



Phytoplankton, harmful algal blooms and PSF Citizen Science monitoring program data

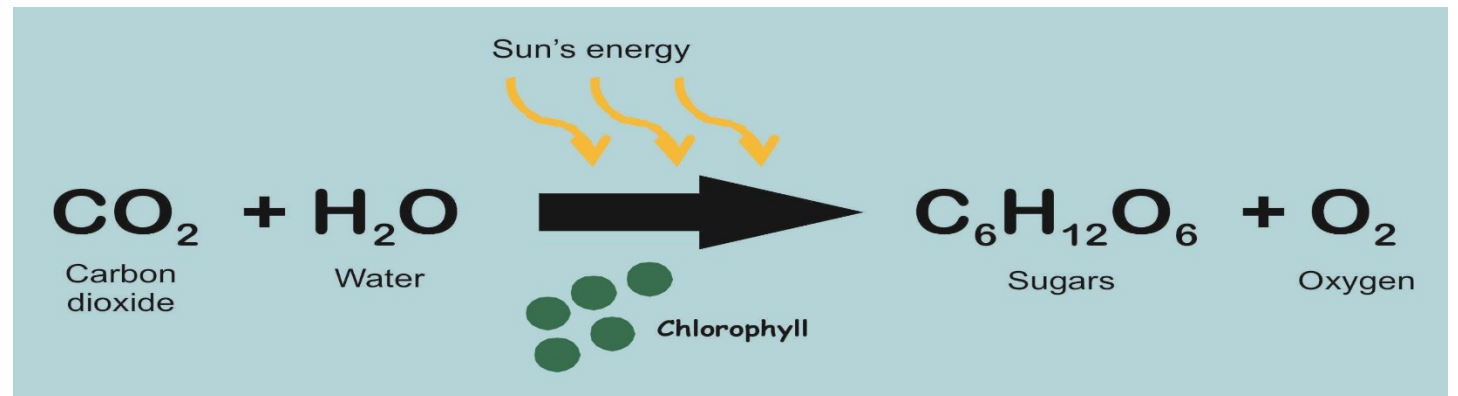
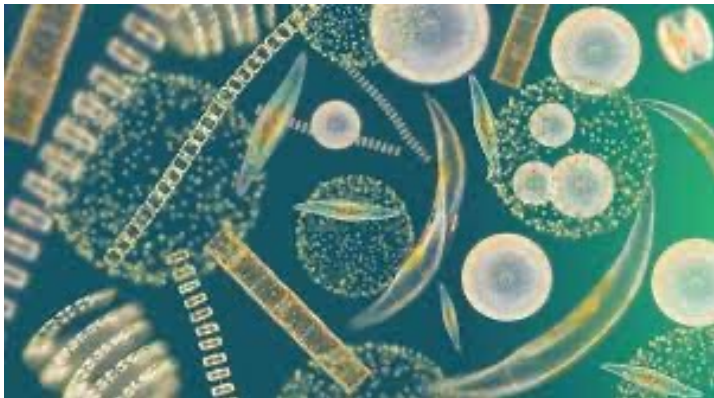
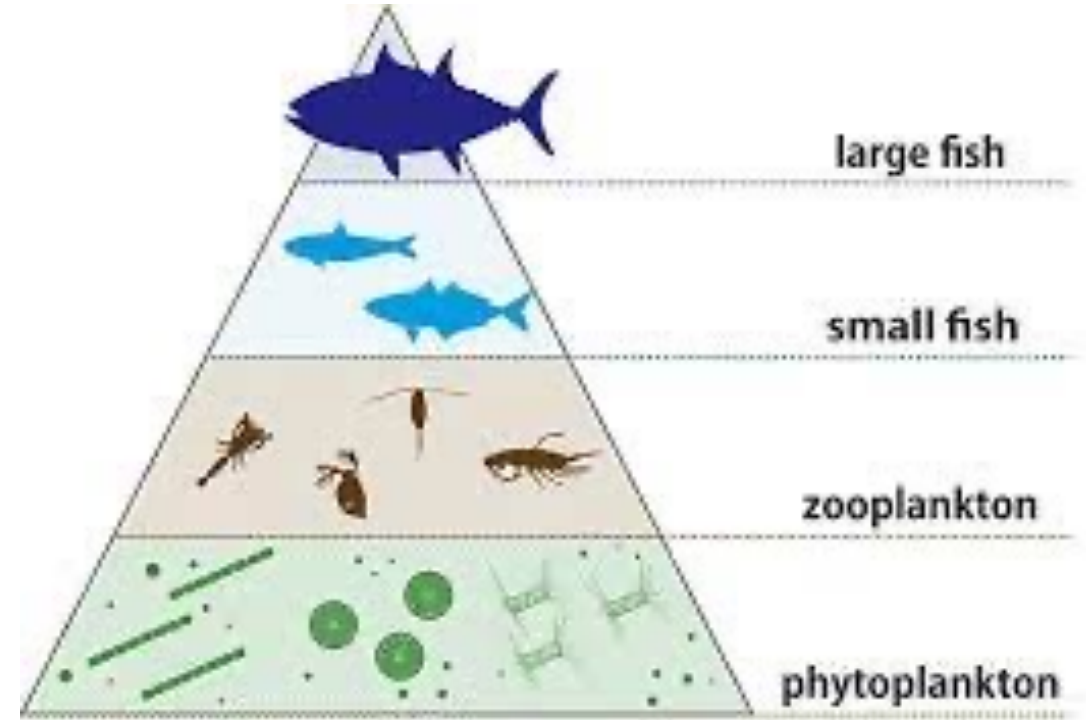


