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Predicting future ecosystem scenarios for the Labrador Sea and the Norwegian/Barents seas: some results from the NORCAN study

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Summary

Results from the Norway-Canada Comparison of Marine Ecosystems (NORCAN) project are used together with previous publications to develop possible future ecosystem scenarios in the Labrador Sea and the Norwegian/Barents seas under climate change. Changes in the physical environments are described based on results from Atmospheric-Ocean Global Circulation Models (AOGCMs) and regional downscaled models. Possible effects of these physical changes on the ecology of the two regions are highlighted. Results indicate strong spatial differences in these responses both within and between the regions depending upon the primary dynamical processes that are in play.

Introduction

The Norway-Canada Comparisons of Marine Ecosystem (NORCAN) project undertook comparative studies of the physical and biological environments in the Labrador Sea region in the Northwest Atlantic and the Norwegian and Barents seas region in the Northeast Atlantic (Drinkwater and Pepin, 2013). Several of these studies, considered the possible impacts of future climate change on different components on the ecosystem in the two regions. In this study we combined the NORCAN results with those of previous published results to provide a general synthesis to date of the possible changes under anthropogenic climate change in both the NE and NW Atlantic.

Results and Discussion

Under anthropogenic climate change, sea surface temperatures are expected to increase by 3-6°C in the Barents/Norwegian seas but show large spatial variability in the Labrador Sea with the southwestern sector cooling while the rest of the region warms. A 40% reduction in sea-ice area is expected in the Barents Sea by 2050 (Overland and Wang, 2007) while reduced ice is expected on the Labrador/Newfoundland shelves (Harrison et al., 2013). Melting of sea ice and the Greenland ice cap plus increased river runoff are expected to decrease near-surface salinities in the Nordic and Labrador seas. This will be counterbalanced by increased salinities in the Atlantic inflow due to increased evaporation in its source region of the tropics. Mixed Layer Depth (MLD) will likely decrease in both the NE and NW Atlantic because of increased vertical stratification through solar heating in the south and increased freshwater input in the north.

Phytoplankton production in the Barents Sea is expected to increase due to reduced ice causing increased light levels and a longer production season but in the Norwegian Sea it will likely decrease because of increased thermal stratification limiting nutrient concentrations (Harrison et al., 2013). In the Labrador Sea, primary production may be limited through lack of nutrients where there is increased thermal stratification but may increase in areas where cooling is expected. Earlier blooms are expected to occur where ice retreat is earlier, but later blooms will occur in areas where stratification is reduced. *Calanus finmarchicus* are expected to develop more rapidly and reproduce earlier in those areas experiencing warming, which could lead to the production of a second generation during the summer (Head et al., 2013). Model projections indicate an approximate 20% increase in Atlantic zooplankton abundance in the Barents Sea but the larger *C. glacialis* may decrease by as much as 50% because of warming (Ellingsen et al., 2008).

In the Norwegian and Barents seas as well as in the warming areas of the Labrador Sea, higher growth rates and improved recruitment survival for fish species, such as cod and herring, are expected under the increasing temperatures associated with climate change (Cheung et al., 2009). Several commercial fish species are expected to expand their distribution northwards and, in the Barents Sea, also eastward (Drinkwater, 2005; Huse and Ellingsen, 2008). In the Labrador Sea, some distributional changes have been suggested by Cheung et al. (2008) but generally less extensive than in the Barents Sea. In recent years capelin in the Northwest Atlantic have extended their range northwards with increases into Hudson Bay and the Canadian Archipelago (Carscadden et al., 2013). Distributional shifts will also result in species invasions with relatively high numbers of invasions in the Labrador and Barents Sea compared to other regions of the world's oceans (Chueng et al., 2009). Spawning sites too are expected to shift northwards (Sundby and Nakken, 2008; Huse and Ellingsen, 2008).

References

Carscadden, J. E., Gjøsæter, H., Vilhjálmsson, H. 2013. A comparison of recent changes in distribution of capelin (*Mallotus villosus*) in the Barents Sea, around Iceland and in the Northwest Atlantic. Progress in Oceanography, 114: 64-83.

Cheung, W., Lam, V., Pauly, D. 2008. Modelling present and climate-shifted distribution of marine fishes and invertebrates. UBC Fisheries Centre Research Report 16 (3), 72 pp.

Cheung, W., Lam, V., Sarmiento, J., Kearney, K., Watson, R., Pauly, D. 2009. Projecting global marine biodiversity impacts under climate change scenarios. Fish and Fisheries, 10: 235-251.

Drinkwater, K.F. 2005. The response of Atlantic cod (*Gadus morhua*) to future climate change. ICES Journal of Marine Science, 62: 1327-1337.

Drinkwater, K.F. and P. Pepin (Eds.) 2013. Norway-Canada Comparisons of Marine Ecosystems (NORCAN). Progress in Oceanography, 114: 1-125.

Ellingsen, I.H., Dalpadado, P., Slagstad, D., Loeng, H. 2008. Impact of climatic change on the biological production in the Barents Sea. Climatic Change, 87: 155-175

Harrison, W. G., Børsheim, K.Y., Li, W.K.W., Maillet, G.L., Pepin, P., Sakshaug, E., Skogen, M.D., Yeats, P.A. 2013. Phytoplankton production and growth regulation in the subarctic North Atlantic: A comparative study of the Labrador Sea-Labrador/Newfoundland shelves and Barents/Norwegian/Greenland seas and shelves. Progress in Oceanography, 114: 26-45.

Head, E., Melle, W., Pepin, P., Bagøien, E., Broms, C. 2013. A comparative study of the ecology of *Calanus finmarchicus* in the Labrador and Norwegian seas. Progress in Oceanography, 114: 46-63.

Huse, G., Ellingsen, I. 2008. Capelin migrations and climate change – a modeling analysis. Climatic Change, 87: 177-197.

Overland, J.E., Wang, M. 2007. Future regional arctic sea ice declines. Geophysical Research Letters, 34, L17705, doi:10.1029/2007GL030808.

Sundby, S., Nakken, O. 2008. Spatial shifts in spawning habitats of Arcto-Norwegian cod related to multidecadal climate oscillations and climate change. ICES Journal of Marine Science, 65: 953–962.