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Forsmark site investigation

Bird monitoring in Forsmark 2002–2003

Martin Green
Department of Animal Ecology, Lund University

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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

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Summary

This report summarizes changes in the breeding bird fauna in Forsmark between 2002 and 2003. The aim of the report is to evaluate the possible effects of the site investigations on the the numbers of breeding birds, and in some cases also on their breeding success. The report covers the total bird fauna, including also common species, but focus is on species listed in the Swedish Red List and/or the EU Birds Directive Annex 1. During both years the overall bird fauna has been censused with a combination of line transects and point counts within the candidate area. The overall bird fauna has also been censused in more detail in three smaller areas around drilling sites 1, 2, and 3 with the territory mapping method. Listed species have been censused in the whole regional model area by special methods. The results presented in this report are indications of short-term effects of the site investigations on the bird fauna. The long-term effects are still unknown.

For the total bird fauna at large, no significant effects were found at all. Both the number of breeding species and their numbers remained stable between the two years in the candidate area. The territory mapping did not show any significant differences in species or bird numbers in the areas close to the drilling sites. There were no indications of that the distribution of bird territories within the territory mapping areas was affected either. Regarding listed species, there were no large-scale effects in the regional model area. Most species showed similar numbers and a normal breeding success in both years. In the candidate area (and the close surroundings of this, i.e. the area with the most intense site investigations) the reactions differed between different species. Some species were not affected at all (whooper swan, black cock, wryneck and red-backed shrike) while others seem to react negatively with unsuccessful nesting attempts or down-right desertion of the area (black-throated diver, white-tailed eagle, capercaillie and hazelhen). The conclusions of this first analysis of the effects of the site investigations on the bird fauna turn out as follows:

- There was no effect on the total bird fauna at large.
- There was no general, large-scale effect on listed species within the regional model area.
- Some listed species seem to be very tolerant and show no signs of being disturbed.
- Other listed species seem to be negatively affected.

To mitigate at least some of the negative effects for the last mentioned group it is suggested that more effort should be put into leaving known nest sites undisturbed during the critical periods of the breeding cycle.

Sammanfattning

Denna rapport sammanfattar förändringar i fågelfaunan mellan 2002 och 2003 i Forsmark. Syftet är att utvärdera den eventuella påverkan som SKB:s platsundersökningar kan ha på de häckande fåglarnas numerär och i vissa fall häckningsframgång. Rapporten behandlar den totala fågelfaunan, dvs inkluderande även talrika arter, men särskild uppmärksamhet ägnas åt arter upptagna i den Svenska Rödlistan samt i EU:s Fågelskyddsdirektiv Annex 1. Under båda åren har den allmänna fågelfaunan följts genom linje- och punkttaxeringar inom Kandidatområdet. Den allmänna fågelfaunan har också studerats mer detaljerat genom revirkartering i mindre områden kring borrplats 1, 2 och 3. Listade arter har följts upp i hela det Regionala modellområdet genom särskilt eftersök. De resultat som presenteras i denna rapport ska ses som indikationer på eventuell korttidspåverkan på fågelfaunan. Vad som händer i ett längre tidsperspektiv är ännu för tidigt att uttala sig om. En utvärdering av eventuella långtidseffekter kräver en betydligt längre undersökningsperiod.

För fågelfaunan i stort kunde ingen större påverkan alls konstateras från de pågående platsundersökningarna. Både antalet häckande arter och deras numerär var likartat under båda åren inom Kandidatområdet. Revirkarteringarna visade inte på några större förändringar i artantal eller antal revir i borrplatsernas närhet. Det fanns inte heller några tecken på att den geografiska fördelningen av fågelrevir påverkades av platsundersökningarna inom dessa områden, dvs fåglarna undvek inte de mest störda delarna kring borrplatserna. Ovan sagda gäller för fågelfaunan i stort. När det gäller de listade arterna har ingen allmän, storskalig påverkan skett inom det Regionala modellområdet. De flesta listade arter uppvisar samma numerär under båda åren och en till synes normal häckningsframgång. Går vi inom Kandidatområdet (och dess omedelbara närhet, dvs delarna med de mest intensiva platsundersökningarna) tycks reaktionerna skilja sig åt mellan olika arter. Vissa arter uppvisar inga som helst tecken på att störas (exempelvis sångsvan, orre, göktyta och törnskata) medan andra möjligen reagerar negativt med misslyckade häckningar och/eller övergivande av de delar där de mest intensiva undersökningarna pågår (exempelvis storlom, havsörn, tjäder och järpe). Sammantaget blir slutsatsen av de första analyserna av platsundersökningarnas eventuella påverkan på häckfågelfaunan som följer:

- Fågelfaunan i stort påverkas inte alls.
- Ingen generell, storskalig påverkan har skett på listade arter inom det Regionala modellområdet.
- Vissa listade arter förefaller vara mycket toleranta och visar inga tecken på att störas.
- Andra listade arter uppvisar tecken på att påverkas negativt.

För att motverka åtminstone en del av de negativa effekterna för sistnämnda grupp föreslås att större hänsyn tas för att försöka lämna boplatser ostörda (t ex när det gäller havsörn) under de känsliga perioderna av året. För att detta ska kunna åstadkommas krävs både god information från ansvariga för platsundersökningarna till alla de som är verksamma inom dessa, men även en hög grad av självdisciplin från de som inom platsundersökningarna rör sig i området.

Contents

1 Introduction

This document reports the data gathered within the monitoring part of the bird surveys, one of the activities within the site investigations in Forsmark, during 2002 and 2003. The bird surveys started in 2002 and continued in 2003, allowing comparisons between the years. The aim of this report is to evaluate the effects of the ongoing site investigations on the breeding bird fauna in the area. The surveys were conducted according to activity plan AP PF 400-02-16 (SKB internal document). The project has been carried out by the Department of Animal Ecology, Lund University. This document is a summary of the data acquired in the candidate area in 2002 and 2003 regarding the complete breeding bird fauna. For listed species the report covers the whole regional model area.

2 Objective and scope

The site investigations in Forsmark started in 2002. SKB has from the start of the investigations aimed at monitoring the effects from all the ongoing activities on the fauna in the area. This in order to ensure that the site investigations are carried out in such a way that disturbances to the fauna, especially sensitive and vulnerable species, can be held at a minimum level (without hindering the essential parts of site investigations).

Forsmark is an area rich in birds, holding high densities of both common species and more rare ones such as species listed in the Swedish Red List /Gärdenfors, 2000/ and European Unions Birds directive 79/409/EEG: Annex 1, (www.environ.se) /cf. Green, 2003/. It is inevitable that site investigations as those conducted by SKB will affect the bird fauna in some way. The investigations are not only likely to affect the specific sites where drilling is made or new roads are constructed. In addition to these direct impacts, involving small, but none the less direct losses of available areas for birds (both directly in a pure physical sense and in-directly through high, long-lasting levels of disturbance), the general level of human activity in the area is greatly increased with more traffic on the roads, more people out in the landscape performing different kinds of investigations. In Forsmark this means a quite dramatic change from the pre-site investigation period, as the area had a rather low level of human disturbance then.

The monitoring part of the bird surveys aims at tracking changes in overall bird numbers (densities) in the areas in close contact with the most disturbing parts of the site investigations (drilling sites) as well as in the candidate area at large. To be able to disentangle changes caused by other factors than the site investigations, the results from Forsmark will be compared with results gathered in the whole eastern Svealand (collected through the national monitoring programme of the Swedish Environmental Protection Agency, http://www.biol.lu.se/zooekologi/birdmonitoring). In this report however, covering only two years of monitoring, no such detailed comparison is made. General national trends of some species are however mentioned (data taken from /Lindström and Svensson, 2003/). For certain listed species (Swedish Red List and the EU:s Birds Directive) the monitoring aims at following the population development in the whole regional model area. In addition to looking at overall numbers for these species, the programme aims at investigating breeding success when this is possible. In this report there is only two species for which there are data on breeding success for both 2002 and 2003, (white-tailed eagle and ural owl). For the eagles, data for comparison is also available for earlier years. For other species of interest, data collection on breeding success was started in 2003 and the data obtained are presented here as a starting point for future comparisons.

The results shown in this report only concern short-term effects from the site investigations. The long-term effects will not be possible to analyse for many years yet. Hence, the results presented here should be taken as indications of possible effects more than as firm conclusions about long-term effects.

The monitoring programme is carried out at different levels, both geographically and regarding the selection of birds that are monitored. More details about these levels are presented in /Green, 2003/ and in the activity plan (AP PF 400-02-16).

Regional model area (area of possible large-scale effects). In Forsmark the size of the regional model area is about 60 km^2. This area is defined by a thick broken line in Figure 2-1. Within this area species listed in the Swedish Red List and/or the EU:s Birds Directive are monitored (from 2004 onwards, only a selection of the listed species will be monitored, but during 2002 and 2003 all listed species as well as non-listed raptors and owls were monitored). The aim of the surveys is to find out the yearly number of breeding pairs within the area, and for a few species also to establish the breeding success of these.

Candidate area. This level involves a smaller area covering all the potential drilling sites, and is the core area of the site investigations. The size of the area in Forsmark is about 10 km^2. The candidate area is defined with a thick unbroken line in Figure 2-1. The candidate area is surveyed more in detail compared to the regional model area. The aim here is to monitor changes in breeding bird numbers not only for listed species but for the complete bird fauna. Special attention is directed to the drilling sites and their infra-structure as well as other possible disturbances caused by the activities within the site investigations. Overall, the candidate area is surveyed by a combination of line transects and point counts. The area is surveyed twice each season (early and late in the breeding season). In order to study direct impacts from drilling activities, smaller areas (about 30 ha in forested parts, larger in open habitats) around three drilling sites have been censused by territory mapping in 2002 and 2003.

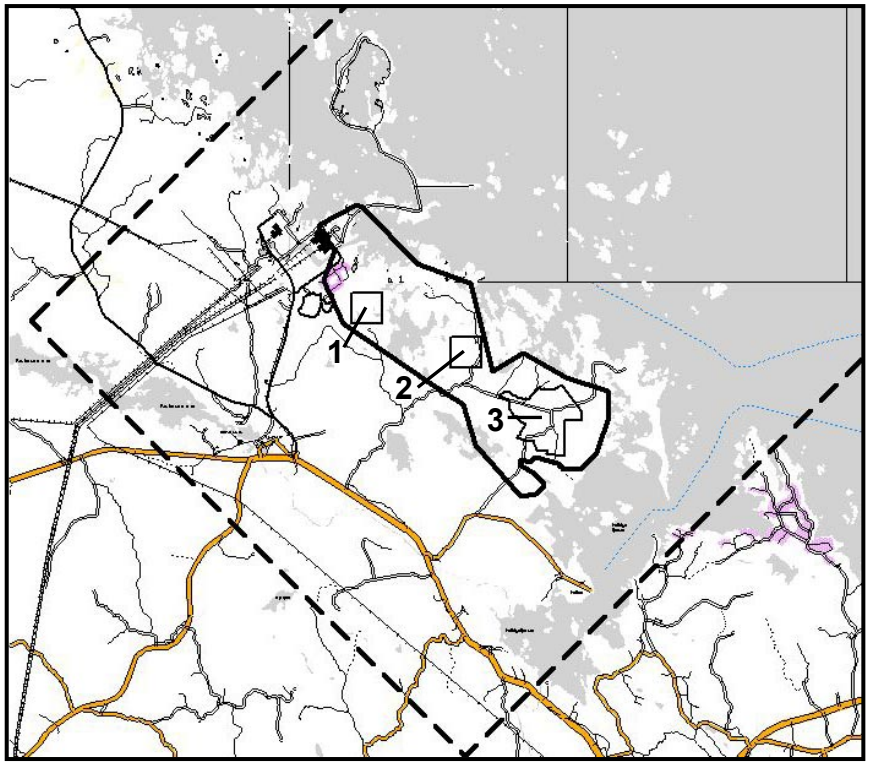


Figure 2-1. *Map of the survey area in Forsmark. The regional model area is marked with a thick broken line, and the candidate area with a thick unbroken line. The territory mapping areas (1, 2, 3) around drilling sites are also illustrated.*

3 Equipment

3.1 Description of equipment

The following equipment was used when conducting the bird surveys.

- GPS (Garmin 12).
- Binoculars.
- Field maps showing each days work.
- Note books and protocols.
- Vehicles for transport to and from the study area.
- Cell phones (safety equipment when working alone in the field).

4 Methods

The methods used are described in detail in activity plan AP PF 400-03-60. More information about the methods can be found at:

www.biol.lu.se/zooekologi/birdmonitoring/metoder.htm

as well as in /Svensson, 1975/ and /SNV, 1978/.

An overview of the methods used in the regional- and candidate areas are presented below. To cover the bird fauna in general, incorporating also the more common bird species, a combination of line transects and point counts is used. The method is more or less directly taken from the manual for standardised breeding bird counts used by the Swedish Environmental Protection Agency in their National Monitoring Program since 1996. By using the identical methods as in these surveys, we get the possibility of making direct comparisons with the data gathered at national and regional level (at a larger scale than the surveys presented here). Territory mapping is used in smaller areas around three drilling sites. Special surveys of listed species are also made.

4.1 Line transects and point counts

The aim of the line transects and point counts is to get a good overview of the breeding bird fauna in the area in a way that can yield comparisons between years (population development) and that can be compared with other areas. The surveys are based on the Swedish Grid (RT-90 2.5 gon W). The line transects are made along the north-south axes of this grid, with grid lines being 1 km apart. To get a more detailed coverage of the candidate area, an additional transect in between the RT-90 lines is added, so that the candidate area is gone through along north-south directed lines being 500 m apart. Point counts are made at every full km, the corners of the km-squares of the Swedish Grid. At the local scale, the point for the extra lines (in between the RT-90 lines) is moved to the midpoint of the km square (according to the grid) to get a better geographic coverage of the area (Figure 4-1).

