Acta Universitatis Latviensis, 2005, Vol. 691, Biology, pp. 17–29

Assessment of compensatory predation and re-colonisation using long-term duck nest predator removal data

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Abstract

Removal of predators has been often found ineffective to increase duck nest success. Most often failures were explained by compensatory predation by other predator species and/or rapid re-colonisation of the target area by new individuals by the same predator species. We used 13-year data of removing marsh harriers *Circus aeruginosus*, corvids *Corvidae* and American minks *Mustela vison* to test whether (i) removal of an individual predator species increased duck nest success; (ii) removal of an individual predator species decreased subsequent duck nest depredation rates by the same predator species; (iii) removal of one predator species increased subsequent proportion of duck nests depredated by other predator species. We removed 1 590 predators and followed the fates of 3 019 duck nests. Predator removal was measured using a concept of predator-free days, expressed as the number of days of active duck nests during exposure to the removed predator's search if the removal would not happen. Predators were removed from the main duck breeding area and from it's surroundings which altogether formed the entire predator removal area. Harrier removal was positively correlated with the apparent duck nest success ($P < 0.05$) and negatively with subsequent harrier predation rate ($P < 0.05$). However, this was true considering harriers removed from the entire predator removal area, but not when they were removed only from the duck breeding area, thus suggesting that arrival of new harriers from the surroundings was an important factor in determining nest success in the much smaller duck nesting area. Removal of corvids and American mink were not correlated with duck nest success nor the subsequent predation rates of the same species. Mink removal was positively correlated with the proportion of nests depredated by harriers ($P < 0.05$) suggesting that harriers were compensatory predators after mink removal. Re-colonisation and compensatory predation after removing certain predator species may occur in many predator communities thus causing waste of management efforts. We suggest ways of how to evaluate past and ongoing management programmes and to plan future programmes with the aim of providing early diagnostics of a predator problem.

Key words: American mink, compensatory predation, corvids, duck nest success, marsh harrier, predator control.

Introduction

Predator removal has been a common tool in managing breeding performance of game birds (Chapsky 1957; Parker 1984; Beauchamp et al. 1996; Grant et al. 1999). Today, ethical considerations place legal constraints on the use of catching devices and killing of predator species (Duebbert, Kantrud 1974; European Commision 1992; European Commission 1996; Jackson 2001). Also, from scientific and economic points of view, this method calls for careful examination before launching wide predator control programmes (Balser et al. 1968; Sargeant et al. 1995; Côte, Sutherland 1997). There have been successful predator removal attempts (Balser et al. 1968; Lynch 1972; Duebbert, Kantrud 1974; Duebbert, Lokemoen 1980; Jackson 2001), but often these efforts have not been rewarding (Parker 1984; Clark et al. 1995; Sargeant et al. 1995; Manchester, Bullock 2000). However, the real proportion between successful and unsuccessful studies probably will remain unknown, because successful results are more often published than unsuccessful ones (Macnab 1983; Beauchamp et al. 1996).

When predator management has not been successful, but all planned activities were carried out with sufficient longevity of efforts and number of removed animals, one possible reason of failure could be a compensatory predation by another predator species or a group of predators (Parker 1984; Clark et al. 1995; Beauchamp et al. 1996). Alternatively, failures can be explained by re-colonisation of the territory by new individuals of the target predator species (Sargeant et al. 1995).

Compensatory predators may seem to be a good explanation, because predator control is often directed towards locally predominant predator species (Clark et al. 1995) or a group of predators, i.e. only avian or mammalian (Parker 1984; Sargeant et al. 1995). Although mammalian and avian predators use different senses and search tactics to locate nests (Clark, Nudds 1991; Pasitschniak-Arts, Messier 1995), these predators can apparently find and depredate the same nests.

