HABITAT INFLUENCES ON BIRD COMMUNITIES IN VADURI-PÂNGĂRAŢI LAKES PROTECTED AREA

ION Roxana, DAMOC Ioana, BODESCU Florian, DAMOC Dorin

Abstract. The protected area of Vaduri-Pângăraţi lakes is home to many bird species, some of them being of great conservation concern. Closely associated with the natural environment, the presence of a specific plant community plays a very important role in feeding and sheltering birds during the nesting and migration period. To show how the habitat characteristics can influence the bird diversity we recorded habitat types, bird species diversity and phenology and we correlated habitat area and functions to observed number of bird species. We found that the bird species composition is strongly related with specific types of vegetation communities and that bird species diversity is not governed by only one single habitat function, but rather by the combined effect of all three.

Keywords: plant habitats, bird species, dam-lakes, Vaduri-Pângăraţi.

Rezumat. Influenţele habitatului asupra comunităţilor de păsări din aria protejată Lacurile Vaduri-Pângăraţi. Aria protejată Lacurile Vaduri-Pângăraţi reprezintă mediul de viaţă a numeroase specii de păsări, unele dintre ele prezentând un interes conservativ foarte mare. Strâns asociate cu mediul natural, prezenţa unei comunităţi specifice de plante joacă un rol foarte important în hrănirea şi adăpostirea păsărilor în perioada de cuibărit şi migraţie. Pentru a arăta modul în care caracteristicile habitatelor pot influenţa diversitatea avifaunistică am înregistrat tipurile de habitat, speciile de păsări şi fenologia acestora şi am corelat suprafaţa şi funcţiile habitatelor cu numărul de specii de păsări observate. Am constatat că speciile de păsări sunt puternic legate de anumite tipuri de comunităţi de plante şi diversitatea speciilor de păsări nu este guvernată de o singura funcţie a habitatului, ci mai degrabă efectul combinat al celor trei.

Cuvinte cheie: habitate, avifauna, lacuri de baraj, Vaduri-Pângăraţi.

INTRODUCTION

Ever since the Late Pleistocene, from the human habitation of Bistriţa Valley until today, the area has suffered transformation of the landscape, especially downstream of Valea Teiului, where the construction of electric power plants started in 1960. The first of this type is Izvorul Muntelui dam and formation of the great lake, followed by those in the middle sector (Pângăraţi, Vaduri, Bâtca Doamnei), then by the lakes from the hilly area of the Bistriţa basin. The petrographic composition of the valley had a major influence on its morphology by alternation of gorges and large valleys (DONISĂ, 1968), this feature of the Bistriţa river favouring the construction of dams in gorges and creating lakes in broad valley sectors. From Straja to downstream of Vaduri, soft rocks existence allowed considerable enlargement of the valley, and hard ones imposed tough narrowing of the valley (Straja Gorge). Thus, in 1964, Pângăraţi lake was created followed by Vaduri lake, two years later, with the purpose of producing electricity and industrial water supplies.

During the lakes formation a large proportion of the initial vegetation was lost, thus providing new places to be colonized by different groups of bird species. Diversified populations of birds use those new habitats, the area becoming one of the most important stop and wintering area for migratory birds using the East-Carpathian Corridor. An important number of bird species present in the studied area are under European and national conservation status. Due to this, on the 30th of November 2004, by Government Decision No 2151 Vaduri and Pângăraţi lakes are designated to be an Important Bird Protection Area - ROSPA0125 Vaduri-Pângăraţi Lakes.

The purpose of this study was to determine the main plant communities and avifauna around the lakes, and bird species associated with a specific type of habitat, in order to establish in which way habitat type, size and composition can influence bird diversity in the study area.

MATERIAL AND METHODS

Study area

Study sites were located in the north eastern part of the country, on the middle Bistriţa river, at the interference between the Eastern Carpathians mountains with Moldavian Subcarpathians hills, in Piatra Neamţ County, Romania. They are situated at the altitude of 350-370m with continental climate and mountain influences. The lakes surroundings have the mean annual temperature of about 8-10º C and 600-700mm mean annual precipitation.

A thorough analysis of the geology was made by CIAGLIC & ICHIM (1970). They specify that Bistriţa river has carved its valley in the Eocene (Bisericani states) and Oligocene deposits (Lucăceşti sandstone), bituminous white marl, schists and Kliwa sandstone. That forms the entire left side and a small portion of the right bank of Vaduri lake. Terrace deposits (gravel) and proluvial (materials brought by the rivulets) form the rest of the right bank and its bottom.

The study involved periodic inventory of the flora and avifauna. In order to identify the main plant habitats we established sample surfaces along the shoreline in forest, shrubs, rushes and sedges and also in the water body of the lakes. During the year 2011, plant sampling was performed monthly from March till September. Using the Braun-Blanquet scale (BRAUN-BLANQUET, 1964), quantitative participation of each plant species was evaluated, enabling us to recognize plant associations and on this basis framing into habitats type (Fig. 1, Table 1). Plant habitats were identified

according to Romanian Habitats (DONIȚĂ et al., 2005) and species composition of plants that occurs in those communities has been determined. Nomenclature follows CIOCÂRLAN (2009).

