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# An alternative method for catching commuting and foraging bats over water

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## Abstract

Due to their typical commuting and foraging behaviour when associating with water features (i.e. flying above and close to the water surface) catching bats such as *Myotis daubentonii* (Daubenton's bat), away from roosts, can at times prove challenging for researchers. A number of techniques have been documented which are not always ideal, either from a perspective of wellbeing for bats being captured, or of health and safety for the people involved. Whilst seeking to tackle the challenges associated with such scenarios an alternative catching technique was developed and successfully used. The technique involves placing a fixed mist net, within a solid aluminium frame, immediately above the water surface. The frame is correctly positioned by two bat workers from a bridge crossing over the water channel, with a third bat worker communicating from below. The technique is particularly useful when dealing with the capture of Daubenton's bats over deeper or otherwise inaccessible water channels (e.g. canals). Elsewhere within Europe two additional species (*Myotis dasycneme* and *Myotis capaccinii*) show a similar commuting and foraging behaviour to Daubenton's bat, and this alternative catching technique may also prove useful for researchers working with either of those additional species.

Key words: *Myotis daubentonii*, Daubenton's, bat, *dasycneme*, *capaccinii*, catching, capture, water

## Introduction

Within Europe three species of bat show a particular association with commuting and foraging close to water surfaces (Dietz and Kiefer, 2016), these species being Pond bat (*Myotis dasycneme*), Long-fingered bat (*Myotis capaccinii*) and Daubenton's bat (*Myotis daubentonii*). One of these species, Daubenton's bat, is resident within and distributed throughout most of the UK (Harris and Yalden, 2008).

Daubenton's bat is a widely distributed species within Scotland (Haddow and Herman, 2000). It shows a strong association with fresh water habitats, in particular calm water surfaces, above which it feeds by hawking or gaffing insects from just above or on the water surface (Rydell *et al.*, 1999; Siemers *et al.*, 2001). In terms of its foraging behaviour, as well as a strong association with calmer water features (e.g. rivers, ponds, lakes, canals), it can also be found foraging away from water, in woodland areas for example.

Bat researchers can encounter difficulties when attempting to capture these bats away from known roosting locations. For example, during radio tracking studies bats may need to be caught whilst commuting or foraging in

order for new roost locations to be found. Difficulties arise, in such circumstances, due to the need for capture techniques to be deployed over the water surface, above which the bats would typically be flying. When the water channel is shallow matters are relatively straightforward in that a mist net or harp trap can be easily reached by a researcher wearing waders. When the water is deep however, as often occurs in calm slow moving river sections or canals, the situation a researcher may find themselves faced with is far more challenging.

## The Challenges

In deep water it is far harder to effectively place harp traps and mist nets. Even when this is possible, the researcher usually has the challenge that should a bat be caught within the trap, how do they get themselves safely to and from the catching area? They also, of course, then need to retrieve the bat quickly, and with the lowest risk of injury to the animal.

A number of methods for catching low flying species have been used in such settings. These all have their merits, but with varying degrees of success, and also, potentially, corresponding degrees of risk. The following

describes examples that the author is aware of:

(i) When using **harp traps** in and above water, the positioning and depth of the holding bag (which lies beneath the trapping area) is such that it can be higher than the area immediately above the water within which these bats are often manoeuvring. As such, for these low flying bats, it can act as a barrier and cause them to change course, as opposed to flying into the trapping area. Also, unless the water channel is narrow (i.e. a similar width to the trap) the area being covered by a harp trap is often quite small compared to the area within which the bats are able to choose to fly. If a bat is caught, there may then be challenges associated with extracting it from the trap, which is within a water channel, and then taking it safely back to dry land for processing.

(ii) When using **mist nets** across deep water, the success rate for capture is considerably greater, if for no other reason than the trapping area is larger. The challenge here lies in, how does the bat worker extract the bat from the net? Perhaps if the bat is caught in the lower section of the net, as anticipated for the species being sought, a bat worker wearing waders in deep water would be able to reach it relatively easily. However, what if the bat is caught in a higher section of the net which could then be out of reach of the bat worker. Bear in mind that in this example the effective reaching height of the person is reduced because they themselves are standing within deeper water. Net sections can of course be lowered in order to reach the bat, but not, bearing in mind the working conditions, with potential risks to all concerned. Also, it should be considered that many bat species (e.g. *Pipistrellus* spp.) may forage or commute above water surfaces at higher flight levels. There is a strong risk that bats from these species may inadvertently be caught, and as such need to be extracted and released. Therefore the bat worker needs to consider, in advance, how to deal with this situation should it occur.

(iii) It may be possible to use a **small boat** (e.g. a canoe) in order to position traps and reach captured bats. If the situation is such that this is an approach being considered, then again there are challenges that need to be

addressed. First of all, as in example (ii) above, the bat worker is relying on the bat being in a position whereby they are able to reach the animal and/or net sections so that these can be lowered if needs be. It may be possible to stand up and balance steadily in the boat in order to reach these higher areas (either for extracting the bat directly or lowering poles), but not without risk to all concerned. Secondly, without knowing in advance which direction any single bat is likely to be travelling from, and hence which side of the net they will be caught within, there is a need for the boat to easily, quickly and safely get to either side of the net. Finally, keeping the boat steady, bearing in mind currents, and removing the risk of the vessel itself colliding with or being caught in the net would be an ever present consideration.

(iv) **Pole flicking** with a mist net, from a bridge above the water surface, has been documented as an acceptable method within the Bat Workers' Manual (Mitchell and Jones, 2004), provided it is carried out carefully. It is not, however, without its challenges. Bats can get relatively more entangled within a net whilst using this technique, and the bat worker has to be extremely careful that the tension of the net remains constant so as not to risk injury to the bat. Also, there is a risk, depending upon the nature of the structure being used and the accessibility to the waterside banks, that a bat could get caught in an area of the net that is not easily accessible. Finally, for structures that are higher or wider this technique could be very difficult, if not unwise, to deploy. It is fair to note that the method, as described within the Bat Workers' Manual, does not suggest that it should be used where the bat workers are not working in close proximity to the net.

(v) So far I have discussed methods that involve placing the trapping area where you would expect the bats to be occurring naturally (i.e. over the water surface). Another approach, whereby a bat's flightpath can be diverted towards and into a trapping area on a waterside bank (see Figure 1) was first described to the author by James Aegerter (Central Science Laboratory) in 2003. This technique was subsequently used, with varying degrees of success, by the author whilst engaged in research projects (e.g. work

associated with BATS & The Millennium Link, [www.batml.org.uk](http://www.batml.org.uk)).

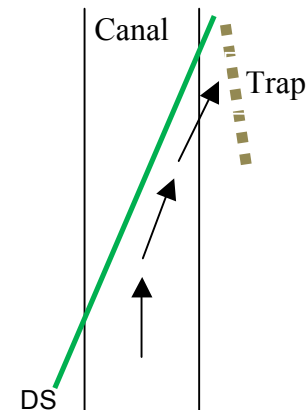


Figure 1: Diversion screen (DS) across water surface, diverting low flying bats (arrows indicate anticipated direction of travel) to the bankside area where a harp trap or mist net is in place.

The technique involves placing a **diversion screen** (e.g. heavy duty scaffolding netting) at an appropriate angle across the water surface, in such a manner that should a bat travel along the water corridor its flightpath is gradually diverted towards the trapping area on the bank. If the anticipated direction of the bats is not known, or could be from either direction, then a second trapping area can be placed on the opposite bank. It is important that the diversion screen itself is not capable of catching bats, as it would not be accessible for a retrieval. Also, it needs to be positioned immediately above the water surface, as otherwise bats will fly underneath and not be diverted. A final point to note is that if the angle of the screen to the anticipated flightpath of bats is not gradual enough, then a bat may perceive it as more of a barrier, and hence turn away, as opposed to being guided in the required direction. This technique can be improved upon further if the trapping area is located beneath a bridge, with the underside of the bridge acting as a roof to further reduce any options that a bat may have for avoiding being captured. It should however not be underestimated the amount of time and materials required in order to put such a mechanism for trapping bats in place.

All of the methods described so far are certainly not without merit, and they will all, to different degrees, be successful in catching bats. But each also appears to have its challenges, usually either associated with

relatively greater risk of distress or potential injury to a bat, and/or the health and safety of the bat workers involved. In the latter instance, especially bearing in mind the combination of working in water during darkness and/or the challenges presented with setting up and removing materials from site. Examples (i) to (iii) involve the researcher making their way through water in order to retrieve bats. Example (iv), if operating to plan, at least involves taking the bat to the researchers who are standing on terra firma, albeit with very careful manoeuvring of the net so as to keep the tension consistent between time of capture and time of extraction. Example (v) involves considerably more planning and materials, which are fixed in position across the entire water surface.

### Alternative Method

A method removing the risks associated with people in deep water and/or bats being more than necessarily put at risk, whilst in a mist net or harp trap in water, would be beneficial. The efficiencies and effectiveness of any alternative method would also need to be factored in. To this end a system was developed whereby it was able to be deployed from a bridge, and when a bat was caught (or if the system needed to be moved due to a passing boat for example) the system could be quickly lifted and moved to the bankside in a fixed state in order for the bat to be extracted. The whole process can operate without any of the risks associated with excessive entanglement within the net, or changes within the net tension putting the bat at risk of being stretched. The system also removes any risks to bat workers needing to manoeuvre themselves through water.

Initially the system is built by creating three sides to what will, in its completed state, become a four-sided aluminium fixed frame. Having created the initial three-sided, U shaped frame (see Picture 1) a mist net of the correct size (e.g. 2m x 2m) is then hooked over the open ends and fitted within.





Picture 1: Aluminium frame extended in U configuration immediately prior to a mist net being placed within.



Picture 2: Trapping frame secured with mist net attached within (net still collapsed – see red arrows) immediately prior to net being extended.

Once the net is in place the final side of the frame is added to the top in order to create a fixed frame with the net secured inside (see Picture 2).

Guide ropes, of the required length, are then tied to the top corners of the frame (see Picture 3) and the net is then extended out within the frame. It is important that the ropes are secured to the corners so as to remove any possibility of them sliding, and hence the trap ending up partially submerged, once catching operations commence. The frame is now ready to be deployed.



Picture 3: Showing rope attached and secured to top corner of the frame prior to it being suspended from bridge. Note that mist net (red arrow) is still collapsed in this picture.

The frame is placed on the ground beneath the bridge. The guide ropes are then passed up to the two people positioned on the bridge (see Figure 2). A third person continues to remain in position with the frame on the bank below. The frame is then moved, using the ropes from above, and guided by the bankside person so that it is put in place just above the water surface, being held in position by the persons on the bridge above. Once the correct height above the water is determined (communicated by the person below on the bank) the ropes can be tied off in order to ensure that the location of the frame does not change. Whilst tying the ropes off it is important to ensure that they can be quickly unsecured so that when a bat is caught the entire frame, including the fixed net with the bat within, can be moved back to the bankside. Figures 2 and 3 show drawings of the two main stages of the system whilst in use.

Once the net is in position above the water and catching commences it is important to keep the net just above the water surface at all times, and at a height that ensures that should a bat get caught very low down in the net its weight does not cause the bat and the net to enter into the water.

When a bat is caught in the net the bat workers on the bridge unsecure the ropes. Both bat workers move the frame towards the bankside where the person below grabs the near side of the frame and moves it away from the bridge. At that point the bat worker labelled 'B'

releases the tension on their rope as the weight of the frame is now being carried by bat workers C and A. Once the frame is fully on the bankside (i.e. parallel to the canal or river) it is placed on the ground in an upright position and the bat extracted by the bankside bat worker.

Having extracted the bat, the manoeuvre is then reversed in order to reposition the frame back over the water surface in order to catch additional bats.

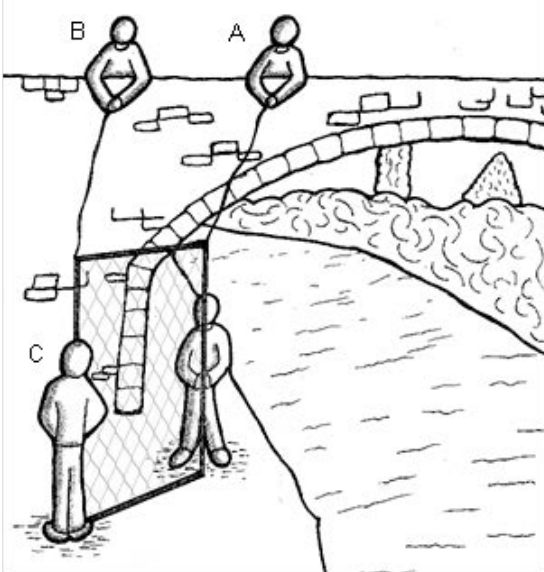
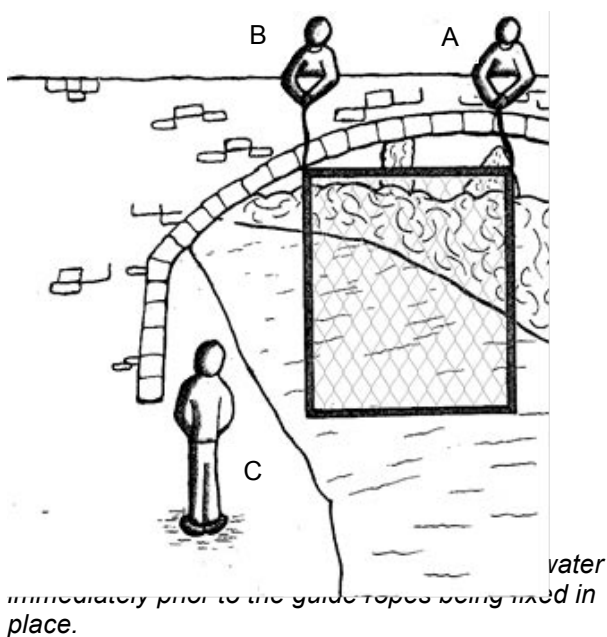


Figure 2: The frame still on the bank immediately prior to bat workers A and B placing it above the water surface.



