



Short communication

Recapture of a banded Bechstein's bat (Chiroptera, Vespertilionidae) after 16 years: An example of high swarming site fidelity

Stefania Bologna^a, Maria Vittoria Mazzamuto^b, Ambrogio Molinari^a,
Stefania Mazzaracca^a, Martina Spada^{a,b}, Lucas A. Wauters^b, Damiano Preatoni^{b,*},
Adriano Martinoli^b

^a Istituto Oikos, Via Crescenzago, 1, I-20134 Milano, Italy

^b Dipartimento di Scienze Teoriche e Applicate, Università degli Studi dell'Insubria, Via J. H. Dunant 3, I-21100 Varese, Italy

ARTICLE INFO

Article history:

Received 30 January 2018

Accepted 9 March 2018

Handled by Danilo Russo

Available online 10 March 2018

ABSTRACT

In late summer and autumn, many species of hibernating temperate bats that form mixed-sex groups visit swarming sites (typically caves or mines). Swarming behaviour is mostly prevalent among bats of the genus *Myotis* and has a crucial role in maintaining gene flow among colonies that are socially isolated and thus demographically independent. This note reports on a recapture record of a Bechstein's bat (*Myotis bechsteinii*) in proximity of the "Grotta Marelli" cave, in the Campo dei Fiori Regional Park (Varese, N Italy). We recaptured a male individual twice, i.e. 3 and 16 years after the first observation, which took place at the same site in 1999. Our observation supports previous studies suggesting that *Myotis* bats are faithful to swarming sites and documents a further record of loyalty to a swarming site, close to the maximum known lifespan (21 years) for *M. bechsteinii*.

© 2018 Deutsche Gesellschaft für Säugetierkunde. Published by Elsevier GmbH. All rights reserved.

Protection and management of swarming sites such as Grotta Marelli has priority importance for bat conservation because of the occurrence and aggregation of different bat species and the role that such sites play in maintaining gene flow and hence genetic diversity.

Many of the most endangered mammal species in Europe are bats (Temple and Terry, 2009). Bats in Europe display marked seasonal phenology throughout the temperate zone. Their annual cycle consists of three main phases: a winter hibernation phase, a summer maternity phase and an autumn mating phase. Several bat species exhibit long-term site fidelity towards roost (Kapfer et al., 2008; Humphrey and Oli, 2015) or foraging (Martinoli et al., 2006; Hillen et al., 2009) sites. In late summer and autumn, many species of temperate bats visit underground sites at night-time prior to hibernation and perform vocalizations (e.g. Nardone et al., 2017), chasing and mating behaviours (Thomas et al., 1979; Parsons et al., 2003). This phenomenon is known as "swarming" (Fenton, 1969; Parsons et al., 2003) and involve association by many bats of several species in mixed-sex groups in and around caves or mines (Parsons and Jones, 2003; Rivers et al., 2005; Burns and Broders, 2015a,b; Dekeukeleire et al., 2016). Several hypotheses to explain swarming

have been proposed: inspection of suitable hibernation sites, information transfer to the young of the year (Davis and Hitchcock, 1965; Fenton, 1969; Humphrey and Cope, 1977), and some role linked to season migrations (Whitaker, 1998) or mating (Fenton, 1969; Thomas et al., 1979; Kerth and Morf, 2004; Rivers et al., 2005). However, the most favoured explanation, confirmed by behavioural and genetic evidence and a male-biased sex ratio observed at those sites, is that swarming is an event that provides mating opportunities to otherwise isolated summer colonies, promoting gene flow and increasing genetic diversity (Kerth et al., 2003; Rivers et al., 2006; Furmankiewicz and Altringham, 2007).

Swarming behaviour is mostly prevalent among bats of the genus *Myotis*, but also occurs in species belonging to other seven genera of Yangochiroptera (Barbour and Davis, 1969; Stebbings, 1988; MacDonald and Tattersall, 2001). In Bechstein's bats (*Myotis bechsteinii*) swarming has a crucial role in maintaining gene flow among colonies that are socially isolated and thus demographically independent (Kerth et al., 2000, 2003). *M. bechsteinii* is a rare (Dietz and Kiefer, 2014) medium-sized bat species that occur at low densities in European mature natural forests (Schober and Grimmerger, 1998; Meschede and Heller, 2000). *M. bechsteinii* is a non-migratory species jeopardized by habitat loss, given its demographically independent small colonies and strict habitat requirements (Napal et al., 2010). It is classified as Near Threatened with a decreasing population trend (Paunović, 2016) and listed in Annexes II and IV of

* Corresponding author.

E-mail address: prea@uninsubria.it (D. Preatoni).

the EU Habitats and Species Directive (European Council Directive 92/43/EEC).

