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

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Importance of zooplankton

Production

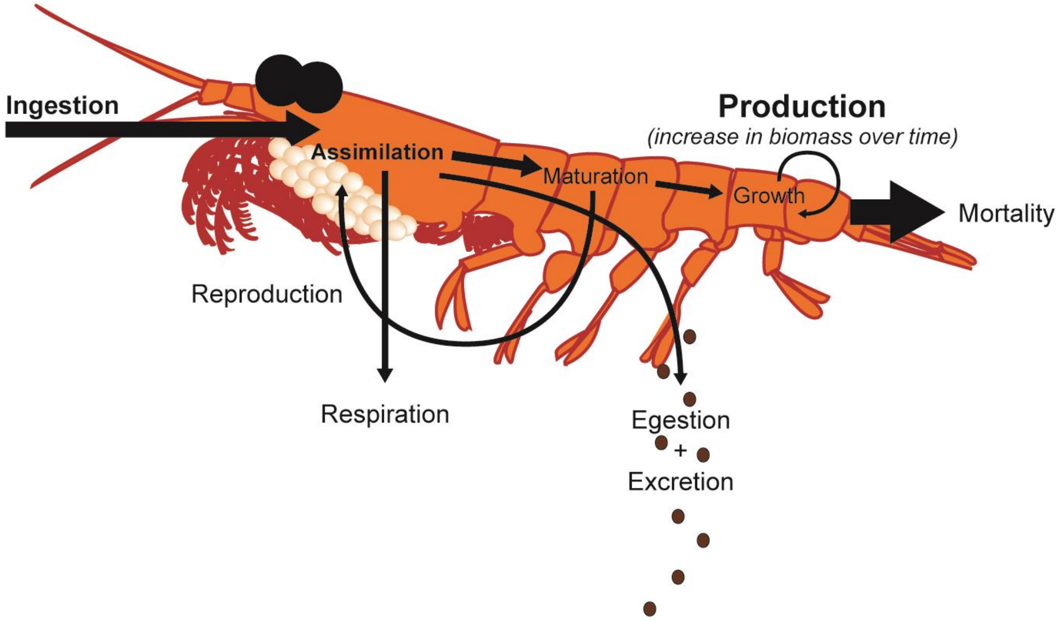
- The amount of tissue or biomass generated in a certain area within a period of time (*Rigler and Downing, 1984*)

*Production = Biomass * 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

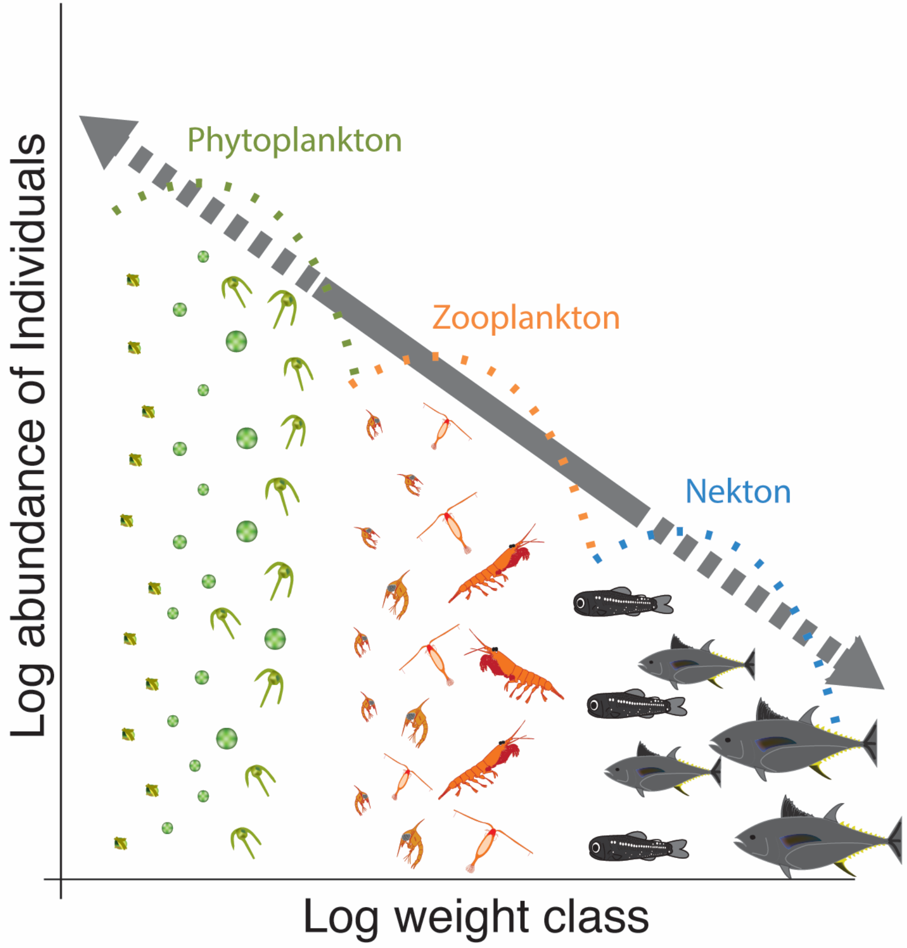
- Direct measure of crustacean productivity in the water column by measuring crustacean moulting enzyme (chitobiase) decay – *Dower lab (UVIC – Sastri, Suchy, et al.)*
- Limitations:
  - Crustaceans only
  - Dead/decaying crustaceans may also release chitobiase
  - Does not include egg production

