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Habitat use and hunting behaviour of Common Buzzards *Buteo buteo* wintering in south-western Poland

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Abstract. During seven winter seasons (1993/1994–1999/2000) 107 roadside counts (28 km each) in agricultural area of south-western Poland were conducted. From among 1526 Buzzards, 1293 were recorded in winter months (November–February) and 233 in March. Birds were non-randomly distributed on nine vegetation types met along the transect route. Permanent papilionaceous crops, along with cereal stubbles, margin habitats, meadows and maize stubbles were preferentially used, whereas bare tillage and winter cereals were avoided. In general, Buzzards preferred habitats of the least amount in the studied area and avoided those which dominated. These data support the idea of high importance of small landscape structures for the biodiversity protection in intensively used farmland. During winter months, most Buzzards (59.5%) were perched when first sighted, most often on trees and in the middle part of their height. The percent of birds sitting on the ground amounted to 34.7%. The smallest amount of individuals (5.8%) was observed flying (flap-sailing, hovering and soaring), however this activity significantly increased in March (up to 17.1%). The significance of various hunting methods for wintering Buzzards is discussed. Even though it is a typical perch hunting raptor, the method of hunting from the ground seems to be particularly suitable for the conditions of winter farmland: common scarcity of perches, poor and low vegetation, local and temporary prey concentrations.

Key words: Buzzard, *Buteo buteo*, birds, habitat preferences, hunting behaviour, perch-site use, wintering, farmland

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INTRODUCTION

The Buzzard is the most numerous raptor species in Europe, widespread throughout the continent, and the nominate subspecies is resident or partly migratory (increasingly so, northwards) (Bijlsma 1997). During winter the species is strongly connected to open habitats, and on prevailing part of the wintering range it inhabits agricultural areas with some trees (Melde 1995). The bulk of the Buzzard literature dealing with winter ecology has concentrated on estimating population levels (see Mülner 2000, Boano & Toffoli 2002, Wuczyński 2003 for reviews). Studies on behavioural ecology and habitat selection of the species are less numerous, and some of them inform on rather general categories of habitats observed, e.g. arable land/grassland (Gamauf 1987, Kasprzykowski & Rzępała 2002). One can expect that such an approach may obscure actual requirements of wintering buzzards, and additional preferences may occur inside particular categories, probably expressing food supply and/or its availability. Besides, documentation of various aspects of ecology of birds wintering in agricultural areas is desired particularly in these Central European countries, like Poland, where important changes of the agricultural landscape have been taking place recently. The present and future influence of these changes on wildlife is poorly recognised, however severe threats to biodiversity are noticed right now (Donald et al. 2002).

My primary objective was to determine whether Buzzards wintering in a selected agricultural area of SW Poland use certain habitats more frequently and avoid others. The second objective was to describe types of behaviour, hunting techniques and perch-site use by this typical perch-hunting predator.

STUDY AREA AND METHODS

The study was carried out in an open, agricultural area of the Wrocław Plain (Lower Silesia, south-western Poland) (50°49′N, 16°51′E). Systematic road survey was established along a busy motor roads: national road No. 384 and international road No. E67. The main habitat characteristics were typical for this part of Poland. Small fields (1–5 ha) of private freeholders predominated, some areas were occupied by larger (5–15 ha) fields. The area was covered by low vegetation, the only wooded areas constituted sparse, small clumps and belts of trees along ditches or roads. Moreover, it is the warmest climatic region of Poland. More precise description of the transect route, weather conditions and relative rodent abundance in the studied years were presented elsewhere (Wuczyński 2003). Densities of wintering Buzzards in this area were relatively high, but typical for Central Europe. The average density for seven winter seasons (1993/1994–1999/2000) was 2.12 ind./km^2 in November–February and 1.34 ind./km^2 in March (Wuczyński 2003). Population is partly migratory but the ratio of resident to inflowing birds remains unknown.

