

2021 “What’s Blooming?” Plankton Monitoring Final Report



Pacific
Shellfish
Institute

120 State Avenue NE #1056
Olympia, WA 98501
Tel: (360) 754-2741
E-mail: psi@pacshell.org

2021 Goals & Procedures

Stream Team partnered with Pacific Shellfish Institute (PSI) to perform its 10th year of the “What’s Blooming?” plankton monitoring program! The goal of this program is to offer engaging activities that educate the public about local water quality issues and encourage environmental stewardship. Monitoring connects the community to their watershed and inspires participants to take evidence-based actions that reduce stormwater pollution, particularly related to nutrients, bacteria and litter. Due to COVID-19, public participation was not explicitly advertised this year. However, the public was allowed to assist with water quality sampling and plankton viewing in a more limited capacity. For those individuals interested in participating, face masks and hand sanitizer were available, and equipment was sanitized between groups. Similar to 2020, no formal community events were held.



Olympia Yacht Club campers from the STEM Sailing program assist with SoundToxins sampling, July 28th.

2021 Task Summary	# events	People Reached (FB)*	Impressions (IG)*	In-person Contacts
Task				
What's Blooming in Olympia? Budd Inlet/Ward Lake	7	1583	469	56
What's Blooming in Lacey? Woodland Creek/Long Lake	2	256	230	40
What's Blooming in TC? Deep Lake/Munn Lake	2	494	186	12
2021 Summer Newsletter Article				Completed
	11	2333	885	108

* Facebook and Instagram analytics used in addition to limited In-person contacts

During the summer, PSI conducted 6 “What’s Blooming in Budd?” events at the Port Plaza dock. Every other week, PSI also sampled at 5 fresh water lakes throughout Thurston County including Deep, Munn, Ward and Long Lakes, in addition to Longs Pond and Woodland Creek at Woodland Creek Park. PSI shared information about the weekly sampling events through enhanced “blog-style” entries (Appendix A) on [PSI’s website](#), [PSI’s Facebook](#) (Appendix B) and [PSI’s Instagram](#) pages. PSI completed a total of 11 sampling events reaching at least 3,326 individuals – 97% of those being contacts via social media sites such as Facebook & Instagram.

PSI posted 10 Facebook and 10 Instagram entries resulting in 2,333 People Reached (FB), 885 Impressions (IG) and 18 Shares further increasing educational viewing. The events resulted in 108 In-Person contacts on the dock and surrounding lakes.

For the “What’s Blooming?” monitoring events, PSI collected water quality and phytoplankton data between June 24th and August 26th. The phytoplankton were viewed under a field microscope and the results were displayed to the public using an A-frame board left on-site until dusk. Plankton samples were further analyzed in the lab to determine species diversity and harmful algal bloom (HAB) concentrations using SoundToxins protocols. SoundToxins is a monitoring program designed to provide early warning of HABs in order to minimize human health risk and losses to fisheries. Data was entered into NOAA’s [SoundToxins](#) phytoplankton monitoring database. Sampling at freshwater lakes was conducted similarly with a focus on water quality, plankton species composition and HABs. The connection between sources of stormwater pollution, downstream water quality, and stewardship was highlighted throughout the program.



Olympia HS intern, Shriya, collecting a plankton sample, July 22nd.

The “What’s Blooming?” program lends itself to supporting additional new partnerships and applications beyond the scope of this contract. For example, on 7/28 and 8/11, campers from Olympia Yacht Club’s STEM sailing program helped sample water quality, collect plankton samples, and screen samples for HAB species. On 8/25, “What’s Blooming in Budd?” plankton samples were shared with a Northwest Youth Corps crew at Capitol Land Trust’s Inspiring Kids Preserve. Students learned about stormwater pollution, plankton, HABs, and shellfish-related job opportunities.

PSI promoted the “What’s Blooming?” program at Deschutes Estuary Restoration Team’s (DERT’s) kayak patrol event at Boston Harbor on 8/21. Paddlers collected water quality data and plankton samples from 3 Boston Harbor locations and compared them to data and samples collected from Budd Inlet that same evening. And finally, “What’s Blooming?” events provided the perfect opportunity for student interns to learn about careers in marine science. Student interns from Olympia High School assisted with sampling on



NW Youth Corps crew viewing a "What's Blooming?" sample at Capitol Land Trust's Inspiring Kids Preserve.