Svetlana Esenkulova and Dr. Andrew Ross
Pacific Salmon Foundation and Department of Fisheries and Oceans Canada

BAYNES SOUND/LAMBERT CHANNEL ECOFORUM, NOVEMBER 24, 2023

Phytoplankton

- Foundation of Marine Food
- Oxygen Production
- Carbon Sequestration



Harmful Algal Blooms (HABs)

- Poisoning – shellfish, mammals, humans
- Fish kills via toxigenic reaction, physical gill damage, hypoxia (low DO)
- Ecosystem disruption/alteration



Howe Sound, July 25 2019.
Photo by Michael Bahrey



Salt Spring Island, May 2 2018.
Photo by Michael Bahrey



Victoria, May 6 2018
Dr. M. Costa (Uvic)

British Columbia HABs history

- The longest documented histories of severe HABs, first case in 1793 (Vancouver 1798)
- Shellfish closures have occurred every year since the 1940s when a government monitoring program was established (Taylor and Harrison 2002)
- *Heterosigma akashiwo* – negative impacts on BC aquacultured salmon since the 1970s (Taylor and Haigh, 1993), multimillion dollar losses annually (Haigh and Esenkulova, 2014)

PSF Citizen Science HAB data

Enumerated (cell mL⁻¹):

Alexandrium spp.

C. convolutus and *C. concavicornis*

Cochlodinium fulvescens

Dictyocha spp.

Dinophysis spp.

