Seasonal and semi-decadal variations in mesozooplankton community composition in coastal Newfoundland waters

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INTRODUCTION

Background

- Zooplankton, and particularly copepods, are a key link in marine food webs, transferring energy from primary producers to higher trophic levels.
- Zooplankton abundance in the Northwest Atlantic is largely dominated by the small copepod taxa *Oithona* spp. and *Pseudocalanus* spp.
- Large, energy-rich copepods of the genus *Calanus* dominate zooplankton biomass in the North Atlantic[1]. They directly or indirectly support fish, sea bird, and marine mammal[4] populations and, as such, are associated with high ecosystem productivity[2,3,4].

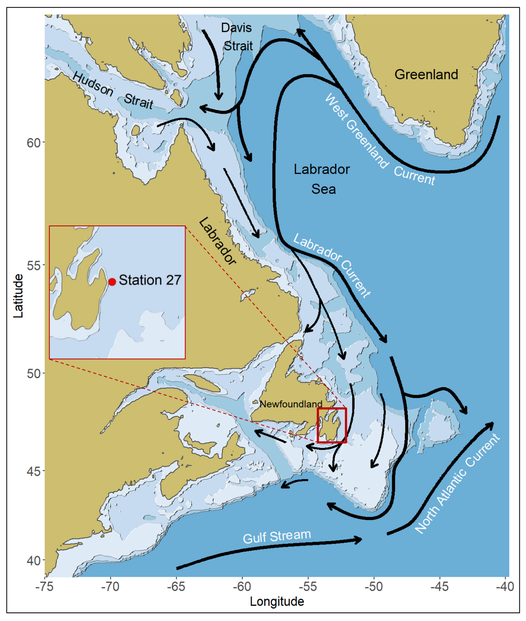

Figure 1. Bathymetry and general ocean circulation upstream and downstream of the study site: Station 27. Isobaths are drawn at 100, 300, and 1000 m depth contours.

Main objective

- Here, twenty years (2000-2019) of data collected by Atlantic Zone Monitoring Program (AZMP) at a coastal monitoring site are used to characterize seasonal and semi-decadal variations in zooplankton assemblages and associated effect on total abundance, biomass and community size structure.

METHODS

Sampling

- Full water column (165 m to surface) vertical net tows were carried out at Station 27 on average two to four times per month from March through November from 2000 to 2019 using a 200-µm mesh net fitted to a 75-cm diameter metal ring[5].

Statistical analysis

- PERMANOVA and SIMPER analyses based on Bray-Curtis dissimilarity matrix were carried out on monthly mean abundances (4th root transformed) of key taxonomic groupings (species, genus, order, class) to detect seasonal (spring=March-May, summer=June-August, fall=Sept-Nov) and semi-decadal variations in zooplankton community composition.
- Multi-level pairwise comparisons were used to detect differences in community composition at seasonal and semi-decadal time scales.

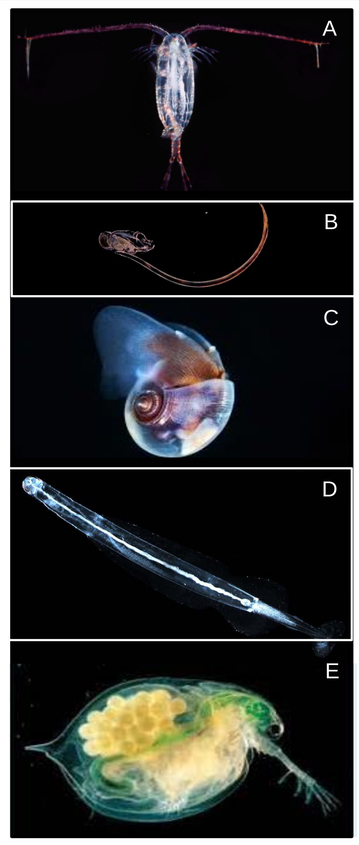

Figure 2. Main zooplankton taxa. A) Copepoda, B) Appendicularia, C) Pteropoda, D) Chaetognatha, E) Cladocera

RESULTS AND DISCUSSION

Community composition

- Zooplankton community dominated by *Oithona* spp. and *Pseudocalanus* spp. copepods year-round.
- General trend of higher abundances in the 2010s compared to the 2000s except for the large calanoid copepods *Calanus finmarchicus* and *C. glacialis.*

