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

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
Hakai Institute Guiding Principles

- Long Term Ecological Research
- Place Based
- Integration Across Disciplines
- Ecology that Includes Human Activity
- Local Analysis -> Regional Insights -> Policy
TWO PRIMARY OBSERVATORIES

Calvert Island
Operational since 2012

Quadra Island
Operational since 2014
OCEANOGRAPHIC CONTEXT

Data source: www.pfeg.noaa.gov/products/
The Coastal Margin: It’s where the Pacific Ocean meets the Coastal Temperate Rainforest.
CLIMATE / OCEAN DRIVERS, RESEARCH AXES & CROSSCUTTING THEMES

ATMOSPHERE

Coastal Watersheds
- Biogeochemistry / Coastal Carbon Dynamics
- Microbial Ecology / Genomics
- Salmon
- Deep Time
- Geospatial / Ecosystem Mapping
- Sensor Networks
- Big Data & Modeling

Estuaries & Nearshore

Coastal Ocean

PACIFIC OCEAN
Routine Field Observations

Watersheds

- Dedicated field teams
- High frequency
- Year round

Nearshore & Estuaries

Coastal Oceans
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

![Map of DOC yield with color coding and global average](image)

**Carbon (kg C km\(^{-2}\) yr\(^{-1}\))**

- 0
- 50
- 100
- 250
- 500
- 1000
- 2000
- 4000
- 8000
- > 20000

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

Global Average $\sim$5,890 kg C km\(^{-2}\) yr\(^{-1}\)
GLOBALLY SIGNIFICANT DOC YIELD

DOC yield

Calvert Island watersheds, areal yield = \textbf{32,800 kg} DOC km\(^{-2}\) yr\(^{-1}\)

(Oliver et al. \textit{in prep})

GLOBALLY SIGNIFICANT DOC YIELD

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

NEWS2 model (Mayorga et al. 2010, Beusen et al. 2009)
UPTAKE OF TERRESTRIAL CARBON BY PLANKTON

Zooplankton (500-1000 μm) δ¹³C
Marine contribution to Kwakshua carbon pool

Total area = 38.5 km²

Annual average phytoplankton biomass of 34 tons C.km⁻²

Annual average phytoplankton carbon production ~ 500 tons C.km⁻².yr⁻¹

Map: Luba Reshitnyk
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

Conservative temperature with absolute salinity contour lines

2014 / 15 winter ~ 2°C warmer than 2013 / 14
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
- Reduced microphytoplankton in 2015
- 2015 Fall bloom dominated by nano and pico size classes
Water temperature & inorganic nutrients explain 60% of the variability in the microbial community composition in Kwakshua Channel.
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
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
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
ROUTINE FIELD OBSERVATIONS

- Temperature
- Salinity
- Turbidity
- PAR
- Fluorescence

- Zooplankton
- Larval fish

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

Sensor Network