From marine terrestrial interactions to the "warm blob": integrating land-ocean-atmospheric research in a coastal observatory framework

Hakai

Science on the Coastal Margin

Brian Hunt, Jennifer Burt, Wiley Evans, William Floyd, Ian Giesbrecht, Alexander Hare, Margot Hessing-Lewis, Jennifer Jackson, Colleen Kellogg, Kira Krumhansl, Allison Oliver, Suzanne Tank

Photo: Grant Callegari

Hakai Institute Guiding Principles

Long Term Ecological Research

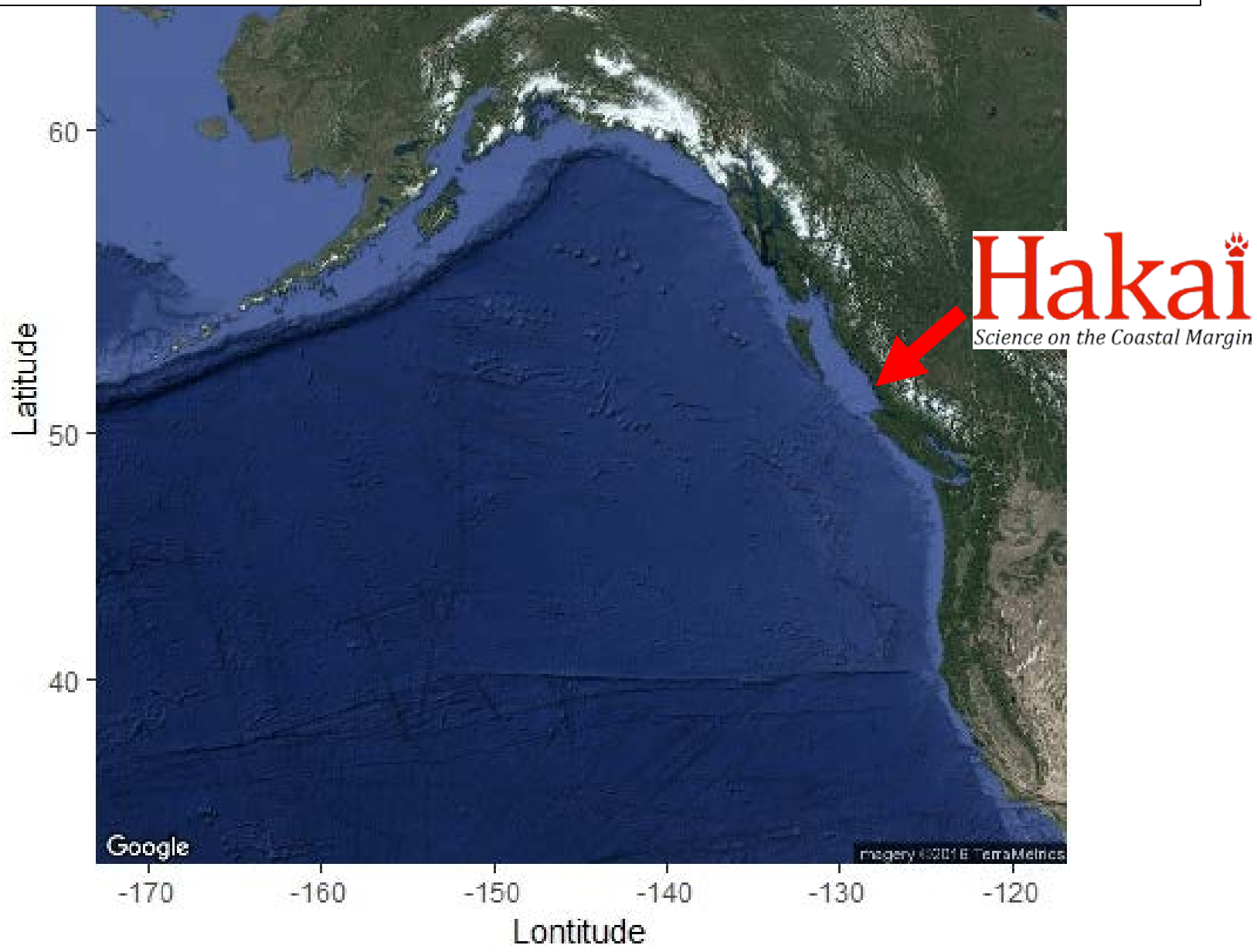
Place Based

Integration Across Disciplines

Ecology that Includes Human Activity

Local Analysis -> Regional Insights -> Policy

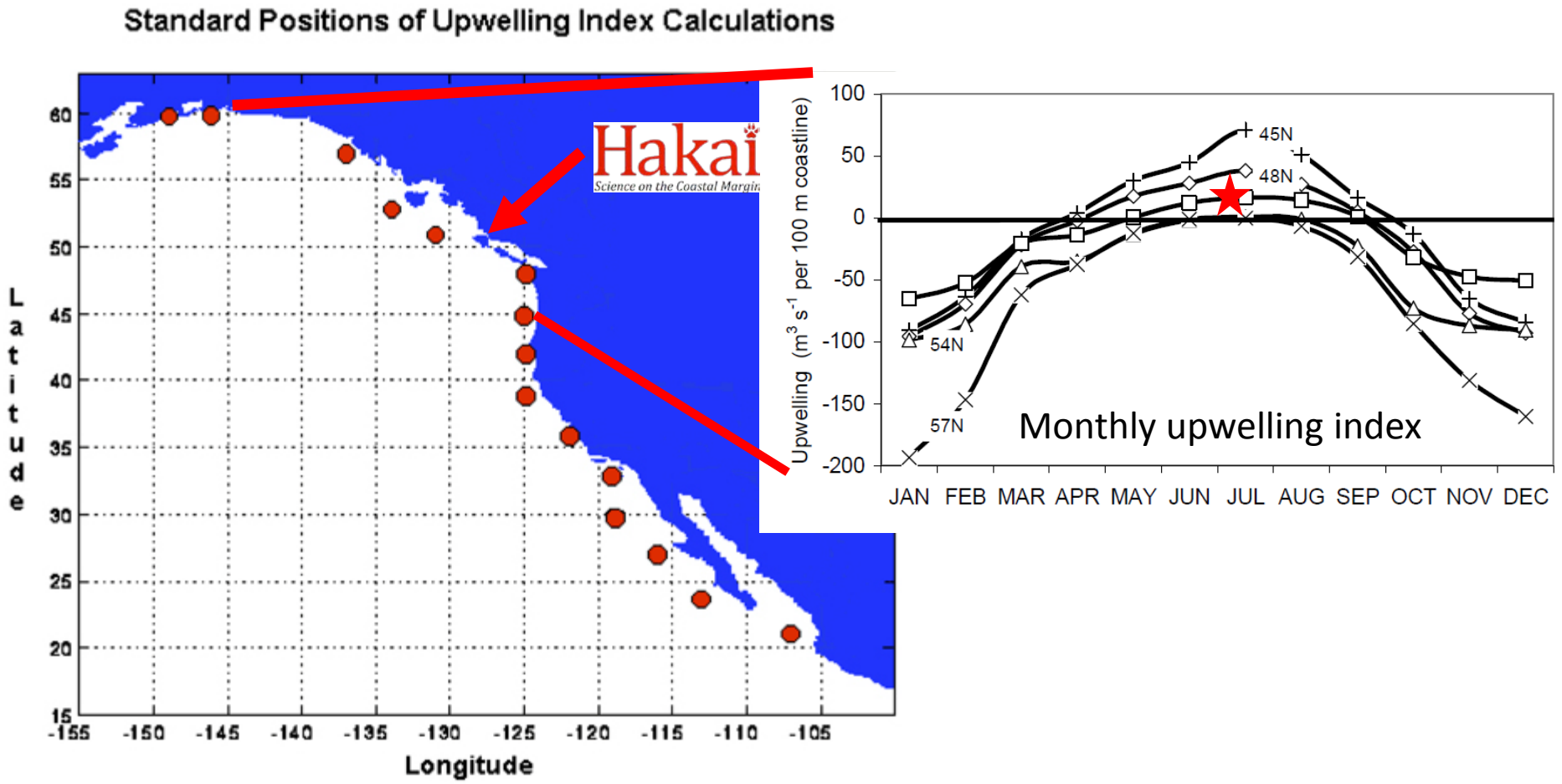
