518 OPPDRAGSMELDING

The Scandinavian lynx projects Annual Report 1997

Henrik Andrén
Per Ahlquist
Reidar Andersen
Tor Kvam
Olof Liberg
Mats Lindén
Johan Odden
Kristian Overskaug
John Linnell
Peter Segerström

Sveriges Lantbruksuniversitet SLU
Høgskolen i Hedmark
NINA·NIKU
NINA Norsk institutt for naturforskning

The Scandinavian lynx projects
Annual Report 1997

Henrik Andrén
Per Ahlquist
Reidar Andersen
Tor Kvam
Olof Liberg
Mats Lindén
Johan Odden
Kristian Overskaug
John Linnell
Peter Segerström

Sveriges Lantbruksuniversitet SLU

Høgskolen i Hedmark

NINA Norsk institutt for naturforskning

NINA•NIKUs publikasjoner

NINA•NIKU utgir følgende faste publikasjoner:

NINA Fagrapport
NIKU Fagrapport
Her publiseres resultater av NINA og NIKUs eget forskningsarbeid, problemoversikter, kartlegging av kunnskapsnivået innen et emne, og litteraturstudier. Rapporter utgis også som et alternativ eller et supplement til internasjonal publisering, der tidsaspekt, materialets art, målgruppe m.m. gjør dette nødvendig.
Opplag: Normalt 300-500

NINA Oppdragsmelding
NIKU Oppdragsmelding
Dette er det minimum av rapportering som NINA og NIKU gir til oppdragsgiver etter fullført forsknings- eller utredningsprosjekt. I tillegg til de emner som dekkes av fagrapportene, vil oppdragsmeldingene også omfatte befaringsrapporter, seminar- og konferanse-foredrag, års-rapporter fra overvåkningsprogrammer, o.a.
Opplaget er begrenset. (Normalt 50-100)

NINA•NIKU Project Report
Serien presenterer resultater fra begge instituttenes prosjekter når resultatene må gjøres tilgjengelig på engelsk. Serien omfatter original egenforskning, litteraturstudier, analyser av spesielle problemer eller tema, etc.
Opplaget varierer avhengig av behov og målgrupper

Temahefter
Disse behandler spesielle tema og utarbeides etter behov bl.a. for å informere om viktige problemstillinger i samfunnet. Målgruppen er "allmennheten" eller særskilte grupper, f.eks. landbruket, fylkesmennenes miljøvern-avdelinger, turist- og friluftlivskretser o.l. De gis derfor en mer populærfaglig form og med mer bruk av illustrasjoner enn ovennevnte publikasjoner.
Opplag: Varierer

Fakta-ark
Hensikten med disse er å gjøre de viktigste resultatene av NINA og NIKUs faglige virksomhet, og som er publisert andre steder, tilgjengelig for et større publikum (presse, ideelle organisasjoner, naturforvaltningen på ulike nivåer, politikere og interesserte enkeltpersoner).
Opplag: 1200-1800

I tillegg publiserer NINA- og NIKU-ansatte sine forskningsresultater i internasjonale vitenskapelige journaler, gjennom populærfaglige tidsskrifter og aviser.

Andrén, H., Ahlqvist, P., Andersen, R., Kvam, T., Liberg, O., Lindén, M., Linnell, J.D.C., Odden, J., Overskaug, K. & Segerström, P. (in alphabetical order). 1998. The Scandinavian lynx projects - Annual Report 1997. - NINA Oppdragsmelding 518: 1-11.

Trondheim, mars 1998

ISSN 0802-4103
ISBN 82-426-0894-6

Forvaltningsområde:
Rovviltforvaltning
Management area:
Carnivore management

Redaksjon:
Kjetil Bevanger og Lill Lorck Olden

Montering og layout:
Lill Lorck Olden

Sats: NINA•NIKU

Kopiering: Norservice

Opplag: 100

Kontaktadresse:
NINA•NIKU
Tungasletta 2
N-7005 Trondheim
Telefon: 73 80 14 00
Telefax: 73 80 14 01

Tilgjengelighet: Åpen

Prosjekt nr.: 12501

Ansvarlig signatur:

Oppdragsgivere:

DN, NFR, SLU, Naturvårdsverket

Referat

Andrén, H., Ahlqvist, P., Andersen, R., Kvam, T., Liberg, O., Lindén, M., Linnell, J.D.C., Odden, J., Overskaug, K. & Segerström, P. (in alphabetical order). 1998. Det Skandinaviske gaupeprosjektet - Framdriftsrapport 1997. - NINA Oppdragsmelding 518: 1-11.

