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Ecological and Economic Effects of Birds of Prey in the Central Region of the European Part of the USSR

with special reference to the Index of Predatory Pressure' as a means for estimating these effects.

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For the last two decades ornithologists as well as experts in game management have devoted much attention to predatory birds. A great number of special studies have been carried out in many countries. The author's twelve-year (1956-67) study of ecological and economic effects of birds of prey in the Central Region of the European part of the USSR was among them.

These efforts have had not only scientific but also practical consequences which have been reflected in legislation: the official attitude to birds of prey in the majority of countries today is not so bad as it was 10-15 years ago. However, we cannot yet say that they are completely out of danger. Unfortunately, besides the grave threat of poisoning by pesticides, predatory birds are still from time to time exposed to attack by gamekeepers, farmers and hunters.

This state of affairs demands new and continuing efforts to analyse the ecological significance and economic importance of birds of prey under differing conditions. For such a controversial group of birds, we have always been convinced, not only from the point of view of their friends but also of that of the general public at large and even of their ill-wishers, of the vital importance of establishing the true facts.

INDEX OF PREDATORY PRESSURE

Our experience has shown that the data which are most convincing and acceptable to ornithologists as well as to the public, can be obtained by means of a combination of qualitative and quantitative analysis of the influence of predatory birds upon the populations of their victims.

As the main numerical basis for measuring the ecological and especially economic importance of birds of prey, an 'index of predatory pressure' (or more simply 'index of predation') was selected, representing the percentage of individuals taken by predators out of the total number of potential victims. Such an index would seem to give a fairly clear picture of the influence of predatory birds on the populations of their prey species and, in practice, has been found to provide an assessment of the part played by birds of prey which fully satisfied experts in game management. To establish the index of predation pressure (X_a^A) exercised by predatory species 'A' upon the population of prey species 'a' in any area, it is necessary to have the following data:

(1) The total number of predators of the species 'A' (or more often of breeding pairs including their broods), which inhabit the area under study (N^A);

(2) The average number of individuals of prey species 'a' which are taken by each predator 'A' (or more often fed to each brood of that predator) within a specified period (Pa): for the purposes of our particular study, this period usually coincided with the breeding season.

(3) The total number of individuals of the prey species 'a' inhabiting the study area (n_a).

If these data are available, the index of predation (X_a^A) for predator 'A' and prey 'a' can be readily calculated by the following formula:

$$X_a^A = \frac{N^A \times P_a^A}{n_a} \times 100\%$$

Although in our study we concentrated on collecting as much reliable information as possible for the application of this formula, we also, in order to obtain a deeper and more detailed assessment of the qualitative aspect of predatory influence, collected data regarding age and sexual composition, and the proportion of normal and defective, healthy and sick, individuals in the prey species, both for the population as a whole and for the individuals actually taken by the predators.

METHODS OF THE STUDY

The basic method used in our investigation was to carry out a continuing study over 3-5 years of bird of prey activity within specified areas, which were known as 'stations'. Each station covered from between about 100 and 350 square kilometres.

A programme of this sort could obviously not be executed by one or two persons. So groups of 6-12 observers (usually members of students' zoological clubs) were organized to undertake the study at each station.

The estimate of the predatory population of each station was carried out by means of systematic inspection of the forests it contained. In the course of the investigation, all territories of birds of prey were mapped and every effort made to discover as many of the occupied nests as possible.

The quantitative and qualitative analysis of the food of predatory birds proved to be the hardest part of our investigation. For that purpose we built hides on trees close to occupied nests, from which a continuous watch was kept on an average of between one in five and one in eight of the total number of broods. These observations gave a great deal of reliable information on the composition and number of prey species taken by predatory birds during the breeding season and, by using special techniques, we obtained samples of each prey species brought to the nest, for careful laboratory examination.

Finally, in order to estimate the natural populations of the potential prey species, we followed generally recognized methods of assessing the numbers of voles, mice, birds, frogs and other species present in the area.

MAIN RESULTS OF THE STUDY

The most valuable data were collected at the Vladimir Station (210 sq. km including 152 sq. km of forests) and Oka Station (350 sq. km including 200 sq. km of forests). The former was situated within hunting grounds approximately 200 km to the north-east of Moscow and the latter included the Oka Reserve and its neighbourhood in Rjazan district (about 300 km south-east of Moscow). As was to be expected the number and variety of birds of prey within the protected area (Oka station) was more than that within the hunting area (Vladimir station).