Each line transect and the point counts along these within the candidate area are performed twice each season, one early round and one late round respectively. All birds seen and heard along the lines are counted while the observer is walking at slow speed, stopping, listening and looking around when needed. The observer registers bird species, number of individuals and the local time. To allow rapid data gathering in the field, all common species are summed (by the observer in the field) per five minute periods. The registration of time is important for linking the bird observations to the GPS-registered route and hence for positioning all bird observations correctly (see below). Observations of listed species (see Appendix 2, Table 1 and 2 in the activity plan AP PF 400-03-60), are registered individually with data on time and position (from GPS) directly in the field.

During the point counts, all heard and seen birds are counted during five minutes (disregarding what has been recorded along the line transects). The start and stop time of each counting period as well as the position from where the count is made is recorded. The count is, if possible, conducted from the pre-determined location. If the pre-determined location cannot be reached, counting from a location not deviating more than 250 m from the pre-determined one is allowed.

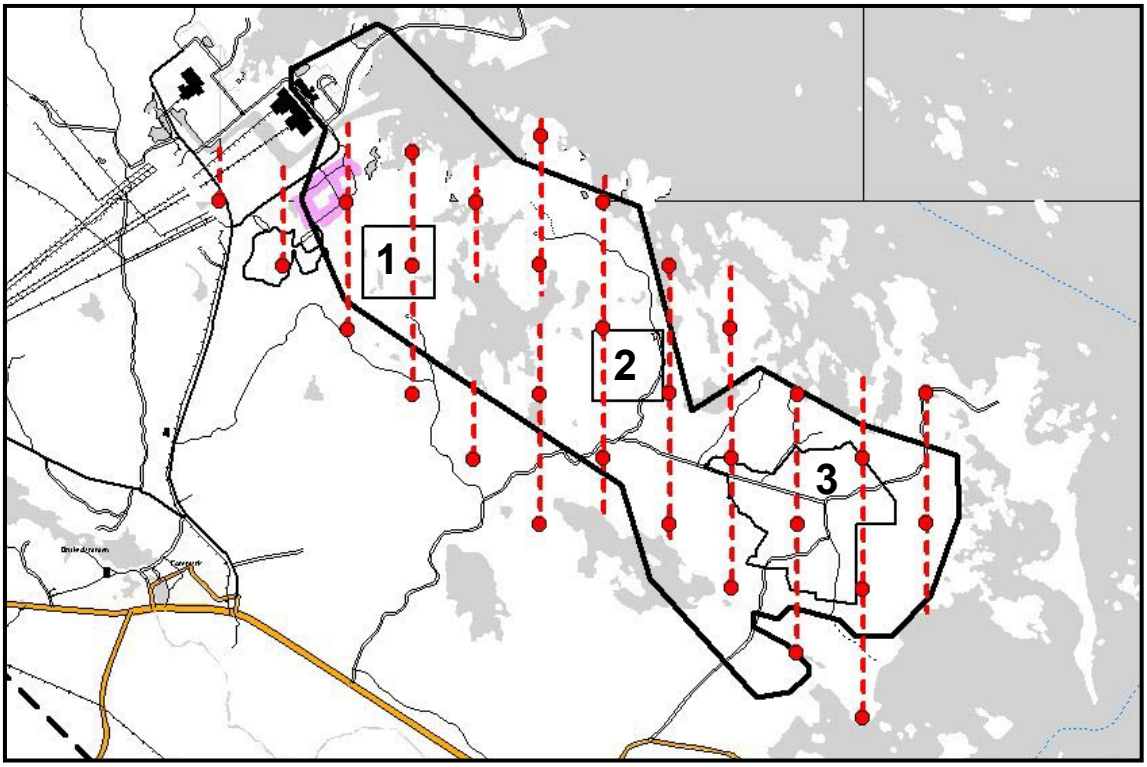


Figure 4-1. *Map of the candidate area in Forsmark showing line transects (broken, red, north-south directed lines, left) and positions for point counts (red dots, right) in 2002 and 2003. The territory mapping areas (1, 2, 3) are shown as well.*

During line transects and point counts, a GPS is used for registration of the route. The GPS logs position data automatically every five minutes and after each day of field work the logged positions (all with data on time as well) are down-loaded and stored as a conventional text file in PC-format.

Line transects and point counts do not give direct measures of absolute bird densities within an area. The density values given are though possible to re-calculate to absolute densities using different assumptions. The bird density measures yielded by the line transects and point counts in Forsmark are however directly comparable to the ones collected through Swedish Environmental Protection Agencys' National Monitoring Program (http://www.biol.lu.se/zooekologi/birdmonitoring) as the methods used are identical. Furthermore the data given by line transects and point counts can be used for index values and absolute density estimates that can be used for comparisons between different years, areas, habitats etc as long as the same methods are used when collecting the data and when calculating the indices and density values.

4.2 Territory mapping in areas around drilling sites

In a small area around three drilling sites, about 30 ha in size for two sites in forested parts and about 100 ha for one site in more open habitat, all breeding birds are mapped with the territory mapping method. Each area is visited six times during the time when the highest activity of breeding birds can be expected. The method gives a direct measure of bird densities (for detailed descriptions see /Svensson, 1975; SNV, 1978/) and hence possibilities

of a detailed picture of changes in relation to ongoing activities. At each visit the observer walks through the area in such a detailed way that no part is more than 50 m away from the observer (100 m in open habitats). The observer marks all individual observations of birds likely to breed in the area on a field map with different symbols showing species identity and behaviour of the bird. All observations are then transferred to species maps (one for each species). After the field work is completed, the number of territories are evaluated following standardised criteria. Territory mapping was made in three areas in Forsmark during 2002 and 2003; 1) Barackbyn (30.25 ha), 2) Jungfruholm (30.25 ha) and 3) Storskäret (101 ha, Figure 2-1 and 4-1).

4.3 Listed species (Swedish red list; EU Birds directive annex 1)

The species in question are shown in /Green, 2003/. For terrestrial species the following setup is used. Basic data have been collected during the line transects and point counts within the characterisation phase of the bird surveys /see Green, 2003/. For some species there already existed local knowledge about nest sites and territories that has been used. In these cases the known sites are checked and if possible (and desirable) the breeding results are followed up as well by direct visits to nest sites where the number of young birds are counted. Also for breeding sites found during the line transects and point counts there is an aim of following up breeding results of at least certain species in the same way. Additional extra visits are made to areas not directly covered by the line transects and point counts, if these are suspected to hold any of the species in question. During both 2002 and 2003 (still very much in the characterisation phase of the project) most time has been directed at finding out where these birds are and how many they are. Detailed following up of breeding results was possible only for white-tailed eagles and some owl species in 2002. In 2003 the aim was to follow up all breeding results for black-throated divers, whooper swans, larger birds of prey and larger owls. All observations of listed species are registered with data on bird species, number of birds, position (from GPS or recorded on field maps) and local time during the field work.

4.4 Nocturnal species

Species with their main activity period during night time are surveyed with special methods. Night-time listening along roads is used both for owls and other night active birds. The observers are travelling along all the roads in the area and make stops not more than 1 km apart. At each stop the observers listen for five minutes and then carry on to the next stop, and so on. The method gives a good overview of the present night active birds, but of course there are limitations due to the availability of roads. In the Forsmark area, however, there are roads enough to give a satisfactory coverage of the entire area, although some parts will remain uncovered. All observations of night active birds are registered with data on bird species, number of birds, position (from GPS or recorded on field maps) and local time. The area is covered both early in the season (March–April) when surveying calling owls and again in June for young owls.

4.5 Execution

Execution of the field work in 2002 has been described in detail in /Green, 2003/. The field work in 2003 was carried out during the period 2003-03-17–2003-08-07. The field work was done by Magnus Klingse (line transects, point counts, listed species), Roine Strandberg (line transects, point counts, territory mapping, listed species), Peter Hunger (territory mapping, listed species), Sören Svensson (listed species) and Martin Green (listed species). The white-tailed eagle work is carried out within the ongoing national project concerning this species by Björn Helander. Organisation, data handling, analysis work and interpretations were carried out by Martin Green, Dep. of Animal Ecology, Lund University.

4.6 Data handling

In the field (line transects, point counts, listed species) all registered birds were recorded in notebooks with data on species, number of individuals and time, together with additional data on bird behaviour and circumstances where such data were relevant. During line transects, common (numerous) species were summed already in the field in five minute periods, while more scarce, and especially listed species were recorded with individual data for each observation. At the same time, position and time were automatically registered by GPS every fifth minute. Observations of listed species were registered with exact position individually taken directly from the GPS in the field. After each day of field work the bird and time data were transferred to pre-made protocols. The logged position and time data were down-loaded from the GPS to text files in PC-format with the programme Waypoint1803. Bird and time data were then entered into Excel-files from protocols, after which the files were cross-checked against the field notes by the project leader. After this, the bird and time data were linked to the position/time data, whereby each observation was assigned a geographic position. The time resolution (five minutes for common species) gives a geographical resolution of about 100–150 m for these. Positions for listed species have the same resolution as the GPS-system. This base-file with data on species, numbers and positions can then be used for different GIS applications, for evaluating bird densities and further calculations.

During territory mapping, all bird observations (seen or heard) within the mapping areas were registered on pre-made field maps. The observations were then transferred to species maps after each field visit. After the field season, these species maps were evaluated and the number of territories for each species in the area was decided. The evaluation was used following guide-lines from /SNV, 1978/. The evaluation was made by two persons independently from each other (the field personnel, in this case Roine Strandberg or Peter Hunger, and the project leader). Deviations between the different evaluators (usually non-existent or in some cases very minor) were then discussed between them before the final number of territories was established. After all territories were evaluated, each one was digitalised and given a position according to the Swedish Grid (RT-90).

4.7 Analyses and interpretations

The results obtained in 2003 during line transects, point counts and territory mapping are compared with results acquired in an identical way in 2002, with the aim of evaluating possible effects in bird numbers both in the areas close to drilling sites and for the candidate area at large. With both methods, statistical testing is not possible at the species level as only

two data points (2002 and 2003) exist. For any meaningful statistical analysis on species level, data from at least five years are needed to evaluate trends in the local population size. For the breeding bird community as a whole, however, the numbers of breeding territories (territory mapping) and breeding birds (line transects and point counts) are tested to look for differences between 2002 and 2003. As data do not conform to normal distributions, non-parametric tests are used. All statistical testing was made in the software SPSS for Windows version 10.0 (SPSS Inc.).

The following statistical comparisons were made:

a) Number of recorded bird individuals per km and species during line transects in the candidate area during 2002 vs 2003.

b) Number of recorded bird individuals per point and species during point counts in the candidate area during 2002 vs 2003.

c) Number of territories per species in all three territory mapping areas during 2002 vs 2003.

These comparisons were made with the Wilcoxon sigend rank test /Sokal and Rohlf, 1997/. Any general decrease or increase in the bird fauna would turn up as statistical differences using this approach. The tests do in reality check whether the number of decreasing and increasing species are significantly different from each other. If the total bird community should decrease, one would expect that more species are decreasing than increasing etc. The normal, undisturbed level would be that similar numbers of increasing and decreasing species are found (i.e. no significant differences).

For each territory mapping area, the distribution of bird territories (regardless of species) within circular sectors with different distance from the centre of the drilling site was compared between 2002 (before) and 2003 (after/or during on-going activities). The following sectors were used (see Figure 5-1–5-3):

a) 0–50 m

b) 50–100 m

c) 100–150 m

d) 150–200 m

e) > 250 m

The idea behind this test is to analyse whether the activities at the drilling site in any way affect the geographical distribution of bird territories. If birds are disturbed by the activities one would expect that the distribution would be shifted towards the outer parts of the area (with a longer distance to the drilling site). If birds on the other hand should be attracted to the activities, the reverse would be expected. This comparison was made using the Chi^2-test.

Changes in numbers of territories and/or individuals at species level for listed species are compared and discussed but not statistically tested in this report. The same procedure is also used for comparing breeding results in a few cases.

5 Results

English and Swedish names of the birds are used throughout the results part. Latin names are given the first time a species is mentioned. A complete list of English, Latin and Swedish names for all bird species breeding in Sweden is given in Appendix A. The data have been stored in the database SICADA under Field Note No. “Forsmark 35 & 190”.

5.1 Line transects

Within the candidate area a total of 42.6 km (22.3 + 20.3 km during the first and second round respectively) of line transects were made in 2002 and 46.5 km (23.4 + 23.1 km) in 2003. The two rounds of line transects were conducted April 14–June 7 and June 19–28 in 2002, and April 29–May 15 and June 9–15 in 2003. During these line transects 3326 birds of 86 species were recorded in 2002 and 3541 birds of 96 species in 2003. In total 107 species were registered during the line transects within the candidate area in these two years. The figures above translate into remarkably similar bird densities between the years, 78.1 birds/km in 2002 and 76.3 birds/km in 2003. The results from the line transects within the candidate area are shown in full detail in Appendix B. There was no statistical difference in the number of birds/km between the years, when comparing the number of recorded individuals/km per species (Wilcoxon signed ranks test, $Z = 1.12$, $p = 0.26$, $N = 106$, white-tailed eagle Haliaetus albicilla (havsörn) was excluded from the comparison as this species was not counted during the line transects in 2002 due to a misunderstanding). Z is the test value computed by the test, a high absolute value of Z means that there is a large difference between the two tested data sets; p is the probability level, a low value of p indicates that there is a high probability that the two data sets differ (or a low probability that they are similar). Following international conventions on statistics, the level used to say that two data sets differ significantly from each other is set at 0.05. The lower the value of p, the more the two sets differ. N is the total number of species entered into the comparison. In other words, there was no significant difference in the number of increasing and decreasing species between 2002 and 2003. Higher densities were registered in 2003 (compared to 2002) for 59 species and lower densities were registered for 47 species.

Among listed birds, four species were registered in 2002 but not in 2003. Three of these were not observed during any other activities in the area either in 2003, i.e. they may have disappeared from the area. These were hazelhen Bonasia bonasia (järpe), three-toed woodpecker Picoides tridactylus (tretåig hackspett) and greenish warbler Phylloscopus trochiloides (lundsångare). Ten listed species were registered during the line transects in 2003 but not in 2002. Seven of these were however observed during other activities than the line transects in 2002, and hence present in the area also in this year. Three ‘new’ listed species appeared in the area in 2003, not recorded in 2002 and not observed during any other activity in that year. These were corncrake Crex crex (kornknarr), wood lark Lullula arborea (trädlärka) and nutcracker Nucifraga caryocatactes (nötkråka).