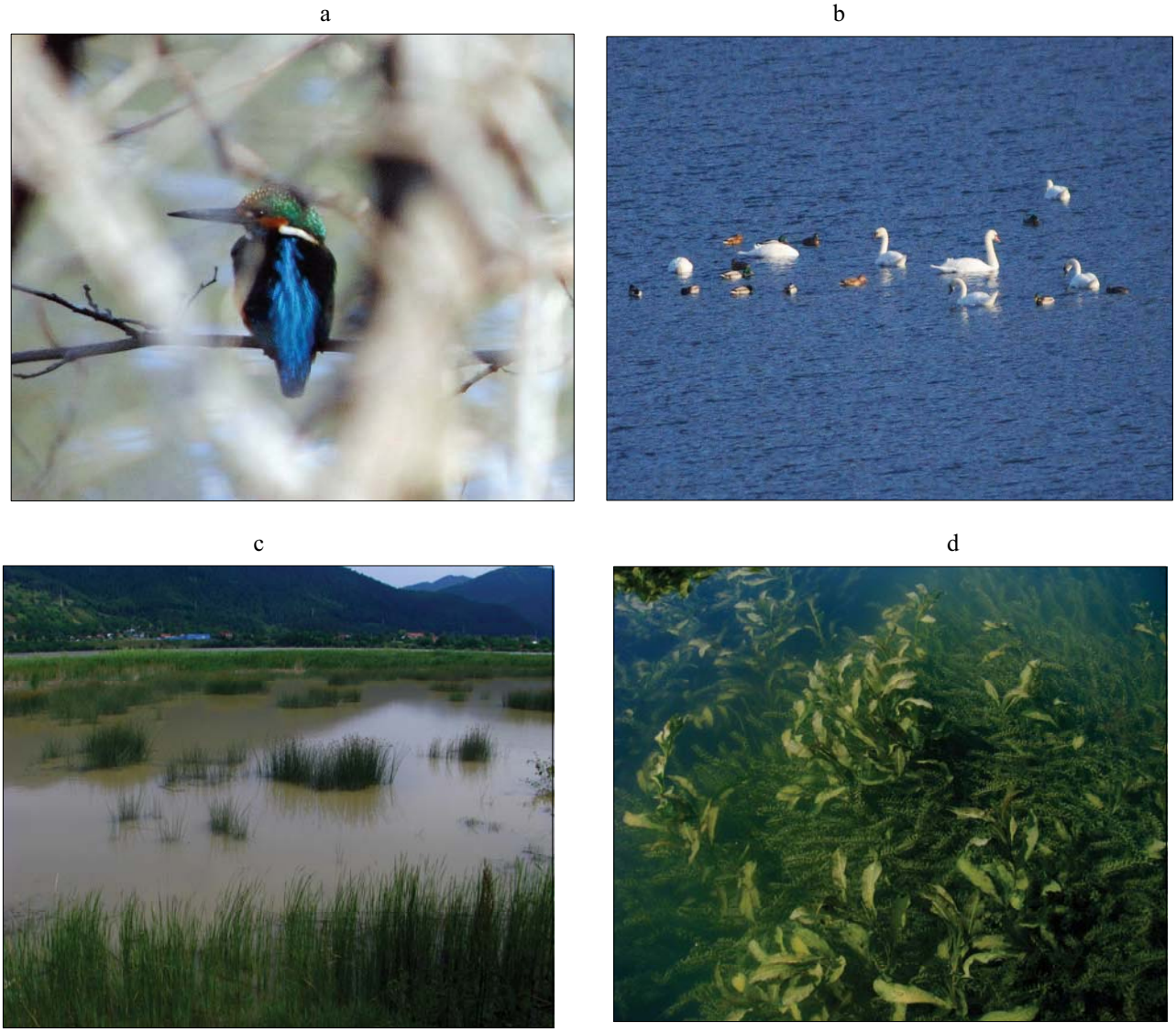

Figure 1. Aspects of avifauna and vegetation in Vaduri-Pângărați protected area: a - *Alcedo atthis* (LINNAEUS 1758) (photo Damoc D.); b - *Cygnus olor* (GMELIN 1789) and *Anas platyrhynchos* (LINNAEUS 1758) (photo Damoc D.); c - *Phragmites australis* and *Schoenoplectus lacustris* communities - R5309 (photo Ion R.); d - aquatic communities with *Potamogeton* and *Elodea canadensis* - R2206 (photo Ion R.).

The birds inventory was made using the transect method (BIBBY et al., 2000) placed around the lakes, in all types of habitats. Observations were made in all seasons to identify the birds that use the habitats around the lake in all the vegetative states. Bird phenology in this specific area was based on the field observations and species biology. When a species was represented by different populations with different phenology we chose the most characteristic population for the analysis. To analyse the importance of the habitats functions for the birds we considered 3 important functions: nesting, feeding and shelter. For each species, based on our observations and bird biology we established which of the habitats offers more functions for the species. Habitat area was calculated using GIS and aerophotograms. In the case of R4104 only the area along the shores, where the observation took place, was calculated.

Table 1. Morphological characteristics of Vaduri and Pângărați dam lakes.

