

The effects of urban driven nutrient imbalance on phytoplankton community dynamics in Vancouver Harbour

Natasha Melo Buckiewicz, PhD Candidate

Stephanie L Moore, Anna McLaskey, Justin Del Bel Belluz, **Brian Hunt**

Contact: n.buckiewicz@oceans.ubc.ca

PELAGIC ECOSYSTEMS LABORATORY

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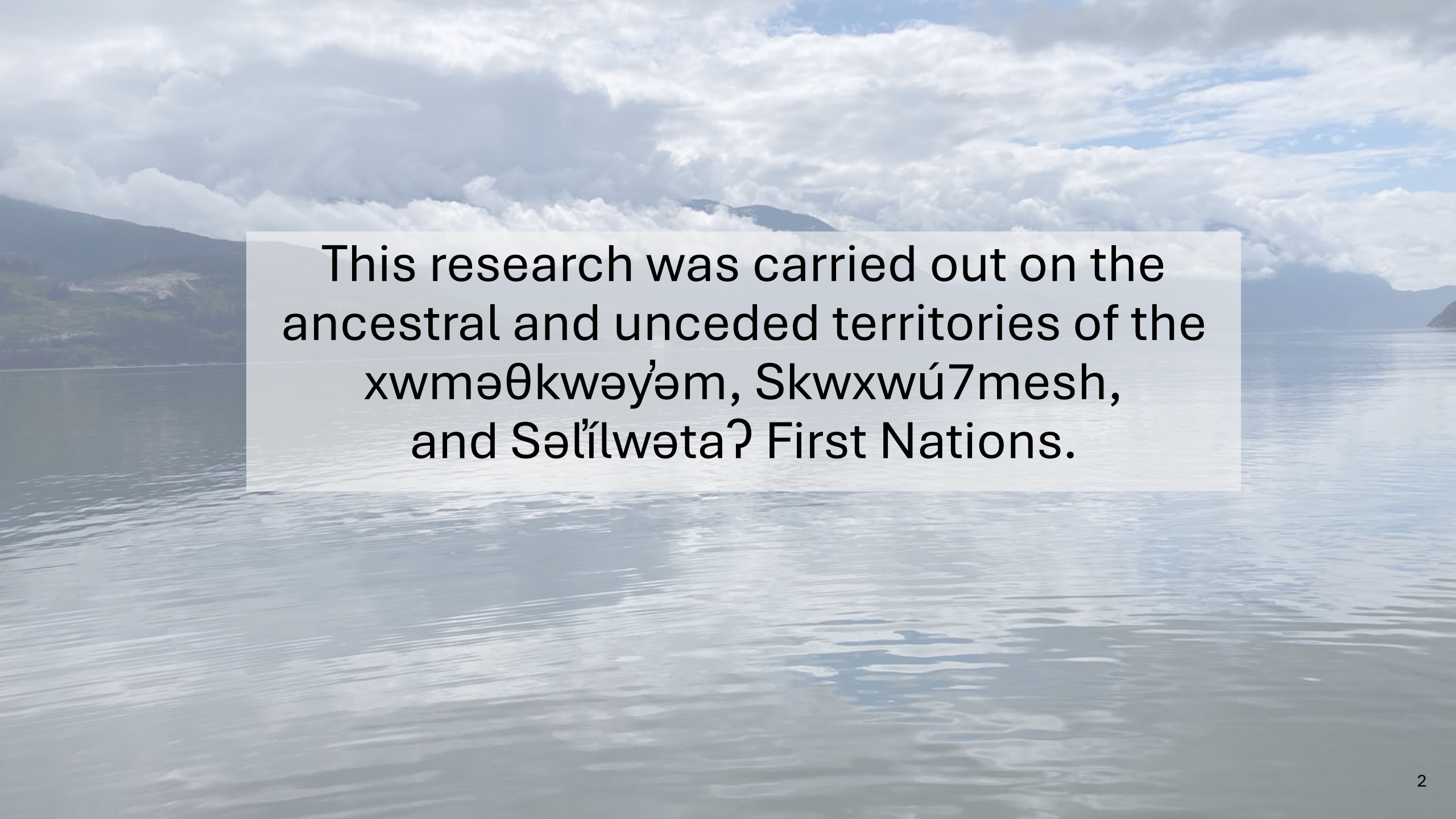
This research was carried out on the ancestral and unceded territories of the xwməθkwəy̓əm, Skwxwú7mesh, and Səl̓ílwətaʔ First Nations.

Coastal Ecosystems: Global Hotspots of Biodiversity



NOAA Ocean Service

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Terrestrial Inputs

Nutrients, sediments, dissolved organic carbon

Marine Response

Primary production, community composition, food web structure

Urbanization: Disrupting Land–Sea Connectivity



https://www.destinationvancouver.com/vancouver/

"Urbanization is the anthropogenic transformation of wildlands or agricultural lands to the built environment where people live and work." — Seto et al., 2012

Urbanization: Disrupting Land–Sea Connectivity



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Habitat Degradation

Shoreline Hardening

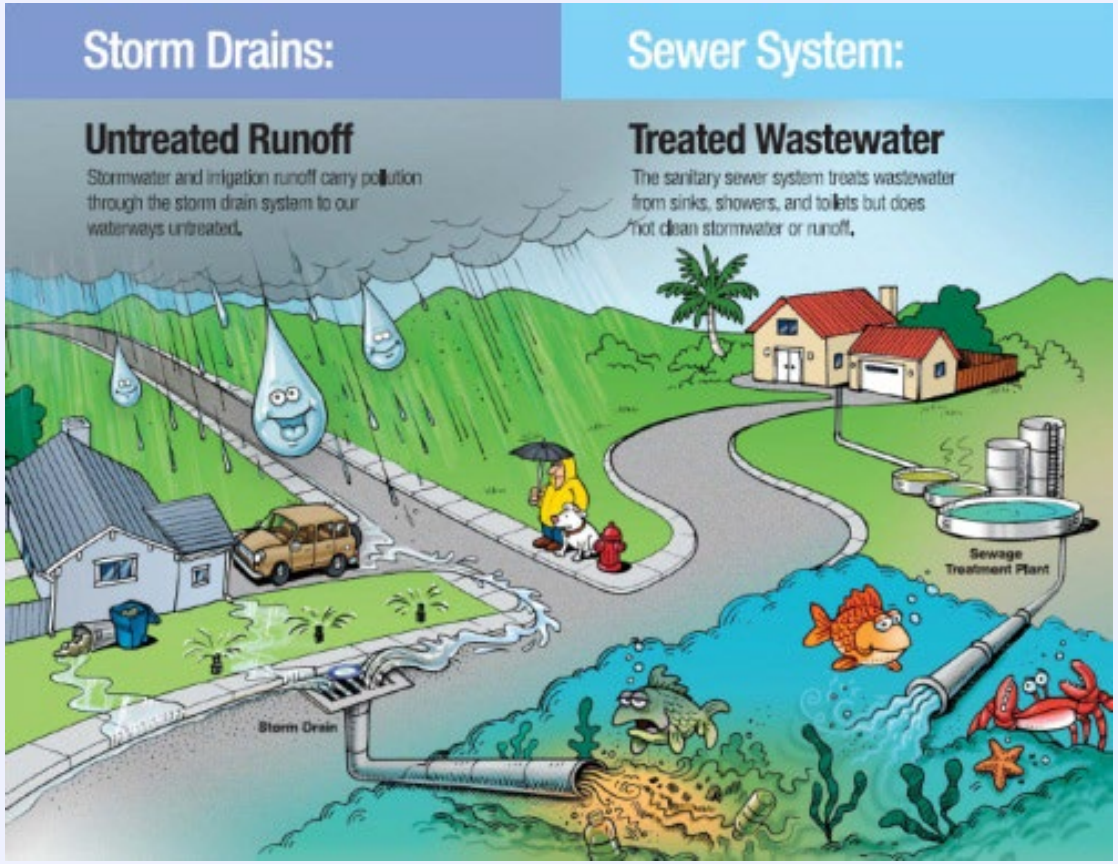
Coastal Squeeze

Water Quality Degradation

Stormwater Runoff

Eutrophication

Urban Inputs: Altered Freshwater Loads



Galveston County Health District

Suspended Solids

1,099% increase in total suspended solids relative to pre-urbanization (Levin et al., 2020)

Urban Runoff & Stormwater

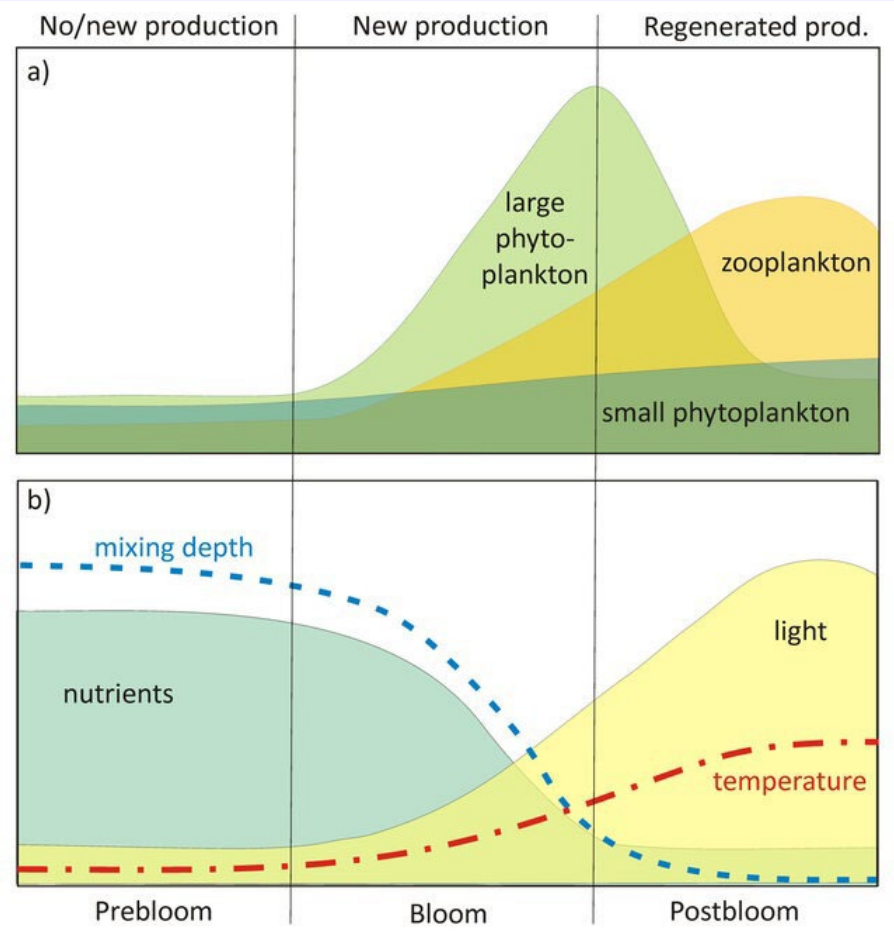
Delivers nutrients, particulates, and emerging contaminants

