Loss of Diversity in Bird Communities After Regulation of Riverine Meanders: How Strong is the Compensatory Effect of Mature Growth on Fishpond Dams?

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Loss of diversity in bird communities after regulation of riverine meanders: How strong is the compensatory effect of mature growth on fishpond dams?

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Abstract. Alterations to riverine ecosystems and the establishment of new man-made habitats along rivers have been accompanied by changes in vegetation composition and structure, which affect the birds inhabiting riparian stands. We examined the differences between bird communities inhabiting the relict growth of river meanders and those inhabiting secondary plantations along the Rivers Otava and Blanice (Czech Republic). In addition, we investigated whether the well-developed oak plantations on artificial fishpond dams, which are common in the studied landscape, might compensate for the loss of bird diversity following river regulation. Breeding bird community and habitat attributes were studied on 30 fixed-width line transects and analysed using Multivariate Redundancy Analysis. Relict meanders were the most structurally diversified habitat type, with the highest species diversity and the great richness of forest birds. In contrast, secondary plantations were the simplest stands with the poorest communities inhabited by more farmland species. Fishpond dams, though resembling the meanders more so than secondary stands, were found to be insufficient compensation for river meanders in regard to avian diversity. Supporting diverse plantations of softwood tree species and widening the narrow belts along river banks are highlighted as ways of managing riparian stands that are beneficial to birds.

Key words: biodiversity loss, fishpond stands, habitat deterioration, redundancy analysis, river ecosystems

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INTRODUCTION

Changes in landscapes induced by man are often accompanied by a degradation of the original environment and a successive loss of biological diversity, including birds (Radford et al. 2005). River beds and riparian stands along river meanders have been extensively modified by development projects arising from demands on agriculture production and flood control (Moerke & Lamberti 2004). These changes have contributed to alterations in the habitat structure and degradation of riverine ecosystems (Pellantová & Martiško 1994), particularly native riparian forests (Gumiero et al. 1998). Riparian banks exhibit both high richness and abundance of breeding birds and may act as migration dispersal corridors on a regional scale (Bolger et al. 2001). Several studies from North America and Australia have shown negative responses of riparian breeding bird communities to land management practices (Jansen & Robertson 2001, Deschênes et al. 2003, Scott et al. 2003). However, though these wetland habitats may become centres of biodiversity particularly in intensively managed agricultural landscapes (Jansen & Robertson 2001, Skórka et. al 2006), no similar studies have been carried out in Europe. Such studies might offer considerable support to reduction of further degradation of riverine habitats and strengthen interest in river restoration projects (Brookes 1996, Badarau et al. 2004). These projects are at present confined to a few localized restoration sites of floodplain forests in most European countries (Hughes & Rood 2003).

On the other hand, the introduction of some artificial habitats such as urbanised areas, pastures, fishponds or dams along water bodies has led to the establishment of new communities

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resulting from the combination of the requirements of some resident and newly-settled species (Musil & Fuchs 1994, Reitan & Sandvik 1996, Kingsford 2000). From this viewpoint, artificial fishpond dams are considered to be a habitat substantially enhancing the avian biodiversity in relatively uniform agroecosystems (Havlín 1986, Balát 1987, Zasadil 2001), especially where fishponds are common due to intensive fish production, e.g. Czech Republic. Most of fishponds were build during the Middle Ages and about 40 000 ha of their former total area (i.e. 25%) now remain in the Czech Republic (Pokorný & Hauser 2002). To a lesser extent, the fishponds occur also in other European countries, e.g. Germany, France, Romania, Bulgaria and Russia (Hejný et al. 1986, Pokorný & Hauser 2002, Mackovčin & Sedláček 2003). The fishpond dams are traditionally planted with the native tree species, common oak *Quercus robur*, which protects the dams from water erosion through its deep and compact root system. As the trees on most fishpond dams achieve the stage of well-developed mature growth, this habitat forms a distinct element of the farmland.

