The Vincent Wildlife Trust

An Roinn Ealaíon, Oidhreachta agus Gaeltachta
Department of Arts, Heritage and the Gaeltacht

THE VINCENT WILDLIFE TRUST'S IRISH BAT BOX SCHEMES

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CONTENTS

EXECUTIVE SUMMARY

- This report presents an analysis of The Vincent Wildlife Trust's Irish bat box project and results of an online survey and was possible due to a grant from the Department of Arts, Heritage and the Gaeltacht.
- The Trust started its bat box project in Ireland in 1999 as a means to confirm the presence of the barbastelle and has made a total of 153 visits to boxes in three woods in County Galway, comprising 7,370 box inspections.
- Although the barbastelle was not found in any of the 162 boxes erected, the project has yielded useful information on seven of the nine resident bat species and on the effectiveness, or otherwise, of bat boxes.
- Sixty-two Schwegler boxes of three models were erected in Portumna Forest Park, 30 1FF, 30 2FN and two 1FW; 50 2FN boxes were erected in Coole-Garryland Nature Reserve and 50 2FN boxes were erected in Knockma Nature Reserve of which 40 were later transferred to Glengarriff Nature Reserve County Cork.
- Initially boxes were checked monthly from April to October. Boxes were occupied quickly but it took time for regular occupation and for breeding groups to form.
- Comparison of box model was only possible at Portumna where there was equal numbers of 1FF and 2FN boxes, but other factors were studied at all three Galway woods.
- Due to the difficulty in separating pipistrelles without handling, soprano and common pipistrelles were grouped as *Pipistrellus* spp.
- Leisler's, brown long-eared and *Pipistrellus* spp. were recorded in boxes at all three Galway woods, Daubenton's bat was only recorded in Garryland, Natterer's bat was only recorded in Glengarriff and whiskered/Brandt's was recorded just twice.
- Portumna Forest Park had the highest total number of bats counted: *Pipistrellus* spp. – 2,607; long-eared – 1,045; Leisler's – 382, and there was a 31% chance of encountering a bat at Portumna Forest Park compared with 11.5% and 10% at Coole-Garryland and Knockma respectively.
- *Pipistrellus* spp. preferred 1FF boxes that offer crevice-like roosting conditions, showed a seasonal preference, with more bats present later in the season (visual observations confirmed the bats were using the boxes as mating roosts), their numbers increased with time but appear to be stabilising, and they preferred boxes located close to the shores of Lough Derg in Portumna.
- The diet of *Pipistrellus* spp. was determined using bat droppings collected monthly from boxes during 1999 and 2000.
- Long-eared bats preferred 2FN boxes that mimic holes in trees; the natural roosting sites for this species. They showed no seasonal pattern to their occurrence in the boxes – possibly as males of this species do not set up mating roosts to attract females.

- Leisler's bat showed no preference for box model, but showed a seasonal preference, with more bats present later in the season (visual observations confirmed the bats were using the boxes as mating roosts) and were present in low numbers until 2001 but present in higher numbers from 2013 onwards.

- Many 2FN boxes were inaccessible to bats during the month of May because birds had built nests in this model of box, and in the 1FWs. These models and similar types therefore need modifying to exclude birds.

- Bats that flew away from boxes upon opening were observed flying either into other boxes or natural cavities in nearby trees.

- Aspect was not a significant factor for occupancy, but most boxes received dappled sunshine for part of the day.

- An online survey was used to gather information on the success of bat boxes erected for mitigation purposes and showed that Schwegler boxes are the most popular box type recommended and are selected over wooden boxes when available. The main reason for mitigation is loss of roosts and all but one contributor to the online survey would recommend bat boxes in the future to replace loss of roosts. Bat boxes are considered suitable alternative roosts for loss of tree roosts but not maternity roosts in buildings.

- Common and Nathusius' pipistrelles, long-eareds and Leisler's have used boxes erected for mitigation purposes (the only record of Nathusius' bat using a bat box was as a result of mitigation work), and boxes are more likely to be occupied by bats if these are erected in an area already used by bats before the onset of development work.

- Very little post-erection monitoring is conducted after development work due to lack of funding and calls into question the validity of proposing boxes as a mitigation measure.

- Schwegler bat tubes are recommended to replace the loss of roosts from bridges for Daubenton's bat, when attached to the underside of arches.

- Detailed guidelines on making and erecting bat boxes are available from www.batconservationireland.org and www.bats.org.uk, and self-cleaning boxes are recommended to prevent droppings accumulating and blocking access by bats.

- Bat boxes are now considered a suitable monitoring tool for some bat species.

- There is research potential on long-eared, Natterer's and Daubenton's bats using bat boxes in three woodlands.

- Recommendations are presented for the design of a systematic study of the value of bat boxes in Ireland.

ACKNOWLEDGEMENTS

We would like to thank the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht for providing funding for this report.

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Finally, we wish to thank all the ecologists who took the time to participate in our Online Survey or who sent us additional information during what is perhaps the busiest time of the year for bat workers.

AIM OF THE STUDY

- Create an Irish dataset from the main VWT bat box dataset
- Evaluate the Irish dataset for evidence of factors influencing the occupancy of boxes
- Undertake statistical analysis of these factors to assess their significance
- Conduct a review of other bat box schemes to allow comparisons
- Survey ecological consultants for information on the use of bat boxes as mitigation measures
- Make recommendations for future schemes

Photograph: Barbastelle © Frank Greenaway

1. VWT BAT BOX PROJECT

1.1 Introduction

The VWT initiated its Irish bat box project in March 1999 in an attempt to confirm the presence of the barbastelle (*Barbastella barbastellus*) in Ireland. Two visiting European bat workers believed that they had recorded it for the first time in the country in Portumna in 1997 using bat detectors. Professor Ingemar Ahlén and Doctor Hans Baagøe visited Ireland in July of that year primarily to record Leisler's bat (*Nyctalus leisleri*) and they visited a number of locations: 11–12th Phoenix Park, Dublin; 12–13th River Slaney, Wicklow; 13–14th Killimer and Kilrush, County Clare; 14–15th Portumna Castle, Priory and Marina, County Galway and 15–16th Blessington Reservoir, County Wicklow.

They recorded Leisler's bat at all the listed locations and other known Irish bat species' recorded were brown long-eared (*Plecotus auritus*), Natterer's (*Myotis nattereri*), whiskered (*M. mystacinus*), Daubenton's (*M. daubentonii*), *Pipistrellus* spp. (*Pipistrellus pipistrellus* – before species separation) and Nathusius' pipistrelle (*P. nathusii*). Ahlén & Baagøe also believed they recorded noctule bats (*N. noctula*) in the Phoenix Park (McAney, pers. comm.).

The records for both barbastelle and noctule bat were accepted by the Atlas of European Mammals (Mitchell-Jones *et al.*, 1999) and both species were listed as present in Ireland in *Bats of Britain, Europe and Northwest Africa* (Dietz *et al.*, 2009).

The VWT and Dublin Bat Group undertook detector and mist netting surveys of Portumna Priory and Forest Park in 1998 to verify the barbastelle record, but without success. The Trust then decided to extend its Rare Woodland Bat Box Project, which was underway in England and Wales for both barbastelle and Bechstein's (*M. bechsteinii*), to Ireland and erected 62 Schwegler bat boxes in Portumna Forest Park in March 1999, and 50 boxes at two other woodlands in County Galway: Coole-Garryland, Gort and Knockma, Tuam.

Although the barbastelle has not been found in VWT bat boxes, nor anywhere else in Ireland during 17 years of surveying, seven of the eight resident Irish species that are able to access boxes have been: soprano pipistrelle (*Pipistrellus pygmaeus*), common pipistrelle (*Pipistrellus pipistrellus*), Leisler's, brown long-eared, Natterer's, Daubenton's and whiskered/ Brandt's. Nathusius' pipistrelle has not been recorded nor has the lesser horseshoe (*Rhinolophus hipposideros*), but the latter is unable to access bat boxes.

The Trust continues to monitor the boxes in Portumna but handed over the Knockma and Coole-Garryland schemes to the National Parks and Wildlife Service (NPWS) in 2002 and 2010 respectively. Forty boxes were removed from Knockma before the handover and erected in a conifer wood near Clonbur for one year before being relocated to two sites in Glengarriff, County Cork. These boxes are now owned by the Cork County Bat Group.

Data from three other bat box projects were kindly supplied for inclusion in this report and are described in Chapter 2, as well as information on an experimental project in Wicklow National Park and a review of the use of bat boxes within past and current agri-environmental schemes.

Bat boxes are often recommended as a mitigation measure to provide alternative roosts during developments where known or potential roosts are at risk or are being removed. However, little information exists on how effective bat boxes are in this situation so, as part of this study, an online survey was conducted to elicit feedback from consultants on their experiences of bat boxes as mitigation measures. The results of this are presented in Chapter 3.

This report on the VWT's Irish bat box project has been possible due to a grant from the NPWS, Department of Arts, Heritage and the Gaeltacht.

1.2 Installation and Surveying

One hundred and sixty-two Schwegler (www.schwegler-natur.de) woodcrete bat boxes (compressed woodchip and concrete mix) were erected in three woodlands in County Galway in March 1999. Three types of boxes were used in Portumna Forest Park, 2FN, 1FF and 1FW, and 2FNs only in Coole-Garryland and Knockma. Nine 2F, two 1FF and one 2FN boxes were erected at Knockma after this scheme was transferred to the NPWS in 2002. Table 1 provides details of the four types of boxes.

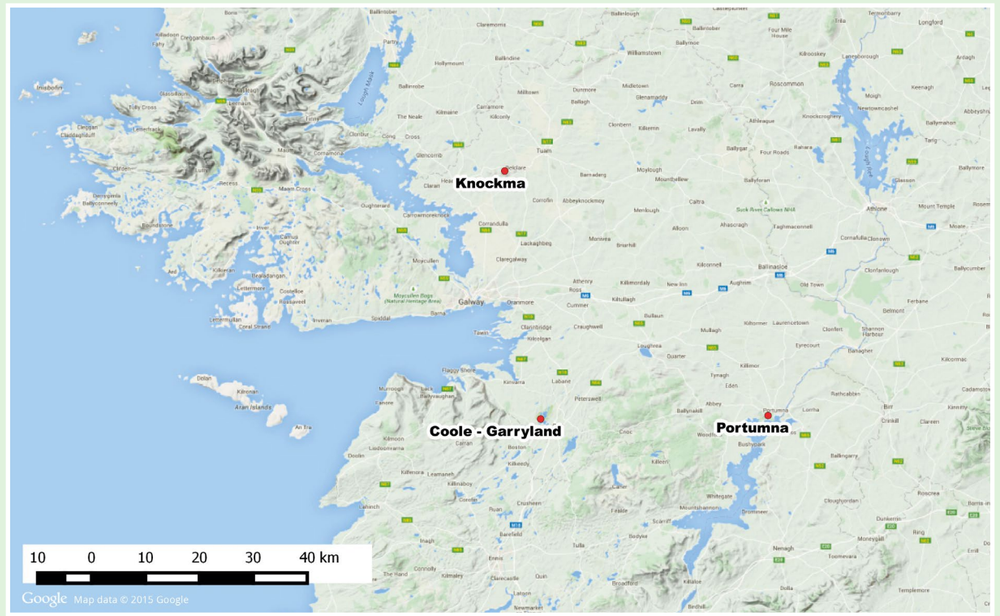
Initially the boxes were not nailed onto the trees due to concern about the effect this would have on the trees, instead galvanized garden fence wire was used to hang them at a height of approximately 4 m with the intention to adjust the wire at regular intervals to prevent it becoming embedded by tree growth. However, as boxes were hung in pairs, which resulted in wire overlapping, this proved impossible to undertake, necessitating the rehanging of some boxes using aluminium nails at a later date.

Photograph: 2FN box on tree.

No systematic approach was adopted for locating the boxes within the woods; rather the selection of trees was based on ease of vehicular access from paths or tracks when erecting the boxes and by the lack of branches that could inhibit ease of access by bats. However, boxes were clustered at various points within the three woodlands and in Portumna Forest Park the 2FN and 1FF paired boxes were hung on adjacent trees. The aspect of each box was noted when it was located on a tree, as was the tree species. The locations of the boxes in the three Galway woods are shown in Figure 1.

During the first four years of the study, boxes were inspected once a month from April to September and occasionally outside these months as time permitted but, once groups of bats took up residence, visits were generally not made during June and July in subsequent years to minimize disturbance. Two people were always involved in box inspection and the following information was recorded for each box: species of bat present and an estimate of the number of individuals, number and condition of bat droppings, and the occurrence of bird nests.

Figure 1: Map showing locations of VWT bat box schemes



Fresh bat droppings were collected in the early years of the study and stored and all droppings were removed at each visit. Torches were often used to verify the presence of bats, especially when checking the 1FF boxes as it was often difficult to determine the species when several bats were present.

Occasionally bats would move within the box while it was being checked and when this gave rise to a risk of their being injured on closing the box, the bat(s) were removed and then guided back into the box via one of the entrance points once the door of the box was secured. A bat handling bag was often used to block an entrance for a minute or so, in order to encourage the bat to remain within the box. On hot days, bats did fly out of a box once it was opened, but generally it was possible to observe them until they entered another box or a natural crevice, either on the same tree as the original box or close-by. A note was taken of any bat movement between boxes to prevent duplication of records.

Photograph: Checking a 2FN box.

Approximately 20 people have assisted the Trust with checking the boxes, ranging from conservation rangers of the NPWS, bat consultants, members of the Galway Bat Group and volunteers. A licenced bat worker was always present during the inspections and bats handled only to prevent injury, as described above, or for the purpose of training. In 2012, all brown long-eared bats found in Portumna Forest were handled so that biometric data could be collected by Bat Conservation Ireland.

Boxes were relocated on three occasions. By 2002, it was apparent that many of the boxes in Knockma Wood were not being used or only occasionally, so 40 were removed and erected for a trial period of one year in Ballykyne Wood near Clonbur, County Galway. After this period they were erected in two woodland sites in Glengarriff, County Cork, with two additional boxes, to bring the total there to 42. Similarly, the 10 2FN boxes in Coole Park were removed and erected in Garryland Wood in 2003.

Photographs: (left) 2FN bat box with a large quantity of droppings, **(above)** Checking a 1FF box with a torch.

