Monitoring Finnish Owls 1982–1996: Methods and Results

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Abstract.—In 1982, the *Raptor Grid,* a nation-wide program for monitoring birds of prey was started by the Finnish Ringing Centre. Voluntary banders were asked to select a 10 x 10 km study plot and find annually all active nests or at least occupied territories of birds of prey from their study plot (annual total averaged 120). Since 1986, additional information was collected with the *Raptor Questionnaire*. In 1996, more than 30,000 potential nest sites of owls were checked. The maximum annual number of nests were: e.g., Tengmalm's Owl 2,265, Ural Owl 901, Long-eared Owl 578, Tawny Owl 548, and Eagle Owl 537 nests. During the program, populations remained stable, although the annual fluctuations were extensive. International cooperation is needed to monitor nomadic species.

Efficient monitoring is a vital part of nature conservation in a rapidly changing world. Reliable information on present population status, including size, fecundity, survival and dispersal and annual fluctuations, is necessary to predict long-term trends and to formulate sound management programs. The Northern Spotted Owl (*Strix occidentalis caurina*) is probably the only owl species which has been professionally monitored (e.g., Forsman *et al*. 1996). Unfortunately, in most countries there are insufficient resources to conduct the necessary field work.

In Finland, both the Christmas Bird Count and the Breeding Bird Survey programs (e.g., Koskimies & Väisänen 1991) have produced valuable data for monitoring common land birds. However, these programs do not produce relevant data for monitoring owls. Up to the early 1980s, the only monitoring programs for birds of prey were on the White-tailed Sea Eagle (*Haliaetus albicilla*), Peregrine (*Falco peregrinus*), Golden Eagle (*Aquila chrysaetos*), and Osprey (*Pandion haliaetus*) (Saurola 1985).

The quality of the Finnish amateur ornithologists (ca. 7,000) including, especially, the bird banders (ca. 670) is very high. During the last 20 years, banding of both diurnal and nocturnal birds of prey has had, for several reasons, a high priority (Saurola 1987a). Hence, more than half of the Finnish banders are interested in research and conservation of birds of prey.

In 1982, the Finnish Ringing Centre, with some support for administration from the Ministry of the Environment, started a monitoring project called the *Raptor Grid* to monitor diurnal and nocturnal birds of prey (Saurola 1986). Since 1986, additional information on breeding performance had been collected with the *Raptor Questionnaire* (Haapala & Saurola 1986).

This paper will describe these monitoring techniques based on voluntary work and present some preliminary results on Finnish owl populations during the last 15 years.

MATERIAL AND METHODS

Monitoring Population Size: The *Raptor Grid*

The *Raptor Grid* program is completely based on voluntary field work by raptor banders.

When the project started in 1982, banders were asked (1) to establish a study group consisting of both banders and other bird-watchers, (2) to select a 10 x 10 km study plot, based on "even-ten-kilometers" of the Finnish National Grid, and (3) to try each year to find all the active nests or at least the occupied territories of the diurnal and nocturnal birds of prey in their

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study plot (Saurola 1986). 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. In addition, the total number of hours of effort used has to be recorded. For 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 number of *Raptor Grid* study plots surveyed averaged 120 per year (Haapala *et al*. 1993).

Monitoring Breeding Output: The *Raptor Questionnaire*

In 1982, a Raptor Nest Card was introduced and banders were asked to fill a nest card for birds of prey nests found during the breeding season. The relatively poor response prompted the use of a special summary questionnaire, since 1986, sent to all bird banders. With this simple *Raptor Questionnaire* all banders *must* report a summary of all nests and territories of all birds of prey they have detected during each year.

The *Raptor Questionnaire*s summarize the total numbers of (1) potential nest sites checked (table 1), (2) active nests and occupied territories found (table 2), and (3) nests of different clutch and brood sizes verified by banders within the "territories" of 25 local ornithological societies in different parts of the country. Further, the bander has to give information on the amount of field work done by comparing the present and previous seasons according to following scale: the amount of field work on the species was (1) much more than, (2) a little more than, (3) the same as, (4) a little less than, and (5) much less than in the previous season.

The main purpose of the *Raptor Questionnaire* is to collect data on the annual breeding output. In addition, this data, although it cannot be precisely standardized from year to year, may be used with care to detect fluctuations and trends in population sizes, especially when the *Raptor Grid* data is too scanty.

Feed-back articles reporting the results of *Raptor Grid* and *Raptor Questionnaire*-programs have been published every year after the breeding season (e.g., Haapala & Saurola 1986; Haapala *et al*. 1993, 1996).

Monitoring Survival and Dispersal: Banding Programs

For a bander, recaptures and recoveries are the "prize" for the valuable voluntary work described above. Banding is also a basis for monitoring survival and dispersal. In principle, it is fairly simple and straightforward to estimate changes in adult survival from representative long-term capture-recapture data sets (see e.g., Forsman *et al*. 1996). Finnish banders have been encouraged not only to band nestlings but to capture and recapture the adult birds at the nest as well (Saurola 1987a).

Table 1.—*The numbers of potential nest sites of birds of prey checked by Finnish banders in 1996 (excluding the special programs for the eagles, Osprey, and Peregrine).*

Nest sites checked	Number
Big stick nests made by buzzards and hawks	4,579
Small stick nests made by crows and squirrels	2,347
Artificial nests for buzzards and hawks	2,179
Artificial nests for small falcons	4,581
Nest-boxes for the Ural Owl (*Strix uralensis*)	4,583
Nest-boxes for the Tawny Owl (*Strix aluco*)	4,308
Nest-boxes for the Tengmalm's Owl (*Aegolius funereus*)	10,038
Nest-boxes for the Pygmy Owl (*Glaucidium passerinum*)	3,753
Large natural cavities (mainly Black Woodpecker cavities)	2,916
Small woodpecker cavities	3,133
Eagle Owl territories	1,325

Table 2.—*Maximum annual number of active nests, nestlings banded, and adults captured (= banded or recaptured) at the nest of Finnish owls during 1986–1996; the respective record years are given in parenthesis. "Active nest" includes here, in addition to nests found, also broods detected after fledging. The proportion of fledged broods is, however, low except of the "nests" of the Long-eared Owl which may be up to 70 percent. "Population estimate" for non-nomadic species equals the average number of territories occupied annually and for nomadic species (indicated by asterisk) the maximum number of breeding pairs in a peak vole year (Saurola 1985).*

Species	Active nests		Nestlings banded		Adults captured at the nest				Population estimate
					Females		Males		
Eurasian Eagle Owl (*Bubo bubo*)	537	(-94)	803	(-94)	5	(-88)	3	(-89)	2,500
Snowy Owl (*Nyctea scandiaca*)	15	(-88)	20	(-88)	0		0		50 *
Tawny Owl (*Strix aluco*)	548	(-94)	1,535	(-94)	265	(-91)	119	(-94)	2,000
Ural Owl (*Strix uralensis*)	901	(-94)	2,006	(-89)	623	(-94)	72	(-89)	3,000
Great Grey Owl (*Strix nebulosa*)	100	(-89)	200	(-89)	20	(-96)	13	(-96)	1,000 *
Northern Hawk Owl (*Surnia ulula*)	119	(-88)	399	(-89)	10	(-89)	4	(-88)	4,000 *
Eurasian Pygmy Owl (*Glaucidium passerinum*)	274	(-95)	1,005	(-94)	155	(-95)	22	(-91)	2,500
Tengmalm's Owl (*Aegolius funereus*)	2,265	(-89)	6,686	(-89)	1,336	(-89)	191	(-89)	15,000 *
Long-eared Owl (*Asio otus*)	578	(-91)	505	(-88)	2	(-88)	1	(-89)	5,000 *
Short-eared Owl (*Asio flammeus*)	132	(-86)	322	(-88)	5	(-91)	3	(-95)	5,000 *

For owl species breeding in cavities and nest-boxes, the data on adults, especially on females, captured at the nest is fairly extensive, but for open-nesting species they are almost totally missing (table 2).

