Bad News and Good News: Population Changes of Finnish Owls During 1982–2007

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Bad news and good news: population changes of Finnish owls during 1982–2007

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In Finland, monitoring of 'common' birds of prey is based on two projects run by the Finnish Ringing Centre: the Raptor Grid (since 1982) and Raptor Questionnaire (since 1986). The Raptor Grid has produced sufficient data for analysing population trends in six of ten owl species. The overall trend during 1982–2007 was significantly negative in the Eagle Owl *Bubo bubo* (–2.2% per year), Long-eared Owl *Asio otus* (–4.7%) and Tengmalm's Owl *Aegolius funereus* (–3.1%), and significantly positive in the Ural Owl *Strix uralensis* (+1%); no significant trend was detected in the Pygmy Owl *Glaucidium passerinum* or Tawny Owl *Strix aluco*. The Eagle Owl population increased to the middle of 1990s, but has since decreased by 5% per year. The decrease coincides with the closing of 90% of local open rubbish dumps, which offered a stable and rich food supply to the Eagle Owls. The decrease in the Tengmalm's Owls can partly be attributed to the decrease in the amount of old forest. The Pygmy Owl population increased steeply (>5% per year) during 1994–2003, then crashed following a mass invasion and has since started to recover. The geographical distribution of the Raptor Grid study plots is not suitable for monitoring the northern nomadic species like the Snowy Owl *Bubo scandiacus*, Northern Hawk-Owl *Surnia ulula*, Great Grey Owl *Strix nebulosa* and Short-eared Owl *Asio flammeus*. Annual totals of active nests and occupied territories reported with the Raptor Questionnaire do not indicate any long-term population changes of these species. However, intensive cooperation over larger areas across national boundaries in northern Europe is urgently needed for reliable monitoring of these nomadic owls.

Key words: population trends, owls, Strigiformes, Finland

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INTRODUCTION

Reliable information on long-term changes of animal and plant populations is an absolute prerequisite and first step of conservation and sound management programs. Thus, surveys and well-planned long-term monitoring programs should be included in official duties of every government in our rapidly changing world. In the competition for resources short-sighted economic considerations and human welfare nearly always win and push nature conservation and worries about the future of our environment to the background. Only when, for example, toxic chemicals, pathogens or pests are directly harmful to people, will governmental resources become available for monitoring and fighting against them. From this follows that the monitoring of species without direct economical value is carried out in most cases on the voluntary basis by non-governmental organizations and idealistic individuals.

Monitoring birds of prey, both diurnal and nocturnal, is important because of two reasons. Birds of prey have suffered more than many other groups of birds from persecution, environmental contaminants, habitat destruction and other negative impacts caused by people (Newton 1979); thus, monitoring is the first step in fighting for the well-being of birds of prey. Because the birds of prey are at the top of their food chains, changes in their numbers, productivity and survival reflect changes in the environment of other species, including man (cf. Sergio *et al.* 2006).

In Europe, the first long-term monitoring of diurnal birds of prey started in the 1940s in Falsterbo, the southern corner of Sweden. Since 1973 this project has been based on standardised counts of diurnal raptors passing the bird observatory during the autumn migration (Kjellén & Roos 2000). In addition to the special projects on endangered species (e.g. Helander *et al.* 2003), nation-wide monitoring projects based on counts or systematic sampling of active nests and/or occupied territories of all species of diurnal and nocturnal birds of prey have been carried out in very few European countries. Such countries are Finland, Estonia, Germany and the United Kingdom (see e.g. Lõhmus 2004, Mammen & Stubbe 2005, Hardey *et al.* 2006).

In Finland, monitoring of four species of endangered species of diurnal birds of prey started in the early 1970s (Ollila 2006a,b, Saurola 2006a, 2008, Stjernberg *et al.* 2006). In the 1970s, as the Head of the Finnish Ringing Centre, I encouraged ringers to ring nestlings and ring-and-recapture breeding adult birds of prey at nest in order to collect mark–recapture data for analysing annual survival and dispersal (Saurola 1987). In 1982, I started the *Raptor Grid*, a bird-of-prey monitoring project based on teamwork surveys by volunteer ringers in 10 × 10 km study plots (Saurola 1985a). In 1986, I launched the *Raptor Questionnaire* (Saurola 2006b), in which the bird-of-prey ringers have to give an annual summary (1) of the numbers of active nests and occupied territories found, and (2) the distributions of clutch and brood sizes observed.

The objective of this paper is to summarise the information on population trends during the last 26 years of all ten owl species breeding in Finland.

METHODS

Raptor Grid

In 1982, the Finnish Ringing Centre started a program called the *Raptor Grid* for monitoring 'common' species of both diurnal and nocturnal birds of prey. Volunteer ringers devoted to birds of prey were asked (1) to join in teams, (2) to select a 10 × 10 km study plot based on the Finnish National Grid and (3) to annually try to find all active nests or at least to locate occupied territories of birds of prey within their study plot (Saurola 1985a).

The annual routine for each study plot is: (1) listening for territorial hoots of owls, (2) watching aerial display of buzzards and hawks, (3) searching for nests, (4) listening for fledged broods, and (5) reporting the results in September to the Ringing Centre (Saurola 1985a). In addition, the total number of hours of effort used has to be recorded. For a relatively good coverage of all raptor species, about 300–500 person-hours/study plot/breeding season is needed in southern Finland (mixture of boreal forest, agricultural land and lakes). The key point is that the effort within a study plot remains the same from year to year as long as the plot is included in the data set – a hundred percent coverage is not necessary and for many species not even possible.

The number of *Raptor Grid* study plots surveyed has averaged 120 per year (Saurola 2006b).

Raptor Questionnaire

Since 1986, additional information has been collected annually from bird ringers on (1) the total numbers of potential territories checked, and (2) the totals of active nests and occupied territories found, and (3) the productivity i.e. clutch and brood sizes of birds of prey by using the *Raptor Questionnaire* (Saurola 2006b). For example, in 2006, which was a good vole year, more than 26 000 potential nest sites of owls were inspected and 6673 occupied territories including 4007 active nests were found and reported (Honkala & Saurola 2007).

Most bird-of-prey ringers survey their ringing territory with about the same activity from year to year, which means that a part of the *Raptor Questionnaire* data is more or less standardized. The total effort has been increasing, because new permits have been issued. This may cause some positive bias in the trends of annual totals, because no corrections have been done so far. In any case, the *Raptor Questionnaire* produces valuable additional information on population changes of all species and is a vital source of data for monitoring northern and nomadic species.

The Finnish Ringing Centre at the Finnish Museum of Natural History has carried out both the *Raptor Grid* and *Raptor Questionnaire* – projects with financial support from Ministry of Environment. The success of the projects is fully dependent on the stamina of volunteers. To maintain motivation, annual reports showing the results and value of the fieldwork have been published since the beginning of the project (e.g. Honkala & Saurola 2007).

