

Research programme

"Macrophyte thicket ecosystems in the Eastern Gulf of Finland"

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Some aspects of hydraulic works and hydraulic constructions impact on macrophyte thicket ecosystems

Limiting direct effect of hydraulic works

- increased water turbidity, sedimentation of suspended particles;
- inhibition of aquatic macrophytes;
- reduction of macrophytes' participation role in self-cleaning of water bodies;
- impoverishment and loss of spawning areas for fish;
- loss of the nests and migratory sites of birds.



Stimulating direct and indirect effect of Saint Petersburg Flood Prevention Facility Complex (FPFC)

Direct impact (near FPFC):

- effect of artificial reefs with significant juvenile substrates.

Indirect impact (out of FPFC):

- a decrease of Neva Bay flow rate, change in shoreline and seabed profiles, formation of macrophyte thicket ecosystems new biotopes;
- stimulation of aquatic macrophytes – expansion of old and formation of new thicket ecosystems;
- an increase of macrophytes' participation role in self-cleaning of water bodies;
- formation of new spawning areas for fish;
- formation of new nests and migratory sites of birds.

Summary effect: need to be studied

Purpose and scope of the programme

The purpose:

to study the regularities of spatiotemporal dynamics of macrophyte thicket ecosystems in Neva Bay and adjacent Eastern Gulf of Finland and to determine the necessary measures for preservation their role in the ecosystem.

Objectives:

The general work program can be divided into two stages: static (short-term) and dynamic (long-term) researches.

Objectives of static (short-term) researches are:

- comparative assessment of macrophyte thicket ecosystems current status of different age and genesis in case of different hydraulic engineering works impact in a zone of direct FPFC influence and beyond;
- creation and debugging of an effective monitoring system for macrophyte thicket ecosystems in Neva Bay and Eastern Gulf of Finland.

Objectives of dynamic (long-term) researches are:

- further monitoring of macrophyte thicket ecosystems in Neva Bay and Eastern Gulf of Finland;
- estimation of ratio and balance of technogenic processes of macrophyte thicket ecosystems loss and growth (especially the most environmentally valuable and advanced) in Neva Bay and Eastern Gulf of Finland;
- definition of the necessity, scopes and directions of special environmental protection measures at design and conducting of hydraulic works for the protection and restoration of macrophyte thicket ecosystems in this water area;
- corresponding updating of the regulatory documents for environmental impact assessment of hydraulic works on macrophyte thicket ecosystems.

Model parcels system

1) System model parcels – 14

Selection and coding of macrophyte thickets ecosystems' model parcels:

- Location concerning dams of Saint Petersburg Flood Prevention Facility Complex (FPFC):
A – out of FPFC, B – near FPFC.

- Gradation of communities' age:

1 - "aged" macrophyte thicket ecosystems – which has been existed before FPFC construction, stable and keeping approximate borders;

2 - "middle-aged" – which has been formed during FPFC construction (1979–2011);

3 - "new" – that has appeared after FPFC construction, actively expanded.

- Gradations of technogenic impact level associated with hydraulic works:

a – minimally exposed to hydraulic works' impact (background state): (absence of significant technogenic water changes) – outside the area of hydraulic works' impact and aftereffect;

b – moderate level of hydraulic works' impact (indirect action);

c – significant level of hydraulic works' impact (direct action, including notable sediment spreading due to hydraulic works).

An example of model parcel: A1b – out of FPFC, stable aged macrophyte thicket ecosystems of moderate (indirect) level.