BRITISH COLUMBIA COASTAL OBSERVATORIES



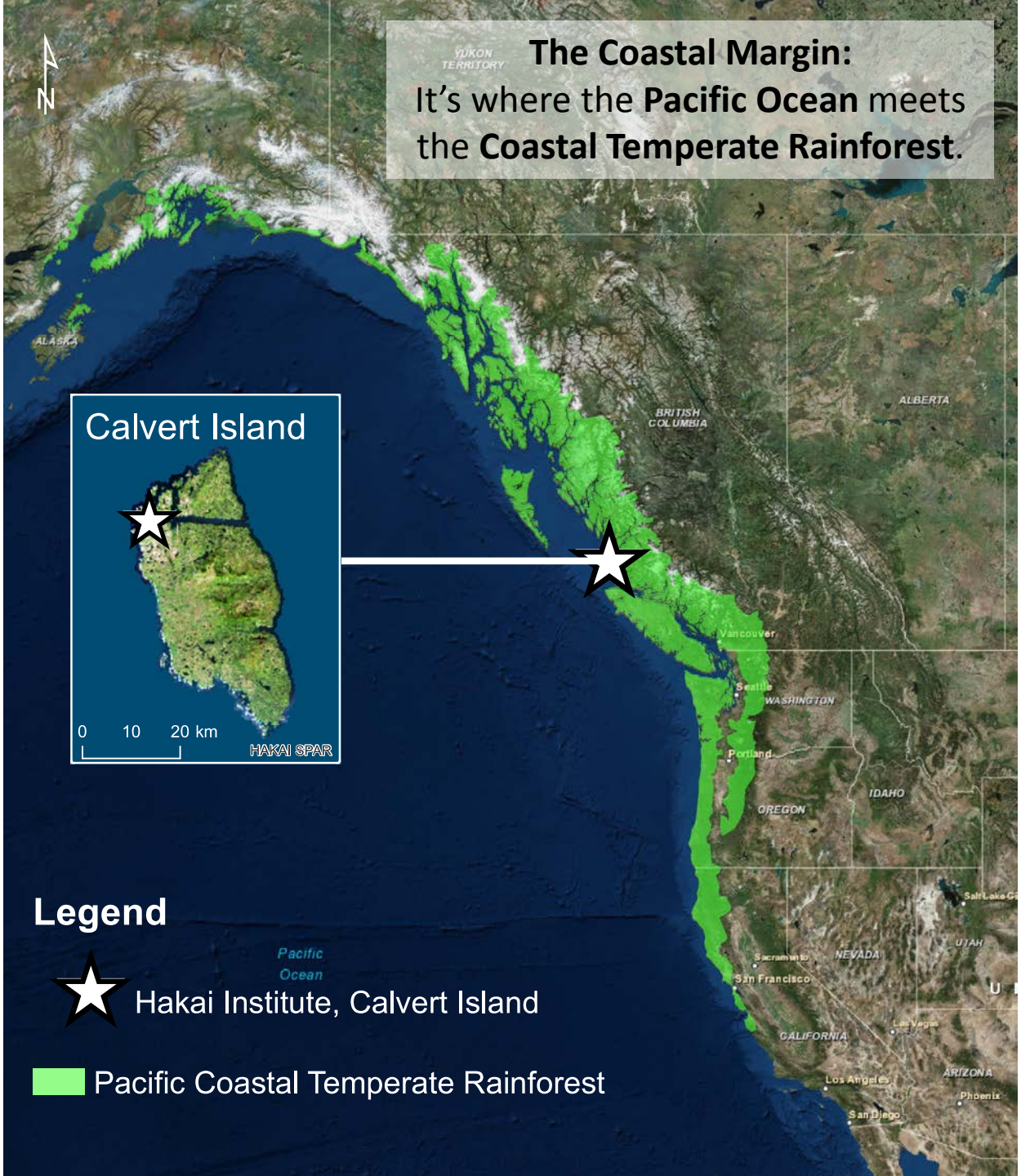
TWO PRIMARY OBSERVATORIES

Hakai
Science on the Coastal Margin

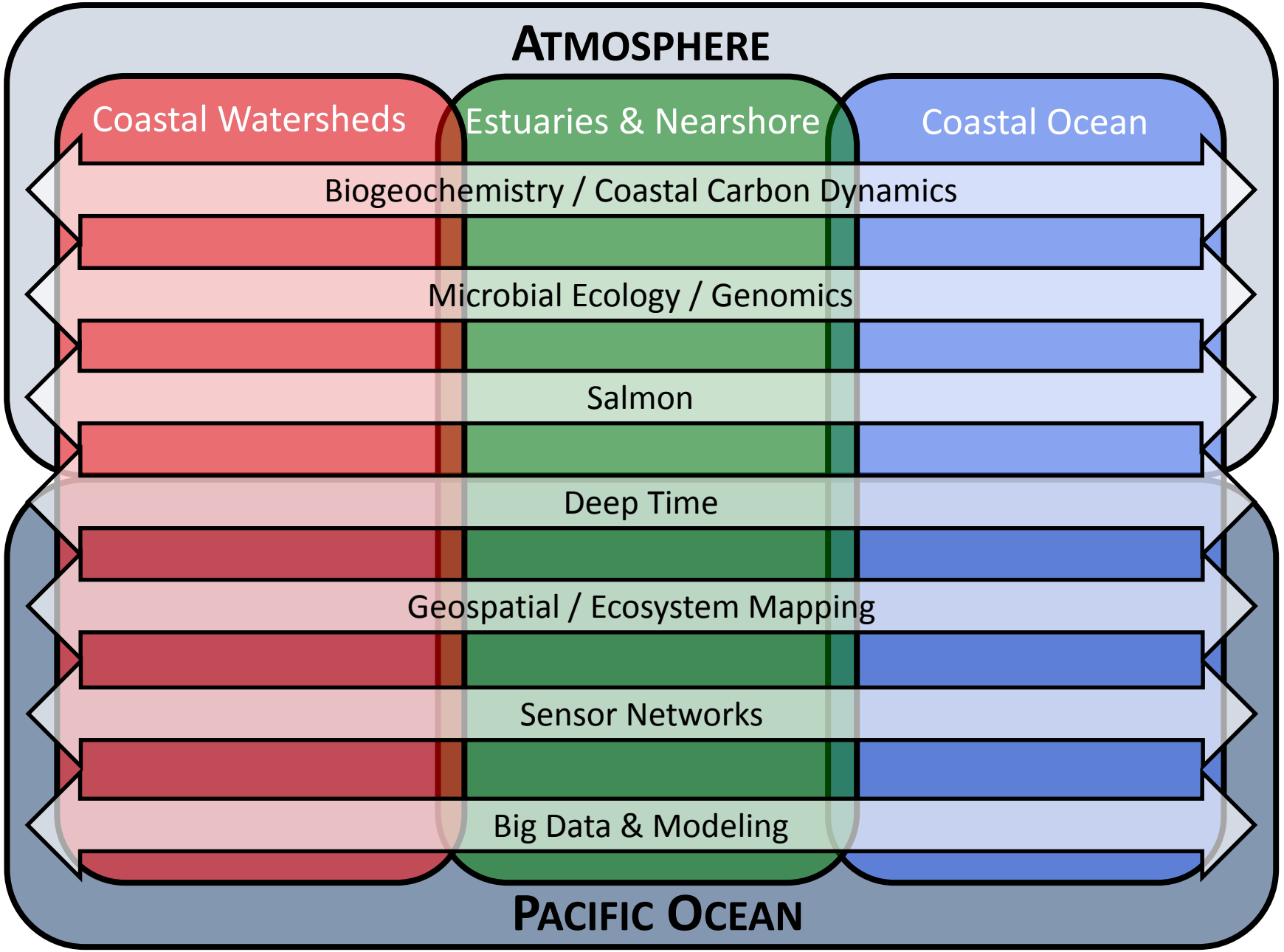
OCEANOGRAPHIC CONTEXT



Data source: www.pfeg.noaa.gov/products/


The Coastal Margin:
It's where the Pacific Ocean meets the Coastal Temperate Rainforest.
N
YUKON TERRITORY
ALASKA
BRITISH COLUMBIA
ALBERTA
Calvert Island
0 10 20 km
HAKAI SPAR
Vancouver
Seattle
WASHINGTON
Portland
OREGON
IDAHO
NEVADA
UTAH
Sacramento
San Francisco
CALIFORNIA
Las Vegas
Los Angeles
ARIZONA
Phoenix
San Diego
Pacific Ocean
Legend
Hakai Institute, Calvert Island
Pacific Coastal Temperate Rainforest