We report on a recapture record of a *M. bechsteinii* in the proximity of the cave “Grotta Marelli” (1020 m.s.l.m.) in the Campo dei Fiori Regional Park (Varese, Lombardy, N Italy; Preatoni et al., 2011). The cave, located in a karstic area, is a hibernating site consistently used by different species of bats as well as a swarming site. Karstic areas play a crucial role in determining the availability of caves that are often used as hibernacula as well as swarming sites (Zukal and Řehák, 2006; Racey and Furey, 2014; Cooper-Bohannon et al., 2016). For this reason, we surveyed the site in question over the last 19 years (1998–2017). Every year we mistnetted bats in autumn (late August–beginning of October), and in 1999, 2002, 2003, 2004, 2008, 2013 and 2015, also in spring (late April–beginning of June). We placed mist nets (Agnelli, 2004) in the proximity to the cave entrance at dusk and checked them continuously to prevent stress in captured subjects. We kept nets operating until bat activity around the cave lowered consistently or ceased. Once caught, bats were held in cotton bags until mistnetting was over. Each subject was identified to species, sexed and banded. We performed species identification based on morphological characters (Dietz and von Helversen, 2004). All the activities were carried on under allowance by the Ministry of Environment and Protection of Land and Sea (authorization no. 17660/15).

On the 4th of September 2015 we caught 43 bats: three male *M. bechsteinii*, three male *M. daubentonii*, 33 *M. emarginatus* (1 female and 32 males), three male *M. nattereri* and one female *Pipistrellus pipistrellus*. For one of the *M. bechsteinii*, this represented the third capture at the same site because it had already been captured and banded, 16 years before in the same cave (September 15th, 1999, ring number T10093 UNIPV), and then again on the 16th of August 2002. In the latest capture event we noticed that the bat showed no signs of damage caused by the ring, which was still smoothly moving along the forearm.

Swarming aggregations frequently consist of more than one species, and there is usually a strong bias towards males (Davis and Hitchcock, 1965; Cope and Humphrey, 1977; Thomas et al., 1979; Kerth et al., 2003; Parsons et al., 2003; Furmankiewicz, 2008). This was also our case with the seven species using the cave during the 19 year period (*Myotis emarginatus*, *M. daubentonii*, *M. bechsteinii*, *Pipistrellus pipistrellus*, *P. nathusii*, *Plecotus auritus*) where a strongly male-biased sex-ratio among caught bats was recorded (only two *M. bechsteinii* females out of 42, over the entire 19 year period). Males try to maximize potential mating by returning to the swarming site more often and by staying longer there than do females, which proceed into hibernation soon after copulation (Tuttle, 1976; Burns and Broders, 2015a,b). Moreover, our record supports previous studies suggesting that *Myotis* bats tend to be faithful to swarming sites (Parsons and Jones, 2003; Furmankiewicz, 2008; Burns and Broders, 2015a,b) because they probably restrict themselves to only a few, intensively visited ones (Parsons and Jones, 2003; Furmankiewicz, 2008). Swarming site fidelity over many years has been documented for *M. nattereri*, *M. daubentonii*, *M. lucifugus* and *Plecotus auritus* (Fenton, 1969; Parsons et al., 2003; Senior et al., 2005; Rivers et al., 2006), but never for *M. bechsteinii*, although there are known longevity records (21 years in the wild, Henze 1979; Fleischer et al., 2017), so we believe our observation, albeit based on a single animal, represents an important contribution towards a better understanding on this species' natural history. Our observation supports the increasing awareness that swarming sites need special attention for bat protection, because of their long-term role in maintaining gene flow and hence genetic diversity (Kerth et al., 2003; Parsons et al., 2003; Rivers et al., 2006). Many bat populations are declining, and for *M. bechsteinii* a 30% decrease is predicted for the next 15 years, because of loss and degradation of old-growth forest (Paunović, 2016). The strict protection and man-

agement of swarming sites such as that where we set our study is, therefore, a crucial step to grant protection to this threatened species.

Declarations of interest

None.

Acknowledgements

The Authors would like to thank the Associate Editor Danilo Russo and an anonymous reviewer for their comments and corrections that have greatly improved the manuscript.