On the Oka station, we counted an annual average of 90 breeding pairs of birds of prey (25. 7 pairs per 100 sq. km or 45. 0 pairs per 100 sq. km of forest) of 12 species (Table 1). The most common were black kite *Milvus migrans korschun* and common buzzard *Buteo buteo,* which formed about 60 per cent of the entire predatory population of the Oka station.

At the Vladimir station we found an annual average of 35 breeding pairs (16. 6 pairs per 100 sq. km or 23. 0 pairs per 100 sq. km) of 6 species (Table 1.) Common buzzard (again forming about 60 per cent of the total) was an absolute dominant among them.

These data and the counts made at other stations made it possible to calculate the approximate number of birds of prey inhabiting the central region of the European part

TABLE 1: NUMBER OF BREEDING PAIRS OF BERDS OF PREY WITHIN OKA (350 sq. km, INCLUDING 87 sq. km OF KEY AREA) AND VLADIMIR (210 sq. km) STATIONS, CENTRAL REGION OF EUROPEAN PART OF THE U.S.S.R.

Predatory species	Oka station, 1956-1958				Vladimir Stn. 1963-1965		
	Number of pairs						
	Within key area* in 1956	Within the whole station	per 100 sq. km	Percentage of total bird of prey pop.	Number of pairs	per 100 sq. km	Percentage of total bird of prey pop,
Goshawk —*Accipiter gentilis*	1	2	0.6	2.2	2	0.9	5.7
Sparrow hawk —*Accipiter nisus*	—	4	1.1	4.4	4-6	1.9-2.9	15.2
Montagu's harrier —*Circus pygargus*	—	1	0.3	1.1	—	—	—
Black kite —*Milvus migrans korschun*	23—16	32-37	9.1-10.6	37.8	2-3	0.9-1.4	6.6
White-tailed eagle —*Haliaetus albicilla*	1	0-1	0-0.3	0-8	—	—	—
Spotted eagle —*Aquila clanga*	4	9	2.6	10.0	—	—	—
Common buzzard —*Buteo buteo*	4	17-22	4.8-6.3	21.1	17-23	8.1-11.0	57.2
Honey buzzard —*Pernis apivorus*	—	3.7	0.9-2.0	5.6	0-5	0-2.4	8.7
Short-toed eagle —*Circaetus ferox*	—	1	0.3	1.1	—	—	—
Osprey —*Pandion haliaetus*	—	1	0.3	1.1	—	—	—
Hobby —*Falco subbuteo*	—	6-8	1.7-2.3	7.8	—	—	—
Kestrel —*Falco tinnunculus*	—	3-11	0.9-3.1	7.0	1-4	0.5-1.9	6.6
Total	33—26	83-102	23.7-29.2	100.0	32-40	15.2-19.0	100.0

Note: *The column includes only those predators which feed on waterfowl and meadow-birds within key area.

of the USSR (about 270 thousand sq. km including about 120 thousand sq. km covered with forest) which embraces Moscow, Vladimir and parts of Rjazan, Gorky and some other districts. According to this estimate (Table 2) the total number within the Region is about 40, 000 breeding pairs. More than half belong to only two species: common buzzard (38 per cent) and black kite (about 18 per cent).

One preliminary conclusion, based on the ratio of certain species to the total bird of prey population, merits some discussion.

It is obvious that influence upon populations of prey species is more likely to be significant in the case of predators which are numerous or at least fairly common. One of the controversies in relation to the economic importance of predatory birds was the question

TABLE 2: THE NUMBER OF BIRDS OF PREY WITHIN THE CENTRAL REGION OF THE EUROPEAN PART OF THE USSR (ABOUT 270 THOUSAND sq. km INCLUDING ABOUT 120 THOUSAND sq. km OF FOREST)

Species	The number of breeding pairs			Percentage of total bird of prey population
	Within the whole region	Possible limits	Per 1000 sq.km	
Accipiter gentilis	1600	1200-2000	6	3.7
Accipiter nisus	3500	3000-5000	13	8.4
Circus cyaneus	1000	500-1500		2.3
Circus pygargus	800	500-1500	3	1.9
Circus aeruginosus	500	200-1000	2	1.2
Milvus migrans korschun	7500	6500-9000	28	17.7
Haliaetus albicilla	100	50-150	0.4	0.2
Aquila clanga	1400	1000-1500	5	3.3
Buteo buteo	16200	14000-20000	60	38.2
Pernis apivorus	3000	2000-4000	11	7.0
Pandion haliaetus	100	50-150	0.4	0.2
Falco subbuteo	2300	1800-3000	8	5.4,
Falco tinnunculus	3500	3000-5000	13	8.4
Falco vespertinus	400	200-600	1.6	0.9
Other (rare) species	500	200-600	2	1.2
Total	about 40000	35-55 thousand	156 (130-200)	100.0

of what prey is taken by species such as the buzzard and kite, which normally live on voles and mice, when there is a decline or, expecially, total absence of rodents. On the basis of conclusions drawn from past analysis of remains of food and pellets, some game-keepers had supposed that in years when voles and mice are scarce, this item in the diet of the rodent-eating birds of prey is replaced by birds, including the young of grouse, capercaillie and partridge.