Lakes characteristics	**Vaduri**	**Pângărați**
Surface (ha)	119	155
Maximum length (m)	3600	3700
Maximum width (m)	825	730
Maximum depth (m)	15	14

RESULTS AND DISCUSSIONS

Although there are numerous studies on the flora and vegetation of the middle basin of the Bistriţa (CĂRĂUŞU & GAVRILESCU, 1968; CHIFU et al., 1987; MITITELU et al., 1985; 1986; 1992; NECHITA, 1995) there is still no complete description comprising the area along the lakes Pângăraţi and Vaduri.

The area is characterized by a mosaic of habitats (Fig. 1); in accordance with characteristic plant species a grouping of habitats has been made: 1 - aquatic communities (R2206); 2 - forest and shrub communities (R4104, R4402, R4407, R4418); 3 - emergent communities along the shores (R3709, R5301, R5302, R5304, R5305, R5306, R5309, R5310) and 4 – anthropogenic areas (pine plantation, orchards, gardens, agricultural crops) (Fig. 2).

Only a part of the existing vegetation prior to the flooding of the valley was preserved in the form of small strips of former riverside coppice and forests which stretch from waterfront to the slopes. Vigorous trees of *Salix alba* L. and *Fagus sylvatica* L., over 100 years old, stand testament to the composition of the initial vegetation, the remaining observed vegetation developing after the appearance of the lakes.

MUNTEANU & MATIEŞ (1983) observed that the occurrence of dam lakes in the mountain sector of the Bistriţa river basin is new in an area where little stagnant water exists. As CONETE et al. (2006) observed, a similar situation exists in the Argeş river, where after a series of dam lakes appeared changes were observed in the landscape and on bird populations in the area. Even before the construction of the dams, the area was visited by a large number of birds, but with the lake creation, aquatic birds appeared in the area. MUNTEANU (2000) states that "Pângăraţi lake was visited by aquatic birds from the early weeks of existence" identifying 25 species of water birds. From a total number of 126 bird species that we recorded (Table 3), 16 of them being strictly aquatic and 41 strongly related to wetlands, the latter forming avifauna of emergent plant communities along the shores. We observed five species of European conservation concern, listed in annex 1 of Birds Directive (2009/147/EC) [6]: *Alcedo atthis* (LINNAEUS 1758), *Dryocopus martinus* (LINNAEUS 1758), *Ciconia nigra* (LINNAEUS 1758) and *Ficedula albicollis* (TEMMINCK 1815).

Table 2. List of habitats identified in Vaduri-Pângăraţi protected area. Romanian code according to DONIŢĂ et al. (2005), Natura 2000 code, Romanian habitat name, habitat total surface, cover and presence around the two lakes.

Ro Code	Natura 2000 Code	Habitat name	Surface (ha)	Cover %	Vaduri	Pângăraţi
R2206	3150	Danubian communities with *Potamogeton perfoliatus*, *P. gramineus, P. lucens, Elodea canadensis* and *Najas maritima*	135.46	<80	x	x
R3709	-	Danubian communities with *Juncus effusus, J. inflexus* and *Agrostis canina*	10.68	80	x	
R4402	91E0*	Alluvial forests with *Alnus glutinosa* and *Stelaria nemorum*	4.46	80	x	
R4407	92A0	Danubian forests with *Salix alba* and *Rubus caesius*	2.46	70		x
R4104	91V0	South-Eastern Carpathian forests with spruce (*Picea abies*), beech (*Fagus sylvatica*) and fir (*Abies alba*) with *Pulmonaria rubra*	20	90		x
R4418	-	Balkan willow scrub (*Salix purpurea*)	16.26	20-80	x	x
R5301	-	Paludous communities with *Glyceria fluitans, Catabrosa aquatica* and *Leersia oryzopsis*	0.2	65	x	
R5302	-	Danubian amphibious communities with *Eleocharis palustris*	0.6	65	x	x
R5304	3150	Danubian communities with *Sparganium erectum, Berula erecta* and *Sium latifolium*	0.5	60	x	
R5305	-	Danubian communities with *Typha angustifolia* and *T. latifolia*	14.06	70	x	x
R5306	-	Danubian communities with *Typha laxmanii* and *Epilobium hirsutum*	0.85	70	x	x
R5309	-	Danubian communities with *Phragmites australis* and *Schoenoplectus lacustris*	32.68	90	x	x
R5310	-	Dacian danubian communities with *Carex elata, C. rostrata, C. riparia* and *C. acutiformis*	1.69	100	x	

Table 3. List of bird species present in ROSPA0125 Vaduri-Pângăraţi Lakes (literature and personal observations) and included in our analysis.

