Ann. Zool. Fennici 21:265–269. 1984

Reproductive success, mortality and nest site requirements of the Ural Owl Strix uralensis in central Sweden

Arne Lundberg & Björn Westman

Lundberg, A. & Westman, B. 1984: Reproductive success, mortality and nest site requirements of the Ural Owl Strix uralensis in central Sweden. — Ann. Zool. Fennici 21:265-269.

We present data from 15 years' study on breeding success and mortality in females and young of the Ural Owl in central Sweden. Mean reproductive was 1.03 young per pair per annum which should be sufficient to compensate for mortality (first year 62 %, breeding females 10.5 %) and theoretically the population should be able to increase with 4 % per year. However, the potential increase is thwarted by increasing scarcity of natural nest sites, this deficit being only partially compensated by the erection of nest boxes, on which a growing portion of the local population is dependent for breeding.

Arne Lundberg & Björn Westman, Department of Zoology, Uppsala University, Box 561, S-751 22 Uppsala, Sweden.

1. Introduction

Most Fennoscandian owl species are heavily dependent on *Microtus, Clethrionomys* and *Lemmus* species for food during the breeding season and as a result the owls' breeding pattern, like their prey, exhibits a four year cycle (e.g. Linkola & Myllymäki 1969, Hörnfeldt 1978, Saurola 1978, Lundberg 1979). To be able to obtain accurate information about the population dynamics of such species, one therefore has to gather long term field data. Moreover, raptors and owls are often susceptible to man-induced environmental perturbations. For example, several species have declined in numbers due to poisoning (e.g., Eagle Owl *Bubo bubo* — Olsson 1979, Peregrine Falcon *Falco peregrinus* — Lindberg 1975, Odsjö & Lindberg 1977, Ratcliffe 1980, White-tailed Eagle *Haliaeetus albicilla* — Helander et al. 1982, Helander 1983) or are threatened by changes in land use, such as modern forestry (see Ahlén 1977), or habitat destruction. In the first case, the population size of a species may decrease because offspring production is too low, while in the latter case a negative population trend may be due to loss of nest sites and/or foraging areas. Since raptors and owls are mostly scarce and/or widely scattered in distribution even in a natural situation, long term studies are needed in order to reveal the sources and effects of possible negative environmental influence.

In this paper we present data, based on 15 years of study, about the breeding of the Ural Owl *Strix uralensis* in central Sweden. This corresponds to approximately four vole cycles which is long enough to enable us to describe the breeding dynamics of the species. We shall also try to analyse whether the breeding success of the population is sufficient to maintain its present size and whether habitat changes, such as increased nest site scarcity, may threaten the population which is the southernmost of the species in Fennoscandia.

2. Study area and methods

The study was performed in the province of Uppland (approximately 60° N) in central Sweden (for further details see Lundberg 1981). Annual auditory censuses in 1969-78 were carried out to monitor the presence of "established" pairs and at the same time "new" pairs were looked for. The total breeding population in the study area (ca 3300 km^2) was estimated at about 100 pairs (Lundberg 1981) but later censuses have suggested even higher figures (175-200 territorial males; Douhan et al. 1982). From 1979 to 1983 we have mainly focused on checking pairs for which we knew the nest site(s). All breeding pairs have been visited to establish clutch size (from 1980 also date of egglaying) and fledging success. Most breeding females have been caught on the nest and ringed. Later in the season we also ringed the nestlings.

Calculations of mortality rates during the first years of life have been based on recoveries of birds ringed as nestlings and reported dead to the Swedish ringing office. For adult mortality we have used data of ringed breeding females and assume, as previous work has shown to be legitimate, that a female which has been replaced at a nest site is dead.

In most territories we carefully searched for potential nest sites. For several pairs no suitable nest sites were found although pairs have been present for many successive years. In some of these territories nest boxes were provided and most often the pairs quickly accepted them for breeding.

The main part of our data about clutch size and breeding success is from nest box breeding pairs since many of the natural nest sites are difficult to inspect.

3. Results

3.1 Breeding success

The major variable components of breeding success in the Ural Owl are breeding frequency, clutch size and hatching failure. Less important is loss of nestlings (Lundberg 1981). Whether a Ural Owl female will breed or not in a particular year is most likely determined by how well nourished she is in the prelaying period. Just prior to egg-laying she receives all of her food from the male and does not hunt by herself. At this time the owls are heavily dependent on *Microtus* and *Clethrionomys* species for food and the fraction of pairs which will start egg-laying varies in synchrony with vole abundance (Lundberg 1981).