Presently, the effects of compensatory predation are poorly documented. In Norway, after the removal of corvids, compensatory predation on willow ptarmigan *Lagopus lagopus* and black grouse *Tetrao tetrix* nests by ermine *Mustela erminea* was suspected (Parker 1984). In Scotland, Jackson (2001) tested if the level of wader nest depredation by hedgehogs *Erinaceus europaeus*, after their removal by fencing, could be maintained by common gull *Larus canus*, but the gull predation rate did not increase in the fenced areas. In Scotland, removal of carrion crows *Corvus corone corone* and common gulls failed to prevent a decline in moorland breeding waders and compensatory predation by red foxes *Vulpes vulpes* was suspected (Parr 1993). In North Dakota, USA, after removal of raccoons *Procyon lotor*, striped skunks *Mephitis mephitis* and red foxes, smaller mammalian predators exhibited compensatory predation on grassland songbird nests (Dion et al. 1999). However, the above findings originate from well-planned short-term experiments but not from long-term management programmes. Although many predator removal programmes exist, reports on their evaluation are generally lacking (Harding et al. 2001).

We used 13-year data from a complex predator control programme to test various hypotheses about changes in duck nest success and the local predator community after predator removal. In theory, any predator removal must result in less prey taken, therefore, both compensatory predation and/or re-colonisation may take place if the removal of a predator species does not increase duck nest success and decrease subsequent nest depredation rates by the removed predator species. We assessed potential re-colonisation effects by using predator removal data only from the target area (duck breeding area where nest success data were obtained) and from the entire predator removal area, which included also the surroundings of the target area. If predator removal from only the entire predator removal area increases duck nest success in the target area, an inference about presence of re-colonisation can be made because predator removal only in target area is apparently insufficient due to the arrival of new predators from the surroundings.

Compensatory predation was evaluated by testing all possible pairwise relationships between removal of a predator species and the subsequent proportion of nests depredated by other predator species. A species was identified as a compensatory predator if it's proportion of depredated nests increased after removal of an other predator species and when removal of the latter was not correlated with duck nest success.

Materials and methods

Study area

The study was carried out on Lake Engure, Latvia (57° 15' N, 23° 07' E), a shallow eutrophic wetland encompassing 3 500 ha. About 40 % of the lake is covered by emergent vegetation, mainly common reed *Phragmites australis*, narrow-leaved cattail *Typha angustifolia* and bulrush *Scirpus* spp. A detailed description of vegetation in the study area was given by Auniņš et al. (2000). The lake hosts internationally important numbers of breeding waterfowl and is a part of a larger Ramsar Site (Vīksne 2000).

We used predator removal and duck nesting data from 1985 to 1997, which were collected as a part of a long-term duck population study (Blums et al. 1996). Predator control has been ongoing in the area since the 1960s but we did not analyse earlier data because of incomplete nest records and because significant transformations of duck nesting habitat took place between 1981 and 1984. Control of avian predators was terminated in 1998, primarily because one of the target species, marsh harrier, is a protected species in the European Union (European Commission 1992) and Latvia aimed to join the Union in the nearest future.

Duck nest data were obtained from the island archipelago and surrounding reedbeds (30 ha, hereafter referred to as the target area) in the central part of Lake Engure. We used two sets of predator removal data: predators removed only from the target area (30 ha, see above) and predators removed from the entire predator removal area (ca 1 600 ha, including large spaces of open water). The target area was situated nearly in the centre of the entire predator removal area.

Duck nest data

Mallard *Anas platyrhynchos*, northern shoveler *Anas clypeata*, garganey *Anas querquedula*, tufted duck *Aythya fuligula* and common pochard *Aythya ferina* were the common breeding duck species in the lake. Gadwall *Anas strepera*, European wigeon *Anas penelope* and ferruginous duck *Aythya nyroca* were present in much smaller numbers and were excluded from the analyses when duck species were studied individually.

The general field procedures were described by Blums et al. (1996). Annually, duck nests were located during two to three complete nest censuses. Nests were monitored weekly until hatching, depredation or abandonment. We obtained the following data for each nest: duck species, clutch initiation date, termination date, nest fate and, in case of depredation, the predator species responsible (see below). Clutch initiation date was estimated by back-dating the total number of eggs in the nest, and by determining the stage of incubation (Westerskov 1950). Many nest hatching dates and some depredation dates were recorded directly, but otherwise, nests were arbitrarily assumed terminated at the middle of the interval between the date of recording termination and the previous visit (see Mayfield 1961 for a similar approach).

