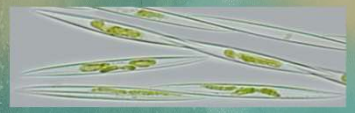
PICES-2022
Sept 23 - Oct 2, 2022
Busan, Korea

Sustainability of Marine Ecosystems
through Global Knowledge Networks during the
United Nations Decade of Ocean Science for Sustainability

Correlations between ocean temperature and the concentrations of harmful algal biotoxins measured in British Columbia coastal waters



Andrew Ross, **Stewart Johnson** and **Lenora Turcotte** (Fisheries and Oceans Canada)

Mackenzie Mueller (University of Victoria) and **Béatrice Ip** (University of Ottawa)

Blair Surridge and **Harry Hartmann** (M.B. Laboratories)

Ovi Haque (Cermaq Canada)

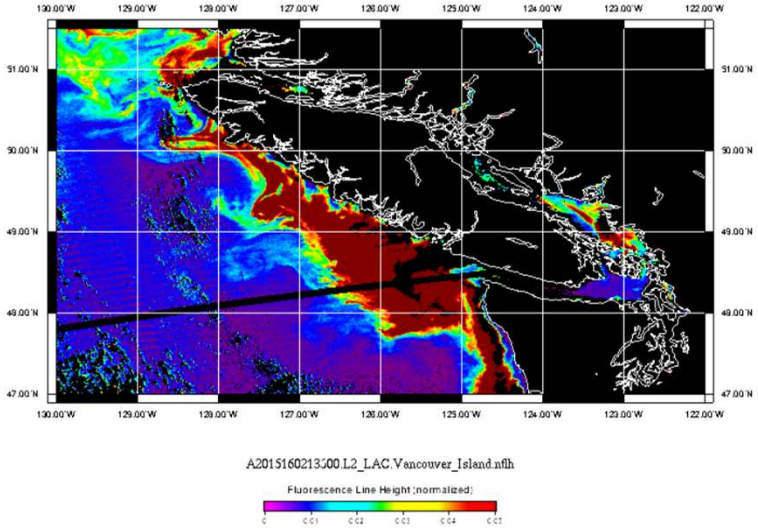
Nicole Frederickson and **Svetlana Esenkulova** (PSF Citizen Science Program)

Session S9 Presentation, 28 September 2022

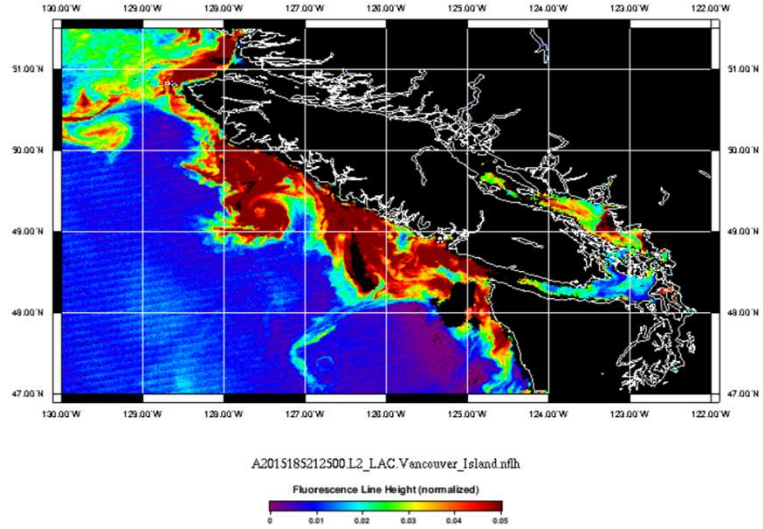
NORTH PACIFIC MARINE SCIENCE ORGANIZATION

Extreme Algal Bloom (2015)

June 9, 2015



July 4, 2015



MODIS NFLH satellite images

- took place during the 2014 - 2016 NP marine heatwave.
- the bloom was highly unusual due to:
  - its size (from California to Alaska)
  - its duration (from May to September)
  - the presence of harmful algae (*Pseudo-nitzschia*)

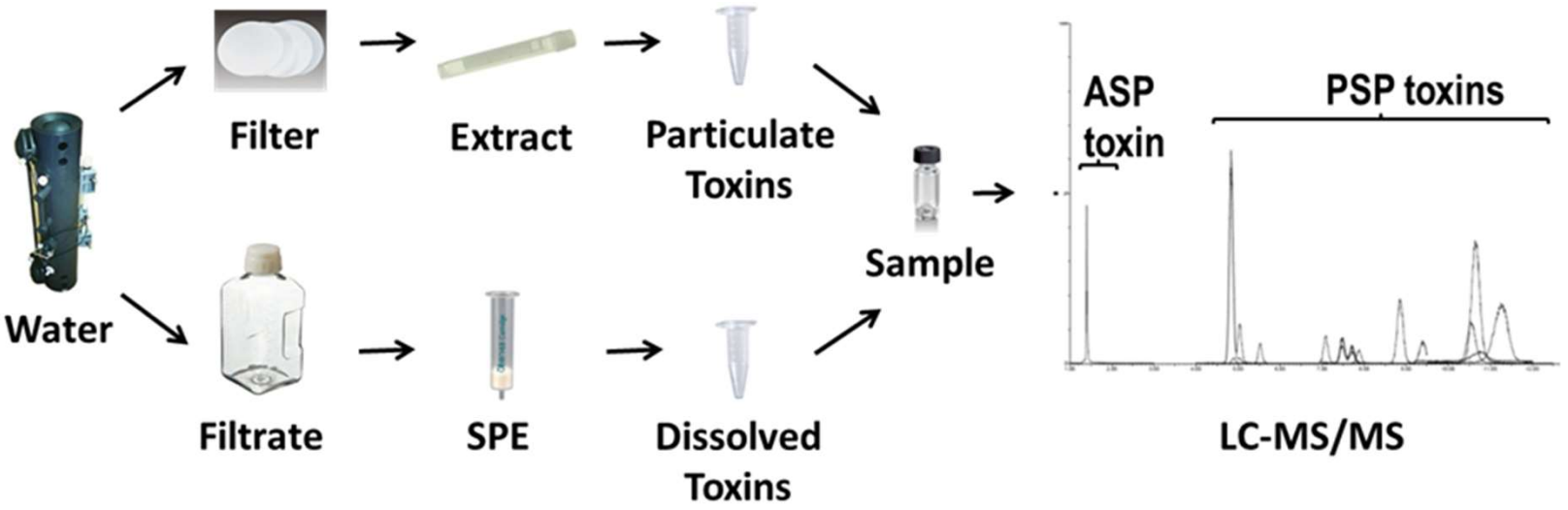
Harmful Algal Biotoxins

- biotoxins and the HABs that produce them can be classified according to the type of illness that may result from eating shellfish contaminated with those toxins:

CLASS	BIOTOXIN(S)	HARMFUL ALGAE
Amnesic Shellfish Poisoning (ASP)	Domoic Acid	*Pseudo-nitzschia*
Paralytic Shellfish Poisoning (PSP)	Saxitoxins	*Alexandrium* *Gymnodinium*
Diarrhetic Shellfish Poisoning (DSP)	Okadaic Acid Dinophysitoxins	*Dinophysis* *Prorocentrum*

Profiling Biotoxins in the Marine Environment

- new method for quantifying multiple biotoxins in seawater:



- biotoxins extracted from filtered seawater and from algae captured on filters are analyzed by liquid chromatography-tandem mass spectrometry (LC-MS/MS).
- ASP and PSP toxins are measured in one LC-MS/MS run while DSP and other toxins are analyzed in another.

Dates: April 1 – December 16, 2022
Recurrence: Annually, since 2020
Location: Strait of Georgia, West Coast Vancouver Island
Vessels: Small boats operated by citizen scientists
Lead scientist: Andrew Ross (250) 363-6800
Andrew.Ross@dfo-mpo.gc.ca

Image 1. Sampling from a Citizen Science vessel.

Map 1. Study locations.