RESULTS

Some preliminary results from both *Raptor Grid* and *Raptor Questionnaire* are presented. These include for each species (1) a distribution map based on the results of the two Finnish Breeding Bird Atlases (Hyytiä *et al*. 1983, Väisänen unpubl. data; figs. 1, 4–12), (2) a column chart for the entire country and corresponding charts for the areas of all local ornithological societies showing the annual numbers of nests and territories found by banders (figs. 1, 4–12), and (3) a diagram of average annual production of young per active nest (excluding the Snowy Owl) in 1986–1996 (fig. 3). In addition, (4) the annual population indices derived from the *Raptor Grid* data are shown for five well-covered species (fig. 2). Please note that all these figures are based on raw data, which has not been corrected with the information on possible changes in the amount and quality of fieldwork carried out. However, the essential effects of changing effort have been mentioned in the text.

Eurasian Eagle Owl

In the early 1960s, the Eurasian Eagle Owl (*Bubo bubo bubo* (L.)) was not protected by law and it was considered, by conservationists, an endangered species in Finland. Protection during the breeding season was finally given in 1966 and since 1983 the Eagle Owl has been protected year round. In addition to full protection, clearcutting of forests, and stable anthropogenic food resources, i.e., large Norwegian rat (*Rattus norvegicus*) populations at rubbish dumps, have been the most important causes of the rapid recovery of the population (Saurola 1985). The Eagle Owl now breeds all over Finland except the northernmost tundra, with highest density in the west–southwest (fig. 1). Since 1982, the population has been slowly increasing (fig. 2). The effect of fluctuating vole populations can be clearly observed in the number of breeding attempts (figs. 1–2), but is not as evident in the breeding output of those pairs which have started to breed (fig. 3).

It is important to predict the population trend of this controversial species. For that purpose it is necessary to have relevant capture-recapture data for survival and dispersal analyses. In total, more than 5,580 nestlings have been ringed during the last 10 years, but only very

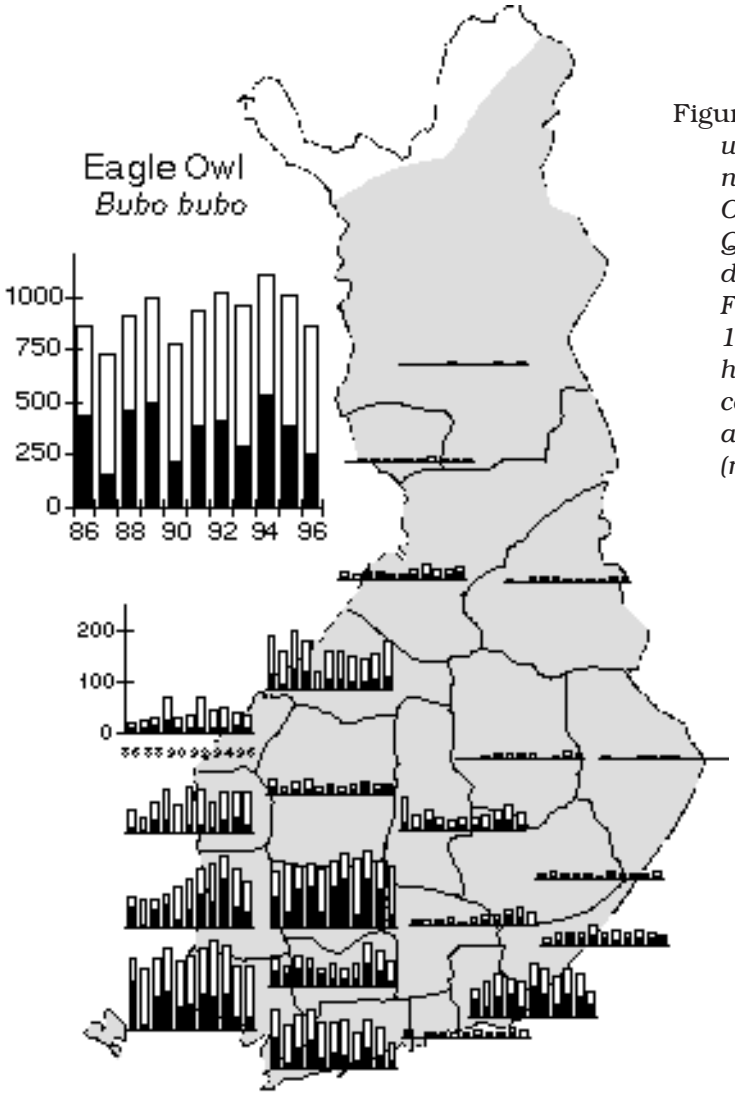

Figure 1.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Eagle Owl (*Bubo bubo*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

few adults have been captured at the nest (e.g., table 2). The Eagle Owl is a very shy breeder. So far, attempts to develop an efficient, but safe method to catch adults at nests have not succeeded.

Snowy Owl

The nomadic Snowy Owl (*Nyctea scandiaca* (L.)) is only an occasional breeding bird in Finland. Only when a Snowy Owl invasion from the east coincides with a microtine peak will breeding occur in the northernmost highlands and bogs of Finnish Lapland (fig. 4). This most recently occurred in 1988, 1987, and 1974. Before 1974, no observations of breeding Snowy Owls were made for several decades in Finland. A few individuals have been seen every winter, especially in the southwestern archipelago, but mass winter invasions seldom occur, the last being the two successive winters of 1960–1961 and 1961–1962.

Tawny Owl

The Tawny Owl (*Strix aluco aluco* L.) is a newcomer to Finland from Middle Europe: the first observation was made in 1875 and the first breeding attempt was verified in 1878 (e.g., Saurola 1995). It has the most southerly distribution of all Finnish owl species (fig. 5). Because the Tawny Owl is a year-round resident, the northern boundary of its distribution is most probably determined by winter mortality. For instance, during the harsh winter 1986–1987 a big proportion of the population starved to death. The population recovered rapidly, but again suffered high mortality