Rapporten presenterer noen demografiske parametre for 4 ulike gaupepopulasjoner i Sverige og Norge. Til tross for store geografiske variasjoner i flere vitale rater, har vi i disse preliminære analysene behandlet dataene samlet. Vi diskuterer behovet for et styrket Nordisk samarbeid innen rovviltforskning, og definerer målene for den videre forskningsaktivitet.

Emneord: Gaupe - overlevelse - reproduksjon - sårbarhets-test

Henrik Andrén, Grimsö forskningsstasjon, avdeling for bevaringsbiologi, Sveriges landbruksuniversitet (SLU), S-730 91 Riddarhyttan, Sweden. Per Ahlqvist, Grimsö forskningsstasjon, avdeling for bevaringsbiologi, Sveriges landbruksuniversitet (SLU), S-730 91 Riddarhyttan, Sweden. Reidar Andersen, Norsk institutt for naturforskning (NINA), Tungasletta 2, N-7005 Trondheim, Norway. Tor Kvam, Norsk institutt for naturforskning (NINA), Tungasletta 2, N-7005 Trondheim, Norway. Olof Liberg, Grimsö forskningsstasjon, avdeling for bevaringsbiologi, Sveriges landbruksuniversitet (SLU), S-730 91 Riddarhyttan, Sweden. Mats Lindén, Avdeling for pattedyrøkologi, Sveriges landbruksuniversitet (SLU), S-901 83 Umeå, Sweden. John D.C. Linnell, NINA og Høgskolen i Hedmark, Evenstad, 2480 Koppang, Norway. John Odden, Høgskolen i Hedmark, Evenstad, 2480 Koppang, Norway. Kristian Overskaug, Norsk institutt for naturforskning (NINA), Tungasletta 2, N-7005 Trondheim, Norway. Peter Segerström, Vaikijaur 617, S-962 99 Jokkmokk, Sweden.

Abstract

Andrén, H., Ahlqvist, P., Andersen, R., Kvam, T., Liberg, O., Lindén, M., Linnell, J.D.C., Odden, J., Overskaug, K. & Segerström, P. (in alphabetical order). 1998. The Scandinavian lynx projects - Annual Report 1997. - NINA Oppdragsmelding 518: 1-11.

The report present some demographic parameters in four different lynx populations in Sweden and Norway. Despite large geographical variation in the vital rates, we have pooled the data from all study sites in these preliminary analyses. We discuss the need for Nordic carnivore research cooperation, and future research goals.

Keywords: Lynx - survival - reproduction - sensitivity analyses

Henrik Andrén, Grimsö Wildlife Research Station, Department of Conservation Biology, SLU, S-730 91 Riddarhyttan, Sweden. Per Ahlqvist, Grimsö Wildlife Research Station, Department of Conservation Biology, SLU, S-730 91 Riddarhyttan, Sweden. Reidar Andersen, Norwegian Institute of Nature Research, Tungasletta 2, N-7005 Trondheim, Norway. Tor Kvam, Norwegian Institute of Nature Research, Tungasletta 2, N-7005 Trondheim, Norway. Olof Liberg, Grimsö Wildlife Research Station, Department of Conservation Biology, SLU, S-730 91 Riddarhyttan, Sweden. Mats Lindén, Department of Animal Ecology, SLU, S-901 83 Umeå, Sweden. John D.C. Linnell, NINA, Hedmark College, Evenstad, N-2480 Koppang, Norway. John Odden, Hedmark College, Evenstad, N-2480 Koppang, Norway. Kristian Overskaug, , Norwegian Institute of Nature Research, Tungasletta 2, N-7005 Trondheim, Norway. Peter Segerström, Vaikijaur 617, S-962 99 Jokkmokk, Sweden.

Innhold

1 Introduction

This research report is from the Scandinavian lynx project, which is a cooperative umbrella for the 4 different lynx sub-projects in Scandinavia (in Sarek, Nord-Trøndelag, Hedmark and Grimsö). This report will present a preliminary analysis of our data on the population dynamics of lynx, i.e. survival rates and reproduction. It describes the status of data collection, presents some reproductive parameters, and calculates the sensitivity of population growth to different variable. From this we aim to point out what is most important to study to increase the precision in population growth estimation, which is essential in the understanding of lynx population dynamics. Thus, one can show what is most important to co-ordinate between the subprojects in future.

