Man-made near-natural structures offer new habitats to macrophytes, as well as fish, in the Austrian Danube (Vienna, hydro-power plant Freudenau)

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Keywords: macrophytes, Danube, fish ecology. man-made habitats

Introduction

Several artificial habitats were created in the course of constructing the hydro-power plant Freudenau (Vienna, Fig. 1). They are located on the left bank of the main channel of the Danube River in the three hydrologically different reaches: head of the impoundment, transition zone, central area. They act as refuge areas for aquatic organisms during floods and as specially structured habitats in periods of regular discharge.

Macrophyte beds developed in these man-made side channels and bays. The influence of water flow velocity, temperature, pH, conductivity and chlorophyll-a on the abundance of hydrophytes were assessed for the time period 2003-2005. Fish studies were carried out at the same time.

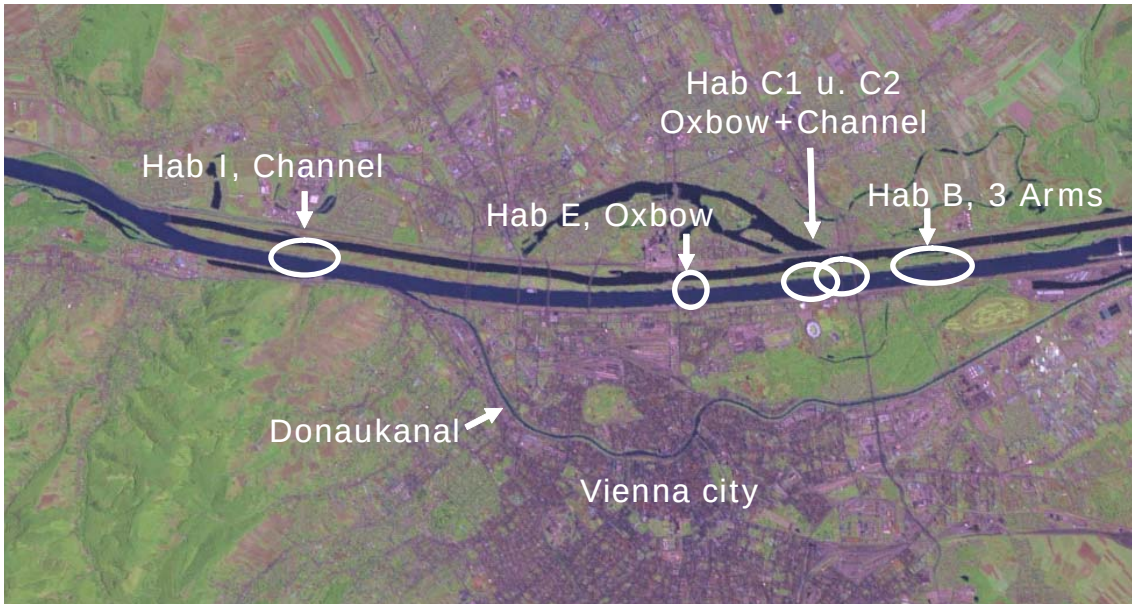

Fig. 1: Map of the surveyed artificial habitats in Vienna

Characterization of the habitats

Habitat B, near Steinspornbrücke, river km 1929, is a 917 m long relict arm, overgrown by riparian vegetation, strongly shadowed and hardly accessibly. In its middle reach an opening connects it with the Danube River. There is practically no flow, except for the mouth of the

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side arm, especially with respect to waves caused by ships traffic. Prior to flood periods the water level in this habitat is very low, which eventually causes large stands of macrophytes to die off, but new species occur frequently.

The two parts of Habitat C are connected by tubes: Habitat C1 (594 m) is a combination of side branch and oxbow with connection to the main channel at the lower end; Habitat C2 is a combination of side branch and oxbow with connection from above (445 m). Both are structured by small islands (c. 10 m x 0,8 m). Water flow occurs at the confluence with the main channel and rheophilic plants were observed. Habitat C2 is influenced by a large oxbow downstream that gathers anthropogenic debris.

Habitat E (181 m) is the shortest and is located downriver of Reichsbrücke. It is a typical oxbow with connection to the main channel at the lower end. Sedimentation is strong in this habitat and succession was recorded from aquatic macrophytes to helophytes and to riparian trees. The mouth of the oxbow is wide but abundant stands of macrophytes decelerate the incoming water flow.

Habitat I (c. 1250m) is located at river-km 1935, and shows several connections with the main channel over its entire length. Its position in the head area of the impoundment induces current velocities close to that in the main river, limiting macrophytes growth to rheophilic species only.

