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Density and productivity of Common Buzzard *Buteo buteo* and Goshawk *Accipiter gentilis* populations in Rogów, Central Poland

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Abstract. Density and productivity of Common Buzzard and Goshawks populations were studied over a period of 11 breeding seasons in Central Poland. The mean densities of Buzzards and Goshawks were 1.73 and 1.63 pairs/10 km^2 of the whole area (105km^2), respectively. Both studied species showed little variation of density during the study period. Breeding pairs constituted over 90% of all pairs recorded in the study area. Productivity of the Common Buzzard was greater than that of the Goshawk. Mean number of fledglings per statistical, breeding and successful pair were 1.67, 1.78 and 2.34 in Buzzard, and 1.96, 2.08 and 2.76 in Goshawks. Between-year variation in number of fledglings was high in Buzzard population and moderate in Goshawks. Buzzard productivity was related to changes in food composition of this species, whereas in Goshawks no relationship between productivity and diet was found.

Key words: density, breeding, Common Buzzard *Buteo buteo*, Goshawk *Accipiter gentilis*

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INTRODUCTION

Since 1975 when Goshawk has been protected by law in Poland, the density of this species increased (Wasilewski 1990, Czuchnowski 1993). The density of Common Buzzard is stable or increases in some areas (e.g. Czuchnowski 1993). At present, the two species occuring in the whole Poland territory, but in few areas only the densities of Goshawk are comparable with those of Buzzard.

This study was conducted in Central Poland, where both raptors occur in similar numbers (Goszczyński & Piłatowski 1986). The investigation was aimed at: 1) evaluating the breeding density of Buzzard and Goshawk; 2) estimating their reproduction success; 3) determining the factors that affect density and productivity.

STUDY AREA

The study was carried out in the vicinity of Rogów (Fig. 1), Skierniewice province, Central Poland in 1982–1992. The study area (105 km^2) represented a mosaic of fields (59%), woods (23%), grasslands (5%) and orchards (5%). Villages, waste land, and roads covered 8% of the area. The whole area is characterized by a dense network of human settlements and extensive agriculture. The pigeon breeding is widespread and traditional hobby of people in the environs of Rogów. The woods were dominated by the Scotch Pine *Pinus silvestris* (77.0%) and oak *Quercus* sp. (10.7%).

Density of the Common Vole *Microtus arvalis*, an important prey for buzzards, fluctuated from < 10 ind./ha to nearly 80 ind./ha. Their mean densities were 4–5 times lower than those reported from western and northern Poland (Goszczyński 1985). Small game

(Brown Hare, Grey Partridge and Pheasant) were moderately abundant (Wasilewski 1986, Dudziński 1988).

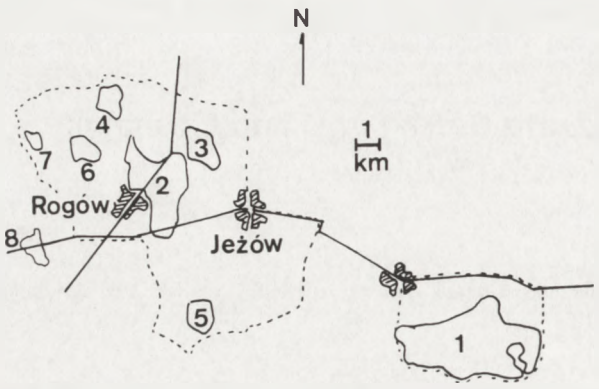

Fig. 1. Distribution of forests (1–8) in the study area.
[Ryc. 1. Rozmieszczenie lasów (1–8) na terenie badań.]

METHODS AND MATERIAL

The number of pairs of Common Buzzards and Goshawks were estimated in early spring (March) of 1982 through 1992. Observations of soaring pairs and calls of raptors were used as indicators of possible places of nesting. Forested parts of the territories were checked to find nests. The searches were done in old tree stands and places where pellets and remnants of prey had been found. If no nests were found in such places, searching was continued in other parts of territory till July. All nest were mapped on the forestry 1:10,000 map.

In the second half of April, the number of nesting pairs was estimated on the basis of bird presence at or the nest. The nest appearance (presence of down, fresh pine or birch twigs on the nest) as well as feathers of female and remnants of prey under the nest were also noted.