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 mammal in British Columbia coastal waters.

Objectives

1. Collect sea water and environmental data (temperature, salinity, oxygen, nutrients) bi-weekly at up to 12 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; and
5. Compare with temperature and other factors to help predict when toxic algal blooms may occur.

Collaborators

- Pacific Salmon Foundation
  - Citizen Science Program
- Grieg Seafood BC Ltd.
- Cermaq Canada

Image 2. Filtering sea water for bio-toxin analysis.

FOR MORE INFORMATION

Citizen Science Program and Collaboration with British Columbia Salmon Farmers

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Millar Channel

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McIntyre Lake
Saranac Island

Image 2. Filtering sea water for biotoxin analysis.

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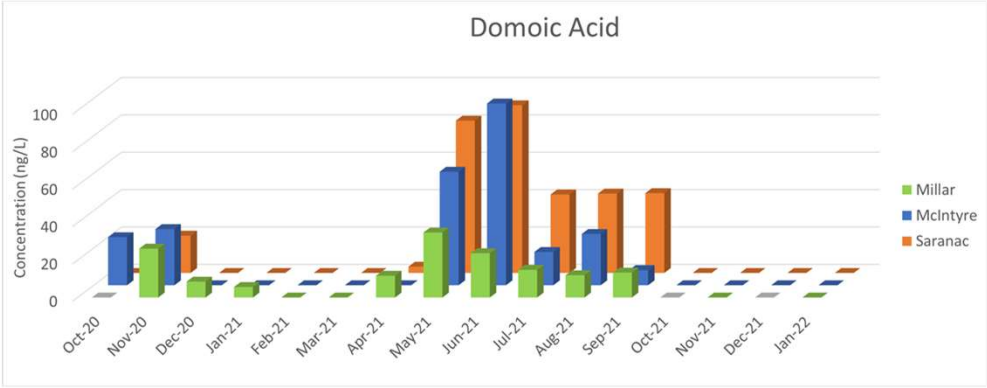
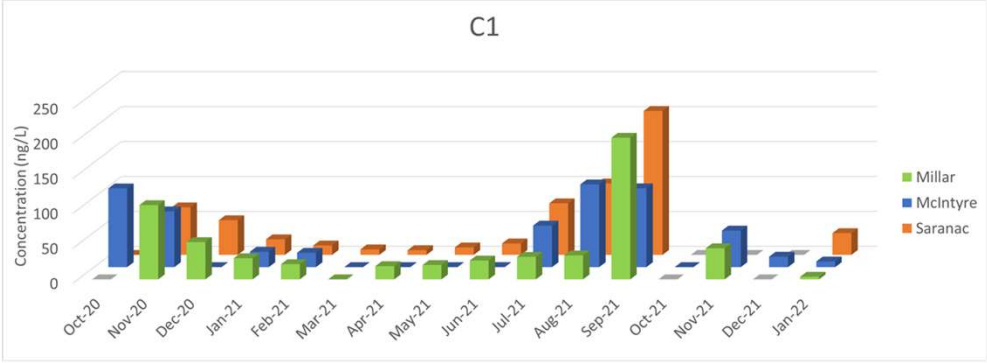
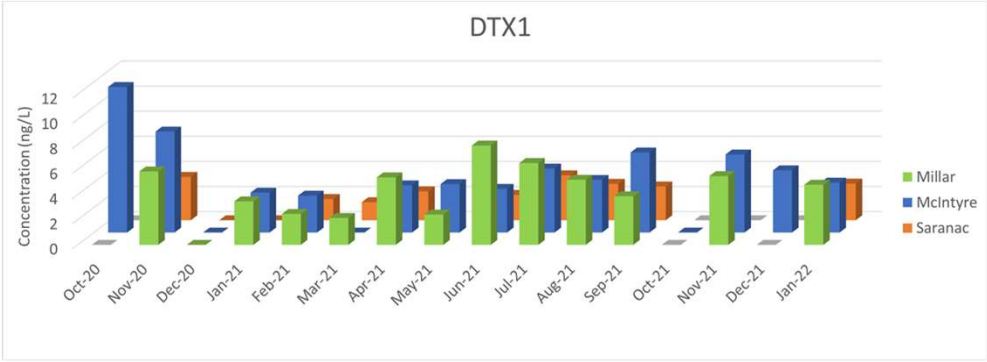
Citizen Science Program and Collaboration with British Columbia Salmon Farmers

Biotoxins at WCVI/Salmon Aquaculture Sites







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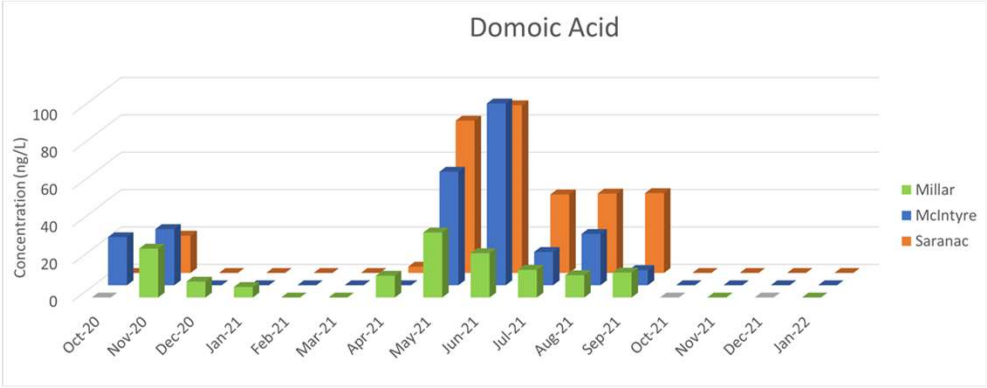
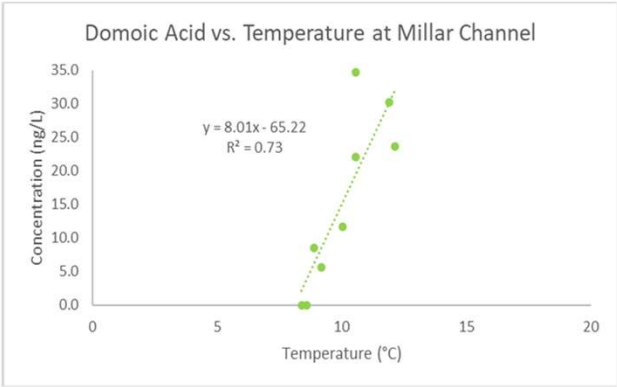
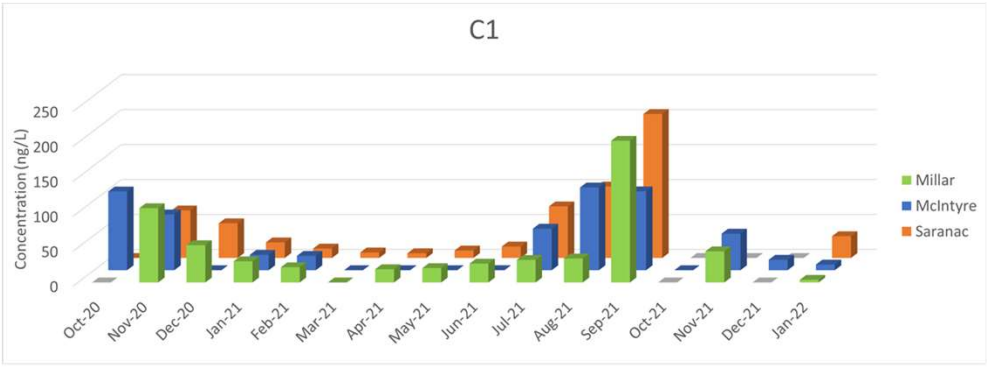
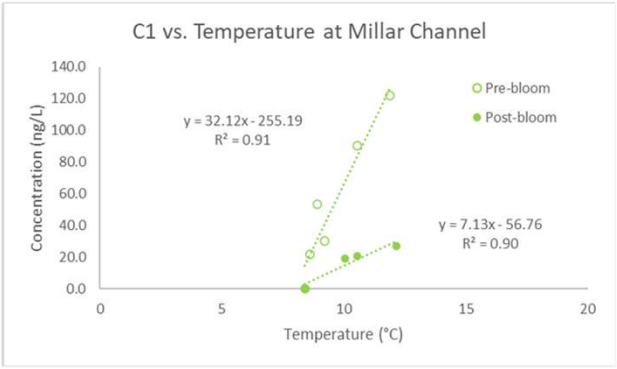
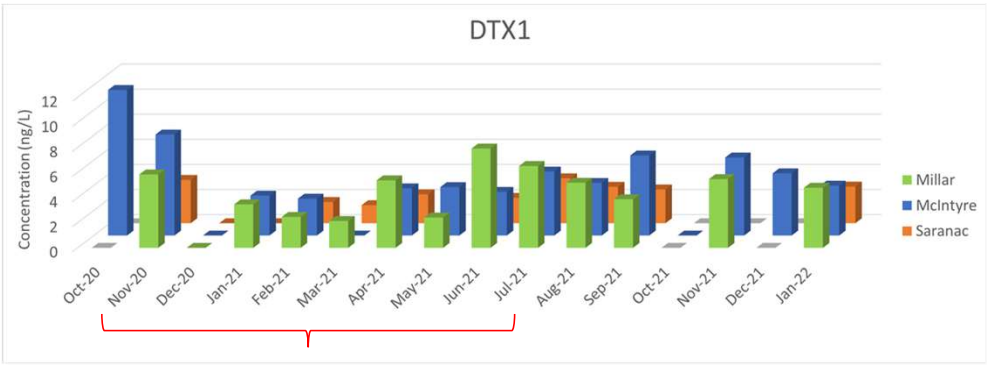