E.g. tire wear byproduct **6PPD-q**

Wastewater Effluent

Provides sustained inputs of bioavailable nitrogen, particularly $\mathbf{NH_4^+}$,

Nutrient Availability Shapes Phytoplankton Communities



Berreville et al. 2008

Diverse Growth Rates

Species-specific responses to temperature, light, and nutrients

Community Composition

Diatom spring bloom determined by stratification and access to Nitrates, Phosphates, Silicates

Trophic Nutrition

Supply essential lipids, proteins, and fatty acids to higher trophic levels

Nutrient availability shapes phytoplankton communities

Diatoms



Dominate during high nitrate conditions; require Silicate for frustule formation

Dinoflagellates



Stratified waters, when nutrients decline
Better competitors for low nutrient environments

Cryptophytes



Efficient uptake of reduced nitrogen (NH_4^+)

Research Aims

Nutrient Stoichiometry

1. How does urbanization contribute to nutrient inputs entering a coastal system?

Community Dynamics

2. What is the seasonality of phytoplankton communities and their relationship to nutrients in an urbanized coastal system?

Study Area: Metro Vancouver

North Pacific Coastal Temperate Rainforest

- Strong land to sea connectivity, seasonality
- High freshwater loading to the marine environment
- Fraser river-average discharge 3620 m^3/s
- High storm water flux: DOC, PN

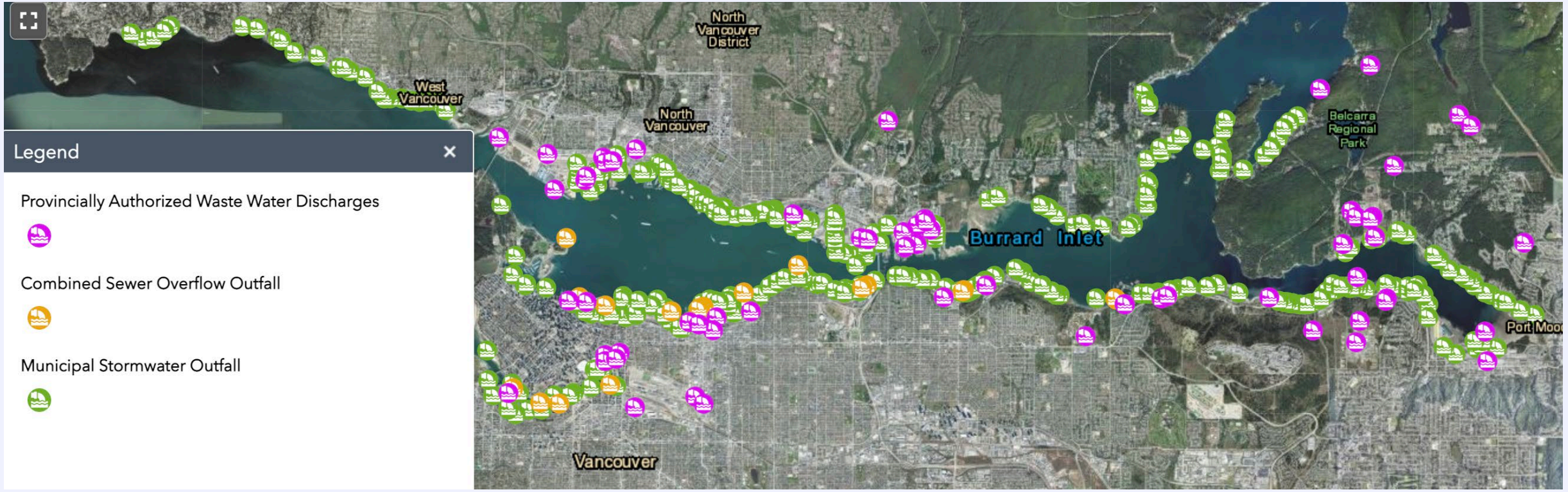




Burrard Inlet



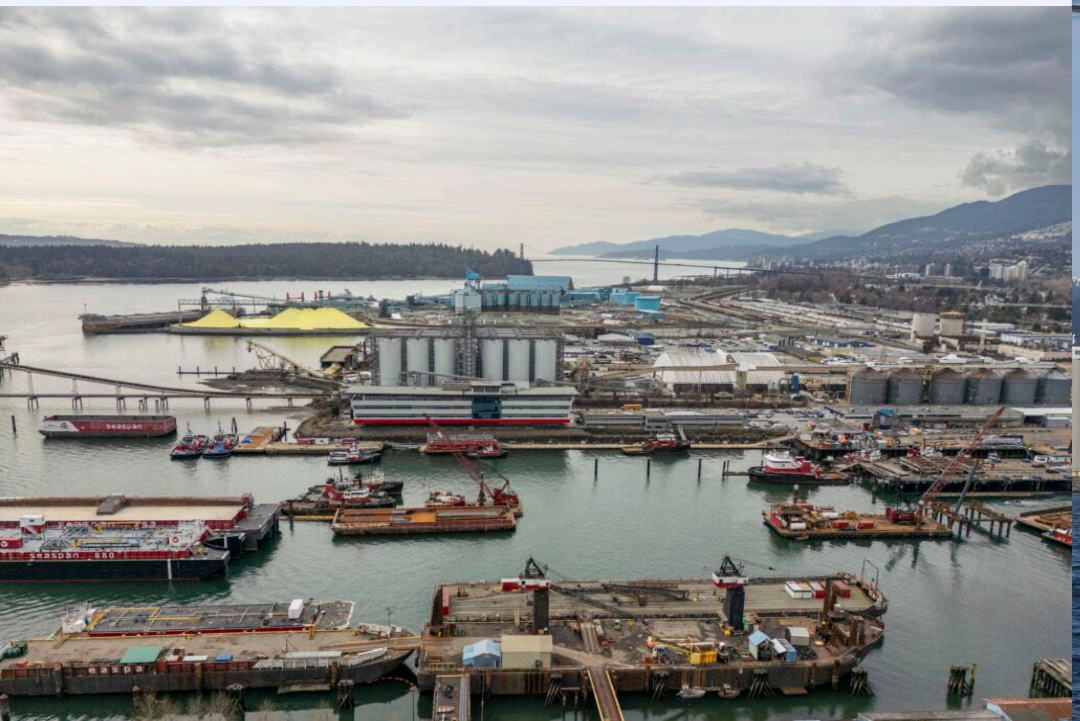
Burrard Inlet



Tsleil-Waututh Nation, 2023

An Urban Coastline







Methods

Seasonal survey bimonthly throughout 2025

Collection of oceanographic data (CTD)

Macronutrients (Nitrates+Nitrites, Silicate, Phosphate)

Phytoplankton community analysis (HPLC paired with Phytoclass)

Urban freshwater Indicators (Ammonia, 6PPD, δ15N)