For most of breeding pairs, nest controls were continued till July to estimate the number of successful pairs and their productivity. In the case of Goshawk, fledglings were counted in mid July. In Common Buzzards, this was done in June–July.

During the period of 1982–1987, two methods of counting fledglings were applied. First, the number of fledglings on nest was estimated from the ground level by binocular observations. Then, climbing the nest tree, and a direct count of fledglings, were performed. Comparison of these two methods revealed that correction factors were necessary when the estimation was done from the ground level (Tab. 1). These correction factors were used to estimate the number of fledglings in the remaining years of the study (1988–1992), when nests were checked from the ground, only.

Table 1. Correction factors for determining a real number of fledglings in the nests of Buzzards and Goshawks by observation from the ground. N — nests checked, f/N — number of fledglings/nest recorded from the ground, TA — total number of fledglings estimated from the ground, TB — total number of fledglings counted directly, TB:TA — correction factor.

[Tabela 1. Przeliczniki wykorzystane do oceny liczby wylatujących młodych. N— liczba kontrolowanych gniazd, f/N — liczba wylatujących młodych na gniazdo wg kontroli z ziemi, TA — ogólna liczba młodych oceniana z ziemi, TB — rzeczywista liczba młodych w gniazdach, TB:TA — przelicznik dla ocen spod gniazda.]

N	f/N	TA	TB	TB:TA
Buzzard				
9	1	9	15	1.67
18	2	36	47	1.31
13	3	39	42	1.08
1	4	4	4	1.00
Goshawk				
7	1	7	13	1.88
18	2	36	50	1.39
15	3	45	50	1.11
7	4	28	28	1.00

In each raptor species, three categories of pairs were distinguished: successful pairs, breeding pairs, and mean (statistical) pairs. Successful pair was a pair, which reared at least one fledgling during the breeding season. All successful and failed pairs were combined into a category of breeding pairs. The sum of breeding pairs and pairs without nests formed the third category: mean (statistical) pairs. The ratio of successful pairs to the sum of successful and failed pairs was treated as an index of breeding success (expressed as percentage).

Each nest was checked several times during the breeding season. The pellets and remnants of prey collected during nest controls were analysed to evaluate the diet of raptors (Goszczyński & Piłatowski 1986, Goszczyński 1991). The food composition of both species was expressed as percentages of occurance and biomass of prey consumed.

RESULTS

Population size and densities in relation to forest area

In the whole study area, an average 18 pairs of Common Buzzards and 17 pairs of Goshawks were recorded during each breeding season. Density changed little between years. The coefficient of variability was 7% in Buzzards and 5% in Goshawks (Tab. 2).

Table 2. Population size and breeding success of the Buzzard and the Goshawk in 1982–1992. N — Number of pairs: wn — without nest, Br — breeding, Suc. — successful, f — failed, ? — unknown, % — breeding success.

[Tabela 2. Liczebnośc i sukces lęgowy ptaków drapieżnych w środkowej Polsce. N — liczba par: wn — bez gniazd, Br — lęgowych, Suc. — z sukcesem, f — ze stratą lęgu, ? — losy pary nieznane, % — sukces lęgowy.]

Year	Total	wn	Br	Suc.	f	?	(%)
Common Buzzard							
1982	18	–	18	13	1	4	93
1983	17	–	17	10	6	1	62
1984	18	1	17	9	7	1	56
1985	17	1	16	10	4	2	71
1986	17	–	17	12	3	2	80
1987	17	2	15	12	2	1	86
1988	18	1	17	12	2	3	86
1989	19	1	18	15	2	1	88
1990	20	4	16	9	7	0	56
1991	18	3	15	11	3	1	79
1992	21	1	20	13	7	0	65
Mean	18.2	1.3	16.9				75
(SD)	1.33	1.30	1.45				
CV%	7.3	100.0	8.6				
Goshawk							
1982	17	–	17	14	1	2	93
1983	16	–	16	10	4	2	71
1984	16	–	16	9	7	0	56
1985	17	1	16	11	4	1	73
1986	18	1	17	10	3	4	77
1987	18	1	17	12	1	4	92
1988	18	–	18	14	5	0	78
1989	18	2	16	9	2	5	82
1990	17	1	16	7	5	4	58
1991	16	2	14	8	2	4	80
1992	17	3	14	9	5	0	64
Mean	17.1	1.0	16.1				75
(SD)	0.83	1.0	1.20				
CV%	4.8	100.0	7.6				