This report was written by Henrik Andrén, who has been the secretary of the Scandinavian lynx project in 1997. The report is based on data and information given by the different subprojects to Henrik Andrén. Pär Forslund, at Grimsö Wildlife Research Station, has been involved in the sensitivity analyses.

2 The common objectve

The object of the Scandinavian lynx project is to produce the knowledge necessary for a co-ordinated (but not necessarily unified) management and conservation of lynx populations on the entire Scandinavian peninsula. Data should also suffice to determine under what conditions the species can be harvested and to determine the size and composition of a possible harvest. To reach these goals we requires data on the range and dynamics of the various demographic variables, and on the nature and effects of the most important factors influencing these dynamics.

Effective management also requires data on the spatial organisation of the various lynx populations, such as home range sizes, habitat requirements and dispersal distances. Finally, the project aims to produce quantitative data on the effect of lynx predation on prey species of interest to local human populations, such as domestic livestock and important game species.

It is important for the project to demonstrate how the various parameters vary between the different study areas, which span over 1000 km of latitude and include very different ecosystems. To this end data collecting methods are being standardised so that results from the various sub-projects will be comparable, and so that data can be pooled when required, to increase the strength of conclusions.

3 Radio-marking of lynx

The different sub-projects started in different years. Sarek and Nord-Trøndelag both radio-marked their first lynx in 1994, Hedmark started in 1995 and Grimsö in 1996. The number of radio-marked lynx shows almost the same rate of development in all studies. After the first field season (first 6 month) all studies had about 5 lynx, after 2 years about 12 lynx and so on (**figure 1**). Thus, it has taken about the same amount of time to get a marked population to study within all study areas. The Nord-Trøndelag sub-project stopped radio-tracking lynx in 1996. Thus, today lynx are radio-tracked in Sarek, Hedmark and Grimsö and the number of lynx followed in these sub-projects in June 1997 were; Sarek 21 lynx, Hedmark 16 lynx and Grimsö 11 lynx (**figure 2**). By the end of June 1997 a total of 103 lynx have been radio-marked in the 4 subprojects and so far 6 lynx have died during the marking process, i.e. the risk of killing a lynx during marking has been 4.7% (**table 1**). In most cases the cause of mortality has been identified and adjustments have been made to field protocols to ensure that the risks are minimised in future.

These 103 lynx have been radio-tracked for a total of 99.1 radio-years in the 4 subprojects (**table 2**). Some individuals have been followed during several years, e.g. both as kittens and yearlings. Therefore, the total number of individuals in **table 2** is lower than the sum of individuals for all categories.

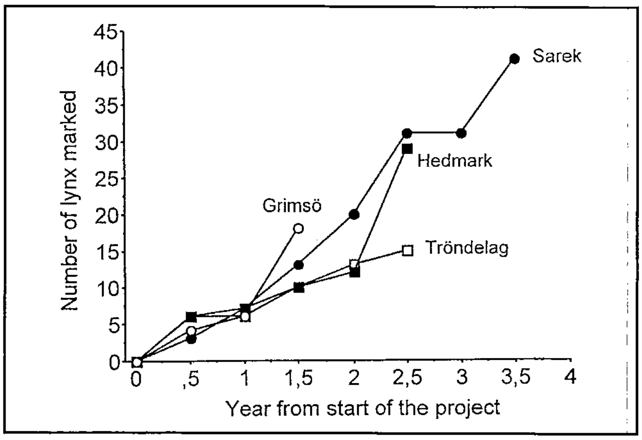

Figure 1 Number of radio-marked lynx in relation to the number of years from the start of the project.

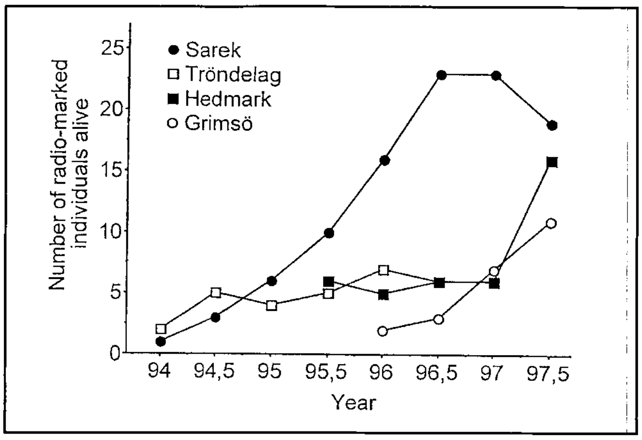

Figure 2 Number of lynx alive and being radio-tracked in the 4 sub-projects in relation to year.

