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# Seashore Litters Impact on Biological Resources of Arctic Seas *

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**Abstract.** In the present manuscript, the impact of seashore plastic litter on the Arctic aquatic environment with a primary focus on fish is discussed. Plastic pollution of seashore and aquatic ecosystem became a major environmental problem in the late 1990s, when it was considered as a major threat for aquatic ecosystem. In recent years, the microplastic (MP) pollution has raised scientific attention and awareness as severe threat for aquatic ecosystem. Since fish is a significant source of food and wealth of Arctic countries, the shrinkage of fishing rates caused by aquatic ecosystems plastic pollution can lead to a significant negative effect on the well-being of the Arctic countries' population and economy. Recent studies showed significant amount of MP in Arctic seas. The MP particles were found in more than 90% of the studied water samples from the Barents Sea. This indicates that MP has become a major threat for aquatic life in the Arctic. Despite the fact the MP may pose harmful effects to aquatic life, there is still a lack of valid information concerning this research. Moreover, standard and generally accepted protocols for MP pollution monitoring and risk assessment need to be implemented. In view of the above, the current state of the problem is described in this paper.
**Keywords**: *plastic pollution, microplastic, aquatic ecosystem, Arctic, marine litter, Arctic environmental problem*

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### *Introduction*

Aquatic bioresources and specifically fish is a significant source of food for people all over the world. It shares on average about 15% of animal protein consumption for the world's popula-


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tion, whereas in poor and food-deficit countries these figures rise to a significant 25% [1]. Marine fish is also one of the major sources of vitamins, essential elements and omega-3 fatty acids which are responsible for normal functionating of the human body, which deficiencies in the diet could cause severe health problems. In some cases, introduction into the diet or increasing the consumption rate of the marine fish could fulfil the necessary amounts of nutrients consumed and significantly decrease the cases of micronutrient deficiencies among the population [1–3]. Adequate micronutrients intake is especially crucial for a population living in Arctic countries, in which harsh climatic conditions demand higher recourses from the human organism for normal functioning.

Considering the mentioned above, fish is a substantial nutritional source for both developing and wealthy countries. According to Obiero et. al. [4] the Arctic region is one of the most fish-dependent parts of the world with the dominance of fish dependence in Nordic countries and Russia.

Fish is also a significant source of income for budgets of seashore countries. Its export constitutes relatively large shares of the GDP for some Arctic countries. Northeast Atlantic is one of the most important fishing areas within the Arctic with a share of about 10% of global fish catches. The Barents Sea is the dominant fishing areas in the Northeast Atlantic region being one of the most productive seas worldwide. Three countries: Norway, Iceland and Russia share 50% of total annual seafood catches in the Northeast Atlantic region [5].

Anthropogenic pollution can significantly affect the aquatic ecosystem. This leads to a shrinkage of seafood production all over the world. However, in the Arctic, this impact is pronounced much more significant due to the harsh local conditions, limited biodiversity, and relatively short food webs, making the Arctic ecosystem strongly susceptible to anthropogenic impact [6]. Since fishery is an important source of food and wealth of Arctic countries the shrinkage of fishing rates caused by anthropogenic pollution of water and seashore territories can lead to a significant negative effect on the health and well-being of the Arctic countries' population and GDP.

The anthropogenic pollution of the seashore is a widespread global problem. Different sources of pollution, as well as different pollutants, can affect the aquatic ecosystem by various pathways. The major contaminants of seashore environment are different organic and inorganic pollutants which rich the seashore by the drain of plants and factories directly or with wastewater to the fresh- or marine water, accidental spills of pollutants, with domestic wastewaters etc. The list of these pollutants is quite large. However, much attention is focused on the most emerging ones such as pesticides and agrochemicals, wastewater bacteria, toxic and radioactive elements, oils and other emerging organic compounds such as PCB, PAH, dioxins etc. All of these pollutants can penetrate the Arctic food web which causes severe damage to the aquatic organisms starting with the bottom levels of phyto- and zooplankton and ending up with the apex predators such as Cod, polar bear and human. The accumulation and magnification of the pollutants in aquatic or-

[1] Fisheries and aquaculture – enabling a vital sector to contribute more. URL: http://www.fao.org/news/story/en/item/150839/icode/ (accessed 01 June 2021).

ganisms affect their biodiversity, numbers and reproductivity [7]. These pollutants have been studied for decades and their serious threat to the marine and freshwater environment has been well studied and proven.