Heterosigma akashiwo

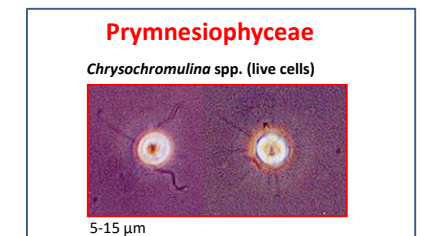
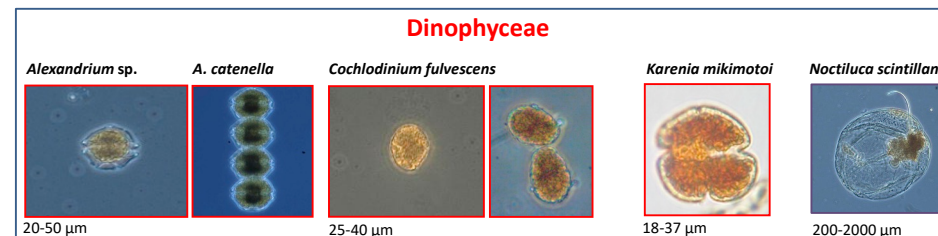
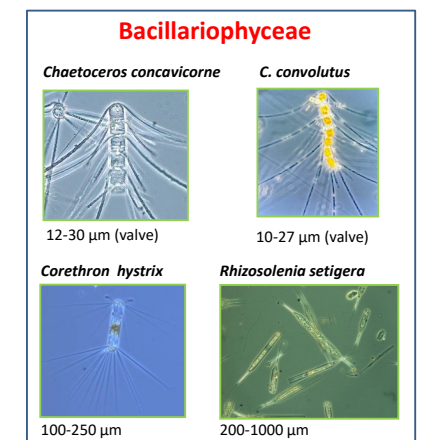
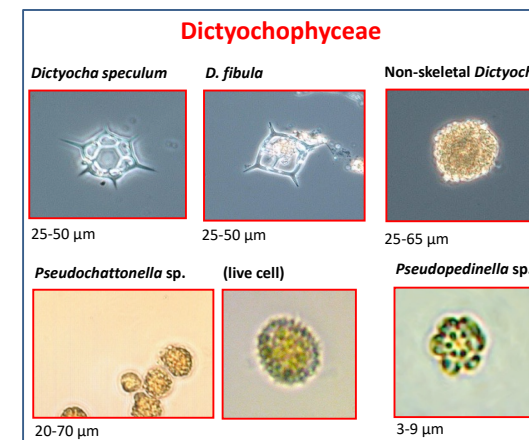
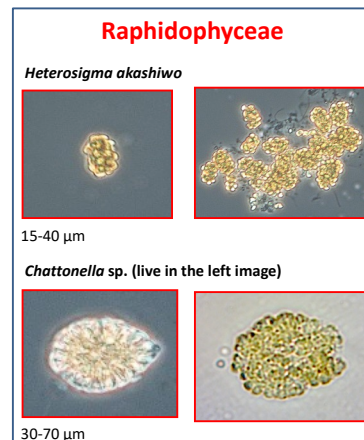
Noctiluca scintillans

Rhizosolenia setigera

Pseudo-nitzschia spp.

Harmful Algae Negatively Impacting Finfish Aquaculture in British Columbia

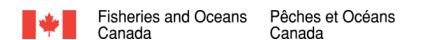
Photographs of algal species that produce toxins harmful to fish are framed with red; species that are mechanically harmful are framed in green; other – purple.



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).



Scale - bloom of *Noctiluca*, Strait of Georgia



Photos by: Dr. Maycira Costa



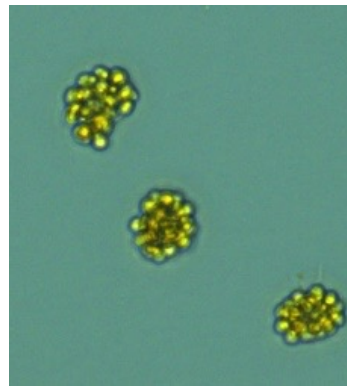
Michael Bahrey



Dr. N Christiansen and Esenkulova

Harmful Algae in Baynes Sound – dense blooms

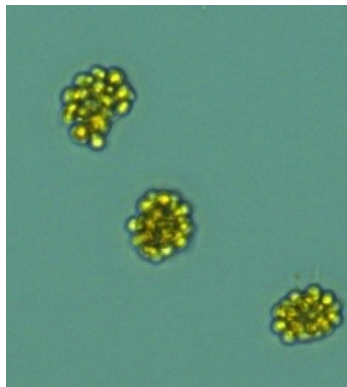
HAB taxa (max cells per mL)	2015	2016	2017	2018	2019	2020	2021	2022
<i>Heterosigma akashiwo</i> - Strait	6	150	20	11000	25000	7000	10	15000
<i>Dictyocha</i> spp. - Strait	5	700	400	10	10	50	150	140
<i>Rhizosolenia setigera</i> - Strait	250	800	1800	4000	500	5	500	400
<i>Pseudo-nitzschia</i> spp.* - Strait	N/A	N/A	N/A	4500	30	70	1800	2000



Blooms and cells of *Heterosigma*, *Dictyocha*, and *Pseudo-nitzschia*. All photos by Esenkulova

