A comparison of zooplankton secondary production in a high nutrient low chlorophyll (HNLC) and seasonally productive regions in the North Pacific

Lian E. Kwong\textsuperscript{1}, Natalie Mahara\textsuperscript{1}, Evgeny A. Pakhomov\textsuperscript{1,2}

\textsuperscript{1}Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, Canada

\textsuperscript{2}Institute of Oceans and Fisheries, University of British Columbia, Vancouver, Canada
Importance of zooplankton
Production

• The amount of tissue or biomass generated in a certain area within a period of time (Rigler and Downing, 1984)

\[ \text{Production} = \text{Biomass} \times \text{Growth} \]

• Primary Production
• Secondary Production
Secondary (Zooplankton) Production

- Estimates of secondary (zooplankton) production are generally limited to certain species, groups or sizes of zooplankton
- Traditional methods: Ecological method, cohort method, physiological method, egg production method, empirical models, biochemical models
Chitobiase technique

• Direct measure of crustacean productivity in the water column by measuring crustacean moulting enzyme (chitobiase) decay – Dower lab (UVIC – Sastri, Suchy, et al.)

• Limitations:
  • Crustaceans only
  • Dead/decaying crustaceans may also release chitobiase
  • Does not include egg production
Biomass size spectra (BSS) (Sheldon et al. 1972)

The distribution of biomass by body size can be represented by a straight line of low, negative slope. Where, the intercept is indicative of system productivity and slope of transfer efficiency.
Edvardsen et al., 2002

• Measured BSS in a sub-artic Norwegian Fjord during 3 cruises separated by ~21 days
• Compare BSS measured using Laser Optic Particle Counter (LOPC) and net tows
• Look at changes in biomass size spectra through time to estimate growth and mortality rates for certain size classes/cohorts = secondary production
• Time series of BSS
Basedow et al. 2014

• Measure secondary production from the biomass size spectra of the Polar fronts in the Barents Sea using a CTD, Fluorometer, and LOPC.
• Estimated growth and mortality
• Point observations of BSS

\[ P_w = g \times w \times \frac{N}{dW} \text{(in mg C m}^{-3}\text{d}^{-1}) \]

Where weight specific growth (Zhou et al. 2010):
\[ g(w, T, C_a) = 0.033 \left[ \frac{C_a}{C_a + 205e^{-0.125T}} \right] e^{0.09T}w^{-0.06} \]

And weight specific mortality at time t:
\[ \mu(w, t) = gS \]

Convert biovolume size spectra to biomass size spectra
\[ mgC = 0.0475 \times \text{body volume} \]
(Calliene et al., 2001)

\[ C_a : \text{Chlr-a} = 50 \]
(Reigstad et al., 2008)

\[ P_w \] = production normalized by size bin (mgCm}^{-3}\text{day}^{-1}); \( w \) = weight (mgC/individual); \( g \) = weight specific growth rate (day}^{-1}); \( N \) = abundance of individuals; \( C_a \) = food concentration (mgC m}^{-3}); \( T \) = temperature °C; \( S \) = slope of size spectra; \( t \) = time
Can point observations of biomass size spectra be used to effectively quantify secondary production?

Compare secondary production in an HNLC and seasonally productive region?
Approach

• Construct biomass size spectra for the North Pacific using zooplankton net samples and multi-frequency acoustics to quantify secondary production

• Compare/calibrate the Chitobiase, Edvardsen et al., 2002, and Basedow et al., 2014 techniques for estimating secondary production during a 2 week study in Saanich Inlet, BC

• Comparison of secondary production between HNLC and seasonally productive regions in the North Pacific (1995-present)
Datasets

**Line P**
- 1995-present
- Oceanic/HNLC
- P04, P12, P20, P26

**La Perouse**
- 1995-present
- HNLC/Seasonally Productive stations
- Continental shelf/Oceanic stations
- CS01, CS07, LC04, LC09, LG02, LG09

**Saanich Inlet**
- 2016 (T. Venello)
- Seasonally productive
- S1, S3, S5
HNLC stations

Seasonally productive stations

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Preliminary results
Preliminary results

P04 – Seasonally productive
P26 – HNLC
Applications

• Food-web models (Cheung lab UBC)
• Implications for fisheries
• NSERC strategic grant linking satellite derived estimates of primary production to secondary production and fisheries productivity
• Modelling climate change scenarios
Limitations/considerations

- Point observations of size spectra
- Day/night variability
- Continuous biomass?
- Simplification of a complex system
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Questions?
Lian Kwong
lkwong@eoas.ubc.ca