Fishpond dams are in some ways similar to mature tree stands along river meanders. Having the shape of elongated or linear forest fragments, they constitute a transitional habitat with sharp edges between open fields and the mosaic of wetland microhabitats (fishpond or river). Moreover, permanent wetness and absence of regular forest management support the development of diverse vegetation across all growth layers from ground to tree canopy, making this habitat attractive for many bird species. Therefore, we may expect high similarity between avian communities along river meanders and those inhabiting fishpond dams. This similarity might strengthen the importance of fishpond dams as a compensatory habitat for birds, where the destruction of meanders has been followed by depletion of avian communities.

The goal of this study was to compare the structure of avian communities in three types of mature growth: 1) relict stands bordering well-preserved river meanders, 2) secondary plantations after river regulation or harvesting in the past, and 3) fishpond dams with well-developed oak growth. We examined whether secondary plantations are poorer than relict meanders as regards the qualitative composition of avian communities. Secondly, we tested the hypothesis that bird communities of fishpond dams do not differ from those inhabiting river meanders. The outlined conservation implications for the stands along river banks arise from differences in qualities of bird communities and habitat attributes among the three habitat types.

STUDY AREA

The study area (40 km^2) was located in the northwest part of the České Budějovice floodplain basin, south of the town of Písek (49°12´–49°17´N, 14°02´–14°13´E), southern Bohemia, Czech Republic. The open flat floodplain (360 m a.s.l.) surrounded by moderately undulating and widely forested upland (up to 600 m a.s.l.) was derived from two basins of broadly meandering rivers in the past, the Otava and the Blanice, having flow rates of 25 and 5 m^3/s , respectively, at the present time (Czech Hydrometeorological Institute, Prague). Most of the floodplain soils are supported by shallow subsurface water resulting in alluvial fluvisols and gleyed soils (Němeček 1972) with drained arable fields (48% of the area) or wet meadows (18%) as the dominant habitats. Small forest fragments (0.2–33 ha, mean 3 ha) represent 16%, and built up areas including roads — 11%. Two large forests (198 ha and 972 ha) spread out over the surrounding uplands were not included in this calculation. The remaining 7% of the area comprises fishponds and rivers. The persisting river meanders with relict growth include 10 km of the river courses, while the mature secondary plantations following river regulations or harvesting take up 21 km. The dams of 14 fishponds account for 6 km.

METHODS

Spatial design of transects

We established 300 m transects, ten in each of the three habitats: 1) relict meanders, 2) secondary plantations, and 3) fishpond dams. Transects in relict meanders were situated in linear woodland parts of the river along meander curves. To reduce a potential bias due to repeated observation of moving birds, the distances between two neighbouring transects were 455 ± 297 m (mean ± SD), but were longer for each particular habitat (meanders 906 ± 698 m, secondary plantations 948 ± 283 m, dams 832 ± 279 m). Transects in meanders and secondary plantations along the particular river courses were arranged in an alternating fashion, i.e. each two neighbouring segments belonged to different habitats. Breeding passerines as the most

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important group of birds detected by the method used here hold small home ranges up to few hectares in preferred habitats (Cramp & Brooks 1992) and their movements for distances of hundreds metres between neighbouring transects can be neglected.

The distances of the transects from the nearest large forest (50 m to 4650 m) might affect the spatial distribution of birds (Hinsley et al. 1995). Therefore, the transects were a priori selected in terms of balanced forest distance to minimize this effect (differences in forest distances among habitats: ANOVA, $F_{2,27} = 0.01$, $p = 0.9$). The parts of the rivers that were adjacent to human settlements were avoided because riparian bird communities may be reduced by urbanization (Rottenborn 1999).

Birds counts

The line transect method (Bibby et al. 1992) was used to characterize avian communities in linear riparian habitats (Dobkin & Rich 1998, Deschênes et al. 2003). Birds were censused three times per transect from the end of April to the beginning of June 2004 to detect early and later breeding species during their breeding period. The highest count from three visits was taken as the resulting abundance of each species per transect giving the best approximation to the actual breeding numbers. Medium values tend to underestimate migratory and inconspicuous species (Bibby et al. 1992), while the sums of numbers may result in overestimation. The study has compared late successional stands which do not change significantly from year to year in terms of variation in habitat attributes and should not vary also substantially among years in composition of associated breeding bird communities (Venier & Pearce 2005).

