dead calf in the study area by a farmer provided a carrion source. Opportunities are demonstrably not equal every year. We are therefore left with the assumption that while martens have a very wide range of prey items and they change from one to another frequently, they maintain a static diet over the year, probably by changing hunting behaviour.

Summary

The diet of the pine marten (*Martes martes L.*) in Dromore, Co. Clare, Ireland, was studied by the qualitative and quantitative analysis of droppings (scats) over a period of four years. Martens are shown to eat a wide variety of prey including berries, fruits, invertebrates, birds, small mammals and carrion. Despite annual fluctuations in the availability of food types martens were found to take equal quantities of the major categories of food each year. A selection of prey within an opportunistic hunting pattern is postulated to explain this.

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Literature

ANDERSON, 1955. The food of the Danish badger. *Danish review of game biology Vol. 3 Part 1 pp. 1-75.*

CORBET AND SOUTHERN, 1977. *The Handbook of British Mammals, 2nd ed.* Blackwell.

DAY, 1968. Food habits of British Stoats (*Mustela erminea*) and Weasels (*Mustela nivalis*) *J. Zool. Lond. 155 pp. 485-497.*

FAIRLEY, 1975. Summer food of Pine martens in Co. Clare. *Irish Naturalist's Journal Vol. 18, No. 8, pp. 257-258.*

FAIRLEY AND O'GORMAN, 1974. Food of Pine martens in the Burren. *Irish Naturalist's Journal Vol. 18. No. 4, p. 125.*

HURREL, 1968. Pine martens. *Forestry Commission: Forest Record No. 64, H.M.S.O.*

KOEHILER, MOORE & TAYLOR, 1975. Preserving the Pine marten. *Western Wildlands Summer 1975. University of Montana.*

KRUNK AND PARISH, 1977. Behaviour of Badgers. *Institute of Terrestrial Ecology.*

LOCKIE, 1960. The Food of the Pine marten, *Martes martes* in West Rosshire, Scotland. *Proc. Zool. Soc. Lond. Vol. 136 Part 2, pp. 187-195.*

MAITLAND, 1972. *Key to British Freshwater Fishes Freshwater Biol. Assoc. Sc. Pub. 27.*

MITCHELL, 1974. *A Field Guide to The Trees of Britain and Northern Europe, Collins.*

QUICK, 1955. Food of Marten (*Martes americana*) Nrothern British Columbia. *The Canadian Field Naturalist Vol. 69, pp. 144-148.*

REMINGTON, 1951. Food habits, growth and behaviour of two captive martens. *Journal of Mammology, Vol. 33, No. 1, pp. 66-70.*

WEBB. *An Irish Flora, Dundalgan Press 1967.*

Does Removal of Breeding Crows Increase Pheasant Production — an Experiment

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Abstract

Nestlings and females of three breeding pairs of crows were removed in an experiemntal area in southern Sweden. This was repeated in the next year. Crow density and pheasant production were investigated in this area and in a control area. In the second year the experimental and the control areas were reversed. The density of feeding crows was unchanged or increased after the elimination of breeding females. This was because the males remated and flocks of non-breeding crows began to exploit the experimental area. No renesting occurred. The predation rate on artificial pheasant nests that were arranged in the two areas did not differ significantly after the elimination. Also, there was no difference in the recruitment to the autumn pheasant population.

Introduction

Hunting people have long believed that crows *(Corvus cornix)*, by extensive predation on pheasant *(Phasianus colchicus)* eggs and chickens, reduce the number of pheasants available for hunting in autumn. To counter this, many hunters reduce the number of breeding crows by destroying their nests and shooting the females as they leave the nests. The killing of males is less frequent as they are difficult to approach close enough. There are at least two reasons why the result may be worse than the hunters expect. First: the effect will be rather small; although crows prey extensively on pheasants' eggs, a female pheasant has high renesting potential. Second: the destruction of breeding pairs in one area may make this site available for non-breeding flocks of crows. Here, we describe an example of this practice. Female crows were killed when breeding, and the effect on egg predation and chicken production was measured. Myrberget et al (1976) and Slagsvold (1978) described experiments involving a systematic extermination of crows in a small area.