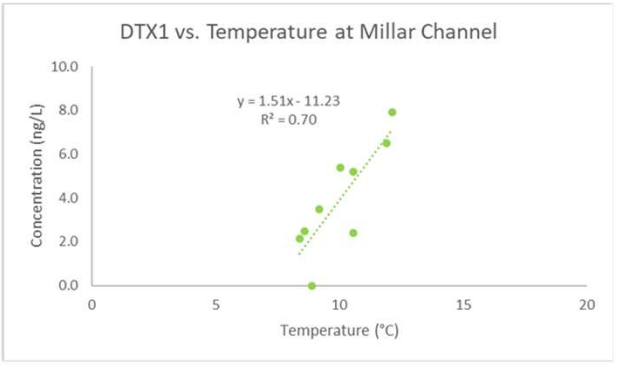








PERIOD OF COMPARISON



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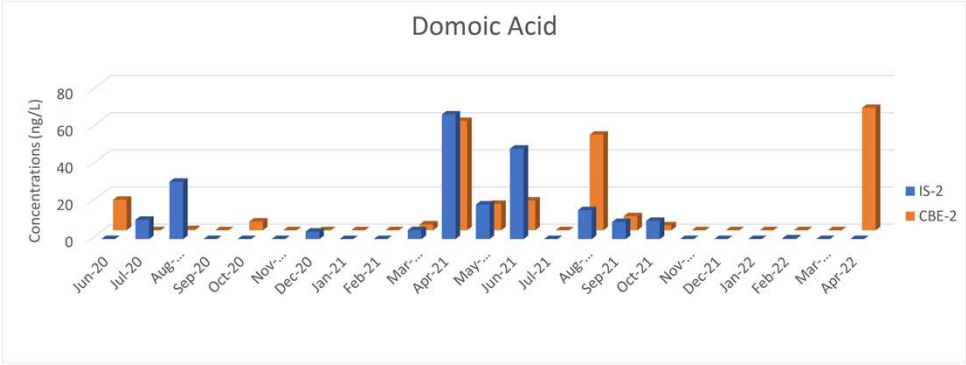
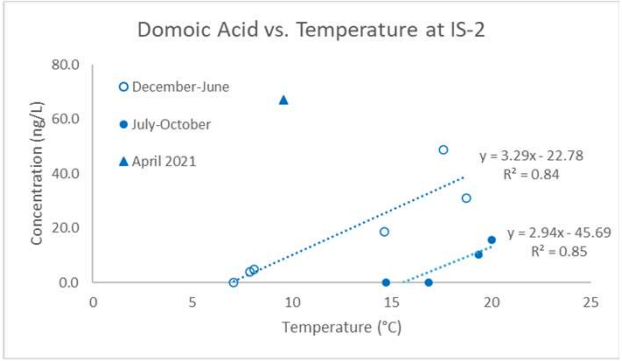
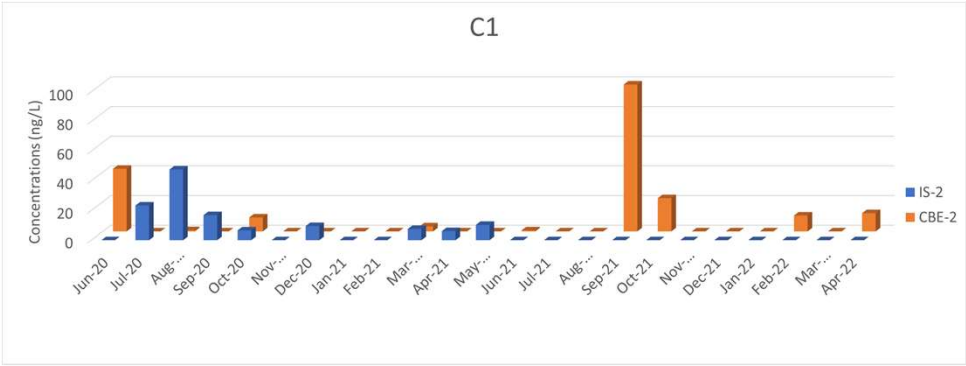
Citizen Science Program and Collaboration with British Columbia Salmon Farmers

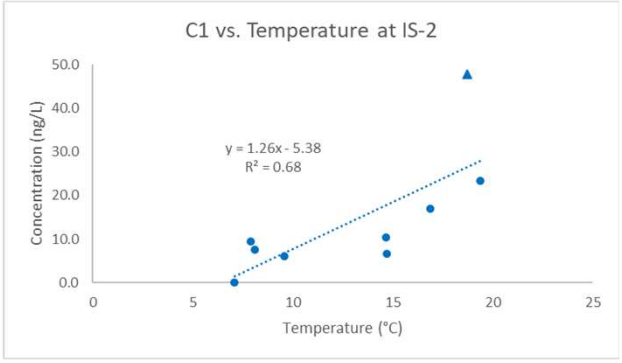
Biotoxins at Strait of Georgia/Citizen Science Sites

