Depth and benthic drivers of nearshore zooplankton assemblages revealed using high-throughput imaging

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PELAGIC ECOSYSTEMS LABORATORY

UBC

PACIFIC SALMON FOUNDATION

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BC Conservation & Biodiversity Awards

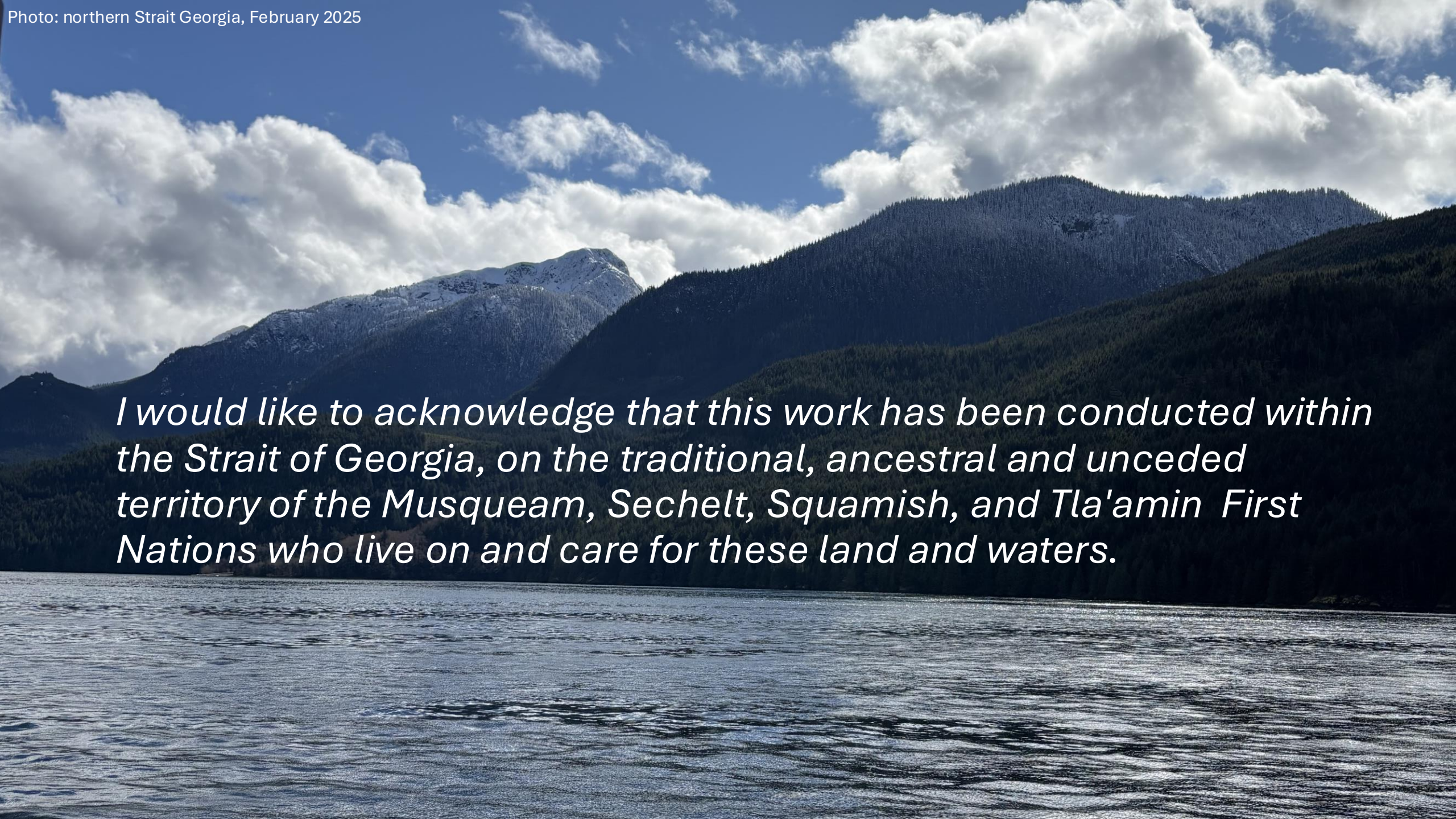
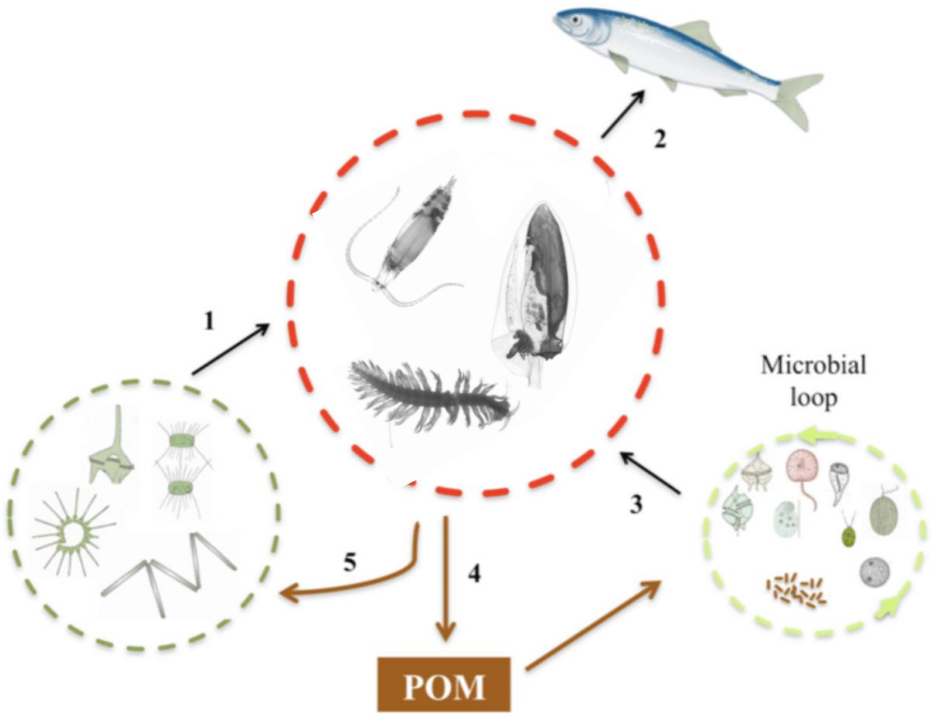


Photo: northern Strait Georgia, February 2025
I would like to acknowledge that this work has been conducted within the Strait of Georgia, on the traditional, ancestral and unceded territory of the Musqueam, Sechelt, Squamish, and Tla'amin First Nations who live on and care for these land and waters.

Zooplankton: delicious and nutritious



Modified from: Herrera, Inma. 2014. "The Use of AARS Activity as a Proxy for Zooplankton and Ichthyoplankton Growth Rates."

Crucial prey resource for multiple fish life stages

Anomalies in zooplankton dynamics impact forage fish survival

- ➢ This includes juvenile salmon! (Boldt et al. 2019, Mackas et al. 2013, Perry et al. 2021)

Large, lipid-rich zooplankton = faster growth and more energy storage (Beamish and Mahnken, 2001, Cushing, 1990, Duffy and Beauchamp, 2011)

Nearshore Zooplankton Assemblages

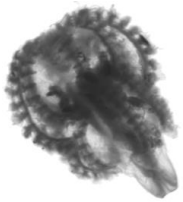
Distinct and highly variable (Barnett and Jahn 1987, Harrison et al. 1983)

Important habitat for many fish species, particularity forage fish such as juvenile salmon and herring (e.g., Duffy et al 2010, Schweigert et al 2013)

Experience closer proximity to terrestrial influences such as urbanization and industrialization.

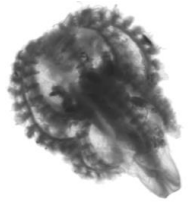
Despite this nearshore zooplankton resources have received little attention in the Strait of Georgia.

Research Aims



Use image analysis to characterize nearshore zooplankton assemblages

Research Aims



Use image analysis to characterize nearshore zooplankton assemblages

Explore depth and proximity to benthic systems as drivers of nearshore zooplankton assemblage structure

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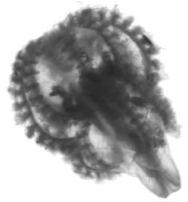


Use image analysis to characterize nearshore zooplankton assemblages

Explore depth and proximity to benthic systems as drivers of nearshore zooplankton assemblage structure

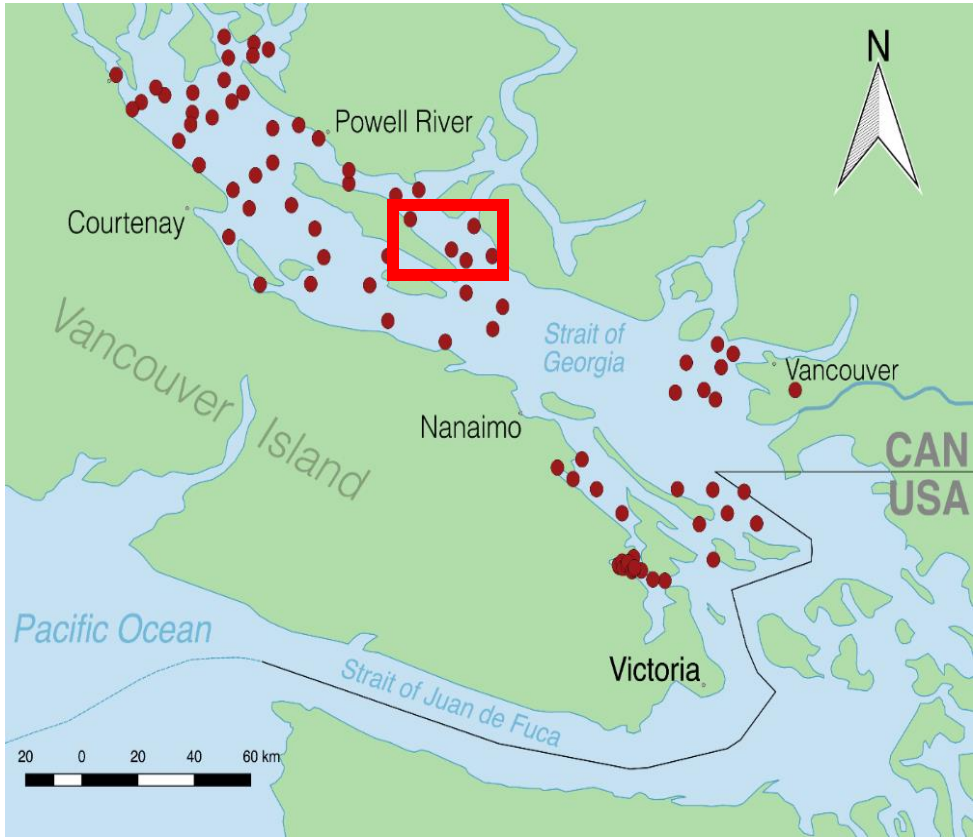
Assess how depth driven dynamics impact trophic energy transfer and zooplankton production over the bloom period

Malaspina Strait

- Located in the Strait of Georgia
  - one of the most seasonally productive regions on the west coast of Canada
- Critical migration pathway for juvenile salmon (Furey et al., 2015, Healy et al. 2017)

Map of the Salish Sea & Surrounding Basin: Stefan Freelan, WWU, 2009

Pacific Salmon Foundation: Citizen Science Project (2015-2025)



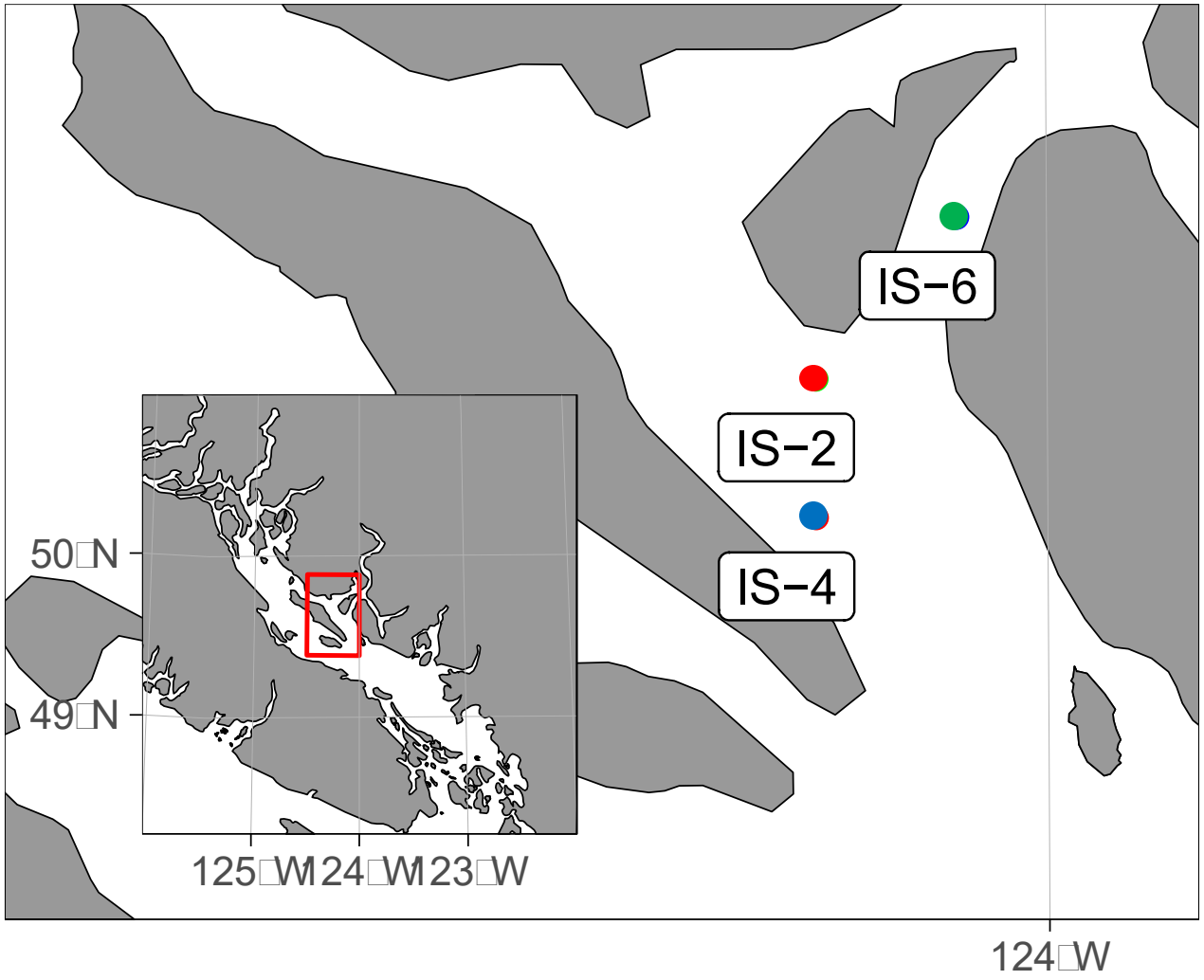
Map courtesy of Pacific Salmon Foundation

