

compilation of

essential ocean variables

for **British Columbia** *based on*
nine decades of observations from disparate databases:

***biogeochemical
regionalization,
variability and trends***

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Brian P.V. Hunt, Stephanie Waterman, Jennifer M. Jackson
thanks to Hayley Dosser and Patrick Pata



Hakai
Science on the Coastal Margin

Mitacs

Tula
TULA FOUNDATION

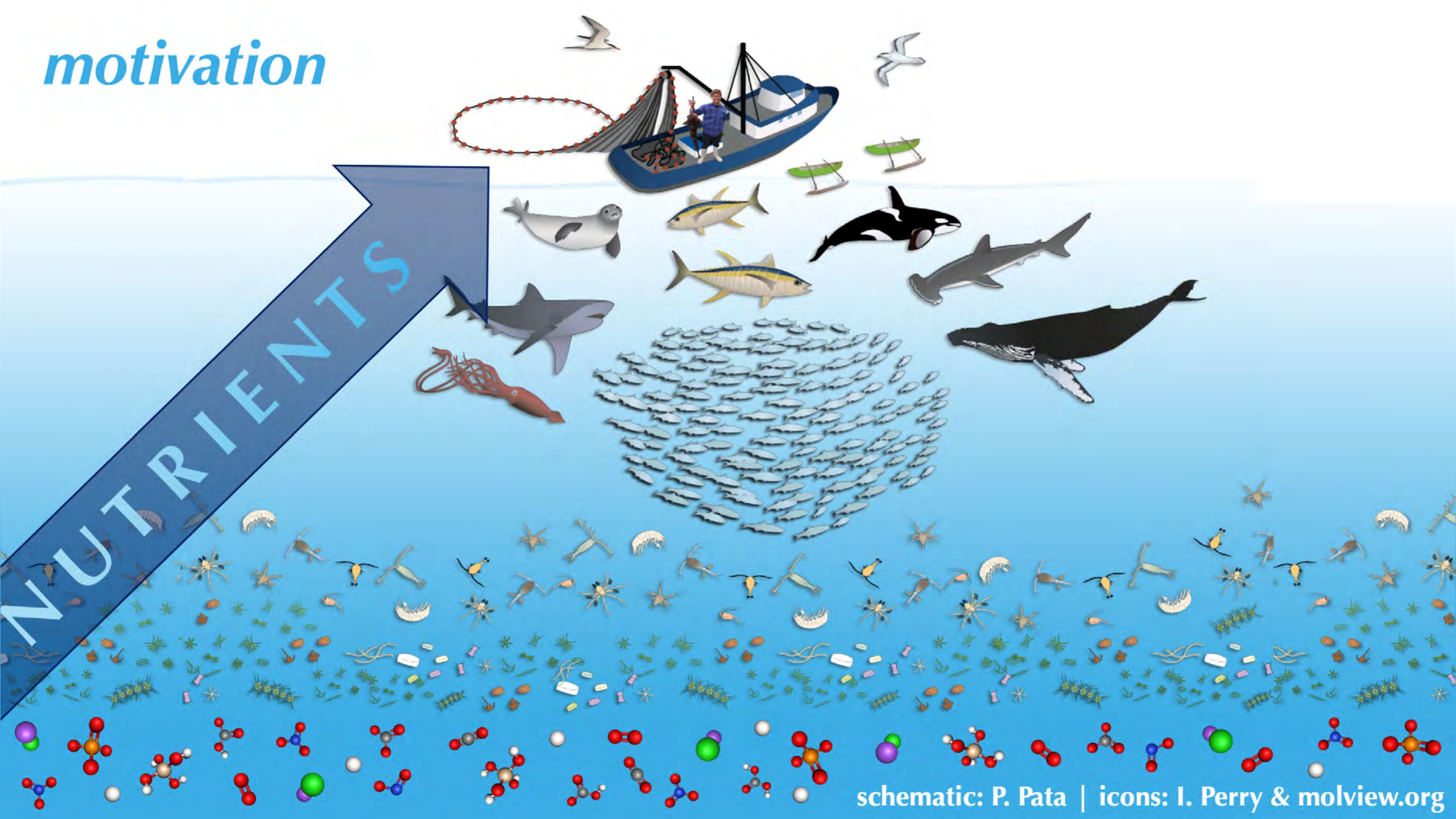
data-driven biogeochemical regionalization

