

Survey of Bats and Bridges in County Waterford

Carl Dixon, Patrick Smiddy and Sorcha Sheehy



DixonBrosnan
environmental consultants

An Chomhairle Oidhreachta
The Heritage Council



© An Chomhairle Oidhreachta / The Heritage Council 1998

All rights reserved.

Published by the Heritage Council

Production, typesetting and layout by .

Design by

Printed in.....

ISSN (To be supplied by the Council)

The Heritage Council of Ireland Series

ISBN (To be supplied by the Council)

Price: £

Contents

1. Introduction	5
1.1 Irish bat species	5
1.2 Bats and bridges	7
1.3 Threats to bats in bridges	8
1.4 Irish bat species	9
2. Survey methodology	11
2.1 Bridge selection and coverage	11
2.2 Timing of surveys	13
2.3 Coding of bridges	13
2.4 Recording form	15
2.5 Bat emergence surveys	18
3. Results	19
3.1 Survey results	19
3.2 Species	20
3.3 Bridge construction	20
3.4 Bridge height	20

3.5 Bridge altitude	21
3.6 Surrounding habitats	21
3.7 Other species	22
4. Literature review	24
4.1 Ireland	24
4.2 Other notable studies	26
4.3 Comparisons with current survey	26
5. Bridge maintenance methods and mitigation	29
5.1 Bridge strengthening procedures	29
5.2 Artificial bat roosts	31
5.3 Timing of bridge works	32
6. Conclusions/Recommendations	32
References	34

Tables and Figures

Figure 1. Location of bridges surveyed	12
Figure 2. Percentage of suitable bridges with evidence of bats	28
Table 1. Bridge code descriptions	14
Table 2. Summary of survey results	19
Table 3. Numbers of bridges recorded in each height range and corresponding bridge code	20
Table 4. Altitudinal ranges (m) of bridges categorised by bridge code	21
Table 5. Habitats surrounding bridges in Code 2 and Code 3	21

bridges	
Table 6. Summary of survey results	27
Table. 7. Survey required for each bridge category	33

Appendices

Appendix 1. Bridge list for County Waterford	36
Appendix 2. Comparison of 1989 and 2008 surveys	42
Appendix 3. Bird, mammal and other species recorded during survey	43
Appendix 4. Artificial roosts	49
Appendix 5. Case studies	52
Appendix 6. Recording form	56
Appendix 7. Health and safety considerations	58

1. Introduction

DixonBrosnan environmental consultants were commissioned by Waterford County Council to survey road bridges in Co. Waterford to determine their usage by bats. The objectives of the surveys were as follows:

- To comprehensively assess bat usage of bridges within the county
- To determine the importance of bridges in Co. Waterford for bats and to compare the data to other similar surveys in Ireland
- To clearly classify bridges in terms of their potential for bat usage
- To present the data clearly within a GIS format to facilitate safeguarding of bats and bat habitat during future repair and maintenance work by Waterford County Council, and
- To raise awareness of bat ecology

Survey work was carried out primarily by Pat Smiddy. Additional survey work was carried out by Carl Dixon who was project manager for the project. Both surveyors have experience in surveying for bats and Pat Smiddy previously carried out surveys of bridges in West Waterford in 1989 (Smiddy, 1991).

1.1. Irish Bat Species

Bats belong to the Order Chiroptera. All eight species of bat occurring in the Republic of Ireland are insectivorous, and belong to the suborder Microchiroptera. One species, the Lesser Horseshoe, belongs to the Family Rhinolophidae, while the remaining seven species belong to the Family Vespertilionidae.

All bat species in Ireland are protected under the Wildlife Act 1976, as amended in 2000, and the Habitats Directive which was transposed into Irish law in the European Communities (Natural Habitats) Regulations (S.I. 94 of

1997), as amended. The Irish government is also a signatory to the Bonn convention (Convention on the conservation of migratory species of wild animals, Bonn 1979) and the Bern convention, 1982 (The convention on the conservation of European wildlife and natural habitats) and has a commitment to the “Eurobats” agreement (Agreement on the Conservation of bats in Europe, 1991) (NRA 2005).

Of the eight species in the Republic of Ireland two are listed as threatened in the Irish Red Data Book (Whilde, 1993) i.e. the Whiskered bat *Myotis mystacinus* and Natterer's bat *Myotis nattereri*. The other six species Lesser Horseshoe *Rhinolophus hipposideros*, Daubenton's *Myotis daubentoni*, Leisler's *Nyctalus leisleri*, Long-eared *Plecotus auritus* and the two species of Pipistrelle *Pipistrellus pipistrelles* and *Pipistrellus pygmaeus*, are all categorised as internationally important. Internationally important taxa are those which are common and/or widespread in Ireland but are considered to be rare or threatened in the European Community (Whilde, 1993).

1.2 Bats and Bridges

Prior to significant human alteration of the natural landscape it is probable that bats roosted in caves and in old trees; however old trees which have sufficient age and structural complexity (i.e. cavities, hollows, decay holes etc) are now largely absent from the Irish countryside. In the absence of such traditional roosting sites bats have adapted to man made structures such as buildings and bridges. The grout and mortar in old masonry bridges in particular may be slowly eroded by water constantly seeping through the structure creating crevices and gaps where stones have become dislodged. Where such crevices and gaps develop they may provide extremely valuable roosting sites for bats. Bats may also roost in fissures which develop in old bridges usually caused by the impact of heavy traffic. Where bridges cross running water there may be protection from predators, lack of human disturbance and relatively constant temperature and humidity. In the UK, the Bat Conservation Trust considers crevices that are at least 400mm deep and between 17mm and 35mm wide are probably optimal (BCT, 2008). However, almost any crevice greater than 50mm deep and 12mm wide can be used as a roost or to

gain access to a bigger chamber behind. Newer concrete bridges, which lack suitable crevices, are less likely to be of value for bats.

Bats may be found in bridges year round. Deep crevices in bridges provide nursery roost sites where large numbers of females can congregate and also provide hibernation sites if they are sufficiently isolated from external temperature fluctuations. Male bats may use bridges as mating stations in the autumn months (Russ, 1995). Smiddy (1991) concluded that bridges provide very important sites for bat species, particularly Daubenton's, with 25% of bridges surveyed either holding bats or having evidence of being used by bats, and a further 26% providing suitable roost sites. A comprehensive study of bridge usage by bats in Cumbria, England (Billington and Norman, 1997) revealed 12.5% of bridges confirmed as bat roosts and a further 41% had suitable crevices. An account of literature relating to bat usage of bridges is included in section 4 of this report. To date, five species of bat have been recorded roosting under bridges in Ireland namely, Daubenton's, Long-eared, Natterer's, Whiskered and Pipistrelle species.

1.3 Threats to bats in bridges

Most bridges in Ireland belong to and are maintained by local authorities. In Ireland, many of the older bridges were built during the 19th century and were designed for horses and carts. Due to the weight and frequency of modern traffic these older bridges often require strengthening or repair works which can significantly impact on bat roosts if bat issues are not actively considered in the planning of such works. For example pressure grouting, pointing and infilling of arches can entomb bats within crevices or exclude them from roost sites. The greatest threat is posed to young or hibernating bats present within crevices as these animals are unable to escape.

Smiddy (1991) considered that the greatest threat to bats in bridges was the danger of encasement during bridge repairs. McAney (1992) concluded that greater cooperation is needed between local authorities, engineers and wildlife officials to enable important bat roosts in bridges to be conserved during bridge maintenance works.

1.4 Irish Bat Species

Five bats species have been recorded in Irish bridges to date. The ecology of these species, Daubenton's, Long-eared, Natterer's, Whiskered and Pipistrelle i.e. Common and Soprano, are discussed below.

1.4.1 Daubenton's Bat (*Myotis daubentoni*)

Daubenton's bat is strongly associated with waterways and is widespread in Ireland and for this reason is sometimes referred to as the "water bat". They are adapted to feeding low over slow moving water and catch insect from the water's surface using their enlarged feet. Daubenton's bats hibernate in caves, mines and other underground sites. The majority of individuals will hibernate towards the end of January and February and remain in hibernation until late March/early April. The Irish Red Data Book (Whilde, 1993) categorises the Irish population of Daubenton's bats as being of international importance. During the National Bat Survey 1985-88 (O'Sullivan, 1994) 213 roosts of Daubenton's bats were recorded and the majority of these were in bridges. Smiddy (1991) found that Daubenton's was the commonest species roosting in the bridges surveyed, recorded in 38 of the 364 bridges surveyed (10.4%). The mean number of bats per bridge was 1.76 (Smiddy, 1991).

1.4.2 Long-eared Bat (*Plecotus auritus*)

Although quite common in Ireland, Long-eared Bats are rarely seen in flight due to their preference for foraging in woodland where they fly amongst the foliage, picking moths and other insects off leaves. Larger prey items such as noctuid moths are taken to a feeding perch, often in a porch or outhouse. These perches are recognisable by the piles of insect remains, such as moth wings, which collect under them. The Long-eared Bat roosts in buildings such as houses with large attic spaces, churches, outbuildings and in tree holes. This was the second commonest species in a study by Smiddy (1991), recorded in eight of the 364 bridges surveyed.

1.4.3 Natterer's Bat (*Myotis nattereri*)

Natterer's Bat is one of the rarer Irish bat species, found mainly in woodland and mature hedgerow habitats. This species has broad wings so can fly with

great manoeuvrability among trees and catch insects from foliage. Its usual roost sites are in tree holes, old stone buildings such as churches and barns, and under bridges. Natterer's bats hibernate underground usually in caves and mines. They arrive at hibernation sites in December with peak numbers recorded in January and February. The Irish Red Data Book (Whilde, 1993) lists Natterer's bat as a species which is considered to be threatened in Ireland. Its true status is listed as indeterminate - a taxa known to be 'endangered' or 'vulnerable' or 'rare' but there is not enough information to say which of these categories is appropriate. In the 1985-88 National Bat Survey (O'Sullivan, 1994) 44 roosts were located in the Republic of Ireland, and of these 20 roosts held only single bats. Based on these results, Natterer's bats were classified as widely distributed in Ireland but with low population levels. Just four single bats were recorded by Smiddy (1991) in a survey of east Cork and west Waterford.

1.4.4 Whiskered Bat (Myotis mystacinus)

Another uncommon and little-known bat, Whiskered bats typically forage along forest tracks or near water adjoining mature trees. It is sometimes found roosting in attics of old buildings or in crevices under stone bridges but there are very few confirmed roosts in Ireland. Whiskered bat has been infrequently recorded in Ireland and is considered to be a threatened species in the Irish Red Data book (Whilde, 1993). Their diet has not been ascertained in Ireland although in England and Europe the diet consists of mainly nematoceran Diptera with large quantities of Tipulidae which may indicate foraging in woodland (Vaughan, 1997). During the 1985-88 survey in the Republic of Ireland (O'Sullivan, 1994) only 34 roosts were recorded, most of which contained only 1-10 bats. Smiddy (1991) recorded just three single individuals. Whiskered bat is the rarest bat species in Ireland.