- ~80 locations sampled 2-3 times per month between February to October
- "mosquito fleet" of citizen scientists that go out simultaneously
- Data on:
  - Ocean Networks Canada
  - Strait of Georgia Data Centre

PACIFIC SALMON FOUNDATION

Zooplankton Sampling Sites (2024)

PACIFIC SALMON FOUNDATION



Sites:

- **IS-2 (depths ~30m)** ➡ sampled to bottom
- **IS-6 (depths ~250 m)**
- **IS-4 (depths ~420 m)**

} sampled to 150m

Variety of data captured

- CTD (temperature, salinity, chl)
- Nutrients
- **Zooplankton (vertical tow, ring net)**

Methods

Photos: PSF volunteers sampling Malaspina Strait, September 2024

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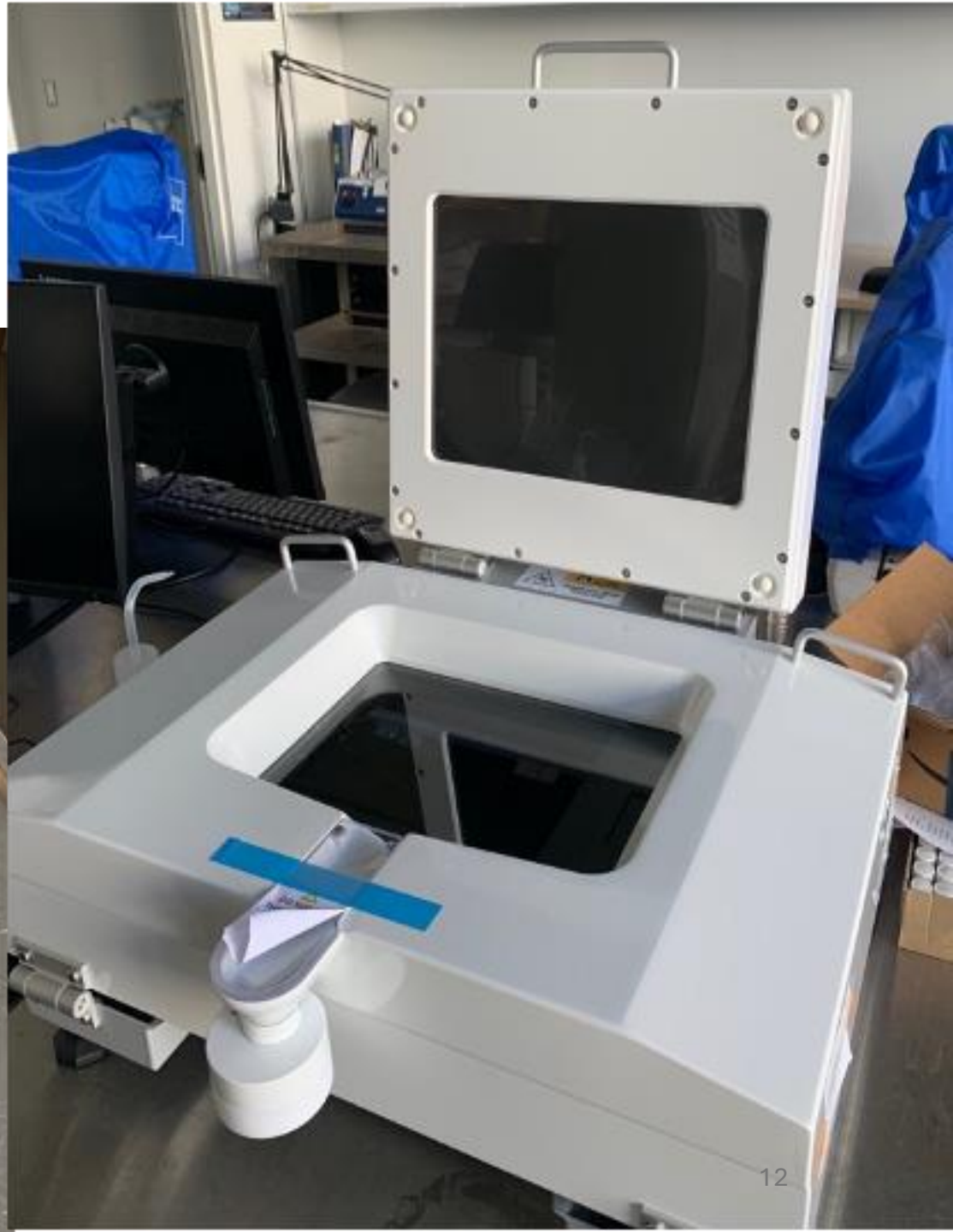
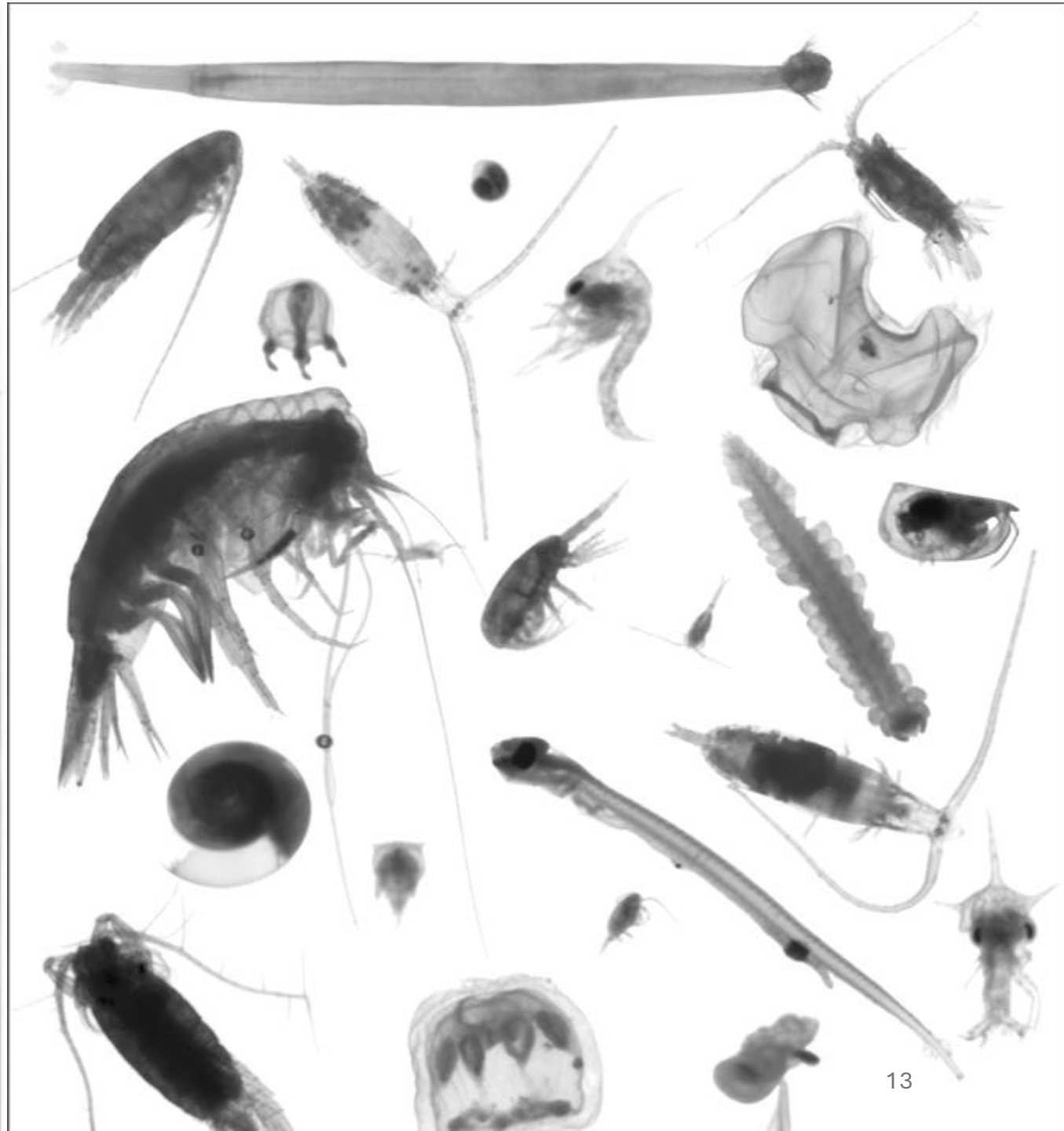


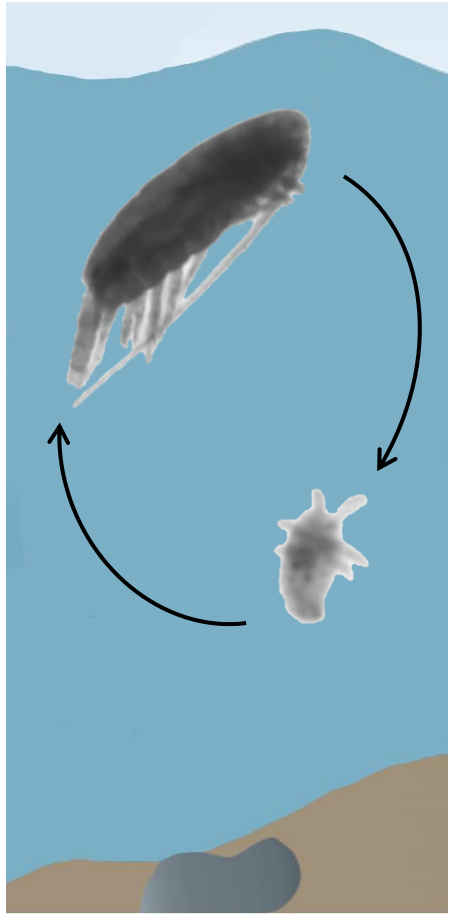


Taxa: Cyphocaris challengeri

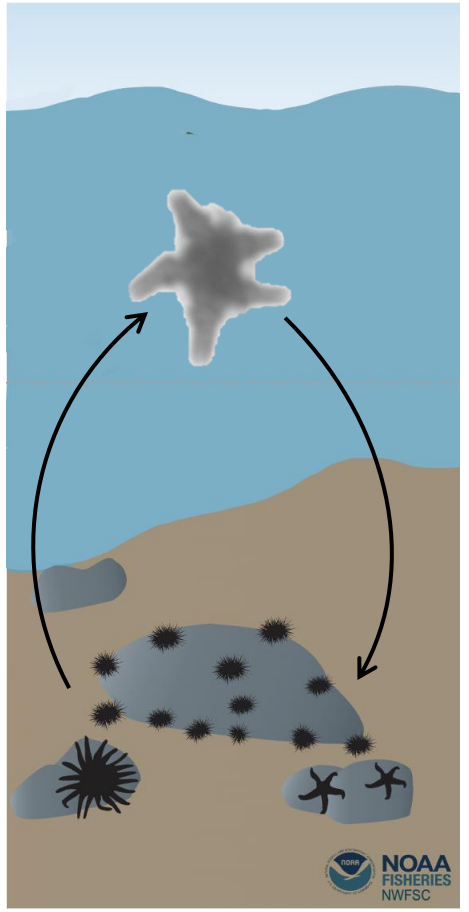
Length: 1.36316 mm

Volume: 0.86908 mm^3

Holoplankton: spend **all** of their life cycle as plankton



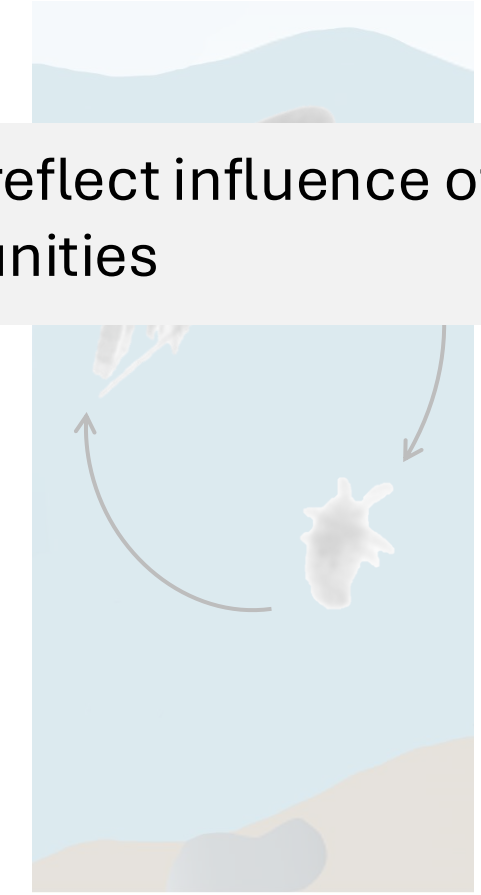
Meroplankton: spend only **part** of their life cycle as plankton



Illustrations: modified from NOAA

Holoplankton: spend **all** of their life cycle as plankton

Meroplankton: spend only **part** of their life cycle as plankton



Ratios reflect influence of benthic processes such as spawning on pelagic communities

