

# Atlas of Finnish bats

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*We dedicate this Atlas of Finnish bats to the memory of Rudolf Lehmann (1955–1985), who in the early 1980s started a new era in bat research in Finland*

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This atlas is based on information in museum collections, literature, databases and unpublished data. In the last 150 years, the number of bat species in Finland increased from six to thirteen. Of these, five are common and regularly breeding (*Eptesicus nilssonii*, *Myotis brandtii*, *Myotis daubentonii*, *Myotis mystacinus*, *Plecotus auritus*), and eight rare (*Eptesicus serotinus*, *Myotis dasycneme*, *Myotis nattereri*, *Nyctalus noctula*, *Pipistrellus nathusii*, *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, *Vespertilio murinus*), of which breeding of two (*M. nattereri*, *P. nathusii*) have been confirmed. The total number of records in the study is 11 234, of which 9717 are identified to species. The records are from 940 (25%) 10-km<sup>2</sup> squares of Finland's land area. Of the records, 89% are new (1993–2014). Of the recorded bat species, only *Eptesicus nilssonii* occurs in each of the 21 biogeographical provinces. A decreasing south–north gradient in species richness and abundance exists which may be related to research efforts that are clearly higher in the south.

## Introduction

Bats are a large and diverse mammalian group inhabiting almost all terrestrial areas of the world (Altringham 2011). According to the Mammal Diversity Database, there are 6399 extant mammal species in the world, of which approximately 20% (1411) are bats (American Society of Mammalogists 2019). Bats play important roles in ecosystems, being for example pollinators and pest-insect predators (Altringham 2011).

However, many bat species are threatened due to various reasons, ranging from habitat degradation and alteration to light pollution and being killed for food. Of the 1261 species included in the global assessment, 21% are either threatened (critically endangered, endangered, vulnerable) or nearly threatened (IUCN 2019).

European records comprise 44 bat species (Dietz & Kiefer 2016). By 2018, 13 bat species were recorded in Finland of which at least 7 also reproduce in Finland: northern

bat (*Eptesicus nilssonii*), Brandt's bat (*Myotis brandtii*), Daubenton's bat (*Myotis daubentonii*), whiskered bat (*Myotis mystacinus*), Natterer's bat (*Myotis nattereri*), brown long-eared bat (*Plecotus auritus*) and Nathusius' pipistrelle (*Pipistrellus nathusii*) (Kyheröinen et al. 2014, Kyheröinen & Hyvärinen 2018). In Finland, bats may be affected by habitat change linked to forestry and land use. Two bat species are on the Finnish Red List: Nathusius' pipistrelle assessed as vulnerable and Natterer's bat assessed as endangered (Liukko et al. 2019).

In Finland, all bat species are strictly protected by national and European Union legislations. Bats have been protected since 1923 (*Nature Conservation Act* 71/1923 [<https://www.finlex.fi/fi/laki/alkup/1923/19230071>]). According to the *Nature Conservation Act* (1096/1996 [<http://www.finlex.fi/en/laki/kaannokset/1996/en19961096>]) §39, it is forbidden to kill or capture bats, or to deliberately harm or disturb them particularly during breeding or at sites of significance to their life cycles. The autonomous Åland Islands have their own legislation in which all mammals except game species are protected (*Landskapslag om naturvård* 1998:82, §14 [[http://old.regeringen.ax/.composer/upload//socialomiljo/ff-1998-82\\_20140116.pdf](http://old.regeringen.ax/.composer/upload//socialomiljo/ff-1998-82_20140116.pdf)]). The regulations arising from the *EU Habitats' Directive* (Council Directive 92/43/EEC 1992) are implemented in §49 of the *Nature Conservation Act*, prohibiting e.g. destruction and deterioration of breeding and resting sites of the Annex IV species. Article 17 of the *EU Habitats Directive* requires the EU Member States to report every six years about the progress made with the implementation of the *Directive* regarding the species listed in the annexes to the *Directive*. Reporting focused on the evaluation of the conservation status of the habitat types and species included in the Annexes to the *Directive*. Only northern bat, Daubenton's bat and long-eared bat have a favourable conservation status (EEA-ETC/BD 2019). Due to deficient data or occasional occurrences of the species, the conservation status could not be assessed for the rest of the bat species. The Article 17 reporting in 2019 is in the process of publication.

As bats are strictly protected, the environmental authorities need basic data on the occurrence and abundance of the species to take it into

account in land use planning, to plan conservation measures and to conduct the obligatory reporting to both the European Union (*Habitats Directive*) and the *Agreement on the Conservation of Populations of European Bats* (EUROBATS).

Knowledge of the Finnish bat fauna has recently increased and hence there is an urgent need to update both the species composition and their distribution ranges. This study provides (1) an updated version of the Finnish bat fauna and (2) an atlas of Finnish bats. The atlas is based on available information in the collections of Finnish natural history museums, literature and databases and hitherto unpublished data of researchers, amateurs and general public. Additionally, incomplete maps may stimulate observers to report new records.

## Historical overview of the bat fauna of Finland

During the last 150 years, the species number in Finland rose from 6 to 13 (see Table 1). Lundahl (1852) published the first comprehensive report on the Finnish bat fauna mentioning five species: northern bat, whiskered bat (*sensu lato*), Daubenton's bat, brown long-eared bat and particolored bat. Malmberg (1872) added one species, Natterer's bat, and Mela (1882) yet another — the noctule — although it is mentioned in the table not in the text. The Finnish bat fauna comprised the same seven species until the 1970s (Siivonen 1967, 1968, 1972).

Baagøe (1973) studied specimens of *Myotis mystacinus* (*sensu lato*) from Finland and discerned Brandt's bat (*Myotis brandtii*) from the whiskered bat (*Myotis mystacinus*) (see also Lehmann 1983–1984). In 1982, Lehmann (1983b) reported the first Finnish specimen of Nathusius' pipistrelle. After that, Ingemar Ahlén reported his observation of this species which he made already in 1979 in the Åland Islands (sound-recording, I. Ahlén pers. comm. spring 2007; see Hagner-Wahlsten & Kyheröinen 2008).

During the 1990s, the Finnish bat fauna still comprised the above-mentioned nine bat species (Haukkovaara 1993, Stjernberg et al. 1993, Mitchell-Jones 1999). Since 2001, a further four species have been added (see Table 1).

Lundahl (1852) published comprehensive information on the distribution of five bat species in Finland based on his own collections and observations. Later, Malmberg (later Mela) (1872) and Mela (1882) also published records and reports obtained from the general public in addition to his own observations. These reports concerned specimens in the Finnish Museum of Natural History (University of Helsinki), where the oldest bat specimens date from 1849, and the collection of *Societas pro Fauna et Flora Fennica*. Subsequently, information on bat distribution presented by Mela (1882) was repeated almost unchanged (e.g., Mela & Kivirikko 1909, Kivirikko 1940).

The first maps illustrating bats' distribution in Finland concerned three species — whiskered bat (*Myotis mystacinus sensu lato*), Daubenton's bat and brown long-eared bat — were published in 1956 (Siivonen 1956). Only in 1967 were distribution maps published for all Finnish species (then seven); simultaneously additional six species were recorded in the other Nordic countries (Siivonen 1967, 1968).

Lehmann (1983–1984) published the first map in Finland of the whiskered bat and Brandt's bat distributions. Skarén (1992) published a distribution map of these two species and added some new records, but the distribution ranges remained mostly unchanged, except for three records of *M. brandtii* from the west coast. The

initial map for Natterer's bat was published by Stjernberg (1996), and later updated by Stjernberg (1998) and Siivonen and Wermundsen (2008c). Siivonen and Wermundsen (2003a) had published the first distribution map of Nathusius' pipistrelle, which they updated in 2004 (Wermundsen & Siivonen 2004); the map of the common pipistrelle was updated by Wermundsen and Siivonen (2004).

In 1993, the first two atlases of all Finnish bats (then nine species) were published (Haukovaara 1993, Stjernberg *et al.* 1993). Data from these two atlases were included in *the Atlas of European Mammals* (Mitchell-Jones *et al.* 1999). We produced distributions maps required by Article 17 of the *Habitats Directive* using the data (or part of it) of this study: in 2007 for 11 bat species, and in 2013 for all 13 bat species recorded in Finland (EEA-ETC/BD 2019, Kyheröinen *et al.* 2013).

# Material and methods

## Data

We divided the data sources into four categories: literature, databases, notifications and museum specimens (Table 2). Only reliable bat records including sufficient information on location and date were included in this atlas. Regarding

**Table 1.** First records of bat species in Finland. MZH = collections of the Finnish Museum of Natural History Luomus.

Species	Year of first record	Source
<i>Eptesicus nilssonii</i> (Keyserling & Blasius, 1839)	1795	Radloff (1795)
<i>Myotis mystacinus sensu lato</i> (Kuhl, 1817)	1851	Lundahl (1852)
<i>Myotis mystacinus sensu stricto</i> (Kuhl, 1817)	1921	MZH
<i>Myotis brandtii</i> (Eversmann, 1845)	1861	MZH
<i>Myotis daubentonii</i> (Kuhl, 1817)	1849	MZH
<i>Plecotus auritus</i> (Linnaeus, 1758)	1795	Radloff (1795)
<i>Vespertilio murinus</i> (Linnaeus, 1758)	1834	Lundahl (1852)
<i>Myotis nattereri</i> (Kuhl, 1817)	1849	MZH
<i>Nyctalus noctula</i> (Schreber, 1774)	1881	MZH
<i>Pipistrellus nathusii</i> (Keyserling & Blasius, 1893)	1979	Pers. comm. by Ingemar Ahlén to the third author, see Hagner-Wahlisten & Kyheröinen 2008)
<i>Pipistrellus pipistrellus sensu stricto</i> (Schreber, 1774)	2001	Salovaara (2001)
<i>Myotis dasycneme</i> (Leach, 1825)	2002	Siivonen & Wermundsen (2003b)
<i>Pipistrellus pygmaeus</i> (Leach, 1825)	2007	Salovaara (2007)
<i>Eptesicus serotinus</i> (Schreber, 1774)	2008	Lappalainen (2008)

reliability, only records provided by observers considered skilled experts, or thoroughly documented observations (e.g. incl. photo or recording) of a specimen were accepted.

Nearly half of the records (44%) were obtained from literature (e.g., articles, books, reports). Of the 400 sources, approximately 300 (marked with an asterisks in the references) contained information on bats with sufficient spatial accuracy.

Many records (28%) were from databases with open or restricted access (Table 2). Due to inexact information or unconfirmed species identification only 30%–60% of data from the open access databases was included in this study.

Researchers, professional bat surveyors and skilled bat amateurs provided survey data or random observations (18%), including some well-documented observations from the general public. The data were either given directly to the authors of this atlas or to the Finnish Museum of Natural History. Data were also collected from the internet. The authors’ own observations are also included.

A lesser yet important source, accounting for 10% of sources, were specimen records in collections of the Finnish Museum of Natural History (Helsinki) and in the regional museums of natural history in Oulu, Turku, Kuopio, Forssa, Iisalmi and Joensuu.

The earliest existing bat records date from the first half of the 19th century (for record numbers see Fig. 1). Observations made between 2001 and 2014 (approximately 11 000) accounted for 86% of the data.

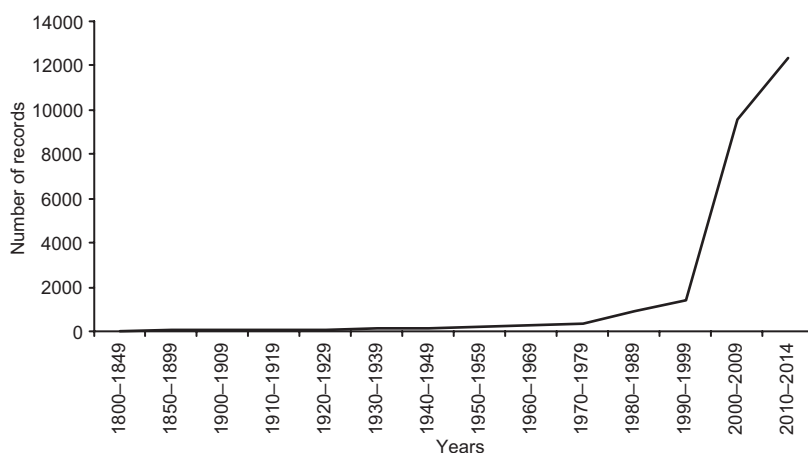
Geographical accuracy

In the original sources, locations of bat observations were given with sufficient accuracy. Of the available bat records, approximately 86% included information on the species observed (including *Myotis mystacinus/brandtii*), and either exact location or information allowing for pinpointing the location with an accuracy of 1–1000 m, that is, within a 10-km<sup>2</sup> grid square. In about 11% of records, locations were given

Table 2. Data sources and their description.

Source	Accessed	Type
Literature	mainly before 2012 (some additional before 2014)	Articles and reports and other literature (see References)
Databases	before spring 2012	Observation database of the Finnish Chiropterological Society (not in use anymore) [open access, 60% of the data included].
	before spring 2012	Observation database Hatikka of the Finnish Museum of Natural History (FinBIF 2019) [open access, 32% of the data included].
	before 2012	Ringling database of the Finnish Museum of Natural History (Ringling Centre) [restricted access, data from 2004–2011].
Museum specimens	before summer 2011	Database of the vertebrate collection of the Finnish Museum of Natural History.
	before 2007	Regional museums of natural history in Oulu, Turku, Kuopio, Forssa, Iisalmi, Joensuu.
Notifications	before 2012	Archives of notifications given to the Finnish Museum Natural History, random observations.
	before 2014	Notifications of unpublished results and survey data from researchers, professional surveyors and skilled bat amateurs, including the authors themselves (see Acknowledgements).
	before autumn 2012	Archives and surveillance data of hibernation sites (Finnish Museum of Natural History).
	2010	Bat survey in eastern Finland (Finnish Museum of Natural History).

**Fig. 1.** Numbers of bat records (incl. unidentified bat records) per decade; for the 19th century, however, records are presented per five decades. The last period comprises only five years. Due to inexact date information, 319 records are not included.



with a 10-km accuracy, allowing for allocation into a correct grid square, particularly in the case when an observer reported the record with an accuracy of 10 km<sup>2</sup>. Inaccuracies in location could have resulted in records being placed in squares neighbouring the correct ones. We, however, consider the effects of such errors on distributions negligible.

Location accuracies could also be less than 10 km. For example, if the municipality where the observation was made was reported, the chosen locality was the geographical centre of the municipality. The resulting accuracy was within a few 10-km<sup>2</sup> squares. Such potentially inaccurate records accounted for 3% of the data (297 bat records identified at the species level).

### Number of records and squares

In this study, an observation of one or more individuals of a certain species at one site, on one occasion was considered one record. Thus, even hundreds of recordings of one species by an automatically recording device produced during one night were included as one record. For common species, especially the northern bat, adjacent and concurrent observations (distance usually < 1 km) were usually pooled into one record. Pooling of some data was due to time or space inaccuracies. For these reasons, the numbers of records are not directly comparable between species or areas.

