

## **Forsmark site investigation**

# **Abundance and distribution of bat (Chiroptera) species in the Forsmark area**

Johnny de Jong, Sofia Gylje  
Swedish Biodiversity Centre  
Uppsala University and Swedish University of  
Agricultural Sciences

May 2005

**Svensk Kärnbränslehantering AB**

Swedish Nuclear Fuel  
and Waste Management Co  
Box 5864  
SE-102 40 Stockholm Sweden  
Tel 08-459 84 00  
+46 8 459 84 00  
Fax 08-661 57 19  
+46 8 661 57 19



## **Forsmark site investigation**

# **Abundance and distribution of bat (Chiroptera) species in the Forsmark area**

Johnny de Jong, Sofia Gylje  
Swedish Biodiversity Centre  
Uppsala University and Swedish University of  
Agricultural Sciences

May 2005

*Keywords:* AP PF 400-04-62, Bat survey, Chiroptera, Pipistrellus nathusii.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

A pdf version of this document can be downloaded from [www.skb.se](http://www.skb.se)

## Abstract

The bat fauna of the Forsmark area (the province of Uppland, south-east Sweden) was surveyed by using ultrasound detectors and mistnets during the period July 17 until August 9, 2004. The objective was to map the distribution of all species in the area, to identify important foraging areas and colonies and to get rough estimates of the abundance of the species. In total seven species were found: Brandt's bat (*Myotis brandtii*), whiskered bat (*Myotis mystacinus*), Daubenton's bat (*Myotis daubentonii*), soprano pipistrelle (*Pipistrellus pygmaeus*), Nathusius' pipistrelle (*Pipistrellus nathusii*), noctule bat (*Nyctalus noctula*) and northern bat (*Eptesicus nilssonii*). At earlier surveys two other species have also been found: Natterer's bat (*Myotis nattereri*) and brown long-eared bat (*Plecotus auritus*), which means that totally nine species have been recorded at the Forsmark area. Three of these species are red-listed: Natterer's bat, Nathusius' pipistrelle and whiskered bat. The most interesting observation is the high abundance and the colony of Nathusius' pipistrelle found at Kallerö in the southernmost part of the study area. Most of the Forsmark area, especially the north and central parts, are trivial with few species and low abundance. In these parts the northern bat dominates. However in some other parts, especially Forsmarks bruk, Habbalsbo, Johannisfors, Kallerö and Storskäret, species richness and abundance is relatively high.

# Sammanfattning

Med hjälp av ultraljudsdetektor och fångst med nät inventerades fladdermusfaunan i Forsmarksområdet, norra Uppland, under perioden 17 juli till 9 augusti, 2004. Syftet var att kartlägga vilka arter som finns i området, viktiga jaktområden, kolonier, samt till viss del också bedöma tätheten av arterna. Totalt hittades 7 arter: Brandts fladdermus (*Myotis brandtii*), mustaschfladdermus (*Myotis mystacinus*), vattenfladdermus (*Myotis daubentonii*), dvärgfladdermus (*Pipistrellus pygmaeus*), trollfladdermus (*Pipistrellus nathusii*), stor fladdermus (*Nyctalus noctula*) och nordisk fladdermus (*Eptesicus nilssonii*). Vid tidigare inventeringar har även fransfladdermus (*Myotis nattereri*) och långörad fladdermus (*Plecotus auritus*) observerats i området, vilket innebär att 9 arter påträffats. Av dessa är tre rödlistade: trollfladdermus, fransfladdermus och mustaschfladdermus. Intressantast av dessa är den stora förekomsten och kolonin av trollfladdermus vid Kallerö. De områden som har flest arter och störst täthet av fladdermöss är Forsmarks bruk, Habbalsbo, Johannisfors, Kallerö och Storskäret. Större delen av området, framförallt i de norra och centrala delarna, är trivialt och hyser få arter och individer. Dominerande art i den miljön är nordisk fladdermus.

# Contents

<b>1</b>	<b>Introduction</b>	7
<b>2</b>	<b>Objective and scope</b>	9
<b>3</b>	<b>Equipment</b>	11
3.1	Description of equipment/interpretation tools	11
<b>4</b>	<b>Execution</b>	13
4.1	Nonconformities	15
<b>5</b>	<b>Results</b>	17
<b>6</b>	<b>Summary and discussions</b>	21
	<b>Acknowledgement</b>	23
	<b>References</b>	25

# 1 Introduction

This document reports the data acquired by inventory of bats in the Forsmark area. The activity, which is part of the surface ecosystems program within the Forsmark site investigations, was performed in compliance with Activity plan AP PF 400-04-62 (SKB internal controlling document). An overview of the Forsmark site investigation area is given in Figure 1-1.

Bats (*Chiroptera*) is a relatively species rich group of mammals. In Sweden totally 18 species have been recorded and most of these species also reproduce in Sweden. This is more than 25% of the terrestrial mammal species /Mitchell-Jones et al. 1999/. Several of these bats species, such as the northern bat (*Eptesicus nilssonii*), Daubentons bat (*Myotis daubentonii*) and the soprano pipistrell (*Pipistrellus pygmaeus*) are very abundant with in some habitats more than 10 individuals/ha. However, a number of species are also rare, and in Sweden 6 species are red-listed /Gårdenfors, 2000/. The number of species is higher in the southern part of Sweden and decreases to the north. In the province of Uppland 11 species are found /Table 5-1, Ahlén and de Jong, 1996/.