Table 1 Number radio-marked individuals in the 4 different subprojects until June 1997.

	Total number of individuals	Number of kittens	Total of marking number events	Number of deaths due to marking
Sarek	41	27 (15)*	55	2
Nord-Trøndelag	15	8	15	1
Hedmark	29	16	36	2
Grimsö	18	11	21	1
Total	103	62	127	6

* In Sarek 27 kittens has been radio-marked so far. This year 9 females had 15 kittens that are not radio-marked yet.

Table 2 The number of lynx radio-marked and the number of "radio-years" these lynx have been followed (within brackets) in the 4 sub-projects until June 1997.

			Adults			
Area	0-1 yr	1-2 yrs	Female	Males	Both	Total
Sarek	27 (17.9)	16 (7.9)	11 (16.8)	8 (11.2)	19 (28.0)	41 (53.8)
Nord-Trøndlag	8 (3.4)	6 (4.2)	5 (4.1)	3 (3.5)	8 (7.6)	15 (15.2)
Hedmark	16 (5.7)	10 (2.9)	8 (6.3)	5 (5.5)	11 (11.8)	29 (20.4)
Grimsö	11 (4.2)	7 (2.7)	3 (1.0)	4 (1.8)	7 (2.8)	18 (9.7)
Total	62 (31.2)	39 (17.7)	27 (28.2)	20 (22.0)	47 (50.2)	103 (99.1)

4 Survival

All radio-marked lynx were used to calculated the survival rate for different age classes. For the first two age classes the sample sizes are fairly small, therefore, both sexes were pooled. For adults the analyses were first made for each sex separately. All four study areas were pooled, as well as all years. Thus, for the purposes of this preliminary analysis we assume that there are no study area or year differences. Because all individuals were not radio-marked simultaneously, the survival estimates were calculated using an extension of the Kaplan-Meier method, "the staggered-entry design" (Pollock et al. 1989),. The lynx-year starts in June. Thus, all lynx are assumed to be born on June 1st. Survival from birth to one year of age and from one year of age to two years of age was calculated using individuals of known age. Adults that were radio-tracked for more than one year had one record added to the number of individuals at risk for every period they were monitored. However, the confidence limits were calculated based on the number of individuals in the sample, rather then the number of lynx years.

Some lynx were confirmed as being illegally shot, 1 lynx in Sarek, 1 lynx in Hedmark and 1 lynx in Grimsö. Sometimes individuals disappear and if the transmitter had not shown any signs of malfunction earlier we often suspect poaching. Interestingly, poaching and suspected poaching occur at different time of the year in Sarek as compared to the other 3 areas. Nine individuals have disappeared in Sarek and all of them disappeared in late winter, i.e. March to May when it is still possible to drive a snowscooter on the snow (**figure 3**). In contrast, of the 6 lynx that have disappeared in the other 3 areas, 4 disappeared in August to October, i.e. during the roe deer and moose hunt (**figure 4**). As the possible poaching occurs at different times of the year in Sarek compared to Hedmark and Grimsö, it is unrealistic to include all poaching in the survival estimates. Therefore, we have calculated more than one survival estimate. The survival rates for males and females were very similar. Therefore, the two sexes were pooled in all the analyses. The minimum survival rates were used in all the analyses, as that will give a conservative measure of population growth.

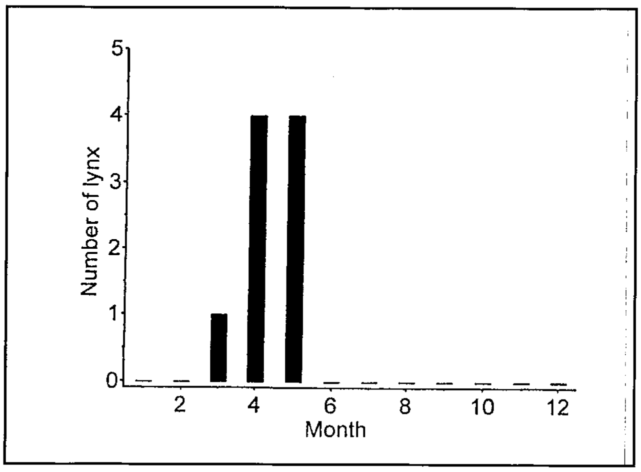

Figure 3 Distribution of known poaching and suspected poaching of lynx in Sarek in relation to month.