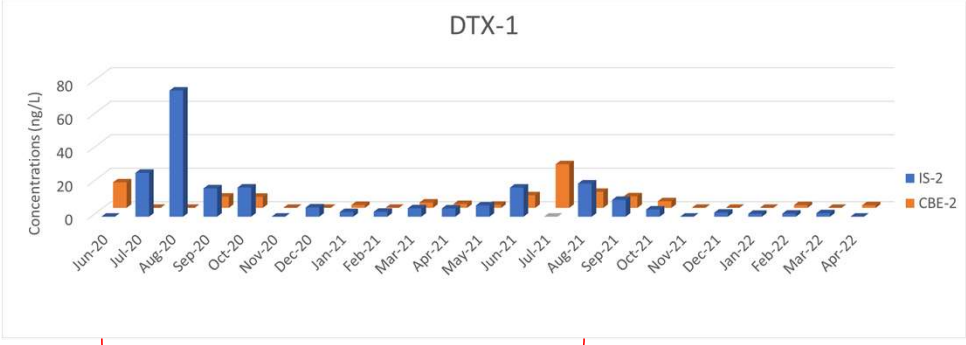
IS-2

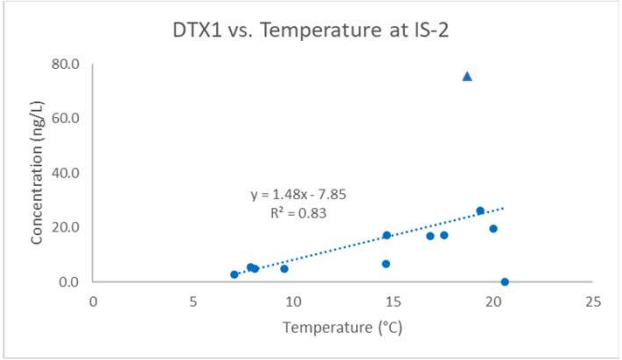












PERIOD OF COMPARISON

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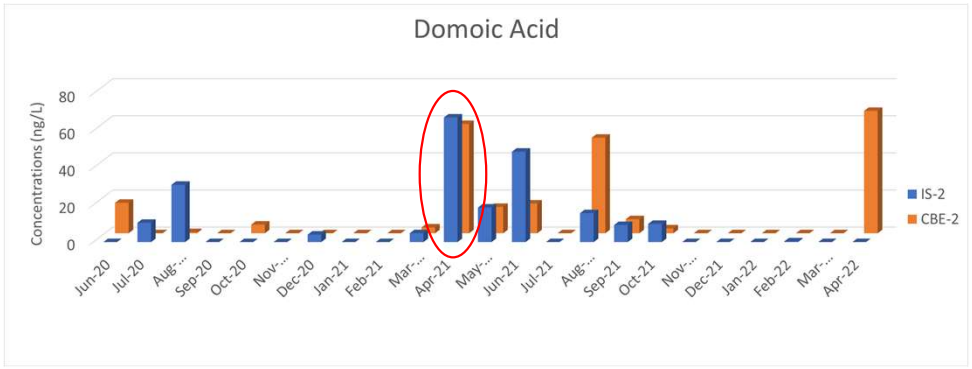

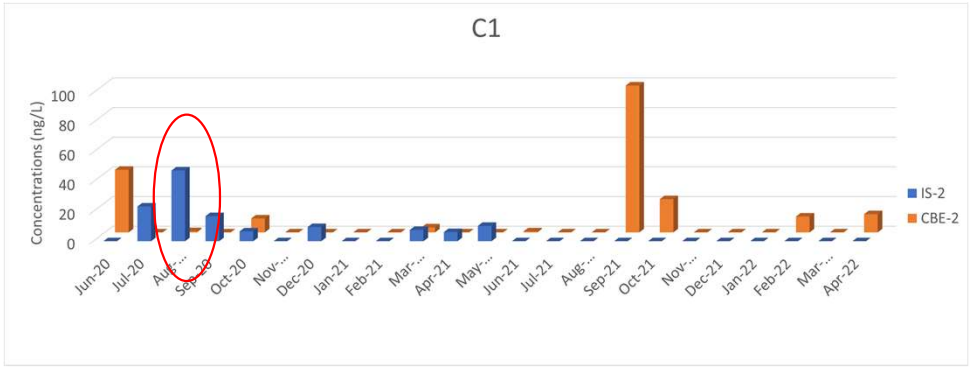

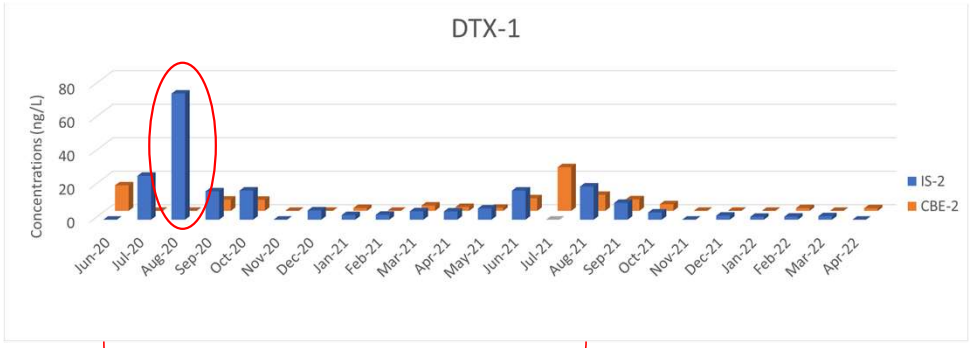

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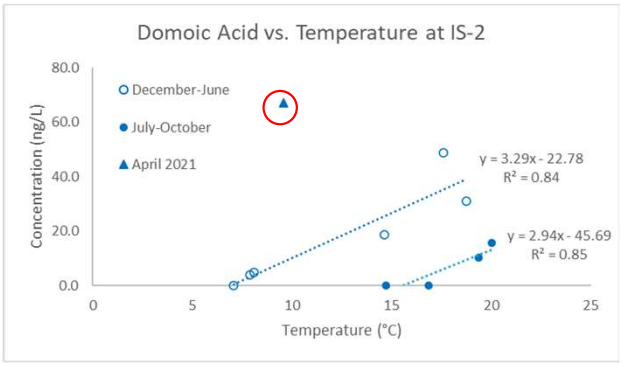
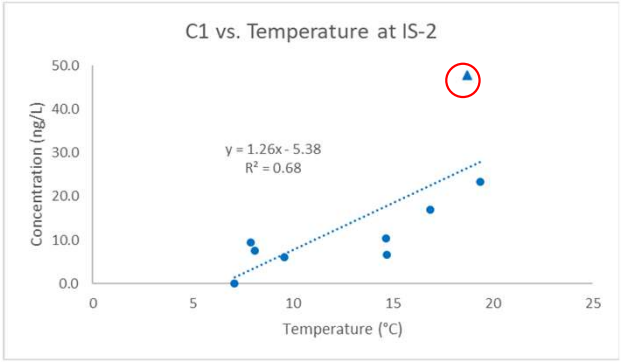
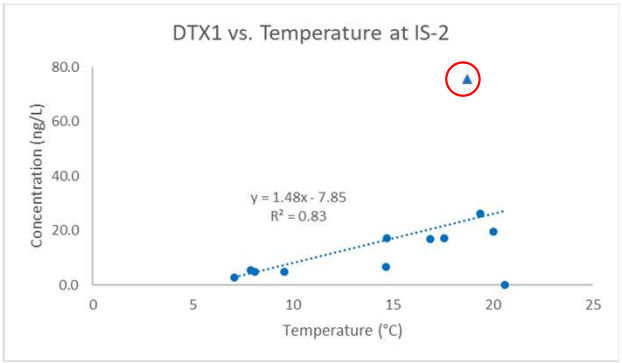
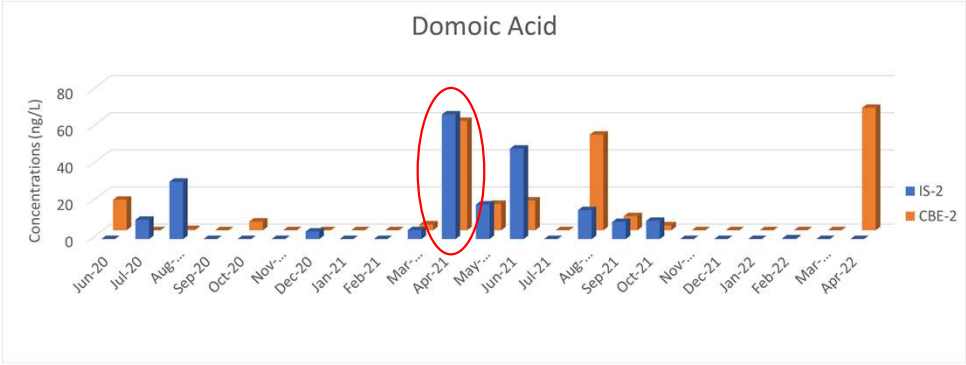


