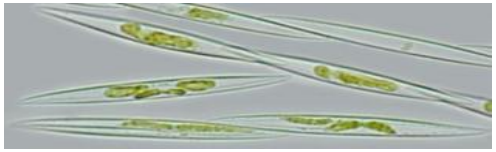
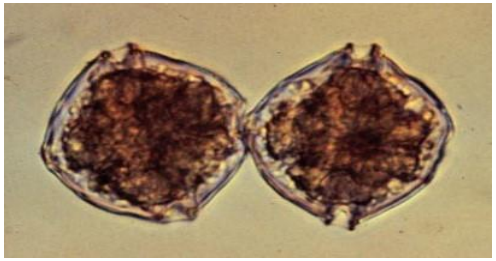
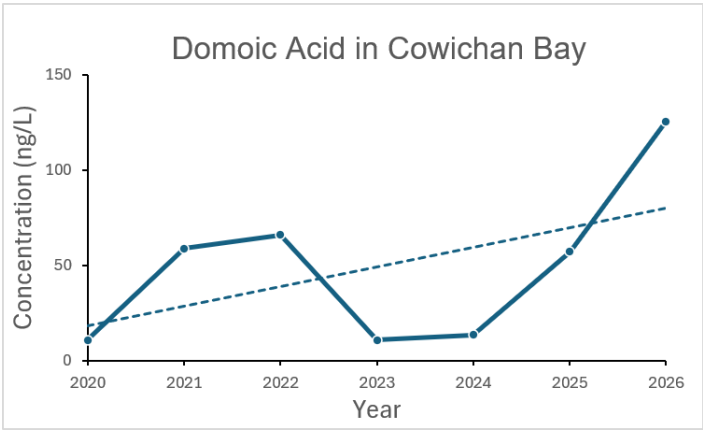
Recent trends in biotoxin production in British Columbia coastal waters









<u>Andrew Ross</u>, Mackenzie Mueller, Navinder Hundal, Cory Albert,

Melissa Hennekes and **Akash Sastri** (Fisheries and Oceans Canada)

Béatrice Ip (University of Ottawa) and **Nathan Matthews** (University of Victoria)

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

Brian Nesbitt and **Peter McKenzie** (Cermaq Canada)

Nicole Frederickson, John Field, Svetlana Esenkulova and **Isobel Pearsall**

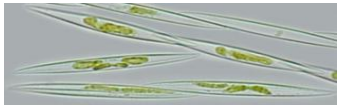
(Pacific Salmon Foundation Citizen Science Program)

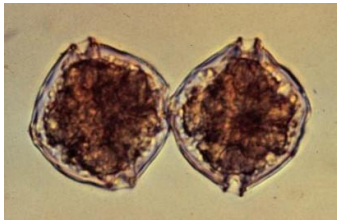
PICES-2026 Session S2

Harmful Algal Biotoxins

- Biotoxins and the harmful algal blooms (HABs) that produce them can be classified according to the type of illness that may result from eating shellfish contaminated with these 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)	Dinophysistoxins Pectenotoxins	*Dinophysis* *Prorocentrum*



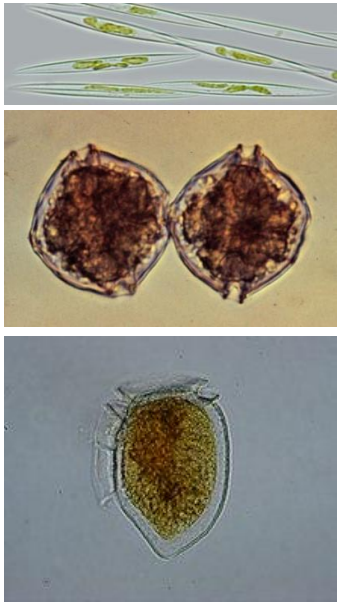




Harmful Algal Biotoxins

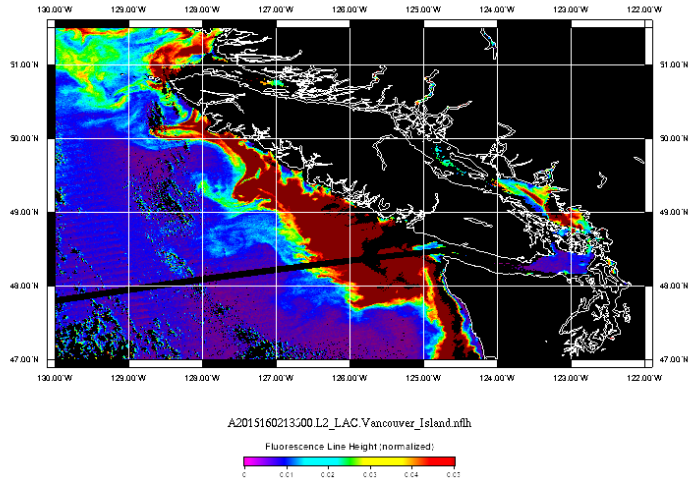
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CLASS	BIOTOXIN(S)	HARMFUL ALGAE
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Paralytic Shellfish Poisoning (PSP)	Saxitoxins **HARMFULTO FISH**	*Alexandrium* *Gymnodinium*
Diarrhetic Shellfish Poisoning (DSP)	Dinophysistoxins Pectenotoxins **LIPOPHILIC / MAY BIOACCUMULATE**	*Dinophysis* *Prorocentrum*

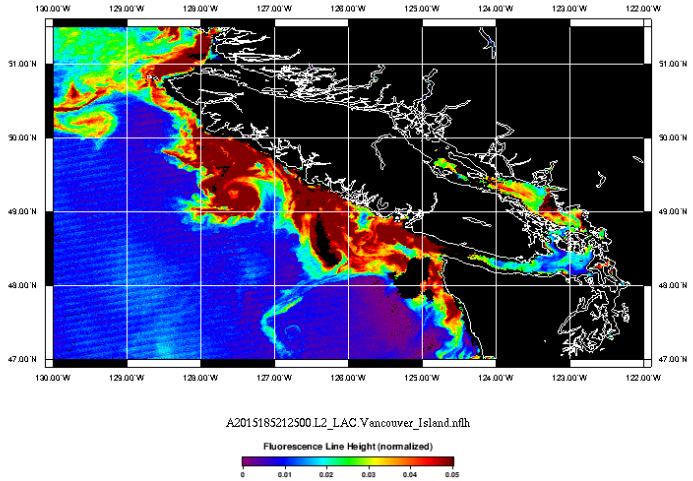


Coastal Algal Bloom (2015)

