

2008

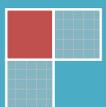
An investigation of the impact of development projects on bat populations: Comparing pre- and post-development bat faunas.

IRISH BAT MONITORING
PROGRAMME

An Chomhairle Oidhreachta
The Heritage Council



Bat Conservation Ireland
11/30/2008



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An investigation of the impact of development projects on bat populations: Comparing pre- and post-development bat faunas.

November 2008



Bat conservation Ireland, www.batconservationireland.org

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Citation:

Aughney, T. (2008) An investigation of the impact of development projects on bat populations: Comparing pre- and post-development bat faunas. Irish Bat Monitoring Programme. Bat Conservation Ireland, www.batconservationireland.org.

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EXECUTIVE SUMMARY

Bat Conservation Ireland received funding (60%) from The Heritage Council to undertake this project. This report presents work undertaken during the field season of 2008 where twelve projects that constitute a selection of development projects previously surveyed for bat populations were resurveyed by Bat Conservation Ireland. Mitigation measures implemented for bat populations were investigated to report their effectiveness for retaining such recorded bat fauna post-development. This report presents these results and endeavours to provide a measure of the effectiveness of such mitigation on local bat fauna.

The following development projects were surveyed:

1. Hotel and residential developments
2. Hotel and golf course developments
3. Residential developments
4. Road schemes (Bat Box Schemes only)
5. Building renovation projects

This report is written in-consideration of the recommendations listed in Kelleher & Marnell, 2007. The projects surveyed are presented as individual case studies and detailed results are presented under the following headings:

- Project Descriptions
- Bat Box Schemes
- Roof Renovation
- Night-time Bat Detection Results



1. INTRODUCTION

Bats constitute a large proportion of the mammalian biodiversity in Ireland. There are currently ten species of bat in Ireland representing two families. This forms almost one third of Ireland's land mammal fauna. Nine species are vesper bats and all the vespertilionid bats have a tragus (cartilaginous structure found in the pinna ear) and are distributed throughout the country. Nathusius' pipistrelle *Pipistrellus nathusii* and the Brandt's bat *Myotis brandtii* are recent additions to the list. The tenth species, the lesser horseshoe bat *Rhinolophus hipposideros*, belongs



Figure 2: common pipistrelle bat

to the Rhinolophids and has a complex nose leaf structure. This species current distribution is confined to the western six counties: Mayo, Galway, Clare, Limerick, Kerry and Cork.

Bats are a species-rich group widely distributed throughout a range of habitats in the Irish landscape. Due to their reliance on insect populations, specialist feeding behaviour and habitat requirements, they are considered to be valuable environmental indicators of the wider countryside. Their validity has resulted in this group being included as biodiversity indicator species in Britain (www.bats.org).

A species profile of each bat species is provided in the Appendices.

Irish bats are protected under domestic and EU legislation. In addition there are a number of international treaties that Ireland is signed up to requiring the legal protection of bats and their habitats in Europe.

1.1 Domestic Legislation

Under the Republic's Wildlife Act (1976) and Wildlife (Amendment) Act (2000) it is an offence to intentionally harm a bat or disturb its resting place.

1.2 The EU Habitats Directive

Article 12(1) of the ‘Council Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora (Habitats Directive) states:

“Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV(a) and their natural range, prohibiting:

- a) all forms of deliberate capture or killing of specimens of these species in the wild;
- b) deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration;
- c) deliberate destruction or taking of eggs from the wild;
- d) deterioration or destruction of breeding sites or resting places.”



Figure 3: soprano pipistrelle bat

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

1.3 International Treaties

Ireland is also a signatory to a number of conservation agreements pertaining to bats such as the Bern and Bonn Conventions. The European Bats Agreement (EUROBATS) is an agreement under the Bonn Convention. Ireland and the UK are two of the 31 signatories. The Agreement has an Action Plan with priorities for implementation. Devising strategies for monitoring of populations of selected bat species in Europe is among the resolutions of EUROBATS.

1.3.1 The Berne Convention

Article 6 of the ‘Convention on the Conservation of European Wildlife and Natural Habitats’ (Berne Convention) reads:

‘Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II. The following will in particular be prohibited for these species:

- a) all forms of deliberate capture and keeping and deliberate killing;
- b) the deliberate damage to or destruction of breeding or resting sites;
- c) the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention; ...

Appendix II lists strictly protected fauna species and this list includes ‘Microchiroptera, all species except *Pipistrellus pipistrellus*’.

1.3.2 The EUROBATS Agreement

The ‘Agreement on the Conservation of Populations of European Bats’ (EUROBATS) was negotiated under the ‘Convention for the Conservation of Migratory Wild Species’ (Bonn Convention) and came into force in January 1994. The legal protection of bats and their habitats are given in Article III as fundamental obligations:

‘1. Each Party shall prohibit the deliberate capture, keeping or killing of bats except under permit from its competent authority.



Figure 4: Brown long-eared bats

2. Each Party shall identify those sites within its own area of jurisdiction which are important for the conservation status, including for the shelter and protection, of bats. It shall, taking into account as necessary economic and social considerations, protect such sites from damage or disturbance. In addition, each Party shall endeavour to identify and protect important feeding areas for bats from damage or disturbance.”

The Agreement covers all European bat species except non-migratory endemics of the Atlantic Islands.

The fundamental obligations cited above are fulfilled by national law in accordance with the EU Habitats Directive.

1.4 National Status of Irish bat species

The Irish Red Data Book of Vertebrates (Whilde, 1993), listed all Irish populations of bats (those species that were known to occur in Ireland at the time) as Internationally Important. Two Irish species, the lesser horseshoe bat and the Leisler’s bat (*Nyctalus leisleri*), were assigned IUCN European threat categories (VU A2c and LR: nt, respectively). VU A2c indicated that the lesser horseshoe bat population in Ireland is vulnerable to decline and such declines may be predicted for the future if there is a decline in occupancy, extent of occurrence or quality of habitat. Ireland holds important European populations of Leisler’s bat, which was formerly categorised as LR (lower risk): nt (near threatened). The conservation status of bats in Ireland and Europe has been recently updated. The threat level for the lesser horseshoe bat is now described as near threatened for Europe and the European States, but within Ireland its population is considered to have good prospects. The status of the European Leisler’s bat population has been changed from nt to Least Concern and within Ireland it is considered to have good prospects. This species is still, however, infrequent in the rest of Europe compared with Ireland where it is quite common.

There has been an increase in levels of knowledge of Irish bats in the past 20 years, mainly due to increased numbers of researchers and bat workers. Despite high levels of legal protection for all species, until 2003 there was no systematic monitoring of any species apart from the lesser horseshoe bat in the Republic of Ireland. The car-based bat monitoring scheme (2003-2008), the Daubenton’s Bat Waterways Survey (2006-2008), the pilot of woodland bat monitoring (2006-2007) and the brown long-eared bat monitoring scheme (2007-2010) are helping to redress the imbalance and ensure countrywide coverage and monitoring of a number of species including our important Leisler’s bat. In addition, the BATLAS 2010 (2008-2010) aims to compliment all of the on-going monitoring programmes and systematically survey the remaining of the country for the distribution of the four common bat species: soprano pipistrelle, common pipistrelle, Leisler’s bat and Daubenton’s bat on a 10km square level.