Harmful Algae in Baynes Sound – dense blooms

HAB taxa (max cells per mL)	2015	2016	2017	2018	2019	2020	2021	2022
<i>Heterosigma akashiwo</i> - Strait	6	150	20	11000	25000	7000	10	15000
<i>Heterosigma akashiwo</i> - Baynes	2	4	20	700	10	70	0	10
<i>Dictyocha</i> spp. - Strait	5	700	400	10	10	50	150	140
<i>Dictyocha</i> spp. - Baynes	5	25	50	5	2	1	3	60
<i>Rhizosolenia setigera</i> - Strait	250	800	1800	4000	500	5	500	400
<i>Rhizosolenia setigera</i> - Baynes	250	250	1100	600	12	0	400	400
<i>Pseudo-nitzschia</i> spp.* - Strait	N/A	N/A	N/A	4500	30	70	1800	2000
<i>Pseudo-nitzschia</i> spp.* - Baynes	N/A	N/A	N/A	20	0	30	500	80



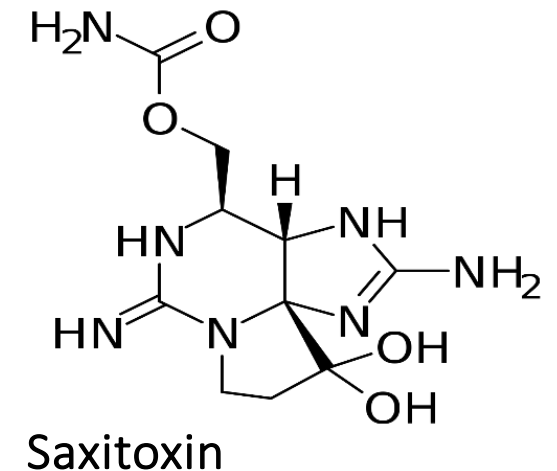
Blooms and cells of *Heterosigma*, *Dictyocha*, and *Pseudo-nitzschia*. All photos by Esenkulova

Toxic HABs and biotoxins

- **Paralytic Shellfish Poisoning – PSP (Saxitoxins)**
- **Diarrhetic Shellfish Poisoning – DSP (Okadaic acid, pectenotoxins, dinophysistoxin)**
- **Amnesic Shellfish Poisoning – ASP (Domoic acid)**
- **Yessotoxin Shellfish Poisoning – YSP (Yessotoxin)**