Each route was walked at a slow speed by one observer on days without rain and wind in the morning from dawn to 09.00 during peak bird activity. Only the birds heard and seen in a narrow band up to 20 m on either side of the transect were recorded to restrict records to the habitat sampled and to obtain comparable data from various species which are detectable to different distances (Bibby et al. 1992). Narrow tree belts which failed this 40 m rule (six secondary plantations) were supplemented by additional adjacent growth on the opposite river bank. Displaying males, territorial behaviour, nest building or feeding the young by single birds indicating breeding status were classified as breeding pairs (i.e. couples of birds). Other observations of single birds (scarcely recorded) were evaluated as individuals ("half-pairs"). Flights of birds over the transects were not registered. Three experienced observers (the authors) changed randomly among transects and habitats during the season in order to reduce potential bias arising from differences in individual ability to detect various species. Sporadic records of non-passerines associated entirely with the water surface and not with the habitats of interest, i.e. ducks (*Anas platyrhynchos*, *A. strepera*), rallids (*Fulica atra*), herons (*Ardea cinerea*) and waders (*Charadrius dubius*), were excluded from the analysis.

Habitat characterization

To describe the differences among habitats and to evaluate the possible effect of vegetation variables on avian communities (Scott et al. 2003), additional habitat attributes were measured at each transect: species composition of the tree community, numbers of young trees (height > 3 m, diameter < 40 cm) and numbers of old trees (diameter > 40 cm), cover of the tree top canopy (estimation in %), mean coverage of the shrub layer (%), proportion of bare ground without vegetation (%), coverage of herb layer (%), vertical diversification of branches and foliage profile and open water surface (%). The mean width of the growth (m) was averaged from six measurements (in 60 m intervals) along this transect using aerial photos. Numbers of young and old trees were counted in representative 50 m belts on each transect and then converted to the whole transects. Vertical diversification of branches and foliage profile were measured as one, two or three-level tree layers based on digital photo of front tree profile. Each habitat measure was quantified by one person.

In general, the tree communities of the meanders were dominated by black alder *Alnus glutinosa* and willows *Salix* sp., mostly *S. alba*. Secondary plantations were formed mainly by poplars *Populus alba*, *P. tremula*, *P. x canadensis* and fishpond dams by common oak *Quercus robur*. The shrub layer of all habitat types was mostly composed from naturally seeded native species, including hazel *Corylus avellana*, common elders *Sambucus nigra*, blackthorns *Prunus spinosa*, willows *Salix* sp., dogwood *Cornus sanguinea*, black alders *Alnus glutinosa* and alder buckthorns *Frangula alnus*. Detailed quantification of dominant tree composition in particular habitats is given in Table 1.

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Table 1. Habitat measures on transects and their importance for breeding bird communities in the three habitats under study. Tree dominants: ALDER — numbers of alders *Alnus glutinosa*, OAK — numbers of oaks *Quercus* sp., WILLOW — numbers of willows *Salix* sp., POPLAR — numbers of poplars *Populus* sp., TREE1 — number of young trees, TREE2 — number of old trees, CANE3 — cover of tree canopy (%), VERT — vertical branch and foliage profile (scale 1 to 3), COVE2 — coverage of shrub layer (%), PLANT — plant coverage (%), BARE — bare soil (%), WIDTH — mean width of the growths, WATER — cover of water surface (%). The differences among habitats were tested using Kruskal—Wallis non—parametric ANOVA. Marginal significances refer to the effects of particular habitat attributes on the structure of avian communities along transects (Redundancy Analysis).

