SoundToxins Phytoplankton Monitoring Program

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SoundToxins (www.soundtoxins.org) is a Puget Sound-wide phytoplankton monitoring program managed by NOAA, Washington Sea Grant and the WA State Department of Health (WDOH). The program provides early warning of harmful algal blooms (HABs) to protect human health and minimize economic losses to fisheries.

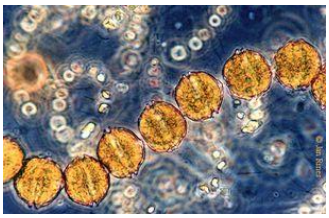
Always check WDOH's Shellfish Safety Map before harvesting: https://fortress.wa.gov/doh/biotoxin/biotoxin.html.

HABs occur when certain types of phytoplankton rapidly reproduce, resulting in toxic or harmful effects on people, fish, shellfish, mammals and birds. Bivalve shellfish (e.g. mussels, clams, oysters) filter feed on phytoplankton, concentrating biotoxins in their tissues. These toxins typically do not harm shellfish, but can cause illness or death in humans and animals.

Shellfish farming and harvesting plays a vital role in many communities – both culturally and economically. WDOH routinely tests shellfish tissues to ensure that shellfish are safe to eat. SoundToxins supports WDOH by providing early detection of HABs and improving our understanding of the factors associated with toxic events in an effort to predict when they will occur.

SoundToxins – How it Works!

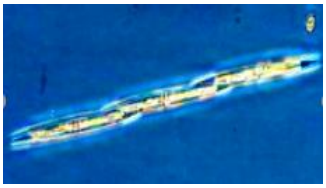
Every week, partners throughout Puget Sound collect plankton samples and site specific data (weather, temperature, salinity, oxygen and pH). Some sites also collect seawater for nutrient



Alexandrium

Paralytic Shellfish Poisoning (PSP)

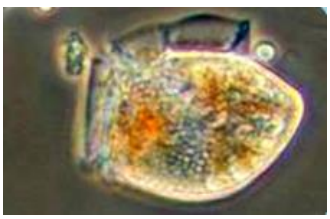
Tingling lips, tongue, fingers, toes; difficulty breathing, paralysis & death.



Pseudo-nitzschia

Amnesic Shellfish Poisoning (ASP)

Nausea, vomiting, diarrhea, cramps, confusion, short-term memory loss, coma & death.



Dinophysis

Diarrhetic Shellfish Poisoning (DSP)

Nausea, vomiting, abdominal pain & diarrhea.

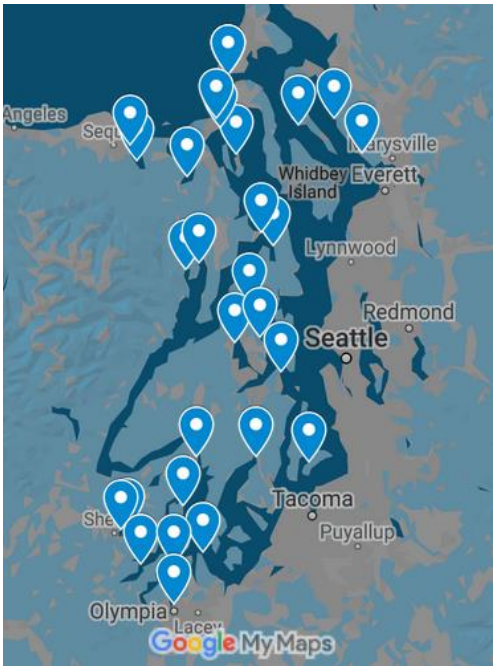
Additional Species of Concern

Heterosigma
Associated with farmed salmon mortality.

Protoceratium
Associated with shellfish mortality.

Akashiwo
Associated with shellfish and coastal seabird mortality.

and toxin analysis. Plankton samples are viewed under microscopes for the presence and number of HAB species. Data are entered into a central database and any increases in HAB concentrations are immediately alerted to the SoundToxins coordinator.



SoundToxins sampling sites. The Olympia Region Harmful Algal Bloom (ORHAB) partnership is a similar monitoring program for the WA Coast.

What's Blooming in Budd?

For the past decade, PSI has invited the public to participate in SoundToxins as part of Stream Team's "What's Blooming in Budd?" program (www.pacshell.org/whats-blooming-in-budd.asp). In 2016, lower Budd Inlet set a national record for the highest level of DSP toxins (DSTs) measured in mussels – 250 µg/100 g tissue! The closure limit is 16 µg/100 g. Budd Inlet has been closed to shellfish harvesting for a portion of every year since. While DSP closures occur throughout Puget Sound, ***Dinophysis*** appears to have a strong affinity towards Budd Inlet. In response, PSI now monitors phytoplankton year-round. NOAA also deployed an Imaging FlowCytobot (IFCB) in lower Budd Inlet to better understand *Dinophysis* and the conditions associated with bloom and toxic events.

Budd Inlet and *Dinophysis* – Help Solve the Puzzle!

As we continue to collect information from Budd Inlet, the long-term data provide clues to help answer important questions. When are DSP closures most likely to occur? What species of *Dinophysis* are responsible for toxin production? What other factors might be associated with DSP closures?