1.4.5 Common pipistrelle (Pipistrellus pipistrelles) and Soprano Pipistrelle (Pipistrellus pygmaeus)

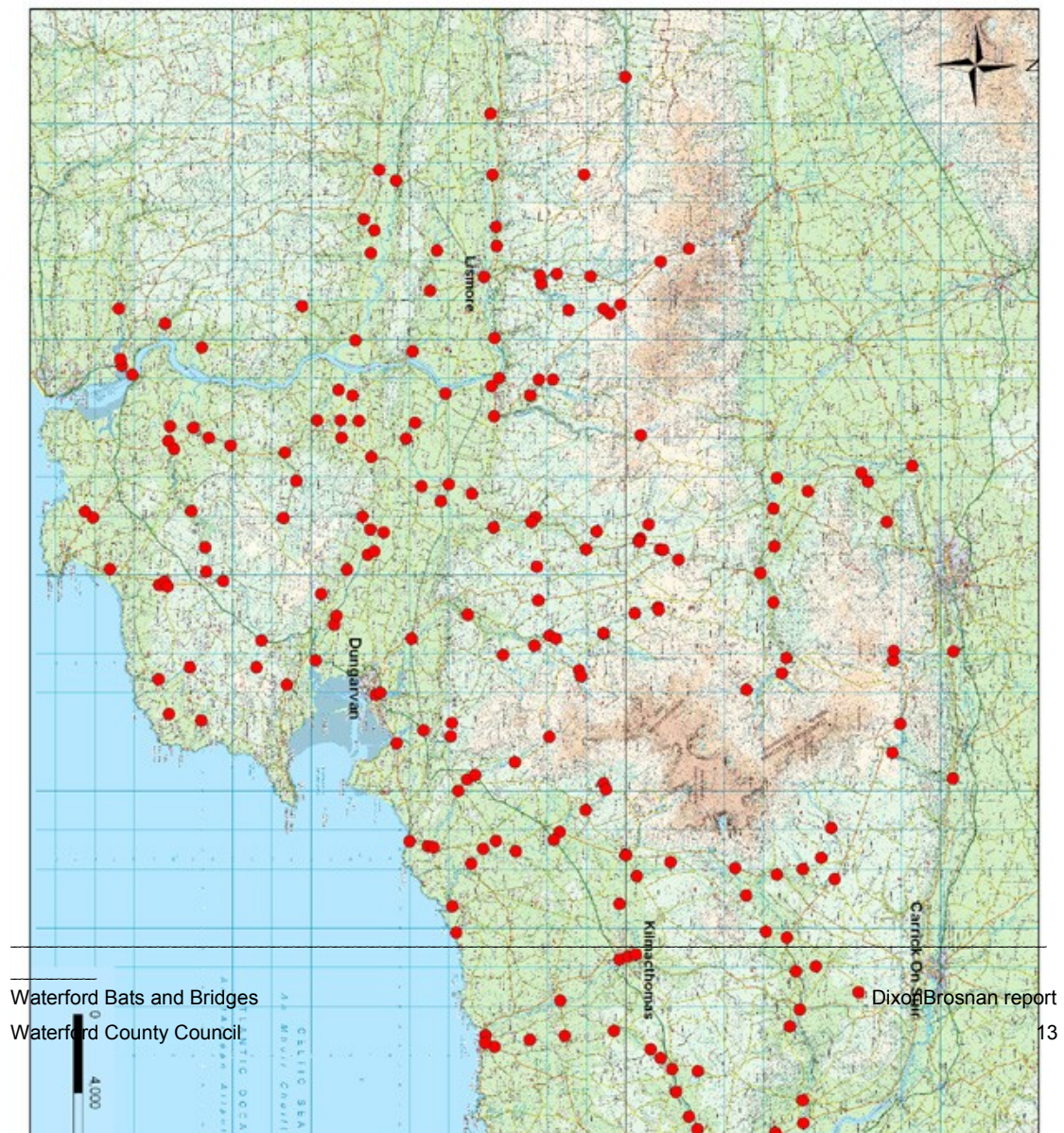
Ireland's two smallest and commonest bat species, the Common and Soprano Pipistrelles are the bats most likely to be seen flying around soon after dusk in both urban and rural areas. Both have a rapid, twisting flight as they pursue

tiny prey of midges, mosquitoes and small moths. Pipistrelles are frequently found roosting in houses, although they also roost in other locations such as tree holes. In houses they prefer to occupy confined spaces such as behind hanging tiles and soffit boards or between roofing felt and roof tiles, rather than the main attic space. Smiddy (1991) recorded Common Pipistrelle at just three bridges during his survey.

2. Survey Methodology

2.1 Bridge selection and coverage

Waterford County Council initially supplied a list of 170 bridges to the surveyors and from personal knowledge and through a scan of the Discovery series Ordnance Survey of Ireland maps for County Waterford (No's. 74, 75, 76, 81 and 82) a further 68 bridges were added to this list. As the results of this report are intended to be used as a practical tool in planning future works on bridges, it was considered important that the survey covered a high percentage of the bridges within the county. The location of these bridges is illustrated in **Figure 1**. A survey timetable was then developed. Although bridges on all main channels and significant tributaries were assessed, not all bridges on minor tributaries or those in private land were covered. With some exceptions many of these bridges (and stone culverts) are believed to be of limited use to bats because of their low clearance height above the water. It is estimated that 90-95% of the larger bridges along public roads within the county were identified and surveyed.



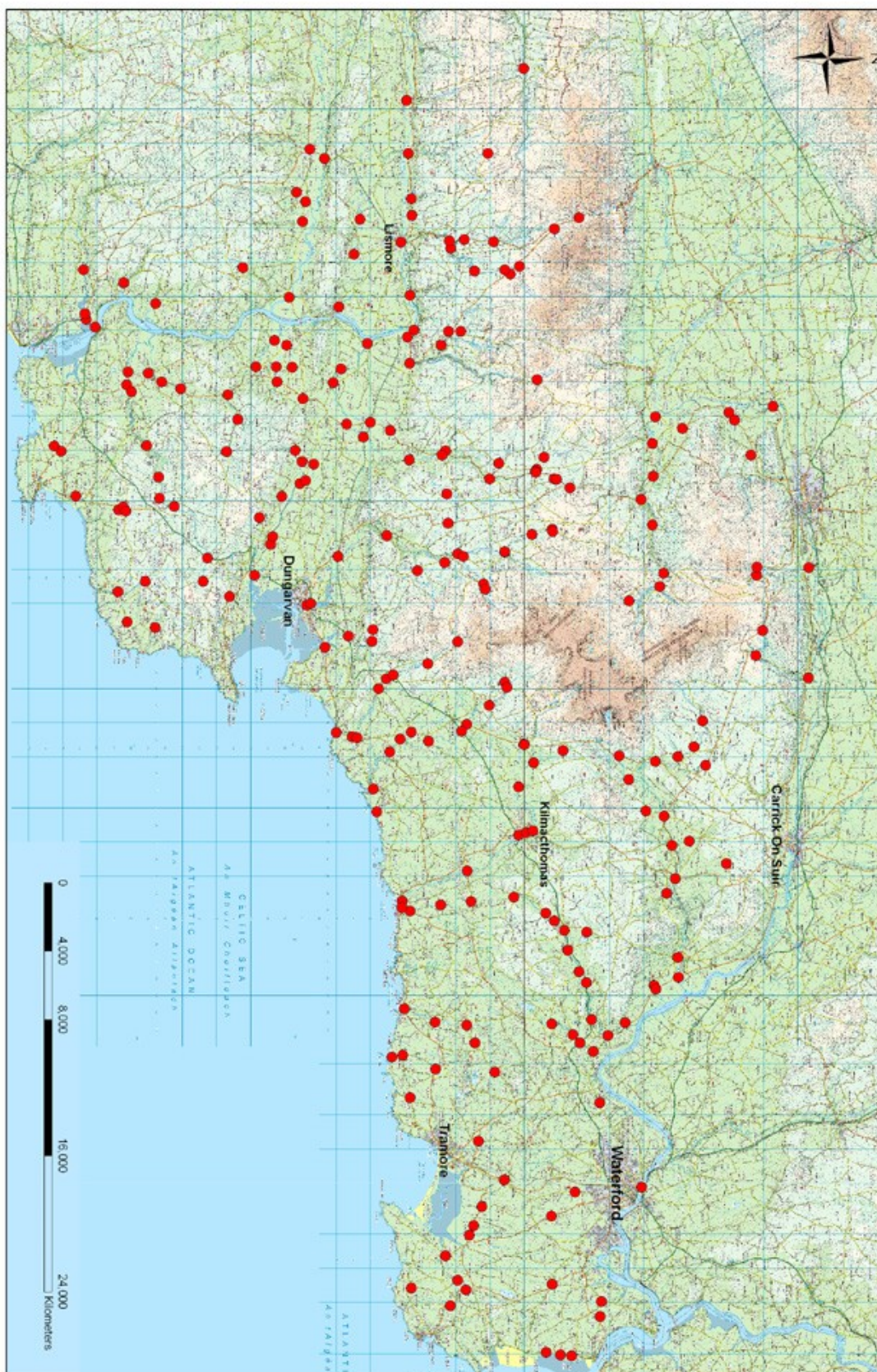


Figure 1. Location of bridges surveyed

2.2 Timing of surveys

The survey was carried out over three periods.

- A preliminary survey was carried out on the 13th May, 2008. The objective of this survey was to standardise the survey methodology and recording protocols.
- The remaining bridges were surveyed during the period from 19th May to 5th June 2008.
- Bridges which were determined to have potential for bats (or contain bats) during the first survey were resurveyed in the period from the 26th to the 29th August 2008. The purpose of the second visit was to determine if there was a seasonal effect in the use of bridges, either in terms of bat numbers or in terms of species.
- One emergence survey was carried out simultaneously by both surveyors using bat detectors (Batbox III and Bat Box Duet). The survey was carried out at a bridge where bats were known to be present (one Daubenton's was in the bridge, but it did not emerge). The survey commenced approximately 1 hour before dusk and continued until approximately 2 hours after dusk.

2.3 Coding of bridges as suitable/unsuitable as bat roost sites

The protocol used for coding bridges was developed by Billington and Norman (1997) and is summarised in **Table 1**. This has been subsequently used in Ireland for a number of bridge surveys (Shiel, 1999; Masterson *et al.*, 2008). Data were recorded on separate rows on the recording form for each individual bridge arch. Each bridge arch was numbered sequentially from left to right with the observer facing downstream. Therefore, arch number one is always the one nearest the left-hand riverbank.

Table 1. Bridge code descriptions

Code	Description
Code 3	Evidence of bats using bridge (sighting of bat(s)) or fresh droppings.
Code 2	Ideal roost crevices in bridge, but no bats or bat evidence seen. Crevices generally greater than 100mm deep, clean and offering good shelter.
Code 1	Some crevices in bridge, but likely to be used rarely, if ever, by bats. Few crevices present, generally less than 100mm deep, and offering poor shelter.
Code 0	No potential as a bat roost (smooth walls of concrete or grouted etc).

A standard set of procedures was carried out at each bridge surveyed. Cracks, crevices and joints on the underside of bridges were closely examined using a strong, narrow-beam torch. The observer systematically examined the roof and sides of each bridge arch, and recorded details of suitability as a bat roost, as appropriate. Bridges with an arch height of up to 4.0m could be surveyed effectively from the ground. Where arch height exceeded 4m the accuracy of the survey was reduced due to the difficulty of examining crevices in detail. However it was possible to determine the suitability of such bridges for bat roosts.

Occasionally, if a bat (or bats) was seen or suspected, a stepladder that lifted the observer about 1.0m was used for closer inspection. A taller ladder was not used for safety and transport reasons. Bat identification was always carried out without catching the bat (an action which would require a licence), and was based on a field guide (Mitchell-Jones, 1994) and personal knowledge of all common Irish species. A small number of bridges (total 12), considered unlikely to be bat roosts, could not be surveyed as their arch height was only 1.0m or less and thus they could not be examined safely. An even smaller number of bridges considered potential bat roost habitats (total 4) could not be surveyed at all for various reasons (i.e. water levels too high or where the bridge was actually a culvert). Data-recording sheets were

completed for all bridges during surveying. Health and safety procedures are outlined in **Appendix 7**.

2.4 Recording form

A standard recording form based on the survey methodology of Billington and Norman (1997) was developed (**Appendix 6**). Copies of the form were carried into the field during surveying so that consistent information was collected at all bridges.

2.4.1 Bridge name

The bridge name used is that shown on the Discovery series Ordnance Survey of Ireland maps (No's. 74, 75, 76, 81 and 82). In some cases no name for the bridge was shown on the map. Generally in such cases the name used was that of the townland closest to the bridge taken from the appropriate discovery series map. An identifiable name was ascribed to bridges where possible, however in the case of any doubt the relevant grid reference should be referred to.

2.4.2 Bridge number

Each bridge was given a sequential number, and this number was used for any subsequent visit.

2.4.3 River name

The river or stream names were also taken from the Discovery Series Ordnance Survey of Ireland maps (No's. 74, 75, 76, 81 and 82). In some cases, especially on tributary and feeder streams, no name was given on the map. In these cases the word 'stream', in brackets, is given. The sequence of river flow from feeder stream to larger named stream or river is indicated by brackets, the first named being, in all cases, the stream or river on which the bridge being surveyed was situated.

2.4.4 Photo number

A digital photo (Canon Cybershot 7.2 megapixels or similar) was taken of surveyed bridges. Small culverts unsuitable for survey and those covered in vegetation were not photographed.

2.4.5 Altitude (masl)

The altitude (metres above sea level) was recorded using a hand-held GPS (Garmin GPS72) at all sites. In order to test accuracy of the altitude recorded by the GPS, a sample of 23 recording forms was selected (every tenth from one i.e. 1, 11, 21 etc.). In these cases the altitude was checked against the Discovery series Ordnance Survey of Ireland maps (No's. 74, 75, 76, 81 and 82). No significant discrepancies were noted.

2.4.6 Road number

The road number on which each bridge was built was taken from the Discovery series Ordnance Survey of Ireland maps (No's. 74, 75, 76, 81 and 82), or from information supplied by Waterford County Council on their list of bridges. Roads for which no number was available were all minor ones, and these were then classified as Third Class Roads.

2.4.7 Grid reference

A ten-figure grid reference was taken from approximately the midpoint of each bridge using a hand-held GPS (Garmin GPS 72).