Habitat	Meanders		Secondary tree stands		Dams		Differences		Marginal significances	
	mean	SD	mean	SD	mean	SD	K	p	F	p
ALDER	270.0	175.0	47.0	72.8	22.0	66.1	16.8	< 0.001	2.51	0.0026
OAK	68.0	123.6	33.0	46.6	159.0	87.4	12.8	0.002	1.10	0.30
WILLOW	61.0	80.5	13.0	22.7	47.0	71.8	4.1	0.13	1.42	0.11
POPLAR	75.0	80.9	23.0	28.1	91.0	147.5	2.7	0.26	1.27	0.18
TREE1	124.0	50.3	36.0	20.9	109.0	118.5	12.4	0.002	1.15	0.28
TREE2	44.0	30.9	35.0	34.2	27.0	23.7	2.3	0.32	1.13	0.28
CANE3	72.0	10.3	29.0	16.0	60.0	16.3	17.9	< 0.001	3.72	0.0002
VERT	3.5	0.8	1.4	0.5	2.7	1.2	14.4	0.001	3.41	0.0002
COVE2	36.5	15.2	12.1	9.0	30.0	15.5	12.5	0.002	2.57	0.0006
PLANT	57.7	25.1	47.5	22.8	69.0	21.9	3.4	0.83	1.11	0.31
BARE	8.3	9.8	1.5	1.9	16.3	21.2	9.4	0.009	0.96	0.45
WIDTH	90.0	37.1	28.0	15.3	39.0	9.8	20.1	< 0.001	2.14	0.0090
WATER	13.9	13.3	24.5	13.1	2.6	3.4	15.5	< 0.001	1.33	0.138

Statistical analysis

We examined relationships between particular measured habitat attributes and defined habitat types (relict meanders, fishpond dams and secondary plantations) and the effects of variables including habitat attributes and habitat types on bird communities on the transects. The analyses were performed using Redundancy Analysis (RDA; ter Braak & Prentice 1988) within the CANOCO package (ter Braak & Šmilauer 2002). This analysis, based on linear responses of a set of species to various environmental variables, enabled us in a comprehensive form to test the effects of particular habitat attributes on the composition of bird communities and to examine how the bird communities differed among defined habitats.

Habitat attributes were standardized in the habitat analysis because of different scales of particular measures. Bird abundances (i.e. the highest counts for each species and transect) were log-transformed to obtain data on a multiplicative scale. The statistical significances of the effects were assessed using the Monte Carlo test, the variables being selected by a manual forward selection procedure with 4999 unrestricted permutations. As more variables were conducted, the Bonferroni rule was applied resulting in a respective significance level. Indices of species diversity were calculated per transect using the Shannon-Wiener formula $H' = -\sum p_i \ln p_i$, where p_i is the proportion that the ith species contributes to the total number of individuals of all species (Krebs 1999). The differences in bird diversity among habitats were inspected using non-parametric Mann-Whitney or Kruskal-Wallis tests. To interpret the results in terms of avian guilds, the birds were grouped as farmland, forest and generalist species according to Tucker & Evans (1997). We also distinguished a well-defined guild of hole-nesting birds which are sensitive to forest management and play an important ecological role in forest ecosystems affecting the numbers and distribution of other birds (Newton 1994, Bai et al. 2005). The adopted combination of species sorting, diversity indices, and species indicator approach provided for reliable and complex information on the nature of avian communities inhabiting the target habitats (Feest 2006). Finally, bird communities in the three habitats were compared by the Bray-Curtis measure of dissimilarity (B), which is based on Euclidean distances standardizing the Manhattan metric to the range between 0 and 1. As a measure of similarity, we present the complement value $B' = 1 - B$ (Krebs 1999).

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RESULTS

Habitat analysis

The habitat attributes revealed substantial differences among the examined habitats (RDA of secondary plantations vs fishpond dams and meanders, Monte Carlo test: F = 8.48, p = 0.0002, fishpond dams vs meanders: F = 5.20, p = 0.0004; particular habitat attributes are quantified in Table 1). Growths of black alders were typical for meanders, while the occurrence of common oak was linked to fishpond dams. The habitats differed also in the width of the growth, the cover of the tree top canopy, the structure of the vertical tree profile, the numbers of young trees, and shrub coverage, all with the significantly highest values in meanders while the secondary plantations were proved to be the structurally poorest habitat type. Only water area was closely associated with secondary plantations.