Plastic pollution of seashore and aquatic ecosystem on the other hand became a major environmental problem in the late 1990s, where plastic pollution was considered as a major threat for aquatic ecosystem and more studies were conducted on the effect of plastic pollution on the marine environment and the health of marine ecosystems [8]. In recent years in plastic pollution studies, a new "branch" was formed – assessments of negative effects of so-called microplastics (MP) (plastic particles less than 5 mm in diameter) on the environment. In the present analytical report, the effect of plastic pollution on the seashore ecosystem of Arctic seas will be discussed.

## *Discussion*

### *Recent studies on the concentration of plastic pollution of Arctic seashore surface waters and ecosystem*

Plastic litter and MP enter the Arctic seas by several pathways. Ocean currents transfer the plastics from more industrial developed regions where plastic production, consumption and, as a result, pollution is much more widespread, to the less anthropogenically developed and populated Arctic region. Plastic pollution from the local pollution sources specifically fisheries is also one of the main causes of plastic pollution in the Arctic. Also, the atmospheric transfer has recently been found as a source of MP in the Arctic, where it is fallout from the atmosphere and accumulates both in surface water and in sediments [9].

The impact on the aquatic ecosystems by plastic pollution can be roughly estimated by the analysis of plastic particles and fragments, including MPs in the surface water and sediment samples. In the research [10] authors claimed that the Arctic Ocean is “the dead-end” for floating plastic. They characterized the Northeaster Atlantic sector of the Arctic Ocean as the most pollutant by MP zone of the Arctic Ocean with the predominance of the plastic pollution of Barents and Greenland seas where 95% of all Arctic Ocean plastic is concentrated. The concentration of plastic in the European part of the Arctic in Northeast Atlantic and Arctic oceans is relatively high and found to be at the same level of magnitude as for more economically developed southern parts of the Atlantic Ocean. The research conducted in the off-shore of the Greenland Sea showed a high abundance of MP in the water samples with its presence in almost all samples treated. The mean value of MP particle in this sector of the Arctic was found to be 2.4 ± 0.8 items/m$^3$ [11]. In the part of the Barents Sea in south and southwest of Svalbard 0.34 ± 0.31 and 2.68 ± 2.95 items/m$^3$ were found in surface and subsurface water (at a 6 m depth) respectively. The MP particles were found in more than 90% of the studied samples [12]. In the Russian part of the Arctic Ocean basin in Barents, White and Kara seas the average concentration of MP in surface water was found to be 0.62 (0.19–6.42) items/m$^3$ [13]. The concentration of MP in these regions of Arctic Ocean is at the same levels of magnitude for MP concentration worldwide [14]. The fact that in almost all studied samples MP particles were found means that MP pollution of the region became a real environmental problem which can affect the aquatic ecosystem.

### *Mechanism of the negative impact of microplastic on biological resources*

The negative effects of MP on aquatic organisms are described in the literature by different mechanisms. First is the straight effect of MP ingestion and physical damage of the organism or its normal functioning. In these case, the ingestion of MP leads to the blockage of the gastrointestinal or respiratory tract of aquatic organisms which lead to its death [15]. Alternative mechanisms of MP impact were also investigated. In research [16] authors found the MP-induced reduction of food intake. The study conducted on common goby fish species showed that it consumes more polyethylene microspheres used in the study as an MP than the real prey (artemia) which could lead to a decreased individual and population fitness. It also reported that the chronic MP exposure led to a significantly decreased growth and reproduction of *Hyalella Azteca* fish species [17]. All of these effects could negatively effect on the aquatic ecosystem population, which could lead to a shortage of bioresources in the Arctic Ocean.