June 9, 2015



July 4, 2015



MODIS NFLH satellite images

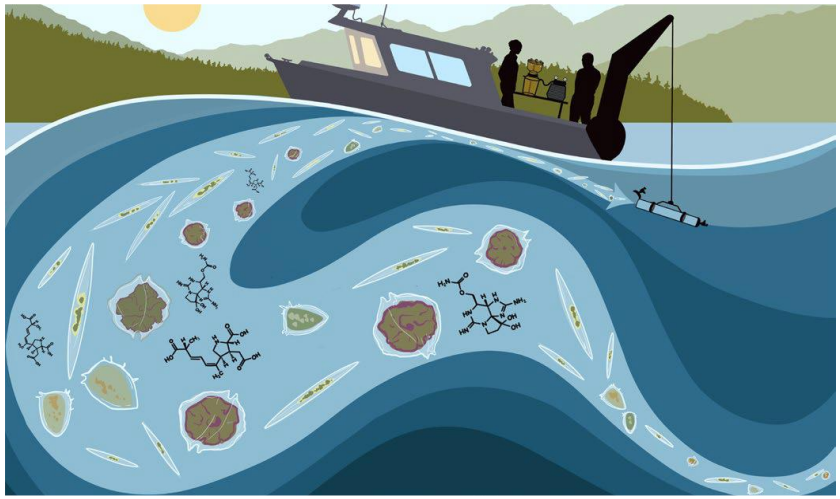
- took place during the 2014 - 2016 NP marine heatwave.
- the bloom was highly unusual due to:
  - its size (from California to Alaska)
  - its duration (from May to September)
  - the presence of harmful algae (*Pseudo-nitzschia*)

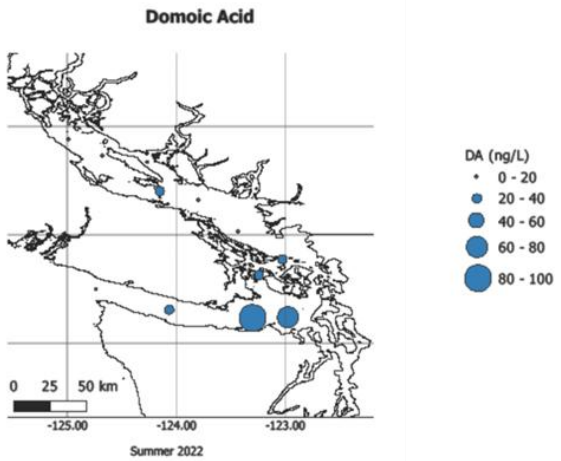
Biotoxin Monitoring Locations



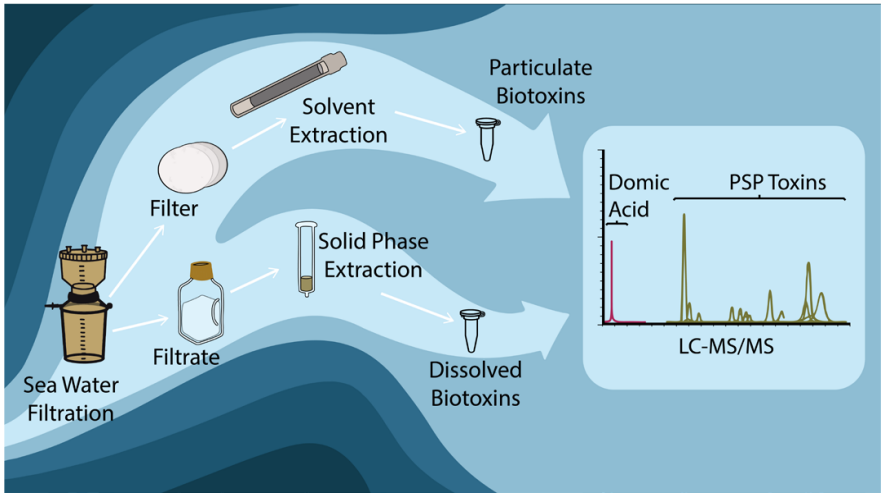
Ross and Mueller (2024) PICES Press Vol. 32, No. 2, pp. 38-40

Monitoring Biotoxins in B.C. Coastal Waters









Ross et al. Harmful Algae 145 (2025) 102854

Harmful Algae 145 (2025) 102854

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Harmful Algae

journal homepage: www.elsevier.com/locate/hal



Seasonal monitoring of dissolved and particulate algal biotoxins in the northern Salish Sea using high performance liquid chromatography and tandem mass spectrometry

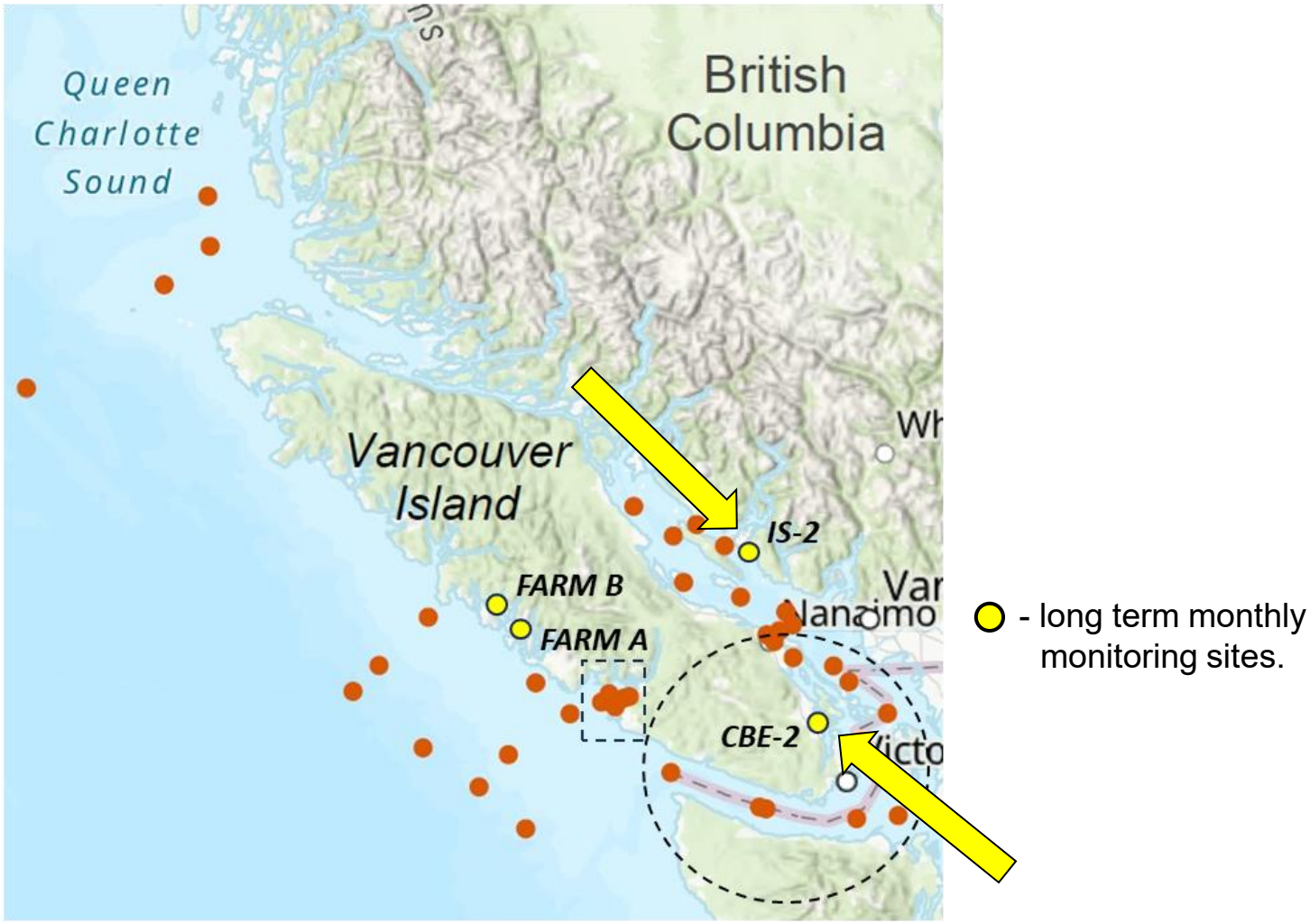
Andrew R.S. Ross [a,b,*], Béatrice Ip [a,c], Mackenzie Mueller [a,d], Blair Surridge [e], Harry Hartmann [e], Navinder Hundal [a,b], Nathan Matthews [a,d], Hayleigh Shannon [a], Melissa Hennekes [a], Akash Sastri [a], R. Ian Perry [a,f]