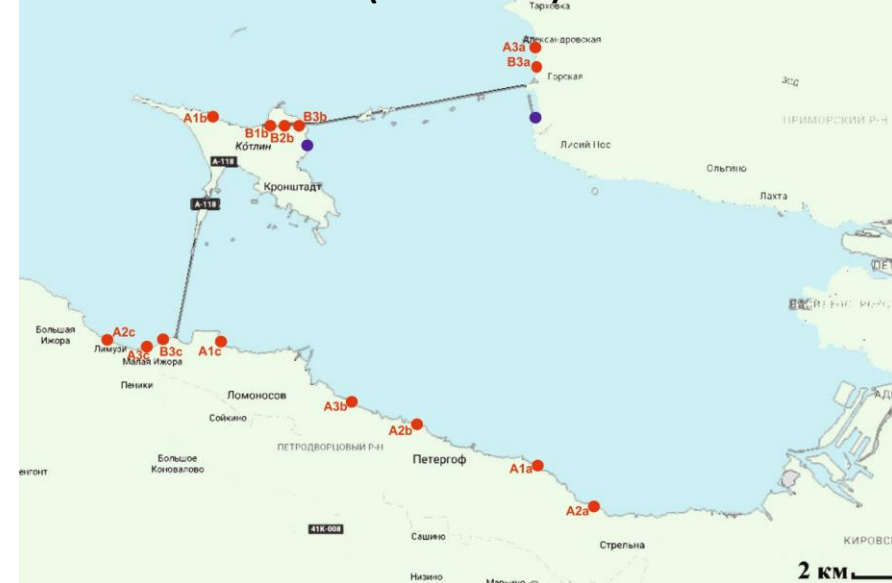
9 possible combinations of vegetation age and technogenic impact gradations were found far from FPFC ("A"); Only 5 combinations of 9 are realized near FPFC ("B").

2) Non-system model parcels – 2

They are in macrophyte thickets with the highest identified biodiversity.

Thus, 16 model parcels, representing the main combinations of thicket ecosystems age and effect level, are observed. The average area of model parcel is 1 km².

Location of the 14 system model parcels (red circles) and 2 non-system sites with the highest biodiversity (blue circles)



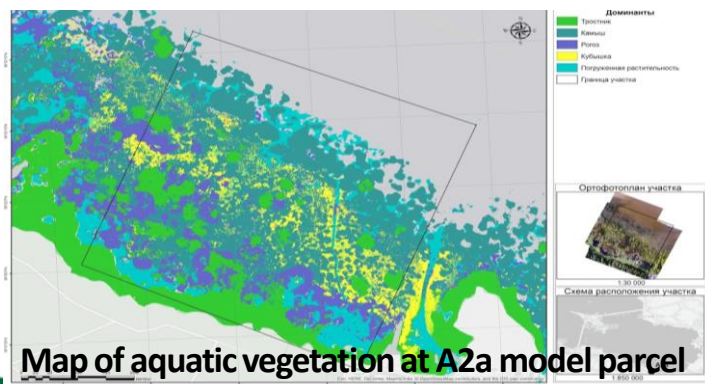
Programme works

№	Type of works at model parcels	Months
1	Studying of birds spring migration	April-May
2	Studying of phytophilous fish species spawning, breeding and fattening (3-4 times of fishing)	May-July
3	The 1 st aerial survey and mapping of aquatic communities (more than 35 km ²)	May-June
4	Observations of aquatic and semi-aquatic birds at nesting	May-June
5	The 1 st hydrobiological survey	June
6	The 1 st hydrochemical survey and soil sampling for particle-size analysis	June
7	The 2 nd aerial survey and mapping of aquatic communities and phytocenological studies	July-August
8	The 2 nd hydrobiological survey	July-August
9	The 2 nd hydrochemical survey and soil sampling for particle-size analysis	July-August
10	Studying of birds autumn migration	August-October
11	The 3 rd aerial survey and mapping of aquatic communities	October
12	The 3 rd hydrobiological survey	October
13	The 3 rd hydrochemical survey and soil sampling for particle-size analysis	October