- complementary to conventional methods
- dynamic regions
 - seasonal variability
 - deoxygenation
 - marine heatwaves
 - oscillations (ONI, PDO, NPGO)
 - long-term trends
 - climate change



motivation

NUTRIENTS



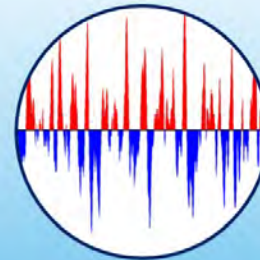
significance



ecosystem-based protection



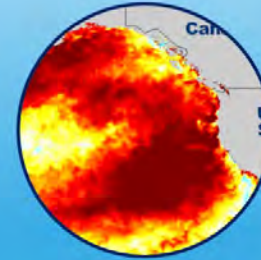
fisheries management



climate variability



habitat range shifts



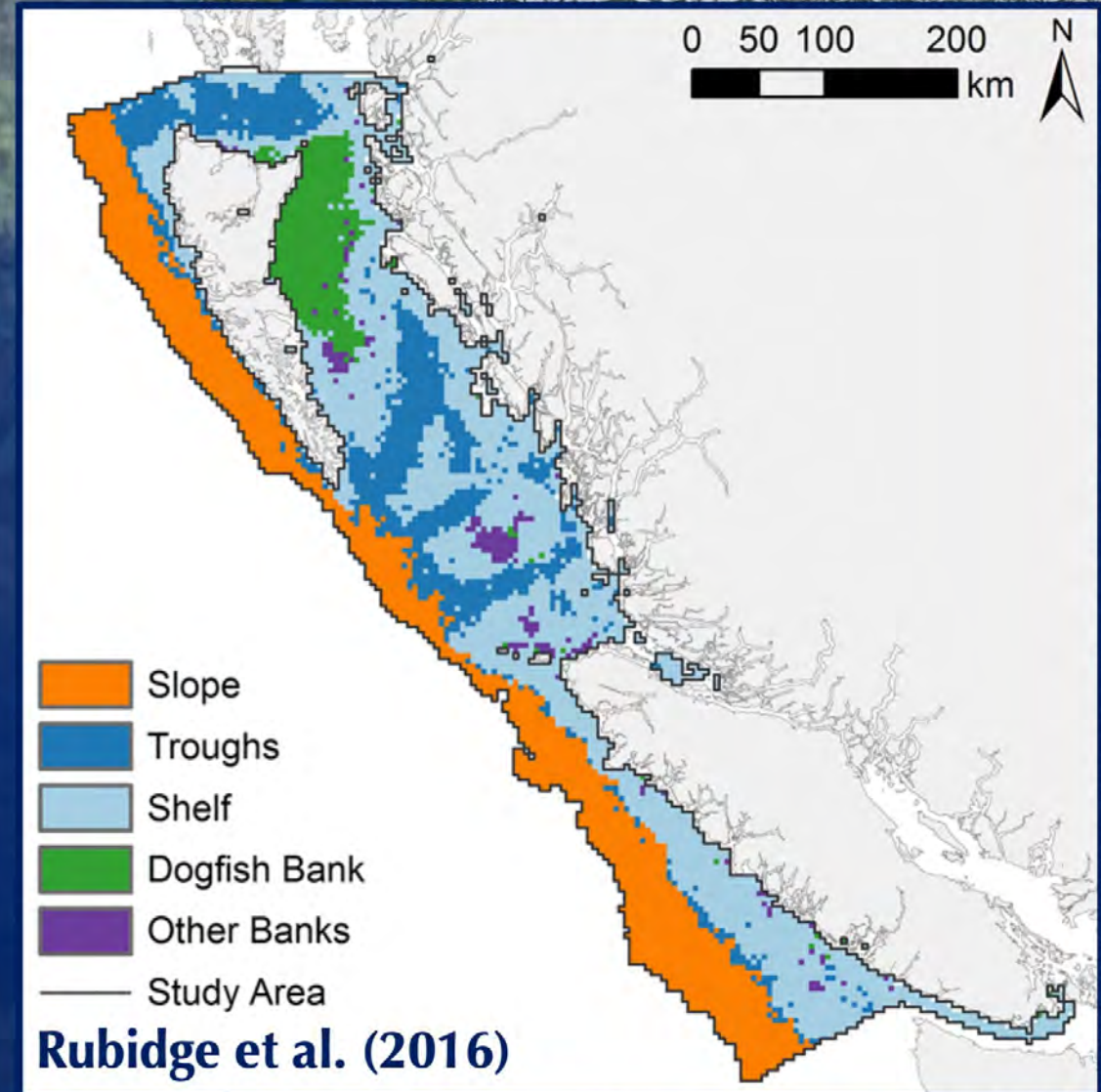
climate change



food webs

data-driven biogeochemical regionalization

- ship-based CTD
 - *salinity*
 - *temperature*
 - *depth* (sample and bathymetry)
 - *density*
 - *oxygen*
 - *date, latitude, longitude*
- bottle
 - *nutrient*
 - *chlorophyll*