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 **L**aser **O**ptic **P**article **C**ounter (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=production normalized by size bin (mgCm^{-3}day^{-1}); w = weight (mgC/individual); g = weight specific growth rate (day^{-1}); **N** = abundance of individuals; $\mathbf{C_a}$ = food concentration (mgC m^{-3}); T = temperature ºC; **S** = slope of size spectra; **t** = time

$$P_w = g * w * \frac{N}{dw} \, (in\, mg\, C\, m^{-3} d^{-1})$$

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:

$$\mu(w, t) = g\boldsymbol{S}$$

Convert biovolume size spectra to biomass size spectra

$$mgC = 0.0475 * body\ volume$$

(Calliene et al., 2001)

C_a:Chlr-a = 50

(Reigstad et al., 2008)

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

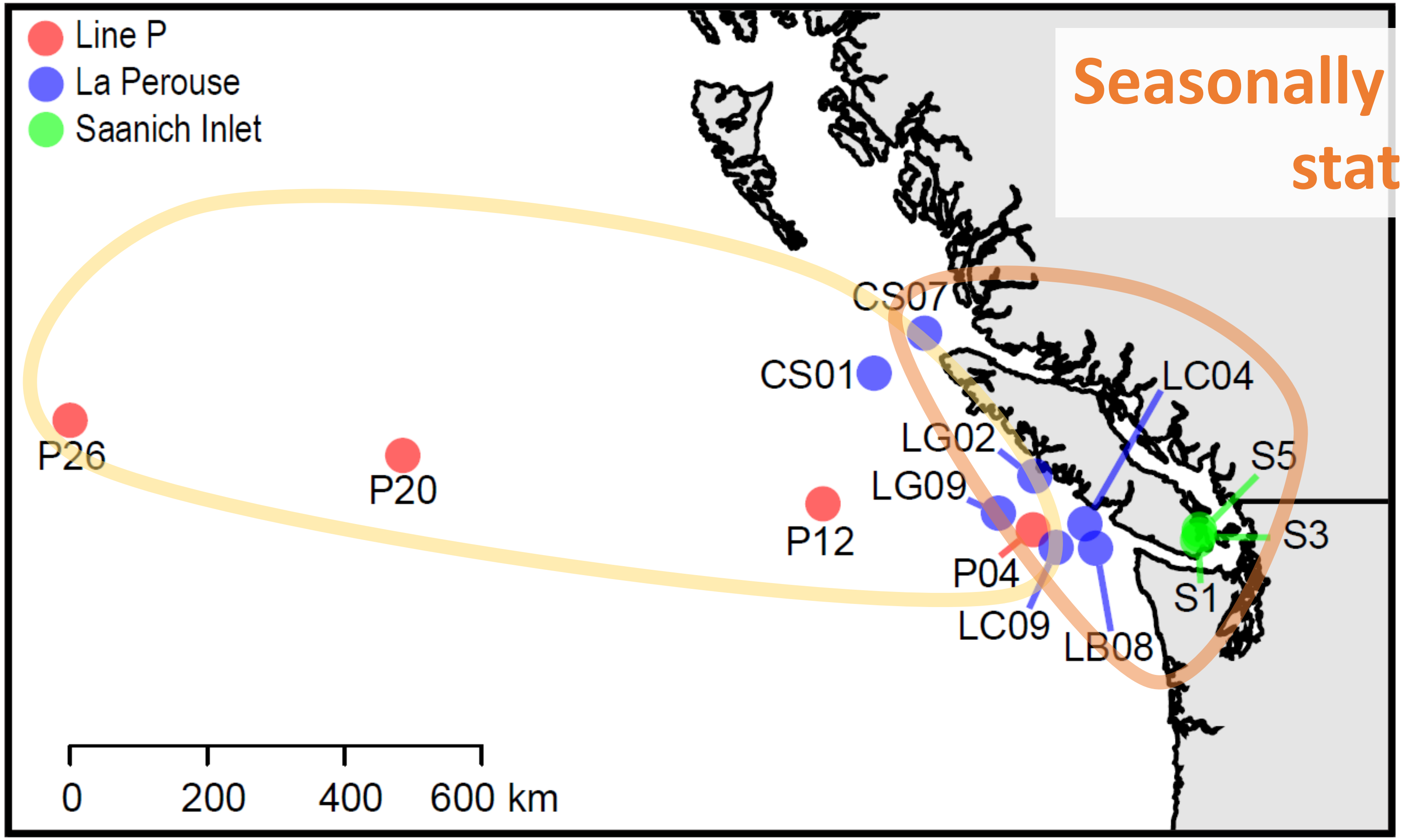
- 1995-present
- HNLC/Seasonally Productive stations
- Continental shelf/Oceanic stations
- CS01, CS07, LC04, LC09, LG02, LG09

