Characterising the influence of urban inputs on zooplankton communities in a coastal temperate estuary

Stephanie L. Moore, PhD Student

Natasha Buckiewicz, Anna K. McLaskey and Brian P.V. Hunt

Institute for the Oceans and Fisheries

PELAGIC ECOSYSTEMS LABORATORY

Land Acknowledgement



This research took place on the ancestral and unceded territories of the **səlilwətaɬ (Tsleil-Waututh), Sḵwx̱wú7mesh (Squamish)** and **xwməθkwəy̓əm (Musqueam) Nations**.

Research Acknowledgements

This research represents the work of many undergraduate and graduate students, researchers and collaborators, and was supported by a variety of funding sources

NSERC CRSNG

Fisheries and Oceans Canada

Pêches et Océans Canada

PETER WALL LEGACY AWARDS
THE UNIVERSITY OF BRITISH COLUMBIA

OCEAN WISE

metro vancouver



Basal resources of coastal food webs



- Source inputs composed of pelagic and benthic **marine production** and organic matter supplied from neighbouring habitats and watersheds
- Rivers and runoff deliver **terrestrial organic matter** providing detrital and microbial pathways
- Relative **importance varies** with habitat, season and land-sea connectivity

Coastal cities reshape land-sea inputs

Drivers of change

- Impervious surfaces and modified shorelines
- Transport of material via wastewater and stormwater runoff
- Composition and timing of nutrient and organic matter inputs

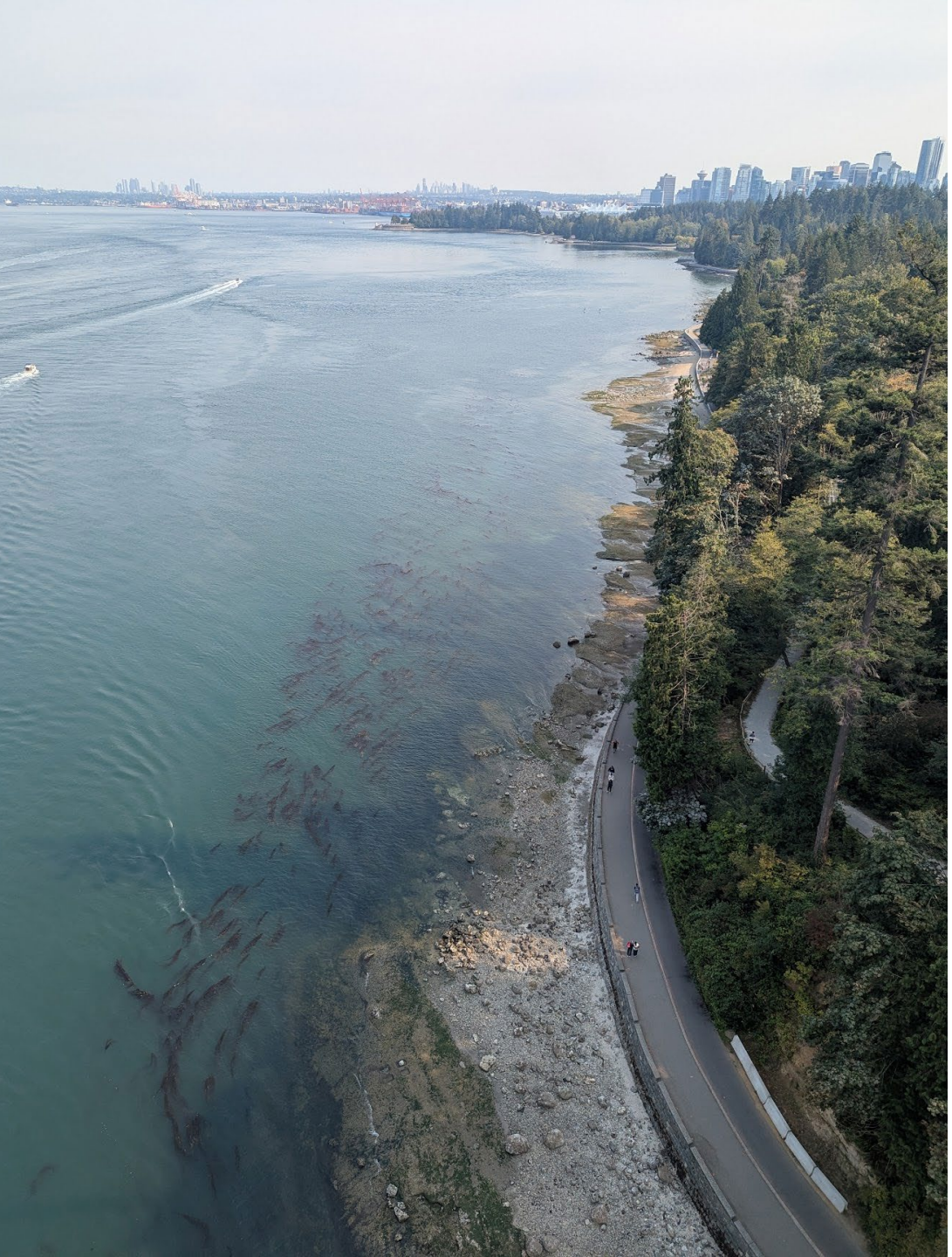
Pathways into coastal food webs

- Anthropogenic nutrients stimulate local primary production
- Land-derived organic matter enters particulate matter pool
- Contaminants enter consumers via exposure and dietary transfer

Potential ecosystem responses

- Altered resource availability and quality
- Changes in trophic pathways and energy transfer
- Shifts in community composition





Burrard Inlet: an urban estuary

Temperate rainforest with significant **land-sea interaction**

Habitat for species of **cultural + economic** importance

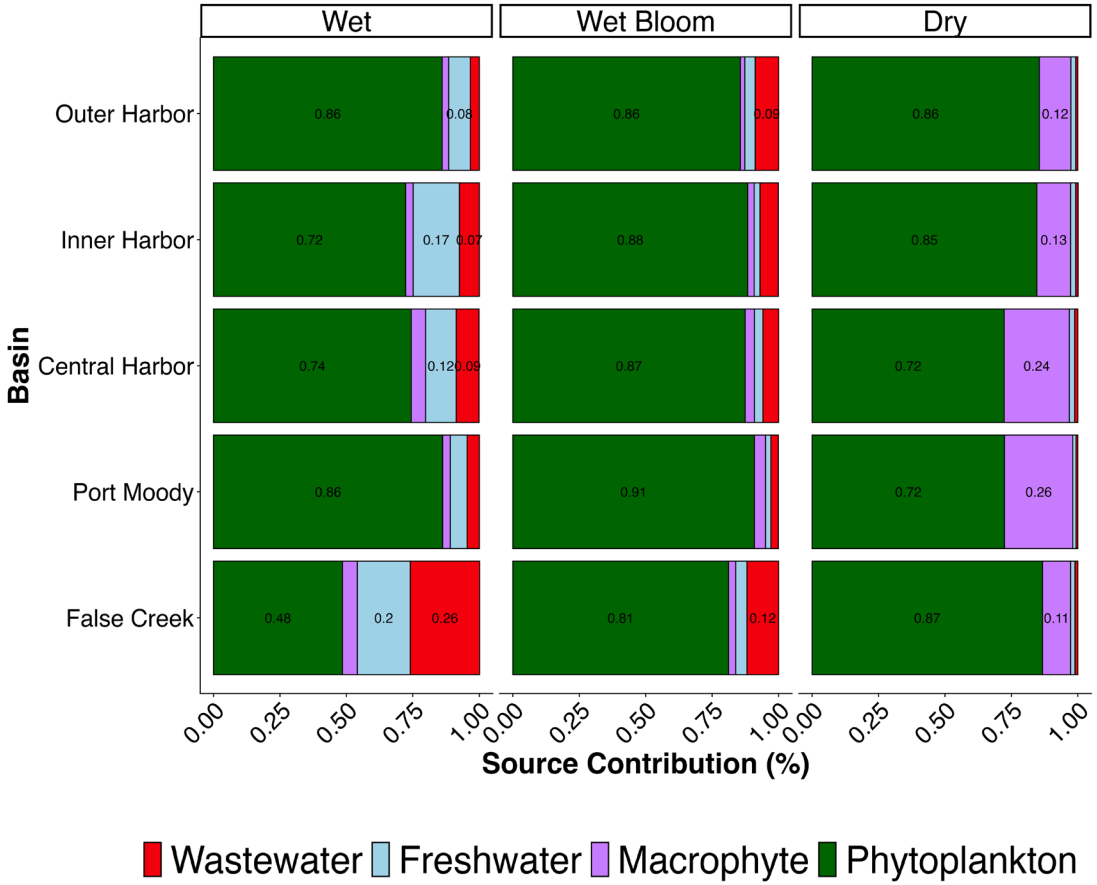
Sewage + stormwater Infrastructure with **27 CSOs/SSOs + 400 stormwater outfalls** (Rao et al. 2022)