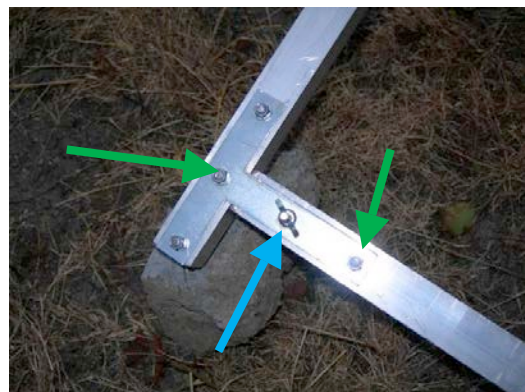
## Materials

In addition to the recommended bat specific materials (e.g. mist net, handling gloves, holding bags) as described within best practice guidance (e.g. Mitchell-Jones and McLeish, 2004) the materials required to build and operate the frame are easily obtainable and affordable.

In the examples used by the author, hollow aluminium tubing (4cm x 4cm) was used due to its durability and light weight. In addition to fixed bolts, in order to create a system that could be folded down (see Picture 4), two of the corners were created with removable wing nut systems (see Picture 5). When the wing nut is removed the remaining fixed bolts enable the system to be folded for transportation and storage purposes. The fourth side (i.e. the top of the frame) was also created in such a way whereby it would be fixed into position using wing nuts.



Picture 4: Collapsed frame ready for transportation.



Picture 5: Corner of frame whilst extended. Green arrows show fixed bolts, and red arrow shows removable wing nut, the latter positioned so that the frame is collapsible.

## Results

The alternative method described within this paper proved to be successful catching *Myotis daubentonii* over canal and river surfaces. Once the frame system was built it was easily transportable, and took less time to construct and deploy than a conventional mist net arrangement using standing poles at each end. Further, once deployed, the system had the advantage that it could be easily and quickly moved should that need to be the case (e.g. a passing boat on a canal). In timed exercises, with assistants experienced with the process, it was able to be demonstrated that, from point of capture until point of the frame being back in place over the water body, a period of less than four minutes was typically required. This included the time relating to the actual extraction of the bat from the net. The efficiency and effectiveness of the process ensured that bat workers were not required to enter the water, and bats were not unnecessarily entangled, or in danger of being injured (e.g. stretched) in a net with changing tension.

### Acknowledgements

I would like to acknowledge and thank the following who helped contribute towards initially testing a prototype of this method in the field: Kirsty Morrison; Chris Gould; Natalie Todman; David Dodds. Also thanks are also due to the BaTML Project Team and volunteers (2003 to 2008) and Echoes Ecology Ltd project teams (2007 to 2015) who assisted with using this method on various occasions during the period 2003 to 2015. Finally, thanks are due to Aaron Middleton for producing the illustrations (Figures 2 and 3) contained within this paper.

April 2016

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# Assessing the effect of habitat type on pipistrelle bat activity through acoustic surveys in rural West Scotland

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Research undertaken in September 2015, submitted in May 2016

## Summary

The activity of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* was assessed using acoustic surveys across three habitats at morning and evening twilight near Oban, Scotland. The relative abundance of insects of the order Diptera was calculated through trapping. Our results showed that activity was greatest prior to dusk. Habitat has the most profound influence on bat activity and relative prey abundance, which were weakly correlated. The rural built-up settlement exhibited greatest activity, however this study area also exhibited greatest habitat heterogeneity. The implications of these findings may be used to assist bat conservation programmes and rural land-use planning in an attempt to increase available favourable areas for roosting and feeding.



**Cologin Country Chalets and surrounding vegetation, the location of this study.**  
Photograph by Cameron Campbell.



## 1. Introduction

Pipistrelle bats are common and widespread throughout Scotland, observed in a variety of habitat types in mainland, estuarine and island environments (Stebbins, 1997; Haddow & Herman, 2000). The estimated abundance of pipistrelles in Scotland is 550,000, with a minimum population density of 18.2 pipistrelles per km<sup>2</sup> (Speakman *et al.*, 1991a; Harris *et al.*, 1995). Two species of pipistrelle bats are most commonly present in Scotland, *Pipistrellus pipistrellus* (Schreber) and *P. pygmaeus* (Leach). *P. nathusii* (Keyserling and Blasius), therefore have been excluded from this study as they are only present in North-East Scotland and the Shetland Isles (Speakman *et al.*, 1991b). The UK Biodiversity Action Plan status for both pipistrelle species is 'priority', while the IUCN also categorises both as endangered (Hutson *et al.*, 2001; Swift, 2004).

Pipistrelle nursery colonies select roost sites based on their structural morphology and food source availability (Swift, 1980). Further, Jenkins *et al.* (1998) suggest that roost selection is influenced by the risk of predation, which bats attempt to reduce through nocturnality (Fox *et al.*, 1976; Fenton *et al.*, 1994; Speakman, 1995). The bats provide multiple ecosystem services (Kunz *et al.*, 2011) and feed on aerial insects, primarily Dipterans, whose activity is greatest prior to dusk (Rydell *et al.*, 1996). Feeding at greater light levels is typically inhibited by the presence of predators (Gillette & Kimbrough, 1970). Swift (1980) showed that mean pipistrelle roost emergence time is 35 minutes following sunset, as a result of the aforementioned behavioural trade-off.

Recent studies have indicated that *Pipistrellus pipistrellus* are habitat generalists; however, roost selection frequently favours rural man-made structures with roof cavities or crevices if present (Vaughan *et al.*, 1997; Jenkins *et al.*, 1998; Swift, 2004). *Pipistrellus pygmaeus* are also expected to roost in rural built-up

areas close to hedgerows (Lourenço & Palmeirim, 2004; Oakeley and Jones, 1998), yet evidence of habitat differentiation and resource partitioning between the sympatric pipistrelle species indicates that *P. pygmaeus* favour riparian environments, whereas *P. pipistrellus* favour open woodland (Davidson-Watts *et al.*, 2006). Jones and Van Parijs (1993) first suggested that cryptic species were present within *Pipistrellus*, due to significant variance in ultrasound echolocation frequencies. This theory was verified through DNA sequencing, which revealed genetic divergence and stimulated a ubiquitous consensus for species reclassification in 1999 (Barratt *et al.*, 1997; Sztencel-Jablonka & Bogdanowicz; 2012).

Due to several morphological and behavioural similarities, varying ultrasound echo-location frequencies are primarily used to distinguish *P. pipistrellus* (45 kHz) and *P. pygmaeus* (55 kHz) (Parsons & Jones, 2000; Swift *et al.*, 201). Echolocation is employed both for navigation and insectivorous foraging purposes (Kaiko, 1995), which Schnitzler *et al.* (2003) showed to be habitat-specific. Habitat is often considered the principal ecological constraint on bat activity (Schnitzler & Kalko, 2001), defined by the proportion of time echolocation calls are emitted by individuals (Miller, new 2001). Pipistrelle flight is affected by wind strength and direction (Verboom & Spoelstra, 1999); though navigation commonly relies on linear landscape characteristics such as forestry plantations, built-up structures or hedgerows; where wind conditions have a lesser effect than in open areas (Verboom & Huitema, 1997; Loeb & O'keefe, 2006; Gaisler *et al.*, 1998).

This study aims to evaluate the relationships between insect abundance and bat activity across a range of rural environments. Despite their protected status, knowledge of the limiting factors on pipistrelle activity in Scotland is relatively incomplete (Thompson, 1992; Swift, 2004). Scientific insight concerning bat activity across a range of habitats is essential for effective application in resource management and town planning.

The conclusions drawn from this study may be applied to conservation orientated agendas, with a particular emphasis on the maintenance of bat habitats and ecosystem biodiversity (Russo & Jones, 2003; Kalko & Handley, 2001; Fenton, 1997).

## 2. Methods

### 2.1 Study area

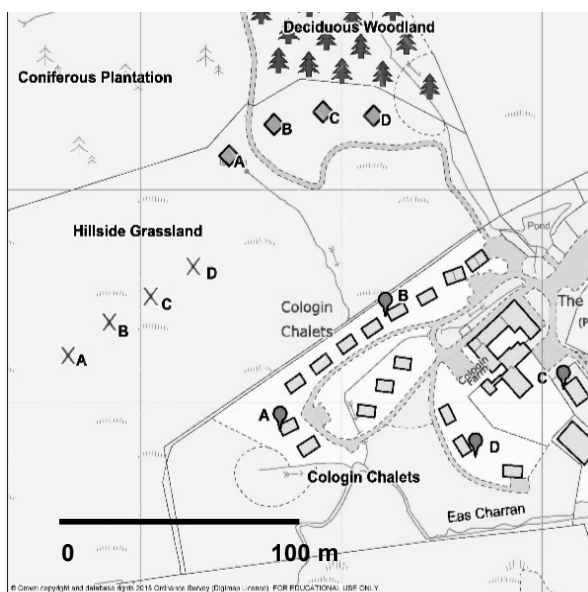
The study area was established around the Cologin Country Chalets and Cologin managed FSC woodland (FCS, 2008), shown in figure 1.

Three distinct habitats were defined: deciduous woodland edge, hillside grassland, and built-up chalets. The deciduous woodland is semi-natural, dominated by *Quercus robur* (L.) and *Sorbus aucuparia* (L.), defined as an A1.1.1 phase 1 habitat after JNCC (2003). The four woodland edge sample sites were placed 5m from the woodland in a parallel transect, at regular intervals of 25 m. The area was grazed by three *Bos (primigenius) taurus* (L.), however dense *Pteridium* and *Calluna vulgaris* (L.) cover prevented grazing closer to the transect. Four sample sites were established along the hillside con-tour at intervals of 25 m. The hillside grassland sites were covered by dense *Pteridium*, *Juncus effusus* (L.) and *C. vulgaris*, defined as a B5/C1 phase 1 habitat after JNCC (2003). Both the

woodland and hillside habitats were homogeneous, however the chalet habitat expressed relative heterogeneity. All chalet sites were close to intermittent deciduous trees and streams; however, sites A and B were closer to grassland, whereas sites C and D were closer to coniferous woodland.

### 2.2 Experimental procedure

Spatial systematic sampling was employed across each habitat type to ensure that there was adequate space between measurement sites, in order to minimise the effect of false duplications. This study used temporally independent replications between sites over five consecutive days in late summer. Bat activity and insect abundance readings were taken at each site during dawn and dusk twilight, defined by the UK Met Office (2015). Temporal systematic sampling was employed through site rotation ensuring each site was studied at various times in twilight, and therefore subject to various illuminance intensities, measured using a 1301 Lux & FC Light Meter (ETI, 2006) over the twilight period. Each site was sampled for ten minutes, therefore readings lasted approximately 120 minutes. 12 sample sites over both time periods, each with five repeats, were assessed during statistical analysis (a total of 120 samples)



**Figure 1. Map of the study area (Image: Digimap, 2015).** The scale of this map is 1:1750, and the general OS grid reference is NM 8532 2606. Hillside sample sites are denoted by crosses, woodland edge sites by diamonds, and the chalet sites by circular pin shapes. This map also shows the location of the Eas Charran stream (a tributary to Loch Feochan), and the boundaries of the deciduous woodland.

Bat activity was monitored for at each site using a Magenta ‘Bat 5’ Digital Quartz Bat Detector (MEL, 2008) set at 50 kHz, the mean ultrasound frequency exerted by the combined *Pipistrellus* species (Swift *et al.*, 2001). Bat activity was quantified as the cumulative time in which calls were recorded within a 10 minute period, to be expressed as a percentage of total time. Relative insect abundance (RIA, %) was calculated using a Russell IPM Insect Trap (Russell IPM, 2013), attached to ranging poles at each site at a height of 1.5 m. Dusk readings showed relative diurnal abundance, whereas dawn readings showed relative nocturnal abundance. Temperature and relative humidity readings were taken at each site to be examined as covariates.

**2.3 Statistical analysis**

All statistical tests were undertaken using Minitab 17 statistical software (2010). Normality tests were applied to determine if the assumptions for parametric statistics were met, after Grafen & Hails (2003). Correlation analysis was used to visualise the relationship between bat activity and RIA. Multiple analysis of variance (ANOVA) tests were used to compare mean bat activity and RIA data between the three habitat groups and two twilight periods; followed by post-hoc Tukey’s tests. RAI, temperature and relative humidity were then included in subsequent bat activity analyses as covariates (ANCOVA).

**3. Results**

**3.1 Twilight illuminance**

Log<sub>e</sub> illuminance (lx) was plotted against minutes before sunrise (min) and minutes after sunset (min) for morning and evening twilight periods respectively. On a logarithmic linear scale distinct lines of best fit were visually apparent in both categories, and regression analysis subsequently indicated that a large proportion of the variance, shown in table 1. The accuracy of measurements using the 1301 Lux & FC

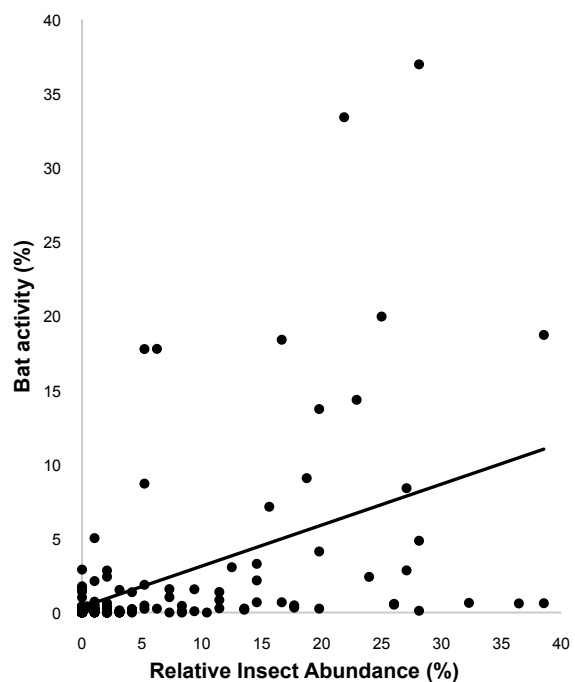
Light Meter was ±5% at scale of illuminance measured.

Twilight Category	Regression equation	R-squared value (r <sup>2</sup> )
Dawn	$y = 127.68e^{-0.134x}$	0.994
Dusk	$y = 159.32e^{-0.148x}$	0.984

**Table 1. Results of Log<sub>e</sub> illuminance and time regression analysis, comparing morning and evening twilight.**

**3.2 Correlation analysis**

When comparing the raw bat activity and insect abundance correlational analyses testing was appropriate, due to the influence of extraneous variables affecting both datasets and the vulnerability of subsequent conclusions to reverse causality (Grafen & Hails, 2003; Ruxton & Colgrave, 2010). The scatter-gram and related tests are shown in figure 2.