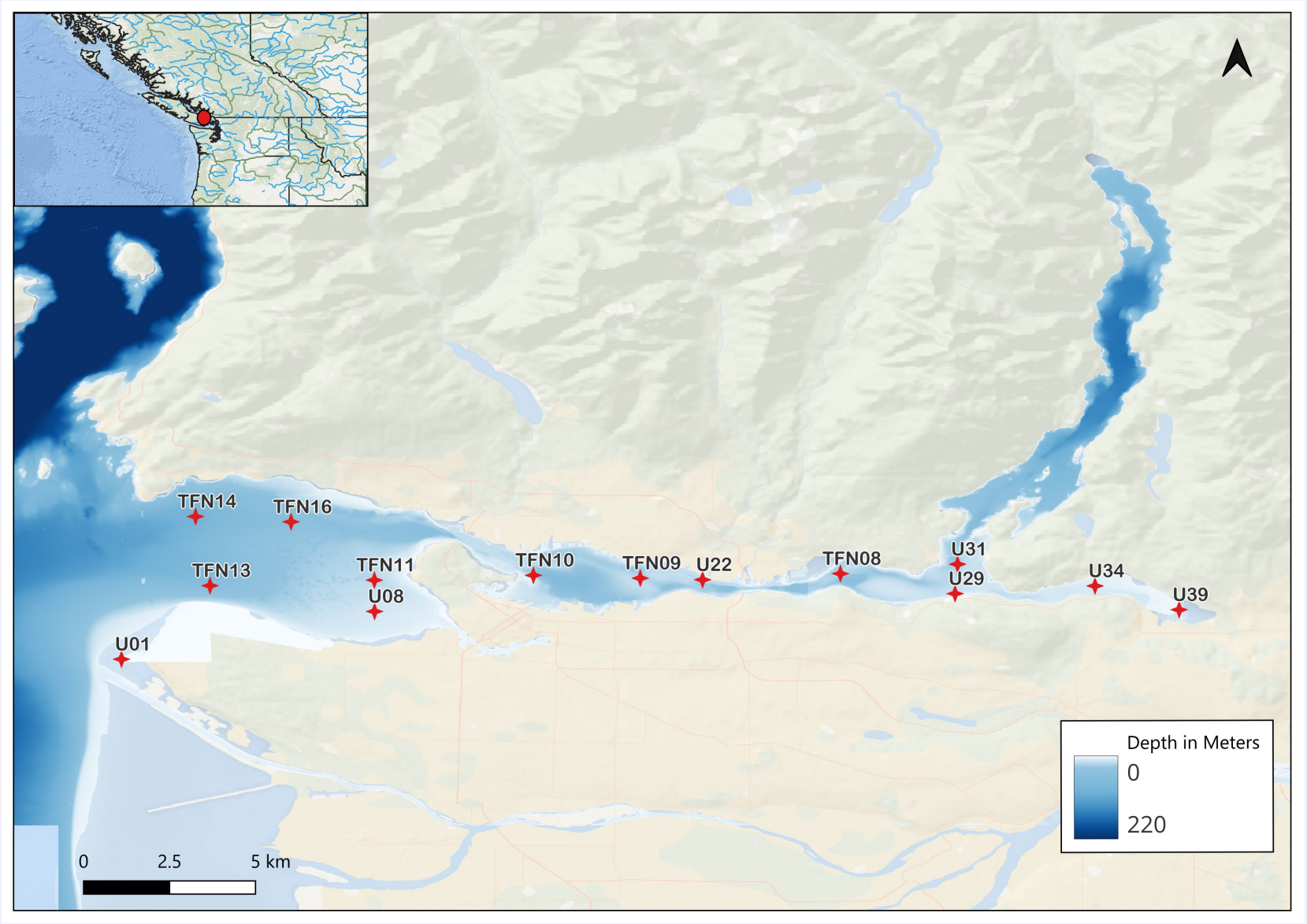








Urban Oceans Seasonal Survey- 2025



NSERC CRSNG

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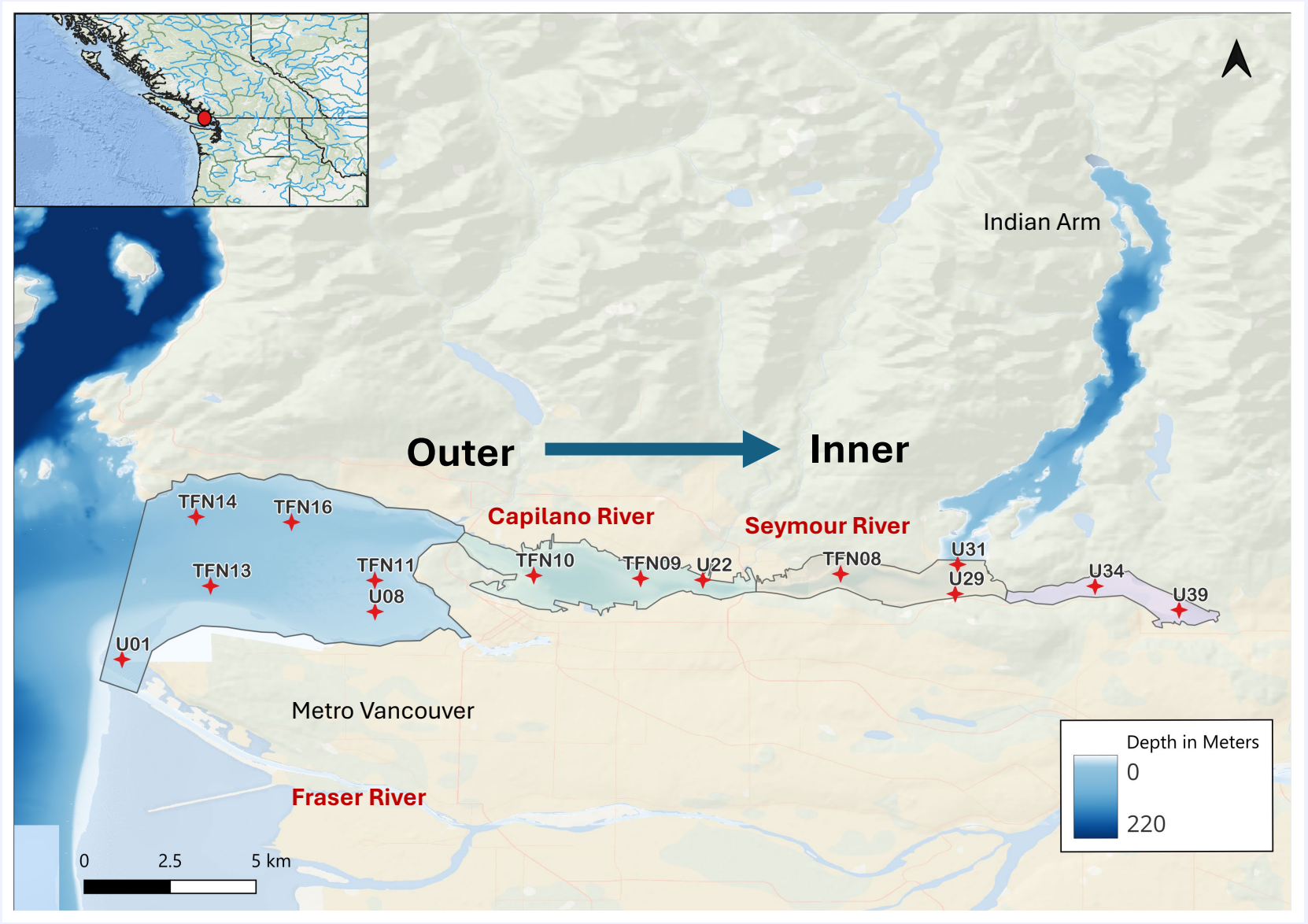
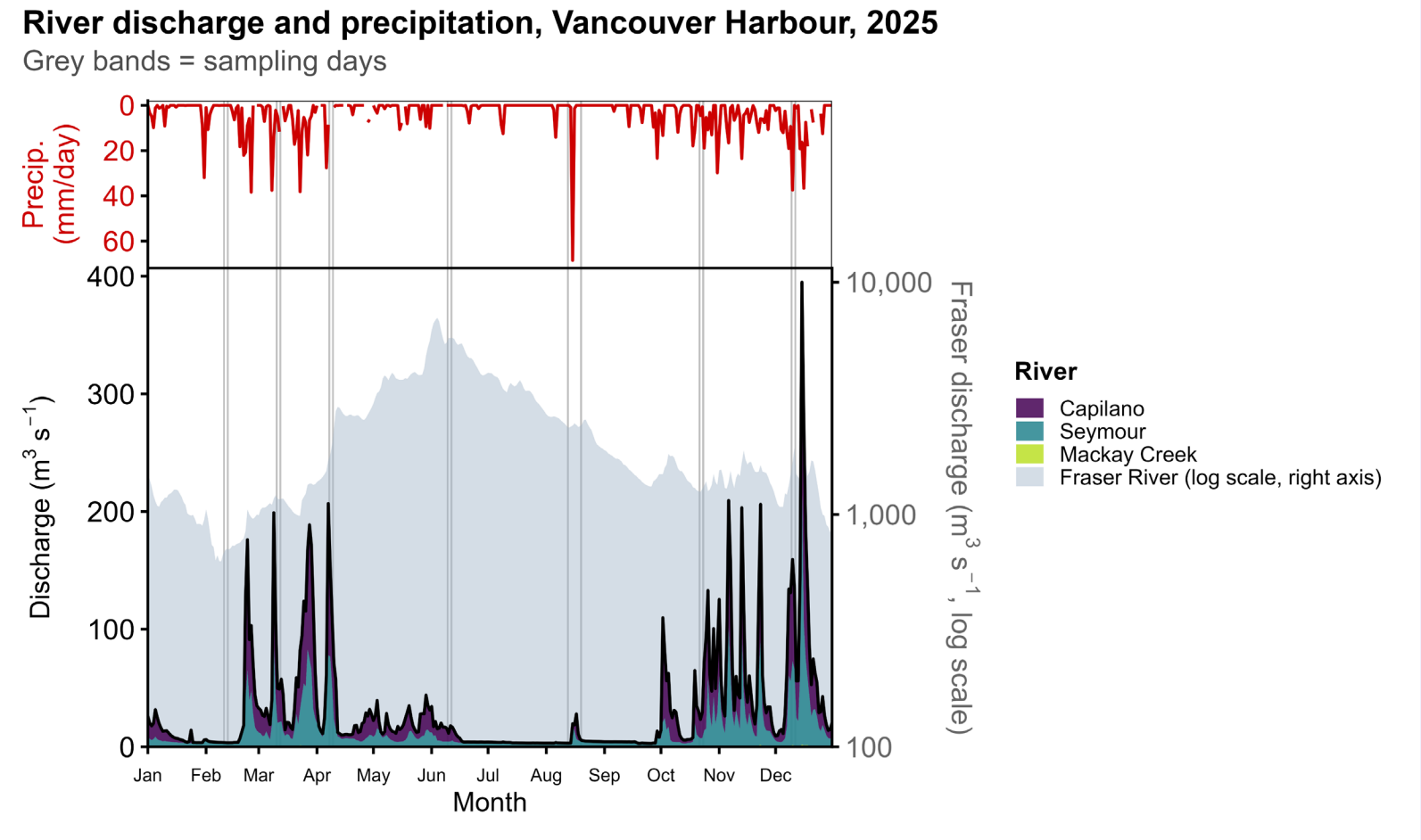
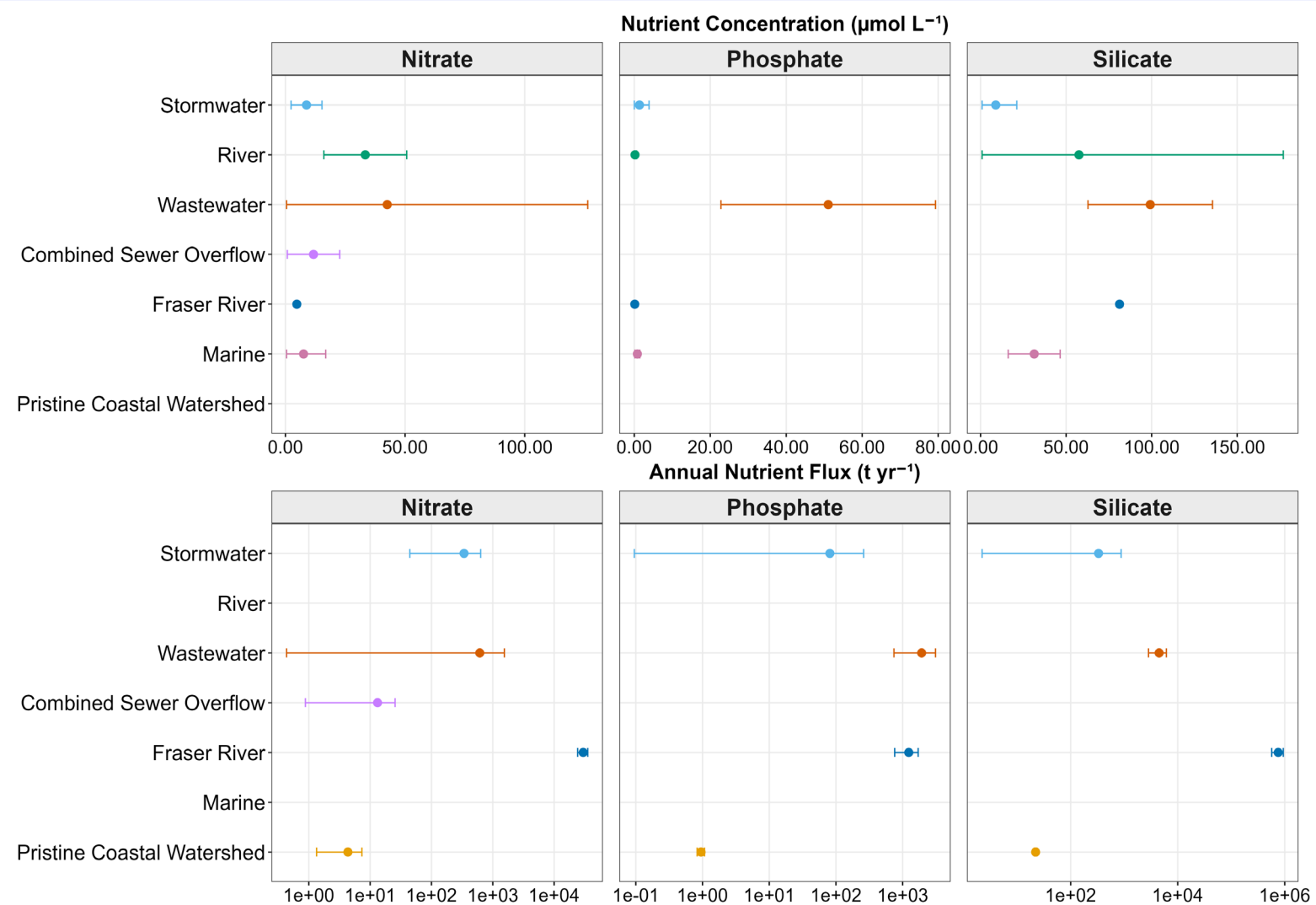


