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Population fluctuations of woodpecker species on the Baltic island of Aasla, SW Finland

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The results of the monitoring of woodpecker abundance on the island of Aasla (Finnish Baltic coast) during 1979–1995 are presented and analysed. Population fluctuations on Aasla were similar to those in mainland Finland in the case of the Grey-headed Woodpecker *Picus canus* and the Black Woodpecker *Dryocopus martius*. Breeding abundance of Black Woodpeckers was negatively correlated with snow depth and positively correlated with temperature in February. Also, breeding densities of Great Spotted Woodpecker *Dendrocopos major* and Lesser Spotted Woodpecker *Dendrocopos minor* correlated positively with mean January and February temperatures. We suggest that several mild winters in the second part of the study period (1988–1995), are the primary reasons for the continuously high population densities of Grey-headed and Black Woodpeckers. We did not find any evidence indicating competition between Grey-headed and Black Woodpeckers. We stress the need for creating foraging substrates (e.g. standing dead wood) as food sources for woodpecker species in boreal forests under severe winter conditions.

1. Introduction

Woodpeckers, as a group, are of special importance due to their key role in supplying forests with tree-cavities, serving several secondary users as nesting or roosting holes. Woodpeckers themselves have specific habitat requirements which are often satisfied only in naturally dynamic forests (Cramp 1985, Wesołowski & Tomiałojć 1986, Stenberg & Hogstad 1992, Angelstam & Mikusiński 1994). Modern forestry has, through the removal of dead wood as well as old and deciduous trees from the forest, together with fragmentation and cuts of existing old forest stands, depleted food resources and diminished the number of potential nesting sites for woodpeckers (Järvinen et al. 1977, Järvinen & Väisänen 1978, Svensson 1992, Angelstam & Mikusiński 1994). This incompatibility of intensive forest management with woodpecker demands has caused a decline of several woodpecker species, leading in extreme cases to local extinction (Pettersson 1984, Tiainen 1985, 1990, Aulén 1986, Väisänen et al. 1986, Koskimies 1989, Virkkala et al. 1993, Tucker & Heath 1994). In Finland, five woodpecker species (Wryneck *Jynx torquilla*, Three-toed Wood-

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pecker *Picoides tridactylus*, White-backed Woodpecker *Dendrocopos leucotos*, Lesser Spotted Woodpecker *D. minor*, and Black Woodpecker *Dryocopus martius*) have declined over the period 1970–1990, while only one has remained stable (Grey-headed Woodpecker *Picus canus*), and one has fluctuated (Great Spotted Woodpecker *Dendrocopos major*) (data supplied from the BirdLife International/European Bird Census Council European Bird Database 1994). According to the "Red Data Book" of Finland (Rassi et al. 1986), the White-backed Woodpecker is classified as "endangered", and the Grey-headed and Lesser Spotted Woodpeckers as "in need of monitoring".

However, locally and regionally, factors other than intensive forest management may also affect population trends, as well as annual fluctuations of woodpecker species. Svärdson (1949) discussed competition for suitable habitats between the Grey-headed, Green *Picus viridis*, and Black Woodpeckers as a possible explanation for the density and distribution patterns in Sweden. All three species forage mostly for ants, and in boreal Europe they seem to prefer aspen *Populus tremula* for nesting trees (Cramp 1985, Angelstam & Mikusiński 1994). It has been suggested that competitive interactions between Black and Grey-headed Woodpeckers might have caused a decline in Black Woodpecker on the Baltic Åland Islands (Haila & Järvinen 1977). Nilsson et al. (1992) considered competition over food resources between Great Spotted and Lesser Spotted Woodpeckers possible in years of low conifer cone abundance. Woodpecker nesting-holes are subject to interspecific competition from some other bird species, especially Jackdaws *Corvus monedula* and Starlings *Sturnus vulgaris*, and possibly Stock Dove *Columba oenas* (Sielmann 1959, Short 1982, Cramp 1985, Wesołowski 1995). The abundance of predators may also limit woodpecker numbers (Wendland 1964). Fluctuations in food resources have been found as a factor regulating abundance in omnivorous species (e.g. *D. major*) (review in Glutz von Blotzheim 1980), and possibly in a specialist such as the Middle Spotted Woodpecker *D. medius* (Wesołowski 1992).

Climatic conditions may also affect woodpecker populations. Nilsson et al. (1992) found positive correlations between mean winter temperature and population indices for the Black Woodpecker in the subsequent breeding season in Sweden. Similarly, the temperature in the preceding winter was found to be positively correlated with the breeding numbers of the Middle Spotted Woodpecker in primaeval Białowieża Forest (Wesołowski 1992) in Poland. Furthermore, it has been suggested (Nilsson et al. 1992, Mikusiński 1995) that the Black Woodpecker may have problems with foraging in winters with thick snow cover. Also, for the Grey-headed Woodpecker, winter food availability due to winter conditions may be a critical factor (Rolstad & Rolstad 1995). Unfavourable winter conditions was the main factor responsible for population crashes of Green Woodpecker in the United Kingdom (Marchant et al. 1990).

