Biomass size spectrum analysis in the Northumberland Strait

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Research Question

How do the ***slope*** and ***intercept*** of the zooplankton ***normalized biomass size spectrum*** change in relation to ***time***, ***space*** and ***water mass*** characteristics in the Northumberland Strait?

Null Hypotheses:

- $H_0$1 (***time***): Primary production and thus, the *biomass of small zooplankton* in the Strait will be *greater* in *late spring* (June/July) than in *autumn* (Aug./Sept.).
- $H_0$2 (***space***): The Strait waters are *uniform* and *well mixed*, with the *same ecological structure* throughout.
- $H_0$3 (***water mass***): There is *minimal connection* between *biological* processes or communities of the estuaries and those of the Strait.

Background

About the Northumberland Strait

- shallow, typically well-mixed habitat characterized by strong tidal current[1]
- influenced by freshwater inflow from several adjoining rivers and nutrient-rich estuaries[2]
- important economic region for generations (e.g. fisheries)
- characterized as data deficient; particularly regarding the role that zooplankton has on the function of the regional ecosystem

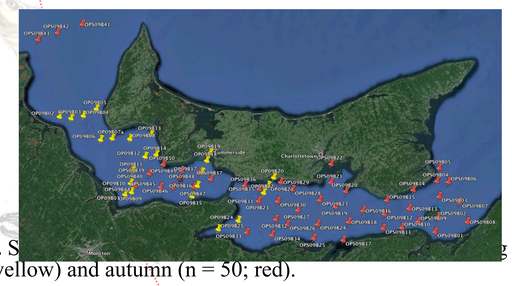


Figure 1. S… late spring (n = 25; yellow) and autumn (n = 50; red).

What is the normalized biomass size spectrum (NBSS)?

- statistical approach that classifies plankton on the basis of size with a theoretical basis in predator-prey dynamics[3,4]
- independent of any specified body size[5]
- can reveal processes not readily apparent using conventional taxonomic approaches[3,6,7]

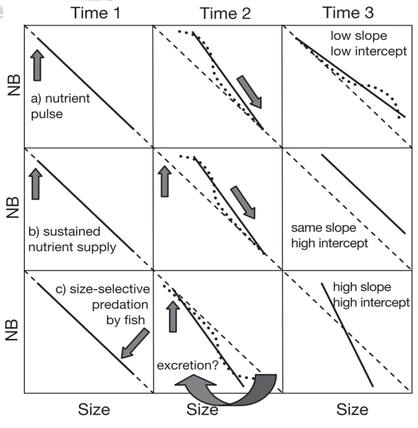


Figure 2. Example of three possible bottom-up and top-down processes altering the slope and intercept of the zooplankton NBSS during three time periods (from Suthers *et al.,* 2006)[7].

Preliminary Results

Example station

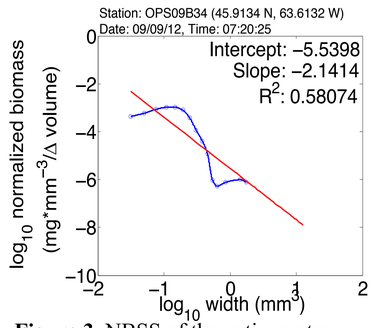


Figure 3. NBSS of the entire water column at station 34 during autumn.

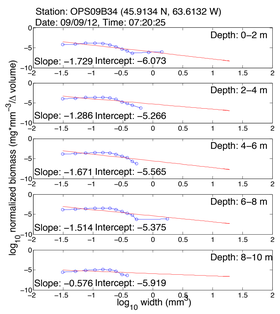


Figure 4. Depth binned NBSS at station 34 during autumn.

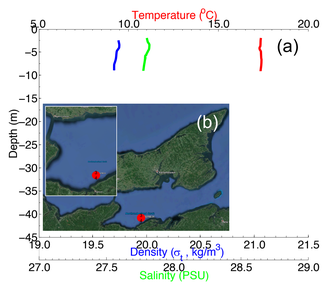


Figure 5. (a) Vertical temperature (° C), salinity (PSU) and density (σ_t, kg/m^3) profiles at station 34 during autumn. (b) Location of station 34 during autumn.

- linear fit does not appear to be representative of the biomass structure at the station
- significant difference between NBSS parameters at depth and from entire water column
- no vertical water mass structure

Behaviour of NBSS and oceanography <u>across</u> the Strait

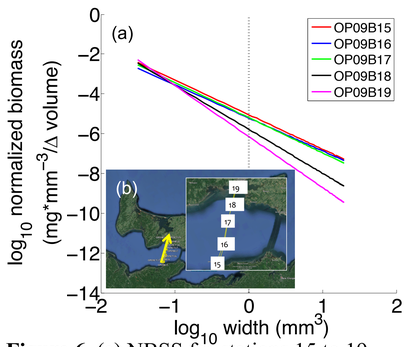


Figure 6. (a) NBSS for stations 15 to 19 during late spring. (b) Location of stations 15 to 19.