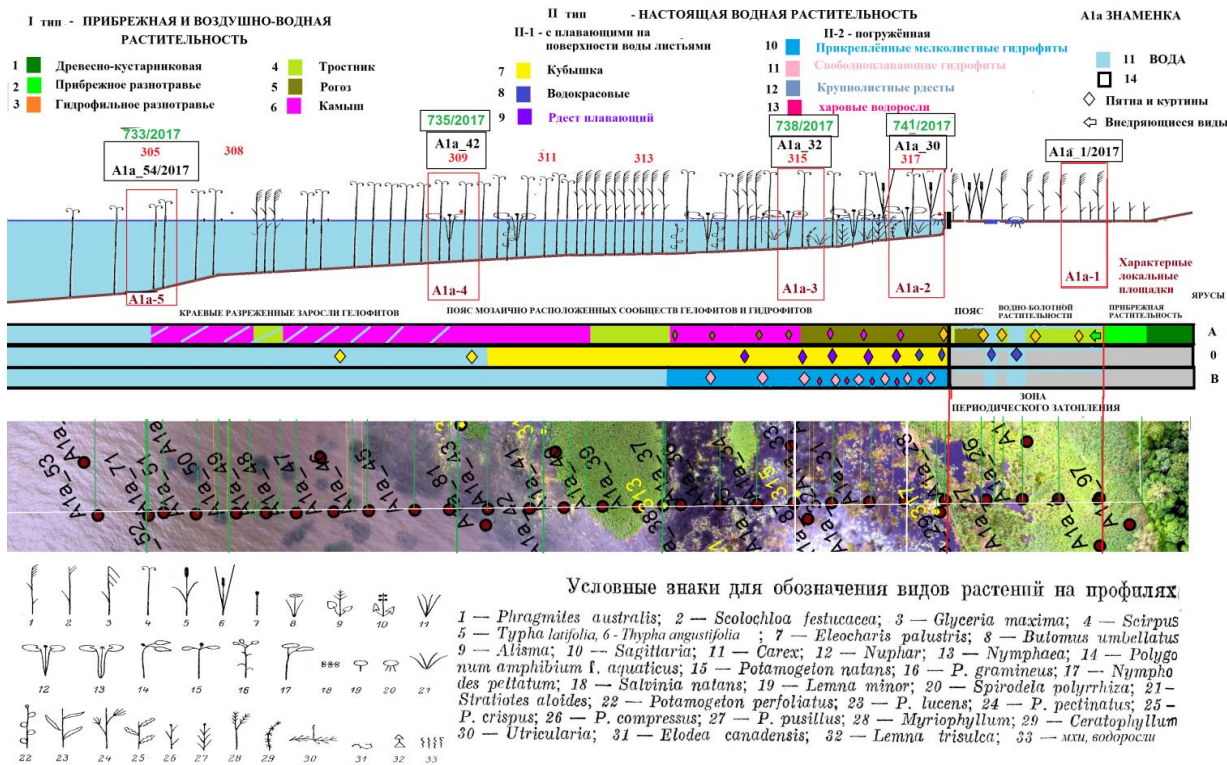
Studying of plant communities

Gradation of communities' age	Characteristics	The projective cover degree of the water surface by vegetation	Additional cover degree of the bottom by submerged vegetation
1. "Aged" 	They have a clearly expressed zonal distribution. Usually they are formed by unistratal and pluristratal groups of macrophytes with a predominance of 2-3 layers. These thickets in many cases are dense and stable. The possibilities for their further expansion are exhausted.	A: 39–41% B: up to 66%	A: + 3-11% B: up to + 23%
2. "Middle-aged": 	They are long-term balanced and replaceable communities of macrophytes with a predominance of simple 1-2-layers groups. Usually these are less dense thickets, they continue to gradually expand and thicken.	A: 14–35 % B: up to 40 For non-system model parcels with the highest identified biodiversity – 14-49%.	A: + 2-7% B: up to + 43% For non-system model parcels with the highest identified biodiversity – 1-12%.
3. "New" 	They are long-term pioneer communities of macrophyte thickets with a predominance of simple 1-layer groups. So far, they occupy a small percent of the biotopes and actively expand.	A: 2-12 % B: up to 20%	A: 0-10 % B: up to 23%



**Orthophotomap of macrophyte thicket ecosystems in the Neva Bay
(August 2017)**

Studying of plant communities



The scheme of dominant groups at the vegetation profile (A1a model parcel in 2017)

"Old" thickets: 4 clearly different characteristic zones:

1. Zone of 1-layer groups of predominantly single-species thickets;
2. Zone of 2-3-layers groups of thickets consisting of mosaic-located monospecific groups of aero-aquatic and multispecific groups of real aquatic vegetation with the predominance of submerged hydrophytes;
3. Zone of 1-2-layers of helophyte thickets with spots of *Nuphar lutea* at places of low and medium overgrowing density;
4. Zone of boundary 1-layer spots of thickets consisting of monospecific communities of aero-aquatic vegetation with low overgrowing density.

Thickets of submerged vegetation are located inside the helophyte thickets. The vegetation belt with leaves floating on the water surface and the *Potamogeton* belt are not found out.



