Tubing, an effective technique for capturing pond bats above water.

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Abstract: Several bat species, including the pond bat (*Myotis dasycneme*), long-fingered bat (*M. capaccinii*) and Daubenton's bat (*M. daubentonii*) hunt primarily above water and predominantly use waterways as commuting routes. Researchers capturing such bats for scientific purposes frequently rely on a mistnet placed under a bridge, which is hoisted after each capture. However, capture rates using the hoisting technique tend to be poor, because many bats escape the mistnet while it is being lifted or pass the hoisted mistnet without being captured. Furthermore hoisting raises some bat welfare issues, such as the low visibility of the captured bats and the length of time between capture and release. Our concern for the welfare of the bats and our aim to make capture more effective has led us to design a new technique called 'tubing'. Tubing consists of a combination of traditional techniques, including hoisting. This article describes the tubing technique and the materials used. It compares the results of the hoisting and tubing techniques during a three year study, involving 134 trapping nights at 154 locations. 868 pond bats of the estimated 1775 flying on these routes were captured during the sessions. The results show a significant difference in capture rate between the two capture techniques, with the tubing technique resulting in a higher proportion of bats being captured than the hoisting technique. This difference was not reduced by the size of the bridge, time of the year, type of waterway or lake. Thus, we argue that tubing represents a more efficient and more ethical technique than hoisting. Other techniques for disentangling bats from a net stretched above water such as using a boat, a chest-wader or trip lines, are also discussed. These are compared with tubing and evaluated for suitability in different environmental conditions, the number of personnel needed and the welfare of bats.

Keywords: *Myotis dasycneme*, *Myotis daubentonii*, *Myotis capaccinii,* survey, bats above water, mistnet , hoisting technique, tubing, capturing, commuting, technique, capture rate.

Introduction

Several bat species, including the pond bat (*Myotis dasycneme*), long-fingered bat (*Myotis capaccinii*) and Daubenton's bat (*Myotis daubentonii*), hunt primarily above water. After sunset they leave their day-roosts and use regular commuting routes, often along waterways to fly to their hunting areas. Bridges on these routes offer good opportunities to capture these bats by using a mistnet since most bridges are located on narrow stretches of waterways and in an open landscape, they are the best places to conceal a mistnet because they act as a funnel.

Researchers capturing trawling bats for scientific purposes usually rely on hoisting the mistnet up and down from the bridge. As part of an ongoing research on the population structure pond bats and the use they make of the landscape, it was necessary to capture as many pond bats on commuting routes as possible. We experimented with various known techniques to reach the mistnet and release the bats: using a boat, using a chest-wader and hoisting. Each of these techniques had its own practical and ethical drawbacks. Our concern for the welfare of the bats and our aim to capture as many pond bats as possible led us to develop a new technique: tubing. In order to test the effectiveness of the tubing technique we applied both hoisting and tubing for the first three research years. In this paper, we compare the capture rates with both techniques and give a detailed description of the tubing technique.

Materials and methods

Study area

The study area covers about 1000 km^2 and is situated in the Dutch province of Zuid-Holland. This area is largely agricultural, but it also includes the cities of Leiden and Den Haag and the smaller towns of Bodegraven and Nieuwveen. The landscape consists mainly of open grassland. Eight clusters of relatively large wetlands are present: they include Kagerplassen, Langeraarse Plassen, Nieuwkoopse plassen, Reeuwijkse plassen, Valkenburgse meer, Wijde AA, Zegersloot en Zoetermeerseplassen/ Vlietlanden.

These wetland clusters are connected by a variety of waterways, including channels, ditches and small rivers, which are largely man made (figure 1). They have been constructed for various reasons; for peat exploitation and transport, drainage of polders, ship traffic and recreation. This has resulted in a pattern of long, straight and broad waterways.

A complex network of roads and highways intersects these waterways, with a large number of bridges. Most of the bridges are drawbridges, which can be opened. In large cities and at important highways there are fixed bridges. The surface of the drawbridges is usually between four and six meters above the water level. The bridges are often about 10 metres wide.