Habitat differentiation of bird communities

A total of 62 bird species which composed the bird communities on transects were included in the analysis. The bird communities differed among the three habitats; the habitat was the only significant predictor explaining 43.1% of the total variation in the composition of the birds on all transects (Monte Carlo test; meanders: F = 3.80, p = 0.0002; dams and secondary plantations: F = 2.28, p = 0.001) while neither of the particular habitat attributes contributed significantly in this analysis (all p > 0.05). However, once the most significant habitat attributes (i.e. cover of tree canopy, mean width of the growths, numbers of alders, vertical branch and foliage profile and coverage of shrub layer; see Table 1) were stated as covariates, the partial effects of habitat types were found to be non-significant in prediction of variation among bird communities on transects (all F < 1.6 and p > 0.03, Bonferroni rule applied). This result confirms that the selected habitat attributes combined reliably defined the differences among the bird communities inhabiting the three habitats under study, or, that the specific structural and quantitative combination of analysed habitat attributes well reflect discrimination among these three habitats by birds.

Similarity and diversity of bird communities

The bird communities inhabiting meanders were more similar to these on fishpond dams (Bray-Curtis measure B´ = 0.69) than to communities in secondary plantations along river banks (B´ = 0.58). The diversity of bird communities including guilds of cavity-nesting species was the highest in meanders and the lowest in secondary plantations. Multiple comparisons revealed significant differences between diversity of bird communities in meanders and secondary plantations (Mann-Whitney test, U = 88, p = 0.004) and meanders and fishpond dams (U = 16, p = 0.01). Diversity of cavity-nesting birds differed significantly between meanders and secondary plantations (U = 84, p = 0.01, all $n_1 = n_2 = n_3 = 10$). Other differences (diversity of birds in meanders vs fishpond dams, cavity-nesting species in meanders vs fishpond dams and these in fishpond dams vs secondary plantations) were found non-significant (all p > 0.07, Table 2).

Species composition of bird communities

Many species were characteristic for meanders contrary to the two remaining habitats (Fig. 1). They include typical forest species such as Blackcap *Sylvia atricapilla*, Song Thrush *Turdus philomelos*, Chiffchaff *Phylloscopus collybita*, Spotted Flycatcher *Muscicapa striata*, Wren *Troglodytes troglodytes*, but also generalists inhabiting various habitat mosaics: Chaffinch *Fringilla coelebs*, Blackbird *Turdus merula*, Garden Warbler *Sylvia borin*, Hawfinch *Coccothraustes coccothraustes* and Short-toed Treecreeper *Certhia brachydactyla*. Cavity nesting species were represented by Lesser Spotted Woodpecker *Dendrocopos minor*, Green Woodpecker *Picus viridis* and Blue Tit *Parus caeruleus*.

In contrast, secondary plantations were characterized mostly by farmland species such as Whitethroat *Sylvia communis*, Yellowhammer

Table 2. Attributes of bird communities on 10 transects in each habitat under study. Diversity indices (means ± SD) are derived from variation on transects in these particular habitats.

	Meanders	Fishpond dams	Secondary plantations
Mean number of species (± SD)	22 ± 4.3	18 ± 2.4	16 ± 3.9
Total number of species	52	44	44
Total number of pairs	387	261	225
Species diversity (H')	2.9 ± 022	2.7 ± 0.11	2.6 ± 0.24
Diversity of hole nesters (H')	1.6 ± 0.10	1.4 ± 0.07	1.1 ± 0.13