Busiest port and adjacent to third largest city

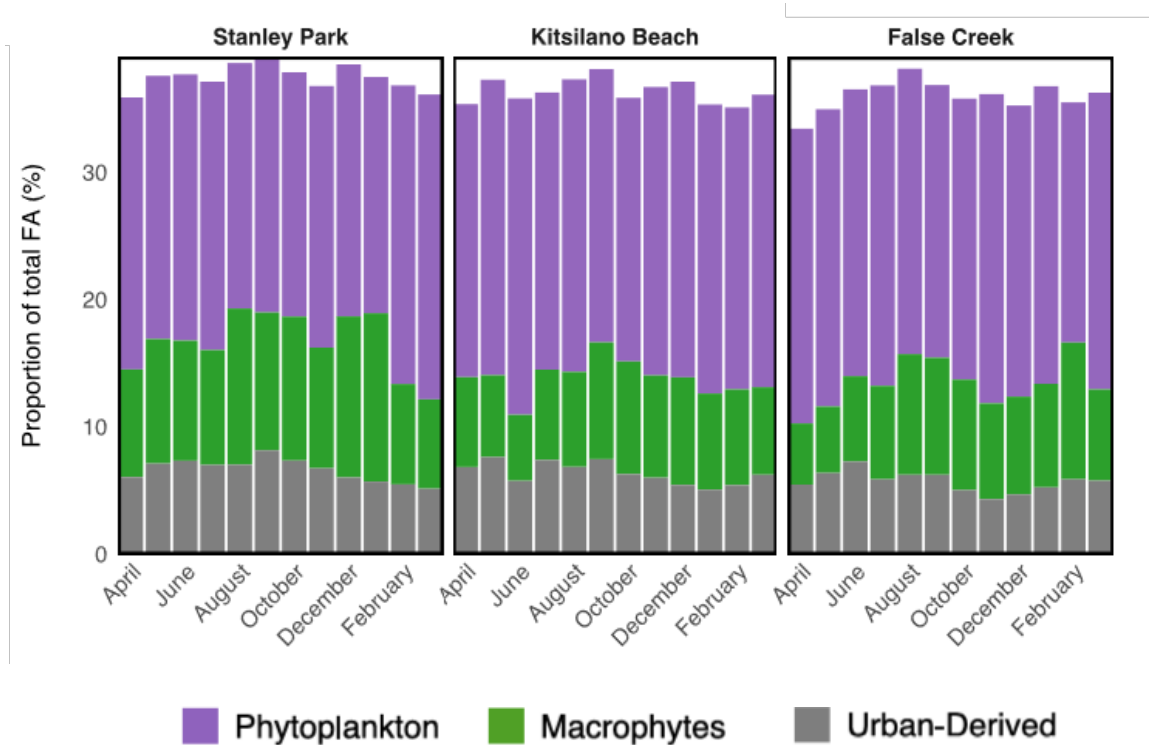
CSO – combined sewer overflow
SSO – sanitary sewer overflow

Urban organic matter in Vancouver's waters

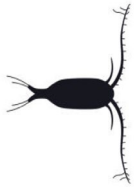
Relative contributions of sources to particulate organic matter (POM) in Burrard Inlet. **Sadie Lye, MSc (2025)**



Organic matter proportions found in mussels. **Dilan Sunthareswaran , MSc (2026)**



Zooplankton link coastal inputs to the pelagic food web



Diverse feeding strategies across size classes integrate inputs via **multiple trophic pathways**



Connect sources at the base of the pelagic food web and higher trophic levels



Planktonic lifestyle results in **direct exposure** to land-derived inputs



Changes in resource use due to urbanisation likely to **propagate** through pelagic food web



Research aims

Tracing urban-derived organic matter inputs into a nearshore pelagic food web

Characterise signatures of food web input sources and their relationship to primary consumers

Estimate relative contribution of urban-derived sources in supporting zooplankton across seasons

Prior Burrard Inlet data

Data compiled from **stable isotope surveys** of pelagic, intertidal, macrophyte, freshwater, terrestrial, and wastewater sources

- **Pollution Tracker** Ocean Wise & coastal partners, 2015-2019
- **Burrard Inlet Survey** Fisheries and Oceans Canada & PEL, 2019
- **Urban Oceans Surveys** PEL & Metro Vancouver 2023-24
- **2024 Lions Gate Survey** PEL & BOGL, 2024