Mean densities of Buzzards and Goshawks were 1.73 and 1.63 p./10 km^2 of the total area, respectively. Densities expressed as number of pairs per 10 km^2 of forested area were much higher (7.46 and 7.01, respectively). Breeding pairs formed, on average, 93% of the total number of pairs in the case of Buzzards and 94% of all Goshawk pairs (Tab. 2).

Buzzards and Goshawks nested in seven woods, from 0.5 km^2 to 10 km^2 each, surrounded with cultivated fields, orchads and grasslands.

In the wood no. 8, density of raptors was estimated during five breeding seasons, only. For comparison with other forests, the number of pairs was recalculated to represent eleven breeding season as in other woods. Length of forest edge estimated on the assuption that the forest is circular.

In both raptors the number of pairs breeding in the wood increased with an increase of forest size (Tab. 3). In Buzzards the density per unit of forested area decreased with an increase of forest size. In the case of Goshawks this relationship is not so strong (Fig. 2).

Table 3. Total number of pairs observed in a particular forest during the whole study, compared to number of pairs expected from the proportional area of the forest and length of its edge. B.b — Common Buzzard, A.g. — Goshawk.

[Tabela 3. Liczba par ptaków drapieżnych obserwowana w ciągu całego okresu badań w poszczególnych komleksach leśnych w porównaniu z oczekiwaną (proporcjonalną do wielkości lasu i długości granicy polno-leśnej) liczbą par. . B.b — myszołów, A.g — gołębiarz.]

Forest	Area (km^2)	Edge (km)	Pairs		Expected number to: area		Expected number to: edge	
			B.b	A.a	B.b	A.g	B.b	A.g
1	10.00	11.21	62	74	87	79	55	50
2	7.17	9.49	44	42	62	57	47	43
3	2.05	5.07	21	20	18	16	25	23
4	1.68	4.59	24	12	15	13	23	21
5	1.66	4.57	25	17	14	13	22	20
6	1.35	4.12	16	12	12	11	20	18
7	0.50	2.51	10	9	4	4	12	11
8*	1.65	4.55	24	20	14	13	22	20
Total	26.06	46.11	226	206	226	206	226	206

Assumption that number of Buzzard pairs inhabiting various forests is proportional to the their area was rejected ($p < 0.01$, Kolmogorov-Smirnoff test). On the other hand, no significant difference was found between observed and expected number of Buzzard pairs, with an assumption that number of pairs is proportional to the lenght of forest edge ($p > 0.05$, Kolmogorov-Smirnoff test, Tab. 3). In the case of Goshawks, both, proportional to the forest size and to the lenght of forest edge, theoretical distributions of the

number of pairs, did not differ significantly from empirical ones ($p > 0.05$, Kolmogorov-Smirnoff test, Tab. 3).

Breeding success and productivity

Mean breeding success was similar (75%) in both species (Tab. 2). During the study period, a significant correlation between the breeding success of Buzzards and that of Goshawks was noted ($r = 0.93$, $n = 11$, $p < 0.001$). The main causes of breeding failure were: abandonment of nests, fall of the nest, predation by martens and ravens, and human disturbance and destruction of nests. The latter factor (humans) accounted for important part (approx. 30%) of egg and nestling mortality during the study.

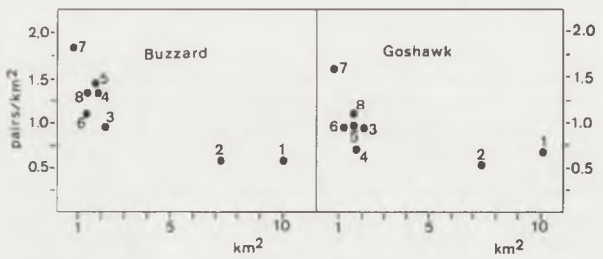

Fig. 2. Relationships between the forest area (km^2) and density (mean pairs/km^2 of forested area). Areas 1–8 — see Fig. 1.