BOX TYPE	DIMENSIONS	DESCRIPTION	PHOTOGRAPH
2FN	Circumference: 16 cm Height: 36 cm Weight: 4.3 g	Two entrances, one at the rear and one at the front. Domed roof to allow bats to cluster. Front panel unscrews to allow inspection.	
1FF	Height: 43 cm Depth: 14 cm Width: 27 cm Entrance: 12–24 cm wide x 21 cm long Weight: 9.9 kg	Designed for crevice-dwelling bats. Rear panel of roughened wood. Door swings downwards to allow inspection.	
1FW	Circumference: 38 cm Height: 50 cm Weight: 28 kg	Large to accommodate clusters of bats in summer. Insulated for winter use. Insert of three timber panels.	
2F	Circumference: 16 cm Height: 33 cm Weight: 3.8 kg	Conical top. One entrance hole at the front.	

Table 1: Types of Schwegler bat boxes used in the four sites.

1.3 Portumna

Portumna Forest Park consists of approximately 450 hectares and is owned and managed by Coillte (www.coillte.ie). In addition to the woodland, the park also contains a range of other habitats, including marsh, open green spaces and turloughs (seasonal water bodies).

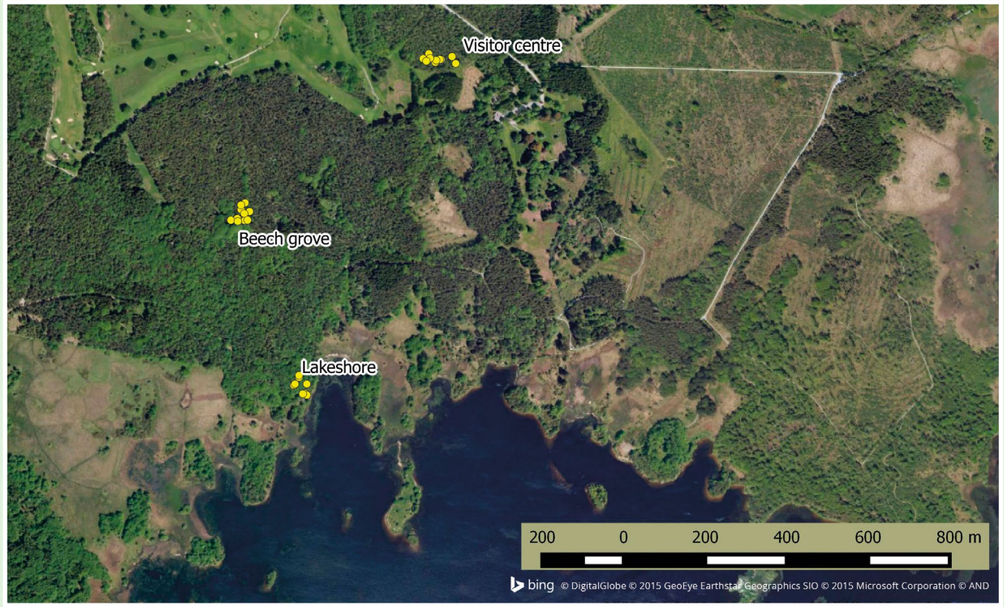
The forest park is located in the south-east of County Galway close to the town of Portumna (M 84 03). It is bordered to the south by Lough Derg and to the north by the R 352 Portumna-Scariff road. The area was originally owned by the Clanrickard family and was acquired by the state in 1948. After state acquisition, much of the original native woodland was planted with conifers, including Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), Sitka spruce (*Picea sitchensis*) and Japanese larch (*Larix kaempferi*), while the remainder consists of other conifers and broadleaves, including beech (*Fagus sylvatica*). Currently over 200 hectares of the forest is designated as Old Woodland and the current forest management plan involves the gradual conversion of the conifers to broadleaves by natural regeneration and replanting, with over 40 hectares under the Native Woodlands Scheme.

Photograph: (above) 1FF boxes on a tree in Portumna Forest Park , **(left)** 2FN boxes on a tree in Portumna Forest Park.

The stands of Scots pine are being managed as Continuous Cover Forestry (CCF) to benefit the population of red squirrel (*Sciurus vulgaris*) that lives in the forest. This population was the source of animals used in a successful translocation project during 2003-2006 (Poole, 2007). Approximately 32% of the total forest area, mainly along the lake shore, is designated a Special Area of Conservation (site code SAC 2241) and a Special Protection Area (Site Code SPA 4058). The area is also designated as 'High Conservation Value Forestry' (HCVF) by Coillte.

A total of 62 Schwegler bat boxes were erected on a variety of trees in the forest park in March 1999; 30 2FNs, 30 1FFs and two 1FW boxes (Figure 2).

Figure 2: Location of bat boxes in Portumna Forest Park



Photographs: (above left) Bat boxes at Beech Grove, **(top right)** Habitat close to the Visitor Centre, **(bottom right)** Bat boxes at the lake shore.

1.4 Coole-Garryland

Coole-Garryland Nature Reserve consists of approximately 404 hectares, made up of the woodland and grounds at Coole Park Visitor Centre and the adjoining wood at Garryland (www.coolepark.ie).

The nature reserve is located in south Galway, 3 km north of Gort (M 42 04) in a karstic limestone basin at low elevation. Historically, between the years 1798–1927, it was owned by the Gregory family who planted woodland and maintained walled gardens and tree-lined avenues. It was acquired by the Irish state in 1927 and for many years was managed by Coillte, during which time much of the deciduous woodland and lawns were planted with conifers. It was designated a nature reserve in 1983 and is now a Special Area of Conservation (site code SAC 252) and a Special Protection Area (Site Code SPA 107) due to a number of rare plant species, a unique assemblage of insects and its importance to wintering wetland birds that use the turloughs. It has been the focus of many ecological studies; some of those focusing on small mammals include O'Mahony (1998), Von Cramon (2003), Connor (2003), Bateman (2007) and Condell (2007).

The habitat in the vicinity of Coole Park Visitor Centre consists of planted non-native beech, parkland, woodland edge and Norway spruce conifers. The woodland habitat at Garryland is considered to be semi-natural broad-leaved with pedunculated oak (*Quercus robur*), ash (*Fraxinus excelsior*) and hazel (*Corylus avellana*), with an understorey of bramble (*Rubus fructicosus*), ivy (*Hedera helix*), and hawthorn (*Crategus monogyna*).

Ten 2FN boxes were erected on beech trees in Nut Wood close to Coole Park Visitor Centre in 1999 and remained there until 2002. They were then moved to the woodland at Garryland where forty 2FNs have been in place since 1999 (Figure 3).

Photograph: (below) Garryland Nature Reserve, **(right)** 2FN boxes, Garryland Nature Reserve.

Figure 3: Location of bat boxes in Garryland Nature Reserve

1.5 Knockma

Knockma Nature Reserve consists of approximately 42 hectares and comprises mixed broadleaved woodland, limestone pavement and hazel scrub.

The nature reserve is located 7 km east of Headford and 11 km west of Tuam, County Galway (M36 48). It is a steep-sloping site, 50 m at the base of the hill rising to 167 m and is the highest point in the surrounding countryside. It was owned by one of the tribes of Galway, the Kirwans of Castlehackett, who managed the woodland for game hunting; this accounts for the presence of cherry laurel (*Prunus laurocerasus*) and rhododendron (*Rhododendron ponticum*). The hill is of archaeological importance due to the presence of four stone cairns located on the limestone summit. The site was transferred to the Irish state in 1956 and bought by Coillte in 1986, before being acquired by the NPWS in 1989. It is designated as a proposed Natural Heritage Area (pNHA 001288).

Photograph: (right) Old boundary line, Knockma Wood, **(below)** Entrance to Knockma Wood.

Figure 4: Location of bat boxes in Knockma

The coniferous trees present were planted by Coillte and include Japanese larch, Douglas fir (*Pseudotsuga menziesii*) and Sitka spruce. Other non-native species include sycamore (*Acer pseudoplantanus*) and snowberry (*Symphoricarpos albus*).

The woodland habitat at Knockma is considered to be semi-natural broad-leaved with oak (*Quercus robur* and *Q. petraea* but also hybrids), ash, hazel, beech, with an understorey of bramble, ivy and hawthorn, and rich ground flora.

Steps to manage the cherry laurel began in 2004 when a large area was chemically treated and this continued in the following year when a second area was felled. In 2014, approximately 2.5 hectares was cut back and will be sprayed either in 2015 or 2016, depending on the rate of growth. Additional boundary fencing was erected in 2013 and 2014 to exclude domestic livestock, and approximately 400 deciduous trees, mainly oak but also mountain ash (*Sorbus aucuparia*) and yew (*Taxus baccata*), have been sown. It has been the focus of a number of ecological studies including one on the Diptera associated with the woodland (McHugh, 2009) and a management plan commissioned by the NPWS (Boyle & McHugh, 2008).

Fifty 2FN boxes were erected at a number of locations within the woodland in March 1999, 10 of which remain today. Forty under-used or unused boxes were removed in March 2002 and relocated to Ballykyne Wood for one year and then to Glengarriff, County Cork. The Knockma Wood scheme was eventually transferred to the NPWS in 2004, after which nine 2F, two 1FF and one 2FN Schwegler boxes were erected by the local conservation ranger who continues to monitor all the boxes at this site (Figure 4).

1.6 Data Processing and Analysis

All data collected for the years from 1999 to 2015 were entered into a central VWT Microsoft Access database. The following baseline information was collected for each site under the following headings: woodland name; tree number (each tree on which boxes were hung was assigned a number), tree species and altitude at tree. Each box was assigned a number and its type, height and aspect on the tree were recorded.

Microsoft Office Excel was used to manipulate the data relating to Ireland and for recording information on the degree of shading on a box, its distance from a path and tree diameter at chest height. Shading was divided into three categories comprising shaded, dappled or full sun and was assessed with reference to the degree of sunlight reaching a box. Diameter at chest height was calculated by dividing the tree circumference value measured at chest height by 3.14. The distance of a box from a path was measured by considering main and vehicular paths only and was divided into intervals of 0-10 m, 11-20 m, 21-30 m and greater than 30 m.

The first visit when boxes were erected was removed from the data, as boxes were not available to bats on this occasion. Where possible, all other occasions when boxes were unavailable to bats were removed from the dataset. This included stolen, damaged or broken boxes and visits when particular boxes were not checked, for example due to flooding. Where a group of boxes were removed and erected elsewhere, the date they were rehung was also removed from the dataset.

Photographs: Ladder at tree to check 2FN bat boxes.

Records of soprano and common pipistrelle were combined as *Pipistrellus* spp. due to the difficulty of separating these species accurately in the early years of the study.

Photograph: *Pipistrelle* spp.

Pivot tables were used to look at trends in the data according to site and variables such as month, box type, bat species and season. Inspection visits were grouped into seasons as follows: April and May - Spring; June and July - Summer; August and September/October - Autumn; November to March - Winter.

The presence of bird nests in 2FN boxes was recorded to assess whether there was a correlation between presence of nests and absence of bats. A nest was marked as present when a box was full or three quarters full with nest material and notes made on the presence of eggs or chicks. Nests with eggs and chicks were left untouched, otherwise the material was removed.

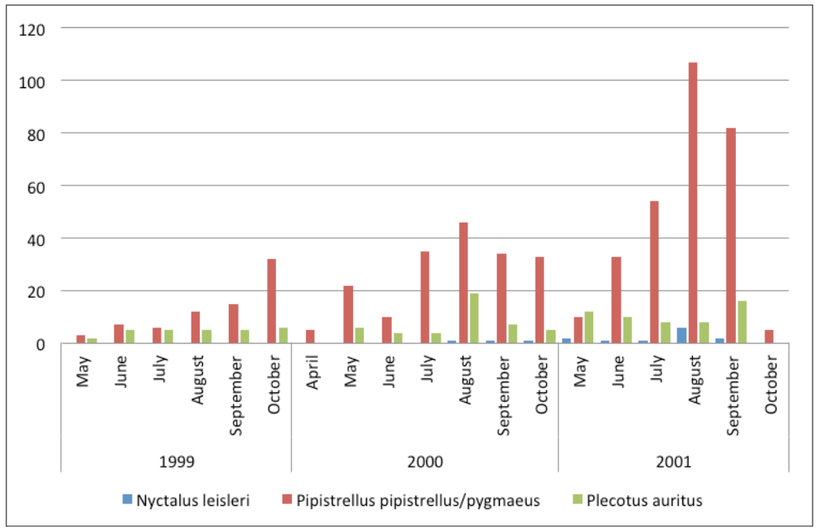
All statistical analysis was conducted externally (stats@stevelangton.org.uk). Initially all data sourced from VWT and external studies were considered for analysis to determine trends and their significance but, due to the variation within the data (for example, types of boxes used and locations), only data from the VWT schemes were analysed. Bar charts were produced by Genstat and trends analysed using Generalised Linear Mixed Models (GLMM) to cater for the analysis of grouped data, primarily different box types at the four sites checked at varying times of year.

1.7 Results

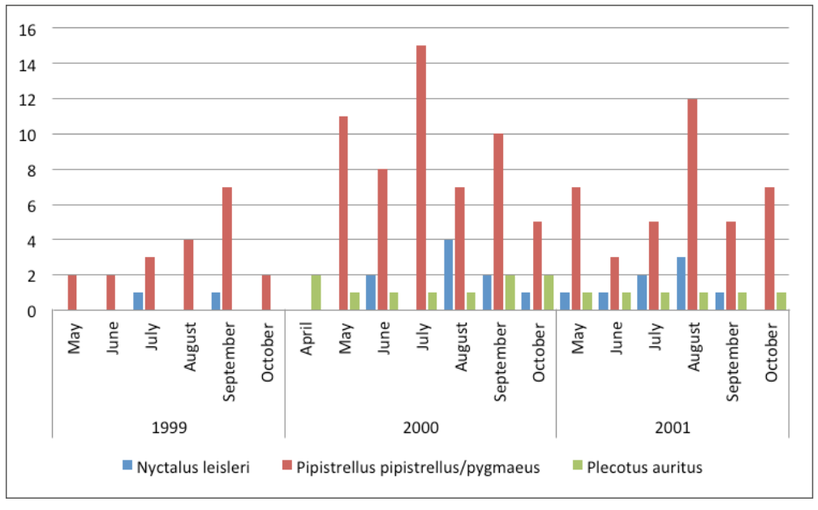
Tables in Appendix 1 and Figure 8 below present a summary of the information gathered during the 17 years of inspections at three woodlands - the sites at Coole and Garryland were grouped as they were always checked on the same day.

Figure 5: The species and numbers of each recorded during spring to autumn in first three years of study.