Statistical analysis

I have used data from the *Raptor Grid* for estimating changes in population size of six owl species. The calculations of the population indices are based on both the numbers of active nests, called here *nest-index*, and occupied territories, called *territory-index*. While an effort has been made to retain the same set of study plots over time, many plots have become inactive and new ones have emerged during 26 years, because of the voluntary basis of the fieldwork.

In my earlier reports (e.g. Saurola 2006b, Honkala & Saurola 2007), the annual population indices for each year were calculated through pair-wise comparisons of mean numbers in that year to those in a reference year by including data only from plots that were active in both years. Thus, substantial data were excluded, especially, if the time series were long.

To be able to incorporate all available data, I have used here, as well, program TRIM (Pannekoek & van Strien 2005) for imputing the missing values and for estimating the annual indices and overall changes. In TRIM option *time effects* was selected and *overdispersion* and *serial correlation* were taken into account. For all six species, the correlations between the two time series of the annual indices calculated with two different methods were surprisingly high (r = 0.97–0.99), which means that by species the two curves illustrating the changes were almost identical. Only the indices calculated by program TRIM are shown here.

Program PIA (Anders Bignert, Swedish Museum of Natural History, Bignert 2003) was used (1) to estimate the average annual change per year in indices on the basis of ordinary log-linear regression, (2) to check the potential leverage effect of points in both ends of the time series on the significance of the trend by using Mann–Kendall trend test, (3) to check for the significance of non-linear trend components by using a 7-point LOESS smoother (Cleveland 1979, Nicholson *et al.* 1995), and (4) to carry out power analysis (Cohen 1988, Fryer & Nicholson 1993, Bignert *et al.* 2004). The sensitivity of the time series was measured by calculating the number of years in the time series needed to detect an annual change of 5% with the observed between year variation and at a statistical power of 80% (Bignert *et al.* 2004).

In addition to estimating the annual population indices, program TRIM calculates the long-term trends and their significance. TRIM treats year effects as fixed factors instead of random factors as in ordinary log-linear regression, and therefore the standard errors of the slopes are smaller in TRIM compared to regression analysis. This means that the significance of the overall trend suggested by TRIM is valid only during a fixed set of years and not in general (see Thomas *et al.* 2004, Pannekoek & Strien 2005). In this paper, the statistical significance suggested by TRIM is mentioned if the trend resulting from the ordinary log-linear regression analysis was non-significant.

RESULTS AND DISCUSSION

Species monitored by the *Raptor Grid*

Overall population changes of the Eagle Owl *Bubo bubo*, Pygmy Owl *Glaucidium passerinum*, Tawny Owl *Strix aluco*, Ural Owl *Strix uralensis*, Long-eared Owl *Asio otus* and Tengmalm's Owl *Aegolius funereus* during the 26-year study period have been calculated on the basis of *Raptor Grid* data. The annual indices and trends are illustrated in Fig. 1 and summarised in Table 1. The annual totals of active nests and occupied territories reported during 1986–2007 by the areas of local ornithological societies and by the entire country are shown in Fig. 2. Table 2 contains a summary of productivity parameters during 1986–2007.

Eagle Owl

The territory-index of the Eagle Owl has varied between 0.45 and 1.09 (Fig. 1A) and the nest-index between 0.11 and 1.38 during 1982–2007. The overall log-linear decrease of the population indices from 1982 to 2007 was 2.2% or 4.1% per year depending on whether calculation was based on the numbers of occupied territories or active nests, respectively (Table 1).

The time series based on the numbers of territories included a highly significant non-linear component (Fig. 1A), which meant that the requirements of the log-linear regression were not fully filled. When the time series was split into two halves, the problem of non-linearity disappeared. During the first half of the period the population change was in fact positive (+1.2%; NS), but during the second half of the period the population decreased steeply: the territory-index by 5.2% ($P < 0.001$) and the nest-index by 8.7% ($P < 0.05$) per year. If this trend would continue, the population would halve in 14 years.

The overall picture (Fig. 2A) of the annual population changes and trend during 1986–2007 was the same on the basis of the *Raptor Questionnaire* data: the annual totals of active nests (range 71–537) and occupied territories (range 427–1106).

According to *Raptor Questionnaire* data, all productivity parameters, i.e. clutch size, productivity (number of young produced per active nest) and brood size (young per successful nest) have slowly decreased during 1986–2007, but statistically significant has been only the decrease of the brood size by 0.46% per year ($P < 0.05$). There are many ring recoveries of Eagle Owls ringed as nestlings and found dead, but not enough live encounters for a survival analysis based on combined data sets (cf. the Tawny Owl account below; Francis & Saurola 2004).

Of all Eagle Owls ringed in Finland 1913–2007 (n = 14 516) and later reported dead, with information of the cause of death (n = 1731), 41% collided with or were electrocuted by power lines, 21% were hit by car and 6% by train, and 7% were deliberately killed. During the last two decades very few Eagle Owls have been killed on purpose. In contrast, power lines are still a very significant cause of Eagle Owl deaths. Thus, power line companies should invest more for developing safer structures for birds.

The Finnish Eagle Owl population was increasing (= partly recovering) during the 1970s and 1980s due to (1) breeding season protection since 1966 and full protection since 1983, (2) increase of suitable nest sites and hunting areas on clear-cuts created by forestry, and (3) especially, excellent year-round food supply of Norwegian Rats *Rattus norvegicus* at the numerous poorly managed local rubbish dumps (Saurola 1985b). Since the middle of the 1990s about 90% of the local rubbish dumps have been closed. This dramatic change of the food supply has certainly been very important factor behind the steep negative trend during the last 15 years (Valkama & Saurola 2005).

In Estonia, the recent distribution of the Eagle Owl is concentrated to the western coast and islands; no major population changes have been detected since the

Table 1. Overall population changes per year during 1982–2007 in Finland of six owl species. Annual population indices (cf. Fig. 1) were based on the numbers of occupied territories and on active nests (*Raptor Grid* study plots). Power: the number of years needed to detect an annual change of 5% with the observed between-year variation and at a power of 80%. Changes that were affected by increasing monitoring effort, are shown in parentheses. Note: a continuous annual change of 1% means that the population will halve or double in 70 years; changes of 2%, 5% and 10% suggest halving/doubling in 35, 14 and 7 years, respectively.

Species	Period	Occupied territories			Active nests		
		Change (%)	R^2	Power (yr)	Change (%)	R^2	Power (yr)
Bubo bubo	1982–2007	–2.2***	0.57***	11	–4.1**	0.27**	23
	1982–1994	+1.2 NS	0.28 NS	8	+1.5 NS	0.01 NS	23
	1994–2007	–5.2***	0.86***	8	–8.7*	0.36*	22
Glaucidium passerinum	1982–2007	(+4.3***)	(0.51***)	(17)	(+10.0***)	(0.68***)	(24)
	1994–2007	+0.4 NS	0.00 NS	15	0.0 NS	0.00 NS	20
Strix aluco	1982–2007	+0.3 NS	0.01 NS	13	+0.5 NS	0.01 NS	18
Strix uralensis	1982–2007	+1.0*	0.15*	12	+1.2 NS	0.03 NS	23
Asio otus	1982–2007	–4.7*	0.19*	30	–3.1 NS	0.06 NS	34
Aegolius funereus	1982–2007	–3.1*	0.15*	24	–2.3 NS	0.07 NS	26

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, NS non-significant.

