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Forsmark site investigation

Surveys of mammal populations in Forsmark

Results from 2004

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Svensk Naturförvaltning AB

June 2005

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Abstract

SKB has expressed the importance of monitoring mammal species that are of interest both in biodiversity issues and for local hunting and recreational purposes. To get relevant data on the dynamics of the mammal populations it is important to estimate the abundance and variations over time. Two of the major goals are to: 1) monitor dynamics of population density over several years; 2) obtain information that is essential for modelling of energy/carbon flows in the biosphere and, ultimately, calculations of the risks of exposure to radionuclides.

Data from the majority of the mammal species were obtained through intensive fieldwork in 2003. However, it was decided that large herbivores should be counted from helicopter and that small mammals should be trapped for another season in Forsmark. The aerial survey was done during midwinter and trapping in October 2004. Besides, attempts were made to trap foxes and badgers during midwinter and spring.

Some of the basic data presented in the report are as follows:

- During the aerial survey, moose were unevenly distributed in a 560 km^2 area along the coast (mean density approximately 0.7 moose/km^2).
- Roe deer were frequently observed from the air, but the observability was too low to allow density estimates.
- Due to error in calculations of the data set from 2003, results from both 2003 and 2004 are included in the presentation in this report.
- Population density among small mammal species (mice and voles) varied within the year (data only from 2003) and between years (2003 vs 2004).
- Autumn density was higher for most of the species (2003). For example, the density of mouse increased four times from spring to autumn (1.1 vs 4.0 ind/0.01 km^2).
- In total, small mammals were more numerous in autumn 2004 compared to autumn 2003 (nearly 30 animals/0.01 km^2, compared with approximately 0.007 moose/0.01 km^2!).
- In general, small mammal density was lower in Forsmark than in Simpevarp. We suggest that it is reflecting differences in the food quality of the habitats between the two areas.
- From the two years of trapping we are not able to describe the dynamics of the small mammal population over years. This has to be done in a long term monitoring program.
- Trapping of badger and fox did not provide data enough to allow density estimates.

Sammanfattning

SKB har uttryckligen pekat på betydelsen av att erhålla data om tätheter av olika djurarter i undersökningsområdena. Relevanta data uppnås bäst genom att man beskriver populationernas numerära utveckling. Två viktiga mål är att: 1) beskriva variationer i tätheten över tid; 2) erhålla information som är viktig för att modellera energi/kol – flöden i biosfären samt att skapa underlag för beräkning av exponering av radionuklider vid eventuella läckage.

Data för ett flertal arter inhämtades genom intensivt fältarbete under 2003. Emellertid beslutades om att smågnagare skulle fångas även under hösten 2004, bl a för att komplettera bristande data från 2003. Fältarbetet utfördes under oktober. Under januari genomfördes en flyginventering av klövdjur. Dessutom gjordes försök att fånga grävling och räv under midvintern och våren 2004.

De viktigaste resultaten är följande:

- Flyginventeringen visade att det fanns ca 0,7 älgar/km^2 inom en 560 km^2 yta längs kusten från Forsmark och norrut.
- Rådjur var mycket talrika vid inventeringen men dålig observerbarhet omöjliggjorde täthetsskattningar.
- På grund av felberäkningar i smågnagardatasetet från 2003 presenteras resultat från både 2003 och 2004 i den här rapporten.
- Populationstätheten bland smågnagarna (möss och sorkar) varierade under året (2003) liksom mellan åren (2003 respektive 2004) för de flesta arterna.
- Tätheten var högre under hösten än under våren för flera av arterna (2003). För möss (inkluderande större och mindre skogsmus) fyrdubblades tätheten mellan vår och höst (1,1 vs 4,0 individer/0,01 km^2).
- Totalt sett var smågnagarna mer talrika hösten 2004 jämfört med hösten 2003. (nästan 30 individer/0,01 km^2 jämfört med 0,007 älgar/0,01 km^2!).
- Sammantaget var tätheten i Forsmark lägre än i Simpevarp. Sannolikt beror detta på att markerna i Simpevarp är rikare på födoresurser av god kvalitet jämfört med Forsmark.
- Data från de två årens fångst är inte tillräckliga för att beskriva den långsiktiga dynamiken i numerären bland mindre däggdjur i Forsmark. För detta krävs ett fullt utvecklat monitoringprogram.
- Fångsten av grävling och räv gav inte tillräckligt underlag för att skatta täthet för dessa arter.

Contents

1 Introduction

SKB has expressed the importance of monitoring mammal species that are of interest both in biodiversity issues and for local hunting and recreational purposes. To get relevant data on the dynamics of the mammal populations it is important to estimate the abundance and variations over time. Data achieved can be used to specifically monitor endangered species (like wolf, *Canis lupus*, and otter, *Lutra lutra*), detect long-term effects on populations (important to hunters) and be used for assessment programs (EIA). Two of the major goals are: 1) to monitor populations over several years, and 2) to obtain information that is essential for modelling of energy/carbon flows in the biosphere and calculations of the risks of exposure to radionuclides.