data sources

Fisheries and Oceans Canada

WaterProperties.ca

CTD 1960s-present
in coordination with CIOOS efforts

NOAA

World Ocean Database

CTD 1960s-present
bottle 1930s-present

Hakai Institute

CTD 2012-present

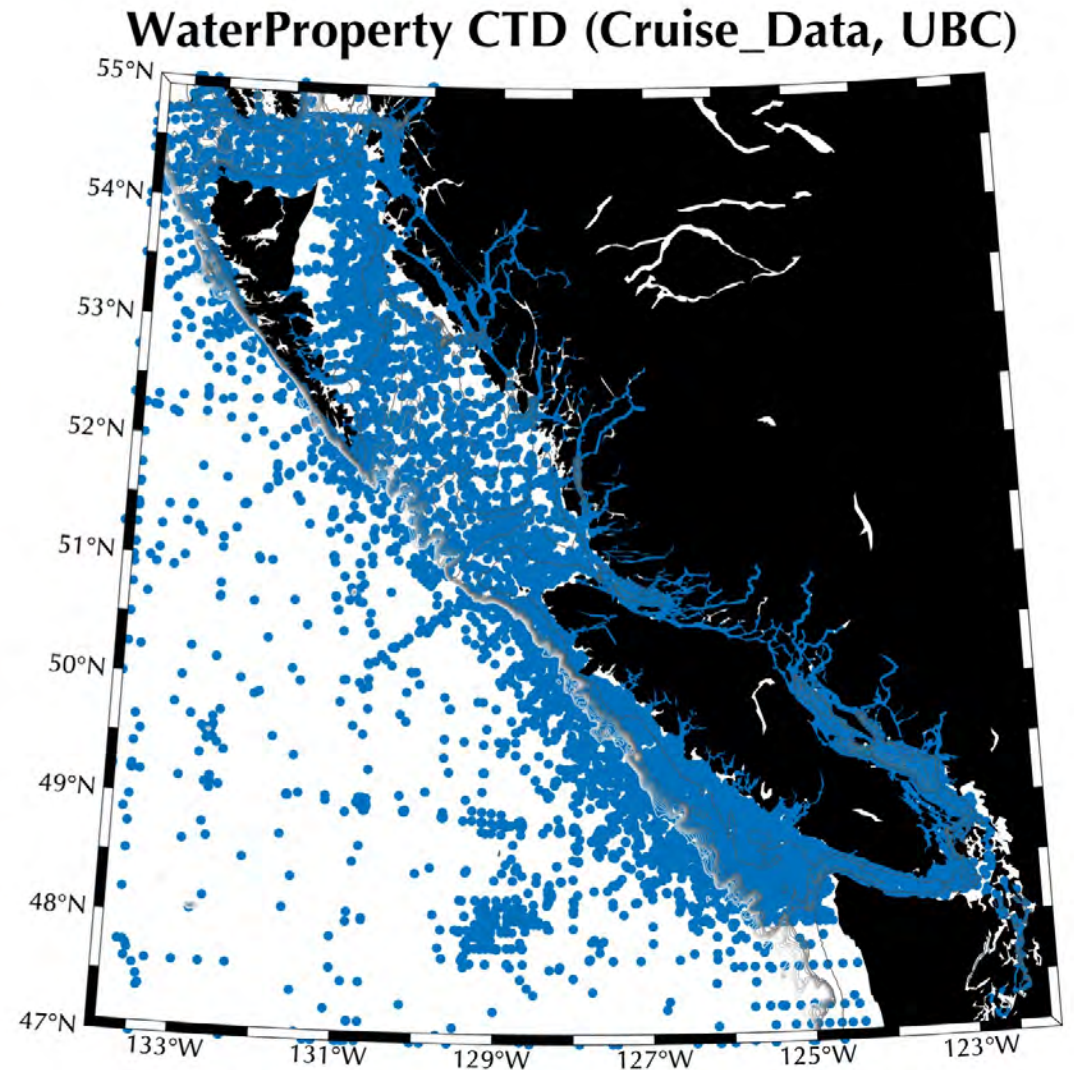
<500 stations
500-2500 stations
>2500 stations

The following slides are early examples of my approach using this data, for PICES 2019.



data for regionalization

- **bulk monthly mean**
- **0.1° latitude
longitude**
- **within density (σ_0) layers**
 - 20-21, near-surface
inlets and Strait of Georgia
 - 23-24, < ~500 m
full system (denoted as "23s")
 - 26-27, > 0 m
ocean-deep shelf exchanges