Climate / Ocean Drivers, Research Axes & Crosscutting Themes



Routine field observations

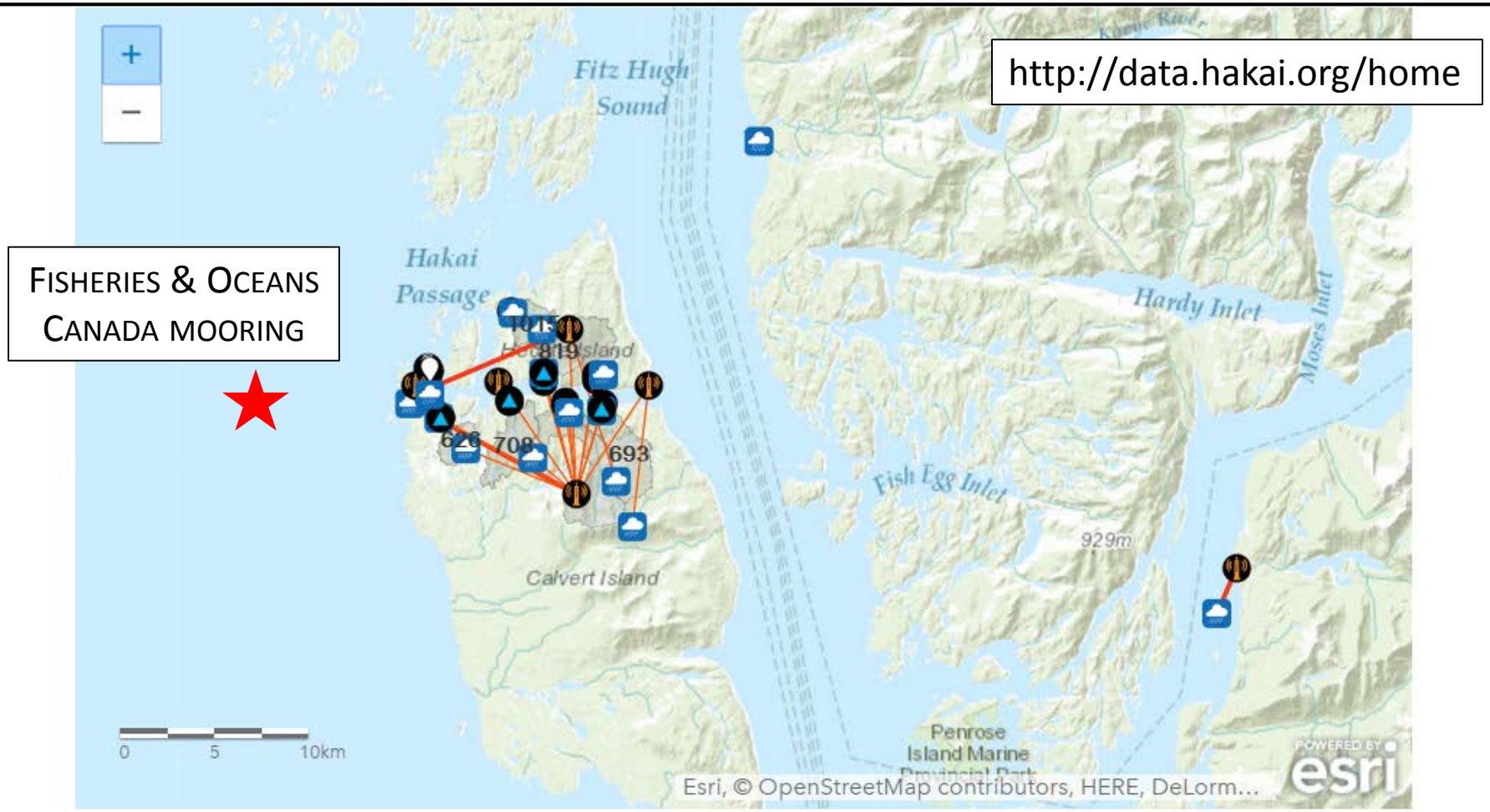
Watersheds

- Dedicated field teams
- High frequency
- Year round

Nearshore & Estuaries

Coastal Oceans

AUTONOMOUS SENSOR NETWORK

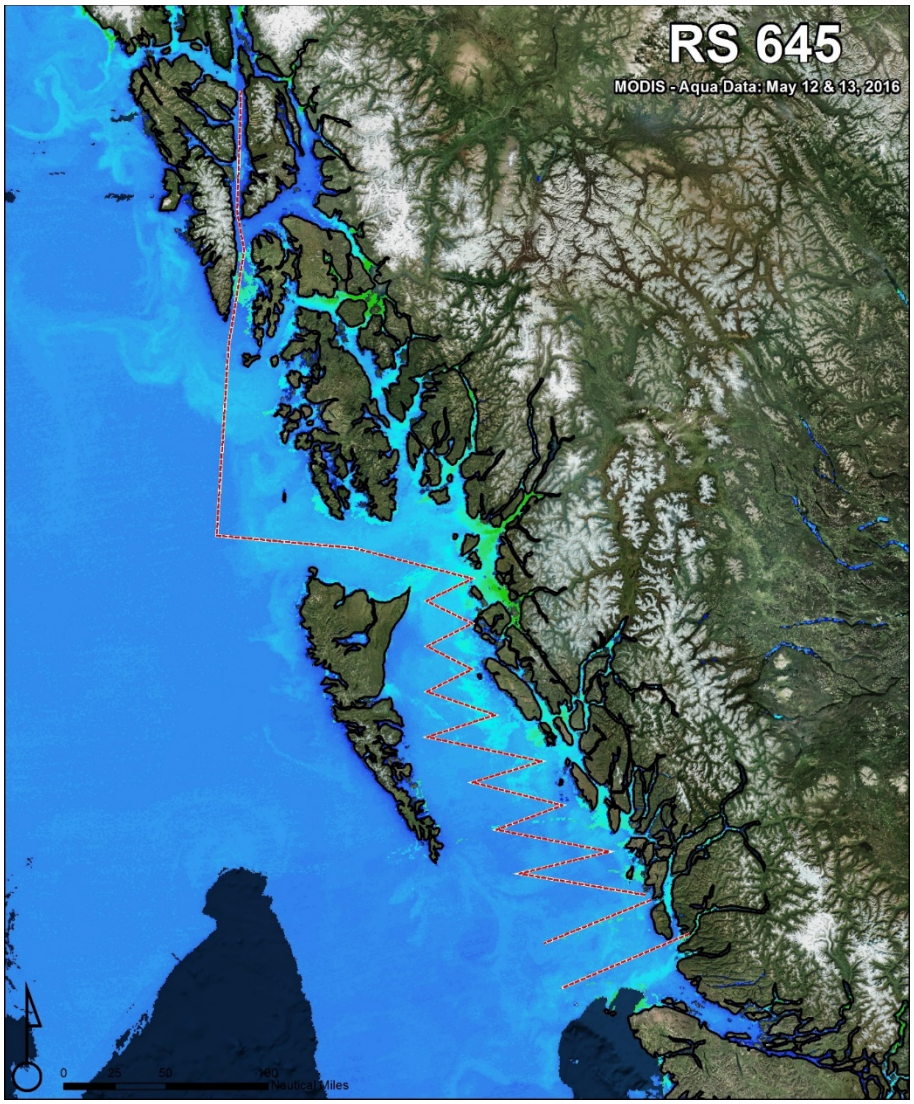


Calvert Island:

- 16 meteorological stations
- 14 stream sensor nodes - depth, T°C, conductivity, fDOM, pCO2.
- 3 terrestrial sensor nodes

