



**PACIFIC SALMON
FOUNDATION**



Fisheries and Oceans
Canada

Pêches et Océans
Canada



Ten years of PSF Citizen Science Oceanography monitoring in the Strait of Georgia, Canada

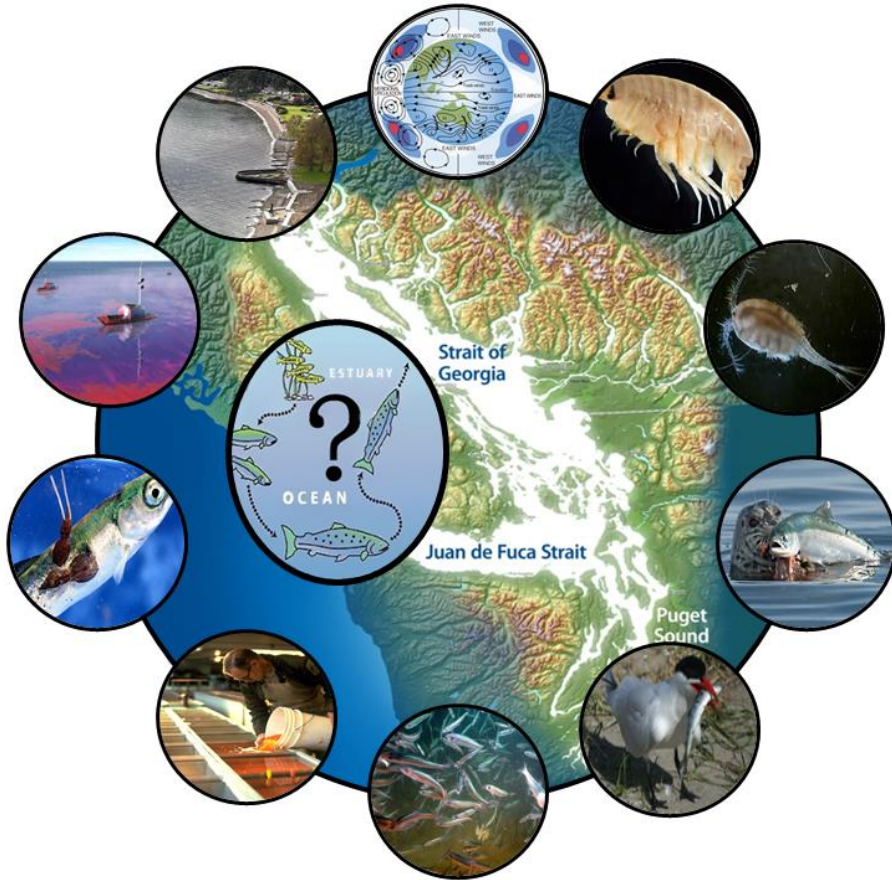
S. Esenkulova¹, N. Frederickson¹, R. Pawlowicz², D. Coskuner², B. Hunt², A. Ross³, I. Pearsall¹¹

¹ Pacific Salmon Foundation, Vancouver, BC, Canada.

² University of British Columbia, BC, Canada

³ Fisheries and Oceans Canada, Sidney, BC, Canada

Background



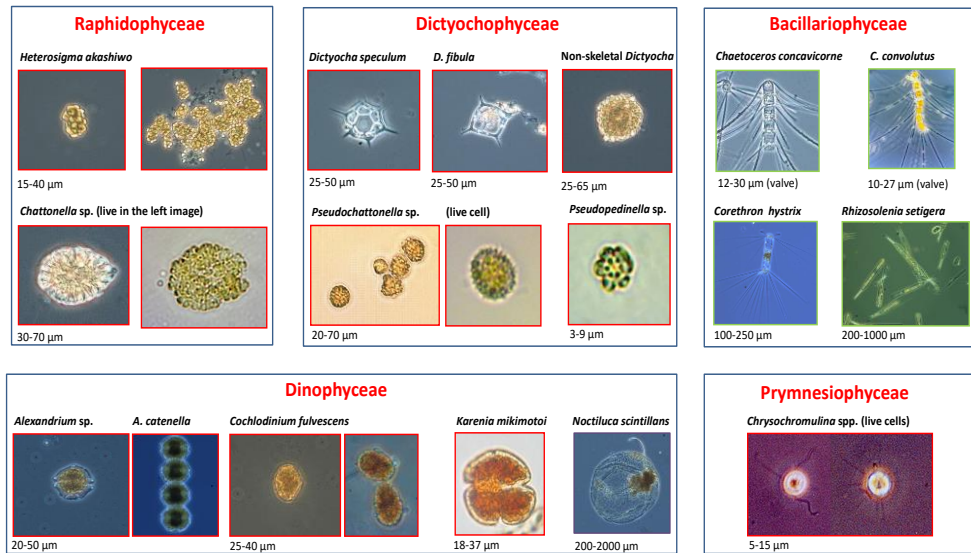
- British Columbia, Canada - crucial rearing ground for salmon: wild and farmed
- Wild BC salmon populations have experienced dramatic declines in the last decades. What is the cause?
- Salish Sea Marine Survival Project, 5 years, >60 USA-CAN entities, >60 publications
- <https://marinesurvivalproject.com/>
- PSF Citizen Science Oceanography Program since 2015-2024
- DFO funding for select stations 2025, 2026

