# Zooplankton community variability on the Scotian Shelf, northwest Atlantic

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## Summary

Marine zooplankton populations and communities are influenced by changes in local environmental conditions and ocean circulation. To provide information on how interannual changes in the pelagic environment and larger scale changes in circulation influence zooplankton communities of the Scotian Shelf, in the Canadian northwest Atlantic, multivariate analyses were used to evaluate mesozooplankton species associations and large-scale spatial patterns in zooplankton communities at both the Scotian Shelf scale and the larger Atlantic Canadian shelf scale. Depth and temperature associations were dominant factors structuring Atlantic Canadian shelf communities. Scotian Shelf species groups could be categorized as dominant shelf species, warm shelf species, Arctic *Calanus* species, and warm and cold offshore species. The abundance of immigrant groups, Arctic *Calanus* and warm offshore species, were strongly correlated with variability in temperature, while dynamics of the dominant species were more complex. While there is substantial uncertainty about how conditions on the Scotian Shelf will change in the future, the influence of the subtropical gyre may become greater, and it is likely that temperature will increase, salinity will decrease, and stratification will increase. Information on large-scale zooplankton community patterns can provide insight into how species ranges and communities may change in the future.

## Introduction

Zooplankton communities play a major role in energy transfer through marine food webs and in the biogeochemical cycle, and they are influenced by climate-driven environmental changes. Here, we used environmental monitoring data to describe the spatial structure of mesozooplankton communities on the Scotian Shelf and at the broader scale of the Atlantic Canadian shelves, which include the Scotian Shelf (Figure 1). The Scotian Shelf, in the northwest Atlantic, is located in a transition zone dominated by subpolar waters but also influenced by subtropical waters, particularly on the western Scotian Shelf and at the shelf break. Both strong decadal-scale variability in this area and longer term changes in the subtropical gyre boundary, circulation, temperature and stratification are likely to influence zooplankton communities of the region. Since conditions on the Scotian Shelf are strongly influenced by the equatorward circulation of the Atlantic Canadian shelf system, consideration of the broader shelf system is critical to understanding

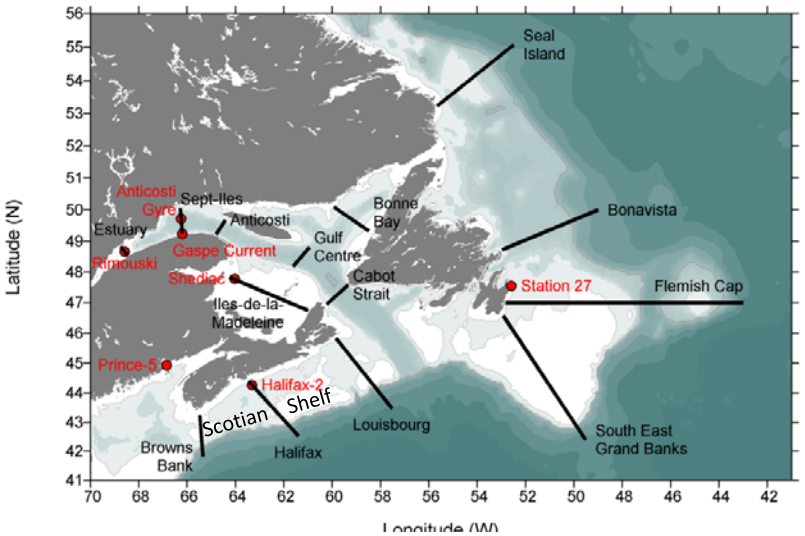


**Figure 1. Atlantic Zone Monitoring Program sampling locations. Red circles are fixed stations sampled 1-2 times per month, lines are transects sampled twice annually.**

interannual variability in Scotian Shelf zooplankton communities and how communities may change in response to future environmental change.

## Materials and Methods

Environmental and lower trophic level sampling was performed twice annually along transects and 1-2 times per month at fixed stations by the Atlantic Zone Monitoring Program (AZMP) since 1999 (Figure 1). Zooplankton were collected with 0.75 m diameter ring nets, equipped with 200 μm mesh, deployed vertically from near-bottom to surface. Copepod diversity was described using rank abundance plots and species accumulation curves. Northwest-Atlantic-scale community patterns in spring and fall were evaluated using Principal Components Analysis (PCA) on fourth-root-transformed zooplankton abundance data. Zooplankton communities were compared with water mass composition at Scotian Shelf AZMP stations using redundancy analysis (RDA).

## Results and Discussion

Mesozooplankton communities of the Atlantic Canadian shelves are dominated by relatively few species and also include subdominant and rare species. Dominant and subdominant species drove variability patterns along the first three principal components of the PCA. The first principal component identified the greatest variability associated with shallow- versus deep-water zooplankton species, while the second principal component was associated with warm-water versus cold-water species and possibly differences in seasonal production cycles. Spatial distributions of the first PC differentiated slope water and the deep Laurentian Channel from shelf waters, while the spatial distribution of the second PC differentiated the southwestern from northeastern regions, generally corresponding to the Scotian Shelf and Newfoundland Shelf. On the Scotian Shelf, redundancy analysis identified the strongest associations between water masses and immigrant communities, notably Arctic *Calanus* species and warm and cold offshore species.

Multivariate analyses of mesozooplankton community structure have made it possible to categorize Scotian Shelf species groups as dominant shelf species, warm shelf species, Arctic *Calanus* species, and warm and cold offshore species. Arctic *Calanus* and warm offshore species abundances had a strong negative correlation to one another and both had strong, contrasting relationships to variability in surface and bottom temperatures and cold intermediate layer (CIL) volume on the Scotian Shelf (Arctic *Calanus* abundance is high when temperatures are low and CIL volume is high) since 1999. Over the past five decades, average temperature and CIL volume have exhibited substantial variability (Hebert *et al.* 2013), with the warm temperatures and low CIL volume observed on the Scotian Shelf in recent years contrasting the cold temperature and high CIL volumes of the late 1980s and early 1990. In contrast to Arctic *Calanus* and warm offshore species, the relationships between the abundance of core shelf species and non-lagged environmental variability are not as strong, likely because core species are influenced more by species interactions, their particular life history traits, and their recent history on the shelf. For these species, a modeling approach will be required to evaluate how interactions among these factors shape population and community responses to environmental variability at an interannual scale.

## References

Hebert, D., Pettipas, R., Brickman, D., and Dever, M. 2013. Meteorological, sea ice and physical oceanographic conditions on the Scotian Shelf and in the Gulf of Maine during 2012. DFO Canadian Science Advisory Secretariat Research Document 2013/058. v + 46 p.