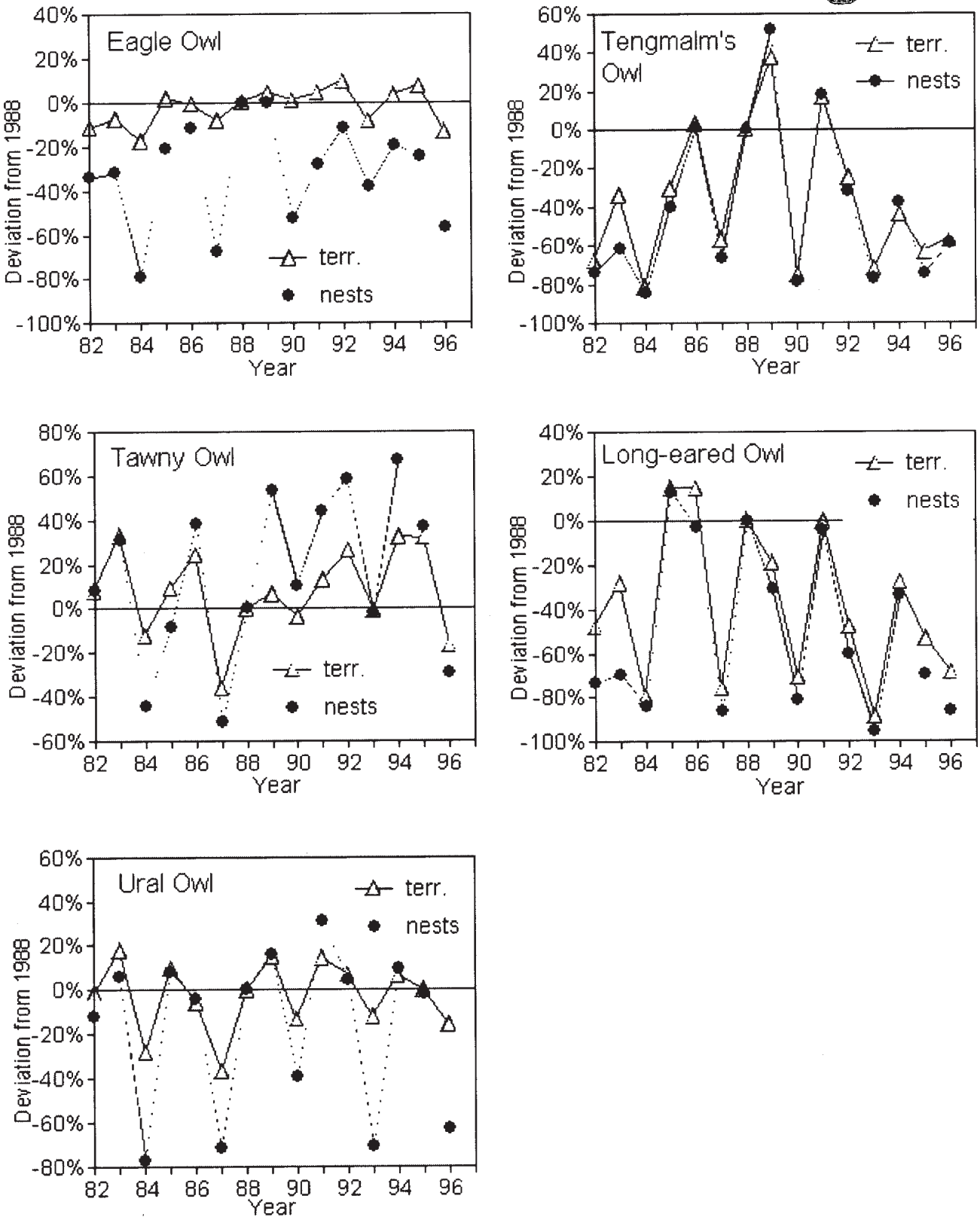

Figure 2.—*Annual variation of the population indices of the Eagle Owl (*Bubo bubo*), Tawny Owl (*Strix aluco*), Ural Owl (*Strix uralensis*), Tengmalm's Owl (*Aegolius funereus*), and Long-eared Owl (*Asio otus*) in Finland, based on data from the Raptor Grid program in 1982–1996. The indices were calculated as percentual deviations from the reference year 1988. Dots = active nests, triangles= all occupied territories (including active nests).*

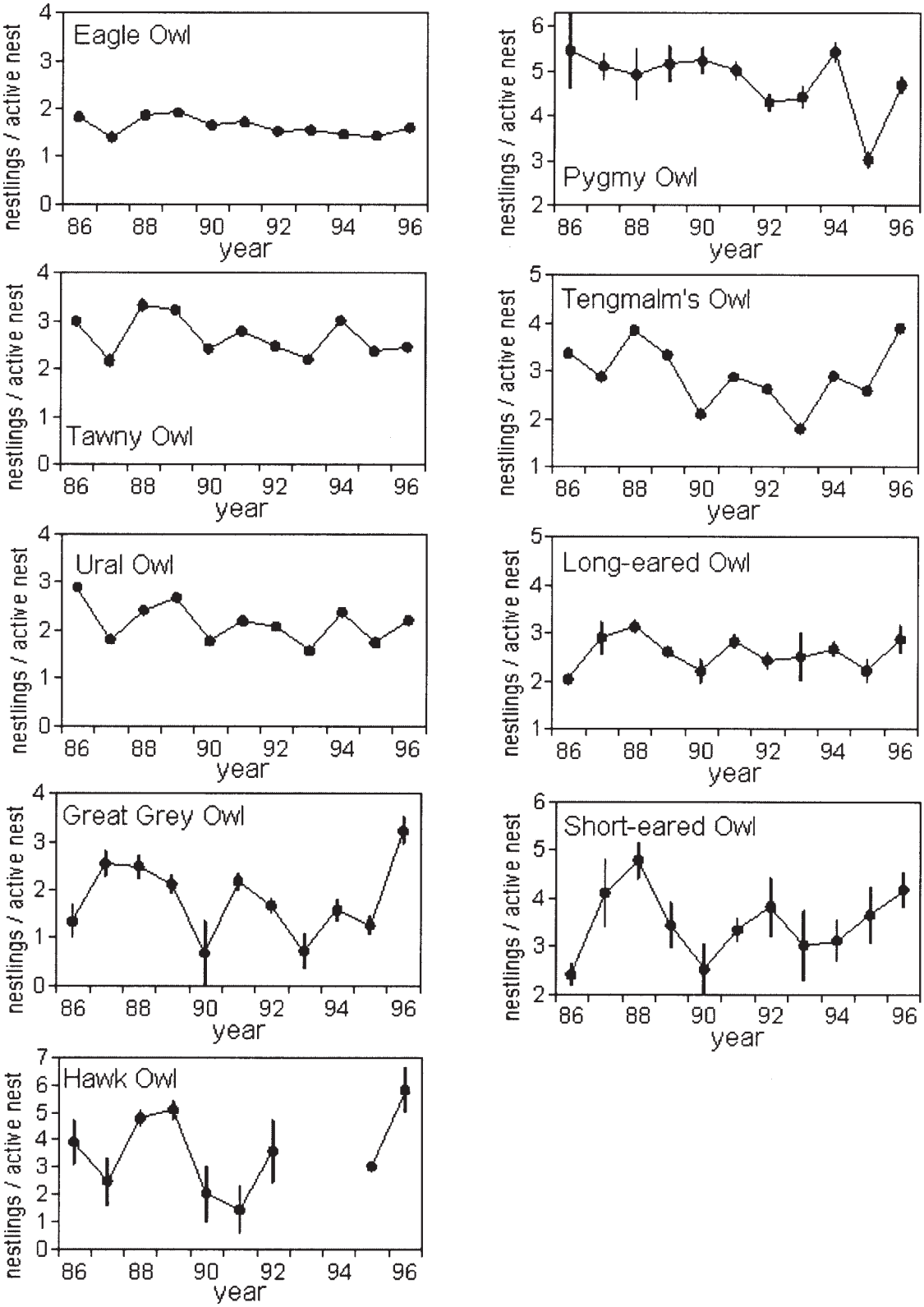

Figure 3.—*The mean annual production of young per active nest of Finnish owls 1986–1996. Standard errors indicated by vertical lines.*