5.2 Point counts

58 point counts were made in the candidate area in 2002 and 64 in 2003. The point counts were conducted simultaneously with the line transects in both years (for dates see above).

During the point counts, 906 birds of 70 species were registered in 2002 and 1404 birds of 81 species in 2003. These figures translate into overall bird densities of 15.6 birds/point in 2002 and 21.9 birds/point in 2003. In total, 92 bird species were registered during the point counts in the two years. The results from the point counts within the candidate area are shown in full detail in Appendix C.

There was a tendency for that more species increased in numbers, than the other way around, although the difference was not fully significant (Wilcoxon signed ranks test, $Z = 1.93$, $p = 0.053$, $N = 91$, white-tailed eagle (havsörn) was excluded from the comparison as this species was not counted during the point counts in 2002). (For explanations of Z, p and N see above under Line transects.) Taken together, 54 species showed higher numbers/point in 2003 compared to 2002 (increased in numbers) and 37 species showed lower numbers/point (decreased in numbers).

For listed species, three species were registered during the point counts in 2002 but not in 2003. All three of these were however observed during other activities in the area also in 2003. Seven listed species were noted during the point counts in 2003 but not in 2002. Three of these were however seen during other activities also in 2002, and thus present in the area also in that year. One further species does not breed in the area and can be excluded. The three listed, possibly breeding species recorded in 2003 but not at all in 2002 were shoveler Anas clypeata (skedand), corncrake (kornknarr) and wood lark (trädlärka).

5.3 Territory mapping

Territory mapping in areas 1–3 (Figure 2-1 and 4-1) were conducted in June in both years. Each area was visited six times during this period. The results from the territory mapping are shown in detail in Appendix D.

Territory mapping area 1; Barackbyn

In area 1 the construction of roads and other things around the drilling site were made already before the field work started in 2002. Hence, any comparison with an undisturbed base-line year is not possible. Furthermore, drilling activities were taking place from April onwards in 2002, i.e. during the breeding season and the territory mapping period. In 2003 no drilling activities were made at this site during the breeding season, but the roads in the area were used for transport to other parts of the candidate area. 136 bird territories of 33 species were recorded in 2002 and 138 bird territories of 32 species were recorded in 2003. There was no statistical difference in the number of territories per species between the years (Wilcoxons signed ranks test, $Z = 0.23$, $p = 0.82$, $N = 41$, N is the total number of species recorded during the two years combined). (For explanations of Z and p see above under "Line transects".) 16 species increased in numbers and 17 species decreased in numbers from 2002 to 2003. For 8 species the numbers of territories were identical during the two years. Two territories of listed species were registered in 2002, one of capercaillie Tetrao urogallus (tjäder) and one of black grouse Tetrao tetrix (orre). In 2003 three territories of two listed species were recorded: black grouse (orre) (2) and wryneck Jynx torquila (göktyta) (1).

The geographical distribution of all bird territories in the two years are shown in Figure 5-1. There was no statistical difference in the distribution of territories in relation to the drilling site between the years (Chi^2-test, $\chi^2_{(1,4)} = 1.65$, $p > 0.50$). Here, Chi^2 is the test statistic. A high value of Chi^2 means that there is a large difference between the two tested data sets.

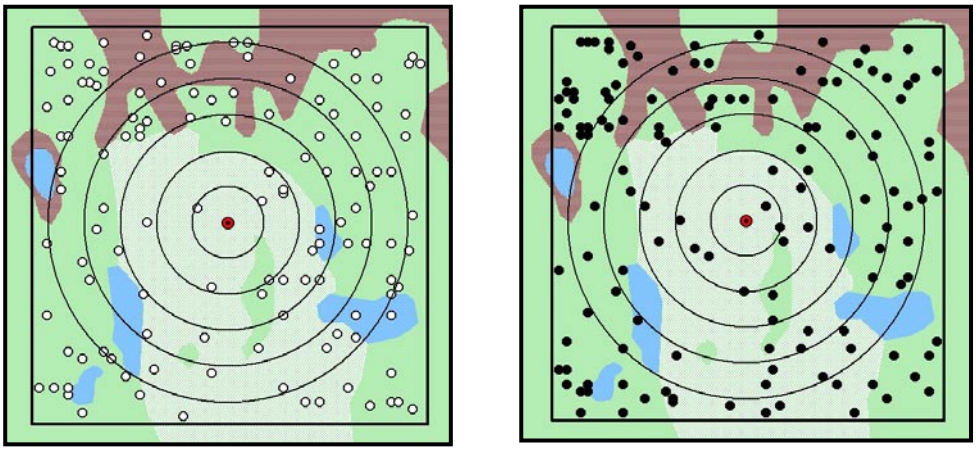


Figure 5-1. *Geographical distribution of all bird territories in mapping area 1 (Barackbyn, bold black line) in 2002 (left; white dots) and 2003 (right; black dots). The centre of each territory is shown, real territories are of various size and shape and bigger than the dots shown here. Note that more than one territory can have the same centre point, i.e. more than one territory are in some cases hiding behind the same dot. The drilling site is shown with a red dot. Circles are drawn at 50, 100, 150, 200 and 250 m from the drilling site (see Analysis and interpretation).*

P is as in the Wilcoxon test the probablity level (see above under "Line transects"). In other words, the birds did not in general change their distribution within the area between the years, avoiding certain parts in any particular year.

Territory mapping area 2; Jungfruholm

No road constructions or preparatory work at the drilling site were made in area 2 before the breeding (and territory mapping) season in 2002. Hence, 2002 can be regarded as an undisturbed base-line year for this area. The road construction and preparation work for drilling were made in Aug–Dec 2002 and the drilling site was active between Nov 2002 and late March 2003, i.e. into the early parts of the breeding season of 2003. No drilling was made during the later part of the breeding (the territory mapping) season in 2003. 132 bird territories of 28 species were recorded in 2002 and 125 bird territories of 26 species were recorded in 2003. There was no statistical difference in the number of territories per species between the years (Wilcoxons signed ranks test, $Z = 0.20$, $p = 0.84$, $N = 33$, N is the total number of species recorded during the two years combined). (For explanations of Z and p see above under "Line transects".) 13 species increased whereas 14 species decreased in numbers from 2002 to 2003. For six species the number of territories was identical between the years. Two territories of listed species were registered in 2002, one of capercaillie (tjäder) and one of hazelhen (järpe). In 2003 no territories of listed species were recorded.

The geographical distribution of all bird territories in the two years are illustrated in Figure 5-2. There was no statistical difference in the distribution of territories in relation to the drilling site between the years (Chi^2-test, $\chi^2_{(1,4)} = 2.89$, $p > 0.50$). (For explanations of Chi^2 and p, see above). In other words, the birds did not in general avoid the area close to the drilling site in 2003 compared to the undisturbed situation in 2002.

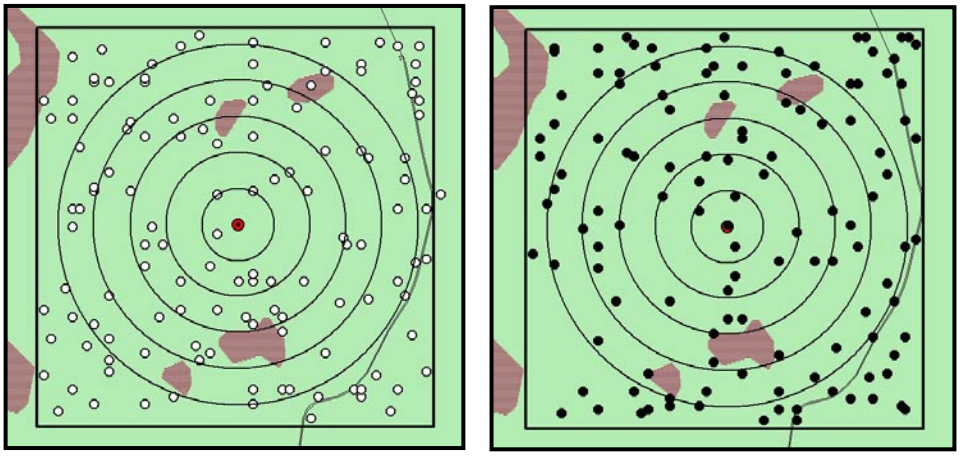


Figure 5-2. *Geographical distribution of all bird territories in mapping area 2 (Jungfruholm, bold black line) in 2002 (left; white dots) and 2003 (right; black dots). The centre of each territory is shown, real territories are of various size and shape and bigger than the dots shown here. Note that more than one territory can have the same centre point, i.e. more than one territory are in some cases hiding behind the same dot. The drilling site is shown with a red dot. Circles are drawn at 50, 100, 150, 200 and 250 m from the drilling site (see Analysis and interpretation).*

Territory mapping area 3; Storskäret

As for area 2, no road constructions or preparatory work at the drilling site were made in area 3 before the breeding (and territory mapping) season in 2002. Also for this area, 2002 can be regarded as an undisturbed base-line year. The drilling site was established in late 2002 and active from Dec 2002 to July 2003, i.e. throughout the whole breeding season of 2003, including the period when territory mapping was made. 155 bird territories of 37 species were recorded in 2002 and 224 bird territories of 45 species were recorded in 2003. Part of the large increase in number of territories and species from 2002 to 2003 is explained by that the monitoring personnel in 2003 was living within the area and had a much better access to gardens and buildings. Birds breeding in such parts were covered to a much higher degree in 2003 compared to 2002, making any meaningful comparison between the years for overall bird numbers non-sensical. All bird species breeding in, or in close contact with, buildings were hence excluded from further analysis. The species in question are shown in Appendix D, Table D-3. Eight species were excluded, yielding 15 territories in 2002 and 63 territories in 2003. After excluding these birds, 140 territories of 34 species were registered in 2002 and 161 territories of 37 species were registered in 2003. These were the data used in the following statistical analysis. There was a tendency for an increase in the number of territories per species between the years (Wilcoxons signed ranks test, $Z = 1.86$, $p = 0.06$, $N = 39$, N is the total number of species recorded during the two years combined), but the difference was not fully significant. (For explanations of Z and p see above under “Line transects”.) 20 species increased in numbers and 11 species decreased in numbers from 2002 to 2003. For eight species the number of territories were identical between the years. Three territories of listed species were registered in 2002. One each of wryneck (göktyta), red-backed shrike Lanius collurio (törnskata) and ortolan bunting Emberiza hortulana (ortolansparv). The number of territories of listed species increased to nine, of four species, in 2003: black grouse (orre) (1), wryneck (göktyta) (3), red-backed shrike (törnskata) (4) and ortolan bunting (ortolansparv) (1).

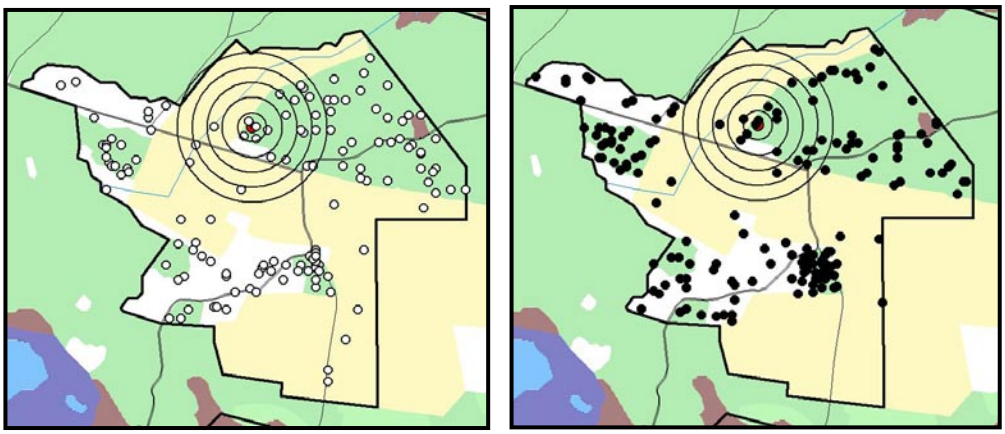


Figure 5-3. *Geographical distribution of all bird territories in mapping area 3 (Storskäret, bold black line) in 2002 (left; white dots) and 2003 (right; black dots). The centre of each territory is shown, real territories are of various size and shape and bigger than the dots shown here. Note that more than one territory can have the same centre point, i.e. more than one territory are in some cases hiding behind the same dot. The drilling site is shown with a red dot. Circles are drawn at 50, 100, 150, 200 and 250 m from the drilling site (see Analysis and interpretation).*

The geographical distribution of all bird territories in the two years are shown in Figure 5-3. There was no statistical difference in the distribution of territories in relation to the drilling site between the years (Chi^2-test, $\chi^2_{(1,3)} = 5.18$, $p > 0.10$). (For explanations of Chi^2 and p, see above). In other words, the birds did not in general avoid the area close to the drilling site in 2003 compared to the undisturbed situation in 2002.

5.4 Listed species

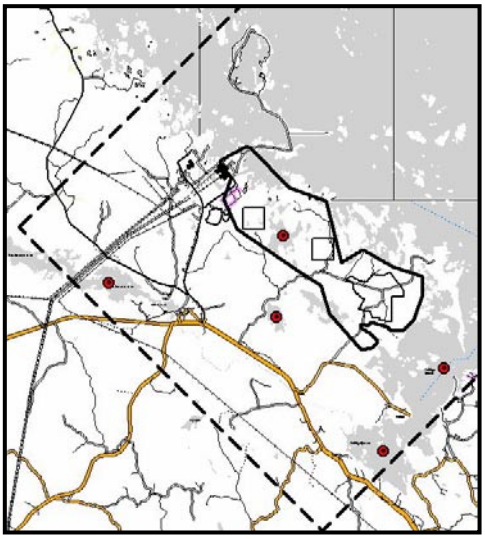
The following section gives a detailed summary of the occurrence of species listed as endangered, threatened or vulnerable according to the Swedish Red List /Gärdenfors, 2000/, and/or species listed in the European Unions' Birds Directive Annex 1 (79/409/EEG) within the main-land part of the Forsmark area (for the time being, the archipelago is left aside). SKB has from the start of the site investigations requested detailed information of the geographical and numerical distribution of these species within the area. The following information is based on data gathered both in 2002 and 2003 and presents a summary of our knowledge about these birds at present. Focus is on demonstrating the occurrence as we know it today and, if possible, to estimate the population development between the years. In addition to the listed species, this section also deals with the occurrence of non-listed raptors and owls.

