will help to streamline the survey process and will reduce the amount of administration time needed to manage these aspects of the scheme.

5.0 BROWN LONG-EARED BAT ROOST MONITORING SCHEME

5.1 Methods

The Brown Long-eared Roost Monitoring Scheme methodology was designed by BCIreland. For a full description of the Preliminary Roost Assessment and Survey Methodology, see Aughney *et al.* (2011).

5.1.1 Annual Roost Counts

Suitable roosts are monitored yearly by either Internal counts (2 counts) or External Emergence Dusk Counts (2-3 counts) during the specified survey periods (See Table A3.1, 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 *et al.*, 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.

Due to COVID-19, an extra effort was undertaken to reduce the number of internal surveys undertaken in 2020 and this continued to be the BCIreland policy in 2022. Internal surveys were only undertaken for roosts with large attic spaces and with PPE worn by the surveyor.

Dates for survey periods are as follows: Survey 1: 16th May to 15th June; Survey 2: 16th June to 31st July & Survey Period 3: 1st August to 30th 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.

Due to the difficulty of detecting brown long-eared bats emerging from some roosts, night vision aids (NVAs) are used. Sony HandyCam FDR-AX33 and FDR-AX53 with night-shot capability along with infrared illuminators and Guide Pro 19 & 25 thermal imagery scopes are deployed. The camcorder is positioned on a tripod (1.5m high) while the IR illuminators are attached to a separate tripod (1m high, two per roost site). Illuminators are shone onto the building in the general vicinity of known exit points. In relation to the thermal imagery scope, the scope is also erected on a tripod (1.5m) and positioned to record emerging bats. Recordings are completed from 20 minutes after sunset for the duration of the roost count. Film footage is examined post-surveying. A selection of buildings are surveyed with the aid of night vision equipment.

On completion of surveys, survey forms are returned to BCIreland for analysis and reporting.

5.1.2 Statistical Analysis

The effects of Northings and Eastings, day number (i.e. survey date), weather data, building type, 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 2007-2024 data. Data from all sites counted in two or more years are included in the trend dataset.

The trend is smoothed using GAM and the yearly estimates are 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 fits the data better and gives 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, factors that were significant from GLMM models.

5.2 Results

5.2.1 Volunteer Participation in 2024

Forty one roosts were surveyed in 2024, thirty one of which were monitored solely by volunteer teams and/or roost owners. The coordinator assisted surveying of one additional roost (County Galway) while training in new people with existing volunteer teams. The remaining roosts were surveyed by the coordinator. In total, 37 volunteers, including roost owners, participated in the monitoring scheme in 2024.

Figure 5.1: Type of Survey Team participation in 2024.

Kildare Bat Group surveyed two roosts, Wicklow Bat Group, Cavan Bat Group, Wexford Bat Group, Donegal Bat Group and Waterford Bat Group surveyed one roost each.

5.2.2 Monitored Roosts in 2024

Brown long-eared roosts monitored in 2024 were distributed in 19 counties. The highest number of roosts were located in Counties Cavan (n=6), Galway (n=5), Cork (n=4), and Wicklow (n=5 each). One roost, verified as suitable for inclusion in 2021, was monitored again in 2022 and 2023 (County Offaly). A new roost was temporarily added to the 2023 survey calendar (County Westmeath). This roost was surveyed again in 2024 and is now included in the monitoring scheme. In 2024, four new roosts were surveyed by the coordinator in County Offaly (n=1), County Donegal (n=2), and County Mayo (n=1). These roosts will be surveyed again in 2025 to determine suitability for inclusion in the monitoring scheme for 2026. Forty five roosts were surveyed in total in 2024, four of these are not included in the trend dataset as it was the first year of monitoring.

In total there are data for 66 roosts in the brown long-eared monitoring dataset (2007 to 2024). Nineteen of these roosts are no longer monitored due to absence of bats, development and access issues over the years. In 2021, 49 roosts were deemed still suitable for monitoring or reassessment for the next contract round of monitoring (Aughney *et al*., 2022). However, one of the roosts deemed no longer suitable was monitored as part of the Ecosystem Services study by UCD and therefore counts for that site continued to be included in the dataset (Site Code 2021) until the end of 2023. Another roost was no longer suitable for monitoring due to development impacting the roost. This means that there were 47 roosts registered for monitoring in 2024, distributed across 21 counties. From this list, 41 were surveyed in 2024. The counties currently with no roosts are Louth, Kerry, Mayo, Carlow, Limerick and Leitrim. Potential new roosts have been identified for scoping surveys in 2025; these include County Limerick (n=1), County Leitrim (n=2), County Wicklow (n=1), County Dublin (n=2), County Donegal (n=1), County Meath (n=1), County Westmeath (n=1), and County Louth (n=1). The coordinator is currently working with local biodiversity officers to identify suitable roosts in Counties Kerry and Carlow.

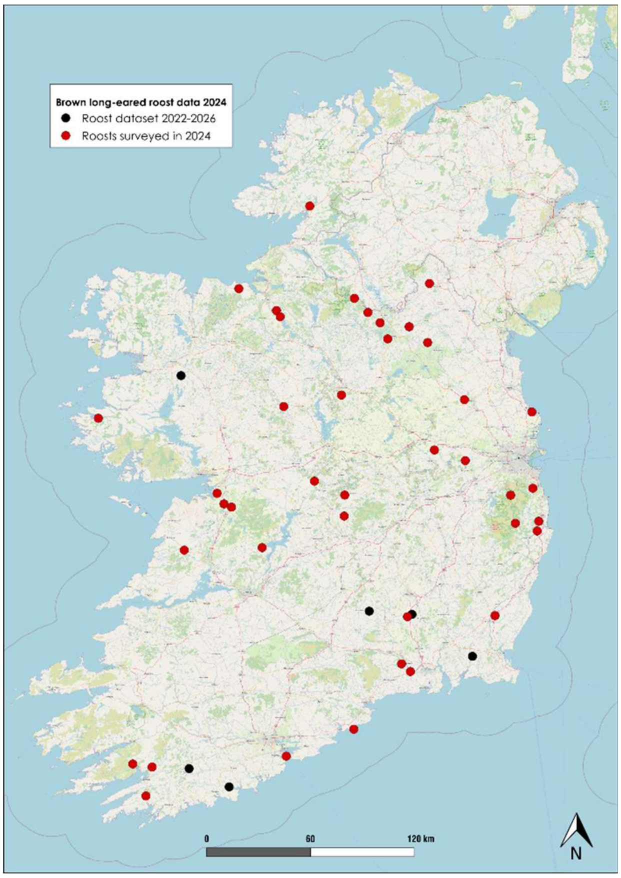


Figure 5.2: Brown long-eared roosts surveyed in 2024 as part of the Brown Long-eared Bat Roost Monitoring Scheme. Red circles = Roosts surveyed in 2024; Black circles = Roosts not surveyed in 2024.

An additional two structures were assessed in 2024 (one in Co. Donegal and one in Co. Louth) but these did not have brown long-eared bats present.

Tables A3.2 and A3.3 (in Appendix 3) indicate how regularly roosts are monitored. Table A3.2 shows that more than half the roosts in the current dataset have been monitored for at least ten years, whilst Table A3.3 shows that, of the 41 roosts surveyed in 2024, 17 were also surveyed in the base year of 2008. There is also a high level of consistency which is a positive factor for accurate trend analysis.

The majority of roosts surveyed in 2024 were surveyed by external Dusk Emergence Counts only (n=37, 90%). An additional four roosts were monitored by internal counts only. A total of 101 external surveys and nine internal counts were undertaken in 2024. (see Appendix 3, Table A3.5 for summary of surveys completed).

The buildings surveyed included churches, houses, an agricultural barn, large buildings/houses and a category named "other", representing two medieval towers and 12th century stone structure. The majority of the buildings surveyed were churches (Figures 5.3 & 5.4).

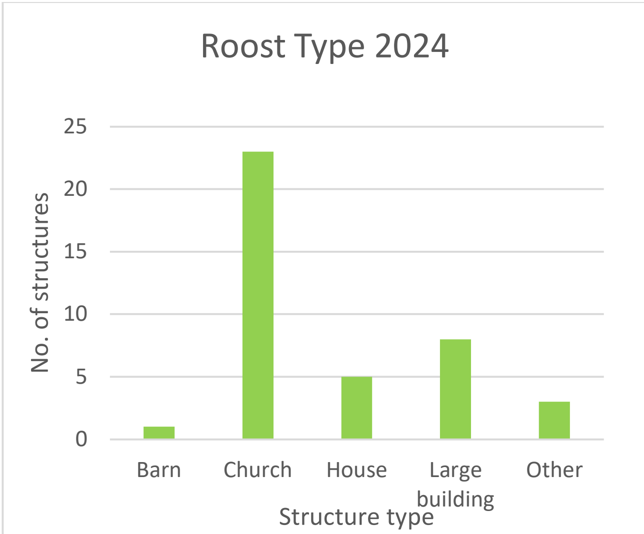


Figure 5.3: Type of buildings monitored in 2024.

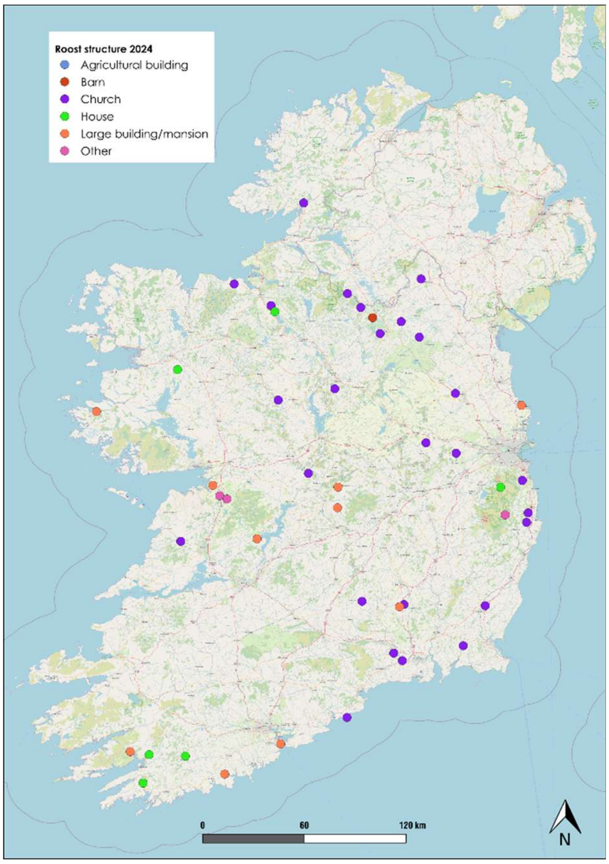


Figure 5.4: Distribution of types of buildings surveyed in 2024. Pink circles = Large building / houses; Green circles = Houses; Purple circles = Churches; Blue circles = Agricultural buildings, Red circles = barn, and Orange = Other.

In 2024, a total of 1,555 individual bats were counted in the 41 roosts. The mean number of bats per roost in 2024 was 32.6 individuals and the median count was 25 individuals.

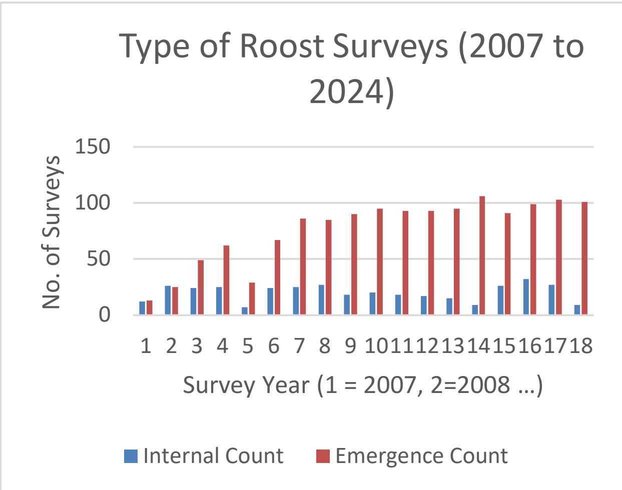


Figure 5.5: Type of roosts surveyed 2007 - 2024

5.2.3 Monitored Roosts 2007-2024

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 season, volunteer teams undertook a minimum of one survey at 34 roosts. The scheme was reinstated in 2012.

A total of 1,743 surveys are included in the 2007-2024 dataset. Four roosts have been monitored for each of the eighteen years of the scheme (See Table 5.2).

Table 5.1: Number of roosts monitored and surveys completed for each year of the Brown Long-eared Roost Monitoring Scheme 2007-2024

Survey Year	Roosts	Surveys
2007	16	25
2008	31	51
2009	36	73
2010	41	87
2011	35	36
2012	41	91
2013	49	111
2014	48	112
2015	47	108
2016	47	115
2017	47	111
2018	45	110
2019	43	110
2020	45	115
2021	44	117
2022	46	131
2023	47	131
2024	41	110

Table 5.2: Number of years of data for each roost monitored in 2007-2024 as part of the Brown Long-eared Roost Monitoring Scheme.

Number of years	Number of sites	% of total
2	6	9.2
3	1	1.5
4	5	7.7
5	3	4.6
6	2	3.1
7	3	4.6
8	3	4.6
9	2	3.1
10	7	10.8
11	2	3.1
12	4	6.2
13	4	6.2
14	7	10.8
15	10	15.4
16	6	9.2
17	6	8.5
18	4	6.1

Most surveys were completed by External Dusk Emergence Counts (n=1,381, 79.2%) compared to Internal Counts (n=361, 20.8%), see Table A3.5, Appendix 3 for more details). From 2011 to 2024 the external Dusk Emergence Count was the preferred method of survey as this was shown by statistical analysis to be a more reliable method to collect information for this monitoring scheme (Aughney *et al.,* 2011). As shown in Figure 5.5, the number of roosts monitored by Internal Counts has reduced from year to year. In 2007, 44% of roosts were monitored by Internal Counts while in 2020, this figure decreased to 9%. But this low figure was influenced by COVID-19 restrictions in 2020. In 2021, 2022 and 2023, the number of internal counts increased slightly due to the surveying of a selection of roosts as part of the UCD Ecosystem Services study.