In this paper we present woodpecker population fluctuations on the island of Aasla (SW Finland) in the years 1979–1995, and compare them with results of winter bird censuses for the whole of Finland. In attempting to evaluate to what extent factors other than forest management are responsible for local fluctuations of woodpecker numbers, we assume that characteristics of forests not intensively managed on Aasla have not changed during the study. Using data on the abundance of individual species, we examine if there is evidence of interspecific competition between Black and Grey-headed Woodpeckers. Next, we test the hypothesis that high population levels of potential avian predators and nest-competitors are negatively affecting the abundance of woodpecker species. Then, we relate woodpecker population sizes to winter climatic characteristics, in order to examine the possible role of weather conditions in determining breeding population levels of different species. We also investigate if breeding success of Black and Grey-headed Woodpeckers is negatively correlated with population densities, which might suggest resource limitations. Finally, we investigate whether population fluctuations of the Great Spotted Woodpecker on Aasla are correlated with cone crops of Scots Pine *Pinus sylvestris* and Norway Spruce *Picea abies* in southern Finland.

2. Study area

Censuses were conducted on the southeastern part of the island of Aasla (total area 16 km^2) in the

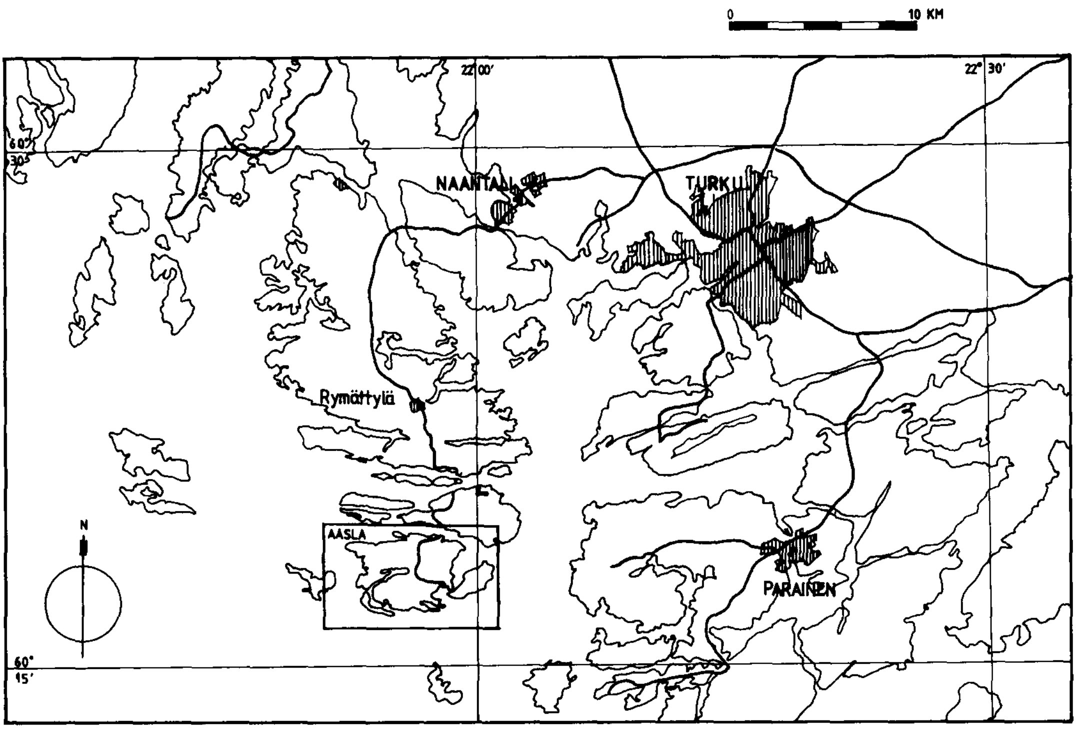

Fig. 1. Location of study area in south-western Finland.

municipality of Rymättylä, in the southwestern archipelago of Finland (60°17′N 21°56′E) (Fig. 1). The topography of the island consists of rocky hills running E–W in direction (the highest elevation is 54 m above sea level), and valleys with several small lakes. Forests cover 73% of the island, while the rest consists of fields, meadows and bogs. The habitats vary from luxuriant groves with Hazel *Corylus avellana* to extremely barren rocky areas covered by Scots Pine intermixed with agricultural fields occupying suitable land. Coniferous forests with Norway Spruce and mixed forests grow in the valleys, and deciduous forests, which compose about 7% of the total forest cover, are found mostly along the shores of lakes and along the Baltic sea. Until recently forest management has been extensive, whereas wood has been taken for domestic use for firewood and building. Very few abandoned fields have been afforested. In recent years a few small clear-cuts, with retention of seed trees, have been made in coniferous stands. Most of the arable land has been taken into cultivation, and the main crop is potatoes. Since the 1960s, when cattle were allowed to graze in the woods, there has been a remarkable change from mixed farming to specialised crops (Saari, Helenius & Ruuska, unpublished). At the end of the 1970s and beginning of the 1980s, grazing by cattle has definitively ceased, and the farms are now relatively small but intensively managed.