Methods

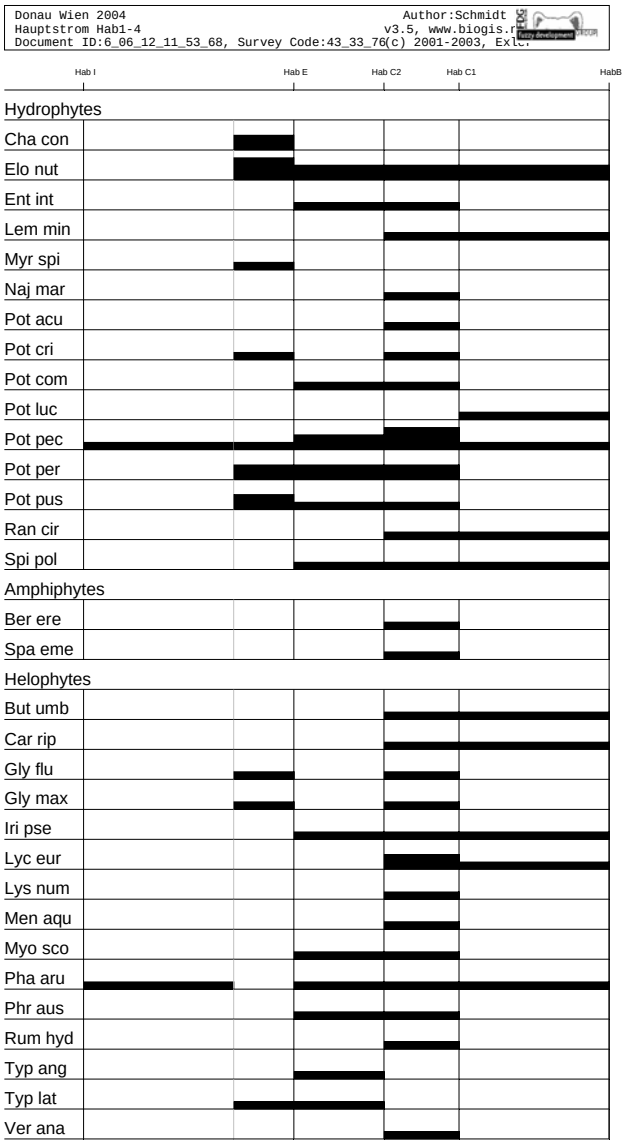
Distribution and abundance of aquatic plants were assessed for each species per habitat using a boat (5-level estimator scale, see KOHLER, JANAUER 1995, and European Standard EN 14184). Relative Plant Mass (RPM), Mean Mass Indices (MMO, MMT) and Distribution Quotient (d) were calculated via Internet Service (© 2001-2005, FDG Austria, DI N. Exler, www.midcc.at). Dominant habitat parameters were also assessed (bank structure, sediment type, flow class, connectivity type, and land use type/CORINE-System).

Fish species were determined in the Danube main channel by electro-fishing, and long-lines. In areas grown with macrophytes air-lift netting was performed. The migration of different fish species was determined with fish traps.

Results and discussion

In the period 2003 to 2005 19 hydrophytes and 15 helophytes were detected, which offer structure, protection and feeding space for young and juvenile fish of the 37 fish species found. Only five hydrophytes and three helophytes were found in the Danube main channel. Both macrophytes and fish prefer different flow conditions and are assigned to two groups in this study: rheophilic and stagnophilic.

Table 1: Distribution of macrophytes in the habitats I, E, C2, C1 and B (from left to right) during the years 2004 and 2005. The right diagram shows less abundance of plants due to four floods in 2005.



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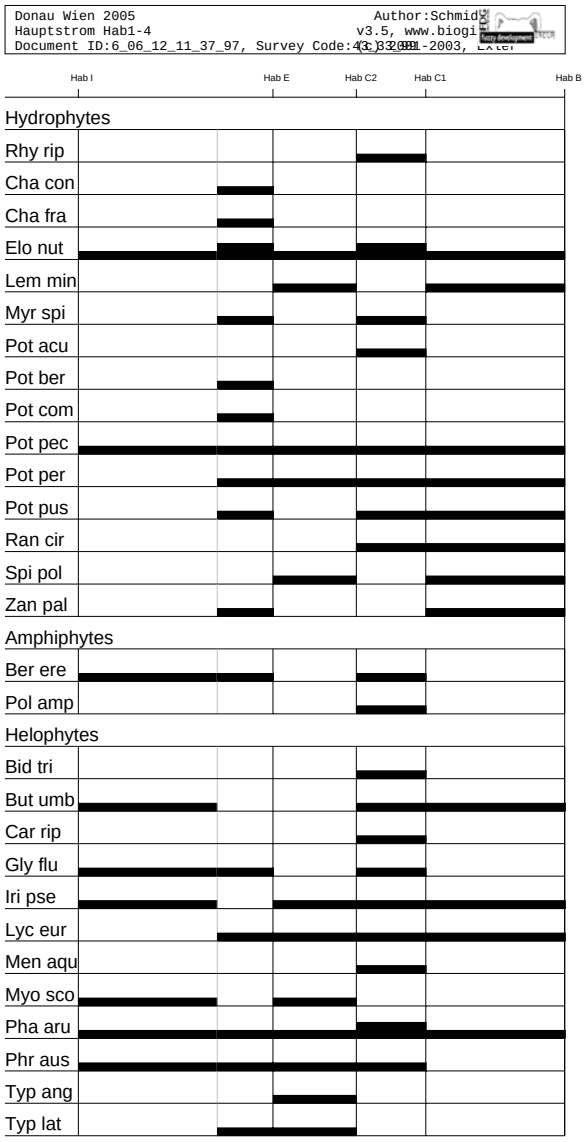

2005

Habitat I stood out due to its high flow velocity, especially induced by wave action caused by passing ships (up to $0.6ms^{-1}$). The rheophilic pondweed *Potamogeton pectinatus* had established itself in this area, but *Elodea nuttallii* was also found there for the first time in 2005.

