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Short Communication

Photography as a low-impact method to survey bats

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A B S T R A C T

Bats are mammals of chief conservation concern and also represent potentially powerful bio-indicators. Surveying bats is thus an important task but the approaches adopted may either be too invasive (capture) or prone to identification errors (acoustic methods). We here report on the use of a photographic trap to survey bat species richness we tested at two drinking sites in central Italy. The species richness we estimated was similar to that obtained by a previous mist-netting effort at the same sites. We also photographed species often overlooked in acoustic surveys due to their faint echolocation calls. From the photographs we could frequently identify sex, reproductive status, age class and individual marks. Given the relative non-invasiveness of this approach, we strongly recommend it in lieu of capture at sensitive sites or to complement acoustic surveys in order to improve identification rates.

There is wide agreement on the potential value of bats as bio-indicators (Jones et al. 2009). Changes in species richness or abundance may effectively characterize habitat structure or quality and reveal trends over time or in space. For this aim bat populations have to be surveyed repeatedly usually over many years. Survey methods that are non-invasive and do not bias the results are thus essential (Hayes et al. 2009). Acoustic methods are often useful for this, but some species of echolocating bats call weakly and are extremely difficult to detect by bat detectors, or they cannot be safely recognized based on their sounds alone (Russo and Jones 2002, 2003; Preatoni et al. 2009).

Capture at water holes or in front of roosts, using mist nets or harp traps, may (sometimes seriously) affect bats. Its success decrease involves a learned response by bats to the net or trap position (Kunz and Brock, 1975). Particularly at roosts there is an obvious risk that the bats abandon the site following a capture attempt, either temporarily or permanently. In the long run, such impact may be potentially detrimental to the populations studied. Capturing also requires specific training and in most countries special permits. Hence, alternative and less invasive methods are welcome.

Although, as for other animal groups (e.g. Caci et al. 2013), the value of photography has been highlighted for the study of bats (Altenbach and Dalton, 2009), its employment in bat surveys has been largely neglected, although suitable methods are available (e.g. Kugelschafter et al. 2014). In this short paper we present a non-invasive way of surveying bats by camera-trapping at drinking sites to assess species presence and richness. The same method may also be used at e.g. entrances to roosts and underground sites, as long as the bats pass predictably within a narrow corridor that can be covered by a light beam and a camera lens.

We tested the technique at two cattle troughs at an elevation of ca 1000 m a.s.l. in the Abruzzo, Lazio and Molise National Park (central Italy, Lat 41°48′ N, Long 13°46′ E), where many individuals of >10 bat species come to drink regularly in summer (Russo et al. 2012). We compare the results (species richness) of the photographic test with a previous netting effort at the same sites. The cattle troughs were ca 1.5 m wide and 12 and 6 m long, respectively, and were fed by natural spring water from the mountains. The surroundings were mostly old beech forest *Fagus silvatica* and cattle-grazed unfertilized meadows.

We sampled bats by erecting 6 × 2.5 and 12 × 2.5 m mist nets (50 denier, mesh size = 38 mm) along the troughs. We erected the nets at dusk and kept them in place for up to 4 h. The captures we considered for the present work were carried out in June–August 2007. Although we have also captured bats more recently at these

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Table 1
Comparison of photography and capture effort of bats at two cattle tanks in the Abruzzo Lazio and Molise National Park, Italy. The photographic method was employed 17–31 July 2014 (8 and 3 nights at each site, respectively). The capture efforts were made in July–August 2007 at the same sites. Asterisks denote that sibling species (*Pipistrellus pygmaeus* and *Myotis brandtii*, respectively) were also included, although they could not be identified reliably from the photographs.

Species	Site 1		Site 2		Total	
	Photo	Netting	Photo	Netting	Photo	Netting
Nyctalus leisleri	15	1	0	0	15	1
Pipistrellus kuhlii	25	7	0	0	24	7
*Ppipistrellus pipistrellus**	23	4	3	6	24	10
Hypsugo savii	3	4	0	5	3	9
*Myotis mystacinus**	48	14	14	6	62	20
Myotis brandtii	0	0	0	2	0	2
Myotis nattereri	1	5	3	4	4	9
Myotis bechsteinii	0	0	2	0	2	0
Plecotus auritus	2	11	0	2	1	13
Plecotus austriacus	0	2	1	0	1	2
Barbastella barbastellus	97	28	3	2	100	30
Total	213	76	26	27	239	103
N species	8	9	6	7	10	10
Time effort (h)	16	16	6	8	22	24

sites, we selected capture sessions with durations and efforts comparable to the photographic sessions (see below). Identification of captured bats was carried out according to Dietz and Helversen (2004).

Our photographic system consisted of an SLR camera (Canon 5D MkIII) with either a Canon 50 mm $f = 1.8$ or a Canon Macro 100 mm $f = 2.8$ lens. This set is suitable for the photography of bats from a distance of 0.5–1.5 m, depending on the lens. Three or four electronic flashes (Canon Speedlite 580 EXII) were placed at various positions relative to the camera (left, right, above, below, respectively), to facilitate an even illumination on the bat. The camera was either mounted on a tripod or placed directly on the concrete frame of the water tank. The primary flash was triggered by a red light photoelectric switch (Omron E3JM-R4M4-G), with the beam aimed horizontally across the tank. The secondary flashes were triggered by the primary flash. The flashes were zoomed according to the lens used. The exposure was determined by the flash duration, which was set at 1/64 full power, which equals approximately 1/20,000 s. The camera was set to B (bulb), $f = 16$ and ISO 320. The shutter was opened and closed manually, using a cable release. The photographic effort was made between 17 and 30 July 2014, each evening for 2–4 h following dusk, depending on the bat activity. In most evenings the weather was cool and rainy and with little bat activity. Hence, most photographs were obtained in warm and dry weather prevailing during four evenings.