RIVERS

monthly variability

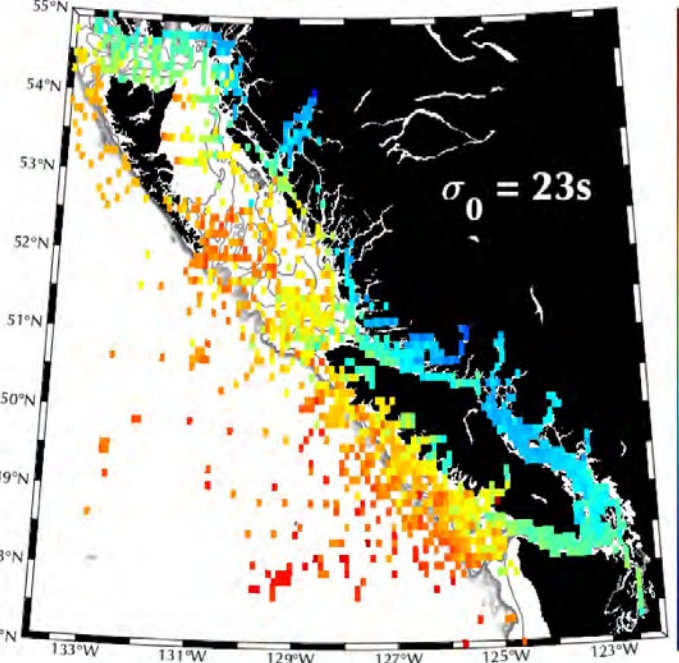
July*

temperature

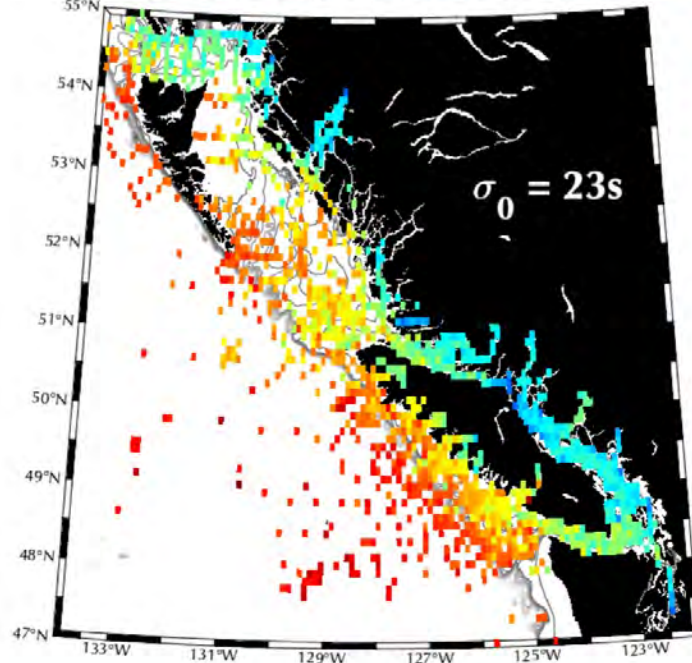
salinity

oxygen

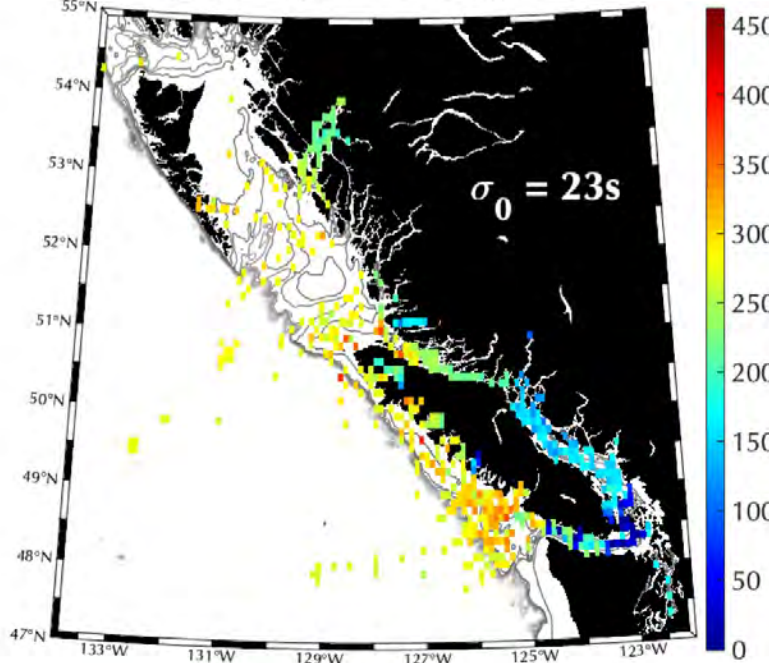
Jul temp. mean (°C)



Jul salinity mean (PSS-78)



Jul oxygen mean (μM)