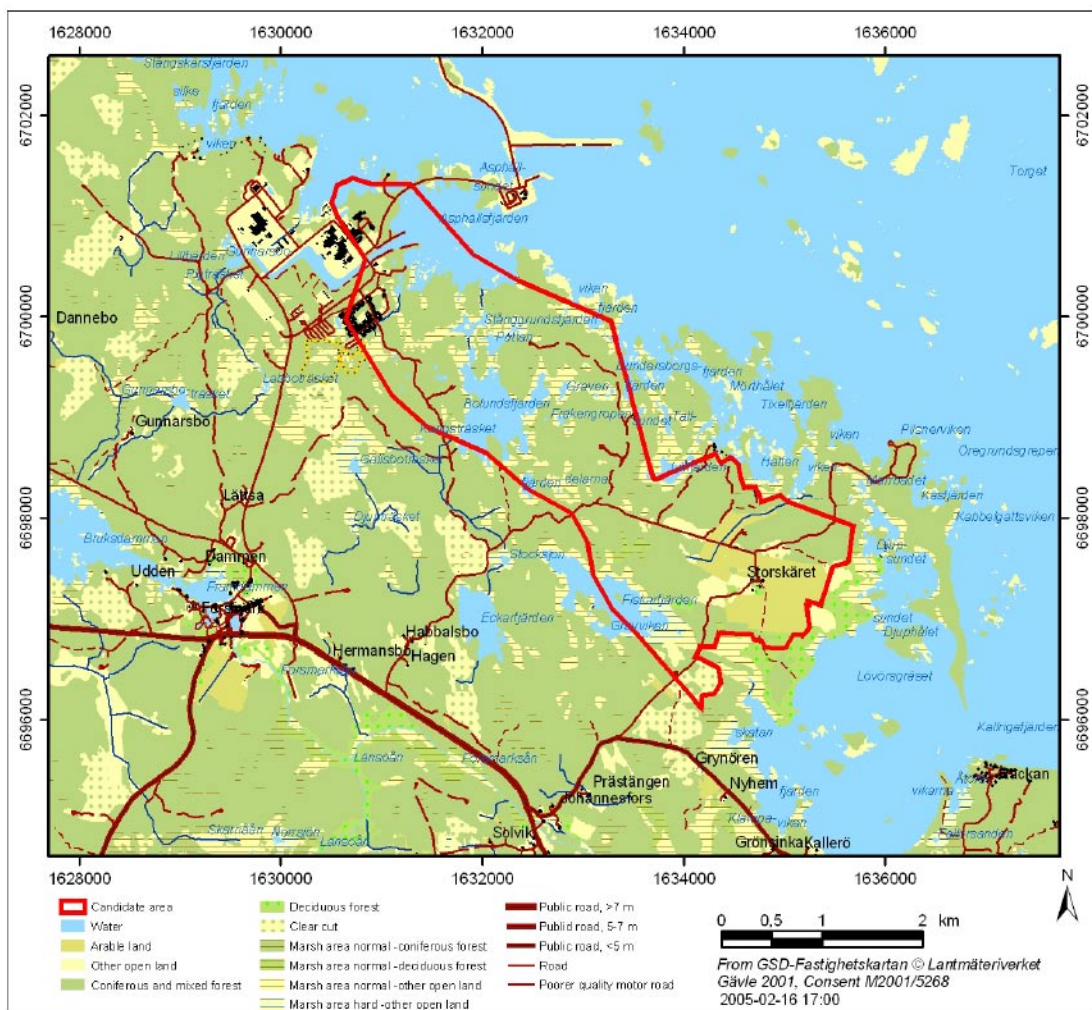


Figure 1-1. General overview over Forsmark site investigation area.

In some cases many of these bat species are able to coexist within a relatively small area. It is for example possible to find 7–10 species within a forest area of 30 ha. This coexistence is possible because all bat species are separated into different foraging niches. The species are specialised in exploiting insects in different ways. Some species feed on insects flying high up in the sky, others feed on insects above the water surface, and others use the insects flying in dense vegetation. The species are adapted to use different vegetation structures and habitats and it is sometimes possible to predict species composition in an area.

All species in Europe use insects as the only food-source, and most species eat mainly night-active flying insects. The most common groups of insects consumed by bats are diptera, tricoptera, coleoptera and lepidoptera. Normally there is a significant relation between insect abundance and bat abundance. A change in insect abundance also immediately affects bat distribution /de Jong, 1994/. Because of this the possibility to use bats as indicators of insect abundance has been discussed. High abundance of flying insects is also important for many other different groups of species, e.g. for birds.

The insects are detected by the sonar. Bats use short pulses of sounds of high frequency which are repeated several times per second. For example the Daubenton's bat produces 10 pulses per second with the frequency of 70 to 30 kHz. Bats are always using the sonar when flying. By using an ultrasound detector which transforms the high-frequency sound into audible sound, it is therefore possible to detect the bats. Because the species use different types of sound (variation in frequency, pulse-duration, repetition rate etc) it is also possible to identify the species by using an ultrasound detector, and to make surveys without trapping bats. However, some species have very similar sound and are therefore difficult to separate. Another problem is that some species use very weak sounds.