Freshwater Sources



Nutrient Sources and Fluxes of Metro Vancouver



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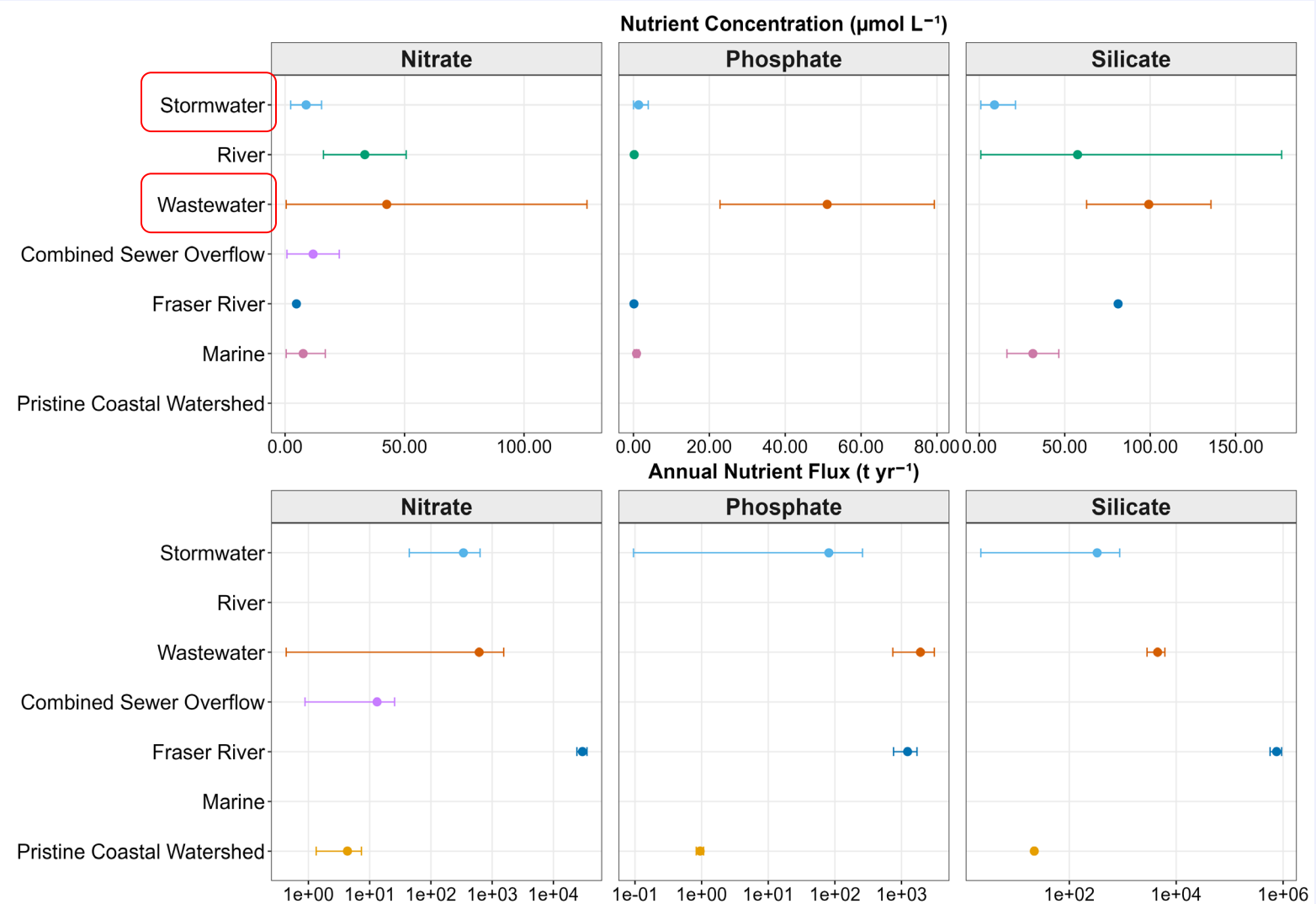

Wastewater delivers a high amount of nutrients, especially phosphate to the coastal ocean