For most species the geographic distribution is shown on a map where territories or pairs are marked with dots. The dots represent estimated territories based on observations made during line transects, point transects, territory mappings and special studies during the seasons 2002 and 2003. In order to maintain a certain amount of secrecy around the nesting sites of especially vulnerable birds, maps are not shown for neither diurnal or nocturnal birds of prey (raptors and owls), nor for Galliform forest birds. After the names of each species three numbers are presented. These display: i) the number of known territories within the regional model area outside of the candidate area, ii) the number of known territories within the candidate area and iii) the estimated total number of territories within the regional model area including the candidate area. The numbers and maps illustrate

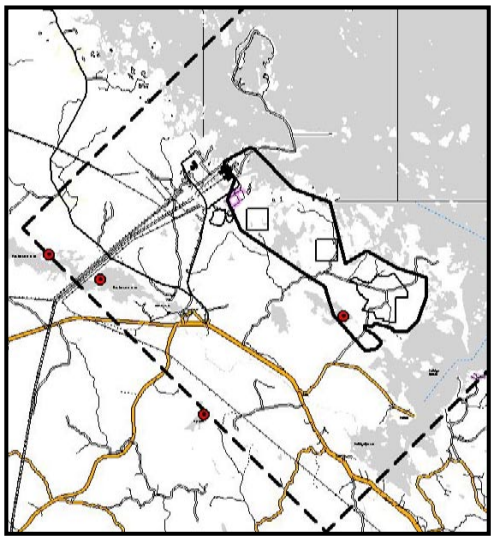
the situation in 2003 (if there is a difference between the years, otherwise the numbers and maps refer to both years). For each species there is also a note on whether it is listed according to the Swedish Red List or the EU:s Birds Directive. Only one species that for certain is breeding in Forsmark is also found on the Global Red List (considered as globally threatened, see /Gärdenfors, 2000/) and this is the white-tailed eagle (havsörn). Another globally listed species did occur in the area in 2003, the corncrake (kornknarr), but breeding remains to be confirmed. The text about the white-tailed eagle is written by Björn Helander.

Where possible, this report shows breeding output for listed species and other birds of interest, and a comparison between the two survey years. The aim is that the figures presented in this report should serve as a baseline for future comparisons. Listed species recorded during the surveys in 2002 and 2003, but not regarded as possible breeding birds in the area, are not treated in this report.

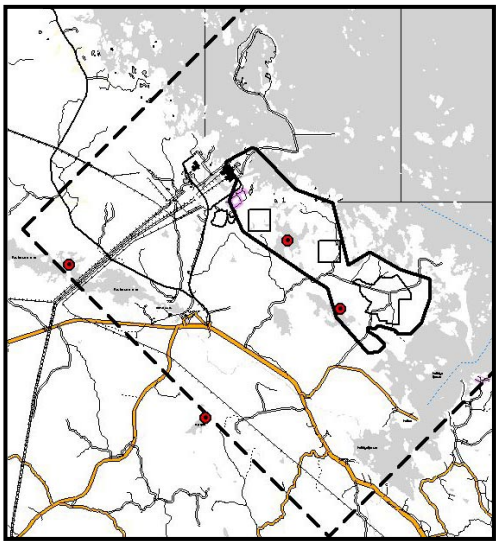
Black-throated Diver *Gavia arctica* Storlom (4; 1; 5; EU Annex 1)
Three pairs in lakes and two pairs in Kallrigafjärden. The number of pairs were the same in both years. No young birds were observed in 2003, indicating that these birds have problems with their reproductive output. No data are available from earlier years on breeding success for comparison, but it is well known that divers may suffer high breeding losses due to human activities during critical periods.



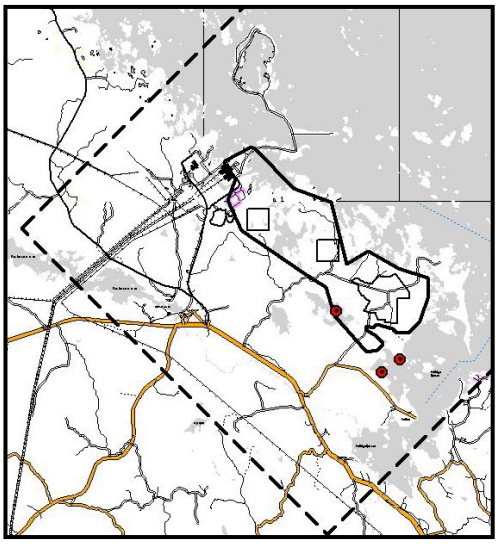
Bittern *Botaurus stellaris* Rördrom (3; 1; 4; Sw. Red List; EU Annex 1)
Four territorial males registered in both 2002 and 2003, although with a slight difference in distribution (cf. Green 2003). Nothing is known about breeding success for this secretive reed bird.



Whooper Swan *Cygnus cygnus* Sångsvan (2; 2; 4; EU Annex 1)
Four territorial pairs in the area in 2003. The corresponding figure for 2002 was three pairs, so the number of whooper swans continues to increase. Successful breeding in 2003 was recorded in Bolundsfjärden (3 juveniles). In 2002 it was the pair in Fiskarfjärden that produced young (4 juveniles). These long-lived birds usually have successful breeding seasons alternating with less successful ones.



Shoveler *Anas clypeata* Skedand (2; 1; 3; Sw. Red List)
One pair bred successfully in Fiskarfjärden and two pairs were present in Kallrigafjärden. Not registered in 2002.



Honey Buzzard *Pernis apivorus* Bivråk (3; 1; 4; Sw. Red List; EU Annex 1)
Two territories are situated completely within the regional model area. One of these also reaches into the candidate area. Two more territories are found along the borders of the regional model area, with parts of the territories also outside of this. No successful breeding recorded in 2003. One of the pairs produced one young in 2002. This is a nationally declining species that needs special attention. Breeding success is reported to be low throughout the country.

White-tailed eagle *Haliaeetus albicilla* Havsörn (Global Red List, Sw. Red List; EU Annex 1)

Background

The white-tailed eagle is one of the bird species that has suffered most from pollution in Sweden and in large parts of Europe. The Baltic population was among the ones most severely affected and was on the brink of extinction in the early 1970's. Retrospective analyses have shown that the effects of, mainly organo-chloric, pollutants can be traced back as early as to the beginning of the 1950's, resulting in a significant decline in number of produced young. The number of breeding attempts resulting in at least one fledged young decreased from 72 % before the 1950's to on average only 23% during the period 1966–1982. The successful broods during this period also contained only one juvenile compared to the normal level of two juveniles/brood. As white-tailed eagles normally have a high adult survival and hence reach an old age, the effects of decreasing reproductive success on overall population size will not be evident until after quite a long time. The problem for the eagles was hence not found until about ten years after it originally appeared. The population along the Swedish coast of the Baltic was halved from the 1950's to the 1970's, when only about 50 pairs remained. The majority of these birds were however not capable of producing young and the effective part of the population (the ones actually reproducing) was less than half of the overall population size (i.e. < 25 pairs). The age structure within the population was at this time very skewed with a high dominance of adult birds.

During the first half of the 1970's, the use of organo-chloric substances such as PCB and DDT was restricted and/or banned. The concentrations of these substances decreased in biota, but it was not until the 1980's that the first signs of an increase in the reproductive ability in white-tailed eagles appeared. The reason for this delay was partly because the concentrations of DDE (from DDT) in the eagles were many times higher than the critical level when reproductive disturbances appear, and partly because many old individuals had chronic toxications. The decreasing levels did thus not really help. The increase in reproductive output from the 1980's onwards depends on recruitment of new birds not exposed to the high levels of organic chloride compounds occurring previously. The proportion of successful breeding attempts reached the same level as before 1950 by the end of the 1990's. The brood sizes are however still significantly lower than during the reference level (before 1950), probably as a result of a certain amount of PCB-effects still lingering on.

Surveys

The white-tailed eagle has been surveyed nationally since the mid-1960's through Svenska Naturskyddsföreningen, and from 1971 onwards within the framework of 'Projekt Havsörn'. The studies of the reproductive output of white-tailed eagles are part of the Swedish Environmental Protection Agency's National Monitoring Program (programområde Hav, projekt Marina toppkonsumenter) since 1989. Results from this programme are produced yearly in reports from the Marine Research Centre in Stockholm.

The survey is made in two steps. First nests are surveyed in March–April to see if they are occupied or not (aerial surveys or long-distance observations, no visit to nests are made at this time). Then the breeding results are surveyed in May–June with nest visits, ringing of young birds etc).

Results, Forsmark 2003

Breeding success was remarkably low in 2002 within the SKB-area at Forsmark, most probably as a result of disturbance from the intense human activities in the area (see Green 2003). In 2003, the outcome was again much lower in Forsmark than in previous years, and in the reference areas, see Table 5-1. The possible influence of disturbance from the site investigations as a reason behind the poor success is difficult to evaluate this year, however, since one occupied nest fell down during the incubation period and it cannot be ascertained whether that breeding attempt would have failed or not if the nest had survived. A strong gale on April 5 also spoiled an occupied nest in one of the reference areas, but on a survey flight on April 8 all occupied nests in the Forsmark area were still intact with adults in an incubating position. It will take several years to evaluate the magnitude of an impact from the activities in the Forsmark area on the breeding success of the eagles.

Table 5-1. Per cent successfully breeding pairs of white-tailed eagle in 2003, 2002 and 1998–2001 in Forsmark and two reference areas north and south of Forsmark respectively (N = number of checked breeding attempts during the time period 1998–2003).

Area	2003	2002	1998–2001	N
Forsmark	33	25	85	20
Reference S	80	100	79	29
Reference N	67	83	72	30

Marsh harrier *Circus aeruginosus* Brun kärrhök (3; 0; 3; EU Annex 1).
Three pairs present in 2003, the species was not covered sufficiently in 2002 to allow any comparison. At least two of the pairs in 2003 produced five (3+2) young, so breeding success was good.

Osprey *Pandion haliaetus* Fiskgjuse (6; 0; 6; EU Annex 1)
Six breeding attempts recorded in 2003. The species was not fully covered in 2002, but three successful breedings were recorded then and the population size was estimated to 6–8 pairs within the regional model area. Of the three successful nests recorded in 2002, one was destroyed, probably by strong winds, between 2002 and 2003, one was unoccupied in 2003, and in the third the breeding attempt in 2003 failed for unknown reasons. Overall breeding success in 2003 was moderate with in total three failed attempts and three successful nests, yielding five fledged young (2+2+1). Occupancy of nests seems to differ quite a lot between years in the area, probably due to competition with the eagles.

Goshawk *Accipiter gentilis* Duvhök (1; 0; 1; Not listed)
One nest site is known (successful breeding in both 2002 and 2003, three large young in the latter year). There could be more territories as the Goshawk is quite secretive during the breeding season.

Sparrowhawk *Accipiter nisus* Sparvhök (2; 2; >4; Not listed)
At least four territories. This species is also notoriously difficult to census due to its secretive habits. In many areas of southern Sweden this is the most common breeding raptor, and it is likely that the true number of territories is higher than shown here, probably equalling the numbers found in Buzzard (cf. Buzzard below). Nothing is known about breeding success in any of the years.

Buzzard *Buteo buteo* Ormvråk (8; 1; 9; Not listed)
The most widespread and common raptor in the area. At least nine territories are known, but it is possible that one or two more exist. Six successful breedings in 2003 yielding nine juveniles (2+2+2+1+1+1) indicate a good breeding success in this year. There are no indications of any change in numbers between the years.

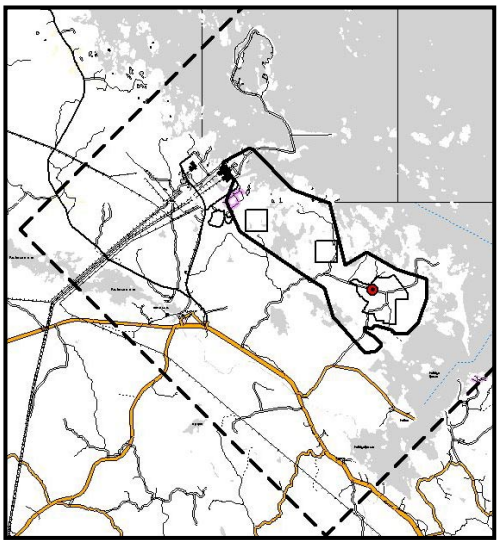
Hobby *Falco subbuteo* Lärkfalk (4; 0; 4; Not listed)
At least four territories. Nothing is known about breeding success.

Black grouse *Tetrao tetrix* Orre (10; 6; 16; EU Annex 1)
16 lekking cocks found in 2003. Not covered well in 2002, but the general impression is that more birds were present in 2003 compared to 2002, especially within the candidate area. No confirmed breeding in 2003 (one in 2002) but hens were observed at several sites.

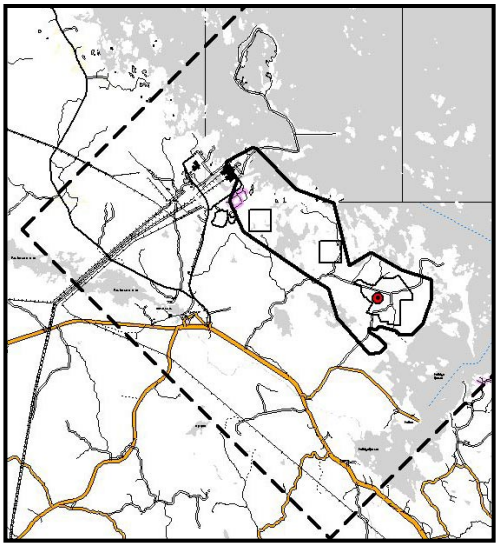
Capercaillie *Tetrao urogallus* Tjäder (6; 0; 6–10; EU Annex 1)
Occurs within three parts of the regional model area, the numbers above refer to the number of observed males. Breeding confirmed in both 2002 and 2003. Did occur also within the candidate area in 2002 (including one hen with chicks) but was not observed in those parts in 2003.