We identified predators based on detailed examination of eggshells (if present), nest material dislocation and signs found in the nest surroundings. This method may not be always reliable (Sargeant et al. 1998; Lariviére 1999) but there are three reasons why we believe that possible misinterpretations were reduced to a minimum. First, field workers were trained in distinguishing between nest predators. Experience was gained from offering duck eggs to captive predators and cases when different predators were disturbed during duck nest predation in field. Secondly, the three most common predators present in the study area leave significantly different cues at depredated duck nests, making their identification relatively easy (Opermanis et al. 2001). Thirdly, in unclear cases, we used the category of unknown predator.

Predator control

The diverse predator community at Lake Engure included mammalian and avian predators, but the predominant predators were relatively few species (Opermanis et al. 2001). Predator species found at least once responsible for depredation of duck nests or killing females were racoon dog *Nyctereutes procyonoides*, red fox, ermine, American mink, wild boar *Sus scrofa*, rats *Rattus* spp., goshawk *Accipiter gentilis*, marsh harrier, eagle owl *Bubo bubo*, common gull, herring gull *Larus argentatus*, raven *Corvus corax*, hooded crow *Corvus corone cornix* and magpie *Pica pica*.

The objective of the predator removal programme was to maintain high and stable duck nest success. Therefore predator control efforts we redirected on the predominant species causing substantial duck nest losses: marsh harrier (further referred to as harrier), corvids (raven, hooded crow, magpie) and American mink (further referred to as mink). Predators were removed by shooting, poisoning and live-trapping prior to and throughout the duck breeding season. All traps were live traps. Net traps baited with artificial duck nest were used for marsh harrier, the Scandinavian trap was used for corvids and tunnel traps for mink. At least daily visits reduced suffering of animals to a minimum. From 1985 to 1992, eggs collected from terminated gull nests and injected with α-chlorolose were offered to avian predators. There was no evidences that other species except target predators were affected, excluding 23 herring gulls and three common gulls. Live-trapped predators were dispatched, but 222 (26 %) marsh harriers were re-located to another coastal lake approximately 60 km SE from Lake Engure. At all times the removed predator species, date, and location were recorded.

Data analysis

We evaluated a predator removal programme rather than conducted a scientific experiment. In most earlier experiments, duck nest success in predator removal areas has been compared with control areas where no predator control was executed with the aim to test differences in nest survival between the areas (e.g. Duebbert, Kantrud 1974; Clark et al. 1995; Sargeant et al. 1995; Beauchamp et al. 1996.. As such a design was lacking in the current study, success of the described predator removal programme could not be tested. Alternatively, we evaluated the functional effectiveness of predator removal using long-term data from a single area. This was done by testing the relationships between