2. PROJECT DESCRIPTION

A total of twelve projects were re-investigated by BC Ireland in 2008. Each project investigated is presented below in individual summary tables stating the pre- and post-survey results and some information on the individual projects. Survey results for each project are then presented in more detail in later chapters.

a. Case Study A

Project Description Survey date: 2002	Road scheme (realignment of national road) which involved: 1. Woodland Removal (large estate) 2. Lighting of road scheme	
Site Description	Mixed woodland, grasslands, watercourse, pond and buildings	
Bat Survey Results	Roosts	soprano pipistrelle (100+) and <i>Myotis</i> species (30+) in buildings
	Detector	soprano pipistrelle, Leisler's bat, common pipistrelle, brown long-eared bat, Natterer's bat and Daubenton's bat
Potential impacts	1.	Tree felling (large tract of woodland felled): loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
Bat Mitigation Measures	1. Tree felling	Implemented according recommendations
	2. Bat Box Scheme	Erected (18 bat boxes) in 2002
	3. Landscaping	Completed
BCIreland Bat Survey 2008	Roosts	Emergence count: Daubenton's bats (70+ individuals)
	Detector	Foraging: soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat, Natterer's bats and <i>Myotis</i> species.
	Bat Boxes	Soprano pipistrelle, Leisler's bat and <i>Myotis</i> species (17 bat boxes checked, one missing)

b. Case Study B

Project Description Survey dates: 2001, 2003 & 2005	Recreational development including interpretative centre and recreational facilities which involved (all completed): 1. Re-pointing of stone work in servant tunnels & lighting of servant tunnels 2. Minor tree surgery works to facilitate tree-top walkway 3. Removal of concrete building and timber buildings 4. Installing a tree-top walkway	
Site Description	Mixed woodland, grasslands, watercourse, lake, tunnels and buildings	
Bat Survey Results	Roosts	Whiskered bat, Natterer's bat & brown long-eared bat
	Detector	soprano pipistrelle, Leisler's bat, common pipistrelle, lesser horseshoe bat, Daubenton's bat, brown long-eared bat, Daubenton's bat and Natterer's bat
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting of tunnels: loss of roosting sites
	3.	Pointing of stone work: loss of roosting sites
	4.	Building removal: loss of roosting sites
Bat Mitigation Measures	1. Tree felling	Implemented according to recommendations
	2. Bat Box Scheme	Erected (12 bat boxes) in 2005
	3. Landscaping	Completed
	4. Bat Houses	Constructed according to recommendations
	5. Tunnel	Lighting and maintenance according to recommendations
BCIreland Bat Survey 2008	Roosts	Natterer's bat
	Detector	Soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat and Natterer's bat
	Bat Boxes	Soprano pipistrelle and Leisler's bat (10 bat boxes, 2 damaged)

c. Case Study C

Project Description Survey date: 2004 & 2006	Hotel, residential and golf course development which involved (majority completed): 1. Renovation of numerous buildings 2. Removal of mature trees 3. Lighting of public areas 4. Removal of habitats (woodland, lakeshore, wet grassland, amenity grassland)	
Site Description	Mixed woodland, grasslands, watercourse, lakes and buildings	
Bat Survey Results	Roosts	Brown long-eared bat, whiskered bat, Daubenton's bat, soprano pipistrelle bat, Natterer's bat and Leisler's bat in buildings and mature trees
	Detector	Brown long-eared bat, whiskered bat, Daubenton's bat, soprano pipistrelle bat, common pipistrelle, Natterer's bat and Leisler's bat
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
	4.	Building renovation: loss of roosting sites
Bat Mitigation Measures	1. Tree felling	Implemented according recommendations
	2. Bat Box Scheme	Erected (33 bat boxes) in 2004 & 2006
	3. Building renovation	Partially completed according to recommendations
	4. Landscaping	Not completed according to recommendations
BCIreland Bat Survey 2008	Roosts	Internal roost checks: brown long-eared bat
	Detector	Foraging: soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat, whiskered bat and Nathusius' pipistrelle
	Bat Boxes	Soprano pipistrelle and Leisler's bat (22 bat boxes checked, 11 missing)

d. Case Study D

Project Description Survey date: 2004 & 2005	Road scheme (by-pass) which involved (road scheme still being built): 1. Habitat removal (tree lines, hedgerows, wet grassland, conifer plantation) 2. Lighting of road ways 3. Demolition of buildings	
Site Description	Mixed woodland, grasslands buildings and watercourses	
Bat Survey Results	Roosts	soprano pipistrelle and common pipistrelle
	Detector	soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat, brown long-eared bat, Natterer's bat and <i>Myotis</i> species
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
	4.	Building works: loss of roosting site
Bat Mitigation Measures	1. Tree felling	Implemented according recommendations
	2. Bat Box Scheme	Erected (18 bat boxes) in 2005
BCIreland Bat Survey 2008	Detector	soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat
	Bat Boxes	soprano pipistrelle and <i>Myotis</i> species (15 bat boxes, 1 damaged, 2 missing)

e. Case Study E

Project Description Survey date: 2005	Residential development on farmland which involved (completed): 1. Habitat removal (scrub, hedgerows and grassland) 2. Lighting of housing estate 3. Infrastructure to support housing and local transportation	
Site Description	Hedgerows, treelines, grasslands, buildings and watercourse	
Bat Survey Results	Roosts	None
	Detector	Soprano pipistrelle, Leisler's bat, common pipistrelle and Daubenton's bat
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
Bat Mitigation Measures	1. Tree felling	Unknown
	2. Bat Box Scheme	Not erected
	3. Landscaping	Unknown
BCIreland Bat Survey 2008	Detector	Foraging: soprano pipistrelle and Leisler's bat

f. Case Study F

Project Description Survey date: 2004	Building (Georgian House, 18 th C) renovation which involved: 1. New slate roof and roof felting	
Site Description	Hedgerows, treelines, grasslands, mixed woodland, buildings and watercourses	
Bat Survey Results	Roosts	Soprano pipistrelle and brown long-eared bat (15+ individuals)
Potential impacts	1.	Roof works: potential loss of roosting sites
Bat Mitigation Measures	1. Roof works	Completed according to recommendations 1. Retention of access points 2. Installation of vents
BCIreland Bat Survey 2008	Roosts	Soprano pipistrelle (334 individuals) and brown long-eared bat (13 individuals)
	Detector	Emergence count and foraging bats: soprano pipistrelles and brown long-eared bats

g. Case Study G

Project Description Survey date: 2004	Road scheme (3-lane national road) which involved: 1. Habitat removal (tree lines, hedgerows, wet grassland & woodland) 2. Lighting of road ways	
Site Description	Mixed woodland, grasslands and watercourses	
Bat Survey Results	Detector	Soprano pipistrelle
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
Bat Mitigation Measures	1. Tree felling	Implemented according recommendations
	2. Bat Box Scheme	Erected (24 bat boxes) in 2004
BCIreland Bat Survey 2008	Bat Boxes	Soprano pipistrelle, Leisler's bat and <i>Myotis</i> species (24 bat boxes)

h. Case Study H

Project Description Survey date: 2004	Road scheme (motorway) which involved: 1. Habitat removal (tree lines, hedgerows, wet grassland, scrub) 2. Lighting of road ways	
Site Description	Mixed woodland, grasslands buildings and watercourses	
Bat Survey Results	Roosts	Soprano pipistrelle
	Detector	Soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat, brown long-eared bat and <i>Myotis</i> species
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
Bat Mitigation Measures	1. Tree felling	Implemented according recommendations
	2. Bat Box Scheme	Erected (60 bat boxes) in 2007 & 2008
BCIreland Bat Survey 2008	Bat Boxes	Soprano pipistrelle and Leisler's bat (30 bat boxes checked)

i. Case Study I

Project Description Survey date: 2004	Building Renovation (one section of building) which involved 1. Internal plumbing works during maternity season	
Site Description	Mixed woodland, grasslands & buildings	
Bat Survey Results	Roosts	Brown long-eared bats
	Detector	Leisler's bat, soprano pipistrelle, common pipistrelle, brown long-eared bat and <i>Myotis</i> species in vicinity of building
Potential impacts	1.	Internal attic works (pipes and water tanks): disturbance of roosting sites
Bat Mitigation Measures	1. Attic works	Implemented according to recommendations
BCIreland Bat Survey 2008	Roosts	Internal check: No bats recorded
	Detector	Emergence: brown long-eared bats Foraging: Leisler's bat, soprano pipistrelle and common pipistrelle