[a] Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, B.C. V8L 4B2 Canada
[b] University of Victoria, Department of Biochemistry and Microbiology, Victoria, B.C. V8P 5C2 Canada
[c] University of Ottawa, Department of Biomedical Sciences, Ottawa, Ontario K1N 6N5 Canada
[d] University of Victoria, Department of Biology, Victoria, B.C. V8P 5C2 Canada
[e] M.B. Laboratories, 2062 Henry Avenue West, Sidney, B.C. V8L 5Y1 Canada
[f] Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C. V9T 6N7 Canada

- Highest total concentrations of domoic acid and saxitoxin were found above a shallow sill in the eastern Juan de Fuca Strait whereas those of…PSP toxins C1 and C2 were measured near the southern end of Malaspina Strait.

- These maximum concentrations were observed in June when surface salinity was lowest, temperature highest, and harmful algae most abundant, as reflected in the relative high proportion of particulate biotoxins.

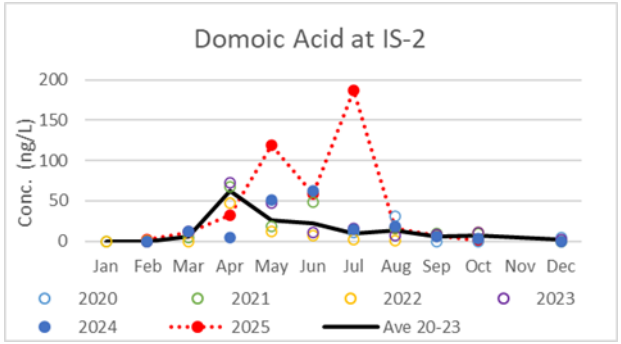
Biotoxin Monitoring Locations



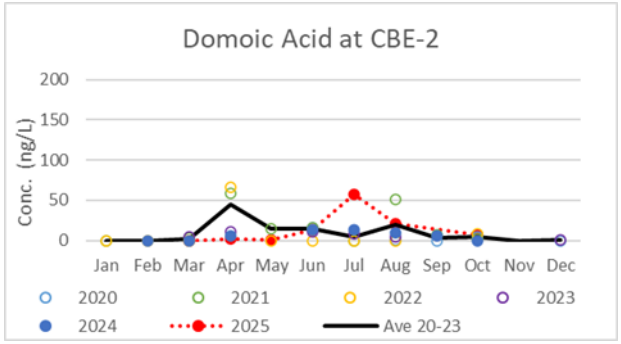
Ross and Mueller (2024) PICES Press Vol. 32, No. 2, pp. 38-40

Domoic Acid in the Salish Sea

Malaspina Strait



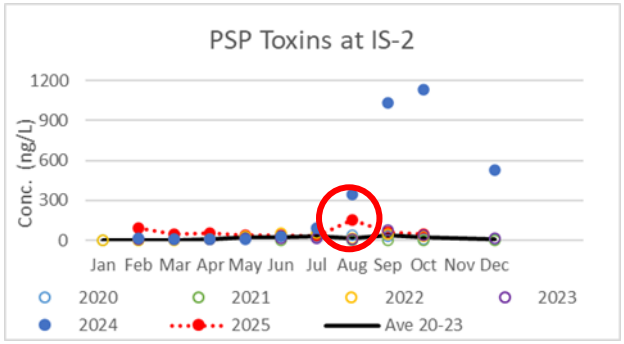
Cowichan Bay



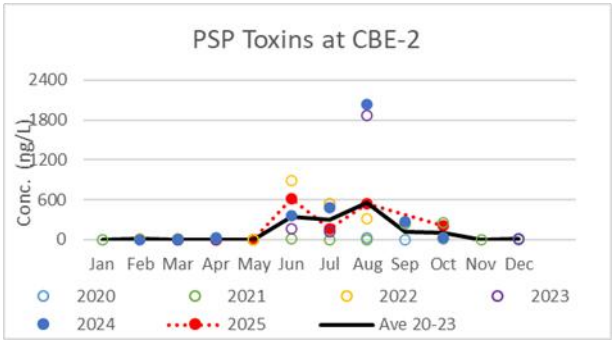
- Two DA peaks were observed in Malaspina Strait in 2025, both being higher and later than average.
- The two peaks are consistent with the double spring bloom observed in the Strait of Georgia and the corresponding drawdown of nutrients, which may induce DA production in *Pseudo-nitzschia* (Ross et al. in preparation).
- DA also peaked later than usual in Cowichan Bay in 2025 but at close to average concentrations, whereas levels in Malaspina Strait reached those associated with DA uptake in shellfish (~200 ng/L) (Perry et al. 2023).