6/24, 7/22 and 7/29. One intern, Shriya, has been assisting with the SoundToxins program since February 2021. Thank you, Shriya!

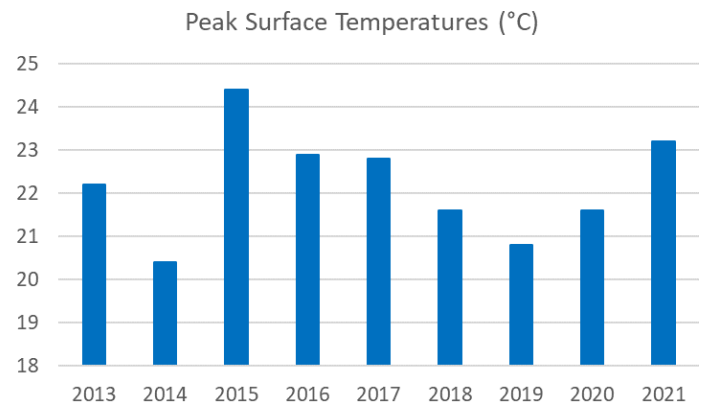
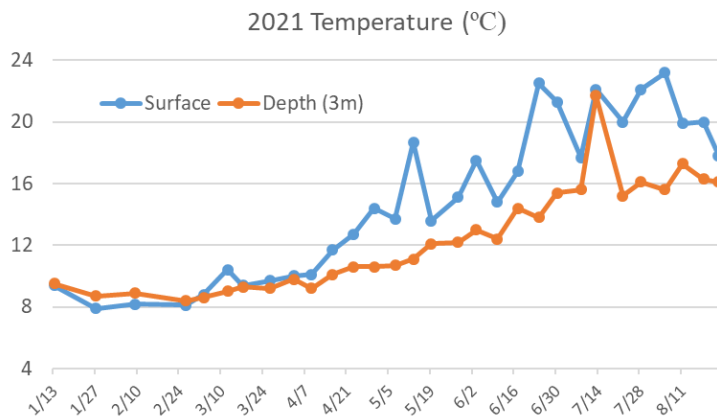
The “What’s Blooming?” program has contributed to a long term data set for Budd Inlet. This spring, PSI used this data to create a SoundToxins phytoplankton monitoring lesson for middle and high school students. This lesson includes a Power Point presentation, data analysis, and hands-on activities including using water quality equipment and identifying phytoplankton. The unit was piloted in Jenna Glock’s 9th grade Biology/STEM Physics class at North Thurston High School. The unit is currently being updated based on this summer’s important new findings related to *Dinophysis* blooms and DSP closures. We look forward to offering this unit to more classes in the future.



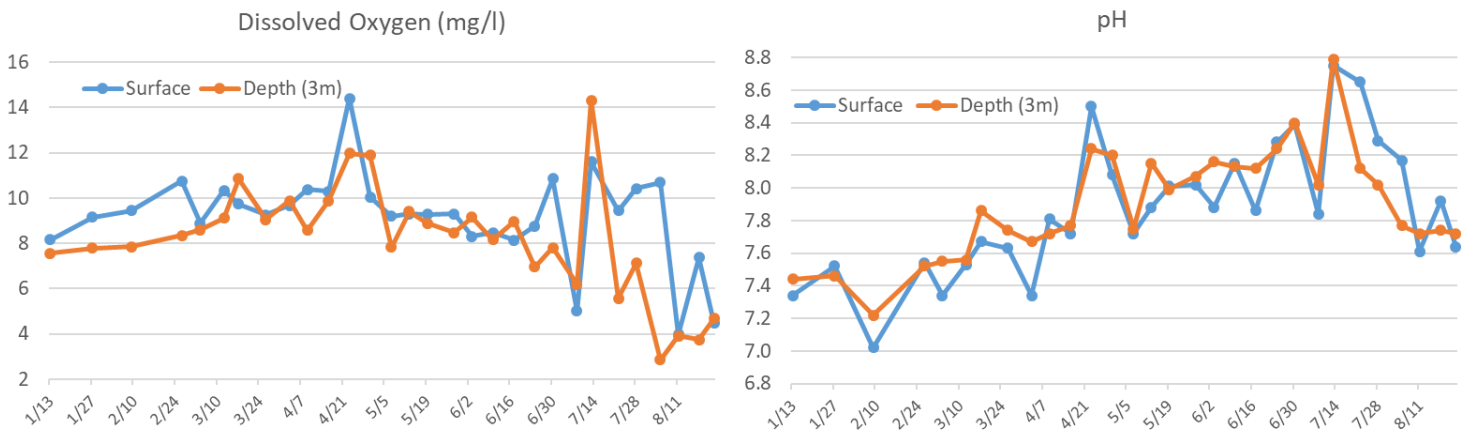
PSI's new SoundToxins Plankton Monitoring unit!