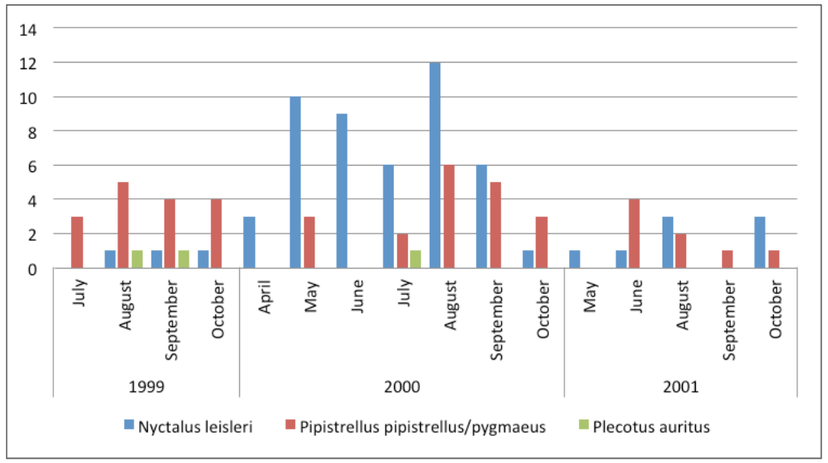
a) Portumna



b) Coole-Garryland



c) Knockma



A total of 153 visits were made; 54, 52 and 47 at Portumna, Coole-Garryland and Knockma respectively, comprising 7,370 box inspections. The breakdown of these inspections under a number of headings is detailed in Tables 2 to 5 below. These tables clearly show how unbalanced the data were, but were useful in identifying the best approaches for further analysis. It is important to remember when reading the tables of results that a box inspected in April and May of the same year contributes two inspections towards the total.

	SITE				
YEAR	COOLE	GARRYLAND	KNOCKMA	PORTUMNA	ALL
1999	70	278	302	446	1096
2000	70	280	350	434	1134
2001	60	240	250	331	881
2002	70	288	89	404	851
2003	0	150	13	174	337
2004	0	200	75	228	503
2005	0	99	45	114	258
2006	0	199	45	168	412
2007	0	194	46	226	466
2008	0	96	46	110	252
2009	0	144	23	164	331
2010	0	48	23	130	201
2011	0	48	21	82	151
2012	0	76	23	51	150
2013	0	0	44	52	96
2014	0	48	21	42	111
2015	0	48	41	51	140
ALL YEARS	270	2436	1457	3207	7370

Table 2: Number of boxes inspected by Year and Site

	SITE				
TYPE	COOLE	GARRYLAND	KNOCKMA	PORTUMNA	ALL
1F	0	0	178	0	178
1FF	0	0	39	1572	1611
1FW	0	0	0	79	79
2FN	270	2436	1240	1556	5502
ALL TYPES	270	2436	1457	3207	7370

Table 3: Number of boxes inspected by Box type and Site

Table 4 shows how the number of visits decline from year 2002 onwards, therefore the results of analysis will be dominated by the data collected in the earlier years of the study. There were only sufficient data on 1FF and 2FN boxes from Portumna to allow comparisons of box type used as 1,572 inspections of 1FF and 1,556 of 2FN boxes were undertaken at this site. Table 4 also shows the variation in visits made by season. There was a good distribution of visits in April and May; only in 2012 was this period missed. Visits in June and July ceased after 2002 to prevent disturbance to breeding groups.

	PERIOD				
YEAR	WINTER (NOV–MARCH)	SPRING (APRIL/MAY)	SUMMER (JUNE/JULY)	AUTUMN (AUG–OCT)	ALL
1999	12	276	324	484	1096
2000	0	324	324	486	1134
2001	0	162	274	445	881
2002	167	229	240	215	851
2003	0	121	0	216	337
2004	0	220	23	260	503
2005	0	128	22	108	258
2006	22	162	72	156	412
2007	23	153	128	162	466
2008	23	206	23	0	252
2009	0	229	0	102	331
2010	75	103	23	0	201
2011	100	51	0	0	151
2012	71	0	0	79	150
2013	23	52	0	21	96
2014	21	42	48	0	111
2015	20	99	21	0	140
ALL YEARS	557	2557	1522	2734	7370

Table 4: Number of boxes inspected by Year and Season for all four sites

Table 5 shows that almost half of the boxes were erected on oak trees (46%), with 33%, 16%, 2.6%, 0.8% and 0.8% on Scots pine, beech, Douglas fir, ash and sycamore respectively.

	SITE				
SPECIES	COOLE	GARRYLAND	KNOCKMA	PORTUMNA	ALL
Sycamore	0	0	19	41	60
Beech	216	0	870	110	1196
Ash	0	0	82	106	188
Douglas fir	0	0	63	0	63
Scots pine	0	0	0	2464	2464
Quercus spp.	54	2436	423	486	3399
ALL TYPES	270	2436	1457	3207	7370

Table 5: Number of boxes inspected by Tree species and Site

The mean and total counts of bats and the percentage of inspections that yielded a bat are shown in Table 6 and 7 for all species and for the four species/groups encountered regularly. Table 8 shows Occupancy Rate, which is defined as the percentage of inspections when a bat was encountered. In these tables, the column giving the results for all bats may be slightly greater or lesser than the sum of the four species/groups listed due to the rare occurrence of other species (whiskered/ Brandt's at Garryland) or unidentified *Myotis* species, and due to the fact that on rare occasions bats of different species were found roosting together in the one box on the same day.

Daubenton's bat was only recorded in Garryland Woodland, while Leisler's, long-eared and the pipistrelles were recorded at all sites. Portumna Wood had the highest total number of bats counted for pipistrelles (2,607), long-eared (1,045) and Leisler's (382). There was a 31% chance of encountering a bat during a visit to this wood compared to 11.5% and 10% at Coole-Garryland and Knockma respectively.

Photograph: Leisler's bats in a 2FN bat box

SITE	n	DAUBENTON'S	LEISLER'S	PIPISTRELLE	LONG-EARED	ALL
Coole	270	0.000	0.059	0.122	0.000	0.181
Garryland	2436	0.091	0.017	0.197	0.130	0.435
Knockma	1457	0.000	0.069	0.079	0.004	0.152
Portumna	3207	0.000	0.119	0.813	0.326	1.260
ALL SITES	7370	0.030	0.073	0.439	0.185	0.729

Table 6: Mean number of bats counted by site (n = number of inspections and not numbers of boxes)

SITE	n	DAUBENTON'S	LEISLER'S	PIPISTRELLE	LONG-EARED	ALL
Coole	270	0	16	33	0	49
Garryland	2436	221	42	479	316	1060
Knockma	1457	0	100	115	6	222
Portumna	3207	0	382	2607	1045	4040
ALL SITES	7370	221	540	3234	1367	5371

Table 7: Total number of bats counted by site (n = number of inspections and not numbers of boxes)

SITE	n	DAUBENTON'S	LEISLER'S	PIPISTRELLE	LONG-EARED	ALL
Coole	270	0.0	3.0	10.4	0.0	13.3
Garryland	2436	1.1	1.6	6.8	2.0	11.5
Knockma	1457	0.0	3.6	5.8	0.4	10.0
Portumna	3207	0.0	4.2	23.2	3.9	31.2
ALL SITES	7370	0.4	3.2	13.9	2.4	19.9

Table 8: Percentage of inspections with bats by site (n = number of inspections and not numbers of boxes)

Table 9 shows the results for the pipistrelle bats. A presence/absence model rather than models of numbers was used because the counts of bats had fairly extreme distribution, with many zeros and a few high counts. Hence, significance tests from the presence/absence GLMMs are likely to be more reliable than those from quantitative models. Two factors are highly significant: Box type (1FF) (F = 49.80, with 1 and 31 d.f., P = < 0.001) and Season (higher occupancy later in the year) (F = 14.93, with 3 and 1891 d.f., P = < 0.001). There was no significant interaction between Box type and Season, so the seasonal pattern appears to be similar for both box types. Tree species and Diameter are both highly significant, but it is possible that these effects are confounded with spatial factors that were not examined in this study. The only other factor that is highly significant is Year (F = 2.43, with 16 and 690 d.f., P = 0.001), with an initial increase over time then a stabilisation. Due to the location of boxes along the shore of Lough Derg, GLMM tests were conducted to see if there was a preference for boxes near the water, as both mean counts and occupancy rate were higher in lake shore boxes, and this proved to be statistically significant (F = 6.06 with 1 and 24 d.f., P = + 0.021).

TERM	F VALUE	NDF	DDF	P VALUE
Aspect	1.07	3	30	0.378
Tree species	6.07	3	32	0.002
DBH	9.88	1	35	0.003
Box type	49.80	1	31	<0.001
Season	14.93	3	1891	<0.001
Year	2.43	16	690	0.001
Shading	2.11	1	26	0.158
Distance from path	1.55	3	47	0.213

Table 9: The significance levels for the presence of pipistrelles at Portumna using GLMM

Table 10 shows the results for long-eared bats. Box type is significant (2FN) (F = 5.17 with 1 and 31 d.f., P = 0.030), but Season is not significant. Diameter has a significant positive relationship (F = 5.21 with 1 and 31 d.f., P = 0.029) and is worth further investigation to see if trees are distributed throughout the site or in a group of similar diameters. There was some significance with respect to Year, with a gradual increase in use over time.

Photograph: Long-eared bats

TERM	F VALUE	NDF	DDF	P VALUE
Aspect	0.46	3	29	0.715
Tree species	1.48	3	32	0.237
DBH	5.21	1	31	0.029
Box type	5.17	1	31	0.030
Season	1.03	3	1812	0.377
Year	1.81	16	592	0.026
Shading	1.93	1	40	0.173
Distance from path	0.79	3	26	0.513

Table 10: The significance levels for the presence of long-eared bats at Portumna using GLMM

Table 11 shows the overall significance levels from GLMM for the presence of Leisler's bat at Portumna Wood in 2FN and 1FF boxes. The only factor that is highly significant is Year (F = 2.62 with 16 and 648 d.f., P = 0.001), with increasing numbers from 2013 onwards. However, Season is also just about significant (F = 2.64 with 3 and 1892 d.f., P = 0.048), with increasing presence later in the year. Test for interactions between other variables did not yield any of significance (Aspect:Box type; Tree species:Diameter; Box type:Season; Aspect:Shade; Season:Shade).

TERM	F VALUE	NDF	DDF	P VALUE
Aspect	0.54	3	32	0.659
Tree species	1.42	3	30	0.258
DBH	0.00	1	53	0.974
Box type	0.00	1	40	0.961
Season	2.64	3	1892	0.048
Year	2.62	16	648	0.001
Shading	0.01	1	27	0.932
Distance from path	0.68	3	34	0.573

Table 11: The significance levels for the presence of Leisler's bat at Portumna using GLMM

Considering Portumna only, Figure 6 shows mean number of bats by Box type and Season and Figure 7 the occupancy rate by Box type and Season. These indicate that pipistrelles have a clear preference for 1FF boxes and long-eareds have a clear preference for 2FN boxes. As discussed above, when these data were tested using GLMM, both were statistically significant.

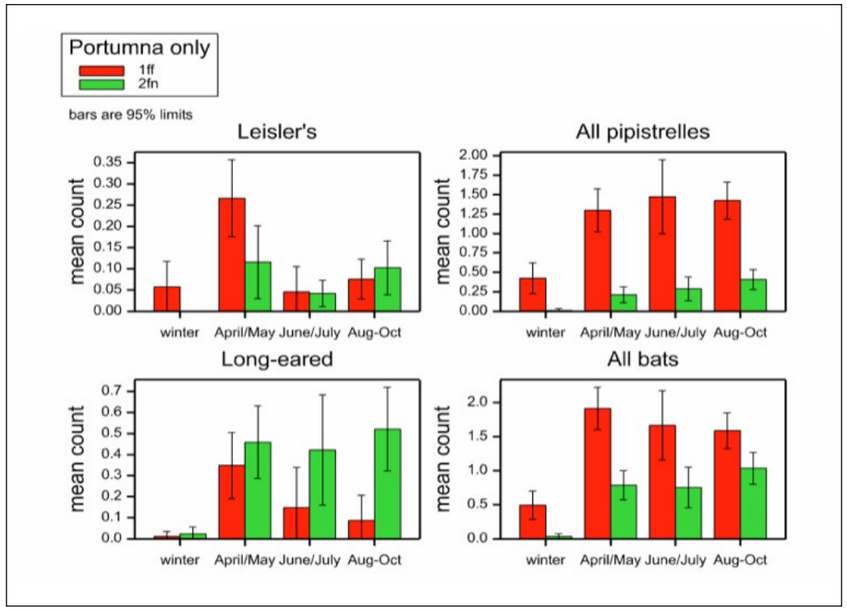


Figure 6: Mean number of bats by Box type and Season

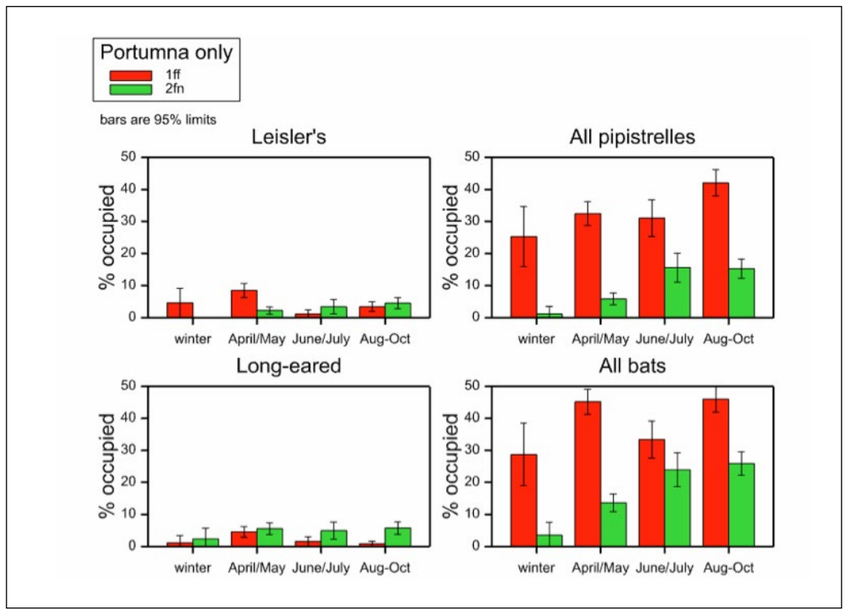


Figure 7: Occupancy rate by Box type and Season

Figure 8 shows the pattern of occupancy by species at the three sites for all years. Leisler's bat was recorded at Coole-Garryland in the second year of the study but has been absent since 2009. This species has been recorded at Portumna every year since 2000 when it first appeared there. It was present during the first year at Knockma but has been absent on occasional years since then.

