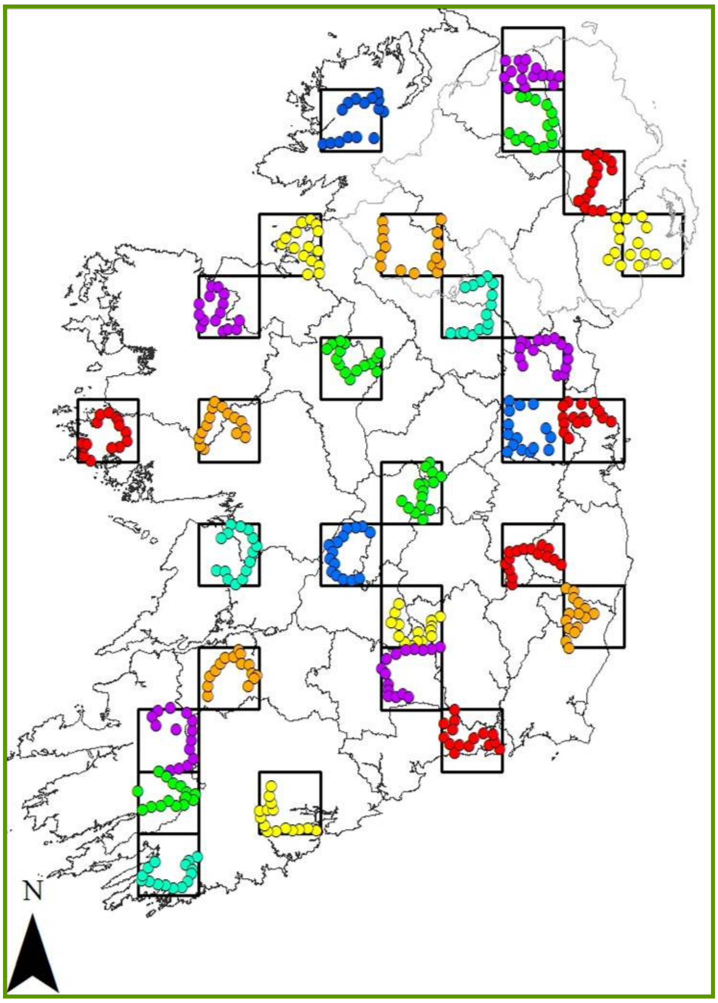
# Car-based Bat Monitoring in Ireland 2003-2011

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# Car-based Bat Monitoring in Ireland 2003-2011

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Cover image: Map of survey routes; see Page 16.

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## Contents

# Executive Summary

The first systematic car-based bat monitoring system in Europe was devised for the Republic of Ireland (ROI) in 2003 by the Bat Conservation Trust (BCT, UK). The scheme has been administered by Bat Conservation Ireland (BCIreland) since 2004 with funding from the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht and the Northern Ireland Environment Agency (NIEA). The main aim of the scheme is to monitor roadside populations of common pipistrelle, soprano pipistrelle and Leisler's bat and to collect sufficient data to identify trends in bat populations.

The method involves driving a known survey route at 24kmph with a time expansion bat detector clamped to the open window of the passenger door. Each survey route consists of 15, 1.6km transects, separated by a 3.2km gap to minimise the possibility of repeat encounters with the same bats. Sounds are usually recorded to minidisc, but a trial using smart phones (Android, HTC) for recording was carried out in 2011. Recordings are analysed by BCIreland using Bat Sound™ software. In the initial pilot study in 2003, routes were mapped and surveyed within seven, randomly selected, 30km squares. The coverage across the country increased yearly until 2007, when routes had been mapped in 28, 30km blocks. Surveys are carried out in July and August by trained volunteers who are mainly staff of NPWS and NIEA, and BCIreland members. Between 60 and 70 surveyors spend approximately 300hrs per annum carrying out the survey.

All 28 squares are usually surveyed every year, meaning that the data collected has high power to detect increases or declines in the target species. Since 2009, on average 1269km of monitoring transects have been driven each year. From 2003 to 2011, 10351km of monitoring transects have been surveyed. In total, 21172 bat passes have been recorded by this monitoring scheme.

The common pipistrelle is the most frequently encountered species. On average 1.55 common pipistrelle passes are recorded during each 1.6km monitoring transect. The soprano pipistrelle is usually the second most frequently encountered species each year. On average 0.67 soprano pipistrelle encounters are recorded from each 1.6km transect. The Leisler's bat is usually the third most frequently encountered bat species. On average, 0.636 Leisler's bat passes are recorded during each 1.6km transect. Other species such as *Myotis* spp., Nathusius' pipistrelle and brown long-eared bats are recorded by the survey in very low numbers.

Smart phones were found to produce recordings with similar results to recordings made with traditional minidisc recorders or other digital methods. Smart phones have an additional advantage in allowing georeferencing of bat locations, something that has not, heretofore, been possible.

GAM models fitted to the yearly (adjusted) encounter rate data for each species show that the roadside common pipistrelle population is stable. The soprano pipistrelle is showing an increasing trend that is just about significant. Leisler's bat is showing a significant increase. Nathusius' pipistrelle data are very limited but show a fairly stable trend, although there are very wide error bars for this species.

Comparison between the GAM and TRIM (TRends and Indices in Monitoring data) methods of estimating population trends were made using the 2003-2011 dataset. The two methods were found to produce very similar yearly estimates but standard errors are calculated differently so these varied

depending on the species. The smoothed population trend data derived from GAM modeling was found to facilitate easier interpretation, compared with TRIM, and we propose to continue using GAM models to interpret bat population trends from the car-based bat monitoring dataset.

An analysis of landscape suitability for bats in Ireland was carried out in 2011 by Lundy *et al*. and results from that study were applied to car-based bat monitoring data. We examined whether survey-square level activity of each species was correlated with the mean landscape suitability index (Lundy *et al*. 2011) for the survey route, and whether differences in trends could be seen in squares that were more or less suitable (than the median). Common and soprano pipistrelle activity levels were positively correlated with predicted landscape suitability (though not significantly), while Leisler's bat activity was not correlated with predicted landscape suitability. The Leisler's bat, on the other hand, showed a significant correlation with temperature, while the pipistrelles did not. These interactions are discussed in the context of climate change and global warming.

We also found a different relationship between Leisler's bats and street lighting, compared with the pipistrelles. The common and soprano pipistrelles were not significantly impacted by the presence of street lighting along survey routes, whilst Leisler's bat activity was positively correlated with the presence of yellow and white street lights.

Other vertebrates were recorded by surveyors during each survey night and in total 2053 living vertebrates other than bats have been recorded from the car-based surveys in July and August, from 2006 to 2011. The most common species is the domestic cat, which accounts for 54% of all living vertebrates observed. Cat abundance was analysed using TRIM and was found to have increased in the first year or two, followed by a decrease in recent years. The next most common species encountered are foxes and rabbits. By way of contrast the most commonly recorded dead vertebrates are rabbits, followed by cats and rats.

A summary for each monitored species is provided, along with an assessment of threats in the context of habitat use, climate change and other factors.

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# Introduction

## Why Monitor 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.

Ireland and the UK are also signatories to a number of conservation agreements pertaining to bats such as the Bern and Bonn Conventions. The Agreement on the Conservation of Populations of European Bats (EUROBATS) is an agreement under the Bonn Convention and Republic of Ireland and the UK are two of the 32 signatories. 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 recent EUROBATS publication outlines various methods for surveillance and monitoring of bats.

Whilde (1993), in the Irish Red Data Book of vertebrates, listed most Irish populations of bats (those species that were known to occur in Ireland at the time of publication) as Internationally Important. The Red Data List for Mammals in Ireland has been updated (Marnell *et al.*, 2009) and most of the bat species, including common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*P. pygmaeus*), Daubenton's bat (*Myotis daubentonii*) and brown long-eared bat (*Plecotus auritus*) are currently considered of Least Concern. All of these species are monitored using one of the BCIreland monitoring schemes. One of the species included in BCIreland's monitoring, the Leisler's bat (*Nyctalus leisleri*), is, however, considered Near Threatened. It has been assigned this threat status because Ireland is considered a world stronghold for the species (Mitchell-Jones *et al.*, 1999). The status of the European Leisler's bat population is Least Concern (Temple and Terry 2007). This species is still, however, infrequent in the rest of Europe compared with Ireland where it is quite common.

## Red and Amber Alerts

Monitoring and surveillance protocols need to be able to inform conservation bodies of the trends of the faunal group being investigated. Population trends are often used to identify species that require conservation measures (Dunn 2002) and confirming a population decline can be used as a rationale to adopt or implement conservation measures. The degree of population decline is also considered to be a valuable evaluation tool with which to identify wildlife populations in trouble (Dunn 2002). Under the Habitats Directive, Member States are required to identify species declining at >1% per year. Such a decline would put a species into the "Red" category. Such targets may be difficult to achieve, given the error bars produced by standard methods of surveillance.

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, i.e. assessment of how robust the data is at detecting increases or declines, for Car-Based Bat Monitoring see Roche *et al*., 2009 and for the Daubenton's Waterways Survey see Aughney *et al*., 2009).

## Bat 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 the 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 broadband 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 identification 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.*, 2009). 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 the Daubenton's bat prior to field work. Surveyors count the number 'bat passes' of this bat species for 4 minutes at each of the ten fixed points on linear waterways. The onset of this scheme was a very significant development in bat monitoring here since it represented the first large-scale recruitment of members of the Irish public to bat conservation-related work.

More recently, in 2007, a brown long-eared bat monitoring scheme was piloted and has since run for a 3-year monitoring period (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 the 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, see (Aughney *et al.*, 2011).

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. Regular monitoring under BCIreland management is, therefore, in process for five of the Annex IV bat species for the Republic of Ireland, and for four 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.

## Factors Impacting Bat Abundance

Many factors, including climate, foraging habitat quality, roost availability, disturbance at hibernacula, landscape connectivity, artificial lighting, predation and competition, among others, combine to regulate the local and national population of a given bat species. The car-based bat monitoring survey takes place within a restricted timeframe each year and although the data collected from it has been shown to be robust, it may only ever be possible to infer or surmise as to which factors are influencing an observed trend. The following elements are among those for which we have collected sufficient data to allow further analyses. In time, some of these may or may not, be shown to influence roadside bat activity.

### *Weather*

Several studies have shown that flight activity of bats generally increases with temperature (e.g. Catto et *al*. 1995; Negraeff and Brigham 1995). Rainfall has also been found to modify bat activity with some species notably reluctant to fly in heavy rain (Erkert 1982). There is some debate as to whether the positive relationship between bat activity and temperature may be attributed to an indirect effect, whereby increased temperature causes more insect prey to become available to bats, or whether the response is physiological on the part of bats themselves, with warmer conditions proving inherently more conducive to flight. In a detailed study of pipistrelle activity in woodlands by Roche (1998), no significant relationship was found between pipistrelle passes and temperature when the number of insects (caught simultaneously in suction traps) was held constant, suggesting for that study at least, the impact of temperature on bat activity was indirect. Also, in different woodlands studied by Roche (1998), pipistrelle activity was found to be most significantly correlated with a different weather variable including maximum temperature, windspeed and humidity. The author hypothesized that the most important weather variables affecting insect and pipistrelle bat activity may actually, therefore, depend on site composition and situation.

Questions surrounding the impact of weather conditions on bat populations become increasingly pertinent in a changing climate. The prospect of range changes and extinctions was addressed by Rebelo *et al.* (2009) who studied the potential impacts of climate change on European bats using four standard IPCC scenarios. Although the two pipistrelles monitored as part of the present car-based scheme were not included, the Leisler's bat was included in their assessment of 28 species. Bats were grouped according to their biogeographic range (Boreal, Temperate, Mediterranean) and Max Ent models were applied to occurrence data and four different climate change scenarios for the remainder of the century. The Leisler's bat was assigned to the Temperate biogeographic group for the purposes of the analysis (following Principal Components Analysis). While the authors predicted a major reduction in available habitat and possible extinction of at least one Boreal species within this century, they also predicted a general increase in occupied area for many Temperate species, at least until the middle of this century. After this, scenarios vary greatly but the Leisler's bat was one of the two Temperate species highlighted as likely to undergo range expansion under all but one of the possible climate change scenarios over the long term. The potential usefulness of the car-based bat monitoring trend data in informing bat species' interactions with climate change is discussed in this report.

### *Street lights*

Artificial light sources attract insects. Rydell (1992) examined the exploitation of insects around streetlamps by bats in Sweden and concluded that only the fast flying species that use long-range echolocation systems (in the case of his study: *Nyctalus noctula*, *Vespertilio murinus* and *Eptesicus nilssonii*) regularly foraged around streetlamps. By way of contrast, other species such as *Myotis* and *Plecotus auritus* appeared to avoid the streetlamps. Shiel *et al*. (1999) recorded Leisler's bat in Ireland feeding around street lights. However, street lighting, has also been shown to affect ecological interactions across a range of taxa and to impact negatively upon animal foraging, reproduction and communication behaviours (Longcore and Rich 2004; Rich and Longcore, 2006). Stone *et al*. (2009) confirmed disruption of commuting routes of the Annex II-listed lesser horseshoe bat (*Rhinolophus hipposderos*) when a lighting experiment was carried out along its commuting route from a nearby roost.

Since the car-based bat monitoring survey takes place along roadways, street lights are often encountered and have potential to impact activity levels, we investigate this in the present report.

### *Landscape Suitability*

Bat Conservation Ireland commissioned the Centre for Irish Bat Research to carry out modeling of bat species occurrence across Ireland based on available records for 2000-2009. This project constituted the first major attempt to establish core ranges and determine landscape suitability for the nine confirmed resident bat species in Ireland (Lundy *et al*., 2011). Maximum Entropy Models (MaxEnt) models were constructed for each species using bat records, land cover (CORINE), soil pH, altitude and human bias factors. MaxEnt models have an advantage over other modeling systems whereby records from various surveys can be combined, and a lack of records is not assumed to indicate true absence of a species.

The bat records used for the project were collated by Bat Conservation Ireland from 2000-2009 and stored in a MySQL online database, based on Recorder 6. While data from the car-based bat monitoring surveys are included in Bat Conservation Ireland's online database, these were *not* included in the landscape suitability modeling because they are geo-referenced to transect start points only, due to a lack of GPS information for each transect. Thus car monitoring bat records are currently only available at a 1.6km resolution unlike other records held in the Bat Conservation Ireland database which are generally more accurate. Over 7,100 records for nine species were included in the Max Ent analyses. The main results of the project were maps of landscape suitability indices for each of the nine species in Ireland, at a 5km square resolution. Examples of these maps are shown in the Results section.

While we had initially planned to carry out a study of CORINE land cover and car-based bat monitoring activity of the three most common species at square level, it became apparent that the Lundy *et al.* (2011) project constituted a much more detailed study using a similar, but better populated dataset at higher resolution. Therefore, some of the results from that project are summarized in the present report. Its limitations in aiding the interpretation of the car-based monitoring scheme are discussed, along with possibilities for future detailed analyses of car-based monitoring routes and bat records.

## Aims of a Car-based Bat Monitoring Scheme

1. Provide a method of monitoring that can be implemented by relatively few surveyors and that does not require highly trained individuals.

2. Provide a method of data collection that is
    - objective
    - easily repeatable
    - cost effective.

3. Ensure sufficient data is collected that will allow early recognition of Red and Amber Alert declines in certain Irish bat species' populations.

4. Record other vertebrate wildlife during the survey.

5. To contribute to information on important areas for bats across the island.

6. To determine population trends and allow early detection of population declines or highlight increases, if any.

## Aims of This Report

This report synthesises the data collected from 2003 to present and

- reviews information from the testing and use of Android smartphones in 2011

- reviews total bat encounters in all years to-date

- examines trends in the three most commonly detected species and Nathusius' pipistrelles using GAM and TRIM

- analyses the impact of weather on bat abundance

- reviews information on roadside street lights to determine whether these have any observable impact on bat activity

- correlates predicted landscape suitability indices for the three most common species with average encounter rates per survey square and examines trends for each species in less and more suitable areas

- reviews overall 'other vertebrate' data from 2006 to 2011 and roadside cat population trends are analysed using TRIM

- makes recommendations on the future of the survey.

# Methods

The detailed methodology for the survey was described in Roche *et al.* (2011).

In summary, training of surveyors is carried out each summer prior to Survey 1 each year. Each year survey teams carry out surveys of a mapped route within a defined 30km ***Survey Square***. Every route covers 15 x 1.609km (1 mile) ***Monitoring Transects*** each of which is separated by a minimum distance of 3.2km (2 miles). Surveyors are asked to carry out the survey on two dates, one in mid to late July (Survey 1) and one in early to mid-August (Survey 2). Transect coverage begins 45 minutes after sundown. Each of the 1.609km transects is driven at 24km (15 miles) per hour while continuously recording from a time expansion bat detector, set to x10 time expansion, on to a recording device such as a minidisc or digital recorder. The time expansion detector is set to record for 320ms, and it then replays sounds at x10 time expansion so that, in effect, each recording consists of a series of 0.32sec intervals with no sound, followed by 3.2sec of time expanded sound. 2011 the first trials were carried out using HTC Android smartphones for recording. Minidiscs or phone mini-SD cards are forwarded (in pre-stamped and addressed envelopes) to BCIreland for analysis.

Note that in 2003 surveys were carried out on later dates than in the following years and the survey began 30 minutes after sunset. An additional change was made to the methodology in 2009; where each route had originally consisted of 20 transects, the final five transects for each route was omitted, due to safety concerns.

Each track is downloaded to Bat Sound™ and calls are identified to species level where possible. Species that can be identified accurately using this method are the common, soprano and Nathusius' pipistrelles (*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, a low frequency echolocating species, can also be easily identified using this method. Occasional calls of *Myotis* bats are recorded but these are noted as *Myotis* spp. since they could belong to one of a number of similar species – Daubenton's, whiskered, Natterer's or Brandt's bat (*Myotis daubentonii, M. mystacinus, M. nattereri, M. brandtii*). Occasional social calls of brown long-eared bats are also recorded. Publications by Vaughan *et al*. (1997) and Russ (1999) are used as the main sonogram identification reference guides.

For quality control purposes a number of randomly selected .wav files are forwarded each year to Jon Russ of The BCT for comparative analysis.

## Statistical Analysis

### *Trends: GAM and TRIM*

Smoothed trends were constructed using the Generalised Additive Model approach described by Fewster *et al.* (2000, see Glossary) with confidence limits generated by bootstrapping at the Survey Square level. A Poisson error distribution was used and the number of degrees of freedom for the spline curve was set to two since there were insufficient years to justify a more complex model. The log of the total number of recording intervals was fitted as an offset (see Glossary) to adjust for different recording lengths. A fully saturated GAM model, which is equivalent to a conventional GLM with estimates for each year, was also fitted to indicate the year-to-year variation about the smoothed curve. Indices were expressed relative to a base year of 2004, since there were relatively few surveys in 2003.

For Nathusius' pipistrelle trend, models were constructed this year based on a binomial distribution. This is because the species sometimes occurs in the same transect on multiple occasions but there are, much more often, transects with no occurrences of this species and, therefore, a large number of zeros in the dataset. No attempt was made to express these results as an index because of the low numbers of encounters, but otherwise the same methodology was applied, with confidence limits constructed by bootstrapping at the square level. A binomial model would not give any advantage for species with enough passes to use a Poisson distribution (such as the pipistrelles and Leisler's bats above) so Poisson GAM was used for these species. It is worth noting that multiple passes are not as relevant with a car-based survey as for a foot-based survey, since the speed of the car means that lots of passes from the same bat are avoided.

The analysis was carried out using the first 15 x 1.6km transects only, from 2003-2008 even though 20 transects were surveyed in each survey square in those years, so that results are comparable with the reduced 2009-2011 sampling plan of 15 transects. All annual estimates are now predicted as if each survey had a total of 1,125 0.32second recording intervals or snapshots (i.e. 75 snapshots for each of the 15 x 1.6km transects).

For comparative purposes, trends to 2011 were also analysed using TRIM (Trends and Indices for Monitoring Data, Statistics Netherland). In order to provide a clear comparison between the two approaches to the data, TRIM and GAMs were fitted to a reduced dataset including only squares with between 1000 and 1250 5s snapshots, thus avoiding the need to use an offset or covariate. TRIM does not fit smoothed curves in the same way as the GAM approach, instead using linear switching trends, where the linear slope can change between some or all times. There is an option to allow automatic detection of changepoints using a stepwise algorithm, and this was compared with the smoothed GAM fit. The models are essentially very similar in terms of the use of a Poisson distribution and a logarithmic link function. However, the two use very different approaches to variance estimation. The TRIM model assumes that variances are equal and hence calculates the confidence limits, even for years with unusual observations, using an overall estimate of variance. By contrast, the bootstrapping approach used with GAM smoothing ensures that unusual observations have a direct impact on the width of the confidence limits for the relevant years

### *Weather*

REML (Residual or Restricted Maximum Likelihood) models were applied to log transformed bat count data and climate variables (temperature and rainfall totals) to determine if there were any significant relationships between bat activity and these weather variables. In most cases bat count data from both surveys in a square in a year were included so results, therefore, compare both within square differences (e.g. more bats present on warmer nights) and between square differences (e.g. more bats present in warmer squares).

### *Street lights*

Data on street lights has been collected every year by surveyors. To enable accurate identification of the various types of lamp, illustrations of high pressure sodium (yellow) and low pressure sodium (orange) lights were provided with the survey information pack to survey teams so that the two types could be distinguished. The other main category of street light that surveyors are likely to encounter is white street lights. In some cases the data collected has been inconsistent with different counts resulting for different survey nights and different survey years. In 2011 the data was gathered into a complete set based on maximum available counts for each transect.

To investigate the impact of street lights on the different species, a REML analysis was carried out at the level of the 1.6km transects with the dependent variable the log-transformed passes per minute. A quadratic term for the start time of each transect was also included, expressed as minutes after sunset, in order to allow for the temporal pattern of activity that has been described previously. This is particularly important for the pipistrelle species, which show a marked rise in activity until around 3 hours after sunset. Terms were fitted for log-transformed numbers of each street light colour (adding one to avoid taking logs of zero). All street light data was included. To help visualise the REML results, numbers of passes per minute were predicted when no lights are present, or when there are 20 lights per transect of the appropriate colour per transect. Predictions are averaged on the log-scale over other terms in the model and so their absolute value is not necessarily realistic, but their values provide an impression of the relative magnitude of effects.

### *Landscape Suitability*

The index of landscape suitability (Lundy *et al.*, 2011) for the start point of each of the 15 x 1.6km transects was noted and the mean landscape suitability for each survey square was calculated. The landscape suitability and car monitoring datasets were combined in a REML analysis to determine whether the landscape suitability index was correlated with bat abundance per survey square.

In addition, separate GLM/GAM trends were fitted to the squares with the highest and lowest landscape suitabilities (i.e. squares were divided according to whether they were above or below the median value for the species). For these trends, 2010 was used as the base year, since the smaller sample sizes in the early years creates problems if the split is not even. Randomisation tests were carried out to determine whether the trends were significantly different between high and low suitability squares. A difference in species trends between these two groups might be expected in some circumstances. It is plausible, for example, that at times of population decline, numbers will remain higher in prime habitat than in marginal areas for the species.

### *Smartphone Trials*

Six new smartphones were purchased for the car-based bat monitoring scheme in 2011. These were HTC Desire Z Android units. An Android App was developed to use the phone to record sound while simultaneously recording GPS co-ordinates. In addition, suitable leads with resistors and capacitors were made by All-Cables Ltd., Dublin for the surveys.

## Other Vertebrates

Other vertebrates were also recorded by surveyors. From 2006 onwards surveyors were asked to note all vertebrates including cats on their record sheets. In addition, observers recorded whether each specimen was living or dead and whether each was observed during or after the transect. This means that recorders were observing living and dead vertebrates, other than bats, along a minimum 93km (58mile) route on each survey evening.

### *Statistical Analysis*

The total number of live cats counted in each square each year was analysed using TRIM, with the time taken to complete the surveys included as a weighting variable (effectively an offset).

# Results

Seven teams participated in the 2003 pilot scheme and 17 squares were surveyed in 2004. Twenty one squares were surveyed in 2005. An additional five squares were surveyed in 2006, bringing the total number of surveyed squares to 26 throughout the island. Equipment for 28 squares was disseminated from 2007 onwards (Figures 1 and 2). The survey represents a considerable input of voluntary time - each survey takes approximately two hours and 55 minutes to complete (mean for 2011, not including travel time to and from the survey squares), and each team typically consists of two people. In total, therefore, surveyors contributed at least 310 hours to the survey in 2011.

The mean time taken to complete a monitoring transect (1.609km/1mile) varies between squares. As the time expansion detector system only samples for 1/11th of the time, there is an average total sampling time of 22 seconds per monitoring transect. Also, for every monitoring transect covered 0.146km (0.091 miles) are actually surveyed (i.e. 1/11th of the distance).

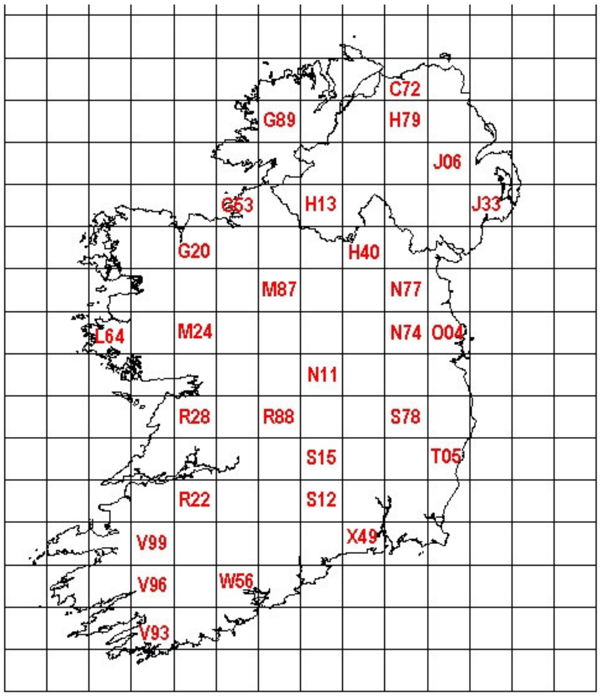


Figure 1: 30km squares in which surveys have been carried out from 2003. Seven of the above squares were surveyed in 2003 and gradually larger numbers were surveyed each year until all survey routes had been established by 2008. The letter and numbers refer to the south western-most corner Ordnance Survey grid reference.

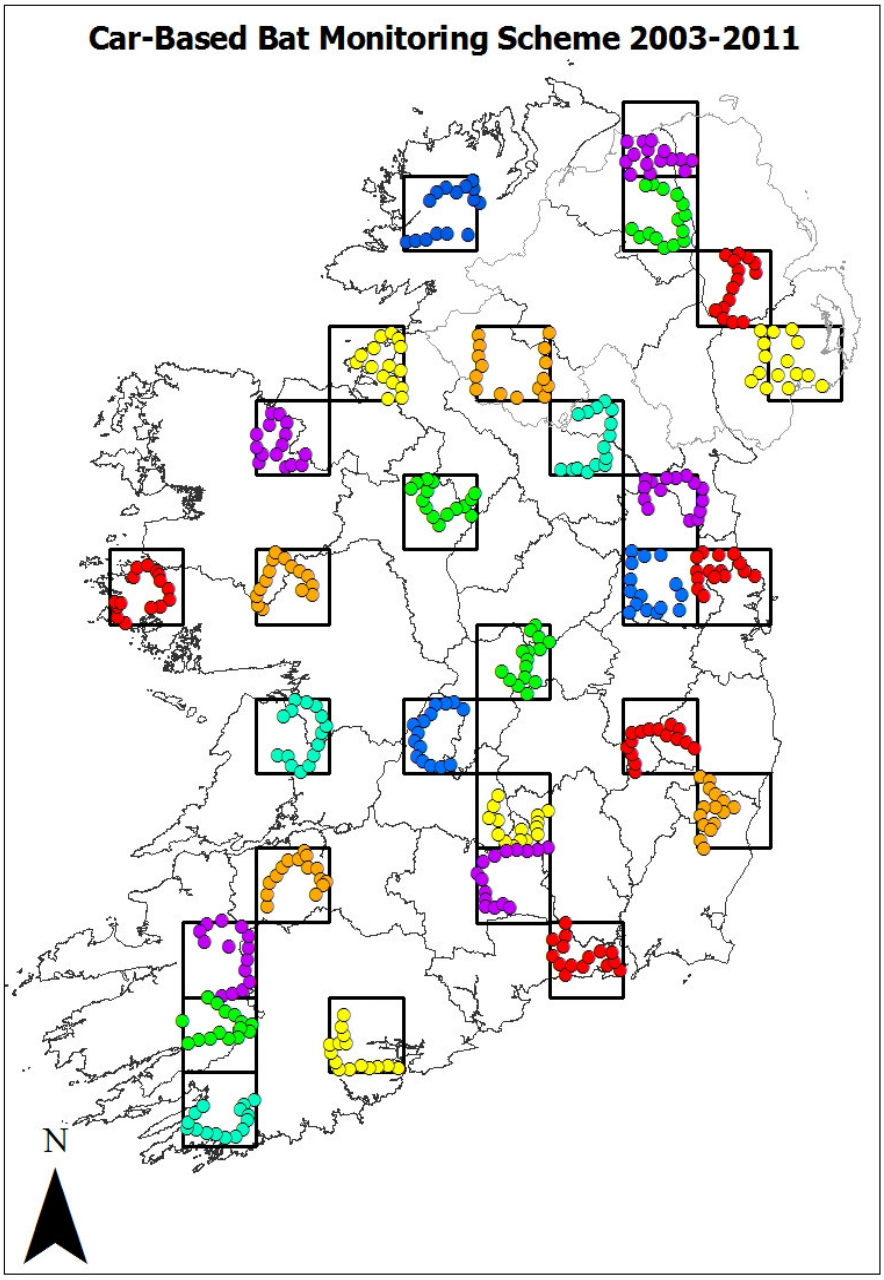


Figure 2: Driven routes within each of the 28 survey squares. Each circle indicates the starting point of a 1.6km transect, with 15 monitoring transects per 30km square.