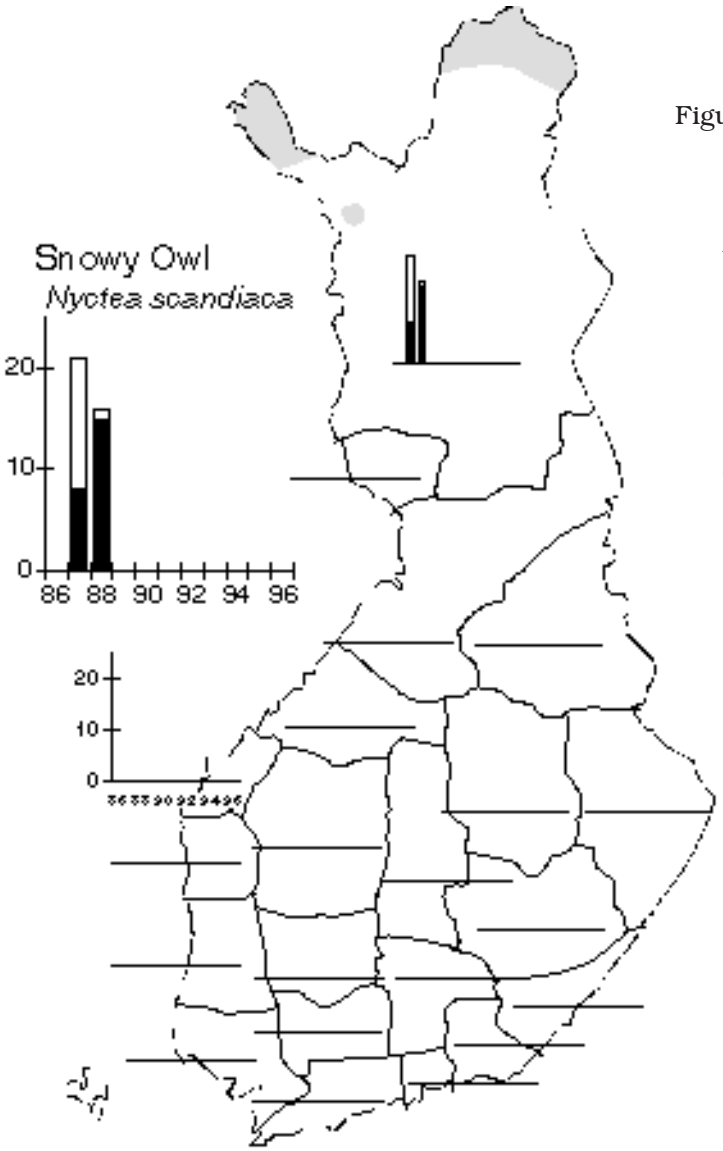

Figure 4.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Snowy Owl (*Nyctea scandiaca*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

during the winter 1995–1996 (unpubl. data, fig. 2). The Tawny Owl is a generalist feeder relative to other Finnish owls, but good and bad vole years clearly affect its breeding performance (Linkola and Myllymäki 1969, figs. 2-3, 5).

The population ecology of the Tawny Owl has been studied for more than 30 years, but few results have been published so far (e.g., Linkola and Myllymäki 1969, Saurola 1987b). In the best year, more than 1,500 nestlings were banded and almost 400 adults captured at the nest (table 2). The first attempts to estimate the annual variation in survival both by using recoveries of birds found dead (Rinne *et al*. 1990, 1993) and recaptures of breeding birds (Saurola, unpubl. data) have already been made.

Ural Owl

The Ural Owl (*Strix uralensis liturata* Lindr.) breeds in coniferous and mixed forests all over Finland up to the southern part of Lapland (fig. 6). However, along the southern and western coastal areas the population is sparse, probably because of competition with and predation by the Eagle Owl. Further, the population density is also very low in northern Finland, where the Ural Owl is mainly replaced by the Great Gray Owl, which is more invasive and better adapted to catch voles through thick snow. In contrast, low numbers of nests found in southeastern Finland are partly due to the lower bander activity.

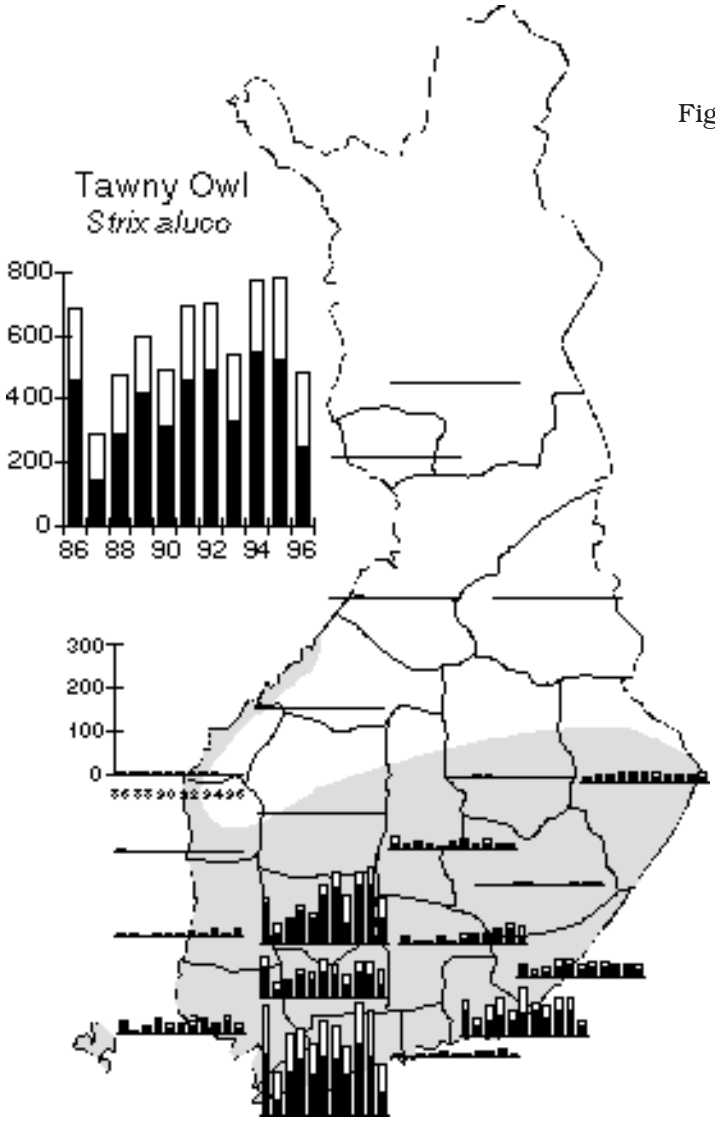

Figure 5.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Tawny Owl (*Strix aluco*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

The population ecology of the Ural Owl have been studied intensively during the last 30 years in two areas in Finland (e.g., Linkola and Myllymäki 1969; Pietiäinen 1989; Pietiäinen and Kolunen 1993; Saurola 1989, 1992). These studies have shown that the breeding performance of the Ural Owl is strongly dependent on fluctuating vole populations. This also can be clearly seen in figures 2, 3, and 6: both the number of breeding attempts and the production of young per attempt have followed a pattern determined by voles. The total number of active nests found in good vole years (fig. 6) seems to have increased slightly during the last 10 years, but more standardized data (Saurola 1992 and unpubl., fig. 2,) does not show any kind of trend during the 1970s, 1980s, and 1990s.

High numbers of nestlings have been banded and females captured (banded/recaptured) at the nest during the last 20 years (table 2), but the analysis on survival rates is not yet finished (Saurola, in prep.). Both recaptures and recoveries of dead birds have shown that the nest site fidelity of breeding Ural and Tawny Owls is very high (Saurola 1987b), which means that figures 2 and 6 reflect actual fluctuations in Finnish populations of these species.