Budd Inlet Water Quality Data

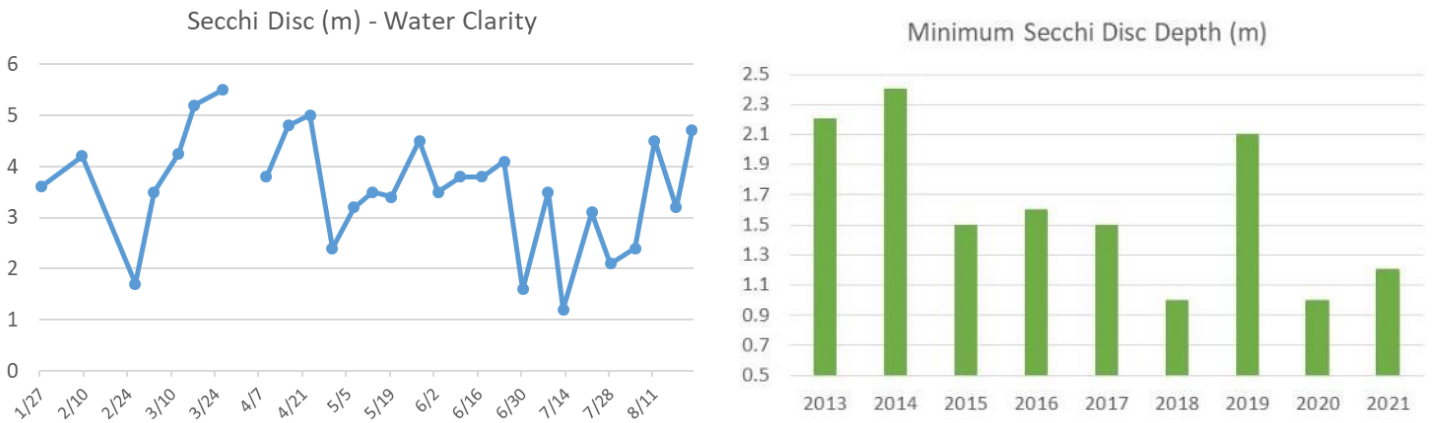
This summer, our region experienced unprecedented periods of extreme heat – reaching triple digit numbers in late June. These maximum temperatures occurred during peak low tides resulting in heat stress and mortality for many intertidal organisms including shellfish. This summer’s peak recorded water temperature was warmer than any other year (23.2°C) since 2013 (when we began collecting data), with the exception of 2015. In 2015, the highest temperature (>24°C) was recorded during the warm water event nicknamed “the Blob.” While the surface temperature reading was 22°C just prior to this year’s “heat dome” event in late June, no measurements were collected during the actual heat wave for safety reasons. Therefore, it is likely that surface temperatures were higher than reported. Regardless, water temperatures were warmer than normal this summer, particularly in June during the kick-off of the “What’s Blooming?” season.



This year, PSI monitored dissolved oxygen (DO) and pH levels throughout the entire year. In general, DO and pH tend to move in sync with one another and are highly influenced by phytoplankton concentrations. For example, when phytoplankton are blooming (spring and summer), oxygen and pH levels are elevated due to photosynthesis. When phytoplankton concentrations are low (winter), oxygen and pH levels decline. In Budd Inlet, DO and pH levels also decline at depth in mid-late summer due to the bacterial decomposition of settled phytoplankton at the bottom of the Inlet. Budd Inlet has long suffered from dangerously low oxygen levels in late-summer due to excess nutrients that fuel rich phytoplankton blooms. Preventing nutrient sources such as animal waste, fertilizer, grass clippings, and soaps from entering stormwater that reaches Budd Inlet is a key step in protecting water quality.