This document reports the results gained by the Survey of Mammal Populations in the Forsmark area, which is one of the activities performed within the site investigation at Forsmark. The investigations during 2004 included arial survey of larger mammal species, capture-recapture of badger and fox and small mammal trapping. The location of the traps in the two later investigations are presented in the maps in Figure 1-1–1-4. The work was carried out in accordance with activity plans AP PF 400-03-76, 400-04-03 and 400-04-82. In Table 1-1 controlling documents for performing this activity are listed (activity plans are SKB's internal controlling documents).

Figure 1-1. *Locations of trap sites for small mammals (mice and voles) during 2003 in Forsmark. Association to habitat type is also indicated on the map.*

Figure 1-2. Locations of trap sites for small mammals (mice and voles) during 2004 in Forsmark. Association to habitat type is also indicated on the map.

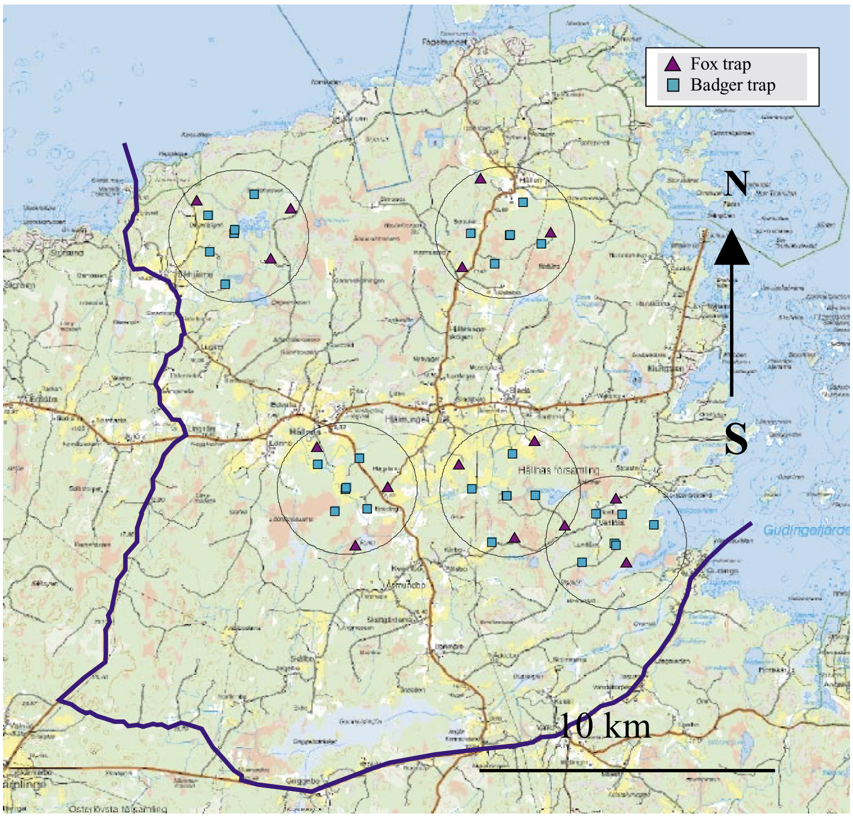

Figure 1-3. Locations of trap sites for badger and fox in 2004 in Hållnäs.