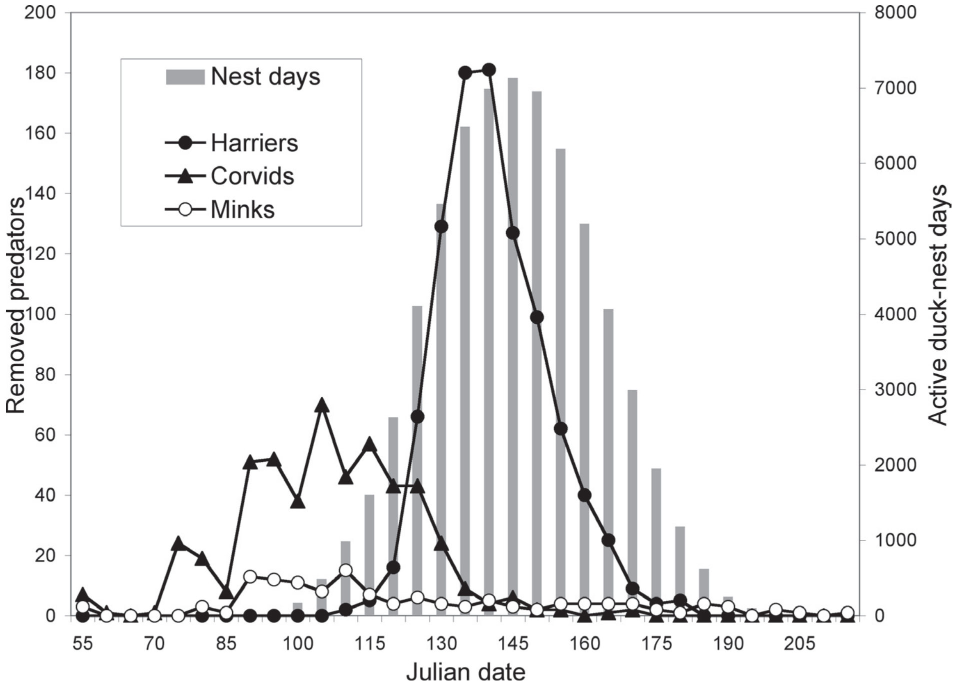

Fig. 1. Times of predator removal and period of duck breeding on Lake Engure, Latvia, from 1985 to 1997. Numbers of removed predators and active duck nest-days were calculated for 5-day intervals. Julian dates are shown on the x-axis.

number of predators removed and duck nest success using a set of breeding seasons. Such an evaluation could be biased, because on Lake Engure, like in many other studies (Balser et al. 1968; Duebbert, Lokemoen 1980; Parker 1984; Sargeant et al. 1995), predator removal was performed before and during the breeding season (Fig. 1). This implies that predators might have been removed after some or many of depredation cases, which were included in estimating apparent nest success for the particular breeding season.

To eliminate the above error, we used a modification of Mayfield's method (1961, 1975) based on nest exposure. The objective of predator removal was to achieve absence of predators in the target area. Predator absence was estimated as the number of days of active duck nests in the target area, which would be exposed to the removed predator's search if the removal did not occur (Fig. 2). Further we refer to this estimate as predator-free days (t). The sum of predator-free days across all individual predator removal cases in a particular breeding season provides a good measure of predator removal, because it accounts for both number of removed predators and prey availability.

We used three response variables to test the effects of t. To test the effectiveness of single predator species predator removal, we used the apparent yearly duck nest success. This estimate is more appropriate than Mayfield's nest success estimate in situations when all initiated nests are found and active nests have an equal probability of being found (Johnson, Shaffer 1990; Johnson 1991); both these conditions were met (Blums et al. 1996). To test the response of predator species after removing one individual, we calculated

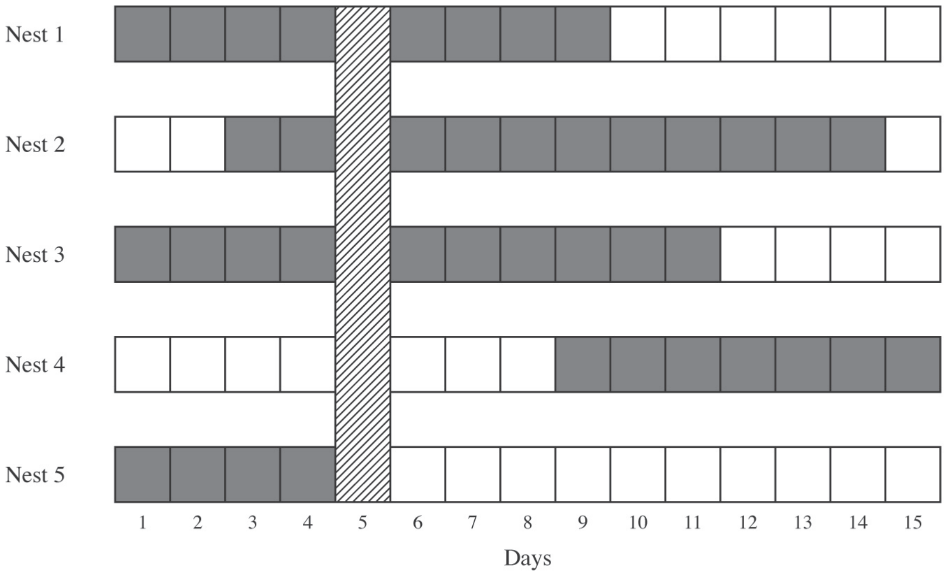

Fig. 2. Calculation of predator-free days (t) for an individual predator removal case. Striped column indicates predator removal day. Grey area indicates active nest days. This simulation assumes that there are only 5 nests in the area and the time span shown represents the whole breeding season. Consequently, t = 5 (nest 1) + 10 (nest 2) + 7 (nest 3) + 7 (nest 4) + 0 (nest 5) = 29 days. The day of predator removal was always included in the estimate of predator-free days.