Salmon growth during the first marine summer affects total marine survival

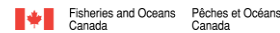
Citizen Science Oceanography Program people



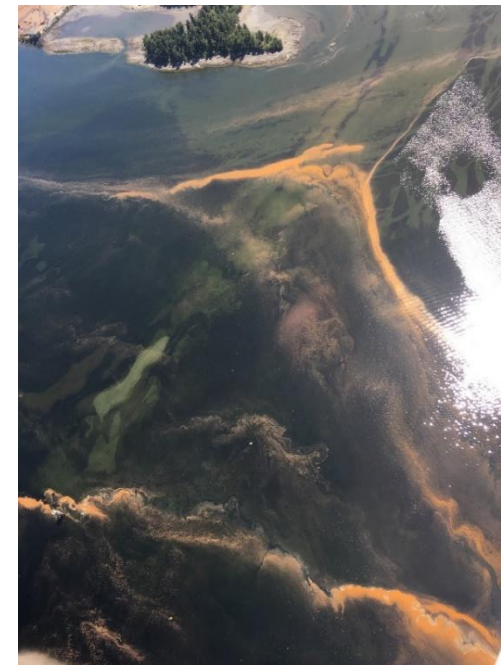
Photographs of algal species that produce toxins harmful to fish are framed with red; species that are mechanically harmful are framed in green; other – purple.



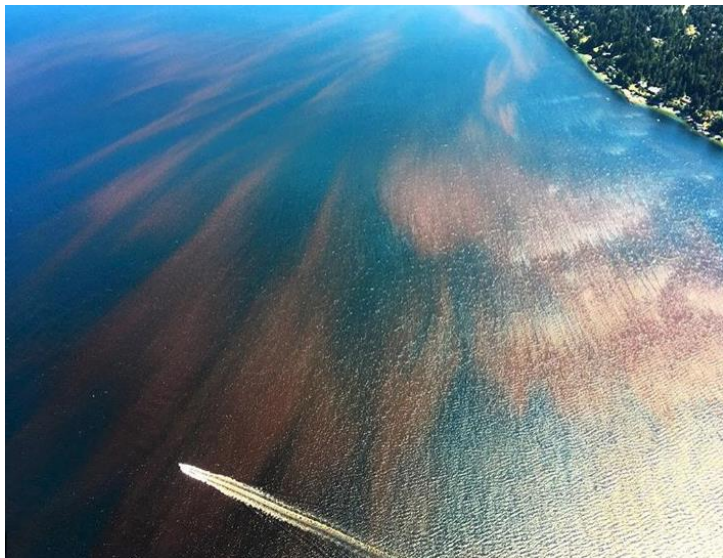
Funding provided by: Fisheries and Oceans Canada, Aquaculture Collaborative Research and Development Program
 Produced by: Nicky Haigh and Svetlana Esenkulova of Microthalassia Consultants Inc. and Dr. Chris Pearce and Laurie Keddy of Fisheries and Oceans Canada
 Note: All algae cells preserved with Lugol's iodine (unless otherwise stated).