Saanich Inlet

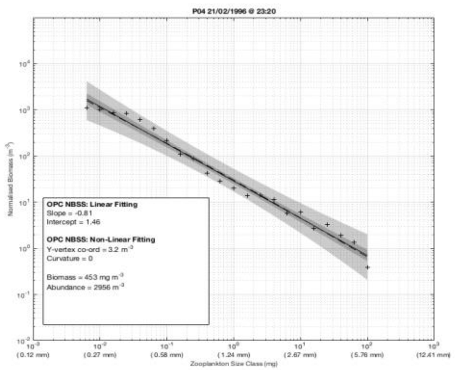
- 2016 (*T. Venello*)
- Seasonally productive
- S1, S3, S5

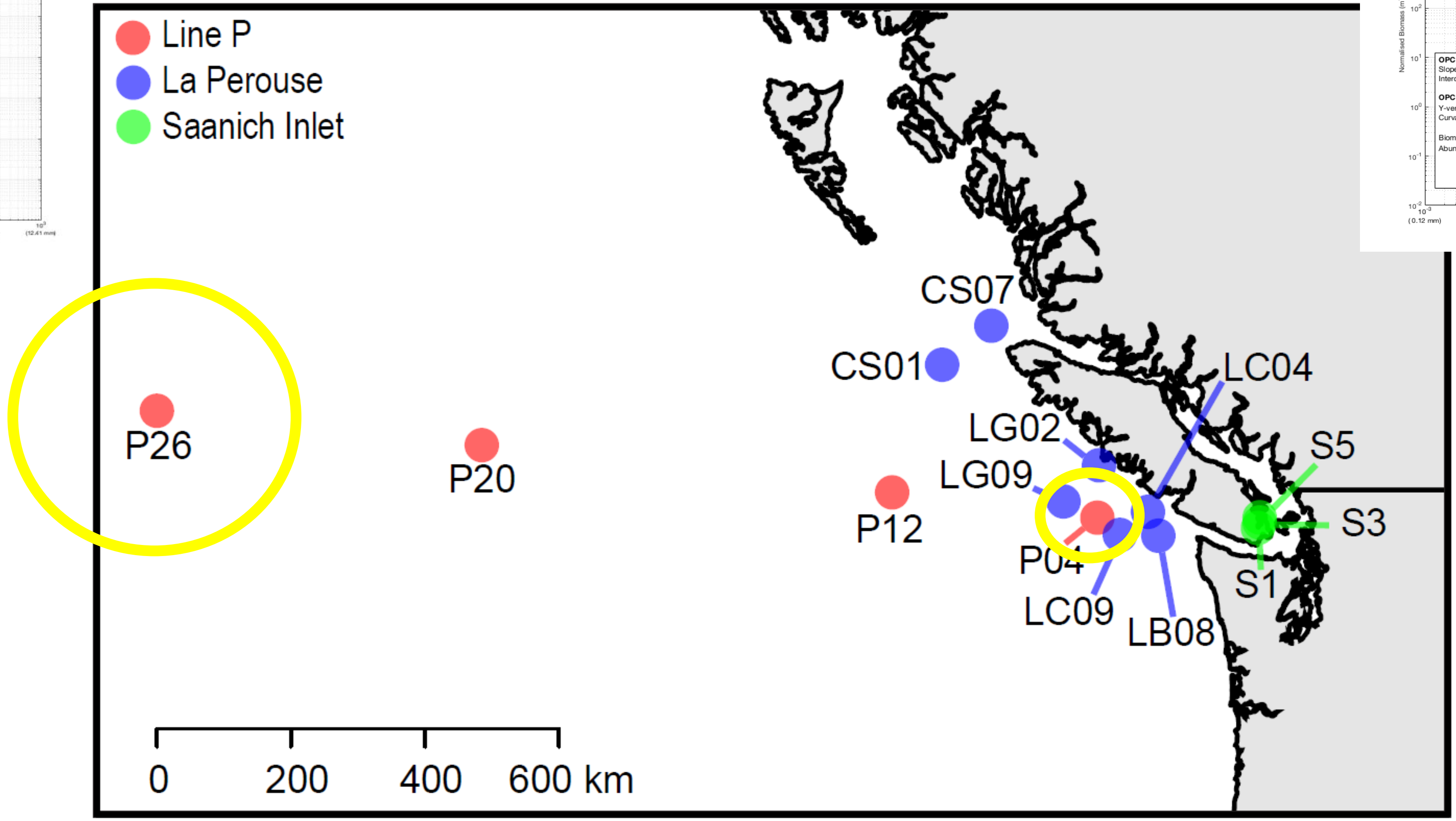