Accipiter gentilis (LINNAEUS 1758), *Accipiter nisus* (LINNAEUS 1758), *Aegithalos caudatus* (LINNAEUS 1758), *Alauda arvensis* (LINNAEUS 1758), *Alcedo atthis* (LINNAEUS 1758), *Anas clypeata* (LINNAEUS 1758), *Anas crecca* (LINNAEUS 1758), *Anas penelope* (LINNAEUS 1758), *Anas platyrhynchos* (LINNAEUS 1758), *Anas querquedula* (LINNAEUS 1758), *Anser albifrons* (SCOPOLI 1769), *Anthus trivialis* (LINNAEUS 1758), *Apus apus* (LINNAEUS 1758), *Ardea cinerea* (LINNAEUS 1758), *Asio otus* (LINNAEUS 1758), *Athene noctua* (SCOPOLI 1769), *Bombycilla garrulous* (LINNAEUS 1758), *Bucephala clangula* (LINNAEUS 1758), *Buteo buteo* (LINNAEUS 1758), *Carduelis cannabina* (LINNAEUS 1758), *Carduelis carduelis* (LINNAEUS 1758), *Carduelis chloris* (LINNAEUS 1758), *Carduelis flammea* (LINNAEUS 1758), *Carduelis spinus* (LINNAEUS 1758), *Certhia familiaris* (LINNAEUS 1758), *Charadrius dubius* (SCOPOLI 1786), *Ciconia ciconia* (LINNAEUS 1758), *Ciconia nigra* (LINNAEUS 1758), *Cinclus*

cinclus (LINNAEUS 1758), *Coccothraustes coccothraustes* (LINNAEUS 1758), *Columba oenas* (LINNAEUS 1758), *Columba palumbus* (LINNAEUS 1758), *Corvus corax* (LINNAEUS 1758), *Corvus corone cornix* (LINNAEUS 1758), *Corvus frugilegus* (LINNAEUS 1758), *Coturnix coturnix* (LINNAEUS 1758), *Crex crex* (LINNAEUS 1758), *Cuculus canorus* (LINNAEUS 1758), *Cygnus cygnus* (LINNAEUS 1758), *Cygnus olor* (GMELIN 1789), *Delichon urbicum* (LINNAEUS 1758), *Dendrocopos leucotos* (BECHSTEIN 1803), *Dendrocopos major* (LINNAEUS 1758), *Dendrocopos medius* (LINNAEUS 1758), *Dendrocopos minor* (LINNAEUS 1758), *Dendrocopos syriacus* (EHRENBERG 1833), *Dryocopus martius* (LINNAEUS 1758), *Emberiza citronella* (LINNAEUS 1758), *Emberiza schoeniclus* (LINNAEUS 1758), *Eremophila alpestris* (LINNAEUS 1758), *Erithacus rubecula* (LINNAEUS 1758), *Falco peregrines* (TUNSTALL 1771), *Falco subbuteo* (LINNAEUS 1758), *Falco tinnunculus* (LINNAEUS 1758), *Falco vespertinus* (LINNAEUS 1758), *Ficedula albicollis* (TEMMINCK 1815), *Ficedula parva* (BECHSTEIN 1792), *Fringilla coelebs* (LINNAEUS, 1758), *Fringilla montifringilla* (LINNAEUS, 1758), *Fulica atra* (LINNAEUS, 1758), *Galerida cristata* (LINNAEUS, 1758), *Gallinago gallinago* (LINNAEUS 1758), *Gallinula chloropus* (LINNAEUS 1758), *Garrulus glandarius* (LINNAEUS 1758), *Hirundo rustica* (LINNAEUS 1758), *Jynx torquilla* (LINNAEUS 1758), *Lanius collurio* (LINNAEUS 1758), *Lanius excubitor* (LINNAEUS 1758), *Larus cachinnans* (PALLAS 1811), *Larus canus* (LINNAEUS 1758), *Larus michahellis* (J. F. NAUMANN 1840), *Loxia curvirostra* (LINNAEUS 1758), *Lullula arborea* (LINNAEUS 1758), *Motacilla alba* (LINNAEUS 1758), *Motacilla cinerea* (TUNSTALL 1771), *Muscicapa striata* (PALLAS 1764), *Nucifraga caryocatactes* (LINNAEUS 1758), *Oenanthe oenanthe* (LINNAEUS 1758), *Oriolus oriolus* (LINNAEUS 1758), *Panurus biarmicus* (LINNAEUS 1758), *Parus ater* (LINNAEUS 1758), *Parus caeruleus* (LINNAEUS 1758), *Parus major* (LINNAEUS 1758), *Parus montanus* (CONRAD VON BALDENSTEIN 1827), *Parus palustris* (LINNAEUS 1758), *Passer domesticus* (LINNAEUS 1758), *Passer montanus* (LINNAEUS 1758), *Perdix perdix* (LINNAEUS, 1758), *Phalacrocorax carbo* (LINNAEUS 1758), *Phylloscopus collybita* (VIEILLOT 1817), *Phoenicurus ochruros* (GMELIN 1774), *Phylloscopus sibilatrix* (BECHSTEIN 1793), *Phylloscopus trochilus* (LINNAEUS 1758), *Pica pica* (LINNAEUS 1758), *Picus canus* (GMELIN 1788), *Picus viridis* (LINNAEUS 1758), *Prunella modularis* (LINNAEUS 1758), *Pyrrhula pyrrhula* (LINNAEUS 1758), *Regulus ignicapilla* (TEMMINCK 1820), *Regulus regulus* (LINNAEUS 1758), *Riparia riparia* (LINNAEUS 1758), *Saxicola rubetra* (LINNAEUS 1758), *Saxicola torquatus* (LINNAEUS 1766), *Serinus serinus* (LINNAEUS 1766), *Sitta europaea* (LINNAEUS 1758), *Streptopelia decaocto* (FRIVALDSZKY 1838), *Streptopelia turtur* (LINNAEUS 1758), *Strix aluco* (LINNAEUS 1758), *Strix uralensis* (PALLAS 1771), *Sturnus vulgaris* (LINNAEUS 1758), *Sylvia atricapilla* (LINNAEUS 1758), *Sylvia borin* (BODDAERT 1783), *Sylvia communis* (LATHAM 1787), *Sylvia curruca* (LINNAEUS 1758), *Tachybaptus ruficollis* (PALLAS 1764), *Actitis hypoleucos* (LINNAEUS 1758), *Tringa nebularia* (GUNNERUS 1767), *Tringa ochropus* (LINNAEUS 1758), *Troglodytes troglodytes* (LINNAEUS 1758), *Turdus iliacus* (LINNAEUS 1766), *Turdus merula* (LINNAEUS 1758), *Turdus philomelos* (BREHM 1831), *Turdus pilaris* (LINNAEUS 1758), *Turdus viscivorus* (LINNAEUS 1758), *Upupa epops* (LINNAEUS 1758), *Vanellus vanellus* (LINNAEUS 1758).