Table 2. Average annual productivity (large nestlings produced per active nest per year) of nine owl species in Finland during 1986–2007. Given are the medians of annual means of productivity, and the change in productivity per year. Power: the number of years needed to detect an annual change of 5% with the observed between-year variation and at a power of 80%. Sample size n is the total number of nests included.

Species	Median	Min – max	Change (%)	Power (yr)	n
Bubo bubo	1.54	1.27 – 2.02	–0.38 NS	10	5710
Surnia ulula	3.72	1.40 – 5.80	+0.97 NS	19	281
Glaucidium passerinum	5.10	3.01 – 6.07	+0.29 NS	11	5532
Strix aluco	2.72	1.96 – 3.43	–0.25 NS	11	7999
Strix uralensis	2.19	1.28 – 3.02	–0.50 NS	14	14 248
Strix nebulosa	2.00	0.67 – 3.67	+2.10 NS	20	629
Asio otus	2.67	1.97 – 3.60	+0.64 NS	12	1277
Asio flammeus	3.52	1.57 – 5.33	+0.73 NS	17	728
Aegolius funereus	2.77	1.78 – 4.32	+0.03 NS	14	14 918

NS non-significant.

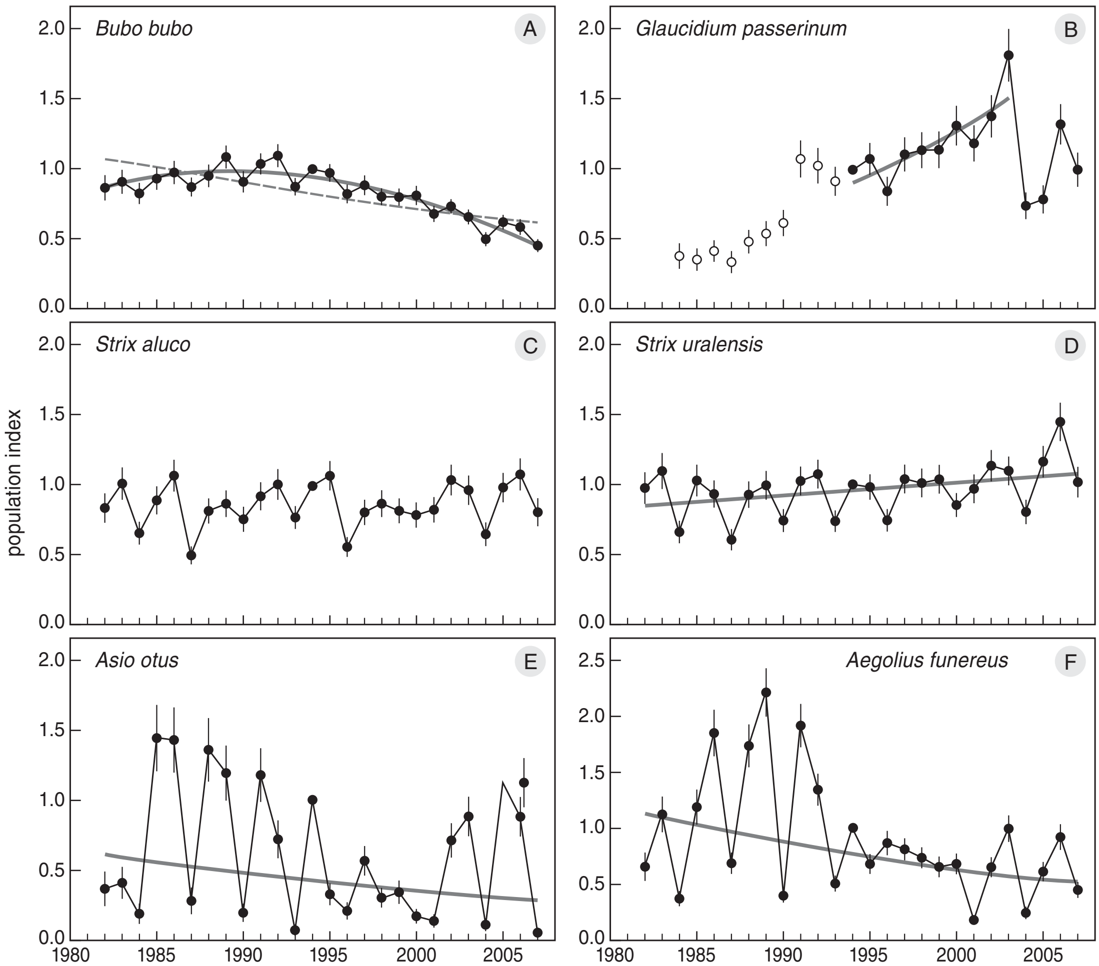


Figure 1. Annual population indices of six species of owls calculated by using the program TRIM and the numbers of occupied territories found from the *Raptor Grid* study plots during 1982–2007. Base year is 1994 with index value 1.0. Vertical bars indicate the standard errors. Thin line connects yearly indices to show year-to-year trajectory.
Statistically significant (see Table 1) log-linear regression line is shown by a thick solid grey line, except in panel A by a dashed line. In panel A the solid line indicates the statistically significant 7-point LOESS smoother (see text). In panel B the indices of the first part of the study period are shown differently, because they are biased by an increasing effort (see text).

early 1990s (Nellis 2006). In many other European countries the Eagle Owl population has been increasing, e.g. in Germany during 1988–2002 by 5.3% ($P < 0.01$) per year (Mammen & Stubbe 2003, 2005).

PYGMY OWL

During 1986–2004, the number of nest boxes constructed especially for the Pygmy Owl *Glaucidium passerinum* increased steeply, from 385 to 6180 and has after that fluctuated around 6000. Because this increase took place in the *Raptor Grid* study plots as well, the steep 'increases' of both territory- and nest-indices during 1982–2007 (Table 1, Fig. 1B) and of the annual totals of active nests (range 20–798) and occupied territories (range 110–1214) reported by the *Raptor Questionnaire* (Fig. 2B) are heavily biased. At least during the first years of the study period the 'increase' must have been caused by the increased detection probability of pairs breeding in nest boxes instead of woodpecker cavities.

In autumn 2003, an exceptionally large invasion of Pygmy Owls took place (Valkama 2003). In spring 2004 the territory-index had crashed down to the level of 1993 (Fig. 1B) and remained much lower during the good vole years of 2005 and 2006 than before the crash. This suggests that the changes detected by the

Raptor Grid were relevant and not biased during the second half of the study period. Thus, the population really increased steeply by 5.6–8.7% ($P < 0.01$) per year during 1994–2003, then crashed and after that started to recover again (Fig. 1B).