predation rate (R) for the period subsequent to the removal as:

$$R_{predator} = n_{predator} / t \times 100,$$

where $n_{predator}$ is the number of depredation cases by a given predator species. To test for compensatory predation, we calculated proportion of nests depredated by a given predator species (P%) after removing one individual of another predator species as:

$$P\%_{predator} = n_{predator} / n_{all\ predators} \times 100.$$

Evaluation of single predator species removal effects is difficult when predators of several species are removed simultaneously. The effect of one predator's removal may be influenced by the effect of another's removal before, simultaneously, or later. Because of this uncertainty, we tested our assumptions using two different methods: (i) using yearly totals (t) and means (R and P%) and (ii) using data matrices based on individual predator removal cases when all years were pooled.

We used the bivariate Spearman Rank Correlation to test the degree of association between t and the response variables described above. One-tailed tests were used because it seemed logical that removed predators cannot further affect nest success, i. e. yearly duck nest success should increase, R of the same predator species should decrease and P% by other predators should increase.

We used Multivariate General Linear Model Contrasts (SPSS Inc. 1999) to test the effects of predator removal on subsequent changes in R and P%. Two models based on data matrices were fitted where individual predator removal was a case and predator species was predictor variable. Correspondingly, $R_{harrier}$, $R_{corvids}$, R_{mink} and $P\%_{harrier}$, $P\%_{corvids}$,

Table 1. Number of duck nests recorded and predators removed on Lake Engure, Latvia, 1985 - 1997. *All species, present in the target area only

Year	Duck nests (number)*	Predators removed (number)					
		Marsh harriers		Corvids		American minks	
		Target area	Entire removal area	Target area	Entire removal area	Target area	Entire removal area
1985	180	44	96	15	18	0	1
1986	187	45	109	10	10	1	5
1987	155	70	144	22	25	6	9
1988	175	51	104	36	53	2	7
1989	191	44	65	66	91	3	9
1990	210	54	63	58	81	9	16
1991	251	65	90	34	44	8	14
1992	295	53	74	25	42	4	12
1993	360	57	58	46	70	14	16
1994	318	26	26	24	24	8	9
1995	280	8	8	34	34	10	13
1996	200	64	64	16	16	1	3
1997	217	49	49	2	2	14	16

$P\%_{mink}$ were response variables. We used square-root and logarithmic transformations to normalise the above variables. Deviation Contrasts were used to test whether the mean $R_{predator}$ after removal of the same predator species was smaller than the grand mean $R_{predator}$, and whether the mean $P\%_{predator}$ after removal of other predator species was larger than the grand mean $P\%_{predator}$.

Results

Number of predators removed

During 13 years, 950 harriers, 510 corvids, and 130 minks were removed and 3 019 duck nests were monitored (Table 1). Harriers were removed during the duck nesting season, but corvids and minks mainly before and in the early duck nesting season (Fig. 1). Nevertheless, despite active predator control, on average 28.8 % of nests were depredated annually: 15.1 % by harriers, 5.0 % by corvids, 3.4 % by mink, 3.8 % by unknown predators, and 1.5 % by uncommon predators (see above). Including other reasons than prediation of nest failure than predation, the mean proportion of unsuccessful nests was 37.9 % (Table 2). Depredated nests by unknown and uncommon predators, abandoned and flooded nests were excluded from subsequent analyses.

Did predator removal affect duck nest success?