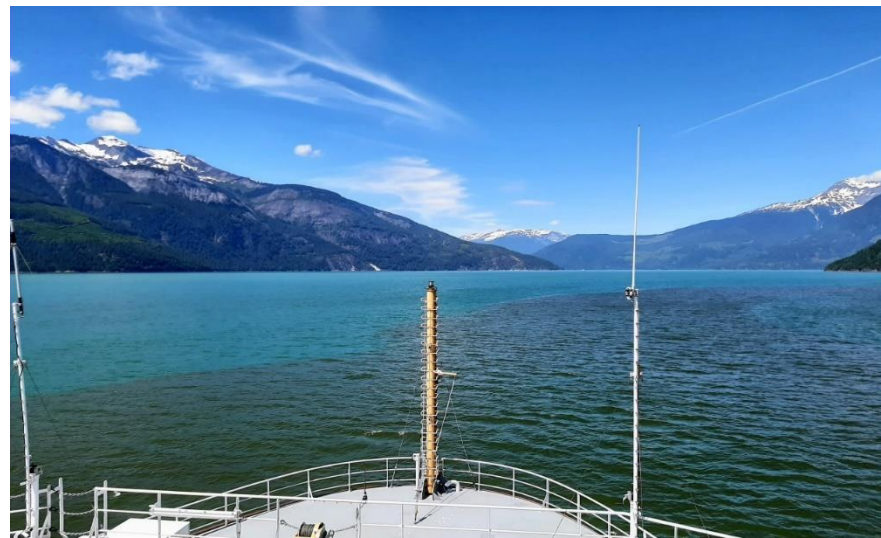
- Enumerated (cell mL⁻¹):
- Alexandrium* spp.
- C. convolutus* and *C. concavicornis*
- Cochlodinium fulvescens*
- Dictyocha* spp.
- Dinophysis* spp.
- Heterosigma akashiwo*
- Noctiluca scintillans*
- Rhizosolenia setigera*
- Pseudo-nitzschia* spp.



Heterosigma + *Noctiluca*, 2018, Kuper



Gonyaulax spp, June 2018, Mill Bay



Heterocapsa triquetra, June 2021, Bute Inlet



Mixed bloom, July 2021, Howe Sound

Bloom of *Noctiluca*, Strait of Georgia



Photos by: Dr. Maycira Costa



Michael Bahrey



Dr. N Christiansen and Esenkulova

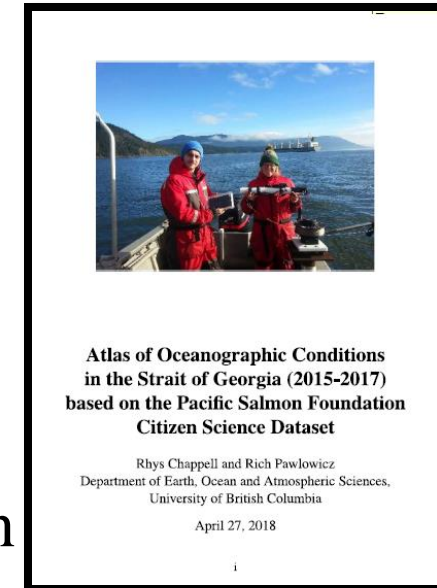
DATA - Data Center
<http://sogdatacentre.ca/>



PLOTS - Digital Atlas, updated annually (Dr. Rich Pawlowicz, UBC)
<https://sogdatacentre.ca/atlas/>

Annual reports – “Harmful algal blooms and oceanographic conditions in the Strait of Georgia” for the DFO State of the Pacific Ocean