j. Case Study J

Project Description Survey date: 2002	Industrial Development (warehousing and waste management facility) which involved: 1. Habitat removal (hedgerows, scrub and grassland) 2. Lighting of industrial units 3. Infrastructure	
Site Description	Mixed woodland, grasslands, hedgerows, treelines, buildings and watercourses	
Bat Survey Results	Roosts	soprano pipistrelle (building)
	Detector	soprano pipistrelle, Leisler's bat, common pipistrelle and <i>Myotis</i> bats
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
Bat Mitigation Measures	1. Building works	Implemented according recommendations
	2. Bat Box Scheme	Unknown (BBS recommended but details not available)
BCIreland Bat Survey 2008	Roosts	Demolished according to recommendations
	Detector	Foraging: soprano pipistrelle

k. Case Study K

Project Description Survey dates: 2002 & 2005	Hotel and golf resort development which involved (golf course completed): 1. Renovation of numerous buildings 2. Removal of mature trees 3. Lighting of public areas 4. Removal of habitats (woodland & grassland)	
Site Description	Mixed woodland, grasslands, buildings and watercourses	
Bat Survey Results	Roosts	soprano pipistrelle, brown long-eared bat, Natterer's bat and whiskered/Brandt's bat (all recorded in low numbers)
	Detector	soprano pipistrelle, brown long-eared bat, Natterer's bat, whiskered/Brandt's bat, common pipistrelle and Leisler's bat
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
	4.	Building renovation: loss of roosting sites
Bat Mitigation Measures	1. Bat Box Scheme	Erected (6 of the 12 bat boxes)
	2. Building works	Not implemented
BCIreland Bat Survey	Buildings	Daytime inspection: no bats
	Bat Boxes	soprano pipistrelle and Leisler's bat (3 boxes missing & 2 boxes damaged)

l. Case Study L

Project Description Survey date: 2006	Road scheme (by-pass) which involved: 1. Habitat removal (tree lines, hedgerows, wet grassland, conifer plantation) 2. Lighting of road ways 3. Demolition of buildings	
Site Description	Mixed woodland, grasslands, treelines/hedgerows, buildings, lakes and watercourses	
Bat Survey Results	Roosts	Natterer's bats (bridge)
	Detector	Soprano pipistrelle, Leisler's bat, common pipistrelle, Daubenton's bat, brown long-eared bat and <i>Myotis</i> species
Potential impacts	1.	Tree felling: loss of roosting sites
	2.	Lighting: loss of foraging areas
	3.	Habitat loss: loss of foraging areas
	4.	Building removal: loss of roosting sites
Bat Mitigation Measures	3. Tree felling	Implemented according recommendations
	4. Bat Box Scheme	Erected (26 bat boxes) in 2007
BCIreland Bat Survey	Bat Boxes	Soprano pipistrelle and Leisler's bats (7 boxes damaged and/or missing)

3. Bat Box Schemes

The main function of bat boxes is to provide alternative safe roosting sites for groups of bats where natural sites are unavailable or become unavailable. Bat boxes are widely used, as part of conservation measures, in many European countries to provide extra roosting sites, especially in habitats where natural roosting sites may be limited e.g. conifer plantations. The use of bat boxes, as part of mitigation measures, is increasing in importance in development projects in Ireland.



Figure 5: Leisler's bats roosting in a 2F woodcrete bat box

In order for a bat box to be used successfully by bats, there are a number of factors at play and these essentially amount to the fact that bat boxes must replicate natural crevices that bats would use if available to them. The internal diameter of a bat box is required to be sufficient to allow bats to cluster together in numbers to retain body heat. It is important to understand the life cycle of bats and their tendency to use an array of roosting sites throughout the year. In summary, bats require different roost conditions for hibernation, during the sensitive time of rearing their young (maternity roost), night roosts for resting stops during night, feeding and satellite roosts in between the main hibernation and maternity season. Roosting conditions also vary with each species.



Figure 6: IFS woodcrete bat box

Thermal properties are also essential factors determining the usage of bat boxes by particular bat species. In general, hibernation boxes require greater insulation (wall thickness of 100mm timber) to provide a constant temperature for bats throughout the winter to prevent bats from freezing. All other boxes, typically called summer boxes (timber or woodcrete), are designed to provide secure and dry sheltered conditions. These boxes have relatively thin walls (about 20-30mm timber) and are used by bats outside the hibernation period. These requirements mean that any Bat Box Schemes

should provide suitable bat boxes to cover the general requirements of different bat species all year around.

Of the 21 bat species considered to be regularly occurring in central Europe, 17 have been observed roosting in bat boxes (which includes all nine vesper bats known to occur in Ireland) with at least 10 species recorded breeding there (again all nine Irish vesper species recorded in Ireland). There have been no records of lesser horseshoe bats or indeed any horseshoe bats using bats boxes.



Figure 7: 2F-DFP woodcrete bat box

To ensure that bats use the bat boxes, it is very important to site them carefully. It is recommended that the publication *Bat Boxes: A guide to the history, function, construction and use in the conservation of bats* by R. E. Stebbings and S. T. Walsh (*The Bat Conservation Trust, 1991*) should be consulted. Some general points to follow include:

- 1 Straight limb trees with no crowding branches or other obstructions for at least 3 metres above and below position of bat box.
- 2 Diameter of tree should be wide and strong enough to hold the required number of boxes.
- 3 Locate bat boxes in areas where bats are known to forage or adjacent to suitable foraging areas. Locations should be sheltered from prevailing winds.
- 4 Bat boxes should be erected at a height of 3-5 metres to reduce the potential of vandalism and predation of resident bats.
- 5 It is recommended that a



Figure 8: 1FD & 2FN woodcrete bat boxes

number of bat boxes are erected on one tree at an array of aspects. South facing boxes will receive the warmth of the sun, which is necessary for maternity colonies. In large bat box schemes it is generally recommended to have three bat boxes arranged at the same height facing North, South-east and South-west. This ensures a range of temperatures are available all day. If the South-facing boxes become too warm, bats can safely move to the cooler North-facing box.

3.1 Bat boxes designs

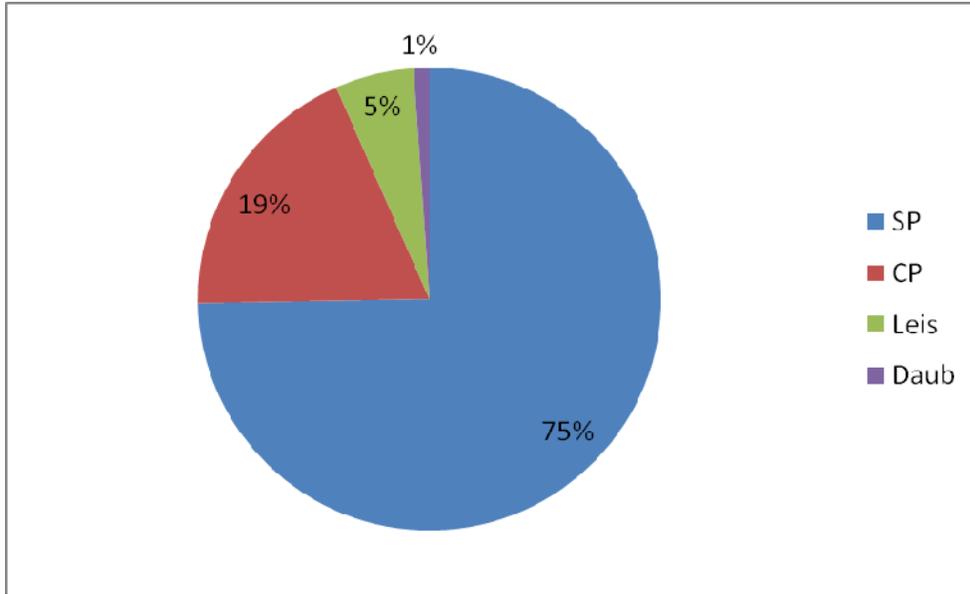
An array of bat box designs were used in the bat box schemes investigated for this report. These varied from summer timber bat boxes to summer woodcrete bat boxes. To illustrate the designs of woodcrete boxes used, the design codes quoted in the table below are taken from the Alana Ecology website (www.alanaecology.com), one of the suppliers of such boxes (Other suppliers are quoted in the Appendices).

