Conference Volume	6th Symposium for Research in Protected Areas 2 to 3 November 2017, Salzburg	pages 537 - 540

Assessing small mammal community diversity with minimally invasive field methods - examples from the Nationalpark Gesäuse (Austria)

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Keywords

Small mammals, live-trapping, minimally invasive field methods

Introduction

Small mammals (Muridae, Cricetidae, Soricidae, Talpidae, Gliridae and Dipodidae) are amongst the most challenging groups for mammalogists mainly based upon their small body size in connection with a concealed and mostly nocturnal activity. They inhabit a diversity of habitats, from lowlands to alpine regions and their lifestyle reaches from semi-aquatic over subterranean to arboreal. Based on this preconditions each research question demands a specifical methodology and in the past decades, a broad range of techniques has been invented, developed and refined (Tab. 1).

Live-trapping is a widespread and common method for surveying small mammals (BARNETT & DUTTON 1995; GURNELL & FLOWERDEW 2006) and its application covers abundancy as well as community and population studies through individual data. Nevertheless it is important to include into considerations that trapping success depends on various factors e.g. species and functional group (JENSEN 1975) as well as used trap type (O`FARRELL et al. 1994; TORRE et al. 2004; ANTHONY et al. 2005) resulting in a risk of under- or oversampling as well as there are rare species that can hardly be captured e.g. *Sicista betulina* (MEINIG et al. 2015). Furthermore, it is expensive in time and effort and inevitably disturbing to the population and survey area. As long as primarily the presence of species is questioned, there is a variety of less invasive alternative methods.

Nest tubes and boxes

Nest tubes are suited for presence and long-term surveys of *Muscardinus avellanarius* (CHANIN & WOODS 2003) and other Gliridae like *Glis glis* (PILĀTS et al. 2009) or *Dryomys nitedula* (JUŠKAITIS & KETURKA 2017). We successfully used this method for surveying the potential presence of Gliridae in 2 different habitats in the Nationalpark Gesäuse in 2013. In a 25000 m² patchy mixed forest site and along a natural avalanche track seamed with young mixed vegetation we used 80 nest tubes and 20 nest boxes. During 2 controls we captured 7 individuals of *G. glis* and 4 *M. avellanarius*. On a second site 9 of 10 boxes were used by *G. glis*, *M. avellanarius* seemed to be absent. The results gave insight into habitat preferences and population structure (BLATT & RESCH 2013).

Hair tubes

Another method for surveying large areas on ground level and arboreal is the use of hair tubes (SUCKLING 1978). These are constructed of a simple plastic-tube in varying diameter and length (depending on intended species) and loose rolls with adhesive paper on each side that must be passed by small mammals in order to run through. Collected hair material can be determined to genus and even species level in many cases (DEBROT et al. 1982; TEERINK 1991; MEYER et al. 2002). In 2012 this method was successfully used in the Nationalpark Gesäuse and led to 58 identified small mammal records (6 species) in addition to 203 captures from live-trapping (4 species) (BLATT & RESCH 2012).

Bait tubes

Bait tubes are particularly suitable for collecting presence data of *Neomys* sp. by analysing the remains of aquatic invertebrates in scats (CHURCHFIELD et al. 2000). Baited tubes can help to concentrate live trapping efforts on positively tested areas. In the Nationalpark Gesäuse in 2013 we used 40 tubes to survey 10 lines with 50 m length along the river Johnsbach for 2 weeks to survey for *Neomys* sp.. Through subsequent live-trapping on 3 sites with positive results it was possible to verify the presence of *Neomys fodiens* on 2 sites (RESCH & BLATT 2013).

Nests surveys, food remains, burrows and tracks

Muscardinus avellanarius produces highly distinctive signs on *Corylus avellana* nutshells therefore the search for signs is a common method for presence studies (BRIGHT et al. 2006). Also, nest surveys (*Muscardinus avellanarius*, *Micromys minutus*), dropping boards (EMLEN et al. 1957), track tubes (GLENNON et al. 2002) and the search for burrows (e.g. Cricetus cricetus) can help identifying promising study sites. The collection of dead animals and the analysis of owl pellets (VAN STRIEN et al. 2015) can provide an overview over the regional small mammal community.

