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# Freshwater habitats in Plovdiv town and its surroundings and their importance for the biodiversity

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## ABSTRACT

The current synopsis reviews the types of aquatic habitats, that are located in the city of Plovdiv and analyses their importance for the biodiversity. Studies of the biodiversity in urban landscapes are of particular importance because they are still scarce. Several plant and animal groups are studied in the city of Plovdiv – mosses, mollusks, fish, amphibians, reptiles, birds and mammals. Their distribution among habitats is presented, as well as specific threats and conservation problems.

**Key words:** freshwater habitats, biodiversity, plants, invertebrates, vertebrates, Plovdiv

## Introduction

Changes in the landscapes and their impact on distribution and abundance of animals are becoming more important issue for the ecologists (Lubchenko et al., 1991). Studies of the biodiversity in urban landscapes are of particular importance because they are still scarce. A better understanding of the ecological processes governing the species composition and distribution of animals in urban environment is necessary for adequate management and conservation (Mollov & Velcheva, 2010).

Urbanization is recognized to be one of the main factors for habitat loss leading to local biodiversity extinction in urban areas (McKinney, 2008). It was also recognized that the negative impact of habitat loss can be ameliorated through adequate management plans (Löfvenhaft et al., 2004). In order to propose efficient management plans in urban areas, local studies should be conducted towards surveying of the ecological needs of the species. Moreover, species' specific information is needed to emphasize the interspecific differences in the preference for different habitat/landscape elements (Hartel et al., 2007). Furthermore, habitat loss and habitat configuration are one of the most important aspects when studying ecosystems in urban areas (Löfvenhaft et al., 2004).

Water quality is the most significant indicator of the impact of human activity on the natural aquatic environment. Industry, agriculture, household activity, transport produce significant amounts of various pollutants, many of which are constantly discharged into surface waters. Part of pollutants, mainly organic, is degradable to a certain extent through natural self-purification processes, but the increasing load


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reduces the effectiveness of these processes. Some substances cannot be decomposed by natural processes, which require human intervention for their removal and disposal to acceptable limit. Water pollution is not only dangerous to aquatic organisms and ecosystems, but also affects the man who in one way or another using those waters. Presence of heavy metals in surface water is the result, on the one hand by the chemical leaching and soil erosion, and the other - of anthropogenic activity. Elevated concentrations are usually an indicator of industrial pollution, discharge of waste waters, urban runoff, especially from areas with heavy road transport. Toxic effect depends not only on their concentration and chemical form, but also by the presence of other pollutants.

The current synopsis aimed to (i) assess and compare the biodiversity in the different freshwater habitats in the city of Plovdiv and its surroundings, (ii) to evaluate their importance for the species and (iii) to propose adequate measures for the habitats conservation and sustainable development.

## Materials and Methods

Plovdiv municipality is located within the Plovdiv field in the middle of the Thracian Lowland (South Bulgaria) at 160 m altitude. City of Plovdiv takes about 102 km$^2$ of the Plovdiv municipality and represents an urbanized area with population over 340 000 inhabitants (NSI, 2011).

Climate is continental with considerable Mediterranean influence. Soils around the Maritsa river and its major tributaries are alluvial, alluvial-meadow (Fluvisols) and alluvial-marsh (Gleysols), formed by the river accumulative deposits and localities with shallow groundwater. Humus horizon is less pronounced with low content of organic matter (1 to 1.5%), and also of total nitrogen and phosphorus, underlied by sandy and gravelly deposits. Reduced speed of the flow and the large amount of deposits led to the formation of islands and island groups in this sector of Maritsa river.

The majority of the area around the city was converted to cropland and highly built-up urban area, therefore naturally abundant flora and fauna are very limited. The natural landscape is replaced by anthropogenic.

The registered urban freshwater habitats in Plovdiv were classified into 7 groups: 1 – Maritsa river and its floods; 2 – City fountains and small ponds; 3 – Temporary and constantly existing puddles; 4 – Rice fields; 5 – Fish farm ponds; 6 – Irrigation canals; 7 –Regata Venue Rowing Canal.

In the current synopsis we used 7 organism groups, as follows: 1 – Aquatic bryophytes (Bryophyta) and vascular plants (Spermatophyta); 2 – Molluscs (Gastropoda and Bivalvia); 3 – Fish; 4 – Amphibians; 5 – Reptiles; 6 – Birds; 7 – Mammals.

