SOUND TOXINS

An Early Warning Program for Harmful Algal Blooms in Puget Sound

Harmful algae

Puget Sound is one of the most naturally beautiful and ecologically diverse locations in the Pacific Northwest. However, these waters are home to several species of algae that can produce deadly toxins when water conditions encourage their populations to explode. During these harmful algal blooms (HABs), the algae and their toxins accumulate in shellfish and are also transferred up the food chain to marine and terrestrial animals. High concentrations of some algal species can sicken or kill marine birds, mammals, or humans and can cause fish to die in large numbers.

The SoundToxins program

We formed SoundToxins—the Partnership for Enhanced Monitoring and Emergency Response to HABs in Puget Sound—to combat the apparent increase in these HAB occurrences over the past decade.

SoundToxins is a diverse partnership of shellfish farmers, fish farmers, environmental learning centers, volunteers, local health jurisdictions, colleges, and Native American tribes that was conceived and initiated by the Northwest Fisheries Science Center (NWFSC), and is now co-directed by Washington Sea Grant (WSG). SoundToxins has grown from four partners in 2006 to 28 partners in 2017, some of whom monitor multiple sites in Puget Sound.

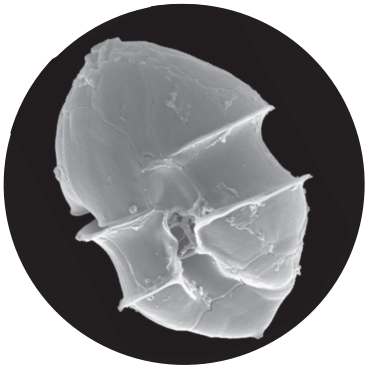
SoundToxins has three main objectives:

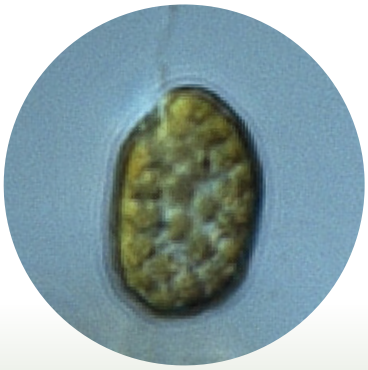
- To document unusual bloom events and new species entering Puget Sound.
- To determine the environmental conditions that promote the onset and flourishing of HABs.
- To determine the combination of monitoring parameters that provide the earliest warnings of these events.

Monitoring Puget Sound

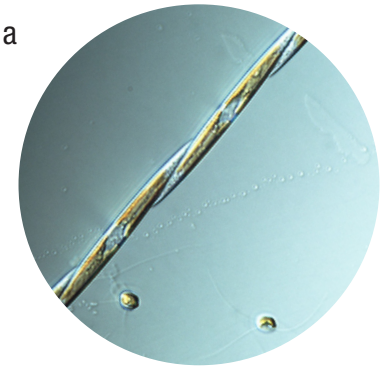
SoundToxins participants use microscopes to identify phytoplankton, or single-celled algae, at sampling sites around Puget Sound. This information is entered into an online database to create "risk maps" (see next page) that can be accessed in real time by state health officials to make timely decisions—about which harvest sites need additional shellfish to be collected, or where shellfish can be harvested prior to impending closures—protecting human health and reducing economic loss. Given that Washington State is the largest producer of shellfish in the United States (total production is valued at $150 million), SoundToxins plays a critical role in maintaining seafood security for the nation.

Samples are collected weekly from March to November, and every other week in the winter. The target species of potentially harmful algae are *Pseudo-nitzschia, Alexandrium, Dinophysis, Azadinium,* and *Heterosigma*.





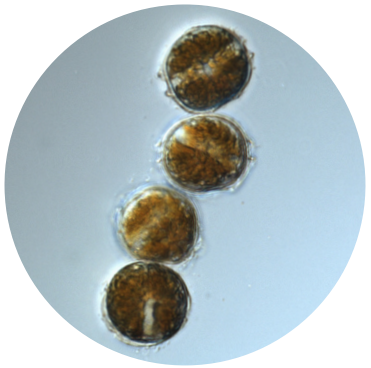
Pseudo-nitzschia



These algae are pennate diatoms that can produce a toxin called domoic acid.