Camera traps

Camera traps are cost-effective and flexible and are gaining considerable popularity in mammal research (McCallum 2013). As a result of the advanced technical capability (increased image quality and detection rate) they are very promising for species that can hardly be detected with conventional methodology e.g. *Sicista betulina* (Kraft et al. 2016; Resch & Blatt 2017; van der Kooij & Møller 2017).

Method	Especially suitable for	Less suitable for	Recommended FFH-Species	Main survey objective	Advantage	To consider
Live trapping	Muridae, Cricetidae, Soricidae	Gliridae, *Sicista betulina*	*Cricetus cricetus, Spermohilus citellus, Microtus oeconomus mehelyi*	Presence data, Population and Community studies, Individual data, parasites, etc.	High quality individual data	Labour and cost intensive, high disturbance of population and survey area
Nest boxes and tubes	Gliridae, tubes especially *Muscardinus avellanarius*	Tubes: *Dryomys nitedula*, *Glis glis*	*Dryomys nitedula, Muscardinus avellanarius*	Presence data, Population studies	Cost-effective, long term use, individual capture possible	High acquisition costs for nestboxes, regular checks and maintenance
Camera traps	Most Muridae, Arvicolinae, Gliridae, Soricidae, especially *Sicista betulina*	Burrowing and ground dwelling	*Sicista betulina, Dryomys nitedula, Muscardinus avellanarius*	Presence data	Cost-effective, long term use	High acquisition costs, no population data. Limited species determination
Hair tubes	Muridae, Arvicolinae, Gliridae, Soricidae	Burrowing and ground dwelling	*Dryomys nitedula, Muscardinus avellanarius*	Presence data	Acquisition inexpensive	Determination often limited to genus, analysis is time intensive, overrepresentation of common species
Baited tubes	Soricidae especially *Neomys* sp.,	Insufficiently tested	-	Identifying *Neomys* sp. study areas	Acquisition inexpensive	Limited species determination, Further analysis required
Nest or nutshell surveys	Especially *Muscardinus avellanarius*, *Micromys minutus* only nests	-	*Muscardinus avellanarius*	Presence data	citizen science projects	Labour intensive through personell, not recommended as main survey method
Burrow survey	*Talpa europaea*, *Arvicola* sp., *Neomys* sp., *Cricetus cricetus*, *Spermophilus citellus*	-	*Cricetus cricetus*, *Spermohilus citellus*	Identifying study areas	Inexpensive	Misinterpretation possible, not recommended as main survey method
Track tubes	*Erinaceus* sp., Gliridae	-	*Dryomys nitedula, Muscardinus avellanarius*	Presence data	Acquisition inexpensive	Often limited to genus, overrepresentation of common species
Owl pellets	Muridae, Arvicolinae, Gliridae, Soricidae, Dipodidae	-	*Muscardinus avellanarius*, *Dryomys nitedula*, *Sicista betulina*	Presence data	Reliable species determination	Overrepresentation of Arvicolinae, restrictions depending on habitat type, limited localisation, collection and analysis is time intensive
Random collection (Roadkill, cat prey,...)	Common Species	-	All	Presence data, Individual data	Reliable species determination	Time intensive, not recommended as main survey method

Table 1 : Comparison of small mammal surveying methods

Discussion & Conclusion

All methods mentioned above have advantages and disadvantages depending on the survey question, the habitat type and the target species. Although live trapping remains the first choice for gaining high quality individual data, there is a risk of over- and underestimation as well as overlooking rare species. The accompanying or preceding use of minimally invasive methods has high potential, either for cost reduction and disturbance minimization on populations and survey sites, as well as for improving overall species detection rate. If combined with genetic sampling, minimally invasive studies like hair traps or baited tubes do overcome even the main disadvantage of limited species determination potential.

We conclude that in national parks more consideration should be given to minimally invasive methods as a way for reducing cost and disturbance and improve data quality in single species studies as well as in community studies. Especially the camera trap method has high potential for small mammal monitoring tasks and presence studies as well as for elusive species and should therefore further be developed.

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