A maximum of 1576km of transects were driven in 2008, when 20 transects were driven along each route. In the most recent survey year, 2011, 1242km of transects were driven. Grid references of transect locations and descriptive information available for transect start points are given in the Appendix, Table 6.

Each year some equipment problems or other difficulties arise, for example heavy rainfall, that result in surveys being abandoned or poor recordings that cannot be included in the dataset. In general, the quality of data collected from 2005 onwards has been very good, however. In 2011, during the pilot use of smartphones by eight survey teams, occasional problems arose whereby the data was not recorded properly on a number of driven transects.

In total, 21,172 bat encounters have been recorded since 2003. The total number of bats encountered increased yearly from 378 in 2003 to 3280 in 2008. From 2009, when the number of monitoring transects was reduced by one quarter (from 20 to 15) there was a drop in number of encounters. See Table 1 to compare yearly totals.

Table 1: Total number of bat encounters and total number of 1.6km transects surveyed per year.

| Year | Total No. Bats | Transects |
|---|---|---|
| 2003 | 378 | 180 |
| 2004 | 2031 | 576 |
| 2005 | 1691 | 608 |
| 2006 | 3212 | 887 |
| 2007 | 3014 | 889 |
| 2008 | 3280 | 927 |
| 2009 | 2147 | 787[1] |
| 2010 | 2672 | 816 |
| 2011 | 2748 | 763 |
| **TOTAL** | **21,172** | **6433** |

## Dataset Generated

Quality control data returned from Jon Russ shows that identifications are carried out in the same manner in Ireland and Britain. No correction factor is necessary since the Irish data is analysed by the same person every year so the Irish results are very consistent. Should a new sonogram analysis method be used in the future (e.g. automatic call identification, or change in analysis personnel) a correction factor may have to be incorporated at that time.

Table 2 below shows raw bat encounter data, with passes per 1.6km transect. Figure 3, a pie-chart, shows proportions of each species or species group encountered, from 2003 to 2011. The common pipistrelle is the most abundant species. Soprano pipistrelle and Leisler's bat are equally represented with 21% each of the total bat encounters. An additional 8% of bat encounters cannot be ascribed to either the common pipistrelle or soprano pipistrelle and are, therefore, recorded as 'Pipistrelle unknown'. *Myotis* spp., Nathusius' pipistrelles and brown long-eared bats are rarely encountered. Note that Figure 3 is not meant to give an impression of the actual relative abundance of each species along Irish roadsides since each species differs in its detectability and flight style. Leisler's bats, for

[1] Number of transects reduced from 20 to 15 per survey square, see Methods for details.

example, have loud, low frequency calls with much greater long-range detectability than either of the two pipistrelles, but would not necessarily fly close to hedgerows along roadsides, unlike the pipistrelles. So while, they are more detectable, their occurrence in the landscape would preclude detection if they had quiet short range calls. It is not possible, therefore, to directly compare detectability between the species and the pie-chart simply illustrates the results of the sampled dataset, irrespective of whether social calls are included.

Table 3: Raw bat encounter data, per 1.609km/1 mile transect, not corrected to encounters per km or per hour, Car-based Bat Monitoring Scheme 2003-2011. Average number of bats reflects the average number of bat passes observed during each 1.609km/1 mile transect travelled. Note that the detector records for just 1/11th of the time spent surveying so to determine the actual number of bat encounters per km this must be divided by 0.146 (the total distance sampled for each 1.609km transect), which has not been done for this table.

| Year | No. Transects | Common pipistrelle | Soprano pipistrelle | Pipistrelle unid. | Nathus. Pipistrelles | Leisler's bat | *Myotis* spp. | Brown long-eared | Total Bats |
|---|---|---|---|---|---|---|---|---|---|
| 2003 | 190 | 1.294 | 0.478 | N/a | 0.000 | 0.289 | 0.039 | n/a | 2.100 |
| 2004 | 577[1] | 1.905 | 0.695 | 0.443 | 0.000 | 0.511 | 0.050 | n/a | 3.621 |
| 2005 | 608 | 1.344 | 0.574 | 0.266 | 0.001 | 0.544 | 0.035 | n/a | 2.781 |
| 2006 | 887 | 1.701 | 0.652 | 0.271 | 0.033 | 0.892 | 0.029 | 0.024 | 3.620 |
| 2007 | 889 | 1.77 | 0.639 | 0.253 | 0.015 | 0.631 | 0.036 | 0.019 | 3.390 |
| 2008 | 927 | 1.686 | 0.768 | 0.294 | 0.006 | 0.739 | 0.029 | 0.002 | 3.537 |
| 2009 | 787 | 1.212 | 0.714 | 0.221 | 0.032 | 0.492 | 0.032 | 0.011 | 2.728 |
| 2010 | 816 | 1.442 | 0.668 | 0.241 | 0.069 | 0.809 | 0.023 | 0.012 | 3.275 |
| 2011 | 763 | 1.560 | 0.800 | 0.360 | 0.022 | 0.790 | 0.038 | 0.020 | 3.602 |
| | **Mean Per Transect** | **1.546** | **0.665** | **0.294** | **0.020** | **0.633** | **0.035** | **0.015** | **3.184** |

1. Number of transects = 597 for Leisler's bats in 2004. More data was available for Leisler's than other species in this year due to a detector problem in one survey square which caused sounds at frequencies above 30kHz to be non-analysable.

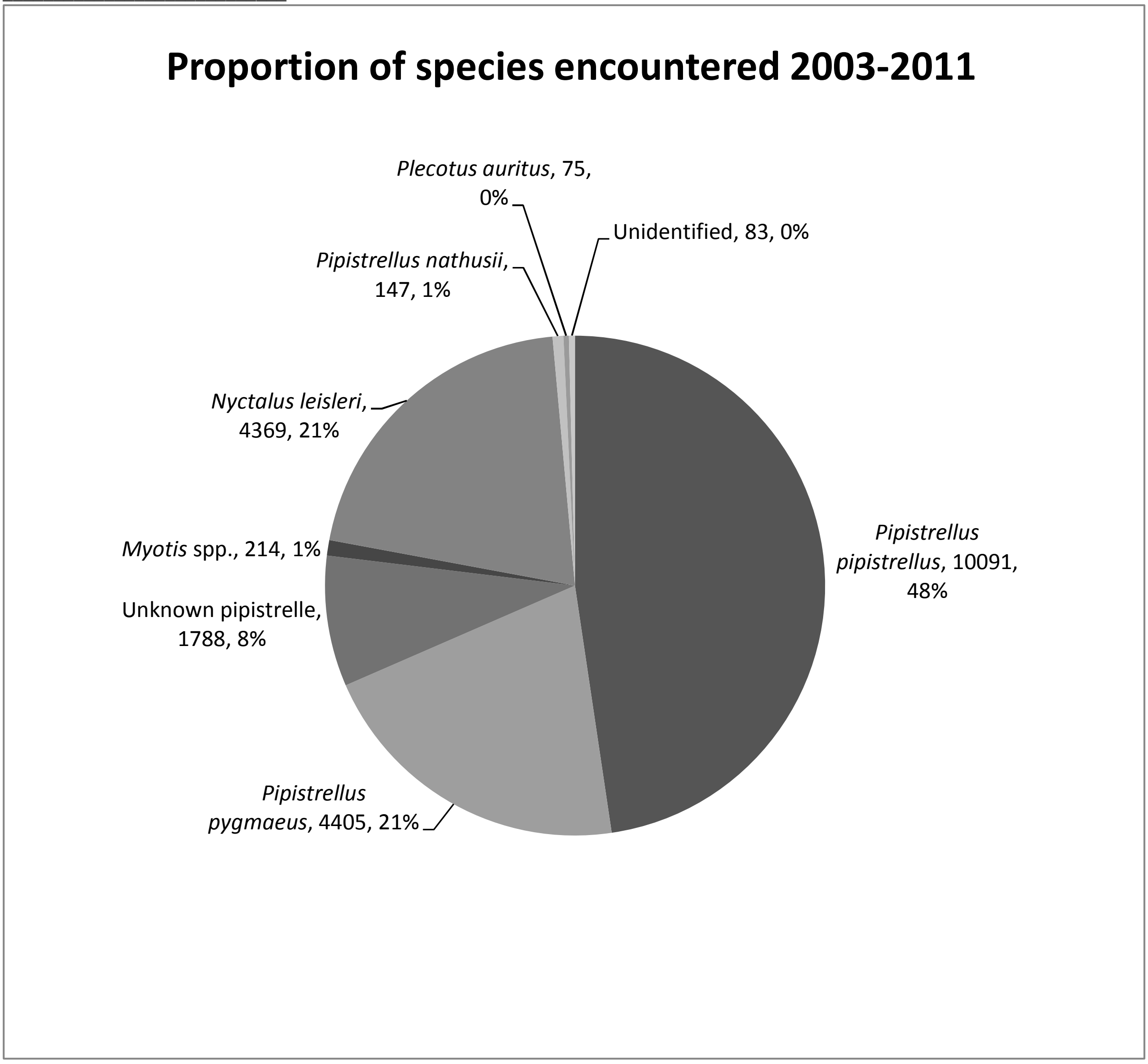


Figure 3: Proportion of species encountered during the survey, 2003-2011. Total number of bat encounters: 21,172. Excepting social calls of Leisler's bats and brown long-eared bats, which are unlikely to be mistaken for those of other species, bat social calls were noted during sonogram analysis but are not included in the above pie chart or in any statistical analyses.

## Smartphone Trials

Trials were carried out to determine whether the number of bat passes recorded by the HTC Smart Phones would differ from those measured by other digital recorders (minidisc and Edirol recorders). Initial trials took place in Co. Meath using traditional minidisc and occasionally Edirol recorders simultaneously alongside HTC phones, both clamped to the left hand windows of the same vehicle, in May and June 2011. Initial results from these experiments indicated no significant difference in observation rates for each species, so smartphones were used in eight survey squares in 2011. Four car surveys (two each in N77 and G89) were also carried out with phones and minidiscs simultaneously. All of the comparative data was incorporated into one dataset. Statistical analysis was carried out to determine whether the numbers of passes of each species were the same irrespective of recorder type.

Some differences in observed bat passes may be expected because, even though the recorders are switched on at the same time, the detectors may be triggering at a slightly different time, hence an individual bat flying past the survey car may be missed by one recorder but picked up by the other. Cumulative results from 12 separate recording instances in 2011, however, showed very similar tallies (Table 4).

Table 4: Results from HTC and minidisc/Edirol recorder trials, June surveys were carried out in various locations in Meath while the July and August surveys took place in G89 (Donegal) and N77 (Meath/Louth) during the car surveys-proper.

| Date | Recording | Common pipistrelle | | Soprano pipistrelle | | Leisler's bat | |
|---|---|---|---|---|---|---|---|
| (2011) | Length (sec) | HTC | Other | HTC | Other | HTC | Other |
| 07/06 | 1565 | 12 | 11 | 2 | 2 | 8 | 6 |
| 13/06 | 1262 | 10 | 11 | 0 | 1 | 4 | 4 |
| 13/06 | 1498 | 18 | 15 | 2 | 4 | 2 | 5 |
| 15/06 | 1340 | 3 | 2 | 2 | 3 | 3 | 20 |
| 15/06 | 1192 | 3 | 4 | 3 | 5 | 24 | 7 |
| 27/06 | 1340 | 6 | 6 | 1 | 1 | 15 | 16 |
| 27/06 | 1457 | 5 | 2 | 7 | 9 | 5 | 3 |
| 27/06 | 1420 | 23 | 24 | 1 | 1 | 0 | 0 |
| 16/08 | 3874 | 25 | 21 | 11 | 15 | 4 | 0 |
| 05/08 | 3590 | 24 | 26 | 14 | 11 | 7 | 9 |
| 26/07 | 3573 | 3 | 4 | 2 | 4 | 23 | 24 |
| 18/07 | 3813 | 32 | 24 | 17 | 7 | 37 | 36 |
| **TOTAL** | **25924** | **164** | **150** | **62** | **63** | **132** | **130** |

Wilcoxon signed ranks tests were carried out on the paired data for each species. No significant differences were found in results for the different recording methods. Recordings made by the HTC smartphone should, therefore, provide the same information on bat passes as minidisc recordings, with the additional benefit of detailed GPS data enabling geo-referencing of bat records.

No comparative analysis was carried out on the irregularly occurring species such as brown long-eared bats or *Myotis* species because insufficient data was available for these.

## Common pipistrelle

Common pipistrelles have been the most frequently encountered species during the monitoring scheme in all survey years to-date. In L64, Connemara, common pipistrelles have never been confirmed in any year when surveys have been carried out in that square.

## *Yearly Trends*

Common pipistrelles showed a consistent increase in the early years (until 2007), but have remained fairly steady since then (Figure 4). The current value of the index is not quite significantly different from the baseline 2004 (fitted) value, as can be seen from the confidence limits which enclose 100. There are significant change points in 2009 and 2010 indicating that the trend line is starting to bend upwards. Also, results indicate a yearly increase of 1.6% but this increase, and trend lines, are strongly influenced by the relatively high mean in 2011 and should, therefore, be treated with caution. Table 5 shows the data used to create Figure 4.

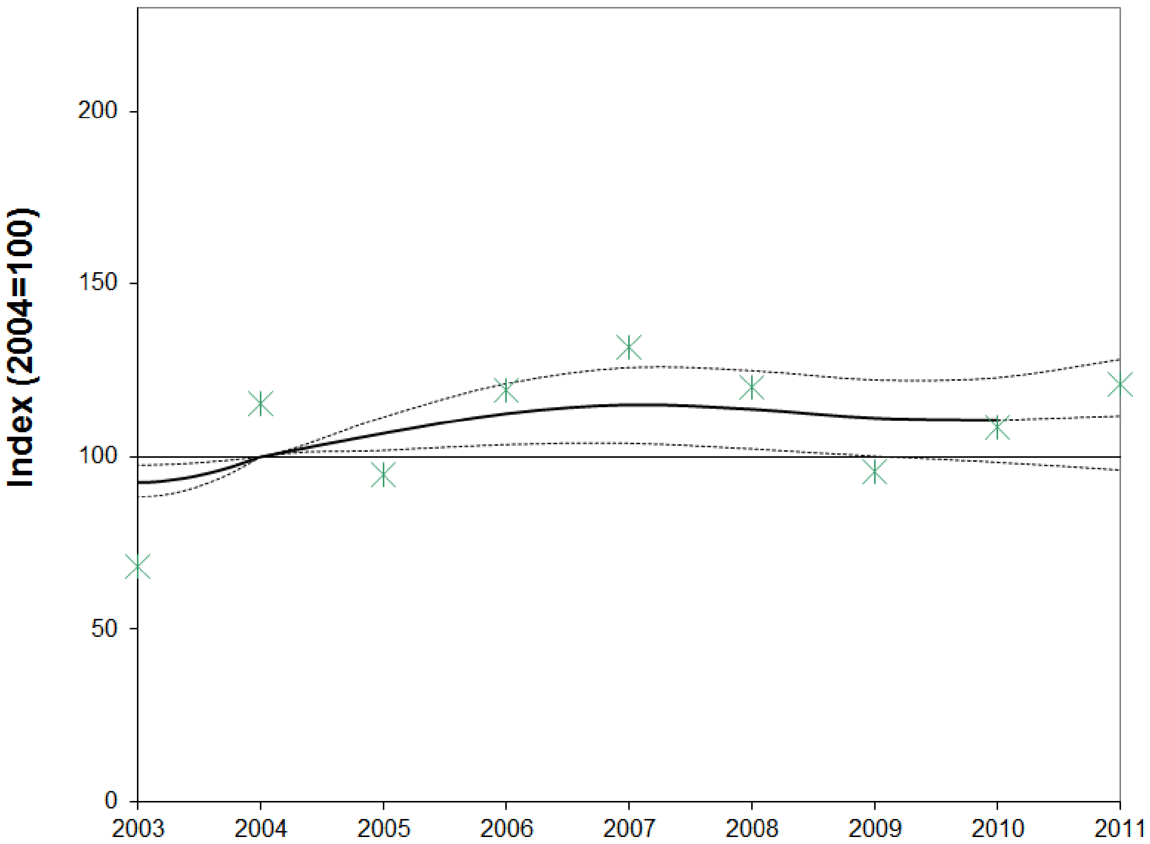


Figure 4: GAM curve for common pipistrelles. The solid black line is the smoothed GAM curve, with 95% confidence limits shown by the dotted lines. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 5: GAM results for common pipistrelles with 95% confidence limits (using first 15 transects only 2003-2008).

| | | | | | Index 2004 = 100 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean passes | | Smoothed | | 95% conf limits | | unsmoothed | |
| *year* | *counts* | *sites* | *Mean* | *s.e.* | *estimate* | *s.e.* | *lower* | *upper* | *estimate* | *s.e.* |
| 2003 | 9 | 7 | 16.4 | 3.6 | 92.5 | 2.4 | 88.4 | 97.5 | 52.8 | 9.9 |
| 2004 | 27 | 17 | 25.6 | 2.9 | 100.0 | 0.0 | 100.0 | 100.0 | 100.0 | 0.0 |
| 2005 | 31 | 17 | 21.3 | 2.3 | 106.8 | 2.5 | 101.9 | 111.5 | 79.3 | 9.0 |
| 2006 | 45 | 25 | 24.3 | 2.6 | 112.5 | 4.6 | 103.6 | 121.2 | 103.7 | 13.9 |
| 2007 | 46 | 26 | 25.7 | 2.7 | 115.1 | 5.7 | 103.9 | 125.8 | 116.2 | 8.3 |
| 2008 | 42 | 23 | 24.1 | 2.8 | 113.7 | 6.0 | 102.3 | 124.9 | 104.6 | 10.8 |
| 2009 | 52 | 28 | 18.0 | 1.6 | 111.2 | 5.8 | 100.2 | 122.3 | 80.2 | 7.0 |
| 2010 | 53 | 27 | 20.9 | 2.1 | 110.6 | 6.3 | 98.3 | 122.9 | 92.9 | 11.0 |
| 2011 | 53 | 28 | 22.5 | 2.5 | 111.8 | 8.1 | 96.1 | 128.2 | 105.4 | 8.4 |

## GAM and TRIM

In order to provide a clear comparison between the two approaches to the data, TRIM and GAMs were fitted to a reduced dataset for common pipistrelles including only squares with between 1000 and 1250, 5 second snapshots, thus avoiding the need to use an offset or covariate. TRIM does not fit smoothed curves in the same way as the GAM approach, instead it uses linear switching trends, where the linear slope can change between some or all times. There is an option to allow automatic detection of changepoints (i.e. when slope of the trend changes from one year to the next) using a stepwise algorithm, and this is compared with the smoothed GAM fit below.

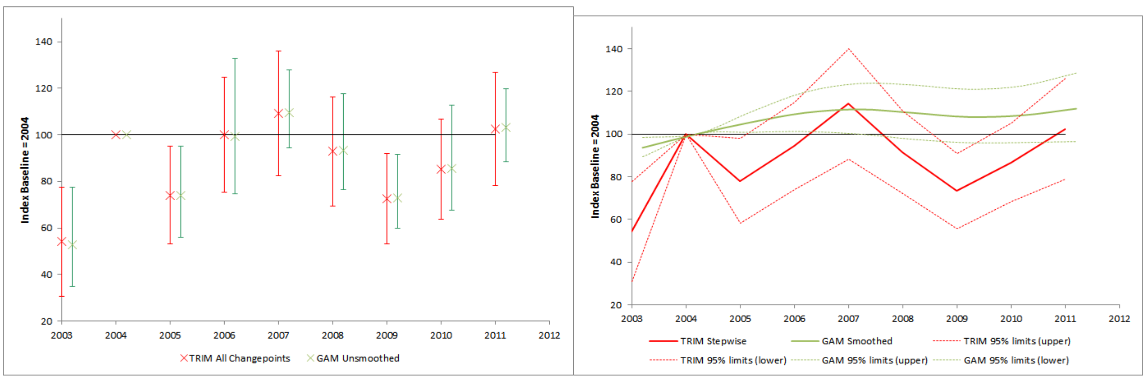


Figure 5: Comparison between TRIM and GAM results for common pipistrelle. The left hand graphs show unsmoothed estimates; the red points are from TRIM using a linear model with all possible changepoints, whilst the 'GAM' result is from a GLM model with estimates from each year and standard errors based on bootstrapping at the site level. The right hand graphs compare a linear TRIM model, using the default stepwise method of selecting changepoints, with a GAM curve with 2 d.f.

From the unsmoothed results, the annual estimates are very similar. This would be expected since the models are essentially very similar in terms of the use of a Poisson distribution and a logarithmic link function. For this species, the confidence limits are quite different in certain years but are generally smaller for the TRIM model, reflecting the different approaches to variance estimation. Comparisons between the GAM smoothed curve and the linear switching trend model of TRIM are more difficult because the models are so different. Overall, the TRIM model is much more jagged, responding to outlying years. The TRIM line tends to be below the GAM curve, which occurs because the base year (2004) is an outlier and the GAM approach smoothes this out, whereas TRIM inserts a change point in the slope to fit it. TRIM confidence limits are wider for the smoothed curve.

### *Weather*

Survey level REML models were constructed with numbers of bat passes per minute, temperature and rainfall. For common pipistrelles encounter rates, no significant correlation was found between these and average monthly temperature or rainfall, although the test statistic was positive with average temperature and negative with rainfall (see Appendix, Table 2). The relationship between the observer recorded temperature at the start of each survey and common pipistrelles passes per minute was also non-significant (see Appendix, Table 3).

### *Landscape Suitability*

The landscape suitability index for common pipistrelles is shown in Figure 6. As can be seen from this map (from Lundy *et al.* 2011), the areas of greatest predicted suitability for the common pipistrelle fall largely across the centre of the island, with a larger proportion of the highly suitable squares being situated in the southern half. The extreme north west, extreme west and areas associated with mountain ranges are generally those predicted to be less suitable for the species. In summary, the habitat types found to be favoured by the common pipistrelle are mixed and broadleaved woodland (albeit at differing spatial scales), riparian habitats and low density urban areas (<30% cover). Landcover types avoided by common pipistrelles include bog/heath, and high density urban areas.

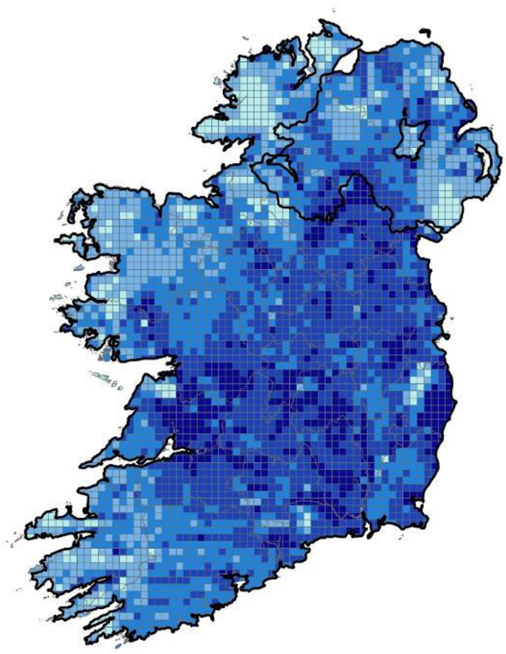

Figure 6: Landscape suitability map for the common pipistrelle, darker areas are more suitable (from Lundy *et al.* 2011).

Using the landscape suitability indices for the start point of each 1.6km transect (derived from Lundy *et al.* 2011) the mean suitability index for each survey route was calculated. A scatterplot of mean landscape suitability and average passes per minute for common pipistrelles is shown in Figure 7.

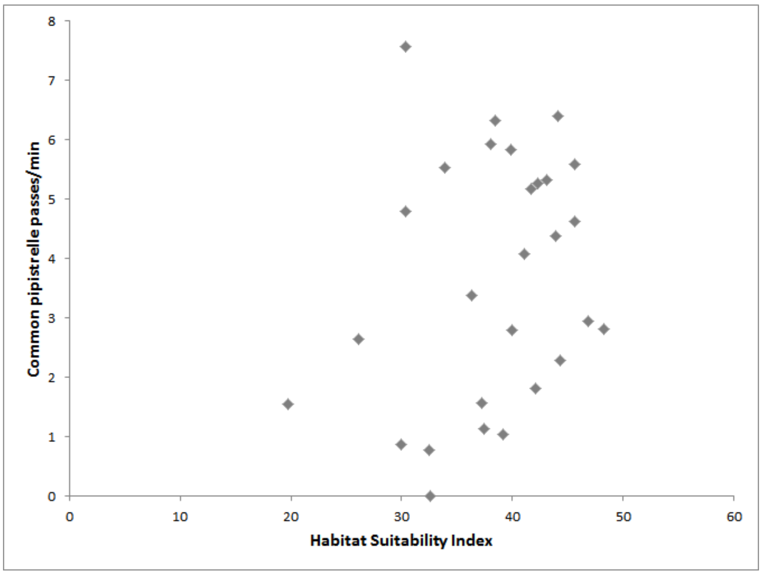


Figure 7: Mean number of common pipistrelle passes per minute for each survey square plotted against landscape suitability indices, averaged for each survey route.

There is a reasonable, though not significant (coefficient 0.263), correlation between observed passes and predicted landscape suitability. One square (V99) stands out as having the highest number of passes and a relatively low suitability (V99: mean passes per minute = 7.57; mean landscape suitability for survey route = 30.4).

Further investigation was carried out by dividing survey squares into those above or below the median landscape suitability (median=39.5) for common pipistrelles. A map differentiating between survey squares above or below the median landscape suitability for all survey squares, is shown in Figure 8.

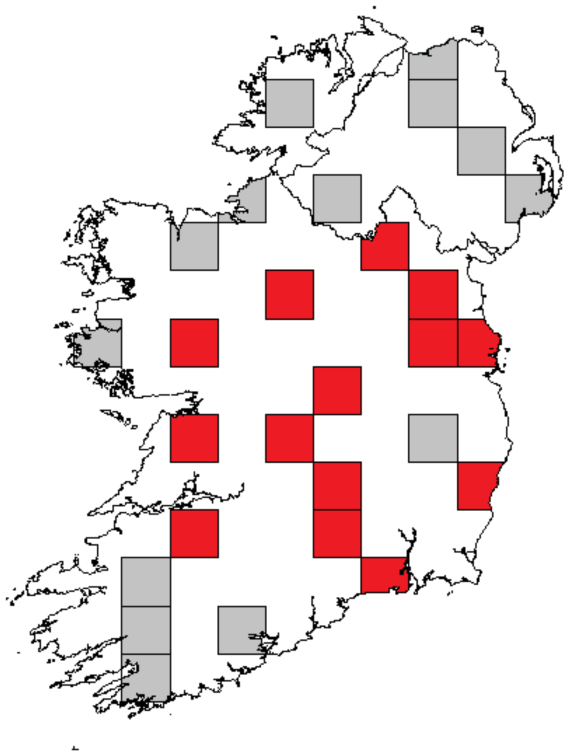

Figure 8: Map showing whether each survey square is above (red) or below (grey) the median predicted landscape suitability (for all 28 survey squares) for common pipistrelles.

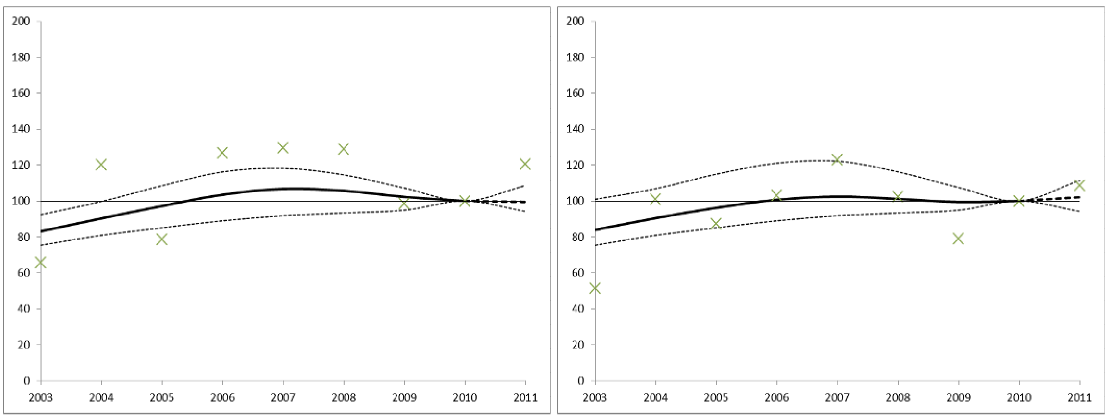


Figure 9: Graph on the left shows trends in common pipistrelles passes per minute for squares with lower landscape suitability (i.e. below the median for all survey squares) while the graph on the left shows trends in common pipistrelles in survey squares of greater landscape suitability. Baseline 2010=100.

Figure 9 shows trends in survey squares of poorer (left) and greater (right) suitability for common pipistrelles. 2010 has been used as the base year, as smaller sample sizes in the early years create problems if the split is not even. As can be seen from the graphs, while yearly means differ slightly there is no appreciable difference in trends between the less and most suitable squares. A randomisation test confirms no significant differences (P=0.993).

## Street lights

Street lights of varying colours were not found to have a significant impact on observed common pipistrelle passes per minute (REML analysis with a quadratic term fitted to the model for time after sunset, see Appendix Table 4). This is illustrated by Figure 10, which shows the predicted number of common pipistrelle passes per minute in transects with twenty street lights of specified colour, or with none. However, most of the transects had relatively low lighting levels, with more than 95% of them having fewer than 20 lamps per 1.6km.