Watch how we sample for SoundToxins!
https://youtu.be/FtSw32ucBUs

Let's Get Started!

Open up the Google Sheets file: **SoundToxins_Data**

This file includes 2 data tabs:

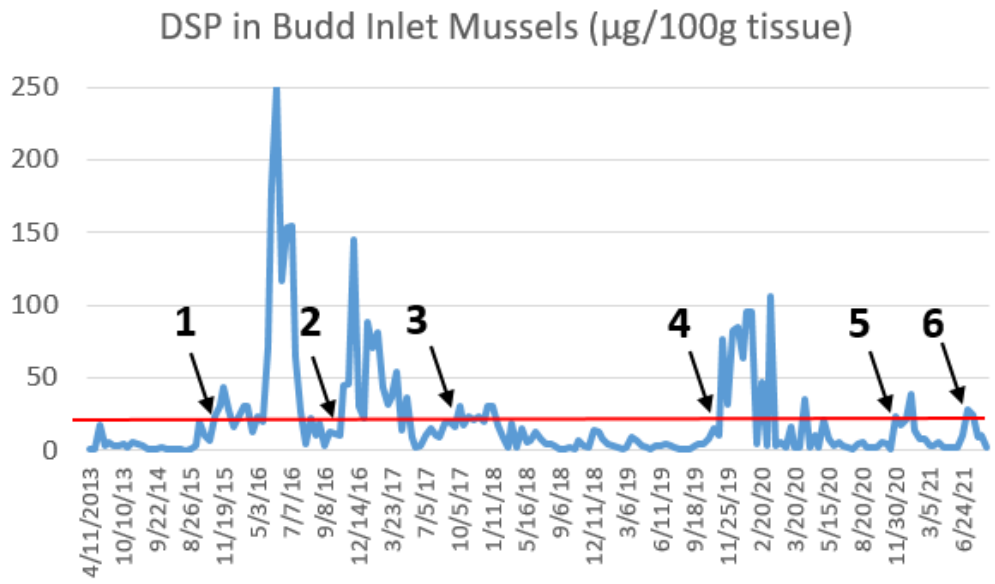
a. WDOH DSP. WDOH routinely collects mussels and sends them to a lab to test for DSP toxins. This file includes Budd Inlet DSP results (2013-2021). Red values meet the DSP closure limit of 16µg/100g.

b. PSI *Dinophysis*. This file includes PSI's cell counts (cells/L) for *Dinophysis*, the species responsible for DSP; collected during the summer (2013-2016) and year-round (2017-2021). This tab also includes the specific *Dinophysis* species observed (%) in the sample.

IFCB is an instrument that uses video technology to capture plankton images.

WDOH DSP Tab

Click on the WDOH DSP tab. Graph the DSP concentrations over time. To do so, click and drag your cursor over all of the DSP Date and DSP (µg/100g tissue) data (Columns C & D, Rows 2-190). Once highlighted, INSERT a Chart (Line Chart). Under X-axis, click on Aggregate. You may Customize the Chart and Axis Titles. Now, draw a horizontal line at the closure limit of 16 µg/100g tissue. To do so, click on INSERT Drawing and Select Line. Draw a 5-inch line, adjust the line color/weight, and select Save and Close. The line should appear on your Sheet. Click on the line and drag it into position on your Chart. Does your chart look something like this?



Olympia High School intern, Shriya, performing a net tow.

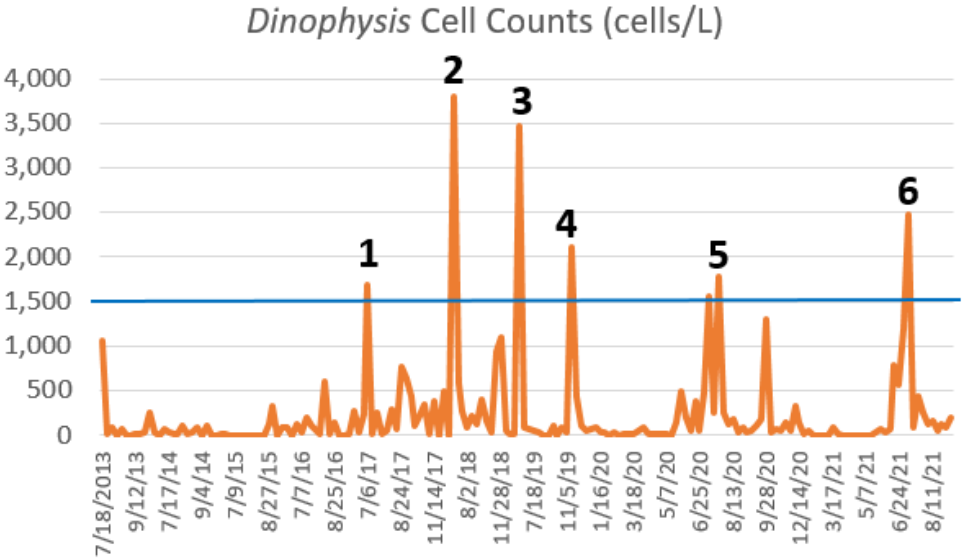
DSP levels spiked above 16 µg/100g tissue (for > 2 consecutive weeks) during 6 time periods between 2013 and 2021 (labeled 1-6) triggering shellfish harvesting closures. For each of these time periods, list the approximate date that the closure **STARTED**. You may hold your cursor over the data line to display the date and DSP level, or refer back to the raw data (Red values are ≥ 16 µg/100 g tissue). Leave the second column (*Dinophysis* Species) blank at this time.