5.2.4 Statistical Analysis

The effects of Northings and Eastings, day number (i.e. survey date), weather data, start time, type of building (different construction parameters) and Internal Counts/external Dusk Emergence Counts are examined annually using a Generalised Linear Mixed Model (GLMM). From analysis of the 2007-2024 dataset, three terms were statistically significant; rain, cloud conditions, roost type and day number. In previous years, terms that were significant included survey period, start time and type of survey (internal versus external roost counts), but these parameters are having less of an influence as the monitoring scheme progresses and surveys are carried out in a more standardised manner (e.g. strictly adhering to completing surveys in the three set survey periods).

There are no major changes to the GLMM model fitted previously. Although roost type is no longer statistically significant at the conventional 5% level, churches still have the highest counts (F=2.34 with 4 and 56 d.f., P=0.066).

Weather data and rain is still significant with higher numbers recorded in drier conditions, as would be expected. As in previous years there has been a tendency for external counts to be higher than internal counts early in the season, but internal to be higher than external later in the year. This trend continues for the 2007-2024 dataset. For the 2024 dataset this interaction term between internal counts and day number is still significant (F=10.64 with 1 and 1134 d.f., P<0.001) with external counts tending to be higher early in the season and internal ones later on. This pattern has been evident (although not always statistically significant) for many years, and as a result, it is a covariate in the GAM model.

Additional statistical analysis was undertaken to investigate the mean time the first bat emerged during external surveys in previous years and this was repeated in 2024. Surveyors counted the number of bats during emergence according to ten minute survey blocks. The ten minute block data was used to calculate the approximate mean emergence time (based on treating bats as if they all emerged at the mid-point of the block) and a time of last emergence, to the nearest 10 minute survey block.

Firstly looking at the relationship with counts:

- **First emergence**: when counts are lower the time of first emergence tends to be later (F= 34.02 with 1 and 701 d.f., P<0.001)
- **Mean emergence time**: whilst there are signs of a negative relationship between the number of bats emerging and the mean emergence time, this is not statistically significant (F=2.76 with 1 and 704 d.f., P=0.097).
- **Last emergence time**: when counts are high, the time of last emergence is later (F=10.01 with 1 and 701 d.f., P=0.002).

These relationships are shown graphically in Figure 5.6, which plots all the data, expressing each count as a proportion of the average count for the roost. It is debatable which way around the axes should be on this plot, but, in practice, it looks clearer with time on the vertical axis.

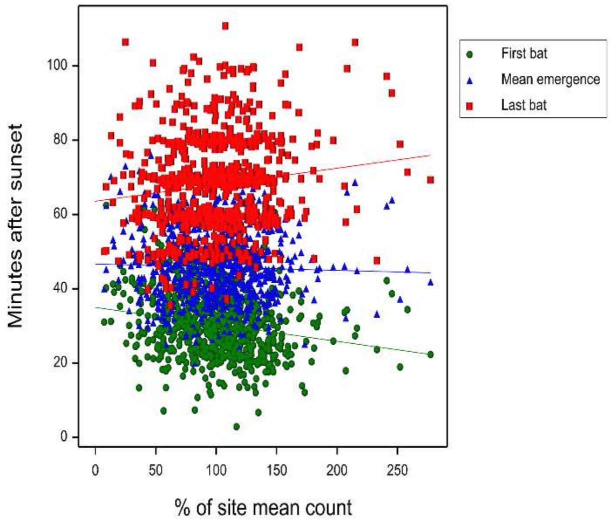


Figure 5.6: First, mean and last emergence times plotted against counts as a proportion of the site mean count. (Note: Last emergence times are only known to the nearest ten minute block). Lines are linear regression lines. Note – this graph is repeated in Appendix 3 in a larger format.

The relationship between the emergence times and the weather data recorded by surveyors (temperatures, cloud, wind and rain) was also investigated. First emergence times relative to sunset were around 2.5 minutes earlier with full cloud, compared to a clear night (F=12.14 with 2 and 871 d.f., P<0.001). The mean emergence time relative to sunset is approximately four minutes earlier at the end of August compared to the start of June i.e. first emergence times tend to be slightly earlier relative to sunset for surveys completed later in the monitoring season (F=15.09 with 3 and 704 d.f., P<0.001) for the linear effect of day number) with a change of around 1 minute per month.

Cloud also has a highly significant impact of similar magnitude on mean emergence times (F=8.8 with 2 and 740 d.f., P=0.001) with emergence times in full cloud around 2.5 minutes earlier than on a clear night. The mean was three minutes later in breezy conditions compared to a calm night (F=7.46 with 2 and 877 d.f., P=0.001). Again, there is a significant relationship with day number, with earlier emergence relative to sunset later in the monitoring season (F=37.39 with 1 and 536 d.f. <0.001).

Last emergence times (based on the last block with bats) are not significantly related to cloud (F=1.34 with 2 and 746 d.f., P=0.263). The linear effect of day number is significant (F=9.82 with 1 and 547 d.f., P=0.002), with the time of the last bat emerging from the roost getting earlier relative to sunset by just under 1 minute per month.

Figure 5.7 shows these relationships (see Appendix Table A3.6 for more details).

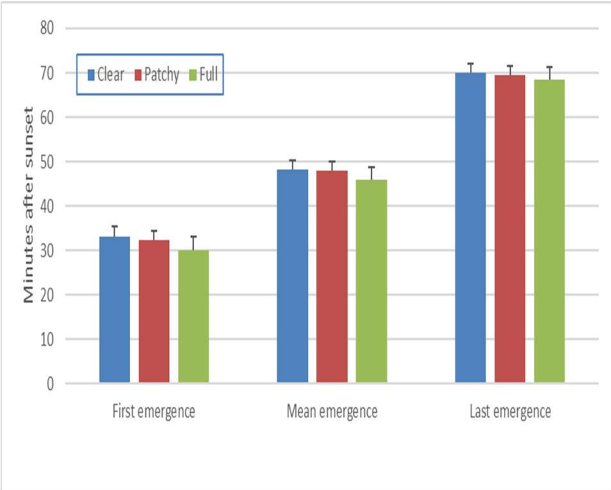


Figure 5.7: Emergence times in different cloud conditions. Bars show estimates from REML models with 95% confidence limits. Note – this graph is repeated in Appendix 3 in a larger format.

There are statistically significant year to year differences in mean emergence times relative to sunset (F=2.27 with 12 and 293 d.f., P=0.009), but there is little sign of a consistent pattern (Figure 5.8).

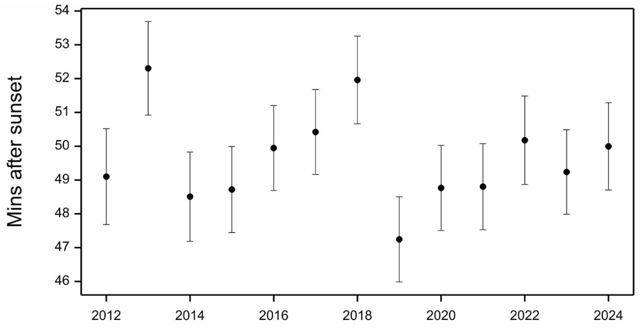


Figure 5.8: Mean emergence times relative to sunset for each year. These are predicted means from the REML model, adjusted for the effect of other factors in the model. Bars are plus or minus one standard error. Note – this graph is repeated in Appendix 3 in a larger format.

It is also worth noting that there is a considerable amount of roost-to-roost variation in the emergence times, as well as some signs of year-to-year variation within roosts (maybe due to factors such as levels of shading by trees). However, there is no sign of a consistent year-to-year pattern across all roosts.

5.2.5 Yearly Trends

Results from a GAM model, expressing the trend as an index with 2008 as the base year, is shown in Figure 5.9 (See Table A3.8, Appendix 3 for more details). The models use a negative binomial distribution, rather than the Poisson distribution used previously (and as used for the GLMM), as this seems to fit the data better and gives 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) and is shown in Figure 5.8. Other than the slight difference in precision, results are similar with and without covariates, with an initial increase followed by relatively stable results for a number of years. Average counts in 2024 were similar to 2023. The smoothed GAM curve remains slightly above the baseline 2009 value, but not significantly different to it, as has been the case for the last ten years.

Overall, the smoothed index using the model with covariates is currently 4.68% above the 2009 base year value which is equivalent to an average 0.22% annual increase (Figure 5.9). The trend is not considered to be significantly increasing, since the lower confidence interval does not exceed the baseline.

The trend derived from the limited number of brown long-eared bat calls picked up during the car-based bat monitoring scheme is shown in Figure 5.10. Error bars are very wide on this trend graph which illustrates the extent of uncertainty using the car monitoring dataset to derive trends for this species.

The Car-based Bat Monitoring Scheme brown long-eared trend has fluctuated over the years. The trend showed an increase from 2008 to 2013 followed by a subsequent decline. More recently the trend has begun to increase since 2019. Overall, the error bars encompass the baseline, indicating that the trend has not been significantly increasing or decreasing. 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 33 brown long-eared bat passes were recorded from 769 x 1.6km transects across Ireland in 2024, compared with over 1,555 individuals counted from 41 roosts during the Brown Long-eared Bat Roost Monitoring Scheme in the same year.

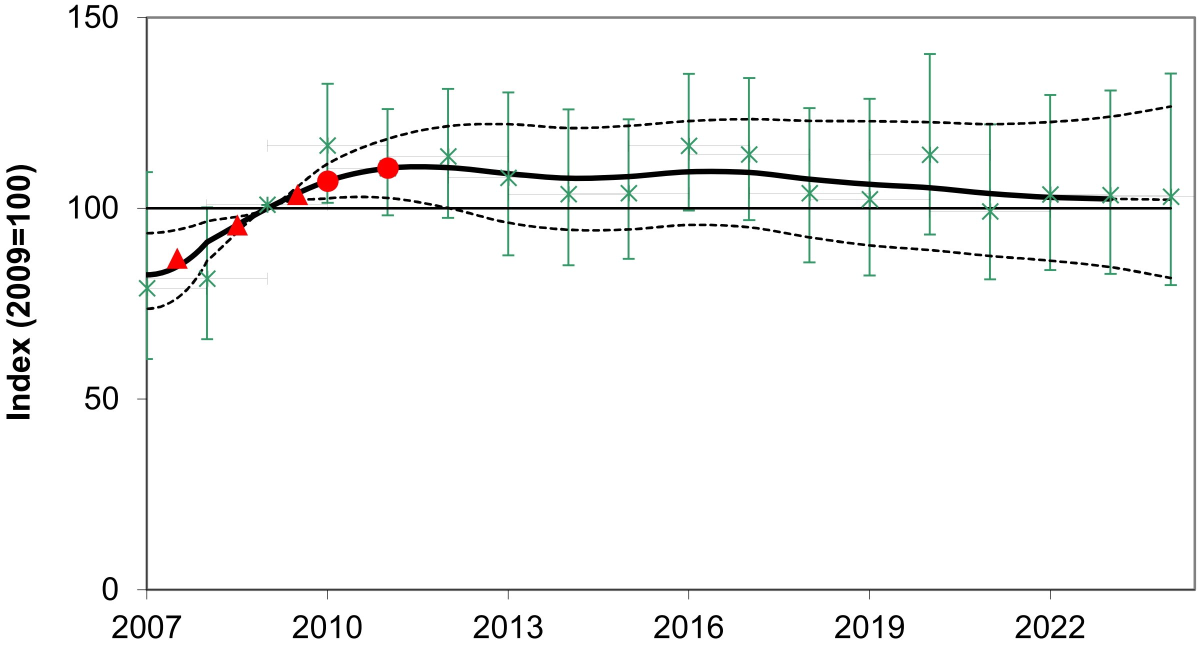


Figure 5.9: Brown long-eared bat annual trend from the Brown Long-eared Bat Roost Monitoring Scheme. GAM curves with covariates. The black line is the smoothed GAM curve, with 95% confidence limits shown by the black dotted lines. Green points are estimated annual means and are shown to illustrate the variation about the fitted line. 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).

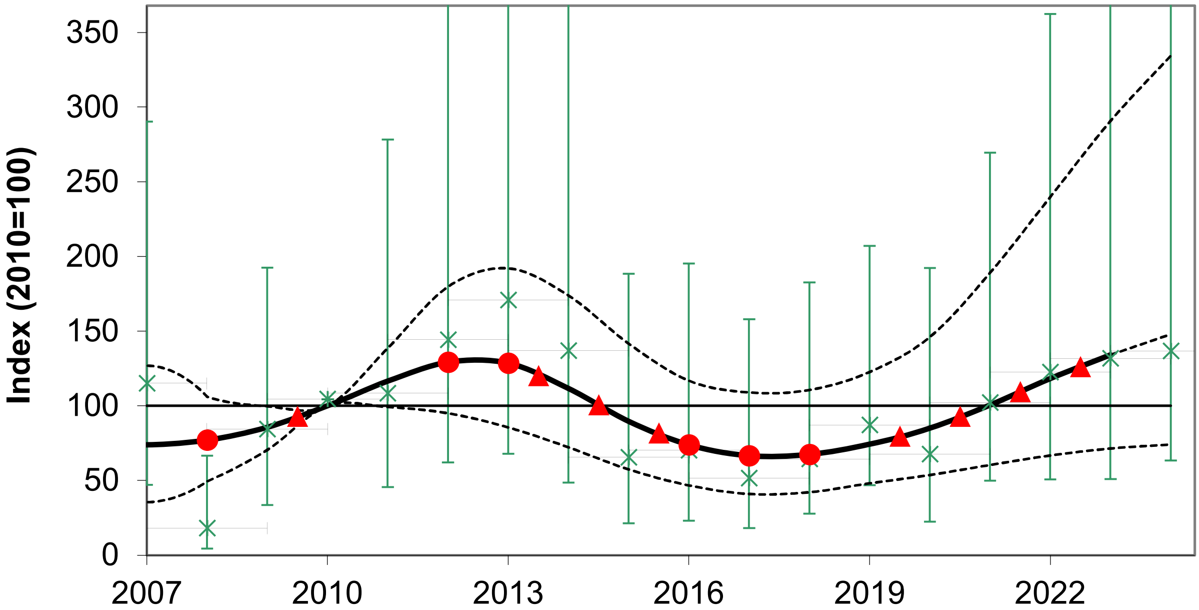


Figure 5.10: Brown long-eared bat annual trend from the car-based bat monitoring scheme (binomial analysis). GAM curves with covariates for detector type. The black line is the smoothed GAM curve, with 95% confidence limits shown by the black dotted lines. Green points are estimated annual means and are shown to illustrate the variation about the fitted line. 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).