References

- Agnelli, P., 2004. Linee guida per il monitoraggio dei Chiroteri: indicazioni metodologiche per lo studio e la conservazione dei pipistrelli in Italia. Ministero dell'ambiente e della tutela del territorio, Direzione per la protezione della natura.
- Barbour, R.W., Davis, W.H., 1969. *Bats of America*. University Press of America, Lexington.
- Burns, L.E., Broders, H.G., 2015a. Who swarms with whom? Group dynamics of *Myotis* bats during autumn swarming. *Behav. Ecol.* 26, 866–876. <http://dx.doi.org/10.1093/beheco/arv017>.
- Burns, L.E., Broders, H.G., 2015b. Maximizing mating opportunities: higher autumn swarming activity in male versus female *Myotis* bats. *J. Mammal.* 96, 1326–1336. <http://dx.doi.org/10.1093/jmammal/gyv141>.
- Cooper-Bohannon, R., Rebelo, H., Jones, G., Cotterill, F.W., Monadjem, A., Schoeman, M.C., Taylor, P., Park, K., 2016. Predicting bat distributions and diversity hotspots in Southern Africa. *Hystrix* 27 (1), 38–48. <http://dx.doi.org/10.4404/hystrix-27.1-11722>.
- Cope, J.B., Humphrey, S.R., 1977. Spring and autumn swarming behavior in the Indiana bat, *Myotis sodalis*. *J. Mammal.* 58, 93–95. <http://dx.doi.org/10.2307/1379736>.
- Davis, W.H., Hitchcock, H.B., 1965. Biology and migration of the bat, *Myotis lucifugus*. *N. Engl. J. Mammal.* 46, 296. <http://dx.doi.org/10.2307/1377850>.
- Dekeukeleire, D., Janssen, R., Haarsma, A.-J., Bosch, T., Schaik, J.V., 2016. Swarming behaviour, catchment area and seasonal movement patterns of the bechstein's bats: implications for conservation. *Acta Chiropterol.* 18, 349–358. <http://dx.doi.org/10.3161/15081109ACC2016.18.2.004>.
- Dietz, C., Kiefer, A., 2014. Die Fledermäuse Europas Kennen, bestimmen, schützen. Franckh-Kosmos Verlags GmbH, Stuttgart, Germany.
- Dietz, C., von Helversen, O., 2004. Illustrated Identification Key to the Bats of Europe.
- Fenton, M.B., 1969. Summer activity of *Myotis lucifugus* (Chiroptera: Vespertilionidae) at hibernacula in Ontario and Quebec. *Can. J. Zool.* 47, 597–602. <http://dx.doi.org/10.1139/z69-103>.
- Fleischer, T., Gampe, J., Scheuerlein, A., Kerth, G., 2017. Rare catastrophic events drive population dynamics in a bat species with negligible senescence. *Sci. Rep.* 7. <http://dx.doi.org/10.1038/s41598-017-06392-9>.
- Furmankiewicz, J., Altringham, J., 2007. Genetic structure in a swarming brown long-eared bat (*Plecotus auritus*) population: evidence for mating at swarming sites. *Conserv. Genet.* 8, 913–923. <http://dx.doi.org/10.1007/s10592-006-9246-2>.
- Furmankiewicz, J., 2008. Population size, catchment area, and sex-influenced differences in autumn and spring swarming of the brown long-eared bat (*Plecotus auritus*). *Can. J. Zool.* 86, 207–216. <http://dx.doi.org/10.1139/Z07-134>.
- Henze, O., 1979. 20- und 21-jährige Bechstein - Fledermäuse (*Myotis bechsteini*) in Bayrischen Giebelkästen. *Myotis* 17, 44.
- Hillen, J., Kiefer, A., Veith, M., 2009. Foraging site fidelity shapes the spatial organisation of a population of female western barbastelle bats. *Biol. Conserv.* 142, 817–823. <http://dx.doi.org/10.1016/j.biocon.2008.12.017>.
- Humphrey, S.R., Cope, J.B., 1977. Survival rates of the endangered Indiana bat, *Myotis sodalis*. *J. Mammal.* 58, 32–36. <http://dx.doi.org/10.2307/1379724>.
- Humphrey, S.R., Oli, M.K., 2015. Population dynamics and site fidelity of the cave bat, *Myotis velifer*, in Oklahoma. *J. Mammal.* 96, 946–956. <http://dx.doi.org/10.1093/jmammal/gyv095>.
- Kapfer, G., Rigot, T., Holsbeek, L., Aron, S., 2008. Roost and hunting site fidelity of female and juvenile Daubenton's bat *Myotis daubentonii* (Kuhl, 1817) (Chiroptera: Vespertilionidae). *Mamm. Biol. Z. Für Säugetierkd.* 73, 267–275. <http://dx.doi.org/10.1016/j.mambio.2007.01.001>.
- Kerth, G., Morf, L., 2004. Behavioural and genetic data suggest that Bechstein's bats predominantly mate outside the breeding habitat. *Ethology* 110, 987–999. <http://dx.doi.org/10.1111/j.1439-0310.2004.01040.x>.
- Kerth, G., Mayer, F., König, B., 2000. Mitochondrial DNA (mtDNA) reveals that female Bechstein's bats live in closed societies. *Mol. Ecol.* 9, 793–800.
- Kerth, G., Kiefer, A., Trappmann, C., Weishaar, M., 2003. High gene diversity at swarming sites suggest hot spots for gene flow in the endangered Bechstein's bat. *Conserv. Genet.* 4, 491–499.