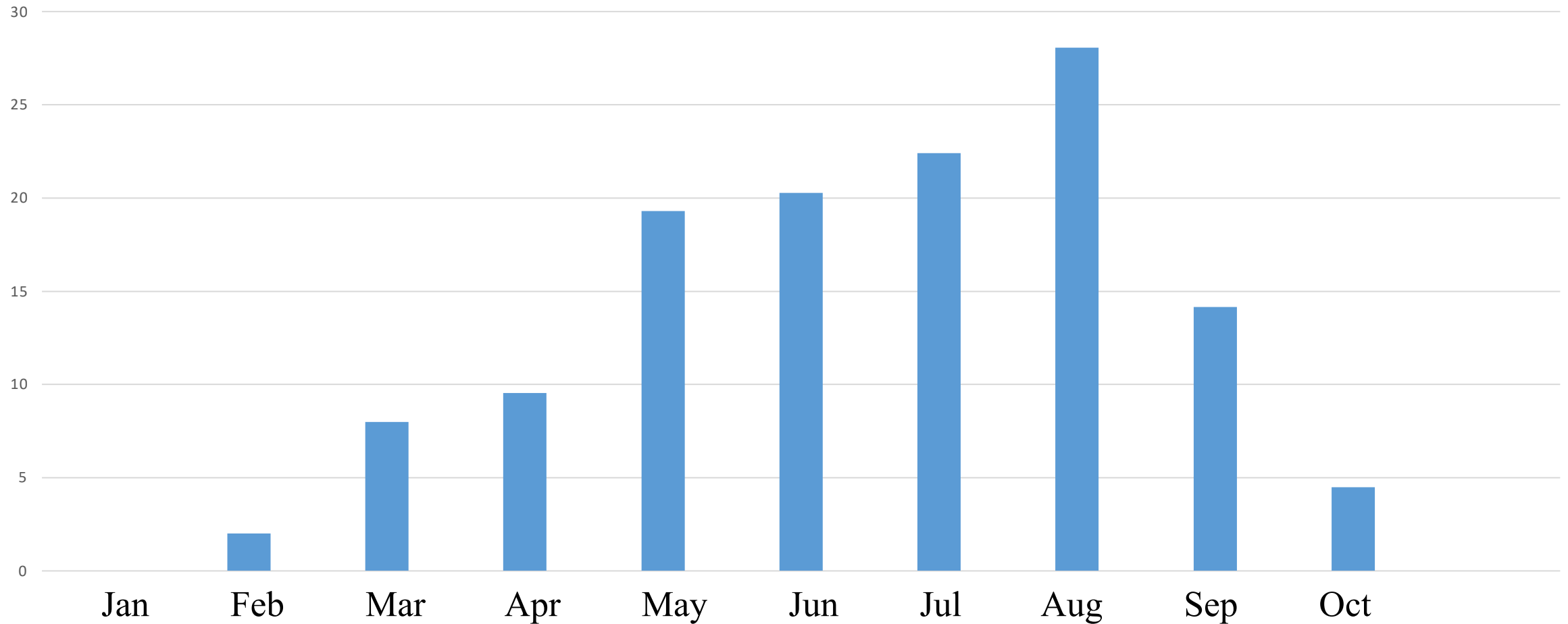


Toxic algae can cause negative effects at VERY LOW densities!
Water can appear clear but have enough cells to cause closures



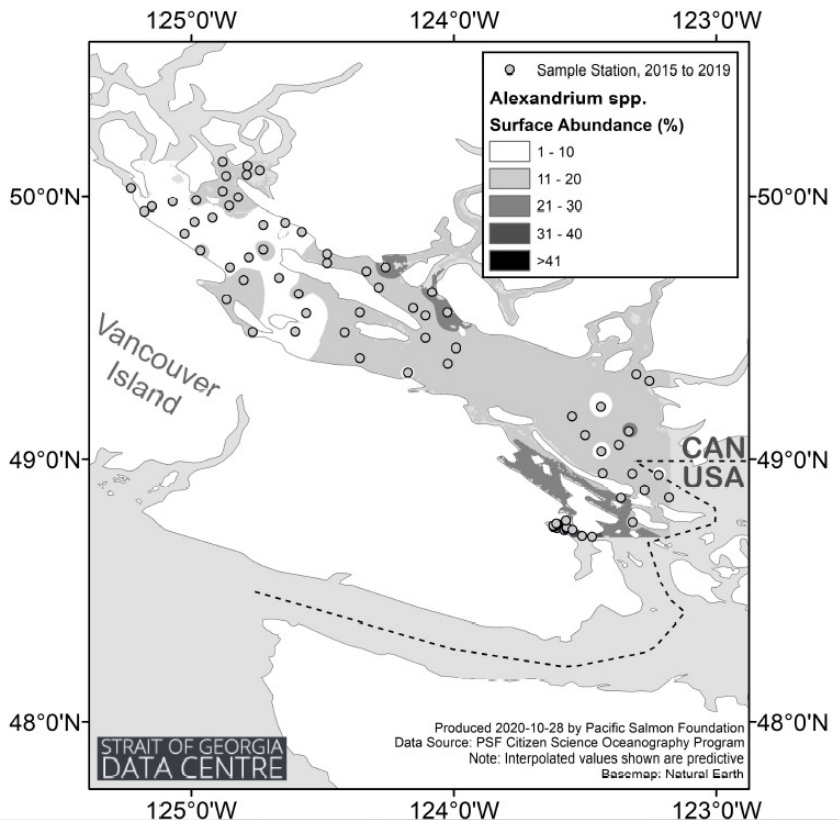
Toxic HABs and biotoxins – *Alexandrium* spp.