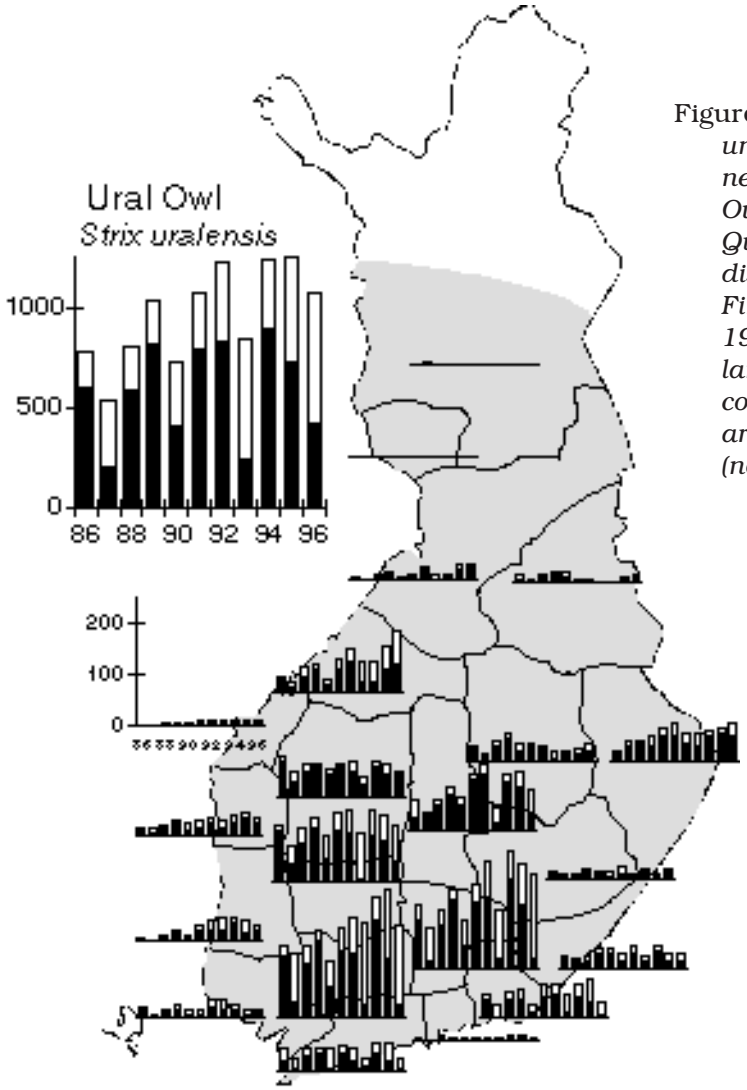

Figure 6.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Ural Owl (*Strix uralensis*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

Great Gray Owl

In principle, a breeding pair of the Great Gray Owl (*Strix nebulosa lapponica* Thunb.) may be found anywhere in Finland, except in the southwestern archipelago and the northwestern corner of Lapland (fig. 7). However, in practice, the Great Gray Owl is a very rare breeder in the southern third of the country (cf. the Ural Owl, fig. 6). Since the late 1960s, the number of active nests found have increased considerably. Although a part of the increase may be attributed to the increased activity of banders and other bird-watchers in northern Finland, the Finnish Great Gray Owl population has certainly increased from the very low level in the 1940s, 1950s, and early 1960s (Sulkava 1997). Compared with the two hole-nesting *Strix*-species, the Great Gray Owl has been studied very little in Finland (cf. table 2). A few band recoveries suggest that a (small) part of the Finnish population is resident, while the others are nomadic.

Northern Hawk Owl

The potential breeding distribution of the Northern Hawk Owl (*Surnia ulula ulula* (L.)) extends all over Finland. However, during the last decades its distribution has been restricted to the northern half of the country (fig. 8). The hawk owl is a nomad which follows vole peaks across wide areas in northern forests: e.g., two nestlings banded in Finland were encountered

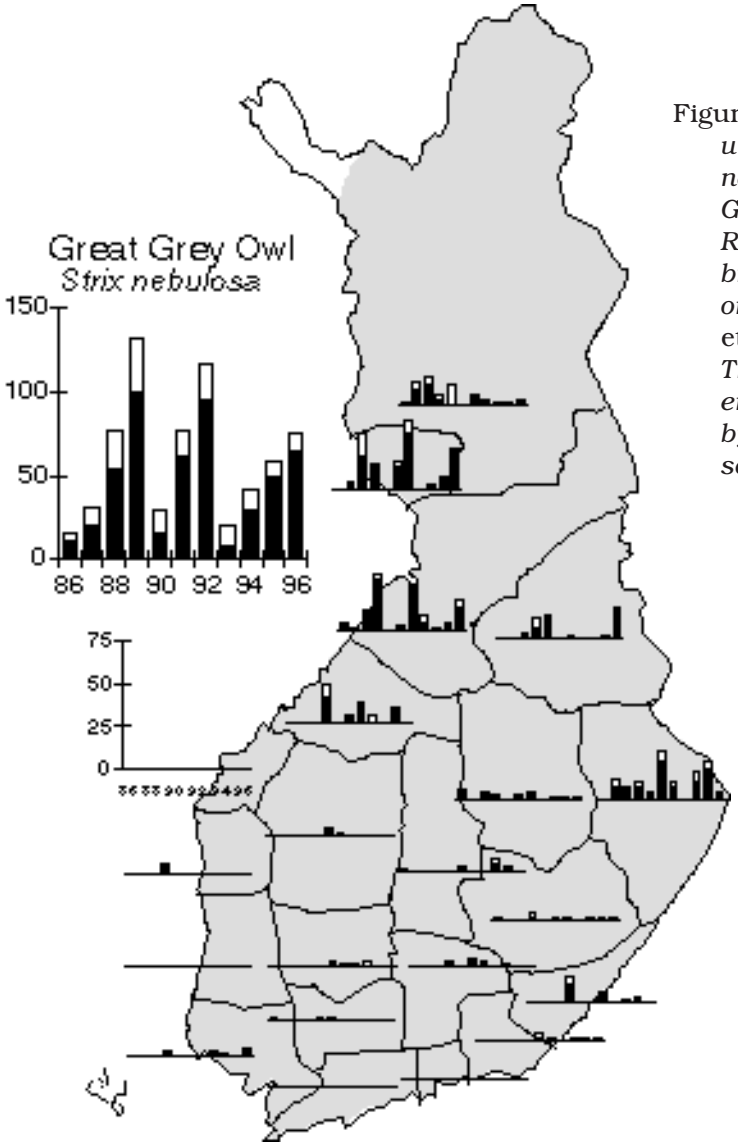

Figure 7.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Great Gray Owl (*Strix nebulosa*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

east of the Ural mountains, 2,700 km away, and three others from southern Norway, 1,200–1,400 km away from their natal areas (Saurola 1995). Thus, the hawk owl is a very difficult species to study and monitor. Banding totals indicate that during the last 3 decades 1–2 year peaks in breeding (1974, 1977–1978, 1982–1983, and 1988–1989) have followed each other with 3–5 year intervals. However, after the last peak year, breeding hawk owls have been almost absent from Finland for 7 years (fig. 8).

Eurasian Pygmy Owl

The Eurasian Pygmy Owl (*Glaucidium passerinum passerinum* (L.)) extends its distribution from the southern coast to middle part of Lapland (fig. 9). Ten years ago the Pygmy Owl was included in the Red Data Book of Finland and the population estimate (= "academic guess") was 2,500 pairs (table 2, Saurola 1985). Since then new information has been gathered as a result of the development of special thick-front-wall nest boxes and early morning hoot excursions. The Pygmy Owl is no longer included in the Red Data Book and the population "guesstimate" should be 3–4 times higher. At the moment, no population trend can be derived from the data (fig. 9), because it reflects the high correlation between the number of available nest boxes and the number of nests found (r = 0.87).

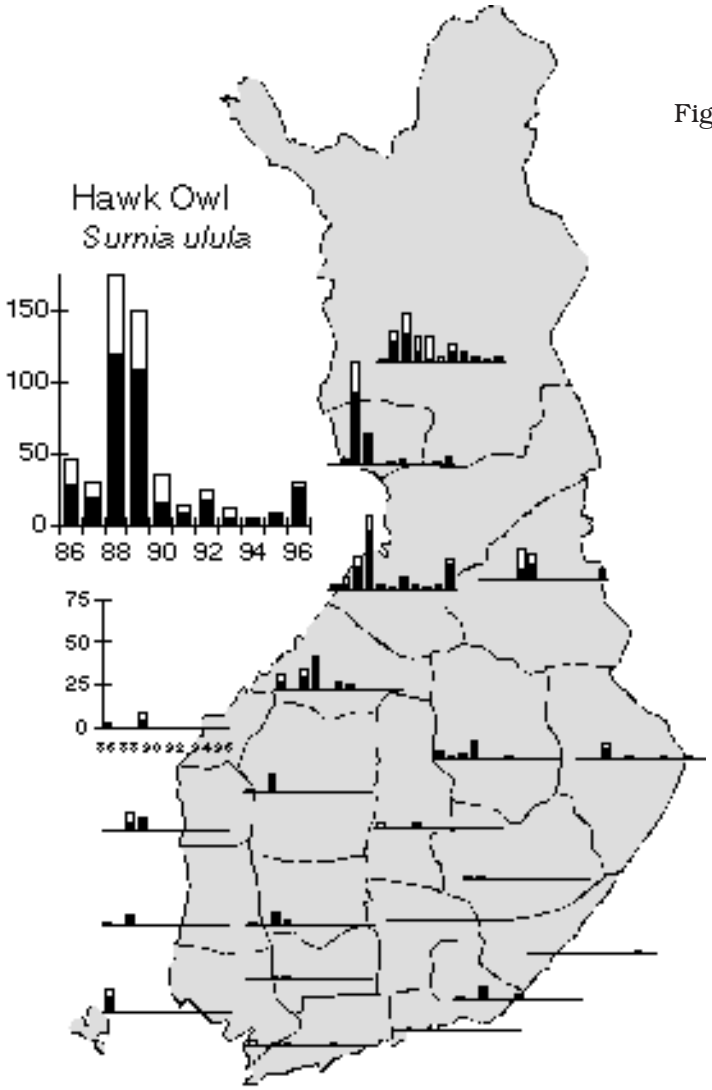

Figure 8.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Hawk Owl (*Surnia ulula*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