Hazelhen *Bonasia bonasia* Järpe (2; 0; ?; EU Annex 1)
The breeding territory in the candidate area that produced young in 2002 was vacant in 2003. Birds were observed in two territories in the regional model area. Surely not a common bird but still there must be more hazelhens than this in the area.

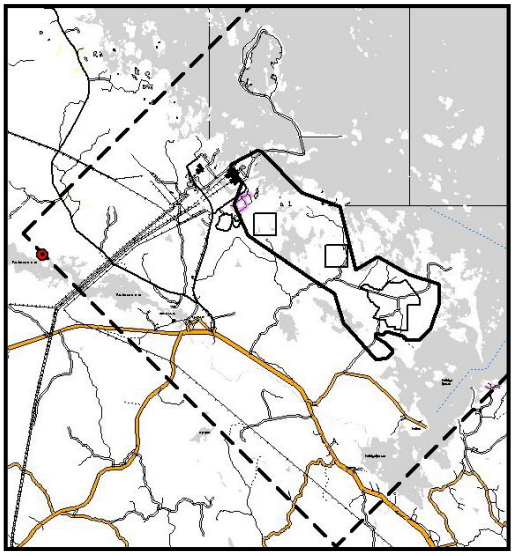
Quail *Coturnix coturnix* Vaktel (0; 1; 1; Sw. Red List)
One male heard at Storskäret in 2003. In 2002 two birds were heard and breeding confirmed later during the summer at the same site.



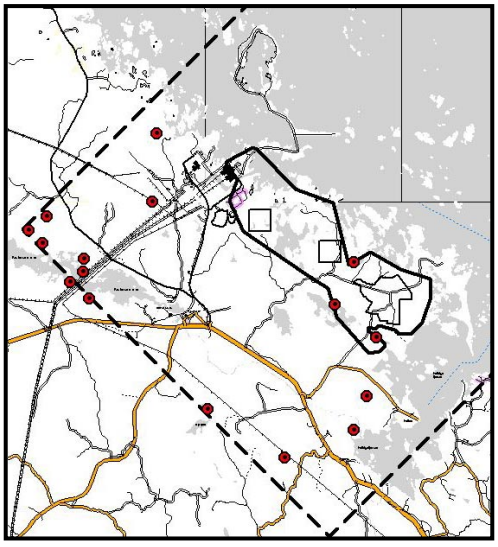
Corncrake *Crex crex* Kornknarr (0; 1; 1; Global Red List, Sw. Red List; EU Annex 1)
One male heard at Storskäret during the initial part of the summer. It is most likely that the bird was solitary but breeding can not be excluded. No corncrakes were recorded in 2002.



Spotted Crake *Porzana porzana* Småfläckig sumphöna (1; 0; 1; Sw. Red List; EU Annex 1)
One male heard just on the border of the regional model area. Three males were heard in 2002. Numbers fluctuate greatly between years and in really good years up to 5–10 males may be present.



Crane *Grus grus* Trana (13; 3; 16; EU Annex 1)
Well spread over the area with pairs in most suitable places. Two territories (birds present in 2002) along the borders of the candidate area were unoccupied in 2003, one of these in close contact with drilling site 4, Gällsboträsket. Otherwise the total number of pairs was similar between the two years. Several pairs were seen with young during late summer in 2003 although no special effort was made to census breeding success.



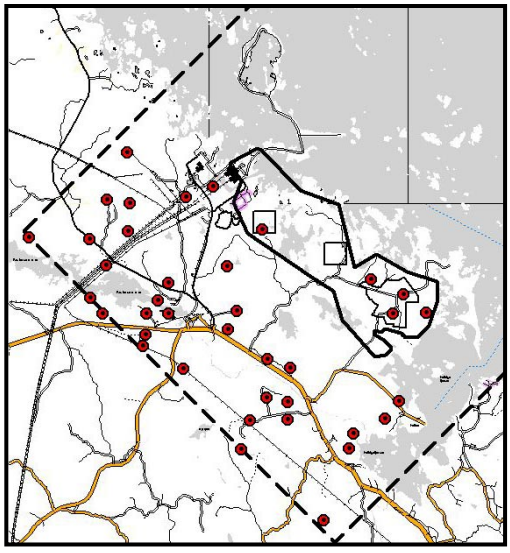
Pygmy Owl *Glaucidium passerinum* Sparvuggla (10; 3; 13, EU Annex 1)
At least 13 territories well spread over the area. Nothing is known about breeding results in 2003, but in 2002 two successful breedings were registered (2+1 young). Nothing indicates any change in numbers between the years.

Tengmalms' owl *Aegolius funerus* Pärluggla (0; 0; ?; EU Annex 1)
No birds observed in 2003, one male was heard in 2002 and in earlier years a few more territories existed. Is said to be regionally declining on a larger scale and seems not to occur within the regional model area any more for unknown reasons.

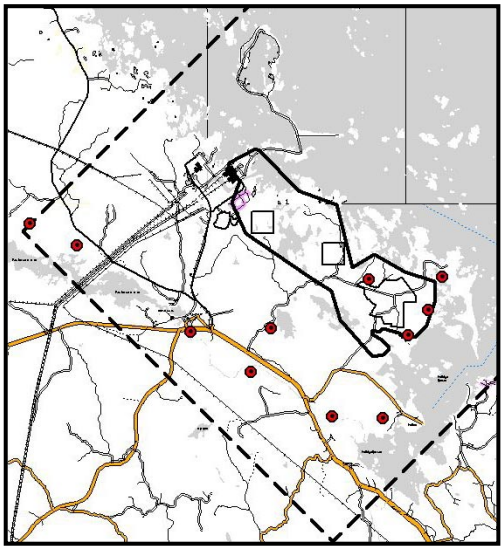
Ural owl *Strix uralensis* Slaguggla (4; 0; 4; Sw. Red List; EU Annex 1)
The same four territories were occupied in both 2002 and 2003. Only one of the territories is situated completely within the regional model area. The three others are situated along the borders with parts both inside and outside the regional model area. While none of the pairs bred successfully in 2002, three of them produced young in 2003 (2+1+1 juveniles).

Tawny Owl *Strix aluco* Kattuggla (6; 5; 11; Not listed)
At least 11 territories. Three broods recorded in 2003 (none in 2002), but breeding success was not monitored in detail.

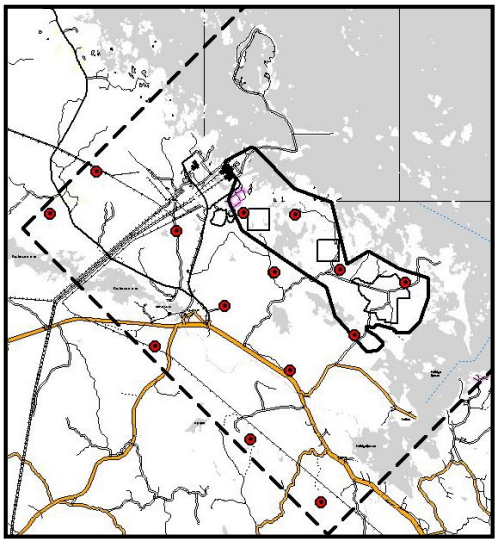
Wryneck *Jynx torquila* Göktyta (33; 5; 40; Sw. Red List)
Occurs in high densities throughout the area. Not covered well enough in 2002 to allow any direct comparison in number of territories between the years, but nothing indicates any decline from 2002 to 2003, rather the contrary. A nationally declining species where Forsmark holds high numbers and where the local trend does not seem to follow the national one.



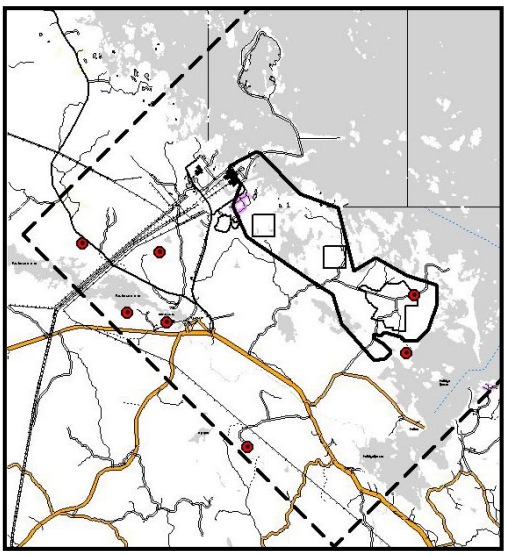
Lesser spotted woodpecker *Dendrocopus minor* Mindre hackspett (8; 3; 11; Sw. Red List)
Eleven territories. Forsmark holds high densities of this vulnerable species. No indications of any decline in numbers between 2002 and 2003, in contrast to the national trend of the species.



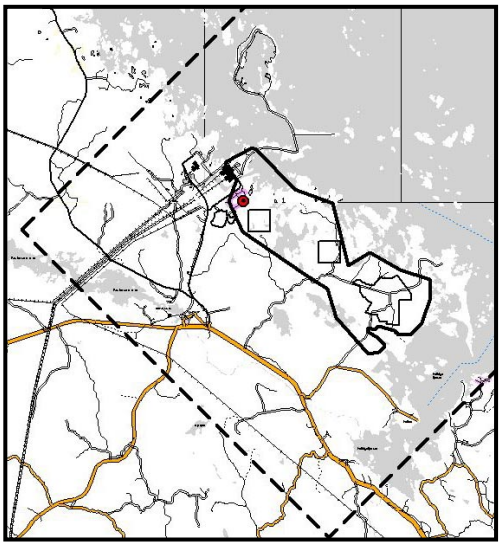
Black woodpecker *Dryocopus martius* Spillkråka (9; 5; 14; EU Annex 1)
Evenly spread over the whole regional model area. A species where we probably have a very good overview of its present status. The large increase in numbers of reported estimated territories compared to 2002 (cf. Green 2003) depends on that the species was surveyed in a much better way early in the season in 2003, and not on an increase in true numbers.



Stock dove *Columba oenas* Skogsduva (6; 1; 7; Sw. Red List)
The number of recorded territories was similar between the two years. The stock dove is declining on the national level.

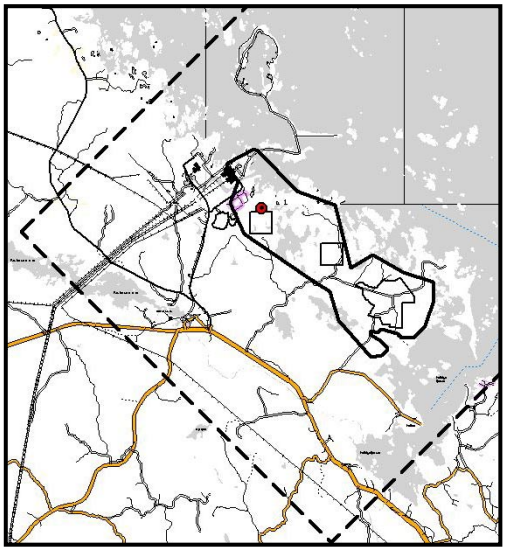


Wood lark *Lullula arborea* Trädlärka (0; 1; 1; EU Annex 1)
Not recorded in 2002, but present close to the nuclear power plant in 2003. Wood larks have occurred around the power plant in many years in low numbers.

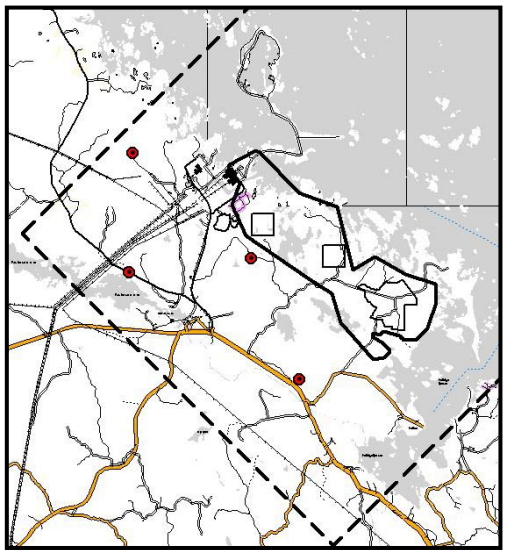


Greenish Warbler *Phylloscopus trochiloides* Lundsångare (0; 0; ?; Sw. Red List)
One singing male heard in 2002. No records in 2003 (and hence no map is shown). Even though it is possible that this bird was just temporarily occurring in the area, one can not exclude the possibility of breeding attempts for this species. Breeding has been confirmed in nearby areas along the coast in recent years.

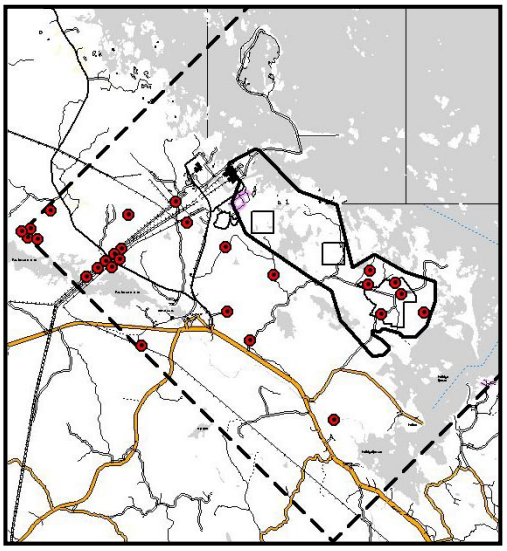
Red-breasted Flycatcher *Ficedula parva* Mindre flugsnappare (0; 1; ?; Sw. Red List, EU Annex 1)
One singing male recorded in 2003. As for the greenish warbler it may have been just a single male, but one can not exclude that breeding may occur.