These data show for the first time that Pygmy Owls, which participated in the mass invasion, really disappeared from the Finnish population. Did they emigrate from Finland and started to breed somewhere else or did they simply die off during the invasion? There is no data to answer this question. But, in any case, these data indicate that invasions are an important part of population regulation of the Pygmy Owl. In conclusion, the *Raptor Grid* data does not suggest any long-term trend of the Finnish Pygmy Owl population during 1982–2007 (Table 1).

Tawny Owl

During 1982–2007, the territory-index of the Tawny Owl fluctuated between 0.50 and 1.08 (Fig. 1C) and the nest-index between 0.32 and 1.03. The time series of the territory-index is very similar ($r = 0.80$), but not quite as 'nicely' regular as the one of the Ural Owl (Fig. 1D). The reason is that the Tawny Owl is, of these two generalist feeders, less dependent on vole cycles than the Ural Owl. No long-term trend of the Finnish Tawny Owl population was detected (Table 2, Fig. 1C).

The annual totals of active nests (range 143–560) and occupied territories (range = 288–789) from the *Raptor Questionnaire* give precisely the same pattern of changes recorded in the Tawny Owl population during 1986–2007 from the *Raptor Grid* (Fig. 2C).

Because the Tawny Owl is a resident species (Saurola 2002, Saurola & Francis 2004), and because the Ringing Centre has encouraged ringers to collect data for capture–recapture analysis (Saurola 1987), it has been possible to calculate reliable and accurate time- and age-dependent survival probabilities for Finnish Tawny Owls (Francis & Saurola 2004).

Survival rates averaged 33% (range 26–43%) in the first-year of life, 64% (57–71%) in the second, and 73% (67–79%) in subsequent years. Approximately 50% of the annual variation in survival could be explained by the stage of the vole cycle and severity of winter weather.

Further, a matrix model based on *Raptor Questionnaire* data on productivity (cf. Table 2) and survival probabilities suggested that the Finnish Tawny Owl population has been decreasing during two years out of three and then recovering to the previous level during the third year of the vole cycle. The model predicted the numbers of breeding pairs to be low in one of three years, with no long-term trend (Francis & Saurola 2004), which is consistent with the *Raptor Grid* and *Raptor Questionaire* data (Fig. 1C, Table 1).

Tawny Owl populations were reported as stable in Estonia during 1991–2002 (Elts *et al.* 2003), *'stable?'* during 1970–2000 in Britain and Ireland (Hardey *et al.* 2006), and decreasing by 3.6% ($P < 0.01$) per year in Germany (Mammen & Stubbe 2003, 2005).

Ural Owl

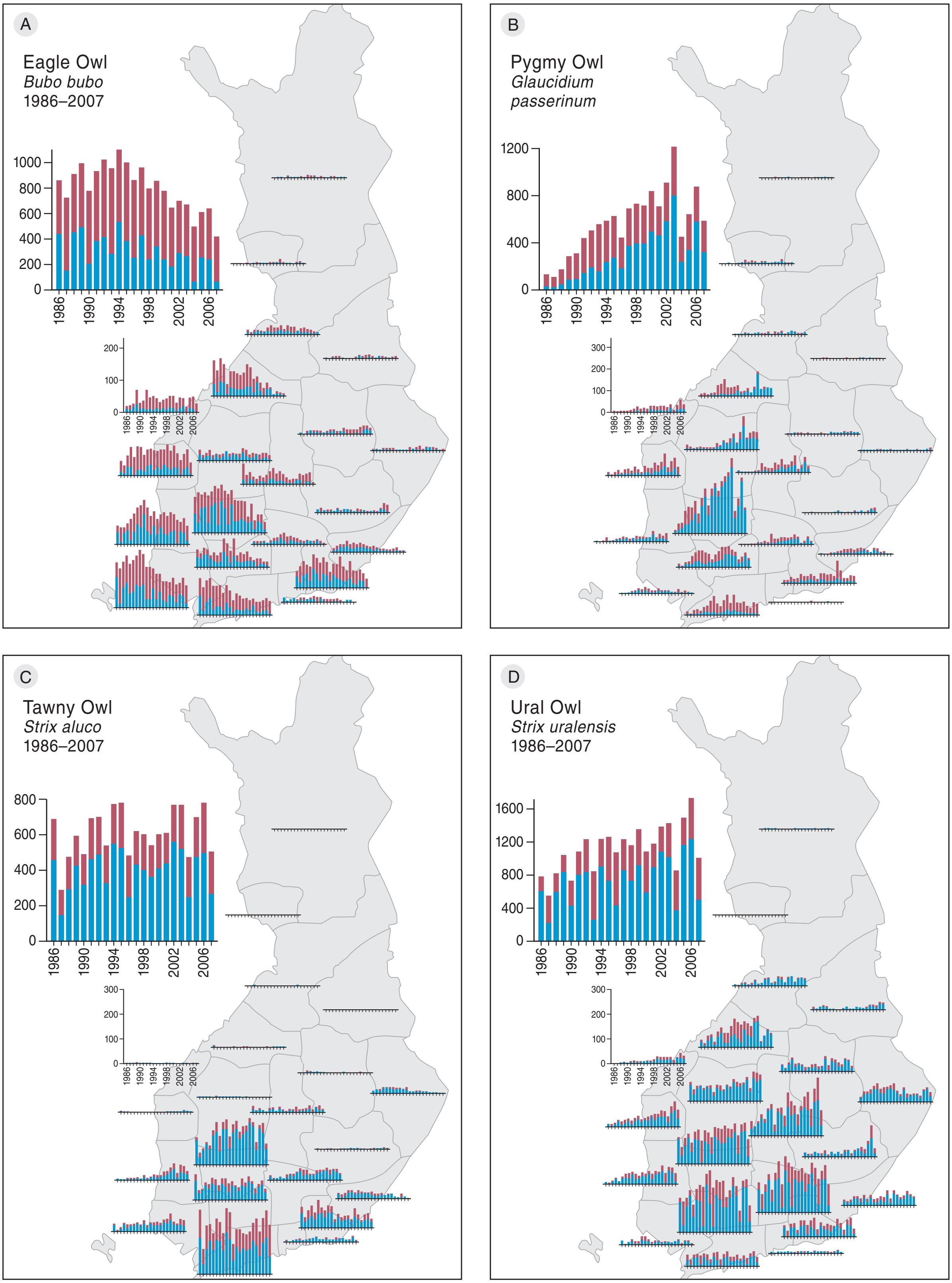
During 1982–2007, population indices for the Ural Owl have fluctuated between 0.66 and 1.44 (territories; Fig. 1D) and between 0.29 and 1.5 (nests). The pattern of fluctuations is very clear: first there were five cycles of three years (two high years and one low), followed by two cycles of four years (three and one) and then again one cycle of three years (two and one). The same pattern can be seen in the annual totals of active nests (range 213–1236) and occupied territories (543–1732) during 1986–2007 (Fig. 2D).

Ordinary log-linear regression analysis shows that the territory-index has increased by 1.0% ($P < 0.05$) and the nest-index by 1.2% (NS) per year during the last 26 years (Table 1). According to program TRIM, both trends are statistically significant ($P < 0.01$). My own study population in southern Finland (61.0°N, 24.5°E) has remained at the same general level during the last 35 years; the annual number of active nests has varied between 15 and 130 (Saurola 2003, 2007)).