Tengmalm's Owl

The Tengmalm's Owl (*Aegolius funereus funereus* (L.)) breeds in various kinds of forests and woodlands all over Finland, from the southern archipelago to northernmost Lapland (fig. 10). It is the most common and abundant of the Finnish owls. It is also the most intensively and extensively studied owl species in Finland (e.g., Korpimäki 1981, 1992a; Korpimäki and Hakkarainen 1991; Korpimäki and Lagerström 1988). Figures 2 and 10 indicate that the breeding population of the Tengmalm's Owl has fluctuated with a 3-year pattern, in fairly extensive synchrony over large areas in southern Finland, and in rhythm with other owl species. The Tengmalm's Owl had an exceptionally good year in 1989 especially along the central part of the west coast. This was probably due both to the high breeding output in 1988 and the exceptionally strong immigration of Tengmalm's Owls to the west coast in 1989. Band recoveries suggest that Finnish Tengmalm's Owls are partly nomadic: when the vole populations crash, females emigrate but males try to survive on their territories (Korpimäki *et al*. 1987).

Long-eared Owl

The Long-eared Owl (*Asio otus otus* (L.)) breeds in various kinds of woodlands, often close to agricultural areas, from the southern coast to southern Lapland (fig. 11). The Long-eared Owl is a vole specialist, which breeds only when *Microtus* populations are high (Korpimäki

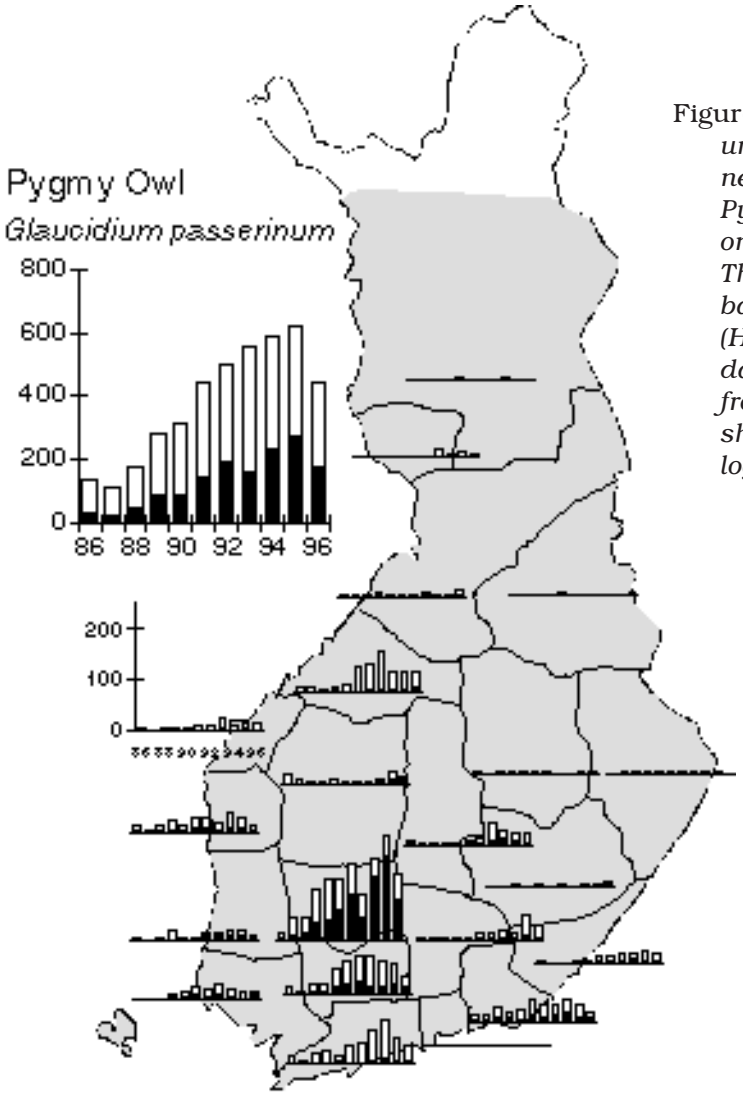

Figure 9.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Pygmy Owl (*Glaucidium passerinum*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

1992b). In Finland it is migratory and at least partly or perhaps totally nomadic (Saurola 1983). Both the number of active nests and occupied territories have fluctuated widely with a 3-year pattern across most of southern Finland (figs. 2 and 11). Since 1986, the total number of nests found in peak years in Finland has been stable, except in 1995, when voles crashed in early spring (fig. 11). Because many of the Long-eared Owl nests have been found after the young start to beg, the bander's data on the reproductive output is biased: the average number of young produced per active nest is likely too high, but probably comparable over the years (fig. 3).

Short-eared Owl

The Short-eared Owl (*Asio flammeus flammeus* (Pont.)) may breed all over Finland from the southern archipelago to northernmost Lapland (fig. 12). However, as figure 12 indicates, there are very few breeding records since 1986 in the southern part of the country. The Short-eared Owl is migratory and mostly, if not totally, nomadic (Korpimäki 1992b, Saurola 1983). Because Short-eared Owls are active and conspicuous during the day, occupied territories are easily detected. In contrast, much more work and motivation is needed for finding the well-hidden nest in a marsh, meadow, or field. This difference can be observed in figure 12: from some areas only territories are reported.