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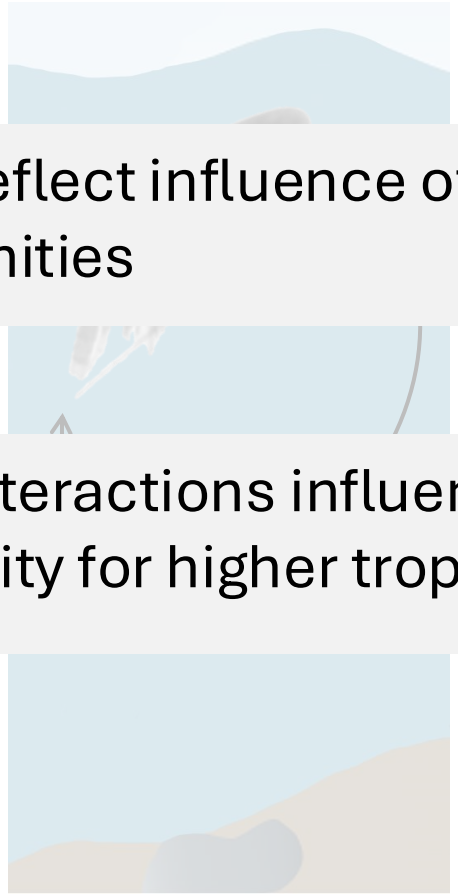
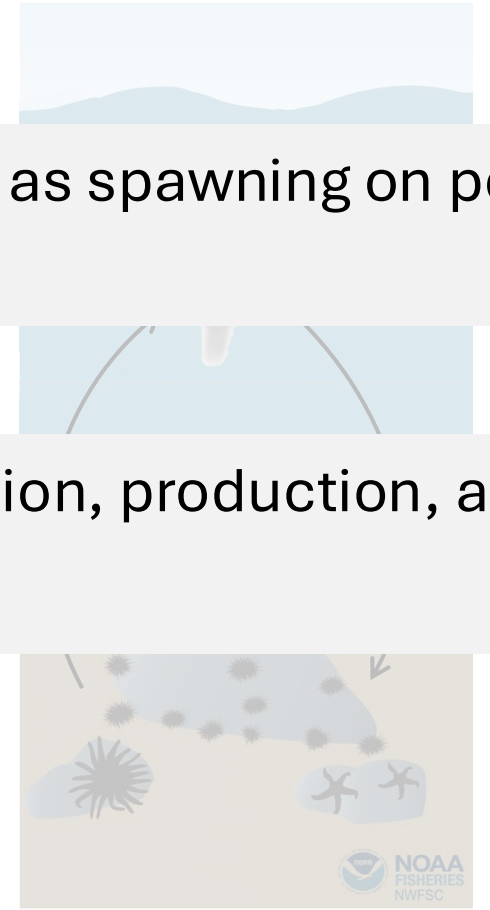
Meroplankton: spend only **part** of their life cycle as plankton





Ratios reflect influence of benthic processes such as spawning on pelagic communities

These interactions influence community composition, production, and prey availability for higher trophic levels

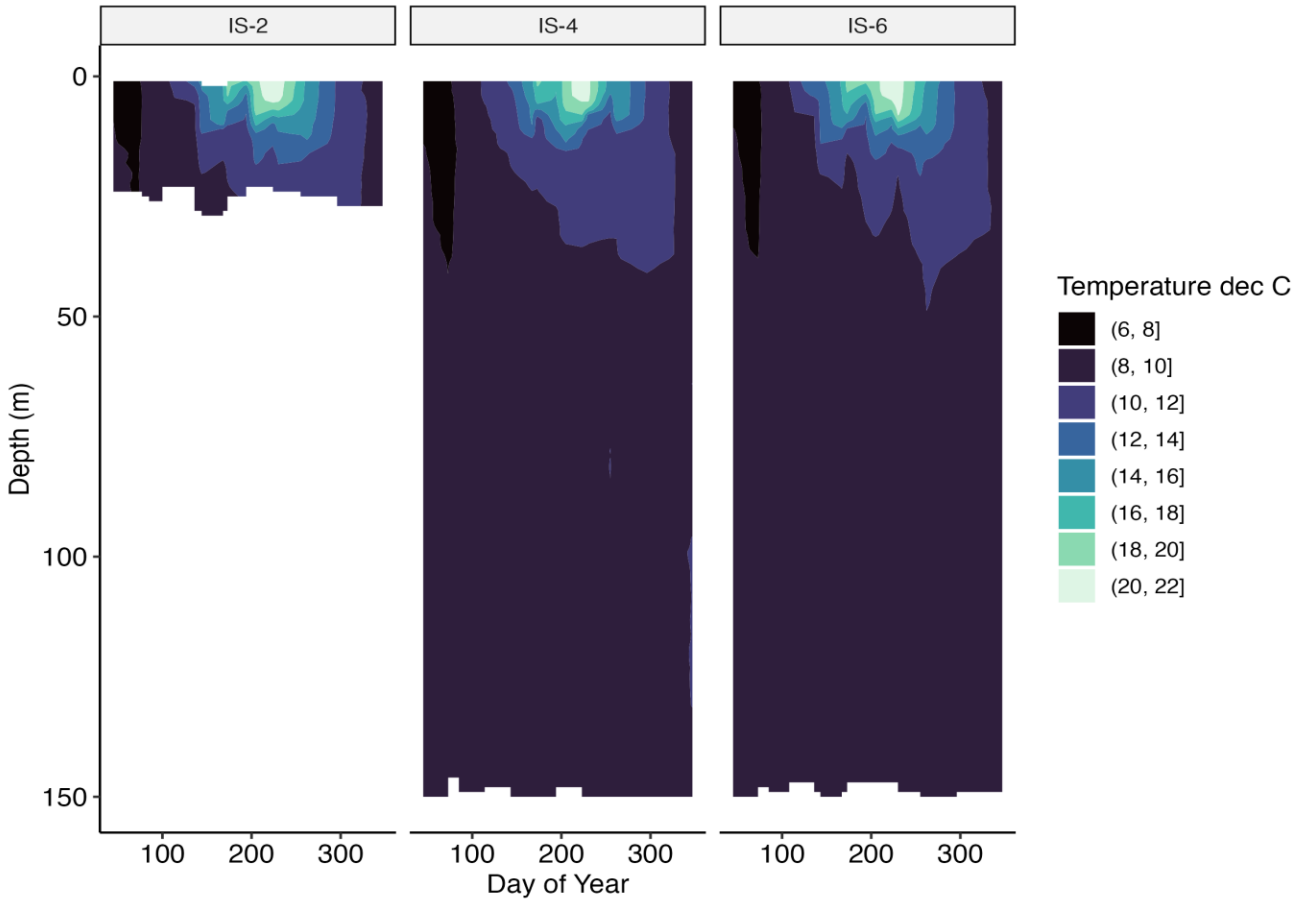
Illustrations: modified from NOAA

Results

Photo: Malaspina Strait, September 2024

Seasonal oceanographic conditions

CTD data by Dr. Rich Pawlowicz, UBC



Strong seasonal patterns

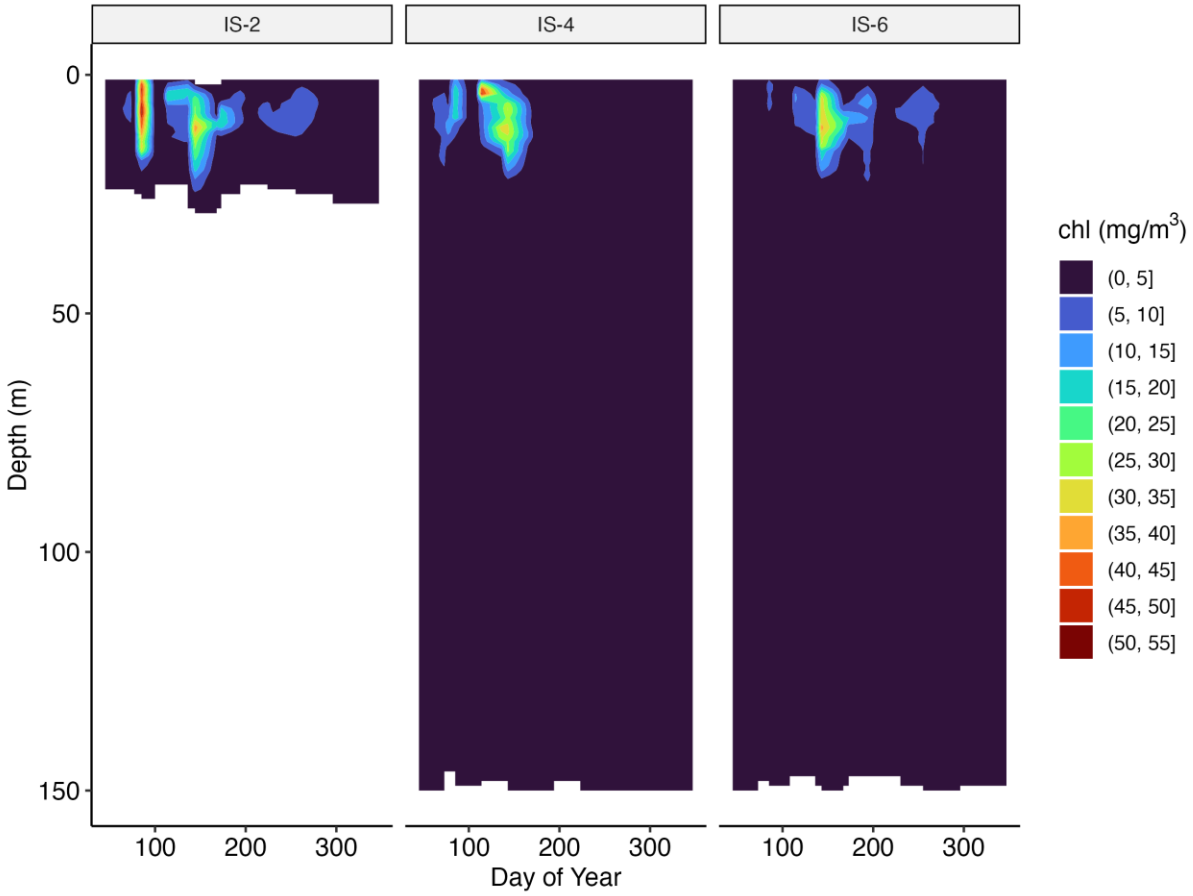
Seasonal stratification begins in spring and strengthens through summer

Deep waters remain cold and saline throughout the year

No strong differences between stations

Spring phytoplankton bloom

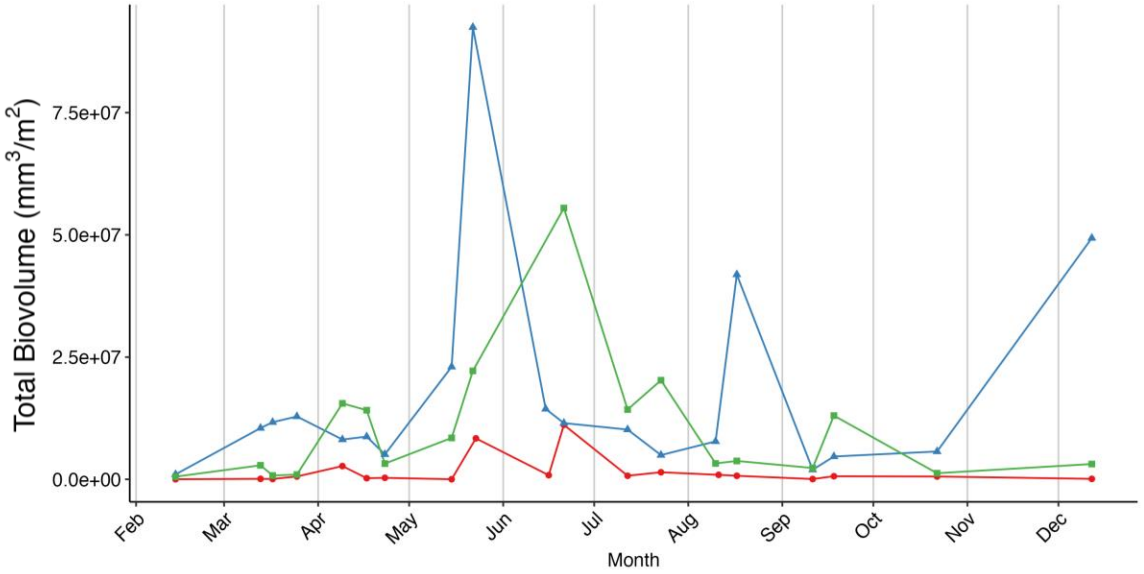
CTD data by Dr. Rich Pawlowicz, UBC



Spring bloom begins late march for all stations

This early bloom is stronger in shallow station

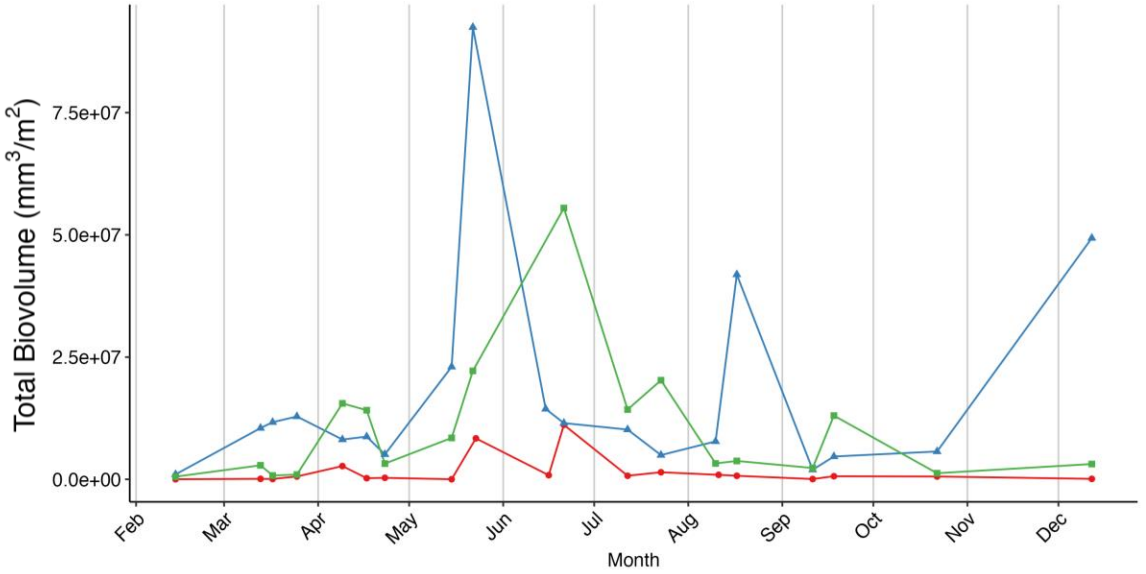
Zooplankton seasonal trends 2024

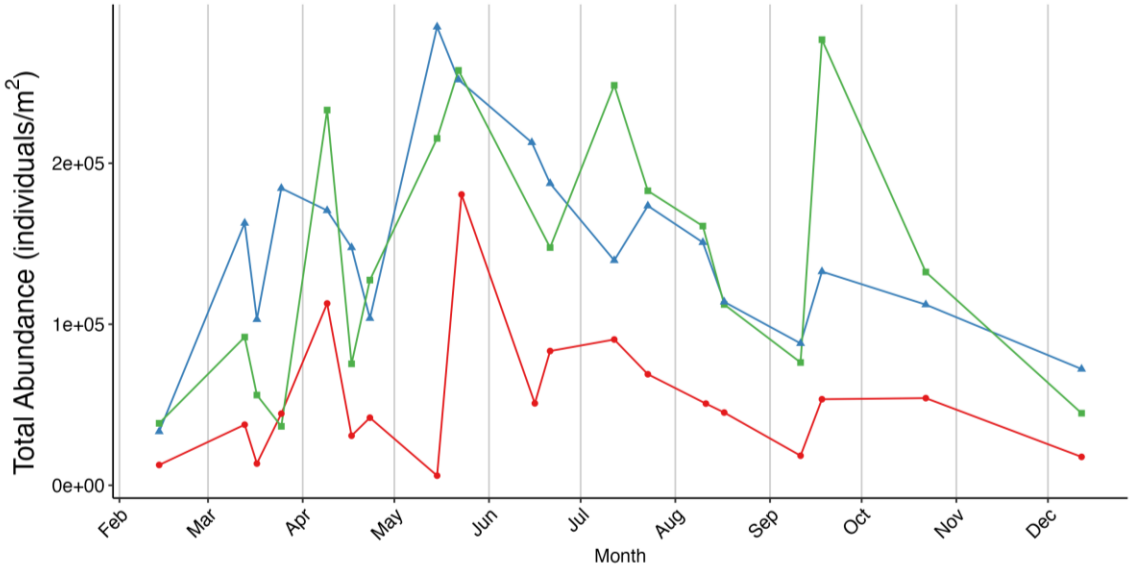


Biovolume peaks between May to July

IS-2	Shallow
IS-6	Middle
IS-4	Deep

Zooplankton seasonal trends 2024





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Abundance initially peaks in April and reaching peak values in May/June