- Domoic acid poisoning in humans is known as amnesic shellfish poisoning (ASP).
- ASP can cause temporary and even permanent short-term memory loss.
- The huge coastwide HAB in 2015 was caused by *Pseudo-nitzschia*. (See this article from the Seattle Times,[1] or this story from the NWFSC.[2])

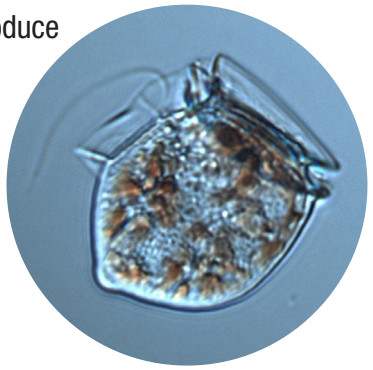
Alexandrium



This is a dinoflagellate known for the suite of toxins that it produces, referred to as paralytic shellfish toxins (PST).

- PSTs are responsible for the human illness called paralytic shellfish poisoning (PSP).
- PSP can cause tingling of the lips and tongue, short-term paralysis, and even death.

Dinophysis



Some species of this dinoflagellate are known to produce toxins such as okadaic acid and dinophysistoxins.

- These toxins are responsible for the human syndrome called diarrhetic shellfish poisoning (DSP). The first DSP event in the USA occurred at a SoundToxins site in Sequim Bay in 2011. (See this article from Earth Fix.[3])
- DSP symptoms include diarrhea, nausea, vomiting, and abdominal cramping.

Azadinium

This small dinoflagellate species is known to produce toxins called azaspiracids. This organism has recently been identified in Puget Sound.

- Azaspiracid poisoning (AZP) can affect humans. AZP was first reported in the Netherlands in 1995.
- Symptoms of AZP include chills, headaches, diarrhea, nausea, vomiting, and stomach cramps.

Heterosigma

This organism is a major cause of fish deaths in Puget Sound. It produces a toxin or toxins that have not yet been characterized.

- *Heterosigma* cells can cause irritation of the gills, creating excess mucus and stopping fish from taking up oxygen from the water.
- It has caused mortality among aquacultured salmon at a cost of several millions of dollars to the industry.

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[1] http://www.seattletimes.com/seattle-news/health/toxic-algae-bloom-might-be-largest-ever/
[2] https://www.nwfsc.noaa.gov/news/features/west_coast_algal_bloom/index.cfm
[3] http://www.opb.org/news/article/toxic-algal-blooms-and-warming-waters-the-climate-/

Funding the SoundToxins program

Currently, SoundToxins is supported, in part, by NOAA grant funding to NWFSC and Washington Sea Grant, with a mandate to study the risks of new toxins in Puget Sound. This funding will end in August 2018.

SoundToxins was established in 2006 with five years of funding from the NOAA Oceans and Human Health Initiative and the West Coast Center for Oceans and Human Health. Other HAB monitoring on the outer coast of Washington has been supported (through a tax on shellfish licenses that supports ORHAB, the Olympic Region Harmful Algal Bloom partnership), and could provide a means for continued and sustained support of SoundToxins.

Washington House Bill 1620 included a surcharge of $2–4 on licenses for shellfish harvesting, both in Puget Sound and along the outer coast. This money helps fund the Washington State Department of Health (DOH), which provides biotoxin testing and monitoring of beaches used for recreational shellfishing, as well as monitoring by the ORHAB partnership; however, SoundToxins was not included in this surcharge.