During our 15 years of study, breeding frequency has varied between 0 % and 88 % with a mean of 56 % (Table 1). Peaks were recorded in 1969, 1974 and 1977 with 88 %, 83 % and 82 % of all pairs breeding, respectively. Another peak was expected in the breeding season of 1981 but vole populations unexpectedly decreased in winter 1980/81 and voles were scarce in spring (Birger Hörnfeldt, unpublished data) resulting in only 41 % of the pairs starting to breed. Years during which less than 50 % of the pairs commenced breeding were 1971, 1975, 1979 an both the successive years 1981 and 1982.

We have recorded clutches of up to five eggs, but clutches of six have been reported from elsewhere (e.g. Dementiev 1966). Mean yearly clutch size among breeding pairs varied from 1.5 to 3.7 eggs (n = 14 years, no pairs bred in 1979) with a mean of 2.4 ± *SD* 0.95 eggs (Table 1). The mean clutch size for all pairs laying eggs and summed over all years was 2.8 ± *SD* 0.98 eggs (n = 101 clutches). However, as stated above, in all years some pairs did not breed, and by including these figures of "zero-egg clutches" the mean clutch size per pair sinks to 1.5 ± *SD* 0.89 eggs (n = 189).

Clutch size depends on the phase of the vole cycle but also on the date of egg-laying with clutches becoming smaller as the breeding season progresses. We have estimated the onset of egg-laying using the method described by Eriksson et al. (1984) for the years 1980 to 1983. This gives a variation in annual mean date from March 29 (in 1983) to April 9 (1980) with an overall mean of April 4 (± *SD* 8.9 days). However, individual pairs can vary far more in the start of egg-laying as the range within and between these four years is 26 and 41 days respectively. The earliest egg-laying start was March 14 (in 1983) and the latest April 24 (1980).

In total, 43 out of 245 eggs (17.6 %) did not hatch and 64 % of these were lost as whole clutches. Once hatched, the young very rarely die during the nestling period. In all, only five young out of 189 hatched (= 2.7 %) died in the nest.

The mean fledging success for pairs producing young in 1969-83 was 2.5 ± *SD* 0.94 young (Table 1). Including pairs which failed to raise

Table 1. Breeding data for the Ural Owl in central Sweden 1969-1983.

	1969	70	71	72	73	74	75	76	77	78	79	80	81	82	83	*CV* %	Mean ± *SD*	*N*
Breeding frequency (%)	88	56	38	67	75	83	19	53	82	56	0	66	41	43	68	44.0	56±24.5	15 years
Mean clutch size	2.5	1.5	2.0	2.0	3.5	3.3	?	2.0	3.7	3.0	0	2.5	2.4	2.4	3.1	39.3	2.8±0.98	101 cl.
Fledglings/pair*	2.5	1.3	1.0	2.0	3.4	3.1	?	1.9	3.0	3.0	0	2.1	2.0	1.9	2.5	37.8	2.5±0.94	94 cl.
No. of pairs studied	8	9	8	13	17	14	15	19	28	36	17	30	22	23	22			

*Based on pairs producing young.

any young and pairs which refrained from breeding gives an overall mean fledging production of 1.03 ± *SD* 0.71 young per pair and year.

3.2 Mortality rates

Ural Owls start breeding at approximately three or four years of age (Valkeila 1976, Pietiäinen et al. 1984, own data). This is probably so because most birds are born during vole peaks and cannot start breeding until the next vole peak which, most often, will occur after three to four years (Lundberg 1979). In fact, the owls are fully capable of breeding when one year old (Lagerström 1969, Scherzinger 1980, Pietiäinen et al. 1984) and most birds probably take up territories at that age.

Only 54 Swedish ringing recoveries of birds ringed as nestlings are available which is too few for calculating accurate mean annual mortality rates except for the first year. Ringing recovery data show a first year mortality rate of 59.3 % (32/54). After the first year of life, we assume annual mortality to be age independent and we use our own controls of breeding females for estimating adult mortality rate. We then assume that when a breeding female is replaced at a nest or in a territory, she is dead. We have recorded 12 deaths during 115 "exposure years" giving an adult mortality rate of 10.4 % (12/115). We have no data for adult males, but assume mortality rates to be similar in the two sexes.

Summarizing, our data yield the following mortality estimates for Ural Owls of different ages: 1) mortality in the nest after hatching 2.7 %, 2) mortality during the first year of life 59.3 %, and 3) during later years 10.4 %.

3.3 Nest site availability

Ural Owls use so-called stump-nests for breeding, most often broken pines *Pinus sylvestris*, aspens *Populus tremula* or birches *Betula* spp. Suitable nest sites are scarce. In most territories we have searched for suitable nest sites and nest boxes have been provided if we have not found any natural nest sites or if they have been of poor quality. Among pairs breeding at least some time during the last four years 15 pairs (71 %) bred in nest boxes (territories having been established before we put up any nest boxes) and 6 (29 %) in natural nest sites. Of the 15 nest box breeding pairs only two (13 %) have a suitable stump-nest within their territories and another pair may have one. Thus, 62 % of the pairs probably are fully dependent on our nest boxes for breeding. Note that all these pairs have most likely had natural nest sites before we provided our nest boxes.