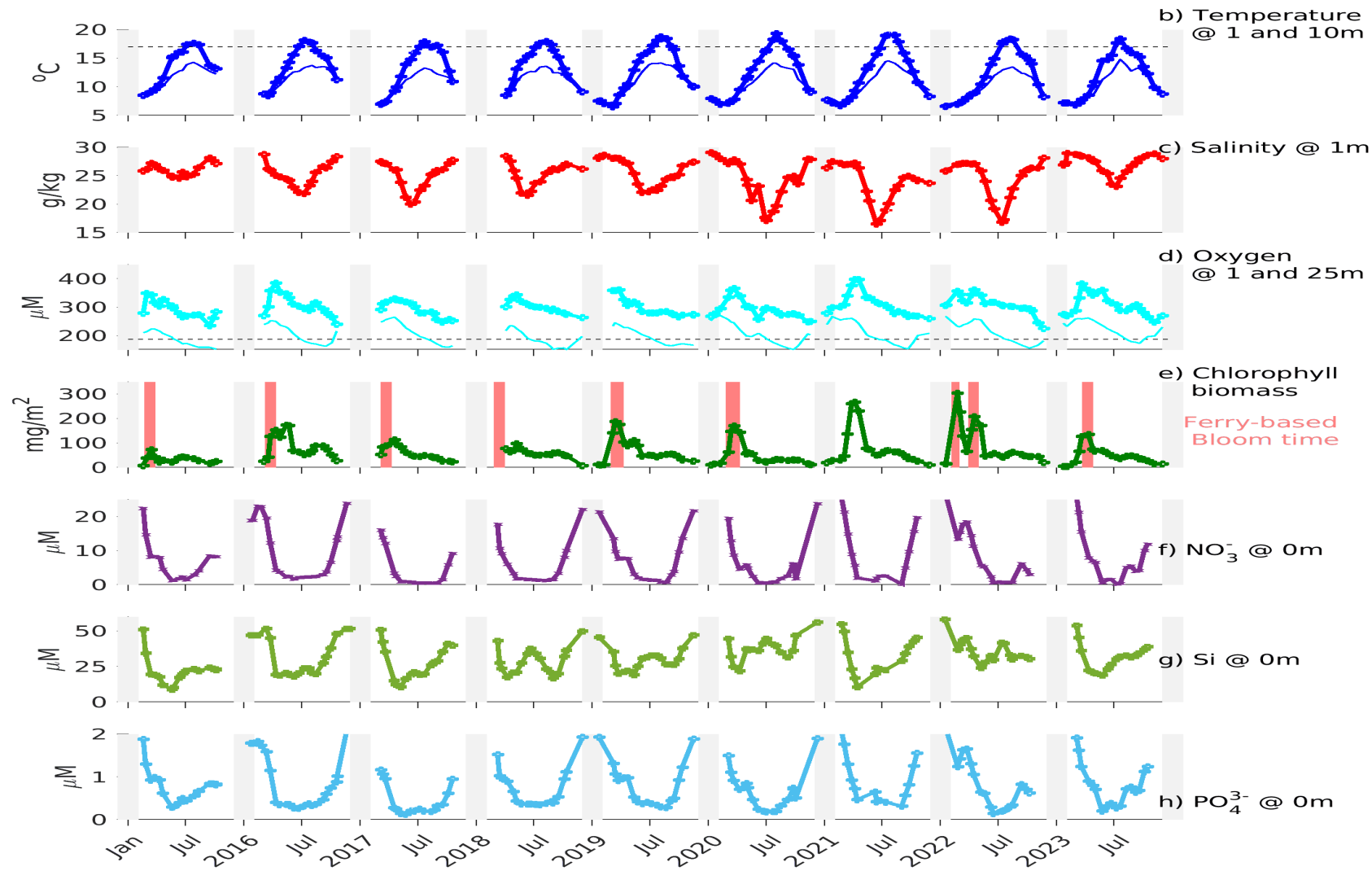
Peer-reviewed publications – S. Esenkulova et al, 2021 Harmful Algae and Oceanographic Conditions in the Strait of Georgia, Canada, Based on Citizen Science Monitoring, *Frontiers in Marine Science*
<https://doi.org/10.3389/fmars.2021.725092>



Social Media – HAB updates on facebook page
<https://www.facebook.com/CitizenSciencePhytoplankton>