The data consist of 12 663 records, of which in 9717 of the cases the species was identified

(Table 3). Distinguishing between the whiskered bat and Brandt's bat is usually impossible unless examined by hand. Hence, in many cases we did not separate the two species and presented them together (*Myotis mystacinus/brandtii* or whiskered bat/Brandt's bat) in the tables and figures. As a result, a total of 11 234 records were used to prepare the maps. Records of unidentified bats (*Myotis* sp., Chiroptera sp., etc.) were included in the map of all records (Fig. 2), but excluded from further analysis. Approximately 3800 10-km<sup>2</sup> squares cover the total land area of Finland; records of bats identified to the species level were from 940 of them.

The data were divided into two temporal categories (Table 3). Records from surveys carried out before 1993 (11%; Haukkoara 1993, Stjernberg *et al.* 1993, Mitchell-Jones *et al.* 1999) were considered old and observations from 1993 and onwards (89%) were considered new. Of the total of 940 10-km<sup>2</sup> squares, 395 and 776 include old and new records, respectively, with 231 squares including both.

### Observation types

We divided the records into three categories according to the observation method (Fig. 3). The method of identification affects the credibility of an observation. Bats were identified (1) through direct examination (by hand) (e.g., dead individuals or individuals caught for ringing); (2) acoustically with a detector or a detector and

a recorder; or (3) visually (when resting, hibernating, from photographs, and in some cases even when flying). About half of the records were acoustical detector observations (54%), one third include direct identification (33%), and only 7% of the accepted records were based on visual observations. In case of 5% of the records, the identification method could not be determined. These records originated from databases (Table 2) without information on the observation types. Despite of the lack of the observation type these records were, however, considered reliable based on the observer's experience and other information included.

Distribution of bat species

Occurrence in biogeographical provinces

There are 21 biogeographical provinces in Finland (Fig. 4 and Table 4; also Heikinheimo & Raatikainen 1971, 1981, Ulvinen 1980). As

expected, species richness and abundance, in terms of record numbers, based on our bat data are highest in the provinces of the southern mainland. More than half of the identified bat records are from the southernmost provinces of Nylandia and Regio Aboensis. By including the records from Tavastia Australis, the proportion increases to 70%. The decreasing south-to-north gradient in the present data of both species richness and abundance is a result of the higher research effort in some regions of the south than the north, but it may also truly exist.

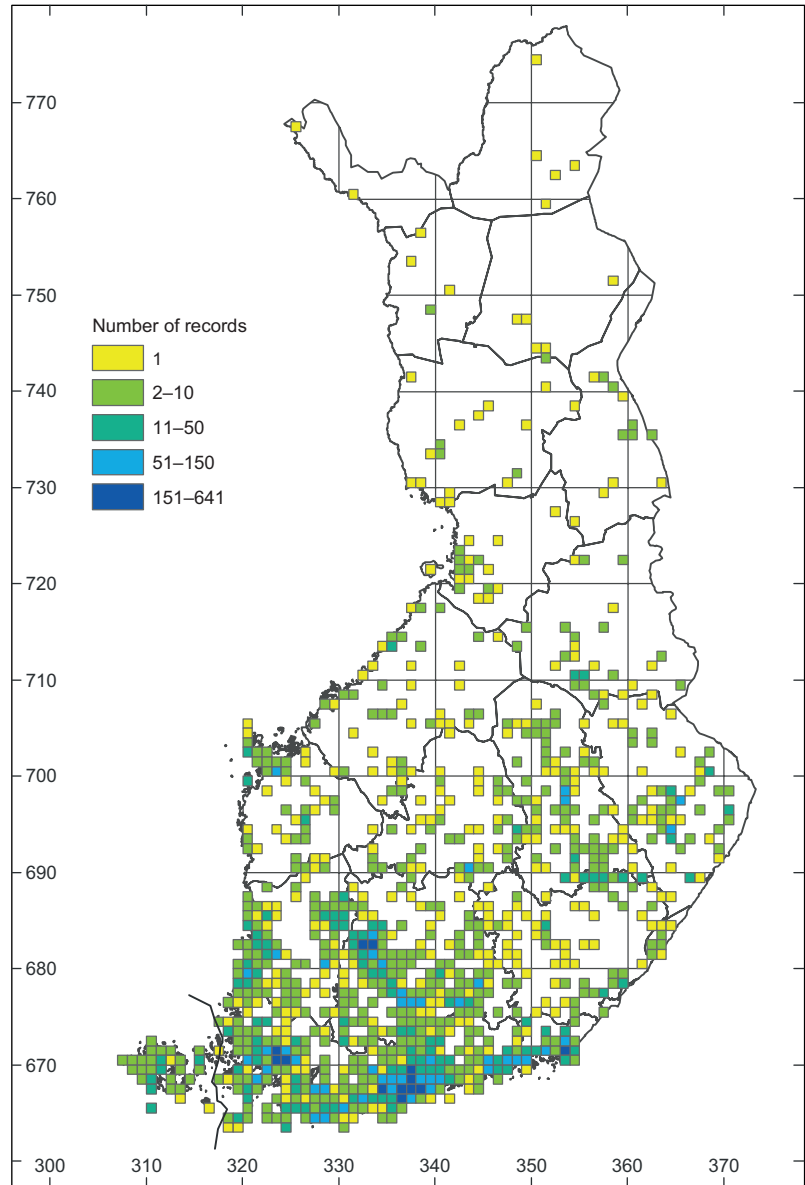
The only species recorded in every province is the northern bat, being the only bat species observed in the four northernmost provinces. Other widespread species which occur in ten or more provinces are Brandt's bat, Daubenton's bat, the long-eared bat and, surprisingly, the noctule and Nathusius' pipistrelle. The last two species are notably less abundant, with fewer records, than the other above-mentioned species. The apparent low number of recorded bat species in the province of Alandia is probably due

**Table 3.** Total numbers of bat records and 10-km<sup>2</sup> squares with bat records in Finland. Records from before 1993 are considered old, and those from 1993 and onwards are considered new. Contribution of new squares to total coverage (last column) was calculated as follows:  $(b - a)/b \times 100$ .

Species	Number of records			Number of squares			Contribution of new squares to total coverage (%)
	total	old (before 1993)	new (1993 and onwards)	with old records <sup>1</sup> (a)	with new records <sup>2</sup>	with old and/or new records (b)	
<i>Eptesicus nilssonii</i>	5107	647	4460	280	547	691	59.5
<i>Eptesicus serotinus</i>	4	0	4	0	4	4	100
<i>Myotis brandtii</i>	645	131	514	55	82	127	56.7
<i>Myotis dasycneme</i>	4	0	4	0	1	1	100
<i>Myotis daubentonii</i>	2556	285	2271	118	251	325	63.7
<i>Myotis mystacinus</i>	189	43	146	21	53	70	70.0
<i>Myotis nattereri</i>	31	8	23	7	8	14	50.0
<i>Nyctalus noctula</i>	152	52	100	36	67	92	60.9
<i>Pipistrellus nathusii</i>	232	5	227	5	97	99	94.9
<i>Pipistrellus pipistrellus</i>	37	0	37	0	25	25	100
<i>Pipistrellus pygmaeus</i>	14	0	14	0	12	12	100
<i>Plecotus auritus</i>	718	127	591	88	126	182	51.6
<i>Vespertilio murinus</i>	28	3	25	3	19	21	85.7
<i>Myotis mystacinus/brandtii</i>	1517	66	1451	42	194	222	81.1
Identified total	11234						
<i>Myotis</i> sp.	821	7	814	—	—		
<i>Pipistrellus</i> sp.	4	0	4	—	—		
<i>Chiroptera</i> sp.	604	29	575	—	—		
Total	12663	1403	11260				

<sup>1)</sup> may also include new records, <sup>2)</sup> may also include old records.

**Fig. 2.** Bat records in Finland in 1834–2014 in 10-km<sup>2</sup> squares (incl. records of unidentified bats). The numbers along axes are coordinates according to the Finnish Uniform Coordinate System (Grid27E).



to the lower research activity there compared with that in the other Finnish southern provinces. There is no province where all species of Finnish bats were observed.

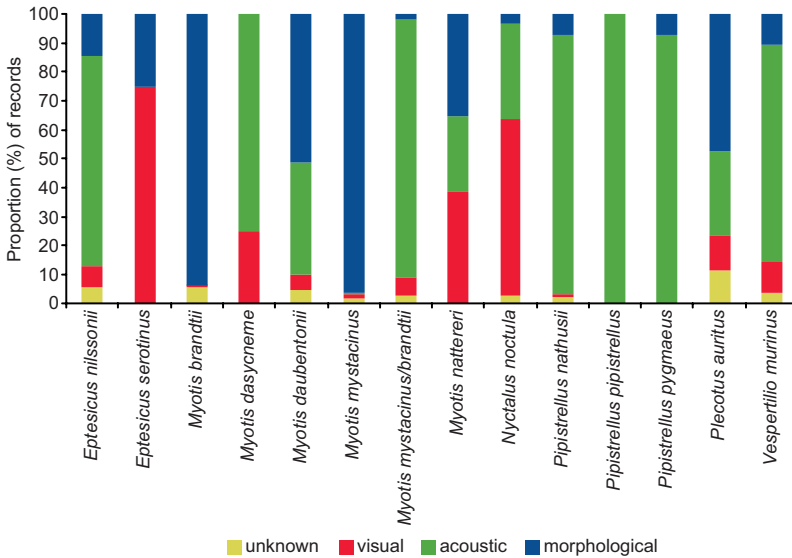
### Species accounts and distribution maps

Species are presented in alphabetical order according to the scientific name. Data on species their global distribution and distribution in Finland as

well as information on species' abundance, status in Finland and habitat use are provided.

The English, Finnish and Swedish vernacular names follow the *Common Names of European Bats* (Lina 2016); the former vernacular name in Swedish is presented in parentheses.

Records of the bat species are shown in 10-km<sup>2</sup> squares of the Finnish Uniform Coordinate System (Grid27E). Squares coded as new records may also include old ones. Contours of the biogeographical provinces are also in each map.



**Fig. 3.** Proportions of observation types in this study.

***Eptesicus nilssonii*** [Eng: northern bat, Fin: pohjanlepakko, Swe: nordfladdermus (nordisk fladdermus)]

**DATA:** Observations of the northern bat account for almost half of our data (5107 records, of which 87% are considered new). The earliest dated record is from 1849, although this species was mentioned for the first time in 1795 (Radloff 1795). Several observations made in close proximity were pooled, hence the number of records for this species differs from the number of observations. Most of the records (approx. 3900) are observations made using a bat detector, as the echolocation calls of the northern bat are loud and easy to register at a distance of 60 to 80 metres (Skiba 2003). Even though more data originated from southern Finland than from other parts of the country due to higher observation efforts in the southern and central parts of the country, the data can be considered representative.

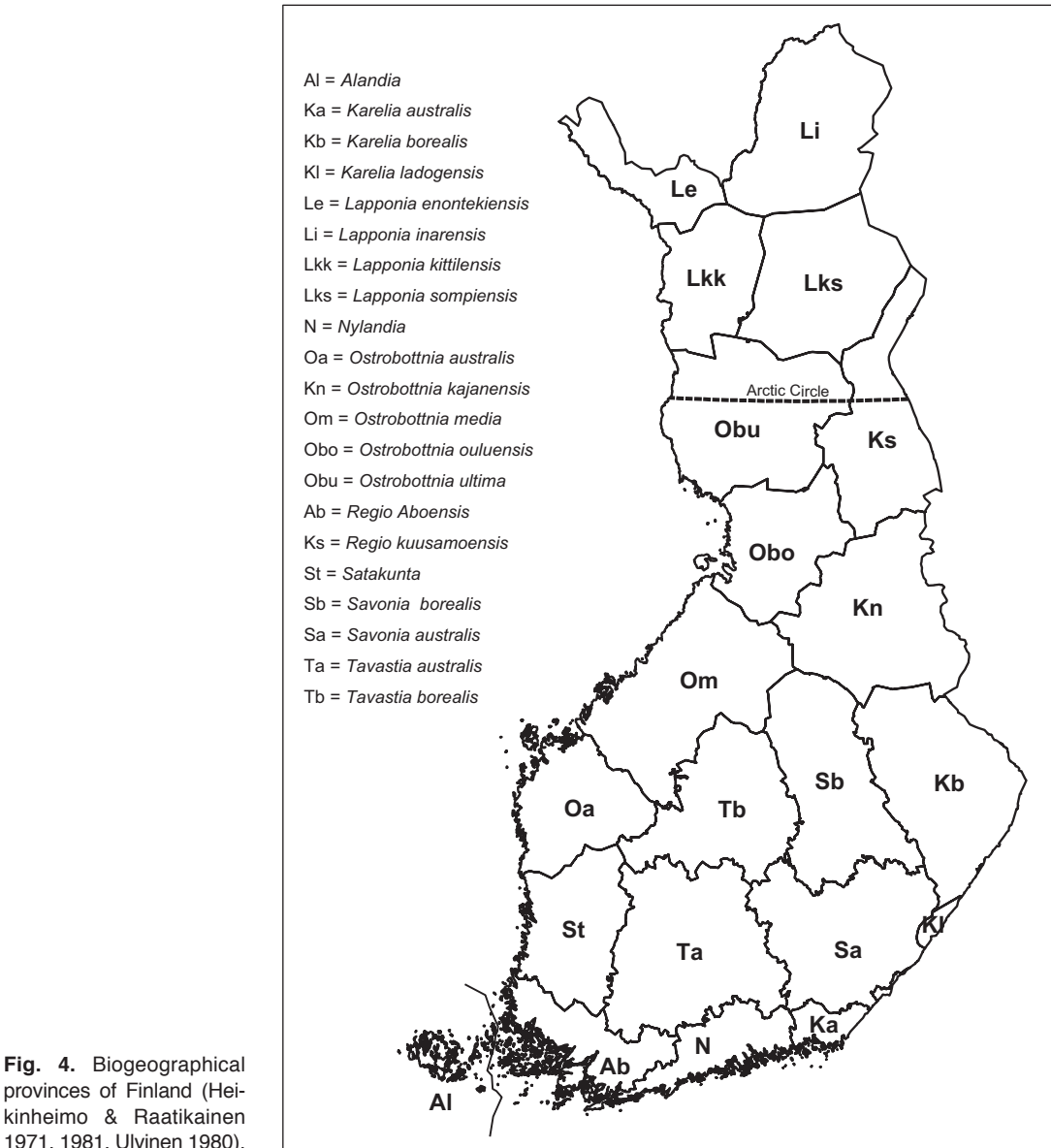
**DISTRIBUTION:** The northern bat is a Palearctic species with a wide distribution, reaching from Europe to eastern Russia and Mongolia, with a disconnected region in easternmost Russia and Japan (Coroiu 2016a).

The northern bat is the only bat species occurring in all biogeographical provinces of Finland (Table 4), including Alandia (the Åland Islands) (Fig. 5). Approximately 33% of the

records were from the biogeographical province of Nylandia alone, and 80% from the five southernmost provinces. Although there are no records from some areas in southern and central parts of the country, if suitable habitats are available the species can probably occur also in those areas. In Lapland, the distribution may be patchy, reflecting harsh conditions and limited availability of roosting sites.