Description of the hoisting and tubing techniques

The use of a bridge

Both hoisting and tubing use a bridge to conceal the mistnet. For a bat flying in from the open end of the bridge, a mistnet hanging on the other side forms an effective trap. The bat, flying fast and relying on memory, cannot make a sharp turn in the restricted space under the bridge to avoid getting captured in the net (figure 2).

Figure 1. A typical waterway in the research area: linear in shape and located in an open landscape. *Photograph: Fons Bongers.*

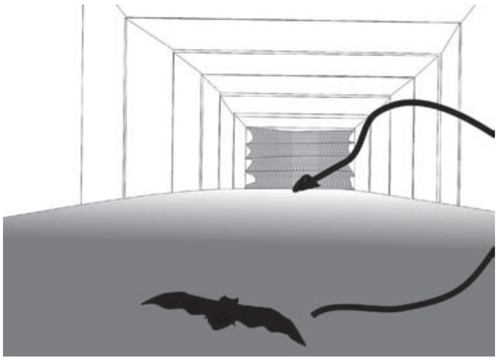

Figure 2. For a bat flying in from the open end of the bridge, a mistnet hanging on the other side forms an effective funnel trap. Fast flying bats cannot make the sharp turn in the restricted space under the bridge.

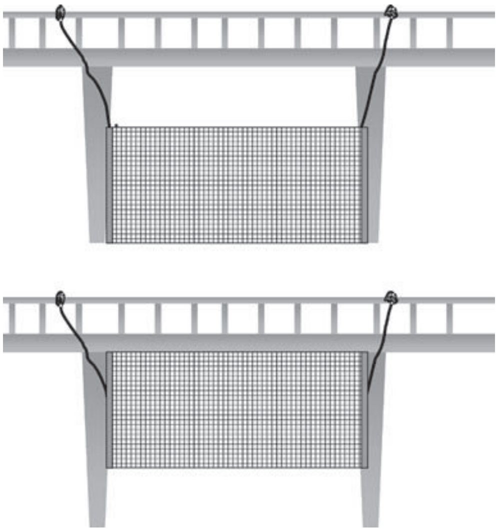

Figure 4. A hoisting construction using lines or poles. The mistnet is attached between poles which are then lowered onto the water surface. During each capture, the net is hoisted up to the bridge, where any captured bats are disentangled. Afterwards the net is lowered again to the water surface.

Placing a mistnet above the water using a bridge

Underneath most bridges the water is too deep to wade in, so the mistnet has to be lowered from the bridge. This can be done by using two techniques. The first includes two lines with a weight attached (figure 3). These lines are suspended from both ends of the bridge and the net is tied in between these lines. Each line serves as a hoisting line by which the net can be lowered onto the water surface. This technique is also used for capturing bats high up in other habitats, e.g. the tropical forest canopy (Hodgkison et al. 2002). The second technique is adapted from the first. Instead of using two lines, the mistnets are tied to two vertical poles (figure 4). In both techniques horizontal tension can be obtained by attaching the lines/poles to the ends of the bridge. For optimal tension it is important that the overall length of the mistnet (including loops) is slightly shorter then the span of the bridge.

Techniques for disentangling bats from the mistnet

Like other water trawling bats, pond bats usually hit the net about 30 centimetres above the water surface. We used two techniques to seize the bats and disentangle them from the mistnet: 1. hoisting the mistnet. 2. floating towards the net while sitting in a tube (hence ‘tubing’).

Hoisting

This technique entails lowering the mistnet from the bridge platform on the water surface and then hoisting the mistnet up again after each bat capture (figure 4). To avoid damaging the net two persons or a complex system of

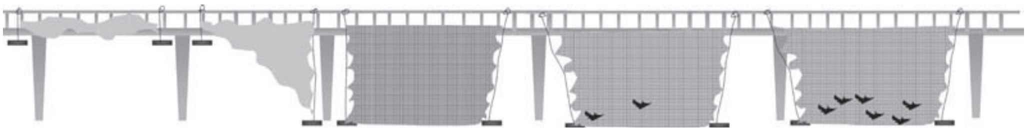

Figure 3. A step by step instruction how to lower a mistnet, using lines and weights. The first step is to attach the lines to the weights and hang them to the bridge. The mistnet is attached to the two lines, opened and the weights are lowered onto the water surface.