HNLC stations

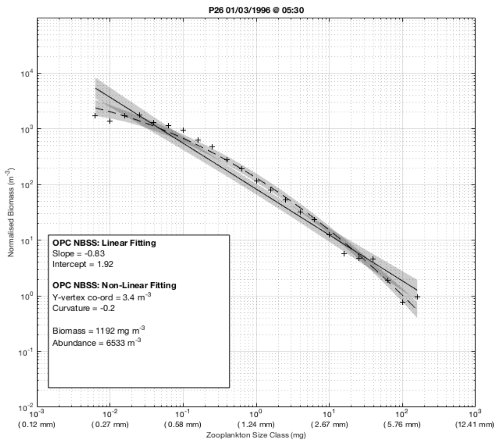
Seasonally productive stations



Preliminary results

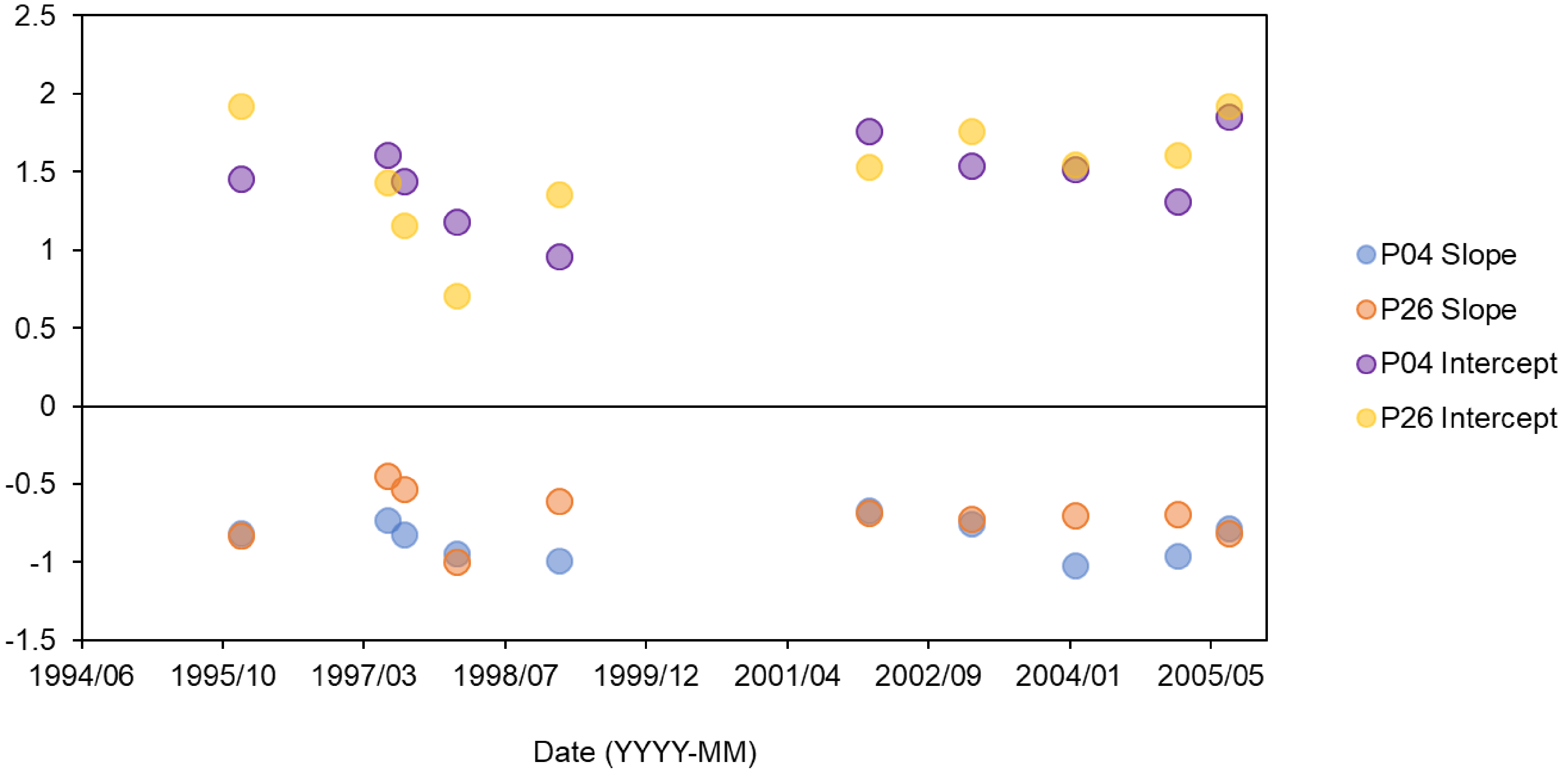


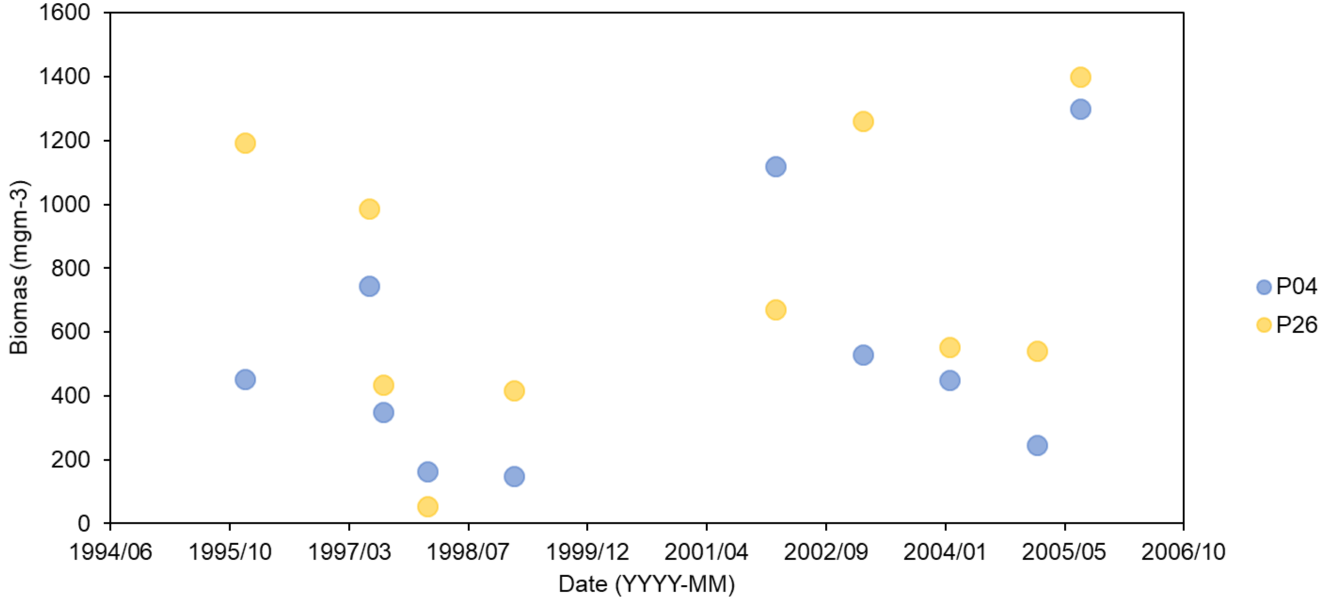




Preliminary results

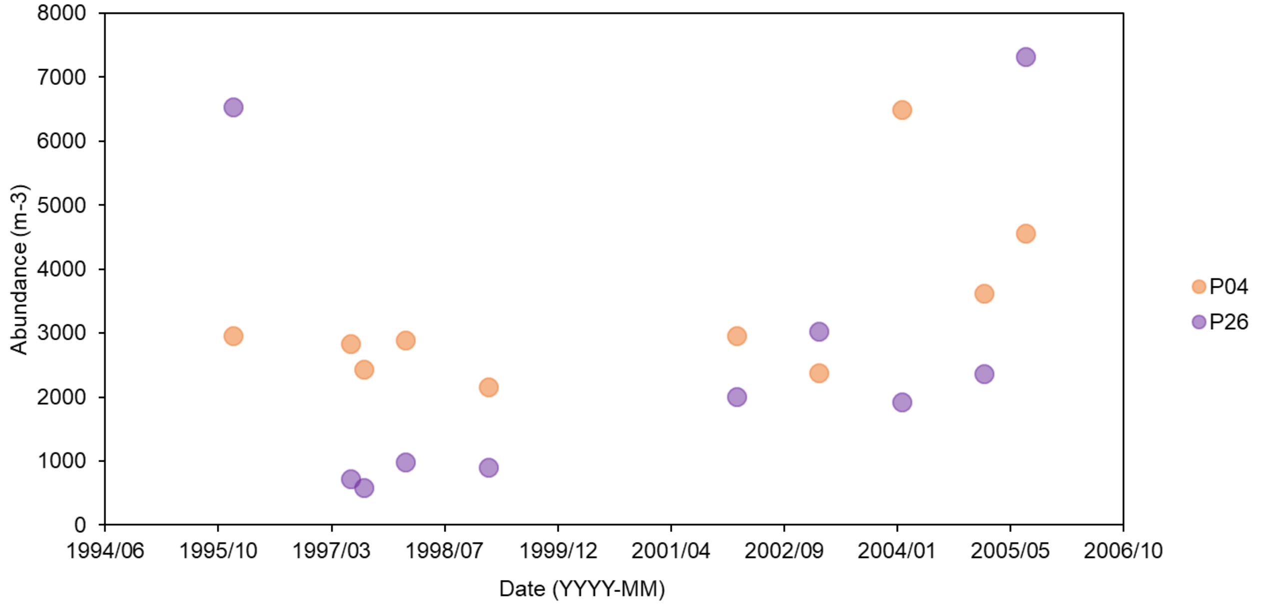
P04 – Seasonally productive
P26 – HNLC





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?

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