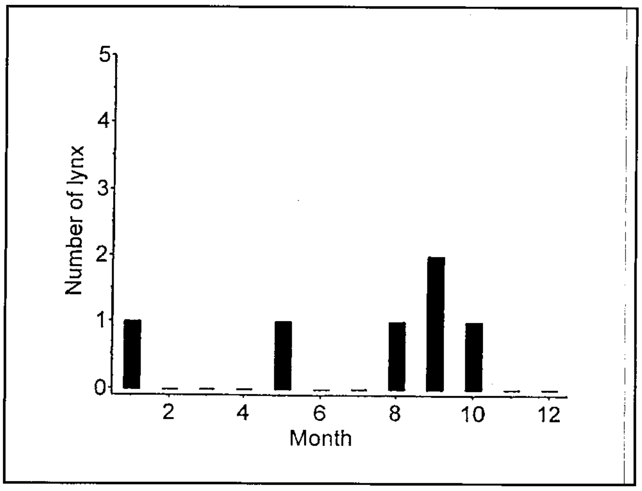

Figure 4 Distribution of known poaching and suspected poaching of lynx in Nord-Trøndelag, Hedmark and Grimsö in relation to month.

Table 3 Causes of disappearance in lynx in the 4 study areas.

	Natural death	Legal hunting	Illegal hunting	Illegal hunting?	Unknown
Sarek	7[a]	0	1	8	2
Nord-Trøndelag	0	4	0	1	0
Hedmark	1[b]	1	1	1	2
Grimsö	0	1	1	1	0

[a] 4 of the 7 individuals were kittens that died during their first year of life.
[b] died from scabies.

5 Reproduction

The reproductive data is based on 60 reproductive seasons for 49 females. None of the 17 one-year-old females produced kittens. Six out of 17 two-year-old females produced kittens. The proportion of two-year-old females that reproduced appears to differ between study areas, although nothing is significant due to very small sample sizes; Sarek 1 out of 4, Nord-Trøndelag 3 out of 3, Hedmark 0 out of 2 and Grimsö 2 out of 2 two-year old females produced kittens. The mean litter size for two-year-old female that reproduced was 2.33, calculated for all two-year-old females it was 1.27, and the number of female kittens produced by all two-year-old females 0.636. The reproductive data for adults females is based on 21 individuals that have been followed for 32 reproductive seasons. Females produced kittens in 23 of these 32 reproductive season. The mean litter size for female that reproduced was 1.87, calculated for all females it was 1.34, and the production of female kittens by all females was 0.672.

Table 4 Annual survival estimates based on the radio-tracked individuals. Sample sizes are given in table 2. Two survival estimates are given, maximum and minimum. The maximum estimate only includes certain deaths, whereas the minimum includes all disappearances as deaths. Confidence limits calculated according to Pollock et al. (1989, J. Wildl. Manage. 53: 7-15). Bold values are used in the calculations below.

Age class	Survival	95% confidence limits Lower	Upper
Birth to 1 year-max	0.88	0.79	0.98
Birth to 1 year-min	**0.75**	**0.63**	**0.86**
1 to 2 years-max	0.90	0.57	1.00
1 to 2 years-min	**0.62**	**0.41**	**0.83**
1 to 2 years-min (alternative 1)	**0.81**	0.62	1.00
Adult-females-max	0.98		
Adult-females-min	0.80		
Adult-males-max	1.00		
Adult-males-min	0.83		
Adults-max	0.99	0.95	1.00
Adults-min	**0.81**	**0.70**	**0.93**
Adults-min (alternative 2)	0.87	0.76	0.97
Adults-min (alternative 3)	0.84	0.74	0.95

Alternative 1 - survival was estimated excluding 4 yearlings in Sarek that either disappeared or were shot illegally in March to May.
Alternative 2 - survival was estimated excluding 5 adults in Sarek that either disappeared or were shot illegally in March to May.
Alternative 3 - survival was estimated excluding 4 adults in Nord-Trøndelag, Hedmark and Grimsö that either disappeared or were shot illegally in August to October.

6 Sensitivity analysis

The aim of this section is to quantify the relative importance of the different survival and reproductive parameters on population growth, to identify the demographic parameters that continued research should focus on, and finally to calculate a rate of increase that includes variation due to the statistical uncertainties give above (**tables 4 and 5**).

