





## Introduction to the Supplement: 'Influence of ecosystem changes on harvestable resources at high latitudes'

### Introduction

# Influence of ecosystem changes on harvestable resources at high latitudes

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Results from investigations of the Barents Sea environment and biological resources were presented at a Russian–Norwegian Symposium in Murmansk, Russia on 5–7 June 2018. The thematic focus of the symposium was "Influence of ecosystem changes on harvestable resources at high latitudes". Contributions to the symposium were organized under five theme sessions: oceanography, plankton, benthos, fishes, and top predators. From the rich spectrum of symposium contributions, five articles appear in this supplemental issue.

**Keywords:** Barents Sea, climate change, ecosystem changes, harvestable marine resources, sea ice extent

Warming in the Arctic and in the Barents Sea has been continuing since the mid-1970s (e.g. [Lind and Ingvaldsen, 2012](#)), with an observed sharp temperature increase in the northern Barents Sea in the mid-2000s linked to declining sea ice import and, hence, weakened vertical stratification ([Lind et al., 2018](#)). During this period, considerable changes have been observed in the Barents Sea ecosystem both in environmental conditions and in organisms such as zooplankton and fish, with boreal species expanding northwards. Boreal zooplankton has expanded, whereas Arctic zooplankton has retreated further north (see e.g. [Eriksen et al., 2017](#)). Not surprisingly, this has led to changes in spatial distribution of demersal fish communities, with boreal communities expanding northwards with associated food web shifts ([Fossheim et al., 2015](#); [Kortsch et al., 2015](#); [Frainer et al., 2017](#)). Invasion of the boreal demersal fish species into the northern area has resulted in increased

predation pressure on forage fish stocks and on the Arctic benthic fish community that has retracted north- and northeastwards to areas bordering the deep polar basin ([Fossheim et al., 2015](#)). Some key endemic marine mammals have adapted to life at high latitudes and spend most of their life in the region. Other species migrate into northern waters to take advantage of high summer productivity and, hence, feeding opportunities, but spend the rest of the year in their largely temperate distributional ranges ([Haug et al., 2017](#); [Moore et al. 2019](#)). Following the receding sea ice, the current northward expansion by large boreal fish predator species (e.g. cod—*Gadus morhua*) will likely cause competition with sea mammals seasonally in the area, and a restructuring of the food web ([Bogstad et al., 2015](#); [Blanchet et al., 2019](#)).

This period of ocean warming and ice retreat permits analyses of changes in animal populations at different trophic levels.

In this context, results from investigations of the Barents Sea environment and biological resources were presented at the traditional Russian–Norwegian Symposium held at the Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in Murmansk, Russia, on 5–7 June 2018. The symposium was organized by PINRO and the Institute of Marine Research (IMR, Norway) with the assistance of the Fishing Industry Union of the North (Russia). The theme of the symposium attracted delegates from scientific institutions (including also other than PINRO and IMR), fisheries managers, and representatives of the fishing industry. The thematic focus of the symposium was “Influence of ecosystem changes on harvestable resources at high latitudes”.

Contributions to the symposium were organized under five theme sessions. Results from investigations of Barents Sea oceanography were presented at session 1, and presentations on impact of environmental changes on separate species and communities of plankton, benthos, fishes, and sea birds/marine mammals were presented in sessions 2–5, respectively. The symposium gave participating scientists a good opportunity to address questions related to how observed changes in the ecosystem influence biological harvestable resources in the area. In general, it was confirmed that increased water temperature resulted in increased abundance and extended northward distribution of boreal organisms (especially fish and marine mammals), while abundance and distribution area of Arctic species decreased. These changes are important for the biological state of marine harvestable resources, interspecific relations in the Barents Sea ecosystem, and national fisheries.

From the rich spectrum of symposium contributions (see symposium proceedings in the [Supplemental material](#)), five articles were selected for publication in this supplemental issue of the *ICES Journal of Marine Science*. The studies presented range from oceanographic frontal zones to seaweeds and zooplankton and up to seals and whales.

The supplemental issue begins with an article in which [Ivshin et al. \(2019\)](#) present and discuss research on the interannual variability in the Barents Sea thermal frontal zones as observed at 50-m depth in August–September over the period of 1960–2017. This contribution is followed by an article by [Prokopchuk and Trofimov \(2019\)](#) focusing on the analysis of interannual variability of zooplankton in the standard oceanographic section “the Kola meridian” in the Barents Sea in the most recent period of warming in the Arctic. The zooplankton community was investigated based on the analysis of 240 plankton samples, collected in late May–early June in 2009–2017. The next article ([Stige et al., 2019](#)) elucidates how reductions in Arctic sea ice may affect marine food webs. Direct, indirect, and delayed associations between winter sea ice cover and year-to-year changes in biomasses of the main zooplankton groups (copepods, krill, amphipods) and planktivorous fishes (capelin, polar cod) were analysed in the central and northern Barents Sea from 1980 to 2015. Climate effects and species interactions were estimated jointly in a Bayesian state-space model framework. A completely different theme is presented in [Malavenda et al. \(2019\)](#) where a combination of field and laboratory studies of the mutual influence of the dominant macroalgae species inhabiting the intertidal zone of the Murman Coast in Russia is presented. Particularly, an assumed negative effect of the species *Palmaria palmata* on the growth of *Fucus* algae species was tested. In the fifth and final article, [Blanchet et al. \(2019\)](#) present a study of the role of marine mammals in the Barents Sea food web. Food web characteristics are compared both within and between phylogenetic groups for 19

selected marine mammal species, and the authors conclude that climatic warming is likely to bring about extensive changes in the food web structure through a redistribution of these species.

## Supplementary data

[Supplementary material](#) is available at the *ICESJMS* online version of the manuscript.

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