OCEAN WISE

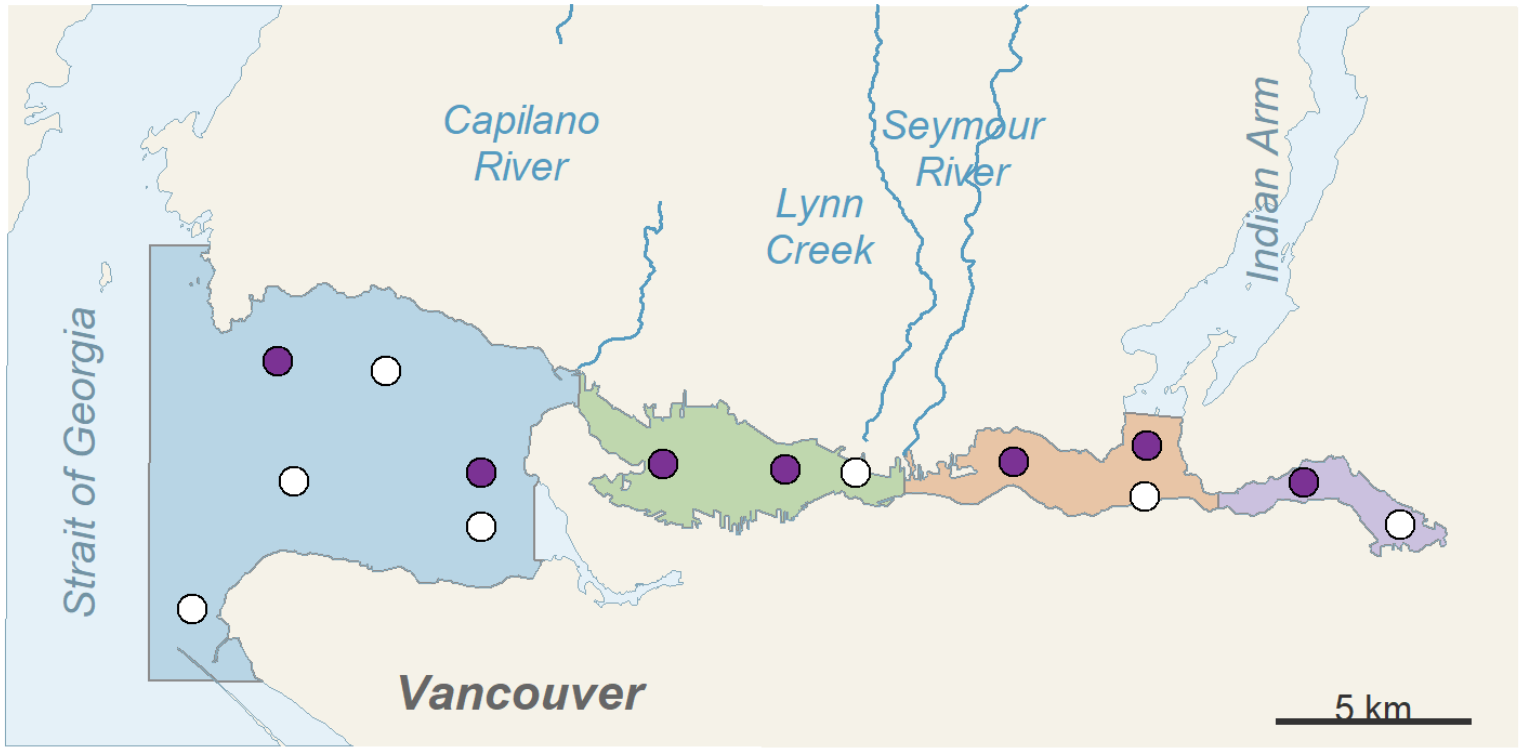
Fisheries and Oceans Canada

Pêches et Océans Canada

metro vancouver

NSERC CRSNG

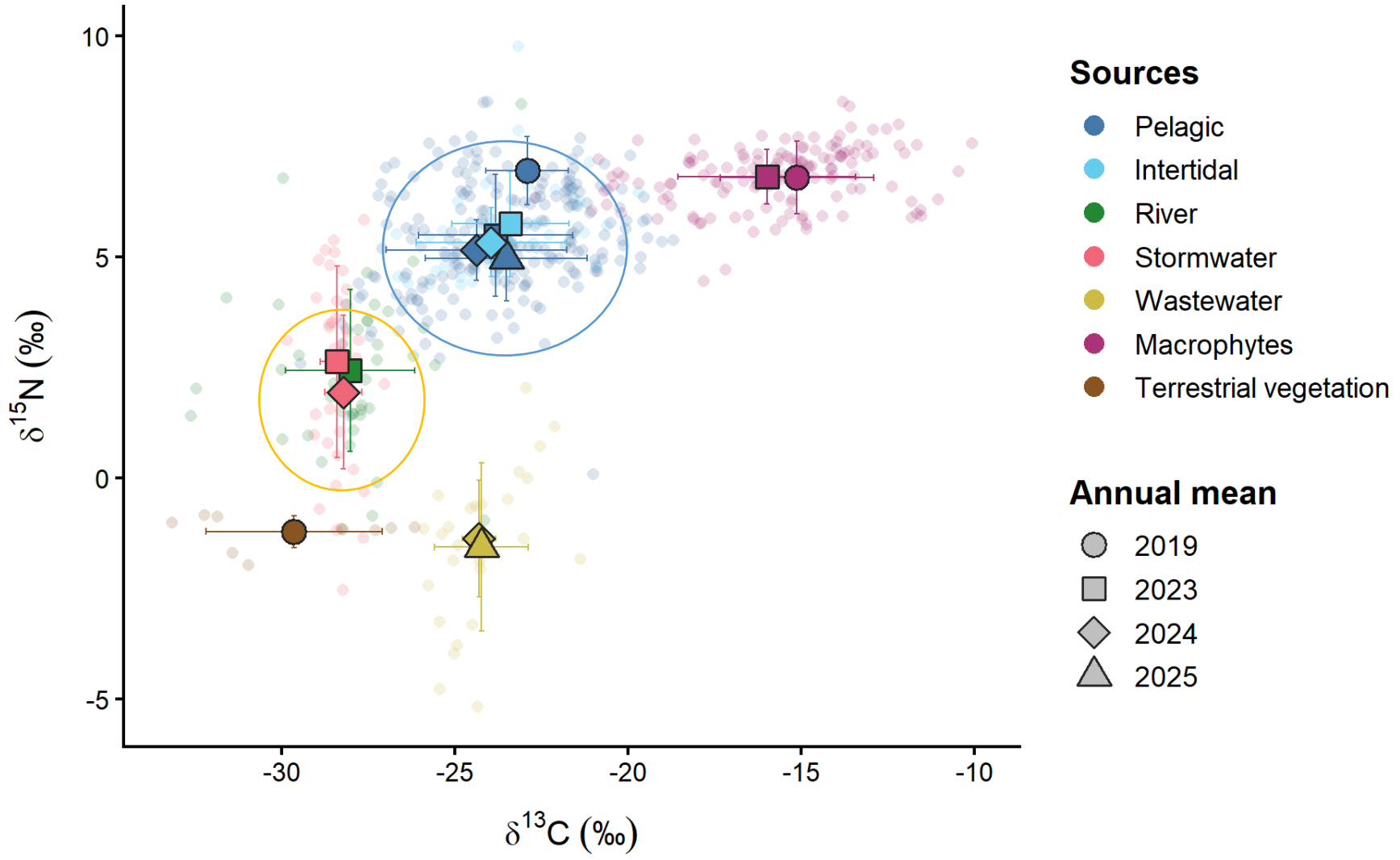
2025 NSERC Urban Oceans Survey



Bi-monthly surveys at 14 sampling stations