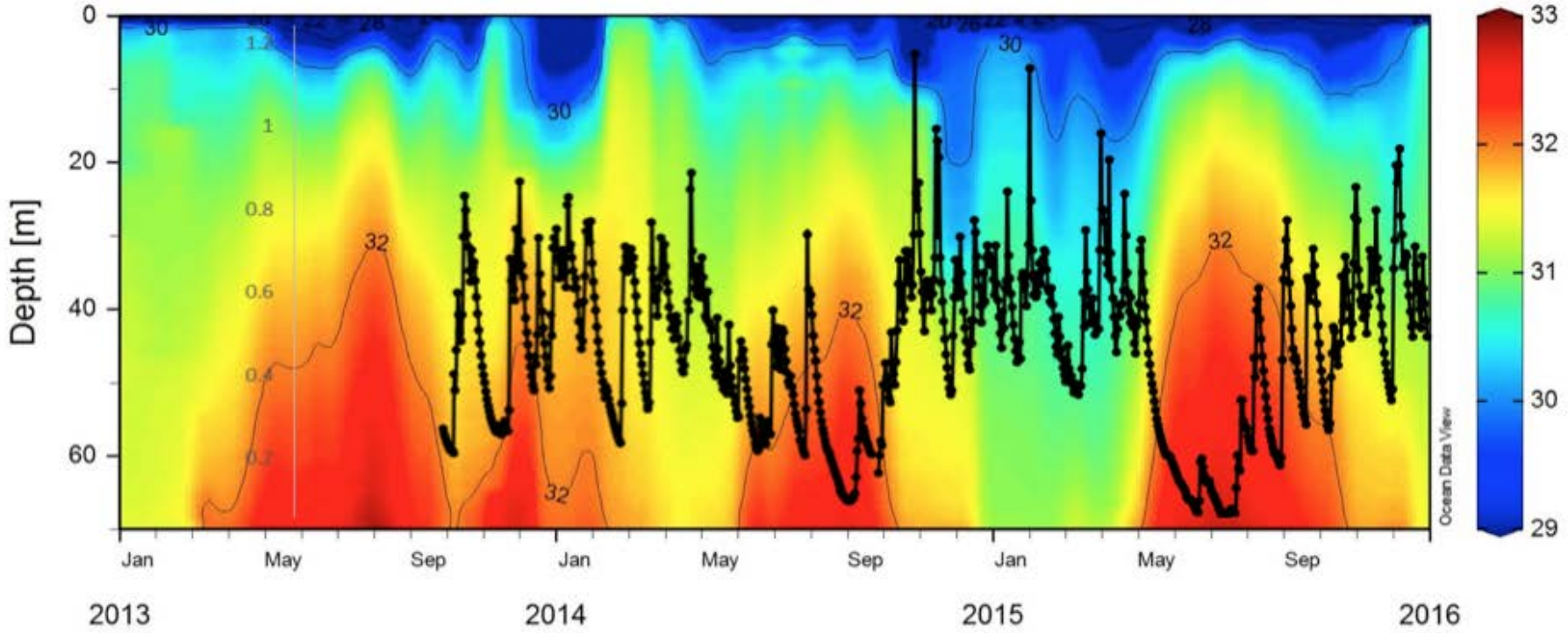
Calvert Island Observatory

1. Marine-terrestrial interactions



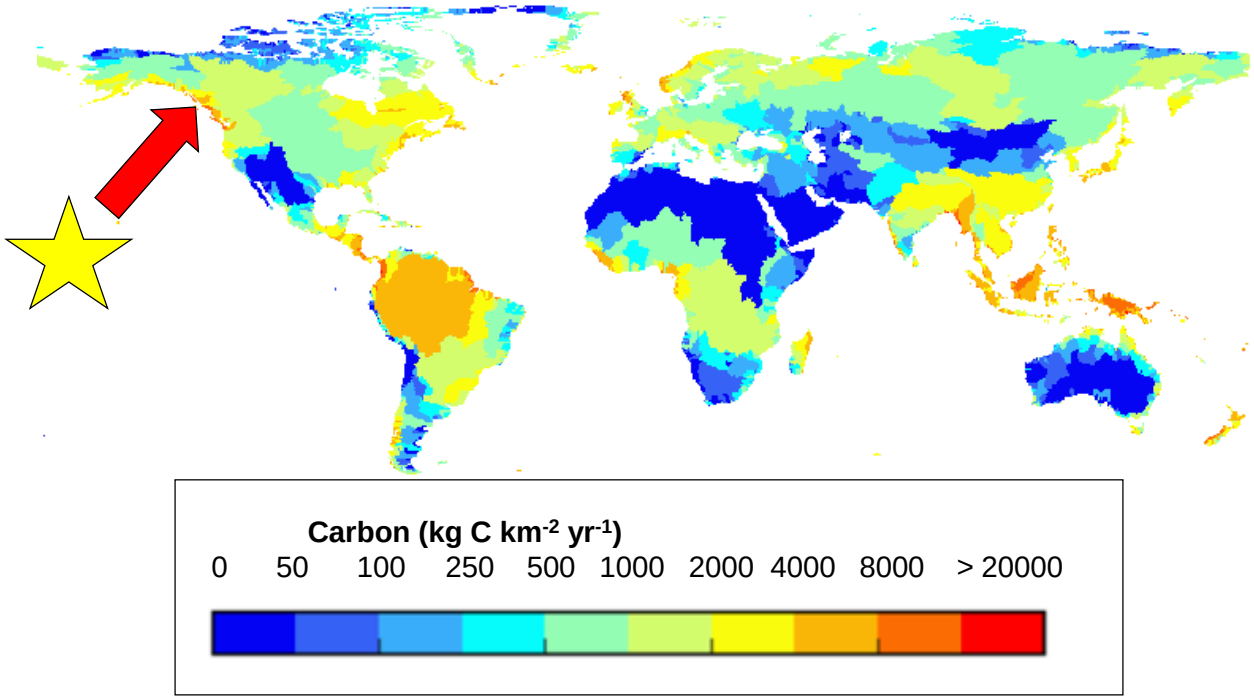
FRESHWATER & OCEAN PHYSICS

Water column salinity profiles & freshwater discharge



GLOBALLY SIGNIFICANT DOC YIELD

DOC yield

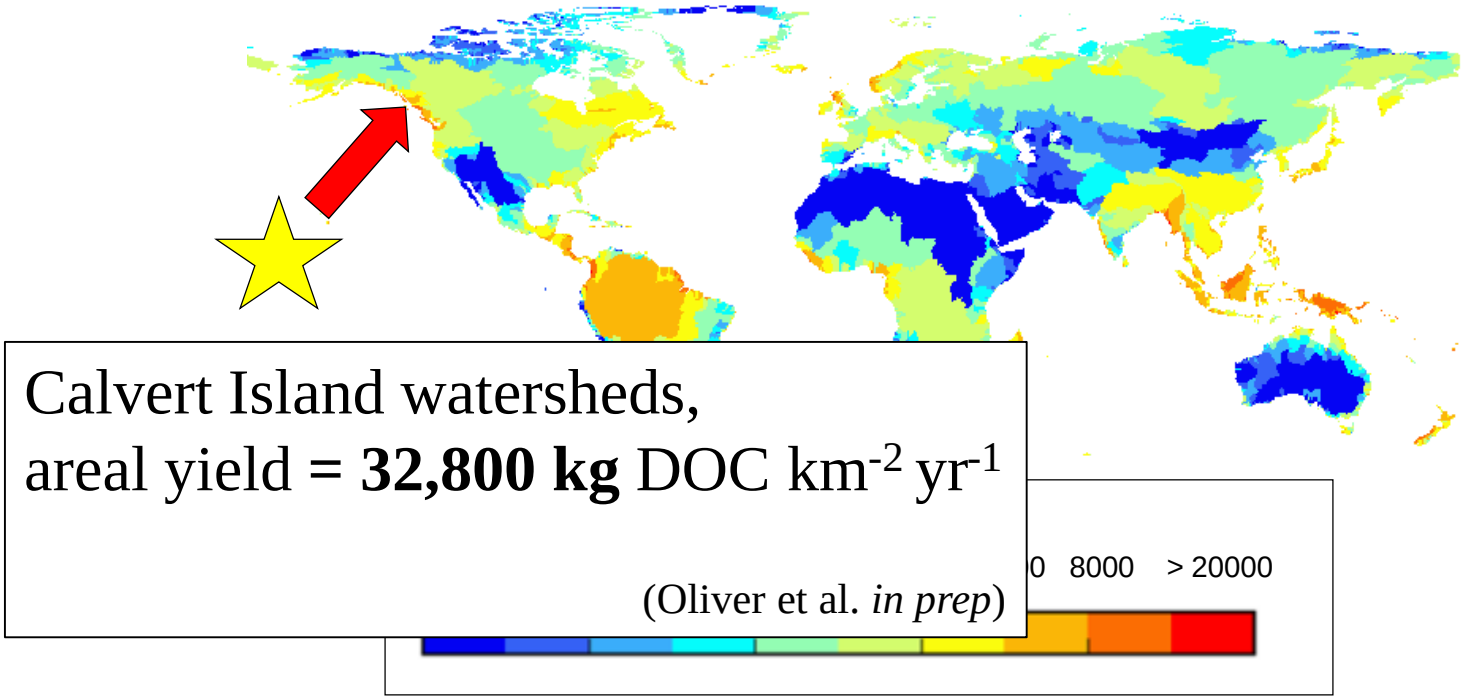


NEWS2 model (Mayorga et al. 2010, Beusen et al. 2009)

Global Average ~5,890 kg C km^{-2} yr^{-1}

GLOBALLY SIGNIFICANT DOC YIELD

DOC yield



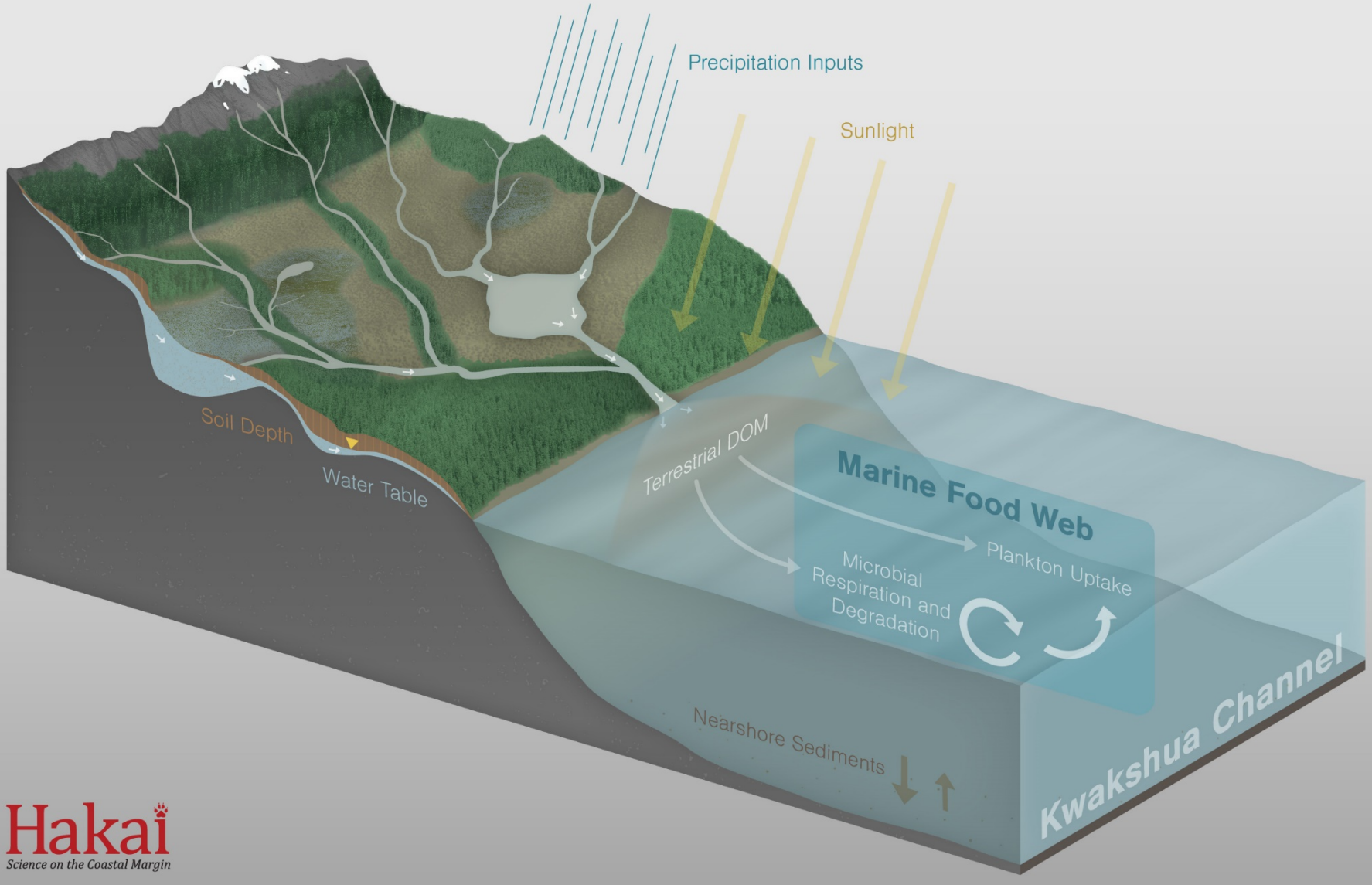
Calvert Island watersheds,
areal yield = **32,800 kg** DOC km^{-2} yr^{-1}

(Oliver et al. *in prep*)

NEWS2 model (Mayorga et al. 2010, Beusen et al. 2009)