In general, the most preferred habitats are different types of wetlands (swamp-forests, streams and lakes), older deciduous forest or deciduous rich coniferous forest and semi-natural pastures with trees. More varied habitats are often rich in species and individuals, while more homogeneous habitats such as big fields and forest monocultures have few species and low abundance. Forestry, agriculture and other types of exploitation might affect the bat fauna positively or negatively. Activities which lead to increase of insect abundance, a varied vegetation structure and a diversity of habitats are positive for bats. One of the most negative factors is probably drainage, which occurs, or has occurred in both forestry and agriculture.

The bat fauna of some parts of the Forsmark area has been investigated before. Forsmarks bruk and Kallerö (Figure 1-1) are included in the monitoring programme of Uppsala county and have been visited several times /de Jong et al. 1997; de Jong and Gertz, 2001; Gylje, 2004/. Forsmarks bruk and Johannisfors have also been included as two sites in a bat survey of the whole province of Uppland /Ahlén and de Jong, 1996/.

## **2 Objective and scope**

The aims of this work were to survey the occurrence of different bat species in the Forsmark area (Figure 1-1), and to map the distribution of colony sites and important foraging areas. The ambition was also to give at least a rough estimation of abundance of different species.



## **3 Equipment**

### **3.1 Description of equipment/interpretation tools**

The survey was mainly carried out by using ultrasound detectors (D-200, Pettersson elektronik) which transform the ultrasound of the bats into audible sounds, thereby making identification possible /Ahlén, 1990/. The bat species also show different foraging behaviour, and by using a good head torch in combination with the detector, identification is in most cases possible without trapping. However, in some situations it is more difficult and the sound is recorded for later analyses in the computer. For these analyses the programme batsound (Pettersson elektronik) was used. Some species are more difficult to identify, especially species belonging to the genus *Myotis*, and very good recordings and observations are needed. Because of this, trapping of bats was necessary in some cases as a complement to ultrasound detectors. The bats were trapped in mist nets which were placed along important foraging routes or near the entrance of a colony. The bats were released again immediately after identification.

## 4 Execution

The survey was carried out during the period July 17 – August 9, 2004. A number of study sites were selected for the survey (Table 4-1, Figure 4-1). Instead of using a random procedure, the site selection was based on three different principles: 1). Sites where many bat species were expected to be found. In general this means a high variation of different habitats, e.g. occurrence of lakes, wetlands, deciduous forest and semi-natural pastures. 2). Sites near potential colonies, especially houses. 3). In total, the sites should cover the whole area and several different habitats should be represented. All study sites were visited at least once, but in some cases, if there were high abundance of bats or many species, the site was visited several times. At four sites, trapping and ultrasound surveys were combined.

In order to get some estimates on bat abundance in the main area, line-transects were used. This was done by driving by car through the area with a speed of 10 km/h and listening with the ultrasound detector out of the window. Each time a bat was observed, the species, number of individuals and position were noted. The total distance was 13 km, and this was repeated twice (Figure 4-2).