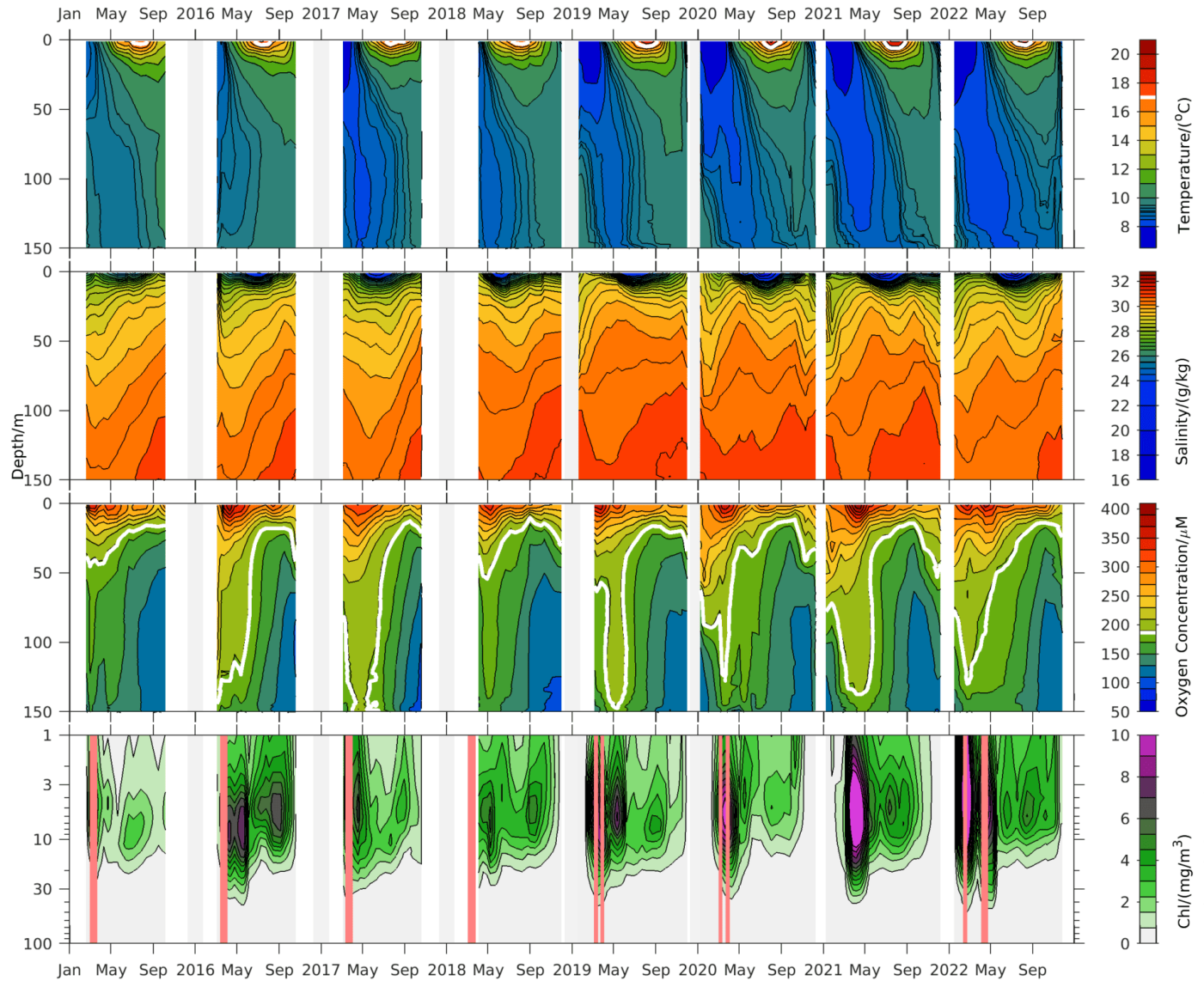
Time Series Hydrography



Unprecedented datasets on

- temperature
- salinity
- dissolved oxygen
- turbidity
- chlorophyll
- nutrients

Hydrography



~800 CTD annually
10 years of DATA

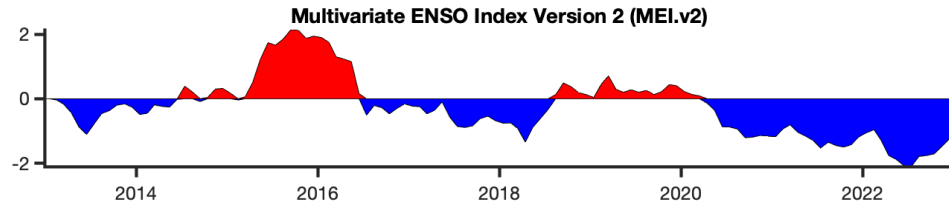
Currently creating a student opportunity with UBC on utilization of this dataset