I conducted 107 roadside surveys during seven consecutive winters from 1993/1994 through 1999/2000, between November and March. However, 23 March counts were treated separately in this analysis because it is the beginning of the breeding season for many, especially resident Buzzards. Total length of the route was 40 km, but effective counts were conducted on 28 km long segment only (settlements and above 1-km length wooded section were excluded). The route was divided into 18 sections (mean length 1.5 km) fixed by consecutive villages. Birds were counted from the bus or car with the driver, in the morning (between 8:30 and 10:00 AM), on days with good visibility. The duration of a single control was ca. 1 hour. All Buzzards seen on one side of the route within a distance of 250–300 m were counted. Vehicles moved with the speed of 50–70 km/h non-stop during counts, but with short stops between sections (in villages), when most details on birds occurrence were noted. This method, together with the estimation of the degree of accuracy, was widely described in separate work (Wuczyński 2001a). Although the speed of the vehicles was higher than usually recommended for road transects, it was proved that the detectability of Buzzards amounted to 80–88%. Similarly, Utchik (1988, after Schröpfer 1997) noted, that the travel speed does not influence the quantitative results of the count, unless it rarely exceeds 60 km/h. The misidentification concerned some cases of Rough-legged Buzzard *B. lagopus* only. However, it could cause a non-significant bias because of the low abundance of this species in Silesia (somewhat less than 1 ind./10 km^2, Dyrcz et al. 1991, Lontkowski 1994, own data). For example, during four precise double counts on the same transect, only two Rough-legged Buzzards were detected, among 109 Buzzards in total (Wuczyński 2001a).

Field data were recorded using a special form and included general characteristics of the count (e.g. date, time, weather) and details of activity and habitat type of each individual Buzzard. The activities were divided into five categories: perching on raised places, sitting on the ground, flap-sailing (usually in a straight line), hovering, and soaring. Perching substrates were characterized as: tree, bush, electricity pole and others — power line, fence post, stack. The number of potential perches was very high, as power lines and rows of trees extended along the whole route. Consequently, a repeated use of exactly the same perch was rarely observed, which prevented data replication. Starting with the winter 1995/1996, the location of each bird in one of the four height levels of the tree was also recorded, i.e. atop, below the top (above 75% of the tree high), in the middle (25–75%), and low (below 25%).

Habitat preferences were analysed in three winters (1993/1994, 1994/1995 and 1995/1996), when detailed data on land use was collected. Nine vegetation types were distinguished, which represented all available habitats within the counting belt (Table 1). Percentage of three main types, i.e. winter cereals, bare tillage and winter oilseed rape was calculated based on data obtained in local commune offices and six large holdings situated along transect route. The amounts of the remaining six habitats were established based on own field measurements and on analysis of 1:25 000 maps. Although crops rotated during the three winters, the area percentages remained constant, thus the average values (expressing habitat availability) were used in calculations. Habitat use was described for 659 Buzzards observed along the route, except flap-sailing and soaring birds. Habitats observed around each Buzzard were scored, taking into account a radius of 100 m which is the maximum attack distance of the perch hunting Buzzards (n = 241 attacks, longer distance was observed in two cases only, A. Wuczyński, unpubl.). When

Table 1. Habitat types used by Buzzards in winter months (N = 1094.2) and in March (N = 170.8) in 1993/1994–1999/2000. Note that the sample sizes relate to sums of scores for each habitat type, and not to the number of individuals (see methods). * — various uncropped areas covered by high herbaceous vegetation: ditches, railway tracks, wide field boundaries etc. ** — roads, edges of woodlots and settlements, atypical crops, e.g. carrot.