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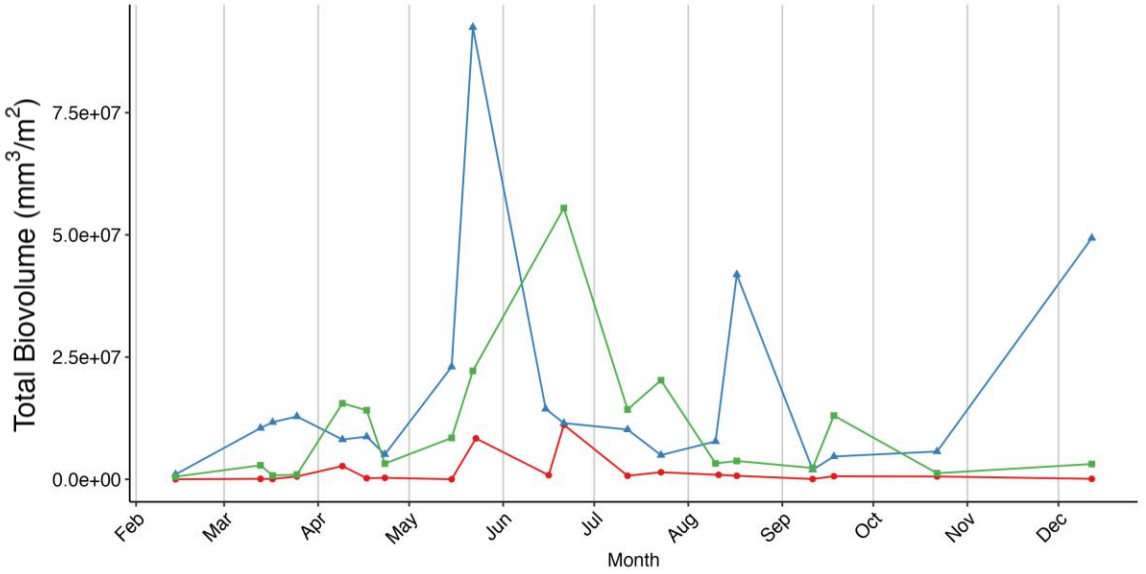
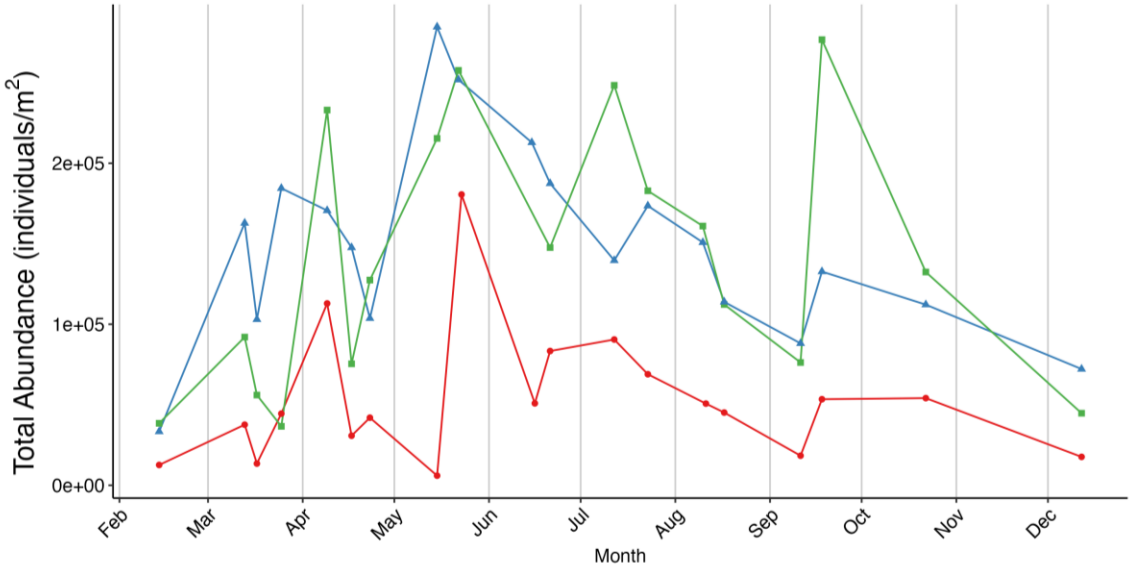




Biovolume peaks between May to July

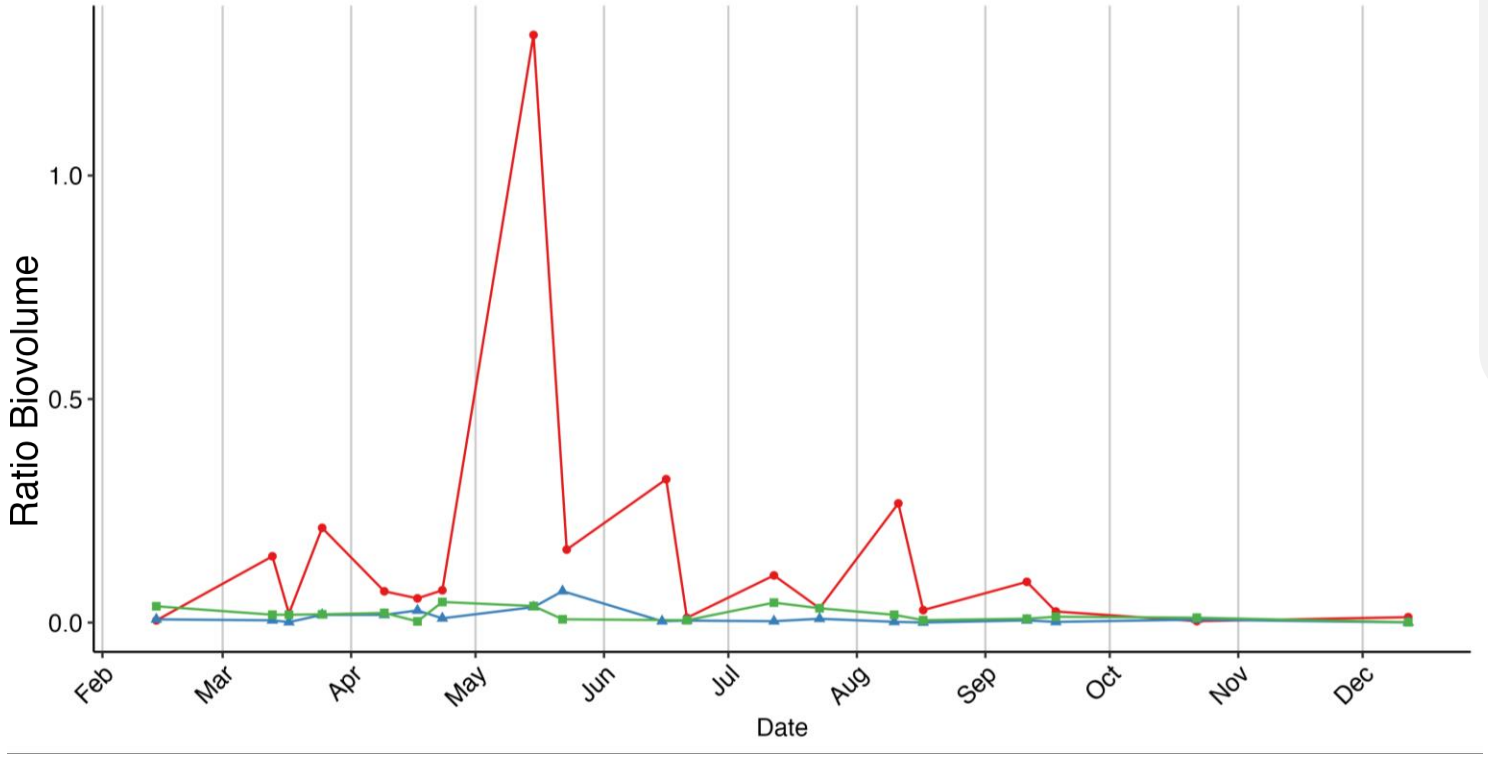
Abundance initially peaks in April and reaching peak values in May/June

Shallowest site shows relatively high abundance but lowest biovolume

- Suggests dominance of **small, fast-reproducing species** in shallows
- Deeper stations likely have more **large, overwintering species**