Aquatic bryophytes (Bryophyta) and vascular plants (Spermatophyta) were studied only at Maritsa river. The nomenclature followed Hill et al. (2006) for mosses and Flora Europaea (Tutin et al., 1964-1980; 1993) for vascular plants. The mollusc data was obtained using following literature sources: Hesse (1911; 1913), Vasileva et al. (2009). Data on the fish species were obtained based on the following literature sources: Velcheva & Mehterov (2005); Georgiev (2006), Mollov & Georgiev (2014). Data on the amphibians and reptiles were obtained from the following literature sources: Mollov & Velcheva (2010), Mollov (2011) and Mollov & Georgiev (2014). Data on birds were obtained from the Bulgarian Society for Protection of Birds – Plovdiv (www.bspb.org). Data about the mammals was obtained using Stoycheva et al. (2009), and Mollov & Georgiev (2014).

## Results and Discussion

Full list of registered species in studied freshwater habitats is presented in Tables 1 and 2.

### 1. *Maritsa river and its floods*

*Contamination of waters:* The middle course of Maritsa river is subject to anthropogenic pressure due to agriculture, urbanization, industrialization and riverbed morphological modifications (Gecheva et al., 2011). According to the national typology it belongs to the type R12 Large floodplain rivers. An increased heavy metals concentration at the region of Plovdiv was reported based on the assessed levels of Zn, Pb, Cu, Ni and Cd in *Amblystegium riparium* (Gecheva & Yurukova, 2006). Such disturbances can result in species replacements or losses and thus in shifts of ecosystems' condition.

*Dominate vegetation:* Along Maritsa river in the region of the town removal of trees and shrubs is practiced due to flood prevention. Character riverside trees are poplars (*Populus alba*, *P. nigra*, *P. euramericana*) and willows (*Salix alba*, *S. triandra*, *S. fragilis*).

*Mosses.* Macrophyte communities are determined by the physical habitat characteristics, water chemistry and anthropogenic impact. Ten taxa, among them 1 moss species were recorded (Gecheva et al., 2011; 2013), typical for lowland sites (Table 1).



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*Molluscs.* Four species of freshwater snails and two species of mussels were registered. Dominant were *Radix auricularia*, *Limnaea stagnalis*, *Stagnicola montenegrinus* and *Unio pictorum*.

**Table 1.** *Aquatic bryophytes in Maritsa river and its flood in the study area.*

| Species | Maritsa | Maritsa floods |
|---|---|---|
| *Leptodictum riparium* | + | - |
| *Ceratophyllum demersum* | + | + |
| *Lemna minor* | + | + |
| *Elodea canadensis* | + | + |
| *Elodea nuttallii* | + | - |
| *Myriophyllum spicatum* | + | - |
| *Najas marina* | + | - |
| *Potamogeton crispus* | + | - |
| *Potamogeton natans* | + | + |
| *Sparganium erectum* | + | - |

*Fishes.* Most of the ichtyofauna of Plovdiv city is localized in Maritsa river passing through. It is a large river with relatively slow current forming some small ponds and floods at its banks. In the city center it is canalized and fast flowing. The dominate species are *Cobitidae* spp., *Pseudorasbora parva*, *Carassius auratus*, *Rutilus rutilus* and *Rhodeus sericeus*.

*Amphibians and Reptiles.* Most of the amphibians occurring in the city are located along Maritsa river and its temporary ponds in the suburban and rural zones of the city. Common species are *Pelophylax ridibundus*, *Hyla arborea* and rarely *Bufo bufo* and *Pelobates syriacus.* From the reptiles, closely depending on running water are *Natrix natrix* and *N. tessellata* and *Emys orbicularis.* Occasionally *Lacerta viridis* can be observed along the river banks. In the temporary ponds located along Maritsa river common species from the amphibians are *Pelophylax ridibundus*, *Hyla arborea* and rarely *Bufo bufo* and *Pelobates syriacus.* From the reptiles – *Natrix natrix* and *N. tessellata.*

*Birds.* Birds are very diverse, represented by 65 species using the river as a migration corridor, nesting and feeding site (Table 2).

*Mammals.* All mammals reported in the present study can be found at this habitat being a semi-natural corridor passing the area (Table 2). The typical species for this area are *Neomys anomalus*, *Arvicola terrestris*, *Myocastor coypus* and *Lutra lutra.* All bat species use the Maritsa river and its floods as drinking and hunting site.

*Threats:* One of the main threats to the flora and fauna along the shores of Maritsa river in the study area is the destruction of the shrub and tree vegetation along the banks of the river, and also the illegal collection of inert materials (sand and gravel) in some areas. There are registered many cases of poaching, killing of various species of aquatic birds in the city's surroundings. Some ecological problems concerning new buildings also occur in the area.