The Ural Owl is, together with the Tengmalm's Owl, the best studied owl species in Finland (see Kontiainen *et al.* 2008, Saurola 2007 for references). The Ural Owl is a generalist feeder, but its reproduction is highly dependent on 3–4-year cyclic fluctuations of microtines (e.g. Brommer *et al.* 2002, Saurola 2003; Table 2). Neither the *Raptor Questionnaire* data nor 43-year data from my study area indicate any long-term trends in productivity.

Preliminary results of a combined analysis of all Finnish recovery and recapture data (cf. Francis & Saurola 2004) from 1968 to 2005 indicate that the median annual survival during the first year of life is

Figure 2. (next pages) The annual numbers of all occupied territories (columns) and active nests (lower parts of the columns in blue) of owls found in Finland during 1986–2007 and reported by the *Raptor Questionnaire*. The numbers are shown both as national totals and by the areas of local ornithological societies. Note: The scale in the panels for all local areas is the same, but different in the panel for the entire country.


A
Eagle Owl
Bubo bubo
1986–2007
B
Pygmy Owl
Glaucidium passerinum
C
Tawny Owl
Strix aluco
1986–2007
D
Ural Owl
Strix uralensis
1986–2007

37% (range 17–68%), is 74% (range 61–81%) during the second year of life, and is 85% (range 75–90%; Saurola & Francis unpubl. data) after that. Because vole populations crash after the peak, first year survival of fledglings hatched during the peak vole year has averaged only 27%. This means that the majority of the high number of fledglings produced during the peak year are 'wasted' and never become recruits (cf. Saurola 1989). No long-term trend in survival has been detected.

The Estonian Ural Owl population has been relatively stable since the beginning of the 1990s, but increased strongly during 1971–90 (Elts *et al.* 2003, Lõhmus pers. comm.).

Long-eared Owl

During 1982–2007, both territory-index (range 0.08–1.60) and nest-index (range 0.05–1.4) have varied widely (Fig. 1E). The general pattern of highs and lows is very similar to that of the Ural Owl. The main differences are the low values in good vole years 1982 and 1983, and the low period without proper highs from 1995 to 2001. In contrast to the Ural Owl, the long-term population change of the Long-eared Owl has been negative: –4.7% ($P < 0.05$) per year based on territories and –3.1% (NS) per year based on nests (Table 1). According to the program TRIM both trends are statistically significant ($P < 0.01$).

The lowest annual total of breeding attempts (i.e. nests plus fledged broods) reported during 1986–2007 was 28 in 1993, while the highest total was 616 in 2003 (Fig. 2E). The range of annual totals of occupied territories was 61–781 during the same period. Data from the *Raptor Questionnaire* shows the same wide annual fluctuations as data from the *Raptor Grid*, but does not suggest any decreasing population trend during 1986–2007.

In Finland, the Long-eared Owl is a regular migrant (Saurola 1983); only a small number of individuals may winter successfully, provided the circumstances are favourable. There is no capture–recapture data available to study the natal and breeding dispersal of the species. Ring recoveries reported by the general public indicate that, on average, Long-eared Owls reported dead during the breeding season were several hundred kilometres away from their natal area (Saurola 2002). Thus, Finnish Long-eared Owls seem to be semi-nomadic, which probably explains why the population highs and lows do not exactly match with those of the sedentary Ural Owl.

In Estonia large annual fluctuations, but no long-term trend has been observed (Lõhmus 2004, Rein Nellis unpubl. report). In contrast, in Germany the Long-eared Owl population has decreased in 1988–2002 by 1.7% per year ($P < 0.05$; Mammen & Stubbe 2003, 2005), and in Britain and Ireland the population was reported as in '*decline?*' for the time period of 1970–2000 (Hardey *et al.* 2006).

Tengmalm's Owl

During 1982–2007, the annual population indices of the Tengmalm's Owl have fluctuated widely: the territory-index between 0.19 and 2.21 (Fig. 1F) and the nest-index between 0.28 and 3.02. The ordinary log-linear regression analysis indicated a significant negative trend of the territory-index by 3.1% ($P < 0.05$) per year during the last 26 years (Table 1), but due to the large between-year variation, the negative trend (–2.3%) of the nest-index was not statistically significant. According to program TRIM, both trends were statistically significant ($P < 0.01$).

Further, the *Raptor Questionnaire* data from 1986–2007 (Fig. 2F) show that the annual totals of active nests (range 201–2265) and occupied territories (range 387–3643) of the Tengmalm's Owl have decreased, especially all over southern Finland. In many other parts of the country the period elapsed between the population peaks have been much longer than 3–4 years, as used to be in the 1970s and 1980s.

What factors could have caused the decrease? Both the annual *Raptor Grid* indices (Fig. 1F) and the annual totals from *Raptor Questionnaire* (Fig. 2F) show that the population first increased steeply and rapidly during the 1980s before the decrease started in the early 1990s. Thus, before trying to analyse the causes of the apparent overall negative trend, one should find out why the numbers of the species 'exploded' in the late 1980s. Did the Finnish population receive, due to particularly favourable vole years, an exceptional influx of immigrants from the east? Respectively, could then an exceptional emigration have been involved in the rapid decrease of the population? Unfortunately these questions remain open. Because few breeding owls have been ringed in Russia, very few Russian-ringed Tengmalm's Owls have been encountered in Finland.

Several studies have shown that productivity, survival and dispersal of the Tengmalm's Owl are highly dependent on 3–4-year cyclic fluctuations of microtines (e.g. Laaksonen *et al.* 2002, Hakkarainen *et al.* 2002, Saurola 2002). Because the Tengmalm's Owl is a forest-dwelling species, continuous degradation of the forest habitat in Finland may play an important role behind the population decrease of the species. According to the results of 9th (1996–2000) and 10th (2004–2006)

National Forest Inventory the total areas of 60–120 year and >120 year forest age classes have decreased by 8% and 6%, respectively, during only ten years (Korhonen *et al.* 2007).

Laaksonen *et al.* (2004) showed that the lifetime reproductive success of the Tengmalm's Owls increased when the proportion of old forest increased in the territory (through higher number of breeding attempts), and decreased with an increasing proportion of agricultural land because of decreased fledging success in years when vole populations crashed during the breeding season. Further, the predation pressure by avian (Hakkarainen & Korpimäki 1996, Hakkarainen *et al.* 2004) and mammalian (Sonerud 1985, Korpimäki 1987) predators probably increases when the amount of optimal forest habitat decreases.

In northern Sweden, the breeding population of the Tengmalm's Owl has declined by 75% with respect to the peak densities from mid-1980s to early 2000s; this decline has happened in parallel with the decline in spring and autumn densities of vole populations (Hörnfeldt *et al.* 2005). In Estonia the Tengmalm's Owl has decreased during 1991–2002 (Elts *et al.* 2003) and, as well, in Germany by 2.1% ($P < 0.01$) per year during 1988–2002 (Mammen & Stubbe 2003, 2005).