It is very difficult to assess the longevity of natural nests and their rate of renewal. Certainly, nest sites in pine have longer longevity than those in deciduous trees, while, on the other hand, new nest sites probably arise more frequently in the latter type of trees. One territory has been occupied for at least 44 successive years and during this time the sequence of pairs have used five different nest sites, all in pine, at least four of which still remain (Allan Lundin, pers. comm.) However, we do not know if all of the nest sites are still suitable for breeding. The sequence of pairs in this territory have alternated between the five nests, and one nest (Fig. 1) has been used during a period of at least 34 years but the other four much more briefly. Two nests in other territories, both in aspens, are known to have been used for six years before they were deserted.

During our 15 years of study at least 13 natural stump-nests have become uninhabitable while we only know of the creation of three new ones which have become accepted (two in aspens and one in a birch). Thus, there is probably a clear deficit in the balance between the creation of new nest sites and the loss of old ones.

4. Discussion

The number of offspring which has to be produced per pair each year for maintaining a stable population size can be calculated provided one knows the age of first breeding and the survival rates for different ages. Henny et al. (1970) give the formula

$$m = (1-s)/[s_0 s_1 s_2 (1-s+s_3)]$$

for species that begin to reproduce in their third year of life, where m is the average number of female fledglings produced per year per breeding female, s is the survival rate during higher ages (assumed to be constant) and s_0, s_1 ... are age-specific survival rates.

Assuming equal sex ratio of fledglings, $2m$ will represent the total number of young that has to be produced per breeding female per year. For the Ural Owl we further assume that $s_1 = s_2 = s_3 = s$. Thus, when $s_0 = 0.38$ and $s = 0.896$ the above formula gives a $2m$ of 0.68 young per pair and year for maintaining a stable population. This can be compared with the observed figure of 1.03 young. Henny & Wight (1969) also provide a formula

$$(1 + u)^2 (1 + u - s) = m s_0 s^2$$

(where u equals per cent population change per year) for calculation of expected rates of increase or decrease in a population. Using the values mentioned above for m, s_0 and s this formula gives a potential increase per year of 4% for the Ural Owl population in our study area.

Has this occurred? The Ural Owl most likely has increased in numbers in our study area between 1950 and 1970 (Lars Gustafsson, Allan Lundin, pers. comm.) during which time the number of nest boxes was low. Although the breeding population has ceased growing, the supply of nest boxes may lead to local population growth (own data). Thus, the expected potential for population growth is supported by observational data. However, since our population is at the southern borderline of the species' distribution in Sweden, one could argue that birds causing this increase were recruited from somewhere else and not from our population. This is not substantiated by our data since most recoveries and controls of our ringed nestlings are very close (mean distance = 28 km, $n = 9$) and we have not found any breeding owl in our area which has been ringed as a nestling outside our study area (regular ringing of nestlings occur north of our area). It is therefore very likely that the calculated potential for population increase is of the correct order of magnitude. The surplus of birds produced probably end up as non-breeders and the fraction of non-breeding pairs has earlier been estimated at 27% (Lundberg 1981). One possible source of error is our assumption of a constant survival rate after the first year of life; for example, it could be lower in the second and third year. If so, this would suppress our estimate of potential per cent change. However, Swedish ringing recoveries are far too scanty for any age-specific mortality calculations. Another possible source of error is that most of our data come from nest box breeding pairs while pairs breeding in natural nest sites may have reduced breeding success and this again would suppress our estimate.

Fig. 1. Stump-nest in a pine which has been used by Ural Owls *Strix uralensis* for breeding during at least 34 years. (Photo: B. Westman)

In summary, we conclude that the Ural owl population in central Sweden is healthy in terms of breeding success. Forest management procedures rather than, for example, environmental contamination limit its size and may prevent its expansion. Specifically, a population reduction due to nest site scarcity seems predictable for the future. Of pairs having had natural nest sites previously, we estimate that 62% would lose access to any nest site if our nest boxes were removed. We do not know the availability of second hand twig nests, which are frequently used elsewhere (Lahti 1972), but so far we have only two observations of Ural Owls breeding in twig nests in our study area. In managed forests in central Sweden where trees are cut down when approximately 100 years old, few natural nest sites for the Ural Owl can arise because most trees are too thin at that age. A suitable nest site is formed when a tree (most often pine or aspen) is broken by strong winds, usually where the trunk contains an old Black Woodpecker *Dryocopus martius* nest. Thus, the woodpecker's nest chamber will become the owl's nesting cavity. Alternatively nest sites may arise at broken branches in formerly pollarded trees which are often birches. New nest sites arise rarely in pines while they more frequently arise in deciduous trees. However, nest sites are much more shortlived in the latter type and, at present, the density of natural stump nests is probably declining. So far, we have compensated this loss by providing nest boxes but without the provision of artficial nest sites the Ural owl population will probably decline in the future.