PSP Toxins in the Salish Sea

Malaspina Strait



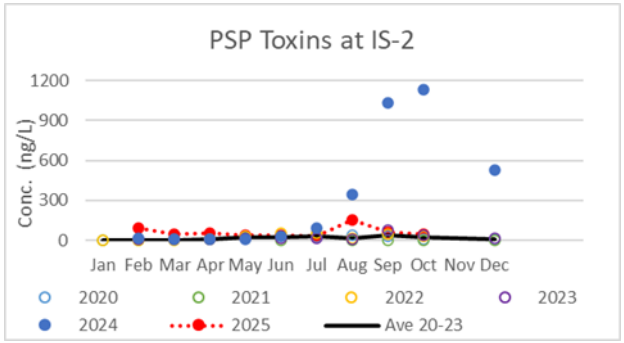
Cowichan Bay



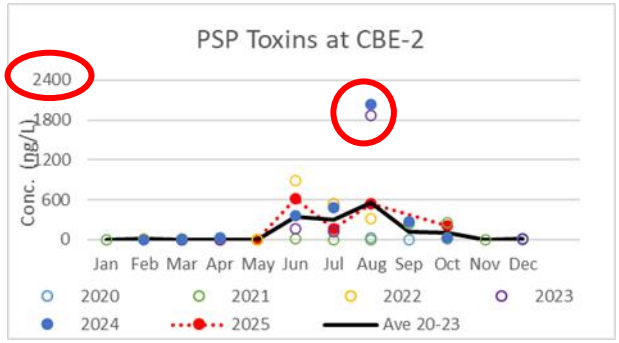
- PSP toxins in Malaspina Strait reached unusually high concentrations in 2024 (blue dots) but were otherwise most abundant in 2025 (red dots).

PSP Toxins in the Salish Sea

Malaspina Strait



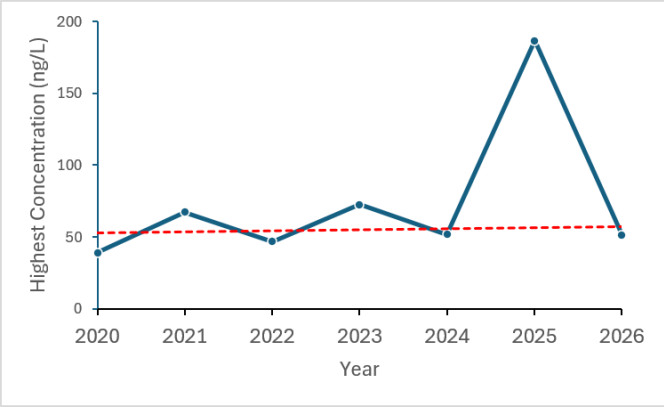
Cowichan Bay



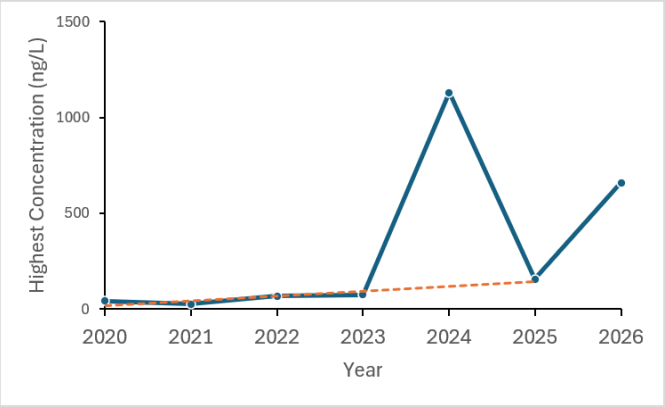
- PSP toxins in Malaspina Strait reached unusually high concentrations in 2024 (blue dots) but were otherwise most abundant in 2025 (red dots).
- PSP toxins in Cowichan Bay spiked to high levels in August 2023 and 2024.
- PSP toxins reached higher concentrations in Cowichan Bay than in Malaspina Strait (approximately 2x).
- *Alexandrium* was more abundant in Cowichan Bay than in Malaspina Strait.

Biotoxin Trends in Malaspina Strait

Domoic Acid



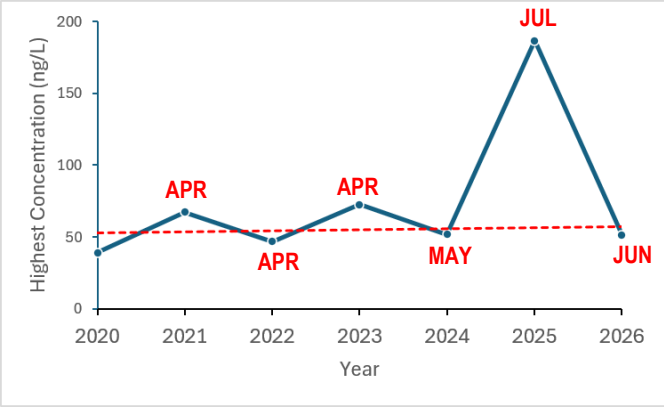
PSP Toxins



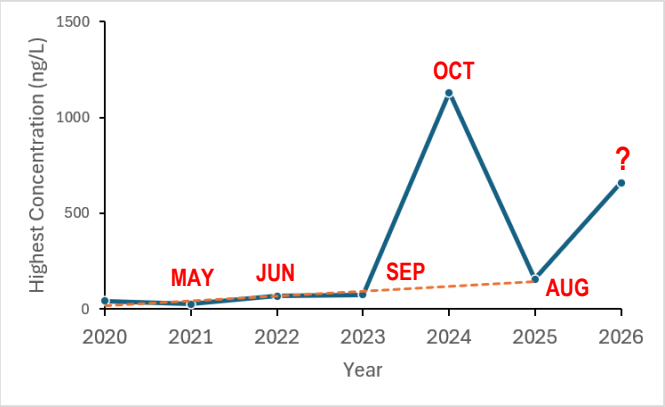
- DA and PSP Toxins appear to be increasing in Malaspina Strait.
- The highest annual DA concentration in Malaspina Strait averaged about 50 ng/L from 2020 to 2024 but reached nearly 200 ng/L in 2025.
- The highest annual concentration of PSP toxins spiked in 2024 (1,169 ng/L) but has otherwise increased at least 4x (from ~40 to 160 ng/L) since 2020.