Habitat types	November–February (%)	March (%)
bare tillage	23.2	26.1
winter oilseed rape	17.3	10.7
winter cereals	14.5	14.7
meadows	10.8	9.4
margin habitats*	10.8	17.1
cereal stubbles	8.8	8.1
maize stubbles	7.8	7.1
others**	4.6	5.7
permanent papilionaceus crops (lucerne or clover)	2.2	1.2
Total	100.0	100.0

the bird was recorded over one habitat type, it received the score 1, when more than one habitat type was situated within the above distance, each of them received an adequate fraction of the score 1 (i.e. 0.5 by two habitat types, 0.3 by three types and 0.25 by four types). Then, scores for each habitat type were counted up (= actual sums) and compared with expected values based on habitat availability. Habitat preferences were expressed by quotient between actual and expected sum for each habitat type. Additionally, habitat selection, as well as the selection of hunting techniques in habitat types, were measured using Jacobs' selectivity index (Jacobs 1994):

$$D = (r - p)/(r+p - 2rp),$$

where r — denotes the proportion of Buzzard sightings (actual sums) or particular technique use over a given habitat type, and p — the proportion of a given habitat type in the studied area. D varies from -1 (complete avoidance) to 0 (habitat/technique use proportional to habitat availability), to 1 (exclusive use). Preferences were tested using χ^2 test for goodness-of-fit, and χ^2 test of independence was used in analysis of other differences. Categories were combined when necessary to eliminate small expected values.

RESULTS

Habitat use

During the seven-year survey, I recorded 1526 Buzzard sightings, including 1293 sightings in winter months (November–February) and 233 sightings in March. Most birds were recorded in habitats dominating in the study area: ploughed fields, winter cereals and winter rape (in total 54.9% in November–February and 51.5% in March). Least buzzards were seen in scarce habitats (Table 1). In March number of sightings on winter rape decreased, and in margin habitats increased, but overall difference in habitat use between March and winter months remained insignificant ($\chi^2 = 10.54$, df = 7, $p = 0.15$).

For the first three seasons only winter cereals and bare tillage were used less frequently than expected, based on the relative occurrences of these land types (Table 2). All the other habitat types were used more frequently than expected, and in general, the null hypothesis of random land-type use was rejected ($\chi^2 = 979.5$, df = 7, $p < 0.0001$). The strongest preference was revealed for permanent papilionaceus crops (expected value was exceeded above eight times). Actual use of winter rape and "other" habitats was close to expected. The results expressed by Jacobs' preference index are shown on Fig. 1.

Table 2. Actual and expected sums of Buzzard sightings on nine habitat types between November and February in winters 1993/1994, 1994/1995 and 1995/1996. The expected values are calculated based on the relative occurrence of each habitat type, shown in the second column. Habitat preferences are expressed as a quotient between the actual and expected sum. Note that these sums relate to scores for each habitat type, and not to the number of individuals (see Methods).

Habitat type	Habitat availability (%)	Actual sum	Expected sum	Habitat preference
permanent papilionaceus crops	0.5	23.0	2.8	8.2
cereal stubbles	2.0	70.7	11.2	6.3
margin habitats	2.0	54.3	11.2	4.8
meadows	2.5	66.0	14.0	4.7
maize stubbles	4.0	50.3	22.5	2.2
winter oilseed rape	8.8	77.3	49.4	1.6
others	3.0	20.2	16.9	1.2
bare tillage	35.8	132.9	201.1	0.7
winter cereals	41.4	67.1	232.6	0.3
Total	100.0	561.7	561.7	-