[Ryc. 2. Zależność zagęszczenia (średnia roczna liczba par/km^2 powierzchni leśnej) od wielkości lasu (km^2). 1–8 — kompleksy leśne (ryc. 1).]

The average production of fledglings by Goshawk pairs was greater than that by Buzzards (Tab. 4). The values of Pairing Disign Test (Woolf 1968) were: $t = 3.34$, $p < 0.01$, $n = 11$ for mean pairs; $t = 4.05$, $p < 0.01$, $n = 11$; for breeding pairs, and $t = 5.22$, $p < 0.001$, $n = 11$ for successful pairs. During the whole study the year-to-year variation of productivity was high in Buzzards (CV = 32% for statistical pairs, 30% for breeding pairs, and 15% for successfull pairs), and moderate in Goshawks (CV = 21%, 19%, and 7%).

During the whole study the correlation between productivity of both raptor species was found (statistical pairs: $r = 0.84$, $p < 0.01$, $n = 11$; breeding pairs: $r = 0.89$, $p < 0.001$, $n = 11$; successful pairs: $r = 0.68$, $p < 0.05$, $n = 11$).

DISCUSSION

During the whole study, the densities of both studied species showed little variation. The mean overall density of Buzzards was similar to those reported from other regions of Poland (Truszkowski 1976, Jędrzejewski *et al.* 1994, Pugacewicz 1996) or smaller (Król 1985, Dyrcz *et al.* 1991). In contrast, the density of Goshawk population found in this study was among the highest ever reported (Thiollay 1967, Kramer 1972, Thissen *et al.* 1982, Fischer 1983, Widen 1985, Czuchnowski 1993, Chmielewski *et al.* 1996).

Table 4. Number of fledgings per pair. $\bar{x}$ — mean pair, Br — breeding pair, Suc. — successful pair.

[Tabela 4. Liczba wylatujących młodych na parę badanych populacji myszołowa i gołębiarza. $\bar{x}$ — para przeciętna, Br — para lęgowa, Suc. — para z sukcesem.]

Year	Buzzard			Goshawk		
	$\bar{x}$	Br	Suc.	$\bar{x}$	Br	Suc.
1982	2.40	2.40	2.58	2.41	2.41	2.58
1983	1.44	1.44	2.30	2.08	2.08	2.91
1984	0.83	0.88	1.56	1.37	1.37	2.44
1985	1.72	1.83	2.56	1.95	2.07	2.82
1986	2.15	2.15	2.69	2.26	2.39	3.11
1987	1.78	2.02	2.36	2.51	2.65	2.87
1988	1.96	2.08	2.43	2.23	2.23	2.87
1989	2.36	2.49	2.82	2.12	2.38	2.91
1990	0.99	1.24	2.21	1.47	1.56	2.68
1991	1.52	1.82	2.32	1.75	2.00	2.51
1992	1.20	1.26	1.94	1.38	1.68	2.62
Mean	1.67	1.78	2.34	1.96	2.08	2.76
(SD)	0.53	0.52	0.35	0.41	0.40	0.21
CV%	31.7	30.0	15.1	20.9	19.2	7.3

In Central Poland, the mean availability of Common Voles for Buzzards is rather small in comparison to other parts of the country (Goszczyński 1985). In consequence, during every breeding season, above 50% of Buzzard diet consisted of birds (Goszczyński & Piłatowski 1986). Generally, food resources for Buzzards were moderate and did not influence their density, but might have affected the reproduction. The impact of food supply on number of fledglings produced by a pair was observed in many studies (e.g. Truszkowski 1976, Sylven 1982, Spidso & Selas 1988, Jędrzejewski *et al.* 1994).

The pigeon breeding, which flourishes in the Rogów area, possibly improved food resourses for Goshawks. Nearly 65% of Goshawk diet consisted of pigeons. Further 8% of biomass was formed by domestic chickens. So, 3/4 of biomass consumed by Goshawks was taken from villages (Goszczyński & Piłatowski 1986, Goszczyński 1991, author's data). This fact may explain extremely high density of Goshawks in the study area.