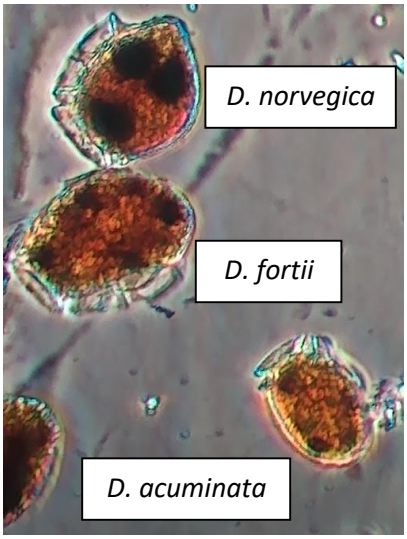
	~ Closure Start Date	***Dinophysis* Species at Closure Onset**
1	10/20/15	No data available
2	10/20/16	No data available
3	8/24/17	*D. fortii*
4	11/20/19	*D. fortii*
5	11/30/20	*D. fortii & D. acuminata*
6	7/8/21	*D. fortii & D. acuminata*

Since 2013, what is the most common **season** for the onset of DSP closures? Fall

PSI *Dinophysis*

Click on the PSI *Dinophysis* tab. Graph the *Dinophysis* cell count data over time. To do so, click and drag your cursor over all of the Date and Cell Count data (Columns A & B, Rows 2-182). Once your data is highlighted, INSERT a Chart (Line Chart). Under X-axis, click on Aggregate. You may Customize the Chart and Axis Titles. Now, draw a horizontal line on the chart at 1,500 cells/L. To do so, click on INSERT Drawing and Select Line. Draw a 5-inch line, adjust the line color/weight, and select Save and Close. The line should appear on your Sheet. Click on the line and drag it into position on your Chart.





Three common Dinophysis species.

PSI observed cell counts above 1,500 Cells/L 6 times since 2013. Use your graph and the PSI *Dinophysis* data tab to determine the **Date** that each spike occurred, the **Cell Count**, and which ***Dinophysis* species** were in the water at the time. While you're at it, complete the column ***Dinophysis* Species at Closure Onset** from Page 3. Now, refer back to the WDOH DSP tab to see if Budd Inlet was closed to harvesting due to DSP (≥16 µg/100g tissue) during these 6 times.

	Date *Dinophysis* > 1,500	Cell Count	*Dinophysis* Species	DPS Closure (Y/N)
1	7/6/17	1679	*D. fortii*	N, but # increasing
2	7/3/18	3798	*D. norvegica*	N
3	6/20/19	3476	*D. norvegica*	N
4	11/19/19	2113	*D. fortii*	Y
5	7/8/20 & 7/22/20	1554 & 1786	*D. acuminata & D. fortii*	N
6	7/8/21	2476	*D. acuminata & D. fortii*	Y

Do spikes in *Dinophysis* cell counts always result in DSP toxicity? No
Which *Dinophysis* species were in the water during the toxic events (refer to both tables)?
D. fortii & D. acuminata

Put it all together!

Based on this limited data set, when would you predict that the next DSP closure is most likely to take place in Budd Inlet?

Fall. However, according to our data, DSP closures can also begin during the summer (August, 2017 and July, 2021).

What *Dinophysis* species would you predict might be in the water?

D. fortii and D. acuminata

Does this data generate any new questions for you? If so, what?

Yes!

1. Which species is/are producing the DSP toxin? D. fortii or D. acuminata or other?

2. What concentration of *D. fortii* and/or *D. acuminata* are required to cause a DSP closure? For example, during the 11/30/20 closure, only 333 cells/L were detected on 12/1/20 (48 cells/L on 11/18/20). Perhaps the sampling effort missed a cell count spike in the week prior. Should monitoring take place weekly (and not every other week) when these 2 species are in the water?

3. What environmental factors are associated with DSP closures?

   While water quality parameters (i.e. temperature, water stratification, oxygen/pH levels, rainfall) may be associated with toxin production, they do not necessarily cause it. Toxin production may also be triggered by additional factors such as food availability, nutrient availability or something else entirely.

4. What was different about Fall of 2018 when no DSP closures took place? What was different about the 2015/2016 record setting DSP closure?

   The summer of 2018 was fairly cool and the unusually warm water mass, nicknamed the Blob, occurred during 2015/2016. However, if DSP closures are temperature related, then why do blooms persist through the winter months?

5. What is it about Budd Inlet (and Sequim, Discovery, & Liberty Bays & Quartermaster Harbor) that make DSP closures more common?

   Nutrients? Food supply (*Mesodinium*)? Stratification?