Pipistrelles were not recorded at Garryland during the 2012 visit, but not all boxes were inspected on the day, no visit was made in 2013, and only one in May 2015 prior to this report. Long-eared bats have been present every year since 1999 at Portumna, rarely at Knockma and absent from Garryland since 2009.

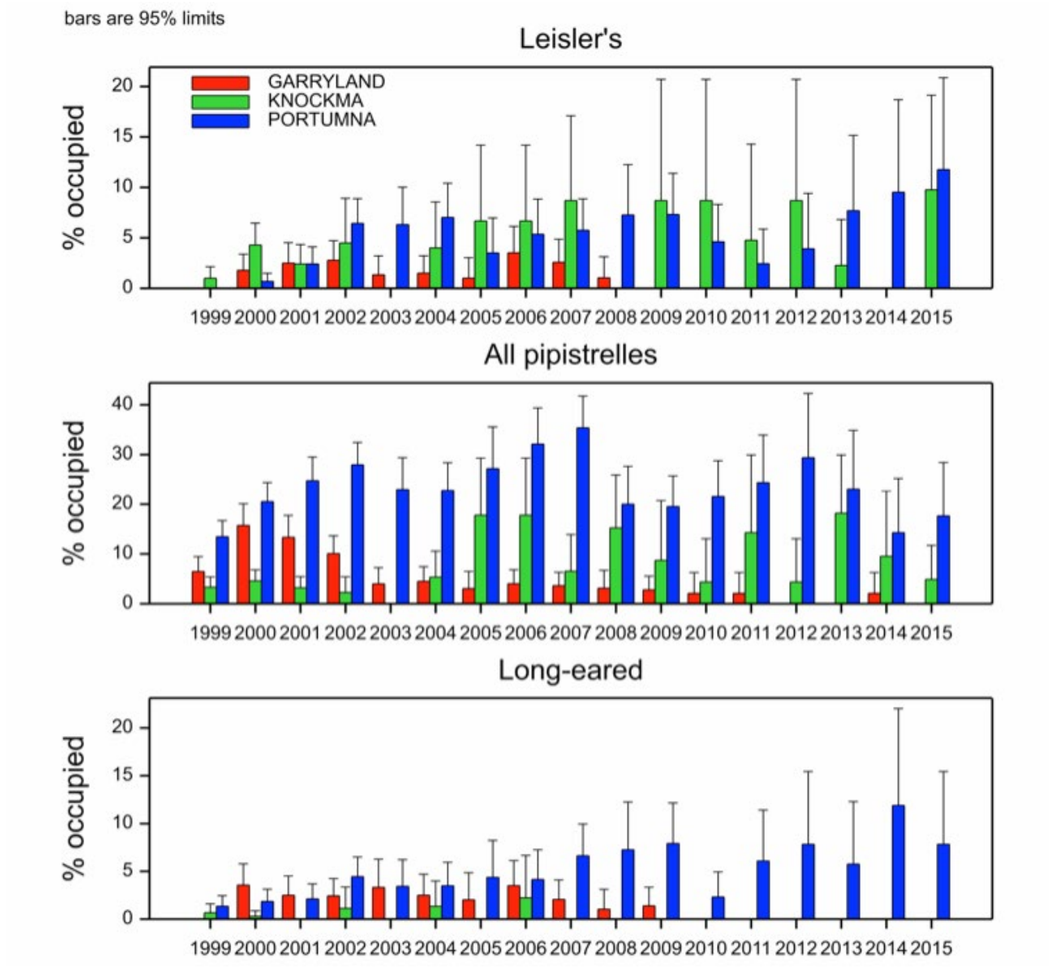


Figure 8: Percentage occupancy of bats by Year and Site

Although notes were taken of the presence of bird nests, this was quite a subjective exercise and the detail of this varied considerably, so no analysis could be undertaken. However, Figure 9 shows that the month of May was the peak time for bird occupancy of 2FN boxes.

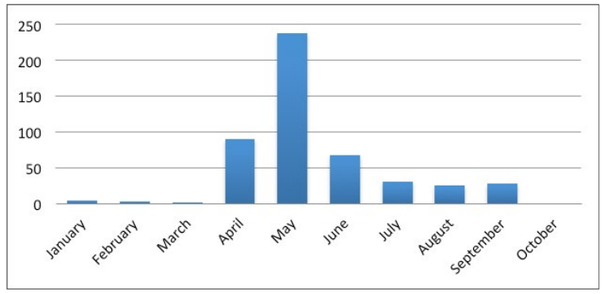
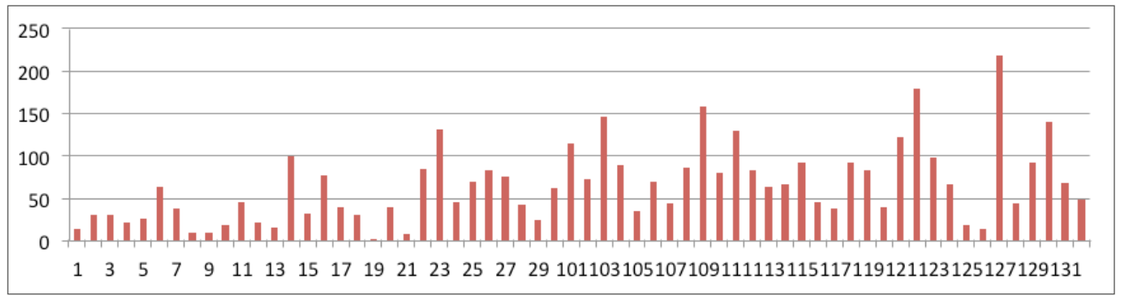


Figure 9: Number of bird nests in 2FNs by month for all sites

Three bat species were found in boxes that contained a substantial amount of bird nesting material on 20 occasions; pipistrelles (n = 10), brown long-eared (n = 9) and Leisler's (n = 1). Usually single bats were found roosting above the nest, but on three occasions groups of long-eared bats (up to 15) were recorded. It appeared that certain boxes were preferred by birds, particularly in Knockma Wood. Figure 10 shows how some boxes were preferred over others.

Photograph: Grounded bat box with bird's nest inside.

Figure 10: Numbers of bats using boxes at each site

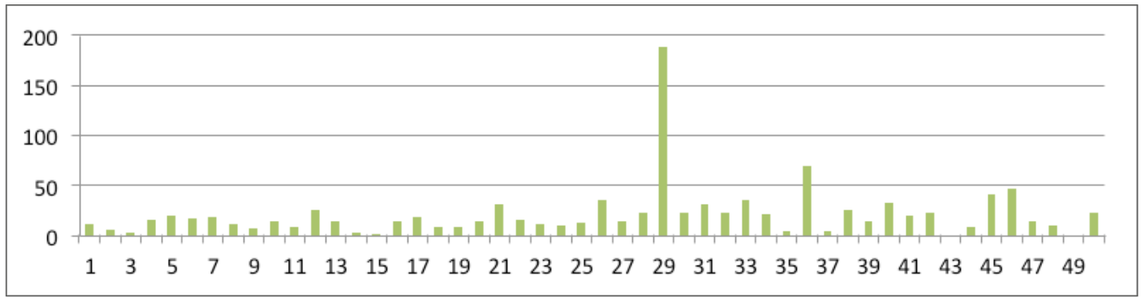


a) Portumna – box number by occupancy

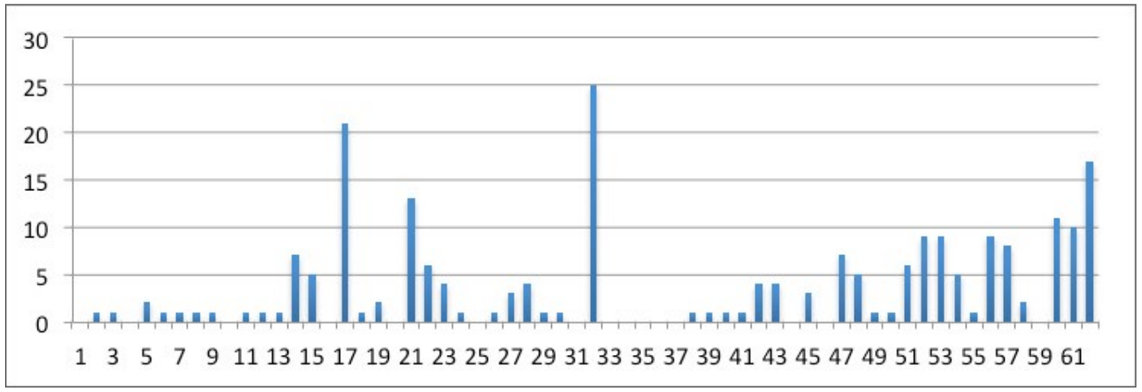
Box 127 had the highest level of occupancy in Portumna. This is a west facing 1FF on a Scots pine in dappled woodland, within 40 m of the lake and more than 30 m from the nearest path. On 10 visits this box was being used by groups of 10 or more pipistrelles.

Groups of bats (> 10) were recorded 187 times and groups estimated to contain more than 20 bats were found during 29 inspections, generally during the visits in April and May. Pipistrelles formed more groups in 1FF boxes than 2FN, whereas groups of long-eared and Daubenton's bats formed in 2FNs.

Box 29 displayed the highest level of occupancy in Garryland. This is a south facing 2FN on an oak tree in a shaded area over 30 m from the closest path. Groups of 10 or more pipistrelles were recorded from this box during eight different inspections.



b) Garryland – box number by occupancy



c) Knockma – box number by occupancy

Boxes 32 and 17 exhibited the highest levels of occupancy with 25 and 21 bats respectively. Both were 2FNs in areas of dappled sunlight: box 17 was west facing on a Douglas fir of 58 cm diameter and 11-20 m from the nearest path; box 32 was south-east facing on a beech tree of 70.7 cm diameter and 10 m from the nearest path. In spring 2000 and 2002, groups of Leisler's (six to eight bats) used box 17.

Photographs: (left) Leisler's bat in the hand, **(right)** Whiskered/Brandt's bat in the hand

1.8 Discussion

The primary aim of the VWT Bat Box Scheme in Ireland – to determine the presence of the barbastelle – was not achieved in the 17 years of the survey. A critical assessment of this species' presence in Ireland, and of the noctule, was undertaken by Buckley *et al*. (2011) using walked transects in the Lough Derg region, with Pettersson D100X bat detectors and by passive monitoring using an SD1 Anabat detector. Out of 1,011 recordings, no calls of the barbastelle were detected. The authors concluded that while it is impossible to prove the absence of a species there is currently insufficient evidence to state that the barbastelle occurs in Ireland. A possible explanation for the 1997 claim is that Daubenton's bat emits a social call that overlaps in call structure with some calls produced by the barbastelle. It is interesting to note that in the late 1990s a Daubenton's colony was discovered roosting in gaps in stonework at the priory in Portumna and it was the most commonly captured species during a mist netting survey by the Dublin Bat Group in 1998 in the grounds of the priory (K. McAney, pers. obs.).

Despite the failure to achieve the primary aim of the project, once the boxes had been adopted by other species it was decided to leave them in place and only to relocate those under-used or on trees that posed a health and safety risk to the persons conducting the inspections – for example trees on sloping ground at Knockma Wood. The number of inspections per year was reduced to minimise disturbance to any groups of bats but was also due to time constraints. In the early years of the study, droppings were collected on a monthly basis and stored. Samples from 1999 and 2000 formed the basis for a final year B.Sc. Zoology thesis on the diet of pipistrelle bats in the three woods (Guillot, 2003). A total of 202 droppings were analysed and 25 Arthropod categories identified. Dipteran insects were the most important prey group making up 80% of the diet; the most important families represented were the Chironomidae/Ceratopogonidae (biting and non-biting midges), Anisopodidae (window midges) and Tipulidae (crane-flies).

In time, three schemes were handed over to the NPWS and Cork County Bat Group, while data on the Portumna boxes, which remained a VWT study, were entered into the main VWT Bat Box Database held in the UK. A major study of the latter was produced in 2006 (Poulton) at which time information on 68,715 inspections of 3,024 boxes on 1,410 trees in 52 woodlands in England, Wales and Ireland was available, covering the years 1985 to 2005. Along with the three models of Schwegler box used in Ireland, seven other types, both woodcrete and timber, were in place in England and Wales. In addition to the species recorded in boxes in Ireland (pipistrelles, brown long-eared, Leisler's, whiskered/Brandt's, Daubenton's, Natterer's), the noctule, serotine and Bechstein's bat were also recorded in the UK. Despite the volume of records there were limitations as to the extent of analysis possible due to the high degree of variability in the types of boxes used and how and where they were deployed. Hence, subsets of data were investigated primarily to determine the factors influencing occupancy rate of box type (woodcrete vs timber) and box model (1FF vs 2FN etc.).

The major results from the Poulton study were that occupancy rates showed a distinct winter low with less than 2% used in February compared with 10% in August and September, and that there was a highly significant difference in occupancy rates between bat box types: in general woodcrete were preferred to wooden. Occupancy rates, bat counts and species counts all increased significantly with the length of time the schemes were established. For all six individual species/groups, occupancy rates differed significantly between types of bat box. There were less marked differences with relation to bat counts. The *Pipistrellus* spp. group accounted for 50% of the occupancy rate but brown long-eared bats were more numerous (n = 9,684) than pipistrelles (n = 5,985) and were the only species that formed clusters. The 1FF and 2FN boxes accounted for 90% of the pipistrelle records with occupancy rates of 12.9% and 8.5% respectively. Also, the 1FF boxes were adopted earlier than the 2FNs (300 and 450 days respectively). However, when 2F box types were available, pipistrelle bats preferred these showing a higher occupancy rate, higher counts and were adopted more quickly than any of the other box types. The other species of relevance to Ireland is Natterer's bat: bat box height seemed to have a significant effect on occupancy rate and time to first use, with this species showing a strong preference for boxes placed low (4 m or lower). Although this species was found in all seven box types used in England and Wales, five of which were woodcrete, it preferred the 2F model (occupancy rate 4.3%) over the 1FF and 2FN (occupancy rates of 2.7% and 2.2% respectively).