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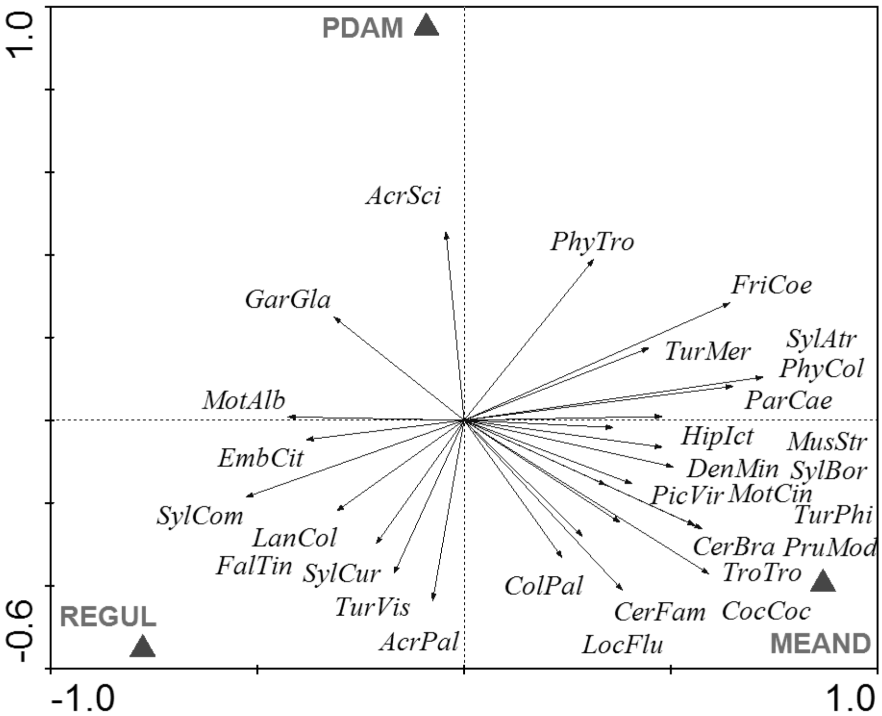

Fig. 1. Bird species-habitat types biplot from Redundancy Analysis summarizing the differences in bird communities among habitats in the space of the first and second ordination axes. Centroids of meanders (MEAND), fishpond dams (PDAM) and secondary plantations (REGUL) are visualized by triangles, the directions of increasing bird abundances are indicated by the arrows. The species listed according to latin names are coded in the diagram: *Acrocephalus palustris*, *A. scirpaceus*, *Certhia brachydactyla*, *C. familiaris*, *Coccothraustes coccothraustes*, *Columba palumbus*, *Dendrocopos minor*, *Emberiza citrinella*, *Falco tinnunculus*, *Fringilla coelebs*, *Garrulus glandarius*, *Hippolais icterina*, *Lanius collurio*, *Locustella fluviatilis*, *Motacilla alba*, *M. cinerea*, *Muscicapa striata*, *Parus caeruleus*, *Phylloscopus collybita*, *P. trochilus*, *Picus viridis*, *Prunella modularis*, *Sylvia atricapilla*, *S. borin*, *S. communis*, *S. curruca*, *Troglodytes troglodytes*, *Turdus merula*, *T. philomelos* and *T. viscivorus*.

Emberiza citrinella, Red-backed Shrike *Lanius collurio* and a few habitat generalists, e.g., Kestrel *Falco tinnunculus*. Only one species, Reed Warbler *Acrocephalus scirpaceus*, was closely associated with fishpond dams, and also two other forest species, Willow Warbler *Phylloscopus trochilus* and European Jay *Garrulus glandarius* tended to keep in this "intermediate" habitat.

DISCUSSION

Habitat type (relict meanders, fishpond dams and secondary plantations) contributed significantly to the explanation in variation of the studied bird communities and had a stronger effect than any particular habitat attribute. However, a set of significant attributes including closure of tree canopy, growths width, numbers of alders, vertical branch and foliage profile and coverage of shrub layer stated in a complex had similar explanatory power as the habitat type. In other words, the composition of the avian communities on transects proved to be more similar within a habitat than among them. Particularly meanders with specifically favourable habitat attributes form a wide variety of ecological niches; high structural complexity of meanders generates a corresponding abundance and diversity of breeding birds (Deschênes et al. 2003, Scott et al. 2003). Both the vegetation structure and the tree composition were important aspects of microhabitat quality (Kreyer & Zerbe 2006).