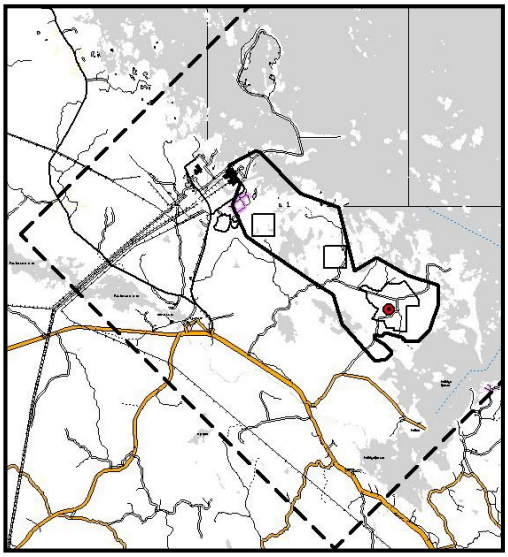
Nutcracker *Nucifraga caryocatactes* Nötkråka (4; 0; 4, Sw. Red List)
At least four territories spread out over the area. This species is quite secretive during the breeding season but the given picture probably reflects the true distribution fairly well. No indications of any decrease in numbers between 2003 and 2002.



Red-backed shrike *Lanius collurio* Törnskata (21; 6; >30; EU Annex 1).
27 territories found and it is likely that the true number exceeds 30. No indications of any decrease in numbers between 2003 and 2002. As for a couple of other species, this is a nationally declining species where the local trend in Forsmark seems to differ from the national trend.



Ortolan Bunting *Emberiza hortulana* Ortolansparv (Sw. Red List; EU Annex 1)
Present in the same territory at Storskäret during both years. Has decreased greatly on the national level.



6 Discussion

The present report is the first trying to evaluate any effects from the ongoing site investigations on the breeding bird fauna in Forsmark. The site investigations started in larger scale during 2002, and the bird surveys started in the same year. Hence, no 'pre site investigation' base-line studies were made in order to establish the bird fauna conditions before the investigations started. However, the general level of possibly disturbing activities (from the birds' point of view) was much higher in 2003 compared to 2002. What kind of effects are the site investigations likely to have on the breeding birds? In areas where drilling sites are established, roads are constructed etc, there is of course a certain loss of habitat, preventing birds from using these for breeding in a way they possibly did before. These areas are however small and any such effect is probably negligible. More important is probably the general increase in human activities in the area and especially around the drilling sites. Long-lasting human presence in previously undisturbed areas may cause breeding birds, especially sensitive species, to abandon such areas altogether. If this should be the case, one would expect decreases in breeding bird numbers in the areas most heavily affected, i.e. were most activities are made. More short-lasting human presence in a breeding area could affect breeding success, as the likelihood of losses of eggs or young through cold, bad weather in general or predators increase with time spent away from the nest by the adults. Effects may also be different at different time scales. At this stage, in this report, one can only evaluate short-time effects. For most species we cannot monitor breeding success (for practical reasons), but if breeding success is decreased by too high levels of disturbance, effects on the population level (numbers) are likely to lag behind. In order to evaluate any long-term effects it is necessary to carry on monitoring for a much longer period than covered here (as long as the site investigations are lasting, and preferably some time after they have been finished). Finally, different species may be affected in different ways. Among the breeding birds, some species are tolerant to disturbances while others are more sensitive. Some need only small areas to conduct a successful breeding, others need vast areas that are relatively undisturbed. In other words, the effects are not likely to be the same for all breeding birds.

In this report one can only scratch at the surface of things and the aim here is to answer the following questions:

- Was there any general difference (decrease or increase) in bird numbers between the relatively undisturbed 2002 and more disturbed 2003?
- Were there any signs of that bird distribution is affected by the most intense parts of the site investigation (i.e. at the drilling sites)?
- Are there any signs of that specific species are affected more (or less) than others? If so, which ones? Here the focus is placed on species listed in the Swedish Red List and/or the EU Birds Directive.

Finally, the question about what could be done within the site investigations to mitigate negative effects for some especially sensitive species is addressed.

Neither the line transects and point counts nor the territory mapping approach showed any general decrease in breeding bird numbers between 2002 and 2003. Absolute bird numbers registered during the line transects were similar in both years. Bird numbers registered during the point counts were even higher in 2003 compared to 2002. Both methods showed that some species were registered in higher numbers in the latter year while others were registered in lower numbers, and there was no overall significant difference in this respect.

In the territory mapping areas 1 and 2 (Barackbyn and Jungfruholm), the number of breeding species and bird territories were fairly stable between the two years, despite the difference in expected disturbance level between the two areas. At Barackbyn drilling was conducted during the breeding season in 2002 while Jungfruholm was undisturbed that year. In territory mapping area 3 (Storskäret) the number of breeding species and bird territories even tended to increase from the undisturbed 2002 to 2003 when drilling was conducted during the breeding season. The conclusion from these results must be that the activities within the site investigations do not cause any immediate, short-time negative effects on the general bird fauna. Both species- and territory numbers seem to remain the same irrespective of the ongoing activities. Whether this also holds in a more long-time perspective remains to be shown.

Within the territory mapping areas, nothing indicated that the breeding birds avoided the most heavily disturbed parts close to the drilling sites. The geographical distributions of bird territories were similar between the two years in all three areas. This does further emphasise the conclusion above, that regarding the general bird fauna, there are no short-term negative effects from the activities of the site investigations in terms of decreasing bird numbers or changes in the distribution.

Any deeper analyses at the species level are not yet possible, as the bird surveys have only just been started. The results obtained for listed species may however indicate certain differences in the reaction of different species. Both the line transect data and the territory mapping data indicate that some listed species are negatively affected, probably by the general increase in human activities within the area. Capercaillie (tjäder) and hazelhen (järpe) disappeared from the territory mapping areas between the years (two and one territory of these species, respectively, were registered in 2002). Both species are probably sensitive to too high levels of disturbance and may simply avoid such areas. The third ‘forest-hen’, the black cock (orre), on the other hand does not seem to be negatively affected at all. More black cocks were registered inside the candidate area in 2003 compared to 2002, and the number of territories within the mapping areas were also slightly higher in 2003. Also for other listed species, there seem to be no general effects at all from the activities of the site investigations. Species such as wryneck (göktyta) and red-backed shrike (törnskata) both bred in relatively close contact with active drilling sites, and no indications of any decrease in numbers were registered. Also when looking in at a larger scale, into the whole regional model area, there was no general difference in numbers of birds of listed species.

More worrying is the low reproductive output for the white-tailed eagle (havsörn). Breeding results of this species in Forsmark have been much lower in 2002 and 2003 than in earlier years (and compared to reference areas surrounding the Forsmark area during the same seasons). Even though the data set is small and not statistically treated, it is hard to see any other explanation for the low breeding output in Forsmark in recent years than the increase in human activities. White-tailed eagles are known to be sensitive around their nesting sites and if disturbed at critical stages of the breeding cycle, the breeding attempt may fail. Admittedly there is a large individual difference between pairs in their tolerance towards human presence in their neighbourhood, but as we are talking about a species recognised as globally threatened, a careful approach is desirable. Special efforts have been made to leave the eagles undisturbed in 2002 and 2003, but this has not worked out perfectly well. Direct disturbances have despite this occurred during both years. Avoiding direct disturbances at nest sites is a necessary first step towards a hopefully regained, normal breeding output for the eagles. In order to achieve this, the planning of the site investigation should be improved in such a way as to reduce the disturbance of the vulnerable species to a minimum during the critical periods of the year. To achieve this, it is necessary to inform everybody involved in field activities of all the restrictions that the site investigation management may decide for protection of the bird fauna. In the end, it is also a personal responsibility of the people involved to see to that the guidelines they receive are followed.

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http://www.biol.lu.se/zooekologi/birdmonitoring

http://www.environ.se

Appendix A

List of all bird species in Sweden

Table A-1. List of all bird species breeding in Sweden with Latin, Swedish and English names

Latin-Genus	Latin-species	Swedish	English
Clangula	*hyemalis*	Alfågel	Long-tailed Duck
Riparia	*riparia*	Backsvala	Sand Martin
Aythya	*marila*	Bergand	Scaup
Fringilla	*montifringilla*	Bergfink	Brambling
Bubo	*bubo*	Berguv	Eagle Owl
Pernis	*apivorus*	Bivråk	Honey Buzzard
Turdus	*pilaris*	Björktrast	Fieldfare
Circus	*cyaneus*	Blå kärrhök	Hen Harrier
Parus	*caeruleus*	Blåmes	Blue Tit
Anas	*penelope*	Bläsand	Wigeon
Fringilla	*coelebs*	Bofink	Chaffinch
Aythya	*ferina*	Brunand	Pochard
Circus	*aeruginosus*	Brun kärrhök	Marsh Harrier
Saxicola	*rubetra*	Buskskvätta	Whinchat
Acrocephalus	*dumetorum*	Busksångare	Blyth's Reed Warbler
Pyrrhula	*pyrrhula*	Domherre	Bullfinch
Actitis	*hypoleucos*	Drillsnäppa	Common Sandpiper
Turdus	*viscivorus*	Dubbeltrast	Mistle Thrush
Accipiter	*gentilis*	Duvhök	Goshawk
Larus	*minutus*	Dvärgmås	Little Gull
Somateria	*mollissima*	Ejder	Ejder
Gallinago	*gallinago*	Enkelbeckasin	Common Snipe
Parus	*palustris*	Entita	Marsh Tit
Phasianus	*colchicus*	Fasan	Pheasant
Pandion	*haliaetus*	Fiskgjuse	Osprey
Larus	*canus*	Fiskmås	Common Gull
Sterna	*hirundo*	Fisktärna	Common Tern
Locustella	*fluviatilis*	Flodsångare	River Warbler
Motacilla	*cinerea*	Forsärla	Grey Wagtail
Milvus	*milvus*	Glada	Red Kite
Tadorna	*tadorna*	Gravand	Shelduck
Phylloscopus	*collybita*	Gransångare	Chiffchaff
Muscicapa	*striata*	Grå flugsnappare	Spotted Flycatcher
Anser	*anser*	Grågås	Greylag Goose
Carduelis	*flammea*	Gråsiska	Redpoll
Passer	*domesticus*	Gråsparv	House Sparrow
Picus	*canus*	Gråspett	Grey-headed Woodpecker
Larus	*argentatus*	Gråtrut	Herring Gull
Anas	*platyrhynchos*	Gräsand	Mallard
Locustella	*naevia*	Gräshoppsångare	Grashopper Warbler

Latin-Genus	Latin-species	Swedish	English
Tringa	*glareola*	Grönbena	Wood Sandpiper
Carduelis	*chloris*	Grönfink	Greenfinch
Picus	*viridis*	Gröngöling	Green Woodpecker
Carduelis	*spinus*	Grönsiska	Siskin
Phylloscopus	*sibilatrix*	Grönsångare	Wood Warbler
Emberiza	*citrinella*	Gulsparv	Yellowhammer
Motacilla	*flava*	Gulärla	Yellow Wagtail
Troglodytes	*troglodytes*	Gärdsmyg	Wren
Cuculus	*canorus*	Gök	Cuckoo
Jynx	*torquilla*	Göktyta	Wryneck
Larus	*marinus*	Havstrut	Great Black-backed Gull
Haliaeetus	*albicilla*	Havsörn	White-tailed Eagle
Asio	*otus*	Hornuggla	Long-eared Owl
Delichon	*urbica*	Hussvala	House Martin
Ardea	*cinerea*	Häger	Grey Heron
Carduelis	*cannabina*	Hämpling	Linnet
Hippolais	*icterina*	Härmsångare	Icterine Warbler
Sylvia	*nisoria*	Höksångare	Barred Warbler
Bonasia	*bonasia*	Järpe	Hazel Grouse
Prunella	*modularis*	Järnsparv	Dunnock
Corvus	*monedula*	Kaja	Jackdaw
Branta	*canadensis*	Kanadagås	Canada Goose
Strix	*aluco*	Kattuggla	Tawny Owl
Sterna	*sandvicensis*	Kentsk tärna	Sandwich Tern
Bucephala	*clangula*	Knipa	Goldeneye
Cygnus	*olor*	Knölsvan	Mute Swan
Turdus	*merula*	Koltrast	Blackbird
Crex	*crex*	Kornknarr	Corncrake
Corvus	*corax*	Korp	Raven
Anas	*crecca*	Kricka	Teal
Corvus	*corone cornix*	Kråka	Hooded Crow
Alcedo	*atthis*	Kungsfiskare	Kingfisher
Regulus	*regulus*	Kungsfågel	Goldcrest
Aquila	*chrysaetos*	Kungsörn	Golden Eagle
Acrocephalus	*palustris*	Kärrsångare	Marsh Warbler
Stercorarius	*parasiticus*	Labb	Arctic Skua
Hirundo	*rustica*	Ladusvala	Swallow
Strix	*nebulosa*	Lappuggla	Great Grey Owl
Phylloscopus	*trochiloides*	Lundsångare	Greenish Warbler
Falco	*subbuteo*	Lärkfalk	Hobby
Phylloscopus	*trochilus*	Lövsångare	Willow Warbler
Dendrocopos	*medius*	Mellanspett	Middle Spotted Woodpecker
Ficedula	*parva*	Mindre flugsnappare	Red-breasted Flycatcher
Dendrocopos	*minor*	Mindre hackspett	Lesser Spotted Woodpecker
Loxia	*curvirostra*	Mindre korsnäbb	Crossbill
Charadrius	*dubius*	Mindre strandpipare	Little Ringed Plover
Scolopax	*rusticola*	Morkulla	Woodcock
Caprimulgus	*europaeus*	Nattskärra	Nightjar
Luscinia	*luscinia*	Näktergal	Thrush Nightingale