Strait of Georgia *Alexandrium* spp. average monthly occurrence (%), 2015-2022

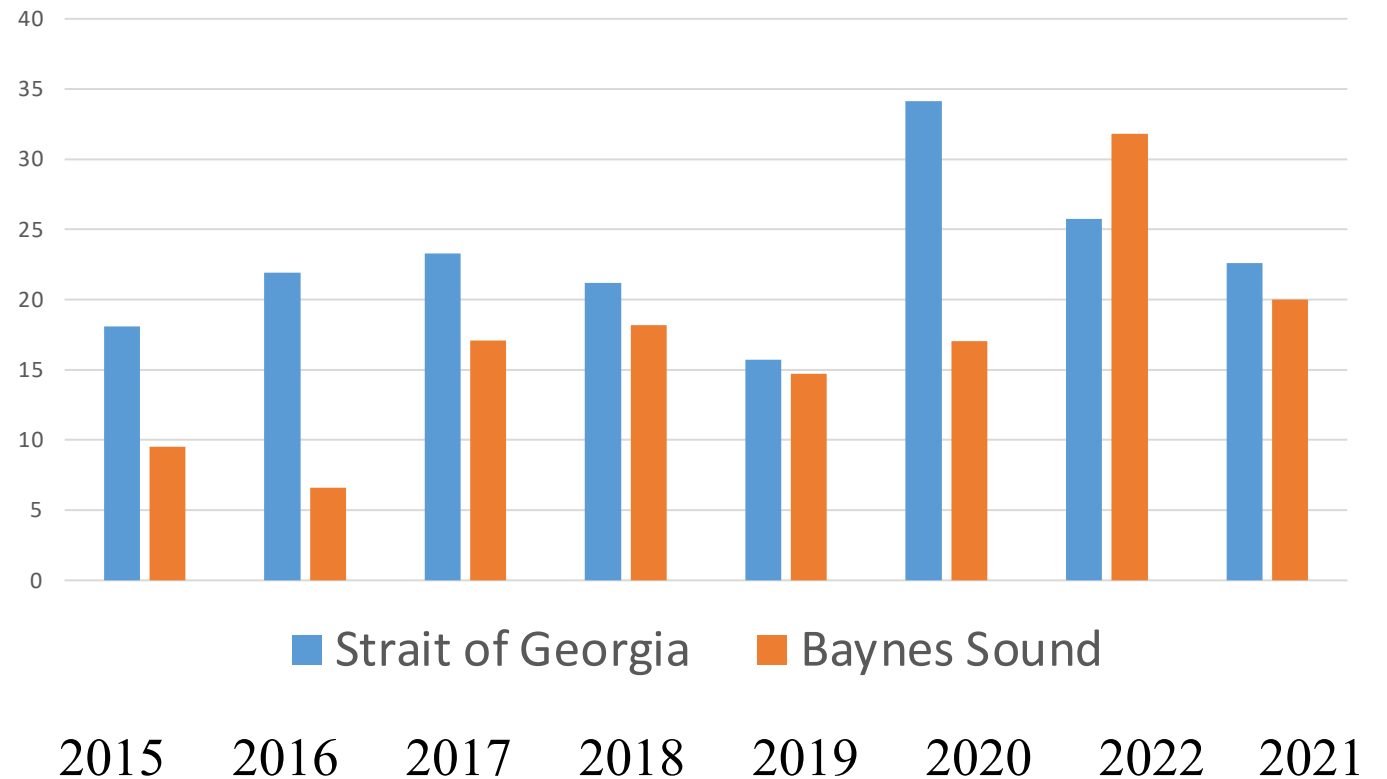


Alexandrium is abundant in summer month, especially in late summer

Toxic HABs and biotoxins – *Alexandrium* spp.



average May-August *Alexandrium* spp. occurrence (%)



Alexandrium is generally less abundant in Baynes Sound than in the Strait of Georgia

Biotoxins in Baynes Sound

- One site (BS-6) one set of samples was in 2020 and 2021 monthly (March-August) in 2022 and in 2023.

