St. Petersburg Scientific Research Center for Ecological Safety RAS

Monitoring and assessing the anthropogenic influence on soil health

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Laboratory of methods for remediation of technogenic landscapes

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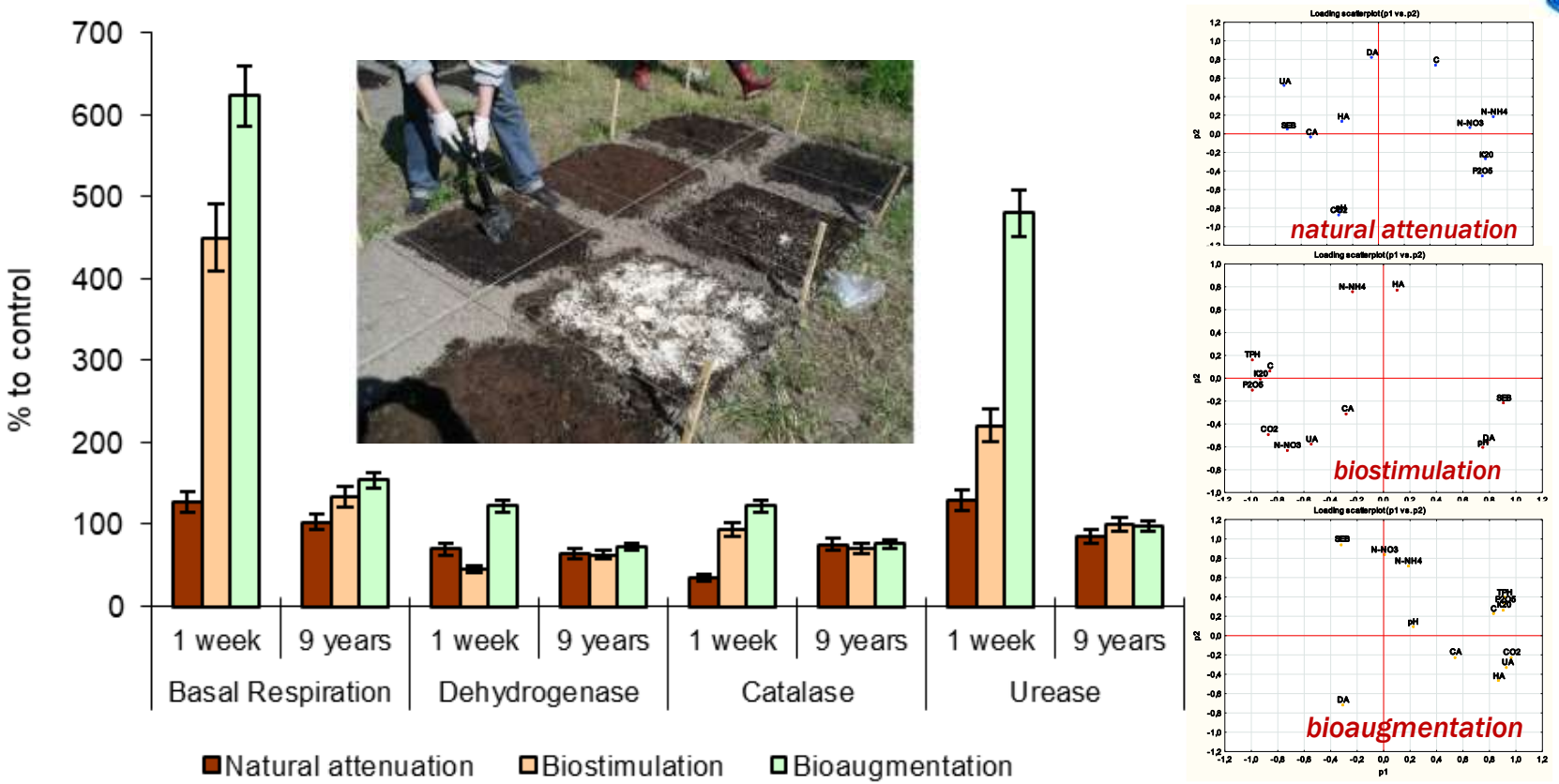
The Laboratory of methods for remediation of technogenic landscapes at SRCES RAS is dedicated to fundamental and applied research that supports soil function preservation and restoration and sustainable redevelopment of Russian regions and cities that carry the burden of anthropogenic pollution.