Latin-Genus	Latin-species	Swedish	English
Nucifraga	*caryocatactes*	Nötkråka	Nutcracker
Garrulus	*glandarius*	Nötskrika	Jay
Sitta	*europaea*	Nötväcka	Nuthatch
Buteo	*buteo*	Ormvråk	Buzzard
Tetrao	*tetrix*	Orre	Black Grouse
Emberiza	*hortulana*	Ortolansparv	Ortolan Bunting
Passer	*montanus*	Pilfink	Tree Sparrow
Aegolius	*funereus*	Pärluggla	Tengmalm's Owl
Perdix	*perdix*	Rapphöna	Partridge
Columba	*palumbus*	Ringduva	Woodpigeon
Carpodacus	*erythrinus*	Rosenfink	Rosefinch
Arenaria	*interpres*	Roskarl	Turnstone
Tringa	*totanus*	Rödbena	Redshank
Erithacus	*rubecula*	Rödhake	Robin
Phoenicurus	*phoenicurus*	Rödstjärt	Redstart
Turdus	*iliacus*	Rödvingetrast	Redwing
Botaurus	*stellaris*	Rördrom	Bittern
Gallinula	*chloropus*	Rörhöna	Moorhen
Acrocephalus	*scirpaceus*	Rörsångare	Reed Warbler
Larus	*fuscus*	Silltrut	Lesser Black-backed Gull
Sterna	*paradisaea*	Silvertärna	Arctic Tern
Pica	*pica*	Skata	Magpie
Anas	*clypeata*	Skedand	Shoveler
Columba	*oenas*	Skogsduva	Stock Dove
Tringa	*ochropus*	Skogssnäppa	Green Sandpiper
Panurus	*biarmicus*	Skäggmes	Bearded Tit
Larus	*ridibundus*	Skrattmås	Black-headed Gull
Sterna	*caspia*	Skräntärna	Carpian Tern
Podiceps	*cristatus*	Skäggdopping	Great Crested Grebe
Anthus	*petrosus*	Skärpiplärka	Rock Pipit
Strix	*uralensis*	Slaguggla	Ural Owl
Tachybaptus	*ruficollis*	Smådopping	Little Grebe
Mergus	*serrator*	Småskrake	Red-breasted Merganser
Porzana	*porzana*	Småfläckig sumphöna	Spotted Crake
Sterna	*albifrons*	Småtärna	Little Tern
Anas	*strepera*	Snatterand	Gadwall
Fulica	*atra*	Sothöna	Coot
Accipiter	*nisus*	Sparvhök	Sparrow Hawk
Glaucidium	*passerinum*	Sparvuggla	Pygmy Owl
Anser	*brachyrhynchus*	Spetsbergsgås	Pink-footed Goose
Dryocopus	*martius*	Spillkråka	Black Woodpecker
Sturnus	*vulgaris*	Stare	Starling
Carduelis	*carduelis*	Steglits	Goldfinch
Coccothraustes	*coccothraustes*	Stenknäck	Hawfinch
Oenanthe	*oenanthe*	Stenskvätta	Wheatear
Anas	*acuta*	Stjärtand	Pintail
Aegithalos	*caudatus*	Stjärtmes	Long-tailed Tit
Gavia	*arctica*	Storlom	Black-throated Diver
Phalacrocorax	*carbo*	Storskarv	Cormorant

Latin-Genus	Latin-species	Swedish	English
Mergus	*merganser*	Storskrake	Goosander
Numenius	*arquata*	Storspov	Curlew
Haematopus	*ostralegus*	Strandskata	Oystercatcher
Cinclus	*cinclus*	Strömstare	Dipper
Dendrocopos	*major*	Större hackspett	Great Spotted Woodpecker
Loxia	*pytyopsittacus*	Större korsnäbb	Parrot Crossbill
Charadrius	*hiaticula*	Större strandpipare	Ringed Plover
Ficedula	*hypoleuca*	Svartvit flugsnappare	Pied Flycatcher
Podiceps	*auritus*	Svarthakedopping	Slavonian Grebe
Sylvia	*atricapilla*	Svarthätta	Blackcap
Parus	*ater*	Svartmes	Coal Tit
Chlidonias	*niger*	Svarttärna	Black Tern
Melanitta	*fusca*	Svärta	Velvet Scoter
Alauda	*arvensis*	Sånglärka	Skylark
Motacilla	*alba*	Sädesärla	White Wagtail
Emberiza	*schoeniclus*	Sävsparv	Reed Bunting
Acrocephalus	*schoenobaenus*	Sävsångare	Sedge Warbler
Parus	*major*	Talgoxe	Great Tit
Parus	*montanus*	Talltita	Willow Tit
Turdus	*philomelos*	Taltrast	Song Thrush
Columba	*livia*	Tamduva	Feral Pigeon
Tetrao	*urogallus*	Tjäder	Capercaillie
Cepphus	*grylle*	Tobisgrissla	Black Guillemot
Parus	*cristatus*	Tofsmes	Crested Tit
Vanellus	*vanellus*	Tofsvipa	Lapwing
Falco	*tinnunculus*	Tornfalk	Kestrel
Alca	*torda*	Tordmule	Razorbill
Apus	*apus*	Tornseglare	Swift
Grus	*grus*	Trana	Crane
Acrocephalus	*arundinaceus*	Trastsångare	Great Reed Warbler
Picoides	*tridactylus*	Tretåig hackspett	Three-toed Woodpecker
Certhia	*familiaris*	Trädkrypare	Treecreeper
Lullula	*arborea*	Trädlärka	Wood Lark
Anthus	*trivialis*	Trädpiplärka	Tree Pipit
Sylvia	*borin*	Trädgårdssångare	Garden Warbler
Streptopelia	*decaocto*	Turkduva	Collared Dove
Streptopelia	*turtur*	Turturduva	Turtle Dove
Lanius	*collurio*	Törnskata	Red-backed Shrike
Sylvia	*communis*	Törnsångare	Whitethroat
Coturnix	*coturnix*	Vaktel	Quail
Lanius	*excubitor*	Varfågel	Great Grey Shrike
Rallus	*aquaticus*	Vattenrall	Water Rail
Aythya	*fuligula*	Vigg	Tufted Duck
Carduelis	*flavirostris*	Vinterhämpling	Twite
Dendrocopos	*leucotos*	Vitryggig hackspett	White-backed Woodpecker
Anas	*querquedula*	Årta	Garganey
Circus	*pygargus*	Ängshök	Montagu's Harrier
Anthus	*pratensis*	Ängspiplärka	Meadow Pipit
Sylvia	*curruca*	Ärtsångare	Lesser Whitethroat

Appendix B

Total numer of birds registered during the line transects

Table B-1. Total number of birds registered during the line transects in the candidate area in Forsmark 2002–2003. English and Swedish names are presented. Listed species in bold text. Densities (no. birds/km) are shown for both years. Due to a misunderstanding, white-tailed eagles were not counted during the line transects in 2002.

Species	No. of birds 2002	No. of birds 2003	No. of birds/km 2002	No. of birds/km 2003
Cormorant, Storskarv	500	0	11.74	0.00
Chaffinch, Bofink	484	617	11.36	13.27
Willow warbler, Lövsångare	482	401	11.31	8.62
Siskin, Grönsiska	152	84	3.57	1.81
Robin, Rödhake	151	188	3.54	4.04
Greylag goose, Grågås	113	137	2.65	2.95
Blackbird, Koltrast	105	105	2.46	2.26
Song thrush, Taltrast	77	178	1.81	3.83
Yellowhammer, Gulsparv	67	70	1.57	1.51
Common gull, Fiskmås	58	190	1.36	4.09
Jackdaw, Kaja	55	153	1.29	3.29
Mute swan, Knölsvan	54	23	1.27	0.49
Great tit, Talgoxe	54	62	1.27	1.33
Garden warbler, Trädgårdssångare	45	60	1.06	1.29
Wood pigeon, Ringduva	43	49	1.01	1.05
Black-headed gull, Skrattmås	41	19	0.96	0.41
Canada goose, Kanadagås	39	2	0.92	0.04
Pied flycatcher, Svartvit Flugsnappare	39	31	0.92	0.67
Tree pipit, Trädpiplärka	37	26	0.87	0.56
Goldeneye, Knipa	36	90	0.85	1.94
Wren, Gärdsmyg	33	33	0.77	0.71
Redwing, Rödvingetrast	32	91	0.75	1.96
Goosander, Storskrake	32	25	0.75	0.54
Dunnock, Järnsparv	30	39	0.70	0.84
Hooded crow, Kråka	30	37	0.70	0.80
Reed bunting Sävsparv	30	26	0.70	0.56
House martin, Hussvala	26	2	0.61	0.04
Blackcap, Svarthätta	24	41	0.56	0.88
Blue tit, Blåmes	23	12	0.54	0.26
Wood warbler, Grönsångare	23	14	0.54	0.30
Goldcrest, Kungsfågel	23	97	0.54	2.09
Lesser whitethroat, Ärtsångare	21	18	0.49	0.39
Skylark, Sånglärka	20	25	0.47	0.54
Sedge warbler, Sävsångare	19	11	0.45	0.24
Swift, Tornseglare	19	2	0.45	0.04

Species	No. of birds 2002	No. of birds 2003	No. of birds/km 2002	No. of birds/km 2003
White wagtail, Sädesärla	18	14	0.42	0.30
Starling, Stare	18	20	0.42	0.43
Whinchat, Buskskvätta	17	1	0.40	0.02
Chiffchaff, Gransångare	15	10	0.35	0.22
Lapwing, Tofsvipa	15	10	0.35	0.22
Crested tit, Tofsmes	14	17	0.33	0.37
Grey heron, Häger	13	7	0.31	0.15
Whooper swan, Sångsvan	**13**	**30**	**0.31**	**0.65**
Treecreeper, Trädkrypare	12	26	0.28	0.56
Greenfinch, Grönfink	10	19	0.23	0.41
Coal tit, Svartmes	10	31	0.23	0.67
Whitethroat, Törnsångare	10	17	0.23	0.37
Common snipe, Enkelbeckasin	9	16	0.21	0.34
Tufted duck, Vigg	9	64	0.21	1.38
Green sandpiper, Skogssnäppa	8	7	0.19	0.15
Mallard, Gräsand	7	19	0.16	0.41
Nuthatch, Nötväcka	7	2	0.16	0.04
Rosefinch, Rosenfink	7	14	0.16	0.30
Herring gull, Gråtrut	6	4	0.14	0.09
Greater black-backed gull, Havstrut	6	6	0.14	0.13
Raven, Korp	6	7	0.14	0.15
Fieldfare, Björktrast	5	6	0.12	0.13
Marsh tit, Entita	5	1	0.12	0.02
Swallow, Ladusvala	5	2	0.12	0.04
Redshank, Rödbena	5	3	0.12	0.06
Redstart, Rödstjärt	5	0	0.12	0.00
Willow tit, Talltita	5	13	0.12	0.28
Cuckoo, Gök	4	8	0.09	0.17
Arctic tern, Silvertärna	**4**	**5**	**0.09**	**0.11**
Common sandpiper, Drillsnäppa	3	3	0.07	0.06
Osprey, Fiskgjuse	**3**	**2**	**0.07**	**0.04**
Spotted flycatcher, Grå Flugsnappare	3	19	0.07	0.41
Icterine warbler, Härmsångare	3	8	0.07	0.17
Lesser spotted woodpecker, Mindre Hackspett	**3**	**2**	**0.07**	**0.04**
Oystercatcher, Strandskata	3	0	0.07	0.00
Bullfinch, Domherre	2	9	0.05	0.19
Hazelhen, Järpe	**2**	**0**	**0.05**	**0.00**
Woodcock, Morkulla	2	2	0.05	0.04
Red-breasted merganser, Småskrake	2	0	0.05	0.00
Black woodpecker, Spillkråka	**2**	**4**	**0.05**	**0.09**
Black-throated diver, Storlom	**2**	**1**	**0.05**	**0.02**
Feral pigeon, Tamduva	2	0	0.05	0.00
Meadow pipit, Ängspiplärka	1	0	0.02	0.00
Greenish warbler, Lundsångare	**1**	**0**	**0.02**	**0.00**
Jay, Nötskrika	1	4	0.02	0.09
Wheatear, Stenskvätta	1	3	0.02	0.06

Species	No. of birds 2002	No. of birds 2003	No. of birds/km 2002	No. of birds/km 2003
Great spotted woodpecker, Större Hackspett	1	7	0.02	0.15
Curlew, Storspov	**1**	**1**	**0.02**	**0.02**
Kestrel, Tornfalk	1	0	0.02	0.00
Crane, Trana	**1**	**4**	**0.02**	**0.09**
Three-toed woodpecker, Tretåig Hackspett	**1**	**0**	**0.02**	**0.00**
Mistle thrush, Dubbeltrast	0	3	0.00	0.06
Common tern, Fisktärna	**0**	**5**	**0.00**	**0.11**
Wryneck, Göktyta	0	2	0.00	0.04
White-tailed eagle, Havsörn	Not counted	6	Not counted	0.13
Corncrake, Kornknarr	0	1	0.00	0.02
Teal, Kricka	0	2	0.00	0.04
Crossbill, Mindre korsnäbb	0	9	0.00	0.19
Thrush nightingale, Näktergal	0	1	0.00	0.02
Nutcracker, Nötkråka	**0**	**1**	**0.00**	**0.02**
Buzzard, Ormvråk	0	2	0.00	0.04
Black grouse, Orre	**0**	**2**	**0.00**	**0.04**
Ortolan bunting, Ortolansparv	**0**	**1**	**0.00**	**0.02**
Bittern, Rördrom	**0**	**1**	**0.00**	**0.02**
Reed warbler, Rörsångare	0	22	0.00	0.47
Caspian tern, Skräntärna	**0**	**5**	**0.00**	**0.11**
Hawfinch, Stenknäck	0	4	0.00	0.09
Long-tailed tit, Stjärtmes	0	9	0.00	0.19
Parrot crossbill, Större korsnäbb	0	57	0.00	1.23
Red-backed shrike, Törnskata	**0**	**1**	**0.00**	**0.02**
Wood lark, Trädlärka	**0**	**1**	**0.00**	**0.02**
Total	**3326**	**3541**	**78.08**	**76.15**

Appendix C

Total number of birds registered during the point counts

Table C-1. Total number of birds registered during the point counts in the candidate area in Forsmark 2002–2003. Listed species in bold text. English and Swedish bird names are shown. Densities (no. of birds/point) are presented for both years. Due to a misunderstanding, white-tailed eagles (havsörn) were not counted during the point counts in 2002.