IS-2	Shallow
IS-6	Middle
IS-4	Deep

Meroplankton:Holoplankton ratios 2024

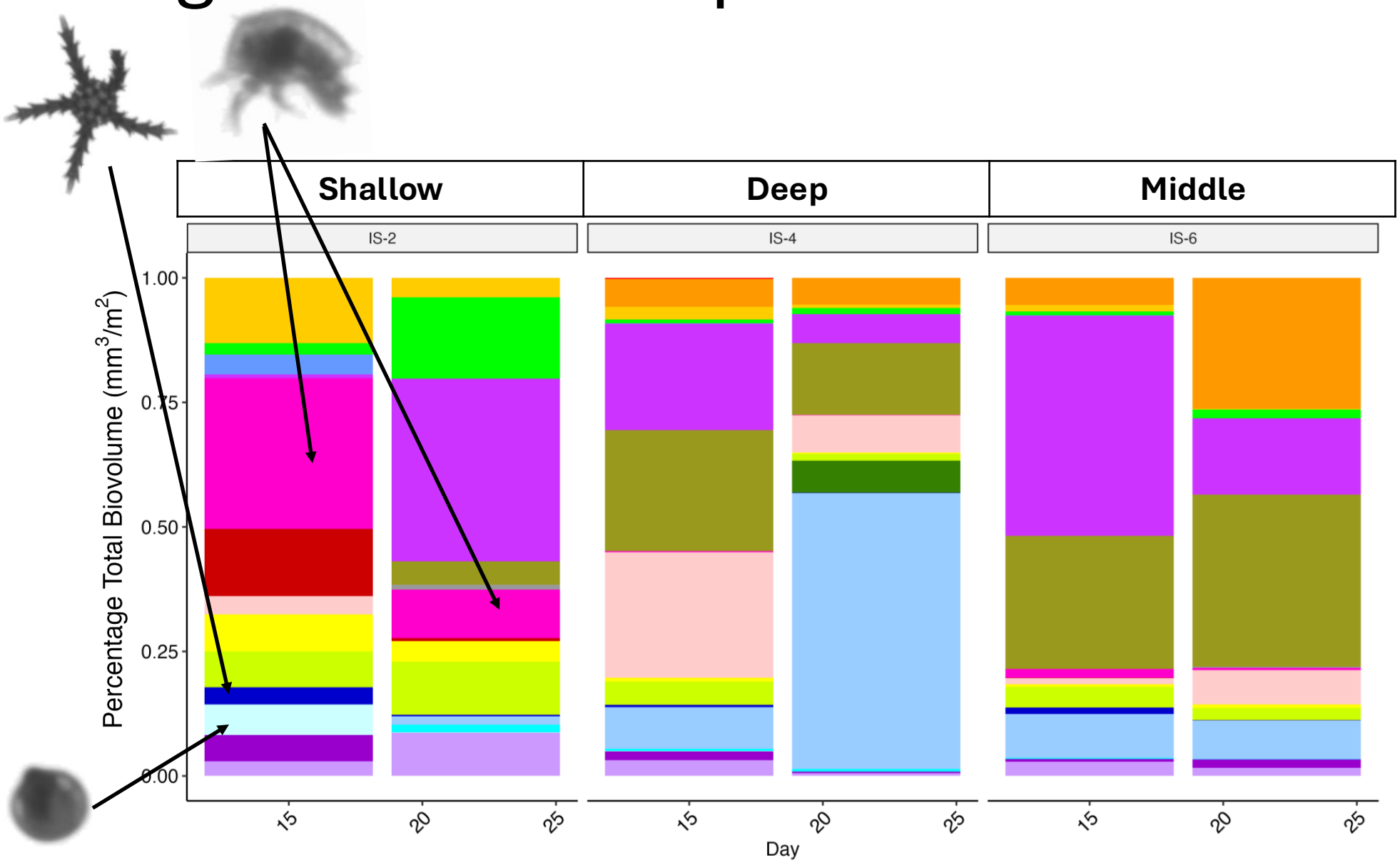


Shallowest site shows highest ratios, coinciding with increased production

- Suggests strong seasonal coupling with the benthos and larval retention

IS-2	Shallow
IS-6	Middle
IS-4	Deep

High relative meroplankton in shallows in May



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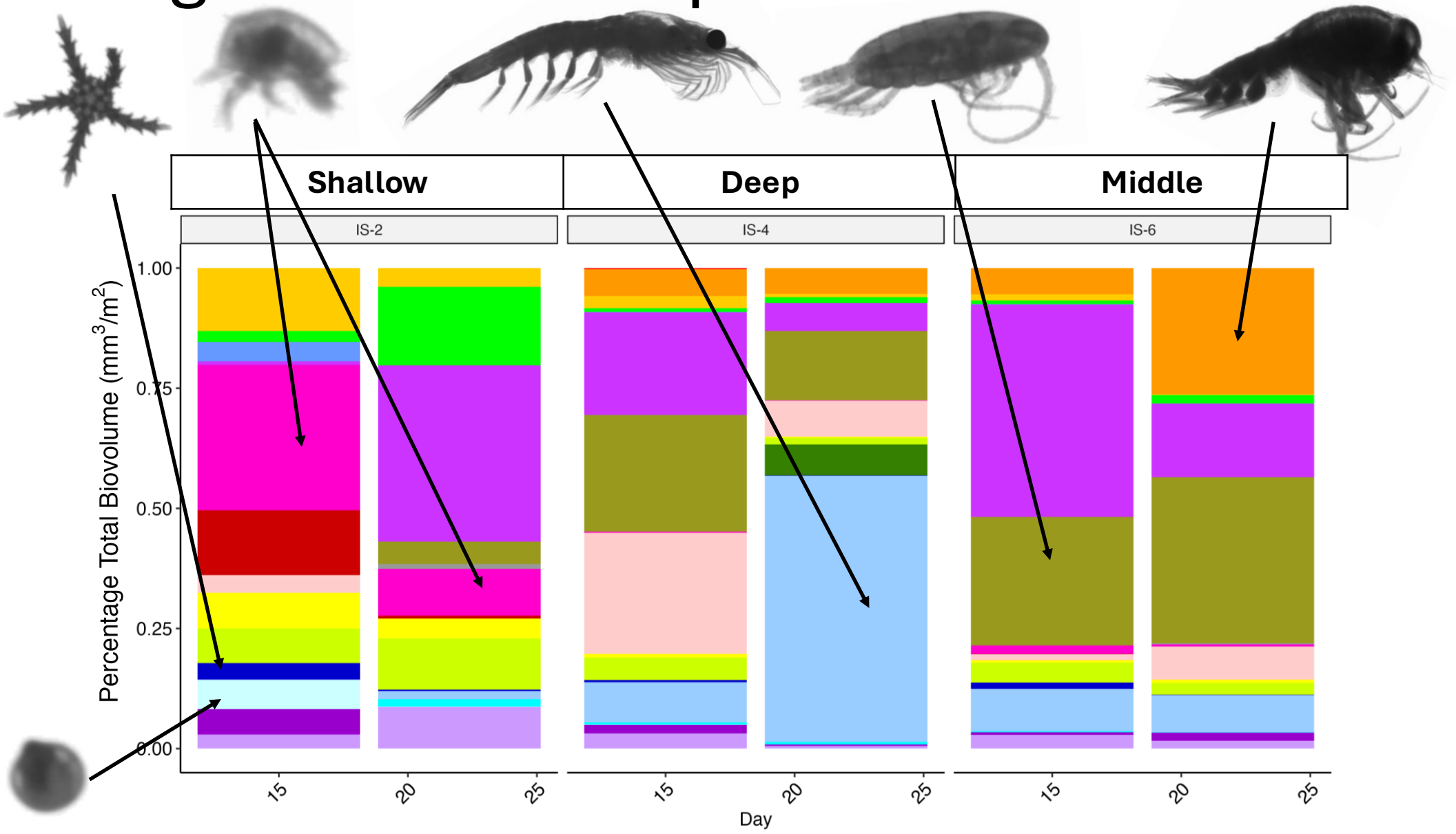

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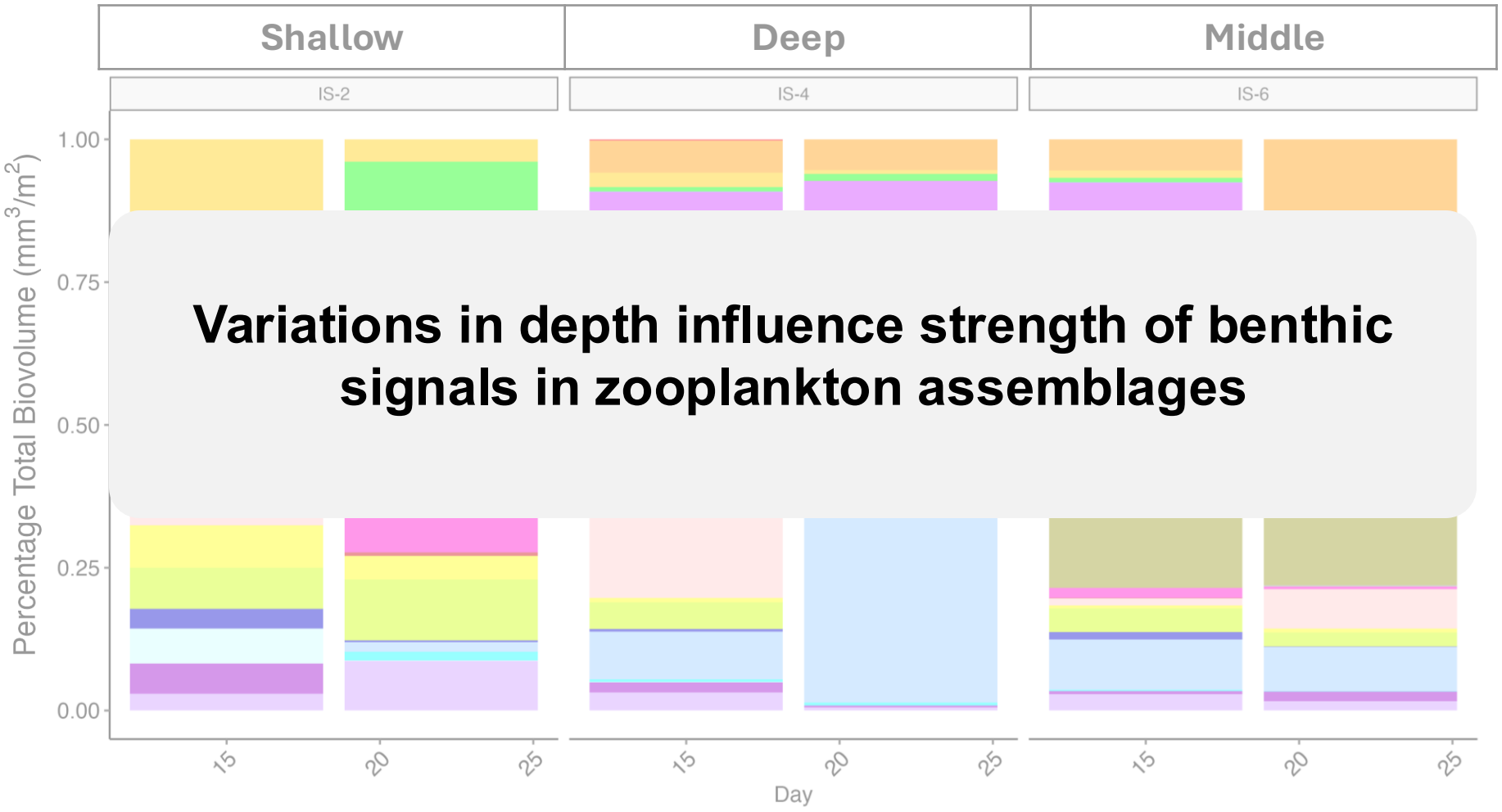

Variations in depth influence strength of benthic signals in zooplankton assemblages

Taxa Group

- Actinopterygii
- Amphipoda
- Annelida
- Appendicularia
- Bryozoa
- Calanoida <=2mm
- Calanoida >2mm
- Chaetognatha
- Cirripedia
- Cladocera
- Cnidarians
- Copepoda other
- Cyclopoida
- Decapoda
- Echinodermata
- Euphausiids
- Heterobranchia
- Mollusca
- Ostracoda
- Other Crustacea

How do these depth driven dynamics impact trophic energy transfer and species composition over the bloom period?

Normalized Biovolume Size Spectra (NBSS)

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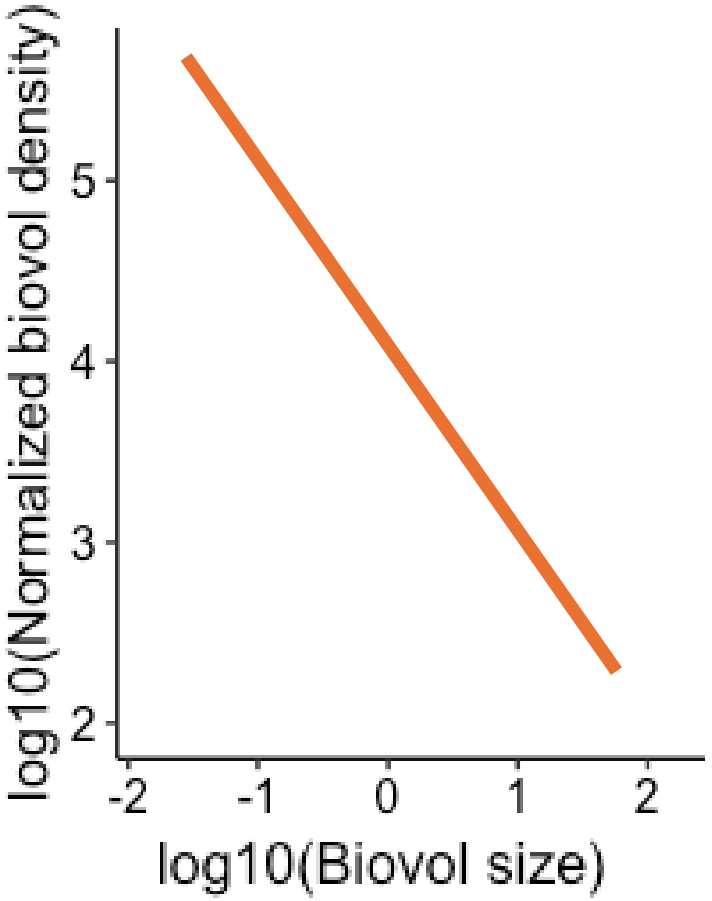
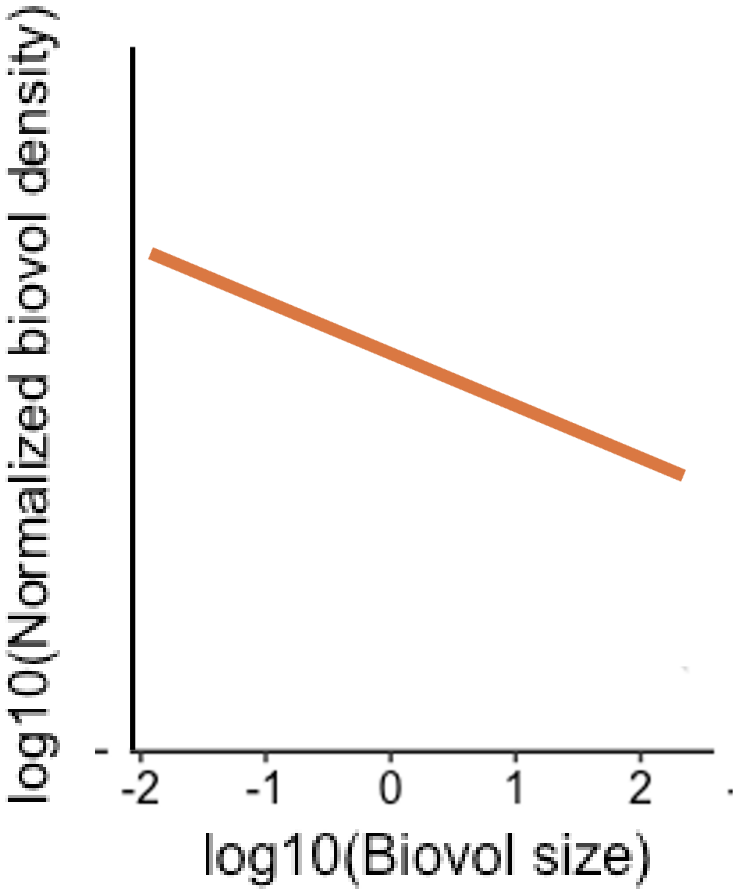


Steeper slope = dominance of smaller zooplankton



Flatter slope = more large-bodied zooplankton

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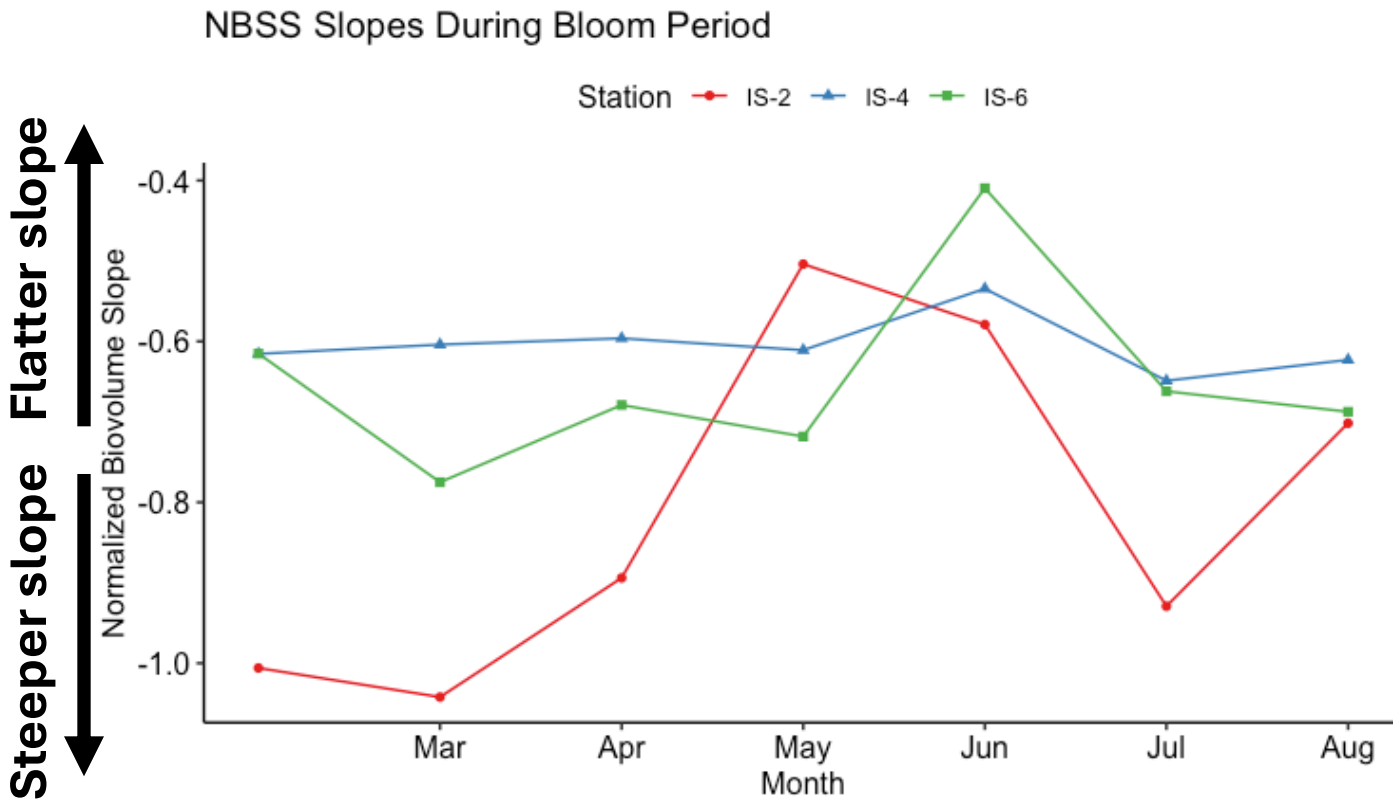