Current research activities are mainly focused on monitoring and assessing exposure and effects of anthropogenic pollution on soil evolution, plant formation, soil and sediment microorganisms, allelopathic effects, polycyclic aromatic hydrocarbons (PAH) and oil in natural environment.

The research helps to assess the long-term acclimation and adaptation of soil biota to pollution, and the consequences for soil function and resilience to change.

The ultimate goal of the lab's research is to promote protection of soil and water resources through understanding of biogeochemistry of natural and technogenic landscapes, stability and resistance of ecosystems to anthropogenic impact.

ECOLOGICAL ASSESSMENT OF OIL-CONTAMINATED SOILS



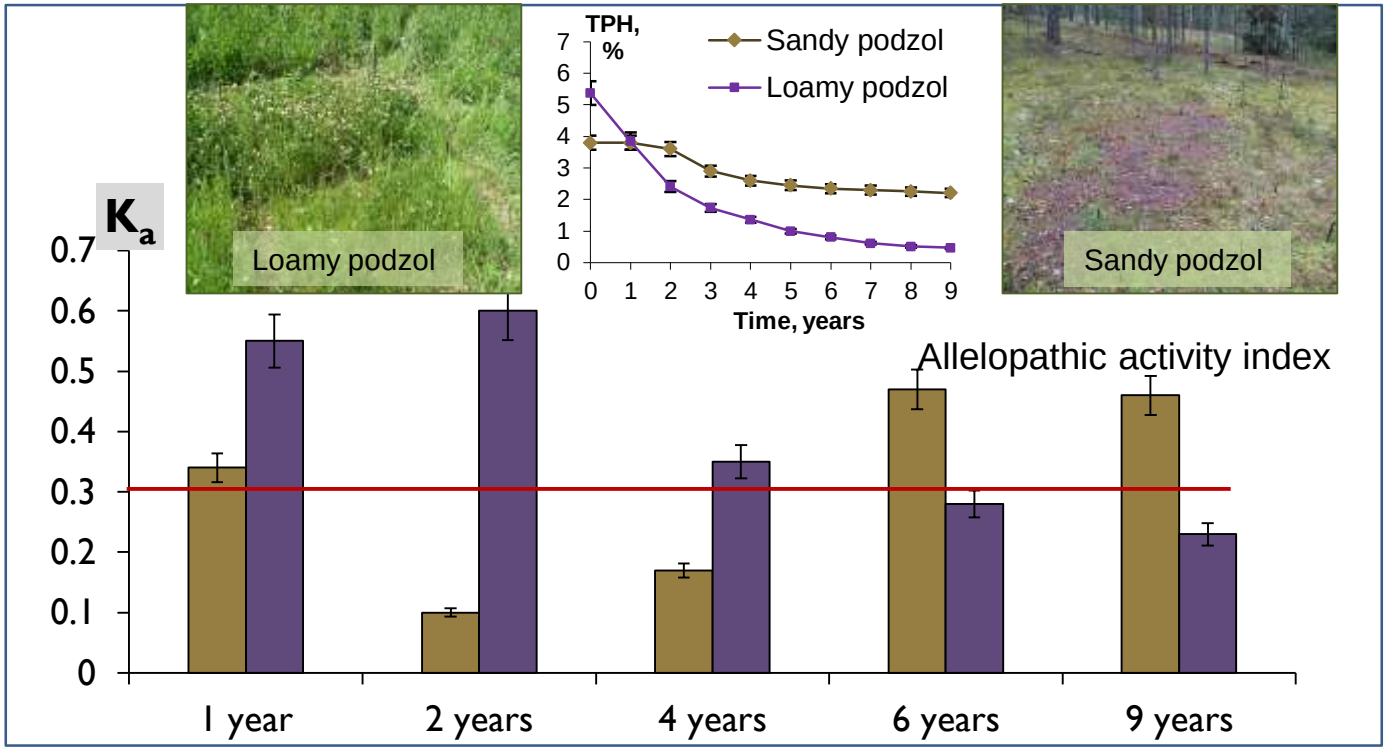
•The effects of oil contamination and different remediation strategies (natural attenuation, biostimulation, and bioaugmentation) on physico-chemical and biological parameters of soils were studied.