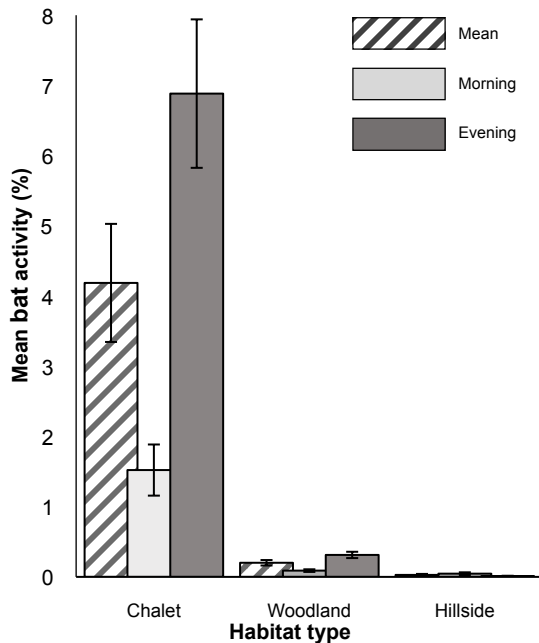


**Figure 2. Scattergram of bat activity against relative insect abundance.** Nonparametric correlational tests were used to determine to statistical dependence of these variables, after Fowler *et al.* (1998b). These results were: Pearson’s product movement correlation (r) = 0.459; Coefficient of determination (r<sup>2</sup>) = 0.211; and Spearman’s rank correlation coefficient (r<sub>s</sub>) = 0.611.



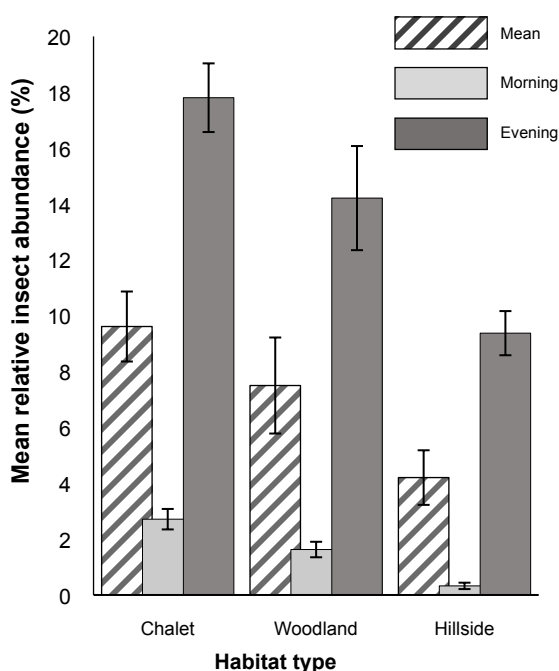
### 3.3 Mean bat activity and insect abundance

The mean bat activity across habitat groups and twilight categories is shown in figure 3.



**Figure 3. Mean bat activity and associated errors, comparing the effect of habitat type and twilight period.** Chalet = 4.19 ± 0.84%; Woodland = 0.2 ± 0.04%; Hillside = 0.03 ± 0.01%; Dawn = 0.55 ± 0.13%; Dusk = 2.40 ± 0.37%.

The mean RAI across habitat groups and twilight categories is shown in figure 4.



**Figure 4. Mean insect abundance and associated errors, comparing the effect of habitat type and twilight period.** Chalet = 9.613 ± 1.25%; Woodland = 7.50 ± 1.72%; Hillside = 4.20 ± 0.98%; Dawn = 1.56 ± 0.25%; Dusk = 13.80 ± 1.29%.

The overall mean bat activity from all readings was 2.19 ± 0.46%, and the overall mean RAI across all sites and times was 7.02 ± 0.86%.

### 3.4 Analysis of Variance (ANOVA) tests

A one-way ANOVA showed that differences in log bat activity across all habitat types was significant at the  $p < 0.01$  level, [ $F_{(2, 78)} = 16.51$ ;  $p < 0.00$ ]. Post-hoc analyses using Tukey's pairwise comparisons test showed that all habitats significantly differed from one another at the  $p < 0.05$  level.

Regression analysis concluded that 20.89% of residual variability was accounted for by habitat type alone, therefore the factor of time was tested by a GLM. A second one-way ANOVA showed that differences in log bat activity between morning and evening twilight periods were significant at the  $p > 0.01$  level, [ $F_{(1, 62)} = 9.38$ ,  $p = 0.003$ ].

Arcsine RAI between habitats was also assessed through a one-way ANOVA. This showed that RAI differences were significant at the  $p < 0.01$  level, [ $F_{(2, 125)} = 4.78$ ,  $p = 0.01$ ]. Post-hoc analyse using Tukey's pairwise comparisons test showed that differences between the chalet and hillside habitats were significant, however RAI did not differ significantly between the woodland edge and the other habitats. Regression analysis concluded that 7.10% of residual variability was accounted for by habitat type, and 40.56% was accounted for by twilight period. A second ANOVA concluded that the differences between twilight periods were significant at the  $p < 0.01$  level, [ $F_{(1, 126)} = 85.98$ ,  $p < 0.00$ ].

A final set of ANOVA tests showed that temperature differences between habitats at the  $p < 0.05$  level were not significant, [ $F_{(2, 125)} = 1.06$ ,  $p = 0.35$ ], nor were differences in relative humidity, [ $F_{(2, 125)} = 0.35$ ,  $p = 0.71$ ].

### 3.5 Analysis of Covariance (ANCOVA) test

Due to the multivariate nature of the factors affecting bat activity, an analysis of

covariance (ANCOVA) test was used to increase statistical power (Cohen, 1977; Leech *et al.*, 2005). This showed that bat activity differences due to habitat were significant at the  $p < 0.01$  level, [ $F_{(2, 121)} = 13.57, p < 0.00$ ], as were differences due to RIA, [ $F_{(1, 121)} = 8.90, p = 0.01$ ]. The differences in bat activity due to the three covariates examined in this ANCOVA were determined not to be significant at the  $p < 0.05$  level; twilight period [ $F_{(1, 121)} = 0.14, p = 0.71$ ], temperature [ $F_{(1, 121)} = 2.22, p = 0.139$ ] and relative humidity [ $F_{(1, 121)} = 0.37, p = 0.54$ ].

## 4. Discussion

### 4.1 Interpretation of results

A logarithmic relationship between illuminance and time since the beginning of the twilight period was observed, which subsequent regression analysis showed to be very strong after Fowler *et al.* (1998b). The mean gradient in both time periods show the speed at which the sun rose at set at the study area, 56.37 °N. The mean twilight duration during the study in late summer was 62.5 min, which finished 18 days before the autumn equinox (UK Met Office, 2015; HMNAO, 2000). Roost emergence and bat activity is closely correlated with the timing of sunrise and sunset (Catto *et al.*, 1995; Swift, 1980), which Welbergen (2008) proved to be independent of environmental and meteorological factors. This was supported by our ANOVA and ANCOVA results, which showed that temperature and humidity had no significant effect on bat activity or RIA.

ANOVA and regression analysis showed that the primary limiting factor on RIA was twilight period, accounting for 40.56% of availability. In addition to this, post-hoc analysis on the effect of habitat on RIA stated that only the chalet and hillside grassland sites were significantly different. Differences between twilight periods are likely to have exaggerated by our sampling method, which relied on insect traps being counted and replaced at dawn (inferring nocturnal RIA) and dusk (inferring diurnal RIA), as Dipterans are primarily diurnal insects (Gregor & Dusbábek, 1982; Racey

*et al.*, 1998; Sanders *et al.*, 2011). However, Rydell *et al.* (1996) showed that the peak in Dipteran flight activity during the two-hour period prior to dusk was significantly greater than the rest of the day in West Scotland ( $t = 2.65, d.f. = 13, p = 0.01$ ); therefore, one could argue this induced bias in our results is a mildly representative estimation of dusk RAI, despite experimental inaccuracy. Despite the timing of insect flight and activity varying across different prey species, a similar study concluded that Dipterans constituted 88.6% of the Scottish pipistrelle's diet (Rydell *et al.*, 1996). Twilight period was also a significant factor affecting bat activity; yet when morning and evening data were compared within habitats, differences in the chalet site were the only group which expressed significance at a  $p > 0.05$  level. This suggests that habitat type played a greater role in limiting the level of bat activity at Cologin (Walsh & Harris, 1996; Norberg, 1994), confirmed by the results of an analysis of covariance.

Correlational analysis investigating the relationship of bat activity and RIA produced a Pearson's product moment correlation ( $r$ ) of 0.459, indicating a "modest correlation" (Fowler *et al.*, 1998b). However, a "weak" coefficient of determination ( $r^2$ ) suggests that other factors are affecting the relationship between bat activity and relative insect abundance. Although Tukey's testing showed that differences in RIA between the chalet and hillside habitats were significant, RIA at the woodland edge did not differ significantly from either habitat, despite an intermediate mean in both bat activity and RAI. Müller *et al.* (2012) presented the complications pipistrelles face when foraging in an open habitat such as the hillside grassland, due to both prey and predator abundance expressing much greater relative variability, and the difficulty faced when locating prey spatiotemporally via echolocation, which may explain this pattern of results.

Following ANOVA and ANCOVA testing, it can be concluded that habitat type was the major determining factor on pipistrelle activity at our study site in late summer. Activity was greatest in the chalet site, supporting Vaughan *et al.*'s (1997) theory that pipistrelles preferentially roost in rural

man-made structures and built-up areas; due to their warmth, stability and security from predators. Kush *et al.* (2004) showed that pipistrelle habitat choice is dependent primarily on local prey abundance and physical structure, both for roosting and foraging. In addition to these preferences, unequal prey distribution often results in aggregations of pipistrelles in favourable environments (Hildrew & Townsend, 1980; Cartar & Real, 1997). Such aggregations are the result of numerous behavioural trade-offs, explained by the optimal foraging theory (Charnov, 1976), where pipistrelles aim to maximise fitness and foraging while reducing effort and risk of predation (Townsend & Hildrew, 1980). This theory offers an explanation into the observed activity variance between habitats, suggests why activity was greatest at the chalet sample site, and why activity was lowest at the hillside grassland site.

Within-site variance in activity was greatest at the chalet sample site (SD:  $\pm 7.28\%$ ); however, this variance was much lower at both the woodland edge and hillside grassland sites (SD:  $\pm 0.23\%$ , SD:  $\pm 0.08\%$ , respectively). The relatively insignificant variance at the woodland and hillside sites can be explained by habitat homogeneity; where physical structure, prey abundance and roost availability are expected to be comparatively uniform. Wickramasinghe *et al.* (2003) showed how bat foraging activity decreases following agricultural intensification, which proved that transforming polycultures into monocultures significantly reduced activity. Conversely, the greater variance within the chalet group can be attributed to its relative heterogeneity, the greatest activity being recorded at sites C and D (see figure 1). Meyer *et al.* (2004) showed that structural and micro-climate heterogeneity had a significant effect on bat activity [ $r^2 = 0.46$ ,  $F_{(2)} = 23.8$ ,  $p < 0.001$ ], which was concluded to have the most profound influence on both bat foraging activity and insect abundance. These results introduce an element of uncertainty to our conclusions; it is unclear whether bat activity is affected more by habitat type or the degree of heterogeneity.

#### 4.2 Limitations and future research proposal

Due to the complex nature of this multivariate system, it is difficult to draw sound conclusions regarding the effect of one variable on another, as is the case with many observational studies (Egger *et al.*, 1998). This reduces the certainty of our conclusions, as the results are extremely vulnerable to the influence of confounding variables. Continuous variables from the RAI and bat activity correlational analysis are subject to bidirectional causation, as typical of most predator-prey relationships (Abrahms, 2000); therefore, direct causality cannot be inferred (Grafen & Hails, 2003). Considering the protected status of Pipistrelles and their roosts following the Wildlife & Countryside Act (1981), manipulative experiments are unethical and illegal, and therefore unlikely to be conducted.

Human sampling error may have affected data, in particular bat activity measurements. Firstly, the response time when logging bat activity (using a stopwatch) is expected to vary from reader to reader. Secondly, when monitoring at a sample site the direction in which the bat detector is orientated affects accuracy (MEL, 2008), which was not standardised across sites. Thirdly, although the bat detector's loudspeaker does not directly cause bat disturbance, proximate human presence is likely to deter bats, and therefore produce biased results (Swift, 1980). Finally, this study failed to differentiate between bat commuting time and bat foraging time within activity measurements, which may have masked interesting findings within the nature of bat activity (as found by Verboom & Spoelstra, 1999).

By virtue of time, resource, and labour constraints, the generality of conclusions from this study is negligible. Only one study area for each habitat type was examined, thus each observation was subject to the same random environmental factors, raising issues regarding the effect of simple spatial pseudo-replication (Hargrove & Pickering, 1992). Furthermore, data were collected over a period of five days in late summer, failing to account for seasonal and yearly variation in biotic factors such as pipistrelle



hibernation or prey abundance; and abiotic factors such as climate. Such close temporal proximity of readings may have resulted in temporal autocorrelation, and render samples temporal pseudoreplicates (Hulbert, 1984). Consequently, no broader biological inferences can be taken from this study, either spatially or temporally. To eliminate the effect of pseudoreplication from this study, repeat readings should be taken from March to November; in order to account for random activity variances due to differences in hibernation emergence times, mating season and other ecological factors (Swift, 1980). Simultaneously, replicate studies should be undertaken across a range of rural built-up areas, open grassland, and woodland edge habitats; allowing broader inferences to be made; which could have considerable implications for conservation orientated management schemes, allowing recommendations for efficient improvement and maintenance of ecosystem biodiversity to be made. In addition to improving the statistical power of this study, additional factors in this system may be explored in order to assess their impact on bat activity and prey abundance. Habitat heterogeneity may be quantified using estimations of land cover, soil and topography (August, 1983); to be examined as a covariate.

## 5. Conclusions

Pipistrelle bat flight activity and prey abundance was assessed using acoustic surveys across three distinct habitats (rural built-up area; woodland edge; and hillside grassland) at morning and evening twilight in rural West Scotland. Pipistrelles select their habitat in an attempt to maximise fitness and foraging success, while minimising effort and the risk of predation, explained by the optimal foraging theory. Bat activity was greatest prior to dusk. A significant difference in bat activity was proven across habitat types. ANCOVA results of this study indicate that habitat has the most profound influence on bat activity and prey abundance; however further analysis is required in order to compare the effect of habitat type and habitat heterogeneity, assisting rural conservation programmes to effectively promote bat activity.