5.3 Discussion

5.3.1 Volunteer Uptake

The main function of the coordinator in relation to volunteer teams is to ensure that suitable roosts are assigned and monitored and that the volunteers are fully trained in the survey methodology. Volunteers recruited for this monitoring scheme need to have some experience in identifying bats using bat detectors. Therefore, 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, teams organised to-date have carried out the counts very successfully, especially when they have been trained in situ by the coordinator 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.

Sixteen roosts were targeted for surveying in 2024 using thermal cameras, camcorders and IR illuminators to obtain more accurate counts and identify all roost exits. A volunteer team (Co. Dublin) expressed concerns that exit points previously used by the bat colony may have changed in 2024 as bats were no longer present. To investigate this possibility, this roost will be surveyed by the scheme coordinator using thermal imaging in 2025.

The majority of the roosts are surveyed by well-established teams, many of which have participated since 2007. This greatly improves the robustness of the data. BCIreland will continue to support current teams and new teams that enter the programme in 2025. The coordinator is currently working with Biodiversity Officers to find suitable sites and volunteers in counties currently missing from the dataset.

5.3.2 Survey Coverage in 2024

The eighteen years of the monitoring programme has yielded consistently high level of surveying. However, new teams are required for roosts that have not been surveyed from 2018-2024 and this will be a priority again for 2025.

Currently, there are roosts available to be monitored in 21 counties across the country.

The participation of roost owners in the monitoring scheme has 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 houses. BCIreland will continue to encourage and assist roost owners with monitoring of their own roosts.

While some roosts have become unfavourable for monitoring or to access, there is an excellent track record in consistency of monitored roosts. Forty roosts in the current dataset have been monitored in at least ten years. Of the 41 roosts surveyed in 2024, 17 were also surveyed in the base year of 2008. Four roosts have been surveyed for each of the 18 years of the scheme. This is an important factor in ensuring robust population trend analysis.

5.3.3 Dataset & Distribution

Roosts were not chosen at random, due to the constraints of locating suitable roosts for surveying. However, the current roost dataset covers a good geographic range across 20 counties. It would, however, be desirable to ensure that the entire geographic spread of the species in the country is covered by the scheme in the coming years so BCIreland proposes to identify additional brown long-eared roosts in the remaining counties of the Republic of Ireland. Currently there are gaps in the location of monitored roosts, principally Counties Louth, Leitrim, Mayo, Limerick, Carlow and Kerry.

5.3.4 Statistical Analysis

Statistical analysis undertaken in 2011 indicated that Dusk Emergence Counts resulted in more reliable data compared to Internal Counts (Aughney *et al.,* 2011). Where possible, Dusk Emergence Counts are now the preferred survey method for this monitoring scheme. Since 2011 more than 75% of roosts monitored were surveyed by this preferred method. This type of survey requires more volunteer teams and greater time input but it is proving manageable at present.

The timing of the survey, in previous years, had a significant influence on mean counts. But in 2024 this was not the case due to the increased experience of survey teams who strictly follow the survey methodology. BCIreland will continue to provide sunset time tables for volunteer teams to ensure that start times are as accurate as possible.

In 2024, the majority of surveys were completed during good weather conditions. However, occasionally weather conditions change during the survey and this has been shown to reduce the mean counts. BCIreland will continue to emphasise the importance of completing surveys on nights where weather is forecasted to remain dry for the entire survey.

5.3.5 Yearly Trends

There was an initial increase in the trend until around 2010. This has been followed by a very stable trend. The population index is currently resting very slightly above the 2009 baseline.

The stable trend is an encouraging outcome and this suggests that trends from the scheme are being derived independently of mobility between roosts.

The Irish trend is similar to the trends from the BCT NBMP. British trends for BLE Roost Counts between 2001 and 2023 show the smoothed survey index has increased by 1.7% (95% CI -28.3% to 36.1%), however this change is not statistically significant (Bat Conservation Trust, 2024). While overall, the trend is considered stable in the long term there is some evidence to suggest that it has been declining in the recent short term (five years). In Britain, the brown long-eared bat Hibernation Survey index shows no significant change since the baseline year of monitoring (1999 for the Hibernation Survey). There is also evidence to suggest that over the last five years the population of brown long-eared bat has declined across its range in GB (www.bats.org).

5.3.6 Additional Technology

Thermal cameras are proving to be useful, resulting in more accurate counts and positive clarification for volunteer teams in relation to their surveying ability. Therefore, night vision aids will continue to be deployed where filming increases the accuracy of routine monitoring surveys. In addition, we will check whether any covariates for night vision technology need to be added to the trend analysis since it is possible the use of such technology boosts emergence count numbers. This will be included in the 2025 dataset.

6.0 LESSER HORSESHOE BAT ROOST MONITORING SCHEME

6.1 Methods

Surveyors are typically trained in the survey methodology in-house by other NPWS staff members. Surveyors are provided with equipment needed for the survey by the NPWS or Vincent Wildlife Trust (VWT).

Each year survey teams complete surveys of specific sites within their district. Surveys take place in summer from dusk and are carried out using bat detectors. Some sites are counted internally. The dates for surveying in summer are May 23rd to July 7th, although counts outside these dates are included in the overall trend series. Winter surveys are carried out in January and February each year.

Data was provided via the newly developed Field Recorder app by NPWS regional staff for summer and winter 2024. These data were cleaned, queried (where necessary) and imported to the database using the Excel to Access Import function in MS Access.

6.1.1 Statistical Analysis

For overall yearly trends, a Generalised Linear Model (GLM) with a Poisson error distribution (see Glossary) 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.

6.2 Results

6.2.1 2024 Dataset

Following requests for data that were circulated to the regions and to the VWT, the following survey records were sent to BCIreland and added to the main database.

Table 6.1: Raw monitoring data collected in 2024

Year	Season	Sites	Counts
2024	Winter	121	137
2024	Summer	143	159

These records include many null counts, surveys that could not be completed because no access was possible and multiple counts in the same season at some sites.

The number of records on the database currently stands at 6,739 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 Correct Date field.

In order to determine the current distribution of the species more accurately, NPWS staff embarked on additional surveys from 2019. The regions were provided with a list of historical roost sites that had not been surveyed for 10 or more years to find out whether bats were still present there. Conservation rangers in many areas have also explored derelict buildings that have potential to harbour roosts. In total, 16 sites required new codes on the database in 2024, these were located throughout the range for the species in counties Clare, Mayo, Kerry, Cork, Limerick and Galway.

Data for 2024 received from the NPWS and VWT were of a very high standard and had very few issues that needed to be queried, thus ensuring efficient processing and importing.

In winter 2024 (January and February), 137 site visits were carried out. The sum of maximum counts for all sites in winter 2024 was 9,800. The maximum number of bats recorded in a single hibernaculum was

1,052 bats in Newgrove, Co. Clare and the second largest number, 818 bats, was recorded at Moorehall, Co. Mayo. The mean number of bats per winter site in 2024 was 83 while the median number was 13.5.

For summer 2024, 159 discrete survey records were provided for 143 sites. At 28 of these, lesser horseshoe bats were either absent or no count was possible due to access or other constraints. In total, a maximum of 12,117 bats were counted during summer 2024. The maximum count at any one site was 500 bats at William King, Kilgarvan, (Site Code 522) on June 23rd 2024. Overall, the mean summer roost size was 85 and median roost size was 51.5 in 2024.

6.2.2 Overall Winter Dataset

There are a total of 2,082 counts with a mean of 71.5 (s.e. 2.78) and a median of 19 bats that can be used for winter trend analysis. Counts of zero bats constitute 10.9% of observations, but this excludes sites where the species were never observed. Table 6.2 shows the number of winter sites by year and county at five yearly intervals until 2020 and annually thereafter.

Table 6.2: Numbers of winter sites by year and county. The table shows numbers of roosts

a) numbers of sites

	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	All years
Clare	2	6	6	11	15	24	26	12	24	26	29	46
Cork	1	1	2	1	10	11	8	4	4	7	10	15
Galway	0	0	2	0	18	23	14	6	13	17	11	34
Kerry	2	5	1	0	24	21	33	12	28	36	30	46
Limerick	0	0	0	0	8	8	6	4	9	11	0	14
Mayo	0	0	1	0	9	12	8	6	9	11	12	17
All	5	12	12	12	84	99	95	44	87	108	92	172

b) percentage of all sites in each year

	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	All years
Clare	40.0	50.0	50.0	91.7	17.9	24.2	27.4	27.3	27.6	24.1	31.5	26.7
Cork	20.0	8.3	16.7	8.3	11.9	11.1	8.4	9.1	4.6	6.5	10.9	8.7
Galway	0.0	0.0	16.7	0.0	21.4	23.2	14.7	13.6	14.9	15.7	12.0	19.8
Kerry	40.0	41.7	8.3	0.0	28.6	21.2	34.7	27.3	32.2	33.3	32.6	26.7
Limerick	0.0	0.0	0.0	0.0	9.5	8.1	6.3	9.1	10.3	10.2	0.0	8.1
Mayo	0.0	0.0	8.3	0.0	10.7	12.1	8.4	13.6	10.3	10.2	13.0	9.9
All	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Tables 6.3 and 6.4 indicate the consistency with which winter sites are monitored, which is important in producing accurate trend estimates. Table 6.3 shows that over half the winter sites in the current dataset have been monitored in at least ten years. Table 6.4 shows that there has been an excellent level of consistency in the winter roosts surveyed over the last few years, although there were far fewer sites counted in winter 2021 due to Covid restrictions.

Table 6.3: Numbers of years of data from each winter roost.

Number of years	Number of sites	% of total	Cumulative %
2	25	14.5	14.5
3	11	6.4	20.9
4	10	5.8	26.7
5	10	5.8	32.6
6	6	3.5	36.0
7	3	1.7	37.8
8	9	5.2	43.0
9	4	2.3	45.3
10	7	4.1	49.4
11	6	3.5	52.9
12	9	5.2	58.1
13	8	4.7	62.8
14	6	3.5	66.3
15	9	5.2	71.5
16	5	2.9	74.4
17	7	4.1	78.5
18	8	4.7	83.1
19	4	2.3	85.5
20	7	4.1	89.5
21	4	2.3	91.9
22	3	1.7	93.6
23	2	1.2	94.8
24	2	1.2	95.9
25	1	0.6	96.5
26	2	1.2	97.7
28	1	0.6	98.3
29	2	1.2	99.4
32	1	0.6	100.0

Table 6.4: Numbers of winter roosts monitored in each year (diagonal in italics) and common to each pair of years (off diagonal). For example 87 sites were monitored in 2022 and 3 of these were also recorded in 1990.

1986	*16*											
1990	4	*5*										
1995	2	2	*12*									
2000	3	1	3	*12*								
2005	5	2	2	3	*12*							
2010	13	4	5	7	9	*84*						
2015	12	4	8	10	11	70	99					
2020	12	4	9	10	12	60	67	95				
2021	6	4	4	5	7	29	34	40	*44*			
2022	8	3	7	8	10	52	59	72	40	*87*		
2023	11	4	8	9	12	64	73	79	41	80	*108*	
2024	12	4	7	10	11	54	64	66	30	59	75	92
	1986	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**	**2023**	**2024**

6.2.3 GLMM Model

The generalised linear mixed model (GLMM) fitted in previous years was refitted and remains a good fit for the data (e.g. see Roche et al. 2024).

6.2.4 Winter Trends

As in previous years, the full GAM approach described by Fewster et al was used, expressing results as an index with 2009 set to 100. The model is fitted from 1986. To contribute to the winter trend, a site must have had the species present at some point and must be counted in at least two years. Data from surveys conducted between 26th December and 7th March are used.

Results are shown in Figure 6.1 using a model with a quadratic term for day number.

The estimated annual mean for 2024 is well up on the very low 2022 value. Another winter of strong counts means that the curve is heading strongly upwards after a period of stability between 2018 and 2022.