The relative importance of the different survival and reproductive parameters on population growth is represented by "elasticity" (**table 6**). Adult survival has the largest influence on population growth, thereafter survival from birth to 1 year, adult reproduction, survival from 1 to 2 years of age and finally reproduction at 2 years of age.

Table 5 Reproductive data for the 4 study areas pooled. Bold values are used in the calculation below.

Age class	Number of females	Number of females with kittens	Mean female kittens per female (±95% C.I.)
1 year old	17	0 (0%)	**0**
2 years old	11	6 (55%)	**0.636 (±0.477)**
Adults	32 (21)*	23 (72%)	**0.672 (±0.182)**

* number of reproductive seasons (and number of individual females).

Table 6 Elasticity, the relative contribution of demographic parameters to population growth.

Parameter	Elasticity
Survival from birth to 1 year	0.204
Survival from 1 to 2 years	0.153
Survival of adults	0.429
Reproduction, 2 years old	0.051
Reproduction, adults	0.154

To identify the demographic parameters that continued research should focus on one has to combine the elasticity of a parameter with the present knowledge about that parameter, i.e. a combination of the relative contribution and the statistical uncertainty (resulting from sample size) of that parameter.

The mean of all the demographic parameters was used as a starting-point. The mean rate of increase was 0.087 (lambda 1.091, or a 9.1% increase per year) using the mean values (**tables 4 and 5**). If we use the alternative for survival from 1 to 2 years that excluded 4 individuals in Sarek, then the a rate of increase will be 0.146 (lambda 1.157, or a 15.7% increase per year). This survival value might be valid for the Hedmark and Grimsö areas. Thus, the suspected poaching has a large influence on the population growth.

To study the effect of the statistical variance in all the demographic parameters on population growth, the rate of increase was calculated for all the parameters using the lower and upper 95% confidence limits (**tables 4 and 5**) and then compared with the population growth for the mean values (**table 7**). These calculation were done for one parameter at a time. Adult survival influenced population growth most, followed by the survival from 1 to 2 year. The three other parameters had almost the same effect (**table 7**). Although population growth was most sensitive to the present knowledge in adult survival, it is not obvious that any particular parameter requires more intensive study than the others. Parameters with low elasticity, survival from 1 to 2 years, and reproduction of 2 year old, are the most difficult parameters to study. Furthermore, population demography is only one of several aims of all the studies, other aims include social organisation and dispersal. The best strategy for radio-marking lynx will therefore be to radio-mark females and follow them and their offspring, especially daughters, throughout their lives. This will not only give data on survival and reproduction, but also on dispersal and social organisation. This strategy has already been adopted in all three study areas where radio-marking continues at the moment.

Simulations were used to calculate the variation in population growth depending on the statistical uncertainties in all the demographic parameters given above (**tables 4 and 5**). One thousand simulations were made. In each simulation a value for each of the 5 demographic parameters was selected a random assuming a normal distribution with the given mean and variance.

The mean rate of increase was 0.0877 and the variance was 0.00434. The rate of increase was not significantly different from 0, as 91 of the 1000 simulations (9.1%) were below 0 (**figure 5**). The alternative with a higher survival rate from 1 to 2 years resulted in a rate of increase of 0.144, with a variance of 0.00369. This was significantly different from 0, only 14 of the 1000 simulations (1.4%) were below 0 (**figure 6**).

These simulations assume that the variation in each of the 5 demographic parameters is completely independent . If there exists a positive relationship among them, e.g. all survival estimates are better than the mean, then the variance in rate of increase will be larger than the simulated one. On the other hand, if they are negatively related to one another, then the variance will be smaller.

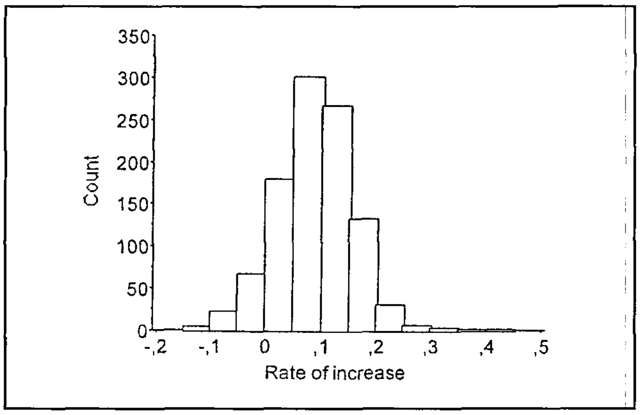

Figure 5 Frequency distribution of 1000 simulation of the rate of increase. The mean rate of increase was 0.0877, 9.1% of the simulation resulted in a rate of increase below 0.