The other mechanism of the negative impact of MP on the marine environment is the sorption of pollutants on the surface of the MP and their further release, while swallowed in the living organism. Recent studies showed the ability of MPs to accumulate persistent organic pollutants (POPs), endocrine disrupting compounds, toxic elements, antibiotics and pesticides. In this case, there is a chance of Adverse effects of both MP and pollutant which is absorbed by MP. This could cause a variety of negative effects, depending on the type of contaminant absorbed on the surface and its concentration. A number of studies on the effect of POPs by MP reported genotoxic and reproductive effects of such combined pollutant [18].

However, there is no evidence of significant exposure of the aquatic organisms to MP and its effects on population and biodiversity in the wildlife. Thus, there is an urgent need for conducting more researches in this field.

### *Concentration of MP found in bioresources of Arctic seas*

There is still a lack of information about the amounts of plastic debris consumed or incorporated in the aquatic organisms in the Arctic region. The review manuscript, published by Collard and Ask in 2021 [19] showed, that together with limited data on the MP content in marine animals there is also a non-standardised approach to analyse microplastic in the marine environment. This non-standardised approach is reflected in significantly different methodologies for sample collection and treatment and also different thresholds of MP’s dimensions which strictly affect the amount and types of microplastics possible to be determined in each study.

Within the available data on the amount of microplastic in marine fish, the concentration of MP in commercial fish species mostly Cod caught in Northern Atlantic and Arctic oceans the frequency of microplastic identification varies significantly from 0 to 100% within the studies. The average identification frequency is around 15% [19].

Another organism that represents the pollution of the Arctic ecosystem with MP is seabirds. The most repetitive bird species is Fulmar. The most data for the analysis of seabirds on the concentration of microplastic in their organisms published in scientific journals done in Canada and Alaska. There is a lack of data for European and especially Russian Arctic seabirds. Totally within studied Fulmars for MP ingestions the frequency of MP occurrence was more than 40% [19].

## *Conclusions and recommendations*

The lack of data both from the analysis of negative effects of MP on the aquatic ecosystem, and fragmentary studies on the concentration of MP in water and marine organisms together with non-standardised protocols of the analysis and sample treatment shows the weakness for the estimation of the anthropogenic impact on the Arctic marine ecosystem from the plastic pollution. The laboratory studies clearly showed the negative impacts on the marine animals from plastic ingestion and synergistic effects from both MP and POPs absorbed on its surface. However, no real-world studies were conducted, and no estimations have been calculated to predict the effect of MP pollution on the ecosystem. This is an urgent task, which needs to be done for the prediction of the negative effects and decreasing of these effects on the marine environment through governmental controls and taxes.

These studies can not be produced by researchers from only one scientific field and should be conducted in the collaboration of environmental scientists, oceanologists, biologists, economists, politicians etc. Based on the above-mentioned problems the recommendations could be provided for all of the parties who would or already participating in this field.

- For clear and precise calculation of the MP pollution standardized and easy to use and implement in practice protocols should be developed;
- The laboratories participating in these studies should conduct the intralaboratory control to estimate the trueness and reproducibility of the results obtained by the standardized protocol;
- The predicting of plastic debris transfer and accumulation sites need to be done through the collaboration between environmental scientists and oceanologist to find the “hot spots” of plastic pollution in the Arctic;
- The in-vitro and in-vivo studies of negative impacts of microplastic ingestion by marine biota need to be conducted to evaluate risks for health and reproduction;
- Based on the risk assessment results the economical consequences caused by microplastic pollution need to be calculated for establishing the taxes and fines related to the production, utilization and emission of macro- and microplastics;

- The programmes of environmental education for citizens and companies need to be performed;
- The citizen science environmental programs need to be supported for both environmental education and reducing the costs of professional science programs in the parts of sample collection and finding of plastic pollution hot spots.

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