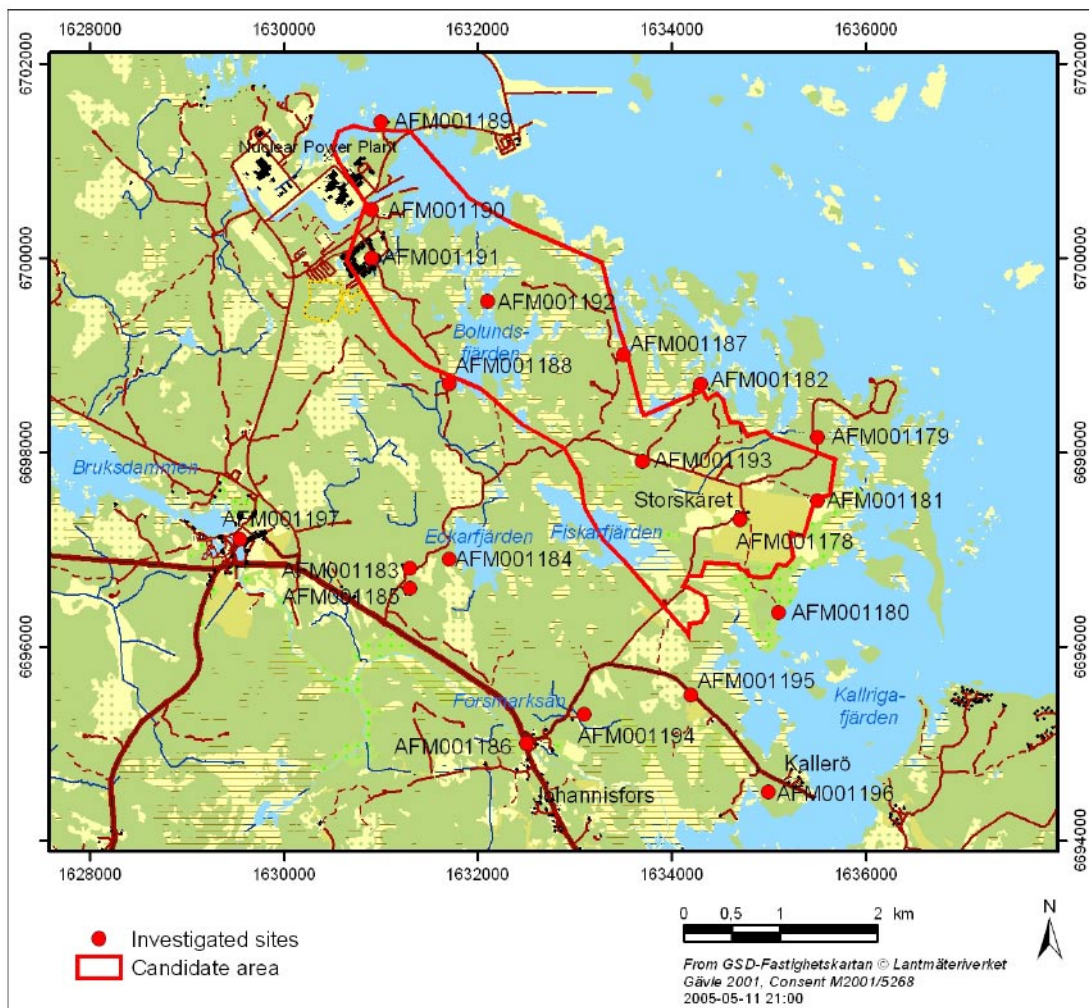


Figure 4-1. Investigated sites in the Forsmark area.

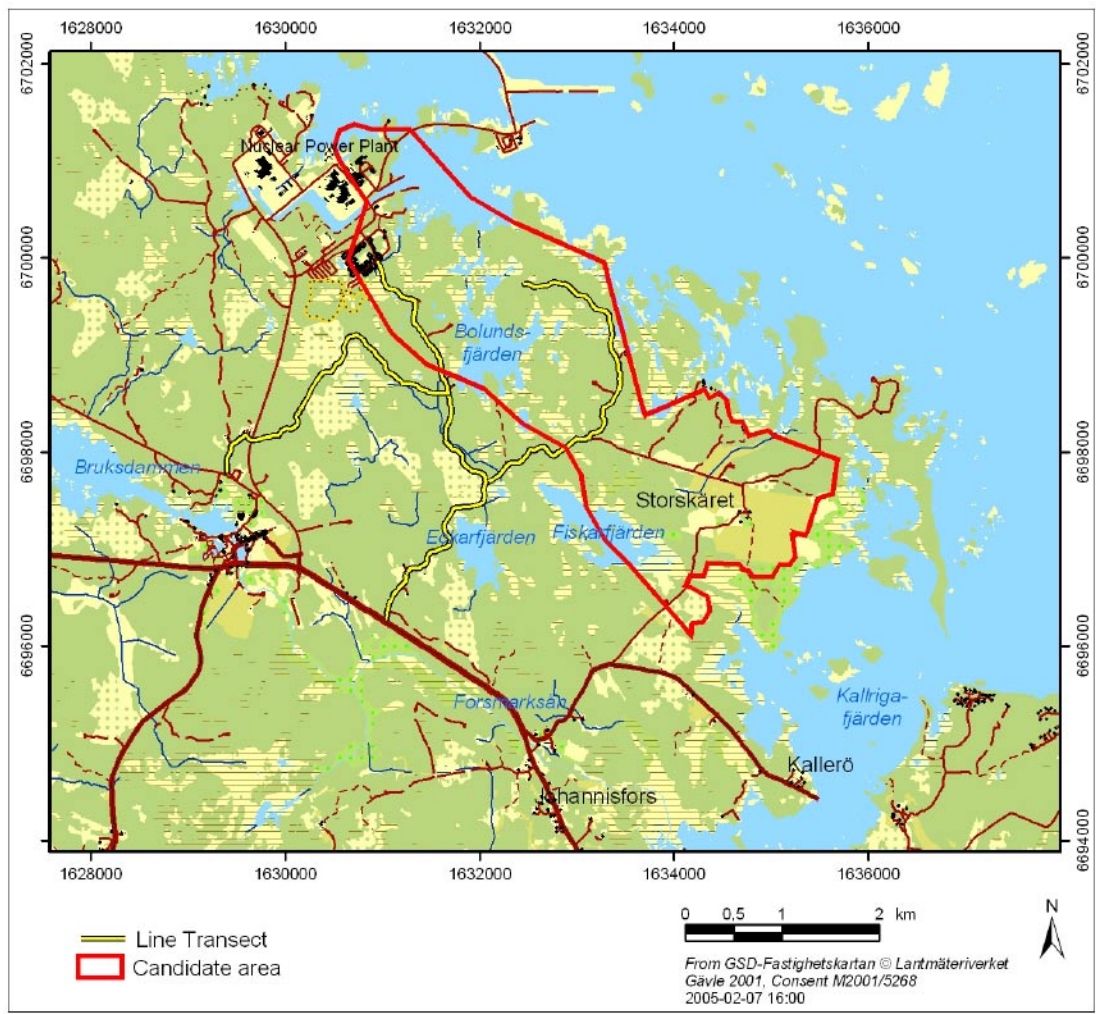


Figure 4-2. Location of line-transects in the Forsmark area.