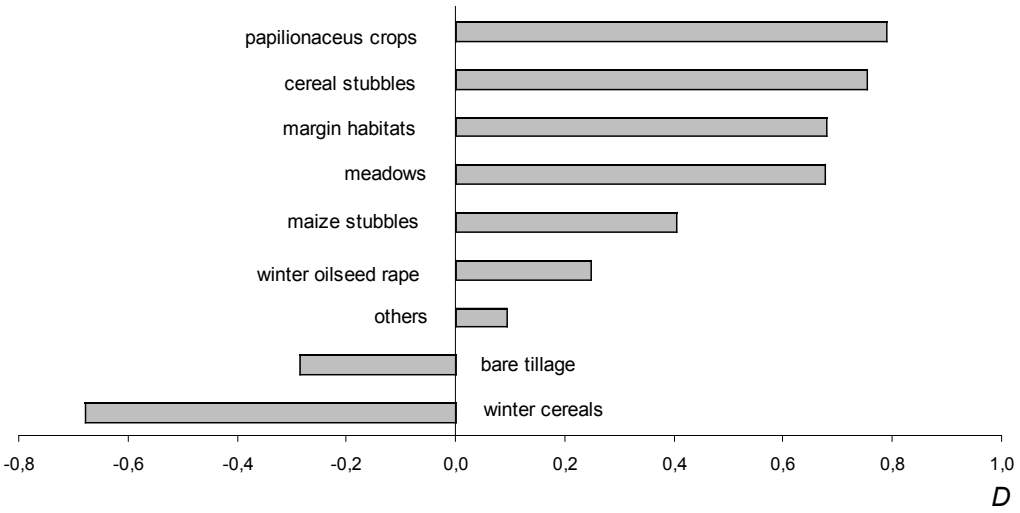

Fig. 1. Habitat preferences of the Buzzard expressed by Jacobs' Index (*D*).

Types of hunting behaviour and perch-site use

In November–February the majority of buzzards (59.5%) perched on raised places when first sighted (Table 3), percentage of ground sitting individuals was also significant (34.7%), but flying birds were rarely recorded. Lack of soaring buzzards was characteristic (merely one record). Percentage of flying birds significantly increased in March and the overall difference in activity forms between these two periods was highly significant ($\chi^2 = 37.8$, df = 2, $p < 0.0001$). Since the frequency of different activities reflects the frequency of hunting techniques (Bildstein 1987), Buzzards wintering in the Wrocław Plain hunted mainly from a perch, to a smaller extent from the ground, and hovering was unimportant method.

Trees were the most frequently used perching substrate (73.6% in November–February and 80.0% in March) (Table 4). Most perching buzzards were observed in the middle part of the tree height, but percentage of birds perching atop was also considerable during winter months. The difference in perching substrate use between these months and March was not significant ($\chi^2 = 3.62$, df = 3, $p = 0.30$), but various tree heights were used differently, i.e. more evenly, in March ($\chi^2 = 11.18$, df = 3, $p = 0.01$).

Frequency of hunting techniques on different habitats

Frequency of both hunting from the ground and perch hunting in habitat types corresponded with the overall habitat preferences in the case of bare tillage and winter cereals (avoidance), and papilionaceus crops, cereal stubbles and meadows (preferential use). Moreover, hunting from the ground was preferentially used in fields with winter oilseed rape, maize stubbles and papilionaceus plants, whereas perch hunting — in meadows, and especially in margin habitats (Table 5). The high frequency of perch hunting in the last two habitats was probably supported by the greater

Table 3. Types of behaviour of Buzzards when first sighted (N = 1293 individuals in November-February and N = 233 individuals in March)

Activity	November–February (%)	March (%)
Perching on raised places	59.5	55.8
Sitting on the ground	34.7	27.0
Flap-sailing	5.1	12.0
Hover flight	0.6	2.1
Soaring	0.1	3.0
Total	100.0	100.0

Table 4. Use of perching substrates by Buzzards in winter (N = 769 individuals) and in March (N = 130 individuals). * — percentages of the location on the tree were counted for Buzzards for which the location was determined (= 100%). ** — power line, fence post, stack etc.

Perching substrates	November–February (%)	March (%)
Tree	73.6	80.0
atop*	26.7	19.2
below the top	14.5	23.3
in the middle	46.1	34.2
low	12.7	23.3
Electricity pole	13.5	7.7
Bush	8.8	8.5
Others**	4.0	3.8
Total	100.0	100.0

Table 5. Habitat preferences for ground-hunting and perch-hunting Buzzards (N = 226 and N = 409 individuals, respectively) expressed by Jacobs' selectivity Index (*D*). Data for the period November-February in three winter seasons (1993/94–1995/96) were used.