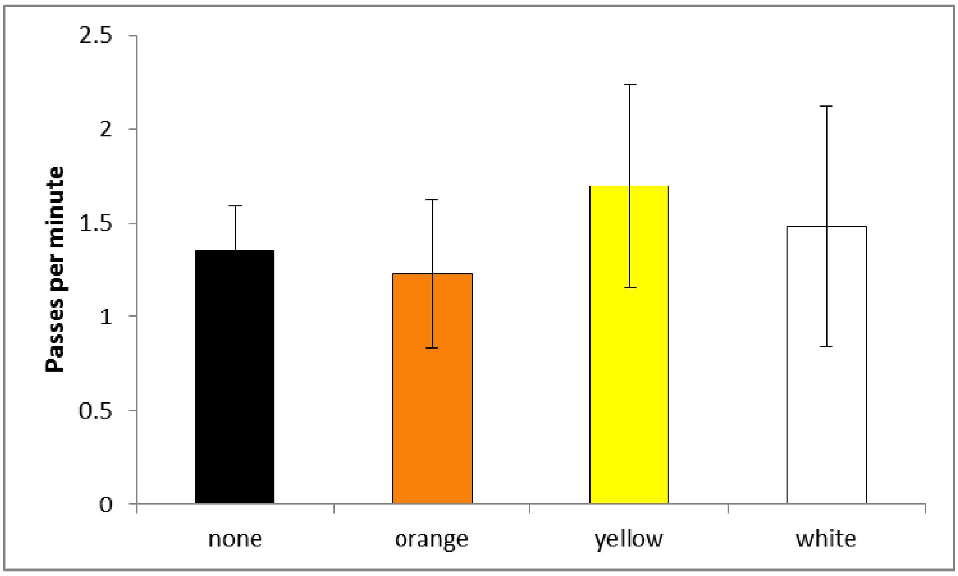


Figure 10: Predictions from the REML models for number of common pipistrelle passes per minute. Standard errors are approximate because the model is fitted on the log scale.

## Soprano pipistrelles

The soprano pipistrelle was the second most frequently encountered species during the car-based bat monitoring scheme in all survey years, except 2006 and 2010, when Leisler's bat passes exceeded those of soprano pipistrelles.

### Yearly Trends

Soprano pipistrelle numbers have been steadily climbing, although year-to-year changes have not been significant in recent years. A high mean in 2011 means that the current index value is just significantly different from the baseline. Results indicate a mean annual increase of 5.29%. The soprano pipistrelle trend graph is shown in Figure 11. Data used to create Figure 11 is shown in Table 6.

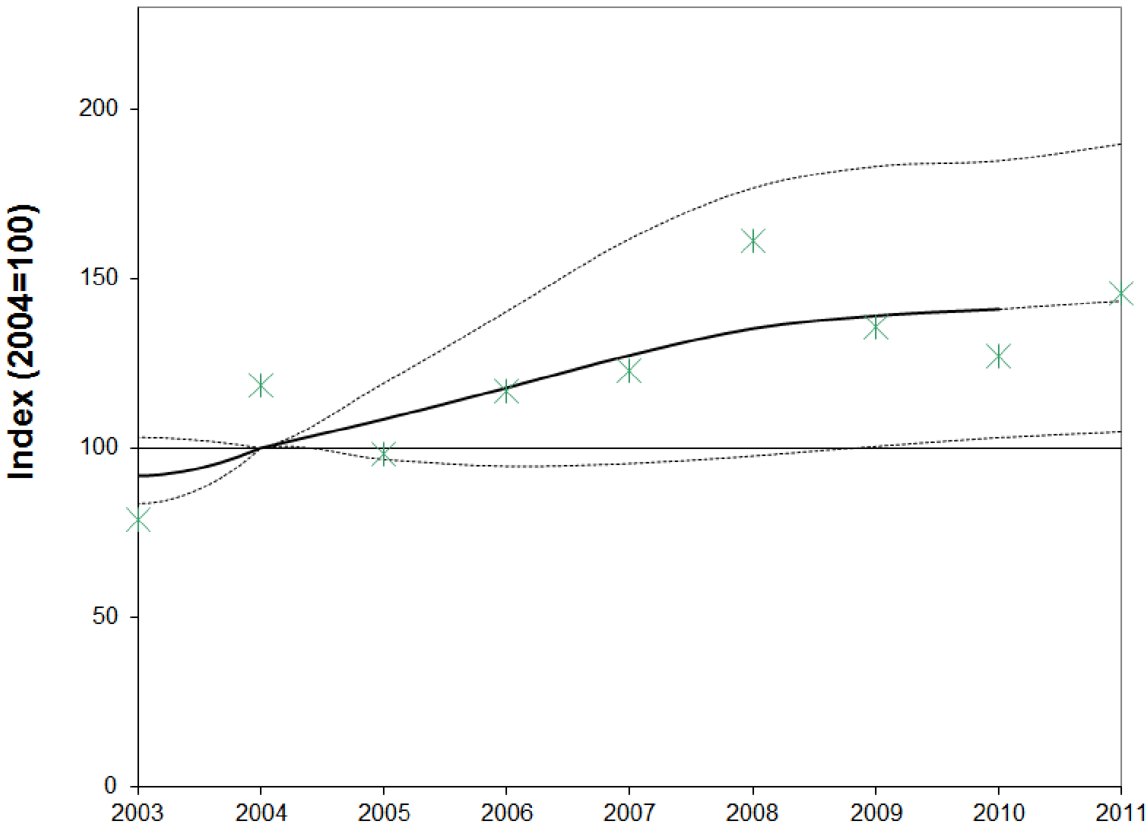


Figure 11: GAM curve for soprano pipistrelles. The solid black line is the smoothed GAM curve, with 95% confidence limits shown by the dotted lines. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 6: GAM results for soprano pipistrelles with 95% confidence limits (using first 15 transects only 2003-2008).

| | | | | | Index 2004 = 100 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean passes | | smoothed | | 95% conf limits | | unsmoothed | |
| *Year* | *Counts* | *sites* | *Mean* | *s.e.* | *estimate* | *s.e.* | *lower* | *upper* | *estimate* | *s.e.* |
| 2003 | 9 | 7 | 6.8 | 1.7 | 91.7 | 5.0 | 83.6 | 103.1 | 60.3 | 16.9 |
| 2004 | 27 | 17 | 10.3 | 1.8 | 100.0 | 0.0 | 100.0 | 100.0 | 100.0 | 0.0 |
| 2005 | 31 | 17 | 7.6 | 0.8 | 108.5 | 5.7 | 96.6 | 119.1 | 79.7 | 16.3 |
| 2006 | 45 | 25 | 9.7 | 1.2 | 117.7 | 11.5 | 94.6 | 140.3 | 98.4 | 19.1 |
| 2007 | 46 | 26 | 9.2 | 1.0 | 127.3 | 16.6 | 95.4 | 161.8 | 104.4 | 27.5 |
| 2008 | 42 | 23 | 12.0 | 1.4 | 135.2 | 20.0 | 97.6 | 176.8 | 143.0 | 32.4 |
| 2009 | 52 | 28 | 10.8 | 1.5 | 139.0 | 20.9 | 100.5 | 183.1 | 117.2 | 28.0 |
| 2010 | 53 | 27 | 10.1 | 1.2 | 140.9 | 20.8 | 103.0 | 184.7 | 108.6 | 26.2 |
| 2011 | 53 | 28 | 11.5 | 1.0 | 143.4 | 21.5 | 104.7 | 189.7 | 127.3 | 26.1 |

## *GAM and TRIM*

Results from TRIM and GAMs fitted to a reduced dataset for soprano pipistrelles, including only squares with between 1000 and 1250, 5 second snapshots, are shown in Figure 12.

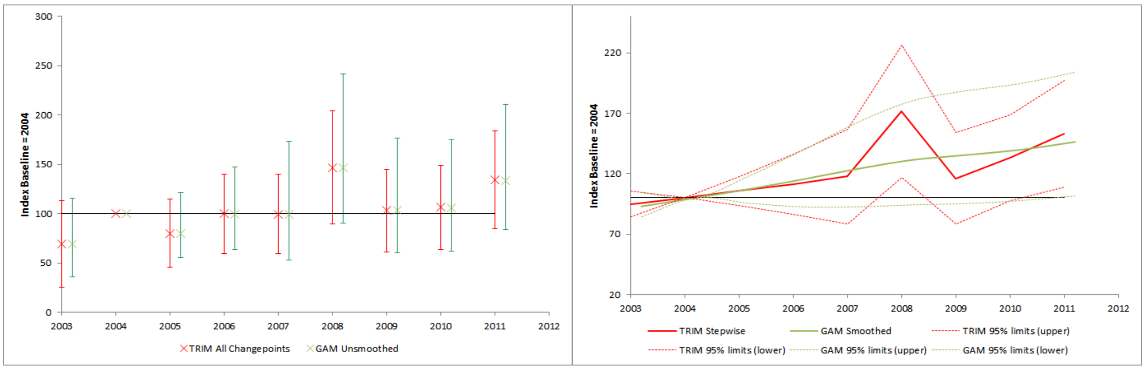


Figure 12: Comparison between TRIM and GAM results for soprano pipistrelle. The left hand graphs show unsmoothed estimates; the red points are from TRIM using a linear model with all possible changepoints, whilst the 'GAM' result is from a GLM model with estimates from each year and standard errors based on bootstrapping at the site level. The right hand graphs compare a linear TRIM model, using the default stepwise method of selecting changepoints, with a GAM curve with 2 d.f.

As for common pipistrelles, the annual estimates are very similar using the two methods. Comparing the GAM smoothed curve and the linear switching trend model of TRIM indicates that the widths of the final confidence intervals are not that different but, again, the TRIM model is much more jagged, responding to outlying years.

## Weather

Survey level REML models were constructed with numbers of soprano pipistrelle passes per minute, temperature and rainfall. For soprano pipistrelle encounter rates, no significant correlation was found between these and average monthly temperature or rainfall, although the test statistic was positive with average temperature and negative with rainfall (see Appendix, Table 2). No significant correlation was found between observer recorded temperature at the start of each survey and soprano pipistrelle passes per minute (see Appendix, Table 3).

## Landscape Suitability

The landscape suitability index for soprano pipistrelles is shown in Figure 13. As can be seen from this map (taken from Lundy *et al*. 2011), the areas of greatest predicted suitability for the soprano pipistrelle fall largely in the west of the island, although a number of predicted high occurrence squares are also found in the border counties. Mountain ranges in the east are among the areas predicted to be less suitable for the species. In summary, the habitat types found to be favoured by the soprano pipistrelle are broadleaved woodland, riparian habitats and low density urban areas (<20% cover). Landcover types avoided by soprano pipistrelles include altitude and high density urban areas.

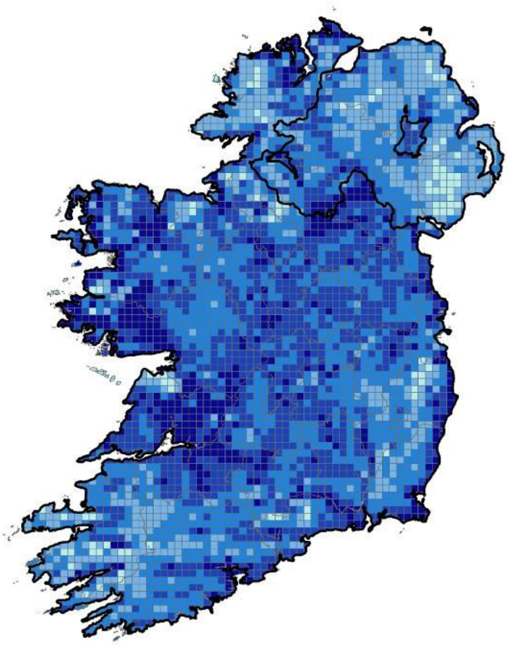

Figure 13: Landscape suitability map for the soprano pipistrelle, darker areas are more suitable (from Lundy *et al.* 2011).

Using the landscape suitability indices for the start point of each 1.6km transect (derived from Lundy *et al.* 2011) the mean suitability index for each survey route was calculated. A scatterplot of mean landscape suitability and average passes per minute for soprano pipistrelles is shown in Figure 14.

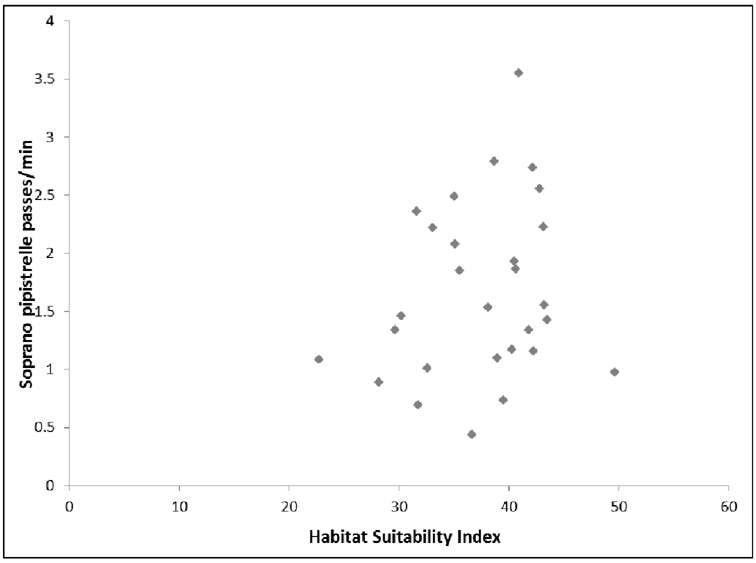


Figure 14: Mean number of soprano pipistrelle passes per minute for each survey square plotted against landscape suitability indices, averaged for each survey route.

There is a reasonable, though not significant (coefficient 0.196) correlation between observed passes and predicted landscape suitability. One square (L64) stands out as having a relatively low number of passes but quite high predicted suitability (L64: mean passes per minute = 0.978; mean landscape suitability for survey route = 49.7).

Further investigation was carried out by dividing survey squares into those above or below the median landscape suitability (median=38.8) for soprano pipistrelles. A map differentiating between survey squares above or below the median landscape suitability for all survey squares, is shown in Figure 15. The trends in the two groups are shown in Figure 16. The trends look a little different in the graph of squares with lower suitability, but confidence limits are wide and the randomisation test indicates that the differences are not statistically significant (P=0.673).

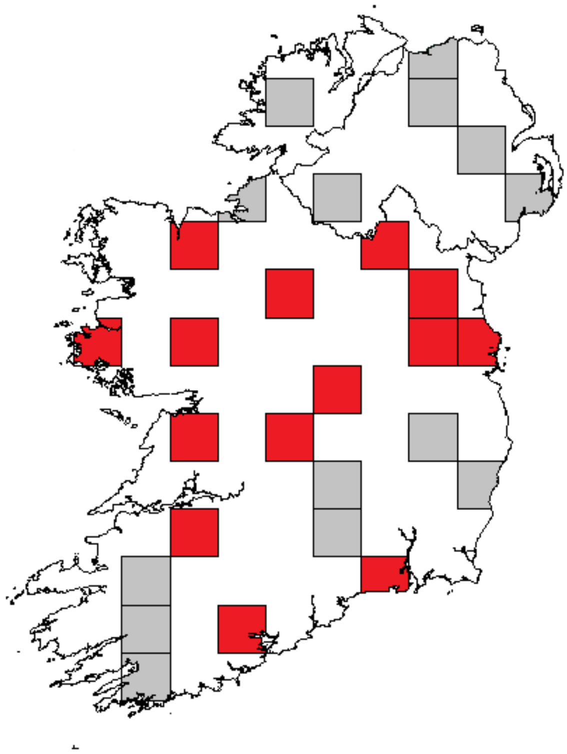

Figure 15: Map showing whether each survey square is above (red) or below (grey) the median predicted landscape suitability (for all 28 survey squares) for soprano pipistrelles.

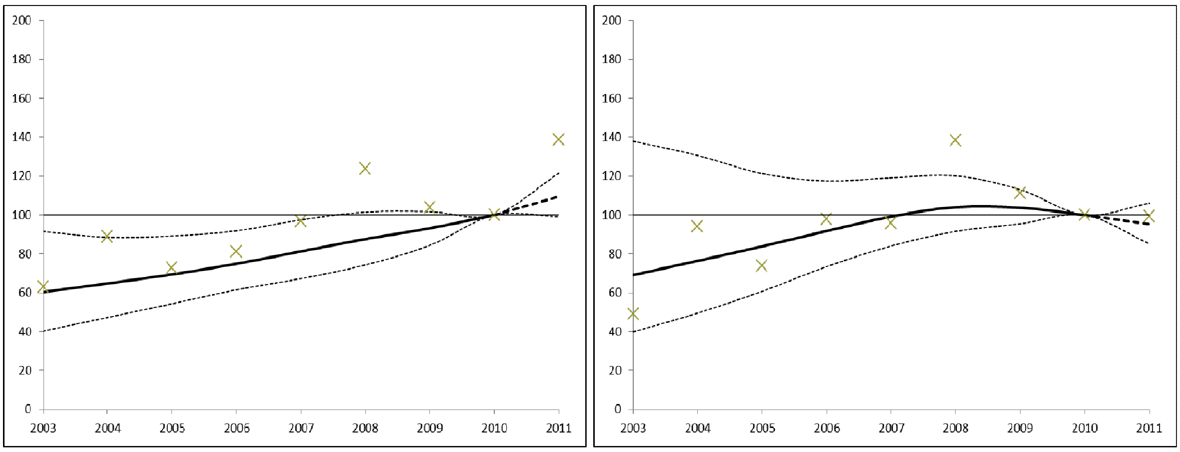


Figure 16: Graph on the left shows trends in soprano pipistrelles passes per minute for squares with lower landscape suitability (i.e. below the median for all survey squares) while the graph on the left shows trends in soprano pipistrelles in survey squares of greater landscape suitability. Baseline 2010=100.

## *Street lights*

Street lights of varying colours were not found to have a significant impact on observed soprano pipistrelle passes / minute (REML analysis with a quadratic term fitted to the model for time after sunset, see Appendix Table 4). This is illustrated by Figure 17, which shows the predicted number of soprano pipistrelle passes / minute in transects with 20 street lights of specified colour, or with none.

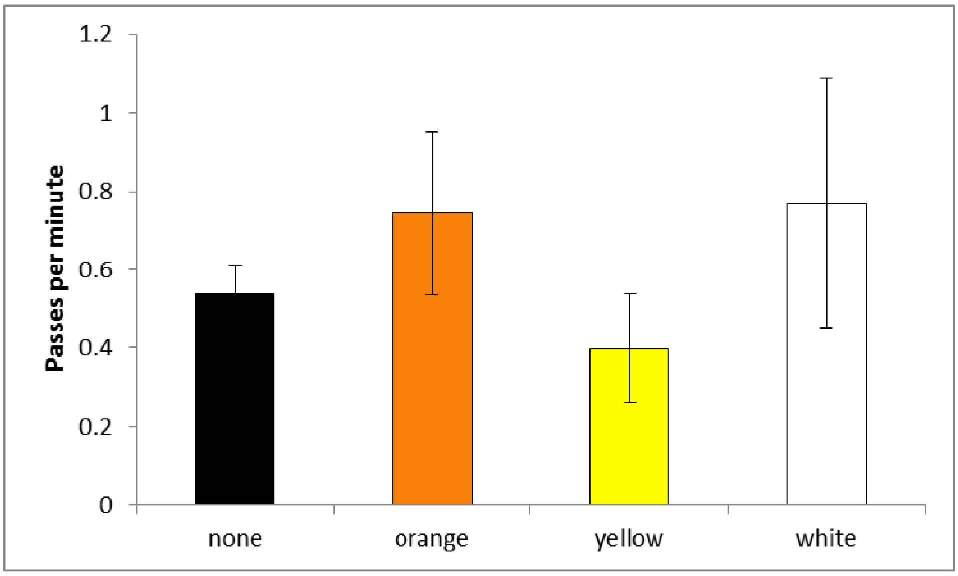


Figure 17: Predictions from the REML models for number of soprano pipistrelle passes per minute. Standard errors are approximate because the model is fitted on the log scale.

## Leisler's Bat

Leisler's bats are the third, and occasionally second, most frequently encountered species during the car-based bat monitoring survey.

### *Yearly Trends*

Leisler's bat yearly figures continue to oscillate somewhat, but the overall trend is significantly up. Results indicate a mean year-on-year increase of 7.41%. An analysis of changepoints suggests that the curve increased steeply at first, then levelled off a little (but still upwards), before rising more steeply in 2010 and 2011. The Leisler's bat trend graph is shown in Figure 18, and data used to create this Figure are shown in Table 7.

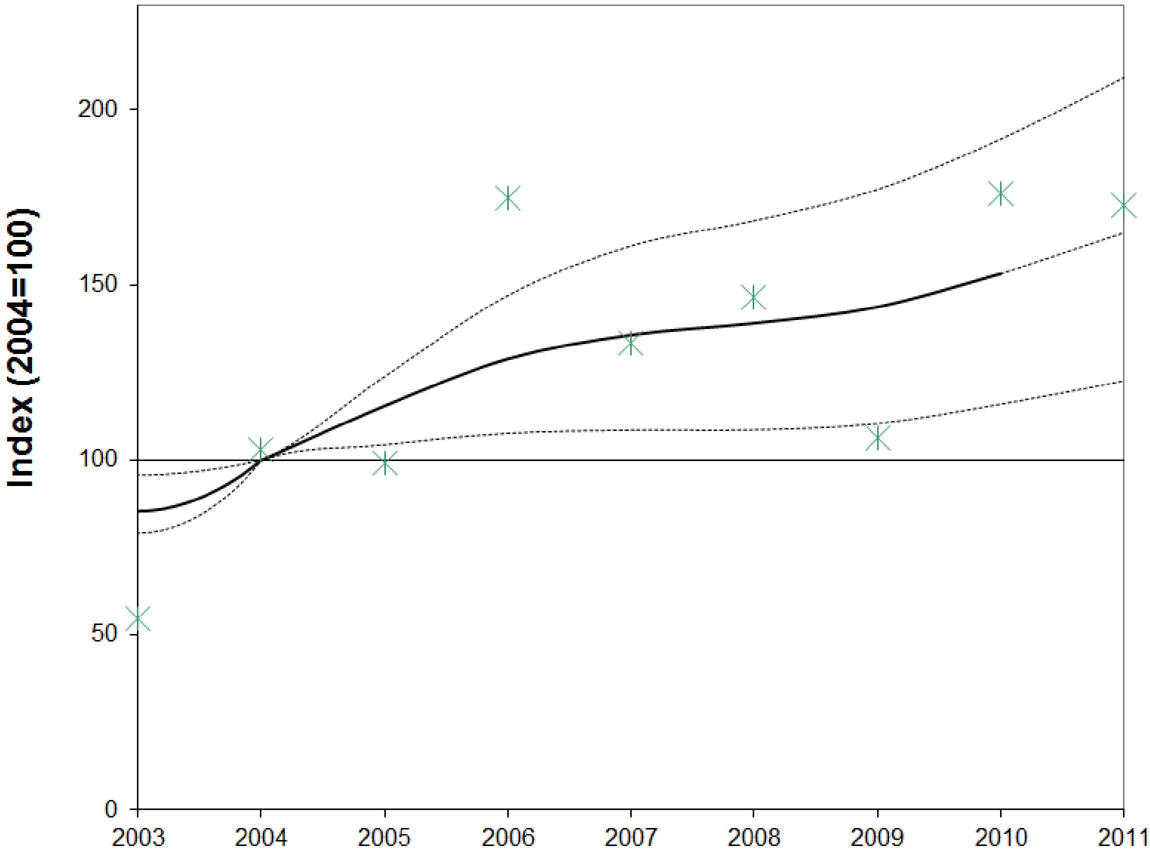


Figure 18: GAM curve for Leisler's bat. The solid black line is the smoothed GAM curve, with 95% confidence limits shown by the dotted lines. Green points are estimated annual means and are shown to illustrate the variation about the fitted line.

Table 7: GAM results for Leisler's bat with 95% confidence limits (using first 15 transects only 2003-2008).

| | | | | | **Index 2004 = 100** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Mean passes** | | **Smoothed** | | **95% conf limits** | | **unsmoothed** | |
| ***year*** | ***counts*** | ***sites*** | ***Mean*** | ***s.e.*** | ***estimate*** | ***s.e.*** | ***lower*** | ***upper*** | ***estimate*** | ***s.e.*** |
| 2003 | 9 | 7 | 5.1 | 1.7 | 85.4 | 4.2 | 79.2 | 95.7 | 52.1 | 24.9 |
| 2004 | 28 | 17 | 7.7 | 1.2 | 100.0 | 0.0 | 100.0 | 100.0 | 100.0 | 0.0 |
| 2005 | 31 | 17 | 7.7 | 1.5 | 115.5 | 5.1 | 104.4 | 123.9 | 96.4 | 23.4 |
| 2006 | 45 | 25 | 13.3 | 1.6 | 128.9 | 10.1 | 107.6 | 147.0 | 172.1 | 34.5 |
| 2007 | 46 | 26 | 9.1 | 1.6 | 135.8 | 13.6 | 108.6 | 161.2 | 130.4 | 37.2 |
| 2008 | 42 | 23 | 9.9 | 1.3 | 139.1 | 15.6 | 108.7 | 168.4 | 143.5 | 28.5 |
| 2009 | 52 | 28 | 7.3 | 1.0 | 143.7 | 17.2 | 110.5 | 177.3 | 103.3 | 23.2 |
| 2010 | 53 | 27 | 12.2 | 1.7 | 153.2 | 19.1 | 116.0 | 191.7 | 173.3 | 38.2 |
| 2011 | 53 | 28 | 11.4 | 1.6 | 164.9 | 21.6 | 122.6 | 209.2 | 170.0 | 38.3 |

## *GAM and TRIM*

Results from TRIM and GAMs fitted to a reduced dataset for Leisler's bat, including only squares with between 1000 and 1250, 5second snapshots, are shown in Figure 19.

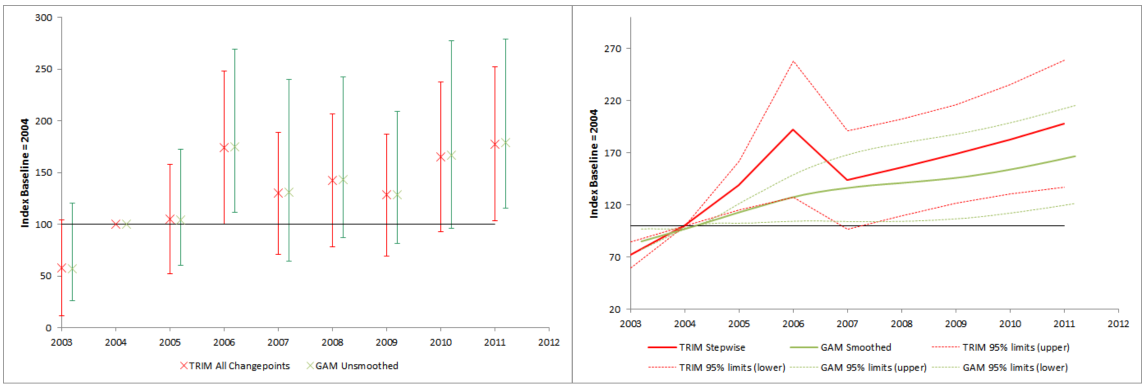


Figure 19: Comparison between TRIM and GAM results for Leisler's bat. The left hand graphs show unsmoothed estimates; the red points are from TRIM using a linear model with all possible changepoints, whilst the green 'GAM' result is from a GLM model with estimates from each year and standard errors based on bootstrapping at the site level. The right hand graphs compare a linear TRIM model, using the default stepwise method of selecting changepoints, with a GAM curve with 2 d.f.

As for common and soprano pipistrelles, the annual estimates are very similar using the two methods. Also the widths of the final confidence intervals of the GAM smoothed curve and the linear switching trend model of TRIM are not that different, but the TRIM model is much more jagged, responding to outlying years.

## Weather

Survey square level REML models were constructed with numbers of bat passes per minute, temperature and rainfall. For Leisler's bat, a significant correlation was found between passes per minute and average monthly temperature and rainfall. The correlation with temperature is positive (estimate 0.033, SE 0.013, Wald p-value 0.01, Figure 20) while that with rain is negative (estimate -0.0007, SE 0.0002, Wald p-value 0.003, Figure 21). A highly significant correlation was also found between observer recorded temperature at the start of each survey and Leisler's passes per minute (estimate 0.02, SE 0.005, Wald p-value <0.001, Figure 22).

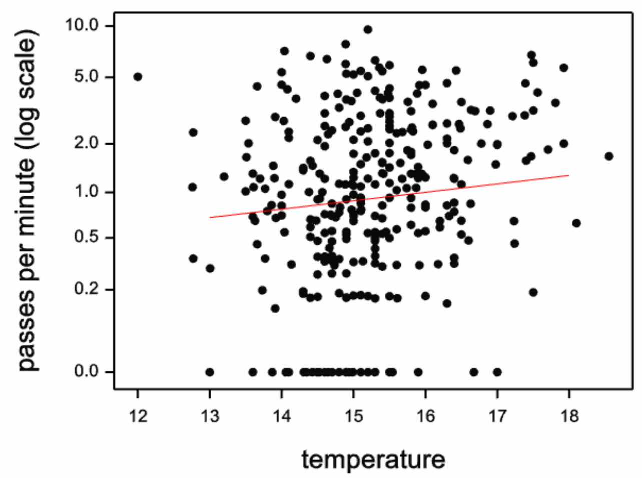


Figure 20: Relationship between Leisler's passes per minute and average monthly temperature (Met Éireann data). Each point represents one car survey and the fitted line is linear on the log scale.