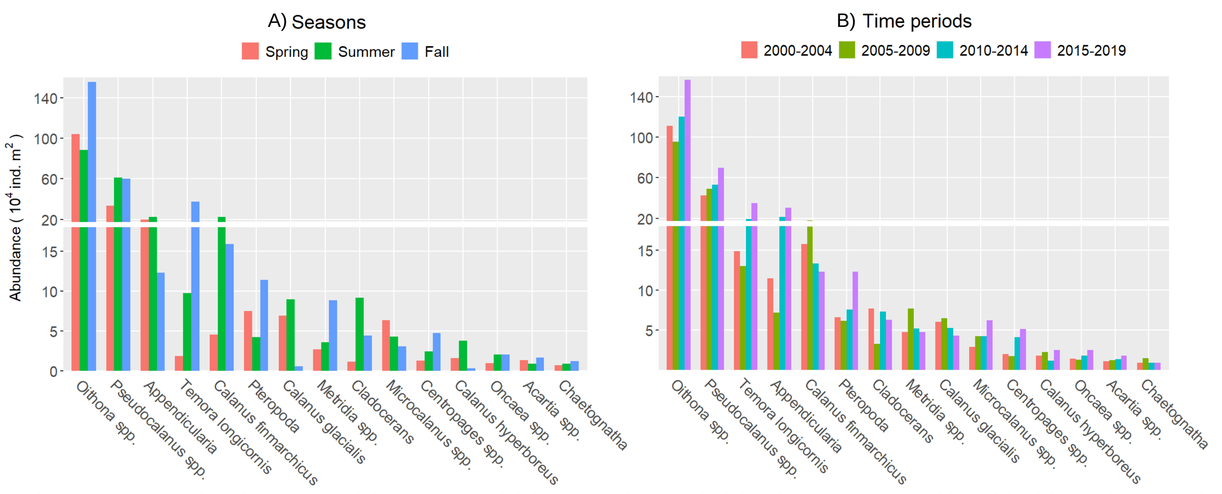

Figure 3. Mean abundances per (A) season and (B) 5-year time period for the 15 taxa considered in this study. Note the change in scaling halfway through the y-axis.

Seasonal and semi-decadal variability

Table 1. Summary of PERMANOVA analysis.

Source	df	MS	F	p
Season	3	0.594	34.676	<0.001
Period	2	0.129	7.507	<0.001
Season x Period	6	0.206	1.204	0.213
Residuals	169	0.017		
Total	180			

- Significant effect of factors Season and Time Period on zooplankton community composition. No interactive effect.
- Environmental variables temperature, salinity and chlorophyll-*a* concentration more associated to Seasonal than semi-decadal dissimilarity

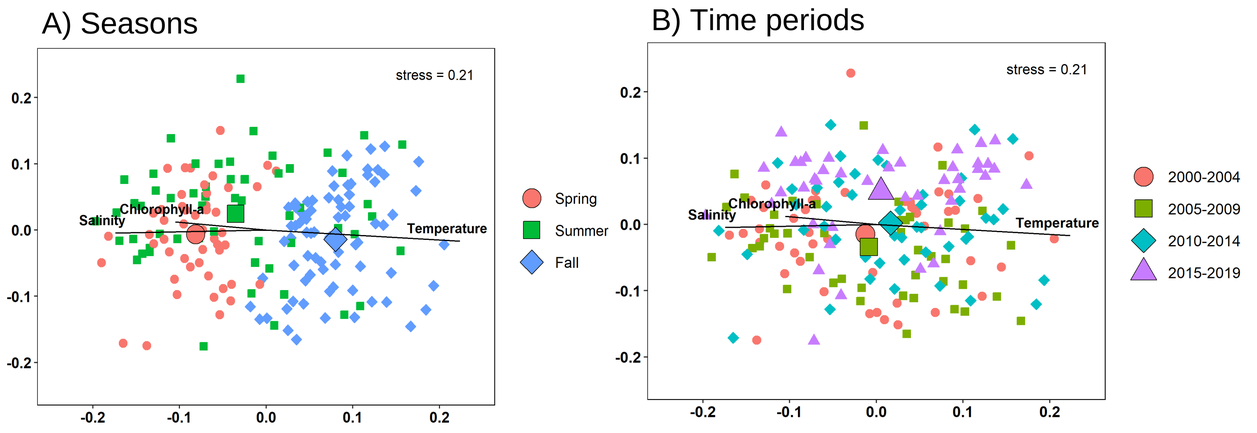

Figure 4. NMDS for (A) the seasonal and (B) semi-decadal dissimilarities in zooplankton community composition at Station 27. The length and angle of the vectors indicate the strength and direction of the significant correlations with environmental variables temperature, salinity, and chlorophyll-*a* concentration. Larger symbols indicate the centroid of each season and time period cluster.