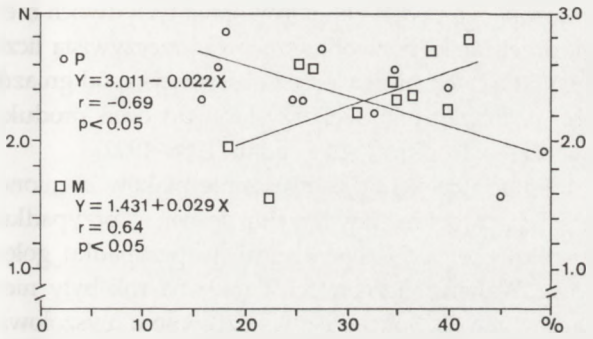

Fig. 3. Relationships between percentage of biomass (%) of some food items in the Buzzard diet and number of fledglings per successful pair of Buzzards (N). Each point denotes one breeding season. P — pigeons and domestic chickens, M — small mammals.

[Ryc. 3. Korelacje między spożyciem (% biomasy) wybranych kategorii pokarmu myszołowa a liczbą młodych na parę z sukcesem (N). Każdy punkt oznacza jeden sezon gniazdowy. P — gołębie domowe i kury, M — drobne ssaki.]

Both species captured most of their prey in open areas (Goszczyński & Piłatowski 1986, Goszczyński 1991). It seems, that Buzzards showed the tendency to minimize a distance between nests and foraging areas. It was reported from Białowieża National Park when density of Buzzards near the forest edge was higer than deep inside the forest (Jędrzejewski *et al.* 1994). In the Buzzard, the number of pairs was related to the length of forest edge. The fact that the length of border line is relatively longer for small woods than for large forests, may explain the negative relationship between buzzard density and size of a forest found in this study. In a very large forest the spatial distribution of nests may be determined not only by a distance to open area, but also by an internal differentiation of forest habitats, i.e. occurence of gaps, open marshes, beds of river etc. (Jędrzejewski *et al.* 1988, Pugacewicz 1996).

Between-year variation of various food items in the diet is greater in Buzzards than in Goshawks (Goszczyński & Piłatowski 1986, Goszczyński 1991, author's data). Variation in diet indicated the changes in prey abundance for both species during the study period. Little changes in Goshawk productivity from year to year reflected stability of its food resources. There was no significant correlation between main food components (e.g. biomass of pigeons) and productivity od this species ($r = -0.20$, $p > 0.05$, $n = 11$).

In contrary, variation in yearly production of Buzzards were much higher. The mean number of fledglinds reared by a successful pair was positively correlated with biomass of small mammals in diet ($r = 0.64$, $p < 0.05$, $n = 11$), and negatively with biomass of pigeons and domestic chickens ($r = -0.69$, $p < 0.05$, $n = 11$) — Fig. 3.

During the 11-year study, a significant correlation between productivity of both birds of prey was found. Theoretically, this correlation may be due to: 1) changes in abundance of prey utilized by both raptor species; 2) external factors (e.g. temperature and precipitation or predator pressure) which affected breeding condition of both birds of prey; 3) competition for available food resources. The first explanation is unplausible because the productivity of the Goshawk did not correlate with its diet. The negative relationship between productivity of the buzzard and share of pigeons and chickens in its diet, suggested that competition for food between the two species studied could have existed.

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STRESZCZENIE

[Zagęszczenie i produktywność populacji myszołowa zwyczajnego i gołębiarza w okolicach Rogowa]

W ciągu 11 lat badań oceniano zagęszczenie i produktywność myszołowa zwyczajnego i gołębiarza w okolicach Rogowa, woj. skierniewickie (ryc. 1).

W początkowym okresie badań (lata 1982–1987) liczbę odchowanych piskląt ocenianio zarówno przez wspinanie się do gniazd jak i przez obserwacje z dołu. Wyliczone, na podstawie porównania tych dwóch metod, przeliczniki pozwoliły szacować rzeczywistą liczbę wylatujących piskląt przez obserwacje spod gniazd (tab. 1). Przeliczniki wykorzystano do ocen produktywności w drugim okresie badań (1988–1992).