Figure 5. A bat worker in a tube. By treading water she can paddle towards the net and handle the bats. *Photograph: René Janssen.*

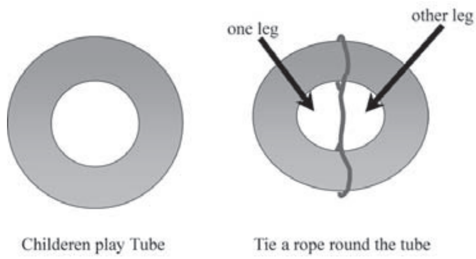

Figure 6. To make a tube, a rope is tied around a children's tube. A leg is put on either side of the rope.

hoisting lines are needed. A third person, standing on the bridge platform, can handle the bats and disentangle them.

Tubing

This technique entails leaving the mistnet on the water surface. The researcher actively floats towards the captured bats in a tube (figure 5). The person handling and disentangling the bats sits on a rope tied to the middle of a tube, which can be an inflatable children's play tube or a tractor inner tube (figure 6). By treading water the researcher can move towards the net. Using legs and feet as rudders, the researcher's hands are free to handle the bat. To keep dry, a neoprene chest wader is recommended as these are much safer than plastic waders. In plastic waders one may drown when scooping water, as the air in the wader cannot escape and will accumulate around one's feet, leaving the user in danger of toppling over and drowning while hanging upside-down in the water, feet in the air. Not only are neoprene waders safer, they are also warmer.

Instead of a tube, a researcher can also use a specially modified tube called a 'belly boat', which is sold in angler shops. Although these have a more luxurious sitting area, their travel speed through the water is much slower. Instead of legs protruding under water and acting as rudders, with a belly boat only the lower legs can be used for this purpose.

Comparing the capture rate of hoisting and tubing

For three years we used both tubing and hoisting and compared the capture rates of both techniques. The *capture rate* is expressed as the number of bats captured relative to the total number of bats observed flying on their commuting route. The total number of bats observed on route is the addition of the following variables:

- The number of bats *avoiding* the mistnet: a bat flying past the net, by for instance flying through a hole in the net or passing under it; this behaviour can be observed around a mistnet blocking a flying route, with both techniques,
- The number of bats *escaping* from the mistnet: a bat flying into the net and escaping before researchers reach it, or a bat passing under a hoisted mistnet and thus escaping,
- The number of bats *captured*: a bat flying into the net without escape.

Statistical analysis

We compared the hoisting and tubing techniques during three research years (2002, 2003 and 2004). For the calculations only those sites were taken into account where both techniques were used and only those nights when two methods were carried out on different

Table 1. The numbers of pond bats that avoided the mistnet, escaped from it and were captured in 154 capture events. Max: maximum number of bats; Sum: total number of bats.

	Max	Sum	Mean	Std. Deviation
Avoiding	35	619	4.0	4.8
Escaping	15	292	1.9	2.7
Captured	41	868	5.6	7.4
Total bats on route	61	1775	11.4	11.6

locations. Nights with no pond bats captures were excluded from the calculations. This resulted in 134 capture nights with a total of 154 capture events to be used for comparison of the two techniques.

Statistical analyses were carried out using SPSS (V. 15). A Generalized Linear Model (GLM) was used to investigate the relationship between the response variable 'number of bats captured' and the predictor variables, using 'total number of bats on route' as a binomial denominator. This was done by using a logit response model, logit being the natural log of the odds ratio, $p/(1-p)$. As independent predictor variables we included 'capture technique', 'size of bridge', 'time of year', 'wetland district' and their interactions. The significance of each term was tested by dropping it from the model and comparing the resulting change in deviance to a Chi-square distribution. Non-significant interaction terms were dropped from the model. Other factors that might influence the capture results, such as wind and temperature were not taken into account as we assume that these factors influenced hoisting and tubing similarly.

Results

Bats were captured during 134 nights over a three-year period. On some nights bats were captured at two or more locations simultaneously, resulting in a total of 154 capture events. During these events a total of 1775 pond bats were encountered, of which 911 (51%) were not captured; of these, 619 bats (35%) managed to avoid the mistnet, while 292 bats (16%) escaped from the mistnet after having flown into it. A total number of 868 pond bats (49%) were captured (table 1). Of the average of 11.5 bats flying on route, 5.6 were captured.