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## Bat boxing in northern Scots pine

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### Summary

- Twenty four bat boxes were erected in mature pine woodland at Loch Fleet National Nature Reserve (NNR) in winter 2007. Boxes were monitored each year to assess bat use, from 2008.
- Two bat species; common pipistrelle and brown long-eared bat use the bat boxes as non-breeding roost sites. Common pipistrelle use continues to increase, whilst use by brown long-eared bats is decreasing.
- The highest number of bats use the boxes in the autumn for mating, but they are also used at other times of the year, including hibernation. Results suggest the number of boxes used has plateaued at an impressive 83%.
- Since 2011, common pipistrelle bats have been found to regularly use the boxes as a winter roost. This site is now monitored as a hibernation site under the National Bat Monitoring Programme.
- Discussion on use of the bat boxes by woodland birds early on within the project, pointed to a scarcity of suitable crevices and chambers for both birds and bats. Competition between birds and bats for the same nesting and roosting crevices is discussed.
- The bat boxes will continue to be monitored on a regular basis. This project remains a good opportunity for members of North Highland Bat Network to be more involved with bats. There is potential for similar companion bat box schemes in North Sutherland, Caithness and Orkney.



*Common pipistrelle.* © BCT.

## 1. Introduction

The Scots pine woodland at Loch Fleet supports a native pine woodland vegetation characteristic of *Pinus sylvestris* – *Hylocomium splendens* woodland (W18) identified in the National Vegetation Classification (Rodwell, 1991). A bat foraging survey within this pine woodland was undertaken in summer 2006. This found the mature pine woodland habitat within Loch Fleet NNR supports four bat species; common and soprano pipistrelle, brown long-eared bat and Daubenton's bat. The survey found that Loch Fleet's pine woodland supported a lower density of foraging bats than two other native pine woodland sites in Sutherland; Amat Wood and Migdale Wood.

It was considered that this could have been due to a lack of pine trees supporting suitable natural roosting crevices, as the Scots pine woodland at Loch Fleet is largely even-aged and mature (SNH 2015a).

Bat box schemes have been found to be most effective in isolated areas where there are few buildings, and conifer forests where tree holes are scarce (Swift, 1998). Bat boxes are an important resource to bats and have obvious value in conifer plantations (Mitchell-Jones & McLeish, 2004). Thus, a project to introduce bat boxes at Loch Fleet NNR was established, aiming to enhance the bat population using the pine woodland habitat (Fig.1).

**Figure 1 – Mature even aged Scots pine woodland at Loch Fleet NNR, with limited understory and natural regeneration.**



## 2. Objectives



The initial main objectives of this project included:

- a) To assess responses of bat populations at Loch Fleet to the introduction of artificial roost sites.
- b) Monitor a pine woodland bat population, helping to increase our knowledge of bats within Sutherland and contributing results to the National Bat Monitoring Programme.

### 3. Methods

Twenty-four bat boxes (Schwegler type) were erected within pine woodland habitat in December 2007. Two different bat box types were used (12 each of 2F [double front panel] & 2FN) to gauge which type might be preferred by bats (see Fig. 2).

Using a consistent survey approach, three monitoring visits (May, July & September) were initially undertaken to

assess bat box usage from 2008-2010. Based on the results of this three year period, it was decided to focus monitoring effort on the autumn period to coincide with peak bat activity. Even though bats may not have been present during monitoring inspections, bat box use was still assessed based on bat droppings within boxes. Bat droppings were cleaned out after each visit to allow an assessment of use to be made after each survey. Bats found roosting within the boxes were removed and aged/sexed where possible to allow a better understanding of how bats were using the boxes.

Winter maintenance on bat boxes in 2011/12, found several common pipistrelle bats over-wintering. One hibernation visit has been conducted in mid-January ever since, where a small number of bats are normally found hibernating within the bat boxes. This bat box scheme has been registered as a hibernation site under the National Bat Monitoring Programme (NBMP).

**Fig 2. – Bat boxes used at Loch Fleet, box A (left - 2F) and box B (right – 2FN).**



**Fig 3. – Lyn Wells assessing the age and sex of a pipistrelle bat from a bat box.**



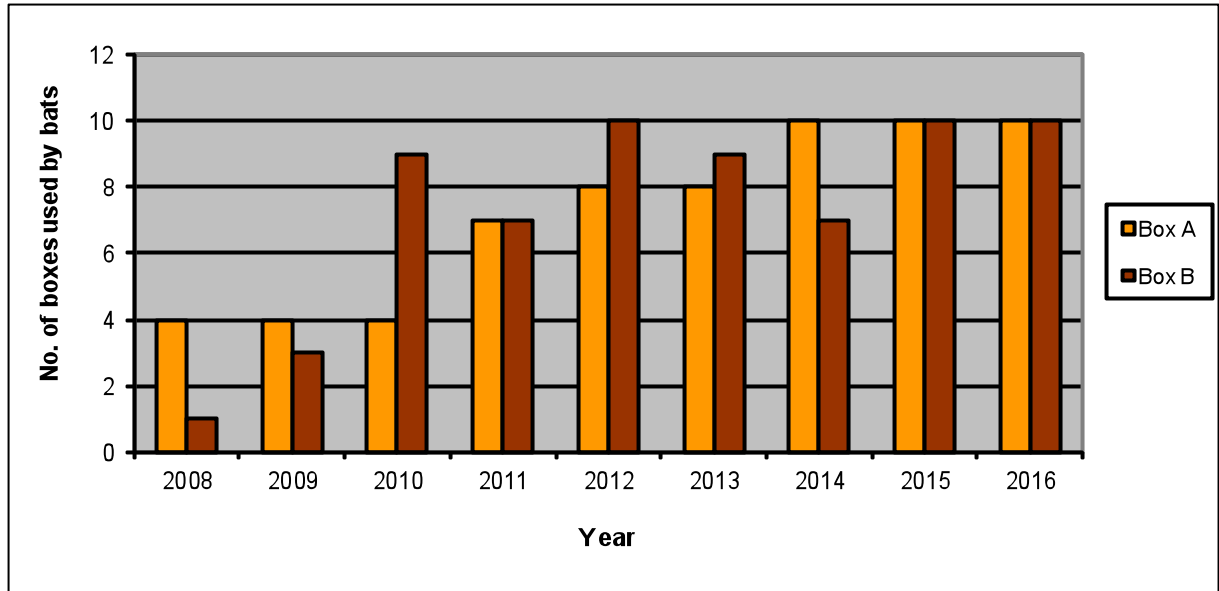
### 4. Results



Five bat boxes were used by bats during the first year of the project (2008). In 2009 cumulative total box use increased to nine (41%). This increased again in 2010, to 13 boxes (54%) being used.

Results from 2015 and 2016 (year eight and nine respectively) show that the number being used by bats has now plateaued at an impressive 20 boxes (83%), see fig. 4 below.

**Fig 4. - Bat box type and number of boxes used by bats at Loch Fleet NNR 2008-2016. This includes assessment of both bats found and bat droppings.**



**Figure 5 - Restrictor fitted within 2FN bat box to prevent use by nesting birds.**

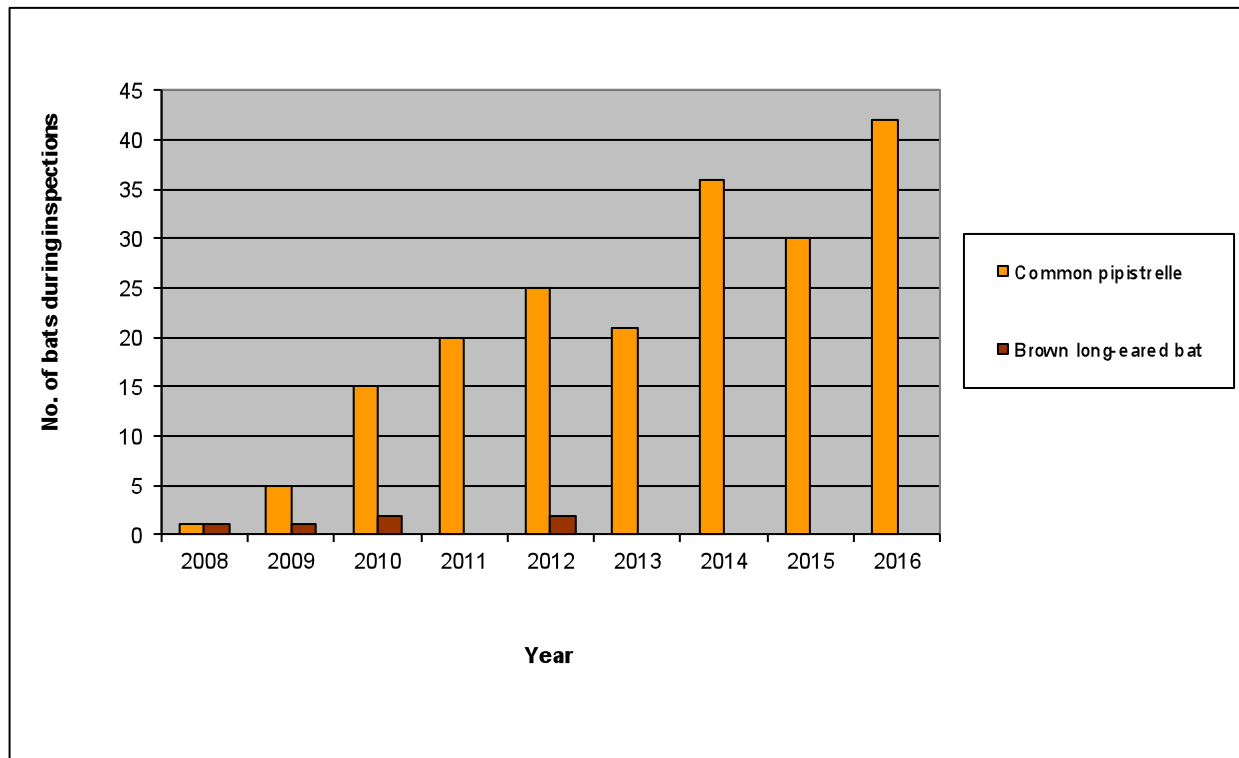
The smaller bat boxes (box A) which are promoted as being more attractive to smaller bat species (such as pipistrelle’s) supported more bats within the first two years of the project, but were overtaken by a preference for the larger cavity boxes (box B) from 2010. Box B was fitted with an internal ‘restrictor’ during winter 2008, as bird use of bat box B (both roosting and nesting) was high at 67%. This restrictor reduced the aperture entrance to the bat box making it more attractive to small bats and less attractive to woodland birds (see fig. 5).

Initially, 2010 proved to be the best bat monitoring year, with 10 boxes showing evidence of bat use and seven supporting roosting bats. An impressive 21 bats were found roosting with the bat boxes, including 4 brown long-eared and 17 common pipistrelle bats (from a spring, summer and autumn visit).

Common pipistrelle use of the bat boxes continues to increase, with a maximum of 42 bats found during September 2016. No boxes were found to have been used for maternity roosts (2008-2010), but this site continues to be used increasingly during the transitional post-breeding period. Results from sexed bats in each box indicates that peak use at Loch Fleet takes place in mid-

September, when they use these boxes are used as communal mating sites. Often one male will accompany a box of three or more female bats, indicative of mating behaviour at this time of the year (Altringham, 2003, p.146). Only six brown long-eared bats have been found in September over the period 2008-2016, compared to 195 common pipistrelle.

**Figure 6 – Bats found within boxes at Loch Fleet NNR in September 2008-2016, during inspections.**



**Table 1 – Common pipistrelle wintering within bat boxes.**

Year	No. of bats (Max group size)	Box type	No. & aspect of box
Winter 2011/12	3 (2)	Three in A/2F.	Two south-east
Jan 2013	0		
Jan 2014	9 (6)	Seven in A/2F & two in B/2FN.	Four south-east
Jan 2015	6 (2)	Four in A/2F & two in B/2FN.	Three south-east & one north-west.
Jan 2016	3 (2)	One in A/2F & two in B/2FN.	Two south-east

## 5. Discussion

Interestingly, perhaps the high proportion of woodland birds using the larger 2FN bat boxes (67%) prior to fitting a restrictor could have arisen due to the scarcity of bird nesting and roosting sites within the even-aged pine woodland. It is therefore likely that competition for these chambers and crevices may be high between bird species and even between animal groups (birds v. bats). If this assessment is indeed a reflection on the paucity of natural woodland features which can be used by bats within Loch Fleet NNR, then it can be deduced that the provision of bat boxes will clearly aid bats to find new and suitable roosting cavities that were otherwise unavailable. At least one other bat box study using Schwegler boxes has also employed modification techniques to reduce bird use (Bilston, 2014).

Although four bat species have been recorded at Loch Fleet, only two species have used the bat boxes thus far; common pipistrelle and brown long-eared bat. However, the two other species of bat, Soprano pipistrelle and Daubenton's bat, are known to occasionally use the pine woodland habitat, either passing through or foraging. Therefore, an important consideration of this project is that there is roosting potential available for these more uncommon species, should they choose to use the boxes.

We were initially surprised to find bats hibernating within our bat boxes, especially as almost all of these are in more exposed and open woodland habitat, where almost all boxes face south-east to the winter sun. Therefore, the temperature fluctuation within these bat boxes, even in the winter, is likely to be significant. In addition, humidity is likely to be very low due to their exposed position. There are other examples of common pipistrelle hibernacula being found either with a low humidity, and/or

semi-exposed to regularly occurring changes in temperature (Herman & Smith 1995, p.18; Pritchard 1992, p.39-40; Altringham 2003, p.127). This re-affirms that common pipistrelles can readily winter in such conditions which may not be suitable for other bats, such as *Myotis*.

Common pipistrelle either tolerates these sub-optimal hibernation conditions, or indeed favours them over and above any other available wintering sites (e.g. a nearby ice-house). These small bats are clearly favouring boxes facing south-east, rather than boxes facing north-west, which means they will receive a greater fluctuation in winter temperature and humidity than if they had chosen those facing NW (see table 1). In Highland region, where ambient temperatures are cooler than other parts of the UK, perhaps the common pipistrelle can be even less specific about its choice of wintering roost requirements. One distinct advantage for common pipistrelle hibernating in these places could be a rapid awareness to mild temperatures allowing individuals to forage during suitable winter evenings (Dietz *et al.* 2009).