We obtained 239 photographs of 10 bat species at the two sites during 22 h of sampling. *Myotis mystacinus* and *M. brandtii* could not be distinguished from the photographs while they were both identified by capture at site 2. Eight species were photographed at site 1 and 6 species at site 2, giving a total of 10 species (Table 1). The netting effort covered 16 and 8 h at the two sites, and led to the recording of 9 and 7 species, respectively. The species scored with the two methods were very similar but not identical. A 2×2 contingency table analysis (data in Table 1) using the number of species stratified by site and method resulted in a chi-square of 0.0024 (d.f. = 1) and $p = 0.96$, i.e. showed no significant difference between approaches. However, it should be kept in mind that the sampling efforts were made in two different years, between which the bat fauna could potentially have changed (although we have no evidence of this), and therefore the two efforts may not be strictly comparable.

Our photographic survey also portrayed species hard to detect by acoustic methods because of their faint calls such as *Plecotus auritus* (Fig. 1) or that may be difficult to identify reliably with the latter approach such as *Myotis* spp. (Waters and Jones 1995). Not only did the pictures reveal the species identity in most cases but also other biologically important features including sex or

Fig. 1. Species broadcasting weak calls such as this drinking *Plecotus auritus* may be easily and non-invasively detected by camera-trapping.

Fig. 2. Male *Nyctalus leisleri* detected by a camera trap while drinking. The penis is evident from the picture and allows safe sex determination.

reproductive condition. The penis was evident in some males (Fig. 2), as was the occurrence of enlarged nipples surrounded by a hairless skin area in lactating females (Racey, 2009). There were also recognizable marks on some individuals, such as a white patch in the face of a barbastelle bat *Barbastella barbastellus* (Fig. 3) that allowed us to identify the same subject over different nights. In all pictures wings were spread and in many cases the shape of finger

Fig. 3. The white patch in the face of this *Barbastella barbastellus* allowed us to identify it over different nights at the same drinking site.

joints was clearly observed, providing a way to tell apart adults from juveniles (Brunet-Rossinni and Wilkinson, 2009). In some cases it was even possible to notice a bat's tooth wear.

Overall, we found that photography and mistnetting provided a similar picture of species richness. Taking both sites together, the same species were found with the two methods with a single exception: *Myotis bechsteinii* was photographed yet not captured. The photographic method provided more than twice the number of records for a similar effort, partly because of the repeated drinking attempts bats made (Russo et al. 2012), sometimes leading to several pictures of the same bat. This issue is similar to that of acoustic surveys, as bat passes may also represent multiple counts of the same individuals (Jones et al. 2003). Although no inference on absolute population size can be made for this reason, getting multiple pictures will increase the chance of correct identification and may help to record otherwise overlooked individual details.

The tricky part of the photographic method is the aiming of the beam so that it is crossed by as many bats as possible and provide sharp images. The extent of this difficulty depends partly on the kind of photo switch used, particularly its practical range. On most modern switches, the beam may be adjusted to cope with this problem. Site-specific and skill-dependent difficulties also apply to mist netting or indeed any capture method and is by no means specific for photography. We stress that it is extremely important to avoid blocking the bats' flyway if we want to minimize the method's invasiveness and that also noise and movement should be kept to a minimum near the setup. Cameras and flashes should be placed at an angle to the expected flight path, not in front of the bat. It should also be placed as far away as possible, to avoid the risk that the bats consider the setup as an obstacle. This caution applies equally to drinking sites and roost entrances. It is also very important that no lights (except the flashes) are used during the exercise and that the setup is removed as soon as possible after the bats have passed. At an exit hole, it is necessary to set up the equipment well before dark and remove it again well before the bats' return to the roost. If not, the bats are unlikely to tolerate the presence of the equipment and the associated activity and my abandon the site.

The most important advantages of the photographic method is the relative non-invasiveness which means that it can be employed even in sensitive places such as roosts. Generally bats do not seem to be disturbed by single or occasional flashes as such (although they can be seriously affected by associated activities or by strobe flashes or continuous lights). The method described here is largely non-invasive if applied properly (although we are not aware of any experimental studies showing this specifically). To reduce the disturbance even further, the camera can be triggered electronically from a distance rather than manually as in our case, and it may perhaps even be possible to employ "near-IR" instead of visible light, by slight modifications of the equipment.

Virtually all bats visiting a given site will have the same likelihood of being photographed, regardless of their call intensity and their skill in avoiding nets, making this technique less prone to biases than other survey methods. We recommend its use particularly in combination with acoustic methods. The obvious disadvantage of the photographic method is that it is not possible to obtain measurements or skin samples and not all pictures will provide information on individual features (sex, age and reproductive condition). Cryptic species may be hard or impossible to identify from the pictures, but such difficulties may also apply to acoustic methods or even capture, unless DNA analysis is carried out (Galimberti et al., 2012).

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