Narrowing down the possible roosting locations of *Myotis daubentonii* along a canal corridor in Scotland. A description of the methods used

Authors: Neil E Middleton* and David Dodds

Dated: 1st December 2005

*Correspondence details: 25 Killin Drive, Polmont, Falkirk, Scotland, UK, FK2 0QQ
email: middleneil@msn.com

Abstract
The BATS & The Millennium Link (BaTML) project used a survey process (Habitat Use Profiling) to clarify the likely location of *Myotis daubentonii* (Daubenton's bat) roosts on the Union and Forth & Clyde Canal network in Scotland. Three survey methods were used; the first employing remote bat detector units, the other two using volunteers with bat detectors. In the first method, adapted heterodyne bat detectors were linked to radio transmitters to provide a flexible method of recording bat passes over a broad area. Whilst the use of these remote units was valuable, occasionally problems were encountered with range, ambient ultrasound and reliability. All three survey methods used had strengths in differing circumstances and results would not have been as valuable had only one method been used.

Key words: Bats, Daubenton's, bat, heterodyne, detectors, radio, transmitters

Introduction

Between 2001 and 2005 the BATS & The Millennium Link (BaTML) project undertook a series of surveys relating to the activity of *Myotis daubentonii* (Daubenton's bat) on the Union and Forth & Clyde Canals in central Scotland (Middleton *et al*., 2004). Amongst other things, these surveys provided data on the initial direction of bat movement at each site (Middleton *et al*., 2005). On each survey evening, the direction of travel of the first bats recorded provided a good indication of the direction of the roost from which they had emerged.

Whilst some of the sites (N=5) presented a confused picture, most (N=17) offered a clear indication of the direction in which a *M. daubentonii* roost was likely to be found. By autumn 2003 the data collected had contributed towards us locating two important roosts used by *M. daubentonii* on the Union Canal.

In 2004 we began to consider how we could use the directional data, for our other 20 survey locations, in order to establish more precisely where the specific roosting sites were likely to be located. After reviewing our databases, it was apparent that as many as ten further roosts existed along the canal corridors. In order to begin to carry an exercise in fine tuning our knowledge a new survey programme was planned for 2005. An initial pilot study took place in 2004 in order to develop appropriate methods.

This aspect of the BaTML project was called 'Habitat Use Profiling' (HUP) and in addition to intending to narrow down the roost locations at the ten identified sites, it also included longer term objectives to map foraging activity and adjacent commuting corridors. Details regarding these latter two objectives will be reported upon separately at some point in the future.

Over the course of 2004 we piloted various methods, including the use of remotely positioned bat detector units, adapted to send signals back to a receiving station using radio technology. This new technique, along with two other more conventional methods, are described in this paper.

Selection of sites for study

With records available from 22 BaTML survey sites it was necessary to prioritise those for which the data already collected was strongest. We collated all of our knowledge and after careful consideration it was decided to concentrate our efforts on ten sites over the course of the 2005 season.

We anticipated that three nights work would be required for each site, with a minimum of four surveyors present on each occasion. The ten sites chosen were then further prioritised to ensure that our resources were allocated according to those where the location of a roost was most likely to be narrowed down.

It was not our expectation that this initial aspect of the HUP programme would find the precise location of any roosts, but it was hoped that it would be possible to identify relatively small areas where the roosts were likely to be or where bats were entering the canal network from adjacent commuting corridors. Having established this information we would then be in a stronger position to deploy other techniques (e.g. radio tagging) in future years to establish exact roosting locations.

Methods

Three methods were adopted and are described as follows.

(1) Radio detector surveys – materials, method and discussion

The primary survey method used was the Radio Detector Survey (RDS). This method employs remote heterodyne detector units. These pick up ultrasonic bat calls and transmits them to a central receiving location where a surveyor can listen to bat activity from many locations simultaneously. This approach identifies and records the movement of bats between each remote unit location, with a maximum of eight locations being live at any one time.