The most common bird species were *Ardea cinerea* (LINNAEUS 1758), *Saxicola torquatus* (LINNAEUS 1766), *Passer montanus* (LINNAEUS 1758) and *Phylloscopus collybita* (VIEILLOT 1817), which have been observed in most of the habitats. The protected species *Ficedula albicollis* (TEMMINCK 1815) was seen in most of the habitats whereas *Dryocopus martinus* (LINNAEUS 1758) was noted only in the mixed spruce, beech and fir forest on the right bank of the lake Pângăraţi.

Spatial distribution of vegetation along the banks varies considerably between the two lakes. This is due to the water depth, land use and conformation.

Unlike Izvorul Muntelui lake, which has a much larger area, but strong steep slopes that do not allow installation of wetlands vegetation favourable to species of birds, the banks of the smaller Pângăraţi and Vaduri lakes (Table 1) are occupied by a very rich vegetation that continues to develop. Only certain portions around the lakes do not allow the plant to set, such as the embankment on the north side of the lake near the dam Pângăraţi, the steep slope on the left bank and the places now occupied by households on both sides of Lake Vaduri. But, large quantities of alluvia carried both by the Bistriţa river and its tributaries led to a powerful river silting in time, enabling aquatic plant and emergent communities to flourish.

A habitat assembly according to the size of the birds specific diversity has been observed in both lakes. Most species of birds were recorded in the forest and shrub habitats, observing how they form a distinct group from that of the wet meadow, tall emergent vegetation or aquatic communities.

Aquatic habitat (R2206) is represented by submersed dense communities formed by *Potamogeton* species (*P. lucens* L., *P. pectinatus* L., *P. perfoliatus* L., *P. natans* L., *P. crispus* L.) with *Elodea canadensis* MICHX. and *Myriophillum spicatum* L. species. Large amounts of *Chara* sp., *Vallisneria spiralis* L. and the aquatic moss *Fontinalis antipyretica* HEDW. have been noted. Underground rhizomes and tubers on which birds can feed in winter provide an important food source along with the seeds and leafy parts for the water birds as *Anas platyrhynchos* (LINNAEUS 1758), *A. crecca* (LINNAEUS 1758), *A. penelope* (LINNAEUS, 1758), *Bucephala clangula* (LINNAEUS 1758), *Cygnus cygnus* (LINNAEUS 1758) and *C. olor* (GMELIN 1789). Most of the birds observed on the lakes are winter visitors. The presence of a great number of water birds especially in the winter period has been observed (COZMA & GACHE, 2008). Unlike the upper Bistriţa river, where there is ice jam formation (RĂDOANE et al., 2010), the water in the studied lakes rarely freezes, due to the intake of warm water from Izvorul Muntelui lake (CIAGLIC & APOPEI, 1970), allowing a large number of water birds to settle (MUNTEANU, 2000; MUNTEANU & MATIEŞ, 1983).

Water birds depend on wetlands for a variety of activities which include feeding grounds, breeding, nesting, migration, shelter and have specific adaptations that enable them to exploit a particular habitat within a wetland and limit direct competition with each other. The highest number of water birds is often found in wetlands which have the greatest diversity of plant species and vegetation types, or where there is permanent water (BALLA, 1994; RĂDOANE et al., 2010).

Woody vegetation represented by black alder alluvial forest and white willow forest have as a component, species adapted to excess moisture conditions. The majority are hygrophyte species that support a higher level of water for long periods of time. Mixed spruce, beech and fir forest is present only in the south-eastern part of Pângăraţi lake.

Alluvial forests occupy a small area in the lower flooded grounds of the lake shores. The dominant species – *Alnus glutinosa* (L.) GAERTN. can reach heights up to 20 m, branches form a dense canopy where many varieties of insects can be found on foliage, thus the habitat provides protection against the predators, space and materials for nest

building, insects and flowers in the breeding season as well as seeds in winter for small birds as: *Phylloscopus collybita* (VIEILLOT 1817), *Sylvia atricapilla* (LINNAEUS 1758), *Erithacus rubecula* (LINNAEUS 1758) and the protected *Ficedula albicollis* (TEMMINCK 1815).