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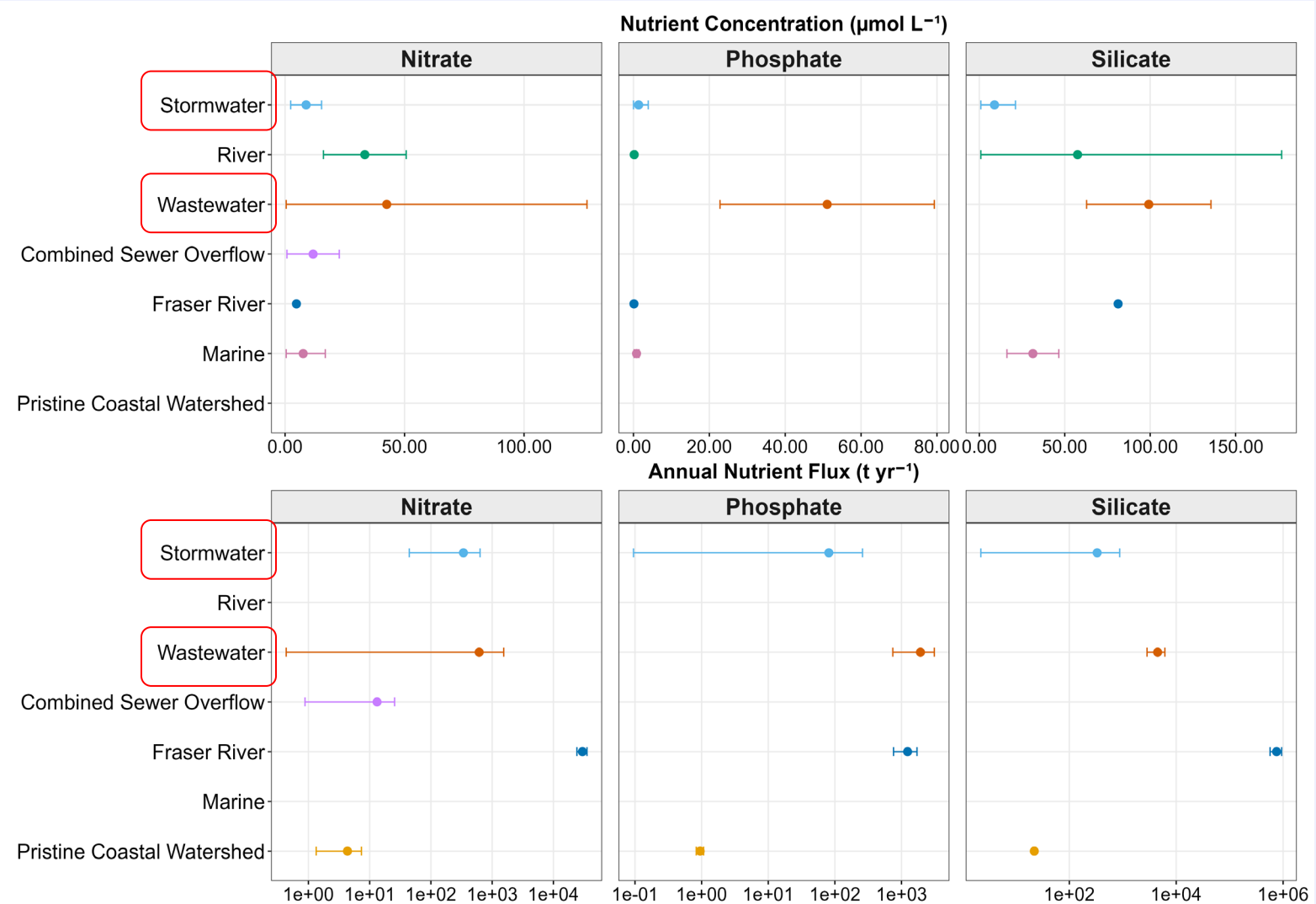
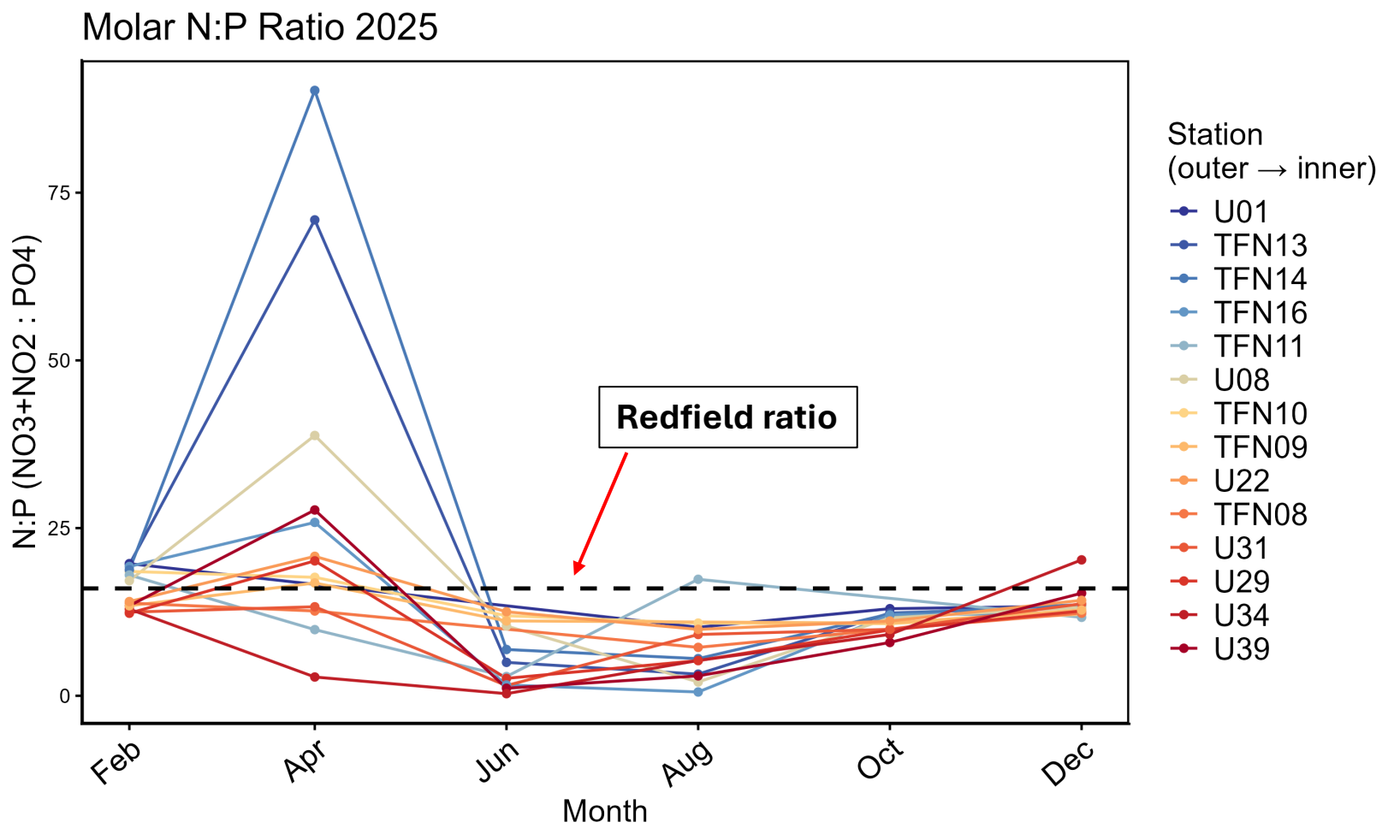


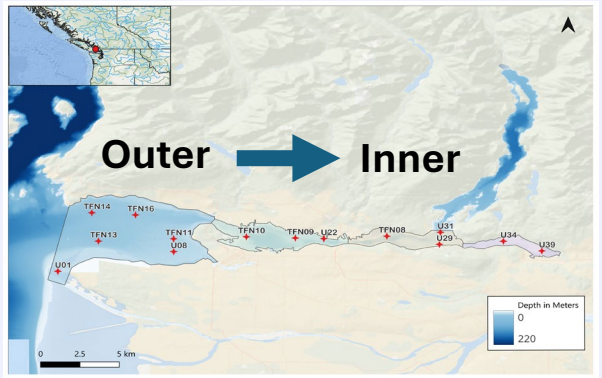
Wastewater delivers a high amount of nutrients, especially phosphate to the coastal ocean

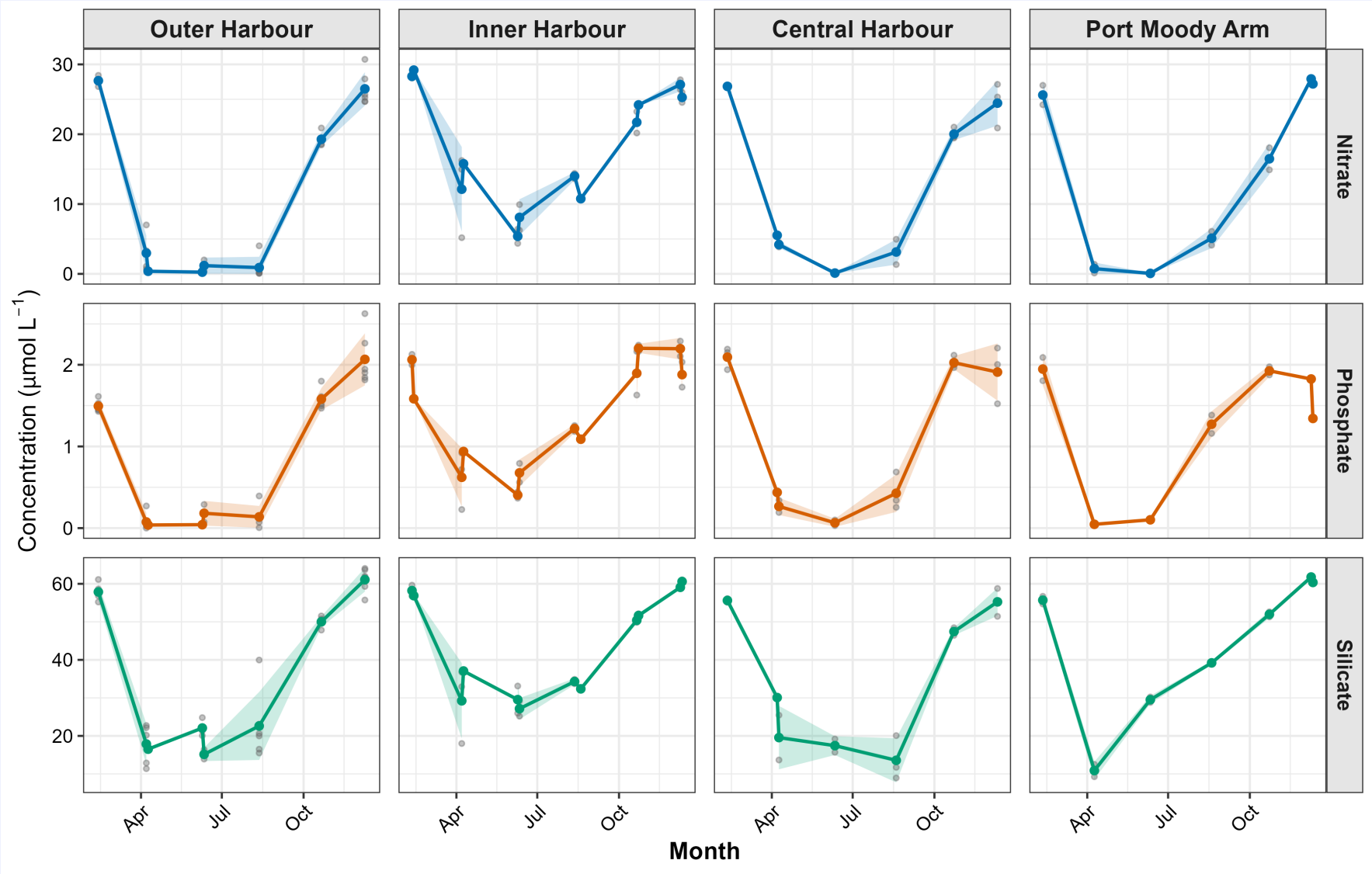
Stormwater delivers a meaningful flux of nutrients to the coastal ocean