Riparian vegetation and forest habitat types along the river systems are extremely vulnerable ecosystem complexes. Reasons are as follows:

- changes in river beds;
- regulation of watercourses ;
- changes in the hydrological regime of the river;
- pollution of rivers and riparian habitats;
- their overexploitation primarily for the extraction of sand and gravel;
- deforestation of riparian forests and conversion of these areas into agricultural lands.

Therefore, riparian communities need urgent measures for their conservation and sustainable management.

Due to natural causes, such type of natural complexes has limited representation. Anthropogenic interference in still retained islands leads to drastic changes in their natural state. As a result of human intervention in the riparian and island cenoses, grass and meadow vegetation have formed that replaced natural communities. Instead of native forests of elm (*Ulmus minor*) and oak (*Quercus robur* and *Qurcus pedunculiflora*) today there are herbaceous communities of ruderal vegetation. Riparian forests occupy significantly narrower and diluted strips compared to the historical data. In many places, the river section forms dynamic sediments, sand bars and island groups.

Analysis of the hydro-morphological elements shows that the left riparian zone of Maritsa river is exposed on considerably greater risk than the right one. Areas with erosion occupy 35.7% and the deforestation is 42.9%. For comparison, data for the right zone are – the erosion of 32.9% and the same percentage of deforested areas. Areas with heavily eroded banks correlate with major deforested areas along Maritsa river.


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**Table 2.** *Full list of registered animal species in the studied freshwater habitats in Plovdiv region.*

| Species | Maritsa river | Maritsa floods | City fontains | Paddles | Rice fields | Fishfarms | Irrigation canals | Regatta Venue Rowing Canal |
|---|---|---|---|---|---|---|---|---|
| ***Mollusca*** | | | | | | | | |
| **Gastropoda** | | | | | | | | |
| *Viviparus acerosus* | - | - | - | - | - | - | + | + |
| *Potamopyrgus antipodarum* | + | - | - | - | - | - | - | - |
| *Valvata piscinalis* | + | + | - | - | - | - | - | - |
| *Galba truncatula* | + | + | - | - | - | - | - | - |
| *Stagnicola montenegrinus* | - | + | - | - | - | - | + | - |
| *Radix auricularia* | + | + | - | - | + | + | + | + |
| *Lymnaea stagnalis* | - | + | - | - | + | + | + | + |
| *Physella acuta* | - | + | - | - | + | + | + | + |
| *Planorbarius corneus* | - | + | - | - | + | + | + | + |
| *Planorbis planorbis* | - | + | - | - | + | + | + | + |
| *Anisus vortex* | - | + | - | - | - | - | - | - |
| **Bivalvia** | | | | | | | | |
| *Unio pictorum* | + | + | - | - | - | - | - | + |
| *Anodonta cygnaea* | + | + | - | - | - | - | - | + |
| **Mollusca Total** | 6 | 11 | - | - | 5 | 5 | 7 | 8 |
| ***Pisces*** | | | | | | | | |
| *Cobitidae spp.* | + | + | - | - | + | - | + | - |
| *Pseudorasbora parva* | - | + | - | - | - | + | - | + |
| *Carassius gibelio* | - | + | - | - | + | + | + | + |
| *Cyprinus carpio* | - | + | - | - | - | + | - | + |
| *Rutilus rutilus* | - | + | - | - | - | - | - | - |
| *Rodeus sericeus amarus* | - | + | - | - | - | - | - | - |
| *Barbus cyclolepis* | + | + | - | - | - | - | + | - |
| *Gobio gobio* | + | + | - | - | - | - | - | - |
| *Alburnus alburnus* | - | + | - | - | - | - | - | - |
| *Leuciscus cephalus* | + | + | - | - | - | - | + | + |
| *Leuciscus borysthenicus* | + | + | - | - | - | - | - | - |
| *Gambusia affinis holbrooki* | - | + | - | - | + | - | + | - |
| *Tinca tinca* | - | + | - | - | - | + | - | - |
| *Chondrostoma vardarense* | + | + | - | - | - | - | - | - |
| *Vimba melanops* | + | + | - | - | - | - | - | - |
| *Aspius aspius* | + | + | - | - | - | - | - | - |
| *Proterorchinus marmoratus* | + | + | - | - | - | - | + | - |
| *Esox lucius* | + | + | - | - | - | - | + | - |
| **Pisces Total** | 10 | 18 | - | - | 3 | 4 | 7 | 4 |