Removal of harriers and all predator species pooled were positively correlated with the apparent duck nest success (Table 3). Both relationships were significant only when predator from the entire predator removal area were used. Removal of harriers was also

Table 2. Number of nests and apparent nest success of five duck species in the Lake Engure study area, Latvia, from 1985 to 1997

Species	Number of nests	Nest success (%)		
		Mean ± SE	Min	Max
Mallard	1286	55.9 ± 4.1	33.3	80.8
Tufted duck	653	67.7 ± 3.0	46.0	83.6
Common pochard	499	60.3 ± 4.7	27.5	77.7
Northern shoveler	322	63.7 ± 4.6	29.6	89.1
Garganey	197	62.9 ± 5.7	44.4	94.7

correlated with nest success of tufted duck (target area $r_S = 0.74$, $P < 0.01$; entire removal area $r_S = 0.83$, $P < 0.01$) and mallard (entire removal area $r_S = 0.61$, $P < 0.05$). Removal of other predators was not correlated with overall duck nest success or nest success of any individual duck species.

Did predator removal affect subsequent predation rates?

Removal of harriers was negatively correlated with the subsequent harrier predation rate but this was not observed in corvids and mink (Table 3). The relationships were statistically significant using predator data from the entire predator removal area and marginally significant using predator data from the target area.

The mean harrier predation rate in the period subsequent to removing one harrier was significantly lower than the average harrier predation rate (grand mean). This was true both using harrier removal from the target area (Contrast estimate = - 0.13, SE = 0.04, P = 0.002) and the entire removal area (Contrast estimate = - 0.14, SE = 0.02, P < 0.001).

Effect of compensatory predation

We found a positive correlation suggesting compenastory predation only between mink removal and the subsequent proportion of duck nests depredated by harriers, which was statistically significant for mink removal data from the target area ($r_S = 0.62$, $P < 0.05$) and marginally significant using data from the entire removal area ($r_S = 0.49$, $P = 0.05$).

The mean proportion of duck nests depredated by harriers in the period subsequent to removing one mink was significantly greater than than the average proportion of nests depredated by harrier (grand mean). These differences were consistent in the target area (Contrast estimate = 0.36, SE = 0.14, P = 0.008) and in the entire predator removal area (Contrast estimate = 0.31, SE = 0.10, P = 0.003). The proportion of depredated nests did not significantly increased for the other predator species after removal of another species.

Discussion

The present study showed that only harrier removal was correlated with duck nest success, indicating that harrier removal at the existing level of intensity had a functional relationship with duck nest success. This was also found for all predator species pooled, but it was obvious that the number of all predators removed was influenced by the number of harriers removed (Table 1). Another reason explaining the effectiveness of harrier removal

Table 3. Correlations between predator removal intensity and duck nest success and between predator removal intensity and subsequent predation rates at Lake Engure, Latvia, from 1985 to 1997. Bivariate Spearman Rank Correlation coeffectives are shown. Significant correlations are indicated: * P = 0.05, ** P < 0.05

Variables	Predator	Removal location	
		Target area	Entire removal area
Sum of yearly predator-free days vs yearly duck nest success	Harrier	0.30	0.57**
	Corvids	0.04	0.16
	Mink	-0.33	-0.20
	All predators	0.12	0.48*
Sum of yearly predator-free days vs mean yearly predation rate	Harrier	-0.50**	-0.53**
	Corvids	0.00	-0.08
	Mink	-0.31	-0.26

was the clear predominancy of harriers on duck nests: they alone were responsible for ca 53 % of all duck nest depredations in the target area, while this percentage for corvids and minks was 17 % and 12 %, correspondingly. In addition, corvide appeared in the study area rather seasonally and restricted to the early breeding season. Most corvids, except magpies and some regularly foraging ravens, disappeared from the study area in early June with an increase of vegetation height and density. Thus corvids caused losses mainly to early nests (see also Opermanis et al. 2001). Thus, if ever duck nest success improved in the early season due to corvid removals, it would have had little effect on yearly nest success. Unlike corvids, harriers imposed severe hunting pressure on duck nests throughout the season. On Lake Engure the hourly probability that a harrier crossed the airspace from which a duck nest in the study area could be spotted was 0.69 (Opermanis 2001). The importance of harriers as duck nest predators was confirmed by the statistics from the years after the cessation of harrier control: the overall duck nest success dropped to 51.9 % in 1999, 23.0 % in 2000 and 32.1% in 2001 (Opermanis, upublished data).