‘Woodcrete’ boxes are made of a mixture of concrete, sawdust and clay moulded into shape. They have the advantage of allowing natural respiration and stable temperature and are considered to be more durable than to timber boxes. ‘Woodcrete’ boxes can last for approximately 25 years and the different shape boxes are designed to cater for different species or different roosting conditions (e.g. 1FF or flat box is considered to mimic gaps behind the bark of trees while the 2FN bat box is shaped like a chimney and therefore aims to mimic a naturally occurring tree hole). Timber boxes are considered to be less durable in weather conditions and therefore have a life span of approximately 5-10 years depending on the quality of timber used.



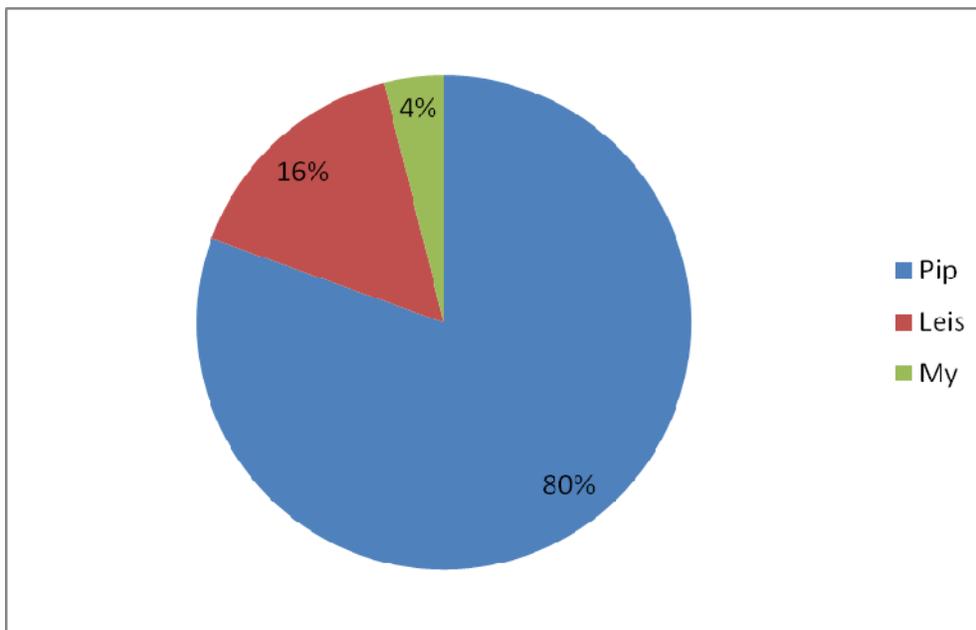
3.2 Survey Results

Eight of the projects surveyed had bat box schemes erected as part of the mitigation process (See Table 1). The majority of bat boxes examined (n=150) were woodcrete boxes of various designs (91%, n=137). At the time of examination (various dates), 33 bat boxes (22%) were occupied by bats while 77 bat boxes (51%) had evidence of bat usage (i.e. bat droppings present). A total of 91 individual bats were recorded in boxes, comprising the following species: soprano pipistrelle (68 individuals), common pipistrelles (17 individuals), Leisler’s bats (5 individuals) and Daubenton’s bat (1 individual) (See Graph 1). Bat droppings of *Pipistrelle* species (droppings cannot be identified to species level) were recorded in 62 bat boxes while Leisler’s bat droppings were recorded in 12 bat boxes and 3 bat boxes had *Myotis* species bat droppings. Such details of bats and evidence of bats were recorded in the woodcrete boxes only.



Graph 1: Proportion of bat species recorded in bat boxes examined in 2008 (n=91 individuals present in 33 bat boxes)

SP = soprano pipistrelle; CP = common pipistrelle; Leis = Leisler's bat & Daub = Daubenton's bat



Graph 2: Proportion of bat droppings according to species/family group recorded in bat boxes examined in 2008 (n=77 bat boxes)

Pip = *Pipistrelle* species; Leis = Leisler's bat & My = *Myotis* species

Table 1: Result of bat box inspections

	Bat box design	Date checked	Aspect	Bats	Droppings	Notes
Case Study A						
1	2F woodcrete	1/6/08		0	0	Bird's nest
2	2F woodcrete	1/6/08		0	0	Bird's nest
3	2F woodcrete	1/6/08		0	0	
4	2F woodcrete	1/6/08		1 x Leis	>50 (Leis)	
5	2F woodcrete	1/6/08		1 x SP	>100 (Pip)	
6	2F woodcrete	1/6/08		0	>50 (Pip)	
7	2F woodcrete	1/6/08		0	0	
8	2F woodcrete	1/6/08		0	>50 (Pip)	
9	2F woodcrete	1/6/08		2 x SP	>200 (Pip)	
10	2F woodcrete	1/6/08		0	<50 (My)	
11	2F woodcrete	1/6/08		0	>100 (Pip)	
12	2F woodcrete	1/6/08		0	0	
13	2F woodcrete	1/6/08		1 x SP	>200 (Pip)	
14	2F woodcrete	1/6/08		3 x SP	>200 (Pip)	
15	2F woodcrete	1/6/08		0	>25 (Pip)	
16	2F woodcrete	1/6/08		1 x SP	>50 (Pip)	
17	2F woodcrete	1/6/08		6 x SP	>500 (Pip)	
Case Study B						
18	2FN woodcrete	24/6/08		1 x SP	>100 (Pip)	
19	2FN woodcrete	24/6/08		2 x SP	>200 (Pip)	
20	2F woodcrete	24/6/08		1 x SP	>50 (Pip)	
21	2F woodcrete	24/6/08		0	0	
22	1FF woodcrete	24/6/08		0	<50 (Pip)	
23	1FF woodcrete	24/6/08		0	>50 (Pip)	
24	2FN woodcrete	24/6/08		0	0	
26	1FF woodcrete	24/6/08		0	0	
27	2F woodcrete	24/6/08		0	>50 (Pip)	
28	1FS woodcrete	24/6/08		0	0	
29	2FN woodcrete	24/6/08		0	0	Damaged
30	1FS woodcrete	24/6/08		0	0	Damaged
Case Study C						
31	1FS woodcrete	3/10/08	S	0	0	Bird's nest
32	1FF woodcrete	3/10/08	S	0	<5 (Leis)	
33	1FF woodcrete	3/10/08	SE	0	<50 (Pip)	Old droppings
34	1FN woodcrete	3/10/08	SW	0	<50 (Pip)	Old droppings
35	1FN woodcrete	3/10/08	SW	0	<50 (Pip)	Old droppings
36	1FF woodcrete	3/10/08	N	0	0	
37	1FS woodcrete	3/10/08	SE	0	<50 (Pip)	Bird's nest
38	2FN woodcrete	3/10/08	S	5 x SP	>500 (Pip)	
39	2FN woodcrete	3/10/08	S	0	<200 (Pip)	
40	1FF woodcrete	3/10/08	SE	1 x Leis	0	
41	1FN woodcrete	3/10/08	SW	0	0	Damaged
42	1FN woodcrete	3/10/08	SE	0	>200 (Pip)	
43	1FN woodcrete	3/10/08	SW	0	>200 (Pip)	
44	1FF woodcrete	3/10/08	N	3 x SP	<5 (Pip)	