- MacDonald, D.W., Tattersall, F., 2001. *Britain's Mammals: The Challenge for Conservation*. People's Trust for Endangered Species, London.
- Martinoli, A., Nodari, M., Mastrota, S., Spada, M., Preatoni, D., Wauters, L.A., Tosi, G., 2006. Recapture of ringed *Eptesicus nilssonii* (Chiroptera, Vespertilionidae) after 12 years: an example of high site fidelity. *Mammalia* 70, <http://dx.doi.org/10.1515/MAMM.2006.058>.
- Meschede, A., Heller, K.-G., 2000. Ökologie und Schutz von Fledermäusen in wäldern. – Schriftenreihe für Landschaftspflege und Naturschutz 66. Hrsg.: Bundesamt für Naturschutz, Bonn Bad Godesberg. [in German].
- Napal, M., Garin, I., Goiti, U., Salsamendi, E., Aihartza, J., 2010. Habitat selection by *Myotis bechsteinii* in the Southwestern Iberian Peninsula. *Ann. Zool. Fenn.* 47, 239–250, <http://dx.doi.org/10.5735/086.047.0402>.
- Nardone, V., Ancillotto, L., Russo, D., 2017. A flexible communicator: social call repertoire of Savi's pipistrelle, *Hypsugo savii*. *Hystrix It. J. Mamm.* 28 (1), 68–72, <http://dx.doi.org/10.4404/hystrix-28.1-11825>.
- Parsons, K.N., Jones, G., 2003. Dispersion and habitat use by *Myotis daubentonii* and *Myotis nattereri* during the swarming season: implications for conservation. *Anim. Conserv.* 6, 283–290, <http://dx.doi.org/10.1017/S1367943003003342>.
- Parsons, K.N., Jones, G., Davidson-Watts, I., Greenaway, F., 2003. Swarming of bats at underground sites in Britain—implications for conservation. *Biol. Conserv.* 111, 63–70.
- Paunović, M., 2016. *Myotis bechsteinii*, The IUCN Red List of Threatened Species 2008.
- Preatoni, D.G., Spada, M., Wauters, L.A., Tosi, G., Martinoli, A., 2011. Habitat use in the female alpine long-eared bat (*Plecotus macrobullaris*): does breeding make the difference? *Acta Chiropterol.* 13, 355–364, <http://dx.doi.org/10.3161/150811011X624820>.
- Racey, P.A., Furey, N.M., 2014. Are bats karst-dependent? *Vespertilio* 17, 157–159.
- Rivers, N.M., Butlin, R.K., Altringham, J.D., 2005. Genetic population structure of Natterer's bats explained by mating at swarming sites and philopatry. *Mol. Ecol.* 14, 4299–4312, <http://dx.doi.org/10.1111/j.1365-294X.2005.02748.x>.
- Rivers, N.M., Butlin, R.K., Altringham, J.D., 2006. Autumn swarming behaviour of Natterer's bats in the UK: population size, catchment area and dispersal. *Biol. Conserv.* 127, 215–226, <http://dx.doi.org/10.1016/j.biocon.2005.08.010>.
- Schober, W., Grimmberger, E., 1998. *Die Fledermäuse Europas*. Kosmos, Stuttgart, Germany [in German].
- Senior, P., Butlin, R.K., Altringham, J.D., 2005. Sex and segregation in temperate bats. *Proc. R. Soc. Lond. B Biol. Sci.* 272, 2467–2473.
- Stebbing, R.E., 1988. *Conservation of European Bats*. Christopher Helm Publishers Ltd, London.
- Temple, H.J., Terry, A., 2009. European mammals Red List status, trends, and conservation priorities. *Folia Zool.* 58, 248–269.
- Thomas, D.W., Fenton, M.B., Barclay, R.M.R., 1979. Social behaviour of the little brown bat, *Myotis lucifugus*: I. Mating behavior. *Behav. Ecol. Sociobiol.* 6, 129–136.
- Tuttle, M.D., 1976. Population ecology of the Gray bat (*Myotis grisescens*): factors influencing growth and survival of newly volant young. *Ecology* 57, 587–595, <http://dx.doi.org/10.2307/1936443>.
- Whitaker, J.O., 1998. Life history and roost switching in six summer colonies of eastern pipistrelles in buildings. *J. Mammal.* 79, 651–659, <http://dx.doi.org/10.2307/1382995>.
- Zukal, J., Řehák, Z., 2006. Flight activity and habitat preference of bats in a karstic area, as revealed by bat detectors. *Folia Zool.* 55 (3), 273–281.