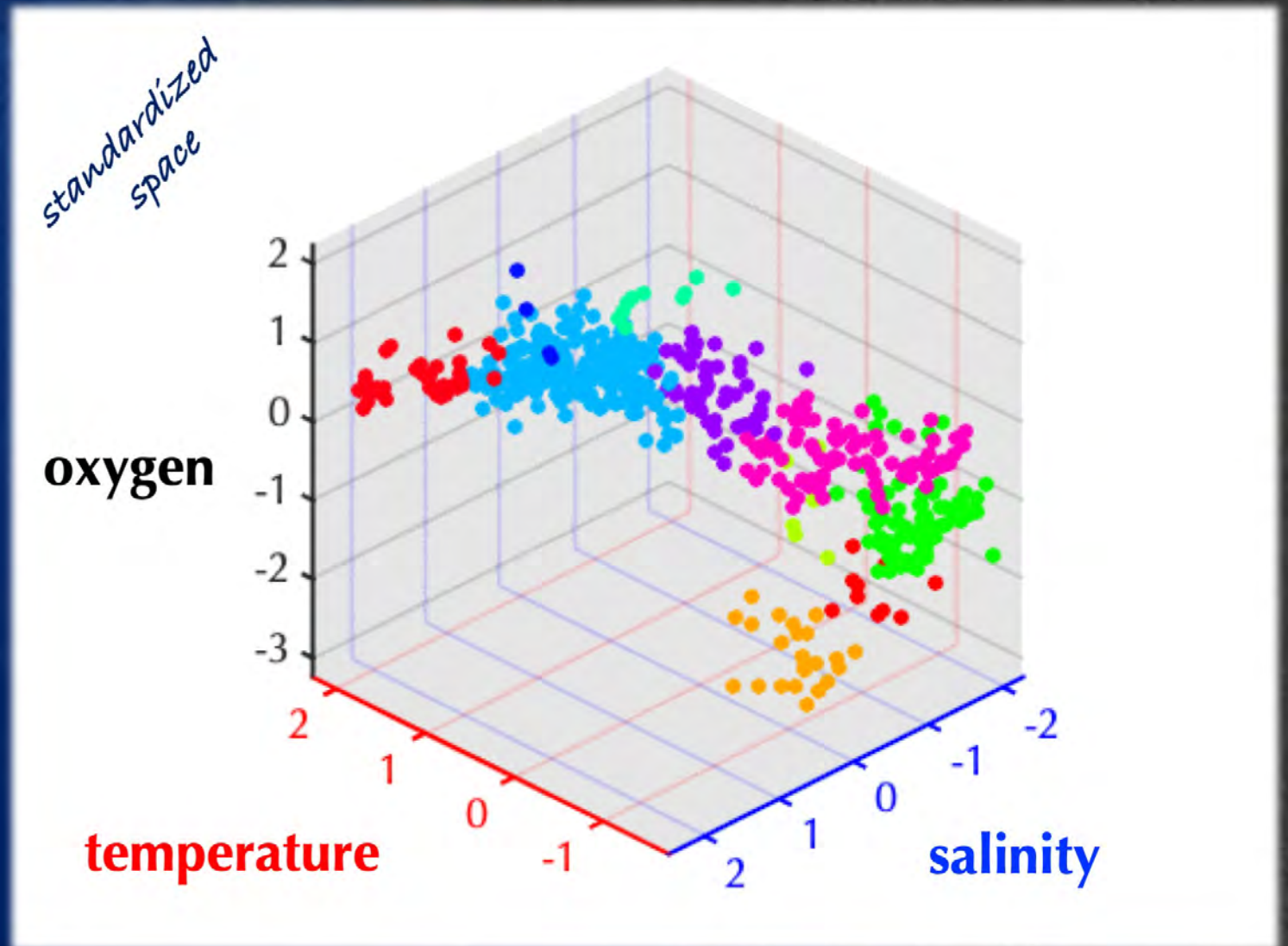


multivariate analysis and clustering

- *bathymetry**
- *temperature*
- *salinity*
- *oxygen*

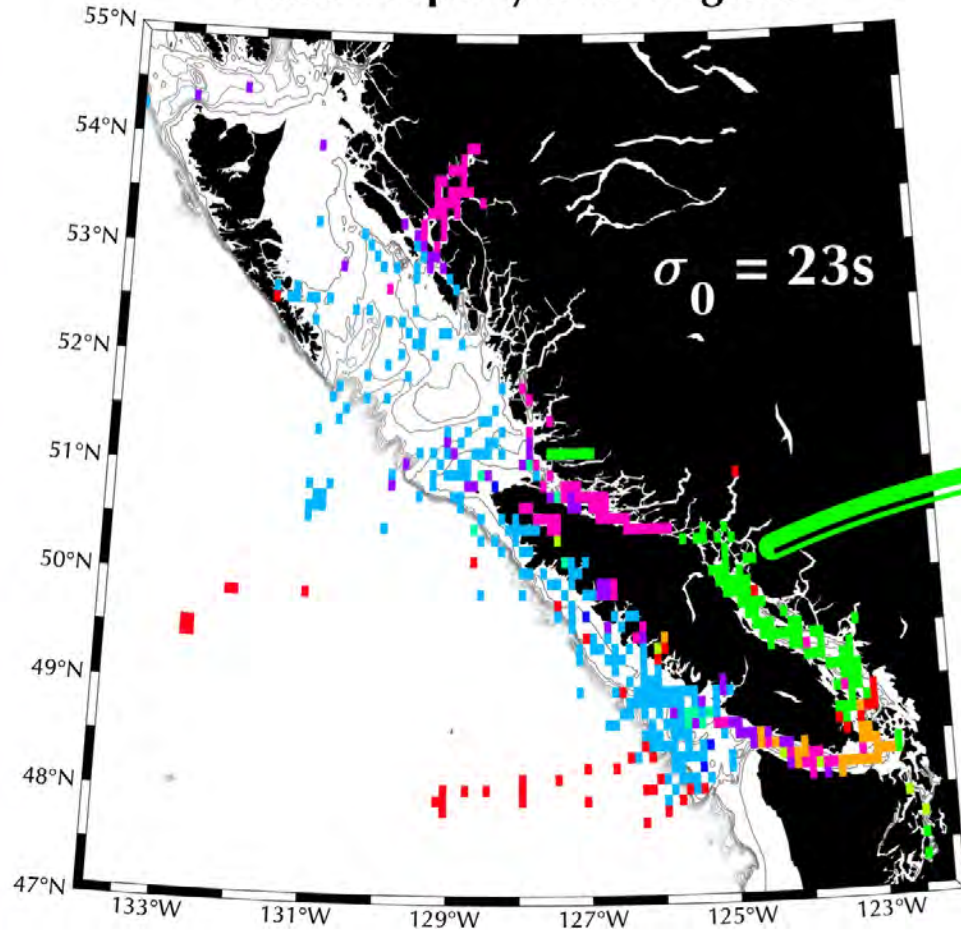
- colored dots represent different regions