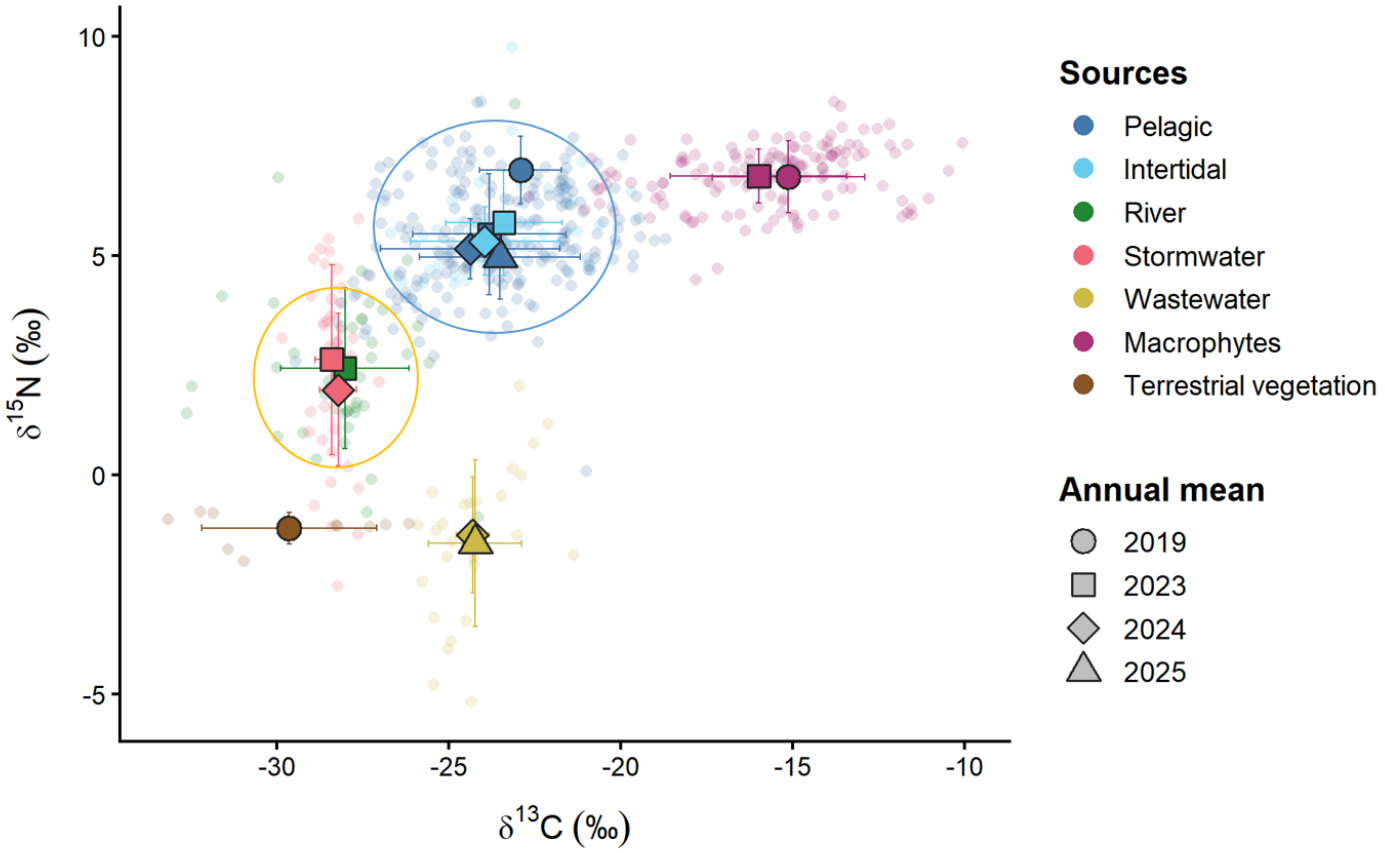
- CTD profiles
- Contaminants: caffeine and 6PPD-quinone (tyre additive)
- Chlorophyll-a and particulate organic matter (POM)
- Size-fractionated zooplankton (250, 500, 1000, 2000, 4000 µm)