Species monitored by the *Raptor Questionnaire*

The number and distribution of *Raptor Grid* study plots are not representative for monitoring the owl species that breed mainly in the northern part of Finland and that may move long distances from one breeding area to the next. However, rough information from the *Raptor Questionnaire* produces better data than the *Raptor Grid* to track annual changes and trends of the Snowy Owl *Bubo scandiacus*, Northern Hawk-Owl *Surnia ulula*, Great Grey Owl *Strix nebulosa* and Short-eared Owl *Asio flammeus*. These data do not suggest any significant long-term trends for these four nomadic species during 1986–2007 (Fig. 2). Productivity parameters and total numbers of nests reported are shown in Table 2.

SNOWY OWL

During 1986–2007, breeding Snowy Owls were reported by the *Raptor Questionnaire* only in three years (Fig. 2G). In 1987, five breeding attempts from 21 occupied territories were verified, in 1988 the corresponding numbers were 15 and 16, and in 2007 five and five. The average annual productivity was quite poor in all three years: 0.38, 1.79 and 0.4 large nestlings per active nest and 1.50, 2.27 and 2.0 per successful nest, respectively.

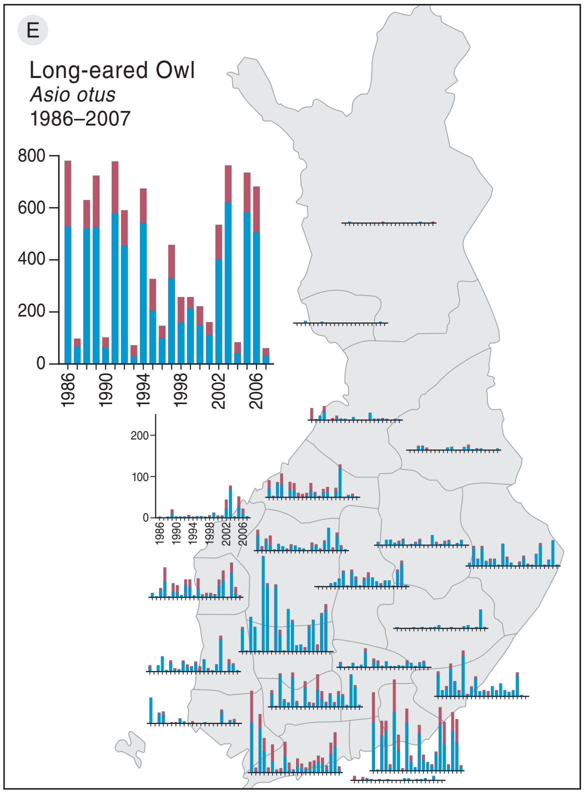
The nomadic Snowy Owl breeds numerously in Fennoscandia only occasionally, when an invasion from the east coincides with microtine peak (e.g. Mikkola 1983, Saurola 1997, Svensson *et al.* 1999, Jacobsen 2005). During the last decades, the maximum annual total for all Fennoscandia has not been more than about 100 breeding pairs. The mass occurrences have always been concentrated in relatively small areas (Wiklund & Stigh 1986), which vary in location from one invasion to the next. According to historical and partly anecdotal records, Snowy Owl invasions 100 years ago were much larger than nowadays: e.g. in 1907 about 800 eggs were collected from 100 nests in north-western Finnish Lapland (Mikkola 1983)!
Satellite telemetry projects such as Fuller *et al.* (2003), will continue to offer new and exciting data on the long-distance movements of Snowy Owls, information important for understanding population trends in this species.

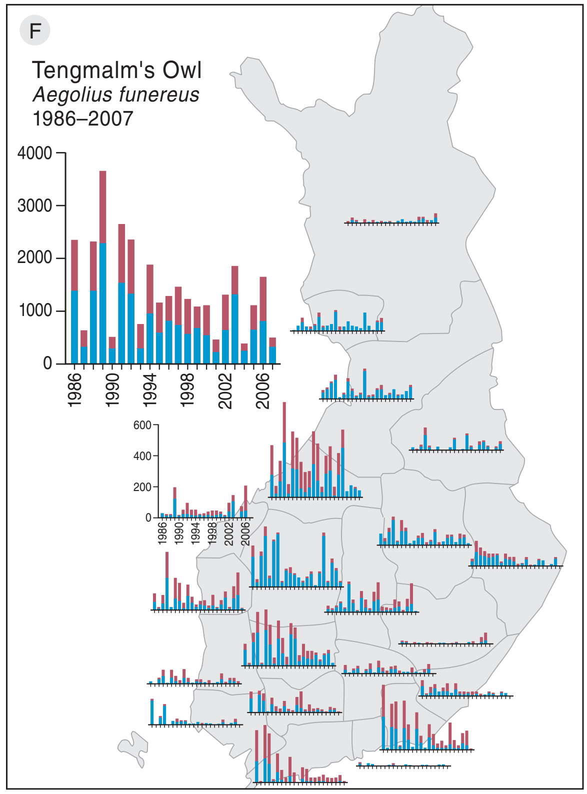
NORTHERN HAWK-OWL

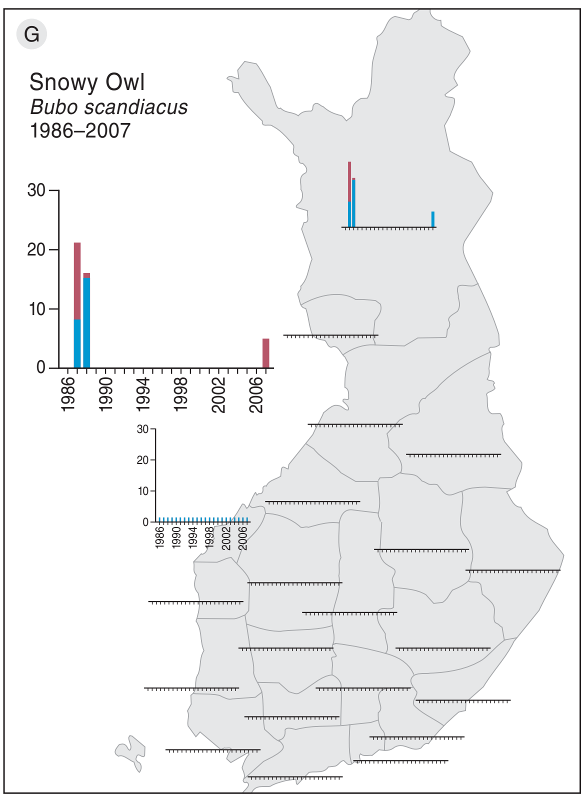
During 1986–2007, the annual totals of occupied territories of the Northern Hawk-Owl reported by the *Raptor Questionnaire* have varied from 4 in 1997 to 175 in 1988 and the numbers of active nests from 1 to 119, respectively (Fig. 2H). In 13 years (1990–2002) breeding Northern Hawk-Owls were almost absent from Finland; the annual numbers of active nests were less than 20 except in 1996 (27). Finally in 2003, Northern Hawk-Owls came back again; nests were found both in Lapland and in some areas in central Finland.