Our results suggest that secondary plantations may have a detrimental effect on the composition and species diversity of bird assemblages inhabiting river banks. Particularly evident is an absence of many forest bird species, probably in response to the loss of forest interior-like

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microhabitats (Deschênes et al. 2003). Forest microhabitats with swamp stands and hygrophilic vegetation create breeding opportunities for wetland birds with specialized foraging or nesting requirements such as Sedge Warblers *Acrocephalus schoenobaenus*, Bluethroats *Luscinia svecica* or Penduline Tits *Remiz pendulinus* (Hagemeier & Blair 1997). Also, the breadth of tree belts along river courses affected the structure of the avian communities (Spackman & Hughes 1995). Significantly narrower growth (< 30 m) along regulated river segments compared to wide meanders (≥ 90 m) were characterized by sparsely stocked tree lines with low shrub coverage and a thin top tree canopy, resulting in a poorly structured organisation of the vertical branch and foliage profile. The narrow growth maintaining only limited species richness (Rottenborn 1999) is easily available for farmland birds which penetrate from the surrounding agricultural landscape (Shirley & Smith 2005).

We also found significant differences between bird communities in river meanders and fishpond dams. Although fishpond dams persist for several centuries in agricultural landscapes of the Czech Republic and have high biological value considering well-developed vegetation structure (Balát 1987, Zasadil 2001), we suggest that they are inadequate as a substitute refuge for birds from altered river meanders. Uniformity of dams, due to the low diversity of the tree communities dominated by even-aged old common oaks, probably reduces breeding and foraging opportunities to birds. A lack of old soft-wooded trees among the hard-wooded common oaks limits construction of breeding holes, and results in low availability of cavities for hole-nesting birds such as tits, flycatchers and woodpeckers. The maturation and dieback of oaks is slower than that of poplars and alders, which may diminish the numbers of invertebrates inhabiting carious tree bodies. Only a few bird species were tightly associated with oak fishpond dams. One of them, the European Jay, commonly inhabits oak stands (Hagemeier & Blair 1997), where it consumes acorns and various insects, especially caterpillars (Owen 1956). Another species, Reed Warbler, was associated entirely with reeds entering the transitional zones of fishpond margins (Hagemeier & Blair 1997).

Conclusions and conservation implications

Undisturbed river meanders provided a refuge for birds that were much more diverse here than in secondary tree stands created along regulated river beds. Fishpond dams, as a compensatory habitat after the destruction of river meanders, were also insufficient, although avian assemblages of this habitat were more diverse than those in secondary plantations. The importance of river meanders for birds in agricultural landscapes is underlined by proceeding forest fragmentation, as many forest species and cavity-nesters find breeding opportunities here. Moreover, interconnected lines of river meanders may act as corridors for birds migrating through open agricultural landscapes than secondary plantations and isolated patches of forest fragments. Protection of river meanders as well as restoration after regulation along rivers should be a concern of nature conservationists on regional and local scales (Moerke & Lamberti 2004); local biodiversity increases with the diversity of wooded habitats (Jobin et al. 2004) which may contribute to forest-bird diversity and enhance bird populations on a regional scale (Merrill et al. 1998).

In the framework of management practices that might create opportunities for more specialised avian species of forest interiors along disturbed river banks, we recommend 1) saving most of the persisting residual meanders along river banks, and conferring the status of nature reserves, 2) supporting diverse plantations of softwood tree species along river banks, applying native deciduous species such as alders, poplars and willows in a density leading to a close top canopy in mature age, 3) substantial widening of the narrow one-tree belts promoted along regulated watercourses at the present time to encourage the internal structure of growth and to strengthen the vegetal complexity, 4) designing warps on the soil surface, including small water pools, as a source of microhabitats for specialized wetland birds and 5) using the forest-interior and wetland avian species that we have identified in this study as indicators of the success of future rehabilitation efforts.