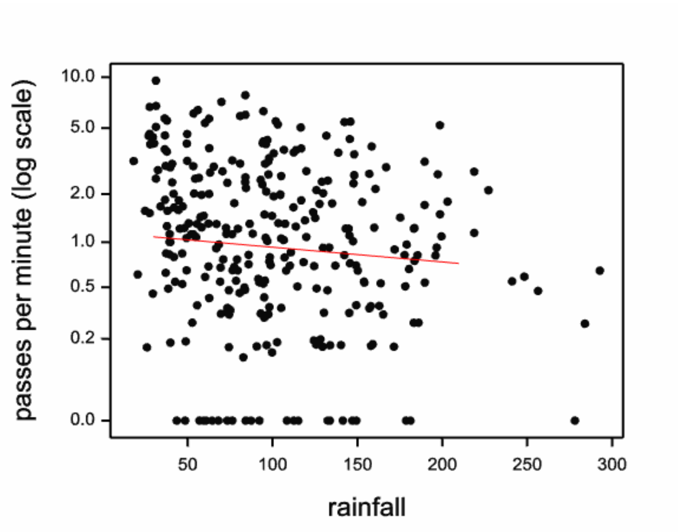


Figure 21: Relationship between Leisler's passes per minute and total monthly rainfall (Met Éireann data). Each point represents one car survey and the fitted line is linear on the log scale.

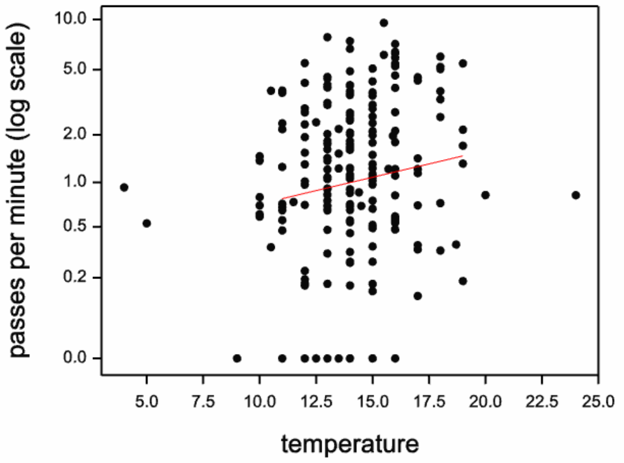


Figure 22: Relationship between Leisler's passes per minute and observer recorded temperature at the start of each survey. Each point represents one car survey and the fitted line is linear on the log scale.

## *Landscape Suitability*

The landscape suitability index for Leisler's bat is shown in Figure 23. As can be seen from this map (taken from Lundy *et al*. 2011), areas of greatest predicted suitability for the Leisler's bat are very widespread. Parts of the north and south west are among the areas predicted to be less suitable for the species. In summary, the habitat types found to be favoured by the Leisler's bat are broadleaved and mixed woodland (at differing spatial scales), riparian habitats and low density urban areas (<30% cover). Landcover types avoided by Leisler's bat include bog/heath and high density urban areas.

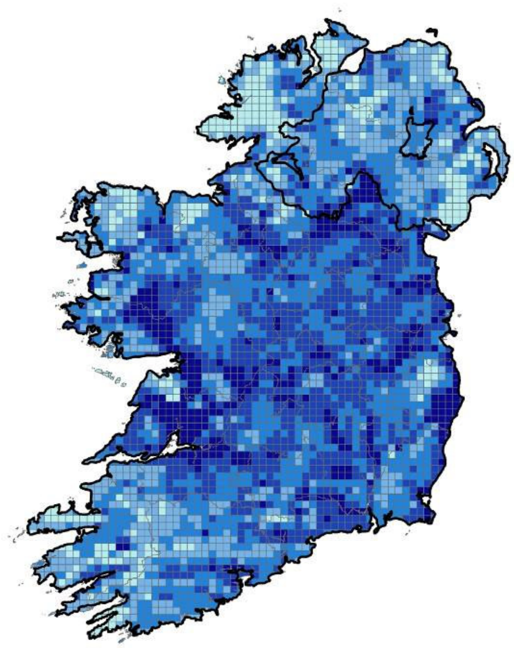

Figure 23: Landscape suitability map for the Leisler's bat, darker areas are more suitable (from Lundy *et al.* 2011).

Using the landscape suitability indices for the start point of each 1.6km transect (derived from Lundy *et al.* 2011) the mean suitability index for each survey route was calculated. A scatterplot of mean landscape suitability and average passes per minute for Leisler's bat is shown in Figure 24.

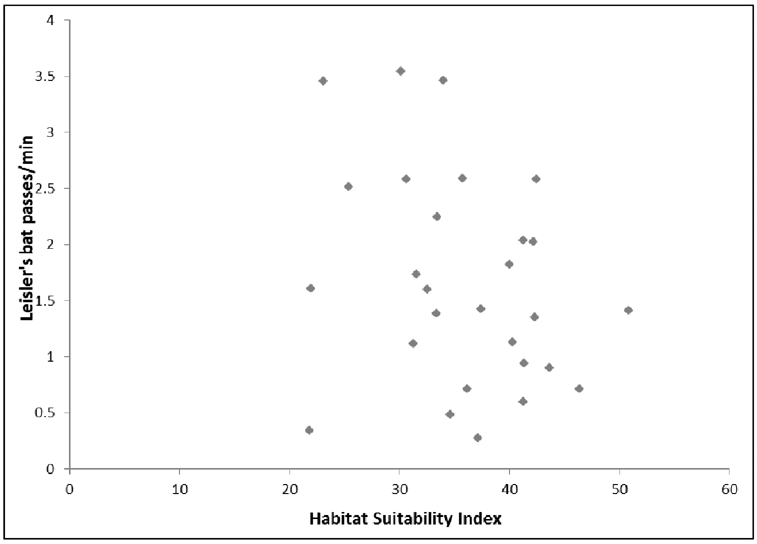


Figure 24: Mean number of Leisler's passes per minute for each survey square plotted against landscape suitability indices, averaged for each survey route.

There is little or no correlation between the landscape suitability indices and observed passes per survey square (coefficient -0.289).

Survey squares were divided into those above or below the median landscape suitability (median=36) for Leisler's bat. A map differentiating between survey squares above or below the median landscape suitability for all survey squares, is shown in Figure 25. The trends in the two groups are shown in Figure 26. The trends look a little different in the graph of squares with lower suitability, but confidence limits are wide and the randomisation test indicates that the differences are not statistically significant (P=0.673).

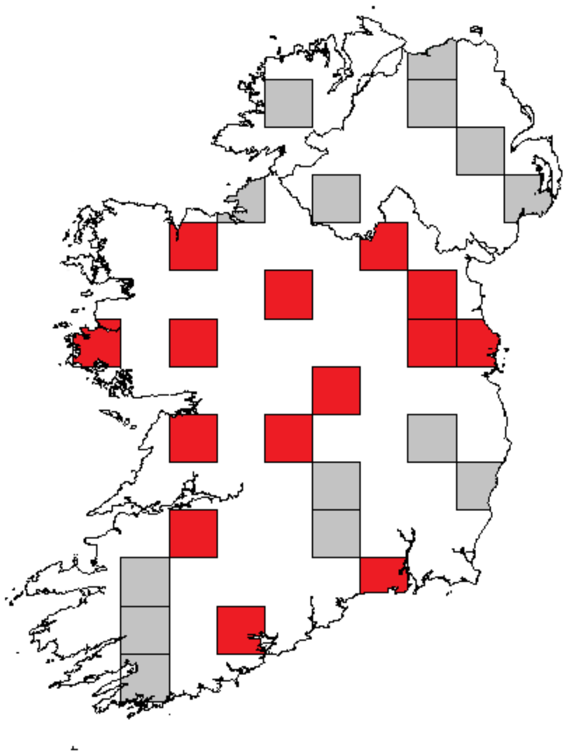

Figure 25: Map showing whether each survey square is above (red) or below (grey) the median predicted landscape suitability (for all 28 survey squares) for Leisler's bat.

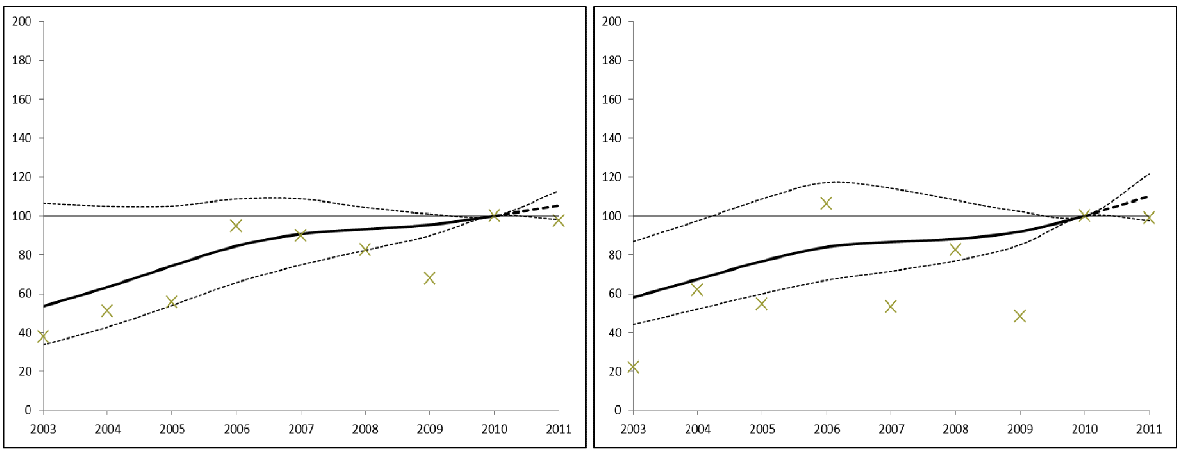


Figure 26: Graph on the left shows trends in Leisler's passes per minute for squares with lower landscape suitability (i.e. below the median for all survey squares) while the graph on the left shows trends in Leisler's bat in survey squares of greater landscape suitability. Baseline 2010=100.

## *Street lights*

Street lights were found to have a significant impact on observed Leisler's passes per minute (REML analysis with a quadratic term fitted to the model for time after sunset, see Table 8). This is illustrated by Figure 27, which shows the predicted number of Leisler's passes per minute in transects with twenty street lights of specified colour, or with none. The number of passes is greatest with yellow and white lights.

Table 8: P-values for Leisler's bat in the REML models. Street light variables are fitted as log-transformed numbers.

| Street light colour | P-value |
|---|---|
| Orange | 0.179 |
| Yellow | 0.004 |
| White | 0.020 |

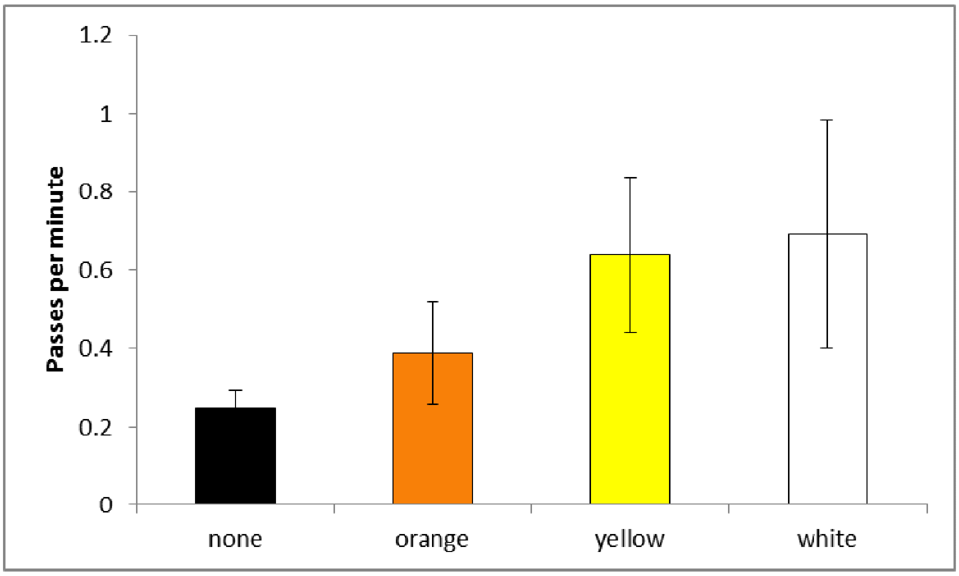


Figure 27: Predictions from the REML models for number of Leisler's bat passes per minute. Standard errors are approximate because the model is fitted on the log scale.

## Summary Trends

A summary trend graph has been produced for the three species monitored by the car-based scheme, see Figure 28.

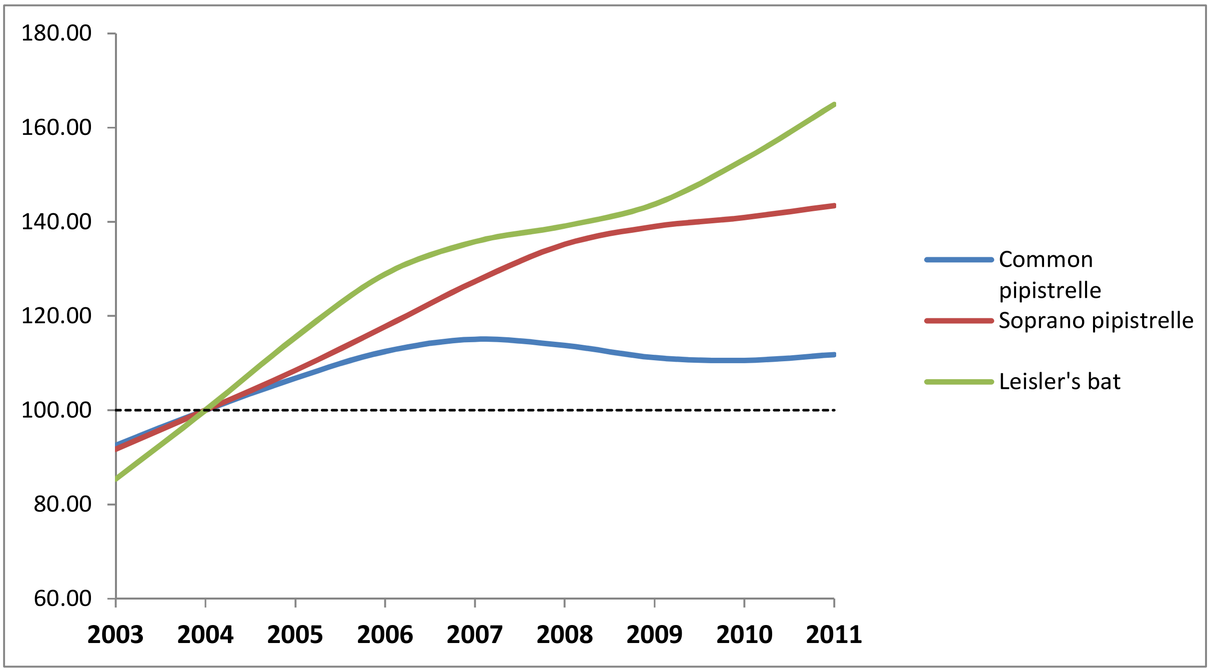


Figure 28: GAM curves for the common pipistrelle, soprano pipistrelle and Leisler's bat. Leisler's bats are significantly increasing, soprano pipistrelles are increasing (the increase was significant for the first time in 2011 so should be treated with caution) and common pipistrelles are stable.

## Nathusius' pipistrelle

Nathusius' pipistrelles remain one of the least encountered species from the survey. It has been recorded less than 150 times since 2005.

### *Yearly Trends*

A binomial model for the proportion of 1.6km transects with Nathusius' pipistrelle passes has been fitted. For this species the results are not expressed as an index, not least because 2004 cannot be used as a baseline since none were identified in that year. After an initial increase from 2005, the proportion has remained more or less constant since 2006. A slightly higher number of passes recorded in 2011 results in the curve no longer bending downwards. The Nathusius' pipistrelle trend graph is shown in Figure 29 with the data used for creating the Figure are shown in Table 9.

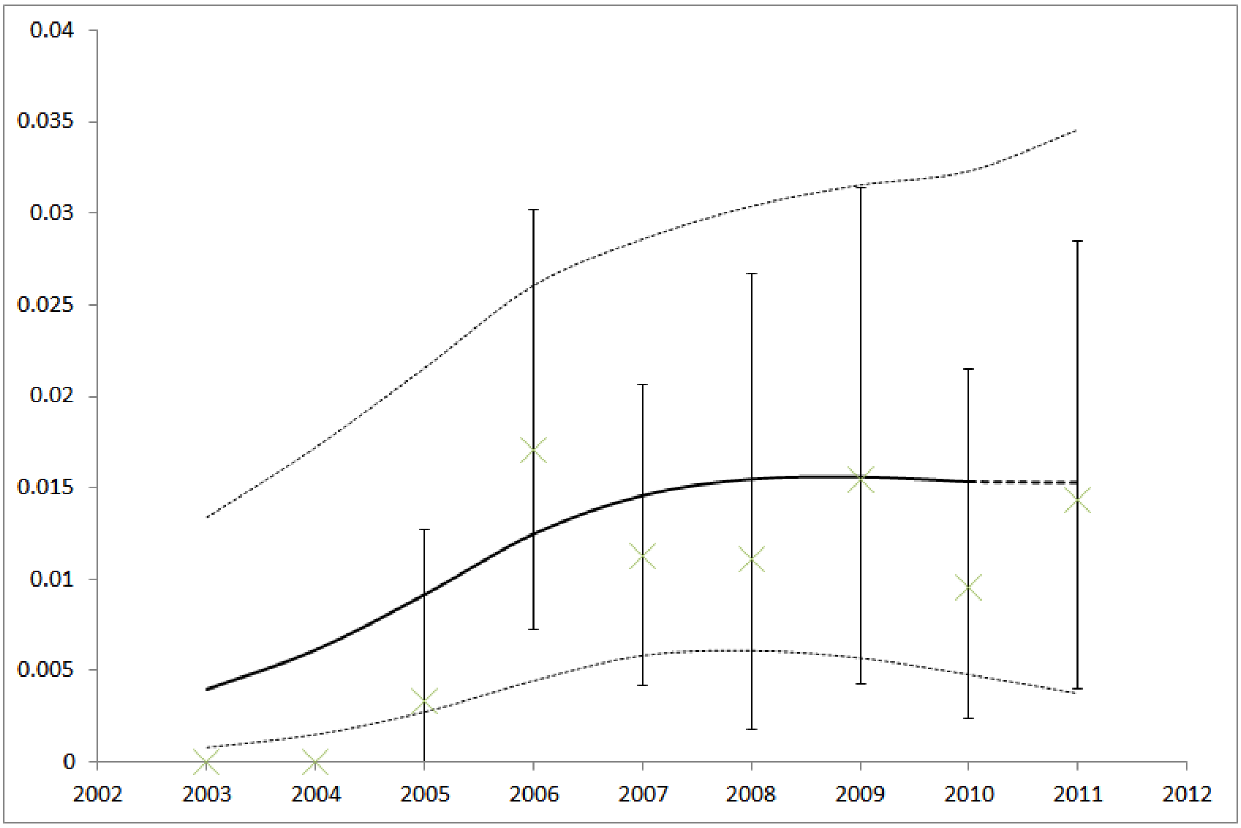


Figure 29: Results of the binomial GAM/GLM model for proportion of 1.6km transects with Nathusius' pipistrelle passes. Green points are estimated annual means and the bars are 95% bootstrapped confidence limits. The solid black line is the fitted GAM curve with 95% confidence limits shown by the upper and lower dotted lines.

Table 9: Binomial GAM results with 95% confidence limits for Nathusius' pipistrelle (using first 15 transects only 2003-2008).

| | | | Prop transects with passes | | Index 2010 = 100 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | smoothed | | 95% conf limits | | unsmoothed | |
| *year* | *surveys* | *sites* | *Mean* | *s.e.* | *estimate* | *s.e.* | *lower* | *upper* | *fitted* | *s.e.* |
| 2003 | 9 | 7 | 0.000 | 0.000 | 0.004 | 0.004 | 0.001 | 0.013 | 0.000 | 0.001 |
| 2004 | 28 | 17 | 0.000 | 0.000 | 0.006 | 0.004 | 0.002 | 0.017 | 0.000 | 0.000 |
| 2005 | 31 | 17 | 0.002 | 0.002 | 0.009 | 0.005 | 0.003 | 0.022 | 0.003 | 0.004 |
| 2006 | 45 | 25 | 0.023 | 0.006 | 0.012 | 0.006 | 0.004 | 0.026 | 0.017 | 0.006 |
| 2007 | 46 | 26 | 0.015 | 0.005 | 0.015 | 0.006 | 0.006 | 0.029 | 0.011 | 0.004 |
| 2008 | 44 | 25 | 0.008 | 0.004 | 0.015 | 0.007 | 0.006 | 0.030 | 0.011 | 0.006 |
| 2009 | 53 | 28 | 0.014 | 0.004 | 0.016 | 0.007 | 0.006 | 0.032 | 0.015 | 0.007 |
| 2010 | 54 | 28 | 0.009 | 0.003 | 0.015 | 0.008 | 0.005 | 0.032 | 0.010 | 0.005 |
| 2011 | 53 | 28 | 0.017 | 0.005 | 0.015 | 0.009 | 0.004 | 0.035 | 0.014 | 0.007 |

### Landscape Suitability

The landscape suitability index for Nathusius' pipistrelle is shown in Figure 30. As can be seen from this map (taken from Lundy *et al*. 2011), areas of greatest predicted suitability for the Nathusius are very restricted compared to the previous three species. Its stronghold is the North and north east, along with lakes in the midlands. Much of the east coast is predicted as having some suitability for the species. It should be noted that this model was constructed on the basis of just 37 records. In summary, the habitat types found to be favoured by the Nathusius' pipistrelles are broadleaved woodland, areas of freshwater (<45% cover) and pasture (<30% cover). Bog/heath is avoided by Nathusius' pipistrelle.

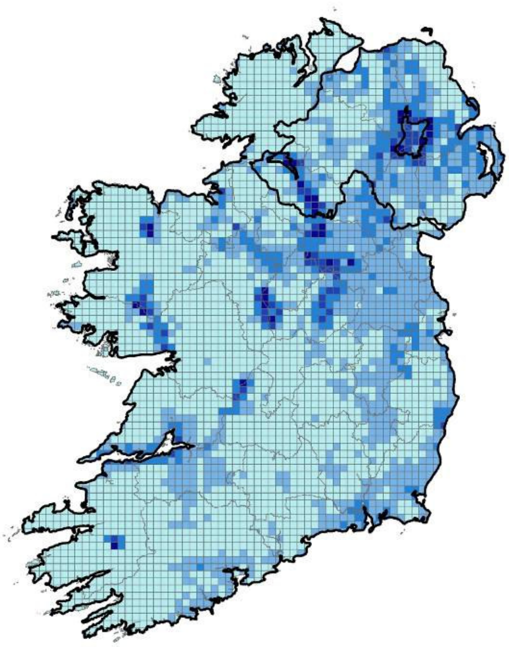

Figure 30: Landscape suitability map for Nathusius' pipistrelle, darker areas are more suitable (from Lundy *et al.* 2011).

At the time that the above modeling was being carried out, records for Nathusius' pipistrelles collected from the car-based bat monitoring scheme had not been georeferenced. However, a back calculation (using transect start point and time spent surveying to calculate the distance travelled and, therefore, likely bat location) was carried out in spring 2012 to pinpoint more than 140 records for publication.

The resulting map (Figure 31) indicates locations of Nathusius' records from the car-based bat monitoring scheme, plotted at a 1km level. As can be seen from this map, Nathusius' pipistrelle bats tend to be found in the same squares year after year, but there are some squares where the species has never been recorded to-date. This reflects the fact that the species can be detected with relative ease but that it has a limited distribution on the island. When viewed in the context of Figure 30 above, it can be seen that Nathusius' pipistrelles picked up during the car-based scheme generally occur in locations predicted to be more suitable for the species. However, notable exceptions can be seen in west Cork and east Kerry, which is not predicted as suitable for the species but where many records for the species have been collected.

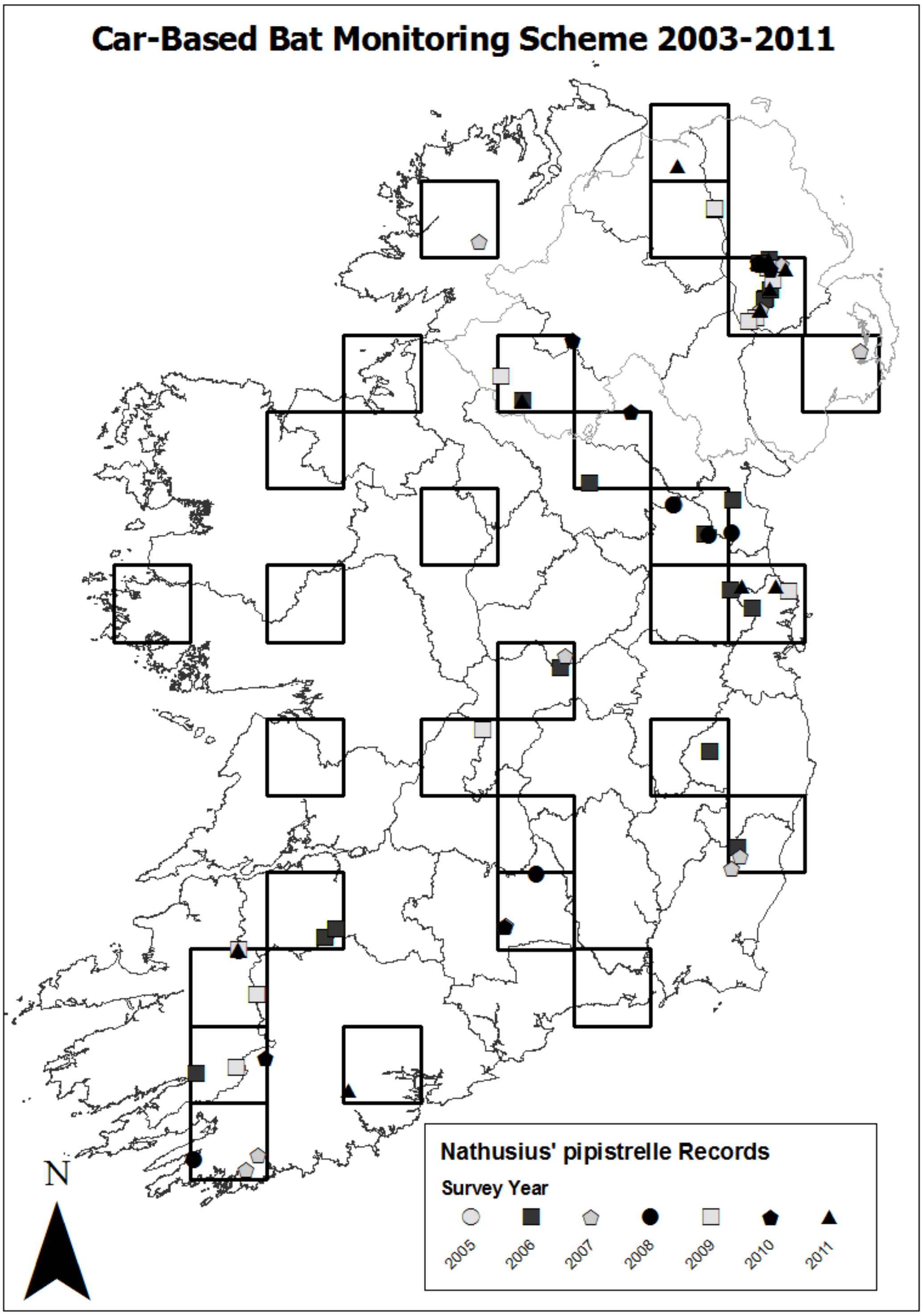


Figure 31: Locations of Nathusius' pipistrelles records derived from the car-based bat monitoring scheme from 2005 to 2011.

## *Myotis* species

Occasional records for *Myotis* species are collected by the car-based bat monitoring method. These records are widespread but infrequent across the island. *Myotis* sp. bat passes could be Natterer's, Daubenton's or whiskered bats but it is not possible to definitively identify them to species level.

While a trend graph (Figure 32) has been constructed for *Myotis* species passes per minute based on the car monitoring data, this shows little evidence of any trend, up or down. Should trends in *Myotis* encounter rates become apparent in time, these should be treated cautiously since the results for *Myotis* bats are likely to comprise a number of species.

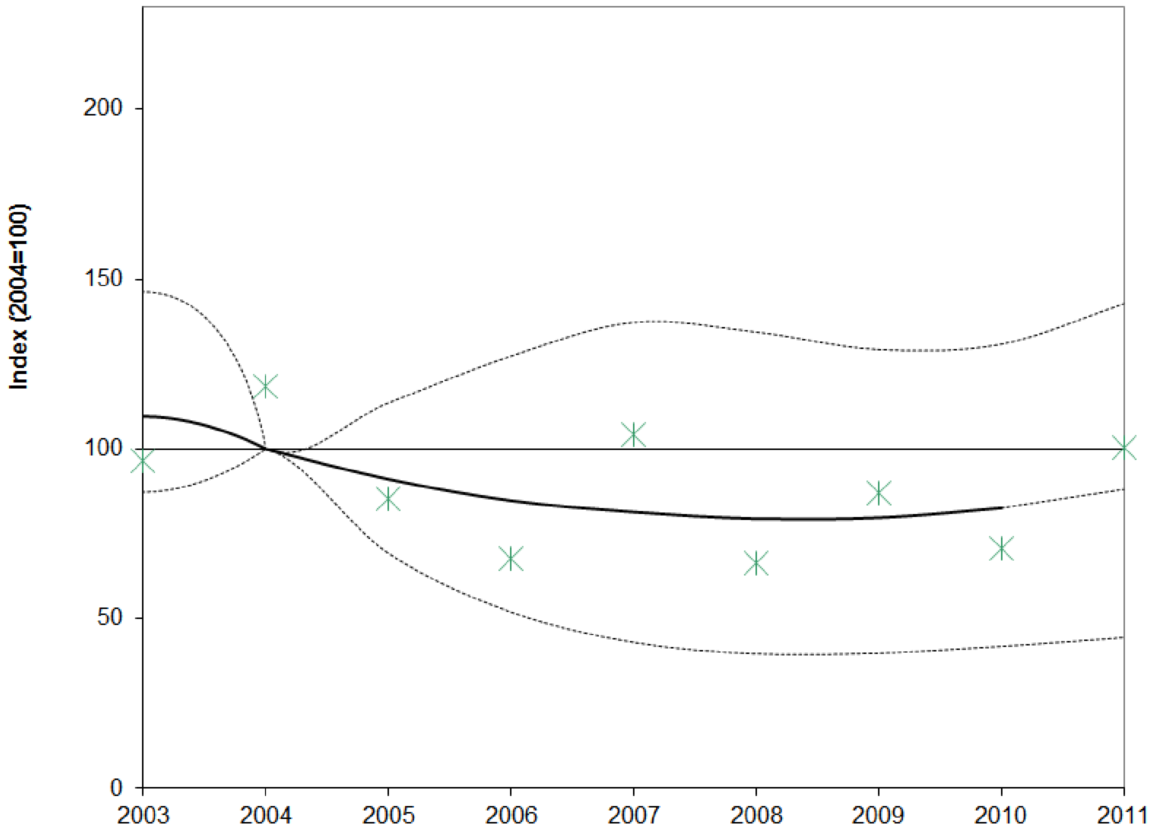


Figure 32: Results of GAM/GLM model for proportion of 1.6km transects with *Myotis* species passes. Green points are estimated annual means and the bars are 95% bootstrapped confidence limits. The solid black line is the fitted GAM curve with 95% confidence limits shown by the upper and lower dotted lines.