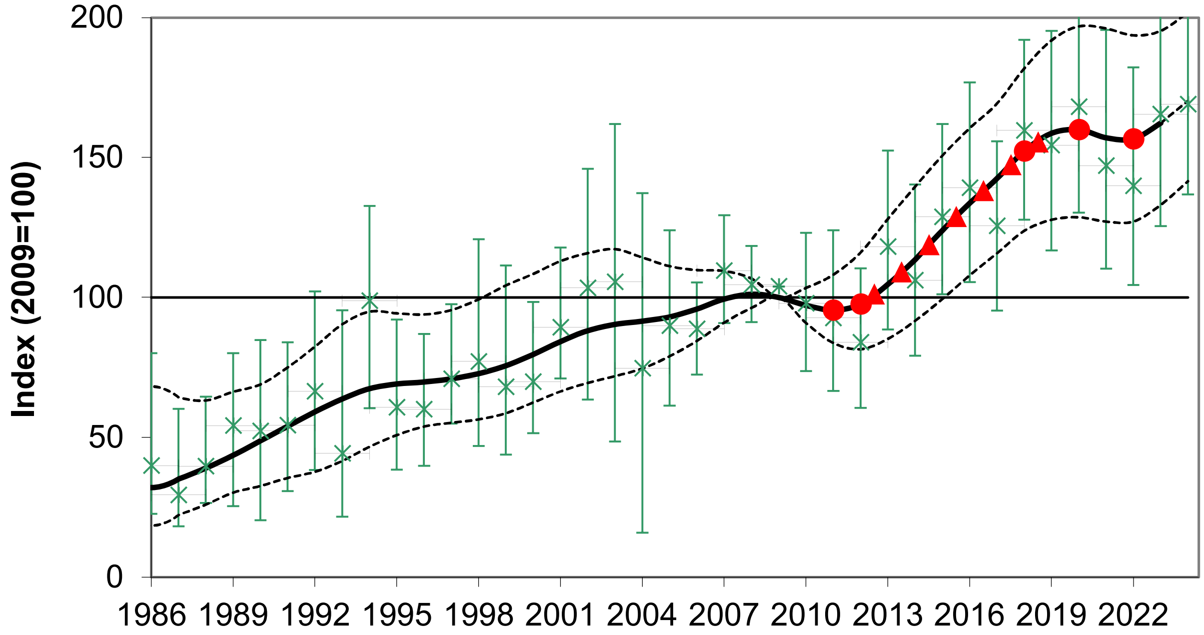


Figure 6.1: Lesser horseshoe bat hibernacula yearly trend GAM results using quadratic day number as a covariate. Points are estimated annual means derived from the Generalised Linear Model and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model curve with 95% confidence limits shown by the broken red lines. Red circles indicate significant (P<0.05) change points, where the slope of the smoothed trend line changes.

Detailed yearly GLM results are shown in Table 6.5 using results from the model above (counts with a quadratic term for day no). The trend for the lesser horseshoe bat in winter has been one of increases since the start of the survey (38 years, 1986-2024). The annual growth rate has been 4.5% per annum in winter. This is similar to the medium term (12 year, 2012-2024) growth rate at 4.74% per annum, while more recently, the short term trend (6 year, 2018-2024) has decelerated a little to 1.9% per annum.

Table 6.5: GAM results for winter counts of lesser horseshoe bat sites (covariate = day number grouped) with 95% confidence limits.

	smoothed		95% limits		unsmoothed			
Year	**index**	**s.e.**	**lower**	**Upper**	**Fit**	**s.e.**	**sites**	**Counts**
1986	32.02	12.85	18.45	68.19	36.01	15.57	16	17
1987	35.17	11.13	22.26	64.28	25.48	12.03	10	13
1988	39.02	9.91	25.96	63.18	35.69	9.59	16	17
1989	43.62	9.00	30.25	66.27	50.24	13.59	3	3
1990	48.71	9.60	32.63	68.91	48.32	17.11	5	7
1991	53.98	10.50	35.50	75.01	50.38	13.24	5	7
1992	59.10	11.92	37.69	82.42	62.50	17.18	9	12
1993	63.70	12.96	41.58	90.41	40.26	18.90	13	15
1994	67.43	12.87	46.65	94.94	94.86	20.17	39	43
1995	69.06	11.40	50.79	94.31	56.73	13.81	12	16
1996	69.79	10.19	53.85	93.89	56.07	11.78	17	17
1997	70.91	10.43	55.24	95.50	67.01	10.76	21	22
1998	72.82	11.48	56.39	99.33	73.18	19.14	6	6
1999	75.65	12.18	58.62	104.29	64.08	17.16	13	13
2000	79.63	12.20	62.46	108.40	65.89	12.89	12	12
2001	84.24	11.94	66.41	112.99	85.42	12.07	25	25
2002	88.15	11.79	69.46	115.82	99.42	22.34	10	10
2003	90.40	11.35	71.90	117.24	101.56	29.12	9	10
2004	91.52	10.09	74.59	114.27	70.71	33.74	8	10
2005	93.05	8.32	78.99	111.16	85.90	15.54	12	21
2006	95.87	6.45	84.47	109.77	84.75	8.30	82	83
2007	99.46	4.71	91.00	109.43	105.63	9.85	46	46
2008	101.14	2.69	96.25	106.73	100.60	6.71	49	49
2009	100.00	0.00	100.00	100.00	100.00	0.00	87	92
2010	97.17	3.26	90.86	103.40	93.95	12.95	84	91
2011	95.44	6.24	83.70	108.12	88.65	14.95	87	94
2012	97.63	8.78	81.49	116.06	80.03	12.66	79	87
2013	104.64	10.97	85.20	128.07	114.25	16.40	84	86
2014	113.62	12.33	91.65	139.62	102.17	15.68	96	101
2015	124.05	13.00	99.44	150.73	124.82	15.35	99	106
2016	133.73	13.37	107.92	160.49	135.22	18.17	108	113
2017	142.49	13.70	115.77	169.29	121.59	15.43	102	115
2018	152.34	14.93	123.80	181.85	155.73	15.90	105	129
2019	158.63	16.51	127.74	191.90	150.51	20.13	108	114
2020	159.93	17.58	128.64	196.85	164.22	19.95	95	103
2021	157.04	17.86	127.09	196.12	143.16	21.87	44	49
2022	156.69	17.16	127.11	193.63	135.96	19.40	87	96
2023	162.29	16.15	133.06	195.22	161.58	21.11	108	124
2024	170.26	15.48	141.53	201.83	165.12	17.16	92	108

6.2.5 Overall Summer Dataset

There are a total of 2,940 counts with a mean of 91.9 (s.e. 2.07) and a median of 50 bats. 12.1% of observations are zero (note this excludes sites where the species were never observed in the May-August period).

Table 6.6: Numbers of summer sites by year and county.

a) numbers of sites

	1992	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	All years
Clare	1	14	10	7	6	29	38	33	27	29	31	69
Cork	0	0	0	7	15	10	19	18	13	23	22	43
Galway	3	0	3	1	2	9	9	3	12	11	11	15
Kerry	5	0	26	9	22	28	49	47	54	57	48	113
Limerick	2	0	0	0	0	6	7	4	7	5	5	14
Mayo	1	1	3	0	2	9	5	7	9	11	11	12
All	12	15	42	24	47	91	127	112	122	136	128	266

b) percentage of all sites in each year

	1992	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024	All years
Clare	8.3	93.3	23.8	29.2	12.8	31.9	29.9	29.5	22.1	21.3	24.2	25.9
Cork	0.0	0.0	0.0	29.2	31.9	11.0	15.0	16.1	10.7	16.9	17.2	16.2
Galway	25.0	0.0	7.1	4.2	4.3	9.9	7.1	2.7	9.8	8.1	8.6	5.6
Kerry	41.7	0.0	61.9	37.5	46.8	30.8	38.6	42.0	44.3	41.9	37.5	42.5
Limerick	16.7	0.0	0.0	0.0	0.0	6.6	5.5	3.6	5.7	3.7	3.9	5.3
Mayo	8.3	6.7	7.1	0.0	4.3	9.9	3.9	6.2	7.4	8.1	8.6	4.5
All	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Tables 6.7 and 6.8 indicate the consistency with which summer sites are monitored, which is important in producing accurate trend estimates. Table 6.8 shows that around half of the sites in the current dataset have been monitored in at least seven years. Table 6.8 shows that there is an excellent level of consistency in the summer roosts surveyed over the last few years. The greater number of roosts surveyed in summer 2019 further increased overlap with earlier years.

Table 6.7: Numbers of years of data from each summer roost.

Number of years	Number of sites	% of total	Cumulative %
2	51	19.2	19.2
3	36	13.5	32.7
4	21	7.9	40.6
5	30	11.3	51.9
6	10	3.8	55.6
7	6	2.3	57.9
8	7	2.6	60.5
9	4	1.5	62.0
10	7	2.6	64.7
11	5	1.9	66.5
12	5	1.9	68.4
13	4	1.5	69.9
14	7	2.6	72.6
15	10	3.8	76.3
16	5	1.9	78.2
17	7	2.6	80.8
18	6	2.3	83.1
19	5	1.9	85.0
20	12	4.5	89.5
21	11	4.1	93.6
22	6	2.3	95.9
23	4	1.5	97.4
24	4	1.5	98.9
25	2	0.8	99.6
28	1	0.4	100.0

Table 6.8: Numbers of summer roosts monitored in each year (diagonal in italics) and common to each pair of years (off diagonal). For example 136 sites were monitored in 2023 and 70 of these were also recorded in 2015.

	1992	1995	2000	2005	2010	2015	2020	2021	2022	2023	2024
1992	*12*										
1995	1	*15*									
2000	2	3	*42*								
2005	1	1	4	*24*							
2010	0	4	9	12	*47*						
2015	7	11	21	19	38	*91*					
2020	7	11	23	15	32	71	*127*				
2021	4	9	20	17	36	70	91	*112*			
2022	6	10	25	13	28	68	88	86	*122*		
2023	7	10	24	15	33	70	90	90	107	*136*	
2024	7	11	20	12	35	67	83	81	95	112	*128*

6.2.6 GLMM

The generalised linear mixed model (GLMM) fitted in previous years was refitted and remains a good fit for the data (e.g. see Roche et al. 2024).

6.2.7 Summer Trends

As in previous years, the full GAM approach has been used expressing results as an index with 2009 set to 100. The model has been fitted from 1992.

Results are shown in Figure 6.2 for the model with a quadratic term for day number and a variable identifying internal counts.

The trend for the lesser horseshoe bat in summer, similar to winter, has been one of increases over the course of the monitoring scheme. Since the start of the survey (32 years, 1992-2024) the growth rate has been 2% per annum in summer. This is just slightly lower than the medium-term growth rate (12 year, 2012-2024) which is 2.5% per annum. The more recent short term (six year 2018-2024) trend is 1.55% per annum.

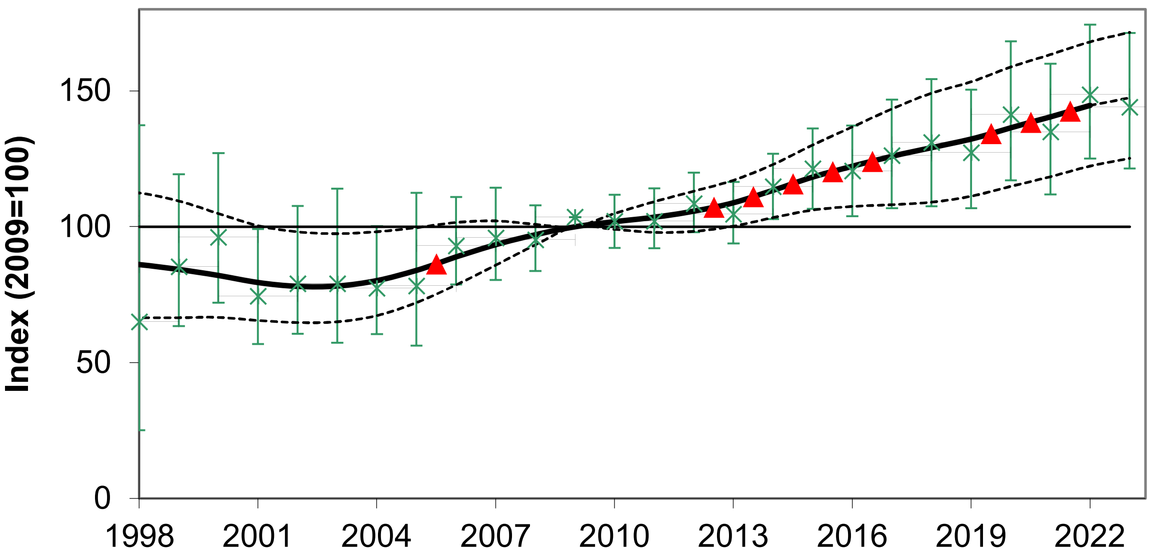


Figure 6.2: Lesser horseshoe bat summer trend GAM results using a quadratic term for day number and a variable identifying internal counts. Points are estimated annual means derived from the Generalised Linear Model and the bars are 95% bootstrapped confidence limits. The heavy black line is the fitted Generalised Additive Model curve with 95% confidence limits shown by the broken red lines. Red circles indicate significant (P<0.05) change points, where the slope of the smoothed trend line changes.

Table 6.9: GAM results for summer counts of lesser horseshoe bat sites (day number and internal counts) with 95% confidence limits.

	Smoothed		95% limit		Unsmoothed			
Year	index	s.e.	lower	upper	Fit	s.e.	Sites	Counts
1992	75.16	12.91	57.65	106.75	68.39	17.11	12	16
1993	78.65	11.55	61.19	104.54	79.94	16.37	11	24
1994	82.03	11.00	64.43	105.74	65.58	19.38	9	12
1995	85.11	11.17	66.29	109.20	88.57	19.32	15	19
1996	87.13	11.41	67.85	112.12	82.64	16.08	3	3
1997	87.51	11.80	66.75	113.51	101.07	14.27	24	32
1998	86.22	11.59	66.00	111.58	61.35	29.66	21	28
1999	84.46	10.81	66.37	108.17	82.17	13.95	61	79
2000	82.34	9.91	65.71	103.84	92.68	14.15	42	47
2001	80.02	9.31	64.66	100.95	71.39	11.58	29	50
2002	78.76	8.93	64.35	98.87	76.11	12.62	43	48
2003	79.00	8.54	65.18	98.29	76.43	14.73	23	35
2004	80.91	8.01	67.46	99.00	74.30	10.37	48	58
2005	84.55	7.16	72.06	100.32	74.49	15.12	24	31
2006	89.25	5.83	78.99	102.32	89.99	8.14	121	127
2007	93.66	4.01	86.46	102.57	92.65	8.61	87	102
2008	97.21	1.86	93.70	100.98	92.03	6.05	72	92
2009	100.00	0.00	100.00	100.00	100.00	0.00	121	149
2010	101.75	1.48	98.99	104.72	98.45	4.71	47	66
2011	103.25	2.84	97.97	108.82	98.43	5.59	102	130
2012	105.39	3.79	98.12	112.88	104.08	5.50	96	129
2013	108.49	4.40	99.65	116.99	100.80	5.66	106	128
2014	113.08	5.10	102.89	122.92	110.86	6.24	110	137
2015	117.95	6.21	105.51	130.17	117.71	7.54	91	116
2016	122.05	7.60	107.07	136.89	116.73	8.84	102	129
2017	125.79	8.97	108.58	144.09	122.58	9.73	109	136
2018	129.21	10.09	109.68	149.87	127.45	11.99	101	134
2019	132.64	10.65	112.22	154.13	123.67	11.25	139	159
2020	136.95	10.99	116.09	159.82	137.97	12.80	127	147
2021	140.80	11.17	119.56	164.45	131.31	12.13	112	129
2022	143.68	11.10	123.15	167.10	145.49	12.40	122	156
2023	143.54	10.71	124.01	166.11	138.12	12.00	136	148
2024	141.71	10.45	122.24	163.16	135.78	10.81	127	143

6.3 Discussion

6.3.1 Survey Coverage in 2024

Very good coverage was achieved in winter and summer 2024. Both seasons have contributed a huge body of information to the dataset. Consistent year-on-year surveying means that annual trends are more reliable and precise. Additional surveys were also carried out at many sites across the range for the species. These checks have yielded new records in some areas, for example a new site in mid-Cork, an area once considered to have very little suitable habitat for the species.