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| Species | Maritsa river | Maritsa floods | City fontains | Paddles | Rice fields | Fishfarms | Irrigation canals | Regatta Venue Rowing Canal |
|---|---|---|---|---|---|---|---|---|
| ***Amphibia*** | | | | | | | | |
| *Bombina bombina* | - | - | - | - | + | - | - | - |
| *Bufo bufo* | + | + | - | - | + | + | - | + |
| *Bufo viridis* | - | - | + | + | + | + | + | - |
| *Pelobates syriacus* | + | + | - | - | - | + | - | - |
| *Hyla arborea* | + | + | - | - | + | + | + | - |
| *Pelophylax ridibundus* | + | + | - | + | + | + | + | + |
| *Rana dalmatina* | - | - | - | - | - | + | + | - |
| **Amphibia Total** | 4 | 4 | 1 | 2 | 5 | 6 | 4 | 2 |
| ***Reptilia*** | | | | | | | | |
| *Emys orbicularis* | + | - | - | - | + | + | + | + |
| *Natrix natrix* | + | + | - | - | + | + | + | - |
| *Natrix tessellata* | + | + | - | - | + | + | + | - |
| *Lacerta viridis* | + | - | - | - | - | - | - | - |
| **Reptilia Total** | 4 | 2 | - | - | 3 | 3 | 3 | 1 |
| ***Aves*** | | | | | | | | |
| *Podiceps cristatus* | + | - | - | - | - | - | - | - |
| *Tachybabptus ruficollis* | + | - | - | - | - | - | - | - |
| *Phalacrocorax carbo* | + | - | - | - | - | + | - | - |
| *Nycticorax carbo* | + | - | - | - | - | + | - | - |
| *Ixobrichus minutus* | + | - | - | - | - | + | - | - |
| *Egretta garzetta* | + | - | - | - | - | - | - | - |
| *Egretta alba* | + | - | - | - | - | + | - | - |
| *Ardea cinerea* | + | - | - | - | - | + | - | - |
| *Anas platyrhynchos* | + | - | - | - | - | + | - | - |
| *Anas querquedula* | + | - | - | - | - | - | - | - |
| *Anas crecca* | + | - | - | - | - | + | - | - |
| *Accipiter nisus* | + | - | - | - | - | + | - | - |
| *Accipiter brevipes* | - | - | - | - | - | - | - | - |
| *Buteo buteo* | + | - | - | - | - | + | - | - |
| *Buteo lagopus* | - | - | - | - | - | - | - | - |
| *Falco tinnunculus* | + | - | - | - | - | - | - | - |
| *Coturnix coturnix* | - | - | - | - | - | - | - | - |
| *Perdix perdix* | - | - | - | - | - | - | - | - |
| *Fulica atra* | + | - | - | - | - | + | - | - |
| *Gallinula chloropus* | + | - | - | - | - | + | + | - |
| *Haematopus ostralegus* | + | - | - | - | - | - | - | - |
| *Actitis hypoleucos* | + | - | - | - | - | - | - | - |
| *Larus argentatus* | + | - | - | - | - | + | - | - |
| *Sterna hirundo* | + | - | - | - | - | - | - | - |
| *Columba palumbos* | + | - | - | - | - | - | - | - |
| *Streptopelia turtur* | + | - | - | - | - | - | - | - |
| *Streptopelia decaocto* | + | - | - | - | - | - | - | - |