White willow (R4407) forest appears as a narrow belt that accompanies the watercourses. Often the forest is populated by vigorous climbers like *Parthenocissus inserta* (A. KERN.) FRITSCH, *Clematis vitalba* L., *Humulus lupulus* L. usually forming impenetrable areas thus providing good nesting and roosting cover and also fruits as food source for small birds as *Troglodytes troglodytes* (LINNAEUS 1758) and *Erithacus rubecula* (LINNAEUS 1758). We found here 79 of the 126 species observed in the protected area.

Mixed coniferous forest (R4104) has a great bird specific diversity (76 bird species) due to the vegetation cover over 90% that can provide shelter for all bird species recorded here.

Purple willow shrubs (R4418) occupy large areas along the shores where the dominant species *Salix purpurea* L. grows in thick communities about 2-3 m height. The habitat provides nesting cover and material, buds and catkins as food. These characteristics attract an important number of bird species, this habitat having a high bird specific diversity. It is a nesting habitat for small passerines as *Parus caeruleus* (LINNAEUS 1758), *Saxicola torquatus* (LINNAEUS 1766), *Coccothraustes coccothraustes* (LINNAEUS 1758), *Sylvia atricapilla* (LINNAEUS 1758), *Erithacus rubecula* (LINNAEUS 1758) and also woodpeckers *Picus canus* (GMELIN 1788) and *Dendrocopos major* (LINNAEUS 1758).

Common reed beds (R5309) are very well represented; *Phragmites australis* (CAV.) STEUD. forms large stands along the margins of both lakes, especially along the south eastern shore of Vaduri lake, where the water is very shallow and the substrate allows its development due to the alluvia deposited during floods. It is a tall grass spreading through perennial rhizomes (roots) which can reach over 10 m in length, producing annual cane-like stems up to 4 m in height. It is an important habitat for birds that use it as a refuge during the passage and wintering period (*Ardea cinerea* (LINNAEUS 1758), *Cygnus cygnus* (LINNAEUS 1758). It also provides roosting and feeding sites for migratory water species like *Anas platyrhynchos* (LINNAEUS 1758), *A. crecca* (LINNAEUS 1758), *Gallinula chloropus* (LINNAEUS 1758).

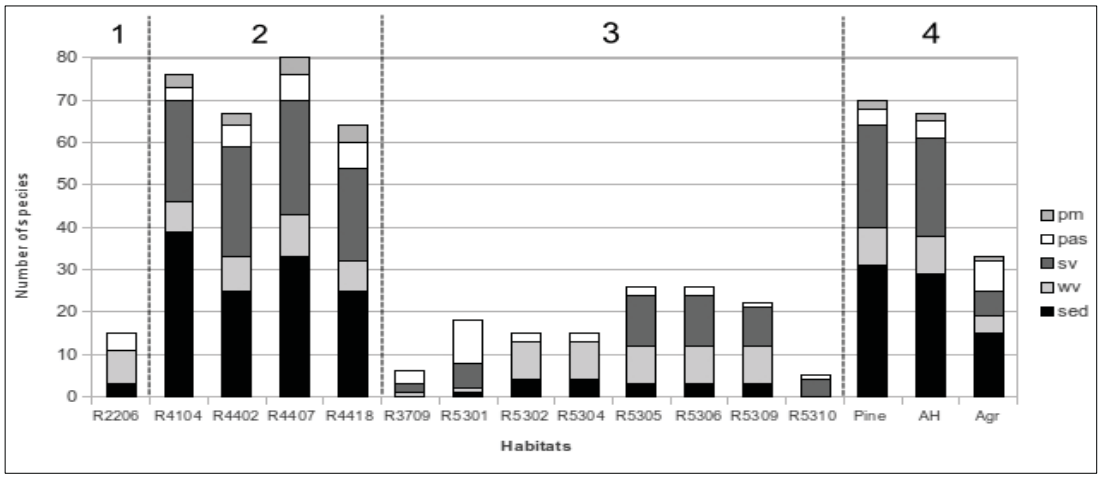

Figure 2. Diversity and phenology of birds in the four types of habitats around Vaduri and Pângăraţi lakes (pm- partial migrators; pas- passage; sv- summer visitors; wv- winter visitors; sed- sedentary).

Cattail communities (*Typha latifolia* L., *T. angustifolia* L., *T. laxmanii* LEPECH.) (R5305, R5306) form dense, nearly single species communities in shallow waters of both lakes. Cattail provides important cover and fruits are food and nesting material for a great number of water birds like *Anas platyrhynchos* (LINNAEUS 1758), *Cygnus olor* (GMELIN 1789), *Fulica atra* (LINNAEUS 1758) and plays a very important role for the passage and wintering birds like protected *Cygnus cygnus* (LINNAEUS 1758) or *Bucephala clangula* (LINNAEUS 1758) and others Anatidae.

Erect bur-reed (*Sparganium erectum* L.) communities, rush meadows (*Juncus effusus* L., *J. inflexus* L.), Common spikerrush (*Eleocharis palustris* (L.) ROEM. & SCHULT.) communities occupy small areas along the shores. The seed of these plants are an important food reserve for many birds during the autumn. The vegetative parts can be utilized for food or cover for water birds as dabbling and diving ducks and swans.