6.3.2 Yearly Trends

According to trend models, the lesser horseshoe bat increased significantly from the early years of the survey. 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 have tended to converge, increasing up to the early 2000s, levelling out somewhat in the mid-2000s and more recently increasing again. Some low counts in sites in 2022 resulted in a downturn in the winter trend but a higher estimate in 2023 and 2024 has pulled the trendline up again.

Overall, over the past 20 years the species increased by between 86.04% (winter) and 77% (summer), equating to a 3.15% yearly increase in winter and a 2.8% increase in summer.

Very similar increases have been reported for the same species in Britain. The lesser horseshoe bat in summer across south west England and Wales, increased by 73.5% from 1999 to 2023. Even higher increases were reported from winter counts (202.4%) in the same timeframe (Bat Conservation Trust, 2024).

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8.0 GLOSSARY

Bootstrapping
This is a method for estimating the sampling distribution of an estimator by resampling with replacement from the original sample. In the context of population indices the resampling is done for entire sites and ensures that confidence limits and significance levels are unaffected by any temporal correlation in the data. It also allows for the effects of 'overdispersion' which occurs when data are more variable than expected from a Poisson distribution.

Covariate
This is a variable that is possibly predictive of the outcome under study. A covariate may be of direct interest or be a confounding variable or effect modifier.

Doppler Effect
Apparent change in frequency of a sound (measured in kilohertz, kHz) as a result of movement, either of the source or the observer. The apparent frequency of a sound increases as the source of the sound moves towards an observer or the observer move towards it and decreases as the source moves away from an observer or the observer moves away from it.

GLM
Generalised Linear Model: a generalisation of ordinary regression and analysis of variance models, allowing a variety of different error distributions and different link functions between the response variable and the explanatory variables. The models used here have a Poisson error distribution and a logarithmic link.

GAM
Generalised additive model: these models allow a smooth, non-parametric curve to be fitted to an explanatory variable, within a GLM. In estimating population indices they are used to smooth out year-to-year variation (Fewster *et al*. 2000).

Offset
A covariate with a fixed slope of 1.0, in this case implying that the total count doubles if the number of recording intervals doubles.

Poisson Distribution
The Poisson distribution is a discrete probability distribution. It expresses the probability of a number of events occurring in a fixed time if these events occur with a known average rate, and are independent of the time since the last event. It is frequently used as the basis of statistical models of counts of organisms or events.

Power Analysis
Analysis of the power (probability) to reject a false null hypothesis. A test with high power has a large chance of rejecting the null hypothesis when this hypothesis is false. In the case of the present project the null hypothesis would state that that there is no decline in bat populations. Power is measured as a percentage, and greater power reflects the increased likelihood of detecting a declining trend (as outlined for Red or Amber Alerts). The power analysis carried out for the present project is one-tailed (i.e. examines a declining trend only) at P=0.05 (which is equivalent to P=0.I for a two sided test).

REML
Restricted (or residual) maximum likelihood (REML) is a method for fitting linear mixed models. In contrast to conventional maximum likelihood estimation, REML can produce unbiased estimates of variance and covariance parameters. This method assumes the data are normally distributed.

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APPENDIX 1

Car-Based Bat Monitoring

Table A1.1: Average number of bat encounters per hour for each survey square, Batlogger detector, Survey 1, 2024 (number of 1 mile transects (n) = 15 for each survey unless otherwise stated). Ppip = *Pipistrellus pipistrellus*, Ppyp = *Pipistrellus pygmaeus*, Punknown = Unidentified pipistrelle echolocating between 48 and 52kHz, Pnath = *Pipistrellus nathusii*, Nleis = *Nyctalus leisleri*, Paur=Brown long-eared bat, Myotis = *Myotis* spp., Allbats = total number of encounters for all species. Data derived from total number of encounters divided by total time spent sampling, corrected to 1hr.

Square	No Transects	Ppip	Ppyg	Punknown	Pnath	Nleis	Paur	Myotis	Allbats
C72	15	13.90	18.24	2.61	0.00	19.11	0.00	0.00	54.73
G20	15	9.72	71.27	12.42	0.00	24.84	0.54	2.16	120.94
G53									
G89	15	49.01	69.59	14.70	0.00	15.68	0.00	0.98	150.94
H13	15	86.89	65.36	10.76	2.31	35.37	0.00	7.69	208.37
H40	15	76.66	105.77	17.47	2.91	16.50	0.00	5.82	226.09
H79	15	30.06	31.83	5.30	3.54	48.62	0.88	0.00	120.24
J06	15	14.60	31.50	3.84	16.13	48.40	0.00	6.91	123.69
J33	10	33.08	19.85	4.96	2.48	46.31	0.83	3.31	110.82
L64	15	4.61	45.21	8.30	0.00	0.00	0.00	0.92	59.05
M24	15	118.99	72.82	16.87	0.00	17.76	2.66	0.00	230.00
M87	15	56.22	60.68	16.96	0.89	43.73	0.00	0.89	179.38
N11	15	122.19	61.99	13.48	0.90	0.90	1.80	0.90	202.15
N74	15	119.40	20.07	13.04	1.00	21.07	1.00	0.00	175.59
N77	15	128.04	84.71	25.61	0.98	62.05	0.98	3.94	307.31
O04	15	147.75	63.89	10.98	0.00	29.95	1.00	0.00	253.58
R22	15	174.86	90.00	7.71	0.00	46.29	0.00	0.00	318.86
R28	15	63.40	58.26	23.13	0.00	11.99	0.00	0.00	156.78
R88									
S12	15	193.88	73.74	15.74	0.00	16.57	0.83	0.83	301.59
S15	15	207.69	56.58	11.91	4.47	9.68	0.74	0.00	291.07
S78	15	174.24	102.61	37.75	0.00	22.26	0.97	2.90	340.74
T05	15	163.55	65.05	15.80	0.93	12.08	2.79	0.93	261.13
V93	15	73.53	83.64	11.95	0.92	18.38	0.00	0.92	189.33
V96	15	158.44	94.18	14.96	0.88	75.70	0.88	2.64	347.68
V99	15	153.42	41.47	12.44	0.83	47.27	0.00	0.83	256.25
W56	15	176.16	121.38	13.49	1.69	60.69	0.84	4.21	378.46
X49	15	150.92	63.44	11.54	0.00	38.45	0.96	7.69	273.00
Average		**103.89**	**64.35**	**13.60**	**1.57**	**30.37**	**0.68**	**2.10**	**216.84**
Stdev		*±64.10*	*±26.99*	*±7.26*	*±3.21*	*±19.80*	*±0.78*	*±2.50*	*±89.42*

Table A1.2: Average number of bat encounters per hour for each survey square, Batlogger detector, Survey 2, 2024 (number of 1 mile transects (n) = 15 for each survey unless otherwise stated). Ppip = *Pipistrellus pipistrellus*, Ppyp = *Pipistrellus pygmaeus*, Punknown = Unidentified pipistrelle echolocating between 48 and 52kHz, Pnath = *Pipistrellus nathusii*, Nleis = *Nyctalus leisleri*, Paur=Brown long-eared bat, Myotis = *Myotis* spp., Allbats = total number of encounters for all species. Data derived from total number of encounters divided by total time spent sampling, corrected to 1hr.

Square	No Transects	Ppip	Ppyg	Punknown	Pnath	Nleis	Paur	Myotis	Allbats
C72	15	11.23	34.62	0.94	0.00	52.39	0.00	0.00	99.17
G20	15	41.45	121.59	34.54	0.00	3.45	0.00	0.69	201.73
G53									
G89	15	58.17	58.17	20.98	0.00	22.89	1.91	0.95	164.03
H13	15	40.93	65.64	13.90	0.00	4.63	0.77	4.63	130.50
H40	15	108.95	129.02	12.42	0.96	21.98	0.00	4.78	278.10
H79									
J06	15	19.71	35.90	11.26	54.20	50.68	0.70	2.82	175.28
J33	10	35.37	52.55	6.06	0.00	20.21	0.00	0.00	114.21
L64	15	0.00	41.84	12.20	0.00	0.00	0.00	1.74	55.79
M24	15	47.68	44.21	19.07	0.00	8.67	0.00	0.00	119.62
M87	15	24.79	56.51	5.95	0.00	3.97	1.98	3.97	97.16
N11	15	148.63	116.38	14.02	1.40	7.01	0.00	0.00	287.44
N74	15	151.50	43.85	10.96	0.00	33.89	0.00	0.00	241.20
N77	15	129.01	93.11	34.78	2.24	35.90	0.00	2.24	297.29
O04	14	97.87	40.70	10.66	0.00	3.88	0.00	0.97	154.08
R22	15	139.40	87.80	10.86	0.00	26.25	0.91	1.81	267.94
R28	15	38.38	68.23	15.35	0.00	3.41	0.00	0.85	126.23
R88	15	48.90	26.03	7.89	0.79	11.04	0.79	1.58	97.02
S12	15	179.84	61.57	12.15	0.81	11.34	0.81	0.00	268.14
S15	15	207.21	66.43	20.56	0.79	7.12	0.00	0.00	302.11
S78	15	175.66	118.08	29.28	3.90	13.66	0.98	0.98	343.51
T05	15	221.75	89.66	9.64	1.93	11.57	1.93	0.00	336.48
V93	15	85.22	134.06	16.63	0.00	1.04	0.00	3.12	240.07
V96	15	97.39	54.20	12.70	0.00	16.09	0.85	0.00	182.07
V99	15	220.99	42.83	9.42	0.86	62.53	0.00	4.28	341.76
W56	15	209.93	107.92	23.61	1.69	60.70	0.00	0.00	403.84
X49	15	92.93	71.34	15.02	0.00	10.33	0.00	10.33	201.83
Average		**101.26**	**71.62**	**15.03**	**2.68**	**19.41**	**0.45**	**1.76**	**212.56**
Stdev		*±70.66*	*±32.49*	*±8.25*	*±10.55*	*±18.81*	*±0.66*	*±2.37*	*±94.56*

APPENDIX 2

All Ireland Daubenton's Waterways Survey

Table A2.1: Total number of waterway sites surveyed (2006-2024) and returned by February 2025.
NB – figures may be different from previous years reporting as any results returned late are added and reported thereafter.

Province and country

Year	Republic of Ireland	Northern Ireland		Ulster	Connaught	Munster	Leinster		TOTAL
2006	120	14		19	27	35	53		**134**
2007	182	20		26	31	42	103		**202**
2008	150	31		37	29	38	77		**181**
2009	174	36		45	30	46	89		**210**
2010	177	36		48	29	40	96		**213**
2011	186	44		52	33	48	97		**230**
2012	182	36		47	31	46	94		**218**
2013	194	34		47	25	46	110		**228**
2014	218	36		60	36	45	113		**254**
2015	216	37		52	40	57	104		**253**
2016	213	32		50	36	56	103		**245**
2017	199	34		45	30	58	100		**233**
2018	207	36		56	33	54	100		**243**
2019	202	36		54	37	50	97		**238**
2020	199	33		56	31	52	93		**232**
2021	196	31		53	32	48	94		**227**
2022	216	27		42	33	59	109		**243**
2023	216	31		43	43	53	108		**247**
2024	219	31		43	40	59	108		**250**

Note: Tables A2.1 detail the total number of waterway sites returned to BCIreland by February 2024. This is greater than the number of waterway sites reported in statistical tables below as statistical analysis was completed on surveys returned by February 2024. In addition, total numbers of waterways sites reported in previous reports will also differ as survey sheets returned late are added to the dataset for the next year of reporting. Only surveys completed within the Day 205-250 are also only included in the statistical analysis.

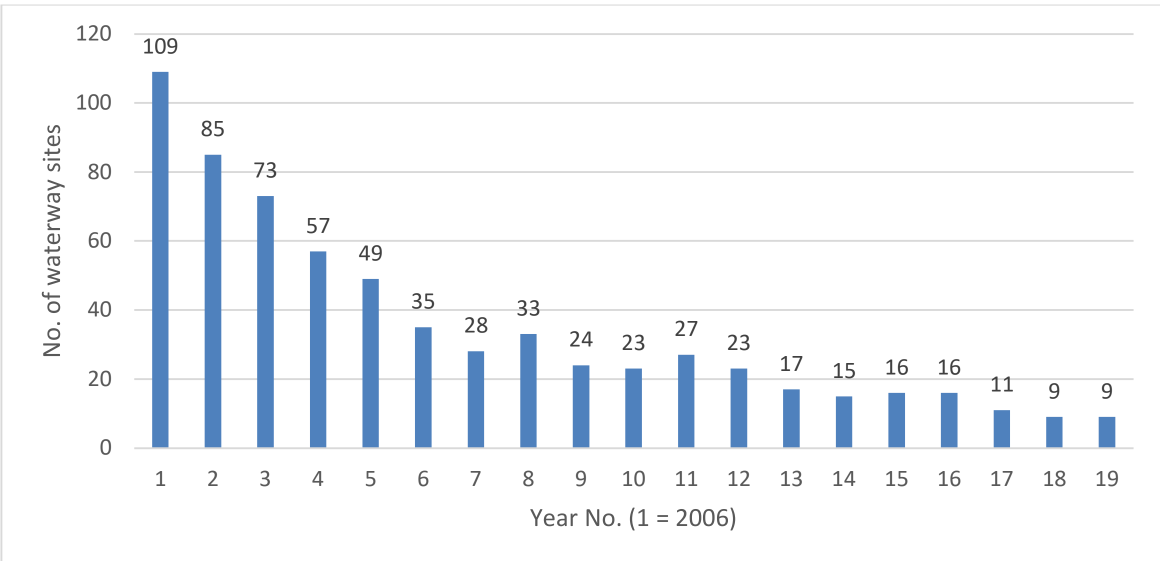

Figure A2.1: Number of years each waterway sites across the island were surveyed during 2006-2024 as part of the All-Ireland Daubenton's Bat Monitoring Scheme.