Table 10: GAM results with 95% confidence limits for *Myotis* species (using first 15 transects only 2003-2008).

| | | | | | Index 2004 = 100 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean passes | | smoothed | | 95% conf limits | | unsmoothed | |
| *year* | *counts* | *sites* | *Mean* | *s.e.* | *estimate* | *s.e.* | *Lower* | *upper* | *estimate* | *s.e.* |
| 2003 | 9 | 7 | 0.8 | 0.3 | 109.6 | 15.3 | 87.3 | 146.3 | 78.0 | 44.1 |
| 2004 | 27 | 17 | 0.8 | 0.2 | 100.0 | 0.0 | 100.0 | 100.0 | 100.0 | 0.0 |
| 2005 | 31 | 17 | 0.5 | 0.2 | 91.1 | 11.3 | 69.3 | 113.6 | 67.1 | 62.2 |
| 2006 | 45 | 25 | 0.4 | 0.1 | 84.8 | 19.2 | 52.0 | 127.3 | 49.3 | 25.6 |
| 2007 | 46 | 26 | 0.6 | 0.2 | 81.5 | 24.1 | 43.1 | 137.3 | 86.0 | 58.7 |
| 2008 | 42 | 23 | 0.3 | 0.1 | 79.5 | 24.6 | 39.7 | 134.4 | 48.1 | 21.4 |
| 2009 | 52 | 28 | 0.5 | 0.1 | 79.8 | 23.7 | 39.9 | 129.3 | 68.8 | 35.1 |
| 2010 | 53 | 27 | 0.4 | 0.1 | 82.6 | 23.3 | 41.9 | 130.9 | 52.5 | 24.8 |
| 2011 | 53 | 28 | 0.5 | 0.1 | 88.1 | 25.2 | 44.5 | 142.8 | 81.8 | 39.4 |

## Brown long-eared bat

This species was encountered for the first time by the car monitoring scheme in 2007. It is largely undetectable during the car surveys due to its quiet echolocation calls. However, it does occasionally produce social calls of higher amplitude (loudness) which may be recorded. The records for the species are summarized in Table 10 but there is little in the way of an obvious trend. A surprisingly low value was recorded in 2008. When occurrences are examined by site and year, there is little sign of a consistent pattern; which is exactly what would be expected from a widely distributed species with low detection rate.

Table 10: Number of 1.6km transects with brown long-eared bats in each year, excluding surveys with less than eight transects completed.

| Year | Transects with species present | Total surveys |
|---|---|---|
| 2007 | 9 | 46 |
| 2008 | 1 | 44 |
| 2009 | 9 | 53 |
| 2010 | 10 | 54 |
| 2011 | 10 | 53 |

The brown long-eared bat is the subject of a roost counting surveillance methodology that provides more detailed population information for the species than is available from the car-based monitoring method.

## Other Vertebrates

Surveyors were asked to record living and dead vertebrates, that they encountered during the surveys during and between transects. This resulted in the collection of 2,053 records of living vertebrates (apart from bats) from 2006 to 2011. Figure 33 is a pie chart illustrating proportions of living vertebrate records attributed to species or species groups. In all survey years the records for living vertebrates have been dominated by cats. In most years, these accounted for over 50% of the records collected. Rabbits were the second most frequently encountered species with 216 records collected. Dogs and foxes are equally common (190 records each). A number of species of conservation interest have been recorded by surveyors including otter, pine marten, and 12 barn owls.

Dead vertebrates tend to be recorded in differing proportions to live ones (see Figure 34). Despite the high numbers of living cats observed during the car surveys, cats are relatively infrequently observed as road kill, relative to the proportion of live sightings, but still constitute the second most frequently recorded dead vertebrate. The most frequently recorded dead species is the rabbit, while rats and hedgehogs are observed less often.

Since cats are the species that occur in greatest numbers, records for this species were analysed further using TRIM. The total number of cats counted in each square each year was calculated and the time taken to complete the surveys in each square was included as a weighting factor (to account for the differences in time spent). The unsmoothed time effects model with all possible changepoints is shown by the green points in Figure 35. The smoothed data from the default method of stepwise model selection indicated significant change points in the first year of the survey 2006, and the second, 2007. The additive slope between 2006 and 2007 was 0.307, while from 2007 onwards counts appear to have decreased, with an additive slope of -0.092. For both models the baseline year was taken as the second year of the survey, 2007.

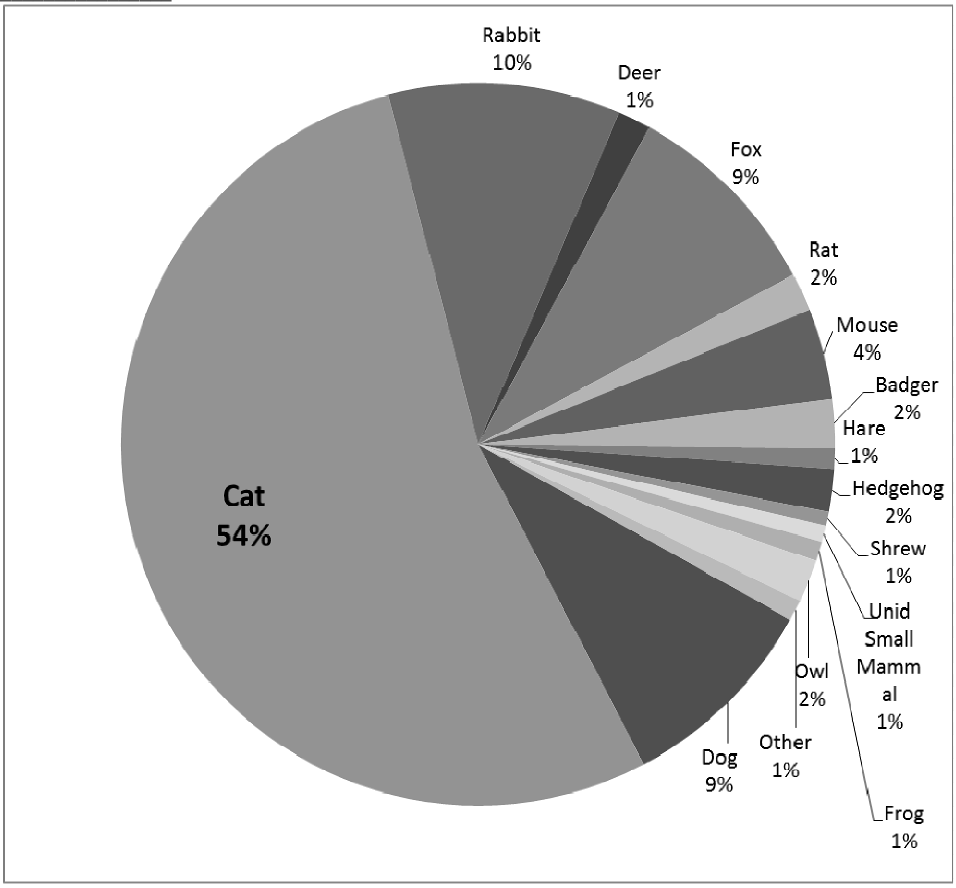


Figure 33: Proportions of living vertebrates recorded during car-based bat monitoring surveys from 2006 to 2011. N=2053.

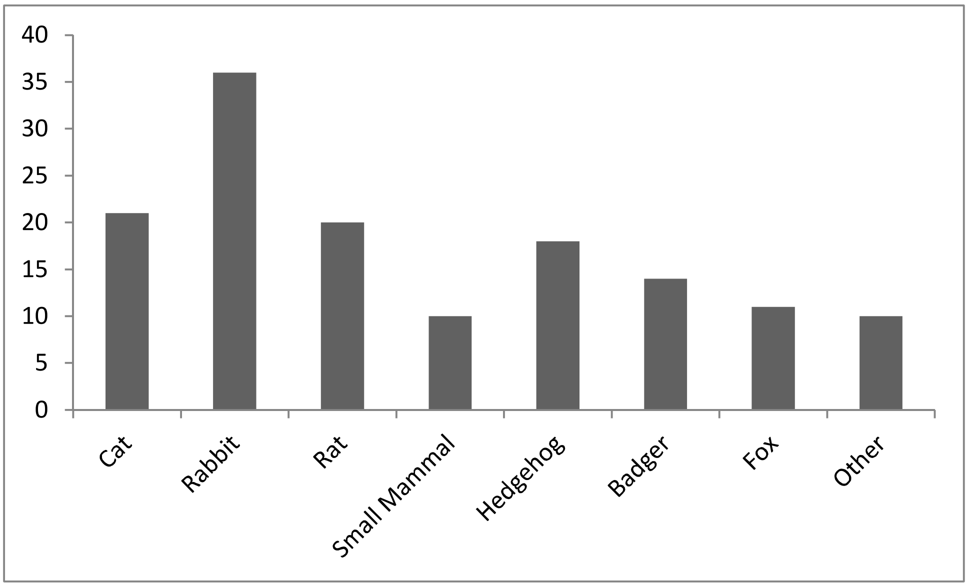


Figure 34: Number of records of dead vertebrates collected during the car-based bat monitoring surveys 2006-2011. N=140.

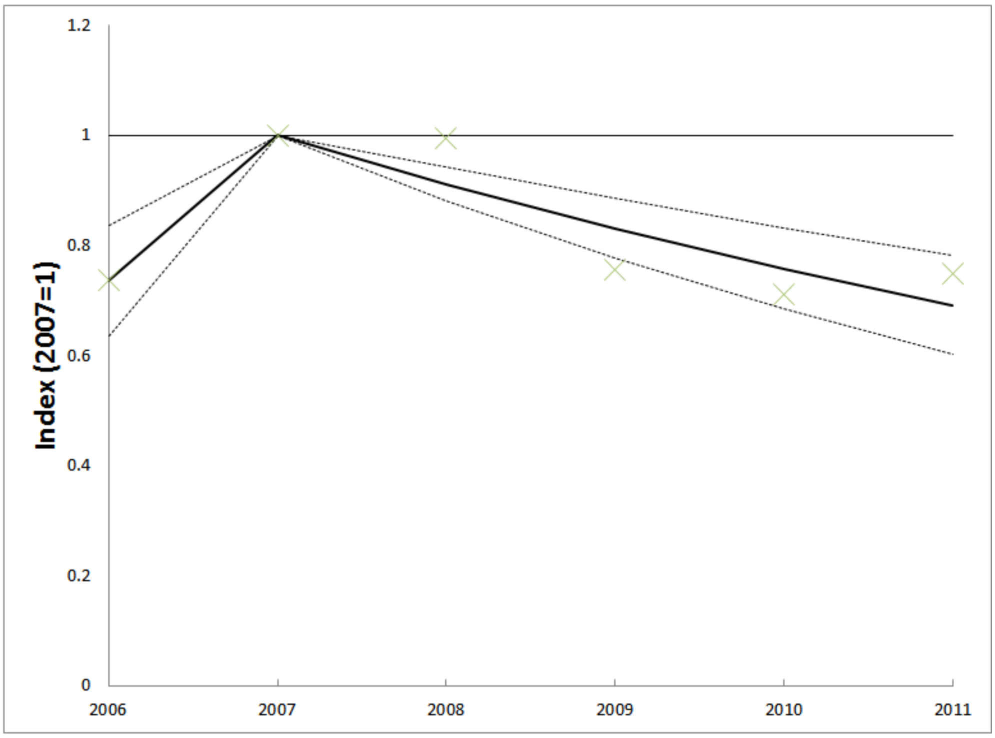


Figure 35: Roadside cat counts, TRIM unsmoothed estimates (the green points are from using a linear model with all possible changepoints) and a TRIM smoothed linear model, with the default stepwise method of selecting changepoints. The baseline year was taken as 2007.

# Discussion

The first nine years of the car based bat monitoring survey has been very successful, with a high level of voluntary commitment (a detailed breakdown of volunteer turnover was provided in 2008, Roche *et al.* 2009), accurate and robust data collection, and routine testing of methodologies and statistical methods. The detailed methodology for the survey was published in 2011 in the peer-reviewed journal, *Animal Conservation* (Roche *et al*., 2011). In addition, sonogram analysis of archived Leisler's bat calls from the survey contributed to a paper on the status of the noctule bat (*Nyctalus noctula*) in Ireland (Puechmaille *et al.* 2011). An additional paper is currently in preparation on the records for Nathusius' pipistrelle that have been collated as part of the survey (Roche *et al.* in prep).

In order to improve the usefulness of the bat records arising from the survey we piloted the use of smartphones as recording devices during 2011. The results from trials were very positive; very similar encounter rates of the three most common species were observed whether recorded by smartphone, minidisc or digital recorder such as Edirol. The phones have the additional benefit of a GPS chip which enables geo-referencing of the bat record without having to resort to a back-calculation (using transect start point and time spent surveying to calculate the distance travelled and, therefore, likely bat location).

This year, with the cumulative data from nine years of the survey scheme, we have carried out a number of new analyses with the aim of assisting in the interpretation of bat occurrence and trend data for the island, as well as examining potential threats to the common bat species.

## Species Trends

The highest common pipistrelle encounter rates were recorded by the car-based bat monitoring scheme in 2007. Unsmoothed estimates for this species tend to show an oscillating trend, although the GAM smoothed trend indicates a small increase since 2003. In 2010, the BCT's National Bat Monitoring Programme reported that this species was significantly increasing in Britain based on the foot-based field surveys carried out there (Anon 2010).

Highest soprano pipistrelle encounter rates were recorded by the car-based bat monitoring scheme in 2008. Again, the unsmoothed estimates for this species tend to show an oscillating trend, but the GAM smoothed trend shows an increase of borderline significance. The BCT's National Bat Monitoring Programme reported in 2010 that this species was showing an increase, based on the foot-based field surveys carried out there, also of borderline significance (Anon 2010). From the available BCT data it appears that the species began to increase from 2004 or thereabouts. The Irish trend for this species, therefore, appears to mirror what has been occurring in Britain.

It should be noted that both common and soprano pipistrelles are also monitored in Britain using colony counts but trends derived from these counts have shown a decrease in both populations.

This decline is considered an artifact of the survey methodology and the field survey results are, in fact, considered more robust (Anon 2010).

Leisler's bat encounter rates were highest in 2006 and 2010. The unsmoothed estimates for this species also oscillate, although the GAM smoothed trend highlights a significant increase since the survey's inception in 2003. Since this species is infrequent in Britain, it is not included in the BCT's population trend indices so no comparable data is available for it.

For all three species, therefore, car-based bat monitoring data indicates that they are stable or increasing. This is encouraging, but, it must be borne in mind that there was a dearth of data on bat populations in Ireland for most of the 20th Century. During this time, particularly during the latter half of the century, there were severe declines documented among many species throughout Europe (e.g. Dietz *et al*. 2009). It can be fairly assumed that declines also occurred here, so any current increases must be placed within this context.

While no other species are encountered by the car-based bat monitoring survey in sufficient numbers to allow robust analysis of trends, a binomial analysis of Nathusius' pipistrelles tentatively indicates that the species remains stable. The records collected for this species from car-based bat monitoring confirm that the species is a summer resident within the Republic of Ireland (RoI), as well as Northern Ireland, even though no maternity roosts have been found in RoI to-date.

## Weather Variables & Climate Change Predictions

In the present study, overall activity of common and soprano pipistrelles was not found to be directly impacted by climate variables (temperature or rainfall). This may be because of the relatively short duration of the study, which takes place over the two warmest summer months when activity is generally at its peak, or because the level of weather data available is not finely tuned enough in the context of the myriad of microhabitats along the route of each survey. It seems likely that the latter may be the case when the results for pipistrelles are considered in the context of the significant positive correlation between Leisler's bat activity (at survey and square level) and temperature.

Leisler's bat was the only one of the three monitored species to show a significant positive correlation with average monthly temperature and temperature data collected by surveyors on the night of the surveys, and a significant negative correlation with rainfall. The direct association between monthly weather conditions and Leisler's activity is probably a reflection of the species' flight and foraging style. It is a high flying, fast species (Shiel *et al.* 2008) that covers much larger distances in one night compared with pipistrelles (e.g. Nicholls and Racey 2006; Waters *et al*., 1999), so weather variables measured at a wider resolution may be more likely to correlate with its activity levels. Well-constructed predictive models for this species with regard to global warming and climate change may, therefore, yield reasonably accurate results. In contrast, potential impacts of climate change on pipistrelles, which forage within a more restricted range and are perhaps impacted at a local scale by weather changes, may be more difficult to predict with accuracy.

The significantly positive correlation between Leisler's bat activity and temperature from the limited timeframe of this study appears to support the findings of Rebelo *et al*. (2009) who predicted range expansion for this species with increasing temperatures. Many factors, climate being just one, can combine to impact on a population, however. One of the reasons why the Leisler's bat is hypothesized to be particularly common in Ireland is the absence of potential competitors such as the noctule bat (Shiel *et al*. 2008). The noctule bat is classified as a Boreal species and is potentially threatened with climate change-induced range reduction (Rebelo *et al*. 2009). However, with predicted increasing temperatures, other large Temperate or even Mediterranean bat species may yet extend their ranges into Ireland thus introducing a new element of competition and potentially reducing Leisler's bats' available prey and/or roost resources.

The Nathusius' pipistrelle was not included in the car-based bat monitoring weather variable analysis since it is recorded too infrequently. Lundy *et al.* (2010) examined records for the species in the UK and found that it was associated with low seasonal variation in temperature and intermediate levels of rainfall. They noted that while suitable areas for the species had existed in the UK since the 1940's, these had expanded and the authors predicted a twofold increase in areas suitable by 2050. The single most influential climate variable contributing to range expansion for the species was the projected increase in minimum temperature (Lundy *et al.* 2010). The ongoing car-based bat monitoring scheme is well placed to pick up Nathusius' pipistrelles should it begin to occur with greater frequency in existing survey squares. However, since this species is modeled as having a currently very restricted range within the island (Lundy *et al.* 2011), it may be worthwhile carrying out stratified sampling within predicted high occurrence areas to increase the number of records collected and to improve the effectiveness of monitoring for the population.

## Street lights

Statistical analyses of street light data did not show any significant impact, positive or negative, on common or soprano pipistrelle passes per minute along lit transects. This indicates that neither species is attracted to or avoids transects with low levels of street lighting. However, it must be borne in mind that most of the transects had relatively low lighting levels, with more than 95% of them having fewer than 20 lamps per 1.6km, whereas much higher lighting levels are likely to be present in densely urban areas or in the vicinity of motorway junctions, for example.

The street lighting analysis showed a clear impact on Leisler's bat activity at transect level. Significantly higher numbers of Leisler's bats may be expected along transects lit with yellow (low pressure sodium lamps) or white (e.g. mercury vapour lamps) street lights. The Leisler's bat has previously been reported as exploiting habitats around street lights in Ireland (Shiel *et al*. 1999).

While street lights, in this report, have been shown to have a neutral or even positive impact on bat activity, there are other bat species that are negatively impacted by them, not least the Annex II listed lesser horseshoe bat (Stone *et al*. 2009). We do not, therefore, propose to promote increased street lighting in the hope that it may provide some benefit to Leisler's bat to the detriment of Ireland's rarer or more light-sensitive bat species. In addition, this study examined relatively low lighting levels, whereas all three monitored species were shown by Lundy *et al*. (2011) to avoid dense urban areas (see below). While a lack of foraging habitat may be one of the reasons for bats avoiding dense urban areas, other factors such as increased traffic and the presence of intense street lighting are also likely to contribute. The car-based bat monitoring scheme, for the most part, avoids dense urban areas for practical reasons, so this habitat types is generally under-represented in the survey.

## Landscape Analysis

Among the habitat types predicted as important for common pipistrelles by Lundy *et al.* (2011) were mixed and broadleaf woodland, riparian habitats and low levels of urban cover. However, the species tends to avoid densely urban areas and bog/heath. The landscape favourability index dataset from Lundy *et al.* (2011) was applied to passes per minute from the car-based survey at square level and there was a positive, though not significant, correlation; average passes per minute increased with improved predicted habitat suitability. This relationship is to be expected. Bearing in mind that the landscape suitability dataset is plotted at a resolution of 5km squares, it is probably not surprising that roadside activity levels do not significantly correlate with average 30km square level habitat favourability.

In a recent paper by Boughey *et al.* (2011) linear landscape features and their characteristics were analysed in the context of the UK National Bat Monitoring Programme Field Survey that has been running in Britain since 1999. The authors found that common pipistrelles were more likely to be present at points adjacent to a linear feature (i.e. hedgerow or treeline), and at points close to woodland than at points with neither.

Some subtle differences were found in habitat preferences of soprano compared with common pipistrelles by Lundy *et al.* (2011). The soprano pipistrelle favoured broadleaved woodland and riparian habitats. While the soprano pipistrelle also favoured low density urban areas, the relationship changes from preference to avoidance at a lower urban density than for the common pipistrelle (i.e. the soprano favoured less densely urban areas than the common pipistrelle). The soprano pipistrelle is also predicted to avoid higher altitudes.

The landscape favourability dataset from Lundy *et al.* (2011) was applied to passes per minute for soprano pipistrelles at square level and there was a positive, though not significant, correlation with increased average passes per minute with higher predicted habitat suitability. This relationship is to be expected. Again, since the dataset from Lundy *et al*. is plotted at a resolution of 5km squares, it is probably not surprising that roadside activity levels do not significantly correlate to a greater degree with 30km survey square level habitat favourability.

Boughey *et al.* (2011) also examined the importance of linear landscape features and their characteristics for the soprano pipistrelle. The authors found that the relationship between soprano pipistrelles and linear features was slightly more complex than that of the common pipistrelle. The soprano pipistrelle favoured points in close proximity to woodland and hedgerows with sparse trees present or treelines (regardless of distance to woodland). However, hedgerows with no trees were only found to be preferred when there was no nearby woodland (>300m distant).

Thus, while overall common and soprano pipistrelle activity along survey routes is approximately correlated with the predicted landscape suitability index, many smaller features, in particular hedgerows and treelines, and even the distance of these from nearby woodland, are likely to impact on pipistrelle activity levels within a locality. Further analysis at transect level may show greater correlation between the landscape index and pipistrelles passes, but a combination of the landscape index and detailed data on linear features would be ideal.

Lundy *et al*. (2011) showed that, in Ireland, the Leisler's bat prefers low levels of urban cover but tends to avoid densely urban areas. Other habitat types found to be favoured by the Leisler's bat were broadleaved woodland, mixed woodland and riparian habitats. Apart from dense urban areas, the main other landcover type avoided by Leisler's bat is bog/heath. The landscape favourability dataset from Lundy *et al.* (2011) was applied to Leisler's passes per minute at square level but there was no correlation found between the two. This result was unexpected. However, results from the weather analyses (above) suggest that Leisler's bat activity is impacted to a greater degree than the two pipistrelles by general weather conditions. The greater mobility of the Leisler's bat compared with the two pipistrelles may be a key factor in explaining their differing interactions with landscape and weather.

The back-calculation of Nathusius' pipistrelle records from the car-based bat monitoring survey has increased the number of available records with which to run a Max Ent model of Nathusius' landscape suitability. While the current model tallies reasonably well with occurrence of Nathusius' pipistrelles along survey routes, there are some exceptions. In west Cork and east Kerry, for example where many records have been collected, some repeatedly, most of the landscape is not shown as even moderately suitable for the species. Fine tuning of the Nathusius' pipistrelle landscape suitability model with the car-based bat monitoring dataset would be ideal and may provide more accurate information on the species' requirements in Ireland.

## GAM and TRIM Trends

For comparative purposes, both GAM and TRIM models were applied to bat pass data. Results showed that there was very little difference in yearly, unsmoothed estimates. This is unsurprising since the models are essentially very similar in terms of the use of a Poisson distribution and a logarithmic link function. The confidence limits can be very different in some cases, reflecting the very different approaches to variance estimation. The TRIM model assumes that variances are equal and hence calculates the confidence limits for these years using an overall estimate of variance. By contrast the bootstrapping approach ensures that unusual observations have a direct impact on the width of the confidence limits for the relevant years.

Comparisons between the smoothed curve of the GAM models and the linear switching trend of the TRIM models, are more difficult because the models are so different. Whilst the width of the final confidence intervals is not, usually, that dissimilar, the TRIM models are much more jagged, responding to outlying years. There is rarely an obvious explanation for the extent of year-to-year variation in bat data, and while the GAM approach smoothes out these fluctuations rendering overall trends more obvious, the jagged results of TRIM tend to mask the underlying trends. Manual, rather than automatic, selection of TRIM changepoints might provide results that were more satisfactory in this respect, but would be more subjective.

We propose to continue using the GLM/GAM method of estimating population trends since this provides a more intuitive result with more apparent trends.

## Other Vertebrates

The car-based bat monitoring project collects records of many living and dead vertebrates along roadsides at night. Bat Conservation Ireland intends to make this data available to the National Biodiversity Data Centre although the data is still collected at relatively poor resolution.

There is currently no data available on the number of cats present in Ireland. The index of cat counts collected and analysed as part of the present project provides an initial attempt to examine trends in cat activity along Ireland's roadsides at night. From TRIM analysis of the available data it appears that the trend is reasonably steady with a recent decrease negating an increase seen in the first year or two of the survey. The prevailing culture of allowing cats to roam freely at night may result in localized impacts to wildlife populations. While the authors of a U.S. study of domestic cats that were allowed to freely hunt found the cats averaged 5.54 kills per month, no relationship was found between the number of cats detected in an area and local small mammal abundance (Kays and DeWan 2006). In contrast, Lepczyk *et al*. (2003) found that cat predation plays an important role in fluctuations of bird populations and should receive more attention in wildlife conservation studies.

In Ireland, the potential for cat predation on bats can only be surmised in the absence of scientifically validated data. In view of the current stable or increasing trends of the three bat species studied in this report, we hypothesise that cat predation is not currently negatively impacting bat numbers on a national scale. However, while the current decrease in roadside cat numbers may simply be coincidental with a rise in some bat numbers, we propose that further investigation of a possible relationship should be carried out as the survey progresses. It should be borne in mind, also, that individual cats with access to a roost exit point have the potential to decimate bat numbers at specific roosts.

This index of roadside night time cat activity may also be of interest to many conservationists, particularly those involved in small mammal and song bird conservation in Ireland so we anticipate submitting the data to a peer-reviewed journal for publication.

## Summary and Assessment of Threats

As mentioned in the Introduction, many factors combine to regulate bat populations and it is unfeasible to imply that this project can fully assess all potential positive or negative influencing factors. The following summaries apply to the species that are monitored using the car-based scheme, since it is not possible to assess population trends or threats to the other species using this method.

### *Common pipistrelle*

This species has the second largest predicted core area of any bat species on the island (56,485ha)

(Lundy *et al*., 2011). Current population trend data indicates that it is stable. While the UK has seen a significant increase in this species (Anon 2011), this has not been reflected in Ireland. It has a range of landscape types available, but favours mixed and broadleaf woodland and riparian habitats. Current research suggests that microhabitats such as linear features play a particularly important role in common pipistrelle activity. It does not avoid low levels of urbanization and it is not negatively impacted by low levels of street lighting. Since no direct correlations have been found from the car-based survey results and weather variables it is impossible to assess how the species is reacting or will react to increasing temperatures.

Small scale habitat management such as hedgerow maintenance (and loss) is likely to play an important role in regulating the species at a local level. Potential loss of hedgerows and treelines is probably one of the main threats for this species in Ireland. In addition, the species often roosts in buildings so there is continuing potential for human disturbance and roost loss through deliberate or accidental exclusion. The possible impacts of climate change on this species are unknown and cannot, therefore, be assessed in terms of potential threats.

### *Soprano pipistrelle*

This species has the largest predicted core area of any bat species on the island (62,020ha) (Lundy *et al*., 2011). Current population trend data indicates that it is increasing. The Irish trend of a (just about) significant increase has been mirrored in the UK (Anon 2011). It has a range of landscape types available but favours broadleaf woodland and riparian habitats, and it selects low levels of urbanization. Current research suggests that microhabitats such as linear features play a particularly important role in soprano pipistrelle activity. This species is not negatively impacted by low levels of street lighting. Since no direct correlations have been found from the car-based survey results and weather variables it is impossible to assess how the species is reacting or will react to increasing temperatures.

Small scale habitat management such as linear feature (hedgerow & treeline) maintenance (and loss) is likely to play an important role in regulating the species at a local level. Potential loss of hedgerows and treelines is probably one of the main threats for this species in Ireland. In addition, the species roosts in buildings, so there is continuing potential for human disturbance and roost loss through deliberate or accidental exclusion. This issue is particularly important for the soprano pipistrelle which sometimes roosts in very large numbers and can cause an odour problem in roosts, therefore resulting in a direct conflict with roost owners (C. Kelleher and P. Scott, *pers. comm*.). The potential impacts of climate change on this species are unknown and cannot, therefore, be assessed in terms of potential threats.