Tubing yielded higher capture rates than hoisting (table 2, $P<0.001$). The tubing technique gave an average capture rate of 47%, with the hoisting technique an average 28% of the bats flying on route were captured.

We found that capture results differed between the eight wetland districts (table 2, $P=0.002$). On average, we captured more bats in the Reeuwijkse Plassen (maximum 41, average 9.3 individuals), Langeraarse plassen (maximum 37, average 10.3 individuals) and Zoetermeerseplassen / Vlietlanden (maximum 24, average 5.6 individuals). The season in which bats were captured (spring, during pregnancy, during lactation, autumn) also influenced the capture results (table 2, $P<0.001$). The average number of bats observed and captured on route was highest at the end of May, and lowest in early spring. We also that the type of waterway influenced capture results (table 2, $P<0.0001$). Fewer bats were observed and captured on lakes and channels, and more on ditches and small rivers. We found no relation with bridge dimensions, neither did one of the predictor variables influence the difference between tubing and hoisting (table 2).

Discussion

Tubing, hoisting and other techniques

Our results show that tubing and hoisting differ in their respective capture rates, with tubing

Table 2. Results of logit regressions investigating the relationship between the response variable 'number of bats captured' and several predictor variables using 'total number of bats on route' as binomial denominator.

predictor variables	Wald Chi-square	df	'Number of bats captured' / 'total number of bats on route'
Technique used	33.672	1	$P<0.001$
Wetland district	22.12	7	$P=0.002$
Season	66.236	7	$P<0.001$
Bridge dimensions	3.288	6	N.S.
Type of waterway	29.125	3	$P<0.0001$
Technique * wetland district	5.892	5	N.S.
Technique * season	2.651	4	N.S.
Technique * type of waterway	2.924	2	N.S.

yielding a 19% higher capture rate. The difference between both techniques was not found to be influenced by the size of the bridge, time of the year, type of waterway or wetland district.

Two other techniques for the approach and handling of bats that are captured in mistnets while flying along a waterway, using a boat and a chest wader, proved to be inappropriate in our study area. A boat can be used in the same way as a tube, with the researcher floating towards the mistnet (figure 7). Unfortunately a researcher in a boat proved to be vulnerable to even very small currents, including those induced by wind, and could easily drift in or out of the mistnet while handling the bats. After a few unsuccessful experiences we decided to stop using a boat to spare our material.

Attempts to capture bats with a chest wader in fordable water also failed (figure 8). In fordable water a mistnet is placed using the same technique as on land (Masing 1987, Kunz & Kurta 1988, Francis 1989, Waldien 1999). Since our research area is very open, bats were presumably able to detect and avoid the mistnet, resulting in a low capture rate.

One technique not tested during our study is the use of trip lines. Trip lines can be used in dry areas to capture bats above small ponds (P. Prevett, personal communication). This technique is mainly used when bats come close to the water surface to drink. Several fish lines are strung parallel to each other low above the water surface. Bats trying to take a drink will hit one of these lines and trip into the pond. The mesh of fish lines above them will prevent them from ascending and they will have to swim to shore, where they can be captured. Pond bats and other water trawling bats will fly at high speed about 30 cm above the water surface in search of prey. Trip lines may therefore be very harmful to these bats. The same may hold for harp traps, another device commonly used for trapping bats over land or water (Kunz & Kurta 1988).

Comparing techniques

In order to choose the best option of the techniques described, an overview is given of the suitability of each technique in different environmental conditions (table 3). Boats and tubes are not very suitable capture techniques in running water: as both vessels are likely to float downstream. The same is applicable for shallow water and windy conditions, although a tube is easier to paddle to counter moderate wind speeds than a boat. In deep water a chest wader will not suffice. With wind and high bridges the mistnet can get entangled during hoisting. On busy shipping lines it is important that a mistnet is hoistable, to prevent damage from passing boats.