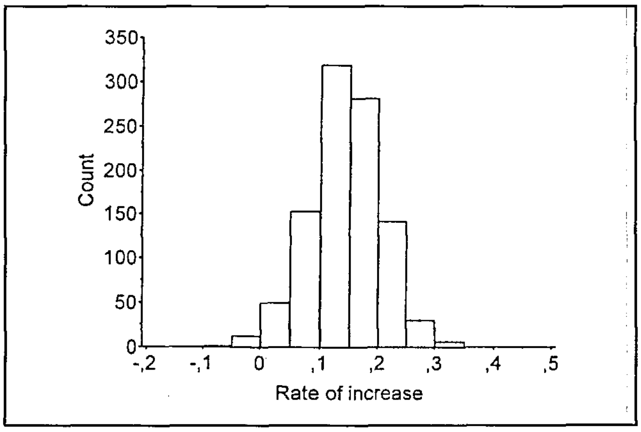

Figure 6 Frequency distribution of 1000 simulations of the rate of increase. The mean rate of increase was 0.144, 1.4% of the simulation resulted in a rate of increase below 0. The simulations are based on the alternative with a higher survival rate from 1 to 2 years, compared to **figure 5**.

Table 7 The effects of the statistical uncertainty in the different reproductive and survival parameters on the population growth.

	r (rate of increase)		
Parameter	**Mean**	**Lower 95% C.I.**	**Upper 95% C.I.**
Mean from tables 4 and 5	0.087		
Mean - alternative 1	0.146		
Survival from birth to 1 year		0.053	0.117
Survival from 1 to 2 years		0.010	0.151
Survival of adults		0.005	0.170
Reproduction, 2 years old		0.051	0.128
Reproduction, adults		0.040	0.125

Alternative 1 - survival from 1 to 2 years was estimated excluding 4 yearlings in Sarek that either disappeared or were illegally shot in March to May.

Importantly, these simulations do not include any demographic or environmental stochasticity, they only include the known statistical uncertainty. In population viability analyses these statistical uncertainties are often ignored and it is assumed that the mean values are the same as the true values. However, as our data set increases we should be able to include biologically-correct estimates of stochasticity into our analysis.

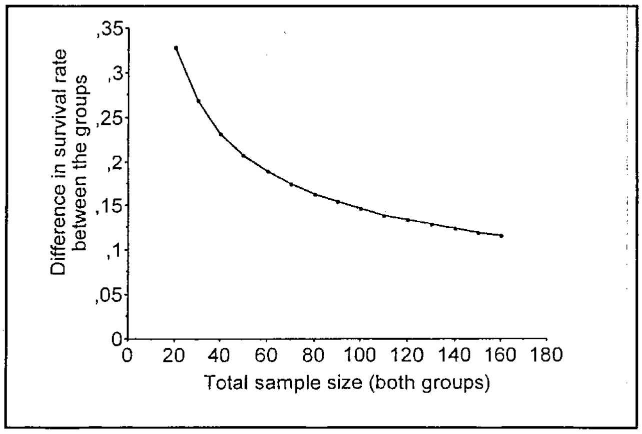

Figure 7 Differences in yearly survival rate likely to be found statistically different at different sample sizes.

7 How much more data do we need?

Assuming the continuity of funding and no increase in the numbers of lynx being shot (legally or illegally), the three sub-projects that are running today (Sarek, Hedmark and Grimsö) will probably have 20-25 radio-marked lynx each at the end of June each year. This is the same as the number of lynx followed in Sarek during the last two years. Funding will probably set the limits to this number, e.g. the brown bear project has had about 75 bears radio-collared during each of the last years (Swenson pers. com.). If we assume that the sample size is about 60-75 lynx in June each year, then one can calculate how the precision in the mortality and natality estimates will increase after each field season.

In June 1997, 21 lynx were radio-collared in Sarek, 9 adult females, 7 adult males and 5 yearlings. The 9 adult females gave birth to 15 kittens. If we assume that this is a possible distribution on different categories in all three areas, then the sample will increase every year by approximately 45 kittens, 15 yearlings and 50 adult-years. The data on reproduction will increase by approximately 25 adults and 10 first year adults per field season.