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| Species | Maritsa river | Maritsa floods | City fontains | Paddles | Rice fields | Fishfarms | Irrigation canals | Regatta Venue Rowing Canal |
|---|---|---|---|---|---|---|---|---|
| *Tyto alba* | - | - | - | - | - | - | - | - |
| *Otus scops* | + | - | - | - | - | + | - | - |
| *Athene noctua* | - | - | - | - | - | - | - | - |
| *Apus apus* | - | - | - | - | - | - | - | - |
| *Alcedo athis* | + | - | - | - | - | - | + | - |
| *Merops apiaster* | + | - | - | - | - | - | - | - |
| *Coracias garrulus* | + | - | - | - | - | - | - | - |
| *Upupa epops* | + | - | - | - | - | - | - | - |
| *Jynx torquilla* | + | - | - | - | - | - | - | - |
| *Picus viridis* | + | - | - | - | - | + | - | - |
| *Picus canus* | + | - | - | - | - | - | - | - |
| *Podiceps major* | + | - | - | - | - | + | - | - |
| *Podiceps syriacus* | + | - | - | - | - | + | - | - |
| *Galerida cristata* | - | - | - | - | - | - | - | - |
| *Alauda arvensis* | - | - | - | - | - | - | - | - |
| *Riparia riparia* | + | - | - | - | - | - | - | - |
| *Hirundo rustica* | - | - | - | - | - | - | - | - |
| *Delichon urbica* | - | - | - | - | - | - | - | - |
| *Lanius colurio* | + | - | - | - | - | + | - | - |
| *Troglodytes troglodytes* | + | - | - | - | - | - | - | - |
| *Erithacus rubecula* | - | - | - | - | - | - | - | - |
| *Erithacus megarynchos* | + | - | - | - | - | + | - | - |
| *Phoenicurus ochrurus* | - | - | - | - | - | - | - | - |
| *Saxicola torquata* | + | - | - | - | - | - | - | - |
| *Turdus merula* | + | - | - | - | - | + | - | - |
| *Turdus viscivorus* | + | - | - | - | - | - | - | - |
| *Acrocephalus palustris* | + | - | - | - | - | - | - | - |
| *Acrocephalus arundinaceus* | + | - | - | - | - | + | + | - |
| *Hippolais olivetorum* | + | - | - | - | - | + | - | - |
| *Hippolais palida* | + | - | - | - | - | - | - | - |
| *Sylvia atricapilla* | + | - | - | - | - | + | - | - |
| *Sylvia communis* | + | - | - | - | - | - | - | - |
| *Sylvia curruca* | + | - | - | - | - | - | - | - |
| *Phylloscopus sibilatrix* | - | - | - | - | - | - | - | - |
| *Muscicapa striata* | + | - | - | - | - | - | - | - |
| *Aegithalus caudatus* | + | - | - | - | - | - | - | - |
| *Remiz pendulinus* | + | - | - | - | - | - | - | - |
| *Parus palustris* | - | - | - | - | - | - | - | - |
| *Parus cristatus* | - | - | - | - | - | - | - | - |
| *Parus major* | + | - | - | - | - | + | - | - |
| *Parus caeruleus* | + | - | - | - | - | + | - | - |
| *Sitta europaea* | + | - | - | - | - | - | - | - |



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| Species | Maritsa river | Maritsa floods | City fontains | Paddles | Rice fields | Fishfarms | Irrigation canals | Regatta Venue Rowing Canal |
|---|---|---|---|---|---|---|---|---|
| *Certhia familiaris* | - | - | - | - | - | - | - | - |
| *Emberiza citrinella* | - | - | - | - | - | - | - | - |
| *Emberiza cirlus* | + | - | - | - | - | - | - | - |
| *Emberiz hortulana* | - | - | - | - | - | - | - | - |
| *Emberiza calandra* | - | - | - | - | - | - | - | - |
| *Fringilla coelebs* | + | - | - | - | - | + | - | - |
| *Serinus serinus* | - | - | - | - | - | - | - | - |
| *Carduelis chloris* | + | - | - | - | - | + | - | - |
| *Carduelis spinus* | - | - | - | - | - | - | - | - |
| *Carduelis carduelis* | + | - | - | - | - | - | - | - |
| *Acanthis cannabina* | - | - | - | - | - | - | - | - |
| *Coccthraustes coccothraustes* | + | - | - | - | - | - | - | - |
| *Sturnus vulgaris* | + | - | - | - | - | + | - | - |
| *Oriolus oriolus* | + | - | - | - | - | + | - | - |
| *Passer domesticus* | - | - | - | - | - | - | - | - |
| *Passer montanus* | - | - | - | - | - | - | - | - |
| *Passer hispaniolensis* | - | - | - | - | - | - | - | - |
| *Garrulus glandarius* | + | - | - | - | - | + | - | - |
| *Pica pica* | + | - | - | - | - | + | - | - |
| *Corvus monedula* | + | - | - | - | - | - | - | - |
| *Corvus frugilegus* | + | - | - | - | - | - | - | - |
| *Corvus corone* | + | - | - | - | - | - | - | - |
| *Motacilla sp.* | - | - | - | - | - | - | - | + |
| ***Tringa ochropus*** | - | - | - | - | - | - | + | - |
| *Himantopus himantopus* | - | - | - | - | - | + | - | - |
| *Vanellus vanellus* | - | - | - | - | - | + | - | - |
| *Glareola pratincola* | - | - | - | - | - | + | - | - |
| ***Aves Total*** | **65** | **-** | **-** | **-** | **-** | **30** | **4** | **1** |
| ***Mammalia*** | | | | | | | | |
| *Neomys fodiens* | + | + | - | - | + | - | + | - |
| *Lutra lutra* | + | + | - | - | + | + | + | + |
| *Arvicola terrestris* | + | + | - | - | + | + | + | - |
| *Myocastor coypus* | + | + | - | - | + | + | + | - |
| *Nyctalus noctula* | + | + | + | + | + | + | + | + |
| *Eptesicus serotinus* | + | + | + | + | + | + | + | + |
| *Pipistrellus kuhli* | + | + | + | + | + | + | + | + |
| *Pipistrellus pipistrellus* | + | + | + | + | + | + | + | + |
| *Hypsugo savii* | + | + | + | + | + | + | + | + |
| ***Mammalia Total*** | **9** | **9** | **5** | **5** | **9** | **8** | **9** | **6** |