Special attention was therefore paid to this question.

The long-term study of birds of prey at the Vladimir station happened to coincide with a complete (4 years) cycle in the fluctuation of rodent populations and therefore provided the opportunity for an analysis of food changes in birds of prey depending on the number of voles and mice available. In the peak period (1963) and at normal levels (1964, 1966) of vole *Microtus arvalis* numbers, the latter formed up to 80-90% of the total food of the buzzard. But in the period when the vole population was at its lowest (1965), their place in the buzzard's diet was largely taken by frogs (as much as 70-80% of the food) and not by game-bird nestlings.

The increase of the latter in the buzzard's diet was quite insignificant and bore no comparison with the very marked increase in the number of frogs, moles, shrews, nestling thrushes and other items taken.

In the Oka, Kudma (Volga valley near Gorky) and other areas within the study region, there was some evidence of kites feeding, partly, on birds and their young, including ducks. At the first sight this seemed to suggest a threat to the duck population. However, a special examination of the ducks brought to the nest by kites definitely showed that as high a proportion as 80% could not really be considered as prey at all, but had been scavenged after being killed or wounded by hunters or hay-cutting machinery.

The only birds of prey in the study region which were in fact found to prey on waterfowl and gallinaceous birds at all regularly were the goshawk, marsh harrier, white-tailed eagle *Haliaetus albicilla* and, to a lesser degree, the spotted eagle *Aquila clanga*. But all of them were scarce or even very scarce and, therefore, had a minimal effect and in many places no effect at all.

Thus, in assessing the economic importance of birds of prey, our preliminary analysis of the facts discussed above clearly showed that, because of the character of their food or their rarity, none of the predatory birds of the region could be considered as an essential factor affecting game-bird populations. But in the long run such a conclusion would in our opinion be much more reliable if it can be firmly based on a calculation of the index of predatory pressure (IPP) exerted upon these populations.

Accordingly, special attention was paid to this point in a study designed to throw light on the relationship between birds of prey and the grouse Family, Tetraoinidae, which was launched at Vladimir station. The results (Table 3) show that the total index of predation upon gallinaceous species did not exceed 5-6 per cent of their total summer population on the station. The essential thing to note is that about 70 per cent of the total losses inflicted on Tetraonidae was caused by only two pairs of goshawks, while the ten times more numerous buzzard accounted for the other 30 per cent. The hazel hen *Tetrastes bonasia* suffered most from predatory birds (the total IPP reached 9 per cent); pressure

TABLE 3: INDEX OF PREDATORY PRESSURE (IPP) UPON GAME BIRD POPULATIONS AT VLADIMIR STATION (210 sq. km.) DURING SUMMER SEASON 1963-1965

Potential prey species	Total number of individuals (ad. + juv.) of game birds within station in June	IPP, i.e. percentage of individuals taken by *predators* out of the total number of game birds in June-July.		
		IPP by Common Buzzard *Buteo buteo;* 17-23 pairs	IPP by Goshawk *Accipiter gentilis* 2 pairs	Total IPP
Hazel Hen *Tetrastes bonasia*				
1963	1400	0.4	5.0	5.4
1964	1400	1.6	5.2	6.9
1965	1200	4.8	4.2	9.0
Black Grouse *Lyrurus tetrix*				
1963	1000	—	2.1	2.1
1964	1100	2.1	1.6	3.7
1965	1200	—	1.7	1.7
Capercaillie *Tetrao urogallus*				
1963	600	—	1.8	1.8
1964	500	—	2.0	2.0
1965	500	—	1.4	1.4
Other Galliformes, including unidentified spp.				
1963	3000	0.7	4.3	4.9
1964	3000	1.9	4.5	6.4
1965	2900	2.3	3.7	6.0