From the northern regions, especially Lapland, only some dozens of records exist; while often anecdotal and lacking species identification, they likely concern the northern bat. Thorough examination of the original sources of these northern records, especially localities, made it possible to avoid several doubles and misinterpretations. In earlier publications based on a very small number of records (e.g. Siivonen 1967, 1968), the species' distribution is shown as continuous throughout Lapland. In this study, only confirmed records and records which most probably concern this species were included, and those indicate the distribution in the north to be scattered.

After comparing our data on this species' distribution in other areas with those of Malmberg (1872) and Mela (1882), or with more recent maps presented by Siivonen (1967, 1968), we can conclude that the distribution of the northern bat did not change much. Newer observations, however, have refined the traditional view of this species as inhabiting the whole country.



**Fig. 4.** Biogeographical provinces of Finland (Heikinheimo & Raatikainen 1971, 1981, Ulvinen 1980).

**ABUNDANCE AND STATUS IN FINLAND:** The northern bat is the most common bat species in Finland, as evidenced by bat surveys conducted in southern and central Finland. These surveys typically covered areas with mosaics of urban and non-urban habitats, suitable for the northern bat. The northern bat breeds in Finland, and maternity colonies are found in southern and central Finland. The few records from Lapland, the northernmost part of the country, are mainly observations of a flying bat. There are no con-

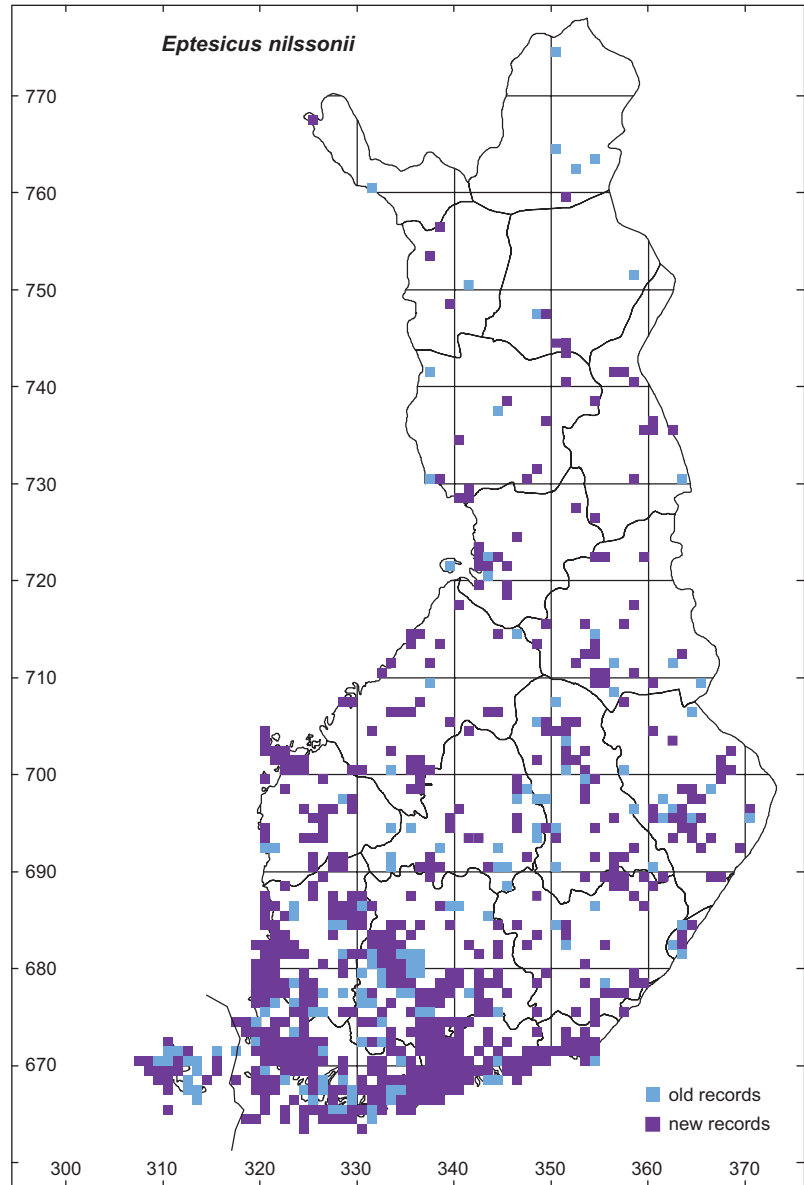
firmed reports of breeding of this species from Lapland, although it is included in the breeding fauna of *Lapponia inarensis* compiled by Iso-Iivari (1975) who in turn cites Siivonen (1972). Siivonen (1972), however, does not mention the species breeding in *Lapponia inarensis*.

The northern bat is considered mostly sedentary, with probably limited dispersal behaviour (Hutterer *et al.* 2005). It is annually observed in many hibernacula in Finland; however, recent data also indicate partial migratory behaviour (*see*

**Table 4.** Distribution data of bat species in the biogeographical provinces of Finland (x = < 20 records, xx = 20–99 records, xxx = > 100 records). For the provinces see Fig. 4.

Species	Al	Ab	N	Ka	St	Ta	Sa	Kl	Oa	Tb	Sb	Kb	Om	Ok	Obo	Obu	Ks	Lkk	Lks	Le	Li	Number of provinces
<i>Eptesicus nilssonii</i>	xxx	xxx	xxx	xxx	xxx	xxx	xxx	x	xxx	xx	xxx	xxx	xx	xx	xx	x	x	x	x	x	x	21
<i>Eptesicus serotinus</i>		x	x																			2
<i>Myotis brandtii</i>		xxx	xxx	x	x	xxx	x		x	x	xx	x	x	x								12
<i>Myotis dasycneme</i>				x																		1
<i>Myotis daubentonii</i>	xx	xxx	xxx	xx	xxx	xxx	xx	x	xx	x	xx	xx	x	x	x		x					16
<i>Myotis mystacinus</i>		xx	xx		x	xx	x			x	x	x		x								9
<i>Myotis nattereri</i>	x	x	x	x		x																5
<i>Nyctalus noctula</i>	x	xx	xx	x	x	x	x	x	x	x	x	x	x									13
<i>Pipistrellus nathusii</i>	x	xx	xxx	x	xx	x	x		x	x			x									10
<i>Pipistrellus pipistrellus</i>	x	x	x	x	x				x													6
<i>Pipistrellus pygmaeus</i>	x	x	x		x				x													5
<i>Plecotus auritus</i>	x	xxx	xxx	xx	xx	xxx	x	x	x	x	x	x	x	x								14
<i>Vespertilio murinus</i>	x	x	x	x	x	x	x		x													8
<i>Myotis mys/bra</i>	xx	xxx	xxx	xx	xx	xxx	xx	x	xx	xx	xx	xx	x	x	x	x	x					16
No. of species	9	12	12	10	10	9	8	4	9	7	6	6	6	5	2	1	2	1	1	1	1	
No. of records*	220	2499	3698	505	720	2021	216	25	280	162	354	276	91	58	48	18	20	9	8	3	3	11234
No. of records**	17	201	504	47	131	216	49	0	48	27	75	67	22	11	6	4	2	0	2	0	0	1429
Total no. of records	237	2700	4201	552	851	2237	265	25	328	189	429	343	113	69	54	22	22	9	10	3	3	12663

\* identified bats (incl. *Myotis mys/bra*), \*\* unidentified bats.



**Fig. 5.** Distribution of the northern bat in Finland.

Kyheröinen *et al.* 2009). This species is a strong flyer, covering distances greater than 10 km between the roost and foraging areas, especially in late summer (de Jong 1994, Kosonen 2008) or during exploration flights (Haupt *et al.* 2006).

The northern bat is a generalist species, foraging in a wide variety of habitats including forests with paths and other open- to semi-open structures, rural landscapes with mosaics of fields or crops and settlements, waterbodies, and urban areas such as towns and suburbs (Rydell 1989,

de Jong 1994, Kosonen 2008, Wermundsen & Siivonen 2008). In Finland, reports of roosts are scarce, but the northern bat is known to use buildings as roosts (see Kosonen 2008). Based on observation data in the archives of the Finnish Museum of Natural History, known hibernacula in Finland are mostly man-made structures, such as cellars and bunkers. Hibernation sites in Norway are rock scree deposits (Michaelsen *et al.* 2013), and such deposits are considered potential hibernation sites also in Finland. Some observations

indicate that bats could also hibernate in snake hibernacula (Viitanen 1967) and tors (stone fields, N. Fritzén pers. comm.) as well as in deep crevices in rock cliffs. Numbers of bats per hibernacula are typically low, one to a few individuals (authors' own data, Wermundsen & Siivonen 2010). Hibernation sites of northern bats have a lower temperature range than those of other bat species, and the species usually hibernates alone not in clusters (Siivonen & Wermundsen 2008a, Wermundsen & Siivonen 2010).

***Eptesicus serotinus*** [Eng: serotine, Fin: etelänlepakko, Swe: sydfladdermus]

**DATA:** The first observation of the serotine in Finland was made in 2008 (Lappalainen 2008). Altogether, only four records of the species were included in this study: one record of a hibernating specimen (Lappalainen 2008) and the other three of daytime flying individuals, of which good photographs were taken (J. Heinonen pers. comm., J. Lehto pers. comm., see also Kosonen 2012).

**DISTRIBUTION:** The serotine is an abundant species with a wide Palearctic range, covering most of Europe and parts of Asia (Hutson *et al.* 2008b). In Finland, a hibernating individual was found in Hanko (Lappalainen 2008) but this bat was later found dead. The records of flying individuals were from Porvoo (J. Lehto pers. comm.), Masku (J. Heinonen pers. comm.) and Parainen (Kosonen 2012). Observations of the serotine were made in only two biogeographical provinces (Table 4) in the southern part of the country (Fig. 6).

**ABUNDANCE AND STATUS IN FINLAND:** As records of the serotine from Finland are few, the status of the species cannot be determined. The serotine is mostly sedentary, but Havekost (1960) recorded movements of up to 330 km. With increased passive monitoring of bats, we can expect new observations of the serotine, especially in southern Finland.

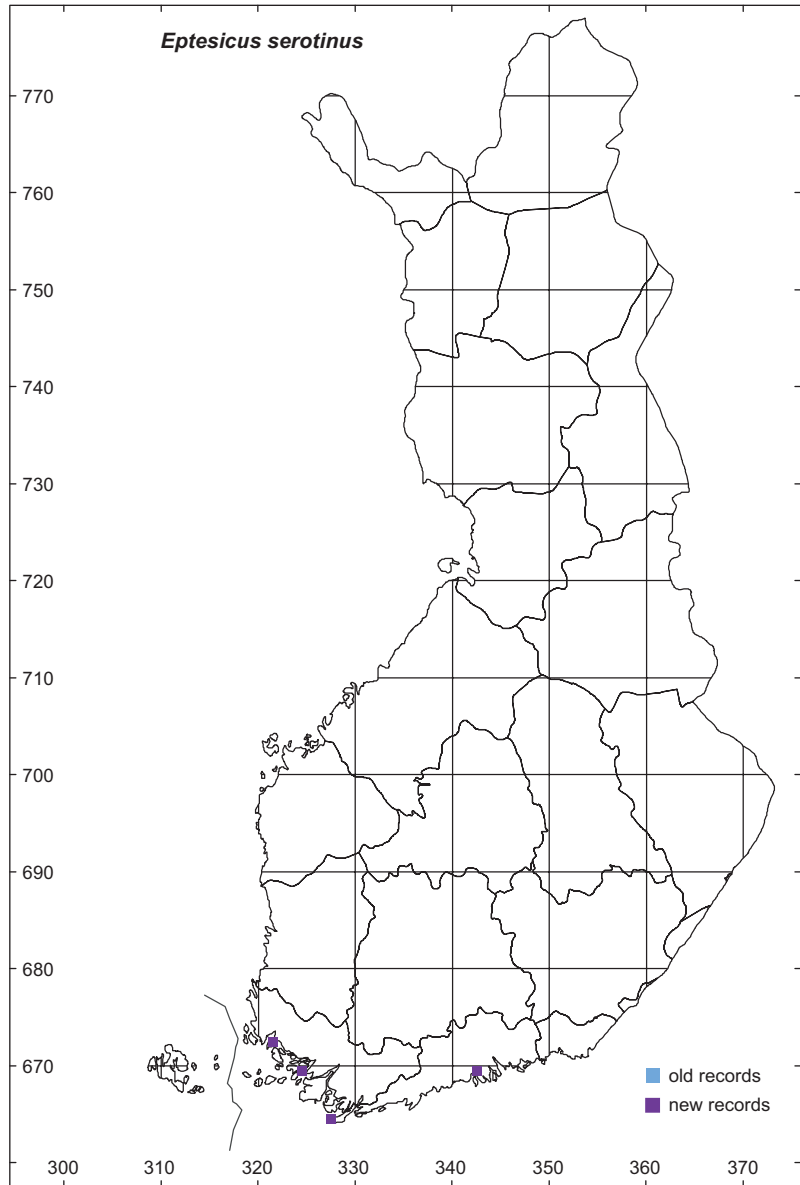
***Myotis brandtii*** [Eng: Brandt's bat, Fin: isoviiksisiippa, Swe: taigafladdermus (Brandts mustaschfladdermus)]

**DATA:** There are 645 records of Brandt's bat,

of which 78% are new. The species *Myotis mystacinus sensu lato* was split in 1970 into *M. mystacinus* and *M. brandtii* (Baagøe 1973). In the early 1980s, Rudolph Lehmann re-examined the specimens in the Finnish Museum of Natural History until 1983 and also the specimens in the zoological museums of Oulu, Kuopio and Turku (Lehmann 1983–1984). Bat surveys conducted with a detector commonly treat Brandt's bat and the whiskered bat as a species pair. These data, however, had to be omitted from the analysis at the species level, as echolocation calls alone are usually not enough to distinguish the species (but see Barataud 2015).

**DISTRIBUTION:** Brandt's bat is a Palearctic species with a disjunct distribution. It is mainly found in Europe (including central but not the westernmost parts of continent) in boreal regions from Great Britain to Russia as well as in central Asia (Dietz & Kiefer 2016). Unconnected areas of occurrence appear in China, Mongolia and Japan (Hutson *et al.* 2008e). Brandt's bat has been recorded in 12 provinces in southern and central Finland (Table 4) but the records are scattered (Fig. 7). There are only few records from western coastal areas, and between the western and central parts of the country are large areas where this species was never observed. An area where the species has been frequently recorded covers south-western Finland. The northernmost records in Finland are from the same latitudes as in Sweden, approx. 64°N (Ahlén 2011). Despite the growing number of bat surveys and research projects, the distribution maps of the whiskered or Brandt's bat have changed only little. The maps of Brandt's bat records in Lehmann (1983–1984) and Skarén (1992) are quite similar to the one presented here, even though more records were available in this study. Further study is needed to clarify whether the records from southeast Lapland are those of *Myotis mystacinus* or *M. brandtii* (see below).