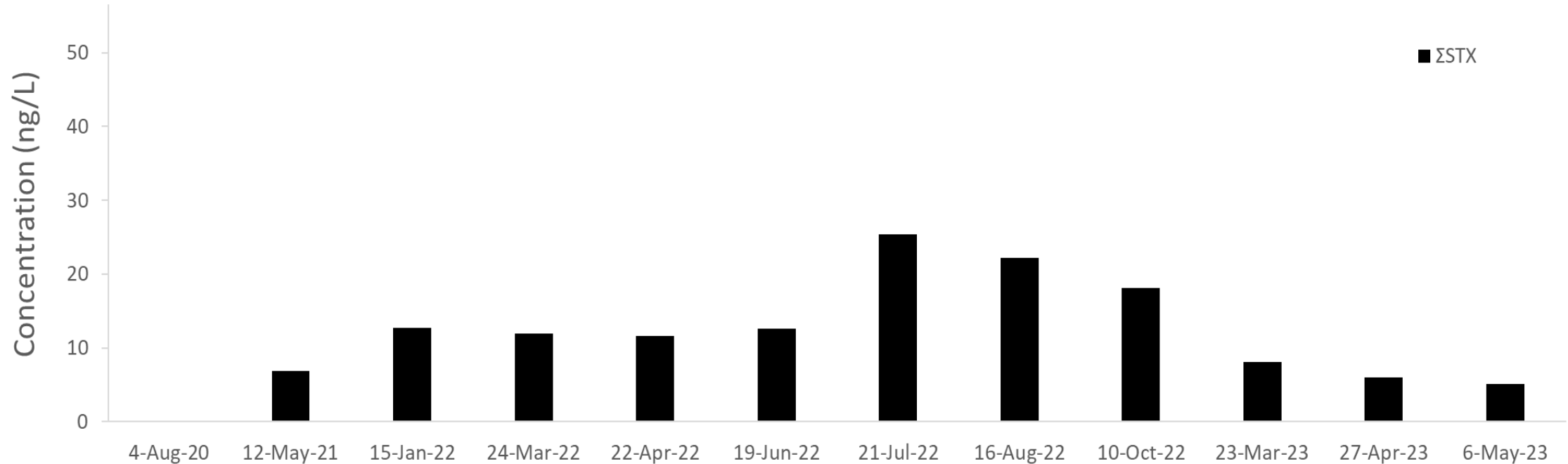
Dr. A. Ross, DFO Andrew.Ross@dfo-mpo.gc.ca
monitors toxins causing:

- Paralytic Shellfish Poisoning – PSP (Saxitoxins)
- Diarrhetic Shellfish Poisoning – DSP (Okadaic acid, pectenotoxins, dinophysistoxin)
- Amnesic Shellfish Poisoning – ASP (Domoic acid)
- Yessotoxin Shellfish Poisoning – YSP (Yessotoxin)

Toxins that can cause all major shellfish poisoning were detected in Baynes Sound



PSP (Saxitoxins) toxins in Baynes Sound



- Present at low concentrations in almost all samples
- Peak later in summer - agreement with algae in water data
- Lower concentrations than other SoG monitored areas (Cowichan Bay, Irvines Sechelt)
- agreement with algae in water data

Alexandrium spp. links to environmental drivers

Inter-annual - Pearson Product-Moment Correlations (r) between mean HABs taxa concentrations and environmental drivers and nutrients during summer (June, July, August) using average values for each station in the Strait of Georgia from 2015 to 2018 (n = 259).

	Environmental Drivers			Nutrients				
	Temperature	Salinity	Stratification	Secchi	N	P	N:P	Si
<i>Alexandrium</i> spp.	-0.143	0.169	-0.140	0.106	0.058	0.023	0.058	-0.036

Intra-annual - Pearson Product Moment

Correlations (r) between mean monthly concentrations of HABs taxa and various physical and chemical variables from March to September 2015-2018 averaged over the entire SoG (n = 28).

Secchi depth	-0.497
Temperature	0.753
Salinity	-0.363
Stratification	0.611
Nitrate	-0.651
Phosphate	-0.557
Silicate	-0.205
Wind Speed	-0.174
Rainfall	-0.505
Cloud Cover	-0.653
Fraser River Flow	0.33

Esenkulova, S., Suchy, K. D., Pawlowicz, R., Costa, M., & Pearsall, I. A. (2021). Harmful Algae and Oceanographic Conditions in the Strait of Georgia, Canada Based on Citizen Science Monitoring. *Frontiers in Marine Science*, 1193.

Summary

- Harmful algae and biotoxins concentrations at Baynes Sound generally lower than in other monitored areas of the Strait
- PSF Citizen Science data on HABs, CTD, nutrients - open access
- Existing datasets can be useful for studies of food web dynamics, impacts on finfish and shellfish, other marine life, building predictive models
- Collaboration is key to addressing environmental challenges

Thank you



**PACIFIC SALMON
FOUNDATION**

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