Habitat type	Proportion of ground-hunting	D index for ground-hunting	Proportion of perch-hunting	D index for perch-hunting
permanent papilionaceus crops	0.08	0.887	0.01	0.498
cereal stubbles	0.14	0.780	0.11	0.719
maize stubbles	0.16	0.649	0.04	0.035
winter oilseed rape	0.22	0.488	0.09	-0.009
meadows	0.06	0.454	0.15	0.747
others	0.02	-0.107	0.04	0.193
marginal habitats	0.01	-0.164	0.15	0.794
bare tillage	0.19	-0.395	0.27	-0.211
winter cereals	0.10	-0.727	0.13	-0.643

availability of perches along field and road boundaries (were also most of marginal habitats and meadows occurred), but also dense vegetation in marginal structures did not allow Buzzards to hunt from the ground. For illustrative purposes, the difference in frequency between these two hunting techniques was calculated, as shown in Fig. 2.

DISCUSSION

Spatial distribution of wintering raptors mirrors the local abundance of food supply (Newton 1990). Indeed, Buzzards wintering in the study area settled preferentially in these habitats, which are known of high rodent abundance, e.g. papilionaceus crops, meadows, stubbles (Adamczewska-Andrzejewska et al. 1982), and these results are consistent with other studies (Jørgensen 1986, Eichstädt & Eichstädt 1991, Sachteleben 1993, Voříšek 1991, Bijlsma 1996, Schröpfer 1997, Mülner 2000, Kitowski 2000, Kasprzykowski & Rzępała 2002). Common features of these habitats are permanent soil surface (no ploughing over long period, which is extremely favourable for rodents), and low vegetation. High seed abundance on stubbles is also important. Characteristic of the observed buzzards distribution was a preference of habitats of the least amount in the studied area, which provides additional evidence of high importance of small landscape structures for the biodiversity protection in areas of intense agriculture (Schifferli 2001).

The Buzzard is a versatile predator using various hunting techniques, depending on prey, habitat, or weather conditions (Pinowski

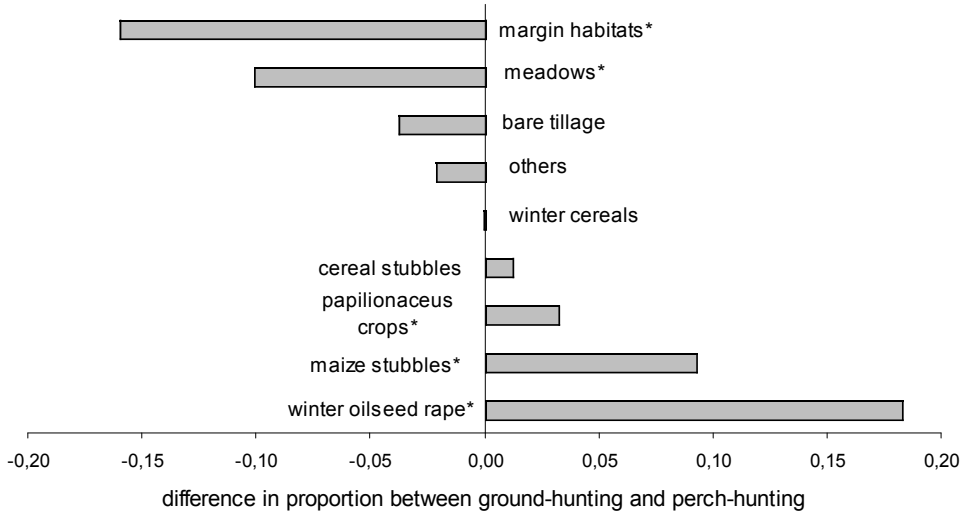

Fig. 2. Frequency of the two hunting modes in relation to habitat types. Data for the period November-February in seven winter seasons (N = 449 ground-hunting and N = 769 perch-hunting individuals). Left side of the axis indicate preferential use of the perch-hunting, right side — of the ground-hunting. Significant differences are indicated by asterisk ($p < 0.001$ in all cases, test for differences of proportion).

Table 6. Percentage of the ground-sitting wintering Buzzards in some central European studies.