Figure 6 shows how many bats were found during bat box inspections. However, using both 'bats found' and 'droppings' assessment our results indicate that the presence of brown long-eared bat has been recorded on 24 occasions. These results suggest that this species appears to favour larger bat boxes, with 21 (87%) records of brown long-eared bat coming from the larger capacity 2FN bat box. All but one of these records occurred after the restrictor was fitted. This has also been found at another UK bat box monitoring scheme, where the brown long-eared bat favoured the large capacity Schwegler 1FS bat box (Dodds & Bilston, 2014).

Standard construction bat boxes, such as the Schwegler bat box are largely maintenance-free, durable and long lasting. Using standard Schwegler boxes can help establish consistency between bat box schemes providing greater potential for comparing results.

At this present time, we could not find any information to suggest that the presence of common pipistrelle, which regularly uses both box types (see fig. 4) at Loch Fleet, could be displacing other bat species (e.g. brown long-eared bats) from using them. There appears to be little information available, on effects of competition between UK bat species for available roost sites. Research suggests that species use of bat boxes can be influenced by siting of boxes within woodland which offers a range of environmental conditions, such as temperature (Bilston, 2014).

#### *Bat survey experience*

Bat box monitoring visits are a great opportunity for bat handling and group working. The September visit at Loch Fleet NNR is promoted to members as being a good opportunity to get close experience of bats, as it is the most productive period for bat use. With few known bat roosts to monitor within North Highland, Loch Fleet bat box project offers great opportunity to discuss bat survey and research with others.

We would encourage and be willing to help other bat box schemes to become established in other parts of northern Scotland which could complement work already done at Loch Fleet. There is potential for small companion schemes in central/north Sutherland, Caithness and Orkney.

## **6. Conclusion**

The bat box project at Loch Fleet NNR has been successful in meeting its objectives. It is likely to have contributed to local bat conservation by providing suitable bat roosts which may be naturally scarce within the mature pine woodland habitat. This bat box scheme is now recognised within the Management Plan for Loch Fleet NNR as a valuable project contributing to biodiversity and volunteering within the nature reserve (SNH, 2015b).

Subject to available funds, it is proposed to establish several of the larger 1FS bat boxes to gauge if they prove more attractive for brown-long eared bats. Bat boxes will continue to be monitored by members of North Highland Bat Network for as long as possible.

## **7. Acknowledgements**

We would like to acknowledge support in the field from other North Highland Bat Network members, including; Karen Reid, Marina Swanson and Tom Talbot. Initial support for this project came from Les Hatton & Gary Mortimer (Fife Bat Group) and Anne Youngman (BCT - Scottish Bat Officer).

We would also like to thank Scottish Natural Heritage for grant support to get this project started, and also to the owner Sutherland Estates. Scottish Woodlands Ltd (the estate woodland agents) ensures box trees are retained for future use. Adam Rose (SNH NNR Manager) also provided ongoing encouragement. Thanks also to the SNH Licencing Team, as all work on this project is done under an appropriate bat survey licence.

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**January 2017.**



# Bat recording in Aberdeenshire for North East Scotland Biological Recording Centre Mammal Atlas

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North East Scotland Bat Group (NESBATS) has been working in partnership with North East Scotland Biological Records Centre (NESBReC) to collect bat records in NE Scotland. The drive for the survey effort was:

- A lack of bat records in the area, and;
- Need for more records to support the production of a NESBReC Mammal Atlas in 2016.

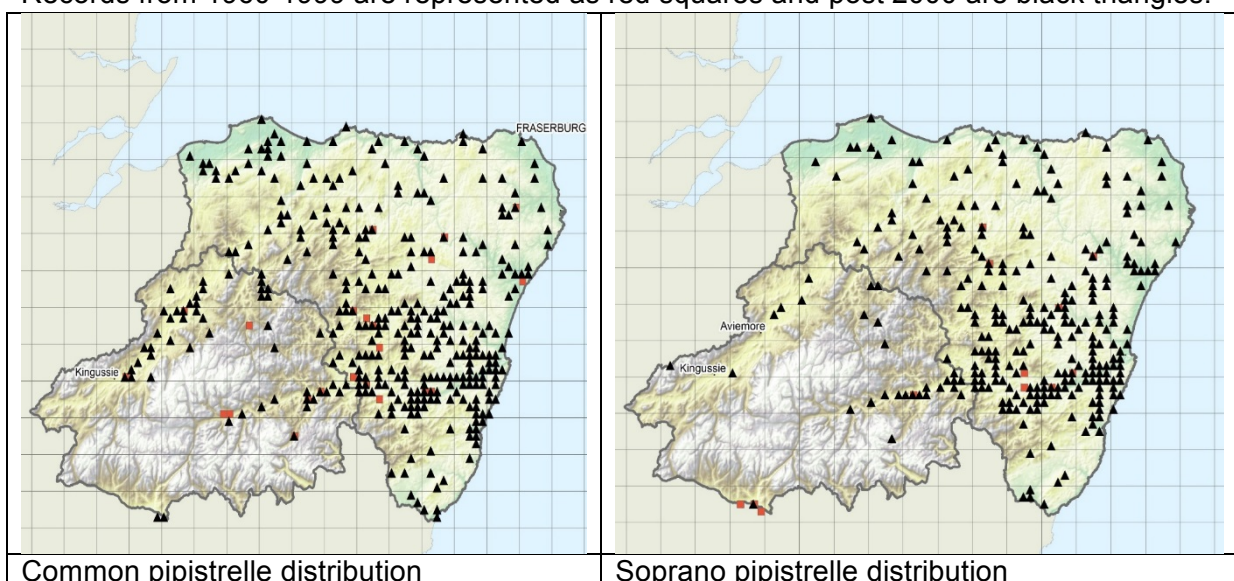
Aberdeenshire Council were able to support NESBATS in buying an SM2 Bat+ passive bat recorder in 2013 as part of the Mammal Atlas project. In addition, since spring 2015 a second passive recorder (Anabat Express) has been kindly loaned to the group. With two passive bat detectors it has been possible to collect many more bat records, including under-recorded species. The local Ranger Service has been very supportive in helping to move detectors around, in return receiving bat data for their sites.

The location of the detectors was decided on a practical level according to where Rangers and bat group members were active and where there was a lack of bat records. Some sites had a few hours of recording where the recorder was put out on the way to a bat survey and collected on the return. However, most sites had 2-4 days of recording and some interesting sites had 2-3 weeks with repeat visits. The records were analysed using Anlook software.

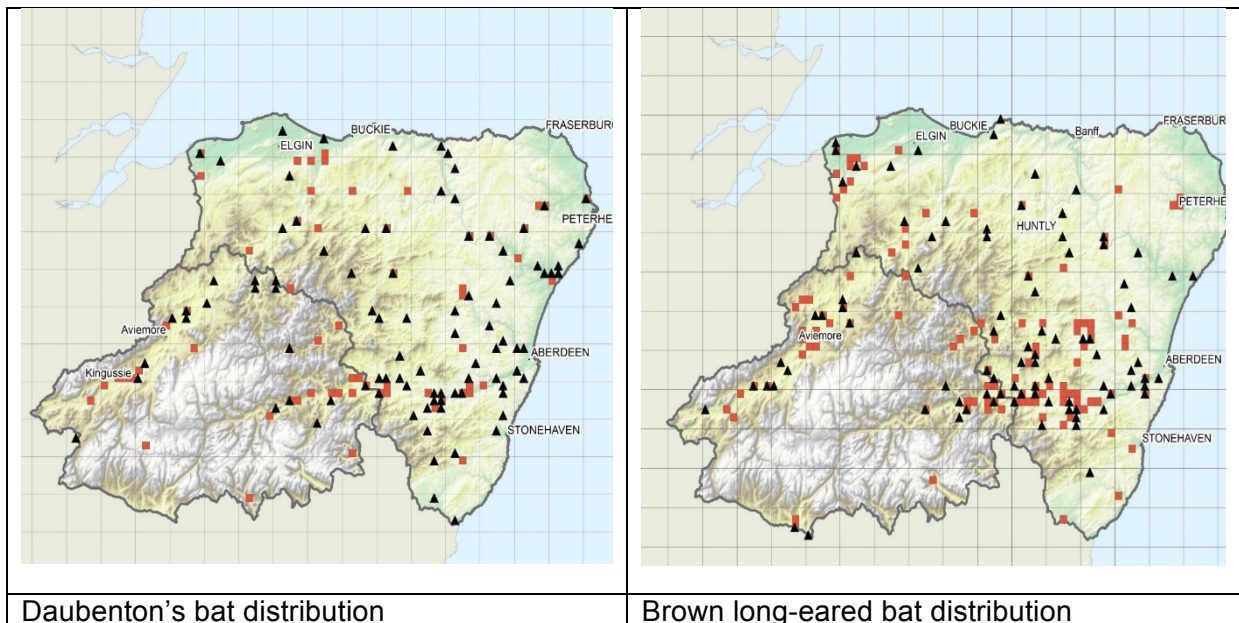
Bat surveyors for commercial surveys also submitted their records to NESBReC. Surveyors are using more effective recording equipment which has the potential to address under-recorded species, even where roosts are not identified. Sharing data with local records centres is regarded as good practice for commercial bat surveyors (Collins, 2016).

## NESBReC Bat Maps

The maps show the distribution of bats in the database at 2km square resolution and will be published alongside bat species accounts which have been written by NESBATS volunteers. Records from 1960-1999 are represented as red squares and post 2000 are black triangles.



There has been an increase in the number of general records of Daubenton's bat, common and soprano pipistrelles through the use of static recorders and submission of records by surveyors. Concentrations of records may reflect surveyor bias as seen by the coverage of the widespread pipistrelle species (see above maps).



The following records of Leisler's bats and Nathusius' pipistrelle are worth detailing, along with records of Natterer's bats, which are poorly recorded.

### 1. Leisler's bat (*Nyctalus leisleri*)

The Mammal Atlas had five records of Leisler's bats. One from a planning survey conducted for the new Aberdeen ring road near the River Dee in the summer of 2006, a second from Forvie National Nature Reserve in autumn 2015 and incidental records during surveys around Banchory, Lumphanan and Aboyne in summer 2016. Rydell *et al* (1993) recorded Leisler's bats in Aberdeen and the lower reaches of the River Dee in 1993 but these are not in the NESBReC database.

Leisler's bat © Hugh Clark/Bat Conservation Trust



At Forvie, Leisler's were recorded on an Anabat Express and the call ID was verified by John Haddow. The recording site was at Sand Loch by the coastal village of Collieston. The loch is 400 metres from the coast and is situated on the edge of extensive dunes and coastal heath. The nearest woodland is a small and isolated shelter belt 500 metres to the north. The recordings are from the evenings of 14<sup>th</sup> to 17<sup>th</sup> September 2015, and are mainly of bats echolocating at 27-30kHz, including a feeding buzz. The detector was at the water's edge by some scrub, therefore the calls are likely to be associated with foraging close to the water surface and/or scrub as the site is otherwise very open. Migrant birds were coming in off the

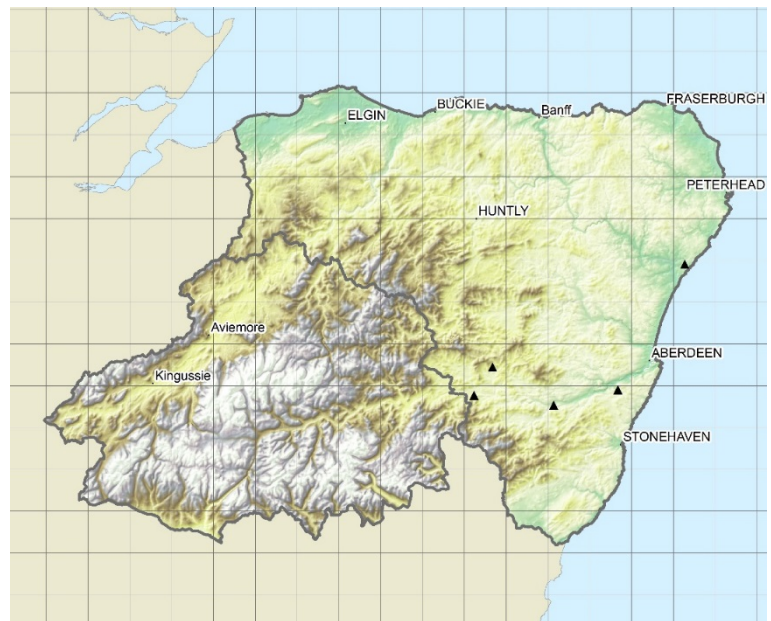
North Sea during this same week and Nathusius' pipistrelle were also present on the site during this time.

In summer 2016 Leisler's were recorded at three sites on Deeside. By the River Dee in the town of Banchory and close to Aboyne, both with a mixture of woodland and farmland near the sites. The other near Lumphanan was close to a small watercourse in a farming landscape, with a plantation woodland nearby.

It seems that Leisler's bats are resident in Aberdeenshire. Hopefully over time we will gather more information on their distribution and seasonal patterns.

**Table and map showing Leisler's bat records**

<b>Sand Loch, Forvie</b>		
Date	Bat passes	Time
14/9/15	3	22:32 - 22:34
15/9/15	26	21:52 - 22:55
16/9/15	13	20:02 - 21:02
17/9/15	3	00:14 and 23:59
<b>River Dee, Banchory</b>		
19/5/16	9	22:13 - 22:36
<b>Lumphanan</b>		
24/8/16	1	21:11
<b>Aboyne</b>		
11/8/16	1	
25/8/16	1	



## 2. Nathusius' pipistrelle (*Pipistrellus nathusii*)

The Nathusius' pipistrelle project has several records of grounded bats and three bat detector records from Aberdeenshire. Many bats have also been found on oil rigs and ships operating in the North Sea. See [www.nathusius.org.uk](http://www.nathusius.org.uk). However the NESBReC database had only one previous record for the area at Peterhead.