Remote Bat Detector Units

This method involved the use of eight custom built remote units. Photograph 1 shows four of the units, alongside each other, prior to being used, during a pilot exercise in April 2005. Each remote unit consists of four component parts:

(a) Ultrasonic microphone, with cabling attached and a telescopic pole
(b) Waterproof housing case
(c) Heterodyne bat detector
(d) Radio transmitter

Each of these components is described more fully as follows:

(a) Each ultrasonic microphone (Rapid Electronics, UK, Product Code 35-0184) is waterproofed and mounted on a lightweight telescopic pole. The pole allows the microphone to be positioned on the canal bank with sufficient height to avoid its reception being obstructed by vegetation, which attenuates sound (including ultrasonic bat calls). In addition, the microphone and pole is camouflaged in order to reduce the chances of detection by other people using the canal towpath. The microphone is then connected to a socket on the outside of the waterproof housing case (b) using screened audio cable (Digital Audio Installation Cable, Van Damme, supplied by Maplin Electronics, UK, product reference PE04E).

(b) Each waterproof housing case (a modified pistol case) is used to protect the bat detector components and the transceivers. It is also camouflaged to reduce detection by passers by. Further, to help protect the equipment within, shock proofing was introduced using of foam rubber. During surveys this case is placed on the ground, beneath the microphone described in (a) above, shielded from view by vegetation.

Photograph 1: Radio Detector System (four remote units pictured)

(c) Each heterodyne detector is adapted from Magenta kits (Magenta Electronics Ltd, Burton-on-Trent, Staffs, UK), modified to operate on a fixed frequency (35 kHz) and to provide a fixed audio output level. The audio output signal from the detectors is fed into the microphone sockets of PMR446 radio transceivers, a UK standard which is freely and cheaply available and requires no operating licence.

(d) Each radio transmitter is set up to transmit automatically upon detecting an audio signal from the heterodyne detector.

During surveys, just before sunset, the remote units are activated and positioned alongside the canal. The outermost units are usually positioned circa 1 km from the central receiving station, with the other units located strategically within the transect. The remote units, which use 9 volt PP3 batteries, are capable of lasting many surveys before a replacement battery is needed.

Receiving Station

In order to establish activity at each of the points where the above remote units would be positioned, it was necessary to build a central receiving station that would pick up any signal transmitted and identify which unit was active at any point in time during the survey analysis. Photograph 2 shows the final version of the receiving station used.

The receiving station consists of; four PMR446 CE-coded radios (each to monitor two remote units); a small bench upon which the radio receivers could be safely held in position; a light and a digital clock to allow the surveyor to easily establish the time of any activity being heard. Alongside the radio receivers, space is provided for a survey form in order to record written details of activity as it occurs. The radio transceivers, which use internal rechargeable battery packs, need recharging after each survey evening.

Photograph 2: Receiving station. Each receiver covered two radio detector locations simultaneously

Survey Protocol

Each survey commences at sunset and an experienced person (i.e. someone that could easily tell apart typical *Myotis* spp. echolocation from that emitted by *Pipistrellus* spp.) monitors the receiving station. As a bat passes each remote unit, its echolocation call is picked up by the ultrasonic microphone, converted to audio by the detector and sent to the transceiver, which then senses the audio and switches to transmit. The transmitted sound of the bat pass is then heard at the receiving station. Upon hearing the bat pass, the surveyor identifies which receiver it is coming from and the channel number from that receiver (each of the four receivers monitor two remote units on separate pre-determined channels). Because each channel number (1 – 8) represents an individual remote unit it is possible to identify where the bat is.

Listening to the audio allows the surveyor to identify whether the bat in question is of the genus *Myotis*, and therefore most likely to be *Myotis daubentonii,* or another genus/species (usually *Pipistrellus pygmaeus)*. Each pass is recorded sequentially on a survey form, with time, location and a note of any unusual aspects/concerns about identity. After the survey has finished it is then possible to link up recorded passes, as shown on the survey form, in an attempt to identify movement along the waterway. This approach is adapted from that used in BaTML standard surveys (Middleton *et al*., 2005).

Radio detector surveys - discussion

The quality of the equipment used was restricted, not only by the need to keep costs to a reasonable level, but also by the expectation that placing such equipment, unsupervised, alongside a busy canal towpath, made a degree of theft or vandalism inevitable, despite effective camouflage.

It was considered that more reliable results may have been possible by using higher quality ultrasonic microphones and transceivers with a higher transmit power and more precise functionality. However, the use of such equipment would have increased costs considerably and as a consequence increased the potential financial loss in the event of theft or vandalism.

