

ASSESSMENT OF THE SPATIOTEMPORAL DYNAMICS OF THE MACROPHYTE THICKET ECOSYSTEMS IN THE NEVA BAY AND THE ADJACENT WATERS OF THE EASTERN GULF OF FINLAND

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The macrophyte thicket ecosystems of higher aquatic vegetation in the Neva Bay (NB) and Eastern Gulf of Finland (EGoF) perform many important roles, including acting as the habitats, nesting sites and migration sites for aquatic and semi-aquatic birds, creating the specific conditions necessary for the spawning and growth of many species of fish, and taking part in the self-purification of the aquatic ecosystems. Many anthropogenic disturbances, hydraulic works in particular, have a significant negative impact on these macrophyte thicket ecosystems.

In recent years, the active growth of a new type of macrophyte thicket has been observed in the NB. This is due to the aftereffects of the construction of the Saint Petersburg Flood Prevention Facility Complex (FPFC). It is quite likely that the total macrophyte thicket area in these waters is currently increasing.

In the future, it will be necessary to assess the environmental impacts of the hydraulic works on the macrophyte thicket of the NB and EGoF, taking into account the background processes of the spatiotemporal dynamics of the reed beds in the waters in question. To do this, it will be necessary to carry out a comprehensive study of these ecosystems and identify patterns in their spatial and temporal dynamics. The program of the study has been developed and is currently being implemented by Eco-Express-Service, a St. Petersburg eco-design company.

Key words: macrophyte thicket ecosystems, Neva Bay, Eastern Gulf of Finland, hydraulic engineering works, aquatic ecosystem, manmade impact, succession, environmental damage

I. INTRODUCTION

The macrophyte thicket ecosystems in the Neva Bay (NB) and Eastern Gulf of Finland (EGoF) are known for their high biodiversity and multifaceted role in the ecosystem. They serve as habitats, nesting grounds and migratory stopovers for aquatic and semi-aquatic birds, create favorable conditions for breeding, spawning and fattening of different fish species, actively participate in self-cleaning of water bodies, etc. [1,2 et al.]

Hydraulic works often have a strong negative impact on these ecosystems. Increased water turbidity and subsequent sedimentation of suspended particles creates unfavorable conditions for aquatic biota by inhibiting aquatic macrophytes, destroying the spawning areas for fish and eliminating their forage reserve, leads to the loss of the nests and migratory sites of birds [3,4,5 et

al.]. Public environmental impact assessments of hydraulic works that may affect on macrophyte thicket ecosystems often include requirements for compensatory measures aiming at restoring water macrophytes. Besides the conventional measures of protection for macrophyte thicket ecosystems, these requirements sometimes include artificial creation of new thickets by environmental engineering means.

Some hydraulic works, however, lead to proliferation of new communities of water macrophytes. This was the case of construction of the dams of Saint Petersburg Flood Prevention Facility Complex (FPFC). Construction and maintenance of FPFC has had a major impact on the flow field of Neva Bay, has decreased the flow rate and increased sedimentation and shallowing processes, and has led to changes in shoreline and seabed profiles. These factors have favoured the increase in surface covered by macrophyte thicket ecosystems and occurrence of new thickets [2, 6 et al.]. These processes are visible both in the NB and to the west from the FPFC dams, including both the shoreline and rapidly developing shallow areas far from the solid ground. Besides that, the dams themselves serve as artificial reefs with significant juvenile substrates, contribute to growth of macrophyte thicket ecosystems on the adjacent water surfaces that are characterized with high biodiversity levels [7].

Thus, the overall surface of macrophyte thicket ecosystems in NB and EGoF may be steadily growing; however, exact data concerning this important process is still missing. Not only the overall balance of increases/decreases in projective cover of macrophyte thickets on the water surface is unknown, but also the ability of new aquatic macrophytes communities to fully compensate the ecological role of thickets lost because of recent hydraulic works remains unclear. Only fragmentary information exists on this account: according to anecdotal observations made by ornitologists, newly formed macrophyte thickets are actively used as stopovers by migratory birds. In general, however, their biochorological, phytocenological and hydrobiological characteristics, the quality of the abiotic environments formed by these thickets, the extent of their use by the fish population and birds remain practically unknown.

Adequate evaluation of environmental consequences of local negative impact produced by hydraulic works can only be made in the context of longer-term processes of spatiotemporal dynamics of overflow lands in the whole NB and EGoF. A complex study of macrophyte thicket ecosystems of these waters is needed in order to find out the spatiotemporal dynamics patterns and provide better foundations for realistic environmental damage assessment of transportation or industrial hydraulic works.