2.4.8 River width (m)

This was judged by eye at the bridge, and the measurement can only be taken as approximate. The river width can be taken as the width of flowing water during summer levels, and thus will naturally vary with rainfall and flow.

2.4.9 Average River depth (m)

This was judged by eye at the bridge, and the measurement can only be taken as approximate. It should be noted that the water depth at the bridge may not be representative of the depth in the river as a whole. Many bridges had a stone or concrete base beneath the bridge arches, which led to shallower water there than elsewhere in the river. Others (without a stone or concrete base) sometimes had deep holes, often caused by tree trunks lodged in the bridge arch causing a diversion of the water. The depth of the river will also vary due to variations in rainfall and flow.

2.4.10 River flow speed

An estimate of water velocity was made at each bridge. This was categorised as very fast, fast, slow and very slow.

2.4.11 Bridge material

The main construction material used for each bridge was recorded. Any significant repairs, alterations or extensions to the bridge were also recorded.

2.4.12 Number of arches

The number of bridge arches was recorded, including those which were dry during the survey.

2.4.13 Height of arches

The height of the bridge arches was approximated by eye, using the height of the observer as a guide.

2.4.14 Habitat

The landscape in proximity to the bridges often supported a range of habitats the boundaries of which were largely indistinct. To simplify classification of habitats the following classifications were used:

- 1st Habitat – the dominant habitat type in proximity to the bridge
- 2nd Habitat – present in proximity to the bridge but less dominant
- Other -- Any other important feature in the surrounding landscape

2.4.15 Coding of bridges as suitable/unsuitable as bat roost sites

The protocol used for coding bridges is included in **Table 1**. Data were recorded on separate rows on the recording form for each individual bridge arch. Each bridge arch was numbered sequentially from left to right with the observer facing downstream. Therefore, arch number one is always the one nearest the left-hand riverbank.

2.4.16 Bat species recorded

The bat species, or bat evidence, seen at each bridge was recorded for each individual arch.

2.4.17 Notes/diagrams

Notes and diagrams to expand on any of the above information were made where relevant.

2.4.18 Other species

Terrestrial and aquatic mammal and bird evidence seen at each bridge was also recorded. In general, this meant evidence of mammal species such as Otter and Mink, and bird species such as Grey Heron, Mallard, Grey Wagtail and Dipper. It should be noted that no specific survey for birds and other mammals was carried out however where these species were observed they were recorded. Therefore these species may have been under-recorded.

2.5 Bat emergence surveys

A bat detector survey was carried out at one bridge known to contain a single Daubenton's bat. This was carried out simultaneously by both surveyors (see section 2.2). The objective of the survey was to determine if emergence surveys would provide additional data which would be useful for this study. The survey determined that the bat did not emerge during the survey although conditions were suitable for bat emergence, and Pipistrelle species were recorded feeding along the river in small numbers at the time. It should be noted that the crevice containing the bat was examined prior to the commencement of the survey to determine if the bat was present. This possible disturbance of the bat may have prevented its emergence. Despite the presence of two surveyors, it was considered that determining the emergence of bats from bridge roosts is difficult and complicated by usage of the channel by feeding bats that had emerged elsewhere. Overall the use of bat detectors and emergence surveys was considered less efficient and effective at determining usage of bridges by bats for the purposes of this study and was not continued for the remainder of the bridges.

3. RESULTS

3.1 Survey results

A total of 238 bridges were surveyed between the 19th of May and the 5th of June 2008. An additional three bridges were surveyed between the 26th and the 29th August 2008. One hundred bridges considered suitable for bats (i.e. Code 2 and Code 3 bridges) were revisited between the 26th and the 29th August 2008. A summary of these results are included in **Table 2** and a full list of bridge locations and their relevant category is included in **Appendix 1**. A number of bridges were unsuitable for survey due to high water levels,

arches which were too low to access or vegetation completely covering the bridge.

Table 2. Summary of survey results

Description	Number
Total bridges surveyed	241
Code 0 bridges (unsuitable)	90
Code 1 bridges (some crevices)	32
Code 2 bridges (ideal roosts)	83
Code 3 bridges (evidence of bat usage)	18
Bridges unable to survey	18

3.2 Species

Relatively few bats were recorded during the bridge surveys. Of the 241 bridges surveyed, only nine contained bats. Of these eight contained Daubenton's bat and one contained a Pipistrelle species. Two bridges held pairs of bats, while the remainder held just a single bat.

3.3 Bridge construction

Of the bridges surveyed, 179 (74.3%) were masonry arch construction, 28 (11.6%) were concrete construction, 22 (9.1%) half concrete/half masonry and half concrete/half steel 2 (<1%).

3.4 Bridge height

Bridges ranged in height from 0.1 to 20 metres (**Table 3**). The majority of bridges surveyed (47%) were between 1 and 2.99 metres in height.

Table 3. Numbers of bridges recorded in each height range and corresponding bridge code

Arch Height	No. of bridges	Code 0	Code 1	Code 2	Code 3
<1m	11	9	0	1	1
1-1.99 m	51	22	5	20	5

Arch Height	No. of bridges	Code 0	Code 1	Code 2	Code 3
2-2.99m	55	17	9	23	7
3-3.99m	29	7	6	13	1
4-4.99m	40	11	4	14	3
>5	26	25	8	13	0

3.5 Bridge altitude

The range of altitudes in which bridges were surveyed is listed in **Table 4**. The majority of bridges surveyed were below 60 m in altitude (60%). No code 3 bridges were detected above 120 m.

Table 4. Altitudinal ranges (m) of bridges categorised by bridge code

Altitude (m)	No. of bridges	Code 0	Code 1	Code 2	Code 3
1-30	92	41	10	32	9
31-60	42	17	8	14	3
61-90	27	9	4	12	2
91-120	32	14	4	11	3
121-150	11	2	2	7	0
151-180	6	4	1	1	0
181-210	6	2	2	2	0
211-240	3	0	0	3	0
241-270	1	0	1	0	0
271-300	2	1	0	1	0
301-330	1	0	0	1	0

3.6 Surrounding habitats

Table 5 describes the habitats surrounding code 2 and code 3 bridges. The dominant habitat at each site was recorded as the 1st habitat. Where a habitat was considered less dominant it was categorised as present (i.e. 2nd and other habitats as per section 2.4.14). Improved agricultural grassland was the most common habitat recorded followed by broadleaved woodland and hedgerows.

Table 5. Habitats surrounding bridges in Code 2 and Code 3 bridges

Habitat Type	Code 2		Code 3		Total	
	Present	Dominant	Present	Dominant	Present	Dominant
Broadleaved woodland/treelines	25	13	7	3	32	16
Coniferous woodland	11	4	3	1	14	5
Improved grassland/amenity	66	52	13	10	79	62

Habitat Type	Code 2		Code 3		Total	
	Present	Dominant	Present	Dominant	Present	Dominant
grassland						
Estuary/saltmarsh/shingle shore	2	1	1	0	3	1
Moorland	5	2	0	0	5	2
Scrub	10	5	0	0	10	5
Buildings and artificial structures	5	1	0	1	5	2
Semi-improved grassland	3	1	0	2	3	3
Freshwater marsh	2	1	0	0	2	1
Mixed woodland	5	3	0	0	5	3
Arable	4	0	0	0	4	0

3.7 Other species

3.7.1 Otter (*Lutra lutra*)

Otters were recorded at 49 of 224 bridges (21.9%). The distribution of these bridges is given in **Appendix 3**. Otters were recorded from either the presence of spraints or footprints in the vicinity of a bridge. Otters mark their territories by depositing spraints in prominent places, including bridge ledges, on rocks and on banks of sediment under bridges. Ireland's population of otters are considered to be internationally important with the highest population density of otters in Western Europe (Whilde, 1993). Otters are widely distributed throughout the country in both freshwater and coastal habitats.

3.7.2 Mink (*Mustela vison*)

Mink were recorded at 10 of 223 bridges (4.5%). Mink were recorded from either the presence of scats or footprints in the vicinity of a bridge or in two cases by direct sightings. Mink place scats in prominent places around bridges to mark territories. Scats are 5-8cm long, usually 1cm or less in diameter and tapered at both ends. Fresh scats have an unpleasant, foetid odour. Mink were first introduced to Ireland in the 1950's and have since spread to most parts of Ireland as a result of escapes during the sixties. As an invasive, predatory species, mink are considered detrimental to the ecology of Irish rivers.

3.7.3 Other mammal species

Foxes (*Vulpes vulpes*) were recorded at one site and Hedgehogs (*Erinaceus europaeus*) were recorded at three sites during the survey.

3.7.4 Birds

3.7.4.1 Dipper (*Cinclus cinclus*)

Dippers' nests were recorded at 44 bridges (**Appendix 3**). Dippers nests consist of a large, mossy dome lodged in a crevice or ledge. Dippers are a resident species and are usually associated with fast-flowing rivers and streams where they feed on freshwater invertebrates.

3.7.4.2 Pied and grey wagtail (*Motacilla alba* and *Motacilla cinerea*)

Grey wagtails were recorded at 55 bridges and pied wagtails at 25. Both species build cup-shaped nests and these are usually placed on ledges or in holes in the bridge walls. Both are widespread resident species. The pied wagtail is found in habitats both with and without water whereas the grey is closely associated with water, especially fast-flowing streams and rivers.

3.7.4.3 Wren (*Troglodytes troglodytes*)

Wrens nests were recorded at 9 bridges. The wren's nest is a small mossy dome which is lodged in a crevice or wedged among thick stems of ivy under a bridge arch. The wren is widespread and numerous in Ireland.

3.7.4.4 A number of warbler species were recorded namely Blackcap (*Sylvia atricapilla*), chiffchaff (*Phylloscopus collybita*), sedge warbler (*Acrocephalus schoenobaenus*), whitethroat (*Sylvia communis*) and willow warbler (*Phylloscopus trochilus*). Blackcaps were recorded at 44, chiffchaff at 42, sedge warbler at 9, whitethroat at 8 and willow warbler at 31 sites during the study period.

3.7.4.6 Other bird species

Other bird species recorded in small numbers included blackbird (*Turdus merula*), blue tit (*Parus caeruleus*), bullfinch (*Pyrrhula pyrrhula*), goldcrest (*Regulus regulus*), goldfinch (*Carduelis carduelis*), great tit (*Parus major*),

house martin (*Delichon urbica*), house sparrow (*Passer domesticus*), long tailed tit (*Aegithalos caudatus*), (reed bunting (*Emberiza schoeniclus*), spotted flycatcher (*Muscicapa striata*), swallow (*Hirundo rustica*), stonechat (*Saxicola torquatus*) and treecreeper (*Certhia familiaris*). Swallow, blue tit and great tit are known to nest under bridges.

4. Literature review

4.1 Ireland

The first comprehensive study of bats at a national level was conducted as part of the National Bat Survey between 1985 and 1988 (O’Sullivan, 1994). Bridges throughout the country were surveyed by staff of the National Parks and Wildlife Service. During the survey 213 Daubenton’s roosts were located, the majority of which held 1-10 individuals, although several held up to 100 bats. The study did note that the small numbers within most roosts was due to the small size of crevices under bridges, the most frequented roost sites, which could not accommodate large numbers of bats. A number of Daubenton’s and Natterer’s roosts were recorded for County Waterford. However, in the case of Natterer’s it is not known if any of these roosts were recorded within bridges.

A smaller survey of bridges within Counties Cork and Waterford was carried out by Smiddy in 1991. In total 366 bridges were surveyed, mostly between August and September 1989. The results found that 14% of bridges contained roosting bats and a further 11% had evidence of recent occupation. Grading these bridges under the classification system used in the current study, 25% of bridges surveyed were Code 3. A further 26% of bridges were considered suitable but no bats were found (Code 2). The remainder of bridges (49%) were unsuitable (Code 0 or 1). Smiddy noted that many bridges in his survey

area appeared to be used erratically or for short periods only and that different species were recorded at different times.

A small scale survey of bridges was undertaken in County Clare in July and August 1995 (McGuire, 1998). This was part of a larger bat survey conducted in the north of the county. Twenty five bridges were surveyed for roosting bats and bat activity was monitored in the vicinity of the bridges after dusk. Bats were found in 12% of bridges and only a single bat was recorded in each case. The species were not identified. Overall, 94% of bridges surveyed were considered to be suitable as bat roosts.

In 1999 the Heritage Council (Shiel, 1999) examined bridges within Counties Leitrim and Sligo. The survey was conducted between late April and mid-November 1998 in north Leitrim and selected regions of Sligo. A total of 174 bridges were surveyed, of which 66 (37.9%) had bats present. A total of 252 bats was recorded - 180 Daubenton's (71.4%), 66 Natterer's (26.2%), 3 Whiskered (1.2%), 1 Long-eared (0.4%), 1 Pipistrelle (0.4%) and 1 unidentified. The study found a significant positive correlation between the presence of Daubenton's bats in a bridge and the presence of slow-flowing water/pools in the vicinity ($p < 0.05$). Similarly there was a significant association between the presence of Natterer's bats and the presence of scrub ($p < 0.01$).