**Table 4-1. Investigated sites at Forsmark area. See also Figure 4-1.**

Site-ID	Coordinates	Name	Dominating habitats	Date for visit (2004)
AFM001178	163470, 669730	Storskäret	Semi-natural pastures, deciduous trees, gardens, houses	17/7 26/7
AFM001179	163550, 669815	Granskäret	Old coniferous forest, wetlands	17/7
AFM001180	163510, 669635	Gåsgrund	Deciduous forest, semi-natural pastures, brackish water	28/7
AFM001181	163550, 669750	Gåsören	Semi-natural pastures, natural shores (grazed), deciduous forest	17/7 26/7
AFM001182	163430, 669870	Tixelfjärden	Houses, brackish water, deciduous and coniferous forest	26/7
AFM001183	163130, 669680	Habbalsbo	Houses, gardens, deciduous trees, coniferous forests	17/7 29/7
AFM001184	163170, 669690	Mossrudan	Lake, semi-natural pastures, coniferous forest, deciduous trees	29/7
AFM001185	163130, 669660	Hagen	Houses, gardens, coniferous forest	29/7
AFM001186	163250, 669500	Johannisfors	Running water, deciduous forest, houses	27/7 28/7
AFM001187	163350, 669900	Jungfruholm	Brackish water, houses, coniferous forest	28/7
AFM001188	163170, 669870	Kungsträsket	Lake, house, coniferous forest	28/7
AFM001189	163100, 670140	Per-Jans grund	Brackish water, houses, coniferous forest	17/7
AFM001190	163090, 670050	Channel at the nuclear power station	Water, young pine plantation, roads and buildings	17/7
AFM001191	163090, 670000	Houses near the nuclear power station	Houses, wetlands, coniferous forests, deciduous trees	17/7
AFM001192	163210, 669955	Norrskäret	Old coniferous forest, lakes	28/7
AFM001193	163370, 669790	Röngrund	Semi-natural pasture, coniferous forest, deciduous trees	17/7 26/7 30/7
AFM001194	163310, 669530	Prästängen	Houses, gardens, mixed forests	28/7
AFM001195	163420, 669550	Grynören	Fields, houses, coniferous forest, deciduous forest	27/7
AFM001196	163500, 669450	Kallerö	Brackish water, houses, gardens, wetlands, deciduous forests	27/7 29/7 30/7
AFM001197	162955, 669710	Forsmarks bruk	Lakes, streams, ponds, houses, deciduous trees, parks, gardens, deciduous forest	30/7

## 4.1 Nonconformities

None.

## 5 Results

In total, 7 species were recorded: *Myotis mystacinus*, *Myotis brandtii*, *Myotis daubentonii*, *Pipistrellus pygmaeus*, *Pipistrellus nathusii*, *Eptesicus nilssonii* and *Nyctalus noctula*. In earlier surveys two other species were recorded /Ahlén and de Jong, 1996/: *Plecotus auritus* and *Myotis nattereri*. Thus, the total number of bat species in the Forsmark area is 9 species (Table 5-1). Of these, 3 species are red-listed: *Myotis mystacinus*, *Myotis nattereri* and *Pipistrellus nathusii*.

The total distance of the line-transect was 26 km (2×13 km). Along this distance totally 15 individuals were recorded. Of these 10 were *Eptesicus nilssonii* and 5 were *Myotis* sp, probably *Myotis brandtii*. The mean abundance was 0.6 individuals/km. This can be compared with line transects made with the same methods on Gotland with the result of 1.2 individuals/km /Ahlén, 1998/, or with a study in Skåne with the result of 0.9 individuals/km /Gerell and Gerell-Lundberg, 2001/. In the latter study the abundance varied between 1.6 and 0.4 individuals/km. From this we conclude that both the species richness and abundance of bats in the main area probably is relatively low. In other parts, however, the species richness and abundance was high. The highest abundance of bats is definitely near Forsmarks bruk where *Pipistrellus pygmaeus*, *Myotis daubentonii* and *Eptesicus nilssonii* are very abundant. Around Kallerö the abundance of *Pipistrellus pygmaeus* and *Pipistrellus nathusii* is high, but here also *Nyctalus noctula* was recorded regularly. At Johannisfors *Myotis brandtii*, *Eptesicus nilssonii* and *Pipistrellus pygmaeus* were abundant. The semi-natural pastures near Storskäret are interesting (site number AFM001178, AFM001181 and AFM001193) with high abundance of *Myotis daubentonii*, *Myotis brandtii*, *Pipistrellus pygmaeus* and *Eptesicus nilssonii*. Near Habbalsbo the abundance of *Pipistrellus pygmaeus* and *Myotis brandtii* is high. Sites with high abundance of bats are in general also species rich. At this survey most species were found at Storskäret (6 species at site AFM001178, AFM001181 and AFM001193), Johannisfors (5 species at site AFM001186 including old records of *Myotis nattereri*), Kallerö (4 species at site AFM001196) and Grynören (4 species at site AFM001195), Figure 5-1.

Colonies of 4 species were found at 6 sites (Table 5-2). In some other cases colonies were not found, but because of high number of individuals it was obvious that there must be colonies nearby. It is most likely that there are colonies of *Myotis brandtii* at Johannisfors, and probably also at Storskäret. At Forsmarks bruk, there are probably colonies of *Eptesicus nilssonii*, *Myotis daubentonii* and *Pipistrellus pygmaeus*. It can be concluded that at least 5 species are reproducing in the area.