Signatures of coastal inputs to Burrard Inlet



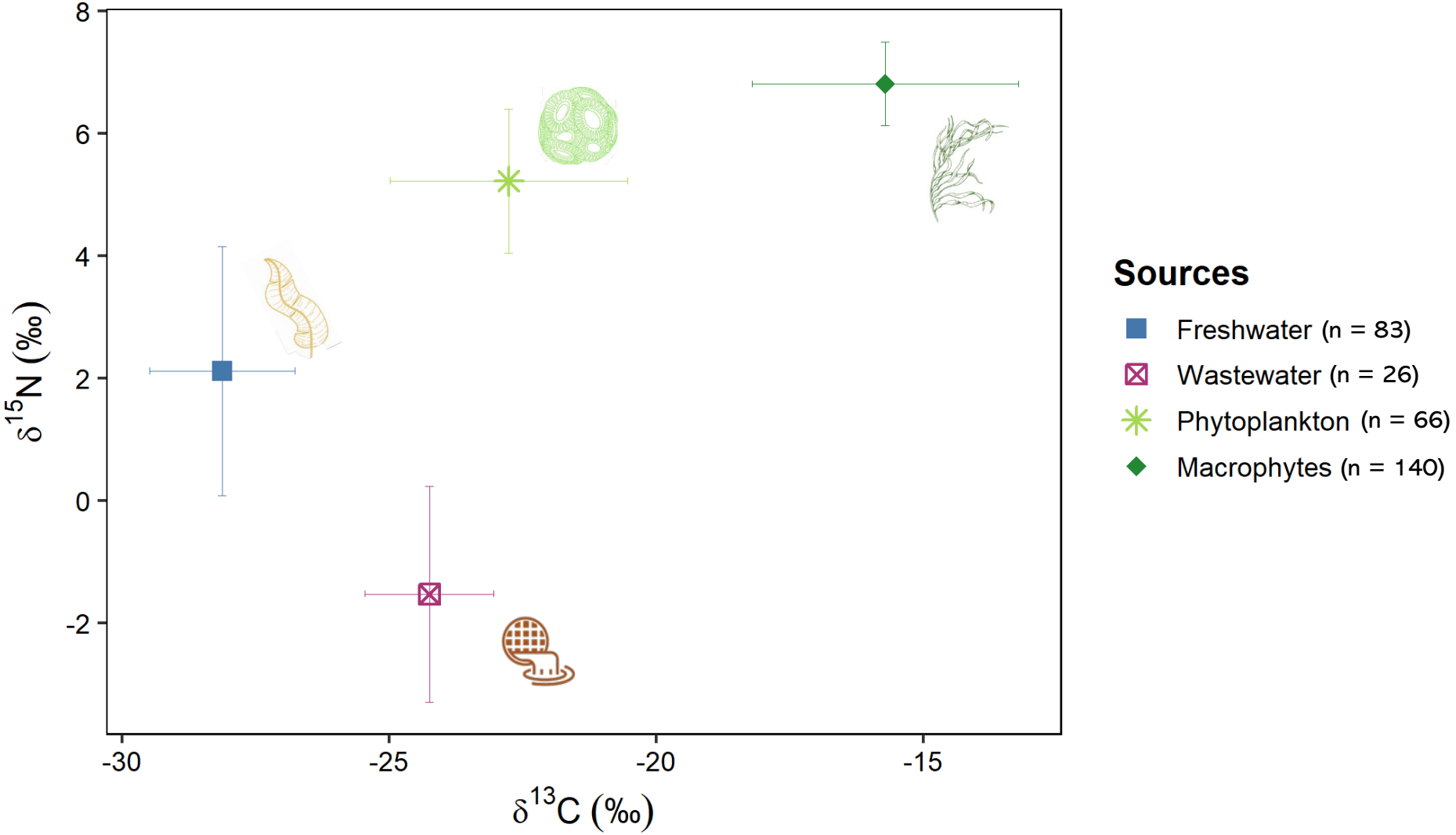
Terrestrial ⟷ Marine

Signatures of coastal inputs to Burrard Inlet

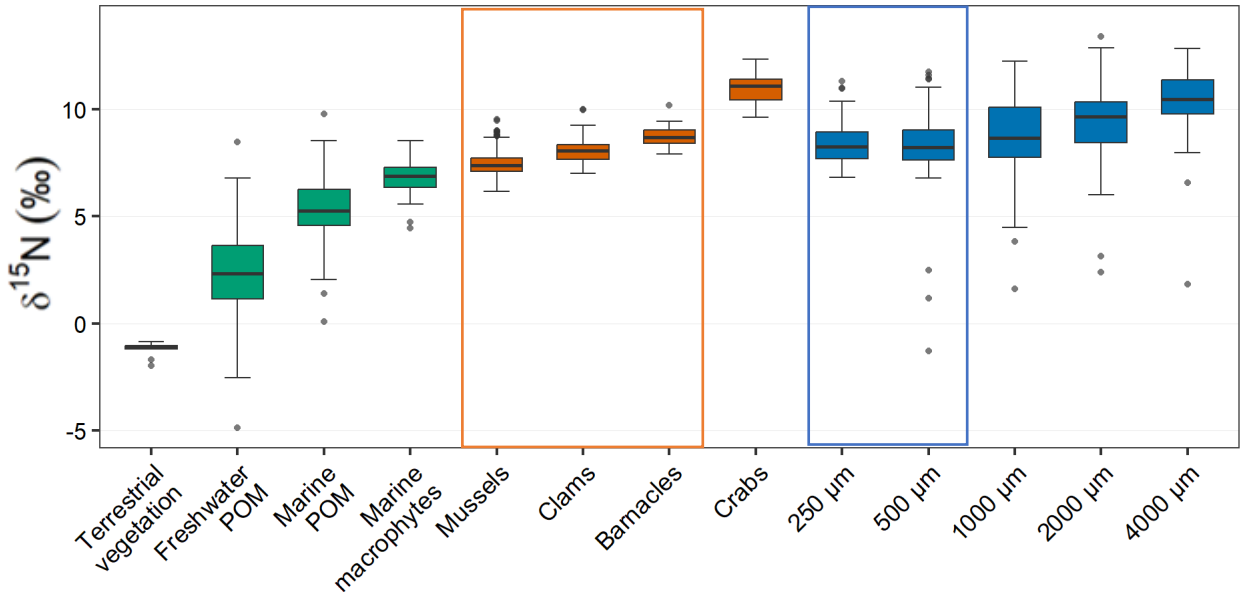


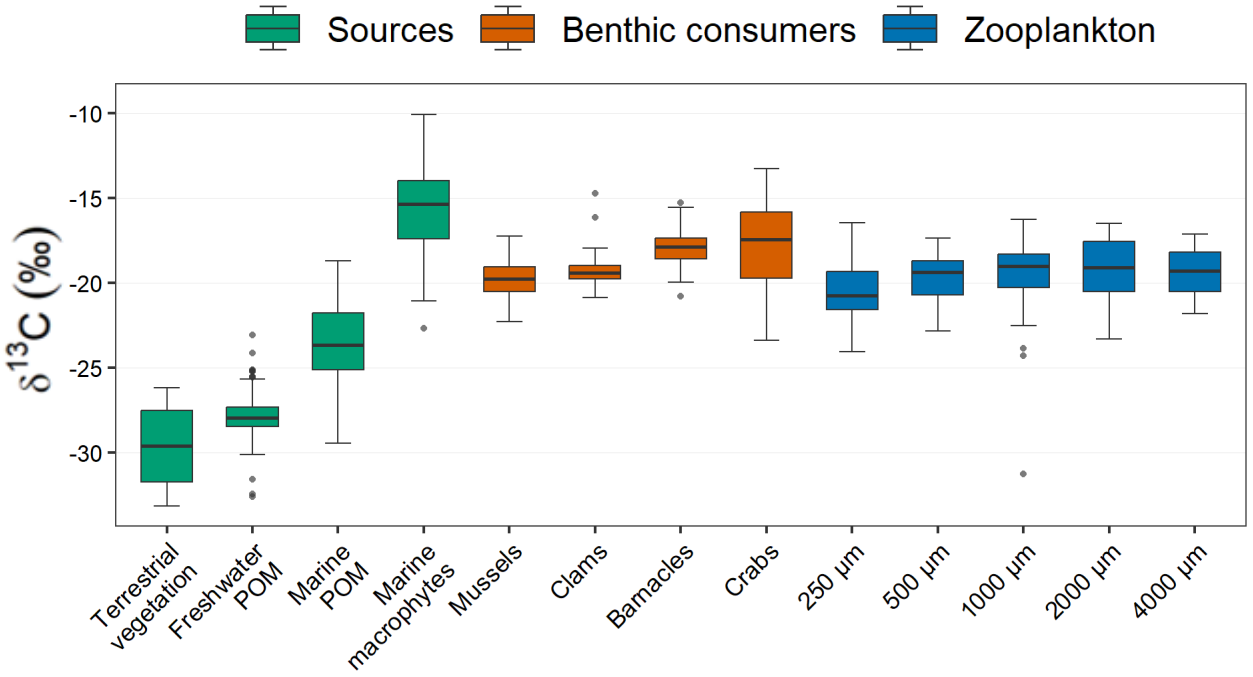
- Combining sources with strong overlap
  - Pelagic + intertidal > marine
  - Stormwater + river > freshwater
- Selecting phytoplankton from marine POM
  - Chl-a as proxy for phytoplankton
  - 75g g^{-1} POC:Chl-a threshold criteria