Ecological status of woody vegetation along the banks of Maritsa river has deteriorated compared with historical data. Preserved habitats represent small areas, from one to 20-25 m width, direction from the river to the bank. It was noticed, that the plantations of hybrid poplar, starting from the adjacent riverbanks without buffer strip of natural vegetation,


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aggravate erosion and worsen the condition of the riverbed.

**2. *City park fountains and small ponds***

*Amphibians and Reptiles.* The only amphibian species that occupies these types of urban habitats is the green toad (*Bufo viridis*). No reptiles occupy these types of habitats.

**3. *Temporary and constantly existing puddles***

*Amphibians and Reptiles.* The only amphibian species that occupy this type of urban habitat are the Marsh frog (*Pelophylax ridibundus*) and the green toad (*Bufo viridis*). No reptiles occupy this type of habitat.

**4. *Rice fields***

*Molluscs.* Five species of molluscs were found here: *Radix auricularia, Limnaea stagnalis, Physella acuta, Planorbis planorbis, Planorbarius corneus.*

*Fishes.* Most common and abundant species here are *Carassius gibelio, Gambusia affinis holbrooki, Cobitidae* spp. The information on other species is scarce.

*Amphibians and Reptiles.* From the amphibians commons species are *Bufo viridis, Bufo bufo, Bombina bombina, Pelophylax ridibundus* and *Hyla arborea*. From the reptiles – *Natrix natrix, N. tessellata* and *Emys orbicularis*.

*Birds.* There were no any detailed studies on the birds in this habitat. It was noted that these shallow, large ponds were used for nesting by species like *Himantopus himantopus, Vanellus vanellus* and *Glareola pratincola*. They were used as feeding sites by herons, storks and plovers.

*Mammalia.* Common mammal species of this habitat are *Neomys anomalus, Arvicola terrestris, Myocastor coypu*s and *Lutra lutra*.

*Threats:* Poaching, pollution by pesticides, over-fertilization of surrounding soils, and other water pollutions were registered. Ecological problems concerning new buildings and following destruction of the habitats also exist.

Most extensive impact have the pesticide use, fertilization, water and soil pollution, burning and destruction of cane and other aquatic vegetation – on 80 to 100% of the protected area. Burning of stubble and reeds often leads to expansion of the fires in the valuable habitats for birds. Cutting of trees and shrubs around the dikes limits the ability of birds to find suitable places for nesting and resting.

Other threats to the wild species are associated with intensive collecting of frogs and the destruction of large numbers of amphibians in drainage channels which reduces the food base for many birds.

Because of the easy access to the area, there is a significant disturbance to birds caused by illegal hunting of protected species, sport fishing, vehicles traffic in daily business activities and more.

**5. *Fish farm ponds***

*Molluscs.* Five species of molluscs were found here: *Radix auricularia, Limnaea stagnalis, Physella acuta, Planorbis planorbis, Planorbarius corneus.*

*Fishes.* The fish bred in those ponds are mainly *Esox lucius, Cyprinus carpio*, and *Hypophtalmychtis* sp. *Carassius auratus* is thriving and reach great abundance at summer and autumn.

*Amphibians and Reptiles.* From the amphibians common species are *Bufo viridis, Bufo bufo, Pelophylax ridibundus, Rana dalmatina, Pelobates syriacus* and *Hyla arborea*. From the reptiles – *Natrix natrix, N. tessellata* and *Emys orbicularis*.

*Birds.* There were no any detailed studies on the birds in this habitat but it was observed that the large dense areas occupied by *Typha* sp. and *Phragmytes* sp. were places used for nesting by *Acrocephalus arundinaceus, Gallinula chloropus* and *Ixoblychus minutes* (Table 2).