Contact

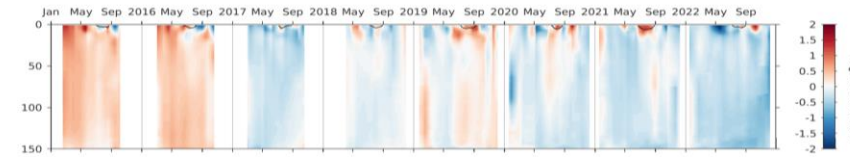
rpawlowi@mail.ubc.ca

Climate Anomalies and CitSc CTD profiles

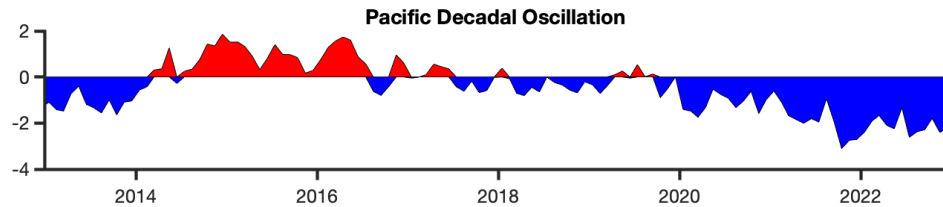
ENSO



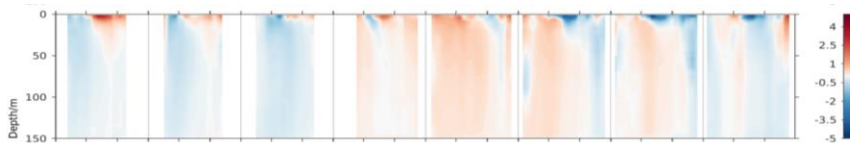
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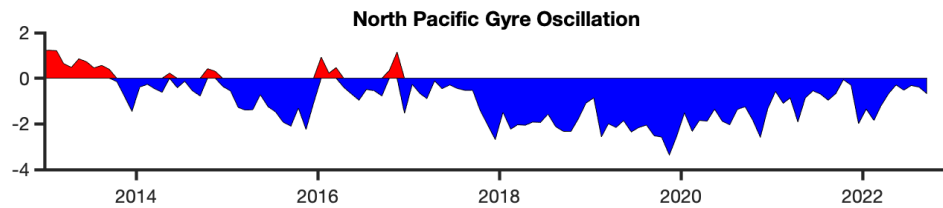
PDO



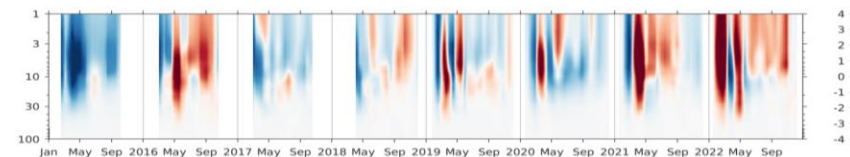
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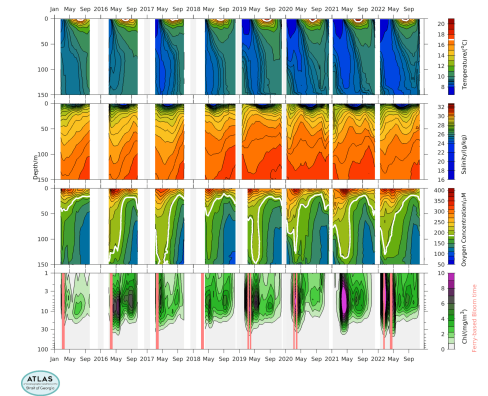
NPGO



Chl



Take this, and subtract the seasonal climatology



Temperature field at depth and ENSO/PDO?

Surface Salinity and PDO?

Deeper Salinity and NPGO?

Summer Chl and NPGO?

Dr. Rich Pawlowicz, UBC

Harmful algal blooms



Esenkulova et al, 2021 Harmful Algae and Oceanographic Conditions in the Strait of Georgia, Canada, Based on Citizen Science Monitoring

Harmful Algae in SoG, 4 years

- What
- Where
- When
- Why




Maple Bay, May 24, 2023.
Photo by K. Shehan, PSF



Sechelt Inlet, April, 2024.
Photo by N. Frederickson, PSF


DFO Marine Biotoxin Monitoring Program. Dr. Andrew Ross

- in 2015 an extraordinary phytoplankton bloom took place along the west coast, during a marine heat wave.
- this bloom contained *Pseudo-nitzschia* species that produce domoic acid (Amnesic Shellfish Poisoning).
- in 2016 DFO started monitoring domoic acid in British Columbia coastal waters, using ELISA.
- in 2020 DFO began collaborating with B.C. Salmon Farmers and PSF Citizen Scientists to monitor domoic acid, saxitoxins (Paralytic Shellfish Poisoning) and other (Diarrhetic Shellfish Poisoning) toxins, using LC-MS/MS.
- the Marine Biotoxin Monitoring Program now includes DFO surveys (Salish Sea, La Perouse) and First Nations.



Marine biotoxin monitoring

Unique ID: OSDOEB_10
Category: Human Impacts Research and Monitoring
Dates: February 27 to December 4, 2024
Start year: 2020
Recurrence: Annually
Vessel: CCGS Vector, citizen scientists and First Nations small vessels
Email: Andrew.Ross@dfo-mpo.gc.ca
Phone: 431-330-0027



Locations: Queen Charlotte Sound, West Coast Vancouver Island, Juan De Fuca Strait, Strait of Georgia

Description

The goal of this project is to increase understanding of the dynamics and drivers of harmful algal blooms and associated biotoxins that can impact wild and farmed salmon and endangered marine mammals in British Columbia coastal waters.