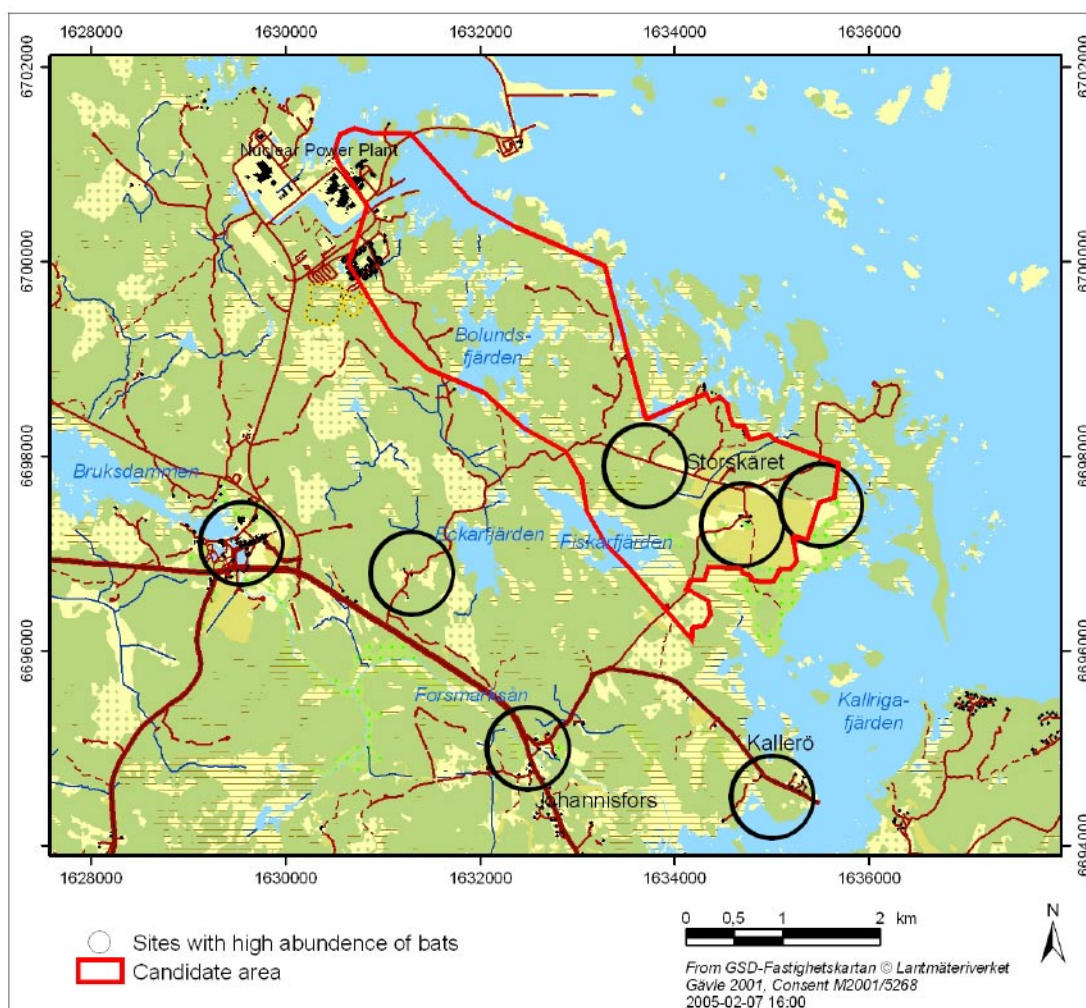


Figure 5-1. Sites with most species and highest abundance of bats in the Forsmark area.

Table 5-1. Species of bats found in the province of Uppland and the Forsmark area.

Species	Scientific name	English name	Swedish name	Found at Forsmark area	Breeding in Forsmark area
Myotis daubentonii	Daubenton's bat	Vattenfladdermus	Yes	Yes	
Myotis brandtii	Brandt's bat	Brandts fladdermus	Yes	Yes?	
Myotis mystacinus	Whiskered bat	Mustasch- fladdermus	Yes	No	
Myotis nattereri	Natterer's bat	Fransfladdermus	Yes, but not in this survey	No	
Myotis dasycneme	Pond bat	Dammfladdermus	No	No	
Pipistrellus nathusii	Nathusius' pipistrelle	Trollfladdermus	Yes	Yes	
Pipistrellus pygmaeus	Common pipistrelle	Dvärgfladdermus	Yes	Yes	
Vespertilio murinus	Parti-coloured bat	Gråskimlig fladdermus	No	No	
Eptesicus nilssonii	Northern bat	Nordisk fladdermus	Yes	Yes	
Nyctalus noctula	Noctule	Stor fladdermus	Yes	No	
Plecotus auritus	Brown long-eared bat	Långörad fladdermus	Yes, but not in this survey	No?	