•Various aspects of soil biological activity proved to be powerful tools for the assessment of long-term changes in oil-contaminated podzolic soil.

•The addition of oil-degrading bacteria (bioaugmentation) enhance biodegradation rates only temporarily indicating that biostimulation is a better remediation strategy for podzolic soil in the field.

Polyak Y.M., Bakina L.G., Chugunova M. V., Mayachkina N.V., Gerasimov A.O., Bure V.M. 2018. Effect of remediation strategies on biological activity of oil-contaminated soil - A field study. International Biodeterioration & Biodegradation. V. 126. P. 57-68. doi.org/10.1016/j.ibiod.2017.10.004

IMPACT OF OIL-CONTAMINATION ON THE ALLELOPATHIC ACTIVITY OF SOIL FUNGI

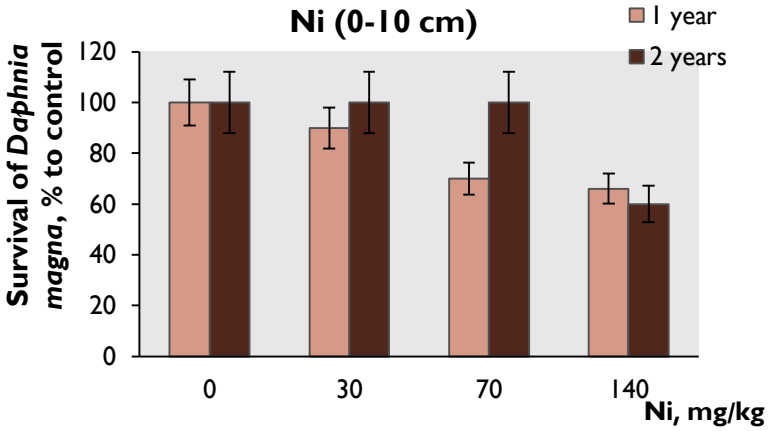


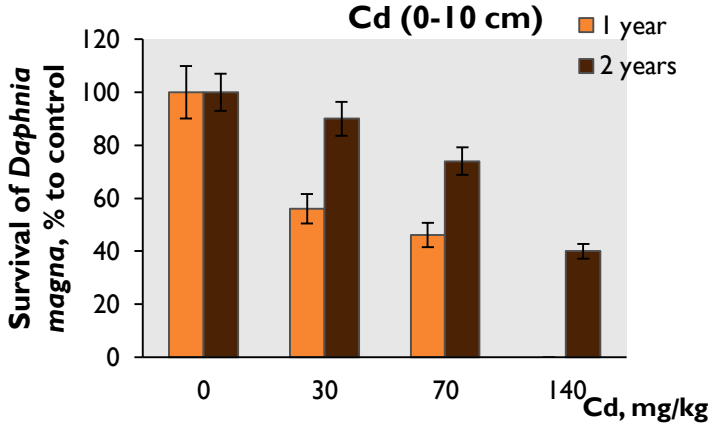
- Toxicity assessment of oil-contaminated soil with allelopathic activity bioassay can provide important information regarding soil ecotoxicity and evaluation of ecological risks associated with oil contamination.
- Allelopathic activity indices (K_a) can be used as potentially valuable indicators to assess soil quality dynamics and soil health.

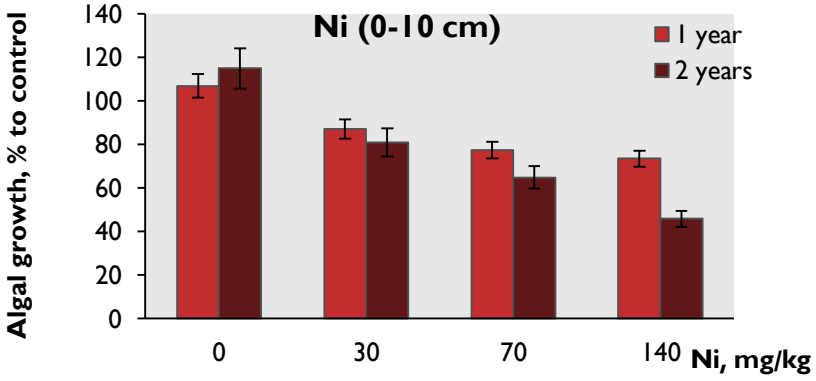
Polyak Y.M., Bakina L.G., Mayachkina N.V., Polyak M.D. 2020.The possible role of toxigenic fungi in ecotoxicity of two contrasting oil-contaminated soils – a field study. Ecotoxicology & Environmental Safety (in press).