**dominant component and excluded for this example*

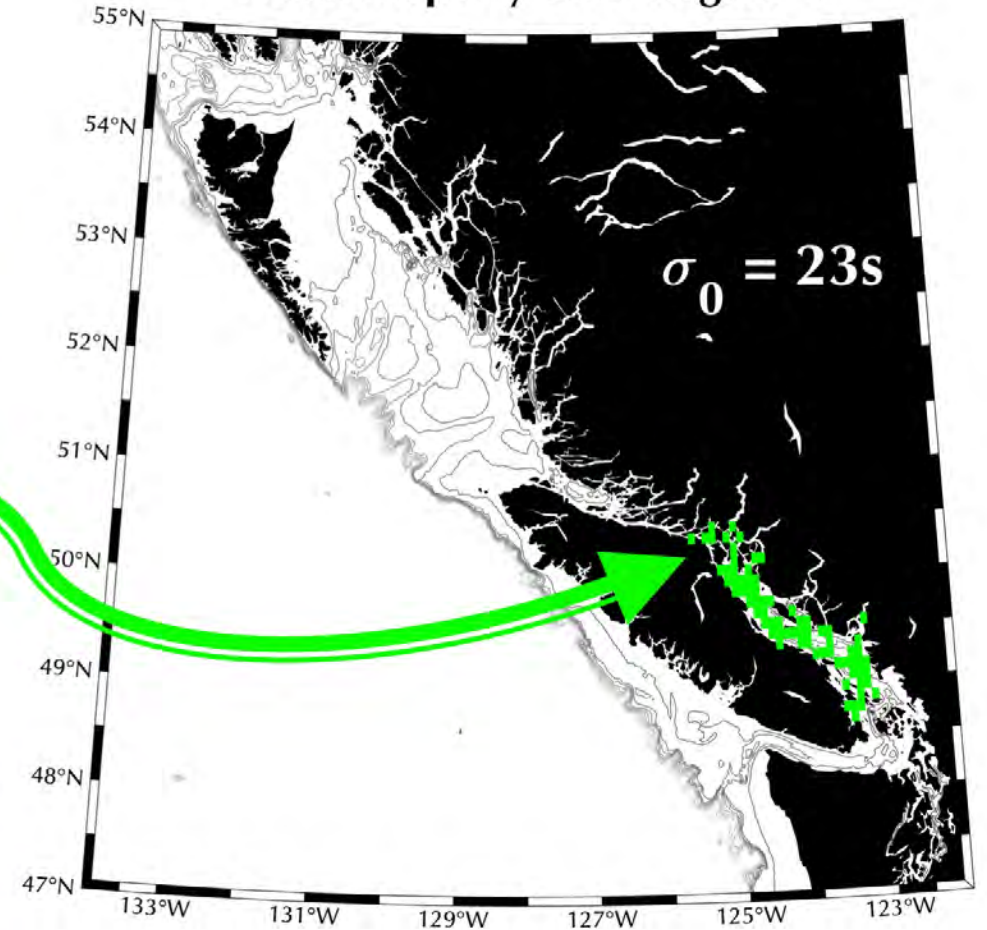


*apply clustered "regions" to map...