Seasonal N:P ratios show nitrate as limiting nutrient



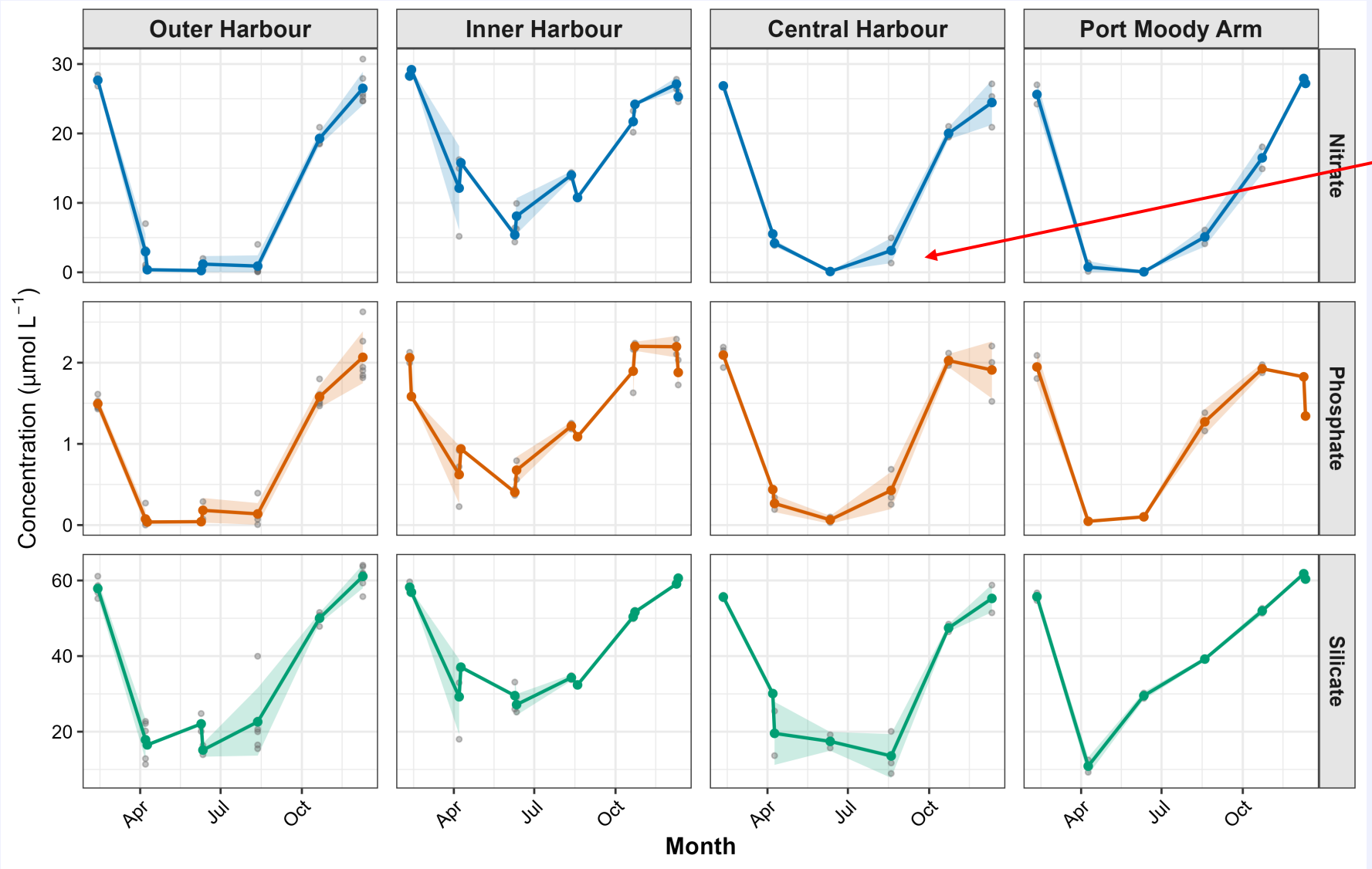
Macronutrient Surface Concentrations





Outer → Inner

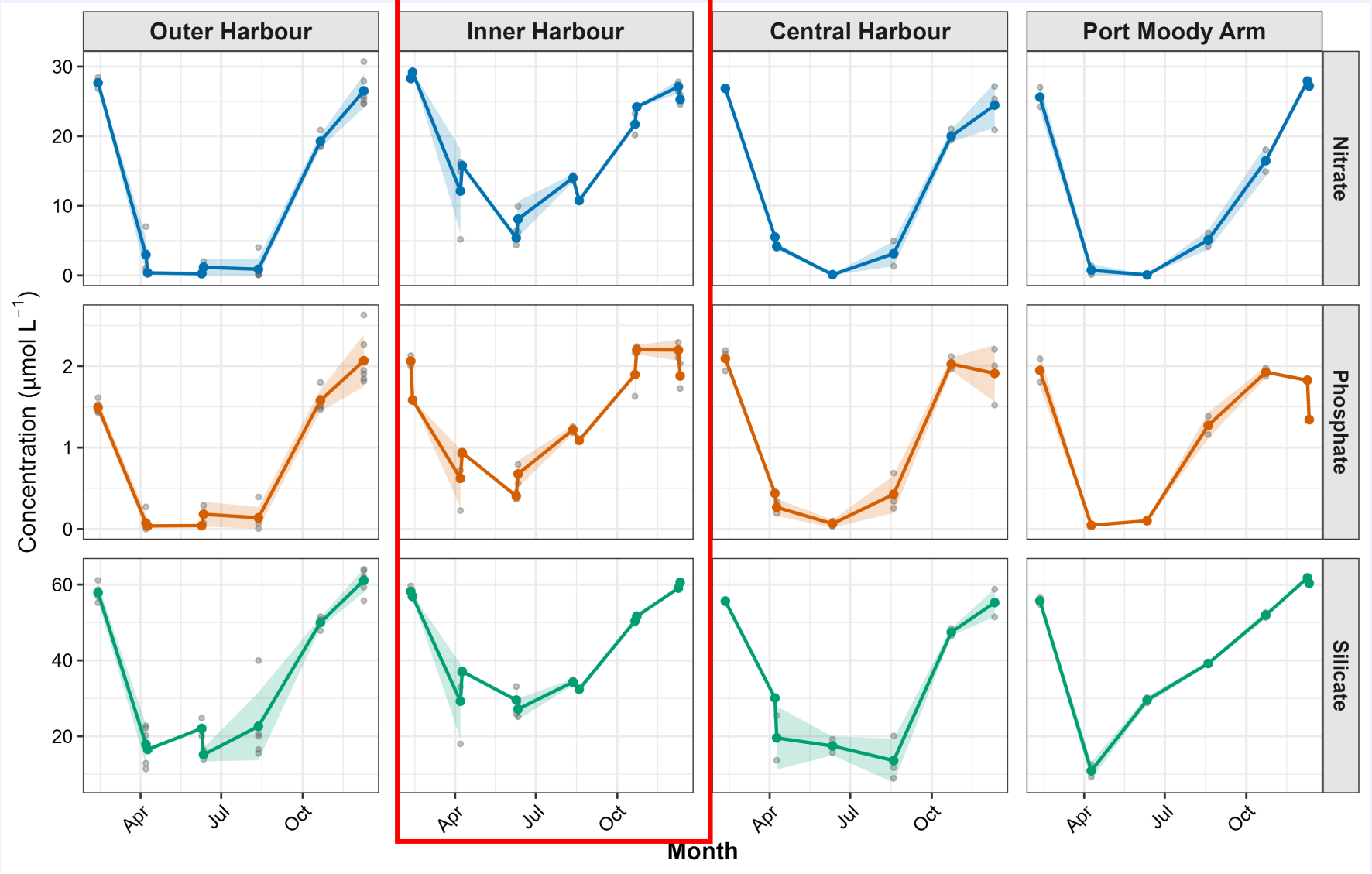
Macronutrient Surface Concentrations



Nutrient drawdown during spring bloom

Outer → Inner

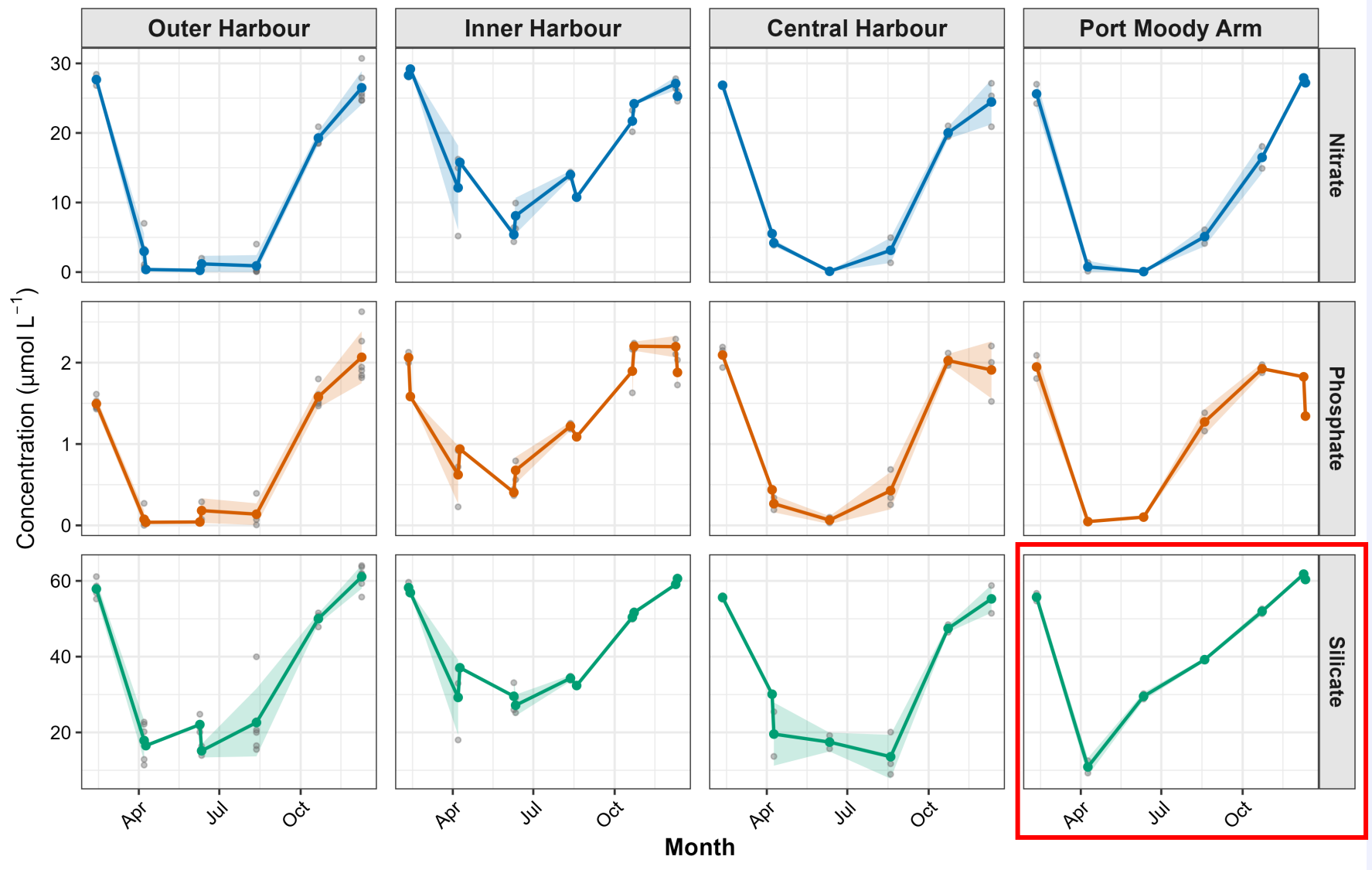
Macronutrient Surface Concentrations



Lowest nutrient drawdown in Inner Harbour where tidal mixing is highest

Outer → Inner

Macronutrient Surface Concentrations