*Mammals.* Common mammal species of this habitat are *Neomys anomalus, Arvicola terrestris, Myocastor coypu*s and *Lutra lutra*. All bat species use the ponds as drinking and hunting site.

*Threats.* Eutrophication and poaching was observed in some of these basins. Burning of the dry plant matter of *Typha* sp. and *Phragmytes* sp. in large areas during autumn and winter was also registered.

**6. *Irrigation canals***

*Molluscs.* Most abundant were *Limnaea stagnalis, Radix auricularia, Planorbarius corneus* and *Planorbis planorbis*.

*Fishes.* Seven fish species were found here (Table 2). Most common were *Leuciscus cephalus* and *Carassius gibelio*.

*Amphibians and Reptiles.* From the amphibians common species are *Bufo viridis, Pelophylax ridibundus, Rana dalmatina* and *Hyla arborea*. From the reptiles – *Natrix natrix, N. tessellata* and *Emys orbicularis*. Occasionally *Lacerta viridis* can be observed along the canal's banks.

*Birds.* Birds were not studied here in detail. The canals were used for hunting and nesting site of *Alcedo atthis, Tringa ochropus, Acrocephalus arundinaceus, Gallinula chloropus*, and *Motacilla alba*.



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*Mammals.* The mammals were represented by *Lutra lutra*, *Arvicola terrestris*, and occasionally by *Myocastor coypus* and *Neomys anomalus*.

*Threats:* Main problem in this habitat were the non-periodical change of water levels. Water pollution and poaching of various types were also registered.

**7. *Regata Venue Rowing Canal***

*Molluscs.* Five gastropod species were found here: *Limnaea stagnalis, Viviparus acerosus, Radix auricularia, Physella acuta, Anisus vortex* and *Planorbarius corneus*. From bivalves – *Unio pictorum* and *Anodonta cygnea*.

*Fishes.* Four fish species were found here (Table 2). While the *Cyprinus carpio* was brought here as fishing object by men, the rest of fish possibly came in this basin by occasion.

*Amphibians and Reptiles.* The only amphibian species recorded in this habitat are *Pelophylax ridibundus* and *Bufo bufo*. From the reptiles only *Emys orbicularis* is registered.

*Birds.* No nesting birds were found here because of the constant human presence and the steep, concrete banks of the canal. Many swallows use the area for drinking. Some *Motacilla* species sometimes forage along its banks. Other bird species can be met here by occasion and do not present here constantly (Table 2).

*Mammals.* The only mammal we registered here was *Lutra lutra*.

*Threats:* Because of the easy access to the area, there is a significant human presence which causes disturbance to the biodiversity (sport fishing, vehicles traffic in daily sport and business activities and more).

## Conclusion

From the studied freshwater habitats in the area, those with the highest biodiversity of birds, amphibians and reptiles are the rivers and their floods, followed by the rice fields and fish ponds.

Most important for the molluscs species were the floods of Maritsa river where 11 species were registered. They were followed by the canals (Regata Venue Rowing Canal and the irrigation canals around the city) with 7 to 8 species found. No molluscs species were collected from the temporary ponds in the city area. From all molluscs the stagnophilous species dominated, and only two rheophilic species occurred in the habitats studied: *P. antipodarum* and *U. pictorum*.

The fishes are presented with 25 species, which represents 17.61% of the Bulgarian freshwater ichtyofauna. Only the reophilous species could be expected in central city stretch of the river, and both fish of running and standing waters can be met in its surroundings. The significant pollution from various city sources perhaps is also a limiting factor for the fish distribution.

The richest of mammal species are the banks of Maritsa river along its stretch.

Our results, based on previous studies as well as our own data indicated that for all studied plant and animal groups extreme urbanization reduces species-richness in most cases in the aquatic habitats. Much of this is predictable by a species-area effect via the loss of suitable habitats and the degradation of remaining habitat by pollution, traffic and other human disturbances. However, the effects of moderate levels of urbanization vary significantly among groups, showing a less consistent tendency to reduce species richness.

In the region there are several threats to biodiversity, which are expressed mainly as water pollution, urbanization, deforestation of riparian vegetation, correction of riverbeds, poaching and invasive species.

Based on these results, we recommend the following measures to reduce the negative impacts on the biodiversity:

1. Construction of new water treatment facilities in places where it is needed

2. Strengthening the control of building construction along the shores of ponds

3. Stopping the practice of clearing the riverbeds from the shrub and tree vegetation

4. Sustainable management of the adjustments of riverbeds and watercourses

5. Strengthening the control of hunting, fishing and poaching in the area

6. Controlling populations of invasive species

Further research may determine the possible explanations for cases where species richness is increased by moderate levels of urbanization. Potential factors to be examined would include the relative roles of alien species, spatial scale, spatial heterogeneity, and intermediate disturbance dynamics.