Woodpeckers on Aasla are represented by the resident Black, Grey-headed, and Lesser Spotted Woodpecker, the Great Spotted Woodpecker (resident and postbreeding visitor on Aasla), the Three-toed Woodpecker (winter visitor), and the Wryneck (tropical migrant). The White-backed Woodpecker has also been observed in winter but not in censuses, hence is not included in our study (see Saari & Nuorteva 1996).

The potential avian predators are represented on the island by the Goshawk *Accipiter gentilis* and the Sparrowhawk *A. nisus*, whereas Starling and Stock Dove are recognized as potential nest competitors. Another potential nest competitor, the Jackdaw, does not breed on Aasla. The main mammalian predator on larger woodpecker species, the Pine Marten *Martes martes*, does not occur on the island.

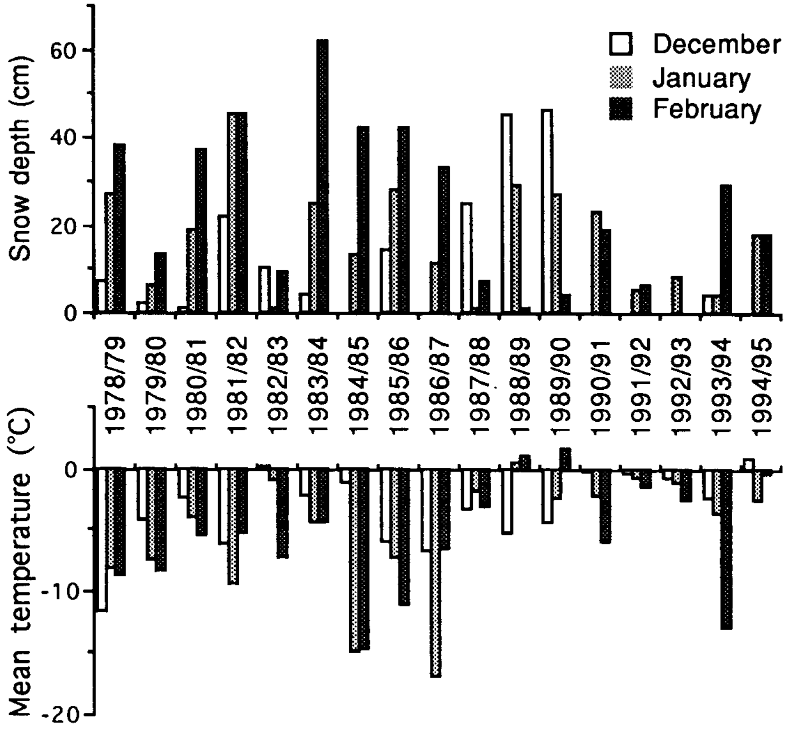

Fig. 2. Mean monthly temperatures and snow cover at the airport of Turku (30 km NE of Aasla), Finland.

3. Methods

Data on the abundance of woodpeckers and their potential avian predators and competitors were extracted from censuses conducted on Aasla along a transect of 10 to 11 km, these censuses being a year-round application of the Finnish winter bird census (Koskimies & Väisänen 1991). The transect was designated to include a representative sample of the habitats used by the birds throughout the year. Thus, in addition to the different types of forest, field, and shores, the transect also included farmyards where a great proportion of birds were recorded in winter. The route was walked by the same person twice per month, every month, from early December 1978 to late December 1995, and if possible in good weather (neither rainy nor windy). The censuses started at about sunrise in midwinter and about one hour after sunrise at midsummer, and took about six hours to complete. All birds seen or heard were recorded irrespective of the distance to the observer (see Swenson et al. 1994). Throughout this paper, the mean number of birds observed along the transect during particular years and seasons is referred to as species abundance.

Data on woodpecker abundance in the whole of Finland in the corresponding period were supplied by the Museum of Natural History, University of Helsinki. For the methodology of data collection see Koskimies and Väisänen (1991). In our comparison we used mean value from early, middle, and late winter indices.

The data concerning winter weather conditions used in the study came from the meteorological station at the airport of Turku (30 km NE of Aasla) (Fig. 2). Data on cone crops of spruce and pine for southern Finland were supplied by the Finnish Forest Research Institute (Fig. 3).

In order to indicate eventual trends in abundance of particular woodpecker species on Aasla during the study period, Spearman rank correlation coefficients were applied. The annual variation in abundance during the study period was described by the coefficient of variation (CV%). To compare annual population fluctuations of five woodpecker species (Wryneck excluded) on Aasla with results of Finnish winter census, Spearman rank correlation coefficients were used. Additionally, we compared, using the same method, abundances of the Black Woodpecker on Aasla in the years 1979–1994 with breeding population den-

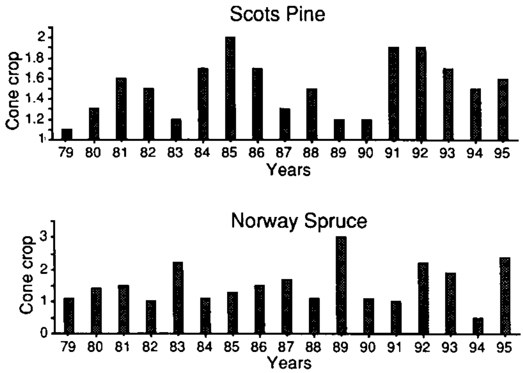

Fig. 3. Relative conifer cone crops in southern Finland in the years 1979–1995. The data is presented as means of the abundance classes for each year.

sity (number of nests), as well as the number of territories of this species in the corresponding period in the Uusimaa study area (250 km^2), located about 150 km east from Aasla (Ahola 1995).