	Bat box design	Date checked	Aspect	Bats	Droppings	Notes
45	1FF woodcrete	3/10/08	W	0	0	
46	1FF woodcrete	3/10/08	SW	0	>200 (Pip)	
47	2FN woodcrete	3/10/08	SW	4 x SP	>1000 (Pip)	5cm droppings
48	1FF woodcrete	3/10/08	S	0	>500 (Pip)	
49	1FF woodcrete	3/10/08	N	0	0	Damaged
50	2FN woodcrete	3/10/08	SW	0	>100 (Pip)	Bird's nest
51	1FN woodcrete	3/10/08	N	0	>500 (Pip)	
52	2F-DFP woodcrete	3/10/08	S	0	>50 (Pip)	Bird's nest
Case Study D						
53	1FF woodcrete	26/10/08	S	1 x CP	>25 (Pip)	
54	1FF woodcrete	26/10/08	S	13 x SP	>25 (Pip)	
57	2FN woodcrete	26/10/08	NE	0	<10 (Pip)	
58	2FN woodcrete	26/10/08	NW	0	<10 (Leis)	
57	2FN woodcrete	26/10/08	S	0	>25 (My)	
58	1FF woodcrete	26/10/08	NE	8 x CP	>250 (Pip)	
59	2F-DFP woodcrete	26/10/08	S	0	>50 (Pip)	
60	2FN woodcrete	26/10/08	S	0	>25 (Pip)	
61	1FF woodcrete	26/10/08	W	5 x CP	>200 (Pip)	
62	2F woodcrete	26/10/08	S	0	>25 (Pip)	
63	2FN woodcrete	26/10/08	E	0	0	Damaged
64	2F-DFP woodcrete	26/10/08	S	0	0	
65	2FN woodcrete	26/10/08	S	3 x CP	>50 (Pip)	
66	2F-DFP woodcrete	26/10/08	S	0	>10 (Pip)	
67	1FF woodcrete	26/10/08	W	0	0	
68	2FN woodcrete	26/10/08	S	0	>25 (Leis)	
69	2F woodcrete	26/10/08	S	6 x SP	>250 (Pip)	
70	2FN woodcrete	26/10/08	N	0	>50 (Pip)	
71	1FF woodcrete	26/10/08	E	0	>25 (Pip)	
72	2F woodcrete	26/10/08	S	2 x SP	>25 (Pip)	
Case Study G						
76	1FS woodcrete	27/10/08	N	1 x SP	>200 (Pip)	
77	2F-DFP woodcrete	27/10/08	SW	1 x Leis	>500 (Leis)	
78	2FD woodcrete	27/10/08	SE	0	>100 (My)	
76	2FD woodcrete	27/10/08	SW	0	>200 (Leis)	
77	1FN woodcrete	27/10/08	SE	0	0	
78	1FF woodcrete	27/10/08	W	1 x Daub	0	
79	1FS woodcrete	27/10/08	S	0	>50 (Pip)	
80	2FD woodcrete	27/10/08	W	2 x SP	>100 (Pip)	
81	1FN woodcrete	27/10/08	W	0	0	Insect nest
82	2FD woodcrete	27/10/08	W	0	0	Insect nest
83	1FN woodcrete	27/10/08	W	0	0	Insect nest
84	2F-DFP woodcrete	27/10/08	SW	0	0	Bird's nest
85	2F-DFP woodcrete	27/10/08	SE	0	0	
86	1FS woodcrete	27/10/08	N	0	0	Bird's nest
87	1FN woodcrete	27/10/08	S	0	0	
88	1FN woodcrete	27/10/08	SW	0	0	
89	1FF woodcrete	27/10/08	SE	0	0	

	Bat box design	Date checked	Aspect	Bats	Droppings	Notes
90	2F-DFP woodcrete	27/10/08	N	5 x SP	>500 (Pip)	
91	1FS woodcrete	27/10/08	N	1 x SP	>100 (Pip)	
92	2F-DFP woodcrete	27/10/08	SW	0	0	
93	1FN woodcrete	27/10/08	SE	3 x SP	>500 (Pip)	
94	2F-DFP woodcrete	27/10/08	S	2 x SP	>100 (Pip)	
95	2F-DFP woodcrete	27/10/08	E	0	0	
Case Study H						
96	1F woodcrete	18/11/08	W	0	0	
97	1F woodcrete	18/11/08	W	0	0	
98	1F woodcrete	18/11/08	E	0	>20 (Pip)	
99	1F woodcrete	18/11/08	N	0	0	
100	1F woodcrete	18/11/08	S	0	0	
101	1F woodcrete	18/11/08	W	0	0	
102	1F woodcrete	18/11/08	N	0	0	
103	1F woodcrete	18/11/08	E	0	<20 (Pip)	
104	1F woodcrete	18/11/08	N	0	0	
105	1F woodcrete	18/11/08	E	0	0	
106	1FF woodcrete	18/11/08	S	0	0	
107	1F woodcrete	18/11/08	N	0	0	
108	1F woodcrete	18/11/08	E	0	0	
109	1FF woodcrete	18/11/08	E	0	0	
110	1F woodcrete	18/11/08	E	0	0	
111	1F woodcrete	18/11/08	E	0	0	
112	1F woodcrete	18/11/08	SW	0	0	
113	Wedge timber	18/11/08	S	0	0	
114	Wedge timber	18/11/08	E	0	0	
115	Wedge timber	18/11/08	W	0	0	
116	Wedge timber	18/11/08	W	0	0	
117	Wedge timber	18/11/08	N	0	0	
118	Standard timber	18/11/08	N	0	0	
119	Standard timber	18/11/08	S	0	0	
120	1F woodcrete	18/11/08	E	0	0	
121	Standard timber	18/11/08	W	0	0	
122	Standard timber	18/11/08	N	0	0	
123	1FF woodcrete	18/11/08	E	2 x SP	>20 (Pip)	
124	1F woodcrete	18/11/08	E	1 x Leis	>200 (Leis)	
125	Standard timber	18/11/08	SE	0	0	
126	Standard timber	18/11/08	SE	0	0	
127	Standard timber	18/11/08	SE	0	0	
128	Standard timber	18/11/08	SE	0	0	
Case Study K						
129	1FF woodcrete	17/10/08	E	0	>5 (Pip)	Damaged
130	1FF woodcrete	17/10/08	N	0	0	Damaged
131	2FN woodcrete	17/10/08	S	0	>10 (Pip)	Old droppings
Case Study L						
132	1FF woodcrete	24/10/08	S	0	<50 (Pip)	
133	2FN woodcrete	24/10/08	S	0	<10 (Pip)	
134	1FD woodcrete	24/10/08	S	0	<10 (Pip)	

	Bat box design	Date checked	Aspect	Bats	Droppings	Notes
135	1FF woodcrete	24/10/08	S	0	1 (Leis)	
136	1FF woodcrete	24/10/08	S	1 x Leis	0	
137	2FN woodcrete	24/10/08	S	0	0	
138	1FD woodcrete	24/10/08	S	0	>50 (Pip)	Bird's nest
139	1FF woodcrete	24/10/08	SW	0	<20 (Leis)	
140	1FF woodcrete	24/10/08	SW	0	<20 (Leis)	
141	2FN woodcrete	24/10/08	S	1 x SP	>200 (Pip)	
142	1FD woodcrete	24/10/08	SE	0	>500 (Leis)	
143	1FD woodcrete	24/10/08	S	0	<20 (Leis)	
144	1FD woodcrete	24/10/08	SE	0	0	
145	2F-DFP woodcrete	24/10/08	W	0	0	
146	2F-DFP woodcrete	24/10/08	W	0	0	
147	2F-DFP woodcrete	24/10/08	SW	0	0	
148	1FF woodcrete	24/10/08	N	0	0	
149	1FF woodcrete	24/10/08	N	0	0	
150	2FN woodcrete	24/10/08	S	0	0	

In addition to evidence of bats, insects were recorded in numerous boxes. Four boxes had large insect nests (ear wigs, wood lice, spiders and solitary wasps). Nine bat boxes contained bird's nests, three of which contained eggs or the remains of young birds (See Figure 8).