TABLE 4: INDEX OF PREDATORY PRESSURE (IPP) ON POPULATIONS OF WATERFOWL AND MEADOW-BIRDS IN THE KEY AREA (87 sq. km) OF OKA STATION, SUMMER, 1956

Potential prey species	Total number of individuals (ad+juv.)of gamebirds within key area in June	IPP, i.e. percentage of individuals taken by five predators out of the total number of gamebirds from 1 June to 10 August 1956					
		Kite *Milvus migrans korschun* 23 — 16 pairs*	Spotted Eagle *Aquila clanga* 4 pairs	White-tailed Eagle *Haliaetus albicilla* 1 pair	Goshawk *Accipiter gentilis* 1 pair	Common Buzzard *Buteo buteo* 4 pairs	Total IPP
Ducks (Anatinae)	1700	5.5	4.1	1.0	1.5	—	12.1
Common Quail *Coturnix cotumix*	2100	1.8	—	—	—	—	1.8
Corncrake *Crex crex*	8500	0.8	0.3	0.1	—	0.3	1.5

* 7 pairs of black kite lost their broods and left the key area during the period of study.

upon black grouse *Lyrurus tetrix* and Capercaillie *Tetrao urogallus* was much less: 2-3 per cent. Goshawk pressure was rather steady during the period of the study, but that exerted by buzzards tended to fluctuate in inverse proportion to the abundance of rodents. It was highest when voles almost completely disappeared (1965), lower when the number of voles was on the decline (1964) and lowest of all during the peak of rodent population (1963). In any case, however, the buzzard's summer season impact on Tetraonidae populations, which never even reached 3 per cent take-off in any of the three years of observation, could for all practical purposes be discounted. Further observations made during the autumn season moreover suggested an obvious preference for birds which had been already wounded by hunters.

The pressure on ducks by all birds of prey within the key area (87 sq. km) of the Oka station of which a special study was made (Table 4), was rather higher. Here the IPP slightly exceeded 10 per cent, due primarily to the greater number of birds of prey supported by the Oka Reserve, particularly black kites and spotted eagles.

In comparison, the pressure of these predators on other gamebird species of the meadowland was insignificant. Despite the relatively high IPP for ducks, it is pertinent to add that the duck population in the neighbourhood of the Reserve was slowly but surely growing, thanks mainly to the strict enforcement of hunting regulations but also to some measures taken to reduce disturbance factors during the breeding season.

It is appropriate at this point to emphasize the necessity for an overall approach in estimating the economic importance of any animal. This principle is fairly widely recognized, but unfortunately quite often seems to be forgotten when it comes to evaluating birds of prey. Yet when due account is taken of their impact on harmful rodents, we found for example that each brood of our most abundant species, i.e. the common buzzard, saved roughly about half a ton of grain by devouring hundreds of voles and mice per season. On the other hand, during the special study at the Vladimir station we found that the entire population of predatory birds accounted for the death of not more than about five dozen nestlings of gallinaceous game-bird. In short, in this case, a balance would have to be cast between, on the negative side, the destruction of not more than a dozen* game birds which might otherwise have been bagged by hunters and, on the positive side, the saving of more than a dozen tons of grain brought about by the destruction of rodents.

The conclusion reached, therefore, in estimating the economic importance of birds of prey within the study region was quite clear, namely that they do practically no harm to game species and at the same time are appreciably useful from an agricultural point of view. On this basis, birds of prey as a whole undoubtedly deserve complete protection everywhere. The comparatively few exceptions to this rule can only apply to specific species under specific conditions, e.g. some hawks in the vicinity of poultry farms or pheasant and partridge rearing-pens and, very occasionally, within specialized hunting areas under intensive game management. Even in these cases, however, a strictly limited control, usually confined to the trapping of actually harmful individuals, is all that needs to be permitted. As for casual attempts at control of so-called 'harmful' predators by hunters at large and even game-keepers, our experience shows they are hardly ever likely to be successful, because of the difficulties of identification (e.g. distinguishing between the Marsh and other harriers) or of coping selectively with such rare and wary species as the goshawk.

THE PRESENT STATUS OF BIRDS OF PREY IN THE USSR

Intensive studies of birds of prey in various parts of the USSR, including the investigations outlined in this paper, have promoted a better understanding of their natural and economic importance. The official attitude towards them has undergone a marked change.

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* On general game management principles hunters may be expected to take off about 25% of the population of gallinaceous game-birds during the autumn shooting season. But the proportion of the young game birds killed by birds of prey, which can be considered as a potential part of the hunters' bag, is of course greatly reduced by the losses inflicted on these juveniles by natural factors such as bad weather, food shortage and disease.