In order to test for the presence of competition between Black and Grey-headed Woodpeckers, we calculated Spearman rank correlation coefficients between the two species on breeding and postbreeding abundances. Breeding abundance was defined as the mean number of birds per route observed in the period March–June, and postbreeding abundance was defined as the mean number of birds per route observed in the period July–November. These two periods are easily distinguished by looking at the number of individuals observed monthly during the total study period (17 years) (Fig. 4).

To test the hypothesis that high population levels of potential avian predators and nest-competitors are negatively affecting the abundance of different woodpecker species, we also apply Spearman rank correlation coefficients to relate annual abundances of woodpeckers to annual abundances of raptors and breeding abundance of Starling (May) and Stock Dove (May–June).

To examine the possible impact of winter weather conditions on population levels of different species, we related the mean temperatures in winter months (December–February) to resident woodpecker abundances in the following breeding season using Spearman rank correlation coefficients. Breeding abundance of Great Spotted Woodpecker was defined as the mean number of birds per route observed in the period May–

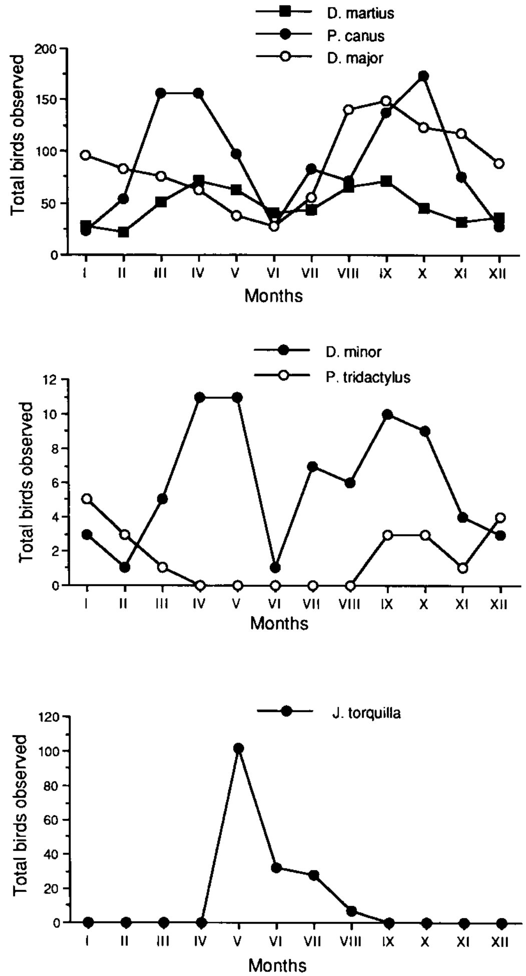

Fig. 4. Total numbers of birds observed in particular months during the study period. The total number of birds observed during 17 years of study totalled: *Dryocopus martius* = 569, *Picus canus* = 1 090, *Dendrocopos major* = 1 056, *D. minor* = 71, *Picoides tridactylus* = 20, *Jynx torquilla* = 171.

June, whereas the period March–June was used for the remaining resident species. Furthermost, in the case of mainly ground feeding species (i.e. Black and Grey-headed Woodpeckers), snow cover measured on the 15th of each of winter month (December–February) was related to woodpecker abundances in the following breeding season using the same statistics.

We did not have any direct measurements of breeding success. However, we assumed the difference between the breeding and postbreeding abundances indicated the breeding success. The

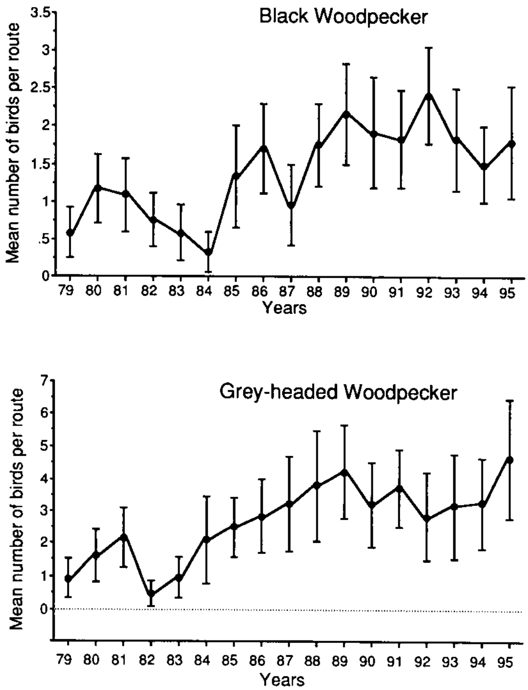

Fig. 5. Annual fluctuation of Black and Grey-headed Woodpeckers on Aasla accompanied by 95% confidence intervals. Annual variation (CV) in woodpecker abundance: *D. martius* = 44%, *P. canus* = 44%.

breeding success is then expressed by the post-breeding:breeding abundance ratio and does not discriminate between in situ production and eventual immigration. To test if high population numbers of Black and Grey-headed Woodpeckers in spring are approaching the carrying capacity of the island, we related breeding abundance to our index of breeding success using Spearman rank correlation coefficients.