Biotoxin Trends in Malaspina Strait

Domoic Acid



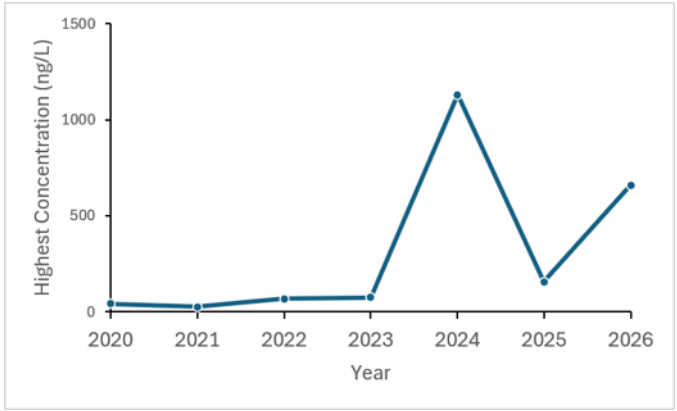
PSP Toxins



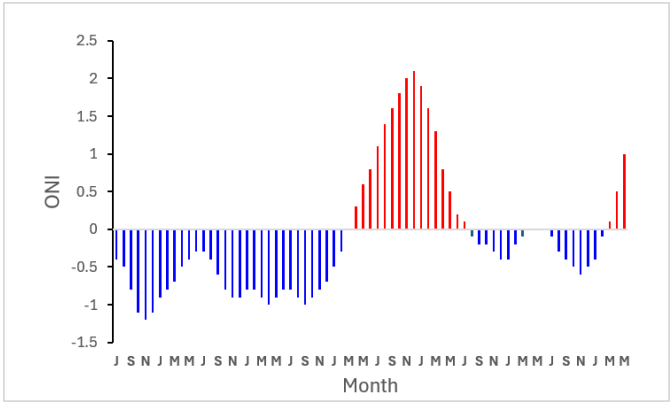
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- The highest annual concentration of PSP toxins spiked in 2024 (1,169 ng/L) but has otherwise increased at least 4x (from ~40 to 160 ng/L) since 2020.
- Increased variability in the timing and magnitude of the highest biotoxin concentrations observed each year suggest that something is changing with regard to factors that drive biotoxin production.