The number of people needed for each tech-

Figure 7. A researcher can use a boat to extract the bats from a net placed over the water surface without hoisting the net, but while handling the bat, the researcher cannot steer the orientation of the boat and the boat is vulnerable to current and wind. *Photograph: Bart Noort.*

Figure 8. In fordable water (up to 1.50 m) a researcher wearing chest waders can wade to the mistnet and extract the bats without hoisting the net. *Photograph: Janko van Beek.*

nique varies. In all environmental conditions three people are needed to hoist a mistnet. All other techniques can, in theory, be performed by only one person. However, by working with two persons in the water simultaneously (applicable for tubes, chest wader and boats), the time between capture and release from the mistnet can be decreased (figure 9).

The choice of these techniques should be informed by ethical considerations. Techniques yielding the shortest time between capture and release should be preferred. Environmental conditions can influence the welfare of bats during capture events (table 4). For the welfare of the bats, a mistnet (and therefore the captured bats) should be visible at all times during a capture event. This is especially important when the distance between mistnet

Table 3. The suitability of each technique in different environmental conditions. Scores range from very suitable (+++) to not suitable (-).

	Hoisting	Chest wader	Boat	Tubing	Remarks
Running water	+++	+++	-	-	Researchers in a boat may have trouble in running water. A *tuber* needs a life line.
Deep water (>2 m)	+++	-	+	+++	A chestwader is inappropriate in deep water.
Wide water	++	+++	+++	+++	Tubing gives the possibility of using several nets next to each other and tying them together for better tension in the nets.
Windy conditions	+	+++	-	++	Researchers in a boat may drift into the mistnet even at low wind speeds
High bridges	++	+++	+++	+++	Extra advantage of tubing: several nets can be hung on top op each other to close off the entire passage.
Shallow water (<30 cm)	+++	+++	-	-	Boat or tubes are not necessary in these conditions

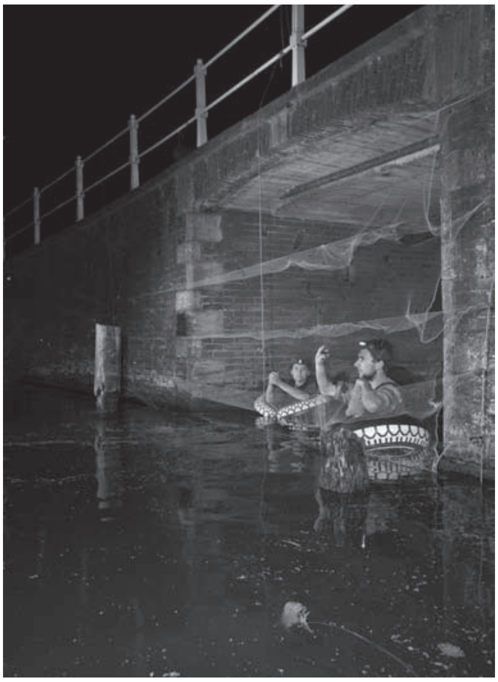

Figure 9. Two persons in a tube under a bridge. By working simultaneously, the time between capture and release from the mistnet can be decreased. *Photograph: René Janssen.*

and water surface is large or when the mistnet is partly hidden underneath the bridge due to the wind direction being opposite to bats' flying direction. When debris floating on the surface enters the mistnet, visibility of the captured bats may become even poorer. Capturing bats above water always brings an extra risk of bats getting wet or even drowning. Researchers should avoid endangering bats.

Conclusions

We conclude that tubing is not only a more efficient but often a more practical and ethical technique than hoisting. It has a number of practical advantages, requiring fewer personnel than hoisting, being useful in deep and broad waterways and tubes are less sensitive to wind and currents than boats.

Tubing also improves the welfare of the bats since the mistnet and captured bats are constantly visible, making it easier to prevent any damage to bats and with several tubing people in the water the time between capture and release of bats from the mistnet can be shortened.

Besides pond bats, large numbers of Daubenton's bats were captured using both techniques (Haarsma, unpublished results) and it is likely that long-fingered bats can also be captured with the same technique. For the same reasons, we thus recommend using the tubing technique for these species as well.