Table A2.2: Bat detector models used by survey teams in different years (2006-2024).
The table shows numbers of sites, and percentages, excluding those outside the usual date range.

a) Numbers of sites

year	2006	2009	2012	2015	2018	2019	2020	2021	2022	2023	2024
detector											
Magenta Mk II	5	1	4	3	3	3	4	4	4	4	4
Magenta Mk III	31	26	10	7	5	5	5	7	6	2	1
Bat Box III	47	48	36	35	20	20	23	19	14	8	6
Pettersson D100	10	23	15	18	14	12	16	10	12	16	7
Pettersson D200	10	9	15	34	42	34	15	13	17	13	9
Bat Box Duet	6	24	21	9	17	10	11	11	11	11	12
Petersson D230	3	1	2	2	1	1	1	1	2	2	2
Petersson D240x	5	6	5	1	3	1	2	2	2	3	3
Sky SBR 2100	2	0	0	0	0	0	0	0	0	0	0
Mini-3	4	8	6	0	0	1	1	1	1	0	0
Magenta Bat 4	0	26	59	93	77	87	86	87	104	111	131
Not noted	11	10	1	5	3	3	3	8	5	2	5
U30 Bat detector	0	0	0	0	0	0	0	0	0	0	0
Bat Box IIId	0	10	17	12	21	18	12	14	10	14	13
Magenta Bat 5	0	13	18	17	22	27	22	25	33	41	38
Ciel Electronics	0	3	9	17	8	7	12	7	12	3	2
Anabat	0	1	0	0	7	9	18	18	9	3	1
Echo Meter Touch	0	0	0	0	0	0	0	0	0	2	3
Echo Meter Touch 2	0	0	0	0	0	0	0	0	0	7	7
Elekon Batscanner	0	0	0	0	0	0	0	0	0	3	4
SSF BAT2	0	0	0	0	0	0	0	0	0	2	1
SSF BAT3	0	0	0	0	0	0	0	0	0	0	1

b) Percentage of sites

year	2006	2009	2012	2015	2018	2019	2020	2021	2022	2023	2024
detector											
Magenta Mk II	3.7	0.5	1.8	1.2	1.2	1.3	1.7	1.8	1.7	1.6	1.6
Magenta Mk III	23.1	12.4	4.6	2.8	2.1	2.1	2.2	3.1	2.5	0.8	0.4
Bat Box III	35.1	23.0	16.5	13.8	8.2	8.4	10.0	8.4	5.8	3.2	2.4
Pettersson D100	7.5	11.0	6.9	7.1	5.8	5.0	6.9	4.4	5.0	6.5	2.8
Pettersson D200	7.5	4.3	6.9	13.4	17.3	14.3	6.5	5.7	7.0	5.3	3.6
Bat Box Duet	4.5	11.5	9.6	3.6	7.0	4.2	4.8	4.8	4.5	4.5	4.8
Petersson D230	2.2	0.5	0.9	0.8	0.4	0.4	0.4	0.4	0.8	0.8	0.8
Petersson D240x	3.7	2.9	2.3	0.4	1.2	0.4	0.9	0.9	0.8	1.2	1.2
Sky SBR 2100	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mini-3	3.0	3.8	2.8	0.0	0.0	0.4	0.4	0.4	0.4	0.0	0.0
Magenta Bat 4	0.0	12.4	27.1	36.8	31.7	36.6	37.2	38.3	43.0	44.9	52.4
Not noted	8.2	4.8	0.5	2.0	1.2	1.3	1.3	3.5	2.1	0.8	2.0
U30 Bat detector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bat Box IIId	0.0	4.8	7.8	4.7	8.6	7.6	5.2	6.2	4.1	5.7	5.2
Magenta Bat 5	0.0	6.2	8.3	6.7	9.1	11.3	9.5	11.0	13.6	16.6	15.2
Ciel Electronics	0.0	1.4	4.1	6.7	3.3	2.9	5.2	3.1	5.0	1.2	0.8
Anabat	0.0	0.5	0.0	0.0	2.9	3.8	7.8	7.9	3.7	1.2	0.4
Echo Meter Touch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.2
Echo Meter Touch 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	2.8
Elekon Batscanner	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.6
SSF BAT2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4
SSF BAT3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4

Table A2.3: Basic descriptive statistics shown by year, province and for All-Ireland. The final column refers to surveys with either sure or unsure Daubenton's passes. All values are per completed survey of 10 spot counts. Excludes surveys outside days 205-250.

a) Connaught

Year	n complete surveys	mean sure	mean unsure	all	All (max 48 per spot)	% surveys with bats	% spots with bats
2006	51	66.1	21.6	87.7	77.1	92.2	55.7
2007	59	55.7	10.5	66.2	62.2	96.6	56.4
2008	47	45.3	6.4	51.7	46.9	95.7	53.6
2009	52	72.9	8.6	81.5	74.2	86.5	62.1
2010	55	68.9	5.8	74.7	71.7	92.7	63.8
2011	59	58.8	5.4	64.3	61.6	89.8	60.5
2012	58	53.3	6.4	59.7	57.4	93.1	59.5
2013	44	61.8	2.5	64.3	58.2	79.1	50.9
2014	71	48.7	9.6	58.3	54.5	88.7	58.6
2015	75	42.5	8.2	50.7	47.0	85.3	54.9
2016	66	58.5	9.5	68.0	63.0	93.9	61.7
2017	52	53.0	7.2	60.1	53.6	88.5	54.8
2018	57	73.6	5.9	79.6	70.4	79.6	56.5
2019	66	36.4	4.2	40.6	38.4	84.8	46.2
2020	56	43.8	5.0	48.7	45.2	89.3	53.2
2021	60	39.0	5.1	44.0	41.6	90.0	51.5
2022	59	37.9	3.8	41.8	37.6	84.7	48.1
2023	75	32.7	8.4	41.1	39.1	91.8	56.1
2024	75	30.8	7.4	38.2	37.2	97.9	57.9
All years	1137	50.8	7.5	58.3	54.0	89.5	55.9

b) Leinster

Year	n complete surveys	mean sure	mean unsure	all	All (max 48 per spot)	% surveys with bats	% spots with bats
2006	102	43.9	27.2	71.2	51.1	94.1	61.1
2007	194	37.5	6.7	44.2	43.4	89.7	55.5
2008	135	33.4	5.6	39.0	38.0	85.9	52.9
2009	165	38.1	7.9	46.0	45.0	90.1	54.9
2010	178	49.4	10.0	59.3	55.7	95.5	63.5
2011	169	44.7	9.2	54.0	53.0	94.1	62.3
2012	176	35.6	9.4	45.1	44.2	90.3	56.4
2013	203	37.6	7.9	45.5	44.0	89.6	52.8
2014	213	38.3	8.3	46.6	42.4	89.2	52.8
2015	190	42.4	8.0	50.4	47.3	92.6	54.3
2016	186	39.2	8.0	47.3	41.6	86.6	52.5
2017	183	40.6	8.2	48.8	44.3	91.8	53.2
2018	173	36.2	5.9	42.1	38.6	88.8	47.7
2019	175	40.4	7.3	47.7	44.6	86.3	50.7
2020	162	35.9	6.7	42.6	40.8	92.6	52.2
2021	171	41.6	9.6	51.2	49.5	90.0	51.9
2022	194	46.7	11.9	58.6	53.2	90.1	57.5
2023	193	42.1	10.1	52.2	46.2	93.0	56.0
2024	201	50.2	12.2	62.3	59.5	89.0	65.3
All years	3363	40.7	9.1	49.8	46.3	90.4	55.3

c) Munster

Year	n complete surveys	mean sure	mean unsure	all	All (max 48 per spot)	% surveys with bats	% spots with bats
2006	64	47.0	13.8	60.8	58.0	95.2	61.6
2007	80	48.4	7.3	55.7	52.1	90.0	50.7
2008	68	39.3	7.6	46.8	42.9	91.2	49.7
2009	78	42.3	6.5	48.8	43.8	89.2	45.8
2010	76	48.1	12.3	60.4	58.7	94.7	59.6
2011	85	57.6	17.4	75.0	68.4	97.6	63.4
2012	84	48.7	12.2	60.8	59.3	98.8	62.1
2013	86	50.4	12.0	62.4	60.2	95.3	62.8
2014	80	50.8	8.2	59.0	53.4	89.9	58.8
2015	105	47.2	10.4	57.6	54.9	94.3	60.9
2016	103	52.9	8.3	61.2	57.6	89.3	58.8
2017	109	55.2	10.1	65.3	59.3	90.8	62.1
2018	100	55.9	9.7	65.6	62.5	89.1	63.1
2019	92	39.5	8.3	47.8	47.3	96.7	57.2
2020	101	45.8	8.0	53.8	52.6	92.0	53.3
2021	91	43.4	6.0	49.4	48.4	92.3	55.8
2022	106	55.0	6.6	61.6	56.6	93.3	55.3
2023	100	46.0	8.9	54.9	53.2	93.6	57.0
2024	112	59.6	11.9	71.5	67.7	94.0	68.9
All years	1720	49.3	9.7	58.9	55.7	93.0	58.5

d) Ulster

Year	n complete surveys	mean sure	mean unsure	all	All (max 48 per spot)	% surveys with bats	% spots with bats
2006	35	32.1	16.9	49.0	48.4	88.6	53.7
2007	49	29.9	8.7	38.6	37.7	95.9	56.9
2008	61	39.8	9.9	49.7	48.7	96.7	56.9
2009	80	46.0	9.6	55.6	53.1	95.0	60.2
2010	93	48.8	7.5	56.3	53.0	90.3	58.2
2011	96	54.1	9.5	63.6	59.5	92.7	62.7
2012	81	50.7	9.4	60.1	57.0	93.8	60.7
2013	83	32.2	8.2	40.5	38.9	89.2	53.3
2014	110	30.8	6.6	37.4	34.4	91.8	45.0
2015	97	47.4	6.3	53.6	51.8	88.7	58.0
2016	87	42.0	5.9	47.9	46.7	92.0	56.3
2017	72	47.9	8.9	56.8	52.2	95.7	61.6
2018	96	37.5	7.0	44.5	43.2	90.3	56.0
2019	93	30.7	6.8	37.5	36.7	90.3	52.9
2020	96	33.3	3.8	37.1	36.6	92.7	51.5
2021	96	27.6	4.7	32.3	32.2	89.6	49.9
2022	80	27.9	4.0	31.9	31.0	87.5	49.0
2023	78	28.8	4.6	33.4	32.9	97.1	55.3
2024	78	40.7	6.9	47.6	43.2	83.9	57.9
All years	1561	38.6	7.2	45.8	43.9	91.7	55.3

e) All Ireland

Year	n complete surveys	mean sure	mean unsure	all	All (max 48 per spot)	% surveys with bats	% spots with bats
2006	252	47.6	21.3	68.8	57.8	93.2	59.1
2007	382	41.6	7.7	49.3	47.4	91.6	54.8
2008	311	37.7	7.0	44.7	42.5	90.7	53.1
2009	375	45.8	8.1	53.9	50.8	90.5	55.2
2010	402	51.7	9.3	60.9	57.8	93.8	61.6
2011	409	51.6	10.4	62.1	59.0	93.9	62.4
2012	399	44.0	9.6	53.6	51.9	93.2	58.9
2013	416	41.7	8.2	50.0	47.8	89.6	54.7
2014	474	40.2	8.1	48.3	44.2	89.9	52.9
2015	467	44.5	8.2	52.7	49.9	91.0	56.7
2016	442	45.8	7.9	53.7	49.5	89.4	56.1
2017	416	47.2	8.7	55.9	50.8	91.8	57.2
2018	426	45.9	7.0	52.9	49.2	88.0	54.3
2019	426	37.4	6.9	44.4	42.5	89.2	51.9
2020	415	38.8	6.1	44.9	43.3	92.0	52.4
2021	418	38.4	7.0	45.4	44.1	90.4	52.2
2022	439	44.1	8.1	52.2	47.8	89.7	54.2
2023	446	39.2	8.7	47.8	44.4	93.6	56.1
2024	466	48.1	10.8	58.9	56.0	91.1	63.9
All years	7781	43.6	8.6	52.2	49.0	91.1	56.1