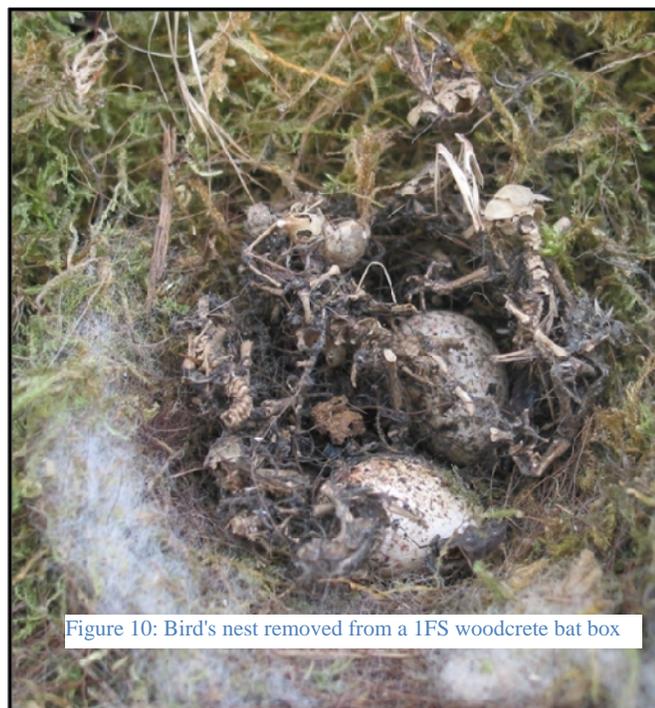


Figure 10: Bird's nest removed from a IFS woodcrete bat box

COMMENTS:

Bat boxes checked as part of this project were used by at least four species of bat. No bat usage was recorded for timber bat boxes. Therefore, woodcrete bat boxes may be more suitable for Irish weather conditions providing bats with protection from weather elements and predation.

The effectiveness of different models requires greater research. However these results indicate, tentatively, that:

- IFS woodcrete bat boxes tended to be occupied by birds. This may indicate that access points are too large and should be reduced to limited occupancy to bats.
- All other woodcrete bat box designs were regularly used by soprano pipistrelles, common pipistrelles, Leisler's bats and *Myotis* species to a lesser extent.
- The absence of brown long-eared bats occupying bat boxes is noteworthy. This may be due to the fact that bat boxes were generally located along woodland edge or along treelines. This species is regularly recorded occupying 1F bat boxes in Garryland, County Galway (pers. comm. VWT) where bat boxes are located within the woodland itself.

The high level of missing or damaged boxes is of concern. Monitoring is therefore essential to ensure the upkeep of bat boxes and replacement of damaged or missing ones is undertaken. In addition, the build up of bat droppings, if left unchecked, may result in blocking access points.

However, further research on bat box usage in Ireland is recommended in this area.

RECOMMENDATIONS:

1. All bat box schemes should be registered with Bat Conservation Ireland Database.
2. Bat boxes should be erected as follows:
 - a. At least 4-5m above ground level
 - b. In areas where public access is low
 - c. Securely to trees to ensure that there little movement during windy conditions (additional measures to a single aluminium nail should be used)
3. Bat boxes should be checked at least once every two years in order to:
 - a. Monitor bat usage
 - b. Remove insect and/or bird's nests
 - c. Remove bat droppings (which may clog up entrance holes to bat boxes)
 - d. Ensure that bat boxes are not damaged and where this is the situation, the bat box should be removed and disposed of safely. Where possible, a new bat box (of similar design) should be erected.
4. Bat boxes not used within 3-4 years of erection should be removed and located in a new position.

4. Roof Renovation Projects

Bats spend a great deal of time roosting and, roosting sites are required to protect bats from the elements and from predators. The great diversity in the ecology of bats has led to an enormous diversity in roosting sites used by different species throughout the seasons. Many bat species have adapted well to man-made structures including abandoned mines, bridges and buildings.



Figure 11: Brown long-eared bat roosting on timber rafters

Due to the fact that many bats species rely heavily on sinanthropic (artificial roosts) such as attic spaces, roof works can have a detrimental impact on roosting bats. Such artificial roosts have replaced many natural structures used as roosts by bats and for many species these artificial roosts may even be more beneficial than natural tree holes. Attics can provide more stable thermal conditions necessary for maternity roosts while allowing young bats to practice flying safely before leaving the roost.

Three of the projects investigated involved roof renovation works (Case Studies C, F & I). Three buildings re-surveyed had provided suitable roosting spaces for brown long-eared bats (maternity roosts). This species is described as a ‘fissure rooster’ where individuals prefer to have constant contact with roof beams on both sides. Consequently, brown long-eared bats are more frequently found roosting in the apex of the roof, in the angle between the ridge beam and the rafters or at the gable ends between stone walls and wooden beams. This species has been recorded to show a high degree of roost fidelity for buildings suitable for maternity roosts (i.e. brown long-eared bats return year after year to the same roost).

In addition, a large soprano pipistrelle roost was also recorded in the same roof space of Case Study F where individuals occupied both gable ends of the building within the roof apex and stonework. This species tends to roost in very confined places, such as behind fascia and soffits, under slates/tiles and within roof cavities. Flat roof extensions are also favoured by this species. Soprano pipistrelles roost faithful and tend to remain in the maternity roost for much of the year.



Figure 12: Brown long-eared droppings below rafters

4.1 Renovation Works

4.1.1 Case Study C

The building re-surveyed was part of Case Study C and is a 19th century 1½-storey brick house with three separate attic spaces. Brown long-eared bats were recorded exiting at two points (Exit A: 19 individuals & Exit B: 8 individuals, emergence count recorded in the original bat survey on 14/6/04) from the main attic space and was most likely a maternity roost given the numbers of individuals recorded. Recommended renovation works involved the provision of vents in the original exit locations to allow bats to continue to utilise the attic spaces post-renovation. These works were not completed as recommended but 2 sets of louvres were installed into the roof at two



Figure 13: Louvre installed into roof space

separate and different locations to those recommended (Works completed in early 2007).

An emergence count was undertaken on 07/08/08 (9.30 – 10.30 p.m., suitable weather conditions) and no brown long-eared bats were recorded exiting the building. A daytime check was not possible on this date.

A daytime check (3/10/08) of the attic space recorded brown long-eared droppings indicating that

individuals of the species were roosting in the main attic post-renovation works but the number of droppings (<100 droppings) noted potentially indicate that there are fewer individuals compared to historical records and that a maternity roosts is not currently present within the attic space.

COMMENTS:

The mitigation measures resulted in the installation of a louvre system into the attic space. Brown long-eared bats are continuing to use this attic space but in reduced numbers. Reduced brown long-eared bat usage may be due to:

1. increased lighting in vicinity of the building
2. new location of exit points
3. felling of trees in front of building

RECOMMENDATION:

1. Monitor building as part of Brown long-eared Roost Monitoring Scheme to determine whether bat usage increases over time.