Study Area And Methods

The experiment was made within 180 ha of the Revinge area in South Sweden (55° 40'N, 13°30'E). Most of the study area was covered by damp meadows and copses of alder and birch. It was divided into two equal parts. One treated as an experimental area and the other as a control in 1977. The areas were reversed in 1978. In each year, all three breeding crow females were shot around 10 May, when the eggs were about to hatch, and the eggs were destroyed. In 1978, a fourth territory was occupied byt no nest was built. This female was not shot as she was as difficult to approach as any of the

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males. This is similar to what probably would have happened if the control had been undertaken by hunters. Both areas had three territorial pairs in the control area. In 1978, one pair did not breed.

The number of crows was monitored in both experimental and control areas from 1 April to 30 June. This was done by driving in the same tracks (7.5 km) by car about every second day and noting the position of all crows. Some in the area were individually marked with wing tags. Crows less than 100 m apart were considered to belong to the same flock.

In order to measure the predation pressure on pheasant nests, we arranged simulated nests, natural pheasant nests being to difficult to find in sufficient numbers. Each nest contained three chicken's eggs painted to resemble pheasant eggs and hidden in the vegetation in a natural fashion. The density of simulated nests was approximately twice that of natural pheasant nests in the area. These proportion of nests not found by predators one week after they were arranged was noted. Previous studies (Loman & Goransson 1978) show that practically all nests lost are the victims of crow predation.

Production of pheasants was studied by mapping broods in September 1977. For all observations, age and number of chickens were noted to avoid double registrations. Bad weather in 1978 prevented mapping.

Results

A larger proportion of the observed crows were found in the experimental area after the females were killed (Table 1). This is because flocks of non-breeding crows began to utilize those territories (Fig. 1). These flocks had previously been present adjacent to the study area. No flocks were observed in the territories of the control area. At least three of the six males remated within two weeks. However, none of these pairs bred during the same season.

There was a tendancy in both years for higher predation on the simulated nests in the control areas, but the difference was not significant (Table 2) (p 0.01, X^2-test, two-tailed).

There were 8 broods of pheasants in each area during September 1977. A similar mapping in the same areas in 1973, when no experiments were made, resulted in 9 and 7 broods, respectively. Thus no significant difference could be demonstrated.

Discussion

The crow territories were less efficiently defended after the loss of the broods and the females. There are a tleast two obvious reasons. Flock crows were probably important predators on crows' eggs (Wittenberg 1968). This is one possible reason for crow territoriality that is no more in effect after losing the brood. Furthermore, after losing the female, the males seek new mates. Whatever the reason for territoriality, it is probably better for the male to allow flocks in the territory and have a chance to mate with one of the flock females than to leave the territory and try to find a new mate elsewhere. In the latter event it is probable that a new pair will settle in the occasionally abandoned territory.

In our study, the distance between the experimental areas and places where crow flocks used to forage was less than 1.5 km. It is possible that if the distance had been greater, flocks would have been less likely to invade the territories after the females and

Table 1. Proportion of total number of crows observed in control and experimental areas before and after elimination of the female crows. The number of crows observed in flocks is given in parenthesis.

	1977		1978	
	Before elimin. n = 166	After elimin. n = 92	Before elimin. n = 104	After elimin. n = 201
Experimental area	39%(8)	50% (10)	28% (3)	42% (53)
Control area	61% (0)	50% (0)	72% (6)	58% (5)

Table 2 The proportion of the simulated nests lost due to predation in the experimental and in the control area.

	1977		1978	
	Proportion nests lost	n	Porportion nests lost	n
Experimental area	42%	84	45%	76
Control area	51%	65	54%	99
X^2	0.57		1.71	