After 5 years, i.e. in year 2002, with this intensity of data collection we should probably find statistically differences in survival rates that are greater than 0.15 to 0.20, depending on category, assuming a type I and type II error of 5 % (Fig. 7, Pollock et al. 1989, Cohen 1988, Statistical power analysis). For example, the difference in annual survival rate from one to two years of age with, and without, the unknown disappearances in Sarek was 0.62 and 0.81, respectively (Table 4). With the level of data that we have the potential to collect by 2002 it should be possible to document this difference statistically. These calculation are based on differences in yearly survival. Differences in survival patterns throughout the year, which will not necessarily result in different yearly survival rate, can also be tested (Pollock et al. 1989).

Furthermore, it is not unlikely that reproduction differs between the three areas, especially for two-year-old lynx. With the data set one has after 5 years one can find differences in reproduction greater than 0.5 and 0.2 female kittens per female for 2 year old females and older females, respectively, assuming a type I and type II error of 5% (Cohen 1988).

Thus, 5 years from now we should probably have quite good data on the demographic parameters, i.e. reduced statistical uncertainty. During this period one might also have some idea about the demographic and environmental stochasticity.

8 Planned joint scientfic publications

1 - After the reproduction in June 1998 it should be possible to write a paper with sensitivity and population viability analyses. This paper should included the type of analyses presented above as well as a viability analysis including demographic and environmental stochasticity and the risk of harvesting lynx at different population sizes and growth rates (e.g. Kokko et al. 1997, Cons. Biol. 11:917-927).

2 - Already now it is possible to compile information on the historical development of lynx and roe deer populations in Sweden, Norway and Finland. The historical part will be based on bag records and the recent development on e.g. the lynx censuses made in Sweden and the wildlife triangle censuses made in Finland. This is particularly interesting as the lynx density in Finland is highest outside the range of roe deer and white-tailed deer distribution. Whereas, the lynx in Sweden and Norway seems to be distributed more in areas where large ungulate prey, semi-domestic reindeer and roe deer, are available.

9 Co-operation

During the last year the Scandinavian lynx project met during the Nordic Wildlife Congress in Trondheim in February 1997. Reidar Andersen has applied for a grant from NorFA to organise a network for the lynx researchers within the Nordic countries (Sweden, Norway and Finland). The first meeting is planned for December 1997. During the year there have been several other meetings. Henrik Andrén was in Trondheim for a few days in November 1996. Henrik Andrén, Tor Kvam, Olof Liberg, Mats Lindén, Peter Segerström and Ilpo Kojola met at the Large Carnivore Meeting in Gillehov in March 1997. Reidar Andersen, Olof Liberg and John Linnell met at the 3rd European Roe deer Workshop in Hedmark in April 1997. Reidar Andersen, Henrik Andrén and Olof Liberg have all been to Sarek in 1997. Henrik Andrén was in Trondheim in October 1997 (NorFA-grant). Ilpo Kojola and Harto Lindén visited Grimsö in May 1997 to discuss large carnivore research. Henrik Andrén and Mats Lindén was on a large carnivore meeting in Helsinki in November 1997.

During the year there has also been co-operation in the field. Per Ahlqvist has been to Sarek and helped Peter Segerström marking lynx. Kent Sköld and 2 more personnel from Grimsö were in Hedmark with dogs and helped in remarking a lynx. A student from Norway has worked in Sarek. Two lynx have dispersed into Sweden from Hedmark, Grimsö are currently radio-tracking these individuals. Based on our observed dispersal distances we expect more animals to move between the study populations in the future.

Information about the radio-tracked individuals, e.g. deaths, reproduction, remarking, is collected in each sub-project in the same kind of data base (Excel-format) and send to all the other sub-projects at least twice a year. This report is mainly based on this data base.

The best strategy for radio-marking lynx is to mark females and follow them and their offspring throughout their lives. To do this one must replace the radio-transmitters every second year. Therefore, it is essential to have a reliable method for recapturing animals. In Sarek one has been very successful in darting the lynx from helicopter. In the forested areas of Hedmark and Grimsö this method is not suitable. Therefore, one has started to use dogs in both areas. To develop this method and to co-operate at recaptures has shown to be very good for both Hedmark and Grimsö.

ISSN 0802-4103
ISBN 82-426-0894-6

518

NINA OPPDRAGSMELDING

NINA Hovedkontor
Tungasletta 2
7005 TRONDHEIM
Telefon: 73 80 14 00
Telefax: 73 80 14 01

**NINA
Norsk institutt
for naturforskning**