Selected sources for Burrard Inlet



Zooplankton in the context of the coastal food web



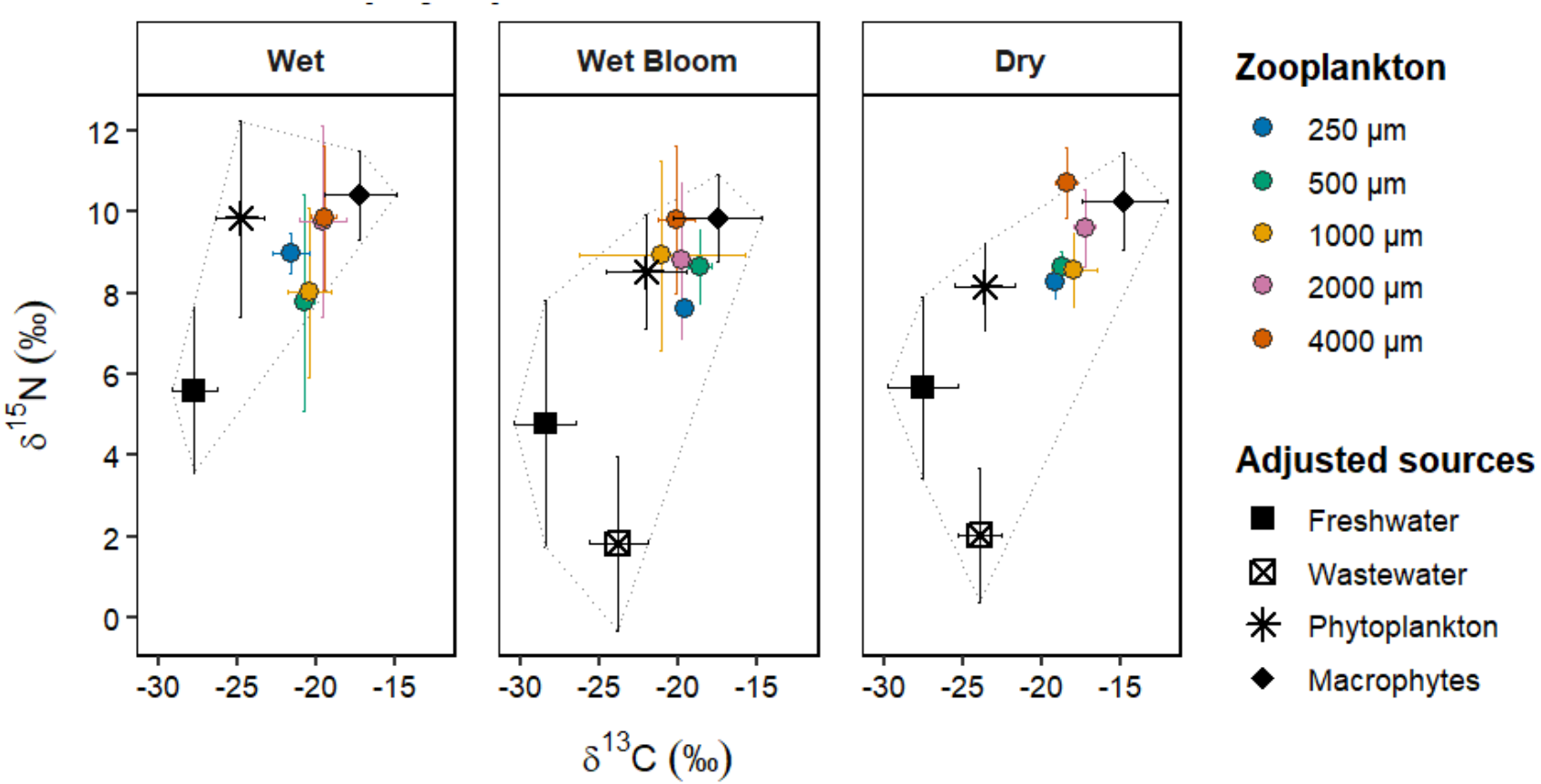


$\delta^{15}N$ = Trophic position
~ 3.4‰ = 1 Trophic level

$\delta^{13}C$ = Basal resource
~ 0.4‰ = 1 Trophic level

Mixing model suitability

Can source distributions plausibly explain seasonal variation in zooplankton isotopic niche?

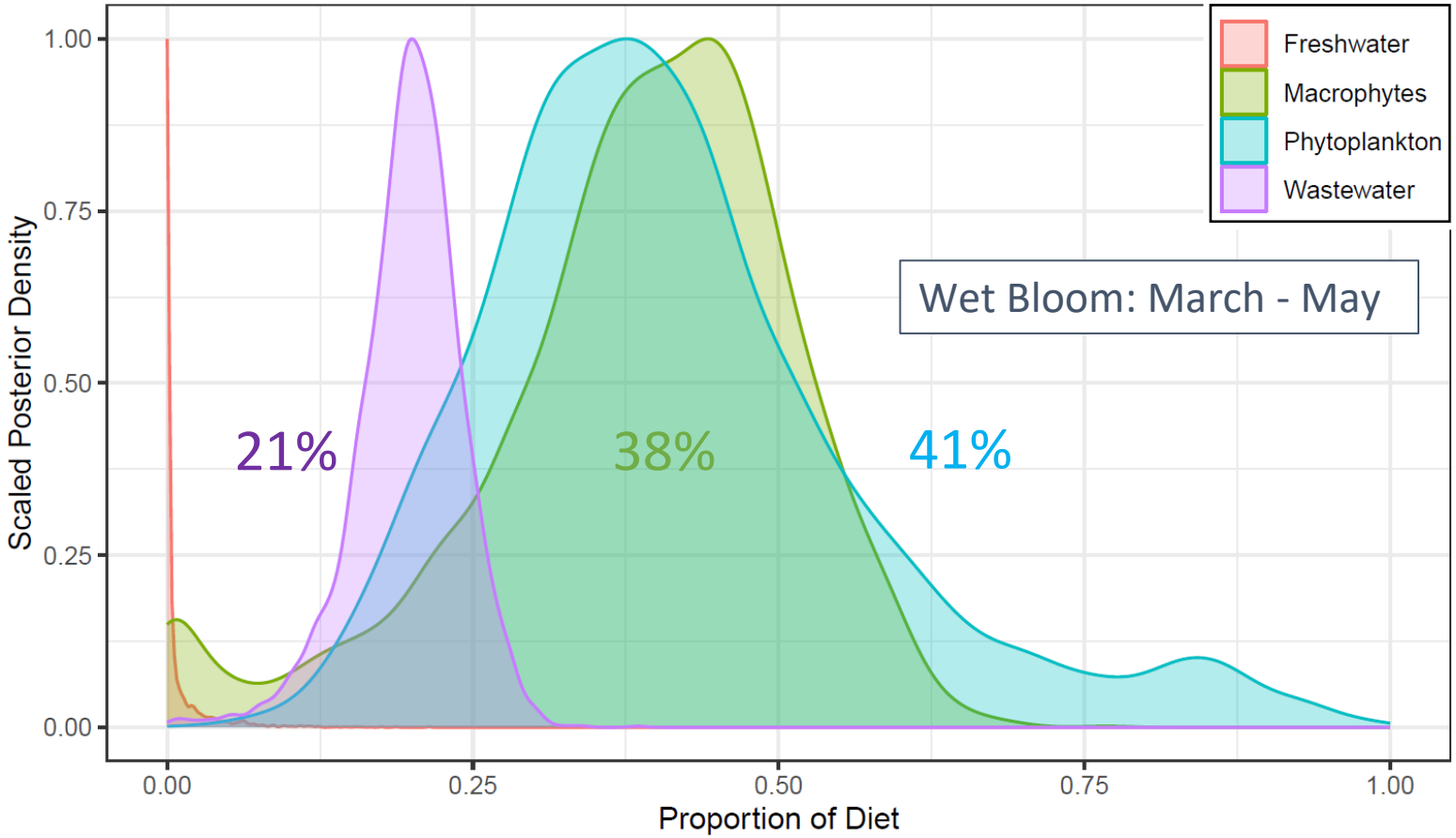


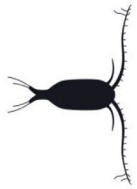
- Sources shifted up one trophic level (Post, 2002)
  - 0.4‰ δ^{13}C
  - 3.4 ‰ δ^{15}N
- Containment within identified sources
  - Poorer containment for larger size fractions
  - Wet season data limited

Seasons: Wet (Oct–Feb), Wet Bloom (Mar–May), Dry (June–Sept); Lye (2025)

Wet bloom mixing model

Consumers: 250µm zooplankton, **Sources:** proportional contributions defined by Lye (2025)