Średnie wieloletnie zagęszczenie ptaków oceniono na 7,5 par/10 km^2 powierzchni leśnej w przypadku myszołowa i na 7,0 par/10 km^2 w przypadku gołębiarza. Wahania liczebności z roku na rok były nieznaczne (tab. 2). Sukces lęgowy zarówno u myszołowa jak i gołębiarza kształtował się na poziomie 75% (tab. 2). U obydwu gatunków odnotowano spadek zagęszczenia ze wzrostem powierzchni lasu (ryc. 2). Liczba par myszołowów w poszczególnych lasach była skorelowana z długością granicy polno-leśnej (tab. 3).

Przy wyznaczaniu granicy polno-leśnej zakładano, że las ma kształt koła. W lesie nr 8, leżącym poza terenem badań, zagęszczenie ptaków oceniano w ciągu pięciu sezonów. Dla porównania z innymi lasami liczbę par przeliczono na 11 sezonów.

Wskaźniki produktywności (N młodych/parę statystyczną, lęgową i parę z sukcesem) wykazywały dużą zmienność. Liczba młodych na parę statystyczną wynosiła 1,67 dla myszołowów i 1,98 dla gołębiarzy. Wskaźniki produktywności dla pary lęgowej i pary z sukcesem wynosiły odpowiednio dla myszołowa: 1,78 i 2,34, a dla gołębiarza: 2,08 i 2,76 (tab. 4). W przypadku myszołowa liczba odchowanych piskląt była dodatnio skorelowana z udziałem drobnych ssaków w pokarmie tego drapieżnika i ujemnie ze spożyciem gołębi i kur (ryc. 3). Produktywność i sukces lęgowy myszołowa i gołębiarza były skorelowane ze sobą. W pracy przedyskutowano możliwe przyczyny tego zjawiska.

PODZIĘKOWANIA

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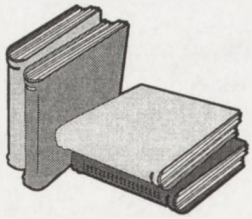

BOOKS RECEIVED

THE EDITION OF GLUTZ & BAUER's HANDBOOK — finished

[KOŃCOWY TOM (14/I–III) MONOGRAFII „PTAKI ŚRODKOWEJ EUROPY"]

Glutz von Blotzheim U., Bauer K. M. 1997. Handbuch der Voegel Mitteleuropas.Band 14 (I–III). AULA-Verlag, Wiesbaden, 1966 pp.

This 14th volume is the final edition of the monumental monography of the present knowlege on birds of the Central Europe (understood in very wide geographic range). The multi-volume handbook was initiatiated by Guenter Niethammer, who thought it as a contemporary and enlarged version of his "Handbuch der deutschen Vogelkunde", published (in 3 volumes) in 1937–1942 — the classic position of the European ornithological literature. The "Handbuch der Voegel Mitteleuropas", althrough it was born from the tradition of Nithammer's work, was written as a new book by Urs N. Glutz von Blotzheim and Kurt M. Bauer, who are its authors. Guenter Niethammer was an editor of the first two volumes, and then he was replaced by the present editor — Urs N. Glutz von Blotzheim. Contributors of data the book is based on, and consultants of its matter, were many ornithologists competent in the avifauna of particular countries of the region. The work begun in 1962 and it took 33 years. The first volume of the monography appeared in 1966. Since that time 22 books, the "Handbuch der Voegel Mitteleuropas" consists of, were published. Total 531 species of birds occurring in our part of Europe were described.

Three parts of the 14th volume cover families *Passeridae* (part I, pp. 1–304), *Fringillidae* (II, pp. 305–1242) and *Emberizidae* (III, pp.1243–1966). The volume is open by the by the editor's "Introduction", with his reflections and thanks od the occasion of the end of the work. The main matter covers descriptions of species arranged according to the scheme of the whole book: — distribution of the species, its taxonomy, morphology and field identification, moult, voice, geographic distribution, abundance, migrations, habitat distribution, breeding, diet and foraging, and at the end — literature concerning the species.

An important enclosure of the final volume is a booklet of corrections and additions to the text of all 14 volumes of the monography.

An edition of the 14th volume completing the Glutz and Bauer's work enriched European ornithology by the basic handbook — which is among the most important sources of the knowlege on birds of our region.

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