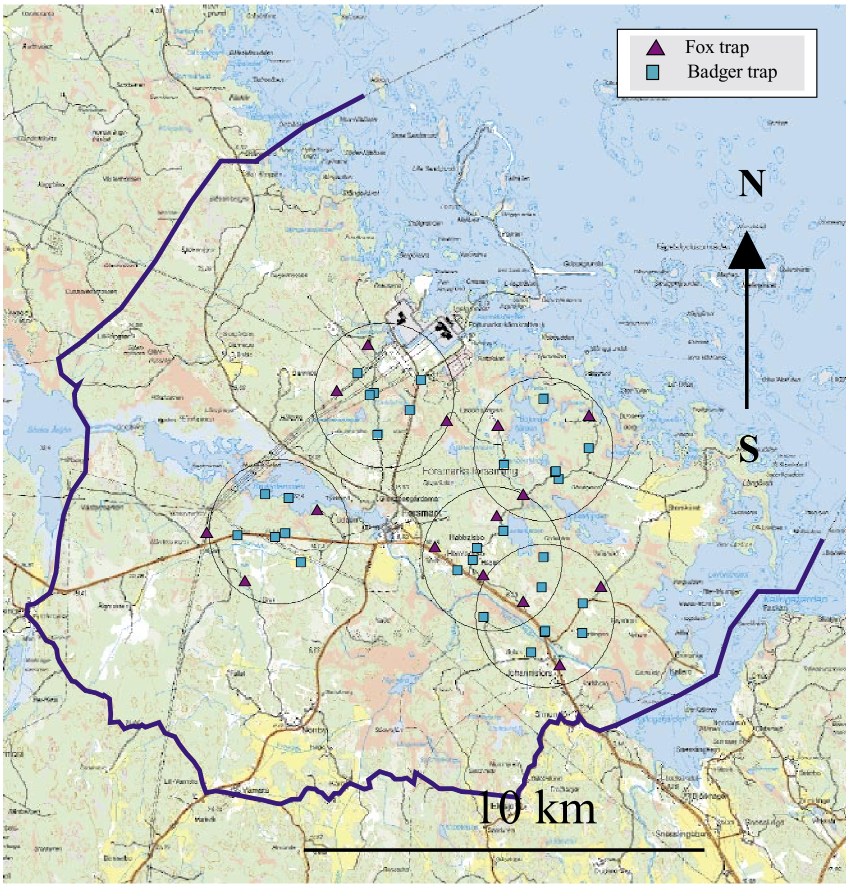

Figure 1-4. *Locations of trap sites for badger and fox in 2004 in Forsmark.*

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
Populationsinv. av vissa däggdjur 2004	AP PF 400-03-76	1.0
Flyginventering 2004	AP PF 400-04-03	1.0
Gnagarinventering 2004	AP PF 400-04-82	1.0

2 Objective and scope

The main objectives includes the following:

- Obtain data on abundance and local densities of the selected species. The results from the SKB areas shall be compared both in a regional and a national perspective. It is also vital to make information available to public interests (like hunters, conservation agencies, forestry companies, county boards (länsstyrelser) etc). Furthermore, data can be used in the context of evaluation of the effect of the field operations during construction as well as operation of a deep repository on the environment (EIA).
- Gather data to design a monitoring system for population surveys that measures annual variation in density, and if possible in other parameters like body mass and reproduction.
- Make data available for modelling of, for example, energy/carbon flows in the biosphere and, ultimately, calculations of the risks of exposure to radionuclides. If necessary, specific projects could be created in order to obtain better data of the selected species, about for example distribution and dispersal or to better understand the flow of energy between trophical levels (including consumption of vegetation as well as prey species).

Data from the majority of the mammal species were obtained through intensive fieldwork in 2002 and 2003 in Forsmark. However, it was decided that large herbivores should be counted from helicopter and that small mammals should be trapped for another season. The aerial survey was done during midwinter and trapping in October. Besides, in order to obtain data for density estimates of badger and fox, trapping was done in midwinter and in spring (see also) /Cederlund et al. 2004/.

3 Equipment

3.1 Description of equipment/interpretation tools

Small mammal trapping

Trapping was done with metal snaptraps ("mouse traps"), see also Figure 3-1. The traps killed the animals instantly and were put out in the selected trap sites the day before the trapping started. Each trap was checked daily during the trapping period. Each trap position was documented with a handheld GPS device.

Figure 3-1. *A trapped water vole. Traps are baited with pieces of carrots.*

Capture-recapture of badger and fox

The traps used were designed for capturing animals alive and approved by the authorities (Naturvårdsverket). We used fox traps (model L81), which were built of wooden material. For badger (potentially also for fox) a special steel trap (model L 8) was used (originally designed for beaver trapping). The design is illustrated in Figure 3-2. It is somewhat smaller than L81, and made of a steel net.

Figure 3-2. *A trapped badger (trap model L 8)*

4 Execution

4.1 General

Aerial survey

The method is primarily adapted for large cervids and gives direct density estimates, but observations of all larger mammal species are recorded (although we have not yet tried to calculate their absolute densities).

Aerial surveys are normally done during mid winter when land areas are covered with >20 cm snow. If possible, the survey is initiated 1 day after snow fall, which makes the tracks easy to detect. We use small helicopters (Hughes 300) that are relatively cheap and easy to manoeuvre. At least two helicopters are used on each occasion. One reason is to reduce the operating time with good weather conditions (e.g. between snow falls). Another reason is that the system requires control surveys by two independent observation teams (see below).

Small mammal trapping

The method is based on trapping and removal of animals within a short sequence of days and frequently used by many biologists all over the world /Williams et al. 2001/.

Capturing of small mammals in 2004 was accomplished in October, which is within the period they are supposed to reach peak density of the year.

Since we recalculated the data from 2003, see section 4.6, the new results are presented together with data from 2004 in figures and tables below.

Capture-recapture of badger and fox

This method is commonly named The Peterson method /Seber, 1982/ and includes a number of methods based on the capture-recapture technique. The basic idea is that the population density can be calculated if we have knowledge of the number of marked individuals and the proportion of marked and unmarked animals in a sample of the total population at a specific time. The method is flexible and does not necessarily require physical marking (like ear tags, collars, rings etc), but can also be used by comparing observations by two or more independent teams made at the same time (see aerial surveys of moose, 4.1). The Leslie method can be associated with the capture technique and can also be used when harvesting a population, marking, observing or making effort estimates etc /Ricker, 1975/.

4.2 Preparations

Aerial survey

Before each operation GPS equipment was calibrated for accuracy when positioning observations.

Small mammal trapping

The procedure did not require ordinary calibration. The function of traps was checked before set out in the terrain.