ONI vs. PSP Toxins in Malaspina Strait

PSP Toxins

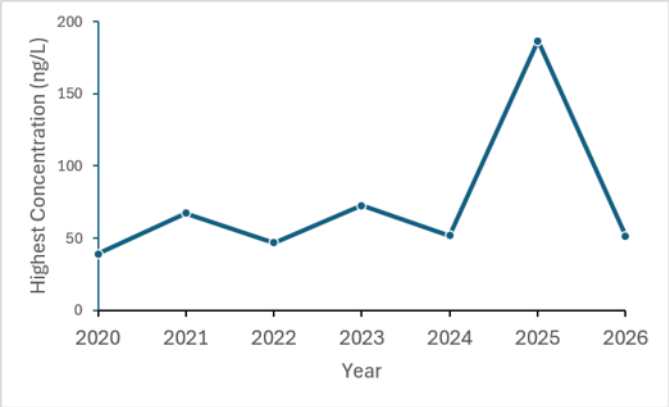


ONI

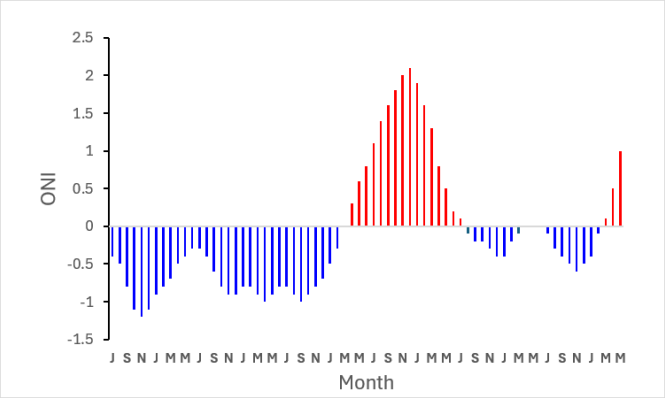


ONI vs. Domoic Acid in Malaspina Strait

Domoic Acid

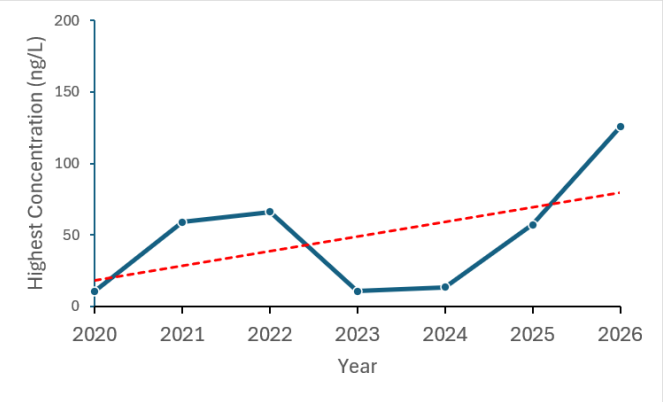


ONI

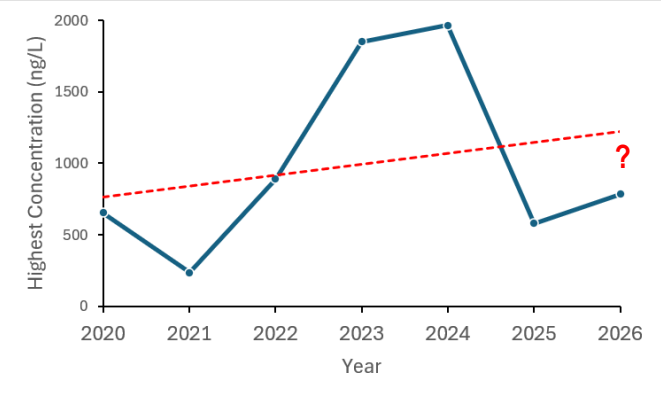


Biotoxin Trends in Cowichan Bay

Domoic Acid



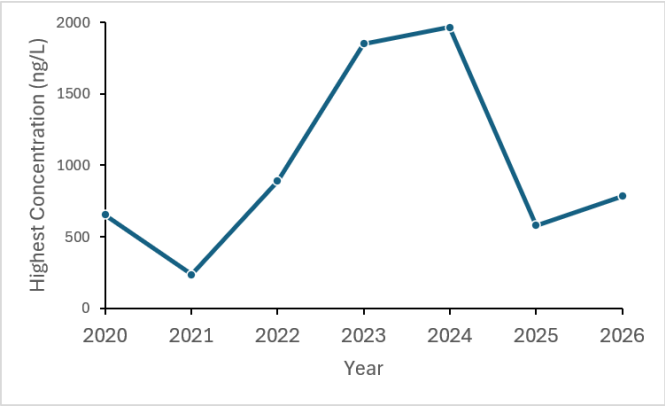
PSP Toxins



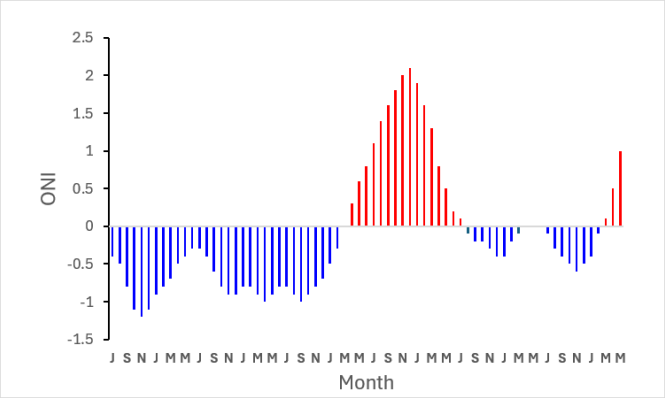
- DA and PSP Toxins also appear to be increasing in Cowichan Bay.
- DA in Cowichan Bay has fluctuated around levels close to those seen historically in Malaspina Strait (~50 ng/L) but was unusually high (126 ng/L) in 2026.
- PSP Toxins in Cowichan Bay are more abundant than in Malaspina Strait, reaching unusually high levels (~2,000 ng/L) in 2023 and in 2024 but showing a drop in 2025 and rebound in 2026 similar to that observed in Malaspina Strait.
- Identifying changes in ocean conditions that accompany these unusual events could shed light on which factor(s) may be linked to biotoxin production.

ONI vs. PSP Toxins in Cowichan Bay

PSP Toxins

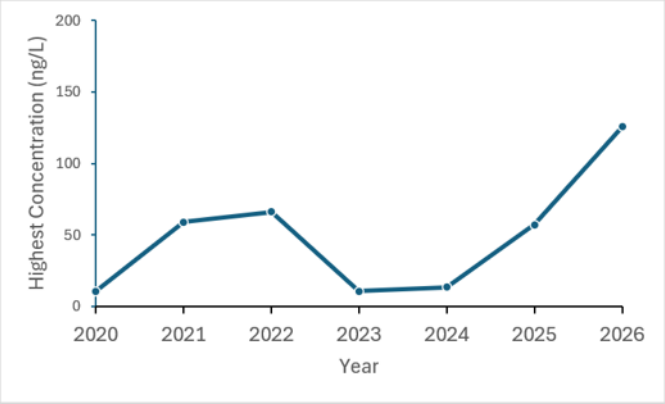


ONI

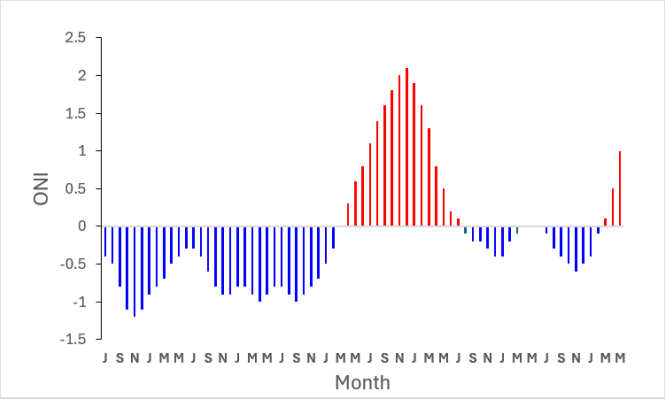


ONI vs. Domoic Acid in Cowichan Bay

Domoic Acid



ONI



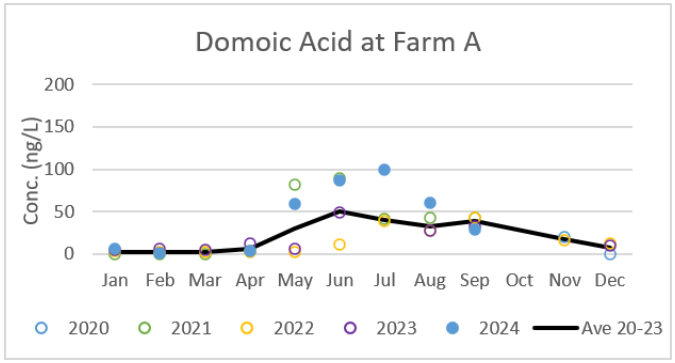
Biotoxin Monitoring Locations



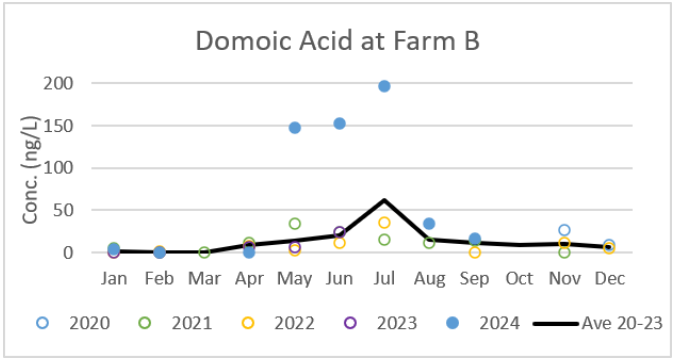
Ross and Mueller (2024) PICES Press Vol. 32, No. 2, pp. 38-40

Domoic Acid in Clayoquot Sound

Farm A



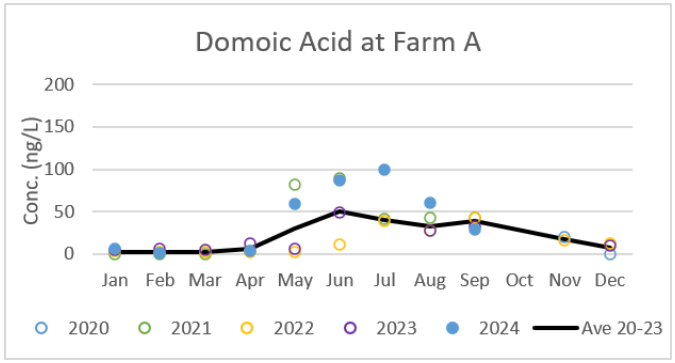
Farm B



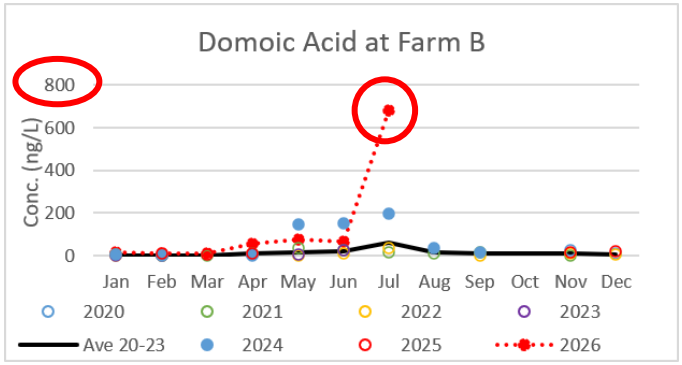
- DA levels in Clayoquot Sound jumped in 2024 (blue dots), reaching a maximum in July.
- DA reached higher concentrations (2x) at Farm B than at Farm A in 2024.