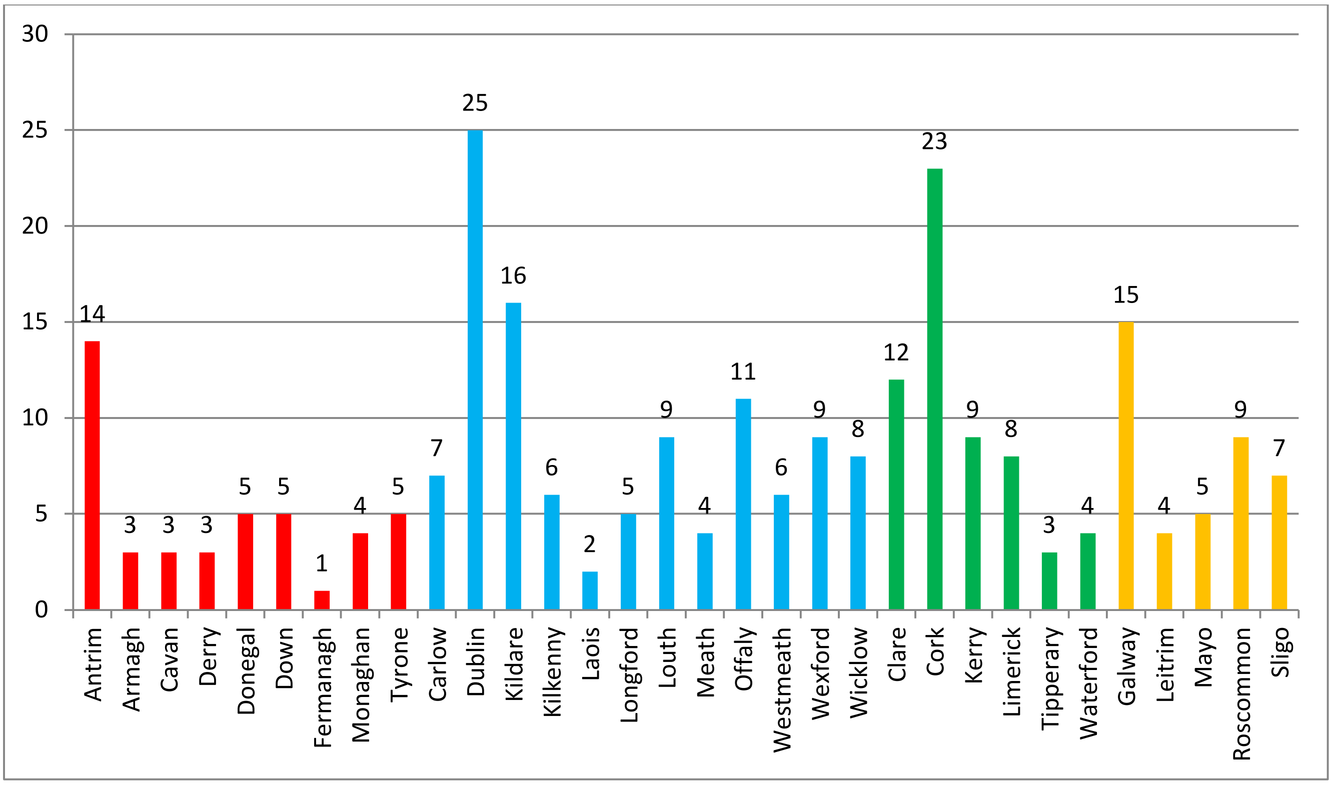

Figure A2.2: Number of waterway sites surveyed in each county in 2024.

Table A2.4: Single Surveys listed per county (in descending order) along with percentage: 2006-2024 Dataset

County	Total No. of Waterway Sites	Single Year Survey	%
Antrim	30	3	10.0
Armagh	9	1	11.1
Carlow	19	6	31.6
Cavan	12	1	8.3
Clare	19	4	21.1
Cork	51	6	11.8
Derry	17	2	11.8
Donegal	16	0	0.0
Down	13	2	15.4
Dublin	32	1	3.1
Fermanagh	10	0	0.0
Galway	29	7	24.1
Kerry	21	0	0.0
Kildare	36	3	8.3
Kilkenny	17	2	11.8
Laois	11	1	9.1
Leitrim	12	2	16.7
Limerick	26	7	26.9
Longford	13	2	15.4
Louth	11	1	9.1
Mayo	25	8	32.0
Meath	27	1	3.7
Monaghan	10	4	40.0
Offaly	22	5	22.7
Roscommon	18	4	22.2
Sligo	16	2	12.5
Tipperary	16	2	12.5
Tyrone	25	9	36.0
Waterford	16	1	6.3
Westmeath	28	9	32.1
Wexford	15	2	13.3
Wicklow	23	1	4.3

Table A2.5: Numbers of years of data from each waterway site (excludes surveys outside the usual date range).

Number of years	Sites surveyed in 2024			All sites ever surveyed		
	N sites	% of total	Cumulative %	N sites	% of total	Cumulative %
1	0	0.0	0.0	84	13.0	13.0
2	16	6.4	6.4	73	11.3	24.4
3	17	6.8	13.2	73	11.3	35.7
4	25	10.0	23.2	60	9.3	45.0
5	19	7.6	30.8	51	7.9	53.0
6	13	5.2	36.0	36	5.6	58.5
7	18	7.2	43.2	39	6.1	64.6
8	12	4.8	48.0	28	4.3	68.9
9	13	5.2	53.2	26	4.0	73.0
10	11	4.4	57.6	23	3.6	76.6
11	13	5.2	62.8	24	3.7	80.3
12	16	6.4	69.2	25	3.9	84.2
13	12	4.8	74.0	15	2.3	86.5
14	15	6.0	80.0	21	3.3	89.8
15	13	5.2	85.2	18	2.8	92.5
16	8	3.2	88.4	15	2.3	94.9
17	10	4.0	92.4	14	2.2	97.0
18	10	4.0	96.4	10	1.6	98.6
19	9	3.6	100.0	9	1.4	100.0

Table A2.6: Matrix of waterway sites surveyed in all possible pairs of years (e.g. 250 sites were surveyed in 2024 and 137 of these were also surveyed in 2020). Numbers on the diagonal (italics) are total sites surveyed in each year.

	2006	2009	2012	2015	2018	2019	2020	2021	2022	2023	2024
2006	*132*										
2009	79	*209*									
2012	66	118	*218*								
2015	65	114	140	*253*							
2018	50	96	116	153	*243*						
2019	54	93	112	138	180	*238*					
2020	49	84	111	140	163	172	*232*				
2021	48	86	106	135	157	154	176	*227*			
2022	60	95	109	139	146	151	152	163	*242*		
2023	57	93	109	133	144	146	142	152	166	*247*	
2024	51	85	113	130	136	142	137	138	153	171	*250*

Table A2.7: Poisson GAM results with 95% confidence limits for Daubenton's bats (2006-2024). Covariates include survey start time, surveyor skills and degree of smooth water as recorded by survey teams.

				Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	**Sites**	**Surveys**	**Mean**	**Index**	**s.e.**	**Lower**	**Upper**	**Fitted**	**s.e.**	**Lower**	**Upper**
2006	107	199	56.87	99.02	2.71	93.97	104.31	107.48	11.21	86.59	129.60
2007	167	304	51.08	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	162	276	42.57	102.05	2.25	97.80	106.56	87.73	5.92	76.94	100.29
2009	185	325	52.03	105.34	3.91	98.03	113.46	112.44	7.76	96.89	128.54
2010	201	369	58.88	107.75	5.03	98.58	118.16	117.97	8.75	102.35	137.04
2011	219	389	58.50	107.77	5.69	97.07	119.56	113.85	8.17	99.23	131.26
2012	215	394	52.18	106.34	6.13	94.58	119.10	104.98	7.84	91.29	122.07
2013	221	404	48.80	105.62	6.51	93.11	118.87	103.57	7.91	88.93	119.25
2014	240	446	45.46	106.84	6.92	93.21	120.92	101.28	8.69	85.76	118.52
2015	241	444	51.13	109.61	7.31	95.40	124.50	119.09	9.86	101.22	139.18
2016	242	438	49.85	111.78	7.64	97.01	127.45	113.52	9.49	96.02	133.08
2017	225	400	51.25	112.33	7.91	97.89	128.99	118.73	11.26	99.33	142.43
2018	231	402	50.57	110.84	7.89	96.76	127.41	117.41	10.74	98.63	140.06
2019	230	410	42.78	108.10	7.66	94.62	124.25	104.40	9.19	87.92	123.67
2020	226	402	43.74	105.72	7.51	92.28	120.69	107.36	9.78	89.83	127.95
2021	219	402	44.72	104.16	7.40	90.31	119.05	107.68	10.02	90.01	128.78
2022	237	428	48.81	103.54	7.30	89.93	118.06	106.89	8.82	89.63	124.80
2023	237	427	44.70	104.28	7.43	90.55	119.55	97.55	9.05	81.05	117.52
2024	184	331	54.11	106.73	8.11	92.04	123.32	116.64	9.44	98.69	136.07

Total Sites: 558
Base Year: 2007 (Index = 100)
Total change since base year = 6.73%
Mean increase/decrease: 0.38%

Table A2.9a: Poisson GAM results with 95% confidence limits for Daubenton's bats (2006-2024) in Northern Ireland.

				Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	**Sites**	**Surveys**	**Mean**	**Index**	**s.e.**	**Lower**	**Upper**	**Fitted**	**s.e.**	**Lower**	**Upper**
2006	13	26	47.85	94.57	6.02	83.91	106.22	108.05	19.76	71.69	141.46
2007	19	35	38.86	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	30	51	44.06	107.48	5.58	98.21	119.01	101.25	14.69	74.49	133.35
2009	35	62	46.02	118.39	10.06	102.21	140.23	114.09	17.59	85.74	153.27
2010	36	70	46.29	131.81	13.27	108.90	163.54	137.54	23.37	100.37	191.13
2011	42	80	55.86	143.40	15.56	115.54	181.64	157.80	20.75	125.29	202.67
2012	35	63	62.00	148.22	17.47	118.23	190.78	176.73	29.28	128.99	246.23
2013	31	59	40.93	147.24	18.42	114.26	191.63	128.65	18.48	95.91	168.70
2014	34	65	37.26	149.20	19.90	111.93	194.75	119.98	20.86	83.35	166.63
2015	35	69	55.64	157.96	22.65	116.42	205.54	174.79	32.60	120.40	246.60
2016	32	61	48.48	169.30	25.99	121.12	227.26	168.27	26.32	121.93	218.28
2017	34	56	56.55	179.55	29.49	127.78	250.43	190.64	35.33	134.38	275.73
2018	32	60	50.65	183.96	31.41	131.76	260.84	212.33	40.77	146.95	297.58
2019	34	61	42.43	180.21	30.92	130.62	250.65	179.42	37.80	123.96	267.35
2020	34	57	36.89	172.31	29.60	123.55	240.42	158.71	27.01	111.35	218.72
2021	32	58	33.88	163.32	28.50	115.43	229.83	179.13	38.48	115.40	272.14
2022	28	55	30.98	152.75	26.14	109.43	215.56	153.25	35.33	100.01	241.14
2023	31	56	35.05	140.97	22.70	103.95	195.62	155.02	25.97	118.57	216.91
2024	21	39	37.18	128.58	19.97	97.53	176.82	122.85	22.34	88.42	170.13

Total Sites: 87
Base Year: 2007 (Index = 100)
Total change since base year = 28.58%
Mean increase/decrease: 1.49%

Table A2.9b: Poisson GAM results with 95% confidence limits for Daubenton's bats (2006-2024) in Republic of Ireland.

				Smoothed		95% conf limits		Unsmoothed		95% conf limits	
Year	**Sites**	**Surveys**	**Mean**	**Index**	**s.e.**	**Lower**	**Upper**	**Fitted**	**s.e.**	**Lower**	**Upper**
2006	111	210	57.68	100.07	2.86	94.30	105.22	113.36	10.92	92.12	134.84
2007	173	331	49.43	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00
2008	146	255	42.00	101.44	2.32	97.56	106.44	89.91	5.84	79.44	101.57
2009	165	297	52.36	104.38	4.01	97.92	113.07	115.88	8.10	103.02	135.54
2010	175	332	60.28	106.37	5.05	98.11	117.65	120.09	9.05	104.40	138.89
2011	177	309	59.18	105.89	5.56	96.51	117.67	116.11	8.90	100.72	134.77
2012	181	333	50.42	103.98	5.81	94.04	117.01	102.50	7.45	90.07	118.27
2013	192	349	50.05	102.89	6.08	92.26	117.55	104.75	7.52	92.39	121.56
2014	209	387	46.45	103.47	6.48	91.90	118.38	102.78	8.27	87.37	121.81
2015	211	385	49.43	105.23	6.91	92.70	121.25	115.83	9.49	100.47	135.72
2016	211	379	49.85	106.46	7.36	92.81	122.24	112.45	9.03	96.66	131.78
2017	194	350	50.30	106.30	7.78	92.03	122.78	115.68	11.50	96.01	140.05
2018	202	348	50.20	104.59	7.90	90.55	121.14	113.00	10.80	94.86	135.37
2019	199	355	42.63	102.29	7.79	88.54	118.33	101.01	9.88	84.35	122.26
2020	196	353	44.53	100.86	7.69	86.98	117.07	106.15	10.16	88.91	129.08
2021	195	359	45.77	100.63	7.61	86.27	115.71	106.58	10.41	88.97	128.49
2022	214	383	50.53	101.80	7.53	87.16	116.56	107.77	9.38	89.89	125.43
2023	208	375	47.08	104.87	7.73	90.26	119.95	100.12	9.94	82.92	121.47
2024	177	317	58.13	110.16	8.60	93.73	129.66	124.15	10.59	104.39	145.77

Total Sites: 471
Base Year: 2007 (Index = 100)
Total change since base year = 10.16%
Mean increase/decrease: 0.57%

APPENDIX 3

Brown Long-eared Bat Roost Monitoring Scheme

Preliminary Roost Assessment

Brown long-eared roosts selected and surveyed in this monitoring scheme were collated from a number of sources:

- BCIreland database
- BCIreland committee members
- NPWS regional staff
- General survey of buildings deemed suitable for this bat species

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 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 1st May to June 15th, Survey 2 June 16th to July 31st, Survey 3 August 1st to 31st 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.