**ABUNDANCE AND STATUS IN FINLAND:** Brandt's bat is common, locally even outnumbering the northern bat, commonly in areas dominated by forests. However, the distribution of Brandt's bat remains very patchy, because normally detector observations cannot be used to identify Brandt's or the whiskered bat. Records are common in the east, and very few near the western coast, possibly due to barrenness of the inner parts of



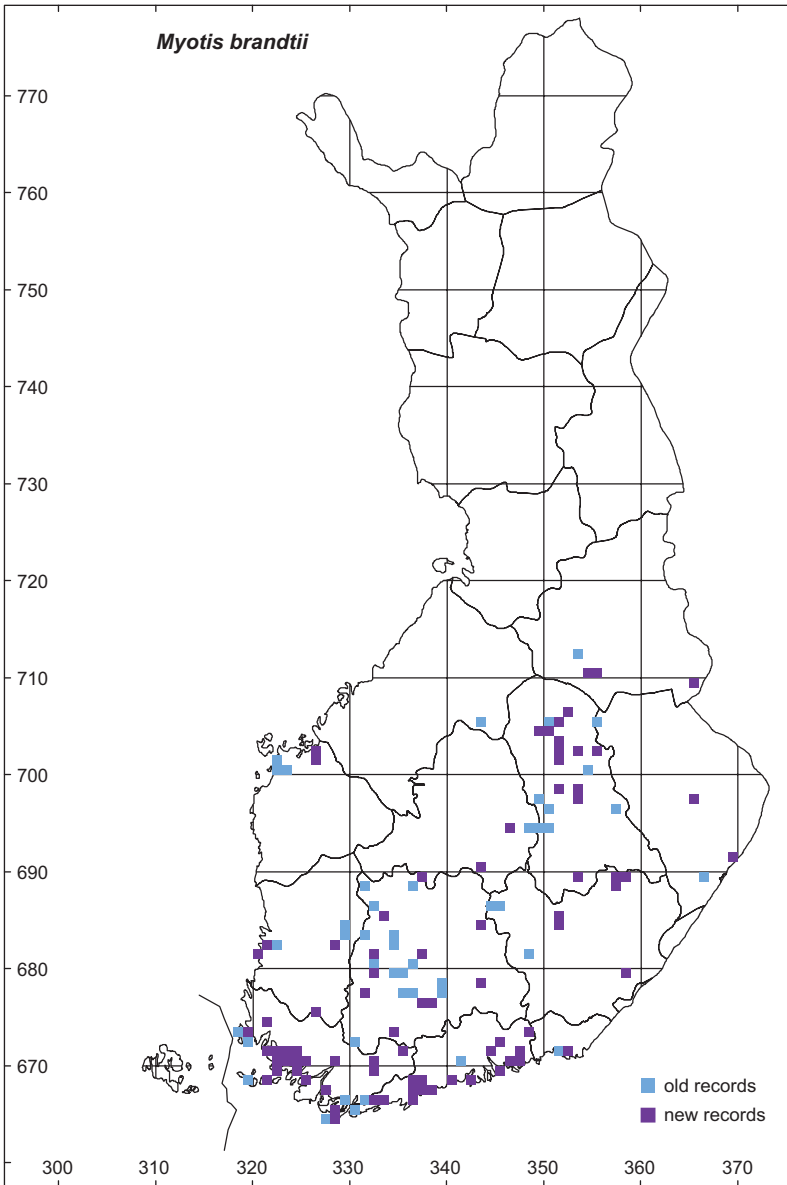
**Fig. 6.** Distribution of the serotine in Finland.

Ostrobothnia or scarcity of surveys during which individuals are caught.

This species is often found foraging in forests. Some longer flights of Brandt's bat were recorded (see Hutterer *et al.* 2005) but no indication of migration were found. In a radio-tracking study, Vihervaara *et al.* (2008) recorded Brandt's bats flying on average 950 metres from their roosts to foraging areas. The species hibernates in Finland.

Brandt's bat is a breeding species in Finland. Maternity roosts are typically located in old

buildings (e.g. Lehmann 1983a, Hagner 1987, Jäppinen 1987, Vihervaara *et al.* 2008). Nyholm (1965) found most of the roosts of whiskered bats in buildings. At the time of his research, however, the species was *Myotis mystacinus sensu lato*, as *Myotis mystacinus* had not yet been separated from *M. brandtii*. Thus, his data may also refer to Brandt's bat. In 1990, Haukkovaara (1997) found colonies of the whiskered bat, Brandt's bat and the northern bat in a big attic; the most numerous was Brandt's bat (140–180 indiv.).



**Fig. 7.** Distribution of Brandt's bat in Finland.

In hibernacula, Brandt's bat cannot be separated from the whiskered bat without disturbing the hibernating bats. The species pair *Myotis mystacinus/brandtii* is often found hibernating in moist underground sites, such as natural and man-made caves (Wermundsen & Siivonen 2010). However, other studies report hibernation occurring in maternity roosts, that is, in buildings (Jäppinen 1987).

***Myotis dasycneme*** [Eng: Pond bat, Fin: lampisiippa, Swe: dammfladdermus]

**DATA:** The first pond bat observed in Finland was a hibernating individual found in south-eastern Finland in 2002 (Siivonen & Wermundsen 2003b). Only three further published records exist, all made with a bat detector (Fig. 3) (Siivonen & Wermundsen 2006, Lindstedt & Laine 2013).

**DISTRIBUTION:** The pond bat occurs in central and eastern Europe, from northwestern

France to central Russia (Piraccini 2016), but not in the southern parts of the continent. In Finland, all records are from a single 10-km<sup>2</sup> square (Table 4) in the Karelia Australis biogeographical province in the southeastern corner of the country, (Fig. 8). The exact location of one record is unknown. New observations, not included in the map, revealed occurrence of the pond bat also along the Vuoksi river (Savonia Australis), approx. 120 km north-east of the mentioned square (K. Kuitunen pers. comm.). Records of the species from western Russia near Finland are scarce and mostly from the area south of St. Petersburg (Chistyakov 2002). Large numbers of pond bats were found hibernating near St. Petersburg (I. Popov pers. comm.).

**ABUNDANCE AND STATUS IN FINLAND:** The status of the species in Finland is thus far unclear due to the absence of information on breeding and existence of just one winter record. In central and northern Europe, the pond bat is a facultative migrant (Hutterer *et al.* 2005). The longest recorded flights in Europe were 344 and 330 km between the Netherlands and Belgium (Fairon 1967, Sluiter *et al.* 1971). Long flights were also observed in Russia (summarised in Hutterer *et al.* 2005). The pond bat is considered migratory in Sweden (Ahlén 2011) but sedentary in Estonia (Masing 2015). The Finnish summer observations were of individuals flying above rivers (Siivonen & Wermundsen 2006, Lindstedt & Laine 2013, K. Kuitunen pers. comm.).

***Myotis daubentonii*** [Eng: Daubenton's bat, Fin: vesisiippa, Swe: vattenfladdermus]

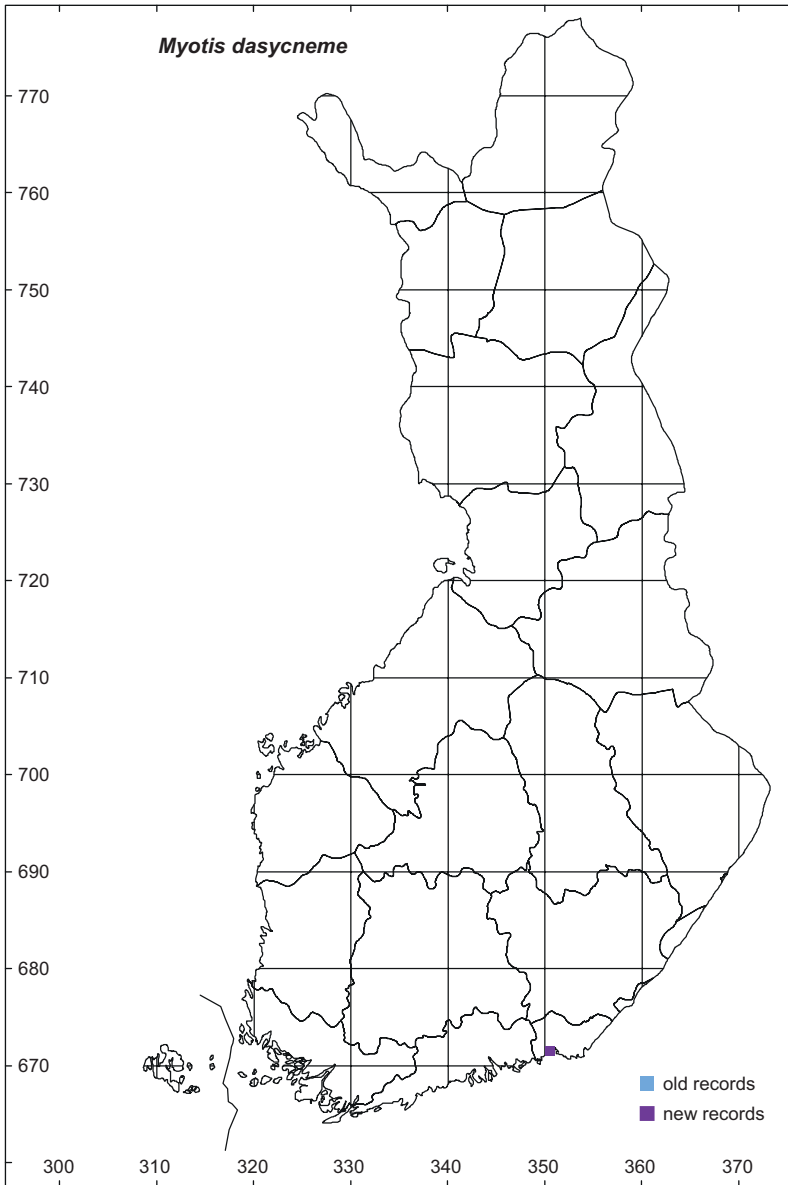
**DATA:** Daubenton's bat is the second most common bat species in Finland, accounting for 20% of the data used in this study. Records of the species number in total 2556, some of which are clusters of several records located in close proximity. Of all the records, 89% are classified as new. Extensive data exists on captured individuals, because most of the ringed bats in Finland belong to this species. Additionally, many observations were made using a bat detector. Daubenton's bat is quite easy to find in two ways: first, by observing lake shores and river banks, where its characteristic flight behaviour near the water sur-

face is easy to see. Second, by using a bat detector, as its echolocation calls can be heard from 15 metres (Barataud 2015) or even from a distance of 40 to 50 metres (Skiba 2003). More data is available from southern Finland than other parts of the country. Some of the unidentified bat observations from northern Finland could concern Daubenton's bat but this is unlikely because observers would probably have identified this species had they seen a bat flying above a water surface.

**DISTRIBUTION:** Daubenton's bat is a Palearctic species with its distribution reaching from Portugal in western Europe to the Korean Peninsula and Japan in Asia (Stubbe *et al.* 2008). In Finland, Daubenton's bat is widespread and common. It was recorded mainly in southern and central parts of the country, in 16 out of 21 biogeographical provinces (Table 4 and Fig. 9) which may be related to higher observations efforts in those areas. Some observations, however, were made further north, and recently even above the Arctic Circle (Siivonen & Wermundsen 2008b). Despite numerous new records, there are still large areas with no reported observations. This may be related to low observation efforts and/or barren landscapes in Ostrobothnia, especially in the western inland areas.

Our data include confirmed first observations from five biogeographical provinces, including two provinces further north (*see* Haukkovaara 1993, Stjernberg *et al.* 1993, Mitchell-Jones *et al.* 1999). In fact, of the common bat species in Finland, the distribution of Daubenton's bat has changed the most. The northernmost records are fairly new and result from a targeted survey by Siivonen and Wermundsen (2008b) to Lapland and other northern provinces. Their survey aimed to find the species in locations lacking previous records, mainly river valleys between 64°N and 66°N. Siivonen and Wermundsen (2008b) obtained several new records, without which the distribution area in Finland would have reached almost the same latitude as in Sweden.

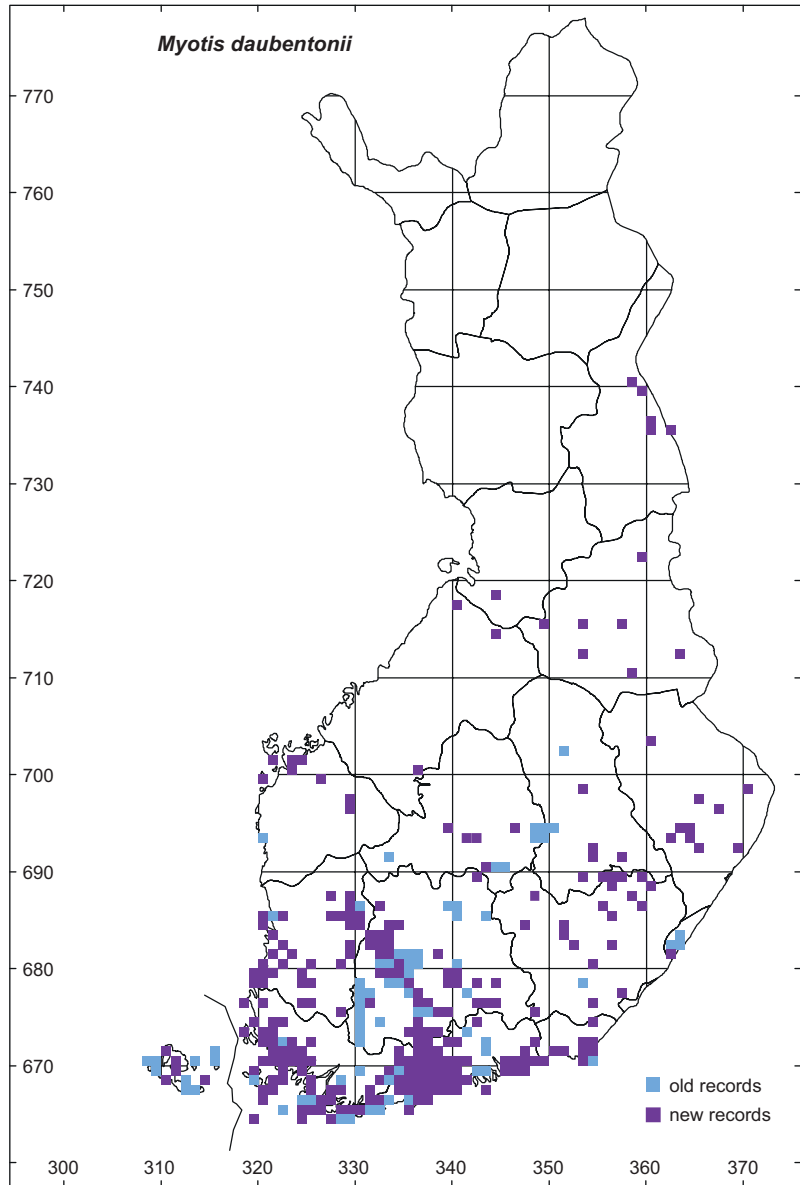
**ABUNDANCE AND STATUS IN FINLAND:** Daubenton's bat is a common and abundant breeding species, found in many areas in Finland. Despite observations of many individuals foraging near waterbodies, known nursery roosts are few. The colonies that were found, were not very large either, typically consisting of some dozens of



**Fig. 8.** Distribution of the pond bat in Finland.

individuals. Daubenton's bats hibernate in Finland and are found in several hibernacula. However, these records concentrate in southern and coastal areas; very little is known about the hibernation sites or numbers of hibernating bats in other areas. This species is sedentary, although some longer flights were recorded in Europe (up to 304 km; summarised in Hutterer *et al.* 2005). No long-distance flights were observed in Finland, however, and the ringing data is rather small (Finnish Museum of Natural History).