### *Leisler's bat*

This species also has a large predicted core area on the island (52,820ha) (Lundy *et al.*, 2011). Current population trend data indicates that it is increasing significantly. No comparable population information is available from any other country since it is infrequent or rare elsewhere in Europe. It has a range of landscape types available but favours mixed/broadleaf woodland, riparian habitats, and low levels of urbanization. It is positively impacted by low levels of street lighting. A direct correlation has been found between the car-based survey results for this species and temperature, indicating that it is positively impacted by increased temperature. Models of Leisler's bat range indicate that it may be positively impacted by climate change in all but the most extreme scenarios examined by Rebelo *et al.* (2009).

Bat Conservation Ireland carried out a voluntary survey of known Leisler's bat roosts in 2011 and found that of the 15 proposed Natural Heritage Areas (pNHAs) for this species, just four of these roosts were currently occupied by Leisler's bat (C. Shiel *pers. comm.*).

In Ireland, therefore, there is direct evidence of roost loss, although in most cases it is unknown whether the bats simply moved or were deliberately or accidentally excluded. Roosting site pressure is therefore considered the main threat to Leisler's bat here but more information is needed. At present, climate change does not pose a direct threat to Leisler's bat and may even benefit the species. However, with climate change there is a potential threat of newly arrived competing bat species where the Leisler's bat currently has none in Ireland. Should an extreme climate change scenario come to fruition, this may also directly, negatively impact the species in the latter half of this century (Rebelo *et al*. 2009).

## Conclusions and Recommendations

- There is no evidence of decline in any of the three species, the common pipistrelle, soprano pipistrelle or Leisler's bat, monitored using the car-based bat monitoring scheme. There is evidence that the common pipistrelle is stable, the soprano pipistrelle is increasing and that the Leisler's bat is significantly increasing. We hypothesise that increases in Leisler's bat are, at least in part, linked to climate change but we have no evidence that this is an influencing factor on the increase in soprano pipistrelles.

- We examined the possibility of using TRIM as an alternative method for assessing population trends but are satisfied that GLM/GAM analysis provides better results for our purposes.

- In a separate project with the Centre for Irish Bat Research, using centrally held data from Bat Conservation Ireland's bat database, we investigated landscape favourability for these species and found that they have a range of habitats available to them while tending to prefer broadleaf woodland, riparian habitats and low density urbanization (Lundy *et al.* 2011). Using the landscape dataset with car-based bat monitoring analysis we found no difference in population trends in areas that were more or less favourable for each species.

- The Leisler's bat shows increased activity in the vicinity of yellow or white street lights while the common and soprano pipistrelles do not show any preference for, or avoidance of, lit roadsides.

- The Nathusius' pipistrelle information gathered by this scheme is limited because many squares do not fall within its core range on the island. As far as we can deduce from the available data it appears to be reasonably stable, but a dedicated Nathusius' pipistrelle car survey targeting known or predicted favourable areas is likely to yield better results.

- Insufficient data are collected by this scheme for analysis of *Myotis* species or brown long-eared bat population trends.

- An analysis of cat counts from roadsides in July and August indicates that this species is not increasing at present.

We recommend the following for the next three years of the car-based bat monitoring scheme:

- Continue surveying all 28 squares twice yearly. Recruit and train new surveyors as required.

- Phase in the use of smartphones and carry out training with survey teams over the next two-three years.

- Ensure that the App used to simultaneously record sound and GPS data is bug free for 2012 survey season.

- Consider options for using satellite tracking software, instead of hard copy maps, in tandem with recording App for 2013 survey season. In addition, survey routes should be digitized to allow easy transfer between devices.

- Consider options to allow geo-referencing of other vertebrate records.

- Weather data – investigate the possibility of continuous weather recording along transects.

- Detailed habitat analysis, in particular of hedgerow and treelines, of survey routes.

- Continue using GLM/GAM method of assessing population trends.

- Investigate the cost and feasibility of car-based survey specifically for Nathusius' pipistrelle monitoring within predicted and confirmed high occurrence areas.

- Continue assessing roadside cat trend data and submit a paper on same to peer reviewed journal.

- Discuss with the National Biodiversity Data Centre options for transfer of other vertebrate data.

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# Glossary of Terms

**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=0.1 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.

**Relative Standard Error**

The standard error of an estimate expressed as a proportion of the percentage of the estimate. Also known as the coefficient of variation.

**TRIM**

TRends and Indices for Monitoring Data. TRIM is a program developed for the analysis of count data obtained from monitoring wildlife populations. It analyses time series of counts, using Poisson regression and produces estimates of yearly indices and trends.

# Appendix

## Summary statistics

Summary statistics are shown in the table below.

**Table 1: Descriptive statistics (transects with less than 50 snapshots are excluded)**

**a) Common pips**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2003 | 217 | 173 | 1.25 | 50.3 | 13225 | 217 | 1.64 | 3.00 |
| 2004 | 1055 | 545 | 1.94 | 57.4 | 41542 | 1023 | 2.46 | 4.80 |
| 2005 | 811 | 596 | 1.36 | 52.2 | 47170 | 798 | 1.69 | 3.23 |
| 2006 | 1506 | 880 | 1.71 | 52.7 | 67314 | 1443 | 2.14 | 4.24 |
| 2007 | 1567 | 880 | 1.78 | 53.9 | 65312 | 1489 | 2.28 | 4.49 |
| 2008 | 1548 | 860 | 1.80 | 50.1 | 63830 | 1548 | 2.43 | 4.52 |
| 2009 | 954 | 782 | 1.22 | 48.5 | 58320 | 936 | 1.60 | 3.04 |
| 2010 | 1157 | 811 | 1.43 | 49.7 | 59608 | 1140 | 1.91 | 3.66 |
| 2011 | 1192 | 783 | 1.52 | 51.2 | 56231 | 1158 | 2.06 | 3.94 |
| All years | 10007 | 6310 | 1.59 | 51.7 | 472552 | 9752 | 2.06 | 3.97 |

**b) Soprano pips**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2003 | 82 | 173 | 0.47 | 24.9 | 13225 | 82 | 0.62 | 1.15 |
| 2004 | 386 | 545 | 0.71 | 34.3 | 41542 | 377 | 0.91 | 1.71 |
| 2005 | 333 | 596 | 0.56 | 31.5 | 47170 | 329 | 0.70 | 1.32 |
| 2006 | 573 | 880 | 0.65 | 33.4 | 67314 | 562 | 0.83 | 1.55 |
| 2007 | 566 | 880 | 0.64 | 32.2 | 65312 | 550 | 0.84 | 1.62 |
| 2008 | 701 | 860 | 0.82 | 38.7 | 63830 | 701 | 1.10 | 2.03 |
| 2009 | 562 | 782 | 0.72 | 32.4 | 58320 | 550 | 0.94 | 1.75 |
| 2010 | 545 | 811 | 0.67 | 33.0 | 59608 | 528 | 0.89 | 1.65 |
| 2011 | 611 | 783 | 0.78 | 36.3 | 56231 | 589 | 1.05 | 2.02 |
| All years | 4359 | 6310 | 0.69 | 33.8 | 472552 | 4268 | 0.90 | 1.70 |

**c) 50khz pips (NB shown as missing in my dataset for 2003)**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2004 | 247 | 545 | 0.45 | 29.2 | 41542 | 247 | 0.59 | 1.12 |
| 2005 | 159 | 596 | 0.27 | 20.0 | 47170 | 159 | 0.34 | 0.63 |
| 2006 | 239 | 880 | 0.27 | 18.6 | 67314 | 238 | 0.35 | 0.67 |
| 2007 | 225 | 880 | 0.26 | 17.7 | 65312 | 221 | 0.34 | 0.65 |
| 2008 | 266 | 860 | 0.31 | 18.4 | 63830 | 266 | 0.42 | 0.77 |
| 2009 | 173 | 782 | 0.22 | 14.7 | 58320 | 171 | 0.29 | 0.53 |
| 2010 | 194 | 811 | 0.24 | 16.6 | 59608 | 194 | 0.33 | 0.59 |
| 2011 | 272 | 783 | 0.35 | 21.7 | 56231 | 270 | 0.48 | 0.89 |
| All years | 1775 | 6137 | 0.29 | 19.2 | 459327 | 1766 | 0.38 | 0.72 |

**d) *Myotis* spp**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2003 | 7 | 173 | 0.04 | 2.9 | 13225 | 7 | 0.05 | 0.11 |
| 2004 | 28 | 545 | 0.05 | 4.4 | 41542 | 28 | 0.07 | 0.12 |
| 2005 | 21 | 596 | 0.04 | 2.3 | 47170 | 21 | 0.04 | 0.08 |
| 2006 | 26 | 880 | 0.03 | 2.4 | 67314 | 26 | 0.04 | 0.07 |
| 2007 | 32 | 880 | 0.04 | 2.5 | 65312 | 32 | 0.05 | 0.09 |
| 2008 | 26 | 860 | 0.03 | 2.6 | 63830 | 26 | 0.04 | 0.07 |
| 2009 | 25 | 782 | 0.03 | 2.7 | 58320 | 25 | 0.04 | 0.08 |
| 2010 | 19 | 811 | 0.02 | 1.8 | 59608 | 19 | 0.03 | 0.05 |
| 2011 | 29 | 783 | 0.04 | 3.2 | 56231 | 29 | 0.05 | 0.09 |
| All years | 213 | 6310 | 0.03 | 2.7 | 472552 | 213 | 0.05 | 0.08 |

**e) Leisler's**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2003 | 52 | 173 | 0.30 | 15.6 | 13225 | 52 | 0.39 | 0.72 |
| 2004 | 295 | 565 | 0.52 | 23.2 | 43087 | 293 | 0.68 | 1.31 |
| 2005 | 314 | 596 | 0.53 | 21.6 | 47170 | 314 | 0.67 | 1.24 |
| 2006 | 787 | 880 | 0.89 | 27.6 | 67314 | 769 | 1.14 | 2.26 |
| 2007 | 557 | 880 | 0.63 | 20.3 | 65312 | 547 | 0.84 | 1.56 |
| 2008 | 556 | 860 | 0.65 | 22.7 | 63830 | 556 | 0.87 | 1.62 |
| 2009 | 384 | 782 | 0.49 | 19.3 | 58320 | 379 | 0.65 | 1.24 |
| 2010 | 651 | 811 | 0.80 | 24.3 | 59608 | 637 | 1.07 | 2.02 |
| 2011 | 605 | 783 | 0.77 | 25.8 | 56231 | 586 | 1.04 | 1.99 |
| All years | 4201 | 6330 | 0.66 | 23.0 | 474097 | 4133 | 0.87 | 1.66 |

**f) Nathusius' Pipistrelle**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2003 | 0 | 173 | 0.00 | 0.0 | 13225 | 0 | 0.00 | 0.00 |
| 2004 | 0 | 565 | 0.00 | 0.0 | 43087 | 0 | 0.00 | 0.00 |
| 2005 | 1 | 596 | 0.00 | 0.2 | 47170 | 1 | 0.00 | 0.00 |
| 2006 | 29 | 880 | 0.03 | 2.2 | 67314 | 28 | 0.04 | 0.08 |
| 2007 | 13 | 880 | 0.01 | 1.2 | 65312 | 13 | 0.02 | 0.04 |
| 2008 | 6 | 860 | 0.01 | 0.7 | 63830 | 6 | 0.01 | 0.02 |
| 2009 | 25 | 782 | 0.03 | 1.4 | 58320 | 25 | 0.04 | 0.08 |
| 2010 | 56 | 811 | 0.07 | 0.9 | 59608 | 41 | 0.07 | 0.19 |
| 2011 | 17 | 783 | 0.02 | 1.7 | 56231 | 17 | 0.03 | 0.06 |
| All years | 147 | 6330 | 0.02 | 1.1 | 474097 | 131 | 0.03 | 0.06 |

**g) Brown long-eared (not separately recorded before 2007)**

| | | Statistics per mile transect | | | Statistics per 0.32ms recording | | | |
|---|---|---|---|---|---|---|---|---|
| year | Total passes | n transects | mean passes | % with passes | n | n with | % with passes | passes per min |
| 2007 | 17 | 880 | 0.02 | 1.4 | 65312 | 17 | 0.03 | 0.05 |
| 2008 | 2 | 860 | 0.00 | 0.2 | 63830 | 2 | 0.00 | 0.01 |
| 2009 | 9 | 782 | 0.01 | 1.2 | 58320 | 9 | 0.02 | 0.03 |
| 2010 | 10 | 811 | 0.01 | 1.2 | 59608 | 10 | 0.02 | 0.03 |
| 2011 | 13 | 783 | 0.02 | 1.3 | 56231 | 13 | 0.02 | 0.04 |
| All years | 51 | 4116 | 0.01 | 1.0 | 303301 | 51 | 0.02 | 0.03 |

## Weather Data

**Table 2: estimates, standard errors and Wald p-values for the relationship between log-transformed passes per minute (real time) and monthly met data.** All species groups are shown, but results for the less common species should be treated with great caution.

| | **Monthly average temperature** | | | **Monthly rainfall** | | |
|---|---|---|---|---|---|---|
| **Species** | **estimate** | **s.e.** | **P** | **estimate** | **s.e.** | **P** |
| Ppipistrellus | 0.00666 | 0.015673 | 0.671 | -0.0003675 | 0.0002727 | 0.178 |
| Ppygmaeus | 0.01904 | 0.013917 | 0.172 | -0.0002062 | 0.0002443 | 0.399 |
| Unk_pipistrelles | 0.00508 | 0.010352 | 0.624 | -0.0001830 | 0.0001887 | 0.332 |
| *Myotis* | 0.00393 | 0.003824 | 0.305 | 0.0000275 | 0.0000726 | 0.706 |
| Leislers | 0.03355 | 0.012935 | 0.010 | -0.0007039 | 0.0002329 | 0.003 |
| Nathusius | 0.00333 | 0.001891 | 0.080 | 0.0000028 | 0.0000375 | 0.940 |
| Brown_lg_eared | 0.00189 | 0.003209 | 0.556 | -0.0000138 | 0.0000524 | 0.793 |
| All_Bats | 0.05031 | 0.016423 | 0.002 | -0.0006999 | 0.0002813 | 0.013 |

**Table 3: estimates, standard errors and Wald p-values for the relationship between log-transformed passes per minute and temperature recorded by surveyor.** All species groups are shown, but results for the less common species should be treated with great caution.

| | **Temperature at start** | | |
|---|---|---|---|
| **Species** | **estimate** | **s.e.** | **P** |
| Ppipistrellus | -0.011029 | 0.006425 | 0.086 |
| Ppygmaeus | 0.005605 | 0.005787 | 0.333 |
| Unk_pipistrelles | 0.001267 | 0.004341 | 0.770 |
| *Myotis* | 0.001909 | 0.001564 | 0.223 |
| Leislers | 0.020168 | 0.005267 | <0.001 |
| Nathusius | 0.000897 | 0.000816 | 0.273 |
| Brown_lg_eared | 0.000385 | 0.000913 | 0.673 |
| All_Bats | 0.006021 | 0.006864 | 0.381 |

## Street Light Analysis

**Table 4: P-values for terms in the REML models.** Streetlight variables are fitted as log-transformed numbers.

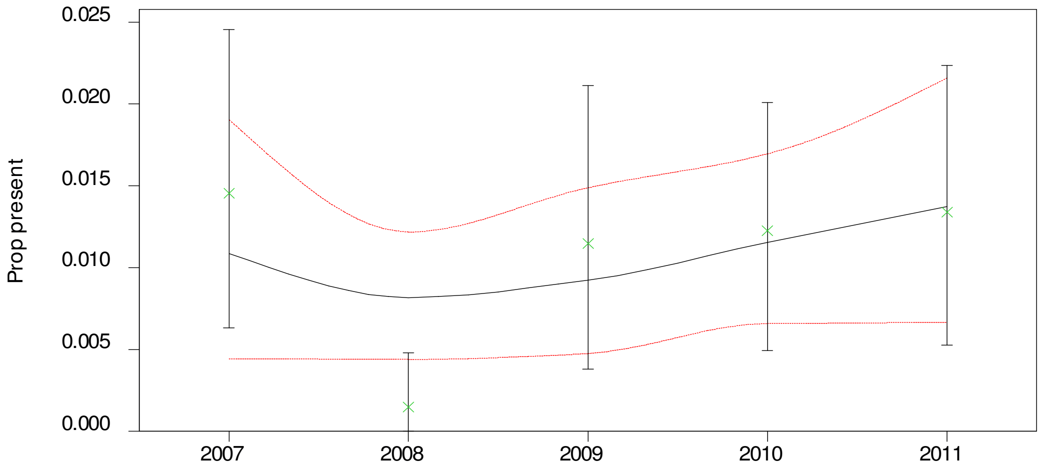
| terms | Common pip | Soprano pips | 50khz pip | *Myotis* spp | Leisler's | Nath pip | Brown long-ear |
|---|---|---|---|---|---|---|---|
| **Streetlights** | | | | | | | |
| orange | 0.726 | 0.232 | 0.217 | 0.624 | 0.179 | 0.084 | 0.256 |
| yellow | 0.391 | 0.331 | 0.058 | 0.888 | 0.004 | 0.136 | 0.817 |
| white | 0.799 | 0.374 | 0.368 | 0.143 | 0.020 | 0.170 | 0.570 |
| **Time after sunset** | | | | | | | |
| linear | <0.001 | <0.001 | 0.001 | 0.020 | 0.034 | 0.009 | 0.283 |
| quadratic | <0.001 | <0.001 | 0.005 | 0.033 | 0.005 | 0.016 | 0.334 |

## Binomial GAM Analysis: Brown Long-eared Bat

**Table 5: Binomial GAM results with 95% confidence limits for Brown Long-eared (using first 15 transects only 2003-2008).**

| | *Data* | | | | *Smoothed GAM model* | | | | **Unsmoothed GLM** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Prp transects* | | | | *95% conf limits* | | | |
| *year* | *surveys* | *sites* | *Mean* | *s.e.* | *estimate* | *s.e.* | *lower* | *upper* | **fitted** | **s.e.** |
| *2007* | *46* | *26* | *0.014* | *0.004* | *0.011* | *0.004* | *0.004* | *0.019* | 0.015 | 0.005 |
| *2008* | *44* | *25* | *0.002* | *0.001* | *0.008* | *0.002* | *0.004* | *0.012* | 0.001 | 0.001 |
| *2009* | *53* | *28* | *0.012* | *0.004* | *0.009* | *0.003* | *0.005* | *0.015* | 0.011 | 0.004 |
| *2010* | *54* | *28* | *0.013* | *0.004* | *0.012* | *0.003* | *0.007* | *0.017* | 0.012 | 0.004 |
| *2011* | *53* | *28* | *0.013* | *0.004* | *0.014* | *0.004* | *0.007* | *0.022* | 0.013 | 0.004 |

**Figure 1: Results of the GAM/GLM model for proportion of mile transects with Brown long-eared passes.** Green points are estimated annual means and the bars are 95% bootstrapped confidence limits. The black line is the fitted GAM curve with 95% confidence limits shown by the red dotted lines.



## Locations and Descriptions of Survey Routes

**Table 6: Transect start and end point grid references and descriptive information. Note that descriptive information may not have been updated since the route was first established so certain details may no longer apply.**

| Square (Transect No) Year Established | Grid ref Start | Grid ref End | Description of Start Point | Address |
|---|---|---|---|---|
| C72 (1) 2007- | C982261 | C989247 | Start at Bogland Road, Dunaghy Road junction. House on right No. 26. End at no. 3 Green Acre lodge, Bogland Road | Northern Ireland |
| C72 (2) 2007- | C9360027000 | C9260028500 | Start at 186 House red brick. Seacon Road. Row of houses on left, open fields. End at 149 House Forest areas on left hand side. End at 148 on right. | Northern Ireland |
| C72 (3) 2007- | C8970026600 | C9070025000 | Start at Glenstall Road, riding school on left. End at bend after marina. House no. 28 pillars on right hand side. | Northern Ireland |
| C72 (4) 2007- | C9560021900 | C9350021700 | Start at Moneycannon road at Claughey Bridge. No. 55 House on left. End at double gates on right. Barns on right. | Northern Ireland |
| C72 (5) 2007- | C8110021200 | C8690020000 | Start at Moneycarrie Road. Start at hump sign. End at first give way sign on left. | Northern Ireland |
| C72 (6) 2007- | C8550026200 | C8430027100 | Start at Coolyvenny Road at No. 72 House. Pillars with dogs on them. End at junction Coolyvenny road and Ballylintogh Road at Killure Bridge. | Northern Ireland |
| C72 (7) 2007- | C8000025000 | C8100026300 | Start at Letterloam Road, at Shinny Bridge cross roads. End at House no. 30 on Letterloam Road, white house on right. | Northern Ireland |
| C72 (8) 2007- | C7330020600 | C7350022500 | Start at Terrydo Road House no. 63/65. End at hill, stop in middle at pole with gas arrow orange top on left. | Northern Ireland |
| C72 (9) 2007- | C7130025600 | C7250026500 | Start at Bolea Road at cul de sac on left, no. 19 house on right. End at wall on right beside farmyard / shed with corrugated iron. | Northern Ireland |
| C72 (10) 2007- | C7450028900 | C7470030500 | Start at Altikearagh Road, conifer forest on each side at start of road. End at point where lines on road start. | Northern Ireland |
| C72 (11) 2007- | C7170034100 | C7300034900 | Start at Bishop\\'s Road, at Gortmore picnic area. End at bridge wall. | Northern Ireland |
| C72 (12) 2007- | C7840033800 | C7760032400 | Start at the start of Sconce Road. Finsh at end of road. | Northern Ireland |
| C72 (13) 2007- | C8010030600 | C8050029100 | Start at no. 67 house with white pillars. End on hill, double gates on left. | Northern Ireland |
| C72 (14) 2007- | C8170034400 | C8300033300 | Start at Cranagh Road, at house with wooden gates on right. End at Hagheragwee Road, fork in road. | Northern Ireland |
| C72 (15) 2007- | C8690029900 | NULL | Start at Mount Sandle Road, at Mountlewood sign, woodland on right. End at house no. 225. | Northern Ireland |
| G20 (1) 2006- | G2150504895 | G2296205204 | Past Pontoon Hotel until Foxford turnoff | Mayo |
| G20 (2) 2006- | G2297407907 | G2238408965 | Small Layby before Knockmore. Stop beside house on left and electricity pole. | Mayo |
| G20 (3) 2006- | G2037610851 | G2054412525 | End of row of houses with Leylandii hedge | Mayo |
| G20 (4) 2006- | G2055616258 | G2130516798 | Stone cottage and barns on left | Mayo |
| G20 (5) 2006- | G2547019773 | G2575721619 | None | Mayo |
| G20 (6) 2006- | G2633124533 | G2694225914 | Had to detour to get to this point (note from 2006). Trip metre mileage at start 21.5 at finish 22.6 | Mayo |
| G20 (7) 2004- | G2991324108 | G3164823879 | Start at newly built house and brick entrance on right. House has pebble dash. Finish at Barrins grove house on left. line of mature sycamores and new stone wall. | |
| G20 (8) 2004- | G3251420927 | G3273919317 | Start at stone shed with red corrugates roof and doors on left. fork in road. Finish at rusty metal gate on right, just after first gate. | |
| G20 (9) 2004- | G3220616373 | G3195114782 | Start at fork in road with western way sign pointing straight ahead. finish at slight layby on left, telegraph pole on right. | |
| G20 (10) 2004- | G3064811719 | G3010810225 | Start at slight layby on left, end of forestry line on right, willow on right. Finish at layby on left at entrance to field, on slight bend in the road. | |
| G20 (11) 2006- | G2822607930 | G2921006284 | T junction start. Stop at fork in road, house at the fork. | Mayo |
| G20 (12) 2006- | G3237602981 | G3260904555 | Start at little road off main Swinford Rd. Mileage 44. Finish at turn to left, sign on wall Cartoonduff. Mileage 45 | Mayo |
| G20 (13) 2004- | G3450603992 | G3580303486 | Start at fork in the road, left road leads to houses, rusty gate on right. Finish at fork in the road with western way marker to right. | |
| G20 (14) 2006- | G3885903985 | G3934905050 | None. Mileage 53 at start, 54.5 at finish. | Mayo |
| G20 (15) 2004- | G4051108229 | G4078409862 | Start at stone wall with gate on left after small white bungalow-rusty gate on right. Finish at pebble dash wall on left and white metal gate into house. | |
| G53 (1) 2004- | G6752243409 | G6444943879 | Start stone house on right hand side. Finish at 2 large Ash trees on right hand side | Sligo |
| G53 (2) 2004- | G6106945154 | G6012044439 | Start at Maneghorow church sign. Finish at gate on left hand side after large 2 storey white house. | Sligo |

| | | | | |
|---|---|---|---|---|
| G53 (3) 2004- | G6317347808 | G6426548671 | Start at Mc Leans pub. Finish at ruin with narrow gate on right hand side of new house. | Sligo |
| G53 (4) 2004- | G6823250713 | G6957251405 | Start turn right below school off main road, sign for b&b. Turn left on this road. Finish at right hand bend, stone walls and shed on left, grey barn on right hand side. | Sligo |
| G53 (5) 2004- | G7105455708 | G7245656058 | Start at left turn to go along lough. Finish between two houses on right hand side. | Sligo |
| G53 (6) 2004- | G7558457003 | G7690157581 | Start off main road at leitrim sign. Finish on right hand side of bungalow after old cottages (take next right to main road and go left) | Leitrim |
| G53 (7) 2004- | G7819454614 | G7957254838 | Turn right off main road, next right. Start at large over landscaped house on right hand side. Finish at Yellow cottage on right hand side of the road after left bend in the road. | Leitrim |
| G53 (8) 2004- | G7926951108 | G7879149723 | Start left after Conwal Bridge. Finish by house on right hand side. | Leitrim |
| G53 (9) 2004- | G7939741838 | G7822642477 | Start after bottle bank. Finish at first post after house on left hand side. Field gate on right hand side. | Leitrim |
| G53 (10) 2004- | G7463643612 | G7338343132 | Start at lovely Leitrim sign on left hand side. Finish at the start of RH7 opposite Bungalow and stone house. | Sligo |
| G53 (10) 2004- | G7463643612 | G7338343132 | Start at lovely Leitrim sign on left hand side. Finish at the start of RH7 opposite Bungalow and stone house. | Sligo |
| G53 (11) 2004- | G7207439546 | G7352539674 | Start at Kilsellaghdem sign. Finish at gate on right hand side. | Sligo |
| G53 (12) 2004- | G7588837295 | G7612735886 | Start at activity sign on right hand side. Finish at top of hill. | Sligo |
| G53 (13) 2004- | G7944734912 | G7888333940 | Start at green barn. Finish at left turn sign. | Leitrim |
| G53 (14) 2004- | G7963230992 | G7828830371 | Start at two storey white house on right hand side. Finish at double gate entry to cottage on left hand side. Oak trees on right hand side. | Leitrim |
| G53 (15) 2004- | G741303 | NULL | Start opposite turn on right hand side. Finish at concealed entrance. | Sligo |
| G89 (1) 2006- | G8150093446 | G82799289 | start at junction outside two storey house on left hand side. Finish at telepgraph pole and galvanised gate. | Donegal |
| G89 (2) 2006- | G85249393 | G86829401 | Start at gate on the right hand side. Finish opposite junction/little bridge on right hand side. | Donegal |
| G89 (3) 2006- | G89719437 | G91109531 | Start at church on left handside. Finish at old house and tractor on left hand side | Donegal |
| G89 (4) 2006- | G93809699 | G95169683 | Start at wire gate at hill top on right hand side. Finish at forestry sign and plantation on left hand side. | Donegal |
| G89 (5) 2006- | G9806196714 | G9958597011 | Start at bungalow on left. Finish at shed on left (which is higher than road). | Donegal |
| G89 (6) 2009- | H0669896354 | H09289626 | Start at junction on right hand side. Finish at church on left hand side | Donegal |
| G89 (7) 2009- | C11610914 | C10300995 | Start at road on left hand side. Stop at B&B on left. | Donegal |
| G89 (8) 2009- | C08881072 | C09321216 | Start at Y junction. Finish just after T-junction. | Donegal |
| G89 (9) 2009- | C09241507 | C09971650 | Start at pull in on left hand side. 2 x gates on right hand side. Finish at house with concrete wall on left hand side. | Donegal |
| G89 (10) 2009- | C08531836 | C07241849 | Start at T-junction right hand side. Sign for letterkenny left hand side. Stop at little road on left hand side with galvanised gate. | Donegal |
| G89 (11) 2009- | C05951587 | C04491453 | Start opposite entrance to garden centre. Stone entrance on right hand side. Stop before road on left | Donegal |
| G89 (12) 2009- | C02061344 | C00451383 | Start at gate to house on left. Finish after 1 mile - no landscape features of note | Donegal |
| G89 (13) 2009- | B97911543 | B96561550 | Layby on right. 2 miles since last transect. Finish after 1 mile (no features) | Donegal |
| G89 (14) 2009- | B94111356 | B92951240 | Start 2 miles since last transect. No visible landmarks. Finish near car park for Lough Bana | Donegal |
| G89 (15) 2009- | B9092810230 | B8957809171 | Start 2 miles after last transect. No visible landmarks, some willow bushes. Stop at old building on right. | Donegal |
| H13 (1) 2009- | H1098856297 | H1169354820 | Start at bend, end at bend? | Northern Ireland |
| H13 (2) 2009- | H1169751985 | H1034551711 | St Patrick\\'s Catholic Church. End at short lane to pebbledashed two-storey house on right. | Northern Ireland |
| H13 (3) 2009- | H1120547467 | H10184766 | Start at road junction with dead end sign beside white bungalow. End at lay-by opposite bath cow water trough. | Northern Ireland |
| H13 (4) 2009- | H1235843947 | H1108043184 | Start at straight concrete lane on right. End where double entrance gates meet on road. | Northern Ireland |
| H13 (5) 2009- | H1002839359 | H1159239435 | Start at hardcore lane on right after tin roofed sheds on right after trees. End at gateway with stony lane on left. | Northern Ireland |
| H13 (6) 2009- | H1027034280 | H1159633650 | Start at gate with layby on left (set back at angle from road before lane to left). End at two cement lanes, one on each side of the road. | Northern Ireland |
| H13 (7) 2009- | H1991032562 | H2008230983 | Bungalow on the left with cream top balustrade. End at two storey house on right with wooden fence. | Northern Ireland |
| H13 (8) 2009- | H2673531038 | H2817831032 | Cluster of three houses starting at McMannus 73. Ornate iron gates on right. Take right towards? End at two opposing field gates, bad bend on right just ahead. | Northern Ireland |
| H13 (9) 2009- | H3551834742 | H3413933624 | Unknown | Northern Ireland |
| H13 (10) 2009- | H3808831278 | H3933330479 | Start at two lanes | Northern Ireland |
| H13 (11) 2009- | H397355 | H384343 | Start at concrete lane on right at an angle to road, old buildings behind trees up ahead. End at staggered cross road, brown sign (Carnore 9) cycle route sign. | Northern Ireland |
| H13 (12) 2009- | H378387 | H383403 | Start at lane to white house on hill. End at Elim Pentecostal Church, Brookeborough. | Northern Ireland |
| H13 (13) 2009- | H387450 | H387466 | Start Concrete lane beside large bricke house on right with ivy and house with monkey puzzle trees. End at Creagh Methodist Church at staggered crossroads. | Northern Ireland |