Multiple pairwise comparisons

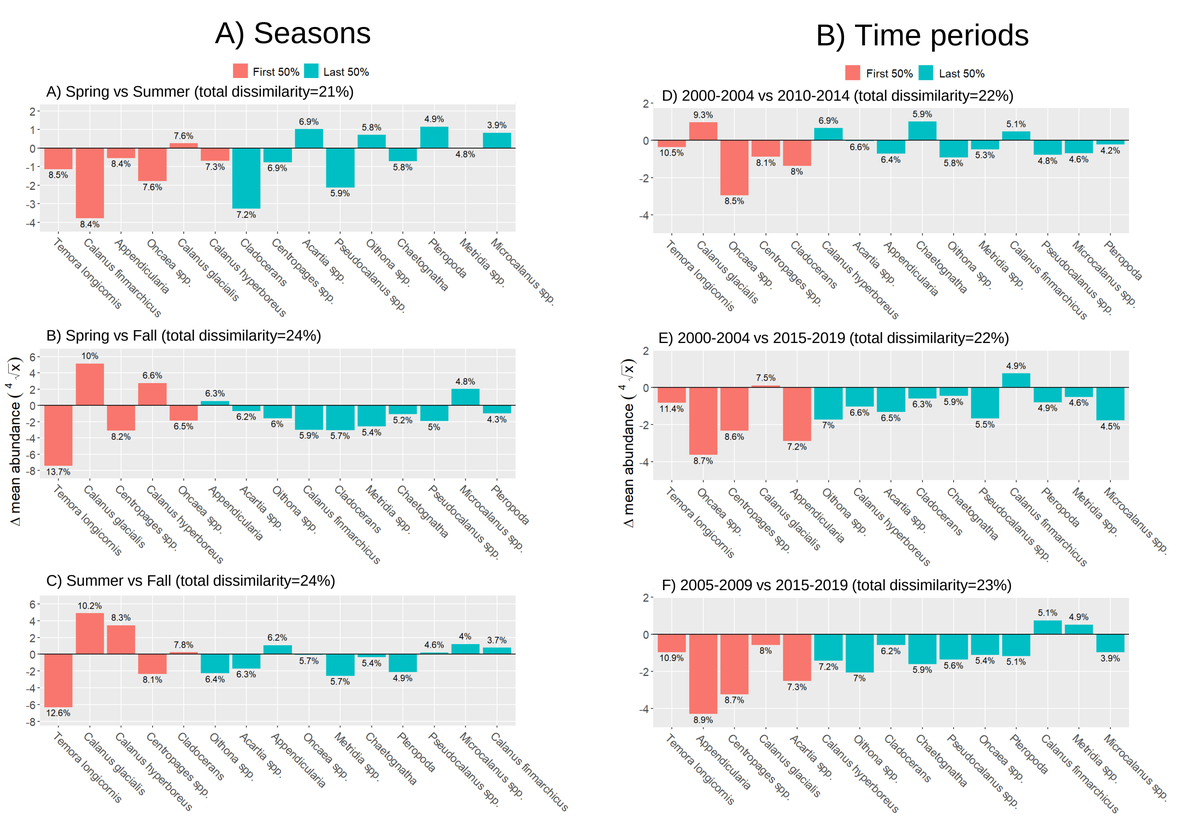

Figure 5. Summary of significant seasonal (A) and semi-decadal (B) pairwise comparisons in zooplankton assemblage dissimilarity at Station 27 based on the results of the SIMPER analysis. Positive (negative) values indicate higher (lower) abundances for the first compared to the second season or time period for each contrasted pairs. Red (green) bars indicate taxa responsible for the first (second) 50% of total dissimilarity. Percentages indicate the relative contribution of each taxa to the total dissimilarity between contrasted pairs.

Main findings

- Abundance is higher in summer and fall compared to spring for most taxa (Figs. 3A & 5A-C).
- Semi-decadal differences in community composition mostly driven by higher abundances during the 2010s compared to the 2000s except for the large *Calanus* copepods (Figs 3B & 5D-F).
- Changes in community composition over the past two decades resulted in a 40% increase in total zooplankton abundance along with a 20% decrease in the abundance of Calanus copepods and a 27% decrease in total zooplankton biomass between the 2000s and the 2010s (results for biomass not presented here).

Conclusion

- The zooplankton community size structure has shifted toward more smaller organisms and less large, energy rich *Calanus* copepods with potential negative impact on energy transfer to upper trophic levels and ecosystem productivity in Newfoundland coastal waters[6,7]

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Acknowledgements. We would like to thank all the personnel from DFO Northwest Atlantic Fisheries Center, Maurice-Lamontagne Institute, and Huntsman Atlantic Reference Center who have participated in the data collection, treatment and analysis as well as all officers and crew members of Canadian Coast Guard Ships and other opportunistic research vessels who assisted with oceanographic and multispecies surveys since the inception of the Atlantic Zone Monitoring Program in 1999.

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