Finally, to detect potential impact of the conifer cone crop on Great Spotted Woodpecker abundance, we measured the annual differences in species abundance in the period of July to April for two consecutive years, and then tested if increases and decreases or no change were related to pine and spruce cone crops using a Mann-Whitney U-test.

4. Results

The monthly and total numbers of birds observed along the transect during the study period are presented in Fig. 4. Annual population fluctuations

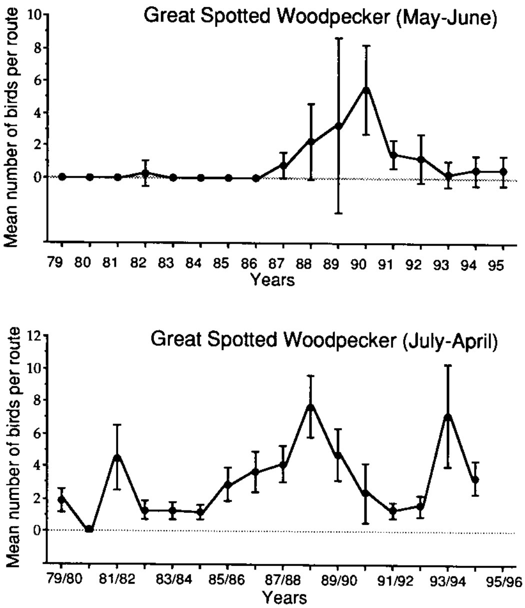

Fig. 6. Fluctuation in breeding (May–June) and post-breeding abundance (July–April) of the Great Spotted Woodpecker on Aasla, accompanied by 95% confidence intervals. Annual variation (CV) in abundance: May–June = 159%, July–April = 70%.

of all woodpecker species are shown in Figs. 5, 6 and 7. For two species, the Black and Grey-headed Woodpeckers, annual abundance showed highly significant positive trends (*D. martius*: $r_s = 0.74$, $p < 0.01$; *P. canus*: $r_s = 0.82$, $p < 0.01$) during the study period (Fig. 4). Also breeding numbers in these species indicated positive trends (*D. martius*: $r_s = 0.70$, $p < 0.01$; *P. canus*: $r_s = 0.68$, $p < 0.01$). For the other species, there were no significant trends in annual abundance (*D. major*: $r_s = 0.46$, $p = 0.06$; *D. minor*: $r_s = 0.29$, $p = 0.24$; *P. tridactylus*: $r_s = 0.43$, $p = 0.12$; *J. torquilla*: $r_s = -0.47$, $p = 0.06$), however, an overall significant increase in breeding numbers of the Great Spotted Woodpecker was detected ($r_s = 0.68$, $p < 0.01$). The breeding abundance (May–June) of this species was positively correlated with abundance in the preceding period (July–April) ($r_s = 0.71$, $p < 0.01$). Annual abundances of the Black and the Grey-headed Woodpeckers on Aasla fluctuated in similar ways with those for the whole of Finland (*D. martius*: $r_s = 0.65$, $p < 0.01$; *P. canus*: $r_s = 0.72$, $p < 0.01$). In other species significant relationships were not revealed (*D. major*: $r_s = -0.03$, $p = 0.92$; *D. minor*: $r_s = 0.16$, $p = 0.52$; *P. tridactylus*: $r_s = -0.26$,