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| H13 (14) 2009- | H379509 | H389522 | Start at Imeroo crossroads, fenced off outbuilding with green door just after the end. | Northern Ireland |
| H13 (15) 2009- | H399569 | H394384 | Start at cross roads with Aspen trees. End at junction. Red tin roofed outhouses, farmhouse on right. | Northern Ireland |
| H40 (1) 2006- | H445019 | H462018 | Start at Crubany National School on left hand side. Finish at yellow dormer house on right. | Cavan |
| H40 (2) 2006- | H492022 | H504023 | Start at derelict building on right. Finish at lay-by entrance to dwelling on left hand side | Cavan |
| H40 (3) 2006- | H515023 | H528870 | Start at entrance to dwelling on right hand side and gate on left. Finish at two new houses on right hand side. | Cavan |
| H40 (4) 2006- | H555008 | H569014 | Start at brick dormer on right hand side and derelict building on the left. Finish at dwelling on left hand side. | Cavan |
| H40 (5) 2006- | H587037 | H601031 | Start after cross and old shed. Dwelling on right hand side. Finish at shed on right hand side and gate on left. | Cavan |
| H40 (6) 2006- | H628041 | H643043 | Start at large 2 storey house on right hand side. Finish situated in left turn in road. | Cavan |
| H40 (7) 2006- | H631068 | H632083 | Start at narrow road on left hand side. Finish at gate on right hand side. | Cavan |
| H40 (8) 2006- | H623111 | H615126 | Start at red outhouse on right hand side. Gate on left with sunclub sign. Finish at powerlines overhead before crossroads. | Cavan |
| H40 (9) 2006- | H647156 | H661164 | Start at filling station on left hand side and lake on right. Finish at lake and dormer bungalow to left. | Monaghan |
| H40 (10) 2006- | H653204 | H648218 | Start at dwelling and garage on right hand side. Finish on bridge. | Monaghan |
| H40 (11) 2006- | H656262 | H647275 | Start just off the Cootehall Road on the left. Finish at lake on left hand side. | Monaghan |
| H40 (12) 2006- | H626297 | H617293 | Start at wooded area (on both sides of road). Finish at red bricked bungalow on right hand side. | Monaghan |
| H40 (13) 2006- | H596273 | H583266 | Start at shed road on left hand side and road on right. Finish at gate and dwelling on right hand side. | Monaghan |
| H40 (14) 2006- | H554252 | H540255 | Start at crossroads at Killevan village. Finish just before red shed on right hand side. | Monaghan |
| H40 (15) 2006- | H516244 | H509235 | Start at two storey house on right hand side. Finish at entrance to field on right hand side. | Monaghan |
| H79 (1) 2006- | H7385798756 | H7479097441 | Northern Ireland | Northern Ireland |
| H79 (2) 2006- | H7694895498 | H7810394838 | Northern Ireland | Northern Ireland |
| H79 (3) 2006- | H8066196677 | H8221496736 | Northern Ireland | Northern Ireland |
| H79 (4) 2006- | H8378594847 | H8450793531 | Norhtern Ireland | Northern Ireland |
| H79 (5) 2006- | H8669391407 | H8827491036 | Northern Ireland | Northern Ireland |
| H79 (6) 2006- | H9086791922 | H9197392934 | Norhtern Ireland | Northern Ireland |
| H79 (7) 2006- | H9510093896 | H9565094929 | Norhtern Ireland | Northern Ireland |
| H79 (8) 2006- | H9439597686 | H9345499120 | Northern Ireland | Northern Ireland |
| H79 (9) 2006- | C9239702748 | C9348402832 | Northern Ireland | Northern Ireland |
| H79 (10) 2006- | C9527104354 | C9546005564 | Northern Ireland | Northern Ireland |
| H79 (11) 2006- | C9468208610 | C9427510179 | Northern Ireland | Northern Ireland |
| H79 (12) 2006- | C9208912577 | C9090013233 | Northern Ireland | Northern Ireland |
| H79 (13) 2006- | C8640414753 | C8232716810 | Northern Ireland | Northern Ireland |
| H79 (14) 2006- | C8232716810 | C8137516359 | Northern Ireland | Northern Ireland |
| H79 (15) 2006- | C7949416140 | C7791216081 | Northern Ireland | Northern Ireland |
| J06 (1) 2006- | J2430081300 | J2440082500 | Start at farm with grey metal out building. End just after thatched house with white posts. | Northern Ireland |
| J06 (2) 2006- | J2400085000 | J2300085800 | Start at cross roads. End just before Templeton Hotel | Northern Ireland |
| J06 (3) 2006- | J2110087200 | J1950087300 | Start at gate lodge. End at Burnside Road Orange Hall. | Northern Ireland |
| J06 (4) 2006- | J1750089000 | J1580089300 | Start at house on right, white lanterns. Stop at crossroads. | Northern Ireland |
| J06 (5) 2006- | J1210088500 | J1330087400 | Start at Castleburn house. End at Gatehouse on right. | Northern Ireland |
| J06 (6) 2006- | J1520085900 | J1670085400 | Start halfway down road. End at Greenmount campus. | Northern Ireland |
| J06 (7) 2006- | J1720082300 | J1720080900 | Start just after Muckamore Abbey. End just after cross roads. | Northern Ireland |
| J06 (8) 2006- | J1680078300 | J1590076900 | Start at metal farm building. Finsh at junction. | Northern Ireland |
| J06 (9) 2006- | J1490074900 | J1400073800 | Start just past built-up area, turn right at sharp bend. End at junction. | Northern Ireland |
| J06 (10) 2006- | J1340070500 | J1320068700 | Start just before Hickland Cycles. End at stoney bridge on road. | Northern Ireland |
| J06 (11) 2006- | J1120067100 | J0970066700 | Start at left turn at Diamond Engineering. End at small cross roads. | Northern Ireland |
| J06 (12) 2006- | J0790065800 | J0870064500 | Start at metal barn. End at junction, 1st house on left. | Northern Ireland |
| J06 (13) 2006- | J1090062900 | NULL | Start where two rows of houses start. Road at right where transect ends. | Northern Ireland |
| J06 (14) 2006- | J1470061400 | J1590061200 | Start just after motorway bridge. End at roundabout. | Northern Ireland |

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| J06 (15) 2006- | J1900061500 | J2020061300 | Start after Orange Hall. End at Robbery Road. | Northern Ireland |
| J33 (1) 2007- | J3350039900 | J3670041700 | Start at road junction, minor road to right hand side. End at large grey building on right. | Northern Ireland |
| J33 (2) 2007- | J3730045500 | J3660047500 | Start at lin eof mature trees to left, just after buildings at road junction. End at crosses stream (bridge), yellow house on right. | Northern Ireland |
| J33 (3) 2007- | J4130053200 | J4060054600 | Start at end of white wall. End at brow of hill, stone wall on right. | Northern Ireland |
| J33 (4) 2007- | J3890058300 | J3760057900 | Start at very prominent landmark - lone mature tree on right. End at low grey wall and bungalow on left. | Northern Ireland |
| J33 (5) 2007- | J3170057400 | J3060056700 | Start at wooden post - rail fence on right, immediate left turn (steep). End at crossroads. | Northern Ireland |
| J33 (6) 2007- | J2610057800 | J2550056300 | Farm entrance with galvanised gates on left, estate wall on right. End - no useful landmark, use milometer. | Northern Ireland |
| J33 (7) 2007- | J2760052700 | J2840051500 | Start by large driveway on left, after tight left hand bend, just after road junction. End at brow of hill, immediately after bridge. | Northern Ireland |
| J33 (8) 2007- | J2820047600 | J2730046000 | Start at bungalow on right hand side, (new, yellow). End at large gateway on right, pillars with statues. | Northern Ireland |
| J33 (9) 2007- | J2580040900 | J2490039600 | Start where road exits Lowtown. End where road enters Moneyslane. | Northern Ireland |
| J33 (10) 2007- | J2240037600 | J2380037000 | Start at large grey Byre (new, curved roof) to left of road. Use mileometer for end point. | Northern Ireland |
| J33 (11) 2007- | J2880034600 | J3030034300 | Start where large lake becomes visible to right of road after rounding bend. No useful land mark for end point, use mileometer. | Northern Ireland |
| J33 (12) 2007- | J3760034500 | J3890035300 | Start at national speed limit sign, exit Maghera. No useful landmark for end point, use mileometer. | Northern Ireland |
| J33 (13) 2007- | J4120040600 | J4260041100 | Start at lay-by, just after national speed limit sign, exit Clough. End at picnic area to right hand side of road. | Northern Ireland |
| J33 (14) 2007- | J4570039700 | J4560038000 | Start at stone wall / end of barn on left hand side. End at bungalow on left hand side. | Northern Ireland |
| J33 (15) 2007- | J5140035700 | J5230034600 | Start at churchyard to left. End - use mileometer. | Northern Ireland |
| L64 (1) 2008- | L7010258626 | L7014060091 | Start by ESB pole on left hand side of road | Galway |
| L64 (2) 2008- | L7142562474 | L7285062547 | Start at house with white guitars on gate on right hand side of road | Galway |
| L64 (3) 2008- | L7555263760 | L7689463240 | Start at ESB pole on ledft hand side of road | Galway |
| L64 (4) 2008- | L7933361361 | L8067860864 | Start at gate with cattle grid on right hand side road | Galway |
| L64 (5) 2008- | L8044659616 | L7917258908 | Start on a rise, start of continuous white line on road, left bend, ESB pole on left. | Galway |
| L64 (6) 2008- | L8081857164 | L8201556177 | Start at bog, no landmarks | Galway |
| L64 (7) 2008- | L8430854042 | L8504752677 | Start just past bridge and sign to Inash Lodge Hotel. R344 on permanent sign. | Galway |
| L64 (8) 2008- | L8454149744 | L8404448273 | Start at double gates on right hand side | Galway |
| L64 (9) 2008- | L8120246962 | L7992047290 | Start at white bungalow on right hand side | Galway |
| L64 (10) 2008- | L7718046694 | L7592346317 | Start at ESB pole on right hand side with transformer. Finish just before bridge. | Galway |
| L64 (11) 2008- | L6673340195 | L6520940384 | Start at pullin on left hand side of the road | Galway |
| L64 (12) 2008- | L6329642651 | L6228343990 | Start at pullin on left hand side of road, cut stone wall | Galway |
| L64 (13) 2008- | L6358046897 | L6500047481 | Start at top of track on left hand side, dangerous bends ahead sign c. 40m in front. | Galway |
| L64 (14) 2008- | L6238148727 | L6189649813 | Start at cut stone cottage on right hand side | Galway |
| L64 (15) 2008- | L6470248424 | L6594247763 | start where Clifden is to left hand side across water | Galway |
| M24 (1) 2003- | M226462 | M215453 | Start at sign for Ower house. Finish at house under construction- left hand side, past staggered junction. | Galway |
| M24 (2) 2003- | M208472 | M207486 | Start at new house under construction on left hand side, old pier on left.Finish at bend in road at bungalow on right. Calito Miralgo | Galway, Mayo |
| M24 (3) 2003- | M204512 | M202525 | Start at new house being built beyond yellow house. Finish at left turn with telegraph pole. | Mayo |
| M24 (4) 2003- | M219542 | M221557 | start at old house with long driveway with cattle grid. finish at T junction with yield sign | Mayo |
| M24 (5) 2003- | M243574 | M252587 | Start at small green area on left hand side to pull in. Finish at 2nd house on left after bridge | Mayo |
| M24 (6) 2003- | M258613 | M260629 | Start at first lane on left at end of white line. Finish at big yellow house on left with stone wall and yellow capping. | Mayo |
| M24 (7) 2003- | M270659 | M264673 | start left turn in Roundfort village. Finish at low wall on left, planning permission sign on left. | Mayo |
| M24 (8) 2003- | M278688 | M292682 | start at big house on left, garage building on right. Finish at second lane on left after school and cross roads. | Mayo |
| M24 (9) 2003- | M317662 | M325656 | start at left turn for Garrymore spa. Finish at slatted house on left. | Mayo |
| M24 (10) 2003- | M345633 | M357618 | Start just after right turn before closed over trees. At pull in on left. Finish at commemorative stone on left for Ballyglass. During course of mile transect meet a T junction and take a right turn | Mayo |
| M24 (11) 2003- | M379613 | M393613 | Start at fork on the right with opposing gates. Take left, at a yield sign take left. Finish at second wall of graveyard on right. | Mayo, Galway |
| M24 (12) 2003- | M412594 | M402583 | Start at council no dumping sign on left. Finish at two storey modern house on right with unbuilt wall. | Galway |
| M24 (13) 2003- | M430553 | M424541 | start at right turn at t junction, two large chestnut trees at a gateway. Finish at stone house on right, dev. land for sale sign. | Galway |
| M24 (14) 2003- | M430517 | M419526 | Start just beyond right turn opposite industrial buildings. Finish at industrial estate on left. | Galway |

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| M24 (15) 2003- | M388534 | M375531 | Start at second left turn at old style bungalow | Galway |
| M87 (1) 2003- | N082837 | N070826 | Start at junction N4, Bornacoola community alert. Finish at gravel into pink house side entrance | Longford |
| M87 (2) 2008- | N054872 | N055892 | Start at end of lights in Roosky, after end of speed restriction. End at 1st bungalow on left coming up before speed restriction to Dromard village. | County Longford |
| M87 (3) 2003- | N081902 | N077920 | Start at house on right hand side after school, Corracramph South. Finish at hedgerow on left before fenced in farm house. | Longford |
| M87 (4) 2003- | N095926 | N104905 | Start at wrought iron fence on right hand side around house, near Lough rinn. Finish at red barn on right hand side. | Longford |
| M87 (5) 2003- | N021864 | N006862 | Start at bungalow with wooden fence (R371) on left handside of Roosky-scramoge road. finish at two houses on right hand side, just after second house | Roscommon |
| M87 (6) 2003- | M984840 | M976824 | Start at kilglass lake sign on right hand side. Finish before quarry entrance | Roscommon |
| M87 (7) 2003- | M947795 | M933800 | Start at Strokestown Park House sign on N5. Finish before 30mph sign, approx. 500m. | Roscommon |
| M87 (8) 2003- | M924832 | M915844 | Start at left hand turn. Strokestown house on right. Finish at sharp right road sign | Roscommon |
| M87 (9) 2003- | M898867 | M884876 | Start at first garden gate after crossroads on the Strokestown-Elphin road. Finish at house on right handside before lane on right hand side | Roscommon |
| M87 (10) 2003- | M882897 | M892907 | Start at Kinard bridge. Finish at house on right via lane on the Carrick-Elphin road | Roscommon |
| M87 (11) 2003- | M903936 | M913948 | Start slightly past left turn along Carrick-Elphin road. Finish just before crossroads sign. | Roscommon |
| M87 (12) 2003- | M925973 | M930988 | Start at house on left opposite 2 road entrances. Finish at N4 T junction. | Roscommon |
| M87 (13) 2003- | M902984 | M886921 | Start at bungalow on left after sharp bend. Finish at house and barn on left hand side. | Roscommon |
| M87 (14) 2003- | M857966 | M847959 | Start at cut stone building. finish at bump in the road before house on left | Roscommon |
| M87 (15) 2003- | M833946 | M836933 | Start at first dangerous bend reflective sign on right hand side. Finish at traffic sign on right hand side. | Roscommon |
| N11 (1) 2003- | N3440039300 | N3270039500 | Co. Westmeath | Co. Westmeath |
| N11 (2) 2003- | N3250037400 | N3330036400 | Co. Westmeath | Co. Westmeath |
| N11 (3) 2003- | N3570034700 | N3740034800 | Co. Westmeath | Co. Westmeath |
| N11 (4) 2003- | N3980032900 | N3890031900 | Co. Westmeath | Co. Westmeath |
| N11 (5) 2003- | N3630029800 | N3470029700 | Co. Offaly | Co. Offaly |
| N11 (6) 2003- | N3130028700 | N3100030300 | Co. Offaly | Co. Offaly |
| N11 (7) 2003- | N2910029000 | N2900027400 | Co. Offaly | Co. Offaly |
| N11 (8) 2003- | N3090025400 | N2950025000 | Co. Offaly | Co. Offaly |
| N11 (9) 2003- | N3060022500 | N3080020900 | Co. Offaly | Co. Offaly |
| N11 (10) 2003- | N3000018600 | N3170017900 | Co. Offaly | Co. Offaly |
| N11 (11) 2003- | N3420016500 | N3340015200 | Co. Offaly | Co. Offaly |
| N11 (12) 2003- | N3070011600 | N2950012700 | Co. Offaly | Co. Offaly |
| N11 (13) 2003- | N2730015000 | N2570015400 | Co. Offaly | Co. Offaly |
| N11 (14) 2003- | N2380017400 | N2510018700 | Co. Offaly | Co. Offaly |
| N11 (15) 2003- | N2030020900 | N2060022700 | Co. Offaly | Co. Offaly |
| N74 (1) 2006- | N8533467628 | N8372567918 | Start at first house on left hand side, disused and boarded up. Young broadleaf plantation on right hand side (Tara mines). Finish at yellow house with porch and leylandii hedge in a group of four houses. 2nd house in the group. | Meath |
| N74 (2) 2006- | N7904667407 | N7748167575 | Start at crossroads (Trim/Athboy/Navan), Cortown. Finish at gateway on left hand side into field, just before crossroads and just before row of houses on left. | Meath |
| N74 (3) 2006- | N7339569390 | N7357764382 | Pass a road on the right and start at gate to field on left hand side. Bungalow on right with leylandii hedge. Stop at laneway on left just before another laneway to farm buildings, before two storey yellow/brick house. | Meath |
| N74 (4) 2006- | N7357764382 | N7416162923 | Start just beyond crossroads. Finish at gateway on right between ash and large beech. | Meath |
| N74 (5) 2006- | N7327557662 | N7305056178 | Start at first house on left after right turn. Gunnings concrete sign. It is a white bungalow. Finish at another white bungalow on right with ballustrades. Copper maple in beech hedge. | Meath |
| N74 (6) 2006- | N7332753266 | N7495453408 | Start after left turn. First house on left hand side, stone cottage. Finish at Boardsmill GAA pitch. | Meath |
| N74 (7) 2006- | N7758751343 | N7874850695 | Start at white brick-effect bungalow with stone wall just after laneway on left. Old concrete barn on right hand side. Finish at new dormer bungalow on left. Entrance between beech and ash tree, next door to new yellow dormer bungalow. | Meath |
| N74 (8) 2006- | N7559147955 | N7419048631 | Start at white cottage on right and hay sheds on left hand side. Stop at black gate on right hand side of road just past magnolia house with wooden fence on right hand side. | Meath |
| N74 (9) 2006- | N7273944501 | N7401744007 | Start at layby just after left hand turn. Finish at double green galvanised gate. | Meath |

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| N74 (10) 2006- | N7962145702 | N8118345584 | Start at entrance to quarry on right hand side. Finish at two mature ash trees and sycamore on left hand side after bend in the road. | Meath |
| N74 (11) 2006- | N8389744378 | N8475143102 | Start at third house after crossroads on left hand side, two storey house. Finish at 50km sign on both sides of road, just after left hand turn. | Meath |
| N74 (12) 2006- | N8562246404 | N8666647440 | Start at slip road on left hand side after right hand turn. Finish at bungalow magnolia with sheds on left hand side. Small white cottage on right. Sign - caution cows crossing. | Meath |
| N74 (13) 2006- | N9328645525 | N9250346917 | Start at first house on right hand side (grey bungalow with pampas grass). Finish at stone gates on right hand side and farm gate on left. | Meath |
| N74 (14) 2006- | N9391951701 | NULL | Start at two storey white house on right hand side with driveway and with small trees and beech hedge. Finish at modern house on right before bad bends. | Meath |
| N74 (15) 2006- | N9166655757 | N9245957100 | Start at entrance to church on right hand side. Finish at sign post for crossroads. | Meath |
| N77 (1) 2009- | N9729381613 | N9593282437 | Start at crossroads sign. Finish at electricity pylon just before two houses on left hand side and one house on right hand side. | Louth |
| N77 (2) 2009- | O0045182026 | O0165482573 | Start at housing estate just before 80kmph sign. End at gate on right hand side, 200m from crossroads | Louth |
| N77 (3) 2009- | O0140185403 | O0095187002 | Start 100m before tiphead on right hand side. End just at T-junction with engineering factory. | Louth |
| N77 (4) 2009- | O0243989410 | O0305890912 | Start just after crossroads just before school. End at bridge adjacent to Ardee livestock sales yard. | Louth |
| N77 (5) 2009- | O0271494253 | O0213195540 | Start just before house on right hand side beside farm gates on left and right, just after line of poplars. Finish after passing through Mansfieldstown at house on right hand side just before stop sign. | Louth |
| N77 (6) 2009- | N9934596781 | N9768596741 | Start 100m after junction off N52 (at 80kmph sign). End at farm house on left hand side. | Louth |
| N77 (7) 2009- | N9580699680 | N9437499650 | Start 50m after The Hill pub. Finish after 1 mile (no particular feature). | Louth |
| N77 (8) 2009- | N9161298734 | N9028497853 | Start at farm gate on left hand side. End at wooden post and wire fence just after large 2 storey house on left hand side. | Louth |
| N77 (9) 2009- | N8782898425 | N8632898074 | Start at white bungalow on left hand side just at ESB pole. End at house on brow of hill. | Cavan |
| N77 (10) 2009- | N8542894039 | N8387295189 | Start at farmyard. End at gate on left. | Meath |
| N77 (11) 2009- | N8171597389 | N8079898753 | Start at house on left hand side, red gate with white pillars. End at stone building on right hand side, gates on left and right. | Cavan |
| N77 (12) 2009- | N7937398229 | N7766498817 | Start at bend in road just after side road on right hand side. End at junction to R162. | Cavan |
| N77 (13) 2009- | N7876394783 | N7869193046 | Start at farm gate on left hand side just past petrol station as leaving Kingscourt on Navan Rd. Finish at gate on left hand side and small layby on right hand side. | Cavan |
| N77 (14) 2009- | N7868590328 | N7874588704 | Head towards Kilmainhamwood (right turn off Navan Rd). Start at driveway of yard on left hand side, house on right hand side. Finish at gate on right side. | Meath |
| N77 (15) 2009- | N8029286274 | N8114384759 | Start at rusty gate to laneway (1st entrance to Brittas House) on left hand side. Laneway with treeline. Finish at T-junction. | Meath |
| O04 (1) 2004- | O237594 | O2259 | Start at Milverton farm gate. Finish at hedge lined hill, lone bungalow on right | Skerries, Dublin |
| O04 (2) 2004- | O198613 | O187616 | Start at start of Naul Road, 50m past no speed limit sign. Finish at small side road with Naul 4/Balrothery 2 sign. | Skerries, Dublin |
| O04 (3) 2004- | O177643 | O171657 | Start at right turn sign 2 miles after kiernans sign. Finish at humpback bridge | Balbriggan, Dublin |
| O04 (4) 2004- | O153685 | O1368 | Start at Bellewstown road, gravel road starts on left. Finish at approach to Motorway crossover. | Gormanstown, Meath |
| O04 (5) 2004- | O093676 | O087689 | Start at no speed limit sign at town limit. Finish at small road off to the right. | Bellewstown, Meath |
| O04 (6) 2004- | O024688 | O009694 | Start at railway bridge. Finish just before (50m) Drumman house on left | Duleek, Meath |
| O04 (7) 2004- | O004670 | O0065 | Start at crossroads with R150 (Navan road). Finish 100m past second entrance to Carrickhill Stud. | Balrath, Meath |
| O04 (8) 2004- | O003614 | O010598 | Start at sign on right for Rathfeigh church. Finish at top of hill at L bend. | Rathfeigh, Meath |
| O04 (9) 2004- | O053613 | O067619 | Start at right hand corner. Finish at roadsign for right turn. | Garristown, Meath |
| O04 (10) 2004- | O104614 | O1162 | Start at Clonalvy National School. Finish at junction with gravel road on right | Clonalvy, Naul, Meath |
| O04 (11) 2004- | O118593 | O115576 | Start at white topped wall. Finish at Y junction | Naul, Dublin |
| O04 (12) 2004- | O072587 | O0558 | Start at end of speed limit-slane road. Finish at dip in road with layby ahead | Garristown, Dublin |
| O04 (13) 2004- | O009583 | O024575 | Start at wooden white painted stones. Finish at yield sign. | Ratoath, Meath |
| O04 (14) 2004- | O008542 | O026540 | Start at crossroads. Finish at gates on either side of the road | Ratoath, Meath |
| O04 (15) 2004- | O0351 | O0349 | Start at new estate entrance on right. Finish 50m before lane to right. | Ratoath, Meath |
| R22 (1) 2004- | R244265 | R246279 | Start at yellow house on left after junction. Finish at first house on left after pub in strand village | Limerick |
| R22 (2) 2004- | R245310 | R243325 | Start at house on left with red paint. Finish at house on left with pink/white wall (Ballypierce) | Limerick |
| R22 (3) 2004- | R255357 | R253368 | Start at passage on right (ashgrove). Finish at five road junction. Revisions to grid ref in 2006 but no updates to transect description. | Limerick |
| R22 (4) 2004- | R282388 | R293401 | Start at pub on left after devon wood products. Finish at junction on left to cahermoyle. revisions to grid refs in 2006 but no update of transect description. | Limerick |
| R22 (5) 2004- | R310421 | R322431 | Start at church on left at coolcappagh. Finish at bad bend sign after turn off to right. Revisions to grid refs in 2006 but no update of transect description. | Limerick |