## References

Gecheva G, Yurukova L. 2006. Biomonitoring in running river water with aquatic bryophytes. – In: Scientific Articles, Ecology, Part 2, p. 209-216.



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**RESEARCH ARTICLE**

Gecheva G, Yurukova L, Ganeva A. 2011. Assessment of pollution with aquatic bryophytes in Maritsa river (Bulgaria). Bull. Environ. Contam. Toxicol., 87 (4): 480-485.

Gecheva G, Yurukova L, Cheshmedjiev S. 2013. Patterns of aquatic macrophyte species composition and distribution in Bulgarian rivers. Turk. J. Bot., 37: 99-110.

Georgiev D. 2006. The fish species participation in otters' (*Lutra lutra*) diet in Maritza river west of Plovdiv town (Southern Bulgaria). – In: Scientific Studies of the University of Plovdiv, Biology, Animalia, 42: 153-159.

Hartel T, Öllerer K, Nemes S. 2007. Critical elements for biologically based management plans for amphibians in the middle section of the Târnava Mare basin. Biologia. Acta Sci. Trans., 15(1): 109-132.

Hesse P. 1911. Zur Kenntnis der Molluskenfauna von Ostrumelien. Nachr. der Deutsch. malakozool. Gesellsch., 43: 142-155.

Hesse P. 1913. Zur Kenntnis der Molluskenfauna von Ostrumelien. II. Nachr. der Deutsch. malakozool. Gesellsch., 45: 1-75.

Hill MO, Bell N, Bruggeman-Nannenga MA, Brugués M, Cano MJ, Enroth J, Flatberg KI, Frahm J-P, Gallego MT, Garilleti R, Guerra J, Hedenäs L, Holyoak DT, Hyvönen J, Ignatov MS, Lara F, Mazimpaka V, Muñoz J, Söderström L. 2006. An annotated checklist of the mosses of Europe and Macaronesia. J. Bryol., 28(3): 198-267.

Löfvenhaft K, Runborg S, Sjögren-Gulve P. 2004. Biotope patterns and amphibian distribution as assessment tools in urban landscape planning. Landscape Urban Plan., 68: 403-427.

Lubchenko J, Olson A, Brubaker L, Carpenter S, Holland M, Hubbell S, Levin S, Macmahon J, Matson P, Melillo J, Mooney H, Peterson C, Pulliam H, Real L, Regal P, Risser P. 1991. The sustainable biosphere initiative: An ecological research agenda. Ecology, 72: 371-412.

McKinney M. 2008. Effects of urbanization on species richness: A review of plants and animals. Urban Ecosyst., 11: 161-176.

Mollov I, Velcheva I. 2010. Spatial distribution and retrospective analysis of the herpetofauna in the city of Plovdiv. Ecol. Balk., 2: 25-38.

Mollov I. 2011. Habitat distribution of the amphibians and reptiles in the city of Plovdiv, Bulgaria. Bihar. Biol., 5(1): 25-31.

Mollov I, Georgiev D. 2014. Plovdiv. – In: Kelcey J. (ed.), Vertebrates and Invertebrates in the European Cities: Selected Non-Avian Fauna, Springer, New York, 700 p.

National Statistical Institute, Republic of Bulgaria. 2011. Population Census – Main Results. (Accessed 9 July 2014) Available from: www.nsi.bg/census2011/PDOCS2/Census2011final_en.pdf

Stoycheva S, Georgiev D, Pandourski I, Tilova E. 2009. Bat diversity in two large towns of the Upper Thrace, Bulgaria (Chiroptera). Lynx, n. s. (Praha), 40: 83-93.

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA. (1964–1980). Flora Europaea, Vol. 2-5. – Cambridge University Press, Cambridge.

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA. 1993. Flora Europaea – Cambridge University Press, Cambridge.

Vasileva S, Georgiev D, Gecheva G. 2009. Aquatic macrophytes as microhabitats of *Radix auricularia* (Gastropoda: Pulmonata): A case study from Southeast Bulgaria. Ecol. Balk., 1: 91-94.

Velcheva I, Mehterov N. 2005. A study on the ichtyocenosis diversity in the downstream of the Maritsa river. – In: Scientific Studies of the University of Plovdiv, Biology, Animalia, 41: 69-78.



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