Daubenton's bat typically forages near and above waterbodies such as ponds, lakes and rivers. This bat also hunts in forests and is occasionally found also in other places, such as edge habitats, parks and harbours (Wermundsen & Siivonen 2008). Maternity roosts and other summer roosts are often in woodpecker holes (Nyholm 1965, Lehmann 1983a), bridges, bird boxes (third author's unpubl. data) and bat boxes (e.g. Sallamaa *et al.* 2011) and occasionally also in buildings (e.g. Lehmann 1983a). The species



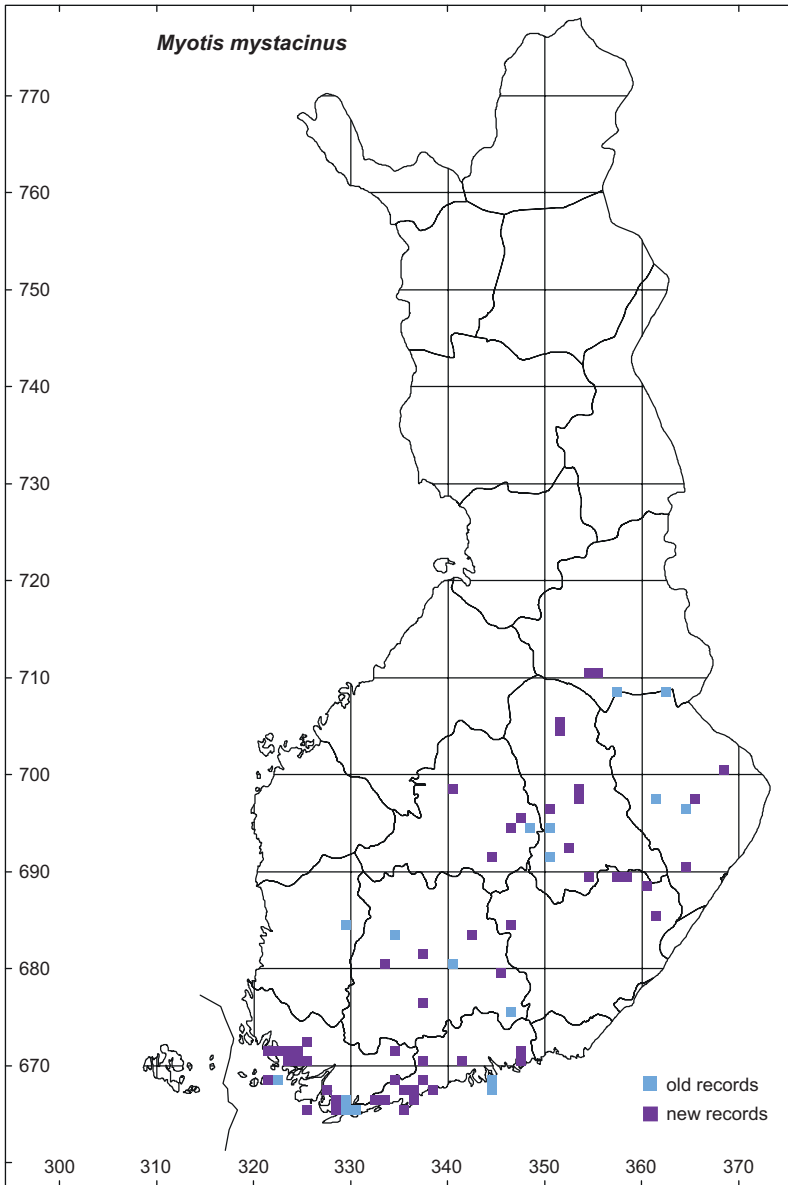
**Fig. 9.** Distribution of Daubenton's bat in Finland.

hibernates in moist conditions (Wermundsen & Siivonen 2010), mainly in man-made underground structures, such as caves and bunkers.

***Myotis mystacinus*** [Eng: whiskered bat, Fin: viiksisiippa, Swe: mustaschfladdermus]

**DATA:** Only 189 records of this species exist, of which 78% are new. The species *Myotis mystacinus sensu lato* was divided into *M. mystacinus*

and *M. brandtii* in 1970 (Baagøe 1973). The whiskered bat (*Myotis mystacinus*) can only be separated from Brandt's bat (*Myotis brandtii*) morphologically or genetically, and not or with great difficulty, with acoustic methods of detection (see Brandt's bat). Hence, records we used concern mainly ringed animals and museum specimens. In bat surveys conducted with an acoustic detector, the whiskered bat and Brandt's bat are commonly observed, typically being treated as a species pair. However, omission of

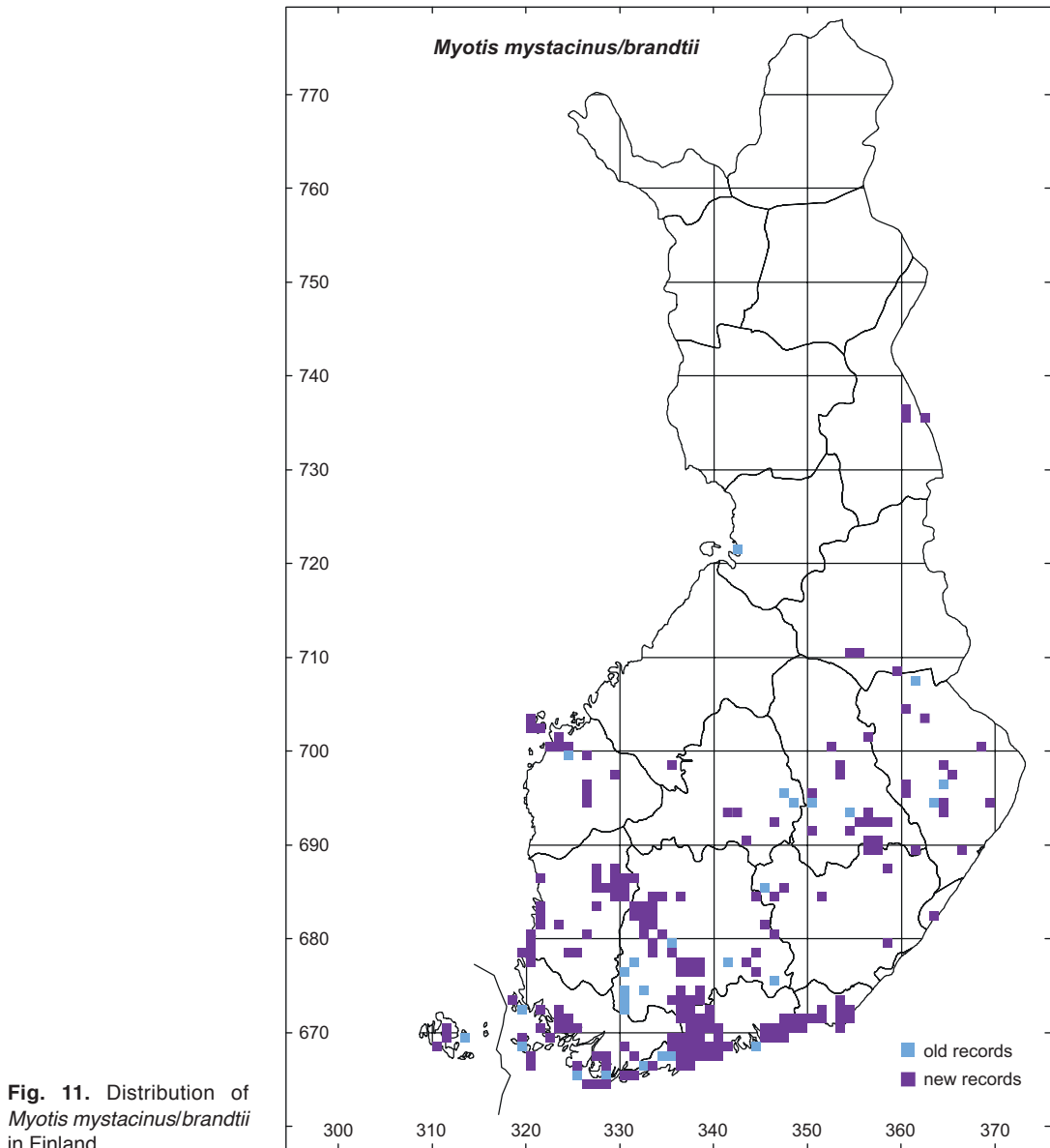


**Fig. 10.** Distribution of the whiskered bat in Finland.

survey data from the analysis at the species level was necessary, as the species usually cannot be separated by echolocation calls (however cf. Barataud (2015) for acoustic separation of the species).

**DISTRIBUTION:** The whiskered bat is a Western Palearctic species with a wide distribution in Europe, from Morocco to Scandinavia (Dietz & Kiefer 2016). Its distribution covers nine provinces in southern and central Finland (Table 4 and Fig. 10). The records are mostly scattered,

however, with no discernible large uniform areas of neighbouring grids. There are no records of the species from western coastal areas, except from the southwestern region, the location of recent active bat research. Despite the growing number of bat surveys and research projects, no major changes have occurred in the distribution patterns of either the whiskered bat or Brandt's bat. However, the data on distribution of *Myotis mystacinus/brandtii* (see Fig. 11) indicate that either one or both species occur in a wider



**Fig. 11.** Distribution of *Myotis mystacinus/brandtii* in Finland.

area than seen in the distributions maps for each species (Figs. 7 and 10). The map of confirmed records of the whiskered bat presented by Lehmann (1983–1984) is quite similar to that presented here. The distribution area of this bat in Finland reaches much further north than in Sweden, where the northern border of the distribution is around 61°N (see Ahlén 2011). Further research is needed to clarify to which species the observations of *Myotis mystacinus/brandtii* in southeast Lapland refer.

**ABUNDANCE AND STATUS IN FINLAND:** The whiskered bat is poorly known in Finland. The study by Nyholm (1965) focusing on the whiskered bat mainly concerned *Myotis mystacinus sensu lato*, that is, either the whiskered bat or Brandt's bat. In Finnish ringing data and museum collections the former is less abundant than the latter. The distributions of both species appear patchy, presumably due to the limited data. Records of the whiskered bat are more abundant in eastern than western Finland.

Whether this pattern reflects the real situation or is the result of non-systematic sampling is unknown. The inner parts of Ostrobothnia in western Finland are partly flat and barren, with large oligotrophic bogs and open fields, which may limit the distribution of most bat species due to the lack of insects and the disinclination of some bat species to cross large fields.

The whiskered bat breeds in Finland. Very few records of roosts are available, but the known maternity roosts are usually located in buildings, and the species can form mixed colonies with other species. Haukkovaara (1997) found colonies of the whiskered bat, Brandt's bat and the northern bat in a big attic, with the number of whiskered bats being fairly low (10–20), however. The whiskered bat is sedentary and typically does not make long-distance flights (Hutterer *et al.* 2005), and hibernates in Finland.

This species prefers forests. According to Ahlén (2011), in Sweden it also favours parks, pastures and grove meadows. Although records are few, the whiskered bat's roosts were found in buildings (e.g. Lehmann 1983a, Haukkovaara 1997, Vihervaara *et al.* 2008). Although according to Nyholm (1965) most of the roosts of whiskered bats were in buildings, it is uncertain to which species those reports refer to as at the time *Myotis mystacinus sensu lato* was not yet separated into two species (the whiskered bat's and Brandt's bat). It seems that the whiskered bat hibernates in relatively warm and moist underground locations (Wermundsen & Siivonen 2010), but as previously stated this information may also concern Brandt's bat.

### ***Myotis mystacinus* or *Myotis brandtii*** [Eng: whiskered bat or Brandt's bat]

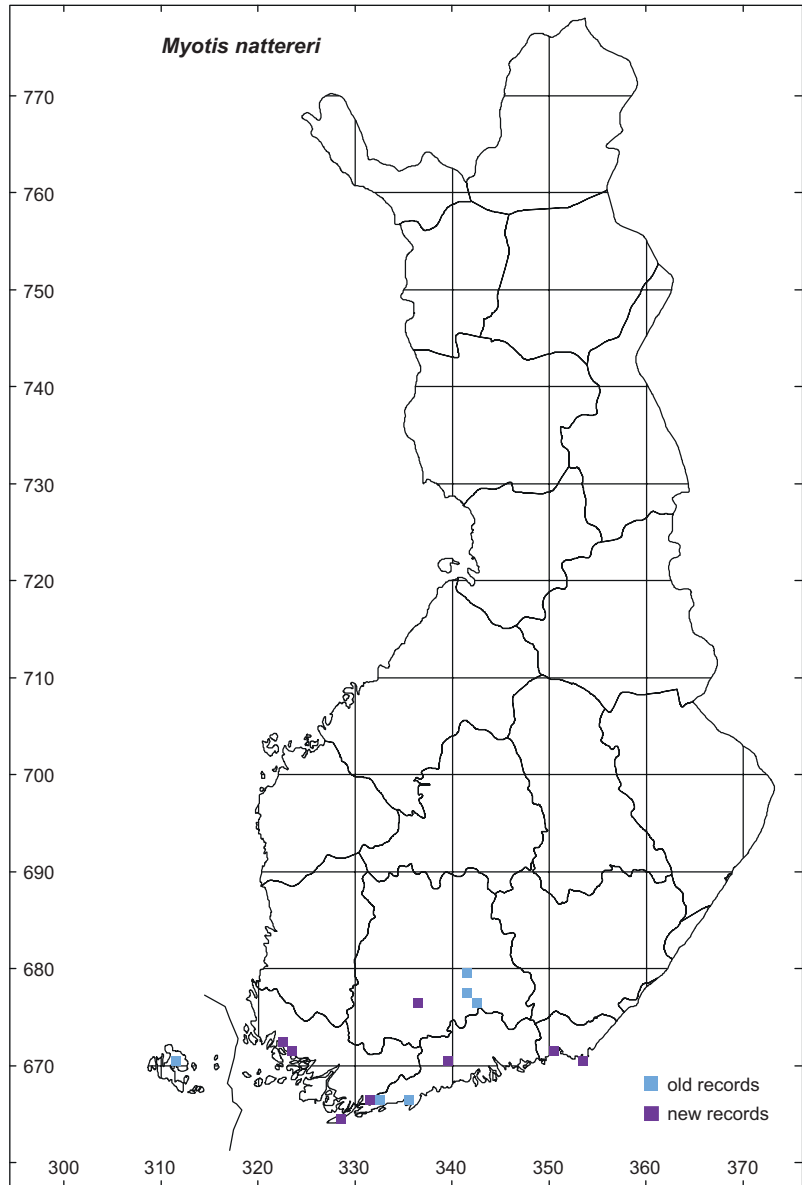
In the records from the studies using an acoustic detector and other surveys the species pair *M. mystacinus/brandtii* is common. Data on this species pair number 1517, of which some are closely located clusters of original records. The distribution map of the whiskered bat/Brandt's bat is less patchy than the map of either of the two species (Fig. 11). In good conditions, this species pair can be separated from other *Myotis* species by echolocation calls but not from each

other (however *see* Barataud (2015)). The northernmost records at 66°N in the Oulanka river valley (Regio Kuusamoensis) are from a targeted survey by Siivonen and Wermundsen (2008b). All other records are from further south. Either one or both species can, however, occur in the area between the new northernmost records and the more central records.