In 2007, Cork County Bat Group undertook a survey of bridges for bat usage within the Rivers Sullane and Laney catchments, tributaries of the River Lee County Cork (Masterson *et al.*, 2008). Of the 113 bridges surveyed, 71 (63%) were classified as being Code 0, 12 (11%) were classified as Code 3. Overall, three bats species were recorded (i.e. Natterer's, Daubenton's and Pipistrelle bats). The study concluded that when suitable crevices are available, bats will use bridges and that efforts should be made to retain crevices or to enhance the suitability of bridges for bats during maintenance works.

Laois and Offaly County Councils undertook an assessment of 102 bridges within these counties (Keeley, 2007). The most commonly occurring species

were Daubenton's bat followed by Natterer's bat. Brown long-eared bat was also recorded. Overall 44 of the 102 bridges surveyed within the two counties (43%) were of no value as day roost sites for bats. Approximately one third (34%) of the bridges had high potential for bats, while a further 21% had possible roost potential.

4.2 Other notable studies

By far the largest survey conducted in the British Isles was carried out in Cumbria, England in 1996 (Billington & Norman, 1997). In total 2,555 bridges were surveyed of which 12.5% were confirmed as bat roosts. A further 41% had suitable crevices but no confirmed roost. As in the Irish studies (section 4.1), the same five species of bats were recorded, with Daubenton's bat being the most frequent and found in 92 bridges (3.6%). Natterer's bats were recorded in 25 bridges (1%). Pipistrelles, Long-eared and Whiskered were recorded in small numbers. In 197 (7.7%) of the roosts bats were not identified to species.

4.3 Comparisons with current survey

Table 6 shows a comparison between the results of the current study and those of previous studies which have used a similar methodology to categorise bridges. The results of the current study are comparable to those of Smiddy (East Cork and West Waterford) and Sheil (Sligo and Leitrim). The relatively low level of suitable sites within the Masterson (Sullane and Laney) may be partially explained by the upland nature of the two catchments surveyed.

A comparison between the Smiddy (1991) survey, carried out in 1989, and the current survey during 2008 is given in **Appendix x**. Smiddy (1991) spanned west County Waterford and east and mid County Cork. In fact most of the bridges surveyed were in County Cork. This list in **Appendix 2** includes only those bridges (total 27) surveyed in County Waterford and found positive for bats or bat evidence in 1989, and resurveyed in 2008. Thirteen of the 27 bridges which had evidence of bats in 1989 showed no evidence of bats during the 2008 visits. Three of these bridges (Licky, Finisk and Old Pike)

have been rendered unusable by bats because of repair works in the intervening period.

Table 6. Summary of survey results

Description	Waterford County Survey	Smiddy East Cork and West Waterford	Sligo Leitrim Survey	Sullane and Laney Survey
Total bridges surveyed	224	366	165	113
Code 0 bridges (unsuitable)	40%	49%	24%	63%
Code 1 bridges (some crevices)	14%		22%	12%
Code 2 bridges (ideal roost crevices)	37%	26%	36%	14%
Code 3 bridges (evidence of bat usage)	7%	25%	18%	11%

The proportion of suitable bridges which contained evidence of bats is illustrated in **Figure 2**. The current 2008 study had the lowest proportion of bat evidence of the four studies. The reasons for this are unclear. Summer 2008 was one of the wettest summers in recent history, and apart from the loss of a few roosts, as well as some potentially suitable bridges due to grouting works, the reasons for the low numbers of Code 3 bridges cannot be explained. It should be noted that the percentage of Code 2 and 3 bridges in the current survey was some 42% as opposed to 51% in (Smiddy, 1991). This may indicate that perhaps the Cork bridges were more suitable for bats than those in Waterford.

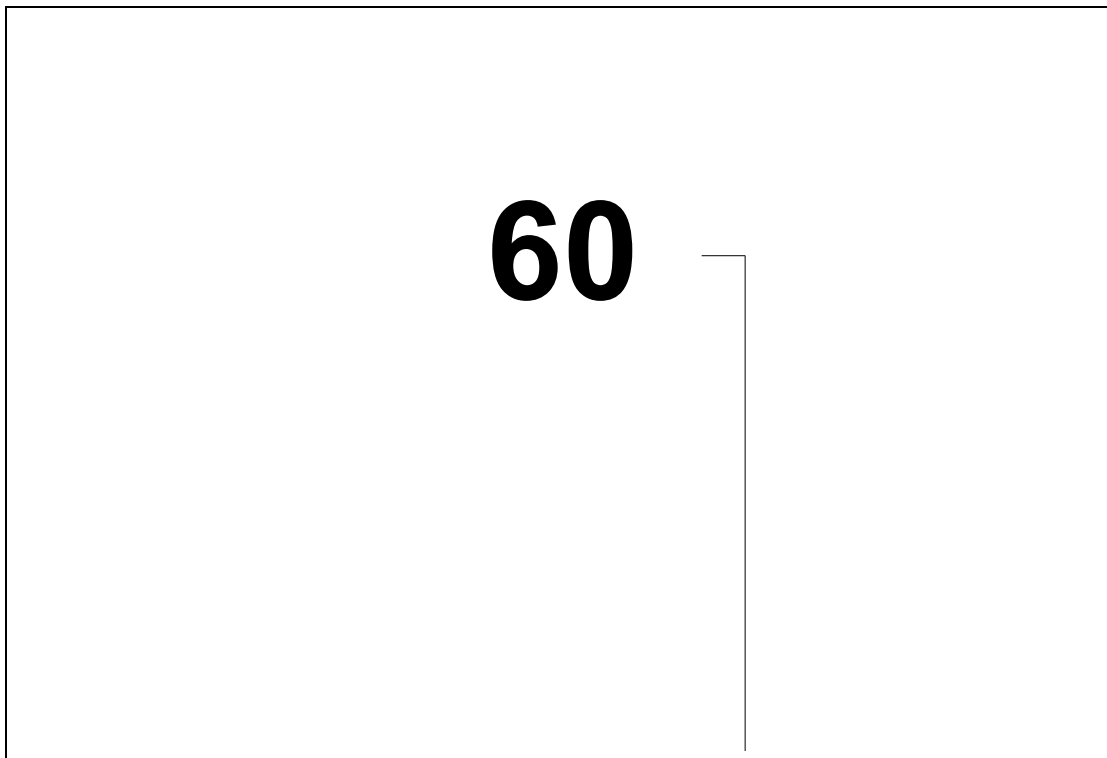


Figure 2. Percentage of suitable bridges with evidence of bats

One of the main methods of repair in recent years has been pressure grouting of the underside of bridges. This involves spraying of liquid concrete, under pressure, into all crevices, and eventually the smoothing of the entire bridge surface underneath each arch. During this survey it was noted that a number of bridges have been treated in this way, probably within the last 10 to 12 years. This process was carried out at 22 bridges which were numbered as follows: 7, 10, 12, 20, 25, 32, 44, 53, 59, 78, 123, 137, 156, 158, 163, 164, 172, 178, 181, 185, 225 and 231.

It is not known exactly how many of these bridges held bats before repair work was carried out. However, it is known that at least one was an important local roost site for Daubenton's Bat (No. 53, Licky Bridge), and that several others also held small numbers of bats. The Daubenton's Bat roost at Licky Bridge was used as part of a study on the diet of that species by Flavin et al. (2001). At Tallow Bridge (No. 32) an effort was made to build bat roosting niches into the bridge during repair work. However, this work does not appear to have been successful and in 2008 there was no sign of usage by bats. It is considered improbable that this bridge will be used in the future unless

remedial work is carried out. It is noted that successfully maintaining and replacing bat roosts requires considerable specialist expertise and experience.

The problems noted above are probably indicative of the lack of protection afforded to bridges in the past and the lack of information available to local authority engineers. It may also illustrate a lack of communication between the local authority and National Parks and Wildlife Service. It is hoped that this report will help to address this imbalance by providing a methodology to be employed for each of the significant bridges within the county. It is noted however that active consultation with the National Parks and Wildlife Service is required prior to the commencement of improvement works on bridges with the potential to support bat roosts.

5. Bridge maintenance methods and mitigation

5.1 Bridge strengthening procedures

Local authorities are required to maintain road bridges in a safe condition. As elsewhere in Ireland, most of the bridges in Waterford are at least 100 years old, and are built of stone. As such bridges age, mortar falls out from between the stones on the underside. It is in the crevices created by this process that bats may roost. Many old stone bridges have also been extended (lengthened) in order to accommodate increased traffic. The joint between the old (stone) section and the new (concrete) section may also provide a suitable niche for roosting bats. However, as bridges age and as the number of crevices beneath increase (often as a result of traffic vibration), local authority engineers carry out repair work to stabilise and prolong the life of the bridge. Masonry bridges require maintenance work and strengthening procedures more frequently in current times due to the increased weight and volume of modern traffic. It is generally the bridges which have structural problems

which have the most potential for bats. Bat roosting sites in bridges are threatened by the following procedures - hand grouting, pressure grouting, shotcreting, saddling and demolition.

5.1.1 Hand grouting

Mortar may be replaced and crevices filled by hand grouting or pointing with cement mortar. Hand grouting can be compatible with the retention of roost sites when the position of these roost sites have been clearly marked and pointed out to the contractor in charge. Hand grouting is used when bridges require the minimum of maintenance procedures.

5.1.2 Pressure grouting

A bridge may become structurally unsound when large voids occur between the rubble filling of a bridge and the road surface. The entire structure may be subjected to a process known as pressure grouting. This is a process where liquid grout is pumped through small bore holes into the internal cavity of a bridge, so that any voids within range of the injection point will be filled. This grout is capable of penetrating crevices in excess of 1 mm width and travel for distances of 6 m or more when injected under pressure. Experience has shown that the main problem with controlling grout flow around cavities that require preservation for bats is knowing when to stop pumping. This can only be achieved through careful observation.

5.1.3 Shotcreting/Guniting

Shotcreting or guniting is a process where liquid cement, sand and chippings are sprayed under pressure usually onto the undersurface of the arches. This effectively seals the underside which prevents water seepage from above. It also effectively eliminates any crevices used by roosting bats. The combination of pressure grouting and shotcreting eliminates any voids in the internal structure of the bridge and also fills up any interstices in the stonework. This process has already led to the loss of many roost sites in bridges in Ireland.

5.1.4 Saddling

Another procedure used during bridge strengthening is termed saddling. This involves the removal of the road surface and excavation of the rubble fill of the bridge down to the arch stones. The voids are then filled with reinforced concrete and the road replaced. This process may also exclude bats from voids within the bridge structure.

More details on the creation and maintenance of roosts within bridges are given in the JNCC publication *Bat Worker's Manual* (JNCC, 2004). Case studies on bridge maintenance are discussed in **Appendix 5**.

5.2 Artificial bat roosts

Attempts have been made to retain crevices being used by bats within bridges and these methods are discussed in greater detail in **Appendix 4** of this report. It is noted however that maintenance of existing roost should be primary objective where it is feasible. New structures such as bat boxes may not re-create the same thermal capacity, conductivity and microclimatic conditions that occur deep with the cavities of an old masonry bridges. Bat boxes may provide bat roosting habitat but should be considered as a last resort where maintenance of a bat roost or suitable conditions for a bat roost are not possible.

Where for health and safety reasons it is inevitable that bat roosts in bridges will be lost due to demolition, re-building or engineering constraints, new bat roosting sites should be created within the existing structures duplicating as much as possible the original crevice dimensions. Crevice-width selection by bat species encountered in the Cumbria survey (Billington & Norman, 1997), suggests that any artificial roosting sites should contain a variety of crevice widths (13–70 mm) and depths (350–>1000 mm) for summer roosts, and deeper for winter hibernation sites. Bats generally avoid wider crevices, but they can occasionally roost in open situations on the walls of enclosed voids, for example. Where opportunities arise to incorporate bat roosting crevices into sites during repairs, rebuilds or construction of new sites these should be taken up. If possible, roosting sites should be incorporated into bridge spans because this is where 75% of bat roosts were found in bridges in Cumbria. Otherwise they should be sited as high as possible in the abutment walls.

There are a number of different artificial bat roosts available. These are discussed in greater detail in **Appendix 4**.