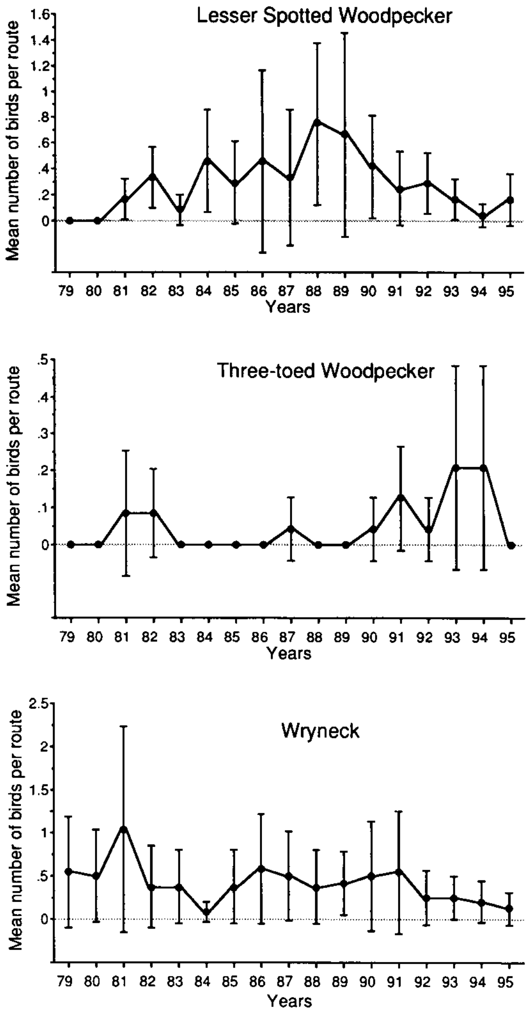

Fig. 7. Annual fluctuation of Lesser Spotted Woodpecker, Three-toed Woodpecker and Wryneck abundance on Aasla during the study period. Values are accompanied by 95% confidence intervals. Annual variation (CV) in woodpecker abundance: *D. minor* = 73%, *P. tridactylus* = 145%, *J. torquilla* = 51%.

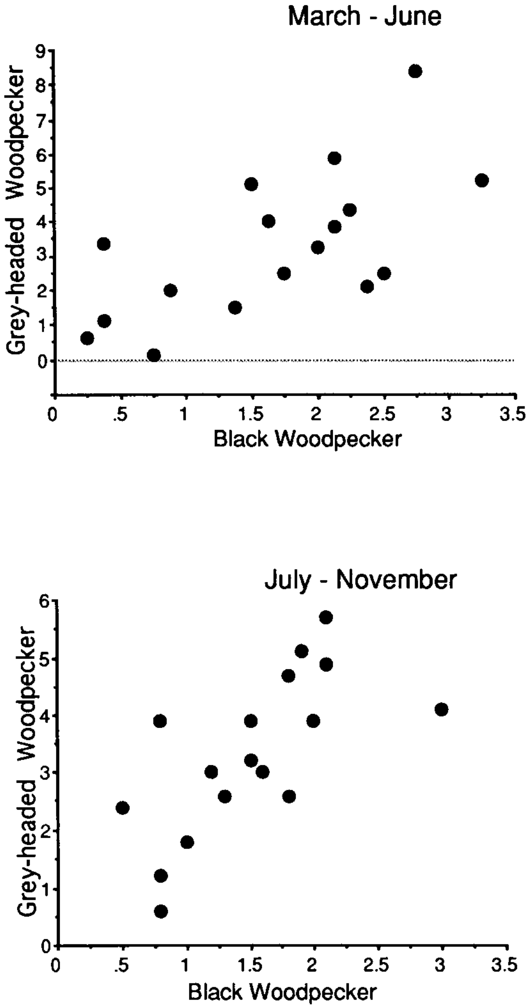

Fig. 8. Relationships between breeding (March–June) and postbreeding (July–November) abundance of Black Woodpecker and Grey-headed Woodpecker.

p = 0.30). Annual abundances of the Black Woodpecker on Aasla were highly positively correlated with the number of nests ($r_s = 0.76$, $p < 0.01$), as well as territories ($r_s = 0.78$, $p < 0.01$) in the Uusimaa study area (Ahola 1995).

The breeding as well as postbreeding abundances of Grey-headed Woodpecker during the study period were on Aasla positively correlated with those of Black Woodpecker (breeding: $r_s = 0.65$, $p < 0.01$, postbreeding: $r_s = 0.78$, $p < 0.01$ (Fig. 8).

Among weather indices used in our analysis, the mean January and February temperatures correlated significantly with abundance of the Great and the Lesser Spotted Woodpeckers (Table 1). Also, the Black Woodpecker breeding abundance correlated significantly with snow cover and temperature in February (Table 1, Fig. 9).

Except for a positive correlation between annual abundances of Grey-headed Woodpecker and Sparrowhawk ($r_s = 0.65$, $p < 0.05$), we did not detect any other significant relationship between abundances of woodpeckers and their potential avian predators ($p > 0.05$). Also, there were no

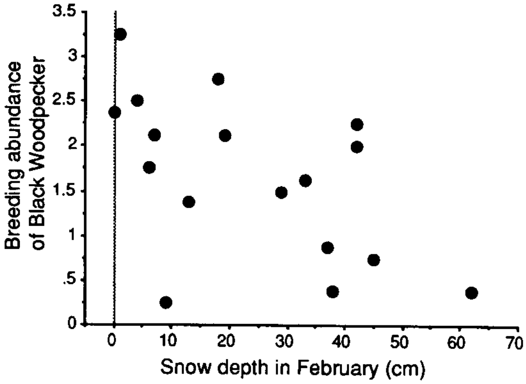

Fig. 9. Relationship between snow cover in February and abundance of Black Woodpecker in the following breeding season.

significant relationships between the breeding density of the Starling and the annual abundance of woodpeckers ($p > 0.05$). However, the breeding density of the Stock Dove was significantly correlated with the annual abundance of the Black Woodpecker ($r_s = 0.49$, $p < 0.05$), the Grey-headed Woodpecker ($r_s = 0.65$, $p < 0.01$), and the Wryneck ($r_s = -0.59$, $p < 0.05$).