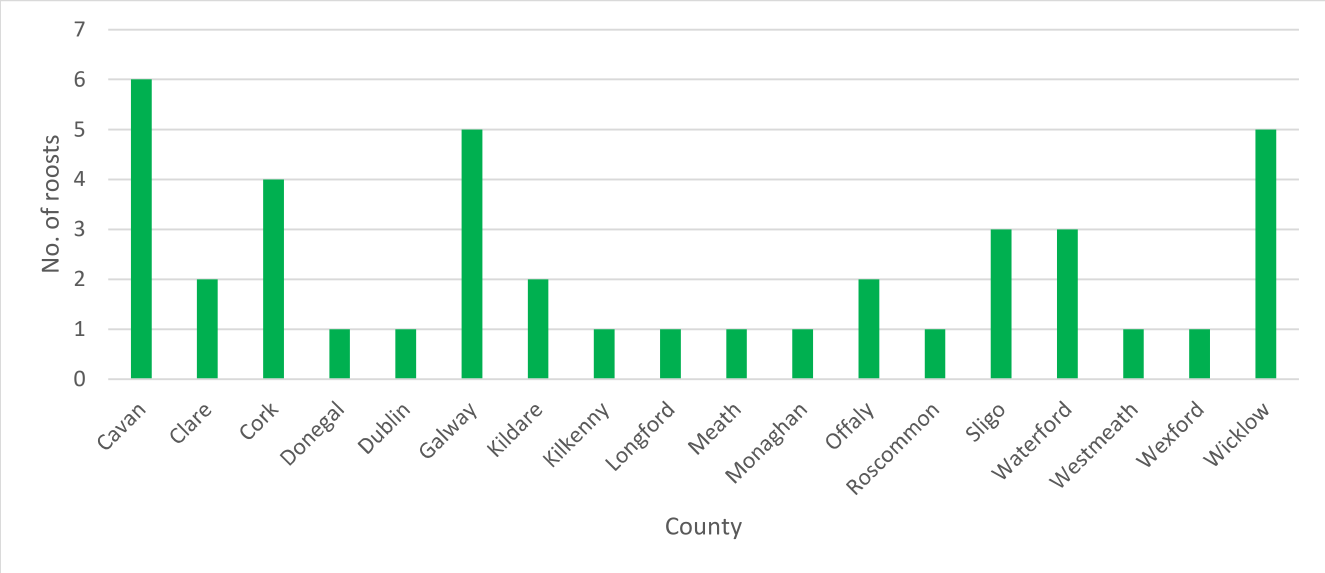

Figure A3.1: Distribution of brown long-eared bat roosts monitored in 2024 by county.

Table A3.2: Types of roost in different survey years. Numbers of roosts monitored as part of the Brown Long-eared Roost Monitoring Scheme 2007-2024.

a) numbers of roosts

year	2007	2010	2013	2016	2017	2018	2019	2020	2021	2022	2023	2024	All
type													
Agric shed	0	0	0	0	0	0	0	0	0	0	1	1	1
Barn	0	2	4	2	1	1	1	1	1	1	1	1	4
Church	5	18	24	26	26	25	24	26	24	25	26	23	29
House	3	7	7	8	8	7	6	7	7	7	7	5	11
Large bld etc	6	12	12	8	9	9	9	8	9	10	9	8	18
Other	2	2	2	3	3	3	3	3	3	3	3	3	3
All types	16	41	49	47	47	45	43	45	44	46	47	41	66

b) percentage of all roosts in each year

year	2007	2010	2013	2016	2017	2018	2019	2020	2021	2022	2023	2024	All
type													
Agric shed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.4	1.5
Barn	0.0	4.9	8.2	4.3	2.1	2.2	2.3	2.2	2.3	2.2	2.1	2.4	6.1
Church	31.2	43.9	49.0	55.3	55.3	55.6	55.8	57.8	54.5	54.3	55.3	56.1	43.9
House	18.8	17.1	14.3	17.0	17.0	15.6	14.0	15.6	15.9	15.2	14.9	12.2	16.7
Large bld etc	37.5	29.3	24.5	17.0	19.1	20.0	20.9	17.8	20.5	21.7	19.1	19.5	27.3
Other	12.5	4.9	4.1	6.4	6.4	6.7	7.0	6.7	6.8	6.5	6.4	7.3	4.5
All types	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: site 2140 previously categorised as a barn is now listed as an agricultural shed.

Table A3.3: Numbers of years of data from each roost. Brown Long-eared Roost Monitoring Scheme 2007-2024.

Number of years	Number of sites	% of total	Cumulative %
1	0	0.0	0.0
2	6	9.1	9.1
3	1	1.5	10.6
4	5	7.6	18.2
5	3	4.5	22.7
6	1	1.5	24.2
7	3	4.5	28.8
8	2	3.0	31.8
9	1	1.5	33.3
10	2	3.0	36.4
11	2	3.0	39.4
12	8	12.1	51.5
13	4	6.1	57.6
14	2	3.0	60.6
15	4	6.1	66.7
16	9	13.6	80.3
17	9	13.6	93.9
18	4	6.1	100.0

Table A3.4: Numbers of roosts monitored in each year (diagonal in italics) and common to each pair of years (off diagonal). For example 47 sites were monitored in 2023 and 42 of these were also recorded in 2021. Brown Long-eared Roost Monitoring Scheme 2007-2024.

2007	*16*											
2010	13	*41*										
2013	11	36	*49*									
2016	10	30	42	*47*								
2017	10	30	41	46	*47*							
2018	10	28	38	43	44	*45*						
2019	9	26	36	41	42	42	*43*					
2020	9	28	38	43	44	42	42	*45*				
2021	9	26	36	41	42	40	40	42	*44*			
2022	10	28	38	43	44	42	42	44	44	*46*		
2023	8	27	38	42	43	41	40	43	42	44	*47*	
2024	7	23	32	37	38	38	38	38	37	39	40	*41*
	2007	2010	2013	2016	2017	2018	2019	2020	2021	2022	2023	2024

Tables A3.3 and A3.4 are useful because they indicate the consistency with which roosts are monitored, which is important in producing accurate trend estimates. Table 2 shows that around two thirds of the roosts in the dataset have been monitored for at least 10 years, whilst Table 3 shows that there is an excellent level of consistency in the roosts surveyed over the last ten years.

Table A3.5: Total numbers of roosts, roost surveys and types of surveys completed in each year. Brown Long-eared Roost Monitoring Scheme 2007-2024.

Year	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total No. Roosts	16	31	36	41	35	41	49	48
Total No. Surveys	25	51	73	87	36	91	111	112
Internal Count	12	26	24	25	7	24	25	27
Emergence Count	13	25	49	62	29	67	86	85
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Total No. Roosts	47	47	47	45	43	45	44	46
Total No. Surveys	108	115	111	110	110	114	117	131
Internal Count	18	20	18	17	15	9	26	32
Emergence Count	90	95	93	93	95	105	91	99

Year	**2023**	**2024**
Total No. Roosts	47	41
Total No. Surveys	130	110
Internal Count	27	9
Emergence Count	103	101

Figure 5.5: First, mean and last emergence times plotted against counts as a proportion of the site mean count. (Note: Last emergence times are only known to the nearest ten minute block). Lines are linear regression lines.

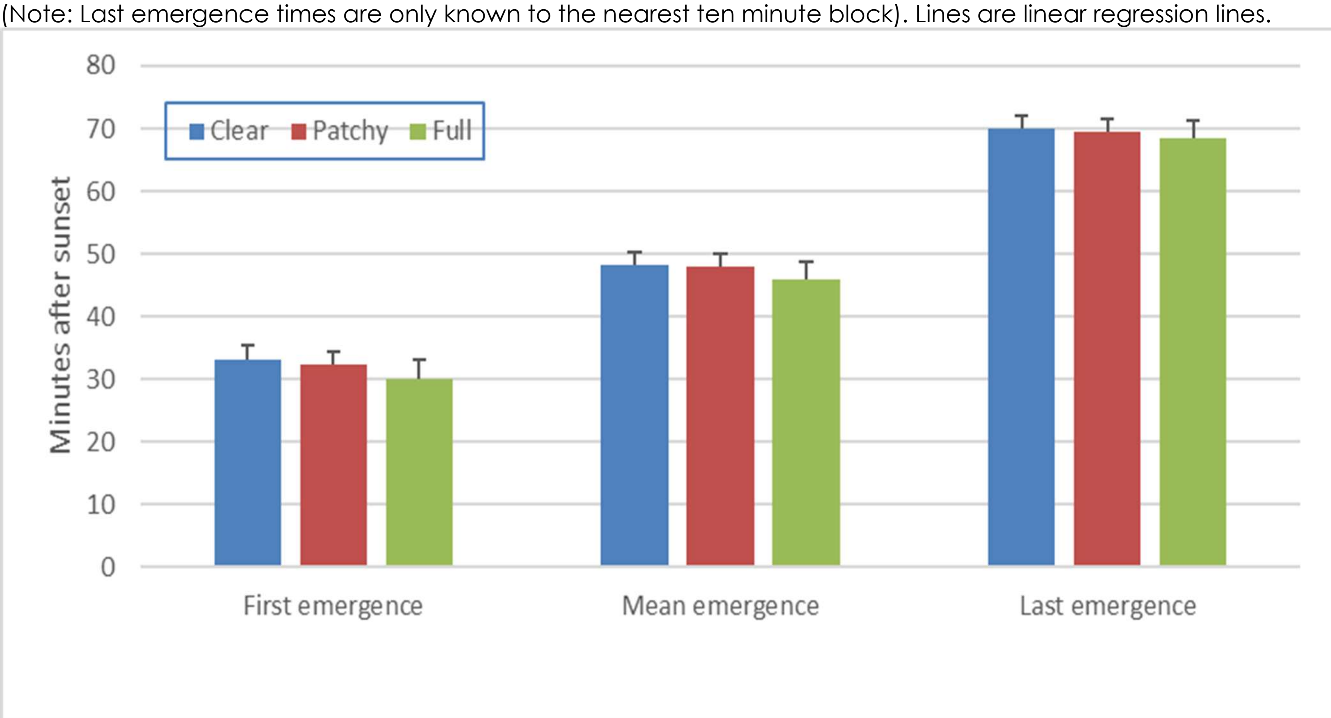

Figure 5.6: Emergence times in different cloud conditions. Bars show estimates from REML models with 95% confidence limits.

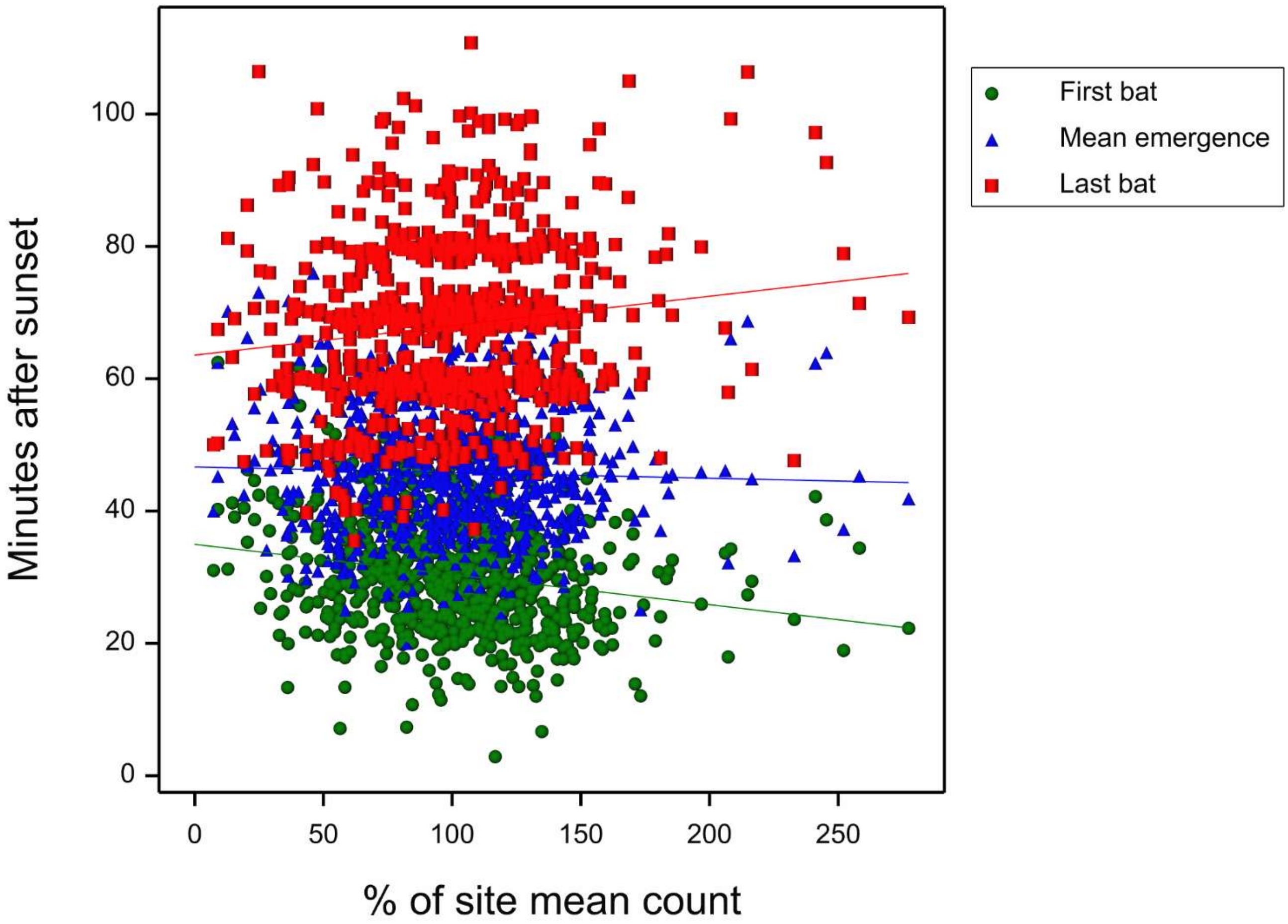

Figure 5.7: Mean emergence times relative to sunset for each year. These are predicted means from the REML model, adjusted for the effect of other factors in the model. Bars are plus or minus one standard error.