Objectives

1. Collect sea water and environmental data (temperature, salinity, oxygen, nutrients) two or three times a year at up to 29 locations and monthly at up to 16 locations, including salmon farms and critical habitat for fish and marine mammals.
2. Filter sea water and analyze filters and filtered seawater for up to 26 biotoxins.
3. Identify and measure the amounts of harmful algae and the biotoxins that they produce.
4. Monitor seasonal and annual trends in the abundance of harmful algae and biotoxins.
5. Compare with temperature and other factors to help predict when toxic algal blooms may occur.

Collaborators

Snuneymuxw First Nation, Pacific Salmon Foundation (Citizen Science Program), Cermaq Canada




Image 1: Citizen Science sampling.
Credit: Nicole Frederickson (Pacific Salmon Foundation)


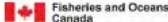



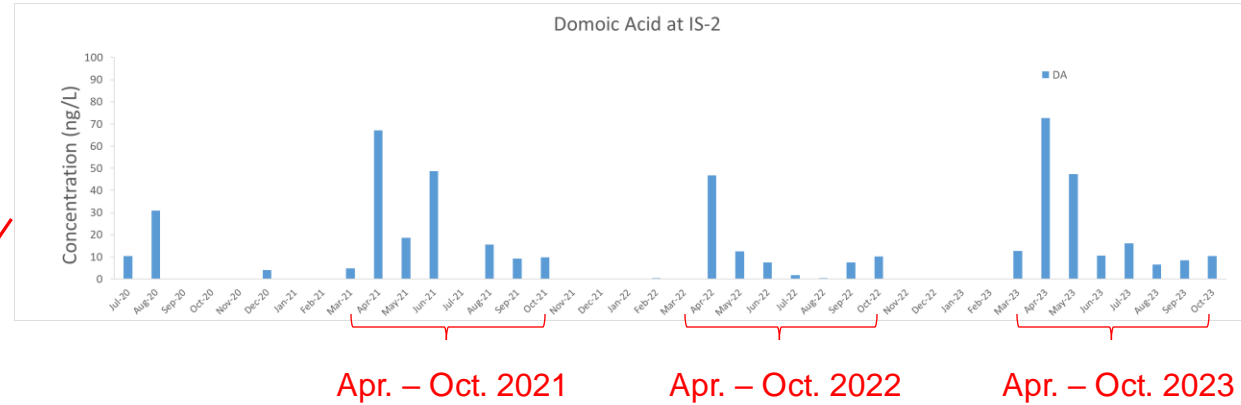
Image 2: Filtering sea water for biotoxin analysis.
Credit: Nicole Frederickson (Pacific Salmon Foundation)



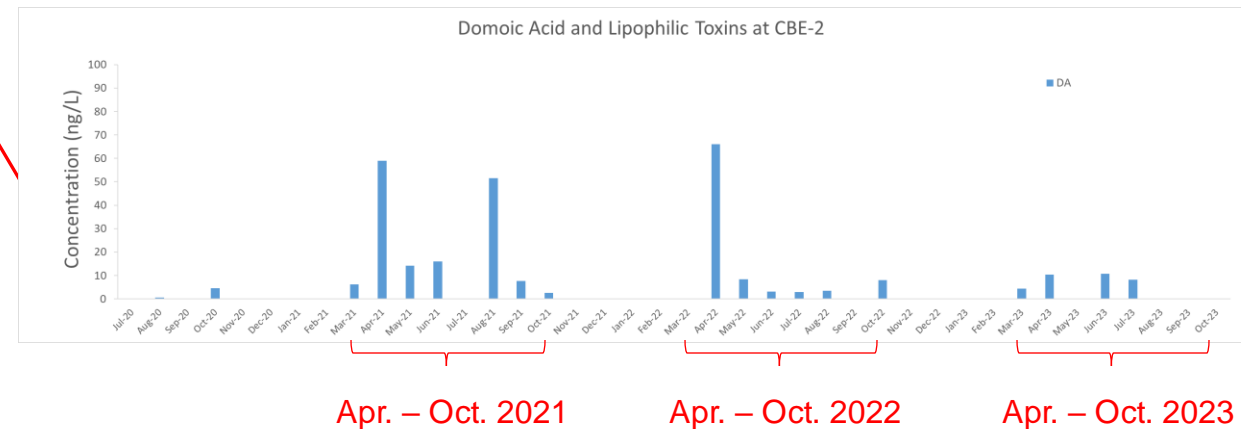
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Biotoxin Monitoring at PSF Citizen Science Sites



- Domoic acid tends to peak in April in the Salish Sea.
- Domoic acid in Malaspina Strait (IS-2) similar in 2021, 2022 and 2023.
- Domoic acid in Cowichan Bay (CBE-2) lower in 2023 than in 2021 or 2022.