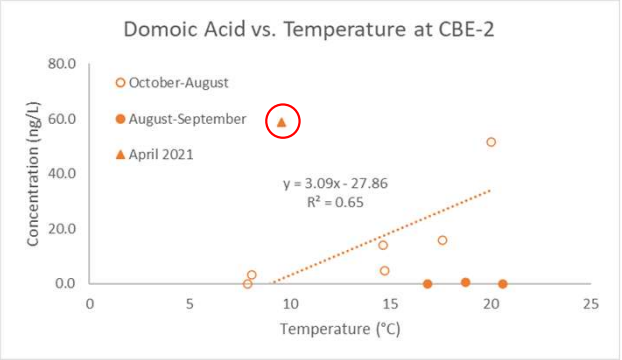


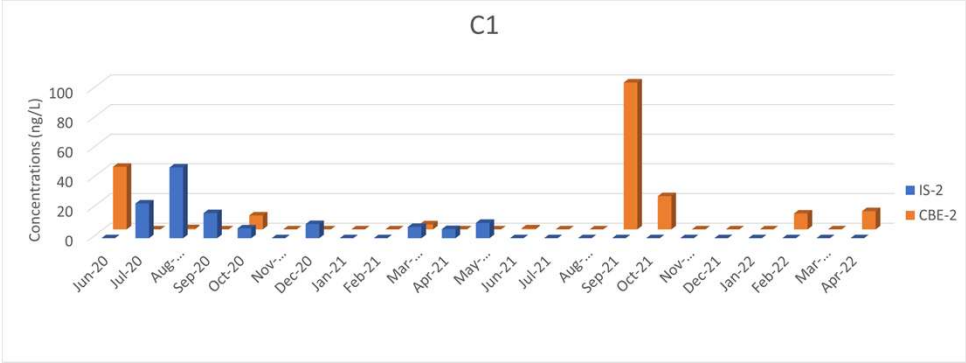


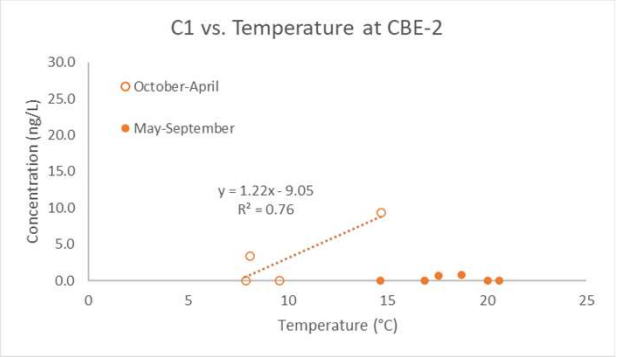
Biotoxins at Strait of Georgia/Citizen Science Sites

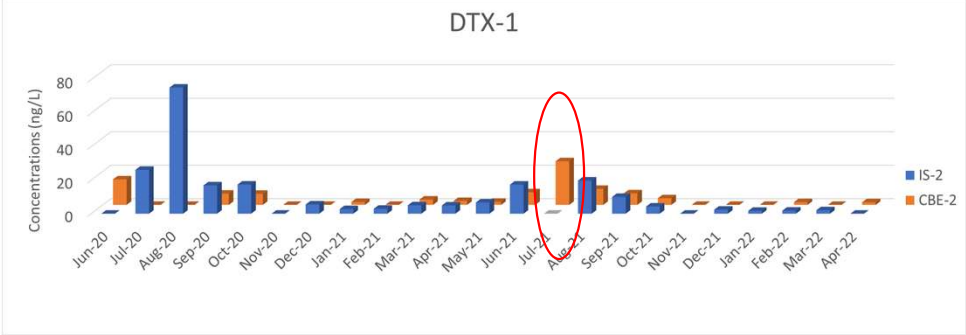
CBE-2

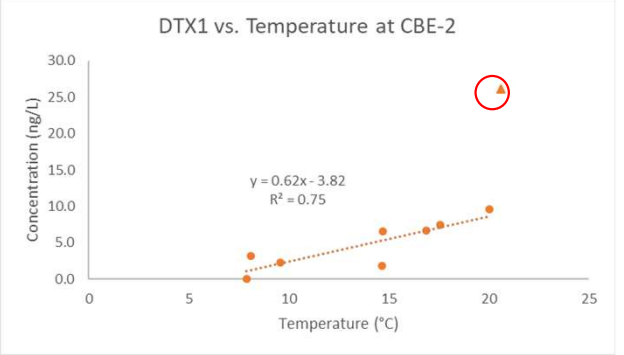












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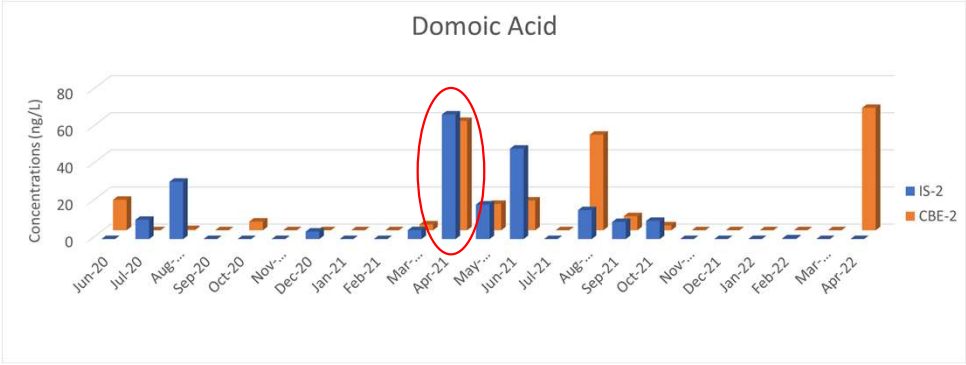