An Anabat Express was placed in a garden adjacent to Inchgarth reservoir on the west side of Aberdeen in July 2015. Nathusius' pipistrelle were present on 3 out of 4 days, likely commuting through the garden to the reservoir. The recorder was at the edge of the reservoir in November 2015 and March/April 2016 during mild weather. While common and soprano pipistrelles were present there were no Nathusius' pipistrelles recorded. Nathusius' pipistrelle were then recorded on 3 out of 6 nights of recording in late May 2016 and at a bat group evening on the 26th May 2016 where they were seen foraging over the edge of the reservoir and along the woodland edge. None were recorded between the 21st and 26th July.



**Map showing distribution of *Nathusius' pipistrelle***



**Nathusius' pipistrelle recordings at Inchgarth reservoir – Anabat Express**

Date	Bat passes	Time
4/7/15	50 (+7?)	00:51 – 02:05
5/7/15	2	01:23
6/7/15	2 (+3?)	02:07 – 02:09
26/9/15	Absent	
5/11/15 – 10/11/15	Absent	
14/3/16 – 27/3/16	Absent	
1/4/16 – 5/4/16	Absent	
21/5/16	55	22:44 – 02:35
22/5/16	17	22:49 – 22:53
23/5/16	8	01:44 and 22:37 – 23:09
21/7/16 – 26/7/16	Absent	

**Nathusius pipistrelle © Hugh Clark/Bat Conservation Trust**



In autumn 2015 bat detectors were put out at large water bodies near the east coast in anticipation of bats migrating from across the North Sea. The sites were Sand and Meikle Lochs near Collieston and Loch of Strathbeg near Fraserburgh. *Nathusius' pipistrelles* were present at all three sites with large numbers of recordings, the bats presumed to have arrived on migration with the early dates coinciding with the arrival of migrant birds. Follow up surveys in spring until May 2016 showed a continued

presence. Detectors will be deployed again in August 2016 to establish if bats are present ahead of the September migration period. A recent record at Loch of Skene further inland showed that *Nathusius' pipistrelle* are present here in the middle of July. There have also been reports of their presence during summer on the lower reaches of the River Don close to Aberdeen. The indications are that this species is resident in Aberdeenshire albeit in small numbers.

<b>Sand Loch, Collieston</b>		
13/9/15	to	Present
18/9/15		
19/9/15	to	Absent (weather fine)
23/9/15		
2/4/16 to 14/4/16		Present 3 out of 13 days
14/4/16	to	Present 5 out of 9 days with active bats
23/4/16		
<b>Meikle Loch, nr Collieston</b>		
2/10/15	to	Present
3/10/15		
4/10/15	to	Absent
9/10/15		
17/10/15	to	Present 1 out of 9 days with active bats
28/10/15		
30/4/16	to	Present 9 out of 15 days
14/5/16		
14/5/16	to	Present
29/5/16		
<b>Loch of Strathbeg, Crimond</b>		
17/10/15	to	Present
23/10/15		
24/10/15	to	Absent (weather cool)
25/10/15		
26/10/15		Present
28/10/15	to	Absent
29/10/15		
31/10/15		Present
2/4/16 to 21/4/16		Present at least 8 out of 19 days with active bats
21/4/16 to 3/5/16		Absent
4/5/16 to 11/5/16		Present at least 2 out of 8 days
<b>Loch of Skene, nr Dunecht</b>		
15/7/16	to	Present 3 out of 5 days
19/7/16		

### 3. Natterer's bat (*Myotis nattereri*)

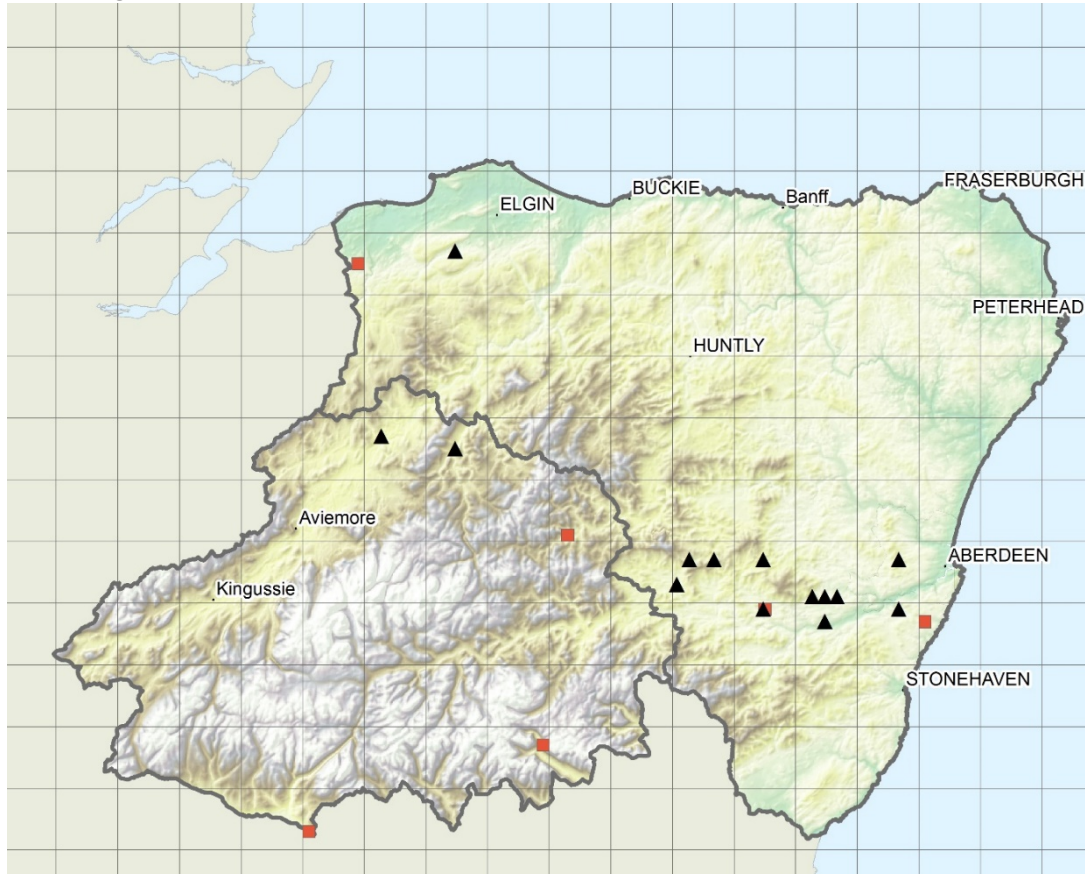
There are new records of Natterer's bats mainly from planning and NESBATS surveys in Deeside. Non-maternity roosts were found in holes in the walls or lintels of three farm steadings, two of which were still in periodic use for cattle. All steadings and additional activity records of Natterer's recorded, were in close proximity to extensive woodland or good networks of woodland in a farming landscape.

*Natterer's bat* © John Altringham/Bat Conservation Trust





**Map showing distribution of Natterer's bat**



### **Going forward**

The bat group will continue to collect records and submit these to NESBReC but additionally there is potential for more survey of the sites used by Nathusius' pipistrelle and Leisler's, possibly including radio tracking. More information will help our understanding of the seasonal patterns and to what extent they are breeding/resident or migratory. It appears that both Leisler's and Nathusius' pipistrelles may be resident in the area given the summer records but the group is not aware of any roosts to date. The use of static detectors by the group has greatly improved the quantity of data available but most especially the quality.

### **Acknowledgements**

Thanks to Aberdeenshire Council and Maurice Webber for the provision of static bat detectors and all those who have helped move them around Aberdeenshire. Thanks also to Glenn Roberts and Konstantinos Sideris at NESBReC for sharing the maps and John Haddow for assisting with call ID confirmation.

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## Kuhl's pipistrelle – ship assisted to Scotland

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On 23 October 2015, I received a phone call from Amanda Wilson, chair of the North East Scotland Bat Group. Would I be able to help with a bat? Of course I could, but this turned out to be no ordinary bat!

A male pipistrelle was found in a container, on a ship that had docked in Aberdeen originating from Romania. Having been collected by Isobel Davidson and passed onto Amanda, it became apparent that this was not a native species. After advice from Department for Environment, Food & Rural Affairs (DEFRA), I agreed to take the bat home with me in order to quarantine him. My bathroom was hastily converted to a quarantine facility, being the only room that could be made escape proof and inaccessible to humans and other animals. The bat was housed in a cage placed within another cage, and a padlock purchased to secure the bathroom door.

A few days later I was visited by a DEFRA veterinary surgeon, and the facilities were approved. The bat was identified, via a series of photographs, as a Kuhl's pipistrelle *Pipistrellus kuhlii*. He weighed 6.97g and had a forearm of 36mm. Despite his confinement, he appeared in good health with had no visible injuries and very few external parasites. However, he was a little skinny but took to mealworms quickly and within a fortnight his weight had increased to 9.6g. He would have to remain in quarantine for a minimum of three months, while a decision was made as to his fate by DEFRA.

Kuhl's pipistrelle's are commonly distributed across the Mediterranean and

North Africa, but are quite rare in Romania, only being found in the North East of the country (Dietz *et al.* 2009).

There have been at least 15 reports in the South of England, the first being in 1991. Whether this represents isolated vagrants or a small colony is unclear as there is no evidence of breeding. Dietz *et al.* (2009) indicates that some records from England (and Netherlands) are attributed to transported animals (i.e. Accidentals) but highlights the continual northward range expansion into north-west France and southern Germany, etc. However, Kuhl's pipistrelle is considered to be generally sedentary, other than small-scale dispersive movements (Dietz *et al.*, 2009).

**Fig. 1 - The ship assisted Kuhl's pipistrelle (photo – Mike Beard)**



In appearance, this bat was quite distinctive. As well as being considerably bigger than our native pipistrelles, the colouring is quite different. The dorsal fur is dark brown at the base but a pale beige

colour at the tips, giving a frosted appearance. The ventral fur is pale grey, similar to that of a *Myotis*. The wing membrane is much paler than in our native pipistrelles, and has a very distinctive white border to the free edge (Dietz & Keifer, 2014), see Figure 2 below.

Following an uneventful quarantine period, which involved filling many forms and a final visit from the DEFRA veterinary surgeon, a decision was made that he could neither be returned to Romania or released in the UK. This left the options of euthanasia or keeping him as a permanent captive. As he had taken so well to captivity, I decided to keep him. He

is now housed in a large cage with another non-releasable male Soprano Pipistrelle, and has already made 'guest' appearances at training sessions and conferences, so earning his keep well.

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**July 2016.**

**Fig. 2 – Kuhl's pipistrelle showing the distinctive pale trailing edge to inner wing membrane (photo – Amanda Wilson).**



## The National Bat Monitoring Programme (NBMP) in Scotland – can you contribute?

Becky Wilson, Bat Conservation Trust – NBMP Survey Co-ordinator  
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### Summary

*The Bat Conservation Trust's National Bat Monitoring Programme (NBMP) currently has 240 volunteers in Scotland and has surveyed over 800 sites across the country since it began. Twenty years after the project started and thanks to all the hard work from our volunteers the NBMP is now able to produce robust trends for three species at a country level for Scotland and with a small increase in survey participation we could get a clearer picture of how other species are faring in Scotland.*

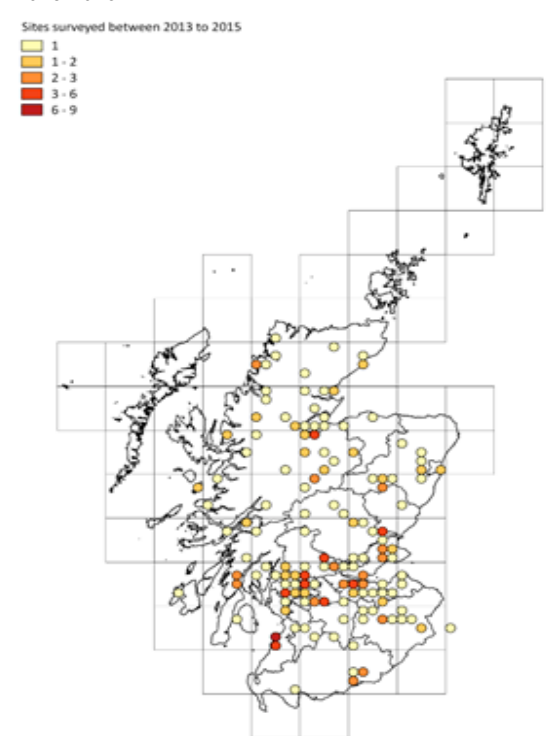
During the second half of the 20<sup>th</sup> century, bat populations in the UK suffered considerable declines driven by factors such as habitat loss and fragmentation as well as direct loss of bats from the effects of pesticides. In an effort to halt this decline, inform conservation policy and provide effective monitoring of resident species of bats in the UK, the National Bat Monitoring programme (NBMP) was established by the Bat Conservation Trust in 1996.

The NBMP has now been going for 20 years, making it the longest running multi-species monitoring programme for mammals in the UK. It currently produces population trends for 11 of the UK's 17 resident species. As our survey coverage has grown in Scotland we are now able to produce country level trends for three species in Scotland. The trends can be found in a trend note published by SNH (<http://www.snh.gov.uk/docs/A1759538.pdf>) and updated trends can be found in the 2015 NBMP Annual Report ([http://www.bats.org.uk/pages/nbmp\\_annual\\_report.html](http://www.bats.org.uk/pages/nbmp_annual_report.html)).

In our UK-level trends, Scotland is under-represented in the NBMP in terms of the number of surveys carried out given the

area of the country. Survey sites are also unevenly distributed across Scotland, with the majority of sites concentrated in the central belt compared to the highlands and lowlands where fewer sites have been surveyed (see Fig. 1). The Hibernation Survey is one of the most under-represented due to a small number of sites being monitored, which are concentrated in the southern half of Scotland.

**Fig.1 – Distribution of NBMP surveys in Scotland 2013-2015**





Anne Youngman, BCT's Scotland Officer, has been actively working closely with some bat groups in Scotland over the past year to help identify hibernation sites and provide valuable hibernation training. If you would like to get involved in the hibernation survey or you are currently monitoring a hibernation site and would like to share your data with the NBMP, please contact us at [nbmp@bats.org.uk](mailto:nbmp@bats.org.uk) or 020 7820 7166.

Despite under-representation in Scotland, survey coverage is sufficient to produce statistically significant species trends for Daubenton's bat, soprano pipistrelle and common pipistrelle (using data from the Waterway survey and the Roost Count survey respectively). This achievement is thanks to all the hard work, effort and late nights from our volunteers in Scotland.