Acknowledgements. We thank H. Pietiäinen, J. Tiainen and S. Ulfstrand for valuable comments on the manuscript. The research was supported by grants from the World Wildlife Fund (to A. Lundberg).

References

Ahlén, I. 1977: Faunavård — om bevarande av hotade djurarter i Sverige. — 256 pp. Skogshögskolan-Statens Naturvårdsverk, Stockholm.

Dementiev, G. P. 1966: Ural or long-tailed night owl (Ural owl), Strix uralensis Pallas. — In: Dementiev, G. P. & Gladkov, N. A. (eds.), The birds of the Soviet Union, 1:459-465. English transl. IPST, Jerusalem.

Douhan, B., Edholm, M., Granberg, B. & Tjernberg, M. 1982: Fågelrapporteringen, Uppland 1981. — Fåglar i Uppland 9:51-73.

Eriksson, D., Lundberg, A. & Westman, B. 1984: Estimating age of Ural Owl nestlings from body part measurements. — Ann. Zool. Fennici 21:313-316.

Helander, B. 1983: Reproduction of the white-tailed sea eagle Haliaeetus albicilla (L.) in Sweden, in relation to food and residue levels of organochlorine and mercury compounds in the eggs. — Ph.D. diss., University of Stockholm, Sweden.

Helander, B., Olsson, M. & Reutergårdh, L. 1982: Residue levels of organochlorine and mercury compounds in unhatched eggs and the relationships to breeding success in white-tailed sea eagles Haliaeetus albicilla in Sweden. — Holarctic Ecol. 5:349-366.

Henny, C. J., Overton, W. S. & Wight, H. M. 1970: Determining parameters for populations by using structural models. — J. Wildlife. Managem. 34:690-703.

Henny, C. J. & Wight, H. M. 1969: An endangered Osprey population: estimates of mortality and production. — Auk 86:188-198.

Hörnfeldt, B. 1978: Synchronous population fluctuations in voles, small game, owls, and tularemia in northern Sweden. — Oecologia (Berl.) 32:141-152.

Lagerström, M. 1969: Viirupöllön (Strix uralensis) sukukypsyydestä (Summary: Age of sexual maturity on Ural Owl). — Ornis Fennica 46:31-32.

Lahti, F. 1972: Nest sites and nesting habits of the Ural Owl Strix uralensis in Finland during the period 1870-1969. — Ornis Fennica 49:91-97.

Lindberg, P. 1975: Pilgrimsfalken i Sverige. — 95 pp. Svenska Naturskyddsföreningen, Stockholm.

Linkola, P. & Myllymäki, A. 1969: Der Einfluss der Kleinsäugerfluktuationen auf das Brüten einigen kleinsäugerfressender Vögel im südlichen Häme, Mittelfinnland 1952-1966. — Ornis Fennica 46:45-78.

Lundberg, A. 1976: Breeding success and prey availability in a Ural Owl Strix uralensis Pall. population in central Sweden. — Zoon 4:65-72.

—"— 1979: Residency, migration and a compromise: Adaptations to nest-site scarcity and food specialization in three Fennoscandian owl species. — Oecologia (Berl.) 41:273-281.

—"— 1981: Population ecology of the Ural owl Strix uralensis Pall. in central Sweden. — Ornis Scand. 12:111-119.

Odsjö, T. & Lindberg, P. 1977: Reduction of eggshell thickness of peregrine in Sweden. — In: Pilgrimsfalk-rapport från konferensen 1-2 april 1977 på Grimsö forskningsstation: 59-60. Svenska Naturskyddsföreningen, Stockholm.

Olsson, V. 1979: Studies on a population of eagle owls. Bubo bubo (L.), in Southeast Sweden. — Viltrevy 11:1-99.

Pietiäinen, H., Saurola, P. & Kolunen, H. 1984: The reproductive constraints on moult in the Ural owl Strix uralensis. — Ann. Zool. Fennici 21:277-281.

Ratcliffe, D. A. 1980: The peregrine falcon. — 416 pp. Calton.

Saurola, P. 1978: The ringing of owls in Finland. — Lintumies 13:7-12 (Finnish with English summary).

Scherzinger, W. 1980: Zur Ethologie der Fortpflanzung und Jugendentwicklung des Habichtskauzes (Strix uralensis) mit Vergleichen zum Waldkauz (Strix aluco). — Bonner Zool. Monogr. 15:1-66.

Valkeila, V. 1976: Pesivien viirupöllönaaraiden ikärakenteesta. — Päijät-Hämeen Linnut 7:80-82.

Received 5.VIII.1983
Printed 16.XI.1984