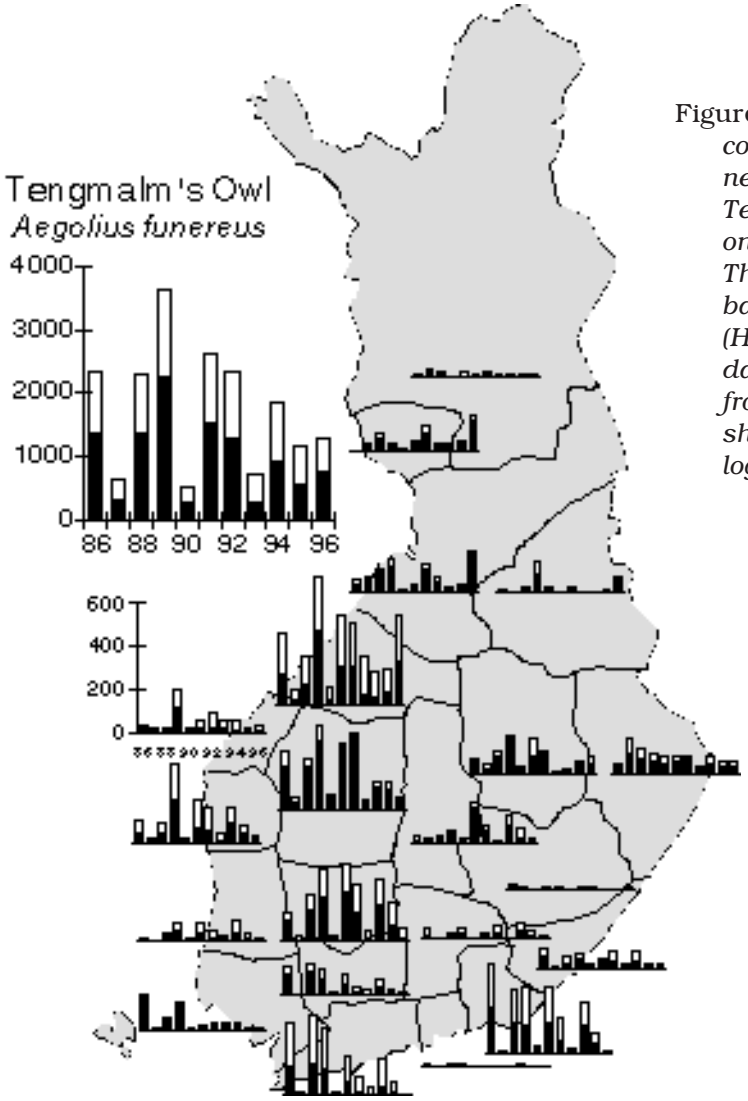

Figure 10.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Tengmalm's Owl (*Aegolius funereus*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

DISCUSSION

Methodological Biases

Raptor Grid

Incomplete Coverage.—This sampling method is, in principle, very simple, but in practice for some species very laborious, when the study plot is 100 km^2. Hence, the variation in search effort and success is high between the study plots. Because the aim of this project is to produce annual population indices for detecting long-term trends, variation between study plots is not critical, providing that effort from year to year within each study plot remains the same.

Turnover of Study Plots.—In principle, the set of study plots and the search effort in each study plot should be the same from year to year. In practice, because the work is voluntary, some study plots become inactive and new ones emerge (Haapala *et al*. 1993). However, this bias may be mitigated by using an appropriate statistical procedure when analyzing the data. Here (fig. 2) all years were compared pairwise with the reference year 1988, which was in general a good year with much data and fairly close to the middle of the study period. This very simple method is relatively unbiased. However, quite a large amount of data from study plots which were not active in 1988 was not used, and, in the future, more sophisticated analytical methods should be used.

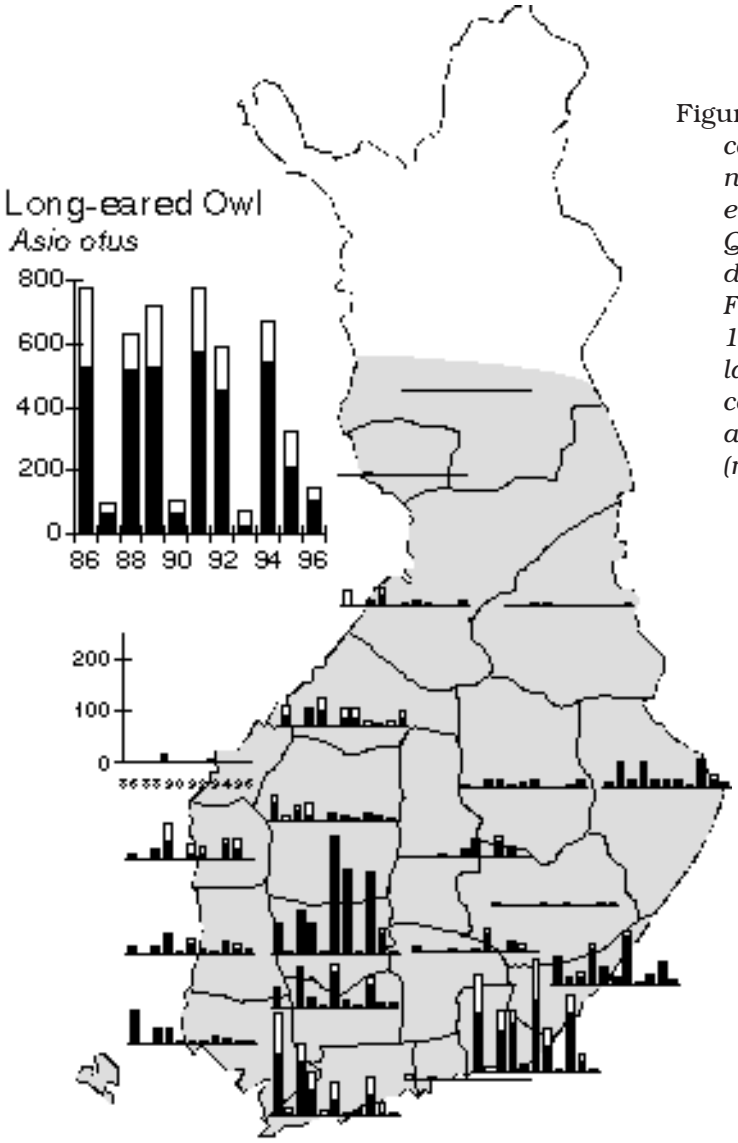

Figure 11.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Long-eared Owl (*Asio otus*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

Semi-random Selection of Study Plots.—Because the *Raptor Grid* 10 x 10 km study plots have not been selected randomly, they may be better areas for birds of prey than other potential study plots nearby, and, hence, the changes detected may not represent the changes in the entire population. Although the banders may freely select their study plots, the boundaries ("even-ten-kilometer" lines) of the plots are randomly pre-determined by the National Grid. For this reason, the quality differences between such large plots and other potential plots nearby are small.

Geographical Distribution of *Raptor Grid* Study Plots.—The number of resident banders is very low in northern Finland and, consequently, the data from both the *Raptor Grid* and the *Raptor Quetionnaire* is not representative for the northern half of the country. This bias is very difficult to avoid without extra funding for travel costs for visiting banders from southern Finland.

Raptor Questionnaire

Population Changes.—The total amount of annual field work done by banders in searching for nests is not constant, although most of the banders have a traditional banding "territory" where they check the same nest-boxes and territories from year to year. So far, the total effort has been increasing: new permits for raptor banders have been issued and some of the veteran banders have increased their effort, e.g., by putting up more nest boxes within their