Capture-recapture of badger and fox

Traps were set out several weeks before trapping procedure was initiated in order to get the animals used to the new features in the terrain. The function of traps was checked before set out in the terrain.

4.3 Execution of field work

Aerial survey

In the study area sample plots (2 km^2) were evenly distributed, covering 25–30% of the entire area. Each plot is thoroughly searched for animals. Each observation was recorded in a computer as to sex and age, time etc. Location was achieved by GPS. With the computer it was possible to discriminate observations that should be included in the sampling plots from those outside the plots. The mean density (like moose/km^2) and variance was then easily calculated.

It is important for the final density estimate to calculate the probability to observe animals in the plots since some animals will not be observed. Weather conditions, flight speed, snow depth, etc, might influence the observation rate. Therefore, 30–40% of the plots were searched by two teams independent of each other. Time lag between the visits in the plots should not be more than 5 minutes so the chances to observe the same animals were as high as possible. By comparing the results from the two teams using a capture-recapture procedure /Seber, 1982/, /Skalski and Robson, 1992/ it was possible to calculate the observability of a given species each day and to correct the mean values calculated from the standard methods.

Small mammal trapping

In order to get sufficient data from different habitats and enough sample size to calculate total density for each of the species captured, we randomly selected 4 trap sites associated with forest and field habitat. Each site contained 100 snaptraps (similar to ordinary "mouse traps") at a distance of 10–15 m (half an average home range). Each trap position contained two traps. Each trap was baited one day and checked the following 4–5 days (depending on the trapability). If necessary, the trap was baited again during the period. As bait we used oat grains and carrots. The age (adult or juvenile) and sex of the captured animals were determined.

In order to catch water voles, 25 traps (two at each position) were put out on 5 randomly chosen trap sites along streams and ditches (other species might also be captured). Distance between traps was approximately 20 m.

Capture-recapture of badger and fox

In total, 30 traps designed for foxes and 60 traps for badgers were put out. Each trap site contained 3 fox traps and 6 badger traps (see Figure 1-2 and 1-3). The traps were placed near structures in the terrain of potential interest to the animals (e.g. fields) or path ways while traversing the area (e.g. along ditches, forest edges, swamps etc). All traps were checked daily during the trapping period.

4.4 Data handling/post processing

Aerial survey

All data from observations were noted in mobile computers and on data sheets in the helicopter during the survey. Data on locations, observations, time etc were compiled and processed at office.

Small mammal trapping

Data on trap position, trap site, date, species, sex and age were recorded in the field on data sheets. All information was immediately after fieldwork transformed to a computer and later processed for database (SICADA) and calculations. All specimens were stored in a freezer in 2003, but not in 2004. Further use of the frozen animals is out of the scope of this study.

Capture-recapture of badger and fox

Data were noted on sheets in the field and transformed into computer.

4.5 Analyses and interpretations

Trapping small mammals

Snaptrapping methods are based on the assumption that all individuals in the trap site are exposed to the traps. In theory, the removal of trapped animals should reduce the population at a corresponding degree. By correlating the accumulated number (each day) to the daily trapping frequency (which should be decreasing), it is possible to calculate the total number of individuals.

Based on the data from 2003, a recalculation was done in order to validate the variation and find an optimal level for trapping effort in relation to error in the estimates (if possible leading to reduced field work). In short, the calculations were as follows:

Total variation:

$$\text{Var[total]} = \text{Var[within trap site]} + \frac{\text{Var[difference between trap sites]}}{\text{Number of trap sites}}$$

Error in calculating animals within a site:

$$Var[\hat{N} \mid \text{N}] = \frac{\text{N}(1-\text{q}^{\text{k}})\text{q}^{\text{k}}}{(1-\text{q}^{\text{k}})^2 - (\text{p} \cdot \text{k})^2 \cdot q^k}$$

N = Number of animals in the area

p = Probability to trap an animal (partly correlated to number of traps and behaviour of the different species)

q = Probability not to trap an animal, e.g. 1-p

k = Number of trap days

Variation between sites:

$$Var[\text{between sites}] = \frac{\sum_{i=1}^{n} (\hat{N}_i - \hat{N})^2}{n(n-1)}$$

$\hat{N}$ = Number of animals

N_i = Number of animals in site *i*

n = Number of sites

The estimates allow us to see how sensitive the trap system is to effort (days of trapping), number of traps (or trap sites) and population density. As indicated in Figure 4-1 and 4-2 the potential error in the calculations of density increases dramatically at low densities, few trap sites and few trapping days. The error develops along a rather similar pattern for the three variables. For example, increased effort by trapping more than 5 days contributes marginally to the reduction of the error (which levels off at approximately 20%). We also used 5 days as trapping period in the autumn 2004.

Similarly, the error is relatively independent of the probability to catch an animal when 20% error is reached.