Success stories

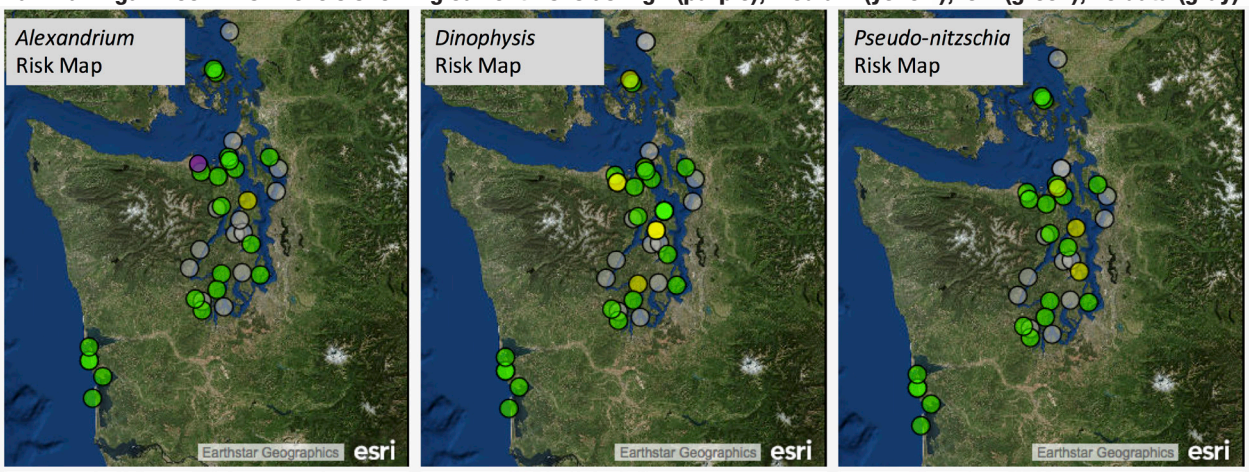
- Real-time warnings: SoundToxins' online database allows DOH and other state managers to view HAB risk maps in near-real time. The data entered by SoundToxins partners are reviewed daily by WSG staff for quality and accuracy. In addition, WSG has established a 24/7 email site where SoundToxins participants alert partners to elevated numbers of HAB species and ask questions. A SoundToxins Listserv distributes weekly and monthly updates of summarized data to all participants.

Protecting public health

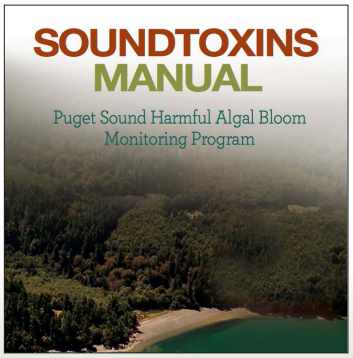
In spring 2015, a SoundToxins partner, Taylor Shellfish, noted high numbers of *Alexandrium* in a water sample collected from Dabob Bay and immediately notified DOH and the SoundToxins Listserv. When the toxicity of a mussel sample collected by SoundToxins personnel assisting DOH exceeded the safe harvest level, commercial and recreational shellfish growing areas in Hood Canal were immediately closed. Four semi-trucks bound for retail and wholesale markets, carrying hundreds of pounds of potentially toxic mussels, were recalled, preventing possible human illnesses.

Without the identification and alert of *Alexandrium* by a SoundToxins partner, this shipment of shellfish would not have been tested, as it was outside of the routine testing by DOH. The early warning provided by SoundToxins very likely averted human illnesses from toxic shellfish.

Harmful Algal Bloom Risk Levels showing current risks as high (purple), medium (yellow), low (green), no data (gray)