Only harrier removal intensity was correlated with subsequent predation rates. Obviously, harrier removal was effective due to a large number of removed animals, which overscored the re-colonisation of the target area by new individuals. However, it was surprising that it was possible to remove on average 73 harriers per year. According to Schipper (1977), the mean marsh harrier hunting range size during breeding is 4.5 km^2 (range: 2.5 to 8.0 km^2). Assuming maximum density, there could be six to seven breeding pairs in the predator control area (16 km^2). The number of removed birds many times exceeded the possible number of resident birds, suggesting that Lake Engure holds a high density of non-breeding birds. In 1999, during the peak duck breeding season between 20 May and 18 June, 30 harriers were captured and released in the study area, but only two birds were recaptured during this period, suggesting that many birds apparently spent a relatively short time at the lake. The above observations show that harrier removal, even at the given intensity and scope, did not fully prevent the re-colonisation. However, in other locations, removing much fewer harriers might result in increased duck nest success.

The fact that harrier removal was correlated with duck nest success and subsequent predation rates only when predator data was used from the entire removal area (Table

3), supports the raised idea about intensive re-colonisation of target area by new harrier individuals as others were removed. Thus this study supports earlier recommendations that predator removal in areas adjacent to a target area should be conducted as well (e.g. Sargeant et al. 1995). This could be especially important when dealing with avian predators.

For corvids and minks, a correlation between removal and subsequent predation rate was not found, probably because of insufficient removal intensity, both in the target area and surroundings (Table 1), and due to lover relative importance of these species as duck nest predators. However, we found a positive relationship between removal of minks and the proportion of duck nests depredated by harrier. This suggests that the potential benefit arising from mink removal was lost due to compensatory predation by harrier. Apparently this compensatory predation did not much affect management results at Lake Engure where harriers were removed as well, but this may be the case in other waterfowl breeding areas where only mink removal is carried out.

The present study raised suggestions for future experimental work and for long-term predator removal programme. The objective of the first is to obtain clear answers on questions asked, while the objective of the second is to maintain or increase duck nest success on a long-term basis. In a thoroughly planned scientific experiment any outcome will provide important results, but for management programmes, a continuous decrease in nest success will be considered a failure.

An experiment can allow the sacrifice of a given amount of duck nests in favour of good scientific results. This is normally acceptable, because experiments are relatively short, i.e., one to five years (Duebbert, Kantrud 1974; Duebbert, Lokemoen 1980; Parker 1984; Parr 1993; Clark et al. 1995; Jackson 2001). To continue studies on compensatory predation, an ideal experimental study should exclude one predator species from a study area while the other predator species are left undisturbed; this arrangement would show if the removal (absence) of this single predator species increases duck nest success. If this is not done, the re-colonisation ability of the species removed and potential compensatory predators could be evaluated as suggested above. Other predator species can be removed during later seasons.

Typically, predator management programmes, which should be based on findings from experimental studies (Macnab 1983; Clark, Nudds 1991), are operated longer than experiments. Unless there is a good reason to believe that duck nests suffer from a single predominant predator species, the entire predator complex should be treated to avoid compensatory predation (Balser et al. 1968). Unfortunately, data from such programmes may not be well-suited for stringent statistical analyses because of simultaneous predator removal and the overlapping of removal effects. For large management programmes it is problematic to establishsufficiently large control areas either because such are not available or because it would at least double monitoring costs. Nevertheless, there is a clear need to evaluate the effectiveness of such management programmes, of which recording of predator removal and duck nesting data must be integral parts. Unfortunately, scientific experiments are carried out by professional biologists, but many management programmes are implemented by site managers with only a general knowledge in animal ecology. Predator management is usually only one of a wide range of activities listed in site management plans, thus often responsible managers lack time, money or experience to care about proper monitoring of management success. The experience problem can be eliminated through transfer of knowledge from scientists to broader environmental managers. To facilitate data collection and adjust the level of complexity, simpler schemes could be planned; e.g., instead of asking managers to identify duck nest predators from nest remains, which is complicated, they could record predator activity through direct (avian predators) and indirect (mammalian predators) observations (e.g. Johnson et al. 1989).