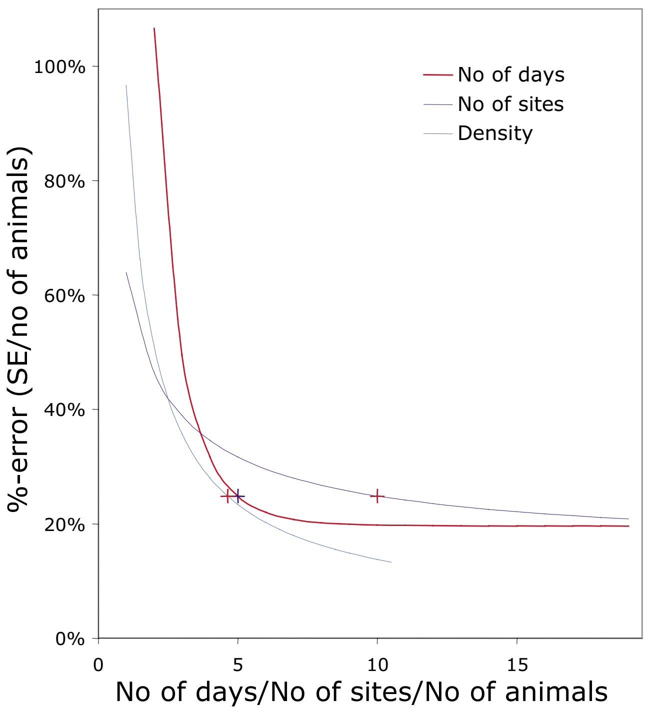

Figure 4-1. *Calculated change in error in relation to trapping intensity (number of trap sites and number of trap days and population density) (data for mouse).*

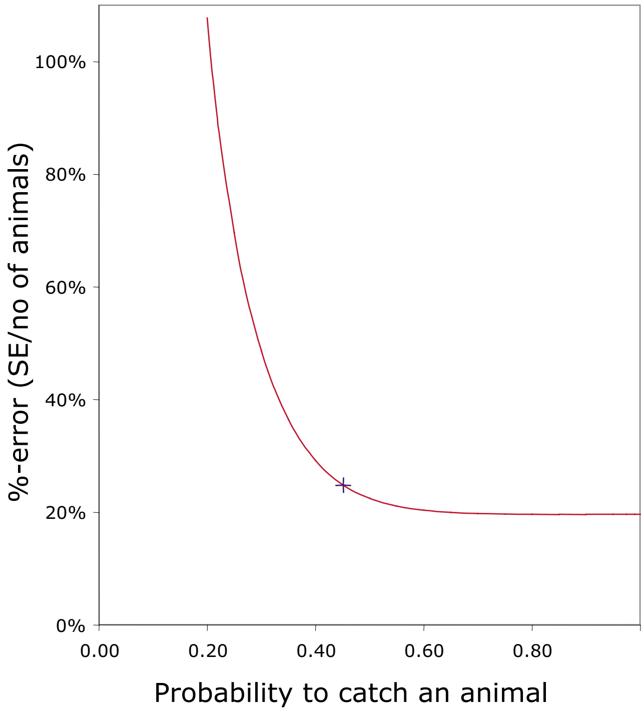

Figure 4-2. *Calculated change in error in relation to probability to catch an animal (data for mouse).*

4.6 Nonconformities

Small mammal trapping

In the season 2004 trapping was successfully accomplished according to the plan. Due to miscalculations in the data set from 2003 (technical error in the data program), it was recalculated together with data from 2004. Therefore, data from 2003 as well as from 2004 are presented in this report (see results).

Capture-recapture of badger and fox

Trapping procedure was done according to the plan. However, indications from observations, tracks on snow and the results from the trapping period clearly indicated that trapping frequency should be too low to allow fair density calculations. The trapping was therefore interrupted earlier than planned.

5 Results

All underlying data to the results presented here have been delivered to SKB and are stored in databases in SICADA.

5.1 Aerial survey

The entire area was approximately 560 km^2 and covered the coastline from Forsmark in the south to the Hållnäs peninsula in the north (see the map in Figure 5-1). It should be noted that the total area surveyed, which is administered by the large forest companies (Stora Enso and Korsnäs), was approximately 220 km^2 large (see Figure 5-1). The larger islands in the archipelago outside the main area were not included in survey. There were no attempts to structure the coastal area into sub-areas since the area is relatively small in relation to mean moose home range size. However, data from all management areas are presented in Table 5-2 and in Figure 5-1.

As indicated by the map (Figure 5-1), the moose were unevenly distributed over the area during the survey. This is normal for this part of Sweden and is certainly associated with factors like hunting pressure, snow depth, availability and distribution of food. Mean density was approximately 7 moose/10 km^2. Evidently, the density is fairly similar to an average for the region.

The age structure (adults and calves) and the sex composition from the aerial survey are presented in Table 5-1 and appear relatively similar to other areas. The dominance of adult females (68%) is due to a long-term effect of high hunting pressure on adult bulls. The high proportion of calves indicates a high fecundity among adult females and/or low hunting pressure.

Additional data in the moose population will be provided in co-operation between SKB and the local hunters in the future.

Roe deer were frequently observed from the air (Table 5-2), but the observability was too low to allow density estimates.