Carex beds grow along the shore forming compact communities due to the dense rhizome network. This habitat occupies small areas along the shores of Vaduri Lake and of the "island" formation in the same lake. As a prolific seed producer sedges are occasionally used as feeding grounds for small passerines like *Emberiza schoeniculus* (LINNAEUS 1758), passage birds like *Crex crex* (LINNAEUS 1758) and *Gallinago gallinago* (LINNAEUS 1758) and sometimes summer visitors like *Saxicola torquatus* (LINNAEUS 1766) and *Serinus serinus* (LINNAEUS 1766).

For many birds that depend on the areas dominated by tall emergent vegetation (with species such as *Typha* sp., *Phragmites australis* (CAV.) STEUD., *Schoenoplectus lacustris* (L.) PALLA) for nesting and shelter it is important to have an open water surface with large pondweed beds available for activities that involve searching for food or resting.

Habitats with low bird specific diversity are Wetlands communities with *Glyceria fluitans* (L.) R. BR., *Catabrosa aquatica* (L.) BEAUV. and *Leesrsia oryzoides* (L.) SW., Dacian-Danubian communities with *Carex elata* A. LOWE, *C. rostrata* STOKES, *C. riparia* CURTIS and *C. acutiformis* EHRH., Danubian communities with *Juncus effusus* L., *J. inflexus* L. and *Agrostis canina* L. and Danubian amphibious communities with *Eleocharis palustris* (L.) ROEM. & SCHULT. Few sedentary birds could be observed *Anas platyrhynchos* (LINNAEUS 1758), *A. querquedula* (LINNAEUS 1758) most of them being passage birds or summer visitors.

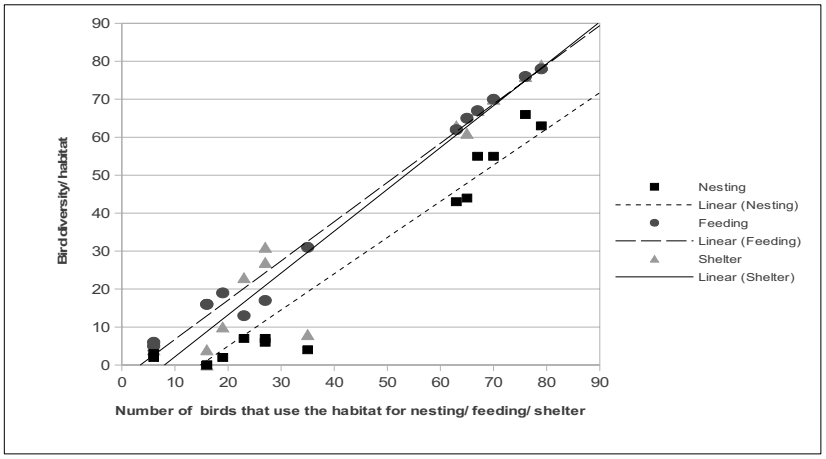

Figure 3. Correlation between total number of bird species that use each type of habitat and number of bird species that use each habitat for a specific need (nesting, feeding, shelter).

An impressive number of bird species could be observed in anthropogenic habitats; 84 bird species are associated with this type of habitat, most being found in the pine plantation and near households in orchards and gardens where 31 birds are sedentary and 24 are summer visitors.

No correlation between habitat area and bird species diversity was established. Habitats that occupy large areas claimed not necessarily a large number of birds, such as aquatic habitat that occupies an area of 135.46 ha but where we observed 16 species of aquatic birds; in habitats with small area (R4407), to 3 ha, we identify a great number of 79 species of birds.

Next we tried to find a correlation between bird biodiversity and habitat functions (nesting, feeding and shelter). Using linear regression we discovered a strong correlation ($R^2 > 0.93$) between the number of bird species using a certain habitat for one of the three main functions and the total number of bird species using that habitat (Fig. 3). This is especially true for feeding ($R^2 = 0.98$), but shelter and nesting have almost equal importance; thus, we can say that bird species biodiversity is not governed by a single habitat function, but rather by the combined effect of all three.

Changes in plant species distribution or abundance can occur mostly due to human influences: removal of vegetation around the lakes by burning intentionally or accidentally, introduction of invasive species and inappropriate tourism. Also, the expansion of house construction on both sides of the lake Vaduri does not allow the installation and development of vegetation. Bird conservation automatically involves vegetation conservation of banks and adjacent areas. Therefore adequate management measures must be taken to allow the maintenance of these important bird habitats.

CONCLUSIONS

We established what habitats are important for bird species in a complementary way, by offering space for nesting, shelter and feeding grounds. This approach allows priority grouping by similarity criteria for the identified habitats, pointing out the relations between the structural heterogeneity and their role in species conservation. This led us to draft the management measures in strong connection with maintaining and improving the favourable conservation status.

ACKNOWLEDGEMENTS

This study is part of the project "Management for the natural protected area – Pângăraţi and Vaduri Lakes" SMIS - CSNR 16714, financed by POS Program (County Council Neamţ), implemented by S.C. MULTIDIMENSION S.R.L. and part of the project RO1567-IBB01/2011 financed by the Romanian Academy. We would also like to thank PhD Monica Neblea for helping us with aquatic macrophytes collection and PhD student Nicoară Andrei for his useful advices in data interpretation and translation of the paper.