5.3 Timing of bridge works

Bats may roost in bridges at any time of the year but usually in small numbers. If a bridge is known to hold a nursery roost of bats it is vital that they are not disturbed in June and July when the young are born and have not started to fly. If major strengthening works are carried out at this time young bats cannot escape and will be killed during the pressure grouting process. It is also essential that bats are not disturbed if they are hibernating. The process of arousal from hibernation uses up critical fat reserves needed to sustain the animal through the winter months. Individual or small numbers of non-breeding bats may be excluded temporarily to allow maintenance work to continue. Most bridge maintenance takes place in summer when water levels are low. It is difficult to draw up general guidelines as to when works should take place as again, each bridge needs to be assessed individually. It is also desirable that nesting birds such as dippers are not disturbed. The main nesting period is April to June.

6. Conclusions/Recommendations

The focus of this study was to classify as many bridges as possible within the county. This provides a practical means to determine the appropriate mitigation measures to be taken if works on the bridges are required in the future. It is important that local authority engineers and other personnel with involved in maintenance and repair of bridges are aware of the importance their importance for bats.

It should be noted that although a relatively small number of bridges were found to support bats, a much larger number of bridges have the potential to support bats. As usage of a bridge may be sporadic and related to seasonal factors any bridge with significant bat potential needs to be assessed prior to commencement of works. The level of assessment required will vary depending on the rating assigned to the bridge. County Council Engineers and must be informed of the importance of bridges for bats and must consider them in planning and maintenance works or in new bridge design. It is recommended that this report be made available to all relevant personnel and the National Parks and Wildlife Service. It is noted that the information in this report will become dated and may require updating in the future.

Table 7. Survey required for each bridge category

Bridge category	Survey required
Code 2 and Code 3	A comprehensive survey of the bridge should be carried out by a suitably qualified expert. In many instances this will require an endoscope survey and may require the use of scaffolding or other climbing equipment. This survey should be carried out irrespective of the season in which it is proposed to carry out the works. It is recommended that this work is carried out in consultation with the NPWS.
Code 1	A cursory examination should be carried out where works are to be carried out during the summer period. Generally an endoscope survey and specialist climbing equipment will not be required.
Code 0	No further works are required

The survey required at each bridge category is outlined in **Table 7**. In all instances works on bridges in categories 2 and 3 should be planned with input from a suitably qualified bat expert. The expert should have input into the surveys required, type of works to be carried out, seasonality of works and appropriate mitigation measures. The expert will liaise with the NPWS. Best practice in maintenance of bridges for bats should be adhered to as outlined in Shiel (1999) report.

Repair work must be done in a bat friendly way, and at a time of year when bats are not using the bridge; niches should be built into any repair work where it is feasible to do so. Even in bridges being newly built, consideration should be given to the idea of providing artificial roosting niches. The retrofitting of artificial roosting niches is recommended for bridges that have already been pressure grouted and which supported bat roosts in the past. All bat roost data shall be forwarded to *Bat Conservation Ireland* for inclusion in their database and information on birds should be supplied to Birdwatch Ireland

Reference

- Billington, G.E. and G.M. Norman (1997).** *A Report on the Survey and Conservation of Bat Roosts in Bridges in Cumbria*. Kendal, English Nature.
- Flavin, D.A., Biggane, S.S., Shiel, C.B., Smiddy, P. & Fairley, J.S. (2001).** Analysis of the diet of Daubenton's Bat *Myotis daubentonii* in Ireland. *Acta Theriologica* **46**: 43-52.
- JNCC (2004).** Bat workers manual 26 (3791). Eds: Mitchell-Jones, A.J. and McLeish, A.P.
- Keeley, B (2007).** *Bats and Bridges: an Evaluation of Selected bridges in Laois and Offaly*. Laois County Council and Offaly County Council.

- Masterson, M., Buckley, D., O'Brien, M. and Kelleher, C. (2008).** *An Investigation into Bridge Usage by Bats within the Sullane & Laney River Catchments, Co. Cork.* Heritage Council publication.
- McAney, K. (1992).** *Bats and Bridges. A report on the importance of bridges to bats.* National Parks and Wildlife Service.
- McGuire, C. (1998)** Survey of Lesser Horseshoe bats *Rhinolophus hipposideros* (Bechstein) and other bat species in north Co. Clare, Ireland. *The Irish Naturalist's Journal* **26**: 43-50.
- Mitchell-Jones, A.J. (1994).** *The Bats of Britain and Ireland.* The Vincent Wildlife Trust, London.
- NRA (2005).** *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes.* National Road Authority.
- O'Sullivan, P. (1994)** Bats in Ireland. *The Irish Naturalists' Journal - Special Zoological supplement.*
- Russ, J.M.R. (1995).** Bats, Bridges and Acoustic Signalling. B.Sc. thesis. University of Aberdeen.
- Shiel, C. (1999).** *Bridge Usage by Bats in County Leitrim and County Sligo.* The Heritage Council, Rothe House, Kilkenny City.
- Smiddy, P. (1991)** Bats and Bridges. *Irish Naturalist's Journal*, **23**:425-426.
- Smiddy, P. & O'Halloran, J. (2004).** The ecology of river bridges: their use by birds and mammals. Pp 83-97. In Davenport, J. & Davenport, J.L. *The Effects of Human Transport on Ecosystems.* Royal Irish Academy, Dublin.
- Whilde, A. (1993)** *Threatened mammals, birds, amphibians and fish in Ireland.* Irish Red Data Book 2: Vertebrates. HMSO, Belfast.

Appendix 1. Bridge list for County Waterford

List of bridges and basic results

This list shows all the bridges surveyed during the first visit. Bridges that had bats present, or where bat evidence was found, and including bridges that were considered suitable for bats (i.e. Code 3 and 2 bridges) are shown in a red background (100 bridges). Bridges that were considered unsuitable as bat habitats (i.e. Code 1 and 0 bridges) are shown in a yellow background (126 bridges). Bridges that could not be surveyed for one reason or another are shown in a green background (12 bridges). Most of the bridges in the latter category were too low for survey, but this fact should not necessarily rule them out as potential bat habitats. However, low bridges are more likely to be affected by flooding.

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
1	Ballyduff	Blackwater	W96490 99130	L1007	0
2	Gleuncael	Gleuncael Gleunaniarn Glenmare Blackwater	R99586 03886	L1002	2
3	Kingston	Araglin Blackwater	R84619 05977	L5005	2
4	Glenmere	Glenmere Blackwater	W99587 99245	R866	2
5	Ballyvena	Stream Blackwater Tributary	X02244 99399	R866	
6	Glenatore	Stream Blackwater	X03232 99446	R866	2
7	Lismere	Blackwater Owennashad	X04799 98815	N72	
8	Glenribbeen	Stream Blackwater	X07912 99347	N72	0
9	Avenmore Cappoquin	Blackwater	X09959 99553	L1018	0
10	Little	Glenishelane Blackwater	X09351 99172	N72	0
11	Glenishelane	Glenishelane Blackwater	X11915 99305	L1028	3
12	Lyre	Glenfallia Glenishelane Blackwater	D10831 01144		0
13	Keenos	Glenishelane Blackwater	D12870 06775		2
14	Beola upper	Menavugga Glenafallan Glenishelane Blackwater	D10034 02291		2
15	Beola	Glenfallia Glenishelane Blackwater	D10032 01586	R869	
16	Gleungariff	Reughylen Glenakeefe Owennashad Blackwater	D06669 05187	R869	1
17	Menaleur	Glenakeefe Owennashad Blackwater	D06499 03113		0
18	Knockaungariff	Glenakeefe Owennashad Blackwater	D06409 04869	D0605	1
19	Glenakeefe	Glenakeefe Owennashad Blackwater	D06214 05726	R869	2
20	Glenatanagree	Glenandaree Owennashad Blackwater	D04008 07770	R868	0
21	Gleuntaunemen	Owennashad Blackwater	D03356 09227	R868	2
22	Moneygerm	Stream Owennashad Blackwater	D04786 04216	R868	2
23	Glongarra	Owennashad Blackwater	D04638 02489	R868	2

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
24	Holy well	Glenakeefe Owennashad Blackwater	D05152 01704		3
25	Drumber	Owennashad Blackwater	D04737 01642	R668	0
26	Killoenagh	Owennashad Blackwater	X06286 89537	L2002	2
27	Campfire	Bride Blackwater	X08030 92250	L1016	0
28	Glenawillin	Stream Bridge Blackwater	X03594 93030	L2001	2
29	Kilwinny	Stream Bride Blackwater	X02420 93215	L2001	2
30	Ballinaha	Stream Bride Blackwater	X01874 92678	L2002	2
31	West street, Tallow	Glenabey Bridge Blackwater	W ⁰ 99330 93465	R628	0
32	Tallow Bridge	Bride Blackwater	W ⁰ 99906 94341	R634	0
33	Ballinacher	Owbeg Blackwater	X03452 96408	L5040	1
34	Owbeg	Owbeg Blackwater	X05505 96046	L5044	0
35	Killahaly	Owbeg Blackwater	X08586 95164	L1018	1
36	Youghal	Blackwater	X09780 80906	N25	0
37	Glendine	Glendine Blackwater	X07184 82587	L2004	3
38	Newport	Stream Blackwater	X08381 84446	L2005	1
39	Rincrow	Teurig Blackwater	X09320 80366	N25	0
40	Teurig New	Teurig Blackwater	X08995 80304	N25	0
41	Bridge quarter	Teurig Blackwater	X06412 80214		3
42	Crossford	Stream	X17055 78919	R673	1
43	Listeige	Stream	X16757 78509	0.10	1
44	Fughnaglara	Stream	X19690 79776	R673	0
45	Ballintlea	Ballymaceda	X24693 83840	L2026	2
46	Ballycurreen	Stream	X27405 84422	L2033	0
47	Hacketstown	Stream	X27083 82774	L2033	1
48	Ballymacart	Ballymacart	X25302 82237	L2033	1
49	Liskeely south	Stream	X20510 82279		2
50	Liskeely N ^W	Stream	X20329 82549	R673	
51	Liskeely N ^E	Stream	X20572 82706		3
52	Ballyhoeny	Licky Blackwater	X12415 82826	L2009	2
53	Licky	Licky Blackwater	X13164 82753	R671	0
54	Clashmore Fishfarm	Licky Blackwater	X13563 83019		0
55	Grallagh	Licky Blackwater	X16741 83908	L6086	2
56	Teer	Licky Blackwater	X18577 84615		0
57	Glenlicky	Licky Blackwater	X19809 84661		0
58	Kiely's Cross	Licky Blackwater	X20301 85530		1
59	Pulla	Licky Blackwater	X23318 87480	N25	0
60	Faha	Licky Blackwater	X24695 87239	X2487	0
61	Clashmore	Greaghagh Licky Blackwater	X12486 84007	R671	
62	Ballynamultina	Greaghagh Licky Blackwater	X12993 84795	R671	2
63	Kneekanearis	Greaghagh Licky Blackwater	X13402 85904	R671	2
64	Teer	Stream Geish Blackwater	X17095 88598	L20221	1
65	Broken	Geish Blackwater	X15184 89257	L2021	0
66	Geish	Geish Blackwater	X13742 88655	R671	1
67	Teelree	Geish Blackwater	X12104 90300	L2011	3
68	Collins	Ballynaparka Geish Blackwater	X12981 91540	R671	1
69	Ballynaparka	Ballynaparka Geish Blackwater	X12112 91502	L6057	2
70	Ballynicole	Stream Ballynaparka Geish Blackwater	X12128 92426	L6057	
71	Achnaclareen	Ballynaparka Geish Blackwater	X10840 92111	L2012	2
72	Ogham stenos	Geish Blackwater	X10556 91404		2
73	Dremana	Finisk Blackwater	X10732 96826	L2012	0

