UDC 502.36:574.5(043.2)

UNDERWATER STRUCTURES FOR THE MAINTENANCE OF AQUATIC BIODIVERSITY IN UKRAINIAN RIVERS

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Keywords: biodiversity, river ecosystem, reef balls.

Introduction. The increased polluted runoff due to plowing of floodplains and ravines erosion results in degradation of aquatic habitats both in chemical and physical forms through the siltation of river beds. Absence or short-term floodplain flooding reduces the yield of meadow vegetation and forage base of all fish species, which leads to a sharp decrease in their reproduction and population decline at high trophic levels. The final outcome is decreased diversity of fish species in most of Ukrainian rivers. However, the lack of consistent aquatic biota reduces the capacity of rivers to provide ecosystem services. Thus, there is an urgent need to develop solutions for the support of biodiversity in these ecosystems, accounting both natural and anthropogenic factors of their dynamics.

Methods and materials. The efficient solution of the tasks aimed at biodiversity support can be based on engineering or managerial approaches. Since the river basins are often managed by a variety of authorities and used by numerous facilities and enterprises, the efficient organization of their protection is possible only under national programs and plans. However, they are often more inclined to setting principles instead of listing actions, expected to provide clear results. Under these conditions, it is necessary to develop lists of applied solutions, which could be implemented under various conditions with predictable and visible result. A good example of such is engineering of river habitats aimed at improvement of river quality as living environment, given the fact that intensive exploitation of rivers is in most cases inevitable.

Results. The main factors of influence on aquatic and coastal ecosystems are increasing recreational pressure and pollution with insufficiently treated sewage water, intensification of eutrophication processes. The other important factor negatively affecting the river ichthyofauna is illegal fishing. During the 1990s, the Dnieper cascade of reservoirs saw a threefold drop in fish production compared to the 1970s and 1980s, declining from 20-22 to 7-8 thousand tons [1]. Deforestation in the river basins leads to the drying up of tributaries, lowering of the water table (surface and underground), reduction in soil moisture, and lowering of the water level in the river. Thus, the suitability of rivers as fish habitats gradually declines.

The diversity of fish species is also threatened by growing number of invasive species, which is especially high on the territory of the Danube Biosphere Reserve. The drivers of invasions are

diverse, including the interactions between river ecosystems, active water transportation by rivers and pollution of waters, which may favor alien species due to their higher adaptation potential.

The proposed improvement of river habitats quality is provided by elaboration of bottom geometry and specific area, using artificial analogues of biogenic structures – reef balls. The reef balls are designed to serve as "birdhouses" for fish and various mollusk species. After all, it is very convenient to hide in such a place in order not to become a prey for larger aquatic species. Reef balls also serve as a place of solitude for spawning. Artificial reefs are often sunken old ships and broken machinery (such as tanks or subway cars), or specially built concrete structures, which are safer in terms of surface geometry and pollution.

To make a reef ball is a low cost task, which can be performed even with amateur engineers and activists. The materials needed are cement, sand, sugar and balloons: the concrete and sand is casted reef base, with the help of balloons are made cavities through which fish and get into an artificial reef. Sugar is needed to make the surface of the reef rough, as close to natural. It is also possible to make artificial reefs with coal ash (1 ton is \$22), or with car tires, which will be 16 to 27 times cheaper per 1 m³ than a concrete reef of the same size. And the cost of the final product is low enough to be affordable for local communities and nature protecting organizations.

The creation of a set of reef balls for 10 km section of a river will cost 4.5 thousand USD, according to our calculations, and will provide benefits of 23.5 thousand USD a year through the increase fish biomass and recreational activity [2], not accounting ecosystem service.

The importance of artificial reefs is enormous. First, they allow restoration of biodiversity in a certain area, serving as natural habitats, spawning grounds and shelters. These in turn contributes to the improvement of self-treatment potential of rivers: an adult mussel settlement on a reef of 1 m² in size is capable of cleaning 7-20 cubic meters of water in a day.

Conclusions

The maintenance of biodiversity in rivers is a crucial factor for the support of water quality, improved fish reserves and ecosystem services provision. It can be achieved among other approaches by inexpensive engineering of river habitats by artificial reefs, capable of providing positive effects with low costs and no externalities.

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