REFERENCES

BALLA S. 1994. *Wetlands of the Swan Coastal Plain. Their nature and management*. Water Authority of Western Australia and the Department of Environmental Protection. Melbourne. **1**. 167 pp.

BIBBY J. C., BURGESS N. D., HILL D. A., MUSTOE S. H. 2000. *Bird Census Techniques*. Second Edition. Academic Press. London. 277 pp.

BRAUN-BLANQUET J. 1964. *Phanzensozologie*. Springer-Verlag. Wien-New York. **3**. 120 pp.

CIOCÂRLAN V. 2009. *Flora ilustrată a României. Pteridophyta et Spermatophyta*. Edit. Ceres. Bucureşti. 1141 pp.

CĂRĂUŞU I. & GAVRILESCU G. 1968. *Observaţii asupra macrofitelor din lacurile de acumulare Bicaz şi Pângăraţi*. Lucrările Staţiunii Stejarul Piatra-Neamţ. **2**: 312-324.

CHIFU T., MITITELU D., DĂSCĂLESCU D. 1987. *Flora şi vegetaţia Judeţului Neamţ*. Memoriile Secţiei Ştiinţifice. Academia Română. Bucureşti. **10**(1): 281-302.

CIAGLIC V. & APOPEI V. 1970. *Înghețul pe lacurile mici de acumulare de pe râul Bistriţa în perioada decembrie 1966 - martie 1968*. Studii şi Cercetări Ştiinţifice. Edit. Universităţii Bacău: 25-28.

CIAGLIC V. & ICHIM I. 1970. *Contribuţii la studiul hidrogeologic al văii Bistriţa în zona lacului Vaduri*. Studii şi Cercetări Ştiinţifice. Ştiinţele Naturii. Institutul Pedagogic Bacău: 111-136.

CONETE M. D., MESTECĂNEANU A., GAVA R. 2006. *Speciile de păsări din situl AIA „Lacurile de acumulare de pe Argeş" protejate pe plan naţional şi european*. Argesis. Studii şi Comunicări. Seria Ştiinţele Naturii. Muzeul Judeţean Argeş. Piteşti. **14**: 103-114.

COZMA MANUELA MARIA & GACHE CARMEN. 2008. *Birds winter monitoring on the lakes from the mountain Bistriţa river*. Natura Montenegrina Podgorica. University of Podgorica. **7**(3): 375-382.

DONIŢĂ N., POPESCU A., PAUCĂ-COMĂMESCU MIHAELA, MIHĂILESCU SIMONA, BIRIŞ I.-A. 2005. *Habitatele din România*. Edit. Tehnică Silvică. Bucureşti. 496 pp.

DONISĂ I. 1968. *Geomorfologia văii Bistritei*. Edit. Academiei Române. Bucureşti. 286 pp.

MITITELU D., BARABAŞ N., ŞTEFAN N., MANCAŞ D. 1985. *Vegetaţia văii mijlocii a Bistriţei*. Memoriile Secţiilor Ştiinţifice ale Academiei Române. Bucureşti. Seria IV. **8**(1): 251-263.

MITITELU D., MANCAŞ D., MONAH F., NECHITA NICOLETA, MITITELU C. 1986. *Flora şi vegetaţia din împrejurimile Municipiului Piatra Neamţ*. Memoriile Secţiilor Ştiinţifice ale Academiei Române. Bucureşti. Seria IV. **9**(1): 245–253.

MITITELU D., MONAH F., NECHITA NICOLETA. 1992. *Contribuţii la studiul florei şi vegetaţiei higro-hidrofile din Judeţul Neamţ*. Studii şi cercetări. Muzeul de Ştiinţe ale Naturii. Piatra Neamţ. **6**: 44-60.

MUNTEANU D. & MATIEŞ M.. 1983. *Modificări induse de lacurile de acumulare în structura şi dinamica avifaunei*. Analele Banatului. Natural Sciences. Universitatea de Vest Timişoara. **1**: 217-225.

MUNTEANU D. 2000. *Avifauna bazinului montan al Bistriţei Moldovenenşti*. Edit. Alma Mater. Cluj-Napoca. 250 pp.

NECHITA NICOLETA. 1995. *Contribuţii la studiul florei zonei Pângăraţi (Judeţul Neamţ)*. Naturalia. Studii şi Cercetări. Muzeul Judeţean Argeş. Piteşti. **1**: 77-83.

RĂDOANE MARIA, CIAGLIC V., RĂDOANE N. 2010. *Hydropower impact on the ice jam formation on the upper Bistriţa River, Romania*. Cold Regions Science and Technology. Elsevier. Stuttgart. **60**(3): 193-204.

***. Formularul standard Natura 2000 pentru aria de protecţie specială ROSPA0125-Lacurile Vaduri şi Pângăraţi. http://biodiversitate.mmediu.ro/rio/natura2000/static/pdf/rospa0125.pdf (Accessed: March 20, 2013).

***. Council Directive 2009/147/EC on the conservation of wild birds.

Ion Roxana, Damoc Ioana, Bodescu Florian, Damoc Dorin
Institute of Biology Bucharest, Romanian Academy
Splaiul Independentei, No. 296, Sect. 6, 060031, Bucharest, Romania.
E-mail: roxanaion85@gmail.com

Received: March 26, 2013
Accepted: June 12, 2013