Studying of phytophilous fish species spawning, breeding and fattening

- "Old" and "middle-aged" thickets were found to be the most attractive for the spawning of phytophilous fishes. "Middle-aged" thickets are characterized by greater accessibility of internal part of the plant massif, have the biggest spawning surface and are quite effective shelters for juveniles. The peripheral zone is used more actively for spawning in denser "old" thickets.
- "New" spaced thickets are mostly used for breeding of juveniles.
- The most productive spawning areas have been identified and studied at Strelna (corresponds to conditions of A2a model parcel), Znamenka (A1a), Bronka (A1c), Limuzi (A2c), Gorskaya and Kotlin Island, at north-west coast (A1b), around the 1st Northern Fort (B1b, B2b) and on the northern coast to the east from FPFC dam.
- Some regularities in the distribution of spawning and juveniles breeding characteristics of different phytophilous fishes' species have been determined in the thickets of different age, structure and level of anthropogenic impact.



Ichthyological material sampling stations (sampling with ichthyoplankton nets and landing net) at A2a model parcel in 2018

- Studying of dependence of spawning indicators on soil types, overgrowing density and thickets area are also carried out as part of programme.

Along with the traditional methods of studying the spatiotemporal dynamics of spawning and distribution of phytophilous fish species juveniles, aerial survey with use of quadcopter has been successfully used.



Ornithological importance of the programme:

- 1) The Neva Bay and St. Petersburg are located on so-called The White Sea-Baltic Sea migration route, main branches of which run along coasts. Macrophyte thicket ecosystems are especially important for aquatic and semi-aquatic migrants.
- 2) It is the first attempt to estimate an ornithological role and to reveal regularities of usage of macrophyte thicket ecosystems of different age and genesis in an influence gradient by birds (usually macrophyte thicket ecosystems are characterized by ornithologists entirely).

The ornithological reason of main system of model parcels location on the southern coast of the Neva Bay. The compared parcels have to be as similar as possible in everything, except the studied factors, but the avifauna of north and south coasts significantly differs. It is richer on the south coast, and is quite similar to Kotlin Island. Parcels are placed within these limits as far as possible.

The most important and illustrative periods:*1) Spring migrations with stopovers in macrophyte thicket ecosystems*

Macrophyte thicket ecosystems role for spring birds migrations is much more important and more accessible for studying than for autumn ones.

2) Nesting in macrophyte thicket ecosystems

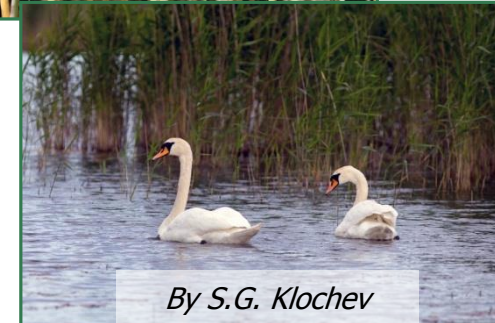
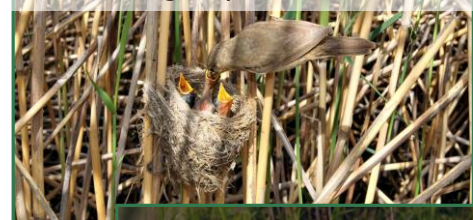
- biological importance (reproductive period);
- the most qualitative, various and objective material for comparison of macrophyte thicket ecosystems model parcels;
- long-term (during a month) accurate localization of birds, careful preliminary selection of the most suitable conditions for this purpose.

Nest of Aythya fuligula at additional model parcel. By V.A. Fedorov



By S.G. Klochev

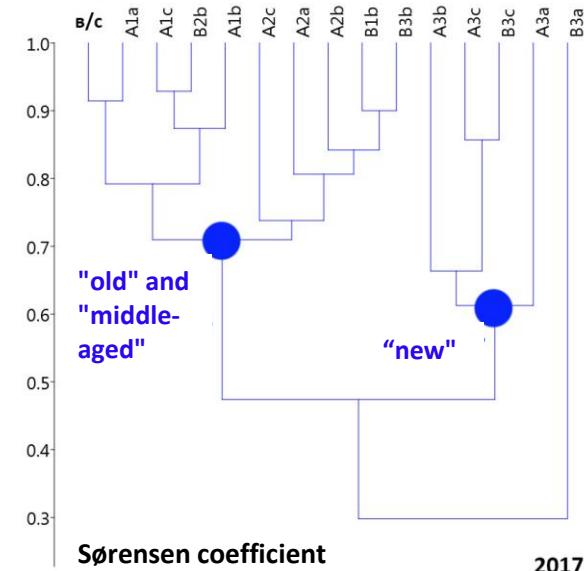
Acrocephalus scirpaceus feeds birdlings. By A.A. Frenkel