### ***Myotis nattereri*** [Eng: Natterer's bat, Fin: ripsisiippa, Swe: fransfladdermus]

DATA: Natterer's bat records number just 31, of which 23 date from 2001 onwards. The three oldest records are museum specimens from between 1849 and 1873 (Stjernberg 1996); the remaining five are from the 20th century. The data comprise observations of hibernating bats, acoustic detector records, ringed animals and few museum specimens (Fig. 3). In addition to the records used in this study, three museum specimens, two adult females and one juvenile, are from Pitkäsaari (approx. 60°30'N, 28°40'E) in the municipality of Johannes near Viipuri, a city formerly belonging to Finland. These specimens are apparently from a maternity colony, as the adult females gave birth soon after being caught (Kivirikko 1940). Despite the growing number of bat surveys and hibernacula checked, the annual number of records is still very small. The species is difficult to observe with an acoustic detector, as its echolocation calls are very weak and can be heard from no farther than 15 m (Barataud 2015).

DISTRIBUTION: Natterer's bat occurs in Europe and northwestern Africa; separate areas occur in southwestern Russia, Georgia and Iran (Hutson *et al.* 2008a). In southern Finland, Natterer's bat was recorded between Virolahti in the southeast (first author's unpubl. data) and the Åland Islands in the west (I. Ahlén pers. comm.) (Fig. 12). The northernmost records are from Hollola (I. Ahlén pers. comm., *see also* Stjernberg 1996) and Asikkala (museum specimen) at about 61°N. In the Turku area in southwestern Finland, several observations of the species were made and its hibernacula, sometimes with several individuals, located (E. Kosonen unpubl. data). Existing records are from five biogeographical provinces



**Fig. 12.** Distribution of Natterer's bat in Finland.

only (Table 4). Old observations come from few sites in three provinces. The species was recorded mostly near the coast, including one record from 1979 from the municipality of Sund, the Åland Islands (see Kyheröinen *et al.* 2010). Two of the three oldest records (from 1849 and 1853) are museum specimens from Inkoo, southern Finland, and the third one (from 1873) is from Tuusula, southern Finland (uncertain identification, see Stjernberg 1996). Old records are summarised in detail in Stjernberg (1996, 1998).

**ABUNDANCE AND STATUS IN FINLAND:** No old and/or new reports of maternity colonies of the species exist even though several individuals were caught and ringed in southwest Finland. In the collections of the Finnish Museum of Natural History, however, there is one juvenile specimen from Inkoo from 1853.

Natterer's bat was found hibernating in Turku for several years (E. Kosonen pers. comm.). Siivonen and Wermundsen (2008c) reported 20 hibernating individuals and seven summer

records. The maximum number of individuals observed in the same hibernaculum was five (Siivonen & Wermundsen 2008c). The numbers of observations are limited, but being from both summer and winter, the species is considered to breed in Finland. Natterer's bat was classified as endangered in the most recent Red List of Finnish Mammal Species (Liukko *et al.* 2019). This species is considered sedentary; however, the evidence of migrations exists (summarised in Hutterer *et al.* 2005) but not from Finland.

Records of foraging Natterer's bats are mainly from woodland edges and parks usually near water (e.g. Stjernberg 1996, Siivonen & Wermundsen 2008c). In Finland, the species has been found hibernating in cellars and other underground structures, such as man-made caves.

***Nyctalus noctula*** [Eng: noctule, Fin: isolepakko, Swe: större brunfladdermus (stor fladdermus)]

**DATA:** In Finland, the noctule has been known for long but is relatively rare. The first record presented here is from 1952, although the species was already mentioned in 1881 (Table 1). Approximately 50 records exist from between the 1950s and the 1980s. Since the 1980s, observations have been made in most years; currently there are more new records (100) than the old ones (52). The data comprise almost exclusively observations made with an acoustic detector or sightings of the species, with only three museum specimens available (Fig. 3). For example, reports of noctules flying during daytime come from bird ringing stations, bird migration observatories, and from islands off the south coast of Finland where these bats were observed by bird watchers used to estimating the size of a flying animal. To be included in these data, sighting records had to include size and other identifying characteristics of the animal. However, the risk of misidentification always exists, as the species could have been confused with the serotine or other *Nyctalus* species.

The species is easy to spot with a bat detector, as its echolocation calls are loud (Barataud 2015). Some people can even hear it, as the

frequency is approx. 20 kHz, which is near the upper limit of human hearing range.

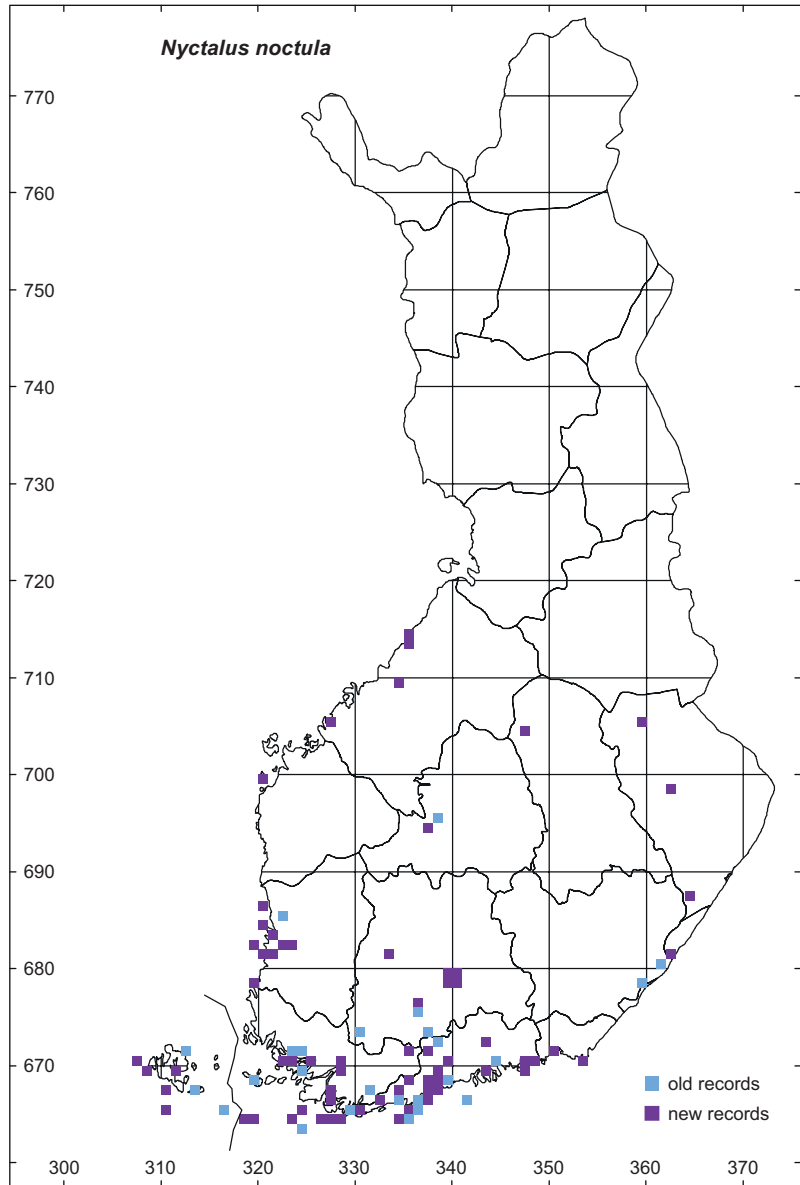
**DISTRIBUTION:** The noctule is common and widespread in Europe. Its Palaearctic range reaches to the Caucasus in the east (Csorba *et al.* 2016). Finnish records of the species are from 13 out of 21 biogeographical provinces including the southern parts of the country and the west coast (Fig. 13 and Table 4). Several inland observations also exist, including eastern Finland near the Russian border. The northernmost record is from Kalajoki at 64°N (Pöyry Management Consulting Oy 2012). As the species is a generalist and a very strong flyer covering long distances, it may occur in a greater area than currently known.

**ABUNDANCE AND STATUS IN FINLAND:** Despite observations made annually and at different times of the summer, it is unclear whether the noctule breeds in Finland. However, a pregnant female found on 13 July 1968 (Bergman & Hackman 1969), and one report from Hamina (southeastern Finland) of one roost in an attic used for several years (Siivonen & Wermundsen 2006) may indicate that breeding takes place.

The noctule is a long-distance migrant with documented movements of up to 1546 km (summarised in Hutterer *et al.* 2005). In Finland, no noctule has yet been ringed, thus the length of migratory flights or the origin of observed specimens is unknown. Indications of noctule migration are based on sightings made at bird ringing stations and observation sites of bats moving from the south over the open sea, as well as from acoustic-detector observations of the species at coastal sites. According to Dechmann *et al.* (2014), females migrate longer distances than males. Thus, noctules seen in Finland could be females, with males remaining close to their wintering areas. The majority of dated observations are from autumn, between August and October, with smaller numbers made in spring and summer.

***Pipistrellus nathusii*** [Eng: Nathusius' pipistrelle, Fin: pikkulepakko, Swe: trollpipistrell (trollfladdermus)]

**DATA:** The first reported record of Nathusius' pipistrelle dates from 1982 (Lehmann 1983b);

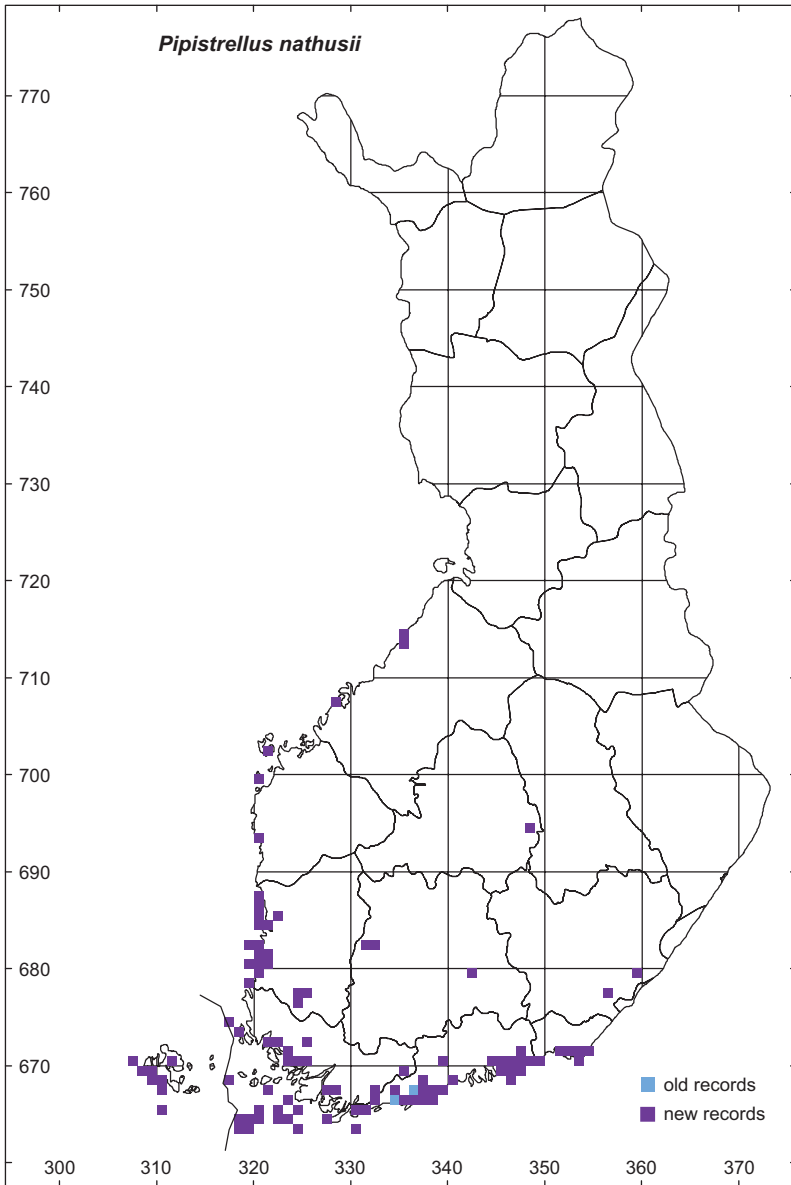


**Fig. 13.** Distribution of the noctule in Finland.

however, an older sound record from the Åland Islands from 1979 was later identified as *Nathusius' pipistrelle* (I. Ahlén, pers. comm. to the third author on 20 Apr. 2007, Kyheröinen *et al.* 2009, 2010). The data comprise 232 records, of which all but 5 are new, mostly from the last ten years. Most of the recent data comes from numerous passive monitoring studies conducted for nature surveys in connection with land use planning, especially along the coast with potential habitats for this migratory species. *Nathusius' pipistrelle*

is quite easy to recognise with a bat detector which was used to make the majority of the observations (Fig. 3). Few records are of caught and ringed individuals, and museum specimens account for even fewer.

**DISTRIBUTION:** *Nathusius' pipistrelle* occurs in the Western Palearctic region, from Europe to Asia Minor and Transcaucasia (Paunović & Juste 2016). *Nathusius' pipistrelle* was recorded in ten biogeographical provinces in Finland, mainly in the southern, southwestern and west-



**Fig. 14.** Distribution of *Nathusius' pipistrelle* in Finland.

ern parts of the country (Fig. 14 and Table 4). Old records are from Nylandia in the south and the Åland Islands. Most records of the species are from coastal areas; however, observations were also made at inland locations. The northernmost records are from Kalajoki (approx. 64°15'N) and Pietarsaari (63°40'N) on the western coast. Despite most of the records being from coastal areas, *Nathusius' pipistrelle* may be more common inland than the current data indicate. Siivonen and Wermundsen surveyed *Nathusius'*

*pipistrelle* and the common *pipistrelle* between 2001 and 2003, reporting several new locations for both species, including some on the southern coast for *Nathusius' pipistrelle*, and one location in central Finland (Rautalampi) (Siivonen & Wermundsen 2003a, Wermundsen & Siivonen 2004).