Results were sometimes confusing, but more often than not a pattern emerged, indicating either a direction in which bats were moving through the area delineated by the remote units or a point amongst the units at which the bats were joining the canal. In the former, a further survey could then be planned to clarify or expand on the information. In the latter, a search could then be instituted for a roost in the vicinity of the point where the bats appeared to be joining the canal.

Whilst this survey method provided much valuable data, there were a number of limitations:

- For the reasons set out above, the equipment used was not always as reliable as might have been wished. It was not possible to set the transmit threshold on the radio transceivers with the accuracy and stability that might have been hoped for. It is also likely that temperature and humidity had an effect on efficiency, resulting in occasional malfunctions.
- During most surveys there were high levels of *Pipistrellus* spp. activity. The detector components we used lacked the narrower bandwidth of better detectors, therefore a number of *Pipistrellus* spp. passes were picked up. The detectors were set to 35 kHz in order to minimise this, but without the ability to adjust detector frequency whilst listening to a bat pass, it required experience to differentiate bat passes.
- In initial tests with prototype equipment during 2004 a range of up to 2 km was achieved, though strongly dependent on environment as UHF radio signals are severely attenuated by factors such as wet tree foliage or rising terrain. For security, the waterproof housing cases were placed on the ground, where they would not be too obvious to passers-by. The effect of having the transceiver antennas so close to the ground was to reduce the usable range. As the density of bank-side vegetation increased through the summer, so the range of the units decreased, until at its worst, the maximum usable range was circa 600 m. Placing the units in an elevated position would have improved this, though further exposing them to potential theft or vandalism.

- Despite considerable efforts to camouflage the units, one unit was stolen and two interfered with during the 2005 survey season.
- This system is dependent on bats moving through the area being surveyed. If a bat was feeding consistently in one small area this tended to swamp the survey as the same unit would be activated by the same bat several times each minute. In these situations we found it necessary to switch the affected unit off to prevent passes at other units being missed.
- The detectors were vulnerable to background ultrasound. Bats are not the only source of ultrasound and thus the transceivers tended to be activated by other factors. Often this was not a problem and it was sometimes amusing to track a cyclist or walker along the canal by the sound of their footsteps or wheels crunching on the gravel. However, in situations where strong wind or heavy rain created high levels of background noise, the system was extremely difficult to use due to the large numbers of false transceiver activations.
- At one site surveyed, the canal crosses a river. As it was felt likely that bats may move between the two watercourses, units were also set up alongside the river. Difficulties were experienced with these units due to the high level of background ultrasound created by the ripples on the river. Although this was alleviated by placing units alongside pools, rather than fast-flowing sections of the river, as *M. daubentonii* tends to feed over smoother water (Seimers *et al*., 2001) this then created the same difficulty as mentioned earlier.

(2) Manned detector surveys - method and discussion

As a development of the RDS, in locations where it was felt the radio detectors could not offer sufficient reliability or where the situation was especially complex, Manned Detector Surveys (MDS) were used.

In this survey method, pairs of volunteers are positioned along the canal towpath. Each pair has a heterodyne detector, usually a Bat Box III or Bat Box Duet (Bat Box Ltd, UK), a radio transceiver and a red-filtered torch (Monhemius, 2002). As a bat passes by, the surveyors briefly view it with the torch in order to confirm it as a *M. daubentonii* (i.e. it was flying close to the water surface) and also to check its direction of travel. The pass is immediately reported by radio so that the next pair of volunteers in the direction the bat is travelling is ready for its approach. At a central location, one volunteer is responsible for recording all reported bat passes in exactly the same manner as for the RDS.

Compared to the RDS, this method is intensive in its use of manpower. There is also a risk of bat behaviour being altered by reaction to the torchlight. However, these problems are balanced by several key benefits:

- Each bat pass has the potential to be visually, as well as audibly, confirmed as a *M. daubentonii*, thus removing uncertainties caused by identification based purely on audio.
- Direction of travel is usually clear at each pass, limiting uncertainty caused by bats changing direction.
- In the event of a pair of volunteers being positioned alongside a feeding site they can quickly and easily be asked to move position.
- Volunteers get a more hands-on and interesting experience.