...biogeochemical regionalization*

WaterProperty CTD Regions

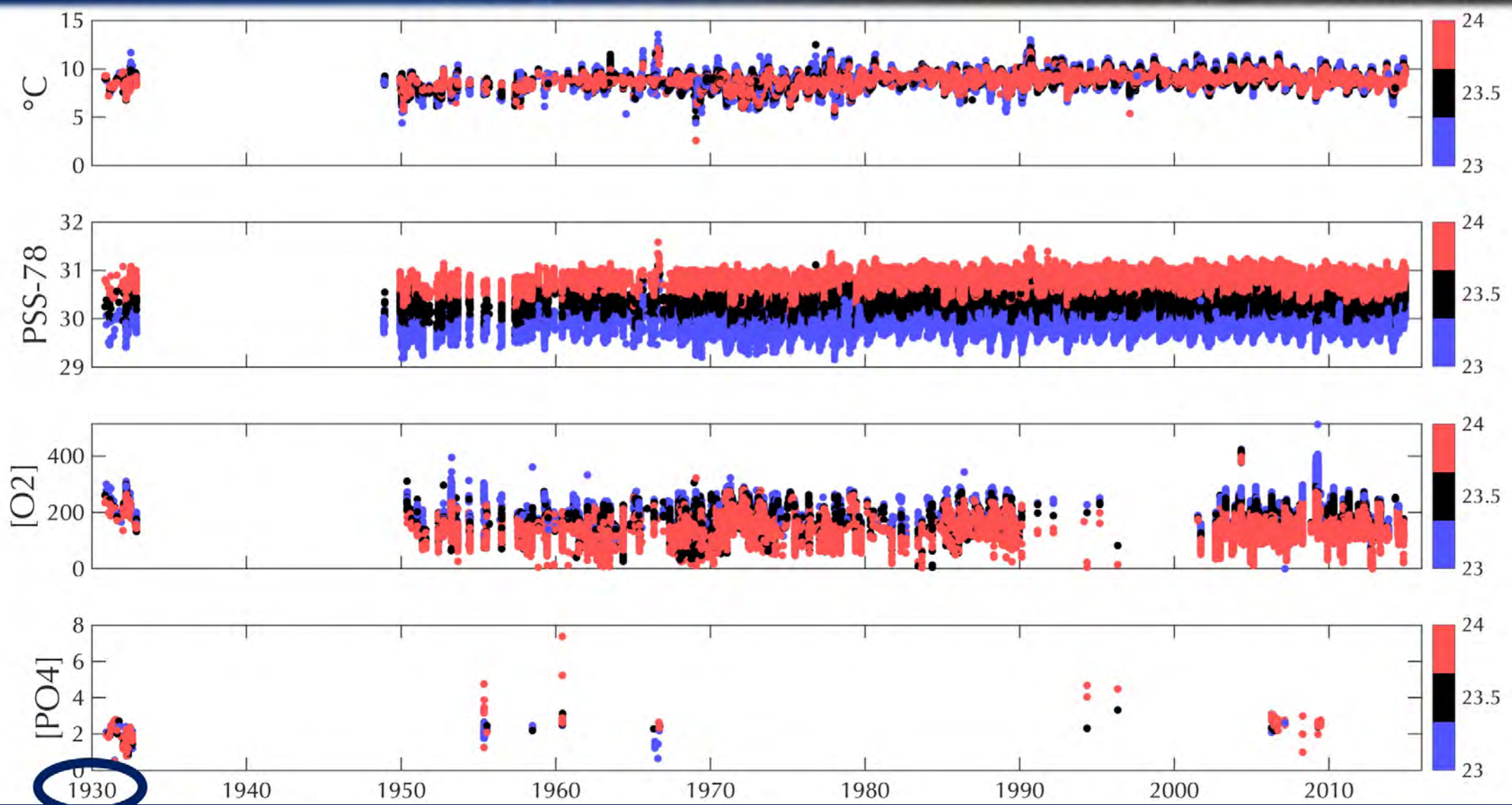
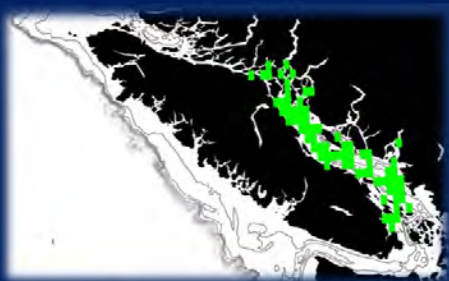