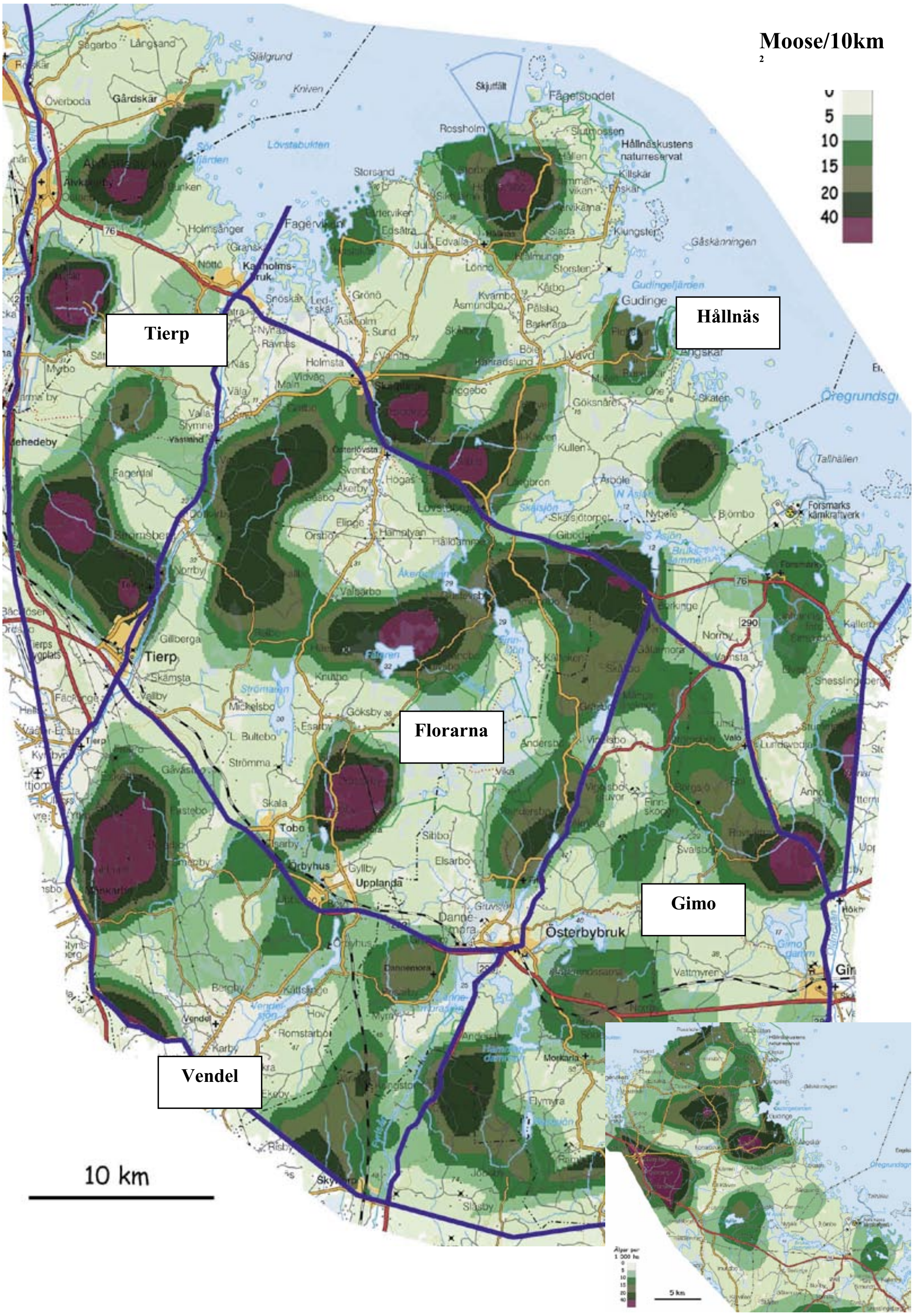

Figure. 5-1. *Distribution of moose during the aerial survey in January 2002 (the small map) and January 2004. Aggregations with different density of moose are indicated by different colours. Sub-areas indicated by blue lines refer to management units.*

Table 5-1. Data from the aerial survey in January 2004 in northern Uppland. Hållnäs refers to the management area where Forsmark is included. Note that arithmetic mean in the management units might be somewhat different from Mean in the right column because of variation in distribution of sample plots in the sub areas.