Domoic Acid in Clayoquot Sound

Farm A



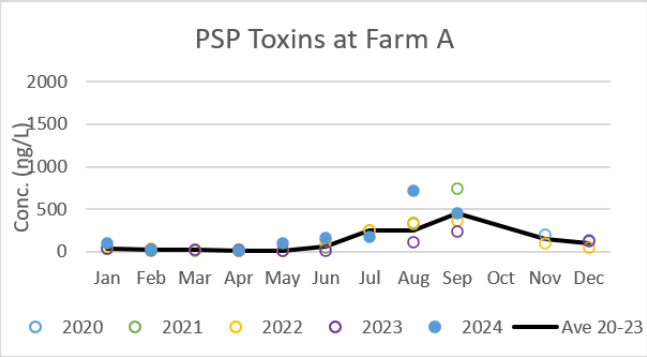
Farm B



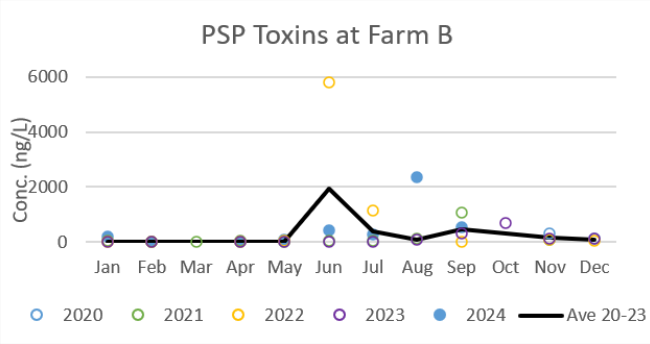
- DA levels in Clayoquot Sound jumped in 2024 (blue dots), reaching a maximum in July.
- DA reached higher concentrations (2x) at Farm B than at Farm A in 2024.
- Sampling in Clayoquot Sound paused in 2025 but resumed in 2026, and latest results for Farm B show unprecedented increase July, again reaching levels associated with uptake of DA in shellfish (results for Farm A pending..).
- Available data suggests that conditions in Clayoquot Sound may have started to change in 2024 (as seen in the Salish Sea).

PSP Toxins in Clayoquot Sound

Farm A



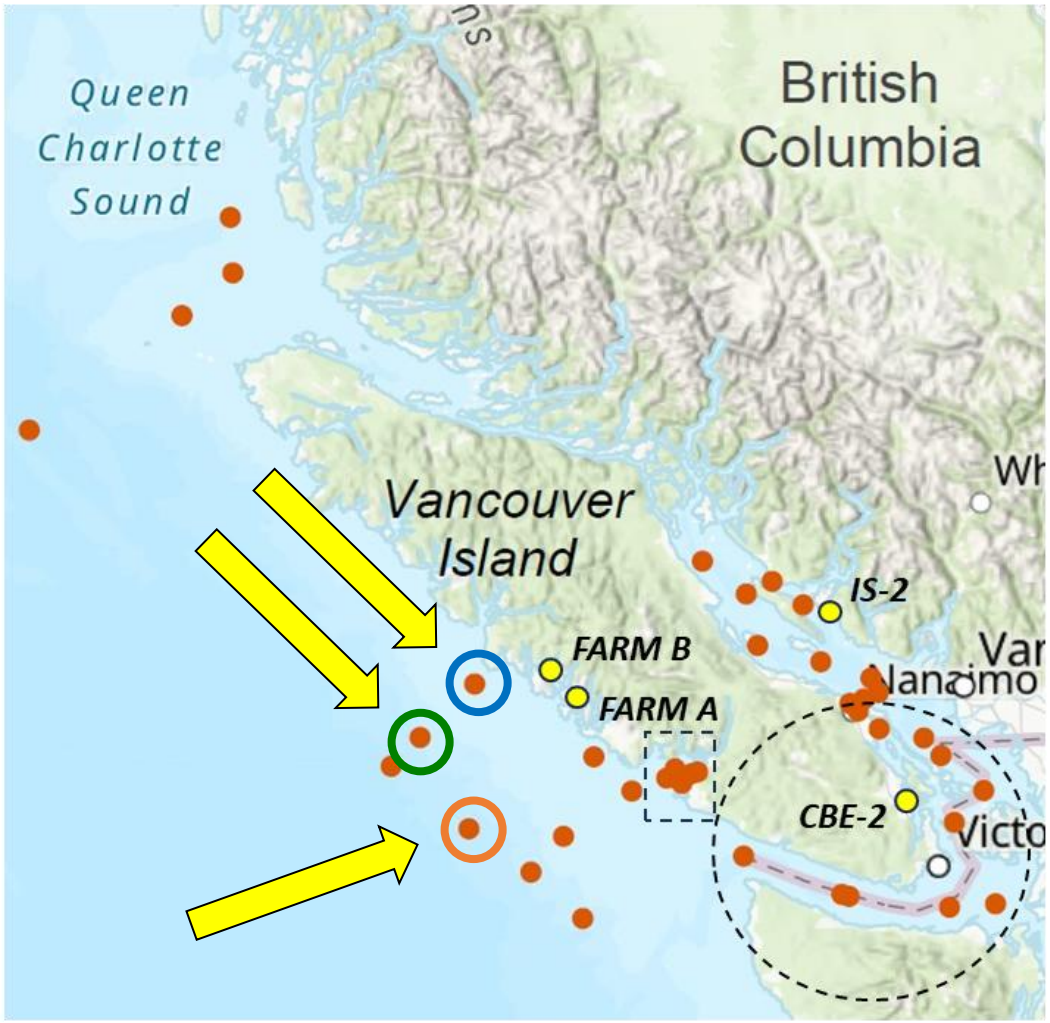
Farm B



- Like DA, PSP Toxins in Clayoquot Sound reached higher than average concentrations in 2024, peaking in August (same as in Cowichan Bay).

- PSP Toxin levels also reached higher (4x) levels at Farm B than at Farm A.