%	Sample size (N of birds)	Method	Area	Sources
11.4	412	roadside census	E Poland	Kitowski 2000
15.3	1018	roadside census	SE Austria	Mülner 2000
34.4	1933	foot-transect	E Czech Republic	Voøšek 1991
34.7	1293	roadside census	SW Poland	this study
35.1	1067	roadside census	NE Germany	Eichstädt & Eichstädt 1991
66.2	386	railway-side census	W Czech Republic	Schröpfer 1997

& Ryszkowski 1962, Tubbs 1974). However, perch-hunting is still the principal method, and not surprisingly, perching was predominant type of behaviour among observed birds. The use of perching sites probably reflected the proportion of different substrates in the studied area (domination of trees, but large number of electricity structures along the route). The use of different tree heights by perching birds is probably influenced by social behaviour of Buzzards, especially tree-top perches are used as vantage points from which to watch other raptors — potential piracy victims (Bildstein 1987) or territory rivals (Weir & Piccozzi 1975, Hohmann 1984). Contrary to expectations, at the beginning of the breeding season in March an increased use of the highest part of the trees for perching (top and below the top combined) was not observed. Small proportion of hovering is characteristic for wintering Buzzards (Sylvén 1978, Sachteleben 1993, Melde 1995, Kitowski 2000), for the sake of high energetic costs of this type of flight (Norberg 1996), not compensated by increased hunting success (Wuczyński 2001b).

However, a technique whose importance in Buzzard foraging is underestimated, is hunting from the ground. In the Wrocław Plain the proportion of Buzzards sitting on the ground (34.6%) was among higher values obtained for Buzzards wintering in central Europe (Table 6). The frequent use of this technique seems to be supported by the following conditions:

a) habitat features — Buzzards spend the winter period in open, arable landscapes, which are poor in suitable hunting perches. In some landscapes the shortage of perching sites may even limit the wintering density of raptors (Newton 1990). From the other site, the lack of high and dense vegetation cover in arable areas enable Buzzards to hunt from the ground. Moreover, these habitats are often characterised by the best food supply, were also raptors concentrations are observed. For example in a plot of 4.2 km^2 dominated by stubbles (40%) in Western Czech Republic 66% of Buzzards were observed sitting on the ground (Schröpfer 1997) (Table 6);

b) energetic profitability — hunting from the ground is more effective than perching (Wuczyński 2001b), and probably cheaper, because each return flight to a perch is very expensive in winter. Müller et al. (1979) and Gamauf (1987) described ground foraging as an exceptionally effective method of hunting on rodents, particularly suitable for young, inexperienced Buzzards and dominating in years and habitats of the best food supply. Long-lasting observations of Buzzards foraging in the Wrocław Plain (A. Wuczyński, unpubl) revealed, that in suitable habitats the technique of hunting from the ground occurs many hours non-stop. Prey consumption occurs usually in the place of attack, in contrast to episodes of perch hunting, when Buzzards return with prey to the perch. Moreover, if other raptors hunt in close proximity, the successful ground hunting Buzzard tends to swallow the whole rodent without tearing it to pieces, as a defence against robbery. These facts also reduce the possibility that prey consumption episodes artificially increased the percentage of ground sitting Buzzards in this research.

The underestimation of the ground hunting mode probably results also from the fact, that most of previous research on Buzzard was done in the breeding season, thus in the period of intense vegetation, when plants are relatively high and dense. Hunting from the ground is rarely suitable in such conditions, as opposed to perching or hovering that, indeed, predominate in this period (A. Wuczyński, unpubl.). Percentage of hovering and overall flying activities significantly increase already in March (Table 3), also due to weather improvement. To sum up, in the conditions of a winter farmland (common scarcity of perches, poor and low vegetation, local and temporary prey concentrations), the ability to use the method of hunting from the ground seems to be one of

contributing factors, which enable Buzzards to survive the critical period of year.