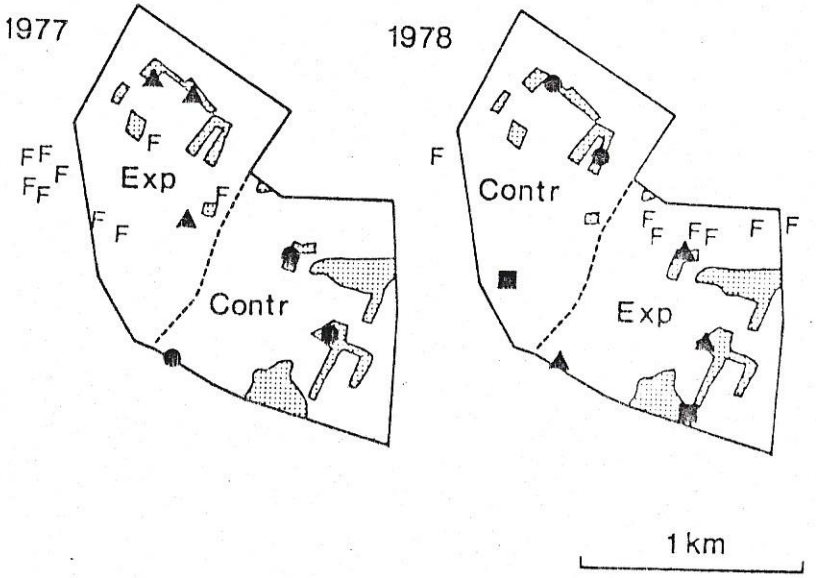

Figure 1. Experimental and control areas in 1977 and 1978 showing the distribution pattern of territorial and non-territorial crows. Shaded areas indicate copses. Triangles = destroyed crow nests, circles = intact crow nests, squares = non-breeding crow pairs, F = place where flocks of non-territorial crows was seen.

broods were destoryed.

This experimental area showed an increase in the number of crows present, but no corresponding increase in the proportion of simulated nests destroyed by predation. Probably the invading flock crows were less efficient egg predators than the territorial ones.

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References

Lomn, J. and Goransson, G. 1978, Egg shell dumps and crow Corcus cornix predation on simulated birds' nests. - Oikos 30: 461-466.

Myberget, S., Kirgvsoll, P. and Erikstad, K.E. 1976. Et forsøk pa a desimere en krakebestand. – Sterna 15:127-132.

Slagsvold, T. 1978. It is possible to reduce a dense Hooded Crow *Corvus corone cornix* population in a woodland area and what does it cost? – Cinclus 1:37-47.

Wittenberg, J. 1968. Freilandsuntersuchungen zu Brutbiologie in Verhalten der Rabenkrahe *(Corvus c. corone).* – Zool. J. Syst. 95:16-146.

Goshawk Predation in a Central Swedish Coniferous Forest Area

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Abstract

Predation of goshawk (*Accipiter gentilis*) in a central Swedish coniferous forest area is investigated. The results presented are from the first two years of the study. During the breeding season grouse, i.e. hazel hen (*Bonasia bonasia*), black grouse (*Tetrao tetrix*) and capercaillie (*Tetrao urogallus*), accounted for 53.7% of prey biomass taken by the goshawks. The relative frequencies of the different grouse species in the diet corresponded to their relative population densities. Altogether, birds formed 84.8% of the diet. Among mammals squirrels (*Sciurus vulgaris*) dominated, with 8.5% of the total diet. In winter squirrels were more vulnerable to goshawk predation, and accounted for 69.1% of prey biomass. The squirrel populations fluctuate strongly, and so far the study has been performed in a situation with high squirrel density. It is concluded that when squirrels are abundant goshawk winterpredation on grouse is low, and a dietary shift towards grouse when squirrel abundance decreases is predicted.

Introduction

For a long time goshawk (*Accipiter gentilis*) predation on small game has been the subject of controversy between hunting and protection interests. This has resulted in many studies of goshawk diet, especially during the breeding season (e.g. Uttendörfer 1939, 1952, Höglund 1964, Sulkava 1964, Kramer 1973, Schnurre 1973). The diet outside the breeding season has been studied by searching for prey remains (e.g. Brüll 1964, Opdam, Thissen, Verschuren and Müskens 1977), by analysing crop contents (e.g. Höglund 1964) and by using radiotelemetry (Kenward 1979). However, there are very few (e.g. Kenward 1977) direct studies of the quantitative effect of goshawk predation on a prey population.

The effect of goshawk predation is being investigated at Grimsö Wildlife Research Station. Assessing the effect of goshawk predation requires simultaneous study of prey population dynamics, goshawk population dynamics and goshawk diet. This study is now under way, and these preliminary data derive from the first two years of my study.

Study Area

Grimsö Wildlife Research Station is situated in south central Sweden (59°40'N 15°25'E), in the southern boreal zone (Lindquist) 1966), often called the south taiga. The research area is fairly flat, rising gradually from 75m above sea level in the south to 180m in the north. The vegetation is mainly