Lower silicate utilization in Port Moody Arm post spring bloom

Outer → Inner

Research Aims

Nutrient Stoichiometry

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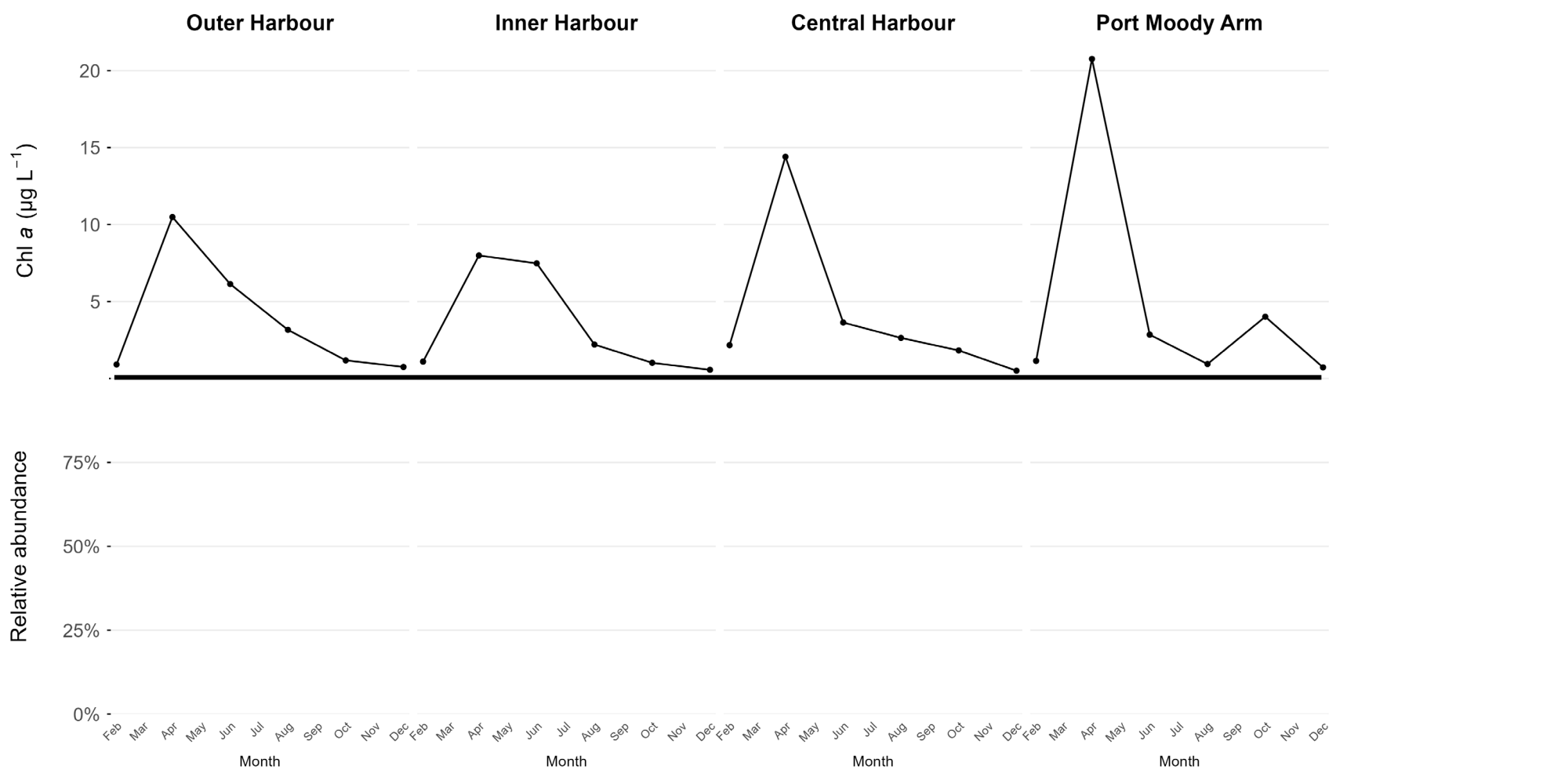
2. What is the seasonality of phytoplankton communities and their relationship to nutrients in an urbanized coastal system?

Seasonal Phytoplankton Community Composition

Determined by pigment-based chemotaxonomy and Phytoclass methods



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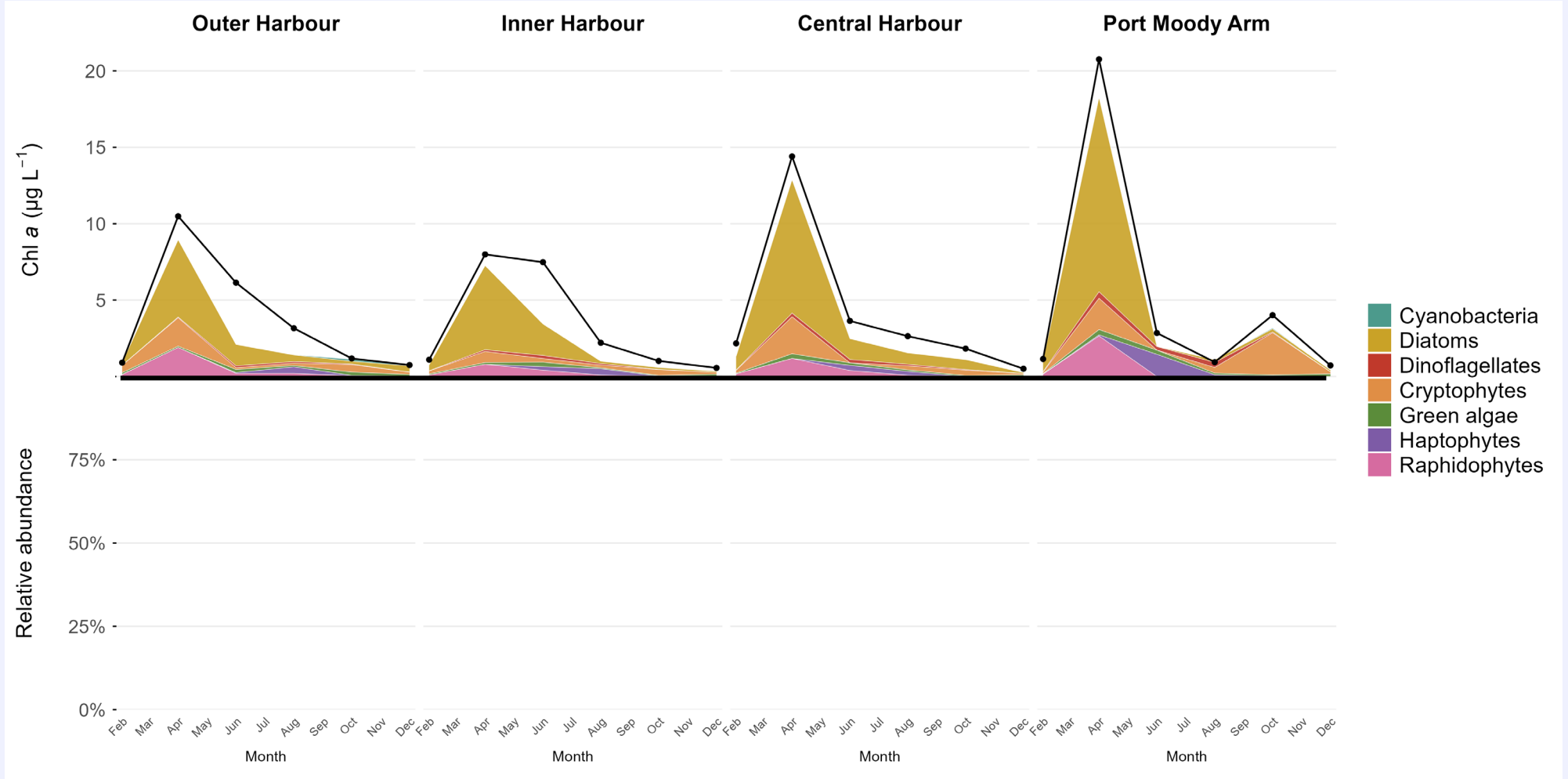