During the “What’s Blooming?” season, DO levels at 3m depth ranged from 14.3 mg/l on 7/13 to 2.86 mg/l on 8/5. Levels below 4 mg/l are stressful to marine life; below 2 mg/l have been shown to cause mortality. Fortunately, a bloom of *Euglenoids* and *Ceratium* increased DO levels to 9.2 mg/l on 9/2. Following a similar pattern, pH levels at 3m depth ranged from 8.8 on 7/13 to 7.7 on 8/11, bumping up to 8.2 during the bloom on 9/2. These ranges were fairly similar to 2020. Last year, summer DO values ranged from 16 mg/l to 3.9 mg/l and summer pH values ranged from 8.9 to 7.8.



The most notable spike in DO and pH occurred on 7/13. According to field notes, this particular day was hot and the water was “warm and gross” with thick brown scum and vegetation hugging the dock and dead jellyfish floating near the surface. The secchi disc reading (water clarity or turbidity) was at its lowest – 1.2 meters – and the water was thick with a bloom of *Chaetoceros*, dinoflagellate species, and euglenoids. Secchi disc readings can fluctuate weekly reflecting blooms as they quickly come and go. Secchi readings as low as 1.0 meters were detected in both 2018 and 2020.

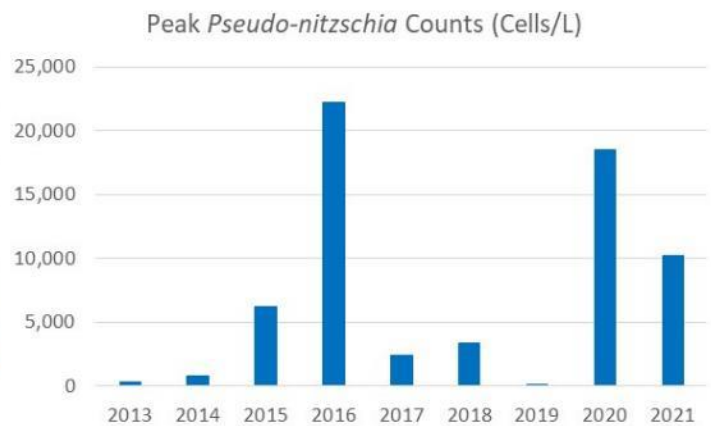
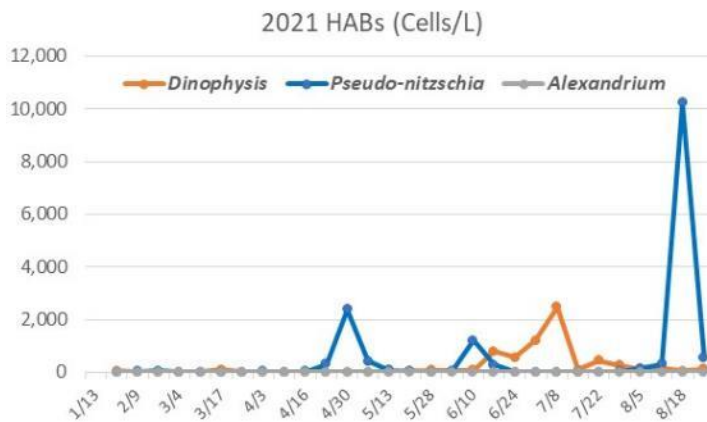
Harmful Algal Blooms (HABs)

Plankton samples were screened for HAB species including *Dinophysis*, *Pseudo-nitzschia*, and *Alexandrium*. This year, *Akashiwo sanguinea*, *Protoceratium reticulatum* and *Mesodinium* were also screened as “Species of Concern” or “Interest.” *Akashiwo sanguinea* and *Protoceratium reticulatum* have been associated with shellfish mortality events, and *Mesodinium rubrum* is an important food source for *Dinophysis*.

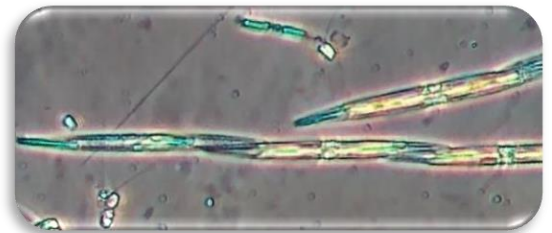


Thick surface scum and floating vegetative debris (Sago Pondweed), Budd Inlet, July 13th.