The study was carried out in the period of transformation of the Polish agriculture, but before its accession to the European Union. Although agricultural intensity in western Poland is much higher than in some other parts of the country, the studied area was still marked by a traditionally fragmented structure of agriculture: high habitat diversity, rich and well vegetated field margins, small fields. However, recently, the loss of these features is noticed and several indices of increasing agricultural intensity are observed, e.g. increased chemical input, changes in crops rotation, e.g. local dominance of maize, increased proportion of big holdings resulted in fields consolidation (Stankiewicz 2004). As further intensification of these processes is expected in the future (Donald et al. 2002), the data presented in this paper, documenting the former situation, may then become suitable for future comparisons.

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STRESZCZENIE

[Wybiórczość środowiskowa i zachowania łowieckie myszołowów zimujących w południowo-zachodniej Polsce]

Badania przeprowadzono w ciągu siedmiu sezonów zimowych 1993/94–1999/00 w otwartych terenach rolniczych położonych na południowy-zachód od Wrocławia. Scharakteryzowano wybrane aspekty ekologii zimujących myszołowów na podstawie 107 liczeń na trasie 28 km, prowadzonych z jadącego pojazdu. Łącznie zarejestrowano 1526 osobników, jednak w analizie oddzielnie potraktowano dane z miesięcy zimowych, tj. listopad-luty (1293 myszołowy) i z marca (233 ptaki). Preferencje siedliskowe myszołowów obliczono dla trzech sezonów, 1993/94–1995/96, poprzez porównanie liczby stwierdzeń na dziewięciu wyróżnionych siedliskach z ich dostępnością w badanym krajobrazie. Mimo, że łączna liczba stwierdzeń była najwyższa w środowiskach dominujących powierzchniowo (Tab. 1), myszołowy zdecydowanie preferowały środowiska o najmniejszym udziale w krajobrazie (Tab. 2). Najsilniejsza preferencja dotyczyła trwałych upraw roślin motylkowych, a w dalszej kolejności ściernisk, nie uprawianych środowisk marginalnych, łąk i ściernisk po kukurydzy (Fig. 1). Są to siedliska o najkorzystniejszych warunkach troficznych, znane z licznego zasiedlania przez norniki, a wspólną ich cechą jest długi okres nie naruszania (przeorywania) powierzchni gleby. Liczba stwierdzeń zbliżona do oczekiwanej dotyczyła rzepaku ozimego i kategorii inne, zaś unikane były zboża ozime i pola zaorane. Wyniki potwierdzają duże znaczenie drobnych struktur w kształtowaniu bioróżnoro-dności intensywnie użytkowanych agrocenoz.

Większość myszołowów w momencie zauważenia przebywała na wywyższonych czatowniach, zwłaszcza drzewach i głównie w środkowej części ich wysokości (Tab. 3 i 4). Znaczny był także odsetek ptaków siedzących na ziemi, zaś niewielki udział miały myszołowy w trzech wyróżnionych kategoriach lotu, zwłaszcza ptaki krążące. Udział myszołowów obserwowanych w locie istotnie wzrastał w marcu. Ponieważ częstość zachowań wyraża frekwencję stosowanych przez myszołowa technik łowieckich, "czatowanie" (z wywyższonego punktu), oraz "polowanie z ziemi" mają podstawowe znaczenie w zaspokajaniu potrzeb pokarmowych zimujących myszołowów. "Czatowanie" było istotnie częściej od "polowania z ziemi" stosowane w środowiskach marginalnych o wysokiej roślinności, a także na łąkach, zaś odwrotna zależność dotyczyła upraw rzepaku ozimego, ściernisk po kukurydzy oraz motylkowych wieloletnich (Tab. 5, Fig. 2). Trzecią techniką, o znikomym znaczeniu w okresie zimowym, jest polowanie z powietrza — "zawisanie". Mimo, iż "czatowanie" tradycyjnie uznaje się za charakterystyczną dla myszołowa technikę łowiecką, wydaje się, że w warunkach krajobrazu rolniczego zimą (powszechny niedostatek czatowni, uboga, niska roślinność głównie zajmowanych siedlisk, lokalne skupiska ofiar), "polowanie z ziemi" jest techniką szczególnie użyteczną, istotnie ułatwiającą przetrwanie krytycznego okresu, jaki w przypadku myszołowa stanowi zima.