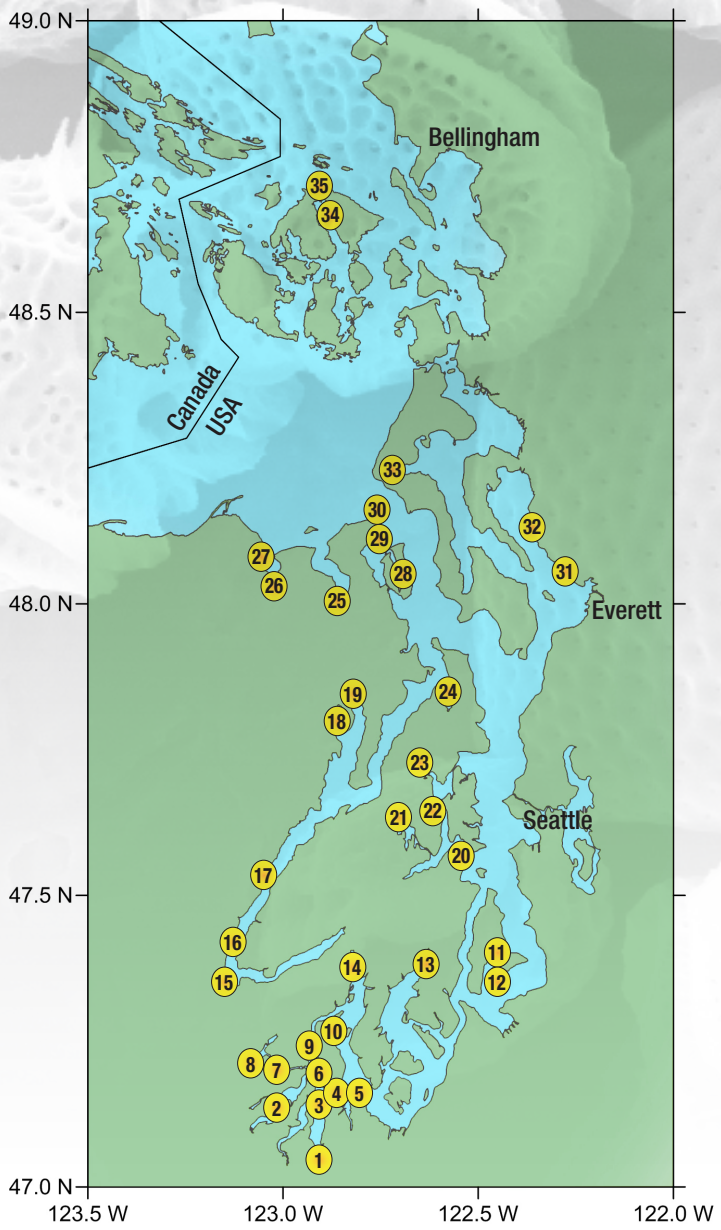


- All SoundToxins participants receive intensive training, an onsite visit and a manual (pictured at right) with detailed methods that ensure consistency of HAB monitoring in Washington State marine waters.



- SoundToxins has partnered on several research proposals by providing samples, data, and endorsement of scientists and their projects around the country. For example, SoundToxins has assisted with cyst mapping to provide an early warning of paralytic shellfish toxin events and has helped to assess the risk of a new azaspiracid toxin to shellfish consumers.

Sampling sites



Sites names

1 Budd Inlet Port Plaza
2 Totten Inlet
3 Budd Inlet - Boston Harbor
4 Dana Passage
5 Nisqually Reach - Zittel's Marina
6 Peale
7 Hammersley Inlet
8 Oakland Bay
9 Pickering
10 Spencer Cove - Harstine Island
11 Dockton Park Pier - Maury Island
12 Quartermaster Harbor - Dockton
13 Burley Lagoon
14 North Bay - Allyn
15 Annas Bay
16 Glen Ayr
17 Hama Hama
18 Quilcene Bay
19 Dabob Bay
20 Manchester - Clam Bay
21 Dyes Inlet
22 Brownsville
23 Liberty Bay
24 Port Gamble
25 Discovery Bay
26 Sequim Bay
27 Sequim Bay Entrance
28 Mystery Bay
29 Port Townsend
30 Fort Worden
31 Tulalip Bay
32 Port Susan - Kayak Point
33 Penn Cove Raft
34 Long Live the Kings
35 County Dock East Sound

New toxins in Puget Sound

In the summer of 2011, three people who had gathered and eaten shellfish in northern Puget Sound were poisoned. A SoundToxins partner identified *Dinophysis* as the causative organism and the toxin analysis by NWFSC and the U.S. Food and Drug Administration confirmed DSP as the illness. As a result, DOH included diarrhetic shellfish toxin in its routine testing. SoundToxins was asked by DOH to provide real-time reporting of *Dinophysis* abundance throughout Puget Sound, allowing managers to target testing at those sites where shellfish were most likely to contain diarrhetic shellfish toxins.

Partners

- **Tribal partners:** Jamestown S'Klallam Tribe, Nisqually Tribe, Port Gamble S'Klallam Tribe, Skokomish Tribe, Squaxin Island Tribe, Stillaguamish Tribe, Tulalip Tribes.
- **Education institutions:** Evergreen State College, Pacific Shellfish Institute, Port Townsend Marine Science Center, University of Washington, Washington Sea Grant (WSG).
- **Fish aquaculture partners:** Long Live the Kings.
- **Shellfish growers:** Clam Fresh Enterprises, Coast Seafoods, Hama Hama Oyster Company, Penn Cove Shellfish, Seattle Shellfish, South Sound Mariculture, Taylor Shellfish.
- **Government:** King County Environmental Laboratory, Kitsap Public Health District, NOAA Northwest Fisheries Science Center (NWFSC), Pacific Northwest National Laboratory, Washington State Department of Health.
- **Private citizens:** residents of Vashon and San Juan Islands.

Contacts

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- Brian Bill, Phytoplankton Specialist (NWFSC)
- www.nwfsc.noaa.gov/soundtoxins or www.soundtoxins.org

*Images: NOAA Fisheries/NWFSC, except HAB images on 2nd page: Gabriela Hannach, King County; Urban Tillmann, Alfred Wegener Institute (*Azadinium *image)*

NOAA FISHERIES

Sea Grant Washington