Seasonal Trends in Biotoxin Concentrations

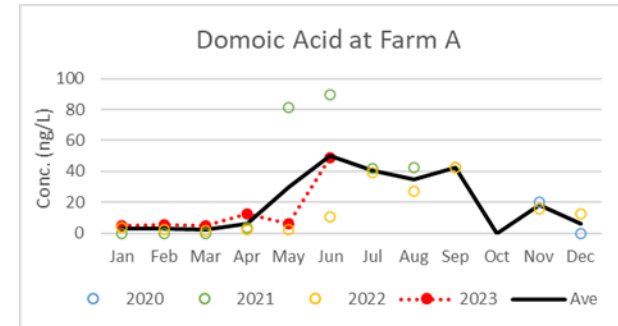
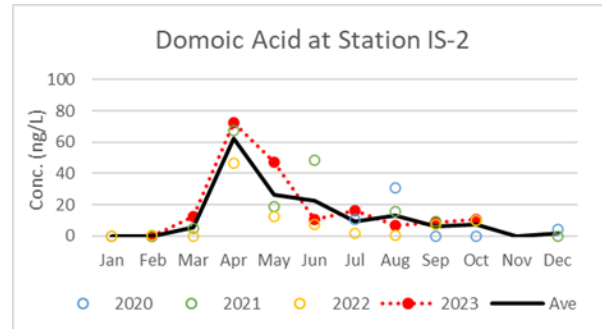
Dr. Andrew Ross

Andrew.Ross@dfo-mpo.gc.ca

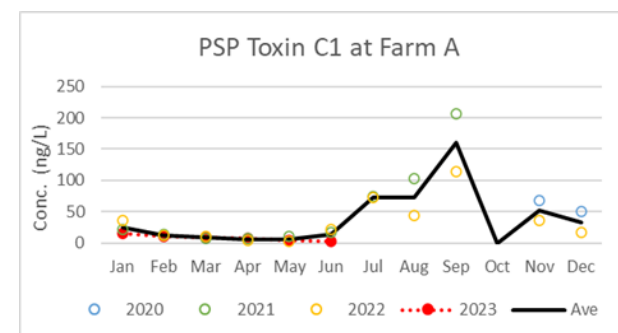
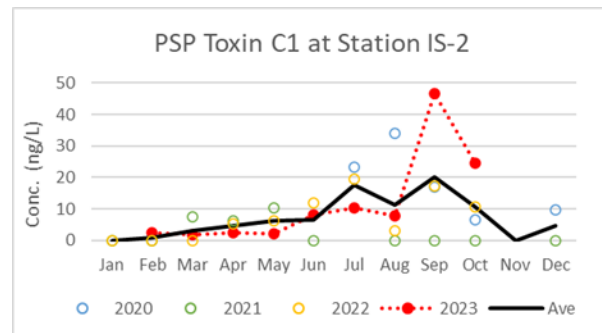
Malaspina Strait

Clayoquot Sound

Domoic Acid (DA)



Saxitoxin (C1)



- ASP toxin (DA) peaks in April in Salish Sea and in June on WCVI (*cf.* spring *Pseudo-nitzschia* bloom).
- PSP toxin (C1) peaks in September at both locations (*cf.* fall *Alexandrium* bloom).

Current work - Zooplankton

Deniz Coscuner, UBC is analyzing zooplankton

d.coscuner@oceans.ubc.ca

Investigating the seasonal dynamics

ZooSCAN technology for image analysis,
focusing on taxonomy, size, and biovolume

She has a poster with details!



Summary

- Citizen Science-based sampling is highly effective and cost-efficient
- Unprecedented spatio-temporal sampling resolution, community engagement, and rapid response capability
- The Pacific Salmon Foundation (PSF) has successfully run its Citizen Science Oceanography Program in the Strait of Georgia for 10 years, achieving unparalleled data collection that aids in understanding the factors influencing salmon survival.
- Collected data can facilitate future ecosystem-based, multidisciplinary research

Thank you

sesenkulova@psf.ca