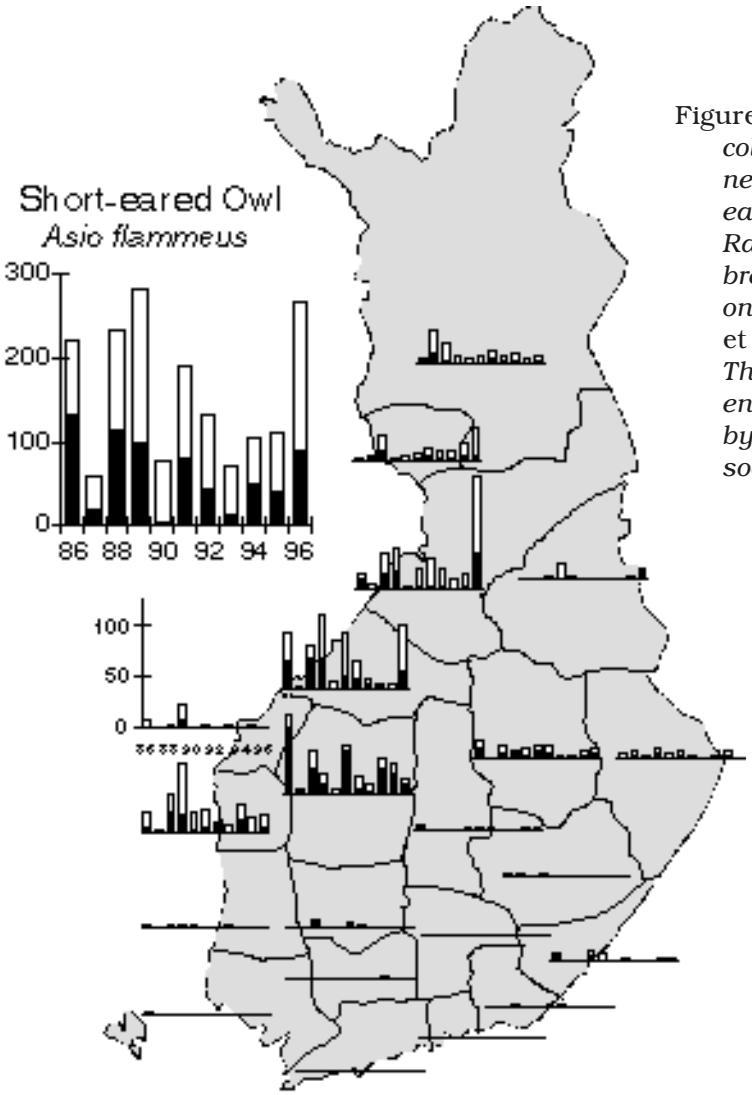

Figure 12.—*Number of active nests (black columns) and occupied territories, where no nest was found (white columns) of the Short-eared Owl (*Asio flammeus*) based on the Raptor Questionnaire in 1986–1996. The breeding distribution (shaded area) is based on the Finnish Breeding Bird Atlases (Hyytiä* et al. *1983 and Väisänen, unpubl. data). The large histograms include data from the entire country; small histograms show data by the areas of the local ornithological societies (note different scales).*

banding territory. In principle, the data could be corrected for the change in effort (see MATERIAL AND METHODS), but this was not done.

Breeding Output.—Data from the *Raptor Questionnaire* gives a fairly reliable picture of the annual breeding output of Finnish owls. However, two potential biases must be noted. First, a successful nest of an open-nesting species is probably found more often than an unsuccessful one. Thus, the breeding output of some open-nesting species (e.g., the Long-eared Owl) may be too high (fig 3). Second, the breeding output in nest boxes may not represent the entire population.

Nest boxes vs. Natural Cavities

Nest box programs were started as a conservation measure to compensate for the loss of natural owl nest sites by commercial forestry. Later, the use of nest boxes became a research method to find and reach owl nests much more easily than in natural circumstances. However, some potential biases must be taken into account when analyzing data from nest box programs.

Population Changes.—If only a small part of the population breeds in nest boxes, and if the number of natural nest sites becomes an important limiting factor, a decrease of the "natural population" will not be detected if all data comes from the "nest box population".

There should still be enough woodpecker cavities available for the Pygmy Owl almost everywhere in Finland. In contrast, commercial forests which are exploited intensively without a positive attitude for conservation, may lack sufficient Black Woodpecker (*Dryocopus martius*) cavities for the Tengmalm's Owl. The Tawny Owl breeds in association with human settlements and may use, in addition to Black Woodpecker cavities and nest boxes for owls, other suitable man-made nest sites like buildings and vacant nest-boxes constructed for the Goldeneye (*Bucephala clangula*) and Goosander (*Mergus merganser*). The Ural Owl probably suffers more than any other Finnish owl species from the lack of good natural nest sites: large cavities in big trees and chimney-like stumps, which are very rare in modern forests. The Ural Owl may nest in vacant hawk nests, although it is not well-adapted to breed in stick nests (see below).

Breeding output.—Properly constructed and placed nest boxes may be better nest sites than natural ones. In virgin forests the number of nest sites is probably large enough that the difference between nest boxes and natural sites accepted by owls is negligible. In commercial forests, in contrast, nest boxes may be, on average, more productive nest sites than natural ones. If so, the data on breeding output from nest box studies does not represent "normal" reproductive success in commercial forests. For example, Ural Owl females may, by scraping the nest bowl deeper and deeper during incubation, push the eggs down through the bottom of a thin stick nest. This cannot happen in a cavity or in a nest box. In addition, young leave a stick nest sooner and are more vulnerable to predators than those in a deep cavity, stump, or nest box.

Evaluation and Potential Improvements

Resident Species

Population Size and Breeding Output.—In principle, it is an easy and straightforward task to monitor resident species. Thus, alarming changes both in population size and breeding output of the Eagle Owl, Tawny Owl, and Ural Owl should be detected by the present monitoring system. Data for the Pygmy Owl comes from a short period and from a fairly restricted area and, hence, the value of any conclusions is so far quite restricted. But "Pygmy Owl disease" is quickly spreading among the banders and within some years the Pygmy Owl will probably be among the well-monitored species as well.

The Finnish Tengmalm's Owl is intermediate between a resident and a nomad: males stay but females emigrate hundreds of kilometers. Thus, local long-term population studies are partly based on resident males (e.g., Korpimäki 1992a). However, the existing banding results suggest, that in contrast to the "real" nomadic species (see below), we may speak about the "Finnish population" of the Tengmalm's Owl. So, the present monitoring system should produce representative data on this intermediate species, too.

Survival.—Monitoring changes in adult and juvenile survival is much more complicated but is at least as important as monitoring fecundity. There is an extensive capture-recapture data set for Ural Owl females caught at the nest and fairly good data on the Tawny Owl; but data on male Ural Owls is, in practice, restricted to my own study area. An analysis of these data is under preparation (Saurola in prep.). Female Tengmalm's Owls have been caught as efficiently as females of the two nest-box using *Strix*-species, from 50–60 percent of known nests, but the proportion of recaptures has been much lower (15–20 percent vs. 70–80 percent in *Strix*). Because of female nomadism this data cannot easily be used for survival analysis. Data on male Tengmalm's Owls comes mainly from Erkki Korpimäki's study area (Korpimäki 1992a).

Survival during the first year of life cannot be estimated with the capture-recapture method. Estimates based only on recoveries of birds banded as nestlings and found dead by the general public are unreliable. However, there is still some methodological work going on, especially analyzing the Finnish Tawny Owl and Ural Owl recoveries (Rinne *et al*. 1990, 1993, and in prep.).

Nomadic Species

In fact, there are no resident "Finnish breeding populations" of the Snowy Owl, Northern Hawk Owl, and Great Gray Owl. These "populations" are only individuals of a large nomadic population from northern Russia through Finland and Sweden to Norway which happen to breed now

and then in Finland. The Short-eared Owl belongs to the same group, but the common area of its "Western-Palearctic population" extends much further south. Long-eared Owls breeding in Finland are also nomads, but probably on a much smaller scale (perhaps mainly within Finland ?). These conclusions are based mostly on "common sense" and not on hard data: there are very few band recoveries of dead birds and hardly any recaptures at nests showing the real extent of the breeding and natal dispersal of these species.

It is not possible to monitor nomadic species properly without intensive cooperation over large areas in northern Europe and across national boundaries. At least during the peak years for these species, which are easily detected, extra study plots should be established to estimate their densities, nestlings should be banded, and the adults banded/recaptured at nests as extensively as possible in all countries sharing the populations. These proposals are of course impossible to realize all over northern Russia. But for the Nordic countries, and perhaps including northwestern Russia, a joint "Nomadic Owls" program is perhaps not unrealistic if the idea is properly "sold" to volunteers.

CONCLUDING REMARKS

1. In Finland, good cooperation between professional-level volunteers (bird banders) and organizations responsible for monitoring bird populations (Ministry of Environment and the Finnish Museum of Natural History) has produced valuable data for monitoring diurnal and nocturnal birds of prey. In fact, for economical reasons, this has been the only way to get such important information.

2. The data available does not suggest any alarming negative trends during the last 15 years for any resident species of Finnish owls.

3. However, in many areas in Finland, commercial forests have been heavily harvested and hole-nesting owl species suffer from the lack of natural nest sites: suitable cavities in hollow trees. In those areas, hole-nesting owls are dependent on the continuous voluntary work of owl banders, who try to compensate the losses with appropriate nest-boxes.

4. More fieldwork and international cooperation is needed before reliable conclusions on nomadic species are possible.

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