Being able to report on how bats are faring at a country level is important in providing us with a clearer picture of bat populations, as UK trends may mask what is happening at country and regional levels. Therefore the continued monitoring of current sites is essential in maintaining the level of survey coverage needed to produce species trends at a country level, so to all our volunteers in Scotland, keep up the good work!

Just a small increase in survey effort could lead to more species being included in

country level trends. To help achieve this increase in survey effort in March 2016 the NBMP trained six new NBMP bat detector workshop leaders in order to increase our capacity to deliver NBMP workshops across Scotland. Our introductory bat detector workshop "Using Your Ears" is a great opportunity to gain more confidence in your surveying skills or refresh your knowledge, so if you are interested in attending a workshop please get in contact or visit our training page to find a workshop near you ([www.bats.org.uk/pages/nbmp\\_training.html](http://www.bats.org.uk/pages/nbmp_training.html).)

If you would like to take part and join the network of volunteers in Scotland and the UK that help monitor these fascinating animals visit our website to sign up (<http://nbmp.bats.org.uk/surveys.aspx>). The NBMP surveys are designed so that anyone can take part and enjoy themselves, from beginners to experts. As well as being of great value to bat conservation, it's a great way to get outdoors and connect with wildlife in your local area.

See the full SNH report, *Developing Scottish bat population trends through the National Bat Monitoring Programme* (2015) here: [http://www.snh.org.uk/pdfs/publications/commissioned\\_reports/796.pdf](http://www.snh.org.uk/pdfs/publications/commissioned_reports/796.pdf).

**June 2016.**

## The Perth Museum Brandt's bat *Myotis brandtii*, collected in the 19<sup>th</sup> century, the first record for Scotland?

John F. Haddow

The first, and until 2013, the only known record of Brandt's bat *Myotis brandtii* from Scotland is a single specimen currently held in the collections of Perth Museum and Art Gallery. The record is from a location in the southern Highlands, near Kinloch Rannoch, Perthshire, but the species distribution known from the late 20<sup>th</sup> Century extended northwards from England and Wales only as far north as the English side of the border with Scotland. For example R.E. Stebbings recorded Brandt's bat from bat roost boxes in Kielder Forest, in Northumberland, England, very close to the border with the Scottish Borders Council, Scotland (Stebbing and Walsh 1985).

### The origin of the Perth Museum Brandt's bat

The Perth Museum bat was originally identified as a whiskered bat *Myotis mystacinus*, a species very similar in morphology to Brandt's bat. The species *Myotis brandtii* was described in 1845 by Eversmann based on Russian specimens, but was not recognised as a separate species resident in Europe until 1970 (Hanak 1970). It was proposed by G. Topal, (Hungary) in 1958 and V. Hanak (Czechoslovakia) in 1965, based on specimens from Central Europe, that there were two separate species of whiskered bat in Europe, viz. *M. mystacinus* and *M. brandtii*. It was only after 1970 that "whiskered bats" were examined widely in Europe to determine which species they should be assigned to, and as a result the distribution of Brandt's bat is now recognised to extend from the United Kingdom, France and Scandinavia eastwards through Siberia to the Kamchatka peninsula, Sakhalin island and northern Japan [from its distribution shown in Harris & Yalden (editors) 2008].

The Perth Museum specimen was identified by Oldfield Thomas as *Vespertilio mystacinus* Kuhl on 18.6.1891 (Perth Museum records). The name also illustrates change in scientific nomenclature and classification, since the genus *Myotis* was described by Kaup in 1829 but at the time of the identification, *Myotis* bats and other Vespertilionid bats

(species in the family Vespertilionidae) in the UK were included in the older genus *Vespertilio*. Carl Linnaeus published *Vespertilio* in 1758 in the original edition of *Systema Naturae*, but in the present day only two species are assigned to this genus, including *Vespertilio murinus*, the parti-coloured bat, found in continental Europe and an occasional vagrant in the UK.

Oldfield Thomas worked in the Zoological Department of the Natural History Museum in London from 1878 until 1929 (at the age of 71 he committed suicide by shooting himself with a handgun while sitting at his museum desk). (Obituary, 1929)

The first published information on the bat specimen appears in a book by William Evans (1892). In a reference to the whiskered bat, he states (p.23): (referring to a Mr. Harting) "I am indebted for a clue which has enabled me to trace an undoubted Scotch example (the only one on record) of this species also. The specimen, which is in the Manchester Museum (Owens College), was captured by Mr. J. Ray Hardy of that institution, who writes me as follows:- "I took the Bat you mention about four miles from Rannoch on the road to Pitlochry, early in June 1874, while sugaring for *Noctuae*. I struck at him with my entomological net, and the cane rim caught him and knocked him down. He died in my hand." "

A later account was given by J.A. Harvie-Brown (1906), who quotes the location given by Evans, but goes on to say: "On applying to Mr. Hoyle of Owens College Museum, and asking for further particulars, that gentleman informed me it was "obtained at Dall, in the Black Wood of Rannoch." This lies in the opposite direction from Kinloch Rannoch (which I presume is what is meant by "Rannoch" as quoted) and from "the Pitlochry road," and thus, being about four miles from Rannoch, would give a locality some eight miles further west. Mr. Hoyle also adds that "the Rannoch specimen was probably taken in July 1865." Mr. Evans quoted direct from information supplied by Mr. Ray Hardy himself, but when I pressed this point, Mr. Hoyle wrote that he had interviewed Mr. Ray Hardy also, and the latter, at such distance of time, could not feel quite certain of the exact locality, and advised the acceptance of Dall as the true one. It may seem finical to insist upon such a slight difference in the two accounts, but it might prove of more importance than appears on the surface, because the characters of the two localities are very different, Dall being within, or close to, the old original Black

Wood of Rannoch and amongst pines, and the Pitlochry road being mostly fringed with natural birch and hardwoods."

The precise locality and the date of collection are therefore not known with certainty. Loch Rannoch runs west to east for 16km (10 miles), with the village of Kinloch Rannoch at its eastern end. The area is well known to Lepidopterists and a number of moth species were originally found here. Species with common names like "Rannoch Sprawler", "Rannoch Brindled Beauty" and "Rannoch Looper" are evidence of this. The Black Wood of Rannoch is approximately mid-way along the southern side of the loch. "Four miles from Rannoch on the Pitlochry road" suggests a locality approximately mid-way between Loch Rannoch and Loch Tummel on the B846 road. If one accepts Harvie-Brown's interpretation, then the locality is likely to be in the Caledonian Pine Forest remnant of the Black Wood of Rannoch (geographical coordinates 56°40'N 4°20'W). "Dall" in the 19<sup>th</sup> Century was Dall House plus associated estate buildings and housing. Today Dall is little changed from the late 19<sup>th</sup> century, as shown in a contemporary map, other than a few more houses built to the south of Dall House. The precise locality of collection in the Black Wood is unknown. There is a remnant of the original Black Wood straddling the Dall Burn at O.S. grid reference NN 586 555. It can only be a guess that if Hardy was "Sugaring for *Noctuae*" (moths) he would not have to go far along the Dall Burn to find a good location within the Black Wood. However the different versions of the date of collection mean that it could be either in July 1865 (Harvie-Brown 1906) or June 1874 (Evans 1892).

John Ray Hardy was a well-known entomologist at the Manchester Museum. Prior to his employment in this museum, he was Keeper of the Queen's Park Museum, Harpurhey, Manchester. During the 1880s he was involved in conservation

and transfer of collections from the Manchester Natural History Society and the Manchester Geological Society to the new museum buildings formally opened in 1888. He became an Assistant Keeper in the Zoology Department (the Manchester Museum) in 1889, and from 1901 held the title of Senior Assistant Keeper and Curator of Entomology until his retirement in 1918 (Standen 1921).

“Sugaring for *Noctuae*” refers to the practice, still used, of sugaring for moths, or smearing a sugary mixture on the bark of trees to attract Lepidoptera (*Noctuae* refers to moths in the genus *Noctua*, for example the large yellow underwing *Noctua pronuba*). It is reasonable to assume that while Hardy was sugaring for moths in the early part of the night, the bat flew in the vicinity of the sugaring site, perhaps attracted by the moths coming for the bait, or perhaps simply foraging in the area. He presumably swiped at it with his entomological net, hoping to catch it, but instead killed the bat with the rim of the net.

As to the date of collection, I have not been able to establish without doubt when Hardy was in the area, but his obituary, published in *The Lancashire and Cheshire Naturalist* (Standen 1921) provides some clues. John Ray Hardy was born on “Easter Sunday 1844” [7<sup>th</sup> April] and died on April 5<sup>th</sup> 1921. The obituary mentions that “... he collected extensively in Lancashire and adjoining counties, the Lincolnshire Fens, and North Wales. Later, he extended his excursions to Ireland and Scotland, on several occasions spending six months in a season at Killarney, or Rannoch (sic) ....” The implication is that he spent some months in the Rannoch area early in his life. There is also a mention of him collecting a rare beetle during a visit to Killarney in 1866. It is possible that Hardy collected the bat on a visit to the Black Wood of Rannoch in July 1865 when he was aged 21, the year prior to collecting in

Ireland. In his obituary there is a description of a trip to America in 1872 “to collect Coleoptera etc., on behalf of several gentlemen interested in Entomology” and “returning to England, after an absence of about 2 years” which suggests he returned home by 1874. Did he then make a collecting trip to Rannoch to collect insects in June 1874, rather than working on the collection made in America, “a great quantity of material, chiefly Insects, Mollusca, and Birds”? In my opinion, based on further investigation of collections made by Hardy, the later date is more likely.

### **Hardy and his entomological collections at the Manchester Museum**

I visited the Manchester Museum in December 2015 in order to examine specimens collected by Hardy, and to look for any documentation of his collecting. As Dr. Dmitri Logunov (Curator of Arthropods at The Manchester Museum) previously explained to me, there was very little published information from Hardy during his time at the museum, labelling of specimens was often very basic, and some of the lepidopteran and coleopteran material he had apparently collected was not present in the current collection, with no historical explanation for its absence.

Colin Johnson of the Entomology Department, The Manchester Museum, published a review in 2004, “British Coleoptera Collections in the Manchester Museum”. He provides accounts and biographies of collectors, and his comments under John Ray Hardy are significant.

Here are some of Johnston’s comments: “Notes: most locality data in his collection is very unreliable” “Specimens are/ were kept in small glass-topped circular pill boxes and printed locality labels placed inside next to the specimens; these pill boxes may also have similar or different data handwritten underneath each pill box. It is quite common to find numbers of

chalk land species of south eastern England labelled as being “shaken out of refuse, Mersey Banks” as well as many Scottish pine forest species labelled Sherwood! Some card mounts are actually recognisable as coming from several separate collectors . . . . ., but this is either not acknowledged or erroneous information is given. Hardy’s old records, even when published, should not be uncritically accepted nowadays” “Hardy and Sidebotham were the last links with the old Natural History Museum and Owen’s College, and they came from an age when the importance of precise capture data of insects and other natural history specimens was only starting to be appreciated.”

I looked through hundreds of Coleoptera specimens in the Hardy Collection cabinet, hoping to find some with precise locality and date data from the 1860s or 1870s but found that this sort of information only started to appear in the 1880s, with dates including months only becoming the norm from 1900 onwards. There were a few early specimens labelled “Rannoch” with no other data. The earliest specimen with more precise information (because clearly he collected from “Rannoch” on a number of occasions) was a Chrysomelid beetle labelled on the box “Rannoch, Perthshire, off Birch, Dall JRH” and alongside the specimen “Rannoch 1883”. Incidentally, in his handwriting, “Rannoch” can look like “Rannock”, but I believe he always spelled it correctly with an “h”.

Although Hardy published a number of notes and short papers in “The Entomologist’s Monthly Magazine” from 1865 onwards, I could not find any reference to collecting in Scotland. He wrote a letter from his Manchester address, published in his journal, dated January 1874, so he can be presumed to be back from his American travels by then. Although my search of his beetle collection was not exhaustive, I found only one pill box containing beetles presumably

from his transatlantic expedition. These were unidentified Chrysomelids simply labelled “Arizona” with no other data.

Hardy’s obituary includes some telling statements: “He was an excellent taxidermist and osteologist; a keen ornithologist, and entomologist, with a special liking for Beetles which were, first and always, his chief favourites, and a group in which he made many important discoveries. It was unfortunate that these discoveries should, in many cases through his reluctance to place them on record, fall to the credit of others who subsequently published them. Of late years he fully recognised the importance of recording notes and observations, as will be seen on reference to the prior volumes of this journal (sic). But it will always be a matter of regret to his friends that the many interesting observations made during his long life, which he could relate in the course of conversation but had never published and much valuable information he had acquired, should in a measure, die with him.” (Standen 1921).

### **Early specimens of bats in the Manchester Museum**

I was also able to examine bat specimens from the 19<sup>th</sup> century currently in the museum’s collection. Although the current collection is well documented and recorded on a computer database, there are no records of how the earliest specimens originally came to be in the collection, other than those labels for the specimens themselves. The condition, and mode of preservation of the Perth bat, indicates that it must have been prepared soon after collection, and not after a gap of years as either a dried specimen or preserved in spirit. The only other specimen in the collection preserved in the same way (i.e. dried skin with separate skull, see below) was donated on 13/07/1917. Only 7 specimens in the collection date from before 1900. The earliest label is 1893, 2 years after the Perth bat was identified. It is possible that



there were more bat specimens in the 1860s or 1870s but they deteriorated and were thrown out, but it is unlikely that there were very many. What is the likelihood of a specimen being donated in the 1860s or 1870s becoming mixed up with another specimen from that era? In other words, what is the probability of Hardy's specimen becoming mixed up with another bat, and in fact the Brandt's bat specimen came from elsewhere in the UK, such as the English midlands? It is a possibility.

The fact that Hardy lived in Manchester and worked for the Manchester Museum explains why the specimen arrived in its mammal collection. However he was not formally employed by the Manchester Museum until the late 1880s, and since there is no record of when the specimen was acquired by the museum, it cannot be certain whether it was donated as a fresh specimen, or if it was prepared and mounted elsewhere, and later donated, as were other bat specimens still in the collection. The earliest record of the specimen being in the Manchester Museum is from 1891 when it was identified as a whiskered bat by Oldfield Thomas (Perth Museum records). The location of the Perth specimen between its collection date (either 1865 or 1874) and 1891 is therefore unknown.