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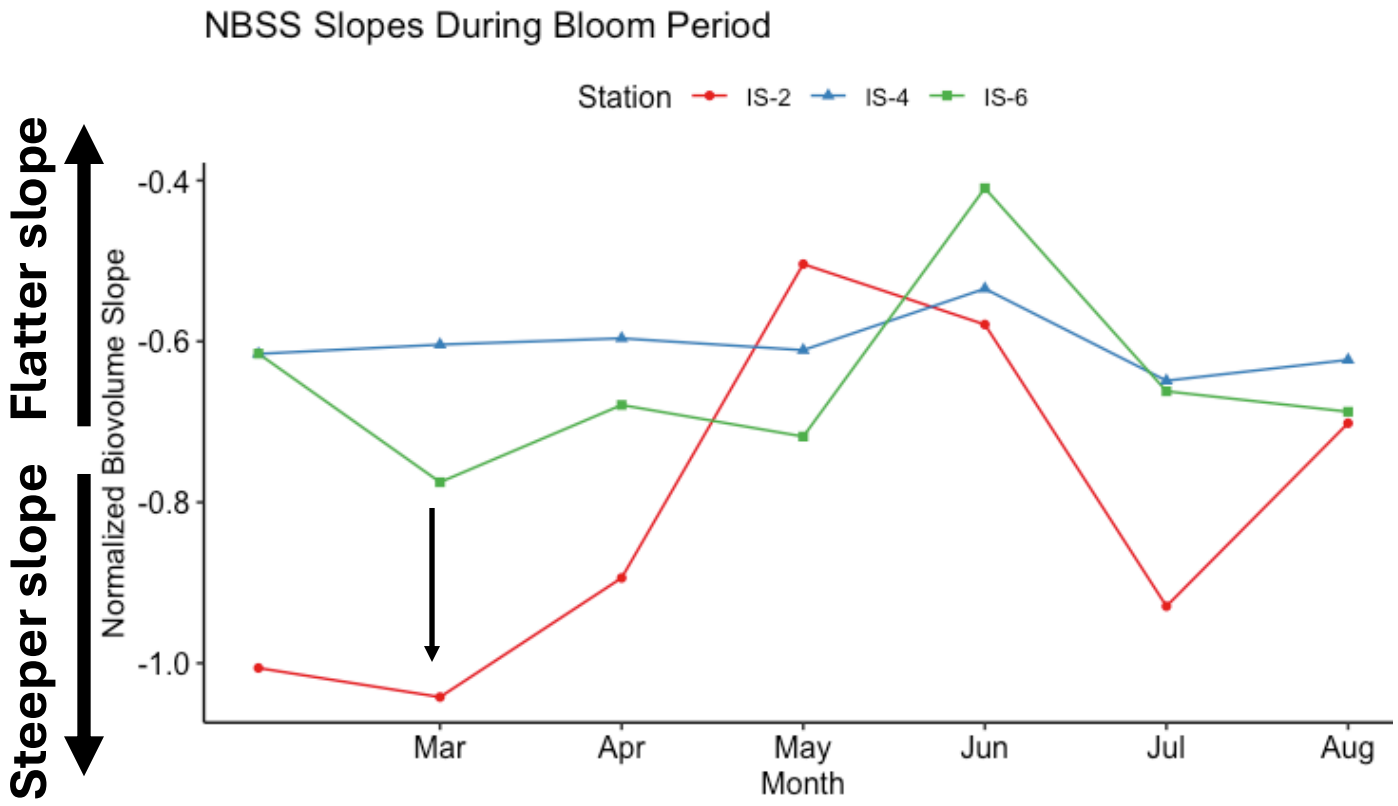

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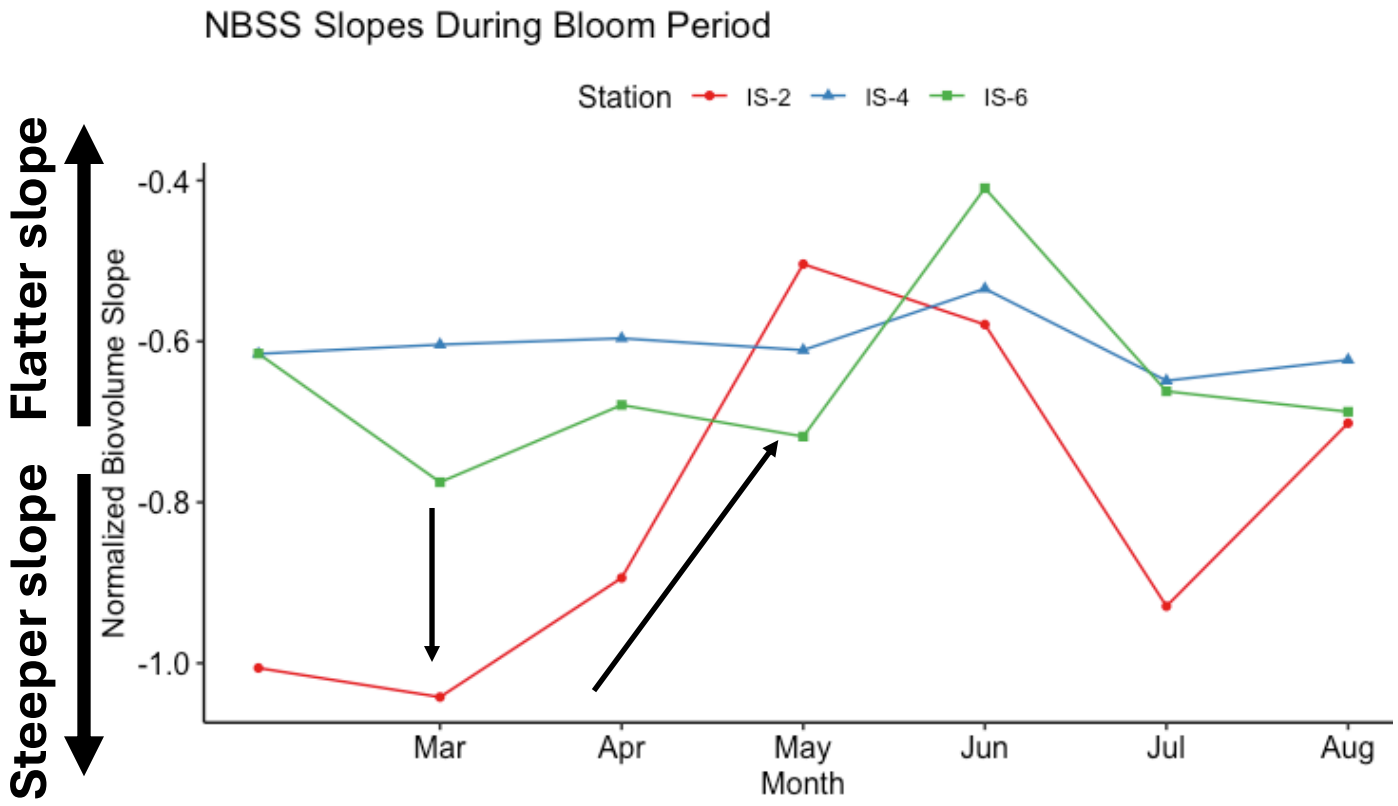

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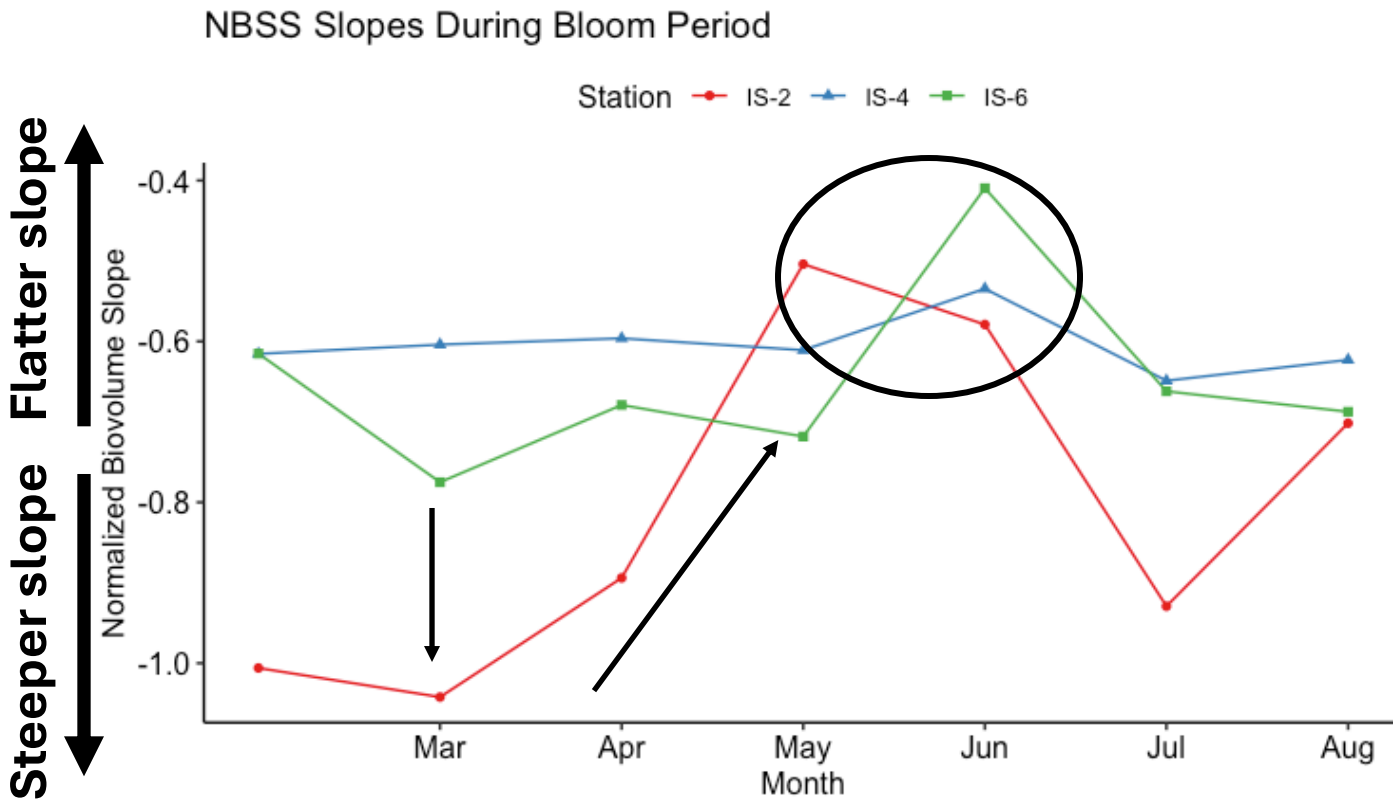

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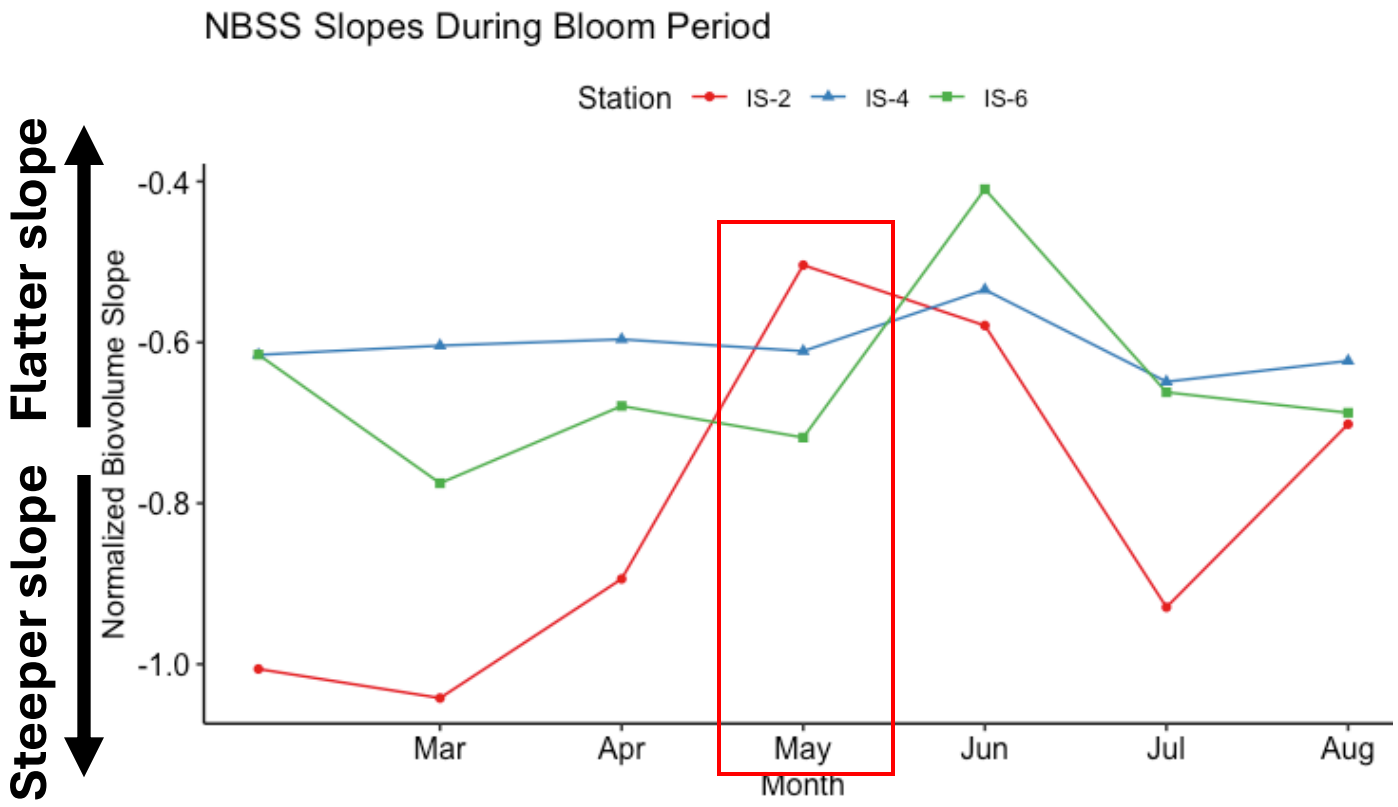