- slope and intercept decrease across the Strait (NB to PEI)
- no vertical water mass structure
- horizontal water mass structure
  - warmer, saltier near both coasts
  - high density core through middle of Strait

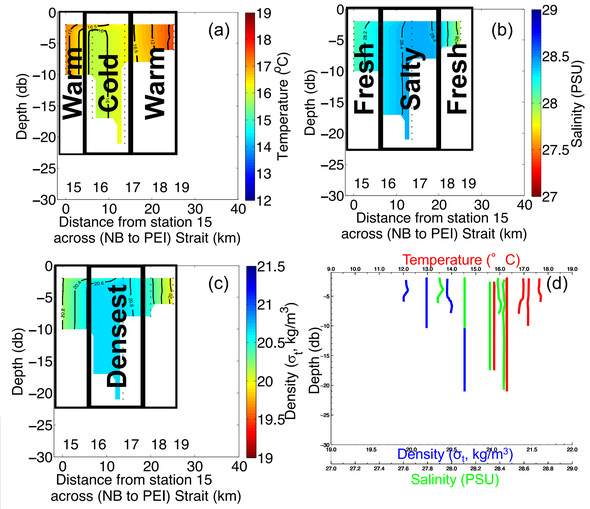
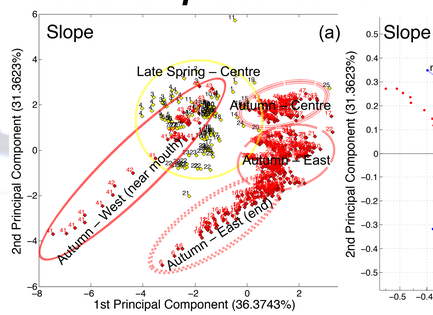


Figure 7. (a) Temperature (° C), (b) salinity (PSU) and density (σ_t, kg/m^3) across the Northumberland Strait (New Brunswick to Prince Edward Island; km) from station 15 to 19 during late spring. (d) Vertical temperature (° C), salinity (PSU) and density (σ_t, kg/m^3) profiles at stations 15 to 19 during late spring.

Relationship between environmental parameters and slope



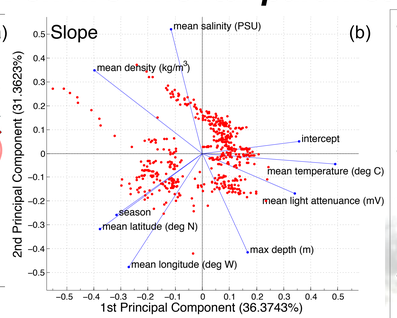


Figure 8. Results of principal component analysis for slope. Principal components 1 and 2 are plotted for the stations (a) and the environmental parameters (b).

- 1st component: 36.37%
  - temperature only "meaningful" (> |0.4|) loading
- 2nd component: 31.36%
  - interaction between salinity, max depth and longitude
- slopes grouped by oceanographic zones[8]
- similar patterns emerge for intercept

Methods

Sampling

- June/July (24) and Aug./Sept. 2009 (50)
- aboard the CCGS *Opilio*
- BIONESS (Bedford Institute of Oceanography Net and Environment Sensing System) equipped with:
  - 5-7 333 µm-mesh nets
  - conductivity, temperature & depth (CTD) sensor
  - 2 flowmeters
  - optical particle counter (OPC)
- vessel GPS
- profiling CTD

Figure 9. BIONESS. (photo credit: CT Taggart)

Data Processing

- in MATLAB

CTD

- downcast data
- averaged into 1 m depth bins
- data spikes removed

BIONESS

- 2-second average of all data
- calculates normalized biomass
- outputs slope and intercept of NBSS

Next Steps

- further statistical exploration of relationships between environmental parameters and NBSS parameters
- relate findings to energy transfer and community structure
- compare linear fit to polynomial fit
- compare NBSS from OPC and NBSS from net samples

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Acknowledgements

Thanks are extended to Dr. Christopher T. Taggart for his ongoing help and support, and to Dr. Iain M. Suthers (University of New South Wales) for his direction.

This research is part of the multi-institutional Northumberland Strait Ecosystem Research Initiative (NSERI). Funding for this project was provided by an NSERC-USRA in the Department of Oceanography at Dalhousie University and an NSERC Discovery Grant.

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