**ABUNDANCE AND STATUS IN FINLAND:** *Nathusius' pipistrelle* currently seems more common and widespread than earlier, probably due to increased survey activity; however, this change

may also reflect a genuine pattern of range expansion. Lundy *et al.* (2010) presented a current (from the 1980s to present) and projected range expansion in the United Kingdom based on records of the species and modelling of habitat and climate. The species has not been found hibernating in Finland, in concordance with its migratory patterns in other European countries. Breeding of the species was confirmed in 2006 in southeastern Finland (Hagner-Wahlsten & Kyheröinen 2008) and in 2009 in Helsinki (Hagner-Wahlsten & Karlsson 2010). These maternity roosts were in old buildings. Further recent evidence of breeding is based on juveniles captured in Helsinki and Espoo (first author's unpubl. data). In the most recent Red List of Finnish Mammal Species, *Nathusius' pipistrelle* is classified as vulnerable (Liukko *et al.* 2019).

*Nathusius' pipistrelle* is known to migrate long distances between summer and winter grounds. Extensive ringing data from Latvia (Pētersons 2004) indicate journeys of over 1900 km through Europe (see also Hutterer *et al.* 2005). The direction of autumn migration is mainly south-west (Hutterer *et al.* 2005). In Finland, the species is not observed during wintertime; instead, many records are made during migration time, especially in the autumn. Based on the data from several countries around the Baltic Sea; in spring, migration activity of this species was correlated with latitude, but not in autumn (Rydell *et al.* 2014). Thus the spring migration starts earlier in Germany and other southern localities than in Finland. *Nathusius' pipistrelles* may migrate not only over the Baltic Sea but also across the narrow strait (Kvarken, at about 63°N) between Finland and Sweden. The data collected in that area shows that *Nathusius' pipistrelles* occur on the islands during the autumn migration period (August–September) and move in the area from east to west (Fritzén 2014, 2015, 2019).

***Pipistrellus pipistrellus*** [Eng: common pipistrelle, Fin: vaivaislepakko, Swe: sydpipistrell (pipistrell)]

DATA: The common pipistrelle is a fairly new species in Finland, being observed for the first time in 2001 (Salovaara 2001). Since then, 37

records exist. All observations were made with a bat detector; no captured animals or museum specimens exist (Fig. 3). The soprano pipistrelle was separated from the common pipistrelle *sensu lato* in 1999, first based on their different echolocation calls, and later by genetic analyses (Barrat *et al.* 1997, Jones & Barrat 1999). The species is relatively easy to observe with an acoustic detector. However, separating it from *Nathusius' pipistrelle* or soprano pipistrelle is not always possible, as the echolocation calls of the three species have partly overlapping peak frequencies (Barataud 2015).

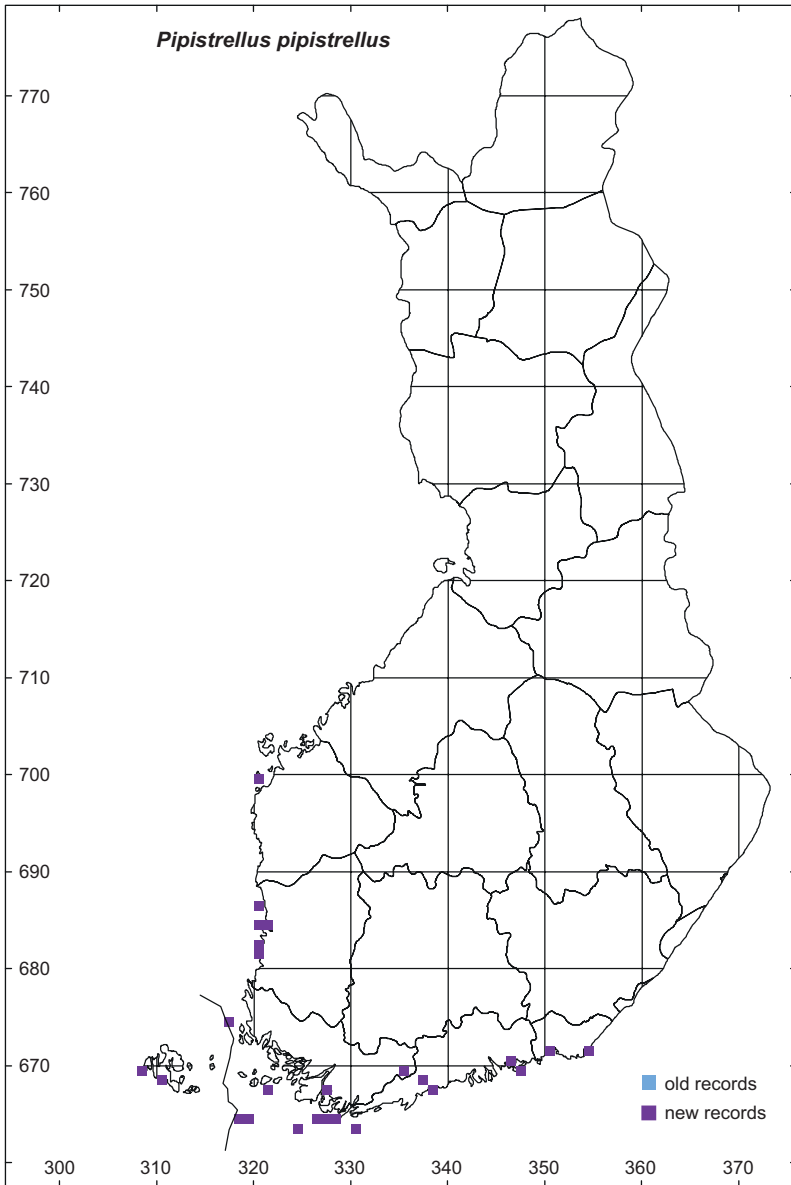
DISTRIBUTION: The common pipistrelle is a common and widespread species. However, due to the relatively recent split of the common pipistrelle *sensu lato* into soprano pipistrelle and common pipistrelle *sensu stricto*, its ranges are yet to be defined. The range of the common pipistrelle covers most of Europe, some of north-western Africa, reaching through south-west Asia to central and eastern Asia (Hutson *et al.* 2008c).

In Finland, all records of the common pipistrelle are from coastal areas and archipelagos, ranging from southeastern Finland to the west coast (Fig. 15). The northernmost records are from Maalahti (Ostrobothnia, at 63°N). Records of the species are from six biogeographical provinces (Table 4), with the species possibly occurring further north at suitable inland sites.

ABUNDANCE AND STATUS IN FINLAND: The common pipistrelle may be more abundant than currently known but still also rare as in the Scandinavian countries (Ahlén 2011, Størkersen *et al.* 2014). There are no indications of the species breeding in Finland. The common pipistrelle is a migrating species. Buresh (1941) recorded migrations of up to 1150 km, normally they are however much shorter (summarised in Hutterer *et al.* 2005). Thus, it is likely a migrant in Finland and other northernmost parts of the species' known range. No roost has yet been found.

***Pipistrellus pygmaeus*** [Eng: soprano pipistrelle, Fin: kääpiölepakko, Swe: dvärgpipistrell (dvärgfladdermus)]

DATA: The soprano pipistrelle was observed in Finland for the first time in 2007 (Salovaara

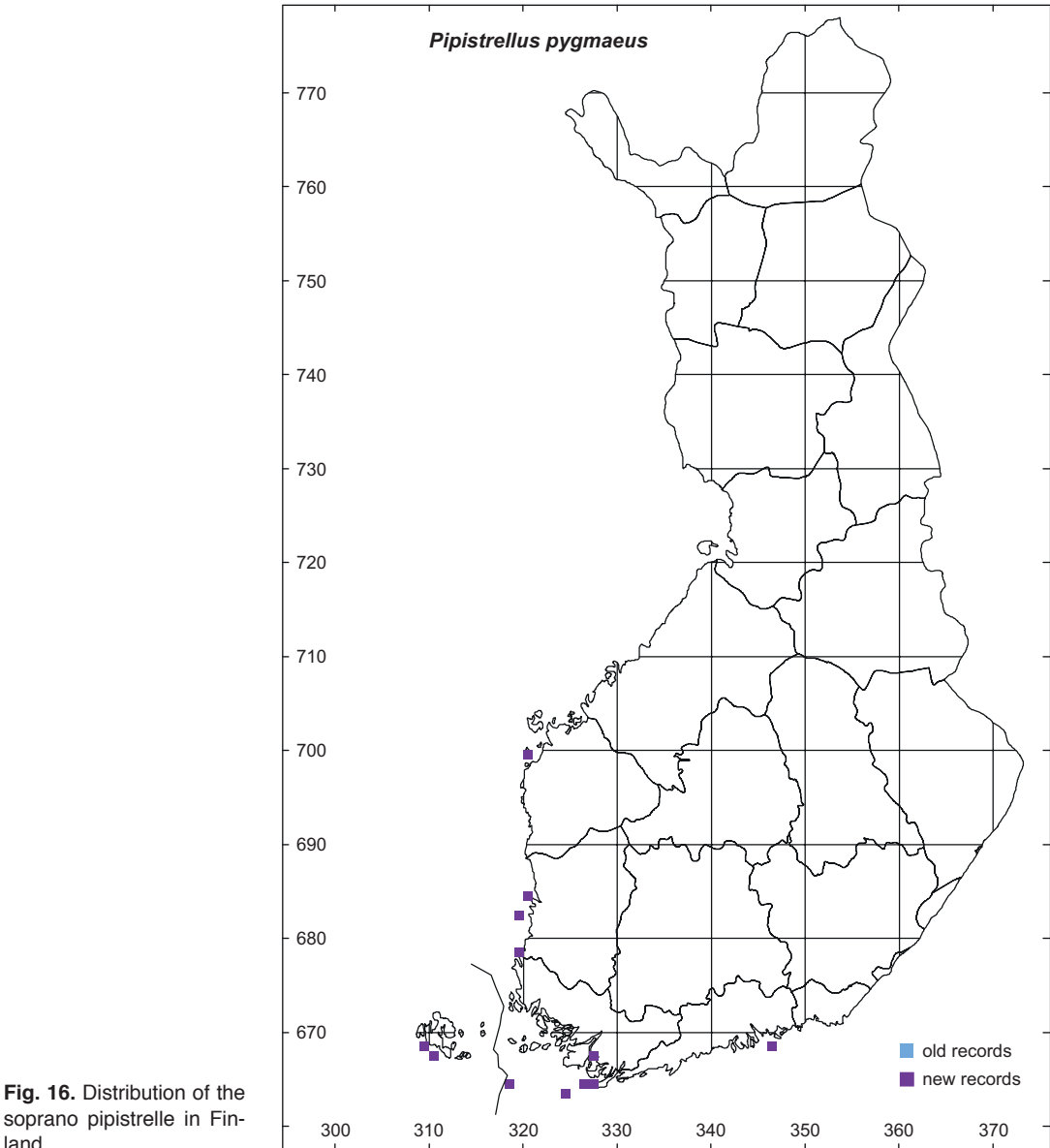


**Fig. 15.** Distribution of the common pipistrelle in Finland).

2007). The soprano pipistrelle was separated from the common pipistrelle in 1999 (Barrat *et al.* 1997, Jones & Barrat 1999). The data comprise 14 records, of which all but one were obtained using a passive monitoring detector (Fig. 3). One dead specimen was found at the Aspskär bird ringing station, an island in the eastern part of the Gulf of Finland.

**DISTRIBUTION:** The breeding range of the soprano pipistrelle is still unknown due to the fact that this species was separated from the

common pipistrelle very recently and records from before it was recognised cannot be used. Its Palearctic range covers the British Isles, much of Europe and western parts of Russia (Benda *et al.* 2016). All records of the soprano pipistrelle in Finland are from five biogeographical provinces from coastal areas and archipelagos west of Loviisa, a city 90 kilometres east from Helsinki (Fig. 16 and Table 4). The northernmost records are from Maalahti on the west coast, at 63°N. As the species was first observed in 2007, new



records in the near future may extend its known distribution in Finland.

**ABUNDANCE AND STATUS IN FINLAND:** No indications currently exist of the soprano pipistrelle breeding or hibernating in Finland. All records are from coastal sites but the species may also occur inland. As the species was separated from the common pipistrelle fairly recently (*see above*), ringing data from Europe are scarce, and there are none from Finland. Few of observations (mostly by passive monitoring) were made

along potential migration routes in coastal areas. No roosts have been found in Finland.

***Plecotus auritus*** [Eng: brown long-eared bat, Fin: korvayökkö, Swe: brunlångöra (långörad fladdermus)]

**DATA:** The brown long-eared bat is considered a fairly common species in Finland, yet there are only 718 records, of which 82% are new. Of the

new records, 53% comprise caught and ringed animals, originating from quite small areas in southern and southwestern Finland. Many of these records are from areas with bat boxes monitored for several years; the remainder are observations made with an acoustic detector, or bats seen in hibernacula or a summer roost. There are few records obtained from various sources with no description of the observation method. This species mainly uses very quiet echolocation calls, only detectable from approx. 5 m, making it difficult to find with an acoustic detector (Barataud 2015). However, the species is easily identifiable by sight.

**DISTRIBUTION:** The brown long-eared bat is an endemic European species with a wide distribution from Portugal to Georgia and Kazakhstan. The range of the brown long-eared bat is from the northern Mediterranean in the south to southern Fennoscandia in the north (Hutson *et al.* 2008d). In Finland, this species is distributed across the southern and central parts of the country, with records from 14 out of 21 biogeographical provinces (Table 4 and Fig. 17). The northernmost records are from 64°25'N (Siivonen & Wermundsen 2008b), further north than in Sweden where its distribution reaches southern Norrland (ca. 63°N) where it was observed along the coast (Ahlén 2011). Many of the new sightings are from sites with no earlier confirmed records of the species. On the other hand, many grids contain only old records. Despite many new observations of the species, its distribution area has not expanded much as compared with that presented in older maps (Haukkovaara 1993, Stjernberg *et al.* 1993), and only two new provinces were included in the new records.

The brown long-eared bat has a sedentary lifestyle and rarely flies long distances (e.g. Kyheröinen 2008), yet it has been found on islands close to the Finnish mainland. A few records from the Åland Islands also exist. Its distribution appears patchy, with areas without records and areas with continuous coverage of grids (Fig. 17). The latter are typically areas where bat observers carried out ringing or surveys. The brown long-eared bat probably occurs in many areas with suitable habitats, but is under-represented in the data as it is difficult to observe with an acoustic detector.