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| R22 (6) 2004- | R331448 | R341452 | Start at first passage on left after sharp bend (Ardlaman). Finish at Ardgoul north-Cottage on right. revisions to grid refs in 2006 but no update of transect description | Limerick |
| R22 (7) 2004- | R374452 | R381467 | Start at phone box in Cappagh. Finish at mobile home on right. Revisions to grid ref in 2006 but no update of transect description | Limerick |
| R22 (8) 2004- | R399486 | R409484 | Entrance to estate on right. Finish at dormer windowed house past garden centre (no revisions given in 2006 despite changes to grid refs) | Limerick |
| R22 (9) 2004- | R406468 | R406455 | Start at passage on left after junction to the right. Finish at junction at Finniterstown. Revisions to grid refs in2006 but no update to transect description | Limerick |
| R22 (10) 2004- | R412423 | R422418 | Start at long passage on left. Finish at house on right after junction to the right (Lissduff). Revisions to grid ref in 2006 but no update to transect description | Limerick |
| R22 (11) 2004- | R450415 | R455401 | Start at Ballyvolge cross. Finish at Liskennett-before road to left. Grid refs revised in 2006 but no updates to transect description | Limerick |
| R22 (12) 2004- | R464373 | R464358 | Start at Kilmore-before piggery on left. Finish at village sigh for Grenagh. Grid refs revised in 2006 but no update of transect description | Limerick |
| R22 (13) 2004- | R489362 | R496356 | Start at Ballygrennan. Finish at Castletown cross. Grid refs revised in 2006 but no updates to transect description | Limerick |
| R22 (14) 2004- | R474348 | R457344 | Start at Castletown cross. Finish at first road on right after cross. Grid refs revised in 2006 but no update to transect description | Limerick |
| R22 (15) 2004- | R447311 | R438303 | Start at Ballyruane cross. Finish at sign post for Kilmeedy. Grid refs revised in 2006 but no updates to transect description. | Limerick |
| R28 (1) 2004- | R287873 | R302867 | Start at junction of rhuan rd with Ennis Corofin road. Finish at white cottage with concrete, front wall concrete piers, white washed walls. | Clare |
| R28 (2) 2004- | R334869 | R335854 | Start at road junction-dalcassian pub on right hand side in rhuan village. Finish at wide stone wall entrance to quarry on right hand side. | Clare |
| R28 (3) 2004- | R345827 | R357823 | Start at setback for large 2 story l shaped house with valcony, circa half a mile after bridge over river fergus. Finish at cream bungalow, first street light on left as approaching village (telegraph pole 26) | Clare |
| R28 (4) 2004- | R385805 | R396805 | Start at salmon pink bungalow, cut stone pier, after windy stretch, green/white cottage ahead. Finish at gradual bend shortly after ESB line crossing +2 new dormer bungalows (c150m) | Clare |
| R28 (5) 2004- | R418830 | R425844 | Start at orange bungalow on right hand side with large front garden and concrete post and rail fence. Finish at road sign for windy section of road on left hand side. | Clare |
| R28 (6) 2004- | R434873 | R439887 | Start at croos with lane to left and forest road to right, open hilltop. Finish at dip in straightish road, land falling sharply to left, start of willow scrub or right hand side. | Clare |
| R28 (7) 2004- | R456912 | R462926 | Start just after ESB overhead wires, start of long stretch with wires to the right. Finish at crest C50m beyond junction. | Clare and Galway |
| R28 (8) 2004- | R470963 | R483962 | Start at junction o minor road from Ballymakill with Lough Cutra-scariff road. Finish at track on left after cross with tracks each way. | Galway |
| R28 (9) 2004- | R490991 | M496004 | Start at track to left up to 2 storey on bend after viewing point turn off. Finish at Ballyturn National school gate opposite layby for lake | Galway |
| R28 (10) 2004- | M467030 | M462043 | Start at crossroads. Finish at setback for bungalow left, cream middle row of 3, stone wall just before overhead line crosses road. | Galway |
| R28 (11) 2004- | M448073 | M437076 | Start at entrance to Lakewood factory on left. Finish at junction with road to left after sign for Lydican | Galway |
| R28 (12) 2004- | M407085 | M392092 | Start at junction with road to right under overhead lines. Finish at thatched house gable to road on left, path on right. | Galway |
| R28 (13) 2004- | M360096 | M357082 | Start at junction with road on right. Finish at slightly derelict thatched cottage on right with newish orange house beside. | Galway |
| R28 (14) 2004- | M346052 | M340026 | Start at layby for agricultural shed on left. finish at layby for agricultual shed on right. | Clare |
| R28 (15) 2004- | M315026 | M303020 | Start at track on right hand side. Finish at thatched white cottage on left. | Clare |
| R88 (1) 2004- | N046057 | N034066 | Start left turn-start at end of junction. Finish at gates, piers and drive into farmhouse on left. | Birr, Offaly |
| R88 (2) 2004- | N008083 | N004068 | Start a T-junction-start at end of junction. Finish at gates on left, white piers with horses on top. Space to pull in. | County Tipperary |
| R88 (3) 2004- | M979078 | M964082 | Start at 2 storey house on left. Cream piers with eagles on top. Just before road to right. Finish at corner, where road widens- lane on left into field. Field gate on right. | Rathcabban, County Tipperary |
| R88 (4) 2004- | M935077 | M926068 | Start at house on left with tall conifers in front (blue door and dashing). Just before sign for junction (right turn) | County Tipperary |
| R88 (5) 2004- | M914038 | M905027 | Start at cream and pink bungalow on left. Built at an angle to the road. Elaborate bird house out front. Finish at field gate on left, just before bungalow. Stone wall around field gate. Gate set back slightly. | Lorrha, County Tipperary |
| R88 (6) 2004- | M889008 | M876006 | Start at cream piers on left with green gates- conifer lined drive into house. Cream bunglaow on right. Finish at old two storey farmhouse on left, not painted, stop at second gate | Terryglass, County Tipperary |
| R88 (7) 2004- | R845997 | R845984 | Start at bend. a drive into house on left surrounded by trees. Small wooden sign "Kylenoe Country house". Finish at rusty field gate on left, with ivy covered lamp post beside it. About 100m after left turn. | Ballinderry, County Tipperary |
| R88 (8) 2004- | R863961 | R848954 | Start at junction. Cream bungalow on left, opposite junction, with picket fence and brown gate. Sharp right turn. Finish at field gate on right, just around bend from new 2 storey dormer house with red roof and mock tudor effect. | Ballinderry, County Tipperary |
| R88 (9) 2004- | R849929 | R866923 | Start at field gate on left, immediately after speedlimit sign and before house on right. Space to pull in. Finish at brown field gate on right. Wide gate consisting of two gates overlapping. Just before big house with treelined drive on left. | Newchapel, County Tipperary |
| R88 (10) 2004- | R873907 | R872983 | Start at old farm buildings on left, just after lane- ramshackle looking, normally old white tractor parked outside. Big slatted shed on right. Finish at lane on left with grass in the middle, house beside lane with a wooden fence. | County Tipperary |
| R88 (11) 2004- | R858869 | R864855 | Start at grey cottage on left, with lots of extensions and sheds, silver gates and two small trees in front. | County Tipperary |
| R88 (12) 2004- | R883847 | R889834 | Start at poplars on left, just before house, rusty field gate on right. Finish at large dormer house on right, with large shed and red brick and white paint, just after junction. Stop at big gates | County Tipperary |

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| R88 (13) 2004- | R914827 | R927824 | Start about 30m from junction. Finish at corner, house on right, white and brick bungalow set at an angle to the road with a garden seat beside the front gate. | County Tipperary |
| R88 (14) 2004- | R957824 | R969818 | Start at brown field gate on left. Silver and black patchy gate on right. At a corner. Stone walls. Large estate house set back on right. Finish at high concrete brick wall on left, old hidden gate on right. Just before hand bend. Well shaded by trees. | County Offaly |
| R88 (15) 2004- | R994834 | R989840 | Start at big entrance gates on left to estate house, wooded drive. Finish at lane on left with red gate and sign for Roe Cottage on it. Tall trees on left. Telephone pole on right opposite lane. | County Offaly |
| S12 (1) 2004- | S3936549954 | NULL | Start at STOP sign at junction with R695 & Graigue Cross Roads (with small corrugated buildings), starting in direction of Ballingarry. End at small bungalow on RHS. | Co. Kilkenny |
| S12 (2) 2004- | S3521649021 | NULL | Start at road junction at Jessfield (no road sign). End just after driveway to house on LHS with pebbledash gateposts. | Co. Tipperary |
| S12 (3) 2004- | S3086448520 | NULL | Start just beyond Ballingarry village, at entrance to O'Suillan Park (GAA) and opposite garage. End on approaching bend to bridge. | Co. Tipperary |
| S12 (4) 2004- | S2684149223 | NULL | Start at two story pebbledash house on left hand side, balls on piers, eagles on gateposts. Just after bungalow on right hand side and lane after bungalow. End after track with gate up to left on left hand side. | Co. Tipperary |
| S12 (5) 2004- | S2248248585 | NULL | Take a right outside Ballynunty village on road to Cashel. Transect starts opposite blue gate on right hand side for Ballynunty Sewage Works. End just after junction and lane up to house on left hand side. | Co. Tipperary |
| S12 (6) 2004- | S1781546755 | NULL | Start just after sign for right turn, at entrance to small quarry / lane on left hand side. | Co. Tipperary |
| S12 (7) 2004- | S1306544297 | NULL | Start at avenue on left hand side to Edwardian House with veranda, black and white gateposts and railings / laurel hedge. End at sign for school (on road), beside bungalow on right hand side. | Co. Tipperary |
| S12 (8) 2004- | S1065739913 | NULL | Start at telegraph pole oppisite yield sign at T junction beside small two storey house on left hand side with metal gate and pebbledash stone wall. End at 1st slow sign, metal gateway on right hand side. | Co. Tipperary |
| S12 (9) 2004- | S1258137199 | NULL | Start at gated land on left hand side with large beech trees. Double metal gate opposite on right hand side. After lane on left hand side with wooden gates. End at new 2 storey house on left hand side, slate, steep pitched roof, dormer windows. | Co. Tipperary |
| S12 (10) 2004- | S1366932201 | NULL | Start at RH junction sign for Tipperary Bridge Old IRA memorial. End at metal gate on right hand side with stone pier. | Co. Tipperary |
| S12 (11) 2004- | S1406529038 | NULL | Start at T junction turning in direction of Poulnamucky. End at sharp bend - sign, house and lane to left hand side. | Co. Tipperary |
| S12 (12) 2004- | S1369226197 | NULL | Take left at sign for Lavally. Transect starts at bungalow on LHS with slate roof, pebbledash and small swirley gates and hedge. End just after 1st turn right, at new house on left hand side, just before gateway. | Co. Tipperary |
| S12 (13) 2004- | S1764226017 | NULL | Start at house after junction, pebbledash wall, brown capping, wooden fence and metal gate with wheels on it. End after turn onto main road, just before right hand turn for Orchardstown with thatched cottage at junction. | Co. Tipperary |
| S12 (14) 2004- | S2112827563 | NULL | Start at telegraph pole at end of wall after GAA pitch on left hand side. End at neo-tudor bungalow on left hand side, big wooden gates and 1 house on right hand side. | Co. Tipperary |
| S12 (15) 2004- | S2394325933 | NULL | Start at 1st bungalow on left hand side, small pillars on front fence and capped piers. Just after 2nd farmyard with grain silo. End immediately after farm buildings and farmhouse with dashed front on left hand side. (Follow signs for Ballypatrick to get to next transect). | Co. Tipperary |
| S15 (1) 2005- | S393647 | S386635 | Start at sharp left hand bend. Two gates on right. Finish at right hand bend. | County Kilkenny |
| S15 (2) 2005- | S354628 | S344620 | Start at left hand bend on hill after holy well and pig farm. White cottage on right. Turn right during transect. Finish before crossroads. | County Kilkenny |
| S15 (3) 2005- | S354600 | S358592 | Start at Killahy crossroads, at church. Turn right during transect. | County Kilkenny |
| S15 (4) 2005- | S345582 | S333577 | Start 2.7 miles from end of last transect. Start at T junction- Coldharbour. | County Kilkenny |
| S15 (5) 2005- | S350552 | S336545 | Start at crossroads, downhill into Tipperary. Finish after U- bend. | County Kilkenny |
| S15 (6) 2005- | S306532 | S310545 | Start facing north at crossroads. Sign for Grange, gable and fencing. Finish at sharp bend. | County Tipperary |
| S15 (7) 2005- | S286571 | S286553 | Start left at Grange, round Kilcooley. Left at crossroads onto main road. Start at crossroads. turn right during transects. | County Tipperary |
| S15 (8) 2005- | S280531 | S285513 | Start left for Coalbrook. Onto right for Emerald resources. Start at Junction. Go straight on. | County Tipperary |
| S15 (9) 2005- | S253505 | S247514 | Start at sign left for Ballinunty. Grey house-gable on road. Start just before staggered junction. Finish just before sharp turn on left. | County Tipperary |
| S15 (10) 2005- | S220526 | S207532 | Start at Cross Bog. Staggered crossroads. Finish at lane on right. | County Tipperary |
| S15 (11) 2005- | S189552 | S187567 | right turn at Littleton. Next left. Start at Lackin Cross. | County Tipperary |
| S15 (12) 2005- | S190612 | S177620 | Turn left at TwoMileBorris. Centenary Co-op, turn left over bridge. Start there. Finish at crossroads. | County Tipperary |
| S15 (13) 2005- | S153622 | S155640 | Past school. Right turn at crossroads. Start at house on right with roses . | County Tipperary |
| S15 (14) 2005- | S174669 | S182684 | Start at crossroads (left hand side is just a lane). finish at lane to right. | County Tipperary |
| S15 (15) 2005- | S191711 | S205718 | Turn left in Templetouhy. Start after turning right at ruin. (Rathdowney 7 1/2). | County Tipperary |
| S78 (1) 2003- | S749804 | S744815 | Begin at cross roads, opposite sign post at right hand side. Finish at brow of hill-where on right hand side, hedgerow begins after short stretch of post and wire fence. | County Kildare |
| S78 (2) 2003- | S749839 | S737846 | Start immediately after telegraph pole on right hand side and before entrance to house on right-opposite large sycamore tree. Finish on bend, immediately after cattle grid at entrance to left, orange and black directional sign ahead | County Kildare |
| S78 (3) 2003- | S734876 | S721879 | Start immediately before bridge, with large willow tree to the right. Finish on bend after small bridge, just before telephone wire cross over road and opposite end of taller hedgerow (hawthorn) to the left. | County Kildare |

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| S78 (4) 2003- | S716903 | S729910 | Start at row of houses, opposite street light on left- white concrete block wall, 2.5 blocks high before house. Finish on gradual bend, tall beech trees to right, before telegraph pole on left, circa 50m from wide entrance on left. | County Kildare |
| S78 (5) 2003- | S736927 | S737939 | Start on straight stretch of road, after lone conifer growing inside hedge on left and opposite next telegraph pole on right. Finish on straight stretch of road between two telegraph poles on either side of road, before place to pull car in off road to left- opposite forest ride. | County Kildare |
| S78 (6) 2003- | S734963 | S741970 | Start just after start of long straightwall to left and opposite telegraph pole on right and before telegraph pole on left. Finish immediately before telegraph ple to left and between two tall ash trees on left. | County Kildare |
| S78 (7) 2003- | S774966 | S785960 | Start at yield right of way sign at T Junction. Finish after entrance to house on left, tall sycamore to left and before telephone pole on left (big gate on right c50m ahead) | County Kildare |
| S78 (8) 2003- | S808977 | S823979 | Start after turning off main road-opposite small house sign- Moyle Abbey to left. Finish after bend to lft, between two house entrances to left road sign ahead. | County Kildare |
| S78 (9) 2003- | S847978 | S858968 | Start at far side of entrance to Rathsallagh demense. finish after wide entrance on left and before entrance to right-half way between both- light at right entrance visible. | County Wicklow |
| S78 (10) 2003- | S879953 | S886967 | Start at entrance to house on left- opposite milk stand on right. Finish after two telegraph poles at opposite side of road after wall to house-wall white with darker top on right hand side | County Wicklow |
| S78 (11) 2003- | S896996 | S909997 | Start halfway between entrance to house on left then on after telegraph pole on left. Finish c. 30m before old (dead) tree on left with prominent bark-two stone piers on left. | County Wicklow |
| S78 (12) 2003- | S930977 | S928964 | Start just after Garda station. Finish immediately after turn to left and before turn to right. | County Wicklow |
| S78 (13) 2003- | S922940 | S937938 | Start at junction-dangerous junction sign. Finish immediately after bridge | County Wicklow |
| S78 (14) 2003- | S960924 | S974918 | Start after turn to left- immediately after place to pull car over to left and before next telegraph pole on left. Finish after entrance to new house on right and before turn- opposite telegraph pole. | County Wicklow |
| S78 (15) 2003- | S991898 | S994885 | Start at end of forestry on left- opposite small willow bush. Finish at end of forestry to left- old forest stand on right- immediately before wide entrance to forestry on left. | County Wicklow |
| T05 (1) 2003- | T018788 | T030790 | Start at red gate into field just after junction heading east. Pasture and stone wall covered in vegetation on both sides until 0.5 miles- several houses on left until 0.8 miles. Finish at pair of field gates opposite each other just past farm yard (which is on left) | Wicklow |
| T05 (2) 2003- | T053772 | T060764 | Start at carrigroe at bend in road with gate to fork on left, broadleaved trees on either side to 3.3 miles, stone bridge at 3.5 miles, houses on left at 3.8-3.9 miles, then trees on both sides. Finish where two house driveways on right hand side-stop in between them. | Wicklow |
| T05 (3) 2003- | T053737 | T054727 | Start at junction where house does not face road. Church gate at 6.5 miles. Some arable uncut hedges and houses. Finish at house on left beside small lane to left with concrete walls. | Wicklow |
| T05 (4) 2003- | T077717 | T088706 | Start at lane on left entrance just before house on right and roads bend to left. Hedgerows with mature trees and pasture. Finish 10-15m past road on left. | Wicklow, Wexford |
| T05 (5) 2003- | T111687 | T122676 | Start 20m past road on left at gate on left into building site. Trees overhang road, conifer plantation on left, stone bridge over river, pasture. Finish at house with well trimmed cypress hedge-centre house in row of three on left. | Wexford |
| T05 (6) 2003- | T153661 | T138654 | Start at corner of memorial garden at crossroads facing southeast, trees and hedgerows sheltered, more open hedges/pasture/arable from 10.3 miles. Finish at side of gravelled entrance to farmyard on right after row of trees on both sides. | Wexford |
| T05 (7) 2003- | T112643 | T096644 | Start at entrance to church, St johns Hollyfort, treelined until 18.8 miles, mixed hedgerows with trees all along, pasture. Finish at farm entrance to left which is almost directly opposite a similar one on right. | Wexford |
| T05 (8) 2003- | T076664 | T063671 | Start at gate on left 20m after right turn, high elevation, fairly windswept, low hedges, banks arable, small bit of clearfell on left. Finish at right turn at junction. | Wexford |
| T05 (9) 2003- | T030663 | T015659 | Start at right turn, just before no dumping sign, forestry plantation on right. Finish 3m after large stand alone conifer on left 100m before junction. | Wicklow |
| T05 (10) 2003- | T016630 | T016616 | Start after turning right on main st Carnew, start transect at large metal gates on left- opposite Carnew grain. Stonewalls, houses then hedges etc. Finish after right turn, just past yellow/strange house on right, stop at small layby on left. | Wicklow |
| T05 (11) 2003- | T029590 | T044596 | Start just past carpark wall on left, opposite church. Finish opposite white house with gates and pillars, trees, hedgerows, houses. | Wexford |
| T05 (12) 2003- | T072598 | T081589 | Start gate into house on left called Farlands, with low stone wall. Finish at T junction, low hedges. | Wexford |
| T05 (13) 2003- | T061572 | T049559 | Start at Carriglegan, directly opposite entrance lane on right- also with field gate and sycamore tree. Finish at double field gate, just after bend before stone and brick house entrance, arable. | Wexford |
| T05 (14) 2003- | T017528 | T017514 | Start at Kilthomas crossroad. Finish opposite bungalow with wooden fence. | Wexford |
| T05 (15) 2003- | T032495 | T045503 | Start at entrance to house called riverside. Finish at Ballynakill, after left turn opposite wooden fenced entrance to small house. | Wexford |
| V93 (1) 2003- | W194488 | W180479 | Start at Clashnacrona wood sign, mixed woodland. Finish at black yellow post, lake | Cork |
| V93 (2) 2003- | W150469 | W136465 | Start at crossroad sign, telephone poles, improved grassland. Finish at metal frame across from bungalow, Improved grassland. | Cork |
| V93 (3) 2003- | W136449 | W147438 | Start at telegraph pole, blue gate, improved grassland. Finish at telegraph pole, house with stone facade, improved grassland | Cork |
| V93 (4) 2003- | W169425 | W184422 | Start at blue farmhouse and gate, treelines (ash) improved grassland. Finish at telegraph pole, sitka spruce wood, improved grassland. | Cork |
| V93 (5) 2003- | W167403 | W165388 | Start at farmyard entrance, red walls, improved grassland. Finish at hawthorn tree on left beyond salmon pink entrance with large metal gates, improved grassland. | Cork |
| V93 (6) 2003- | W146366 | W137354 | Start at pillar wall, group of bungalows, scrub. Finish at crossroad sign on right hand side of road opposite bungalow, scrub, improved grassland. | Cork |

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| V93 (7) 2003- | W119337 | W106338 | Start at bridge house pub, Skibereen, urban area. Finish at sign, Abbeystowrey graveyard, easturine river. | Cork |
| V93 (8) 2003- | W077335 | W062329 | Start at gate (new court) black/yellow sign, tall tree lines. Finish directly opposite St Matthews church of Ireland, Aughadown, Improved grassland | Cork |
| V93 (9) 2003- | W039347 | W025347 | Start 100m beyond coolbawn lodge b&b sign, passed overhead powerlines, improved grassland, heath. Finish at willow scrub and heath on right. | Cork |
| V93 (10) 2003- | V998352 | V984354 | Start at wind stunted oak 200m off road on left, telegraph pole on right with single wire. Finish at quarry gates beyond childrens crossing sign, tall Ash, gorse on right. | Cork |
| V93 (11) 2003- | V958369 | V945374 | Start at crossroads (durrus 8, Bantry 14.5, Ballydehob 2) Heathland, improved grassland. Finish at willow tree on left, wet grassland on both sides of ditch. | Cork |
| V93 (12) 2003- | V917374 | V904382 | Start at tall ashes on left, cottage on right. with sycamore and semi-improved grassland. | Cork |
| V93 (13) 2003- | V926398 | V939407 | Start at Dunbeacon on stone wall (house) fuschia hedge on left, grassland and birch woodland. Finish at stone house on left and cottage on right, tall hedgerow and amenity grassland. | Cork |
| V93 (14) 2003- | V954433 | V969438 | Start at white bungalow and garage off the road on right, improved grassland. Finish opposite metal gate, lane to farm on left, improved grassland. | Cork |
| V93 (15) 2003- | V984460 | V978473 | Start at crossroad onto bantry road, yield sign, amenity grassland, improved grassland. Finish at layby on left 100m before left turn to sheeps head peninsula, scrub on right. | Cork |
| V96 (1) 2005- | W002898 | NULL | Start opposite Lissivigeen school on N22, N72 junction. Finish at 100kmph sign opposite sign for river vally farmhouse B+B. | Kerry |
| V96 (2) 2005- | W040876 | NULL | Start at N22 sign after Brewterheld exit from N22. Finish at junction for Kilaha church. | Kerry |
| V96 (3) 2005- | W075844 | NULL | Start at field gate opposite bungalow with blue gate. Finish opposite Glen farmhouse. | Kerry |
| V96 (4) 2005- | W112826 | NULL | Start after Clydagh bridge on N22. Finish just after Clomceen road junction on N22. | Kerry |
| V96 (5) 2005- | W142801 | W152794 | Start atan gaeltacht sign on N22 SE bound. Finish at 100kph sign on left handside. | Cork |
| V96 (6) 2005- | W183788 | NULL | Start 30m in front of NDP/EU sign and junction. Finish at do not pass signs NW of Ballyvourney | Cork |
| V96 (7) 2005- | W177763 | W163757 | Start at junction for Tir na Meala. Finish at coolea crossroads. | Cork |
| V96 (8) 2005- | W139774 | W140760 | Start at Coolea junction. Finish at Bardinch Bridge. | Cork |
| V96 (9) 2005- | W130738 | NULL | Start at forestry layby on left hand side. Finish at wire fence on right handside not before road to gouganbarra | Cork |
| V96 (10) 2005- | W089734 | W076740 | Start at Sillardane lodge on left hand side. Finish at pull in opposite taller conifersafter Inchee bridge. | Kerry |
| V96 (11) 2005- | W051754 | W042745 | Start at bad bend in main road. Finish opposite gates into forestry. | Kerry |
| V96 (12) 2005- | W015735 | V999733 | Start at 50kph sign at Kilgarvan. Finish at conifer avenue and stone wall entrance just after GAA sign on right hand side. | Kerry |
| V96 (13) 2005- | V968728 | V955724 | Start at cahir garden centre after cement mixers sign, house with blue and white garage. Finish at 2 houses on left hand side. | Kerry |
| V96 (14) 2005- | V926716 | V912707 | Start at Neidin sign and heritage trail on rock. Finish at junction into town | Kerry |
| V96 (15) 2005- | V902804 | NULL | Start opposite Lough on bridge on N71 before ladies view. Finish at Derrycunnihy church | Kerry |
| V99 (1) 2006- | W0064389816 | W0217589654 | Start at Darby O'Gill's Hotel. End at danger sign on left, Quarry exit. | Co. Kerry |
| V99 (2) 2006- | W0609890220 | W0764890605 | Road widens, large farm yard on right with white wall. End approximately 100m before before Barraduff. Birch trees on right. | Co. Kerry |
| V99 (3) 2006- | W1049291274 | W1206991703 | Start at Bridge (train). End at house on left with wide entrance. | Co. Kerry |
| V99 (4) 2006- | W1478792932 | W1624493153 | Start at pass road for Greevguille. Entrance to Monastic house on right. End at entrance to Rathmore. Junction on right. | Co. Kerry |
| V99 (5) 2006- | W1731295862 | W1720197406 | Start at junction on right. Farmhouse on right. End at Knocknagree Community Centre on left. | Co. Cork |
| V99 (6) 2006- | R1557901008 | R1595202481 | Start crossroads at Munster Joinery. End at right hand bend, pencil quarry on left. | Co. Cork |
| V99 (7) 2006- | R1640005100 | R1755706079 | Start at railing and monument to Billy Murphy on left. Old cottage on right. End - junction to left (go left). Newmarket - Ballydesmond sign. | Co. Cork |
| V99 (8) 2006- | R1701809907 | R1663811076 | Start at crossroads, sign for Taur 7. Ballydesmond 8 and Abbeyfeale 21. End at house on hill at 2 o\\'clock. | Co. Cork |
| V99 (9) 2006- | R1693214456 | R1727915767 | Start at church and school on right. House on left. End - tree lined left and right. | Co. Cork |
| V99 (10) 2006- | R1412818391 | R1262518508 | Start at football field on left, sign for Brosna. End at white farmhouse and yard on left. | Co. Kerry |
| V99 (11) 2006- | R0890919424 | R0834320080 | Start details - T-junction, take right community alert sign. End details - lay-by on left. Red house and shed on right - velux window. | Co. Kerry |
| V99 (12) 2006- | R0595920519 | R0447420237 | Start details: left at Knocknagabhal cross for Tralee. End details: farmyard - green hed, pink house after bad bends. | Co. Kerry |
| V99 (13) 2006- | R0004519451 | Q9851419153 | Start past bad bends, house on left with poles and barbed wire fence - Fenton Lyons. End at lay-by on left, conifers on right. | Co. Kerry |
| V99 (14) 2006- | Q9702816633 | Q9734515170 | Start at bridge - junction on right. End after cross roads. | Co. Kerry |
| V99 (15) 2006- | Q9897712228 | Q9950210840 | Start at Mullaghmarky Bridge. End at 50km/hr sign entering Castleisland. | Co. Kerry |
| W56 (1) 2005- | W7814861380 | W7684061298 | Start at green and red railway signal on white pole, right hand side of the road. Finish at sign on left for road narrowing, life buoy on right. | Cork |
| W56 (2) 2005- | W7398262175 | W7257062125 | Start at gate to house, Brookfield on left. Finish at gate to house on left. | Cork |
| W56 (3) 2005- | W6974261868 | W6836561344 | Start at stone gateway on left, forestry sign, trackway on right surrounded by hazel. Finish at grey bungalow-maryville-on left | Cork |

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| W56 (4) 2005- | W6618661559 | W6595262741 | Start at tall hedges on left and willow on right. Finish at piers and gateway on left, 80kph sign on road. | Cork |
| W56 (5) 2005- | W6285762305 | W6135261747 | Start after flyover, signs to Cork, halfway,crossroad. Finish at layby on left, horsechestnut tree opposite cream cottage. | Cork |
| W56 (6) 2005- | W5853561113 | W5688661278 | Start at layby on right, stone wall on left. Finish at bridge on bend, black and yellow stripes. | Cork |
| W56 (7) 2005- | W5390560804 | W5209061187 | Start at house with stone porch on left. Finish opposite graveyard, derelict farm buildings on right. | Cork |
| W56 (8) 2005- | W5265363954 | W5221365493 | Start at two silver gates on left hand side of road. Finish at croosroads yield sign. | Cork |
| W56 (9) 2005- | W5086167396 | W5120068841 | Start outside cream bungalow on left. Finish at white dormer on right with low stone walls. | Cork |
| W56 (10) 2005- | W5020170701 | W5154271172 | Start at crossroads, black and white house walls opposite. Finish at treelines on both sides of the road. | Cork |
| W56 (11) 2005- | W5404171385 | W5562671786 | Start opposite white bungalow with low white walls. finish at track to bungalow on right tree lined road. | Cork |
| W56 (12) 2005- | W5710571286 | W5599572063 | Start at Crossroads outside Inniscarra bar. Finish at tree lined avenue gateway to house on left. | Cork |
| W56 (13) 2005- | W5576274531 | W5463575580 | start outside two semi detached houses, opposite cream coloured wall. Finish at slippery road sign on right. | Cork |
| W56 (14) 2005- | W5499278092 | W5565079580 | Start opposite bungalow outside tractor storage yard after church. Finish at iron roofed building on right bend. | Cork |
| W56 (15) 2005- | W5610482525 | W5613784083 | Start outside cream coloured cottage.Next to old cottage. Finish outside white bungalow on left just after crossroads. | Cork |
| X49 (1) 2009- | S465197 | S470183 | Start on bridge, bank of Fiddown island. Finish at new house and farm gate on right. | Waterford |
| X49 (2) 2009- | S467147 | S453151 | Start at 1st gate on right hand side 10m beyond junction. Finish at end of wall on left, road rises. | Waterford |
| X49 (3) 2009- | S412131 | S425124 | Start from junction. Finish at quarry on right, 100m beyond stream/valley bottom. | Waterford |
| X49 (4) 2009- | S454104 | S449085 | Start at junction. Finish at back of pub just before main road. | Waterford |
| X49 (5) 2009- | S414067 | S429056 | Start at gate 20m after turn off main road. Finish at estate entrance. | Waterford |
| X49 (6) 2009- | S440030 | S442015 | Start at junction. Finish at gate into field on right just after wood on left. | Waterford |
| X49 (7) 2009- | X466990 | S464005 | Start at junction at cove. Finish half way round bend, just past cottages. | Waterford |
| X49 (8) 2009- | S491027 | S501017 | Start beside junction with farm track. Finish at main road. | Waterford |
| X49 (9) 2009- | S537021 | S545032 | Start at junction. Finish at at junction. | Waterford |
| X49 (10) 2009- | S562060 | S571072 | Start at junction. Finish at start of leylandii hedge on right. | Waterford |
| X49 (11) 2009- | S606082 | S609067 | Start at junction. Finish at estate entrance on left. | Waterford |
| X49 (12) 2009- | S636025 | S642013 | Start at Murphys bar. Finish at 2nd junction in 50m | Waterford |
| X49 (13) 2009- | S688007 | S675097 | Start at junction. Finish at layby on bend on left hand side opposite bungalows | Waterford |
| X49 (14) 2009- | S663041 | S669056 | Start at beginning of wood. Finish at junction. | Waterford |
| X49 (15) 2009- | S656078 | S644086 | Start at junction. Finish at junction. | Waterford |