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
74	Bowley	Finisk Blackwater	X 12338 95287	L6062	2
75	Kilmelash	Finisk Blackwater	X 13051 94828	L2017	3
76	Kooreen	Stream Finisk Blackwater	X 13966 93064	R571	2
77	Whitechurch	Finisk Blackwater	X 15471 95619	R571	3
78	Finisk	Finisk Blackwater	X 16222 96603	N72	0
79	Kilclegher	Magaha Finisk Blackwater	X 15375 97019	N72	0
80	Beherawillin	Magaha Finisk Blackwater	X 15840 98175	L1028	1
81	Modellige	Finisk Blackwater	X 17571 99296	L1032	3
82	Derry	Farnane Finisk Blackwater	D 17044 01414	R571	0
83	Mountain Castle	Finisk Blackwater	D 17277 01209	L1034	2
84	Kneekounnagheko	Kilbough Finisk Blackwater	D 19558 01495	L1034	
85	Millinacorka	Finisk Blackwater	D 18685 03980	L5071	1
86	Fughaluck	Lisbough Finisk Blackwater	D 17781 04516	L1030	2
87	Ballnamult	Finisk Blackwater	D 18127 06752	L1035	0
88	Ballynamult	Finisk Blackwater	D 18252 06668	R571	1
89	Priestown	Fugavanemaun Finisk Blackwater	D 17413 07181	L5075	2
90	Ballnamult	Stream Finisk Blackwater	D 18310 06681		2
91	Taherbrack	Stream Finisk Blackwater	D 18691 07751	L5074	2
92	Taherbrack	Stream Finisk Blackwater		R571	
93	Kneekraha	Stream Finisk Blackwater	D 19220 08684	R571	
94	Holvick road	Druhnalough	X 25569 08769	R574	2
95	Killongford	Brickey	X 24335 90247	N25	0
96	Twemile	Brickey	X 22534 91165	L2022	
97	Technageur	Brickey	X 22070 91287		2
98	Hallys	Stream Brickey	X 20964 90513	L2022	1
99	Ballyguiry	Stream Brickey	X 19733 91818	L6078	3
100	Lauragh	Brickey	X 18951 92888		1
101	Kneeknaen	Brickey	X 18778 93213	L2020	1
102	Tanty	Brickey	X 17817 93704	L6068	2
103	Lauragh	Bearingwaters Brickey	X 17656 93011	L6068	2
104	Fughanerrick	Bearingwater Brickey	X 17008 92618	L6068	3
105	Devenshire	Telligan	X 26090 93290	R211	0
106	Shandon	Telligan	X 25980 93522	N25	0
107	Ballyneety	Telligan	X 24834 94675	TCR	0
108	Kildangan	Telligan	X 23225 95120	N72	0
109	Telligan	Telligan	X 22024 97970	L5104	2
110	Tellinasmear Upper	Glendernmet Telligan	X 24074 99768		2
111	Technasmear Upper	Glendernmet Telligan	X 245996		0
112	Behadeen	Stream Telligan	D 23574 01346	L1039	2
113	Lackandarra	Telligan	D 23072 02105		0
114	Ballynakill	Fraglin Telligan	D 23224 02440	L1039	2
115	Coem	Fraglin Telligan	D 24855 03644	L1040	2
116	Coem East	Fraglin Telligan	D 25152 03722	L1040	0
117	Scart	Telligan	D 22969 04866	L1041	2
118	Scart (2)	Stream Telligan	D 22955 04864		2
119	Lagg	Stream Telligan	D 21945 06455	L1043	0
120	Ther	Stream Telligan	D 24653 07654	L5129	
121	Shoheens	Stream Telligan	D 21774 07674	L51291	2
122	Kneeknower	Kneeknower Telligan	D 21277 01560	R572	
123	Old Pike	Glendine	X 27916 95720	N25	0

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
124	Menarud	Glendine	X 27529 97164		0
125	Ballyveyle	Dalligan	X 33577 95043	L7016	2
126	Ballyveyle new	Dalligan		R675	
127	Ballyveyle Viaduct	Dalligan	X 337 960		0
128	Killineen	Dalligan	X 31002 97494		3
129	Shanbally	Dalligan	X 30405 97936		2
130	Dalligan	Dalligan	X 30179 98357	N25	2
131	Glendalligan	Dalligan	S 29515 00379		0
132	Dalligan	Dalligan	S 28237 02103		1
133	Aughatriscar	Stream Tay	S 30622 04875	L30192	1
134	Ballykilmurry	Tay	S 30907 06006	L3019	2
135	Aughnacurra	Tay	S 31982 03972	L3021	0
136	Lemybrien (1)	Tay	S 33080 02650	R676	2
137	Lemybrien	Tay	S 33497 02351	N25	0
138	Fox's castle	Tay	S 34063 00420		2
139	Cleghelewish	Deehil Tay	X 33540 99406		2
140	Durrew	Tay	X 33956 98745	L7027	2
141	Carriganaffrin	Tay	X 34716 98155	R675	0
142	Stradbally	Tay	X 36878 97174	L3025	2
143	Deelish	Glendine	X 28217 97109		1
144	Bunmahon (1)	Mahon	X 43456 98880	R675	0
145	Annestown	Annestown	X 49772 98994	R675	0
146	Dunhill Lodge	Annestown	S 50545 00807		0
147	Ballyphilip	Annestown	S 50745 02656	L4007	2
148	Killoen	Stream Annestown		L4007	
149	Kilminin	Glendine	X 28571 94358	R675	2
150	Ballyveeny	Stream	X 38228 97393		2
151	Bunmahon	Dawn	X 44021 99344		1
152	Bunmahon (3)	Dawn	X 43826 98848	R675	0
153	Ballyristeen	Dawn	S 43684 01124		0
154	Aughnagaul	Dawn	S 43484 02908	L3036	1
155	Aughshemus	Mahon	S 41678 02672	L3036	2
156	Kilmacthomas (Old)	Mahon	S 395056	N25	0
157	Kilmacthomas (New)	Mahon	S 3905	N25	0
158	Kilmacthomas (Town)	Mahon	S 39425 06136	R677	0
159	Kilmacthomas (Mills)	Stream Mahon	S 39339 06526		3
160	Currabana West	Mahon	S 36759 06689		2
161	Aughlohan	Stream Mahon	S 35338 06560	L3052	2
162	Ashtown	Stream Mahon	S 34634 08279	L7049	3
163	Mahon	Mahon	S 34251 06017	R676	0
164	Mahon (2)	Mahon	S 34264 05996	L3052	0
165	Whitestown	Dawn	S 43221 05410		0
166	Ballybrack	Dawn Suir	S 44155 07262		0
167	Greenan Hill	Dawn Suir	S 44619 07782		0
168	Carrell's Cross	Dawn Suir	S 45167 08372		2
169	Ballysheneck	Reservoir	S 45263 09662	L4022	0
170	Haughton's Cross	Dawn Suir	S 46344 08556		1
171	Kildermody	Dawn Suir	S 47594 09218		0

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
172	Kildermody (A)	Dawn Suir	T 48236 09637	N25	0
173	Ballyduff East	Dawn Suir	T 50402 09949		2
174	Kilmeadan	Dawn Suir	T 51329 10925		3
175	Pouldrew	Dawn Suir	T 50579 11915	R680	2
176	Kilbunny	Stream Suir	T 48395 13610	L 4029	2
177	Darrigal	Stream Suir	T 48618 13731	R680	0
178	Gledingh	Gledingh Suir	T 47927 15029	R680	0
179	Pertlaw	Gledingh Suir	T 46774 15019	L 4500	2
180	Tebarchuain	Stream Gledingh Suir	T 41262 17847	L 7095	2
181	Lewry	Gledingh Suir	T 42142 14859	R677	0
182	Casvys	Stream Gledingh Suir	T 42991 14359	L 4027	2
183	Glenstown	Gledingh Suir	T 40188 14663	L 7074	1
184	Clashdeg	Stream Gledingh Suir	T 39923 15660	L 7074	0
185	Glenea	Gledingh Suir	T 38475 14198	R678	1
186	Spuhayreghaun	Stream Gledingh Suir	T 38181 13144	L 7059	0
187	Sraigavalla	Gledingh Suir	T 32888 16443	L 7070	3
188	Shanakill	Gledingh Suir	T 34395 15932		0
189	Bess	Gledingh Suir	T 34981 15008	L 3057	2
190	Lackan	Gledingh Suir	T 35256 13694	R676	2
191	Ceeinaherna	Sre Gledingh Suir	T 36311 12114	L 3056	2
192	Kilcleoney	Sre Gledingh Suir	T 34931 11574	R676	0
193	Kilmeadan (A)	Whelanbridge Suir	T 50667 07624		2
194	Kilmeadan (B)	Whelanbridge Suir	T 51292 08857		2
195	Kilmeadan *	Whelanbridge Suir	T 51773 09275	N25	2
196	Whelans	Whelansbridge Suir	T 52272 10049	L 4411	0
197	Killoteran	Stream Suir	T 55295 10420	L 4411	2
198	Rice	Suir	T 602 129	N25	
199	Ceuse	John's Suir	T 60508 08984		0
200	Killure	Johns Suir	T 61936 07598	R 708	2
201	Callaghane	Ballycanvan Suir	T 65933 07647	R684	0
202	Strengbews	Woodland Pill Suir	T 66934 10536	L 4082	0
203	Cowaheen	Woodlandpill Suir	T 67829 10464	R683	0
204	Creeke	Stream	T 70126 08801	L 4076	0
205	Careys	Stream	T 70072 08134	L 4076	0
206	Ragheen	Stream	T 69925 07305	L 4076	2
207	Leperstown	Stream	T 66247 02604	R684	2
208	Ballymabin	Stream	T 67185 01685		1
209	Rathmelylan	Stream	X 66144 99410	L 4068	0
210	Aughanadrish	Stream	T 65693 02123	L 8050	1
211	Kilmacleague	Stream	T 64255 01401	L 4068	1
212	Boalanaslatteen	Stream	T 63047 02804	R685	0
213	Barnaboy	Stream	T 62476 03062	R685	0
214	Lisselan	Stream	T 61374 03541	R685	2
215	Perrya	Railway Line	T 59814 04852	L 96756	0
216	Glenread	Stream	T 57522 03325	L 8038	0
217	Caher	Stream	X 54989 99335	L 4054	0
218	Fenner	Kilfarassy		R675	
219	Reisk	Ballymeat	T 53489 04293		0
220	Teerreen East	Nier Suir	T 25824 12140		0
221	Lahartts	Nier Suir	T 25006 13956	L 1049	1

Bridge No	Bridge Name	River Name	Grid reference	Road number	Bridge code
222	Birchells	Nier Suir	T 24 211 14172	L3060	0
223	Knockalisheen	Nier Suir	T 21384 13520	L5083	0
224	Ballymacurry	Nier Suir	T 19898 12871	L5083	2
225	Deerpark	Nier Suir	T 18523 13573	R871	0
226	Treggane	Nier Suir	T 16597 13507	L5079	2
227	Ballymakee	Nier Suir	T 15031 13697		1
228	Kesal	Keshrush Suir	T 15722 15252	L1036	
229	Boeding	Boeding Glenary Suir	T 14785 17983	R871	0
230	Kilmanahan	Glenary Suir	T 15233 18308	R871	3
231	Knocklefty	Suir	T 14438 20561	R665	0
232	Sir Thomas	Prisen Suir	T 23887 22668	R880	2
233	Glen	Glasha Suir	T 30346 22647	R880	2
234	Glenpatrick	Glasha Suir	T 29038 19568	L3061	2
235	Beela	Glasha Suir	T 27566 19961	R878	2
236	Barravakeen	Stream Prisen Suir	T 24342 19615	R878	2
237	Laurel	Prisen Suir	T 23887 19636	R878	0
238	Russelstown	Glenary Suir	T 17282 19313	L5093	2
239	Kilfarrassy (A)	Kilfarrassy	X 52611 98269		2
240	Kilfarrassy (B)	Kilfarrassy	X 52499 98914		0
241	Foddans	Aughataswillin Clodiagh Suir	T 35488 16638	R878	0

Appendix 2. Comparison of 1989 and 2008 surveys

<i>Bridge name</i>	<i>Road</i>	<i>Grid</i>	<i>Evidence in 1989</i>	<i>Evidence in 2008</i>
11. Glenshelane	L1028	X1199	Positive	Positive
29. Kilwinny	L2001	X0293	Positive	Negative
30. Ballinaha	L2002	X0192	Positive	Negative
37. Glendine	L2004	X0782	Positive	Positive
41. (Bridgequarter)	TCR	X0680	Positive	Positive
51. (Liskeelty NE)	TCR	X2082	Positive	Positive
52. Ballyheeny	L2009	X1282	Positive	Negative
52. Licky	R671	X1382	Positive	Negative *
55. Grallagh	L6086	X1683	Positive	Positive
63. Knockanearis	R671	X1385	Positive	Negative
67. Coolroe	L2011	X1290	Positive	Positive
71. Auchnaclareen	L2012	X1092	Positive	Negative
72. (Ogham Stones)	TCR	X1091	Positive	Negative
74. Bewley	L6062	X1295	Positive	Negative
75. Kilmolash	L2017	X1394	Positive	Positive
77. Whitechurch	R671	X1595	Positive	Positive
78. Finisk	N72	X1696	Positive	Negative *
81. Modelligo	L1032	X1799	Positive	Positive
94. (Helvick Road)	R674	X2588	Positive	Negative
99. Ballyguiry	L6078	X1991	Positive	Positive
110. (Coolnasmear Upper 1)	TCR	X2499	Positive	Negative
123. Old Pike	N25	X2795	Positive	Negative *
125. Ballyvoyle	L7016	X3395	Positive	Negative
128. (Killineen East)	TCR	X3197	Positive	Positive
129. (Shanbally)	TCR	X3097	Positive	Negative
139. Cloghlowrish	TCR	X3399	Positive	Negative
140. Durrow	L7027	X3398	Positive	Negative

* = Recently pressure grouted.