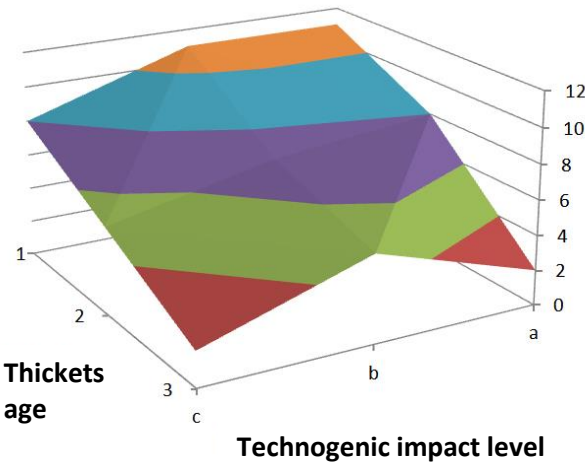
By S.G. Klochev

Ornithological observations (continuation)

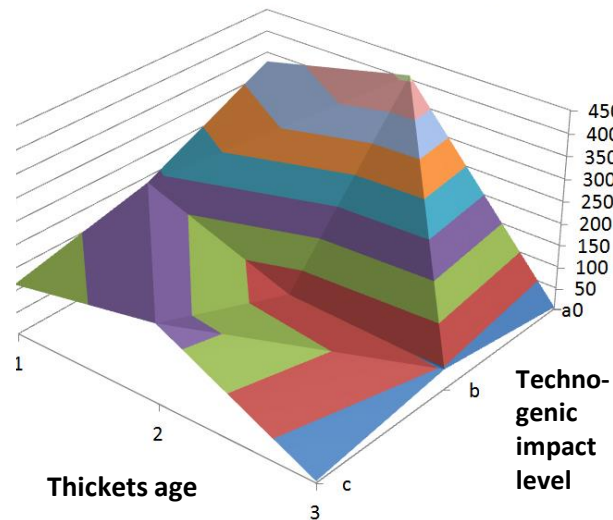
- Significant clusters of spring migrants were observed at all model parcels in "old" and "middle-aged" thickets.
- The "old" and "middle-aged" thickets during the nesting period also have the highest "ornithological value".
- During spring migrations and nesting birds sometimes prefer "middle-aged" thickets but not "old" as its' lower density and presence of open space allow birds to freely maneuver and feed.
- The maximum number of species reaches (13) and the number of birds (405) is also noted at the water area of non-system sites with the highest biodiversity ("middle-aged" thickets).



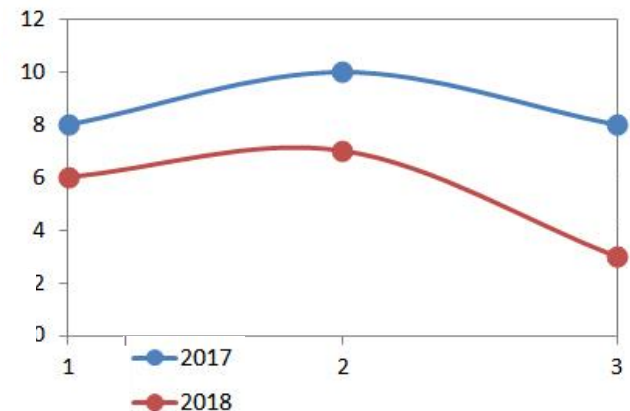
The total number of bird species at model parcels during the spring migration of 2017 outside the FPFC ("A")



The maximum number of birds at model parcels (individuals) during spring migration of 2017 outside the FPFC ("A")