**Table 5-2. Species and colony occurrence, and number of individuals at each site. Abundance = an estimation of the number of individuals passing or foraging in the area during the survey.**

Site- ID	Species	Abundance	Method	Occurrence of colonies*
AFM001178	<i>Eptesicus nilssonii</i>	4	Sound	No
	<i>Pipistrellus pygmaeus</i>	2	Sound	No
	<i>Myotis brandtii?</i>	3	Sound	No
	<i>Nyctalus noctula</i>	1	Sound	No
AFM001179	<i>Myotis brandtii?</i>	1	Sound	No
AFM001180	<i>Eptesicus nilssonii</i>	5	Sound	No
	<i>Myotis brandtii?</i>	1	Sound	No
	<i>Pipistrellus pygmaeus</i>	1	Sound	No
AFM001181	<i>Eptesicus nilssonii</i>	10	Sound	No
	<i>Pipistrellus pygmaeus</i>	4	Sound	No
	<i>Myotis daubentonii</i>	>13	Sound, trapping	Yes
AFM001182	<i>Eptesicus nilssoni</i>	3	Sound	No
	<i>Myotis brandtii?</i>	2	Sound	No
AFM001183	<i>Pipistrellus pygmaeus</i>	>10	Sound, trapping	Yes
	<i>Eptesicus nilssonii</i>	1	Sound	No
	<i>Myotis brandtii</i>	3	Sound, trapping	Yes
AFM001184	<i>Myotis brandtii?</i>	5	Sound	No
	<i>Eptesicus nilssonii</i>	1	Sound	No
AFM001185	–	–	–	–
AFM001186	<i>Myotis brandtii</i>	>10	Sound, trapping	No
	<i>Myotis mystacinus</i>	1	Trapping	No
	<i>Eptesicus nilssonii</i>	5	Sound	No
	<i>Pipistrellus pygmaeus</i>	5	Sound	No
AFM001187	<i>Eptesicus nilssonii</i>	2	Sound	No
	<i>Myotis daubentonii?</i>	1	Sound	No
AFM001188	–	–	–	–
AFM001189	–	–	–	–
AFM001190	<i>Myotis daubentonii?</i>	1	Sound	No
AFM001191	<i>Eptesicus nilssonii</i>	2	Sound	No
	<i>Pipistrellus pygmaeus</i>	2	Sound	No
AFM001192	<i>Eptesicus nilssonii</i>	3	Sound	No
AFM001193	<i>Myotis brandtii</i>	8	Sound, trapping	No
	<i>Pipistrellus pygmaeus</i>	4	Sound	No
	<i>Pipistrellus nathusii</i>	1	Sound	No
	<i>Eptesicus nilssonii</i>	12	Sound	No
	<i>Nyctalus noctula</i>	1	Sound	No
AFM001194	–	–	–	–
AFM001195	<i>Eptesicus nilssonii</i>	>5	Sound	Yes
	<i>Pipistrellus pygmaeus</i>	2	Sound	No
	<i>Myotis brandtii?</i>	2	Sound	No
	<i>Pipistrellus nathusii</i>	1	Sound	No

Site- ID	Species	Abundance	Method	Occurrence of colonies*
AFM001196	Pipistrellus nathusii	>10	Sound	Yes
	Pipistrellus pygmaeus	>10	Sound	Yes
	Nyctalus noctula	3	Sound	No
	Eptesicus nilssonii	3	Sound	No
AFM001197	Pipistrellus pygmaeus	>10	Sound	No
	Eptesicus nilssonii	>10	Sound	No
	Myotis daubentonii	>10	Sound	No

\*"Yes" means that colonies were found during the survey. However "no" does not mean that there are no colonies in the area. If the number of observations is high, this indicates that there is probably a colony nearby. ? means that the species determination is uncertain.



## 6 Summary and discussions

The Forsmark area is dominated by coniferous forest (mainly pine), and most of the area is intensively used by forestry. However, along the coast, in the eastern part (near Storskäret, in the south part, along the river Forsmarksån, at Forsmarks bruk and at some other sites near houses and old farms the landscape is more diverse. In this fragmented landscape it was relatively easy to select survey sites where many species and a high abundance of bats were expected. As a comparison to these sites, some other sites in different parts of the area were also investigated, and a line-transect was placed through the more trivial parts of the area.

In total 9 species of bats have been found in the area. Of these, 7 species were identified in this survey (Table 5-1). The two species that previously have been recorded in Uppland, but not in the Forsmark area, are the pond bat (*Myotis dasycneme*) and parti-coloured bat (*Vespertilio murinus*). The pond bat is an extremely rare species and there are only a few records of the species in Sweden every year. It is not known if breeding colonies exist in Sweden at the moment. The parti-coloured bat is more common, but occurs mainly in south-Sweden. It is common to find it in cities, e.g. Uppsala, Stockholm, Enköping, Norrtälje, during the mating period in autumn, when it is possible to hear the social calls from the male during display flight. However, during summertime it is relatively rarely found in Uppland. Both species have strong sounds and are relatively easy to detect (especially the parti-coloured bat) and it is unlikely that they occur in the area without being detected. The other two species which have been found in the Forsmark area before, but not in this survey, are the Natterer's bat (*Myotis nattereri*) which has been observed at Johannisfors, and the long-eared bat (*Plecotus auritus*) which has been found at Forsmarks bruk. Both are quite difficult to detect. The long-eared bat has often a very weak sound and shy behaviour (foraging in dense vegetation, just above the ground, or inside houses) and is probably often underestimated in surveys based on ultrasound detection. It is relatively common, and it is most likely that it occurs in the area even though it was not observed in this survey. The Natterer's bat is, on the other hand, a rare species. It has a strong sound, but it might be confused with some other species of the genus *Myotis*. It is possible that it remains in the area, but if so probably in low numbers.