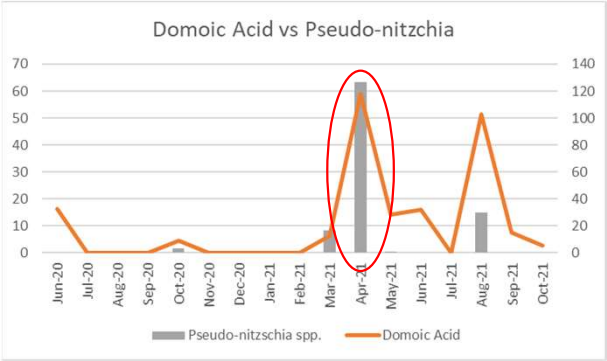

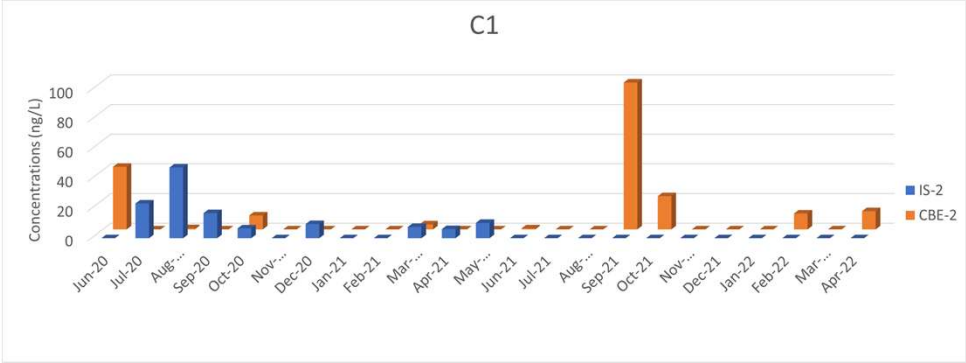

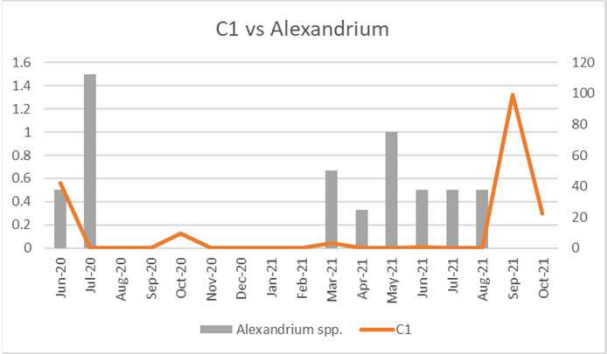

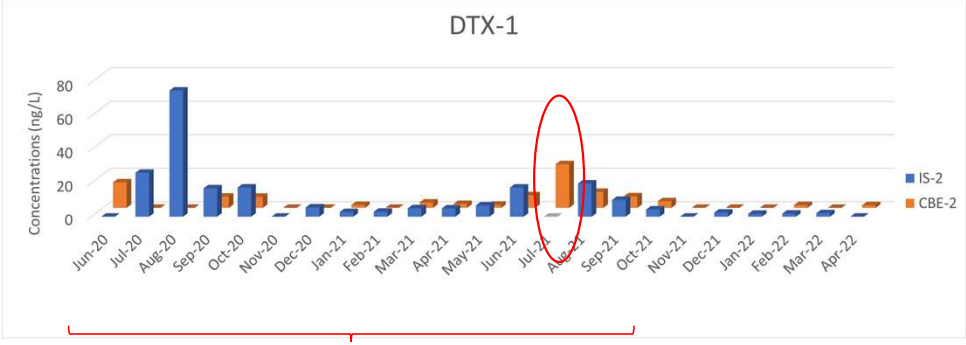

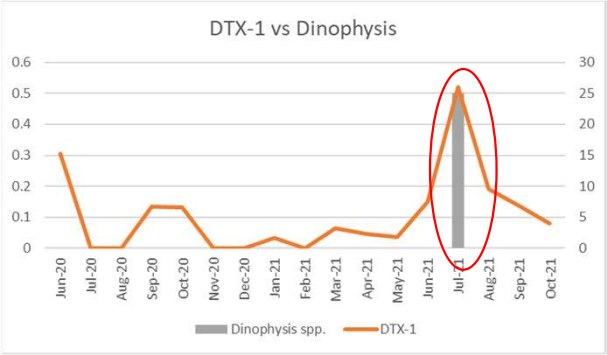

PERIOD OF COMPARISON

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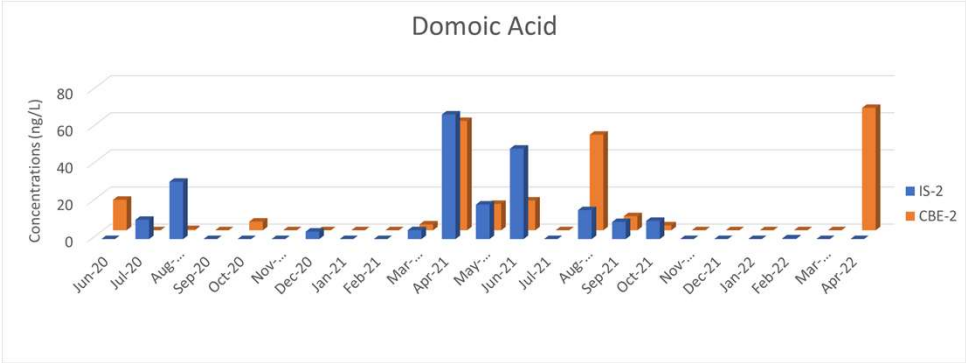
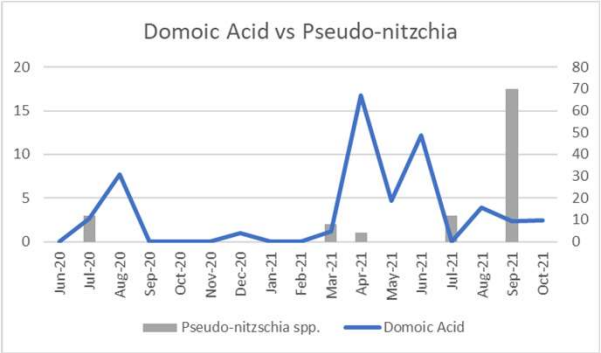
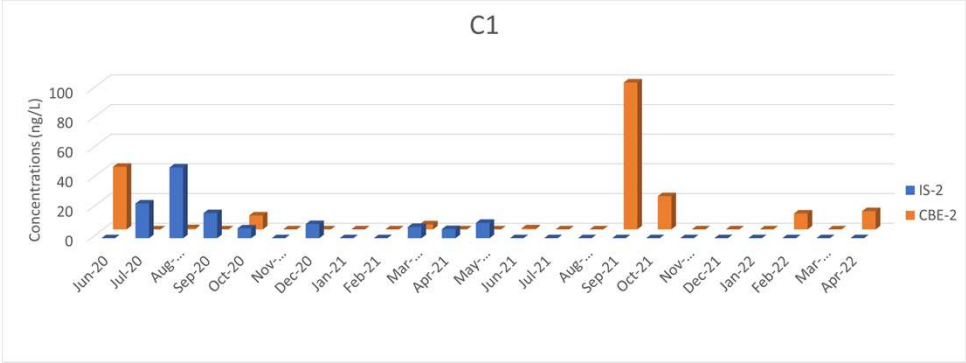
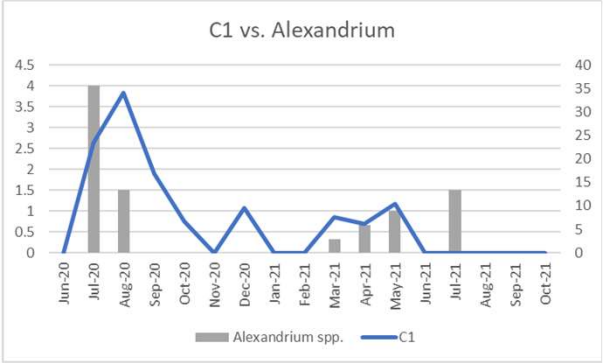
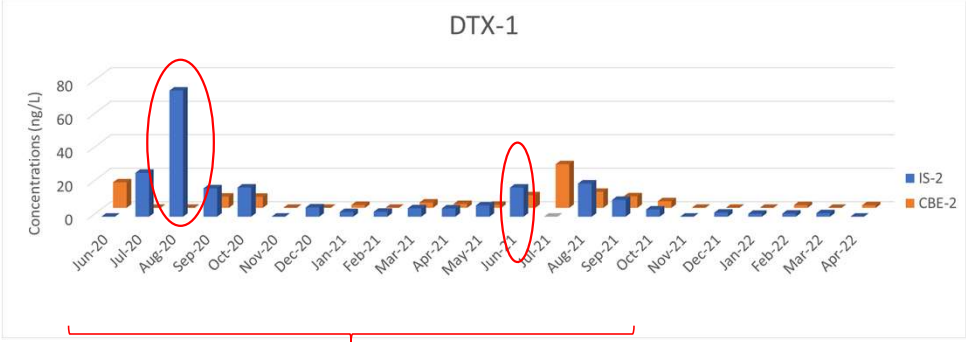
IS-2