The majority of the breeding records of the Northern Hawk-Owl have been made in the northern half of the country, where the density of ringers, other birdwatchers and people in general is quite low. This means, that the numbers of nests and territories reported are only a (small) fraction of the real annual totals. On the other hand, the nest site and territory of the Northern Hawk-Owl are easier to find than those of the other owls, because the Northern Hawk-Owl is a day-active and easily perceptible species, revealing the nest to the intruder by aggressive and noisy behaviour. Thus, the time series data from the *Raptor Questionnaire* probably reflects the real annual fluctuations of the breeding population.

In principle, Northern Hawk-Owls may breed throughout Finland. According to indirect historical records (egg collections and numbers of birds killed) Northern Hawk-Owls decreased in Finland during the first half of the 20th century, especially in the southern part of the country (e.g. Mikkola 1983). Sonerud (1997) concluded in his overview on population fluctuations:







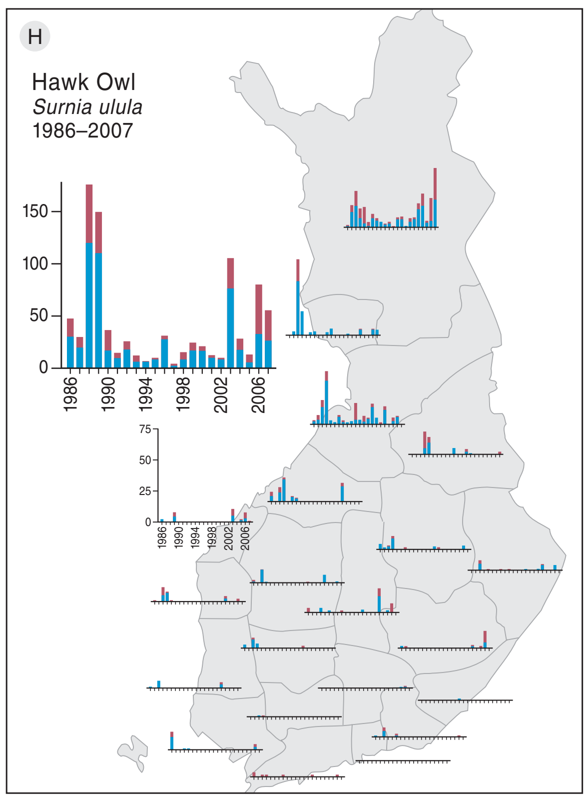


Figure 2. Continued

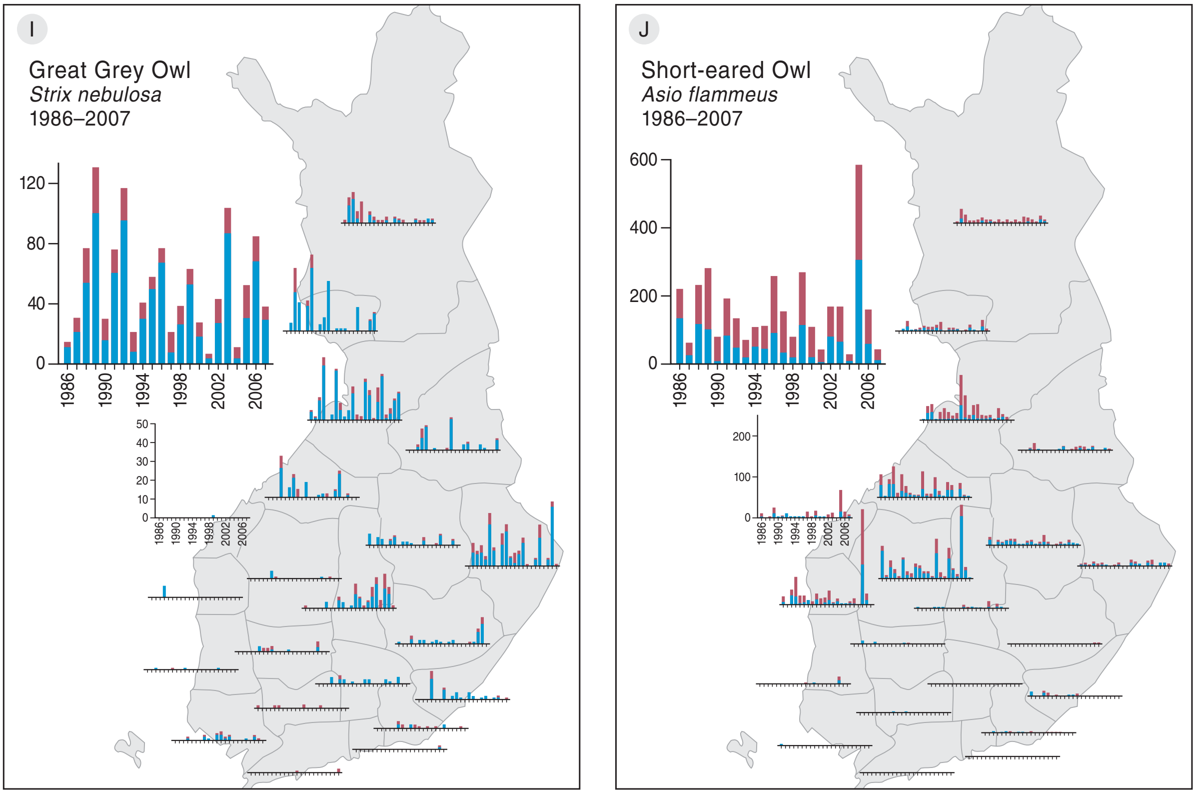


Figure 2. Continued

"Hawk Owl seems to have been more common in Fennoscandia during the first and last quarters of the past 100 year than in the intervening time".

Ring recoveries give an idea of the scale of the nomadic movements of Northern Hawk-Owls. Of nestlings ringed in Finland, two were encountered east of the Ural Mountains at 2795 and 2659 kilometres to the east from their natal sites and three others were recovered in southern Norway at 1200–1400 kilometres southwest of their natal sites (Saurola 2002).

Great Grey Owl

The annual total of active nests of the Great Grey Owl reported by the *Raptor Questionnaire* has varied between 4 and 100 during 1986–2007 (Fig. 2I). The minimum and maximum totals of the occupied territories detected during the same period were 7 and 131. Contributions to the national total from local areas are very different from year to year and no trend during the study period can be suggested (Fig. 2I). The wide annual variation of numbers can be attributed to the vole cycles and semi-nomadic lifestyle of the species (Stefansson 1997, Saurola 2002).

The numbers of clutches of the Great Grey Owl in egg-collections collected during 1880–1910 suggest that the species must have been quite numerous in Finland one hundred years ago; in 1910–30 only few nests were found, in the 1930s a couple of good years were registered and during 1940–60 the species was almost absent from Finland (e.g. Sulkava & Huhtala 1997). Since the 1960s the number of breeding records has slowly increased to the present level. Correspondingly, the numbers of the Great Grey Owl have increased in northern Sweden since the middle of the 20th century (Stefansson 1997).