Species	No. of birds 2002	No. of birds 2003	No. of birds/ point 2002	No. of birds/ point 2003
Willow warbler, Lövsångare	111	96	1.91	1.50
Chaffinch, Bofink	92	150	1.59	2.34
Greylag goose, Grågås	86	75	1.48	1.17
Canada goose, Kanadagås	60	28	1.03	0.44
Siskin, Grönsiska	41	26	0.71	0.41
Robin, Rödhake	37	42	0.64	0.66
Great crested grebe, Skäggdopping	31	2	0.53	0.03
Mute swan, Knölsvan	29	11	0.50	0.17
Blackbird, Koltrast	27	41	0.47	0.64
Black-headed gull, Skrattmås	25	25	0.43	0.39
Common gull, Fiskmås	24	27	0.41	0.42
Song thrush, Taltrast	22	66	0.38	1.03
Yellowhammer, Gulsparv	21	32	0.36	0.50
Arctic tern, Silvertärna	**21**	**23**	**0.36**	**0.36**
Goldeneye, Knipa	18	86	0.31	1.34
Wood pigeon, Ringduva	17	21	0.29	0.33
Skylark, Sånglärka	14	9	0.24	0.14
Great tit, Talgoxe	14	18	0.24	0.28
Hooded crow, Kråka	13	18	0.22	0.28
Whooper swan, Sångsvan	**12**	**19**	**0.21**	**0.30**
Pied flycatcher, Svartvit flugsnappare	12	10	0.21	0.16
Wood warbler, Grönsångare	10	4	0.17	0.06
Reed bunting, Sävsparv	10	8	0.17	0.13
Red-breasted merganser, Småskrake	9	0	0.16	0.00
Blackcap, Svarthätta	9	12	0.16	0.19
Garden warbler, Trädgårdssångare	9	15	0.16	0.23
Wren, Gärdsmyg	8	11	0.14	0.17
Jackdaw, Kaja	8	1	0.14	0.02
Goosander, Storskrake	7	208	0.12	3.25
Crested tit, Tofsmes	7	6	0.12	0.09
Common tern, Fisktärna	**6**	**2**	**0.10**	**0.03**
Tree pipit, Trädpiplärka	6	7	0.10	0.11
Lesser whitethroat, Ärtsångare	5	6	0.09	0.09
Common snipe, Enkelbeckasin	5	3	0.09	0.05
Chiffchaff, Gransångare	5	6	0.09	0.09
Greenfinch, Grönfink	5	10	0.09	0.16

Species	No. of birds 2002	No. of birds 2003	No. of birds/ point 2002	No. of birds/ point 2003
Whitethroat, Törnsångare	5	6	0.09	0.09
Grey heron, Häger	4	2	0.07	0.03
Lapwing, Tofsvipa	4	2	0.07	0.03
Winchat, Buskskvätta	3	0	0.05	0.00
Common sandpiper, Drillsnäppa	3	3	0.05	0.05
Osprey, Fiskgjuse	**3**	**0**	**0.05**	**0.00**
Goldcrest, Kungsfågel	3	15	0.05	0.23
Swallow, Ladusvala	3	0	0.05	0.00
Redshank, Rödbena	3	2	0.05	0.03
Redwing, Rödvingetrast	3	20	0.05	0.31
Fieldfare, Björktrast	2	3	0.03	0.05
Bullfinch, Domherre	2	0	0.03	0.00
Mallard, Gräsand	2	7	0.03	0.11
Gret black-backed gull, Havstrut	2	2	0.03	0.03
House martin, Hussvala	2	2	0.03	0.03
Dunnock, Järnsparv	2	12	0.03	0.19
Raven, Korp	2	2	0.03	0.03
Redstart, Rödstjärt	2	0	0.03	0.00
Rosefinch, Rosenfink	2	12	0.03	0.19
White wagtail, Sädesärla	2	5	0.03	0.08
Starling, Stare	2	12	0.03	0.19
Goldfinch, Steglits	2	0	0.03	0.00
Crane, Trana	**2**	**0**	**0.03**	**0.00**
Marsh tit, Entita	1	0	0.02	0.00
Lesser spotted woodpecker, Mindre hackspett	**1**	**0**	**0.02**	**0.00**
Crossbill, Mindre korsnäbb	1	0	0.02	0.00
Jay, Nötskrika	1	3	0.02	0.05
Nuthatch, Nötväcka	1	1	0.02	0.02
Buzzard, Ormvråk	1	0	0.02	0.00
Sedge warbler, Sävsångare	1	3	0.02	0.05
Great spotted woodpecker, Större hackspett	1	1	0.02	0.02
Coal tit, Svartmes	1	13	0.02	0.20
Willow tit, Talltita	1	4	0.02	0.06
Swift, Tornseglare	1	2	0.02	0.03
Treecreeper, Trädkrypare	1	11	0.02	0.17
Blue tit, Blåmes	0	5	0.00	0.08
Cuckoo, Gök	0	7	0.00	0.11
Spotted flycatcher, Grå flugsnappare	0	2	0.00	0.03
Herring gull, Gråtrut	0	3	0.00	0.05
Icterine warbler, Härmsångare	0	2	0.00	0.03
White-tailed eagle, Havsörn	**Not counted**	**2**	**Not counted**	**0.03**
Corncrake, Kornknarr	**0**	**2**	**0.00**	**0.03**
Woodcock, Morkulla	0	1	0.00	0.02
Thrush nightingale, Näktergal	0	2	0.00	0.03
Black grouse, Orre	**0**	**2**	**0.00**	**0.03**

Species	No. of birds 2002	No. of birds 2003	No. of birds/ point 2002	No. of birds/ point 2003
Ortolan bunting, Ortolansparv	**0**	**2**	**0.00**	**0.03**
Reed warbler, Rörsångare	0	3	0.00	0.05
Lesser black-backed gull, Silltrut	**0**	**2**	**0.00**	**0.03**
Shoveler, Skedand	**0**	**1**	**0.00**	**0.02**
Green sandpiper, Skogssnäppa	0	4	0.00	0.06
Black-throated diver, Storlom	**0**	**2**	**0.00**	**0.03**
Parrot crossbill, Större korsnäbb	0	10	0.00	0.16
Ringed plover, Större strandpipare	0	2	0.00	0.03
Oystercatcher, Strandskata	0	1	0.00	0.02
Wood lark, trädlärka	**0**	**1**	**0.00**	**0.02**
Tufted duck, Vigg	0	71	0.00	1.11
Total	**908**	**1396**	**15.66**	**21.81**

Appendix D

Number of territories per bird species

Table D-1. Number of territories per bird species in territory mapping area 1: Barackbyn in 2002 and 2003. English and Swedish names are shown. Listed species in bold text.

Species	No. of territories 2002	No. of territories 2003	Change 2002–2003
Willow warbler, Lövsångare	32	29	–3
Chaffinch, Bofink	18	19	1
Robin, Rödhake	13	12	–1
Blackbird, Koltrast	6	5	–1
Goldcrest, Kungsfågel	5	6	1
Song thrush, Taltrast	5	4	–1
Siskin, Grönsiska	4	5	1
Dunnock, Järnsparv	4	5	1
Garden warbler, Trädgårdssångare	4	7	3
Lesser whitethroat, Ärtsångare	3	1	–2
Spotted flycatcher, Grå flugsnappare	3	3	0
Yellowhammer, Gulsparv	3	3	0
White wagtail, Sädesärla	3	2	–1
Pied flycatcher, Svartvit flugsnappare	3	1	–2
Great tit, Talgoxe	3	3	0
Willow tit, Talltita	3	2	–1
Crested tit, Tofsmes	3	3	0
Chiffchaff, Gransångare	2	0	–2
Mallard, Gräsand	2	0	–2
Reed bunting, Sävsparv	2	2	0
Green sandpiper, Skogssnäppa	2	2	0
Tree pipt, Trädpiplärka	2	2	0
Bullfinch, Domherre	1	0	–1
Common snipe, Enkelbeckasin	1	3	2
Wood warbler, Grönsångare	1	1	0
Goldeneye, Knipa	1	0	–1
Black grouse, Orre	1	2	1
Redstart, Rödstjärt	1	0	–1
Reed warbler, Rörsångare	1	3	2
Rosefinch, Rosenfink	1	0	–1
Goosander, Storskrake	1	0	–1
Blackcap, Svarthätta	1	0	–1
Capercaillie, Tjäder	1	0	–1
Wryneck, Göktyta	0	1	1
Hooded crow, Kråka	0	1	1
Woodcock, Morkulla	0	1	1
Wood pigeon, Ringduva	0	3	3
Redwing, Rödvingetrast	0	2	2

Species	No. of territories 2002	No. of territories 2003	Change 2002–2003
Coal tit, Svartmes	0	2	2
Whitethroat, Törnsångare	0	1	1
Treecreeper, Trädkrypare	0	2	2
Total no. of territories	**136**	**138**	**2**

Table D-2. Number of territories per bird species in territory mapping area 2: Jungfruholm in 2002 and 2003. English and Swedish names are shown. Listed species in bold text.

Species	No. of territories 2002	No. of territories 2003	Change 2002–2003
Chaffinch, Bofink	34	23	–11
Robin, Rödhake	16	14	–2
Willow warbler, Lövsångare	11	14	3
Goldcrest, Kungsfågel	9	9	0
Siskin, Grönsiska	7	7	0
Blackbird, Koltrast	6	7	1
Song thrush, Taltrast	5	9	4
Wren, Gärdsmyg	4	5	1
Coal tit, Svartmes	4	2	–2
Great tit, Talgoxe	4	5	1
Tree pipit, Trädpiplärka	4	2	–2
Yellowhammer, Gulsparv	3	1	–2
Redwing, Rödvingetrast	3	1	–2
Green sandpiper, Skogssnäppa	3	0	–3
Willow tit, Talltita	3	2	–1
Lesser whitethroat, Ärtsångare	2	0	–2
Bullfinch, Domherre	2	2	0
Crested tit, Tofsmes	2	3	1
Spotted flycatcher, Grå flugsnappare	1	3	2
Wood warbler, Grönsångare	1	1	0
Hazelhen, Järpe	**1**	**0**	**–1**
Woodcock, Morkulla	1	0	–1
Jay, Nötskrika	1	1	0
Rosefinch, Rosenfink	1	1	0
Blackcap, Svarthätta	1	0	–1
Pied flycatcher, Svartvit flugsnappare	1	0	–1
Capercaillie, Tjäder	**1**	**0**	**–1**
Garden warbler, Trädgårdssångare	1	3	2
Dunnock, Järnsparv	0	3	3
Nuthatch, Nötväcka	0	1	1
Wood pigeon, Ringduva	0	1	1
White wagtail, Sädesärla	0	1	1
Treecreeper, Trädkrypare	0	4	4
Total no. of territories	132	125	–7

Table D-3. Number of territories and densities (territories/km²) per bird species in territory mapping area 3: Storskäret. English and Swedish names are shown. Listed species in bold text. Species excluded from the statistical analysis (see text) are in italics and marked with *. The figures for 2002 and the change in numbers of territories for these species are written within parenthesis as they are of little value (see text).

Species	No. of territories 2002	No. of territories 2003	Change 2002–2003
Yellowhammer, Gulsparv	18	23	5
Chaffinch, Bofink	12	17	5
Willow warbler, Lövsångare	12	11	–1
Skylark, Sånglärka	9	6	–3
Greenfinch, Grönfink	8	11	3
Great tit, Talgoxe	8	6	–2
Garden warbler, Trädgårdssångare	8	7	–1
*Jackdaw, Kaja**	*(7)*	*10*	*(3)*
Rosefinch, Rosenfink	7	9	2
Whitethroat, Törnsångare	7	7	0
White wagtail, Sädesärla	6	3	–3
Blackbird, Koltrast	5	6	1
*Starling, Stare**	*(5)*	*13*	*(8)*
Song thrush, Taltrast	5	4	–1
Blue tit, Blåmes	3	3	0
Nuthatch, Nötväcka	3	3	0
*Tree sparrow, Pilfink**	*(3)*	*5*	*(2)*
Robin, Rödhake	3	2	–1
Fieldfare, Björktrast	2	1	–1
Winchat, Buskskvätta	2	1	–1
Spotted flycatcher, Grå flugsnappare	2	2	0
Siskin, Grönsiska	2	3	1
Wood pigeon, Ringduva	2	3	1
Blackcap, Svarthätta	2	4	2
Pied flycatcher, Svartvit flugsnappare	2	3	1
Meadow pipit, Ängspiplärka	1	0	–1
Lesser whitethroat, Ärtsångare	1	1	0
Marsh tit, Entita	1	1	0
Wryneck, Göktyta	**1**	**3**	**2**
Wood warbler, Grönsångare	1	0	–1
Linnet, Hämpling	1	1	0
Icterine warbler, Härmsångare	1	4	3
Goldcrest, Kungsfågel	1	2	1
Ortolan bunting, Ortolansparv	**1**	**1**	**0**
Wheatear, Stenskvätta	1	1	0
Red-backed shrike, Törnskata	**1**	**4**	**3**
Tree pipit, Trädpiplärka	1	2	1
Cuckoo, Gök	0	1	1
*House sparrow, Gråsparv**	*(0)*	*1*	*(1)*
*House martin, Hussvala**	*(0)*	*18*	*(18)*
*Tawny owl, Kattuggla**	*(0)*	*1*	*(1)*
*Swallow, Ladusvala**	*(0)*	*2*	*(2)*

Species	No. of territories 2002	No. of territories 2003	Change 2002–2003
Black grouse, Orre	**0**	**1**	**1**
Redwing, Rödvingetrast	0	1	1
Goldfinch, Steglits	0	1	1
Goosander, Storskrake	0	1	1
Wllow tit, Talltita	0	1	1
*Swift, Tornseglare**	*(0)*	*13*	*(13)*
Total no. of territories	155	224	69