The program of such study was developed and currently is under implementation by “Eco-Express-Service”, a Saint-Petersburg-based environmental design company [8].

A thorough and detailed study of all parcels of aquatic macrophyta is currently impossible; thus, the program combines large-scale general observations and detailed study of the most characteristic (model) parcels.

II. MAIN COMPONENTS OF THE STUDY

1) Comparative evaluation of spatiotemporal changes in NB and adjacent EGoF waters based on accumulated literary and graphic material, manuscripts and satellite imaging;

- Definition and description of quantitative patterns of distribution, seasonal and long-term dynamics of projective cover.

2) Selection of model parcels of macrophyte thicket ecosystems for detailed study according to their division into three categories by their stage of succession:

I) Aged macrophyte thicket ecosystems with relatively stable projective cover and high level of biodiversity;

II) Relatively unstable ecosystems that have appeared or substantially expanded/reduced their surface during the observation period before the construction of FPFC;

III) Relatively recent communities formed as a result of artificial changes in hydrologic mode of the Neva bay.

Every category is supposed to have four types of water surface parcels:

a) surfaces unaffected by hydraulic works and minimally exposed to other anthropogenic factors (authentic state);

b) surfaces outside the area of impact of hydraulic works exposed to moderate level of other anthropogenic factors (background state);

c) surfaces situated in the impact zone of hydraulic works and exposed to moderate level of other anthropogenic factors (impacted state);

d) macrophyte thicket ecosystems directly adjacent to FPFC, whose development is determined by its influence.

Thus, the selection of model parcels is presumed to reflect characteristic situations in each of the following 12 types:

Ia, Ib, Ic, Id;

IIa, IIb, IIc, IID;

IIIa, IIIb, IIIc, IIId.

3) Primary complex study of chosen model parcels of macrophyte thicket ecosystems in NB and adjacent EGoF, including the characteristics of abiotic environment, aquatic biota, fishery and ornithologic importance (2016 growing season).

4) If needed, corrections in selected model parcels can be made according to the results of primary assessment in order to achieve better correspondence to preset types of conditions (2016 fall and winter).

5) Organization and implementation of seasonal (phenological) and interannual dynamics monitoring of macrophyte thicket ecosystems on selected model parcels (the scheme of monitoring can be quickly optimized).

Finding out patterns of spatiotemporal dynamics of these communities, abiotic conditions, and their biochorologic, fishery and ornithologic importance, including the following elements:

- Estimating the redistribution of migratory birds across stopover sites, bird species composition and quantitative characteristics, estimating the real impact of specific overflow lands inhibition during hydraulic works compared to larger-scale dynamics of their development in the studied region;

- Estimation of fishery importance of new macrophyte thicket ecosystems, including their suitability for breeding, spawning and fattening of fish, productivity of these communities, species composition of breeding and fattening fish, quality of fish, disease and survival rates of different fish

species, and overall share of macrophyte thicket ecosystems in the reproduction of fish livestock in NB and EGoF.

6) Statistical processing of obtained data and determining of key characteristics to be taken into account during the assessment of changes in macrophyte thicket ecosystems under the impact of hydraulic works in context of longer-term background processes.

7) Developing proposals on improvement of technical and methodological documents that are used for environmental impact assessment in case of industrial/transportation hydraulic works that may affect aquatic macrophytes communities.

8) Further environmental monitoring of model parcels according to the established scheme and based on information obtained during the previous stages of research.

III. EXPECTED RESULTS OF RESEARCH PROGRAM IMPLEMENTATION

1. Established and regularly updated data base on hydraulical, hydrochemical, phytocenological, hydrobiological, ichthyological and ornithological parameters of macrophyte thicket ecosystems in NB and adjacent EGoF;

2. Proposals on improvement of technical and methodological documents on environmental impact assessment of hydraulic works on macrophyte thicket ecosystems of NB and adjacent EGoF, and estimation of environmental damage of such works considering the background dynamics;

3. Developed methods of quantitative evaluation of compulsory compensation payments for negative biotic impact of hydraulic works affecting the macrophyte thicket ecosystems in NB and EGoF;

4. Materials for including corresponding methods and clauses in environmental legislation;

5. Established system of environmental monitoring of model parcels of macrophyte thicket ecosystems in Neva Bay and adjacent Eastern Gulf of Finland.

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