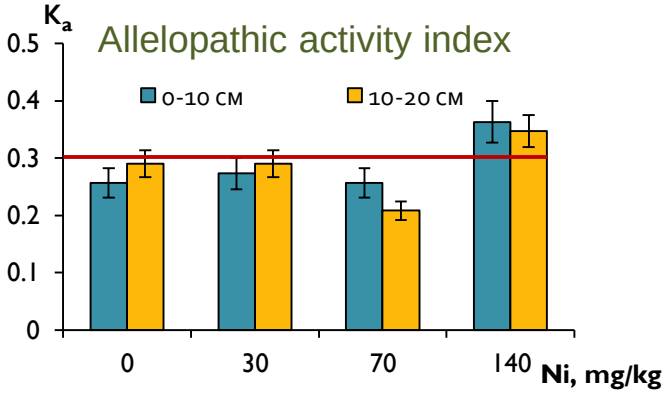
Polyak Y.M., Sukcharevich V.I. Allelopathic interactions between plants and microorganisms in soil ecosystems. Biology Bulletin Reviews. 2019. V. 9, № 6. P. 562–574. https://doi.org/10.1134/S2079086419060033

ECOLOGICAL ASSESSMENT OF METAL-CONTAMINATED SOIL









•The biological effects of metal contamination were evaluated in cultivated urban soil under field conditions.

•The methods of bioindication and bioassay indicated high toxicity, deterioration in biochemical properties and slow recovery of contaminated soil.

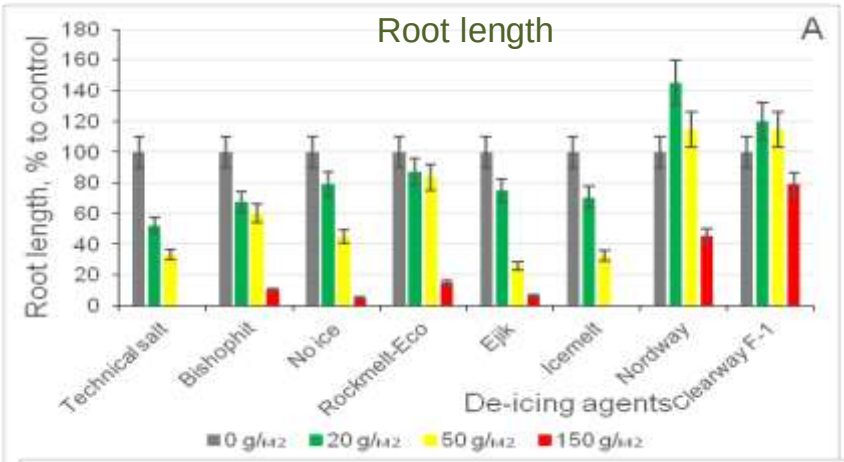
•Soil dehydrogenase is a sensitive indicator of metal contaminations, which allows identifying the biological effects that occur even in slightly polluted soils.