The first study of exclusively Irish VWT bat boxes was undertaken by Teesdale (2006) who analysed the data collected at Portumna Forest Park during the first seven years of the study, by which time 2,124 bats had been counted during 37 visits. As in the Poulton study, the lack of a systematic approach to the initial placement and subsequent inspection of the boxes limited the amount of analysis possible, but a number of statistically significant results were obtained and some observations that merit future research. The pipistrelle group was recorded in 70.4% of the inspections, followed by brown long-eareds and Leisler's at 21.8% and 7.8% respectively. The pipistrelles showed a clear preference for 1FF boxes and brown long-eareds for 2FN while Leisler's bats showed no preference. Teesdale mapped all the boxes using a GPS and GIS and was able to assign the boxes to either wood edge (close to a path/track) or wood interior and found all three species preferred boxes that were located closer to woodland edge, and also that pipistrelle bats preferred those boxes closest to Lough Derg, while the other two species preferred boxes more than 50 m away from the lake. Her results also suggested that the clustering or isolation of boxes was an influencing factor, with all three species/groups choosing isolated boxes. Aspect of the box appeared to be a factor influencing occupancy, with Leisler's using north and east facing boxes, pipistrelles using west and east facing and long-eareds selecting south facing. There was also evidence of seasonal variation in box occupancy, with more bats present in the spring than summer and autumn, although pipistrelles were more often recorded in 2FN boxes in summer than at other times of the year.

The analysis carried out for this report supports some of the findings detailed above, which is not surprising considering that the dataset used here also formed part of the earlier studies, but additional significant factors were identified. As in the Poulton study (2006) subsets of data were used depending on the factor being assessed; only data from Portumna Forest Park for the years 1999 to 2002 were used to test bat box preference as only at this site were two different box models used, but the entire dataset was used to look at species behaviour in relation to other factors, such as year or season. A common result with the other two studies is the preference by pipistrelle bats for 1FF boxes and, in common with Teesdale (2006), that brown long-eareds preferred 2FNs. The 1FF box is designed to replicate the narrow crevice-like spaces favoured by pipistrelles while the 2FN design mimics holes in trees, the natural roosts of the long-eared bat. The preference by pipistrelles for boxes close to water was replicated in this study.

Seasonal use by both pipistrelles and Leisler's bat was confirmed in this study; however, contrary to Teesdale's finding, this was for more bats of both species to be present later in the year. This may reflect the use of the boxes by females who leave maternity roosts in buildings once the pups are weaned and by male bats seeking to attract females for mating, as sexually active males of both species were encountered singly or with females in the autumn. Brown long-eareds did not show any seasonality. Research since the 1960s on the mating behaviour of this species shows that mating occurs mainly in winter and early spring, rather than autumn. This may explain the lack of seasonality in the occurrence of this species in boxes, as unlike pipistrelle and Leisler's bat, male brown long-eareds do not set up autumn mating roosts to attract females.

Swift (1998) refers to a study by Altringham & Bullock (1988) where a bat box scheme was set up in a coniferous forest in south-east Scotland in an area where there were few alternative roost sites. Within three years 60% of the boxes had been used, with pipistrelles the most numerous but only for mating purposes, while brown long-eared and Natterer's bat both formed nursery colonies, as was the case in this study for long-eareds in Portumna and Natterer's in Glengarriff, but also Daubenton's in Garryland.

Brown long-eared bat colonies are typically small compared with those of other species, generally from 10–20 adults (Entwistle *et al.*, 1997) and it is one of the European species that most frequently uses bat boxes and one of the few that forms nursery colonies in them. The sustained presence of groups of long-eared bats at Portumna is in agreement with this and mirrors the south-east Scottish experience where this species readily adopted boxes in coniferous woodland that offered no natural roosts. Yet, some of the boxes in Portumna are on deciduous trees and there was a significant positive relationship exhibited by this species and tree diameter. It is clear that further work is needed to determine the factors influencing the use of boxes by the long-eared bats.

The other factor that proved significant was the length of time the boxes were in place, with occupancy rates increasing for all three species, although in the case of pipistrelles this increase appears to have stabilised. So, although the boxes were occupied very quickly, it took several years before they were regularly occupied and before clusters of bats were formed and breeding was confirmed.

In this study four species or groups formed clusters in boxes, pipistrelles, brown long-eared, Daubenton's and Natterer's, probably reflecting the length of time the boxes have been in place, although Natterer's bat adopted the 2FN boxes in Glengarriff very quickly. In the UK VWT study, this species was able to choose between seven types of boxes and selected the 2F model over the 2FN; both models provide space for clustering in the roof, the major difference is one opening in the front door panel of the former whereas there are two openings, a slit near the bottom of the box at the front and one to the rear, in the latter.

No significance for box occupancy in relation to a variety of factors was detected in this study of Portumna Forest Park. Although aspect is often considered to be an important factor to consider when erecting boxes, this was not the case here. Several studies have tested the influence of aspect with varying results (no relevance in a wood in the UK – Dodds & Bilston, 2013; preferences for east-facing boxes during breeding in a wood in Spain – Flaquer *et al.*, 2006). In guidelines for erecting bat boxes in the northern hemisphere provided by Bat Conservation Ireland (www.batconservationireland.org) and the Bat Conservation Trust (www.bats.org.uk), both organisations recommend that boxes should be positioned so that they receive sunlight for several hours each day – so on a southerly or westerly aspect – because lack of warmth is considered to be the main reason why bat boxes are not used by bats. This may be more critical if only two or three boxes are being erected as opposed to a large scheme with tens of boxes in woodland. All the boxes in place in Portumna, Garryland and Knockma woods were visited in June 2015 and their degree of exposure to sun was assessed with most categorised as receiving dappled sunlight, with low numbers as shaded or exposed, therefore the effect of aspect may be modified to some extent by tree cover.

The month of May was the peak time for occupancy by birds of 2FN boxes in the three woods and undoubtedly prevented their use by bats. Several studies have remarked on the exclusion of bats by birds occupying different models of bat box (Meddings *et al.*, 2011; Dodds & Bilston, 2013), but occupation can operate in reverse; brown long-eared bats used bird boxes erected in a pine forest in central Spain (Benzal, 1991) and at a London woodland, Wytham Woods, bats moved into Schwegler bird boxes erected for great and blue tits (*Cyanistes (Parus) caeruleus* and *Parus major*), as described by Dani Linton in a presentation at the 2012 Belgium Bat House Meeting. Dodds & Bilston (2013) describe the use of bat boxes by birds despite the availability of bird boxes on the same tree and state that the influence of bird competition was significant and boxes need to be modified to exclude birds, including the large hibernation and summer models.

Photograph: Knockma woods

The two hibernation boxes erected at Portumna were quickly adopted by birds, although also used by groups of pipistrelles and on one occasion brown long-eared bats. Bilston (2014) investigated methods to exclude birds from 1FS and 2FN boxes during the nesting season in an ancient woodland in Buckinghamshire, using expanded foam to restrict the size of the entrance and the internal area available to nesting birds, but still enabling bats to roost. The first year results were positive, with the exclusion measures working 100% in both box models. Bat occupation rates in the 1FS boxes, the preferred model, were higher in the modified boxes during the bird nesting season than in previous years.

Portumna Forest Park was the obvious woodland in which to erect bat boxes as this was where the barbastelle was believed to have been detected and it has proved to be a very successful scheme for pipistrelle, long-eared and Leisler's bats. Although some deciduous trees occur many of the boxes are located on conifers that do not offer natural roosts. No doubt the lakeshore and other wetlands associated with the park provide adequate foraging grounds for bats that now choose to roost in the wood using the boxes. It is interesting that no Daubenton's bats were found in the boxes during inspections, yet a colony is known to roost in the stonework of buildings adjacent to the park. On occasions when pipistrelles and Leisler's bats were active during inspections and flew away on opening the box, they were usually observed entering another adjacent bat box.

Coole-Garryland was chosen as a study site because it was the best example of a semi-natural broad-leaved oak woodland in the county with ease of access, that might have been suitable for barbastelles. More species of bat were recorded here than at the other woods, only Natterer's bat was unrecorded. However, this species is present in the area because a colony of approximately 50 bats were identified in a dawn survey as they entered a gap in a stone wall of the courtyard close to the visitor centre (O'Mahony, 1998). When bats flew away from boxes in Garryland during inspections, in contrast to Portumna, they disappeared into naturally occurring cracks of the tree on which the box was hung or on an adjacent tree.

Knockma Wood was the smallest of the three woodlands chosen and the results reflect this with fewer species and number of bats recorded, yet more Leisler's bats were recorded here than at Coole-Garryland. It is possible that the woodland management being undertaken will enhance this site for bats. Little can be said about the one-year scheme at Ballykyne Wood, except that pipistrelle bats were recorded in the boxes very quickly, probably because there was a large nursery colony in a building within 500 m of the wood. Results from Glengarriff Wood are discussed in Chapter 2.

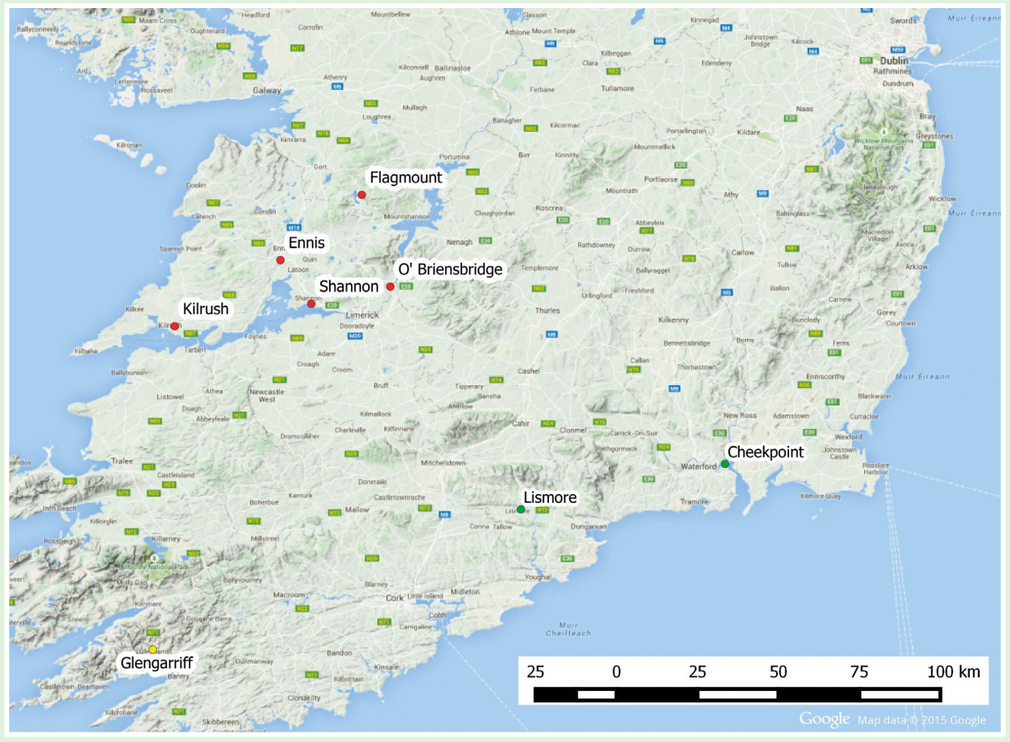
The VWT study has shown that seven of the nine Irish bat species use artificial bat roosts in the form of woodcrete boxes for a variety of reasons but certainly for breeding and mating. Some species, such as brown long-eareds, form clusters and appear to be resident within the woods, while many boxes contain single or small numbers and may indicate transient use. Whiskered/Brandt's bat was a rarely recorded occupant, possibly surprising as it is a species associated with woodland, but this is one of the most rarely recorded bat species in Ireland (Bat Conservation Ireland, 2014). An eighth species, Nathusius' pipistrelle, was not recorded in VWT bat boxes but did occur in a box erected as a mitigation measure. The only species not recorded was the lesser horseshoe bat but, as mentioned earlier, this species is not able to access the openings in the boxes, although it will use a bat box as a perch from which to hang (C. Morris pers. comm.). Unfortunately the data collected by the VWT were not in a format that could be easily shared with Bat Conservation Ireland when information on all Irish bats was being collated for the 2014 publication 'Irish bats in the 21st Century', but as a result of this study these data are now being incorporated into Bat Conservation Ireland's bat database.

Photograph: 1FF bat box in Portumna Forest Park

2. OTHER BAT BOX SCHEMES

Three other bat box schemes used Schwegler bat boxes and the results of these are presented here. The Glengarriff scheme was initiated by the VWT and is now managed by the Cork County Bat Group, but records for certain years were collected by the Centre of Irish Bat Research (CIBR).

Figure 11: Map of other bat box studies included in this report



2.1 Glengarriff Wood

The 42 2FN boxes moved to Glengarriff in May 2003 were located at two sites, in the oak wood within the nature reserve and on pine trees in a nearby Coillte plantation. Table 12 shows the results from inspections for the years 2003 to 2010 and Figure 11 the location of the boxes.

YEAR	MONTH	SITE	BAT PRESENCE
2003	August	Oak wood	Two male soprano pipistrelles in separate boxes, sexually active Male and female Leisler's bats in a box – male sexually active
		Conifer	Two soprano pipistrelles in separate boxes
2004	February	Both sites	No bats present, old droppings present in many boxes
	May	Oak wood	Two soprano pipistrelles in separate boxes, droppings in other boxes
		Conifer	Bat droppings only in 11 boxes
2005	June	Oak wood	One soprano pipistrelle
		Conifer	Bat droppings only in some boxes
2006	May	Oak wood	Seven Natterer's bats in one box, one Natterer's in another box
		Conifer	Bat droppings only in some boxes
2007	June	Oak wood	20 Natterer's in one box, young present One male Natterer's in another box One male Leisler's in another box
		Conifer	Bat droppings only in some boxes
2008	May	Oak wood	No bats, droppings in some boxes
		Conifer	No bats, droppings in some boxes
2009	February	Oak wood	No bats, droppings in some boxes
		Conifer	No bats, droppings in some boxes
	July	Oak wood	55 Natterer's in a box; 32 adult females, one adult male, 11 juvenile females and 11 juvenile males One female Natterer's bat in another box
		Conifer	One whiskered/Brandt's bat in a box One male common pipistrelle in another box
2010	July	Oak wood	A total of 64 Natterer's in two boxes
		Conifer	39 brown long-eared bats in one box, juveniles present One male soprano pipistrelle in another box

Table 12: Results from inspections of bat boxes at Glengarriff Wood, 2003–2010

Bats were recorded in the boxes during the first inspection in August 2003 when it appears as if the boxes at both sites had been adopted as mating roosts by male pipistrelle and Leisler's bats. Low numbers of soprano pipistrelles were recorded in 2004 and 2005 and Natterer's first appeared in 2006 and were present in 2007 and 2009 and were using the boxes for breeding. This species was probably also present in 2008 but no summer visit was possible that year. Eight years after erection, a maternity group of long-eareds moved into a box in the conifer wood, and although boxes here held low numbers of bats, they had been used by five different species by 2010.