A negative correlation between breeding success and population size in the breeding season was revealed for both the Black ($r_s = 0.76$, $p < 0.01$), and the Grey-headed Woodpeckers ($r_s = 0.81$, $p < 0.01$) (Fig. 10).

Finally, we found that annual changes in the postbreeding abundance of the Great Spotted Woodpecker were not significantly correlated either to Scots Pine or Norway Spruce cone crops (Mann-Whitney U-test, Pine: $n_1 = 8$, $n_2 = 7$, $U = 13$, $p = 0.08$; Spruce: $n_1 = 8$, $n_2 = 7$, $U = 16.5$, $p = 0.18$).

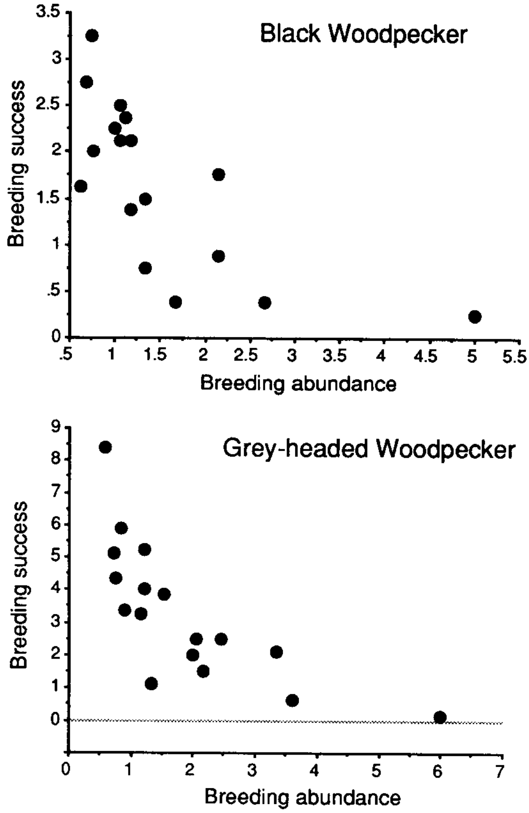

Fig. 10. Relationship between breeding success and breeding abundance in Black and Grey-headed Woodpeckers.

5. Discussion

During the 17 years of study, although the characteristics of forests on Aasla have not changed, all woodpecker species censused on Aasla have

Table 1. Spearman rank correlation coefficients (R_s) for winter weather conditions and breeding abundances of the resident woodpecker species in the following spring at Aasla, Finland.

		Dryocopus martius	*Picus canus*	*Dendrocopos major*	*Dendrocopos minor*
December	Snow	$0.00^{(n.s.)}$	$-0.18^{(n.s.)}$	–	–
	Temp.	$0.11^{(n.s.)}$	$-0.19^{(n.s.)}$	$0.02^{(s.)}$	$0.17^{(n.s.)}$
January	Snow	$0.17^{(n.s.)}$	$0.05^{(n.s.)}$	–	–
	Temp.	$0.39^{(n.s.)}$	$0.19^{(n.s.)}$	0.50*	0.55*
February	Snow	– 0.54*	$-0.09^{(n.s.)}$	–	–
	Temp.	0.51*	$0.14^{(n.s.)}$	0.65**	0.54*
Mean temp.	(Dec.–Feb.)	$0.37^{(n.s.)}$	$0.33^{(n.s.)}$	$0.35^{(n.s.)}$	$0.27^{(n.s.)}$

undergone considerable changes in abundance. The observed similarity of population fluctuations in the Black as well as Grey-headed Woodpeckers on Aasla with those on the Finnish mainland, indicates that factors operating at a regional scale are underlying observed population dynamics of these species during the study period. In particular, seasonal weather conditions seem to be the major factor affecting population changes in these two species. The observed correlation between snow cover in February, and Black Woodpecker abundance in the following breeding season, as well as the observed relationship of breeding abundance with the mean temperature in this month, may confirm the hypothesis that winter is a critical period for this species (Nilsson et al. 1992, Mikusiński 1995). Weather conditions in February, which according to long-term meteorological data has the thickest snow cover and is the coldest among winter months in the region, seem to be essential.

In the case of the Grey-headed Woodpecker, the suggested negative effect of winter harshness on breeding abundance (Rolstad & Rolstad 1995) is not evident in our analysis. However, the most dramatic crash in species abundance observed in 1982 coincided with a very long, snowy winter (L. Saari pers. obs., Fig. 2). It is possible, that in the remaining years, the ability to switch diet from ants to arboreal insects in cold, snowy winters described elsewhere (Rolstad & Rolstad 1995), as well as access to large numbers of feeding stations provided by humans on Aasla, partially mitigated the negative effect of winter conditions. Contrary to the Black Woodpecker, the Grey-headed Woodpecker has been reported to use such supplemental food in winter (Alatalo 1978, Rolstad & Rolstad 1995). Feeding stations may improve winter survival of birds, and eventually increase their breeding densities (Jansson et al. 1981).