Predominantly **marine**-derived support to 250µm zooplankton



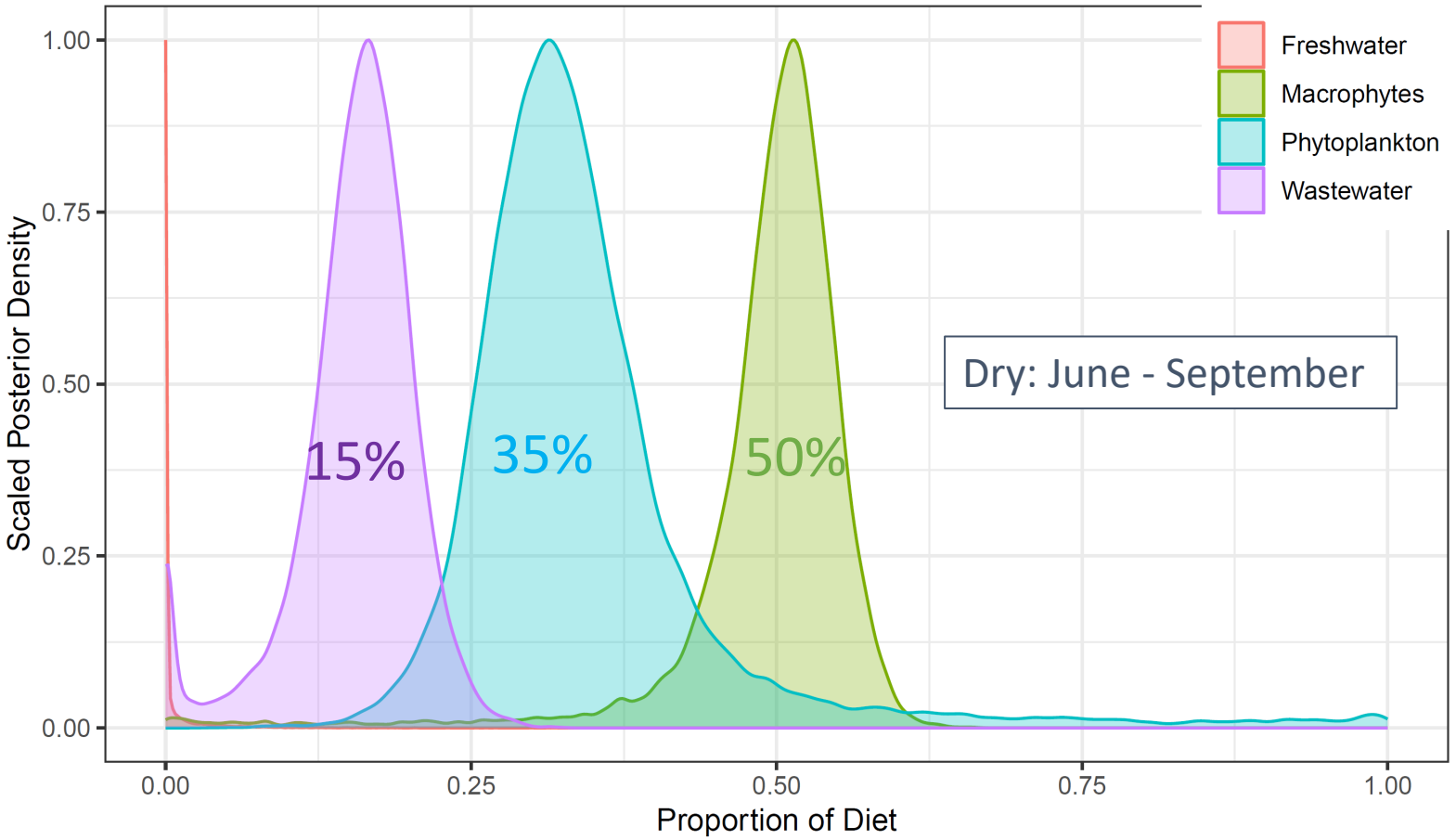
Wastewater contribution approx. 21%



Phytoplankton-macrophyte contribution division poorly constrained

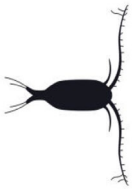
Dry season mixing model

Consumers: 250µm zooplankton, **Sources:** proportional contributions defined by Lye (2025)





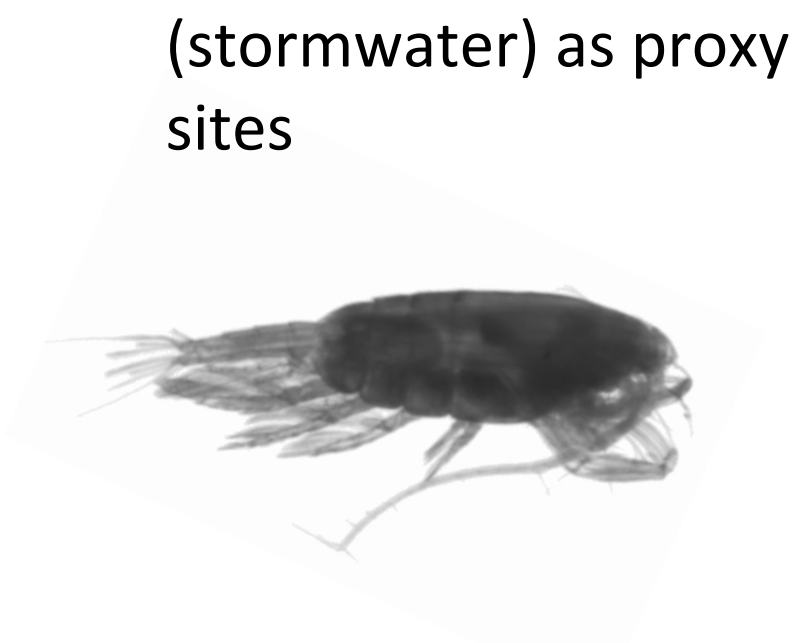
Marine consumption remains dominant with **less wastewater contribution**