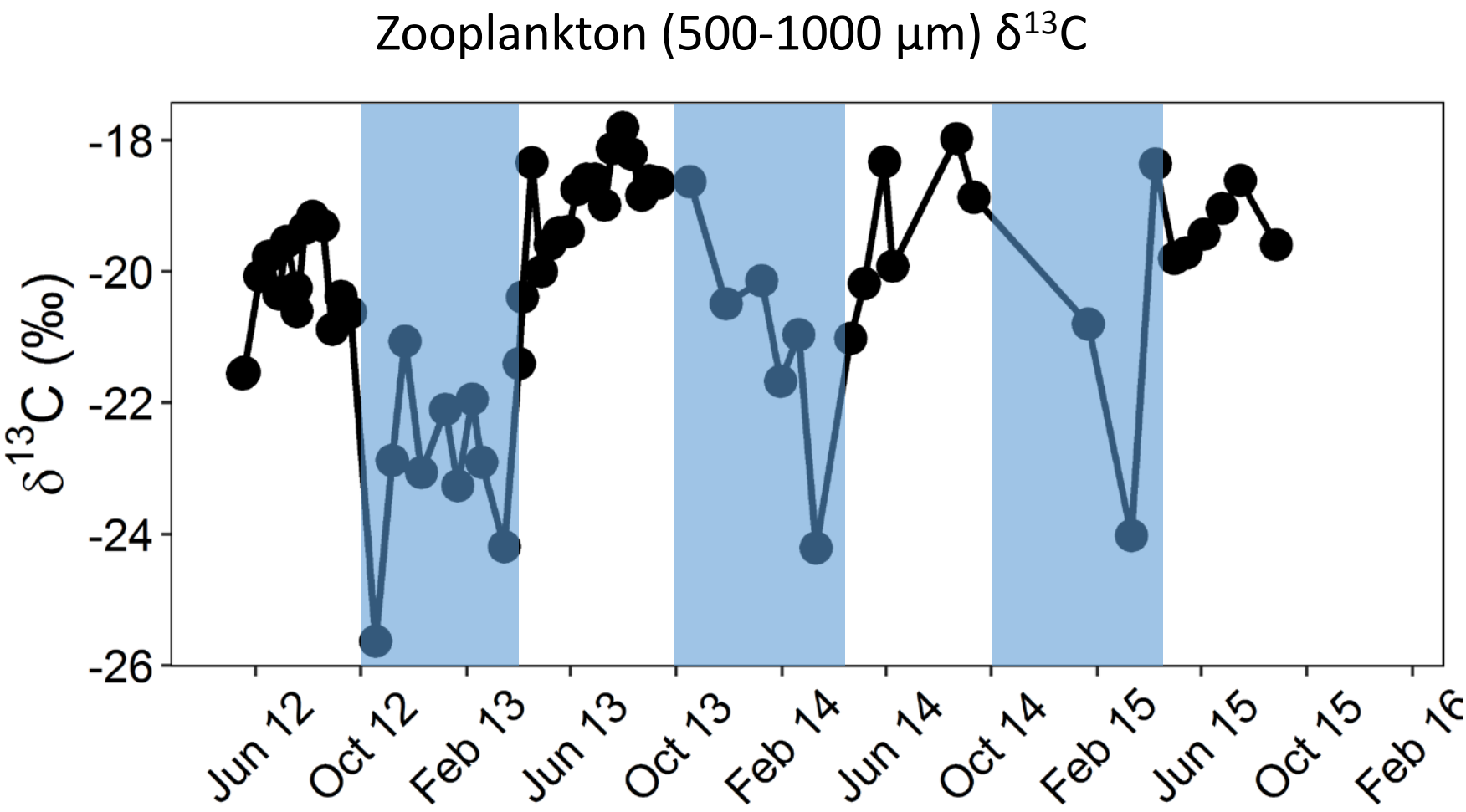
Global Average ~5,890 kg C km^{-2} yr^{-1}

TERRESTRIAL CONTRIBUTIONS TO THE MARINE FOOD-WEB



Hakai
Science on the Coastal Margin

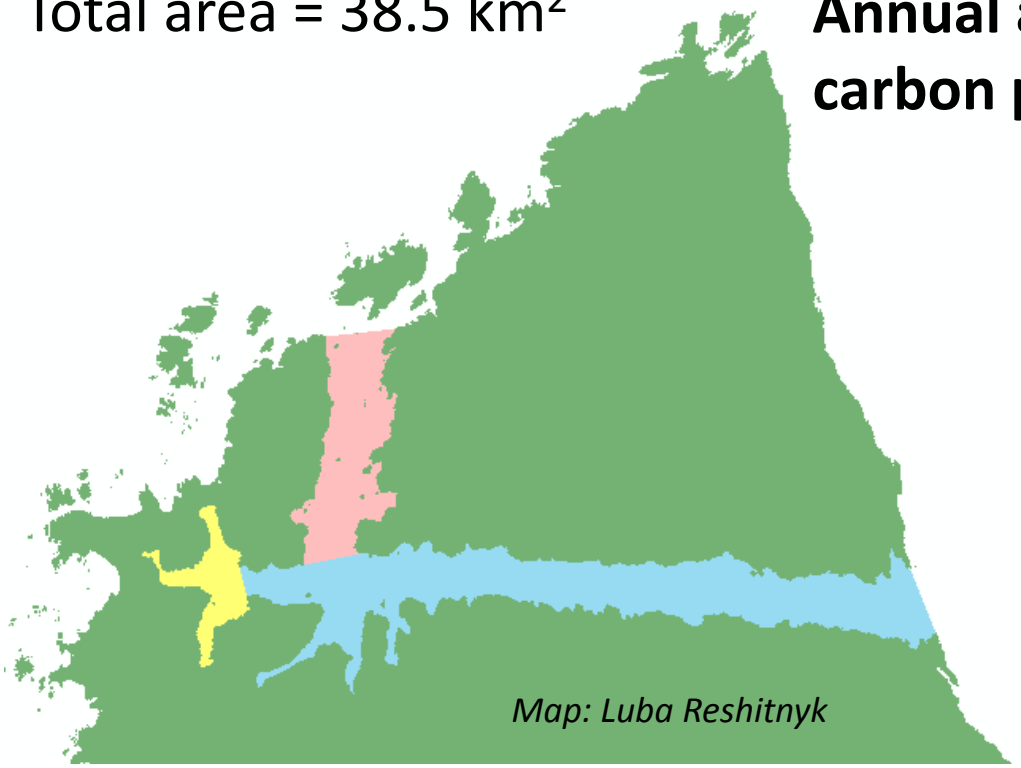
UPTAKE OF TERRESTRIAL CARBON BY PLANKTON



Marine contribution to Kwakshua carbon pool

Annual average phytoplankton biomass of 34 tons $C.km^{-2}$

Total area = 38.5 km^2



Annual average phytoplankton carbon production ~ 500 tons $C.km^{-2}.yr^{-1}$

SUMMARY: MARINE-TERRESTRIAL INTERACTIONS

A key area of research in the Pacific Temperate Rainforest Domain

Ongoing measurement of key variables required:

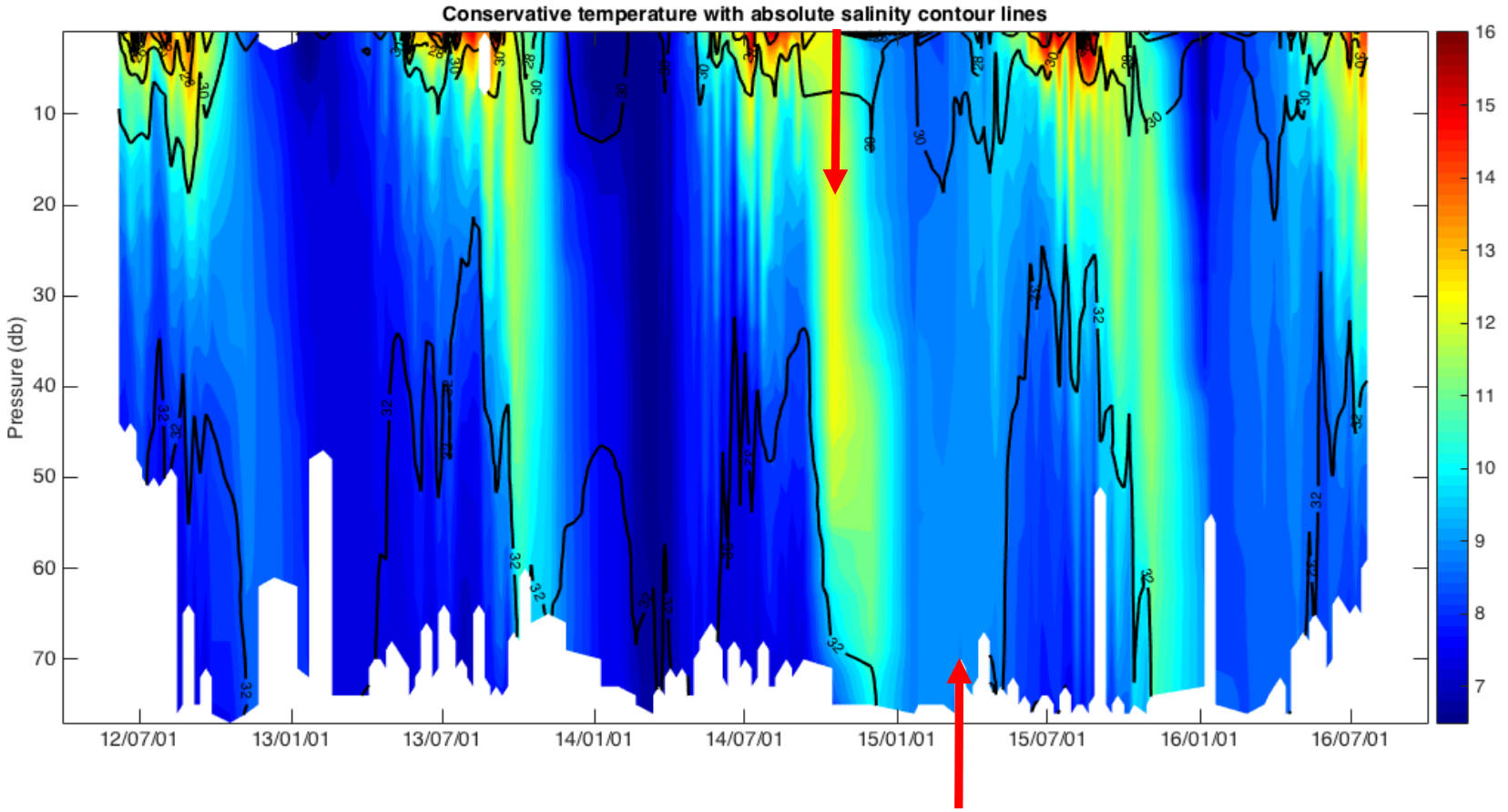
- Freshwater discharge
- DOC load
- Biochemical tracers

Process studies

- Pathways of terrestrial material into the marine food-web
- Response of marine-terrestrial to changing climate