AERIAL SURVEY OF NORTHERN UPPLAND INCLUDING FORSMARK							
	Tierp	Hållnäs	Florarna	Gimo	Vendel	Totalt	
Moose/10km² (observered)	5.1	5.5	7.2	5.7	6.2	5.8	Total number of moose
Observervability						87%	
Moose/10km² (adjusted)	**6.9**	**6.5**	**8.4**	**6.1**	**6.5**	**6.7**	**1472**
Standard error (SE)	1.01	0.69	0.80	0.51	0.59	0.62	**±137**
							Moose/10km² land area
Moose category/10km²							
Males	2.1	1.6	1.7	1.5	1.5	1.5	**7.1**
Females	3.1	3.4	4.6	3.0	3.1	3.4	
Calves	1.6	1.5	2.1	1.5	1.9	1.7	Moose/10km² forest
Calf/cow	0.52	0.43	0.46	0.5	0.62	0.49	**8.8**
Calf/adult	0.27	0.28	0.32	0.32	0.38	0.31	
							Water 5%
Cows witout calf	48%	63%	63%	55%	50%	58%	
Cows with one calf	52%	30%	30%	45%	42%	37%	**Field 17%**
Cows with two calves	0%	7%	6%	0%	8%	5%	
							Forest 76%
Proportion males of adults	40%	31%	27%	33%	33%	32%	
							Other 2%
Area size (km²)	3 400	5 600	5 400	4 600	3 100	22 100	

Table 5-2. Other species than moose observed during the aerial survey in January 2004. Second search is the control survey in those plots where observation tests for moose were done (see Methods 4.1). No such tests were done for other species. Therefore, observations listed here should be considered as minimum figures and used as an index if aerial surveys are repeated.

	First search	Second search
Roe deer	480	174
Wild boar	0	1
Fox	7	6
Capercaillie	11	2
Black grouse	9	3
Eagle	15	6

Small mammal trapping

Trapping was performed between September 26 and October 4. Seven species were captured (see the list below), but only the most common species revealed data for fair calculations of density estimates. Data from 2003 and 2004 are presented in Table 5-3.

The following species were captured in 2004:

Clethrionomus glareolus (Skogssork/ängssork) Bank vole.

Microtus agrestis (Åkersork) Field vole.

Apodemus fluviatilis (Större skogsmus) Yellow necked mouse.

Apodemus sylvaticus (Mindre skogsmus) Wood mouse.

Sorex araneus (Vanlig näbbmus) Common shrew.

Sorex minutus (Dvärgnäbbmus) Pygmy shrew.

Sorex fodiens (Vattennäbbmus) Eurasian water-shrew.

The data presented in Table 5-3 clearly indicate the dynamics in density among small mammals in Forsmark both within and between years. As expected, estimated density was higher in the autumn than in the spring populations in 2003 for most of the animals. The most plausible explanation is that autumn population includes recruitment of juveniles. Moreover, several species were more numerous in autumn 2004 than in 2003. Field vole was by far more common in 2004.

Table 5-4. presents the estimated sex ratio, whereas Table 5-5 displays the estimated juvenile/adult ratio among the most frequently captured small mammals in 2003 and 2004 in Forsmark.

Males were more frequent among the captured animals for the majority of the species (Table 5-4). The exception was Common shrew, which was permanently dominated in the data set by females. We have no good explanation to the skew ratio.

Table 5-3. Estimated population density among small mammals in Forsmark in 2003 and 2004. Number of trap sites is denoted as n. The SE95% figures indicate the 95% probability to find the mean density estimates within the interval.

Forsmark	Spring 2003			Autumn 2003			Autumn 2004		
	Population density (ind/0.01km²)								
	n	Mean	$SE_{95\%}$	n	Mean	$SE_{95\%}$	n	Mean	$SE_{95\%}$
Mouse - forest	11	0.7	0.19	11	2.8	0.38	4	2.5	0.39
Mouse - field	4	0.4	0.30	4	1.2	0.55	4	0.2	0.15
Bank vole - forest	11	2.3	0.36	4	3.2	0.43	4	7.4	0.82
Water vole	5	5.7	1.47	5	4.8	1.35	4	7.9	1.28
Field vole - forest	11	0.1	0.03	11	0.1	0.04	4	1.5	0.13
Field vole - field	4	0.4	0.11	4	0.1	0.06	4	10.2	0.35
Common shrew	15	0.2	0.09	15	0.8	0.18	8	2.7	0.30

Table 5-4. Estimated sex ratio (proportion of males to total number of adults) among the most frequently captured small mammals in 2003 and 2004 in Forsmark. Mouse includes both Wood mouse and Yellow necked mouse.

Forsmark	Spring 2003			Autumn 2003			Autumn 2004		
	Population density (ind/0.01km²)								
	n	Mean	$SE_{95\%}$	n	Mean	$SE_{95\%}$	n	Mean	$SE_{95\%}$
Mouse - forest	11	0.7	0.19	11	2.8	0.38	4	2.5	0.39
Mouse - field	4	0.4	0.30	4	1.2	0.55	4	0.2	0.15
Bank vole - forest	11	2.3	0.36	4	3.2	0.43	4	7.4	0.82
Water vole	5	5.7	1.47	5	4.8	1.35	4	7.9	1.28
Field vole - forest	11	0.1	0.03	11	0.1	0.04	4	1.5	0.13
Field vole - field	4	0.4	0.11	4	0.1	0.06	4	10.2	0.35
Common shrew	15	0.2	0.09	15	0.8	0.18	8	2.7	0.30

Table 5-5. Estimated juvenile/adult ratio (proportion of juveniles in relation to total number of captured animals) among the most frequently captured small mammals in 2003 and 2004 in Forsmark. Mouse includes both Wood mouse and Yellow necked mouse.