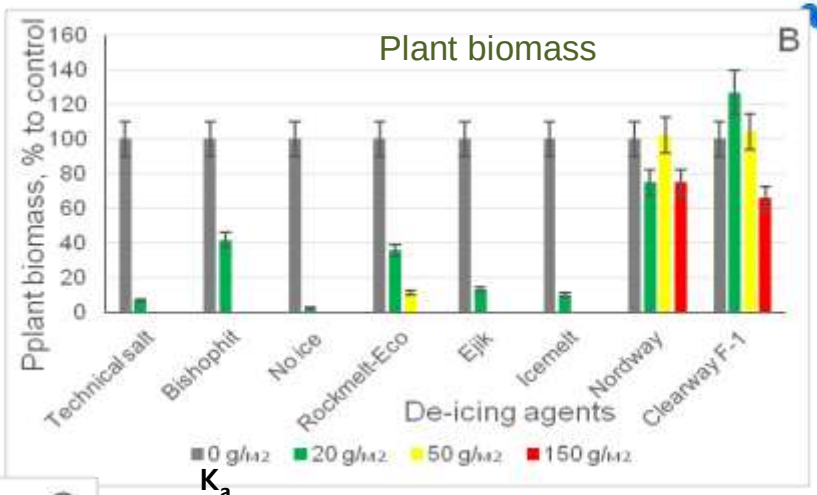
Mayachkina N.V., Chugunova M.V., Bakina L.G., Polyak Yu.M., Gerasimov A.O., Drozdova I.V. 2017. The dynamics of ecotoxicilogical state of organo-mineral piled-up soil contaminated with cadmium in field experiment. Reg. Ecol. 4:83-91.

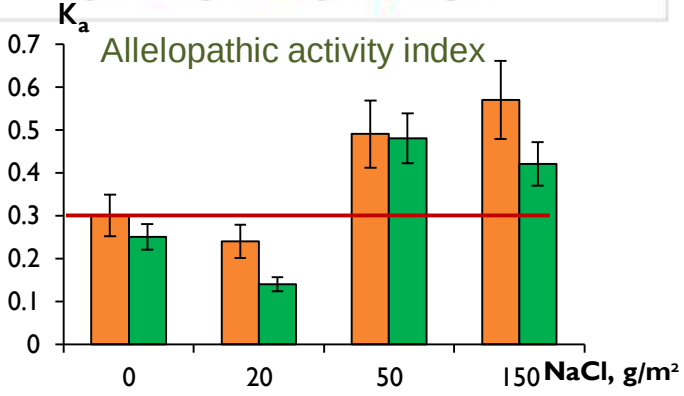
Polyak Y.M., Bakina L.G., Mayachkina N.V., Drozdova I.V., Kaplan A.V., Golod D.L. 2018. Biodiagnostics of the cultivated urban soil polluted by metals: bioindication and bioassay. The Journal of Soils and Environment. 1(4): 232-242.

https://doi.org/10.31251/pos.v1i4.34

THE STUDY OF ROAD SALT ECOLOGICAL IMPACTS







- Application of high doses of chloride reagents led to an increase of salt concentration in soil up to level of slightly saline soils. However, under field conditions soil salinity eventually decreased due to salt washout by atmospheric precipitation.
- Contaminated soils had salt levels high enough to be toxic to plants and soil microorganisms.
- Acetate and formate de-icing agents demonstrated the least environmental effect.

Gerasimov A.O., Chugunova M.V. 2018. Evaluation of the impacts of ice control materials having different chemical compositions on grass growth and soil respiration. Biosphere. 10(4):273-281.

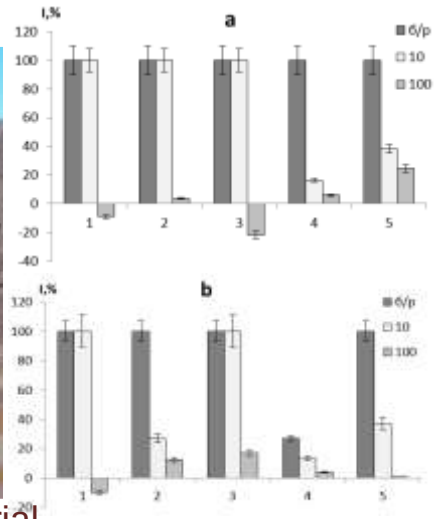
Gerasimov A.O., Chugunova M.V., Polyak Y.M. 2019. The seasonal changes in the content of de-icing salts in sod-podzol soil in laboratory and field experiments. Biosphere. 11(4):171-177. http://ww.mmps.ru/index.php/bio/article/view/512

ECOLOGICAL ASSESSMENT OF THE SOILS FROM THE BROWNFIELD SITE

Industrial waste dump located near lake Ladoga

Surrounding land was also contaminated

Long-term unregulated storage of industrial wastes of sulfuric acid production (Pb, Zn, Cu, As)



- All ecotoxicity bioassays revealed a dangerous level of toxicity at the brownfield site.
- Both eluate and contact bioassays are well-suited and should be used together for ecotoxicological assessment of brownfield soils.
- A distinctive feature of the initial stage of soil formation at the dump site is low biological activity of soil.