2. THE WARM BLOB

Blob onshore in October 2014

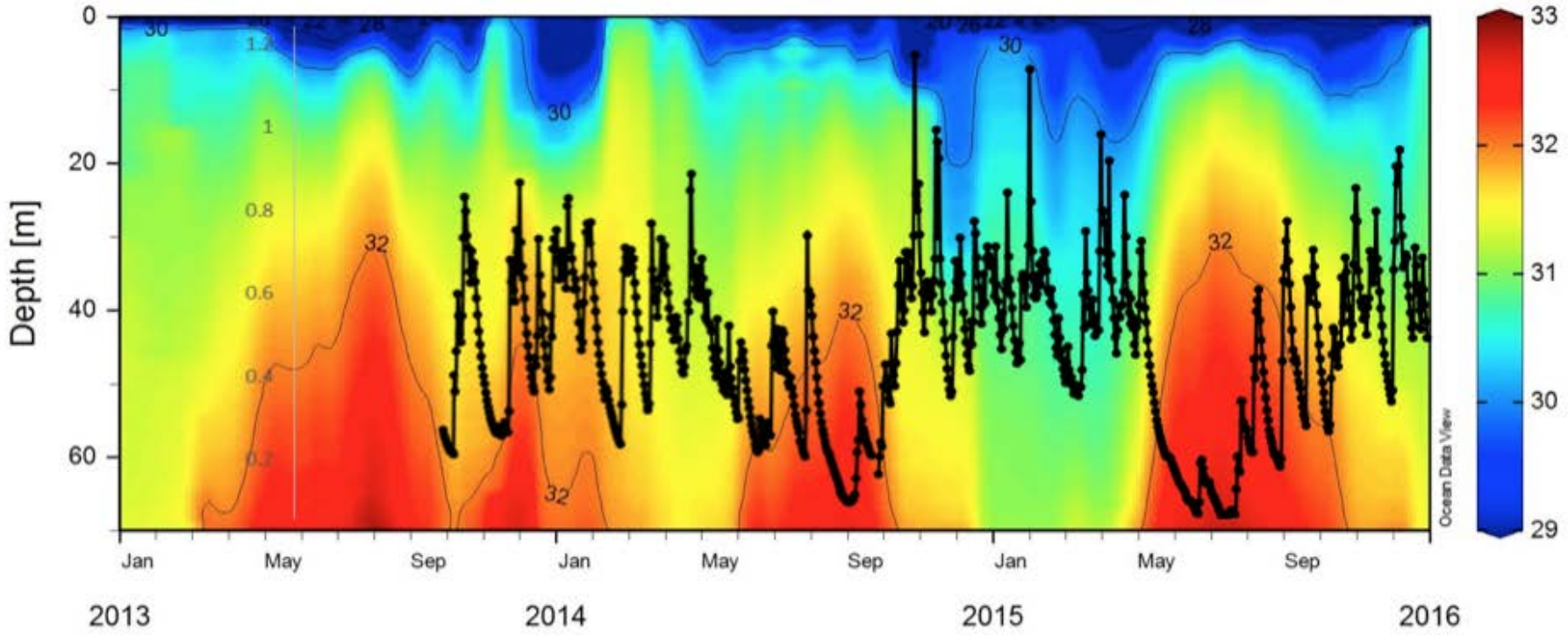


2014 / 15 winter ~ 2°C warmer than 2013 /14

FRESHWATER & OCEAN PHYSICS

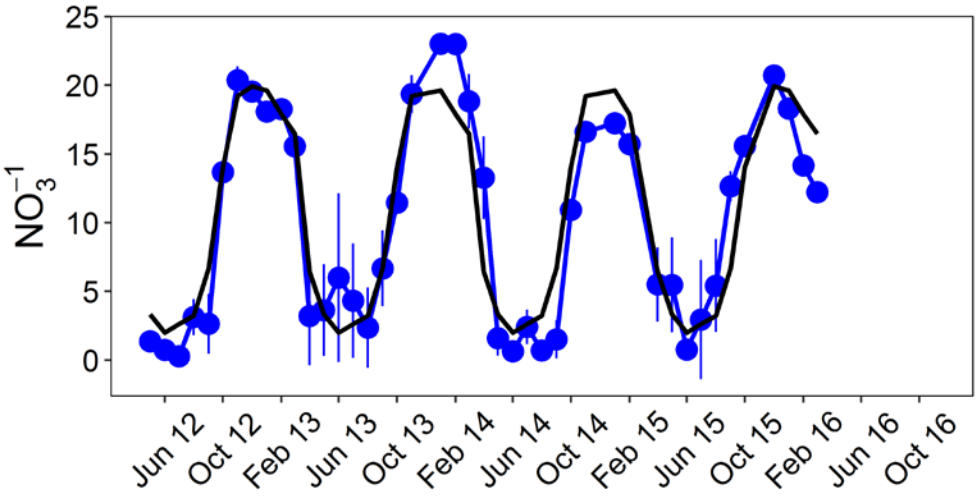
Water column Temperature profiles & freshwater discharge

- High freshwater input during winter 2014/2015



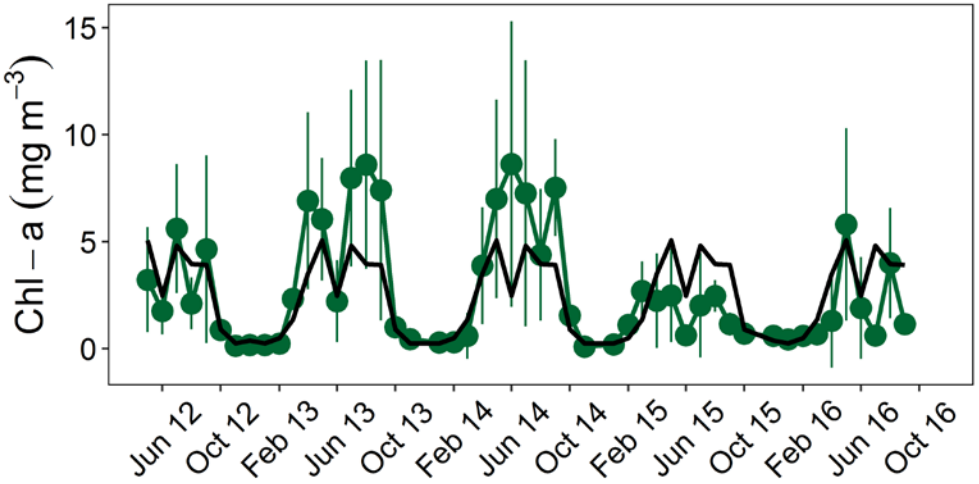
Response: Food-web Base

Nutrients (5m)



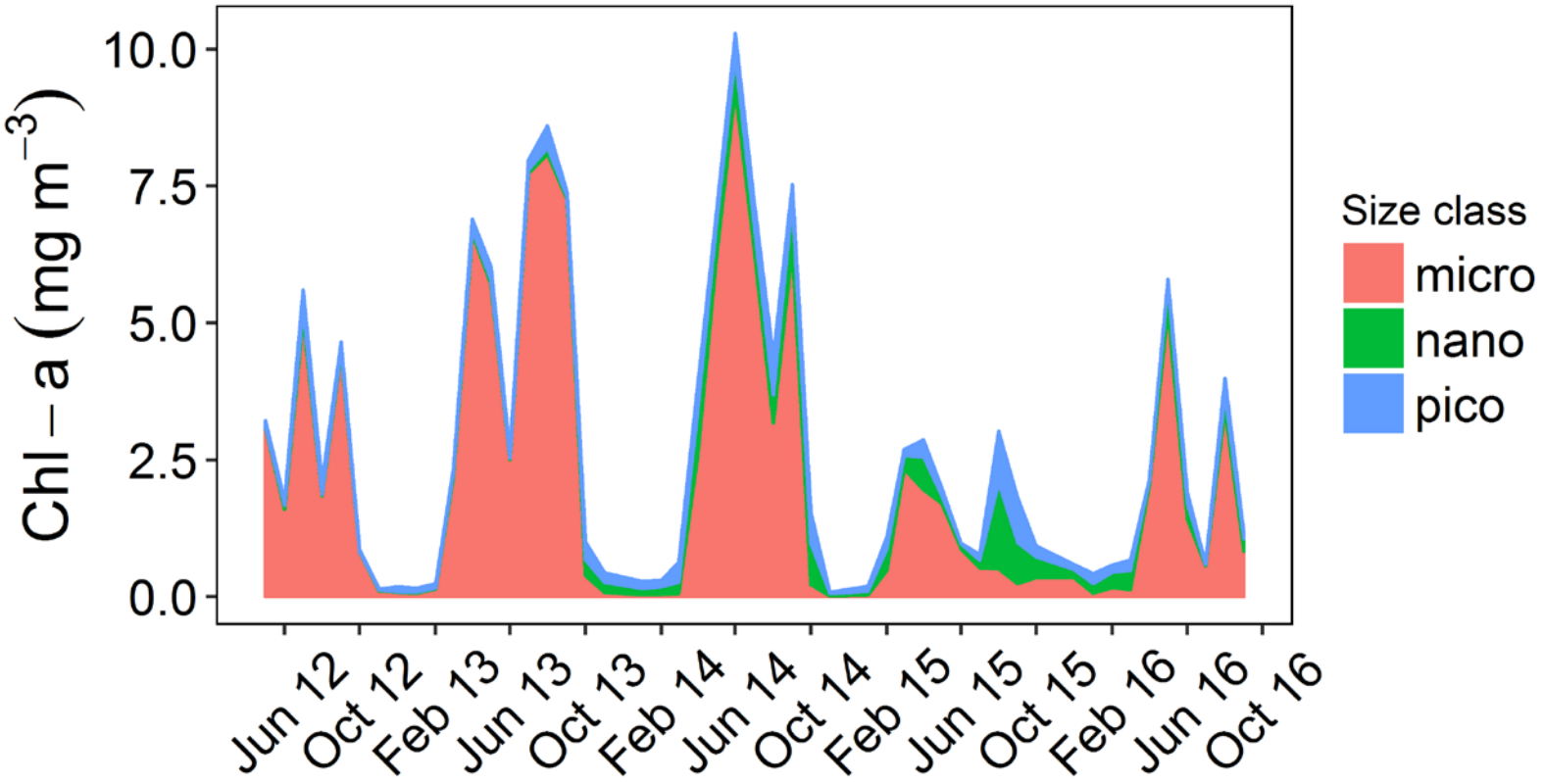
Decreased winter renewal in 2014/2015

Phytoplankton Biomass (5m)