Population fluctuations of the Great Spotted, the Lesser Spotted, and the Three-toed Woodpeckers on Aasla, having higher annual variation than Black and Grey-headed Woodpeckers, do not show similarity to those on the mainland. This may indicate that on Aasla, a set of factors operating locally is the most important in regulating abundance. The eventual negative effects of avian predators and competitors on the annual population levels in these species have not been detected in our study. However, in the case of Great and Lesser Spotted Woodpeckers, their breeding abundances were positively correlated with mean temperature in January and February. This may be explained by energetic problems faced by these species in severe winters. Both species, which occur even in subarctic environments, seem to be well adapted to cope with low temperatures. However, in the case of a coastal island such as Aasla, low winter temperature is, more often than on the mainland, accompanied by strong winds or high air humidity. Thus, we suggest, that wind and air humidity, as directly related to the rate of heat loss in the living organism, may greatly increase a negative effect of low temperature on these species on Aasla. Additionally, the hoar-frost caused by high humidity may aggravate the accessibility of food resources for the Lesser Spotted Woodpecker.

In the case of the Wryneck, observed population fluctuations may be associated with the cessation of grazing by cattle and intensification of agriculture in the beginning of the study period. Transformation of grassland habitats into intensively managed fields, followed by a reduction in ant numbers, are recognized to be the main causes for the species decline in Europe (Tucker & Heath 1994). However, since the Wryneck is a tropical migrant, the observed fluctuations may be an effect of variation in mortality during migration or in winter.

Our results did not support the hypothesis concerning competition between Black and Grey-headed Woodpeckers (Haila & Järvinen 1977). However, the positively correlated population levels of these species in our study may indicate that there are some other factors which play a more important role (i.e. weather conditions), and hence the presence of competition is difficult to detect on Aasla. Our study points out that both species, which largely forage for the same prey (ants), are affected by a similar set of factors.

We found that in Black and Grey-headed Woodpeckers, breeding success was negatively correlated with breeding abundances, which suggests that both species after years of increase are close to the carrying capacity of the island, when food limitation or territoriality may act as limiting factors. We suggest that several mild winters, resulting in low winter mortality in the second part of the study period (1988–1995), seem to be the primary reason for continuously high abundances of Black and Grey-headed Woodpeckers on Aasla in this period.

In conclusion, although our analysis is built only on correlations, and on this basis it is difficult to draw definite conclusions concerning casual relationships, it appears that for most resident woodpecker species on Aasla, winter mortality may play an important role in regulating breeding abundances. Therefore, from a management point of view, we point out the necessity of creating sufficient food resources in managed forests which could fulfil the increased energetic demands of woodpecker species during severe winters. Such resources are standing, dead and dying trees containing a rich invertebrate fauna, and the presence of which seems to be crucial in boreal forests. More studies are needed to establish the adequate amount of dead wood, qualitatively and quantitatively, for woodpecker species in boreal forest. This information would be essential from the point of view of developing ecologically sustainable forestry practices.

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Selostus: **Tikkojen kannanvaihtelusta lounaissaaristossa**

Kuuden tikkalajin kannanvaihteluita tutkittiin Rymättylän kunnan Aaslan saarella vuosina 1979–1995. Tikat laskettiin kahdesti kuussa 10–11 km:n pituiselta reitiltä ja kaikki havaitut yksilöt merkittiin muistiin. Menetelmällisesti laskenta oli ympärivuotinen sovellutus talvilintulaskennasta. Tässä tutkimuksessa kannan suuruutta kuvataan yksilömäärillä laskentakertaa kohti eri vuosina tai vuodenaikoina. Kannanvaihteluita verrattiin etupäässä valtakunnallisten talvilintulaskentojen tuloksiin, talven säätilaan, petojen (kana- ja varpushaukka) ja mahdollisten pesäpaikkakilpailijoiden (kottarainen ja uuttukyyhky) määriin sekä käpytikan osalta männyn ja kuusen siemensatoon Etelä-Suomessa.

Aaslan harmaapäätikka- ja palokärkikannat vaihtelivat samansuuntaisesti muun Suomen kanssa. Palokärjen pesimäkannat korreloivat negatiivisesti helmikuun lumipeitteen ja positiivisesti helmikuun keskilämpötilan kanssa. Myös käpy- ja pikkutikkakantojen koko korreloi positiivisesti sekä tammi- että helmikuun keskilämpötilojen kanssa. Oletamme, että tutkimusjakson loppupuolen (1988–1995) pääsääntöisesti leudot talvet ovat ensisijainen syy jatkuvasti korkeina pysyneisiin palokärki- ja harmaapäätikkakantoihin. Emme löytäneet mitään todisteita harmaapäätikan ja palokärjen välisestä kilpailusta. Ankarina talvina pystyyn kuolevien tai kuolleiden puiden merkitys tikkojen ravintotaloudessa korostuu. Koska näitä nykyisissä hoitometsissä on vain vähän, on niiden määrää ekologisesti kestävän metsänhoidon nimissä lisättävä.

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