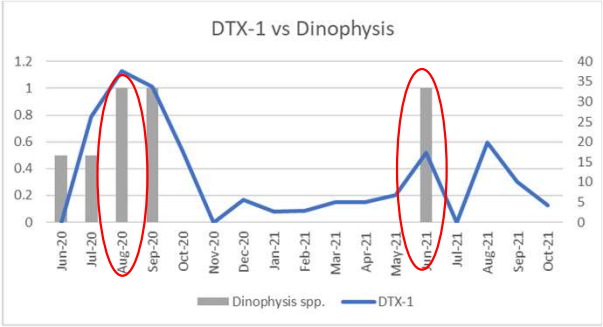






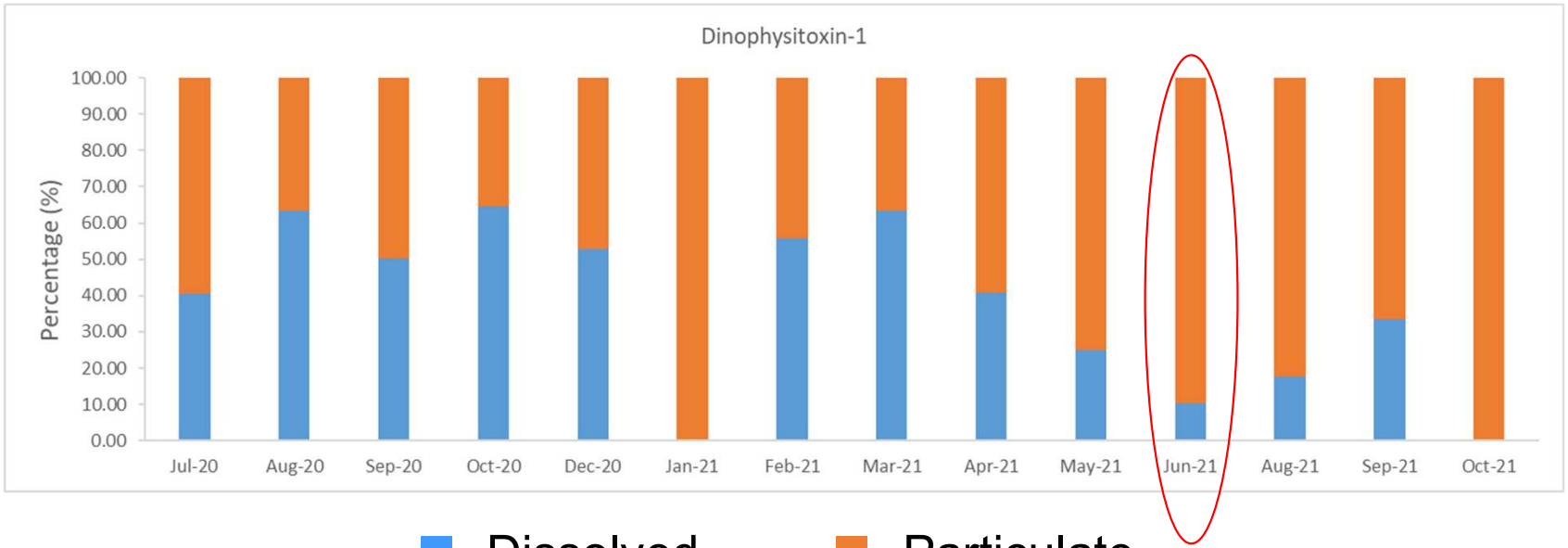




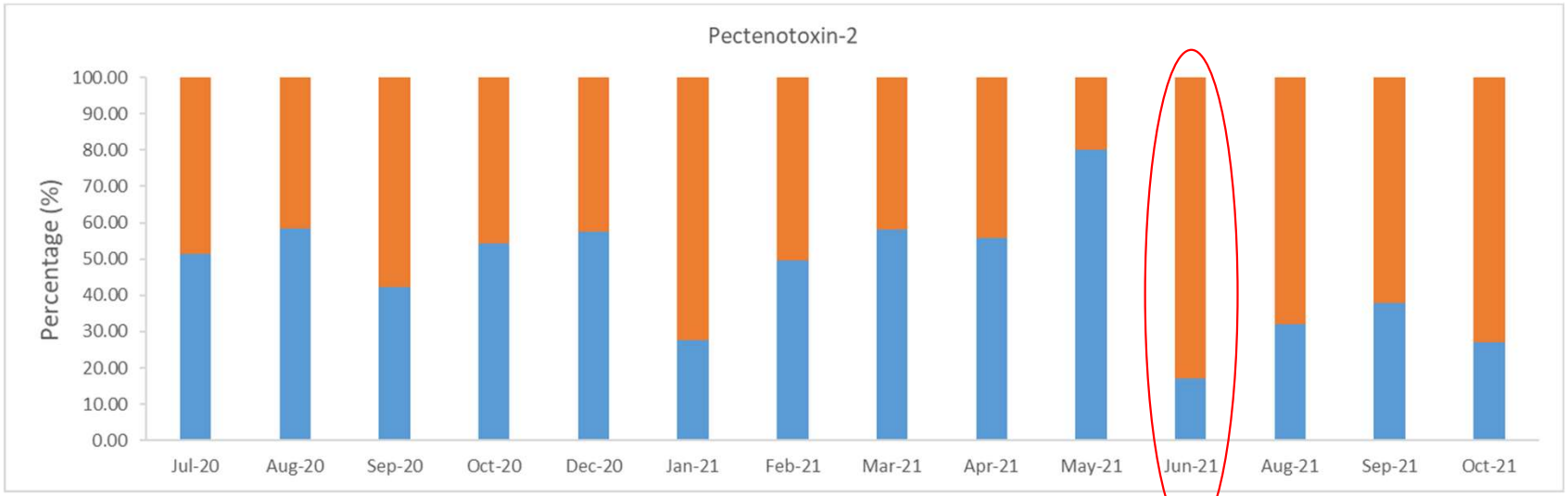


PERIOD OF COMPARISON

Dissolved vs. Particulate Toxins at IS-2

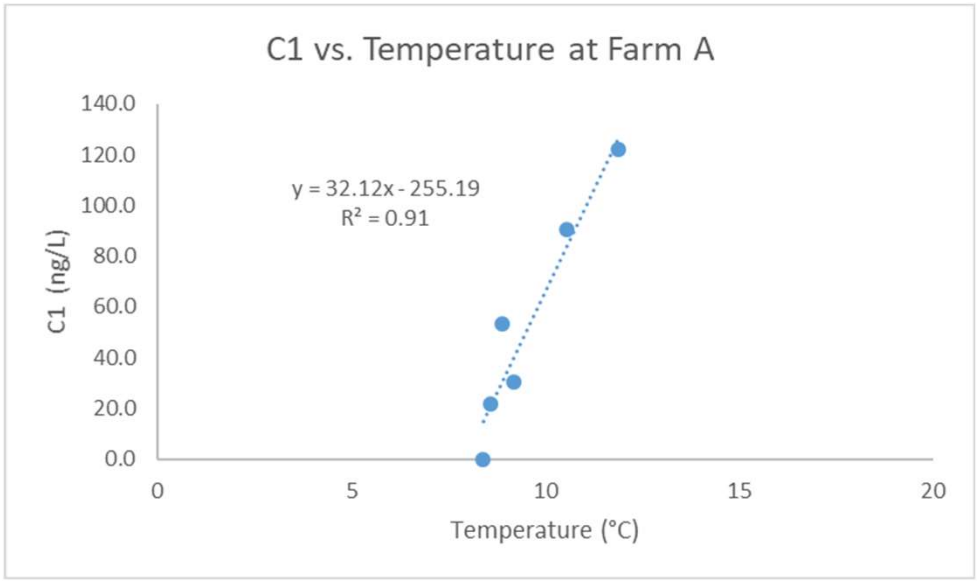


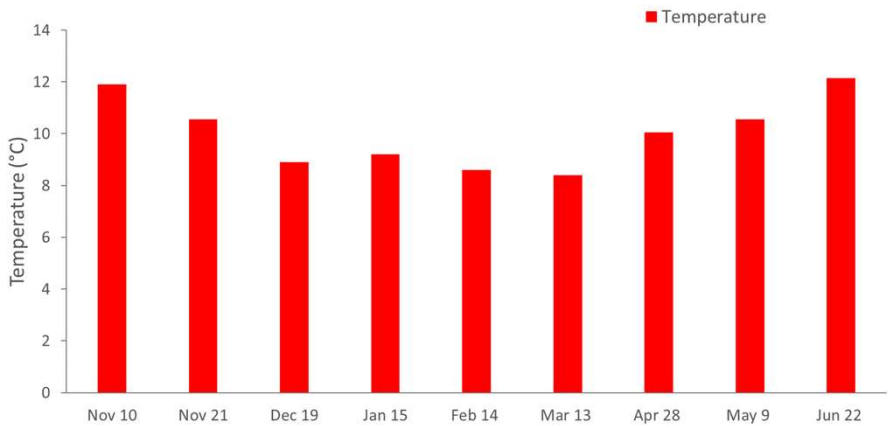
Dissolved Particulate

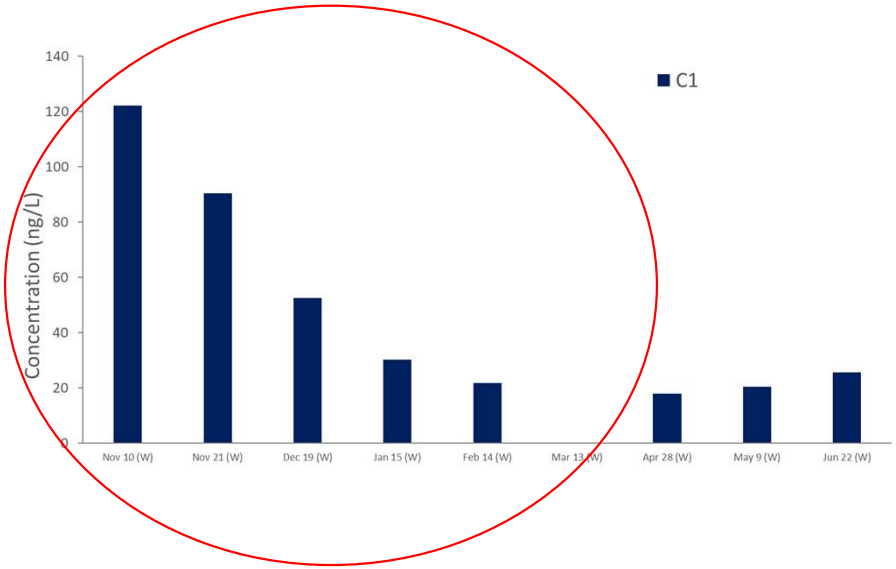


PSP Toxin C1 at Millar Channel

Total C1 closely correlated with water temperature ($r^2 = 0.91$) between Nov 2020 and March 2021.



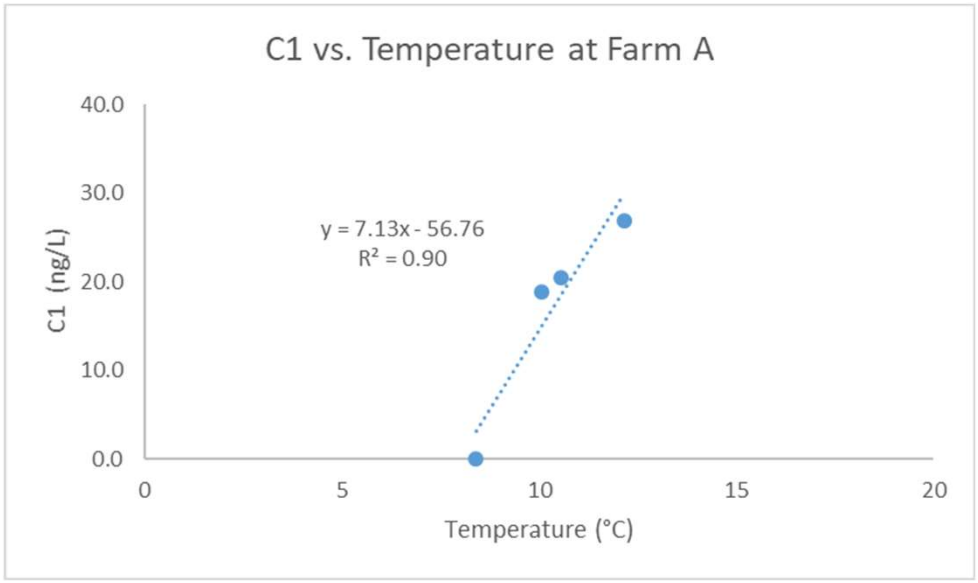


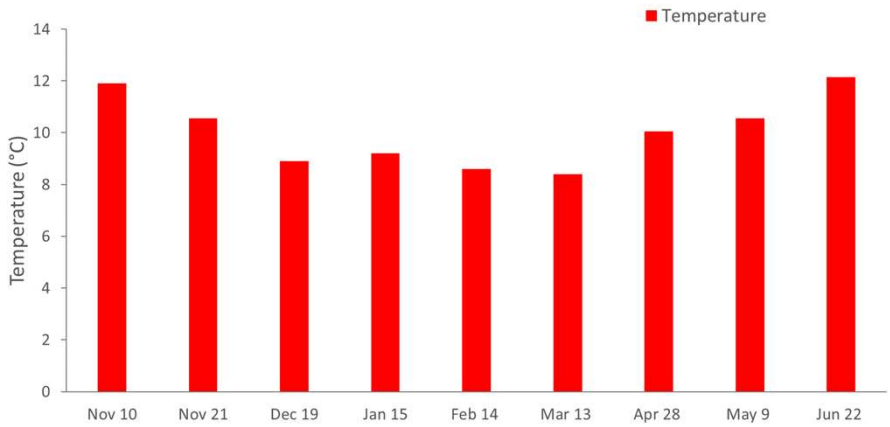


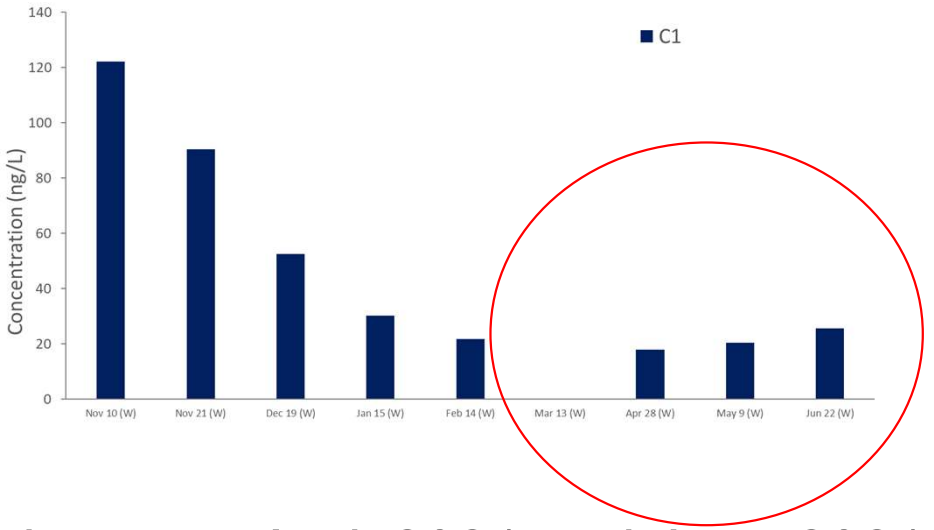
- *Alexandrium* cells were absent between November 2020 and March 2021, during which time no PSP toxins were detected on filters.

PSP Toxin C1 at Millar Channel

Total C1 closely correlated with water temperature ($r^2 = 0.90$) between Mar 2021 and June 2021.







- *Alexandrium* cells were present between April 2021 and June 2021, during which time PSP toxins were detected on filters.

Summary

- a new (LC-MS/MS) method has been developed to profile harmful algal biotoxins in seawater.
- the method has been used to monitor biotoxins in British Columbia coastal waters since 2020, in collaboration with citizen scientists and the BC salmon aquaculture industry.
- results obtained at different locations in the Salish Sea and at salmon farms on the West Coast of Vancouver Island show seasonal and inter-annual variability in biotoxin levels.
- the concentrations of certain biotoxins appear to correlate with water temperature and/or the appearance of associated harmful algae, depending on the location and time of year.

Summary

- these include domoic acid and saxitoxins (e.g. C1), which are known to harm mammals and other marine animals.
- certain DSP toxins (e.g. dinophysitoxin), which are relatively large/lipophilic, are also widespread in BC coastal waters.
- comparing dissolved and particulate concentrations suggest that some toxins (e.g. hydrophilic saxitoxins) may persist in seawater in the absence of associated harmful algae.
- this information may help predict the abundance of biotoxins and their potential impacts on wild and farmed species.
- future work is aimed at comparing biotoxin concentrations with multiple variables over longer time periods (i.e. years).