Decreased biomass in 2015 & 2016

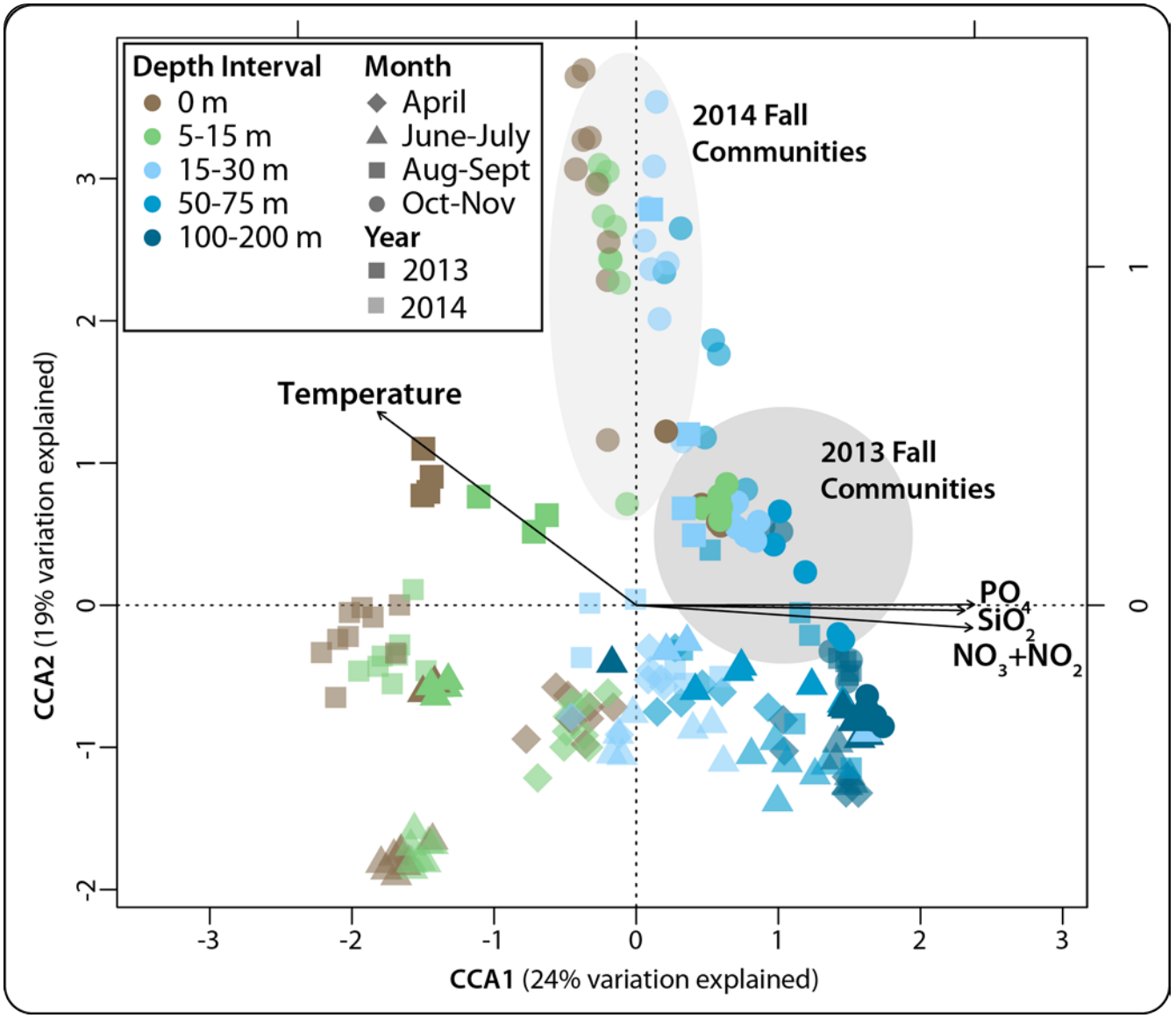
RESPONSE: PHYTOPLANKTON SIZE STRUCTURE



- Reduced microphyotplankton in 2015
- 2015 Fall bloom dominated by nano and pico size classes

RESPONSE: MICROBIAL COMMUNITIES

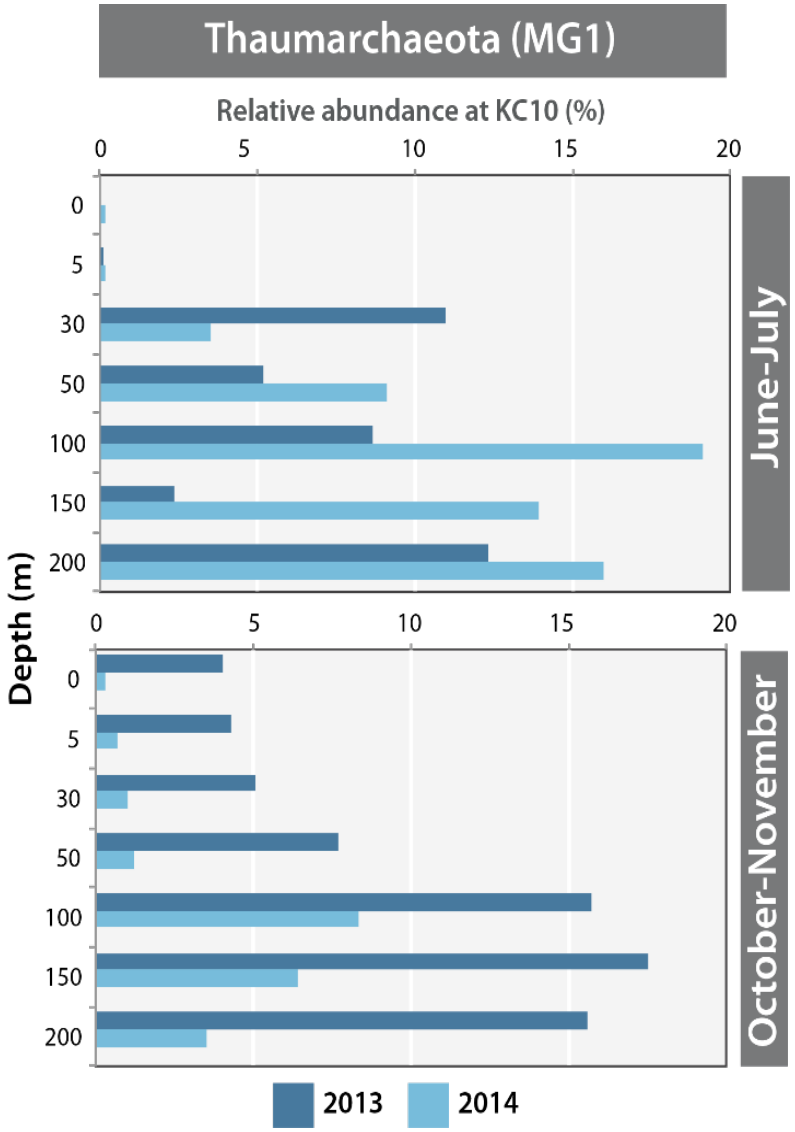
Hakai
Science on the Coastal Margin



Water temperature & inorganic nutrients explain 60% of the variability in the microbial community composition in Kwakshua Channel