A study of the use of natural and artificial roosts by Natterer's bat was conducted in the UK by Phillips (2009). Roosts were found in areas of high understorey growth and close to water bodies, features in common with the oak wood at Glengarriff. The presence of breeding females in boxes in the UK study was thought to be related to the warmer and more humid conditions provided by the bat boxes.

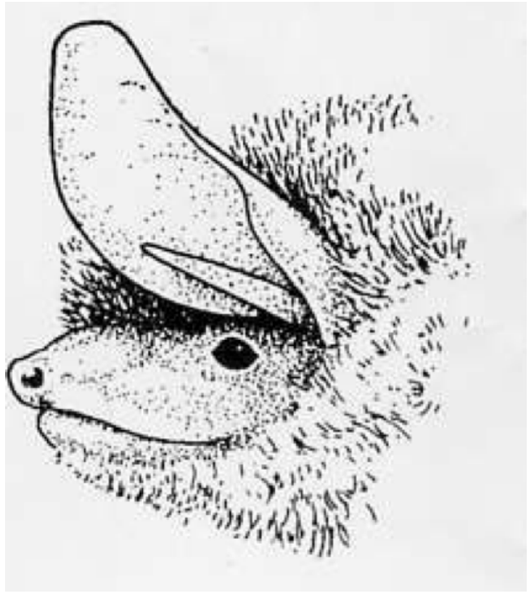


Illustration: Natterer's bat

2.2 Clare County Bat Group

The Clare County Bat Group erected 35 Schwegler bat boxes in 2008 and 2009 with grant assistance from the Heritage Council towards the purchase of the boxes. The boxes were located in five woods within the county (Figure 11) and were generally checked in early spring and late autumn during the years 2008 to 2014. Table 13 gives details of the five sites and the results obtained.

Photographs: (left) Members of the Clare County Bat Group checking a bat box, **(right)** Soprano pipistrelle in a bat box in Kilrush.

SITE NAME	WOODLAND TYPE	2FN	1FF	SPECIES	COMMENTS
Shannon	Sycamore and beech at edge of estuary	3	3	Pipistrelle, Leisler's, Daubenton's	Bird nests in 2FNs
Flagmount	Mixed Coillte woodland at lake edge	4	4	Pipistrelle, Leisler's, Brown long-eared	All eight boxes in use. Bird nests in 2FNs.
Kilrush	Mixed Coillte woodland with adjacent beech woodland	4	5	Pipistrelle, Leisler's, unidentified	Two boxes stolen, one box damaged. Dead pipistrelle found. Bird nests in 2FNs.
Ennis	Mixed woodland	3	3	Pipistrelle, *Myotis* spp.	One box damaged. Bird nests in 2FNs. Dead pipistrelle found.
O'Briensbridge	Riparian woodland	3	3	Pipistrelle	One box damaged. Dead pipistrelle found. Bird nests in 2FNs.
		18	17	(105 Bats in Total)	

Table 13: Results of the Clare County Bat Group Bat Box Scheme

In the first three years of the study 81% of the boxes had been used by bats. The 1FF boxes were used more than the 2FNs and the pattern of occupancy varied.

2.3 Waterford

Eighteen Schwegler 2FN bat boxes were erected in two woodlands in September and October 2013; 12 in a mixed woodland along a river in Lismore and 6 along a treeline at the edge of the village of Cheekpoint, close to mixed woodland (Figure 11).

The boxes were checked in May and September 2014 with an additional visit to Lismore in June. All droppings found were collected and species identified using DNA analysis. Three soprano pipistrelles were found in Lismore and all droppings found were those of soprano pipistrelles. No bats used the boxes at Cheekpoint.

Photograph: Pipistrelles in a 1FF box

2.4 Wicklow National Park

A study was undertaken by Enda Mullen, District Conservation Officer NPWS, at Wicklow National Park in summer 2012 on a series of commercially available bat boxes to test how these compared to the conditions inside a maternity pipistrelle bat roost within an attic with respect to temperature and humidity values. The purpose of the study was to determine if bat boxes were suitable as alternative roosts for bats that needed to be excluded, under licence, from occupied houses and was part funded by the Heritage Council.

Gemini data loggers were used to measure temperature and humidity within the roost, within three types of Schwegler boxes (2FN, 1FD, 1FF) and two timber boxes, and on a west-facing window ledge on the building on which the boxes were fitted. The timber boxes were a standard timber bat box and a timber maternity style specifically designed for the project by Batroost Ireland (www.batroostireland.org). The Batroost Ireland box was constructed using a design from Bat Conservation International (www.batcon.org) and contained a copper pipe filled with sand in the top of the box to serve as a heat reservoir.

The main findings from this study were as follows:

- Temperature within the attic was consistently warmer than external ambient temperature
- Temperature within the boxes was consistently cooler than that in the attic
- Temperature within the boxes closely matched that of ambient temperature
- There was little variation in temperature values between the different box types
- The 1FF and Batroost Ireland boxes had mean temperature values closest to the attic values, with the 1FF performing slightly better
- There were differences in how temperature varied between the 1FF and Batroost Ireland box, with the former heating up quicker by day but the latter retaining heat longer during the night
- Humidity values were lower in the attic than in the boxes and again the 1FF was closest to the attic values

2.5 Mount Falcon

Dr Tina Aughney, Bat Ecologist, provided information on the use of Schwegler bat boxes as a mitigation measure for the removal of trees during road improvements to the N26, south of Ballina, County Mayo, in the vicinity of Mount Falcon Estate. Mayo County Council provided the funding for the purchase of the boxes. Eighteen 2FN boxes were erected on six trees in six different locations, therefore three boxes to a tree.

Photograph: Schwegler 1FD, 1FF and 1F bat boxes.

The species of trees chosen were a beech in the centre of a beech woodland, a beech at the edge of an open glade in a mixed woodland, a beech near the edge of a mixed woodland, a conifer at the edge of a pond and close to a trackway, a beech in the centre of a second beech woodland and an oak in the centre of a mixed woodland. All the boxes were located 4 m high and positioned south-east, south and south-west.

The boxes were checked in September 2004 by Dr Aughney who found bat droppings in 16 of the 18 boxes with the other boxes blocked by bird nests. Four of the boxes had bats of two species, soprano pipistrelle (one, two and four individuals in three boxes) and three Leisler's bats in one box.

2.6 Bat Boxes and Agri-environment Schemes

In contrast to previous agri-environment schemes, the current GLAS scheme promotes the use of bat boxes as a separate measure that farmers can choose to implement. In previous schemes, there was no distinction made between bat and bird boxes, so no information is available as to how many bat boxes were erected in the past or any way of determining how successful or otherwise this measure was, but the general view of this measure is that the erection of bat boxes was an awareness raising exercise rather than a practical conservation action (C. Keena, pers. comm.). A variety of timber bat boxes have been on display at the Teagasc Centre in Athenry, County Galway since 2008 and are used to raise awareness about bats amongst farmers and advisors during open days at the centre. Under GLAS the rate of payment each year per bat box is €13, with a minimum of three boxes and a maximum of 15 allowed per farmer. Farmers are reported to have opted to erect 80,000 bat boxes at a cost of €1.04 m per year (Irish Independent, 30/06/2015).

Photograph: Bat boxes at Teagasc, Athenry.

2.7 Summary

The results obtained by these different studies have added to our knowledge of the use of bat boxes in Ireland. Natterer's bat is now confirmed as using boxes for breeding here. Autumn inspections and handling has provided additional evidence of the use of boxes as mating roosts by pipistrelle and Leisler's bat. The Clare project showed a high success rate within three years and again highlighted the problem of bird nests in the 2FNs. Interestingly, all the droppings analysed from the Waterford boxes were from soprano pipistrelles and none of the boxes erected close to a village were used.

The Wicklow study differs from the others in that it was designed to investigate a specific question – can boxes be recommended as alternative summer roosts for bats excluded from buildings? The Schwegler 1FF bat box performed better than the other five types tested in relation to temperature and humidity, but the final conclusion from this study was that none of the commercially available boxes are suitable alternatives as maternity roosts for soprano pipistrelle bats and are therefore not suitable as a mitigation measure when bats need to be excluded under licence.

The Mt. Falcon post-mitigation study proved once again that 2FN boxes are readily adopted by soprano pipistrelles and Leisler's, but also birds. These findings are similar to those from eight bat box projects investigated by Bat Conservation Ireland in a report to the Heritage Council in 2008 titled '*An investigation of the impact of development projects on bat populations: comparing pre and post-development bat faunas*'. A total of 150 boxes were examined, of which 137 were woodcrete (2F, 2FN, 1FF, 1FS, and 2F-DFP) and the remainder standard or wedge timber boxes. None of the timber boxes were used by bats, while the woodcrete ones were used by soprano and common pipistrelles, Leisler's and Daubenton's bats, while many other boxes had bat droppings. No long-eareds were recorded. Of the 91 individual bats observed in 33 boxes, 75% were soprano pipistrelle, and 19%, 5% and 1% were common, Leisler's and Daubenton's respectively. Seven boxes were damaged.

The following recommendations were made arising from this study:

- All bat box schemes should be registered with Bat Conservation Ireland
- Boxes should be erected 4-5 m above ground level in areas with low public access
- Boxes should be fixed securely to trees to prevent movement by wind
- Boxes should be checked at least once every two years
- Boxes unused within three to four years should be relocated

Although the erection of bat boxes was the only measure for bats included in past agri-environmental schemes, no information is available on how many were erected or how successful or otherwise this measure was for bats. Hopefully, some information will be collected on how effective, other than awareness-raising, the proposed expenditure of €1.04 million a year for five years on bat boxes will be under the current GLAS scheme.

3. BAT BOXES AS MITIGATION MEASURES

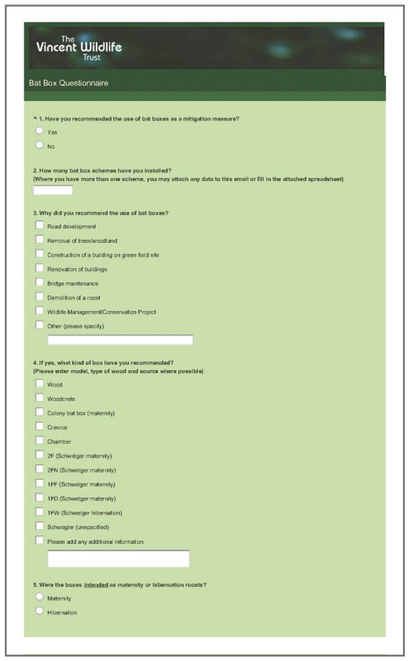
3.1 Background

Since 1998, the protection of individual bats and their breeding and resting sites has come within the remit of local authorities in relation to proposed developments requiring approval by these bodies, as described in Directive 2001/42/EC of 27 June 2001. Guidelines were produced in 2006 (Kelleher & Marnell) to provide assistance to those involved in land-use planning and development where bats were known or suspected to occur. The use of bat boxes was considered to be an appropriate form of mitigation, with some qualifications, specifically where roosts of low conservation significance were going to be lost to developments, but they were not considered appropriate substitutes for significant roosts in buildings. Schwegler boxes were recommended due to their durability and reduced maintenance and three boxes (a mix of models) were suggested per tree to cater for the needs of bats on a seasonal and species basis.

3.2 Online Survey

Apart from the assessment conducted by Bat Conservation Ireland in 2008 and referenced in Chapter 2, little information was available on how many bat boxes had been proposed as mitigation measures, how successful these had been and how the results of these schemes might compare to the VWT boxes. For this reason the online survey tool SurveyMonkey was used in this study to gather information from ecologists and bat professionals on bat box schemes they had recommended, the purposes for which they were recommended, the number and types of boxes used and the results obtained. Initially a trial survey was sent to a limited number of bat professionals for feedback on the content of the survey to maximize its effectiveness and following this a final survey was circulated (Appendix 2) to 15 recipients, including Bat Conservation Ireland, the Chartered Institute of Ecology and Environmental Management (CIEEM) and the Environmental Science Association of Ireland (ESAI). Responses were received from eight sources and are presented below. In addition to the 13 questions posed, contributors were also invited to supply additional comments in a separate box at the end of the survey form.

Photographs: Pages from the online survey


The Vincent Wildlife Trust

Bat Box Questionnaire

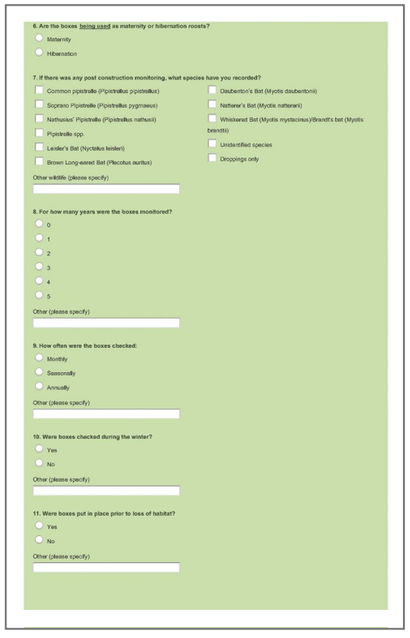
* 1. Have you recommended the use of bat boxes as a mitigation measure?
- Yes
- No

2. How many bat box schemes have you installed?
(Where you have more than one scheme, you may attach any data to this email or fill in the attached spreadsheet)

3. Why did you recommend the use of bat boxes?
- Road development
- Removal of trees/woodland
- Construction of a building on green field site
- Renovation of buildings
- Bridge maintenance
- Demolition of a roost
- Wildlife Management/Conservation Project
- Other (please specify)

4. If yes, what kind of box have you recommended?
(Please enter model, type of wood and source where possible)
- Wood
- Woodcrete
- Colony bat box (maternity)
- Crevice
- Chamber
- 2F (Schwegler maternity)
- 2FN (Schwegler maternity)
- 1FF (Schwegler maternity)
- 1FD (Schwegler maternity)
- 1FW (Schwegler hibernation)
- Schwegler (unspecified)
- Please add any additional information

5. Were the boxes intended as maternity or hibernation roosts?
- Maternity
- Hibernation


6. Are the boxes being used as maternity or hibernation roosts?
- Maternity
- Hibernation

7. If there was any post construction monitoring, what species have you recorded?
- Common pipistrelle (Pipistrellus pipistrellus)
- Soprano Pipistrelle (Pipistrellus pygmaeus)
- Nathusius' Pipistrelle (Pipistrellus nathusii)
- Pipistrelle spp.
- Leisler's Bat (Nyctalus leisleri)
- Brown Long-eared Bat (Plecotus auritus)
- Daubenton's Bat (Myotis daubentonii)
- Natterer's Bat (Myotis nattereri)
- Whiskered Bat (Myotis mystacinus)/Brandt's bat (Myotis brandtii)
- Unidentified species
- Droppings only