The full case was presented by a special All-Union Public Committee on Birds of Prey headed by Prof. S. P. Naumov, with Dr. Rykovsky and the present author appointed as Deputy Chairmen. It led directly to the issue in 1964 of a new directive, with supporting regulations. This declared that, in general, birds of prey should be classed as useful species and that, in view of this, wholesale measures for their control must be terminated everywhere and a total ban placed on bounty payments for killing birds of prey of any kind. Strictly limited control measures were permitted only in respect of the goshawk and marsh harrier, within the hunting season and where game is specially managed. Thus, the problem of protecting birds of prey has now been duly resolved in the USSR and the new legislation has undoubtedly been a great success. In order to consolidate the position, the main effort is now directed to obtaining additional data to cover varying conditions and situations and to constant and patient exposition of the real ecological and economic effects of birds of prey to hunters and the general public.

SUMMARY

The results of a twelve-year (1956-1967) study of birds of prey in the central part of the European region of the USSR (some 270, 000 km^2) are reviewed. Their main feature was an attempt to evaluate the precise influence of these birds, by calculations based on an 'index of predatory pressure' (IPP), namely the percentage of the population of particular prey species killed by birds of prey in a given area during a given period of time (for the purposes of this study the latter being the duration of the breeding season).

In the whole region there are about 160 breeding pairs of birds of prey per 1000 km^2, mostly common buzzard *B. buteo* (38%), and black kite *Milvus migrans* (18%); the two allegedly 'harmful' species, marsh harrier *Circus aeruginosus* and goshawk *Accipiter gentilis,* comprised together less than 5%. It was found that the IPP (exercised largely by buzzard and goshawk) on the grouse family (Tetraonidae) in a 210 km^2 special study area at Vladimir amounted to 5-6%. In the key section of 87 km^2 in the Oka and Oka Reserve study area, the IPP on ducks, exercised largely by black kite and spotted eagle *Aquila clanga,* amounted to about 10%, but the duck population was still steadily increasing.

The damage to hunting interests represented by this level of predation (some 60 young Tetraonidae were killed in the Vladimir study area, for example) is far off-set by beneficial effects such as the saving of an estimated 12 tons of grain which would otherwise have been eaten by the thousands of voles and mice which the birds of prey killed in this area.

This and similar studies elsewhere in the Soviet Union led directly to the promulgation in 1964 of effective regulations for the protection of birds of prey.

RÉSUMÉ

Les résultats d'une étude sur douze années (1956-1967) des oiseaux de proie dans la partie centrale de l'URSS (quelques 270, 000 km^2) se trouvent examinés. Leur trait principal était un essai d'évaluer l'influence précise de ces oiseaux par des calculs basés sur un index de pression prédatoire (IPP), c'est à dire le pourcentage de la population d'espèces prédatoires particulières tué par des oiseaux de proie dans un terrain déterminé pendant une période de temps délimitée (en ce qui concerne cette étude cette période est la durée de couvaison).

Dans la région entière il y a environ 160 couples nidifiants d'oiseaix rapaces par 1000 km^2, pour la plupart la buse *B. buteo* (38%) et le milan noir *Milvus migrans* (18%); les deux espèces passant pour nuisibles—le busard des roseaux *Circus aeruginosus* et l'autour *Accipiter gentilis* représentaient ensemble moins de 5%. On constata que l'IPP (practiqué en grande mesure par le busard des roseaux et l'autour) sur la famille des tétras (Tetraonidae) dans un terrain d'étude spéciale de 210 km^2 à Vladimir revenait à un 5-6%. Dans la section-clé de 87 km^2 dans le terrain de recherches Oka et Oka réserve, l'IPP sur les canards (pratiqué par les milans noirs et l'aigle criard *Aquila clanga* revenait à 10% environ, mais la population des canards s'augmetait continuellement.

Le dommage causé aux intérêts de chasse représentés par le niveau de prédation (par example, une soixantaine de jeunes Tetraonidae se trouvait tués dans le terrain de recherches de Vladimir) se trouve compensé, et de beaucoup, par des effets bénéfiques tels que le sauvetage d'une douzaine de tonnes (estimées) de grain qui autrement auraient été dévorées par les milliers de campagnols et de souris que tuaient dans ce terrain les oiseaux rapaces.

Celle-ci et d'autres études semblables dans l'Union soviétique conduisirent comme résultat direct à la promulgation en 1964 de lois effectives pour la protection des oiseaux de proie.