RESPONSE: MICROBIAL COMMUNITIES

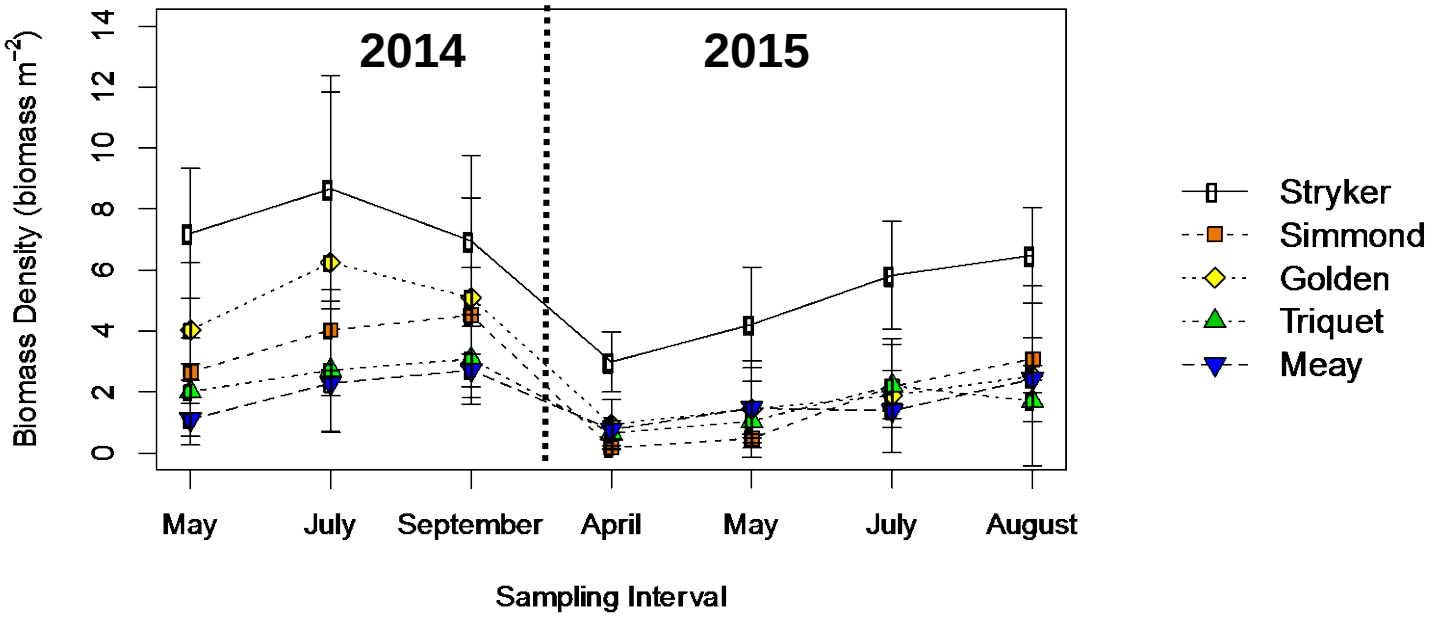
Hakai
Science on the Coastal Margin



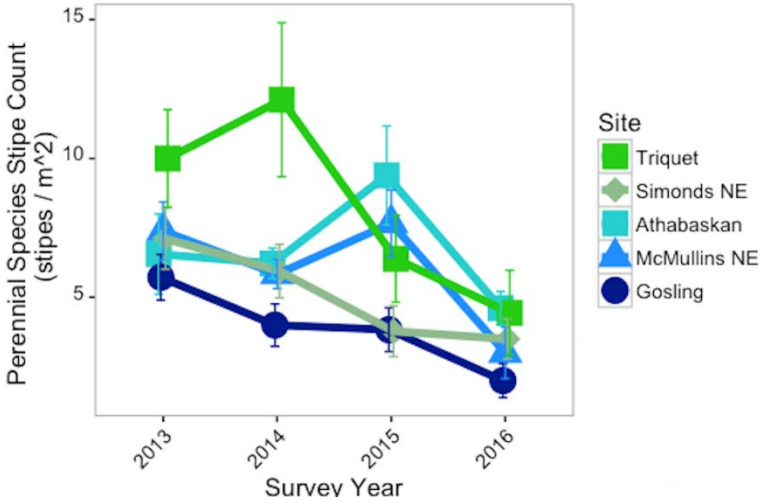
Relative abundance of ammonia-oxidizing archaea (Thaumarchaeota) in Fitz Hugh Sound in summer and fall of 2013 (dark blue) and 2014 (light blue).

RESPONSE: MACROPHYTES

Macrocystis



Perennial algae



SUMMARY OF WARM BLOB IMPACTS

Central Coast conditions in 2015 dominated by the warm Blob impact

↑ Temperature

↓ Salinity

↓ Winter nutrient renewal

↓ Phytoplankton biomass (diatoms)

↑ Dominance of small phytoplankton size classes

↑ Zooplankton biomass

↑ Zooplankton grazing impact - top-down control

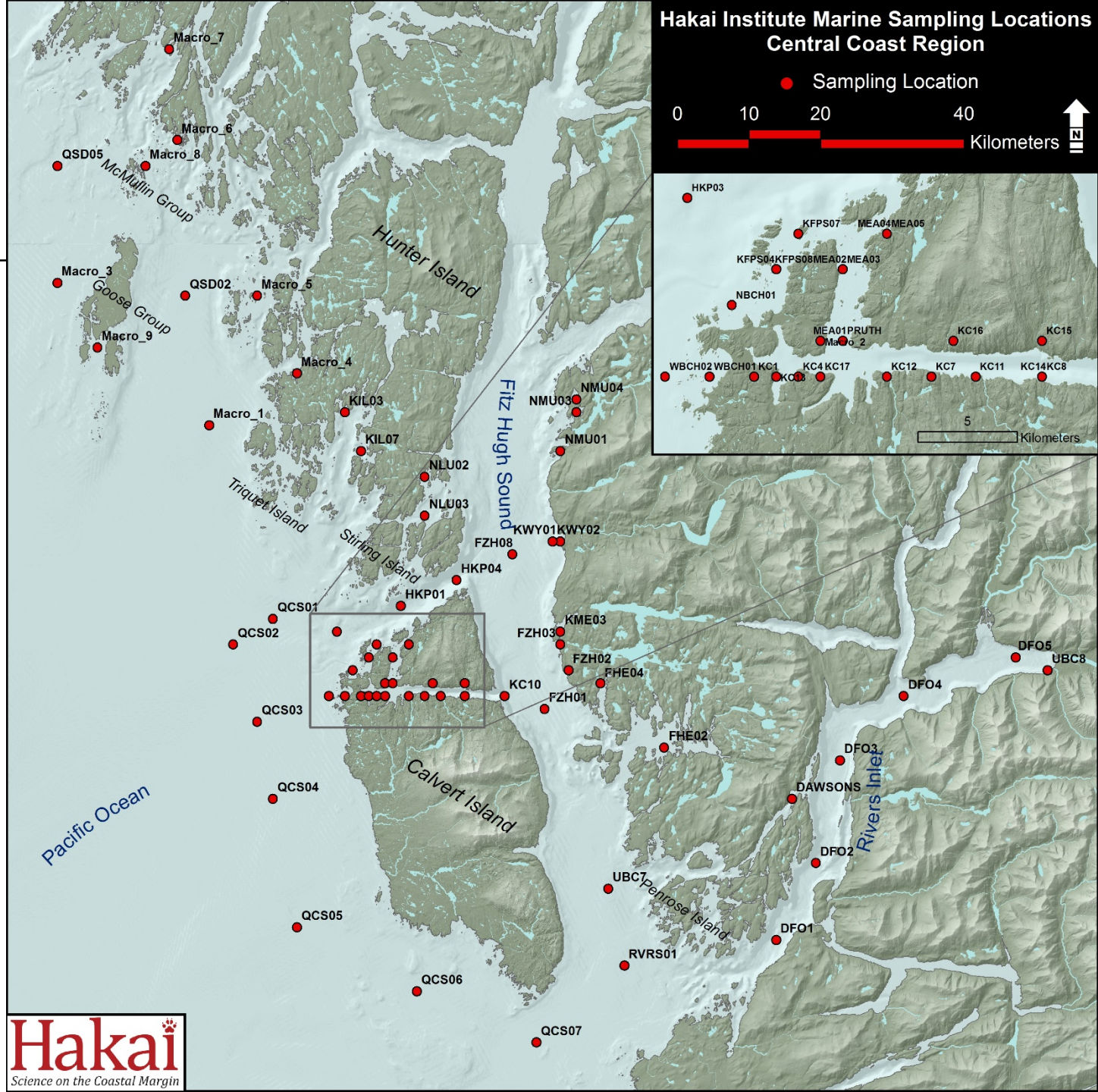
→ Shift in Fall microbial community

↓ Macrophyte biomass


Hakai
Science on the Coastal Margin
Integrated observatory platforms offer a new level of understanding of ecosystem function, establishing connections between adjacent systems and organisms, and identifying mechanisms behind response to perturbation.

Extra slides

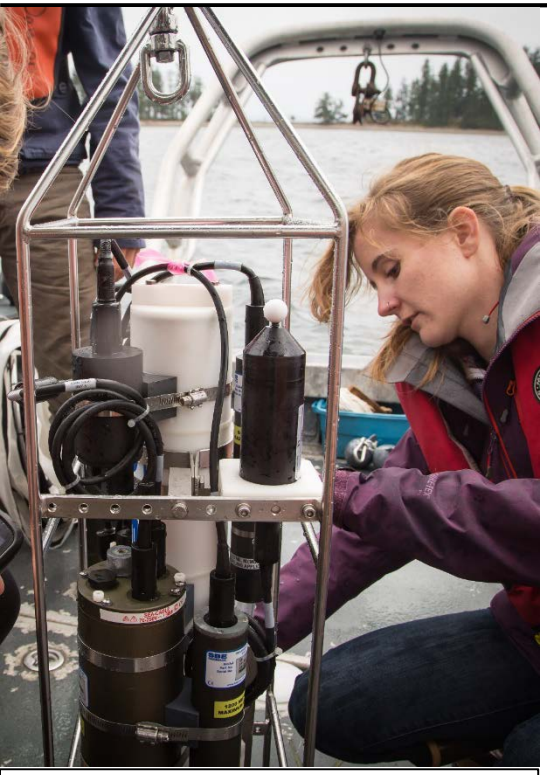
CENTRAL COAST



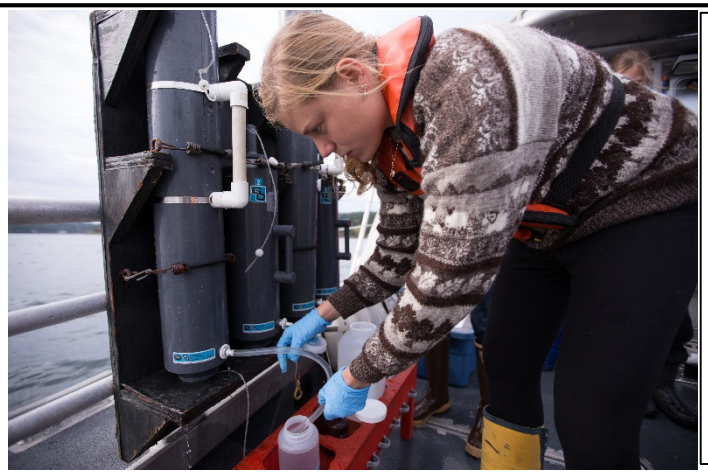
Hakai
Science on the Coastal Margin

ROUTINE FIELD OBSERVATIONS

Hakai
Science on the Coastal Margin



- Temperature
- Salinity
- Turbidity
- PAR
- Fluorescence



- Nutrients
- Oxygen
- Stable isotopes
- pCO2, TCO2
- Phytoplankton
- Bacteria & Viruses

- Zooplankton
- Larval fish

Sensor Network