Forsmark	Juvenile/adult ratio		
	Spring 2003	Autumn 2003	Autumn 2004
Mouse sp	0%	2%	32%
Bank vole	5%	0%	14%
Water vole	17%	0%	42%
Field vole	0%	0%	12%
Common shrew	0%	0%	31%

The proportion of juveniles varied between seasons and years (Table 5-5). As mentioned earlier, it is logical to find more juveniles in the autumn population. In the autumn 2003 very few juveniles were trapped, maybe because of low recruitment rate (or high mortality). The data set is too small to allow further conclusions about the dynamics on the demographic parameters among the small mammal species. Monitoring over several years is needed to obtain sufficient data of that kind.

The literature contains limited data on actual density estimates from different regions. Therefore, it might be of interest to compare Forsmark with Simpevarp. As indicated in Figure 5-2, Simpevarp is generally characterised by a higher number of small mammals (all species) compared to Forsmark. This is probably due to habitats containing better food quality. Also, note the general increase in density between the two years of trapping.

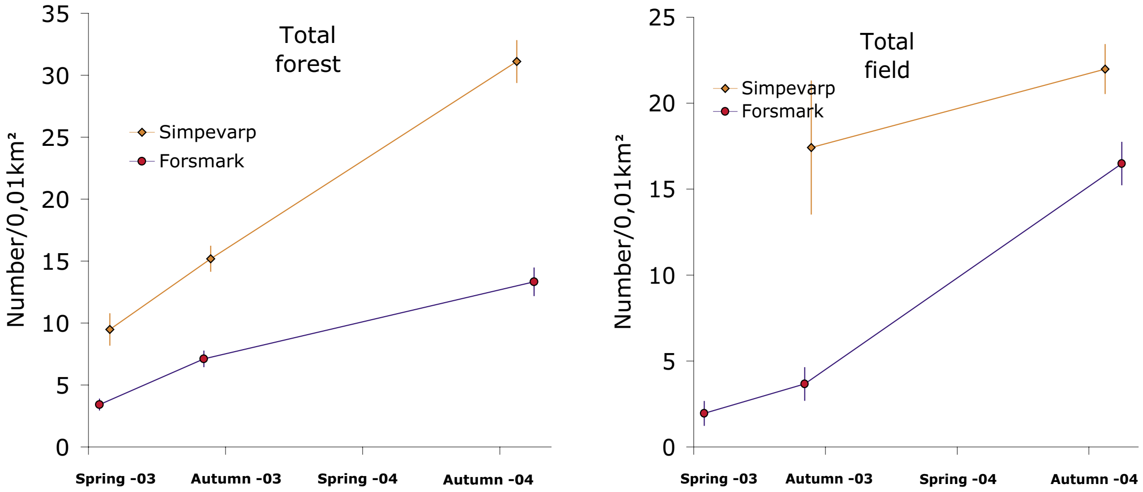

Figure 5-2. *Total density of small mammals in Forsmark and Simpevarp, including all captured species in trap sites located within the forest habitat and field habitat, respectively. Data refer to spring 2003, autumn 2003 and autumn 2004, in chronological order.*

Capture-recapture of badger and fox

The first trapping period was between February 22 and February 28. Before that traps were regularly supported with bait (oat grain, fish, honey etc), and possible activity in or around the traps were recorded. In total, 5 adult badgers were caught. All animals were marked (tattooed on the chest skin) and released after being immobilized. In addition, two cats and one marten were caught during the midwinter period.

The second trapping period (May 11 to May 16) resulted in only one badger. No fox was trapped during any of the two trapping periods.

6 Summary and discussions

Aerial survey of moose and other large herbivores is outstanding for achieving instantaneous demographic data from large herbivore populations. If repeated every 3–5 years it provides managers and scientists with relevant data about dynamics in populations and should be incorporated in a future monitoring program. However, optimal use requires additional data, such as age structure, fecundity data, standardised direct measurements or indexes of population development (ÄLGOBS) etc.

This study is one of few that has revealed actual density estimates of small mammals. Usually most trappings refer to index or other indirect measurements (see for example) /Hansson and Henttonen, 1988; Steen et al. 1996; Hörnfelt, 1998/. However, since most small mammals may undergo dramatic changes between years and over time in long-term oscillations, and since we have only data from two years, it is not possible to tell from where in the cycle of population development we have obtained data. Therefore, density estimates of small mammals require data from a monitoring system, which has been suggested earlier see /Cederlund et al. 2003 and 2004/. It is especially important since small mammals constitute a large part of the mammal biomass and thus contributes to an essential part of the carbon flux in the ecosystem /Truvé, 2005/.

Unfortunately the trapping of badger and fox gave limited data. However, we believe that if the procedure is started with putting out traps several months before trapping season (in summer), the animals normally get used to the new features in the terrain, hence allowing fair numbers of trapped animals. This is also in accordance with experiences from professional managers. It is also important to be flexible in time and adjust trapping season to climate (snow and temperature). In addition, the trapping season must be extended and include more trapping days.

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