Other wildlife (please specify)

8. For how many years were the boxes monitored?
- 0
- 1
- 2
- 3
- 4
- 5

Other (please specify)

9. How often were the boxes checked:
- Monthly
- Seasonally
- Annually

Other (please specify)

10. Were boxes checked during the winter?
- Yes
- No

Other (please specify)

11. Were boxes put in place prior to loss of habitat?
- Yes
- No

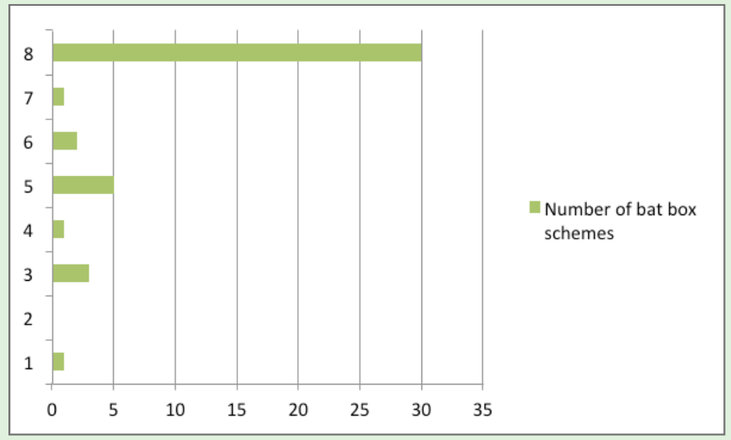
Other (please specify)

3.3 Results

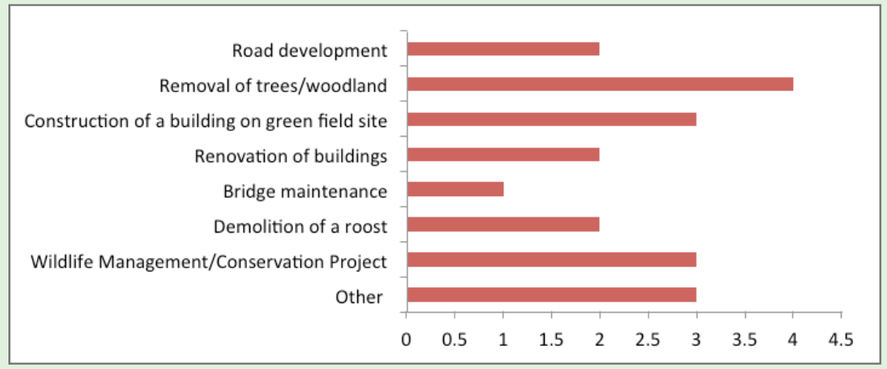
Q1. Have you recommended the use of bat boxes as a mitigation measure?

Yes 7/8 No 1/8

Q2. How many bat box schemes have you installed?

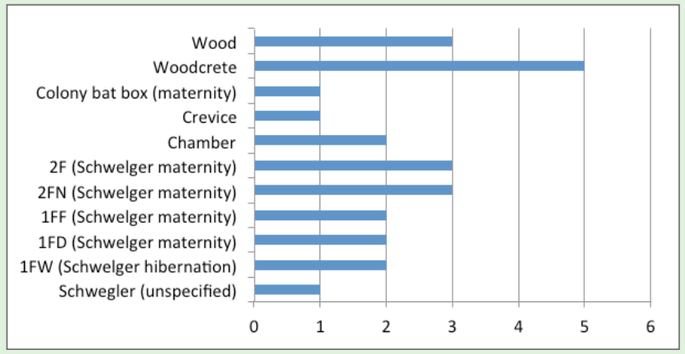


Q3. Why did you recommend the use of bat boxes?



Other: Habitat enhancement, demonstration purposes, to promote wildlife in gardens and at schools

Q4. If yes, what kind of box have you recommended? (Please enter model, type of wood and source where possible)



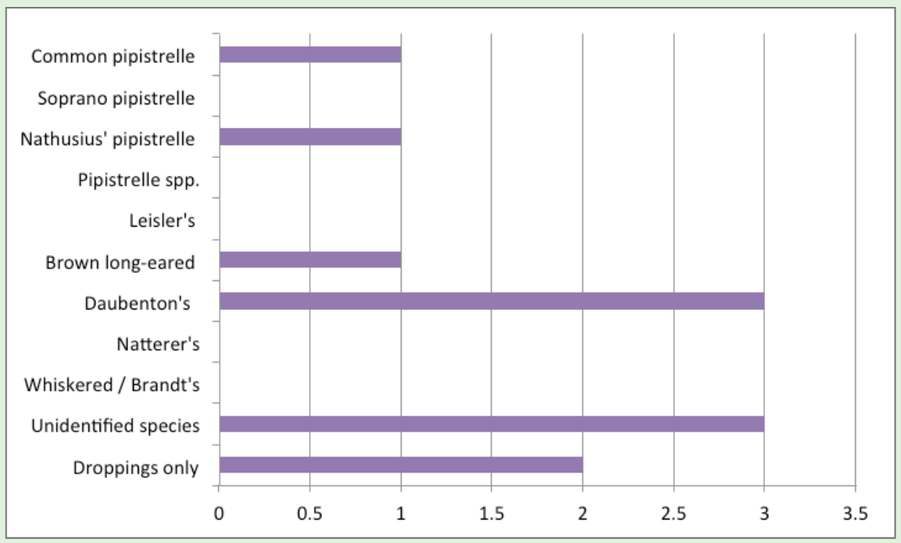
Q5. Were the boxes intended as maternity or hibernation roosts?

Maternity 2/8 Hibernation 5/8

Q6. Are the boxes being used as maternity or hibernation roosts?

Maternity 2/8 Hibernation 2/8

Q7. If there was any post construction monitoring, what species have you recorded?



Q8. For how many years were the boxes monitored?

1 year 1/8 2 years 2/8 12 years 1/8

Q9. How often were the boxes checked?

Annually 4/8 Seasonally 2/8

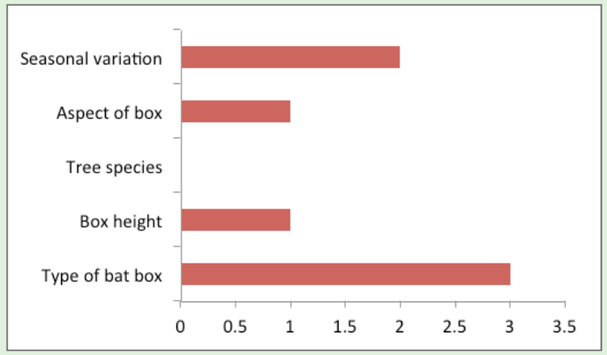
Q10. Were boxes checked during the winter?

Yes 1/8 No 5/8

Q11. Were boxes put in place prior to loss of habitat?

Yes 4/8 No 1/8

Q12. Were you able to detect any preferences with regards to the following?



Q13. Would you recommend bat boxes as a suitable mitigation measure?

Yes 7/8 No 1/8

3.4 Discussion

The results obtained by this small survey indicate that Schwegler boxes are the main box type being used and they are primarily being used as mitigation for loss of roosts. Four species have been recorded and boxes are being used as maternity and hibernation roosts. Where post monitoring is taking place, preference for type of box and season was detected in a few cases and all but one contributor said they would recommend the use of boxes as a mitigation measure in the future.

However, the lack of post-erection monitoring was a common theme raised by a number of participants. One ecologist recommended the use of over 200 boxes in five cases yet no or little post monitoring work was possible due to lack of funding. Additional comments raised are discussed in Chapter 4.

Bat Conservation Ireland is conducting a field survey of bat box schemes in 2015 and is currently creating a register and a database of such schemes in order to gather information about Irish bats using bat boxes (www.batconservationireland.org). All the VWT bat box data have now been transferred to Bat Conservation Ireland for this purpose and contributors to the VWT SurveyMonkey were asked if they wished to be involved with this.

4. RECOMMENDATIONS

4.1 Introduction

Stebbings & Walsh (1991) refer to a description of boxes provided for bats that was published in France in 1918. Interest in providing boxes for bats increased throughout Europe and North America in the 20th century and two meetings have been convened in Belgium to discuss this topic; the 2012 and 2014 Bat House Meetings. There are many reviews of artificial roosts for bats (Mering & Chambers, 2014; Poulton, 2006; Boye & Dietz, 2004; Swift, 2004), the common aim of which is to draw conclusions on their success and to provide advice on future use. This chapter presents a summary of a number of these. However, it should be noted that because the definition of the success of a bat box scheme will vary depending on the reason for providing the boxes, so too will the recommendations for the best way to deploy boxes.

4.2 VWT Irish Bat Box Project

If a barbastelle had been found once in a box in Portumna Forest but none of the other 161 boxes had ever been used, this project would have been deemed a success. Although a barbastelle was not recorded, the following recommendations can be made, based on the results of this scheme and incorporating analysis by Teesdale (2006).

1FF Schwegler boxes are recommended for use by pipistrelles, particularly if the boxes are located close to water. 2FN boxes are recommended for use by groups of brown long-eareds, Natterer's and Daubenton's bats. Leisler's bat does not appear to have a preference. The longer the boxes are in place, the number of bats and number of species using them will increase. Boxes are important as mating sites for males of species, such as pipistrelles and Leisler's, which seek to attract females in the autumn. 2FNs are used by birds during the nesting season and are thus unavailable to bats so a modification to reduce the access point to deter birds should be made to these boxes. Using wire to loop boxes in pairs on trees is not recommended, particularly for fast growing conifer species.

4.3 Online Survey opinions

As mentioned in Chapter 3, many contributors to the SurveyMonkey supplied feedback on the use of bat boxes in addition to that prompted by the thirteen questions, the main points raised are presented here:

- The lack of funding for post erection monitoring was a common concern and the validity of proposing boxes as a mitigation measure without adequate monitoring was questioned.
- The required period of monitoring should be extended from one year to allow a more valid assessment of success.
- A bat box scheme should only be erected in an area that is already in use by bats and that boxes should be located as close to the original roost as possible.
- It was the opinion of one contributor that some schemes have been placed too close to a new road and that too many boxes were erected.
- Bat boxes on masonry bridge walls do not attract the target species of Daubenton's and Natterer's bats.
- Bat boxes may replace tree roosts but not maternity roosts; an example was given of a pipistrelle colony attempting to use a series of buildings after being excluded from the original roost, rather than using bat boxes that had been erected as the mitigation measure.
- Bat boxes are a suitable mitigation measure for the loss of a small roost of a common species.
- Bat boxes are useful as transitional and mating roosts and occasionally as hibernation sites.
- Schwegler bat tubes (1FR, 2FR and 1GS) are recommended by one ecologist for Daubenton's bats excluded from bridge crevices, where these are attached to the underside of arches.

4.4 Bat Conservation Trust's Bat Box Information Pack

The study undertaken by Swift (2004) formed the basis for a revised leaflet on bat boxes in the UK, which is available as an eight page downloadable file (www.bats.org.uk). Some of the main recommendations in this leaflet are that the box should be draught proof and made of a thermally stable material such as untreated wood, woodcrete, brick or stone. Ideally the box should have several internal chambers. Lack of warmth is noted as the most important known cause of bat box failure, so advice is given for placing boxes for use as nursery sites in a southerly or westerly aspect and that a number of boxes should be placed on the one tree to provide the bats with a variety of roosting temperatures. Location is also considered to be a key factor in the success of a bat box, so boxes should be erected where bats are known to feed, such as close to water or trees, and also close to linear features such as tree lines or hedgerows that bats use for navigation purposes.

4.5 Bat Conservation Ireland's Bat Box Guidance Notes for Agri-environmental Schemes

These guidelines were updated in January 2015 to coincide with the new GLAS agri-environmental scheme and are available as a six page downloadable file (www.batconservationireland.org). Some of the main recommendations in this document are that boxes should be located on the farm where bats have been seen flying, woodcrete boxes should be used because of their durability, a number of box types should be erected in groups of three facing different directions, and boxes should not be located in illuminated parts of the farm.

4.6 Bat boxes as a monitoring tool

In Guidelines for Surveillance and Monitoring of European Bats (Battersby, 2010) the question of using counts of colonies of bats in bat boxes as a means of monitoring bats was discussed. The conclusion was that this might be the only suitable method for some woodland species whose natural roosts are seldom found and which often use a roost network, which in Ireland includes Daubenton's, Natterer's and brown long-eared bats. However, it was clearly stated that in such cases the sampling unit would be the area of woodland and not the individual bat box. Certain caveats were raised, such as the fact that population estimates could not be reliably made using this method, the invasive nature of such a method and the potential risk to existing woodland bat communities using natural cavities by introducing large numbers of artificial roosts.

A number of these concerns have since been investigated and there is increasing evidence to support the use of bat box schemes as a suitable monitoring tool for selected species. In a presentation to the Belgian Bat House meetings referenced earlier, Matthew Dodds stated that bat boxes should now be considered to be a passive monitoring tool, disturbance can be minimised by adopting a suitable protocol, suitable species are Natterer's, Daubenton's and brown long-eared, boxes are just as readily used in mature deciduous woodland as coniferous, bird access to boxes needs to be prevented, bats using boxes do not abandon natural roosts and appropriate modelling will detect population fluctuations. The information basis for these statements has primarily come from studies by members of the North Bucks Bat Group in Finemere Wood, Buckinghamshire, several of which have been submitted for Master and PhD theses (Dodds, 2008; Phillips, 2009; Bilston, 2011).

4.7 Guidelines for a robust experimental study of bat box use in Ireland

Although a limited amount of information was redeemed from the VWT bat box scheme, probably the largest single scheme in Ireland, significant results were obtained, and when combined with results from other studies clearly demonstrate that bat boxes have a positive role to play in bat conservation and ecology. However, more data are needed in order to maximise the potential bat boxes have as conservation, mitigation or monitoring tools.

In concluding remarks under the heading 'Management Implications' in their paper 'Thinking Outside the Box: A Review of Artificial Roosts for Bats', Mering & Chambers (2014) stated that additional research is needed and should focus on measuring a consistent set of parameters that can be compared across studies, such as dimensions and volume of artificial roosts, percentage occupancy, location, height, aspect, type of use and microclimate – temperature at least.

Just over 10 years earlier Altringham (2003) made an appeal for a systematic study of the value of bat boxes and suggested a possible project design:

- Minimum of 50 boxes
- If using a single model, place boxes so that occupancy can be compared in relation to exposure to sun, height above ground, tree species, entrance obstruction by vegetation, habitat type, micro habitat – such as woodland edge vs interior
- Check boxes frequently – monthly April to October
- Decide on the level of information collected but aim to minimise disturbance
- To be able to determine if boxes attract bats into a habitat, measure bat activity before and after the introduction of bat boxes

Poulton (2006) also provided guidelines for a bat box scheme that would allow more powerful analysis of the effects of the various factors at play, which was based on the outcome of his analysis of the entire VWT bat box database.