4.1.2 Case Study F

This building is an 18th Century Georgian House and was surveyed under The Heritage Council Buildings at Risk Scheme in 2004. The bat survey recorded both brown long-eared bats and soprano pipistrelles roosting within the building. Recommendations to aid roof works were made in relation to:

1. Timing of works (outside the maternity season)
2. Replacement of access points via vents in the ridge tiles (a total of 4 vents were installed)
3. Re-felting



In 2008, this building was surveyed twice. During the first visit (11/06/08), an internal examination revealed that both soprano pipistrelles and brown long-eared bats were roosting within the attic space. The brown long-eared bats (2 individuals) were recorded within the rafters roosting singly. A large scattering of brown long-eared droppings were recorded throughout the attic space. Soprano pipistrelles were visible within the rafters

at both gable ends of the house (> 50 individuals) and a large pile of droppings were recorded below both roosting points. However, inclement weather conditions prevented an emergence count being completed on this visit.

A second visit (19/09/08) was undertaken and during this visit, both an internal examination of the attic space and an emergence count was completed. A total of 16 brown long-eared bats (exiting from the vents) and 334 soprano pipistrelles (exiting from fascia board at gable end of house) were recorded.

COMMENTS:

The mitigation measures were successful with both species of bat roosting in similar numbers to that recorded pre-renovation works.

RECOMMENDATION:

1. Monitor building as part of Brown long-eared Roost Monitoring Scheme to determine whether bat usage increases over time.

4.1.3 Case Study I

This building is a large 18th century 3-storey building (plus extensions) with numerous large attic spaces. Proposed works involved the conversion of dormitories and physics laboratories into classrooms. This required the replacement of water tanks and pipes within one large attic space. During works, brown long-eared bats were encountered. Consequently, a bat specialist was called in to undertake survey work and to propose mitigation measures to ensure that the continuation of works did not impact further on the bats. Work is completed and BC Ireland, in liaison with assigned bat specialist, monitored the attic space in 2008 to determine whether the bats returned to the attic space post-works.

An internal inspection was undertaken on 25/6/08. Brown long-eared bat droppings were recorded at three locations within the main attic space. However, these droppings did not appear to be fresh. In addition, discarded wings of the Large yellow under-wing moth possibly indicating that brown long-eared bats were recently feeding within the attic space. However, no bats were recorded roosting in the rafters during this inspection. A second visit was undertaken on the 11/7/08 and again no bats were recorded within the attic space. An emergence count was undertaken by four BC Ireland contractors on 8/9/08 to determine if brown long-eared bats were roosting in the building. Due to the size and height of the building, an emergence count was difficult to complete but brown long-eared bats were recorded indicating that this species still utilise the building but are more than likely roosting in a different attic space.

COMMENTS:

The mitigation measures were continued successfully with disturbance to roosting bats in 2007. However, the bats did not return to the same attic space in 2008. The reasons for this are unknown.

RECOMMENDATIONS:

1. Monitor building as part of Brown long-eared Roost Monitoring Scheme to determine whether bat usage returns to the main attic space.
2. Monitor all other attic spaces in the building to determine where the bats have moved to.

In conclusion, to ensure continued usage of bat roosts by bats, mitigation measures must be strictly adhered to. If a derogation licence is required, conditions of this licence should specify a monitoring programme to ensure that mitigation has been successful and such results should be reported back to NPWS.

5. Night-time Bat Detector Surveys

Night-time detector surveys were completed for only eight case studies (Case Studies A, B, C, D, E, F, I & J) due to poor weather conditions encountered in 2008. In all cases, bats were recorded during the post-construction bat surveys. **However, in the majority of surveys, a reduction in the number of species was recorded.**

Table 2: A comparison of bat species recorded in pre- and post-construction bats surveys.

All species listed below were recorded on bat detector: SP = soprano pipistrelle; CP = common pipistrelle, NP = Nathusius' pipistrelle, Pip = *Pipistrellus* species; Leis = Leisler's bat; Natt = Natterer's bat, Daub = Daubenton's bat; Wh/Br = whiskered / Brandt's bat; My = *Myotis* species & LHS = lesser horseshoe bat.

Case Study	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	LHS
Case Study A											
Pre-survey	√	√			√	√	√	√			
Post-survey	√	√		√	√		√	√		√	
Methodology	<ol style="list-style-type: none"> Emergence count (16/6/08) of water tower Completed using a harp trap to identify bats to species level: 70+ Daubenton's bats Detector Survey (25/8/08 & 26/8/08) Heterodyne bat detectors (3 surveyors) and 2 stationary Time Expansion bat detectors 										
Comment	While large tracts of woodland were removed to facilitate the road development, large areas of woodland remain with extensive grasslands. One species of bat (brown long-eared bat) was not recorded in post-construction bat survey compared to pre-construction survey. This may have been due the fact that weather conditions were not ideal and that this species of bat is difficult to detect in the field.										
Case Study B											
Pre-survey	√	√		√	√	√	√	√	√		√
Post-survey	√				√		√	√			
Methodology	<ol style="list-style-type: none"> Daytime inspection (24/6/08) Crevices in stone work checked with aid of a torch: 1 x Natterer's bat Detector Survey (24/6/08 & 25/6/08) Heterodyne bat detectors (2 surveyors) and 2 stationary Time Expansion bat detectors 										
Comment	While works primarily involved buildings located on-site, this area consists of large tracts of woodland, grassland and is located adjacent to a large lake. Therefore, extensive foraging areas remain in vicinity of the development. Three species of bat (brown long-eared bat, common pipistrelle and lesser horseshoe bat) were not recorded in post-construction bat survey compared to pre-construction survey. In relation to brown long-eared bats, this may have been due the fact that weather conditions were not ideal and that this species of bat is difficult to detect in the field.										
Case Study C											
Pre-survey	√	√			√	√	√	√	√	√	
Post-survey	√		√		√			√	√	√	
Methodology	<ol style="list-style-type: none"> Emergence count (7/8/08) 2 buildings (4 surveyors): No bats Detector Survey (7/8/08) Heterodyne bat detectors (4 surveyors) 										
Comment	While large tracts of woodland were removed to facilitate this development, large areas of woodland remain with extensive grassland still present. This development is also located adjacent to two lakes and a river so extensive foraging areas are available to bats. However, the degree of renovation of buildings has greatly reduced roosting sites especially for bats not regularly recorded roosting. Three species of bat (common pipistrelle, brown long-eared bat and Natterer's bat) were not recorded in post-construction bat survey. One new species of bat was recorded: Nathusius' pipistrelle. This species has increased its distribution in the country over the last few years and has been previously recorded in County Leitrim.										