Sulkava & Huhtala (1997) reported two conditions that coincided with the increase of the Finnish Great Grey Owl population during the last five decades. The area of forest clear-cuts has increased since the 1950s providing open and vole-rich hunting areas for the owls. In addition, with the change in the attitude towards all birds of prey, illegal persecution of owls decreased and has essentially stopped during the last decades. Nonetheless, part of the perceived population increase may have been due to the more efficient monitoring and ringing of all birds of prey (Saurola 1985a, 1987).

SHORT-EARED OWL
The time series of the territory-indices (range 0.19–7.27) based on insufficient data from the *Raptor Grid* suggested a very strong decrease (–8% per year; $P < 0.01$) of the Short-eared Owl in Finland during 1982–2007. However, corresponding decreasing trend is not indicated from the larger *Raptor Questionnaire* data set (Fig. 2J).

During 1986–2004 the annual totals of nests and territories of the Short-eared Owl reported by bird ringers fluctuated as widely as those of the Northern Hawk-Owl and Great Grey Owl: from 1 to 132 active nests and from 26 to 280 occupied territories (Fig. 2J). Then, in 2005, the annual totals jumped surprisingly up to 304 nests and 586 occupied territories. In 2006 the numbers were again 'normal': 55 nests and 158 occupied territories.

The Short-eared Owl may breed all over Finland, but the present distribution is concentrated to the northern half of the country (Väisänen *et al.* 1998). However, the majority of breeding data reported by ringers comes from Bothnia, an area in western Finland with large peat bogs and agricultural fields (Fig. 2J). This means that neither the *Raptor Questionnaire* nor the *Raptor Grid* data on the Short-eared Owl is fully representative for the entire country.

Short-eared Owls migrate away from Finland in the autumn; some of them extend their migration at least to northern Africa (Saurola 1983). Ring recoveries have proved that a part of the Short-eared Owls are highly nomadic, changing their natal and breeding areas more than 1000 km from one breeding season to the next (Saurola 1983, 2002). In the future, more fieldwork is needed for surveying Short-eared Owls, as well as the three other northern species in Lapland.

In Estonia the Short-eared Owl population has decreased strongly during the last two decades (Elts *et al.* 2003). In Britain and Ireland, similar to the Long-eared Owl, the Short-eared Owl has been in 'decline?' (Hardey *et al.* 2006).

CONCLUDING REMARKS

(1) The *Raptor Grid* project data examined in this paper was based on 26-years of voluntary fieldwork of bird-of-prey ringers. This project has been a cost-effective monitoring method, producing unique data on the recent trends of six species of owls breeding in the southern half of Finland. The trend has been negative in three species, slightly positive in one species and neutral in two species. Only subjective explanations as to the causes of the trends can be offered. The statistical power of most of the time series was inadequate, as expected, because of the large annual fluctuations between years (caused by the vole cycle). This is in contrast to data from most of the diurnal raptors where power was adequate, because of much smaller between year fluctuations (Saurola 2008).

(2) During 1986–2007, the *Raptor Questionnaire* project has produced additional data on the annual breeding performance of all 10 species of owls breeding in Finland. These semi-standardised data offer crucial information on the annual population changes of four nomadic species breeding mainly in sparsely inhabited northern half of the country. However, without extensive international cooperation it is impossible to acquire reliable population trends of highly nomadic species. A new international monitoring project *Northern Nomadic Owls* is urgently needed to track the well being of these species, which will probably be threatened by the global climatic change.

(3) Sophisticated demographic modelling is the basis of realistic predictions about the future population trends, and of sound conservation measures (e.g. Anthony *et al.* 2006). The realistic and useful population models must be based on real and representative field data on productivity, survival and dispersal. The *Raptor Questionnaire* has produced a large amount of representative data on the annual fluctuations and long-term trends in productivity of Finnish owls at both the local and nationwide scales. Yet, the Tawny Owl and Ural Owl are the only two owl species thus far, for which ringing, recapture, and recovery data sets fulfil the requirements of sophisticated survival and dispersal analyses. The monitoring work done in Finland is a very good example of the huge potential of voluntary fieldwork in population monitoring. But there is still much more work to be done in the near future for gathering systematic mark–recapture data on all owl species in the country.

(4) Finally, I want to make a philosophical remark related to the title of this paper. What is the bad and good news for an owl conservationist? The Eagle Owl population has been decreasing during recent years. This is bad news for many, but good news for those conservationists who state that after the 'acceptable' recovery, the 'explosion' of the Eagle Owl population was artificial, caused by man and detrimental to almost all other species, e.g. to the Ural Owl and Tawny Owl. Further, the Ural Owl population has recently been increasing. This is good news for many (including myself as a Ural Owl researcher), but bad news for those who think that too many nest boxes have been offered to a predator that might be harmful, e.g. to Tengmalm's and Pygmy Owls. Finally, there are several

conservationists who think that too many nest boxes have been constructed for the Pygmy Owl, an efficient killer of passerine birds. Thus, in many cases bad-or-good-judgements are just subjective personal opinions and not a universal 'truth' of conservation.

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SAMENVATTING

Om het aantal broedparen van uilen te schatten worden in Finland jaarlijks inventarisaties uitgevoerd op basis van een raster van 10 × 10 km. Over de jaren 1982–2007 kromp de populatie van de Oehoe *Bubo bubo* met gemiddeld 2,2% per jaar. Ook de Ransuil *Asio otus* (–4,7%) en Ruigpootuil *Aegolius funereus* (–3,1%) namen in aantal af. De aantallen van de Dwerguil *Glaucidium passerinum* en Bosuil *Strix aluco* veranderden niet aantoonbaar. De Oeraluil *Strix uralensis* was de enige soort die in aantal toenam (+1,0% per jaar). Tot het midden van de jaren negentig van de vorige eeuw nam de Oehoe toe, maar de aantallen namen daarna met 5% per jaar af. Deze snelle afname wordt toegeschreven aan het op grote schaal sluiten van vuilstortplaatsen, die tot dan voor een belangrijke en voorspelbare bron van voedsel hadden gezorgd. De afname van de Ruigpootuil wordt geweten aan het inkrimpen van het areaal oude bossen. De Dwerguil nam over de periode 1994–2003 met meer dan 5% per jaar toe waarna de populatie instortte, gevolgd door een langzaam herstel. Aanvullende informatie over aantallen en verspreiding werd verzameld voor de Sneeuwuil *Bubo scandiacus*, Sperweruil *Surnia ulula*, Laplanduil *Strix nebulosa* en Velduil *Asio flammeus* omdat deze soorten van jaar op jaar sterk in aantal fluctueren en daarom moeilijk met een standaard bemonsteringsprogramma zijn te volgen. Geen van deze uilensoorten liet over lange termijn een toe- of afname zien, maar internationale samenwerking is nodig om een betrouwbaar beeld van de aantalsveranderingen van deze nomadische soorten te krijgen.

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