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References

Francis, C.M. 1989. A comparison of mist nets and two designs of harp traps for capturing bats. Jour-

Table 4. The influence of environmental conditions on the welfare of bats during capture events. Scores range from high consideration (+++) to no consideration of bat welfare (-). X: not relevant

	Hoisting	Chest wader	Boat	Tubing	Remarks
Running water	-	+++	X	X	The mistnet may be dragged under water
Deep water	+++	X	+++	+++	
Wide water	++	+++	+++	+++	With all techniques except hoisting, bats can be released by more than one person.
Windy conditions	+	+++	X	+++	Visibility of the mistnet from the bridge may be low with the hoisting technique.
High bridges	-	+++	+++	+++	Visibility of the mistnet from the bridge will be low with the hoisting technique.
Shallow water	+++	+++	X	X	

nal of Mammalogy 70 (4): 865-870.

Hodgkison, R., D. Ahmad, S. Balding, T. Kingston, A. Zubaid & T.H. Kunz 2002. Capturing bats (Chiroptera) in tropical forest canopies. In: A.W. Mitchell, K. Secoy & T. Jackson (eds.). The Global Canopy Programme Handbook: Techniques of Access and Study in the Forest Roof: 160-167. Global Canopy Programme, Oxford, UK.

Kunz, T. & A. Kurta 1988. Capture methods and holding devices. In: T.H. Kunz (ed.). Ecological and Behavioral Methods for the Study of Bats: 1-28. Smithsonian Institution Press, Washington, USA.

Masing, M. 1987. Experiments with bat traps. In: V. Hanák, I. Horácek. & J. Gaisler (eds.). European bat research: 617-618. Charles University Press, Prague, Czechoslovakia.

Waldien, D. 1999. A technique to capture bats using hand-held mist nets. Wildlife Society Bulletin 27 (1): 197-200.

Samenvatting

Drijven in een band: een effectieve techniek om vleermuizen boven het water te vangen

Verschillende soorten vleermuizen, waaronder de meervleermuis (*Myotis dasycneme*), Capaccini's vleermuis (*Myotis capaccinii*) en de watervleermuis (*Myotis daubentonii*), jagen voornamelijk boven water. Onderzoekers die deze vleermuizen voor wetenschappelijk onderzoek willen vangen doen dit meestal door een mistnet onder een brug te plaatsen en dit na elke vangst omhoog te hijsen door middel van hijslijntjes. Boven op de brug kan de gevangen vleermuis uit het mistnet worden bevrijd. Het vangstsucces bij deze hijstechniek is normaal gesproken vrij laag, omdat veel dieren ontsnappen uit het net terwijl dit omhoog wordt gehesen. Ook vliegt een aantal dieren het net voorbij terwijl dit omhoog staat. Naast praktische problemen, merkten we dat de hijstechniek soms het welzijn van de vleermuizen in gevaar bracht. Het mistnet (en daarmee de gevangen vleermuizen) was niet altijd goed zichtbaar en het duurde soms lang voordat een gevangen vleermuis bevrijd kon worden. Vanwege onze zorg om het welzijn van de vleermuizen en met het oog op het vergroten van het vangstsucces, hebben we een nieuwe techniek ontwikkeld om vleermuizen boven water te benaderen en hanteren: de bandtechniek. Deze maakt gebruik van een combinatie van traditionele technieken, waaronder hijslijntjes. In dit artikel vergelijken we de resultaten van de hijslijntjestechniek met de bandtechniek over een periode van 3 jaar, waarbij in totaal 134 vangnachten werden georganiseerd op 154 verschillende locaties. We hebben in totaal 868 meervleermuizen gevangen van de ongeveer 1775 passerende dieren. De resultaten tonen aan dat het vangstsucces met de bandtechniek gemiddeld hoger is dan met de hijslijntjestechniek. Dit verschil wordt niet veroorzaakt door de afmetingen van de brug, het seizoen, het type waterweg of geografische ligging (het merendistrict). We concluderen dat de bandtechniek een significante verbetering is van de traditionele methode om vleermuizen boven water te vangen. Bovendien is de bandtechniek vleermuisvriendelijker. In dit artikel worden ook andere technieken om vleermuizen boven water te vangen besproken, zoals het gebruik van een boot, een waadpak, struikellijnen en een *harptrap*. We vergelijken de toepasbaarheid van deze technieken in verschillende omgevingsomstandigheden. Verder wordt per techniek een inschatting gemaakt van het aantal benodigde personen en wordt aangegeven welke techniek het welzijn van vleermuizen het minst verstoort.

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