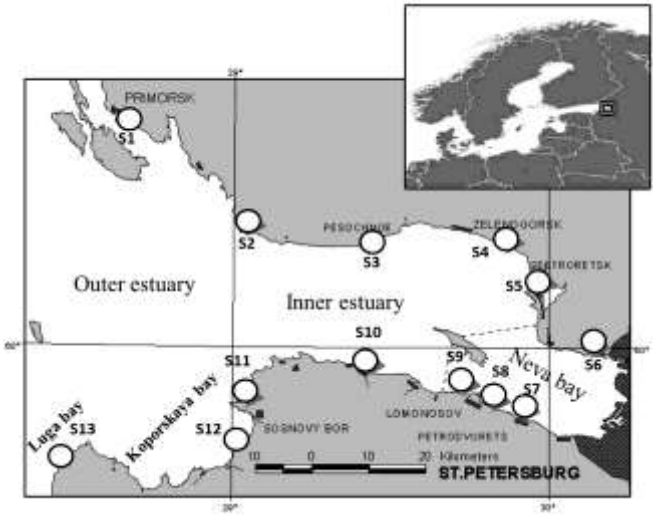
Bardina T.V., Chugunova M.V., Kulibaba V.V., Polyak Y.M., Bardina V.I., Kapelkina L.P. 2017. Applying bioassay methods for ecological assessment of the soils from the brownfield sites. Water Air Soil Pollut 228:351. https://doi.org/10.1007/s11270-017-3521-3

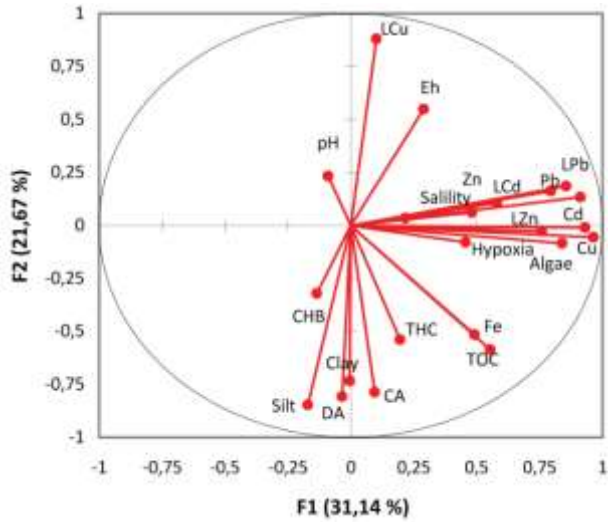
DIAGNOSTICS OF ANTROPOGENIC IMPACT ON THE COASTAL ZONE OF THE EASTERN GULF OF FINLAND

Cross-Border Cooperation Programme "Estonia-Russia"

Project "Hazardous chemicals in the eastern Gulf of Finland – concentrations and impact assessment – HAZLESS" 2019-2021

The objective of the project is adaptation and implementation of uniform biological indicators for assessment and control of environmental quality in the eastern GoF.





- The most relevant factors, playing major role in the coastal sediments of the eastern Gulf of Finland were identified.
- Anthropogenic activities leading to deposition of pollutants are harmful to sediment environment and influence benthic organisms and the activities of sediment microbiota.

Gubelit Y., Polyak Y., Dembska G., Pazikowska-Sapota G. et al. 2016. Nutrient and metal pollution of the eastern Gulf of Finland coastline: sediments, macroalgae, microbiota. Science of the Total Environment. 550: 806-819. https://doi.org/10.1016/j.scitotenv.2016.01.122

Polyak Y., Shigaeva T., Gubelit Y., Bakina L. et al. 2017. Sediment microbial activity and its relation to environmental variables along the eastern Gulf of Finland coastline. Journal of Marine Systems. 171: 101-110. http://dx.doi.org/10.1016/j.jmarsys.2016.11.017

Thank you for your attention!

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