Appendix 3. Bird, mammal and other species recorded during survey

Bridge No.	Bridge Name	Bird sp 1	Bird sp 2	Bird sp 3	Bird sp 4	Bird sp 5	Mammals	Other sp
1	Ballyduff	Grey wagtail	Pied wagtail	Starling	House sparrow			
2	Glunacael	Great tit	Redpoll	Sedge warbler	Willow warbler		Otter	
3	Kingston	Chiffchaff	Grey wagtail	Blackcap	Dipper	Mistle thrush		
4	Glennmore	Pied wagtail	Kingfisher					
5	Ballyvena							
6	Glennatere	Chiffchaff						
7	Lismore							
8	Glennribbeen	Pied wagtail	Treecreeper				Otter	
9	Evenmore Cappoquin							
10	Little	Long tailed tit	Dipper	Cellared dove	House martin	Starling	Otter	
11	Glenshelane	Blackcap	Grey wagtail	Spotted flycatcher	Dipper			
12	Lyre	Dipper	Blackcap					
13	Keanes	Dipper						
14	Beela upper	Willow warbler	Bullfinch	Dipper				
15	Beela							
16	Glungarriff	Willow warbler	Meadow pipit	Stenochat				
17	Mcnaicur	Grey wagtail	Willow warbler	Long tailed tit				
18	Knockaungarriff	Willow warbler	Grey wagtail	Chiffchaff				
19	Glennakeefe							
20	Glennatanagree	Goldcrest					Otter	
21	Glentaunemen	Stenochat					Otter	
22	Mcneygerm	Willow warbler						
23	Glengarra							
24	Hely well	Grey wagtail	Dipper					
25	Drumber	Dipper						
26	Killeenagh	Blackcap	Chiffchaff	Long tailed tit				
27	Campfire	Swallow	House martin	Grey wagtail	Sedge warbler			
28	Glennawillin	Raven	Blackcap	Spotted flycatcher	Pied wagtail	Goldcrest		
29	Kilwinny	Blackcap	Goldfinch	Goldcrest			Otter, hedgehog	
30	Ballinaha	Blackcap	Grey wagtail				Otter	
31	West street, Tallow	Blackcap	Grey wagtail	Mallard	Great tit		Otter	
32	Tallow Bridge	Pied wagtail	Goldfinch	Sandmartin				
33	Ballinacher	Mistle thrush	Bullfinch	Feral pigeon			Otter	
34	Owbeg	Willow warbler	Chiffchaff	Raven				
35	Killahaly							
36	Leughal							
37	Glendine	Blackcap	Grey wagtail	Kestrel	Mallard		Otter	Mink
38	Newport							
39	Bincrew	Chiffchaff	Goldcrest					
40	Tourig New	Sedge warbler	Chiffchaff	Greenfinch	Swallow	Feral pigeon		
41	Bridge quarter	Spotted flycatcher	Kestrel	Pied wagtail	Dipper	Heron		
42	Crossford							

Bridge No.	Bridge Name	Bird sp 1	Bird sp 2	Bird sp 3	Bird sp 4	Bird sp 5	Mammals	Other sp
43	Listeige	Wren						
44	Aughnaglara							
45	Ballintlea	Grey wagtail						
46	Ballycurreen	Whitethroat					Otter	
47	Hacketstown	Grey wagtail						
48	Ballymacart	Blackcap						
49	Liskeely scuth	Chiffchaff					Otter	
50	Liskeely NW	Willow warbler	Dipper					
51	Liskeely NE	Willow warbler	Long tailed tit	Goldcrest			Otter	
52	Ballyhoeny	Grey wagtail	House sparrow	Great tit	Goldcrest	Long tailed tit/Germarant		
53	Licky	Chiffchaff	Great tit				Otter	
54	Glashmore Fishfarm	Grey heron	Dipper	Swallow				
55	Grallagh	Goldcrest	Dipper	Long tailed tit	Wren		Otter	
56	Teer	Blackcap	Dipper					
57	Glenlicky	Willow warbler	Grey wagtail					
58	Kiely's Cross	Grey wagtail	Blackcap					
59	Pulla	Whitethroat	Willow warbler	Sedge warbler	Reed hunting	Swallow	Otter	
60	Faha	Whitethroat	Willow warbler	Goldcrest				
61	Glashmore	Grey wagtail	Pied wagtail	Dipper				
62	Ballynamultina	Goldcrest	Long tailed tit	Chiffchaff			Otter	
63	Kneekanoaris	Grey wagtail	Chiffchaff				Mink	
64	Teer	Blackcap	Grey wagtail	Dipper	Mistle thrush			
65	Broken	Willow warbler	Grey wagtail	Chiffchaff	House martin	Blackcap		
66	Greish	Grey heron	Chiffchaff	Blackcap	Jackdaw			
67	Coelree	Mallard	Goldfinch	Chiffchaff	Long tailed tit	Reed hunting		
68	Collins	Goldcrest	Swallow				Otter	Mink
69	Ballynaparka	Blackcap	Grey wagtail	Wren	Spotted Flycatcher			
70	Ballynicole	Grey wagtail	Goldfinch					
71	Achnaclareen	Spotted flycatcher	Wren				Otter	
72	Ogham stenos	Great tit					Otter	
73	Dromana							
74	Bowley	Goldcrest	Redpoll				Otter	
75	Kilmelash	Pied wagtail	Goldcrest	Spotted flycatcher			Otter	
76	Keereen	Grey wagtail					Otter; hedgehog	
77	Whitechurch	Goldcrest	Meerhen	Raven	Dipper	Goldfinch	Otter; mink	
78	Finisk	Dipper					Otter	
79	Kilcleher						Otter	Mink
80	Beherawillin							
81	Medellige	Dipper	Wren					
82	Derry	Chiffchaff	Spotted flycatcher	Pied wagtail	Jackdaw	Starling		
83	Mountain Castle	Blackcap	Grey wagtail	Pied wagtail	Goldfinch			
84	Kneekannaglekoo							
85	Millinacreeka	Grey wagtail	Dipper	Goldfinch	Chiffchaff		Otter	
86	Aughaluck	Kestrel	Stenechat	Willow warbler			Otter	
87	Ballnamult							
88	Ballynamult	Heron	Blackcap					
89	Priestown	Dipper	Pied wagtail	Chiffchaff	Sedge warbler	Goldcrest		
90	Ballnamult							
91	Caherbrack	Pied wagtail	Jackdaw				Otter	
92	Caherbrack							

Bridge No.	Bridge Name	Bird sp 1	Bird sp 2	Bird sp 3	Bird sp 4	Bird sp 5	Mammals	Other sp
93	Kneekraha							
94	Heelick road	Blackcap						
95	Kilengford	Curlew						
96	Twemile	Chiffchaff	Goldfinch	Goldcrest	Heron			
97	Coelnageur	Willow warbler	Blackcap	Grey wagtail				
98	Hallys	Long tailed tit	Dipper					
99	Ballyguiry						Otter, mink	
100	Lauragh	Willow warbler	Blue tit					
101	Kneekmaen	Grey wagtail	Dipper					
102	Tanty						Otter, mink	
103	Lauragh	Long tailed tit						
104	Aughanerrick							
105	Devenshire							
106	Shandon							
107	Ballyneety							
108	Kildangan	Pied wagtail	Grey wagtail	Dipper				
109	Celigan	Grey wagtail	Dipper	Chiffchaff				
110	Cellnasmear Upper	Grey wagtail	Chiffchaff	Willow warbler			Mink	
111	Cellnasmear Upper						Otter	
112	Behadcen	Redpoll						
113	Lackandarra	Chiffchaff						
114	Ballynakill							
115	Coom	Willow warbler	Meadow pipit	Long tailed tit	House martin			
116	Coom East							
117	Scart	Dipper	Wren					
118	Scart (2)	Dipper	Pied wagtail				Otter	
119	Lagg	Grey wagtail	Stock dove					
120	Shor	Red hunting	Willow warbler					
121	Shoheens	Pied wagtail	Meadow pipit					
122	Kneekampower							
123	Old Pike						Mink/otter	
124	Menarud	Spotted flycatcher	Chiffchaff	Goldcrest	Blackcap	Goldfinch		
125	Ballyveyle	Whitethroat	Blackcap	Grey wagtail	Pied wagtail	Chiffchaff		
126	Ballyveyle new	Chiffchaff	Goldcrest					
127	Ballyveyle Viaduct							
128	Killineen	Grey wagtail	Blackcap					Frog
129	Shanbally	Goldcrest					Otter	
130	Dalligan	Grey wagtail	Dipper	Blackcap			Otter	
131	Glendalligan	Dipper	Grey wagtail	Pied wagtail	Bullfinch			
132	Dalligan	Bullfinch	Pied wagtail	Grey wagtail	Meadow pipit	Willow warbler		
133	Aughatriscar	Long tailed tit	Redpoll	Willow warbler				
134	Ballykilmurry	Blackcap						
135	Aughnacurra							
136	Lemybrien (1)							
137	Lemybrien	Dipper					Otter	
138	Fox's castle	Dipper	Grey wagtail	Blue tit	Wren		Fox	
139	Coghlewish	Grey wagtail	Dipper	Chiffchaff	Goldcrest	Blackcap	Otter	
140	Durrow	Grey wagtail	Dipper	Chiffchaff	Spotted flycatcher	Lacklaw		
141	Garriganaffrin	Grey wagtail	Dipper	Chiffchaff	Blackcap		Otter	
142	Stradbally	Grey wagtail	Dipper	Spotted flycatcher				

Bridge No.	Bridge Name	Bird sp 1	Bird sp 2	Bird sp 3	Bird sp 4	Bird sp 5	Mammals	Other sp
143	Deelish	Starling	Grey lag	Goldcrest	Chiffchaff	Goldfinch		
144	Bunmahon (1)	Pied wagtail	Thougn					
145	Annestown	Goldfinch	Mute swan	Meadow pipit	Whitethroat	Pied wagtail		
146	Dunkill Lodge	Blackcap	Chiffchaff	Heron	Mallard	Chiffchaff		
147	Ballyphilip	Reed bunting	Sedge warbler	Mallard	Heron			
148	Kilheen	Kestrel	Stonchat					
149	Kilminin							
150	Ballyveeny							
151	Bunmahon	Pied wagtail	Reed bunting	Mallard	Chiffchaff	Sedge warbler		
152	Bunmahon (3)	Stonchat	Heron					
153	Ballyristeen							
154	Aughnagaul	Chiffchaff						
155	Aughshemus	Dipper	Grey wagtail	Goldfinch				
156	Kilmactemas (Old)	Grey wagtail	Dipper	Cormorant			Otter	
157	Kilmactemas (New)							
158	Kilmactemas (Tawn)	Reed bunting	Willow warbler	Grey wagtail	Chiffchaff			
159	Kilmactemas (Mills)	Grey wagtail						
160	Currahana West	Chiffchaff	Raven					
161	Aughlehan	Chiffchaff	Bullfinch				Otter	
162	Ashtown	Long tailed tit						
163	Mahon	Pied wagtail	Goldcrest					
164	Mahon (2)	Bullfinch					Otter	
165	Whitestown	Willow warbler	Goldfinch	Swallow				
166	Ballybrack	Whitethroat	Willow warbler	Sedge warbler	Stonchat			
167	Greenan Hill							
168	Carroll's Cross						Otter; mink	
169	Ballysheneck	Willow warbler	Chiffchaff	Blackcap	Heron	Mute swan		
170	Haughton's Cross							
171	Kildermedy	Grey wagtail	Long tailed tit	Willow warbler				
172	Kildermedy (2)	Dipper						
173	Ballyduff East	Willow warbler	Dipper	Goldfinch	Blackcap	Long tailed tit		
174	Kilmeadan	Redpoll						
175	Pouldrew	Blackcap	Mallard	Long tailed tit				
176	Kilbunny	Blackcap	Long tailed tit					
177	Darrigal	Whitethroat						
178	Cedraugh	Sedge warbler	Reed bunting	Blackcap				
179	Portlaw							
180	Tobarchuain							
181	Lowry	Blackcap	Grey wagtail					
182	Caseys	Blackcap	Chiffchaff					
183	Glentstown	Grey wagtail	Chiffchaff	Willow warbler	Blue tit			
184	Glashdeg	Grey wagtail	Pied wagtail					
185	Clonea	Grey wagtail	Blackcap					
186	Spukayreghaun	Chiffchaff						
187	Sraigavalla	Raven	Long tailed tit	Dipper	Heron			
188	Shanakill	Chiffchaff	Blackcap	House martin				
189	Bess	Grey wagtail	Goldfinch				Otter	
190	Lackan	Chiffchaff	Dipper					
191	Geelnaherna	Willow warbler	Grey wagtail					
192	Kilseeneey							