(3) Back-tracking surveys - method and discussion

At some sites, whilst using either of the two methods described previously, it was ascertained that a large population of *M. daubentonii* commuted through a section of canal each night. At these sites our follow up work adopted a third survey technique, based on a method developed in the Netherlands (Limpens, 1993).

This technique involves waiting at sunset for the first emerging bat to pass, and then moving swiftly in the opposite direction from which it came. For a short period after emergence, as each subsequent bat passes by, it provides, by its direction of flight, an indication of where its roost is. This technique is particularly useful for *M. daubentonii* on a narrow waterway as the bats tend to follow and associate with this type of habitat (Vaughan, 1997; Altringham, 2003). When the waterway is a canal, with a flat, well-maintained towpath, the technique comes into its own.

This method was used for a small number of the sites with good levels of success. It has the advantage that it can be carried out by one pair of surveyors who are not tied to a particular spot. The surveyors can move along the canal for as long as the supply of commuting bats continues. At a site where 25-30 bats passed by, it was possible to understand their movements far more quickly than using either of the other two methods described.

It should be noted that in situations where the number of commuting bats is smaller, this technique is less suitable as it depends on a regular flow of commuting bats over a relatively short period of time.

Conclusion

It is interesting to note that the survey season commenced with a clear plan to use entirely Radio Detector Surveys. However, as the survey season developed, the strengths and limitations of that method became clear and it was necessary to adopt a varied menu of survey techniques to suit differing circumstances.

The surveys produced encouraging results for six out of the ten sites studied. These six sites have now been earmarked for intensive study during the period 2006 - 2008, whereby the BaTML project will concentrate its efforts in finding the exact locations of these roosts using radio tagging methods. In addition, the sites identified will now form the focus of our ongoing work in other areas (e.g. foraging, commuting, insect prey, and habitat assessment).

Acknowledgements

We are greatly appreciative of the funding obtained from Falkirk Environment Trust with regards to the RDS system. Without this funding we would have struggled to produce the results obtained.

In addition, we are also keen to acknowledge the support given to us by the following organisations: Scottish Natural Heritage, British Waterways, The Royal Bank of Scotland Group, The Bat Conservation Trust, BTCV, Central Scotland Bat Group, Clyde Bat Group and Lothians Bat Group.

Finally we would like to thank all of the volunteers that have been associated with this aspect of the BaTML project to date, including the following people who contributed a considerable amount of time and effort: Susan Craig, Sallie Deans, Christopher Gould (BaTML), Callum Hollywood, Jonathan Kendrew, Craig Macadam (BaTML), Shoana Mackenzie (BaTML), Kirsty Morrison (BaTML), Catarina Rie, Scott Riddell, Caroline Robertson, Stewart Storrie, Lesley Sweeney and Natalie Taylor.

References

Altringham, J. D. (2003). British Bats. HarperCollins, ISBN 000 220140 X. 117 - 118.

Limpens, H.J.G.A., (1993). Bat Detectors in a Detailed Bat Survey: A Method. Proceedings of the first European Bat Detector Workshop: Netherlands Bat Research Foundation. 79 - 90.

Middleton, N. E., Gould, C., Macadam, C. R., Mackenzie, S. and Morrison, K. (2004). Introducing BATS & The Millennium Link. A study of bats and their use of canal corridor habitat in the Central Belt of Scotland. BaTML Publications, Vol 1, 2 - 5.

Middleton, N. E., Gould, C., Macadam, C. R., Mackenzie, S. and Morrison, K. (2005). A new methodology for studying bats in narrow habitat corridors. BaTML Publications, Vol 2, 2 - 8.

Monhemius, L. (2002). Does torchlight affect the number of passes counted in the NBMP Daubenton's field survey? Bat Monitoring Post, The Bat Conservation Trust, April 2002, 15.

Siemers, B. M., Stilz, P. and Schnitzler, H. (2001). The acoustic advantage of hunting at low heights above water: behavioural experiments on the European 'trawling' bats *Myotis capaccinii, M. dasycneme* and *M. daubentonii*. Journal of Experimental Biology. Vol 204, 3843 - 3854.

Vaughan, N., Jones, G. and Harris, S. (1997). Habitat use by bats (Chiroptera) assessed by means of a broad-band acoustic method. Journal of Applied Ecology. Vol 34, 716 - 730.