IS-2	Shallow
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NBSS: May

IS-2	Shallow
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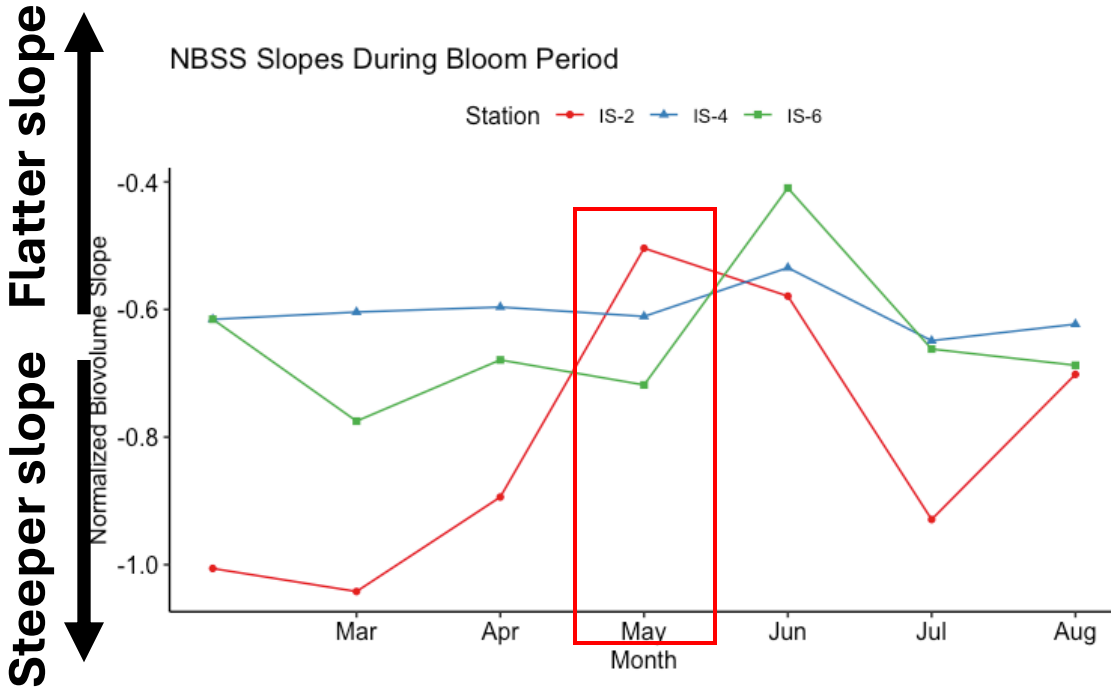
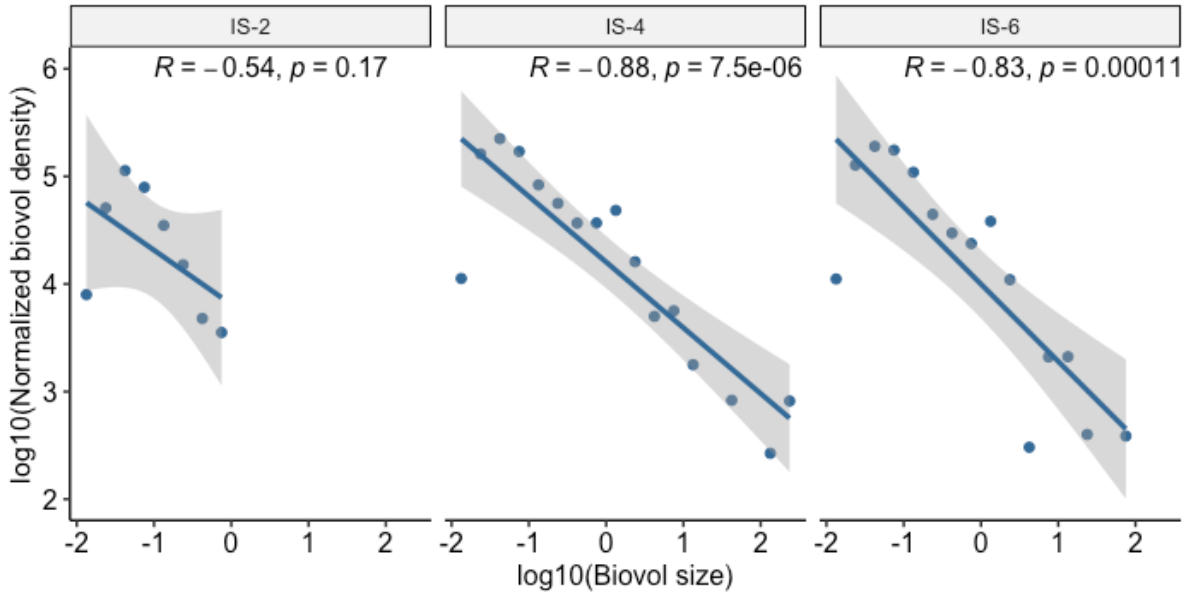
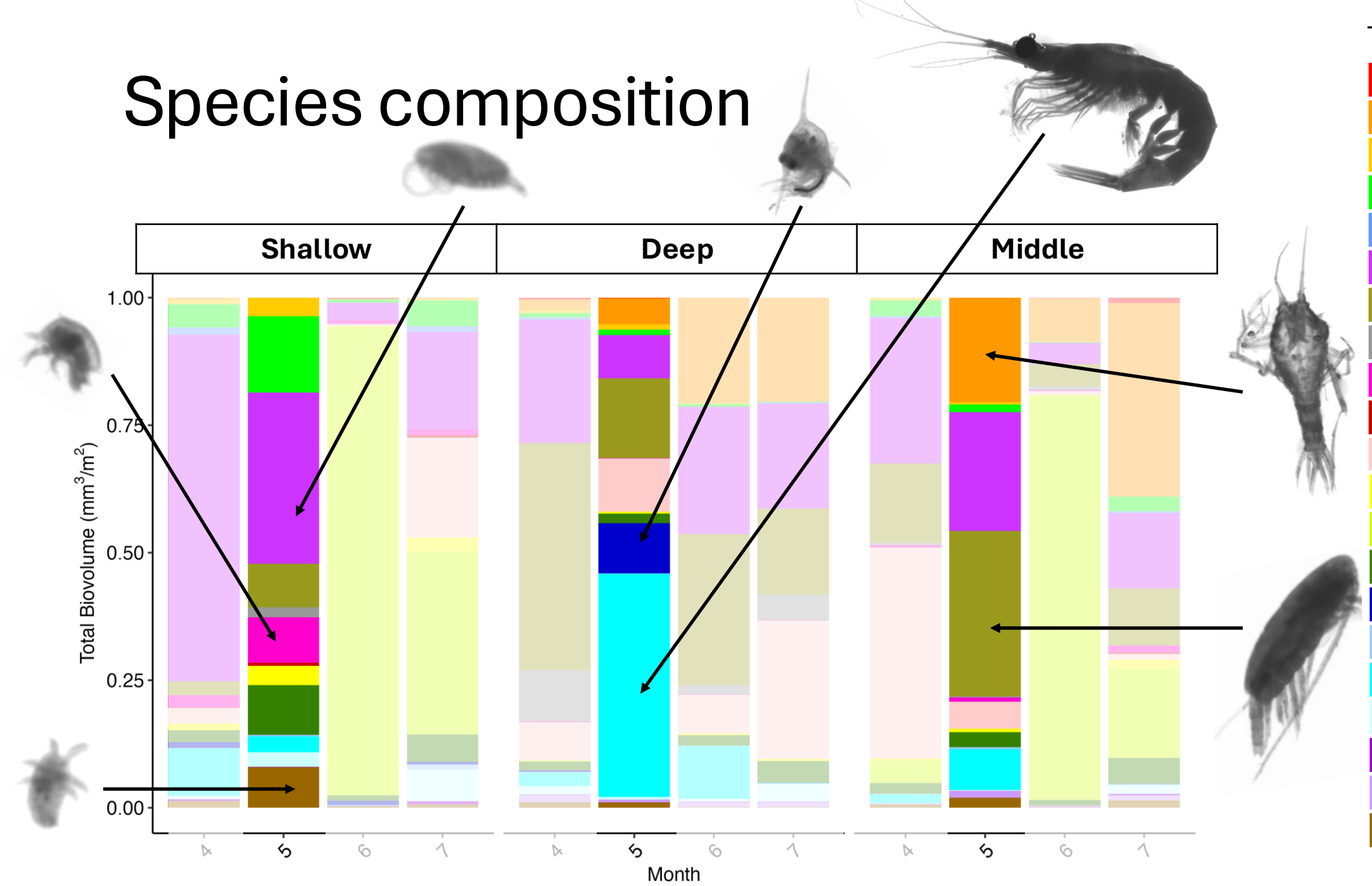
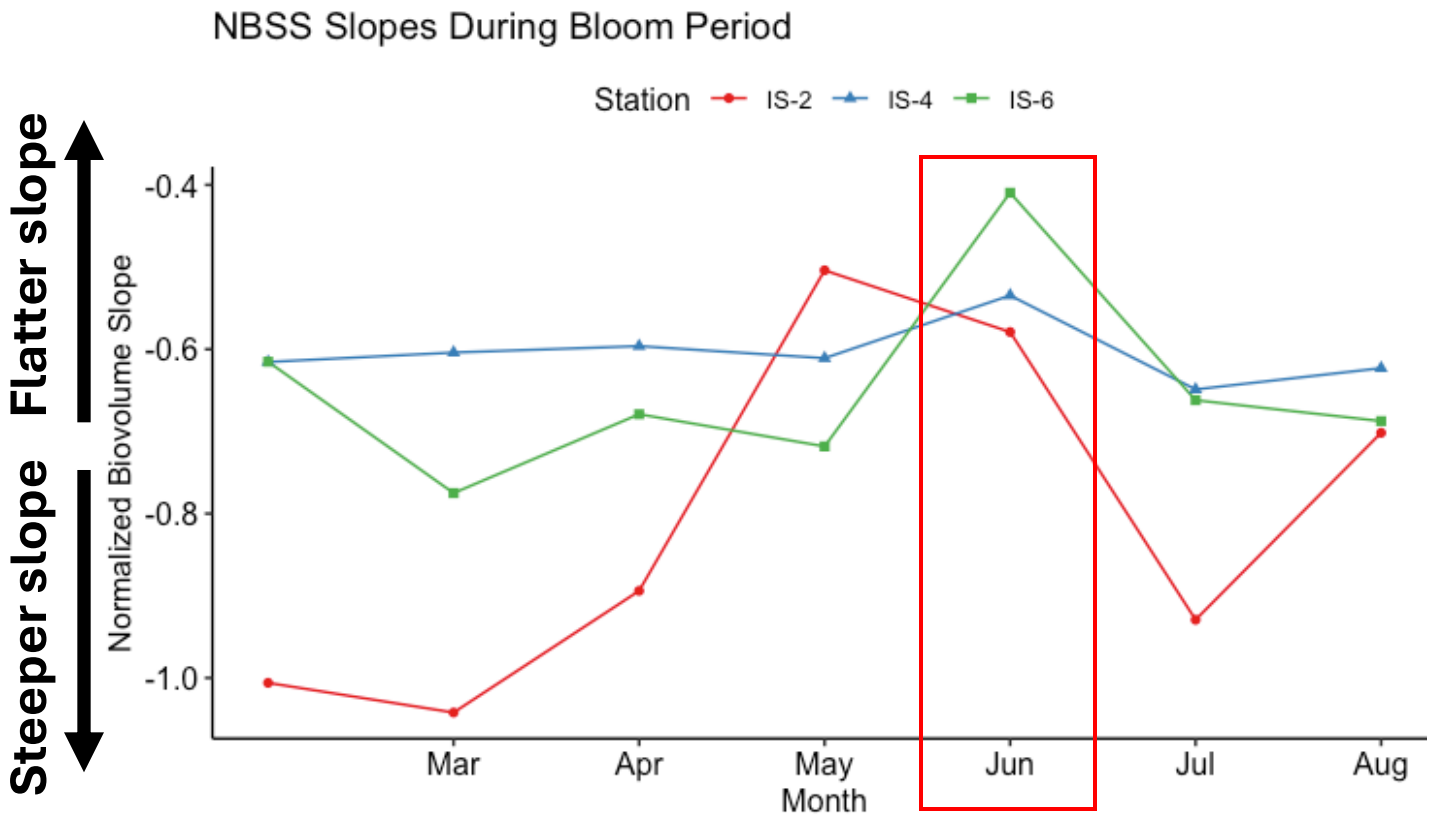




Species composition



NBSS: June



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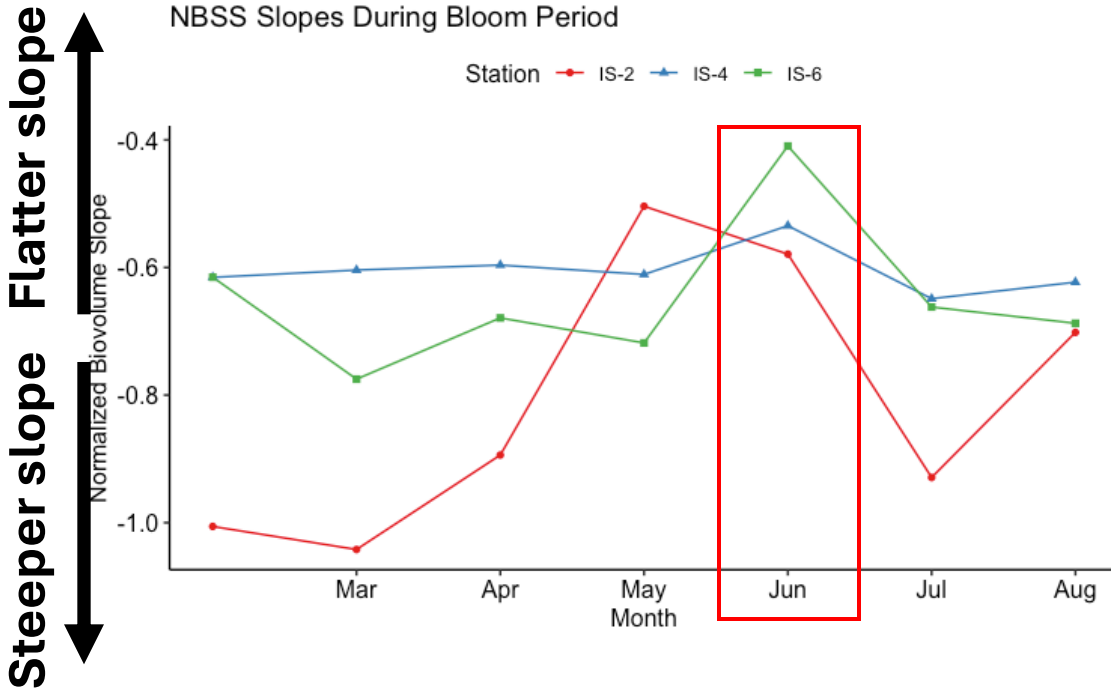