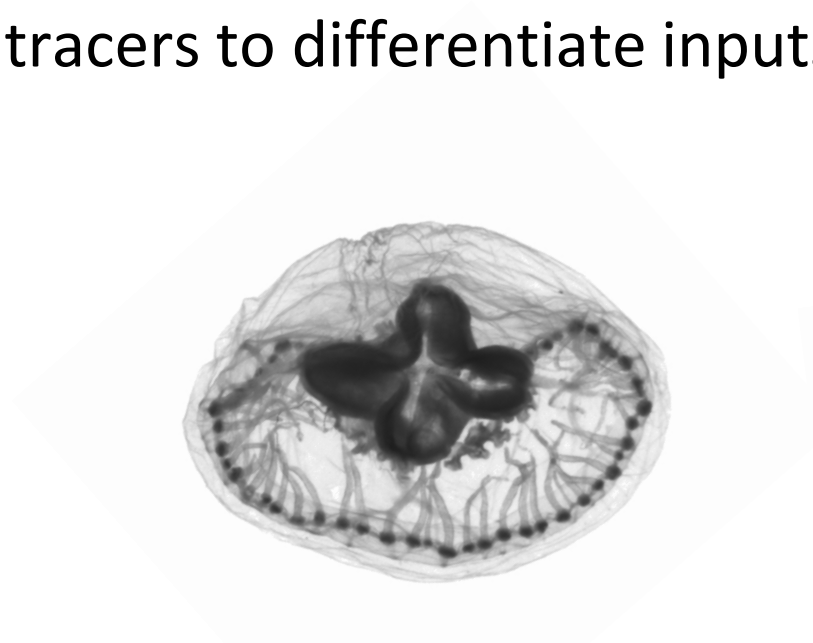


Convergence limitations due to limited phytoplankton candidates

Next steps

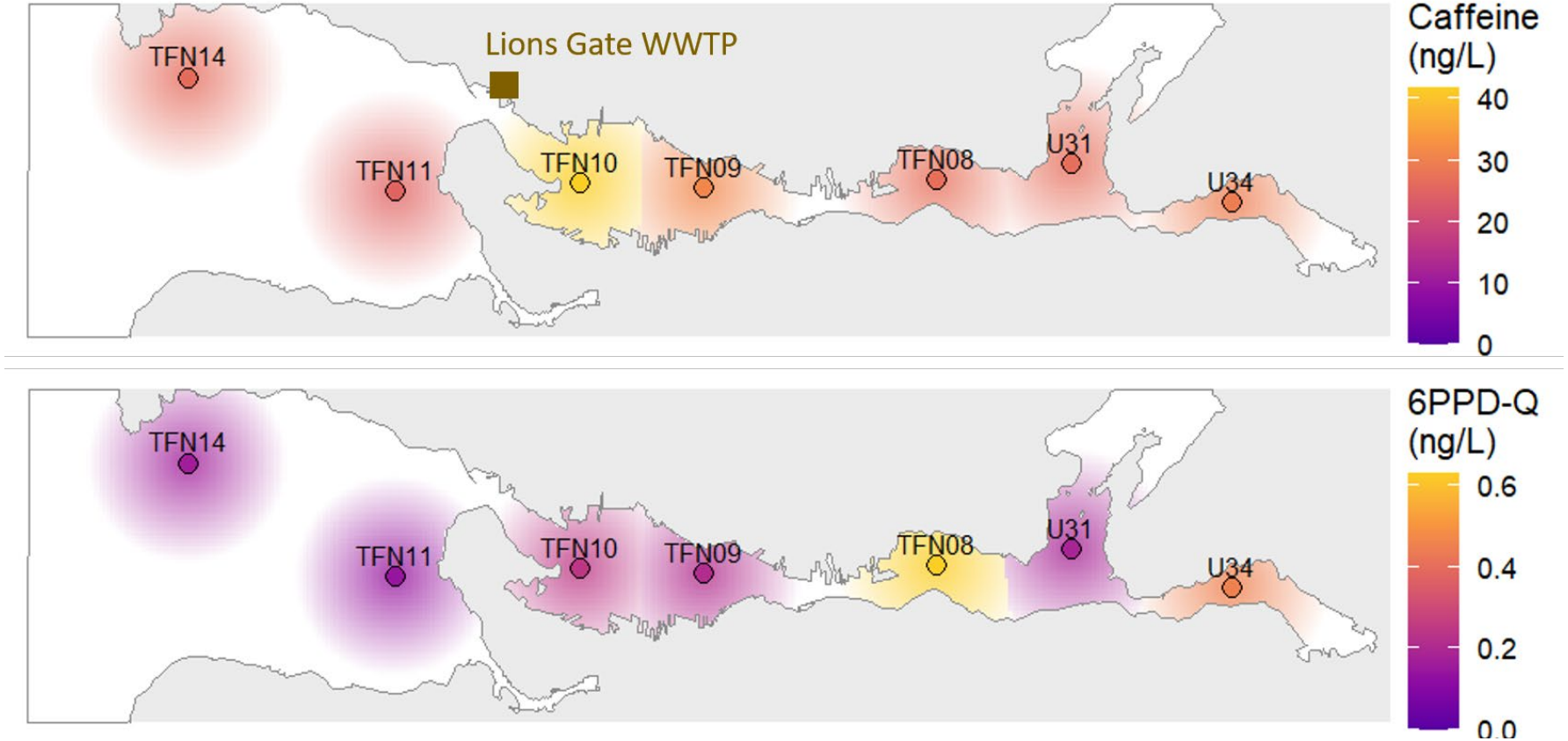
- Resolve spatiotemporal variation in zooplankton resource assimilation through **refining mixing models** using 2026 dataset
- Integrate **community composition** to separate assemblage turnover from within-taxon dietary shifts as drivers of resource use
- Develop **urban source indicators** from caffeine (wastewater) and 6PPD-q (stormwater) as proxy tracers to differentiate inputs and exposure across sites





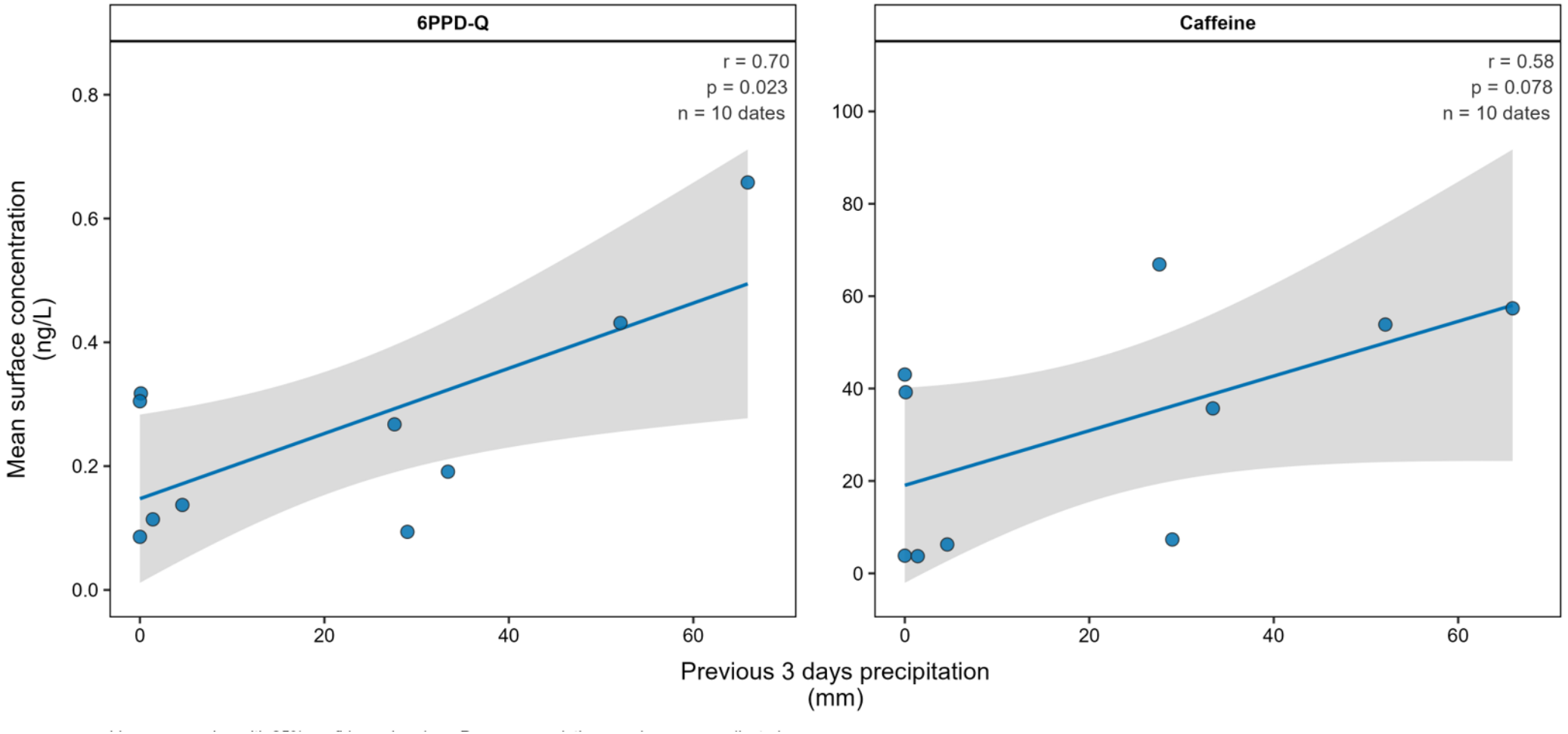


Tracers of wastewater and stormwater runoff



- **Spatial variation** throughout the inlet
- Differences in **peak concentrations** between contaminants
  - Caffeine greatest near wastewater treatment plant
  - 6PPD-q concentration notable at U34

Relationship between urban tracers and rainfall





Conclusions



- Coastal input sources retain **distinct isotopic signatures** across 2019-2025
- Preliminary mixing models estimate modest **wastewater contribution** to 250µm size class during wet bloom and lower assimilation in dry season
- Further **model refinement** required for resolving uptake into pelagic food web
- Promising initial patterns for **6PPD-q and caffeine** as **urban tracer** proxies



PELAGIC
ECOSYSTEMS
LABORATORY

UBC

Photo credit: Dr. Loïc Jacquemot

Acknowledgements

NSERC CRSNG

PETER WALL LEGACY AWARDS
THE UNIVERSITY OF BRITISH COLUMBIA

Fisheries and Oceans Canada
Pêches et Océans Canada

metro vancouver

PELAGIC ECOSYSTEMS LABORATORY

OCEAN WISE

IOF | UBC THE UNIVERSITY OF BRITISH COLUMBIA
Institute for the Oceans and Fisheries



Contact: s.moore@oceans.ubc.ca