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STRESZCZENIE

[Zmniejszanie różnorodności zespołów ptaków po regulacji rzek i rola zadrzewień rosnących na groblach stawów rybnych w zachowaniu bogactwa awifauny]

Przemianom ekosystemów nadrzecznych towarzyszą zmiany w składzie gatunkowym i strukturze roślinności, co wpływa na zamieszkujące je ptaki. Z drugiej strony tworzenie przez człowieka nowych środowisk może wiązać się z powstawaniem nowych zbiorowisk roślinnych zasiedlanych przez ptaki. Celem pracy było porównanie struktury zespołów ptaków zasiedlających pozostałości naturalnej roślinności porastającej tereny nadbrzeżne rzek oraz tych zamieszkujących wtórne nasadzenia drzew wzdłuż rzek Otawy i Blanice w Republice Czeskiej. Dodatkowo zbadano czy dobrze rozwinięte dąbrowy porastające groble stawów rybnych, rozlegle występujące na obszarze badań, mogą kompensować utratę różnorodności gatunkowej ptaków po regulacji rzek.

W celu scharakteryzowania zespołów ptaków w nadrzecznych środowiskach o charakterze liniowym, zastosowano metodę transektową. Ptaki oraz cechy środowiska notowano na 30 transektach o szerokości 20 m z każdej strony przeprowadzonych na terenach pozostałości naturalnych lasów nadrzecznych, wtórnych nasadzeń, i na groblach stawów rybnych (po 10 w każdym ze środowisk). Ptaki były liczone trzykrotnie na tym samym transekcie od końca kwietnia do początku czerwca w 2004 roku. Analizy wykonano stosując analizę redundancji. Zróżnicowanie gatunkowe zostało określone za pomocą formuły Shannona-Wienera, a podobieństwo porównywanych zespołów ptaków miarą Bray-Curtisa.

Struktura środowiska różniła się znacząco między trzema typami środowisk (Tab. 1). Stwierdzono, że naturalne lasy nadbrzeżne były środowiskiem najbardziej zróżnicowanym, podczas gdy wtórne nasadzenia — środowiskiem najuboższym (Tab. 1). Zaobserwowano występowanie znaczących różnic w strukturze zespołów ptaków między środowiskami (Fig. 1); najbardziej zróżnicowane zespoły stwierdzono na terenach pozostałości po naturalnych zadrzewieniach nadrzecznych, podczas gdy na terenie wtórnych nasadzeń zespoły ptaków były najuboższe (Tab. 2). Uzyskane wyniki sugerują, że wtórne nasadzenia mogą mieć negatywny wpływ na skład i zróżnicowanie gatunkowe zespołu ptaków, gdyż w wyniku utraty mikrośrodowisk typowych dla wnętrza lasu, rzadko zaobserwowano tam gatunki leśne, a przeważały gatunki typowe dla otwartych środowisk rolniczych (Fig. 1). Mimo, iż uważa się, że groble stawów rybnych porośnięte dąbrowami są środowiskiem o dużej wartości biologicznej m. in. dla bogactwa gatunkowego awifauny, nie rekompensują one w sposób istotny zniszczenia naturalnych zadrzewień pobrzeży rzek. Jednolita struktura zadrzewień na groblach stawów, wynikająca z dominującego udziału jednowiekowych dębów szypułkowych, prawdopodobnie zapewnia ptakom jedynie ograniczony układ nisz ekologicznych. Co więcej, brak w tych środowiskach starych drzew o miękkim drewnie utrudnia ptakom wykuwanie dziupli lęgowych, i powoduje ich niską dostępność dla dziuplaków takich jak sikory, muchołówki i dzięcioły.

Przywracanie środowisk nadrzecznych z wykorzystaniem rodzimych gatunków drzew liściastych o miękkim drewnie, prowadzone do wytworzenia drzewostanu ze zwartym okapem koron, warstwowym układem pionowym oraz zwartą warstwą krzewów, jest sugerowane podczas zagospodarowywania drzewostanów nadrzecznych jako rozwiązanie korzystne dla ptaków.

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