Three of the species found at the Forsmark area are red-listed: the Nathusius' bat (*Pipistrellus nathusii*), the whiskered bat (*Myotis mystacinus*) and the Natterer's bat (*Myotis nattereri*). The whiskered bat was only found once, a single individual at Johannisfors. The Natterer's bat was not observed at all at this survey, but has been found before (see above). The most interesting of these three red-listed species is, however, the Nathusius' bat. The colony found at Kallerö 2003 /Gylje, 2004/ is probably the northernmost colony in the world, and in Sweden the nearest verified colony is found in Kalmar County. However there are also indications of colonies in Östergötland and Gotland County. Furthermore it is found in Finland, but only from a few records, and it is quite common in the Baltic States. In this survey it was established that the colony found in 2003 still occurs at the same place near Kallerö.

The most common species in the Forsmark area is the northern bat, which occurred all over the area and at several sites in very high abundances. Also the pipistrelle bat and the Brandt's bat were common and occurred at about 50% of the investigated sites, and in most cases in high abundances. The Daubenton's bat is found at several sites and at two sites in very high abundance. Daubenton's bat is one of the most common bat species in Sweden.

In the Forsmark area there are many lakes and good habitats for this bat. However, several lakes are difficult to survey because of dense vegetation of reed and difficulties to reach areas with open water. Probably the abundance of Daubenton's bat is underestimated in this study. Other species occurring at several sites are the noctule bat and the Nathusius' bat. The noctule bat was recorded from three sites, but at two sites only occasionally, and probably individuals were commuting between different foraging areas. At Kallerö it was more common, and the area near Kallrigafjärden is probably one important foraging site for the species. Also Nathusius' bat was recorded from three sites, but was abundant only at Kallerö. Finally, the whiskered bat was found only at one site. This species is difficult to identify and trapping is the way to obtain a certain identification. Radio-tracking studies of the whiskered bat have provided information about the species habitat selection and from this it is possible to conclude that most parts of the Forsmark area are not typical habitats for the species. The exceptions are the more deciduous rich areas near Johannisfors, Forsmarks bruk and some other areas in the southern part.

All of the most interesting localities, except one (Storskäret) were located outside the main area of Forsmark site investigation. The eastern part of the main area is much more varied with pastures, fields and deciduous forest. Other areas within the main area which might be interesting for bats are around the lakes and along the coast. Besides this, the area is very trivial with regards to the bat fauna. Activities in the main area that might affect the abundance and distribution of bats in a negative way are drainage, and regrowth of vegetation in old pastures. Logging can be both positive and negative depending of what kind of forest that is logged, and what kind of general concerns for nature conservation that are taken. Other activities, such as a restoration of semi-natural pastures, removing of old ditches, creating a more varied structure of the forest and increasing the abundance of deciduous forest will probably have positive effects. Outside the main area it is important to conserve the environment along Kallrigafjärden, Johannisfors, along the river Forsmarksån and of course also at Forsmarks bruk. Other areas, such as Habbalsbo, will successively loose its value unless the landscape will be restored.

In conclusion, the number of bat species and bat abundance of the Forsmark area is high with several interesting and red-listed species. However, the most important areas are located outside the main area of Forsmark site investigation.

## **Acknowledgement**

We want to thank Nils Möller for help with our field-work. Niklas Heneryd, Gerd Nirvin and Sara Karlsson helped us with all practical details such as permissions, contact with land-owners, maps etc. Finally we want to thank all house- and landowners in the area for their friendly and helpful attitudes, reporting colonies and letting us walk around in their gardens in the middle of the night.

## References

**Ahlén I, 1990.** Identification of bats in flight. Swedish society for conservation of nature. Stockholm.

**Ahlén I, de Jong J, 1996.** Upplands fladdermöss – Utbredning, täthet och populationsutveckling 1978–1995. Länsstyrelsens meddelandeserie 1986: 8. Länsstyrelsens i Uppsala län. Uppsala.

**Ahlén I, 1998.** Gotlands fladdermusfauna 1997. Länsstyrelsen i Gotlands län, Livsmiljöenheten – Rapport nr 4. Visby.

**de Jong J, 1994.** Habitat use, home-range and activity pattern of the northern bat, *Eptesicus nilssonii*, in a hemiboreal coniferous forest. *Mammalia* 58: 535–548.

**de Jong J, Gertz J, Johansson M, 1997.** Inventering av fladdermöss 1997 – Sammanställning av resultat från Uppsala och Stockholms län. Länsstyrelsen i Uppsala län. Uppsala.

**de Jong J, Gertz J, 2001.** Inventering av fladdermöss 2000 – Regional fladdermusövervakning i Stockholms och Uppsala län. Länsstyrelsen i Stockholms län, rapport nr 4. Stockholm

**Gerell R, Gerell-Lundberg K, 2001.** Övervakning av fladdermöss i Skåne. Rapport för 2001. Länsstyrelsen i Skåne län. Malmö.

**Gylje S, 2004.** Inventering av fladdermöss 2003 – Regional fladdermusinventering i Uppsala och Stockholms län. Länsstyrelsen i Stockholms län. Stockholm.

**Gärdenfors U (ed.), 2000.** Rödlistade arter i Sverige 2000 – The 2000 red list of Swedish species. ArtDatabanken, SLU, Uppsala.

**Mitchell-Jones A J, Amori G, Bogdaniwicz W, Kryštufek B, Reijnders P J H, Spitzenberger F, Stubbe M, Thissen J B M, Vohralík V, Zima J, 1999.** The atlas of European mammals. Poyser natural history. London.