### **The Brandt's bat specimen in Perth Museum**

As a result of the publication of the record by first Evans and then Harvie-Brown, Perth Museum requested that the specimen be transferred from Manchester to the Scottish museum. The information on the specimen recorded on the current Perth Museum database states that "Henry Coates arranged for the transfer of the bat from Manchester Museum". Henry Coates was a curator at Perth Museum at the time. The record also states that the specimen was a donation, dated 19<sup>th</sup>

February 1916, from (Dr.) W. Tattersall, Manchester Museum.

The Perth specimen remained on the record as a whiskered bat, until it was sent to Robert E. Stebbings for examination in 1988. The museum has a letter from R.E. Stebbings, at the time one of the foremost experts on bats in the UK, and working at the Institute of Terrestrial Ecology, Monks Wood Experimental Station, in Northamptonshire, which no longer exists. In his letter dated 10<sup>th</sup> May 1988 to Steve Hewitt (working at Perth Museum) he states that the "whiskered bat" is a *Myotis brandtii*, "probably a 3 yr old+ adult". He adds the note, "An interesting record. Now find the colony!". Hewitt published this record in the Glasgow Naturalist journal (1989).

I examined the Brandt's bat specimen in Perth Museum in December 2014. Stebbings, in his letter (1988) says that "identification was confirmed by the size of the extra cusp on the 3<sup>rd</sup> upper premolar but also by the fact the p1 and p2 of the mandible were of similar size whereas for *M. mystacinus* p2 is very small." (p1 and p2 = 1<sup>st</sup> and 2<sup>nd</sup> premolar teeth)

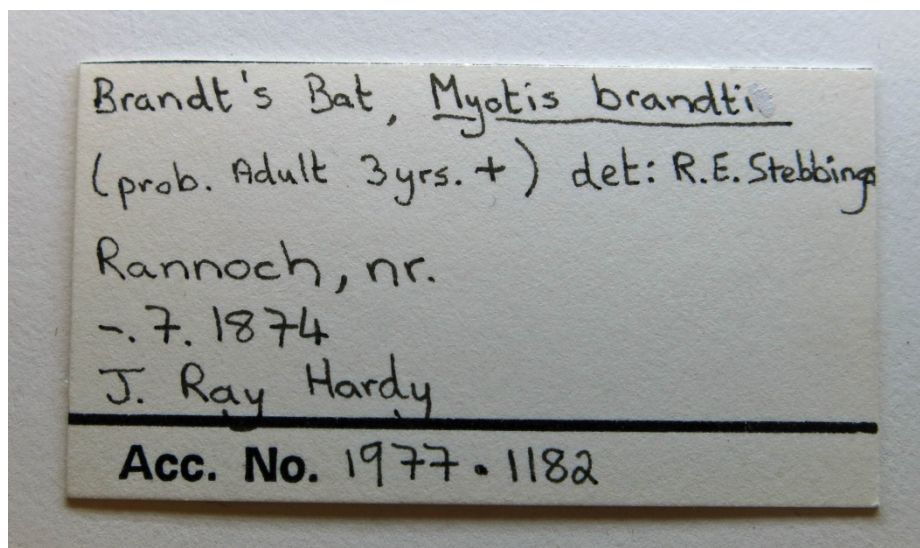
The specimen consists of two preserved components. The skin has been dried and mounted, and is contained in a glass display case with a wooden base. The skull and mandibles (lower jaw) have been cleaned and preserved separately. Identification of mammals using skull and dentition has long been a standard method used.

I was able to confirm the identification features described by Stebbings, still a normal morphological method for separating Brandt's bat from whiskered bat, which it closely resembles. Illustrated below (Fig.1) is a drawing from Hanak (1970) showing the differences in dentition.

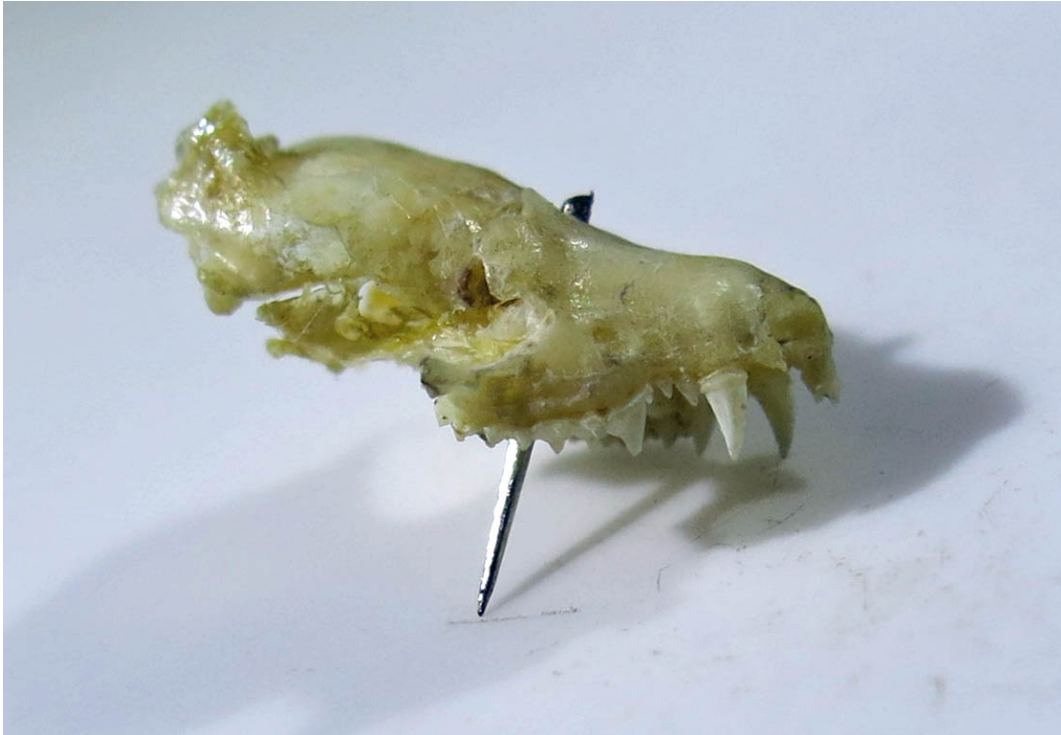
**Photo 1** the Perth Museum specimen of Brandt's bat *Myotis brandtii* mounted in its glass case. The colours of the skin and fur have faded with time and exposure to light. (photos 1 – 4, J. Haddow 02/12/2014)



**Photo 2** the label accompanying the Perth Museum specimen



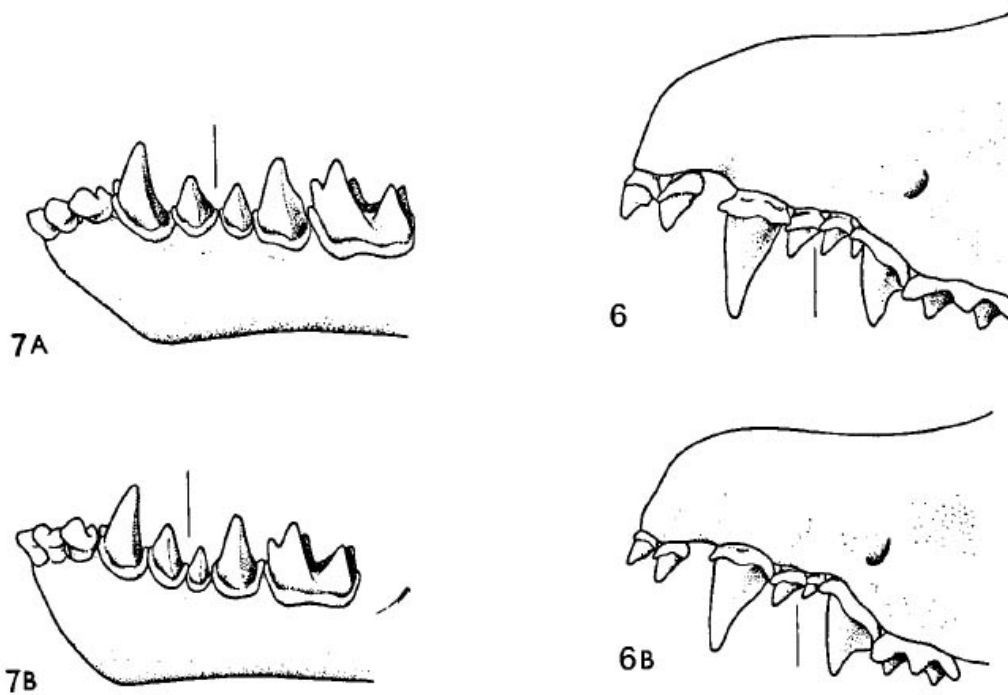
**Photo 3** The Perth Museum Brandt's bat skull. The species can be identified by the small cusp at the front of the large upper premolar 3, similar in height to the small pm2 in front of it.



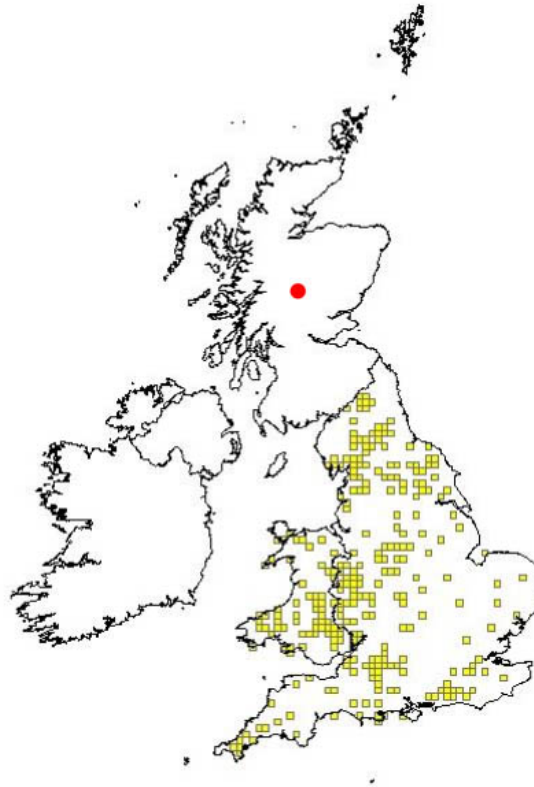
**Photo 4** the mandible (lower jaw) of the Perth Museum specimen showing the similar sized premolar 1 and 2 (premolar 2 in *M. mystacinus* is very small)



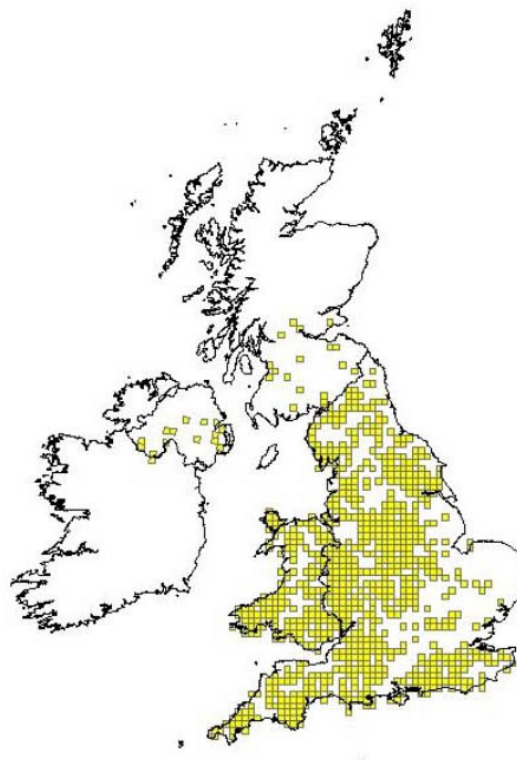
**Figure 1** illustration from Hanak 1970 showing the lower (left) and upper jaws (right) of *M. brandtii* (upper drawings) and *M. mystacinus* (lower drawings)



**Figure 2a** Brandt's bat distribution in the UK (JNCC) – the red spot shows where the Perth Museum bat was recorded.



**Figure 2b** whiskered bat distribution in the UK (JNCC)





**Photo 5** the Black Wood of Rannoch and the Dall burn (photo J. Haddow 05/04/2015)



**Photo 6** John Ray Hardy (standing, second from right) and the Manchester Museum staff in 1898 (source, the Manchester Museum)



### **The Perth Museum bat in relation to other records of Brandt's bat in the UK**

In 2013 a small roost of Brandt's bat was identified in a building owned by the Forestry Commission, near Newton Stewart in Dumfries & Galloway (R. Osborne *pers. comm.*). Identification of the contained DNA as from *Myotis brandtii* was confirmed using a faecal sample collected in the roost. The analysis was carried out at the School of Life Sciences, University of Warwick, where there is a laboratory dedicated to providing this service.

The known distribution of this bat species in the UK includes much of England and Wales, north to the Scottish border, so finding the species in southwest Scotland is not surprising (Fig.2a). Whiskered bats are found further north, uncommon, but one small nursery roost has been recorded north of Glasgow, in Blanefield, Stirlingshire, discovered in 1993 (Haddow 1993) (Fig 2b). The occurrence of Brandt's bat in the heart of the Scottish Highlands, so far north of any other records of the species, is an enigma. Is it possible that there was a more extensive population of the species in the 19<sup>th</sup> century? Was this a single stray bat that just happened to fly too close to an enthusiastic entomologist's hand net? If it was a stray bat, where did it stray from? Could it have reached the Highlands from southern Scotland, or did it fly over the North Sea from continental Europe?

Finally, it is necessary to add a cautionary question mark to the origins of this *Myotis brandtii* specimen. While there seems little doubt that John Ray Hardy collected a bat during one of his entomological trips to Scotland, there is a possibility that this specimen is not the same bat. Uncertainty over its early history makes it possible that at some date between the specimen arriving in the Manchester, possibly in 1874, and its identification as a whiskered bat by Oldfield Thomas in 1891, that it was

mixed up with another bat specimen. The origin of the bat in Perth Museum cannot be considered reliable. Unless there is further evidence for the presence of Brandt's bat in the Scottish Highlands, now or during the 19<sup>th</sup> Century, the northern limit of its natural range in Scotland should be considered to be Dumfries-shire and possibly the Scottish Borders.

### **Acknowledgements**

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