Bridge No.	Bridge Name	Bird sp 1	Bird sp 2	Bird sp 3	Bird sp 4	Bird sp 5	Mammals	Other sp
193	Kilmeadan (A)	Goldcrest	Willow warbler	Chiffchaff	Blackcap	Bullfinch		
194	Kilmeadan (B)	Blackcap	Goldcrest	Long tailed tit				
195	Kilmeadan *	Dipper					Otter	
196	Welans	Chiffchaff	Blackcap	Bullfinch				
197	Kilfeteran	Grey wagtail	Swallow					
198	Rice							
199	Cause							
200	Kilfure	Pied wagtail					Otter	
201	Cullaghane							
202	Strengbaws							
203	Cewaheen							
204	Creeke							
205	Careys	Blackbird						
206	Ragheen							
207	Leperstewn							
208	Ballymabin	Whitethroat						
209	Rathmeylan							
210	Aughanadrish						Otter	
211	Kilmaclogue	Wren						
212	Boalanaslatteen							
213	Barnaboy							
214	Lisselan							
215	Perrya							
216	Glenread							
217	Caher							
218	Fenner							
219	Ragisk							
220	Tecreen East							
221	Labartts	Blackcap	Willow warbler	Chiffchaff				
222	Birchells	Swallow	Dipper					
223	Kneekashheen							
224	Ballymacarry	Grey wagtail						
225	Deerpark							
226	Treggane	Little egret	Grey heron	Mallard	Pied wagtail	Long tailed tit		
227	Ballymakee	Willow warbler	Grey wagtail	Grey heron	Tuckee	Goldfinch		
228	Keal	Willow warbler	Pied wagtail					
229	Boeding	Reed bunting	Willow warbler					
230	Kilmanahan	Dipper	Swallow	Pied wagtail			Otter, hedgehog	
231	Kneeklefty	Grey heron	Grey wagtail					
232	Sir Thomas							
233	Glen	Grey wagtail	Dipper	Spotted flycatcher			Otter	
234	Glenpatrick							
235	Beela	Raven	Blackcap	Mistle thrush				
236	Barravakeen	Dipper	Blackcap					
237	Laurel	Blackcap						
238	Russelstewn	Grey wagtail	Dipper	Long tailed tit				
239	Kilfarrassy (A)							
240	Kilfarrassy (B)	Wren						
241	Feddans							

Appendix 4. Artificial roosts

Schwegler Boxes

A range of bat boxes are available for different species. Schwegler boxes are probably the most popular choice as they have excellent thermal insulation properties and are extremely durable. However there are products available from other manufactures. The characteristics of some of the available boxes are detailed below in **Table A3.1**.

Table A3.1. Range of Schwegler boxes

Product	Manufacturer	Species	Dimensions	Notes
Model 1FF		crevice-dwelling species such as Daubenton's and Natterer's	27x14x43cm	Rectangular box with a narrow crevice-like internal space.
Model 2F			diameter 16cm height 33cm.	Rounded, free-hanging box with a narrow entrance slit on the front.
2FN Special			diameter 16cm, height 36cm	Access slit at the base and an access hole on the underside
Type 27			width 18cm, height 29cm and depth 23.5cm	hollow concrete brick type of box and is designed to be built into

Product	Manufacturer	Species	Dimensions	Notes
				new or rebuilt structures. It contains a single internal wooden panel.
Model 1FW				Large box (27kg) specially adapted to accommodate hibernating bats although bats will use it throughout the year. It is built with a very effective insulating material between the outer and inner walls. The internal cavity contains three wooden panels which form crevices.
1FS.				
Marshall's Bat Access Brick	Marshall's Clay Products		11x15x21.5cm.	
Belfry box			27cm high x 19cm diameter.	

Other artificial roosts

Other artificial roosts include a bat roost unit designed by Marshall's Clay Products in England. This unit consists of a hollow cube with three open sides. As with the Schwegler Type 27 it is designed to be built into a structure and faced with a Marshall's Bat Access Brick which has a slit to allow bats into a void of 11x15x21.5cm.

Appendix 5. Case studies

Barth Bridge, U.K.

A single-arch stone bridge with low flood inverts. Major re-pointing and pressure grouting was scheduled for May 1995. Bat signs were discovered in September 1994. Scaffolding was erected 2 weeks ahead of works to take account of any bats present. A detailed survey was carried out using a fibrescope and several bat holes were identified and marked. A site meeting was held with the engineer. A further survey and exclusion (after removing one Daubenton's bat) was carried out at the beginning of June, but due to contractors not following instructions most of the holes were lost.

Rash Bridge, U.K.

Double-arch stone bridge in which the main roosts of Daubenton's (12) and Natterer's (3) bats are situated in the northern arch. Major re-pointing and pressure grouting works were carried out in 1994 and 1995. Works were delayed after bats were found. A fibrescope survey was carried out from scaffolding on the southern arch. Several bat holes were marked and successfully retained, some more than 700 mm deep. Works were delayed on the northern arch until May 1995 (in case hibernating bats were present). Holes were surveyed with a fibrescope and marked. Problems arose because some of the bat holes extended upwards for almost 1 metre. English Nature contracted an independent engineer to produce a report on retaining deep crevices. Before works on the northern arch were carried out several bats had to be excluded. Daubenton's bats were observed at the bridge in 1995 but Natterer's bats do not seem to have returned.

Tattynure Bridge, Omagh

Tattynure Bridge is located approximately six miles north of Omagh. It is a two hundred year old masonry arch spanning Cappagh Burn (bridge span 7.5m).

It was known that Tattynure Bridge did not hold a nursery roost of bats so that work could proceed safely. Nevertheless provisions were made for the small numbers of bats using the bridge. By the time work commenced the dippers had fledged and were using the bridge as a night roost only.

The bridge required repairs which included the removal of vegetation, underpinning of an abutment, rebuilding several areas of loose masonry, stitching cracks in the arch barrel, pointing joints in the masonry and pressure grouting the entire structure.

Work commenced in June 1988 with the foundations of the bridge being strengthened by underpinning and the erection of a cement plinth around the base of the weakened abutment. The foundations and spandrel walls were then pressure grouted. Prior to work commencing on the arch crevices which were used by bats and dippers were clearly marked with paint. Decisions were then reached as to which crevices would be retained by negotiations between wildlife worker and the bridge engineer.

The main problem encountered was to prevent the inflow of liquid grout during pressure grouting into a deep fissure (450mm) which was targeted for retention. This fissure extended along the arch barrel. Firstly existing masonry stones adjacent to the fissure were removed. The internal surfaces of the void was coated with cement mortar by hand which acted as a sealant. The removed masonry was then rebuilt. The contractor then inserted 24 stitch bars across the fissure in the arch barrel to strengthen the structure. In places where it was impractical to remove masonry voids were filled with twigs, straw and other vegetable matter which remained in place during the pressure grouting procedure. In this manner voids preserved were generally around 300mm long x 25mm wide x 300mm deep.

Additional voids were formed by removing individual stones, cutting the stone and replacing it so that an opening 50mm x 100mm x 100mm leading into a larger void behind 150mm x 100mm x 150mm deep was formed. Again, these voids were protected from the inflow of grout by sealing the internal surfaces

of the void with grout. In addition to the above measures a 600mm x 600mm x 12mm thick cement plasterboard slab was fixed to the apex of the arch and camouflaged with rough dash mortar. An access point to the space above the board was provided at one end. Even though the entire structure was pressure grouted a total of seven natural voids were preserved and two additional voids formed to accommodate both bats and dippers. Bats and dippers were reported to be roosting in the crevices provided the following year.

The cost of the additional work necessary to accommodate the bats and dippers at Tattynure bridge was £220 which was equivalent to 4% of the total cost of repairs.

Bridge maintenance procedures

Both paper and polystyrene have been placed in bat holes prior to pressure grouting to prevent the cavity filling up with liquid grout. This has had only limited success as it can be difficult to remove the material afterwards. Crevices retained in this manner are often too shallow for bats.

A process termed 'ring grouting' has proven successful in Cumbria in England. This procedure involves carrying out pressure grouting at low pressure in the area of the cavity that is to be retained. Pumping continues until grout first appears at the back of the cavity. Pumping is then stopped to allow the grout to set. This effectively seals off the cavity and should prevent water seepage from above. Once the cement has set above the cavity grouting at normal pressure can continue. This method was successful in retaining the full depth of the cavities at a bridge in Cumbria (Billington & Norman, 1997).

English Nature commissioned an independent engineer, N. Turner, NET Geotechnical Contract Management and Consultancy, Lancashire, England to draw up plans to assist engineers in the retention of deep crevices in bridges for bats. This report is entitled Practical engineering and environmental problems associated with the strengthening of rubble filled masonry bridges inhabited by bats: including suggestions for measures compatible with the

engineering solution and the preservation of bat roosts. Two options were proposed which incorporate bat roost construction within the bridge strengthening process.

1. A section around an existing crevice in a bridge is excavated from underneath. Stainless steel bars are inserted as reinforcements and set in cement and the internal faces of the crevice sealed with a layer of shotcrete. The excavated stonework is replaced and pressure pointed into position, leaving gaps for the bats to gain access to the cavity. The bridge arch needs to be supported by propping during these works.

2. The second option can be carried out in conjunction with the strengthening procedure termed saddling. The road surface and rubble fill of a bridge is excavated. A pre-cast concrete slab is placed in position over an existing crevice. The slab prevents the passage of liquid cement into the cavity below when the bridge is being infilled with cement. Access to the roost is through gaps retained in the arch masonry.

These plans may need modifications to adapt them to suit particular bridges. In all cases each bridge needs to be surveyed and its cavities assessed individually.

It is vital that a bridge is thoroughly surveyed prior to the commencement of any works in order to identify which crevices are in use and to establish the size of these crevices. A small opening in the undersurface of an arch may lead into a larger network of connected voids. It may be necessary to inspect such crevices with a fiberscope.

It may be necessary to exclude bats temporarily from a bridge prior to work commencing. This task is usually performed at dusk after the bats emerge to feed. Access to the roosting cavities is then blocked with newspaper to prevent re-entry. This can only be performed under licence by a wildlife expert as bats are protected under the Wildlife Act (1976) and a licence is required to handle them.

Appendix 6. Recording form

County Waterford Bats & Bridges Survey, 2008

Bridge name:		Bridge number:	
River name:		Photo number:	
Altitude (m, asl):		Road number:	
Grid reference:			
River width (m):		River depth (m):	
River flow speed:			
Bridge material (stone/concrete etc):			
Number of arches:		Height of arches (m):	
Habitat surrounding bridge:	First habitat:		
Habitat surrounding bridge:	Second habitat:		
Other habitats:			

Suitability of bridge as a bat roost site:

	Code 3	Code 2*	Code 1**	Code 0	Wet/Dry	Notes etc:
Arch 1:						
Arch 2:						
Arch 3:						
Arch 4:						
Arch 5:						
Arch 6:						
Arch 7:						
Arch 8:						
Arch 9:						
Arch 10:						
Arch 11:						
Arch 12:						

Date of survey:		Surveyor(s):	

Notes:	
Code 3:	Evidence of bats using bridge (sighting of bat(s) or fresh droppings)
Code 2:	Ideal roost crevices in bridge, but no bats or bat evidence seen
Code 1:	Some crevices in bridge, but likely to be used rarely, if ever, by bats
Code 0:	No potential as a bat roost (smooth walls of concrete/grouted etc)
Code 2*:	Crevices generally greater than 100mm deep, and offering good shelter
Code 1**:	Few crevices, generally less than 100mm deep, and offering poor shelter

Bat species recorded in bridge:

	Daub:	Natt:	Whis:	Long-e:	Pipi sp.:	Other:	Unid:
Arch 1:							
Arch 2:							
Arch 3:							
Arch 4:							
Arch 5:							
Arch 6:							
Arch 7:							
Arch 8:							
Arch 9:							
Arch 10:							
Arch 11:							
Arch 12:							

Notes/diagrams etc:

Appendix 7. Health and safety considerations

A high level of importance was given to safety in three different areas. First priority was safe parking on the roadside, with flashing indicators used where necessary. Sometimes the surveyor had to park some distance from the bridge in order to do so safely, and then had to walk to the bridge wearing a high visibility jacket. Second priority was safe access to the bridge. This often involved climbing over a fence (without damaging it), or accessing it through a field. Obstacles such as barbed wire, electric fences and bulls had to be borne in mind. Thirdly, at each bridge the river had to be assessed for safe access. In a great many cases the surveyor was familiar with the bridges and rivers concerned as a result of other survey work in the past, and this made assessment of safety easier. Rivers were never entered if in flood (no survey work was carried out in such conditions). Although the surveyor wore a dry suit, no river was entered if the water depth was assessed as being more than 1m deep. However, even in deep rivers it was often possible to assess the suitability of the bridge as a bat site, therefore, entry to the river was not absolutely necessary in all cases