In the present study we lacked data on the numerical response of predator species to removal efforts; we analysed only the functional response of predator removal in terms of duck nest success and predation rates. In future programmes, we recommend recording the number of predators removed, number of predators observed, and duck nest success, which should provide a sufficient basis for assessment of management effectiveness, including the presence of potential compensatory predation and re-colonisation effects.

Acknowledgements

The study was supported by the Latvian Council of Science grant No. 01.0342. We thank Antra Stīpniece for technical help. P. Blums, A. Celmiņš, B. Dugger, J. Kacs, J. Kazubiernis, P. Leja and V. Pilāts helped with the fieldwork. A. Auniņš, O. Keišs and P.E. Rasmussen provided useful comments on earlier drafts of the paper. We express many thanks to G. Brūmelis for improving the English.

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Kompensējošās plēsonības un plēsēju rekolonizācijas novērtējums izmantojot ilglaicīgus pīļu ligzdu postītāju skaita regulācijas datus

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Kopsavilkums

Plēsēju skaita samazināšana bieži neuzlabo pīļu ligzdošanas sekmes. Visbiežāk to izskaidro ar citu plēsēju sugu kompensējošo plēsonību vai arī ar teritorijas ātru rekolonizāciju ar tās pašas sugas īpatņiem. Mēs izmantojām 13 gadu datus par niedru lijas *Circus aeruginosus*, vārnveidīgo putnu *Corvidae* un Amerikas ūdeles *Mustela vison* skaita samazināšanu Engures ezerā, lai pārbaudītu (1) vai katras atsevišķās plēsēju sugas īpatņu skaita samazināšana ietekmēja pīļu ligzdošanas sekmes; (2) vai katras atsevišķās plēsēju sugas īpatņu skaita samazināšana izraisīja tās pašas sugas postījumu biežuma samazināšanos; (3) vai vienas plēsēju sugas īpatņu skaita samazināšana izraisīja citas plēsēju sugas postījumu biežuma palielināšanos. Pavisam 1590 plēsējus likvidēja vai arī transportēja prom no ezera un izsekoja 3019 pīļu ligzdu likteņiem. Plēsēju skaita samazināšanu mērīja, ieviešot parametru "no plēsējiem brīvās dienas". To izteica kā to dienu skaitu, kuru laikā pīļu ligzdas pētījumu rajonā būtu plēsēja barības meklējumu padraudētas, ja vien šis plēsējs nebūtu likvidēts. Plēsējus ķēra gan pētījumu rajonā, kur tika novērotas pīļu ligzdas, gan arī šī rajona apkārtnē. Niedru lijas skaita samazināšana pozitīvi korelēja ar pīļu ligzdošanas sekmēm ($P < 0,05$), bet negatīvi ar turpmāko niedru lijas postījumu biežumu ($P < 0,05$). Tomēr šī likumsakarība bija spēkā tikai iekļaujot likvidēto niedru liju skaitu gan no pīļu ligzdošanas vietām, gan arī no to apkārtnes. Tas lika domāt, ka pīļu ligzdošanas sekmes ietekmēja arī niedru liju rekolonizācija no plašākas apkārtnes. Vārnveidīgo putnu un Amerikas ūdeles skaita samazināšana nekorelēja ne ar pīļu ligzdošanas sekmēm, ne ar to pašu sugu turpmāko postījumu biežumu. Amerikas ūdeles skaita samazināšanas intensitāte pozitīvi korelēja ar niedru lijas izpostīto ligzdu proporciju ($P < 0,05$). Tas nozīmē, ka niedru lija varēja veikt kompensējošo postīšanu pēc Amerikas ūdeles skaita samazināšanas. Kompensējošā plēsonība un rekolonizācija pēc kādas plēsēju sugas skaita regulēšanas var notikt daudzās plēsēju sabiedrībās, tādējādi apsaimniekošanai patērētās pūles un ieguldītie līdzekļi var nedot cerēto rezultātu. Mēs esam ieteikuši veidus, kā izvērtēt bijušās un notiekošās plēsēju skaita regulācijas problēmas, kā arī to, kā plānot nākotnes projektus, lai iepriekš minētās problēmas tiktu diagnosticētas savlaicīgi.