WaterProperty CTD Region 4



regional variability and long-term trends

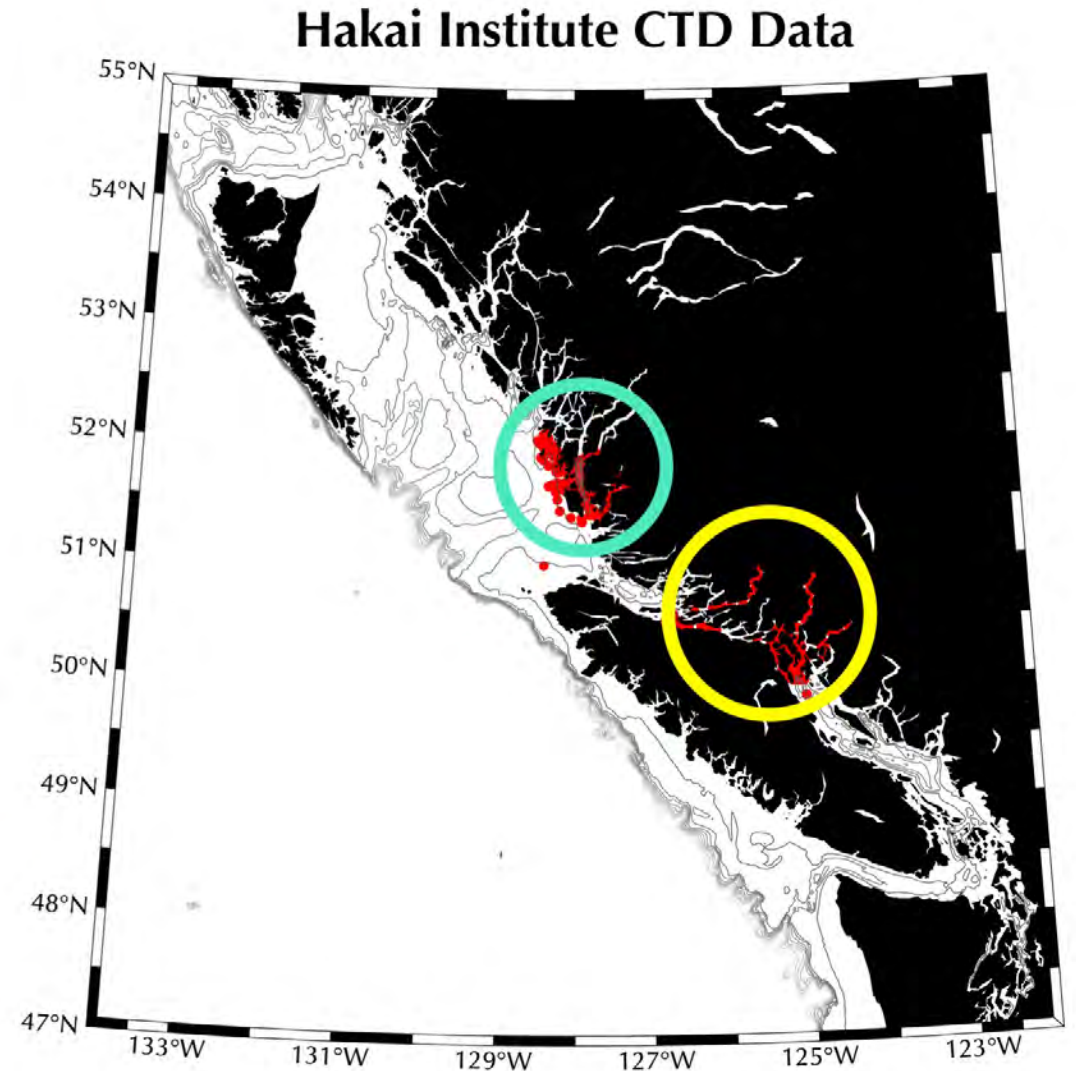
World Ocean Database CTD + bottle



σ_0

key regions for data-driven assessment

- characterize well-sampled regions (2012-pres)
- **Quadra Island region**
- **Calvert Island region**



next steps...

- better assess temporal and spatial “bins” to incorporate nutrient data
 - climate change?
 - seasonal variability?
- comprehensive multivariate analysis and clustering → regionalization
- explore on smaller scale (e.g., Hakai dataset)
- essential ocean variables
 - salinity, temperature, depth, density
 - date, location, bathymetry*
 - oxygen, nutrient? chlorophyll?



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