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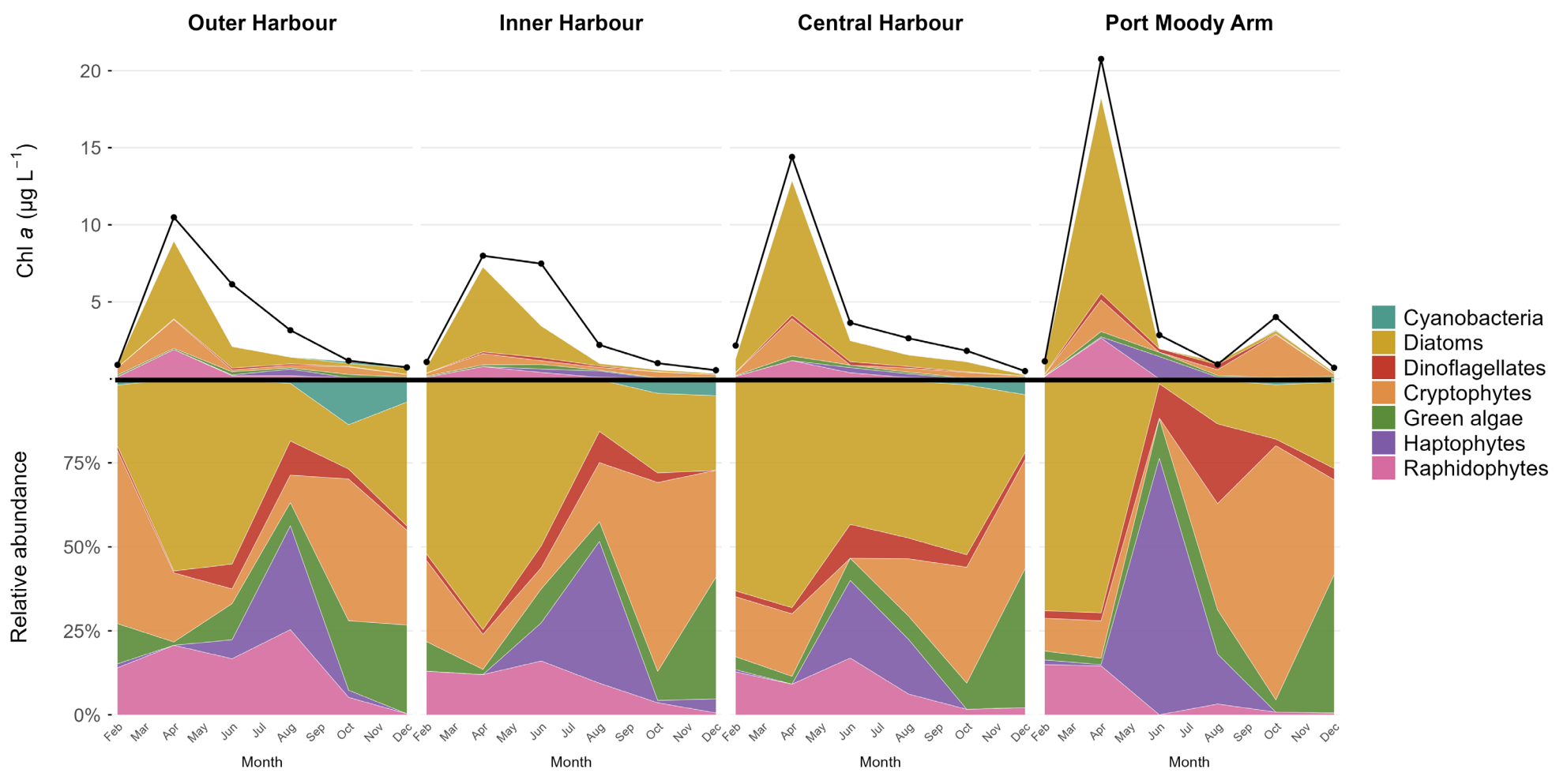

Outer → Inner

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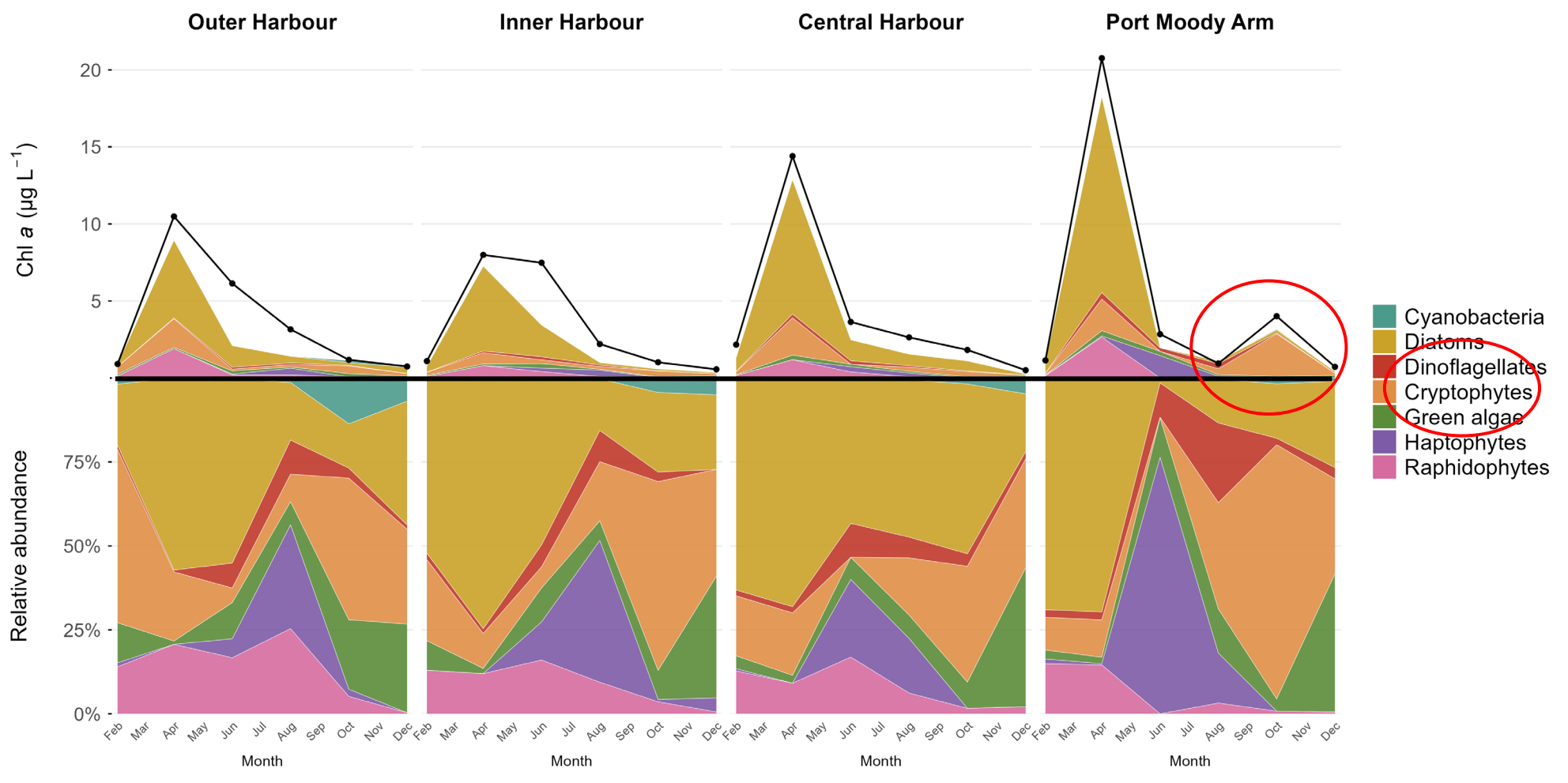


Outer → Inner

Conclusions

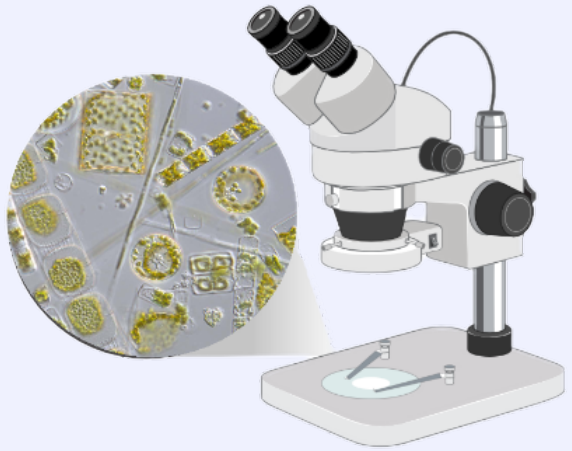
1. Seasonality structures phytoplankton succession

2. Urbanization may matter most where water is retained

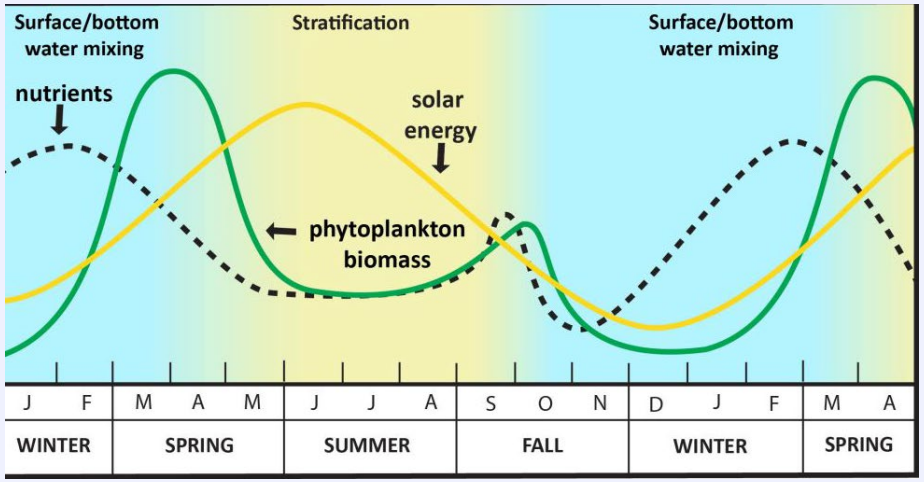
3. Urban inputs could shift which strategies succeed
   High DOM and regenerated N *may* favour mixotrophy

4. Consequences of altered community composition could change food quality for higher trophic levels

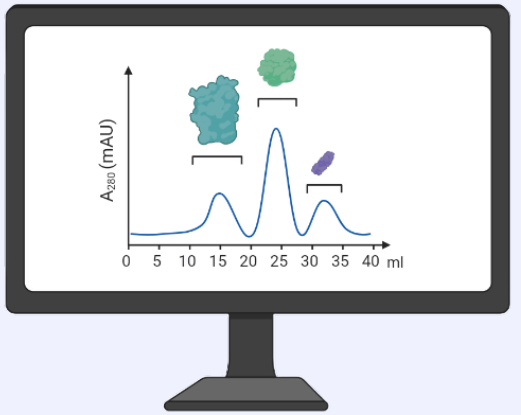
Next Steps



1. Microscopy



2. Fine scale bloom sampling



3. Fatty Acid Analysis

Thank you!

Contact: n.buckiewicz@oceans.ubc.ca

Supervisor: Brian Hunt
Committee: Maite Maldonado, Chris Parrish, Rana El-Sabaawi
Field Work: Stephanie Moore, Chris Payne, Deniz Coskuner
Lab Work: Anna McKlaskey, Aoniya Colynn, Jacobo Abad Gonzalez, Lief Bjornson
Support: Pelagic Ecosystems Lab

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