The guidelines that are relevant to Ireland are as follows:

- Select 10 sites that could be comfortably monitored for a number of years and that have good geographical spread, but avoid sites at altitude or close to urban areas
- At each site, select 20 trees of several genera, in all parts of the woodland using a grid system to ensure a random or regular location
- Determine the number of boxes per tree – if four models are being used, one of each per tree
- Within the constraints of the tree, randomly locate each box at a unique height and orientation
- Bi-monthly visits should give a sufficiently detailed pattern of occupancy throughout the year
- Continue the survey for at least two whole years but preferably four to five to account for aberrant seasonal or year effects.

This design would require a total of 800 boxes, 200 of each of four types, located on 200 trees and over a five-year period would give rise to 24,000 bat box inspections.

Photograph: 1FF and 2FN bat boxes,

Bilston (2014) also provides guidelines for future bat box projects on woodland specialist species, based on studies carried out since 2008 in woodlands in Buckinghamshire and Oxfordshire:

- Placing bat boxes at varying heights (3-6 m) appears to attract more species
- Place bat boxes approximately 20 m apart from each other
- Ensure the box is shaded from sun for most of the day
- Erect boxes in different compartments within managed woodlands to allow bats to move if necessary
- Use 2FN or 1FS boxes that have been modified.

Much of the work involved with running a bat box scheme is not invasive, as it is usually possible to determine the species or species group in a box without handling the animals, therefore, a handling licence is technically unnecessary. However, it is desirable that a licensed and trained bat worker be present during all bat box inspections in case bats need to be handled after opening the box. Obviously any study that seeks to gather information on the individuals within a group will require the relevant licences to be issued by the NPWS.

Photograph: Whiskered bat

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APPENDICES

Appendix I – Summary tables of visits to VWT schemes

Table A: Summary of events recorded during visits to Portumna bat boxes for the years 1999 to 2015

YEAR	MONTH	ACTIVITY	OBSERVATIONS
1999	March April – October	62 Schwegler boxes erected Boxes inspected monthly	Bird activity in most of the 2FNs during first month; first bats found in May – three pipistrelles and two brown long-eareds; slow occupation of 1FFs at first, but by Oct. equal numbers of both 1FFs and 2FNs being used by pipistrelles; small groups of long-eareds in 2FNs from June onwards. Hibernation boxes being used by birds.
2000	February, April – October	Boxes inspected monthly	February – one pipistrelle in each hibernation box. May – dead pipistrelle bat in 1FF box – may have been trapped during April inspection; Hibernation boxes being used by birds from April onwards; Group of 20 pipistrelles in a 1FF; Group of 12 long-eareds in a hibernation box, also single bats.
2001	May – October	Boxes inspected monthly – none in April due to Foot and Mouth.	Consistent observation of groups of long-eareds in 2FNs, in August 60% of 1FFs occupied by pipistrelles and single bats present in both hibernation boxes.
2002	April, August, November	Seasonal inspections commence	Discovery in April that two 1FFs (boxes 125 and 126) and one 2FN (box 19) stolen; one Leisler's bat recorded in a hibernation box.
2003	May, August, September	Seasonal inspections	May – two long-eared bats roosting in a 2FN box with a full nest, but without birds. September – eight semi-torpid pipistrelles in a hibernation box.
2004	April, May, August, October	Seasonal inspections	October – group of pipistrelles in a hibernation box.
2005	May, September	Seasonal inspections	Groups of long-eareds in different boxes both visits.
2006	April, May, September	Seasonal inspections	May – dead long-eared and pipistrelle found in separate boxes – no obvious cause of death. September – dead Leisler's bat and a dead unidentified juvenile bat found in separate boxes – no obvious cause of death. Group of pipistrelles in a hibernation box.
2007	April, July, September, October	Four inspections	April – Box 1 removed; Group of long-eareds using hibernation box and also found in some of the 1FFs.
2008	April, May	Only spring inspections	April – Groups of long-eareds found in three different 1FFS.
2010	February, March, April	No autumn checks	In February the wire of those boxes that could be easily loosened were repositioned on the same tree – nine pipistrelles and one long-eared recorded, most bats roosting singly. One pipistrelle in a hibernation box.
2011	March, April	Only Spring inspections	March – wire removed from many of the boxes and boxes rehung using aluminium nails. Box 116 on ground, box 103 – hinge damaged so removed, box 5 removed. Dead long-eared in 2FN box 29 – no obvious cause of death. Group of long-eareds in 2FN box number 18.
2012	August	Only one inspection	August – BCIreland take biometrics from long-eareds. Box 101 removed. Three dead bats found in separate boxes – no obvious cause of death.
2013	May	Only one inspection	Two groups of long-eareds in two different 2FN boxes; 18 Leisler's counted as they flew out of 2FN box number 30.
2014	May	Only one inspection	Three groups of long-eareds in three different 2FN boxes; four boxes at lake shore not checked to prevent disturbance to nesting birds on island.
2015	April	August inspection planned	26 2FN boxes and 24 1FF boxes remain accessible to bats, both hibernation boxes need to be removed as doors cannot be opened. Group of 10 pipistrelles and 10 long-eareds in two separate 2FN boxes; group of 15 long-eareds in 1FF box number 114 and another group of 15 in 1FF box number 123; group of 12 pipistrelles in 1FF box number 127.

Table B: Summary of events recorded during visits to Coole-Garryland bat boxes for the years 1999 to 2015

YEAR	MONTH	ACTIVITY	OBSERVATIONS
1999	March April – October	50 2FNs erected Boxes inspected monthly	First bats recorded in May – two male pipistrelles in two boxes, bat droppings in other boxes and bird nests; First Leisler's bat recorded in box in Coole Park; Male pipistrelles recorded in separate boxes in both Coole and Garryland in autumn, male and female Leisler's found also. Dead pipistrelle found in September – no obvious cause of death. October – boxes 7 and 8 inaccessible due to turlough.
2000	April – October	Boxes inspected monthly	Dead long-eared bat found in box 8 – presumed drowned, so boxes moved to tree further away from winter water level. Female whiskered/Brandt's bat recorded. Groups of long-eareds occurring in Garryland. Only single or low numbers of pipistrelles and Leisler's in Coole.

2001	May to October	Boxes inspected monthly – none in April due to Foot and Mouth.	Bird nests in boxes in May, dead chicks found in June. Groups of long-eareds found frequently.
2002	April – October	Boxes inspected monthly	Group of 10 Daubenton's bats recorded for the first time in August in Garryland.
2003	May, August, September	Seasonal inspections commence	10 boxes from Coole removed and erected in Garryland. Group of Daubenton's and long-eareds recorded in May; three groups of Daubenton's recorded in August; one group of Daubenton's in September.
2004	April, May, September	Seasonal inspections	A group of Daubenton's recorded each month, as well as groups of long-eareds and pipistrelles. Three decomposed dead bats recorded in May, no species identification possible.
2005	May, September	Seasonal inspections	Groups of Daubenton's, pipistrelles and long-eareds found both months, also single or low numbers of pipistrelles.
2006	April, June, September	Seasonal inspections	Groups of Daubenton's, pipistrelles and long-eareds found in all months, but only low numbers in September.
2007	April, May, July	Seasonal inspections	Tree with boxes 43/44 fell so boxes removed. Naked baby bat observed in box of group of pipistrelles in May so maternity roost confirmed. Dead juvenile long-eared found in July so breeding of that species also confirmed.
2008	April, May	Spring inspections	Two male pipistrelle and Daubenton's bats in box 40 in April.
2009	April, May, Sept	Seasonal inspections	No groups of any species recorded on visits.
2010	May	One inspection	Scheme handed over to the NPWS. In May only one pipistrelle recorded, possibility that some areas with boxes had been flooded previous winter. 40 of the 48 boxes had nesting material.
2011	March	One inspection	One pipistrelle recorded, 23 boxes had bat droppings, also nibbled acorns.
2012	March, Sept	Seasonal inspections	Daubenton's recorded again in small numbers; again many boxes with nesting material.
2013		No visit	
2014	July	One inspection	One soprano pipistrelle identified, again many boxes with nesting material. Two active wasp nests, one old wasp nest.
2015	May	One inspection	No bat recorded; some droppings, 36 boxes with nesting material or eggs, two boxes found on the ground – one with a wood mouse, both rehung.

Table C: Summary of events recorded during visits to Knockma bat boxes for the years 1999 to 2015

YEAR	MONTH	ACTIVITY	OBSERVATIONS
1999	March April – October	50 2FNs erected Boxes inspected monthly	No bats or droppings recorded during April, droppings in two boxes by May, droppings in 12 boxes by June, three male pipistrelles in three boxes recorded in July, one long-eared and one Leisler's bat recorded in August, all three species present in low numbers in Sept and October.
2000	April – October	Boxes inspected monthly	Low numbers of pipistrelle and long-eared bats recorded at all visits, small groups of Leisler's bats recorded from June onwards, but singles of all species in September and October.
2001	May – October	Boxes inspected monthly – none in April due to Foot and Mouth.	Mainly low numbers of pipistrelle and Leisler's bats, no long-eareds recorded.
2002	May – July	Boxes inspected monthly	38 boxes removed in March.
2003	May, August, September	Seasonal inspections commence	No bats recorded in May, two more boxes removed. Scheme handed over to NPWS.
2004	May, June, August, September	Seasonal inspections	12 new boxes erected of three types to bring total to 22. Low numbers of bats – pipistrelle, Leisler's and long-eared recorded.
2005	May, July	Seasonal inspections	Low numbers of pipistrelle, Leisler's and long-eared bats recorded during both months.
2006	February, July	Seasonal inspections	Low numbers of pipistrelle and Leisler's recorded during both months, long-eared bat recorded again in July.
2007	March, June	Seasonal inspections	Low numbers of pipistrelle and Leisler's recorded during both months.
2008	February, June	One inspection	One pipistrelle in February; five pipistrelles in separate boxes in June, Leisler's bat droppings in two boxes.
2009	May	One inspection	Two Leisler's bats in two boxes; two pipistrelle bats in two boxes.
2010	July	One inspection	Two Leisler's bats in two boxes; one pipistrelle bat in a box, bird nests removed.
2011	January	One inspection	One Leisler's bat in one box, one, three and four pipistrelles in three other boxes.

2012	January	Seasonal inspections	Four Leisler's bats in one box, a single Leisler's in another box and three pipistrelles in one box.
2013	January, August	Seasonal inspections	Single pipistrelles in five boxes in January; three single pipistrelles in three boxes in August, one Leisler's bat.
2014	January	One inspection	Two pipistrelles in two boxes.
2015	January, June	Seasonal inspections	Two Leisler's in two boxes in January; droppings in some boxes, single Leisler's in one box, two Leisler's in one box and two single pipistrelles in two boxes.

Appendix II – Bat box survey questionnaire

The Vincent Wildlife Trust

Bat Box Questionnaire

*** 1. Have you recommended the use of bat boxes as a mitigation measure?**

- ○ Yes
- ○ No

2. How many bat box schemes have you installed?
(Where you have more than one scheme, you may attach any data to this email or fill in the attached spreadsheet)

3. Why did you recommend the use of bat boxes?

- ☐ Road development
- ☐ Removal of trees/woodland
- ☐ Construction of a building on green field site
- ☐ Renovation of buildings
- ☐ Bridge maintenance
- ☐ Demolition of a roost
- ☐ Wildlife Management/Conservation Project
- ☐ Other (please specify)

4. If yes, what kind of box have you recommended?
(Please enter model, type of wood and source where possible)

- ☐ Wood
- ☐ Woodcrete
- ☐ Colony bat box (maternity)
- ☐ Crevice
- ☐ Chamber
- ☐ 2F (Schwelger maternity)
- ☐ 2FN (Schwelger maternity)
- ☐ 1FF (Schwelger maternity)
- ☐ 1FD (Schwelger maternity)
- ☐ 1FW (Schwelger hibernation)
- ☐ Schwegler (unspecified)
- ☐ Please add any additional information

5. Were the boxes intended as maternity or hibernation roosts?

- ○ Maternity
- ○ Hibernation

6. Are the boxes being used as maternity or hibernation roosts?

- ○ Maternity
- ○ Hibernation

7. If there was any post construction monitoring, what species have you recorded?

- ☐ Common pipistrelle (Pipistrellus pipistrellus)
- ☐ Soprano Pipistrelle (Pipistrellus pygmaeus)
- ☐ Nathusius' Pipistrelle (Pipistrellus nathusii)
- ☐ Pipistrelle spp.
- ☐ Leisler's Bat (Nyctalus leisleri)
- ☐ Brown Long-eared Bat (Plecotus auritus)
- ☐ Daubenton's Bat (Myotis daubentonii)
- ☐ Natterer's Bat (Myotis nattererii)
- ☐ Whiskered Bat (Myotis mystacinus)/Brandt's bat (Myotis brandtii)
- ☐ Unidentified species
- ☐ Droppings only

Other wildlife (please specify)

8. For how many years were the boxes monitored?

- 0
- 1
- 2
- 3
- 4
- 5

Other (please specify)

9. How often were the boxes checked:

- Monthly
- Seasonally
- Annually

Other (please specify)

10. Were boxes checked during the winter?

- Yes
- No

Other (please specify)

11. Were boxes put in place prior to loss of habitat?

- Yes
- No

Other (please specify)

12. Where you able to detect any preferences with regards to the following?

- Type of bat box
- Box height
- Tree species
- Aspect of box
- Seasonal variation

Other (please specify)

13. Would you recommend bat boxes as a suitable mitigation measure?

If no, please state why:

*** 14. Do you have detailed survey data you wish to share with us?**

Other (please specify)

*** 15. If you are providing additional survey data, do you agree for this to be registered with Bat Conservation Ireland?**

16. Please provide any additional information you wish.
(e.g. decision influencing model of box chosen; maintenance issues; costs associated)

*** 17. Please enter your contact details**

Name

Organisation

Email Address

The Vincent Wildlife Trust

The Vincent Wildlife Trust has been playing a key role in mammal conservation in the Republic of Ireland since 1991, specifically bat conservation. VWT staff work independently, but are in close liaison with the National Parks and Wildlife Service. Today, the Trust is currently working on a number of Irish mammal species. Where a need is identified, the Trust will initiate a research programme that will support other bodies working to safeguard the future of all mammals in Ireland.

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