P. pectinatus was found in all habitats in the mouth section where wave action was strong. In Habitats C and E it was followed in abundance by *P. perfoliatus*, a broad-leaved pondweed, which is less flow resistant.

The greatest variety of species (14 hydrophytes, 15 helophytes) was observed in the two Habitats C1 and C2, which are characterized by shallow water (1.5 to 0.30 m) and small islands. Where a lateral connection to the main channel exists, macrophytes developed much better than in the habitats with rather still water.

Despite its short length Habitat E the seven hydrophyte species found there make it the habitat with the highest relative number of aquatic plant species.

In Habitat B the intensive shading and the rather stagnant water supported only six macrophytes species.

Regarding the results on fish the highest density of individuals was found in the central part of the impoundment. The concentration of juvenile and sub-adult individuals of the rheophilic fish guild was unexpectedly high in the man-made habitats (Fig.2) and indicates their ecological importance for the power-plant impoundment as an artificial ecosystem. This is caused by several factors, as there are the macrophytes stands, tree roots and trunks, a higher water temperature than in the main channel and possibly by reduced wave action inside the artificial habitats. The lateral connections between artificial habitats and the main river channel also seem to have positive influence on fish density, including eurytopic species in the transition zones. (http://www.fidon.at/de/mainframe.htm; last access 27.06.2006, 16:00h)

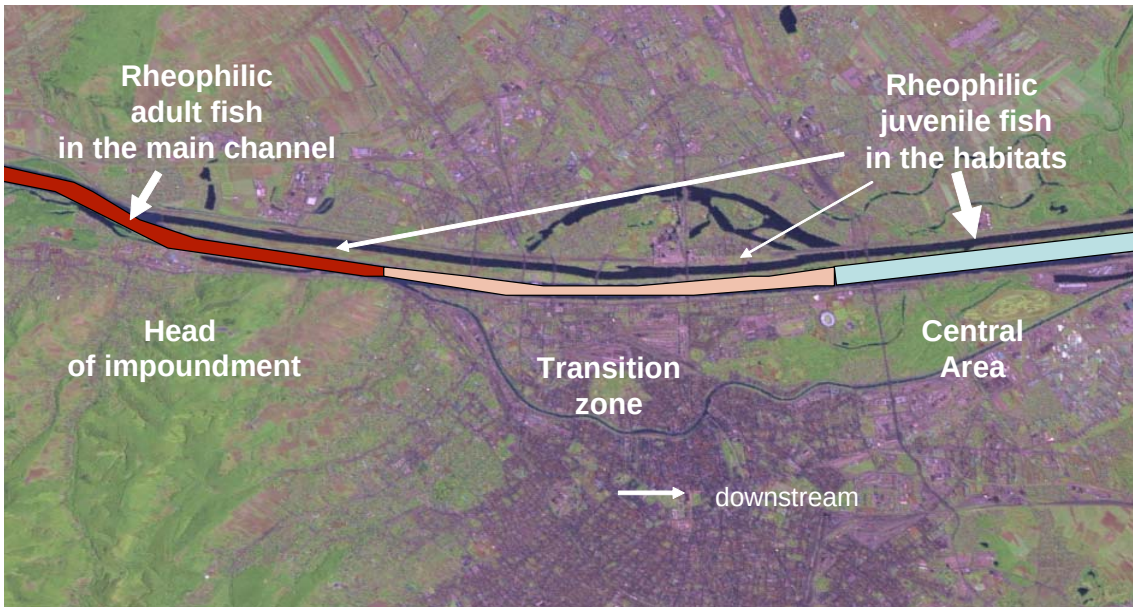

Fig. 2: Map of the impoundment reaches in Vienna; occurrence of the rheophilic fish guilde

Summary

Our studies demonstrate that structures like Habitat C1 and E are the most effective for supporting the development of rich macrophyte stands, which serve as high quality environments for juvenile fish. However, at present no results are available to predict in detail processes of sedimentation and erosion, which in turn influence aquatic plant succession which is one of the parameters dominating the richness of the fish fauna. With respect to the regulations of the EU Water Framework Directive artificial habitats like the ones studied in the Freudenau hydro-power impoundment can well be seen as serving the conditions for the good ecological potential in large heavily modified rivers or artificial water bodies.

Acknowledgements

This study was supported by the EU INTERREG IIIA-project “FIDON” Vienna – Györ (“Fischökologische Untersuchung zur Funktionsfähigkeit anthropogen gestalteter Flusshabitate an der Donau und ausgewählter Zubringer in den Regionen Wien und Györ”), co-financed by the Municipality of Vienna, MA-45 Water Management, the NÖ - „Landschaftsfonds“ of the Province of Lower Austria, and the Federal Ministry of Education, Science and Culture (Austria).

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