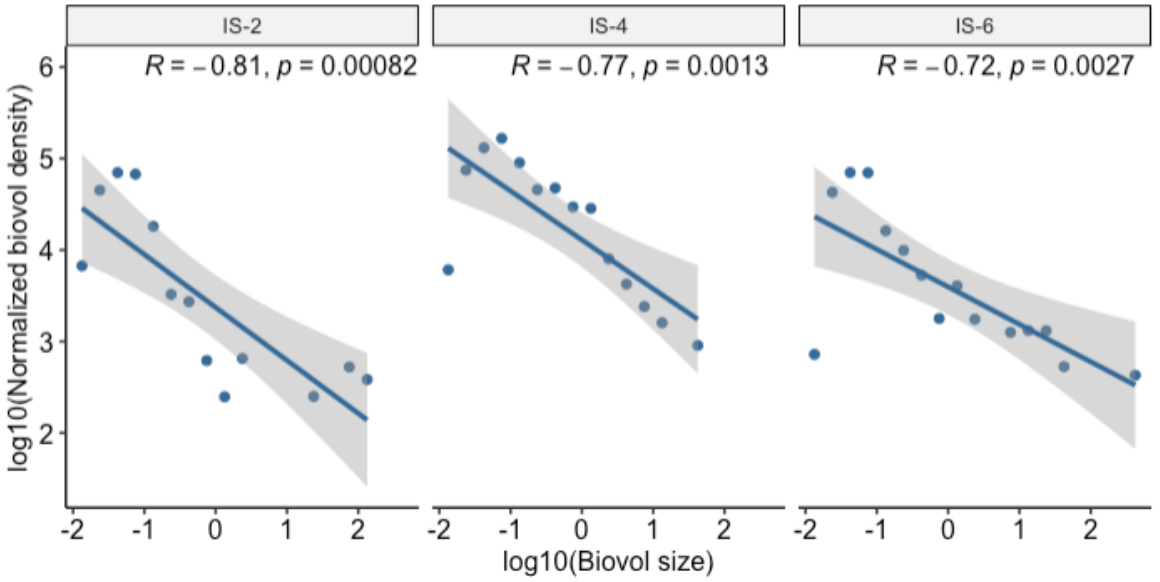

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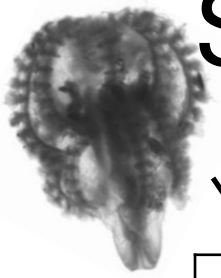

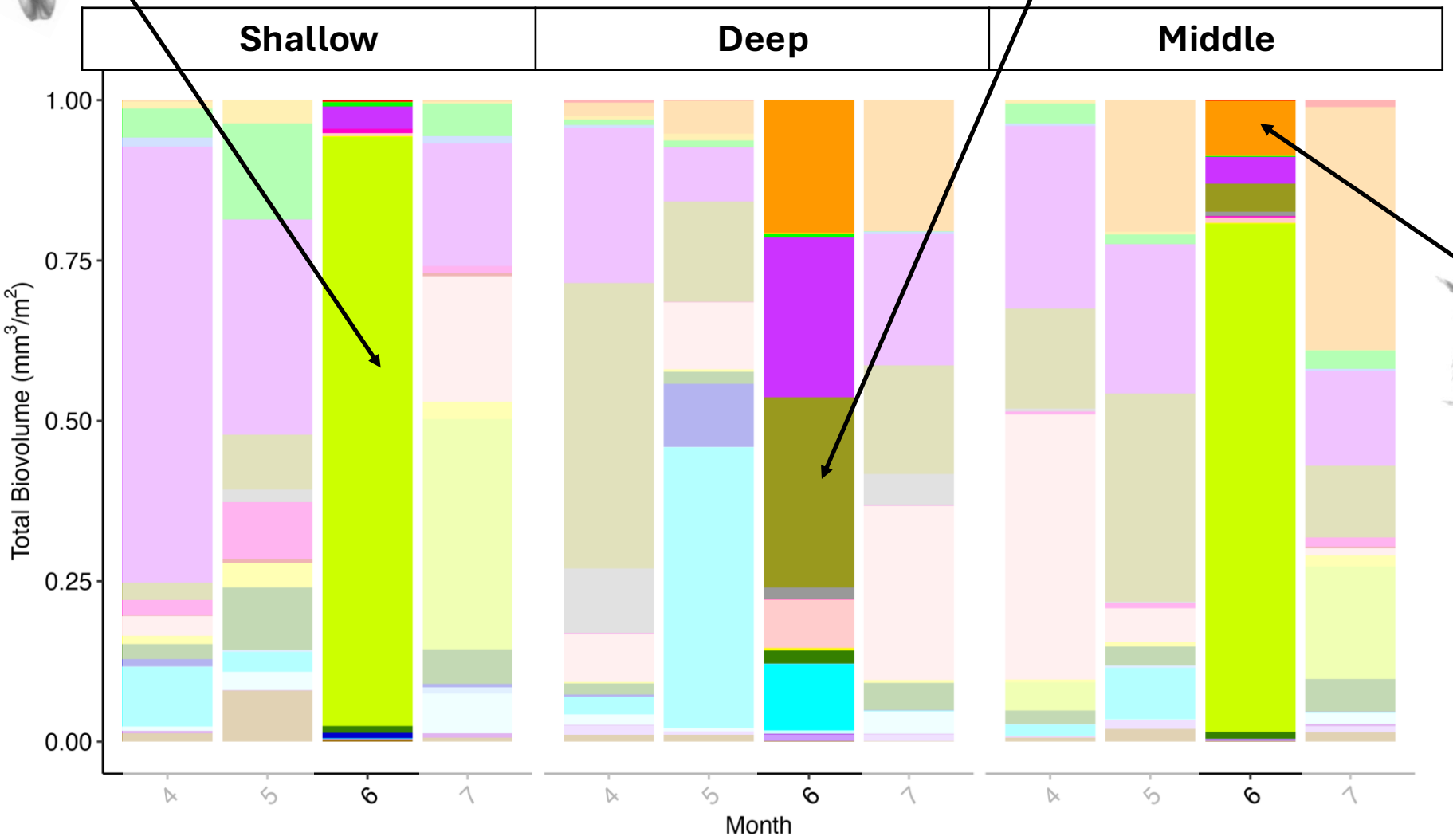

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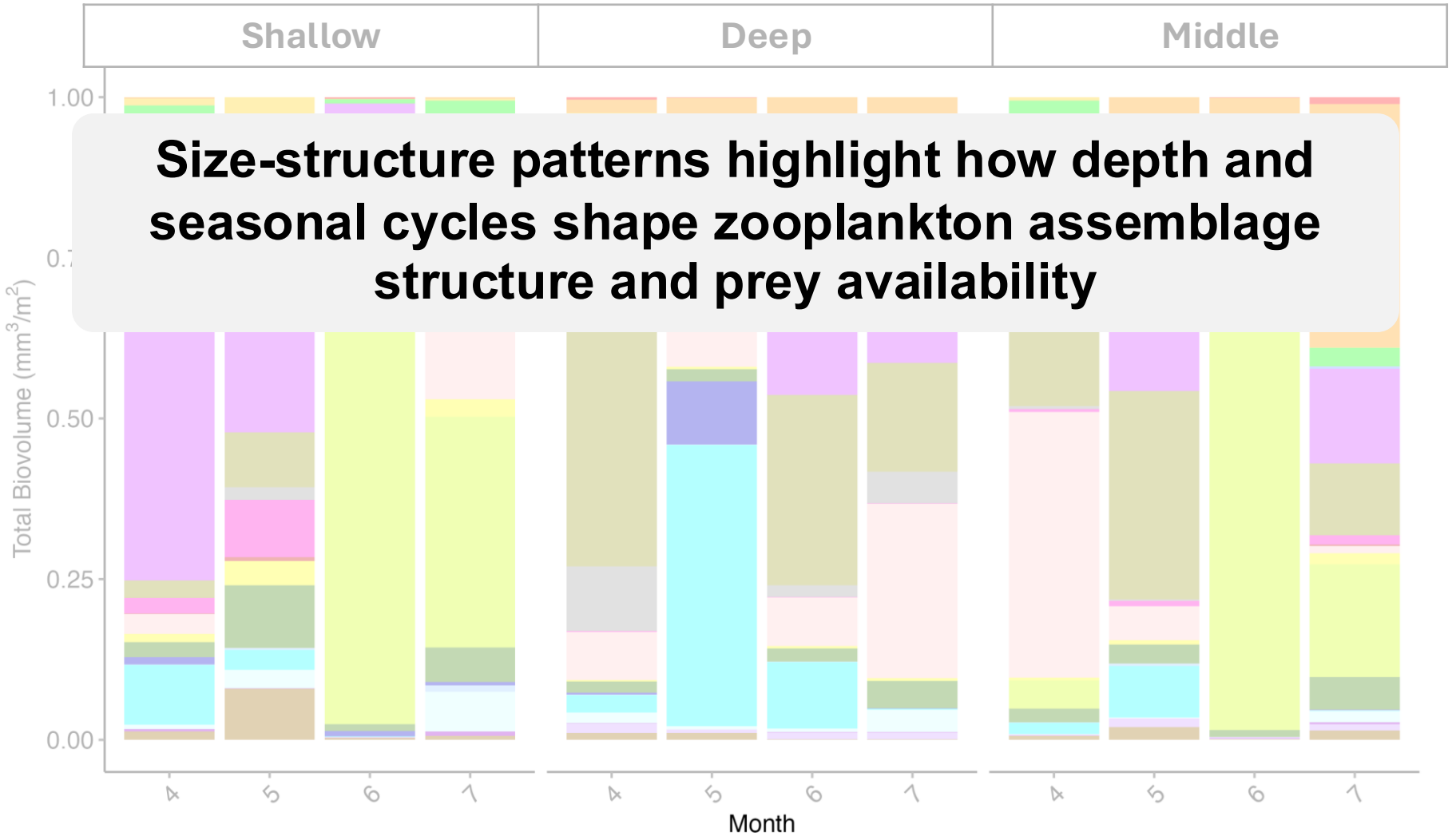

Size-structure patterns highlight how depth and seasonal cycles shape zooplankton assemblage structure and prey availability

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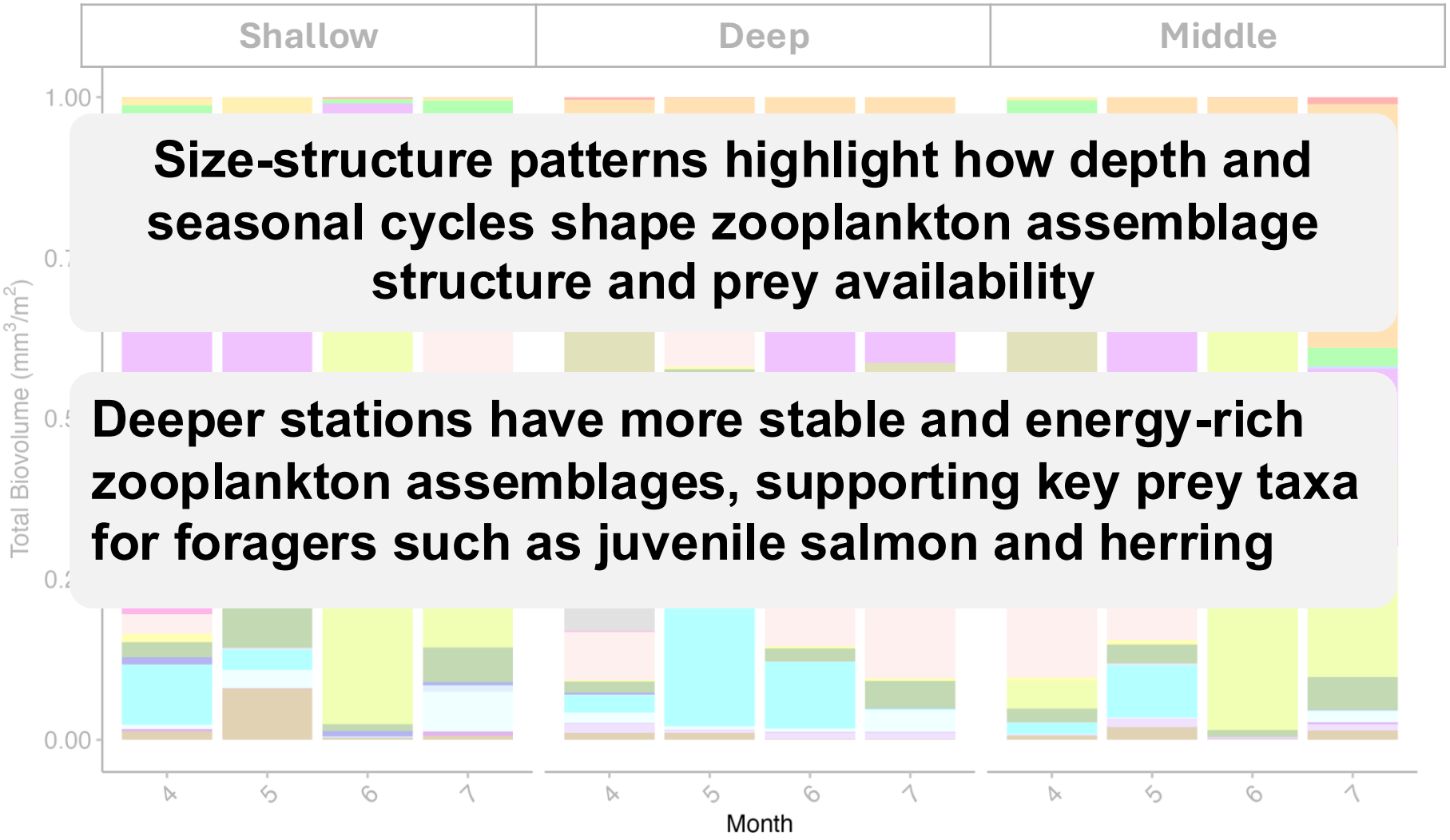

Size-structure patterns highlight how depth and seasonal cycles shape zooplankton assemblage structure and prey availability

Deeper stations have more stable and energy-rich zooplankton assemblages, supporting key prey taxa for foragers such as juvenile salmon and herring

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- Other Crustacea

Conclusions

Image analysis is capable of showing variability and seasonal fluctuation in shallow, dynamic habitats

Variations in depth influence strength of benthic signals in zooplankton assemblages

Deeper stations have more stable and energy-rich zooplankton assemblages, supporting key prey taxa for foragers such as juvenile salmon and herring

Future work

Assess impact of oceanographic drivers, including indices of urbanization, on nearshore zooplankton assemblages

Evaluate how depth and benthic driven effects vary interannually

Thank you!

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