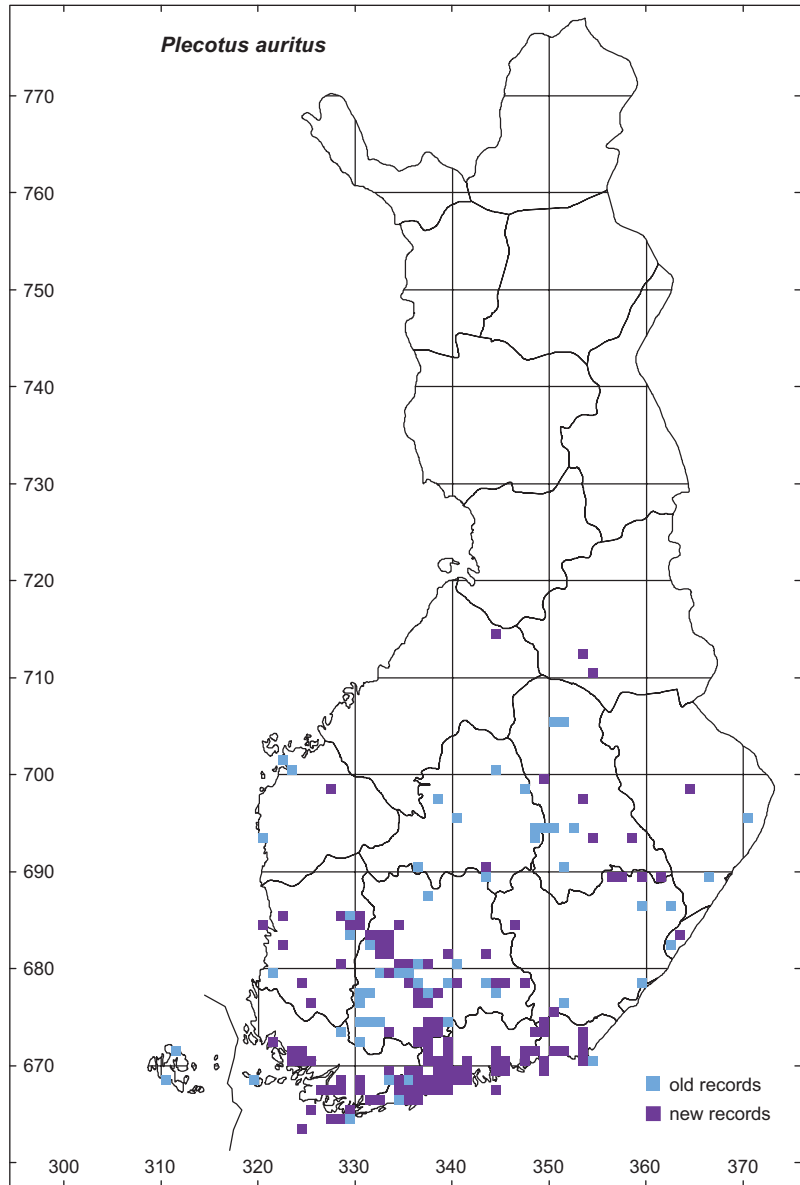
**ABUNDANCE AND STATUS IN FINLAND:** The brown long-eared bat breeds in Finland, and is a sedentary species, typically moving only very short distances. In a radio-tracking study in southern Finland, these bats foraged near the roost but sometimes travelled up to 2 km to foraging areas (Kyheröinen 2008). There is one observation from Finland of a ringed brown long-eared bat found alive 20 km from the ringing locality in Nylandia, southern Finland (first author's unpubl. data). The brown long-eared bat hibernates in Finland.

Bat and also bird boxes are used for roosting, sometimes even as nursery roosts (Sallamaa *et al.* 2011). Nursery roosts have also been found in summer cottages in the archipelago off the south coast of Finland (third author's unpubl. data). Hibernating specimens have been found in cellars, bunkers and caves (first author's unpubl. data). Brown long-eared bats typically hibernate alone, that is, not in clusters, and in colder and drier conditions than *Myotis* species (Wermundsen & Siivonen 2010).

***Vespertilio murinus*** [Eng: parti-coloured bat, Fin: kimolepakko, Swe: gråskimlig fladdermus]

**DATA:** The parti-coloured bat is very rare in Finland; the data include 28 records only but the majority of these (25) are new. The first record dates from 1834; the second one from 1981. Three records are from the 20th century, and the rest from the year 2000 onwards. Most of the records were made with a bat detector (Fig. 3), although included are few sightings and two museum specimens.

**DISTRIBUTION:** The parti-coloured bat is widely distributed in the Palearctic, from France to China. The westernmost areas of Europe are outside its range, and so are the northernmost ones although the species occurs in Scandinavia (Coroiu 2016c). Records of the parti-coloured bat are mainly from southern Finland, from Virolahti in the south-east to the Åland Islands in the west, with a few records from the western coast (Fig. 18). The northernmost record is from Maalahti, at 63°N (Vasko & Hagner-Wahlsten 2010). New records of the parti-coloured bat are from eight



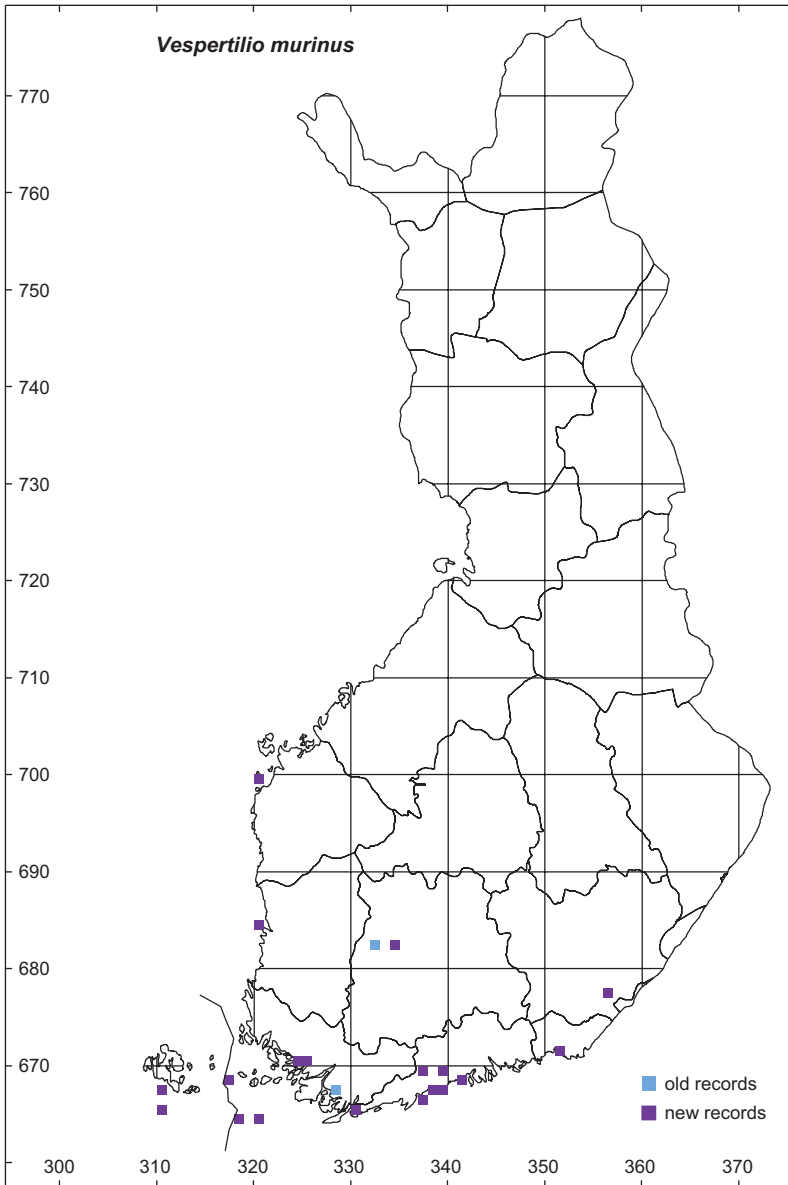
**Fig. 17.** Distribution of the brown long-eared bat in Finland.

biogeographical provinces (Table 4), whereas three old records came from three provinces.

**ABUNDANCE AND STATUS IN FINLAND:** Despite the growing number of bat surveys and detectors used, the parti-coloured bat has not been observed as often as other rare or migratory species. The species seems very rare and is most likely migrant. No records exist of this species breeding in Finland. However, Lundahl (1852) reported killing six specimens in a garden in August 1834 in Tampere; this relatively large

number of individuals may refer to a colony. No observations of hibernating individuals exist, although one individual was found in November 1986 (stored as a museum specimen since its death). Another museum specimen was found dead in February 2011 at a bird ringing station; the time of the animal's death being unknown.

The parti-coloured bat is a strong flyer and a migratory species. The longest recorded movement was 1780 km (Markovets *et al.* 2004). In the 2010s in Finland, the species was very rarely



**Fig. 18.** Distribution of the particoloured bat in Finland.

recorded in bat migration monitoring and other surveys using passive detectors.

## Discussion

### Quality of the data

Most of the data used in this bat atlas was collated before 2014. As the amount of new bat observations is growing rapidly due to increas-

ing bat survey and research activity, more data are yet to be published. Many professionals and amateurs often use passive detectors that can be left in the field for a longer time, due to the easy use and the significant decrease in the prices of these devices. Thus, there are large data sets from many locations. When made public, these data will most probably include records from new locations and further north than to date. This atlas thus presents the current knowledge also revealing gaps and need for further research.

We collated data from different sources, with varying reliability. We evaluated the records, especially those of rare species, considering the species, type and location of the observation and how experienced the observers were. However, in many cases we had no access to primary data, for example the original detector recordings.

The evaluation of the reliability of the records varies with the species. For some species, a visual observation was considered reliable. For example, our data includes several visual observations of a large, highflying bat not supported by detector observation or photos. We classified these observations based on the description of size, colour and flight style, and accepted them as sufficiently detailed records of the noctule even though some of the observed bats might have been serotines. Concerning the whiskered bat and Brandt's bat, we only accepted records based on morphological identification. We also recognise the difficulties in the identification of *Pipistrellus* species, as there is variation and overlap in their echolocation calls. In most cases, we trusted the expertise of the surveyors although we could not assess the primary data for species identification.

### Changes in the species numbers

The number of bat species recorded in Finland increased during the last decades, and even more species might be found in the near future. According to three bat atlases from the 1990s (Haukkovaara 1993, Stjernberg *et al.* 1993, Mitchell-Jones *et al.* 1999), the Finnish bat fauna comprised nine species until 2001. After 2001, further four species were added to the Finnish bat fauna: common pipistrelle, pond bat, soprano pipistrelle and serotine (*see* Table 1). This addition was mostly due to new technology, mainly bat detectors, and an increasing interest in bats among researchers and amateurs. For example, the first bat detector in Finland was used in 1982 while by 1999 there were 28 such detectors (third author's unpubl. data). In 2002, the Finnish Chiropterological Society was founded and has since worked actively to raise bat. Publications devoted to bats (e.g. de Jong *et al.* 1995, Lapalainen 2003) have also played a role in raising

awareness. The first doctoral thesis on bats in Finland was published by Nyholm in 1965, and the following three theses were published not until the 2010s (Wermundsen 2010, Lilley 2012, Vesterinen 2015). The increasing interest in bats and activities related to bat research are detailed in national reports to the Agreement on the Conservation of Populations of European Bats (EUROBATS) (Kyheröinen *et al.* 2003, 2004, 2005, 2006, 2009, 2010, 2014, Kyheröinen & Hyvärinen 2018). Changes in bat population sizes as well as changes in climate may also result in an increase in the number of bat species in Finland. Still, new bat species may be recorded in Finland, as ranges of some species in neighbouring countries expand. For example, the barbastelle (*Barbastellus barbastellus*), Leisler's bat (*Nyctalus leisleri*) and Alcaholic whiskered bat (*Myotis alcathoe*) occur in Sweden (Ahlén 2011) and may be detected in Finland as well. Observations of the barbastelle have increased in Sweden quite rapidly and the northernmost sites of occurrence are approximately at the same latitude as the Åland Islands.

Despite new species being recorded, the number of species in Finland decreases towards the north. This may be due to long and harsh winter and lack or very little darkness during summer nights in northern areas. Observation efforts are also much higher in the south than in the north. Many observations made in the north include very few details but have been accepted as the northern bat records. However, it is possible that some of those observations concern other species. For example, the particolored bat, which occurs very north in Norway, could also occur in Finnish Lapland.

### Changes in distributions

The maps produced from our data compared with those of earlier studies (handbooks and atlases) are mostly similar for many species. However, for some species and in some biogeographical provinces the changes have been remarkable. For example, Nathusius' pipistrelle is now present in ten biogeographical provinces as opposed to two in old records. According to Ahlén (2011), the range and abundance of this

species increased in Skåne (southern Sweden) and on Gotland. Migration patterns of *Nathusius*' pipistrelles in the Kvarken strait between Finland and Sweden are not yet known, and it is unclear from where in Finland individuals come to this area. Thus far, using radio-tracking Fritzén and Hägg (2019) found one individual that migrated from Finland to Sweden in autumn. Hence, more research on the migratory behaviour of this and other species is needed to clarify the migration paths and breeding areas of bats in Finland.

The species composition in northern Finland has changed. Daubenton's bat has been recorded further north, and there were records of *Myotis mystacinus/brandtii* from Lapland, though it is not known which of the two species is in question. Also in the southwestern areas and the Åland Islands, there are records of species new to the provinces. This is presumably due to increased research and survey activities in those areas. One example is from the island of Bergö, in Ostrobothnia Australis, where a survey carried out for a wind farm project produced data on four bat species new to the province (Vasko & Hagner-Wahlsten 2010). Improved species identification and awareness of challenges it includes may also result in an increased numbers of new species records. Targeted survey trips to areas with no or little previous data can be very valuable in finding new locations of occurrence. Siivonen and Wermundsen (2008b) demonstrated this in their systematic surveys of river corridors in northern Finland, which produced many new records of Daubenton's bat. We thus encourage researchers and amateur bat observers to survey areas with few bat records, as well as regions north of the known ranges of different species.

No major differences in the species distributions could be detected when comparing with the near-by areas of the neighbouring countries. However, the distributions of Daubenton's bat, the whiskered bat and Brandt's bat extend further north in Finland than in Sweden (Ahlén 2011, EEA-ETC/BD 2019). Contrary to what our limited data indicate for Finland, in Scandinavia, the common pipistrelle seems rarer than the soprano pipistrelle (Ahlén 2011, Størkersen *et al.* 2014). The common pipistrelle is also uncommon in the Baltic states, being only locally present in Estonia (Tõrv 2014) and rare in Latvia (Pētersons

2014). In Sweden and Norway, the soprano pipistrelle is common and has extensive ranges in the southern parts of those countries (Ahlén 2011, Størkersen *et al.* 2014) while in Estonia it is rare (Tõrv 2014, Masing 2015).

## Future use of the data

This study provides a review of data previously not available or not collated. As such, it can be used as a base material for future presentations of bat species distribution in Finland. We also encourage bat researchers and amateurs to publish their observations with details on the observation method and species identification and hence make the data available. This would greatly help future bat research and conservation. The Finnish Biodiversity Information Facility ([www.laji.fi](http://www.laji.fi)) offers an easy-to-use portal for observation-data uploading and for retrieving data from many sources.

To fulfil obligations arising from legislation, agreements and the recently published *Action Plan for the Conservation of All Bat Species in the European Union*, robust monitoring of bats should be carried out. At the moment there is no country-wide monitoring system in Finland. Regional or local monitoring activities, for example hibernacula censuses and monitoring using bat detectors in summer, have been running for several years but their geographical coverage is insufficient. Thus no information on population trends is available. This makes for example reporting required by the Article 17 of the *EU Habitats Directive* complicated, as the data is deficient for assessment of the conservation status of most of the bat species. While bats may be harmed by intensive forestry and other land use practices causing habitat change and fragmentation, there is an urgent need for surveying occurrences of bats and monitoring their populations.

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