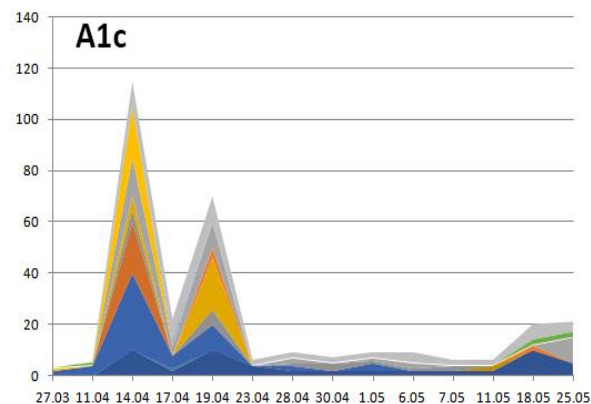
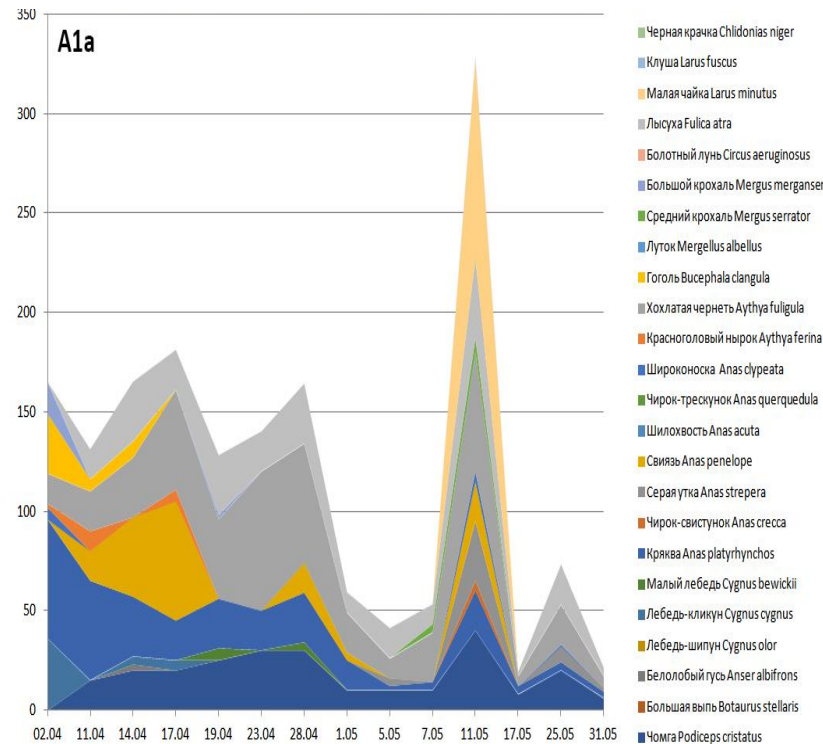


The number of aquatic and semi-aquatic bird species at model parcels near the FPFC ("B") in a zone of moderate impact ("b") during spring migration in thickets of different ages (1,2,3)



Ornithological observations (continuation)

The dynamics of birds number at model parcels A1a and A1c (individuals) during the spring migration of 2017



- A successful nesting of *Cygnus olor* was noted in the Neva Bay for the first time in "middle-aged" thickets (2018).
- "New" thickets are minimum used for nesting and migratory stopovers.
- Autumn stopovers of wetland birds in the Neva Bay seemed to be expressed much worse than spring. The total number of birds in the Neva Bay during the autumn migration 2016-2017 doesn't exceed 4-5 thousand individuals.
- Hydraulic works and the operation of hydraulic structures can significantly influence on the use of thickets for birds migration sites (for example, model parcels A1a and A1c).
- It is obvious that FPFC and its operation doesn't have negative impact on the birds distribution. Moreover, the FPFC construction has provided birds with new biotopes for migration sites and nesting.



Some preliminary results

Currently, the received material is being processed.

Further monitoring is planned according to the same programme.

In general, thickets, which have appeared during FPFC construction, are not behind the older thickets in the most important environmental properties and, in some cases, they even prevail.

The environmental role of younger thickets, that formed after the completion of FPFC, is still less significant, but they have a good potential.

The validity of these preliminary results will be thoroughly verified in the course of further observations according to the programme "Macrophyte thicket ecosystems in the Eastern Gulf of Finland".



Preliminary and expected results

The following results of research programme implementation are expected:

1. Proposals on improvement of technical and methodological documents on environmental impact assessment of hydraulic works on macrophyte thicket ecosystems of Neva Bay and adjacent Eastern Gulf of Finland, and estimation of environmental damage of such works considering the background dynamics;
2. Established and regularly updated data base on hydraulic, hydrochemical, phytocenological, hydrobiological, ichthyological and ornithological parameters of macrophyte thicket ecosystems in Neva Bay and adjacent Eastern Gulf of Finland.
3. Materials for including corresponding methods and clauses in environmental legislation.
4. Established system of environmental monitoring of model parcels of macrophyte thicket ecosystems in Neva Bay and adjacent Eastern Gulf of Finland.





Thank you for your attention!

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