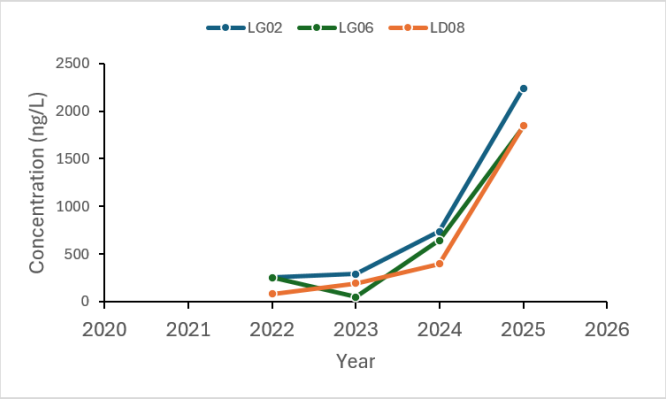
Biotoxin Monitoring Locations



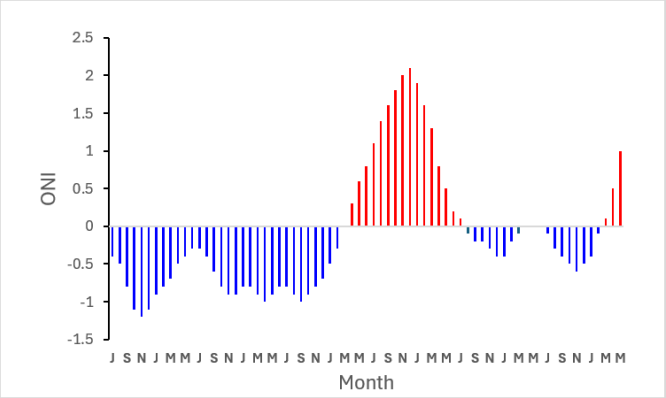
Ross and Mueller (2024) PICES Press Vol. 32, No. 2, pp. 38-40

PSP Toxins on WCVI in September

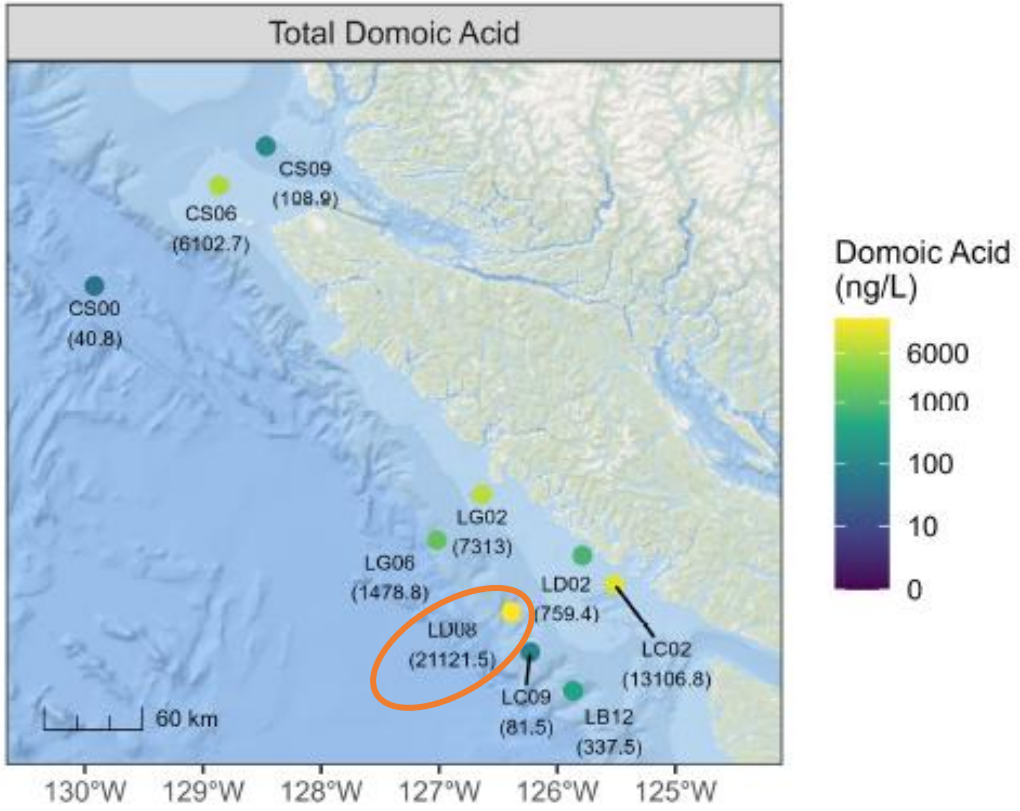
PSP Toxins



ONI



DA on WCVI in September 2026



- Total DA reached over 21,000 ng/L on the outer shelf, of which 70% was in particulate form (consistent with the presence of toxic *Pseudo-nitzschia* cells).

- This latest (and highest) DA peak coincides with the onset of a ‘super’ El Niño.

Summary

- Data gathered in 2022 using a new method to monitor algal biotoxins in sea water suggests that higher concentrations of domoic acid and PSP toxins in the Salish Sea tend to occur when salinity is lower, temperature higher, and harmful algae more abundant (as confirmed by particulate biotoxin levels).
- Time series established in the Salish Sea and in Clayoquot Sound on the west coast of Vancouver Island show that significant changes have taken place in the timing and extent of biotoxin production in B.C. coastal waters since 2024.
- These changes appear to date from the El Niño event that occurred during the winter of 2023/2024.

Summary (contd.)

- DA (which has been poisoning Californian marine mammals during spring blooms) reached concentrations associated with accumulation in shellfish during July 2025 in the Salish Sea, and unprecedented levels on the WCVI in September 2026.
- PSP toxins reached their highest recorded concentrations in Malaspina Strait and Cowichan Bay during fall 2024 but appear to be increasing again in fall 2026.
- Drawdown of nutrients following algal blooms may induce biotoxin production in cells stressed by lack of those nutrients.
- A large spike in PSP toxin concentrations in Clayoquot Sound in July 2022 occurred at a time when water temperature was highest and *Alexandrium* cells most abundant that year.

Summary (contd.)

- Climate change is expected to result in warmer ocean temperatures and higher periodic freshwater inputs, both of which tend to increase stratification in surface waters.
- Stratification acts as a barrier to the renewal of depleted nutrients in surface waters, potentially increasing the impact of nutrient stress on biotoxin production by harmful algae.
- Warmer conditions may also promote algal blooms and/or cause additional stress to toxic harmful algae.
- The recent spikes in biotoxin concentration superimposed upon a steadily increasing baseline suggest that ocean conditions may be changing in a way that increases the magnitude and/or alignment of factors (temperature, algal abundance, nutrient stress…) that drive biotoxin production.

Thank-you!

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- CCG and DFO Science Crews (Salish Sea, La Perouse)