Case Study D	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	
Pre-survey	√	√			√	√	√	√			
Post-survey	√	√			√			√			
Methodology	1. Detector Survey (25/7/08 & 26/7/08) Heterodyne bat detectors (1 surveyor) and 2 stationary Time Expansion bat detectors										
Comment	Two species of bat (brown long-eared bat and Natterer's bat) was not recorded in post-construction bat survey. The area where these bats were recorded pre-construction consisted of scrub and treelines. These habitats were removed as a result of the development thereby reducing suitable foraging areas for such species.										
Case Study E	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	
Pre-survey	√	√			√			√			
Post-survey	√				√						
Methodology	1. Detector Survey (28/8/08 & 29/8/08) Heterodyne bat detectors (1 surveyor) and 2 stationary Time Expansion bat detectors										
Comment	Foraging areas have been greatly reduced as a result of this development. Lighting has also increased. This is reflected in the reduction in bat species recorded on-site. Bat activity was confined to the river and immediate grassland area. No bats were recorded within the developed area.										
Case Study F	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	
Pre-survey	√					√					
Post-survey	√	√			√	√					
Methodology	1. Emergence count (19/9/08) Brown long-eared bats: 13 individuals; soprano pipistrelles: 334 individuals 2. Detector Survey (19/9/08) Heterodyne bat detectors (1 surveyor)										
Comment	No impacts on the surrounding area resulted in the works on the building. Therefore, bats roosting within the building continue to forage in vicinity of the building with additional species detected.										
Case Study I	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	
Pre-survey						√					
Post-survey		√			√	√					
Methodology	1. Emergence count (8/9/08) (4 surveyors) Brown long-eared bats were present 2. Detector Survey (8/9/08) Heterodyne bat detectors (4 surveyors)										
Comment	Due to the size and height of this building, it was not possible to determine the exit points used by brown long-eared bats. However this species was detected indicating that brown long-eared bats are continuing to roost within the building at an undetected location.										
Case Study J	SP	CP	NP	Pip	Leis	BLE	Natt	Daub	Wh/Br	My	
Pre-survey	√	√			√					√	
Post-survey	√										
Methodology	1. Detector Survey (2/10/08) Heterodyne bat detectors (3 surveyors)										
Comment	Extensive areas of foraging habitat remains in vicinity of the development site. However, lighting has greatly increased and this may account for the reduction in species detected during post-construction survey.										

COMMENTS:

In the majority of these bat detector surveys a reduction in both the number of bat species and the number of individuals was recorded. The reduction may be due to:

- Habitat loss
- Loss of roosting sites
- Increased lighting
- Increased noise and human activity.

Such results emphasize the need for good practical mitigation measures for bats. Bats, in all cases, were still present on-site in post-bat surveys. However, much of these species were common bat species while bat species more sensitive to the development works reported were not detected in many post-development bat detector surveys. Therefore, it is essential that mitigation measures cater for such species. In addition, the following should be undertaken during pre-development bat surveys to assist monitoring of the impacts of mitigation measures:

- Light levels should be measured adjacent to roosts, principal foraging areas and along recorded commuting routes.
- Roost floors (where buildings are being retained) should be lined with plastic or paper sheets to monitor bat dropping levels
- Detailed Roost Record Sheets to be included in Appendices of reports (such record sheets would allow information collated to be transferred readily to Bat Conservation Ireland Database and to the Biological Records Database)
- Detailed Bat Detection Record Sheets to be included in Appendices of reports (such record sheets would allow information collated to be transferred readily to Bat Conservation Ireland Database and to the Biological Records Database)

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Acknowledgements

Thanks to The Heritage Council for awarding funding to undertake this project.



Survey work was undertaken by: Tina Aughney, Imelda Barry, Ruth Carden, Hannah Denniston, Ashlyn Kessoparadh, Enda Mullen, Joe Sheehan, Brian Stack, Mairead Stack, Ger Stanton & Faith Wilson.

Additional information was contributed by CIBR with particular thanks to Daniel Buckley.

Thanks to BCireland committee members for comment on the report, in particular, Austin Hopkirk, Caroline Shiel and Faith Wilson.

Appendices

Suppliers of artificial bat roost units:

- i) Schwegler Bat Boxes, Jacobi, Jayne & Co., Hawthorn Cottage, Maypole Hoath, Cantebury, Kent CT3 4LW, England. Phone: 01227 860521.
- ii) Alana Ecology Ltd., The Old Primary School, Church Street, Bishop's Castle, Shropshire, SY9 5AE. Phone: 01588 630173.

Species descriptions

These are brief descriptions of the species bat recorded in Ireland (written by Conor Kelleher).

Soprano pipistrelle *Pipistrellus pygmaeus*

The soprano pipistrelle's echolocation calls peak at 55 kHz, which distinguishes it readily from the common pipistrelle. The pipistrelles are the smallest and most often seen of our bats, flying at head height and taking small prey such as midges and small moths. Summer roost sites are usually in buildings but tree holes and heavy ivy are also used. Roost numbers can exceed 1500 animals in mid-summer.

Brown long-eared bat *Plecotus auritus*

This species of bat is a 'gleaner', hunting amongst the foliage of trees and shrubs, and hovering briefly to pick a moth or spider off a leaf, which it then takes to a sheltered perch to consume. They often land on the ground to capture their prey. Using its nose to emit its echolocation, the long-eared bat 'whispers' its calls so that the insects, upon which it preys, cannot hear its approach (and hence, it needs oversize ears to hear the returning echoes). As this is a whispering species, it is extremely difficult to monitor in the field as it is seldom heard on a bat detector. Furthermore, keeping within the foliage, as it does, it is easily overlooked.

Common pipistrelle *Pipistrellus pipistrellus*

This species was only recently separated from its sibling, the soprano or brown pipistrelle *Pipistrellus pygmaeus*, which is detailed below (Barratt, E. M., Deauville, R. Burland, T. M., Bruford, M. W., Jones, G., Racey, P. A. & Wayne, R. K., 1997). The common pipistrelle's echolocation calls peak at 45 kHz. The species forages along linear landscape features such as hedgerows and treelines as well as within woodland.

Leisler's bat *Nyctalus leisleri*

Leisler's are dark brown and Ireland's largest bat. Due to its wide distribution in numerous numbers across Ireland and of its dramatic worldwide decline, the Irish population is considered to be very important. According to O'Sullivan (1994) Ireland now holds the largest population of this species. Their echolocation calls are around 23 kHz and they emerge early in the evening, flying high. Leisler's prefer to roost in trees and buildings and during the autumn, males establish colonies in tree holes or buildings to attract females. They feed on non-biting midges and moths / beetles later in the season.

Natterer's bat *Myotis nattereri*

This species has a slow to medium flight, usually over trees but sometimes over water. They follow hedges and treelines to their feeding sites, consuming flies, moths and caddis-flies. Natterer's bats are frequently recorded in hibernation sites in winter but there are few records of summer roosts. Those that are known are usually in old stone buildings but they have been found in trees and bat boxes.

The status of the Natterer's bat has not been determined but it is classed as *Threatened* and is listed in the *Irish Red Data Book* (Whilde, A 1993).

Whiskered/brandts bat *Myotis mystacinus/brandtii*

This species, although widely distributed, has been rarely recorded in Ireland. It is often found in woodland, frequently near water. Flying high, near the canopy, it maintains a steady beat and sometimes glides as it hunts. It also gleans spiders from the foliage of trees. Whiskered bats prefer to roost in buildings, under slates, lead flashing or exposed beneath the ridge beam within attics. However, they also use cracks and holes in trees and sometimes bat boxes. The status of the species has not been determined but it is classed as *Threatened* and is listed in the *Irish Red Data Book* (Whilde, A 1993).

Daubenton's bat *Myotis daubentonii*

Daubenton's have a reddish face, dry-white underside and uniformly brown and rounded short ears. They are considered to be a specialist skimmer of water picking insects from air or water surface. In general, maternity roosts in summer are found in bridges, old stone buildings or hollow trees and research has shown that Daubenton's bat will rarely use bat boxes as either maternity or temporary roosts. They hibernate in underground sites in small crevices. They emerge late in the evening and Daubenton's bats feed mainly on caddis flies and aquatic larvae.

O Sullivan (1994) reported in the 1985-88 Wildlife Service Survey a total 200 roosts located by Conservation Rangers but the majority of which only contained small numbers (1-10 individuals). Whilde (1993) considered that the main treats to this species are pointing and reinforcing bridges.

Nathusius' pipistrelle *Pipistrellus nathusii*

Nathusius's pipistrelle is a recent addition to the Irish fauna and has mainly been recorded from the north-east of the island in Counties Antrim and Down (Richardson, P, 2000) and also in Fermanagh, Longford and Cavan (B. Keeley, pers. comm.). It has also recently been recorded in Counties Cork and Kerry.