Pseudo-nitzschia, the species responsible for Amnesic Shellfish Poisoning (ASP) bloomed mid-August peaking at a concentration of 10,000 cells/L. Concentrations were higher in both 2020 and 2016 (22,000 cells/L). While it is not uncommon for *Pseudo-nitzschia* to bloom in Budd, ASP closures are rare in South Sound. In fact, while cells are often present, or even common, they remain non-toxic in this region.



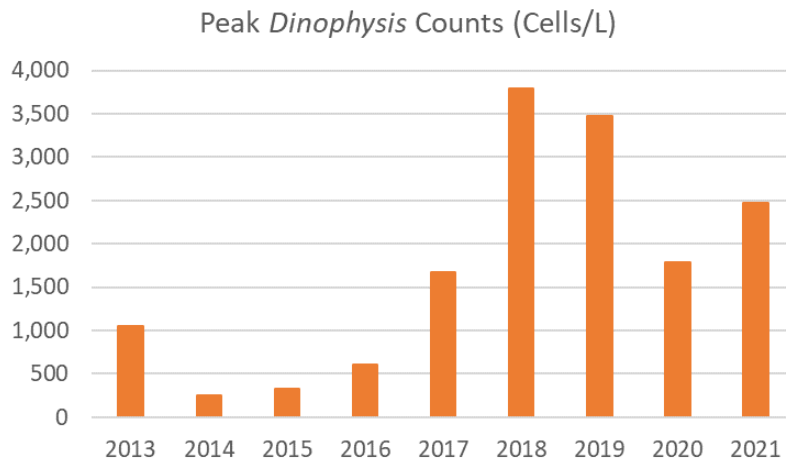
Dinophysis, the species responsible for Diarrhetic Shellfish Poisoning (DSP), was found in every sample collected this summer, blooming in late June and early July with a maximum concentration of 2,476 cells/L. WDOH closed Budd Inlet to shellfish harvesting on July 12th due to elevated levels of DSTs (Diarrhetic Shellfish Toxins) in blue mussels.



Pseudo-nitzschia bloom, August 18th.

Shellfish measured 28 µg/100 g tissue, exceeding the closure limit of 16. Budd Inlet remained closed throughout the summer.

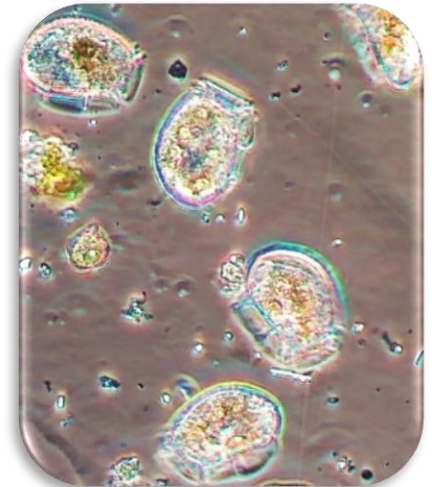
As we continue to collect information from Budd Inlet, this long-term data provides clues to help answer important questions. For example, 1) When are DSP closures most likely to occur and 2) What species of *Dinophysis* are responsible for toxin production? This summer's *Dinophysis* data provided valuable clues to address these questions.



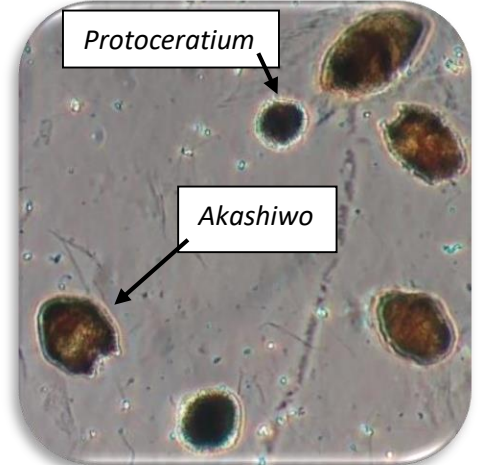
Since 2015, almost all DSP closures have been initiated in late summer or early fall. Some – like during fall of 2015 – persisted until mid-summer of the following year. In fact, in June 2016, lower Budd Inlet set a national record for the highest level of DSP toxins (DSTs) measured in mussels – 250 µg/100 g tissue! During all of these closures, *Dinophysis fortii* and *D. acuminata* (particularly the former) have been blooming. In 2018 and 2019, extremely high cell counts (~3,500 cells/L) were detected in June/July, but did not result in shellfish toxicity. In those two instances, *D. norvegica* was blooming. This year, *D. fortii* was blooming in June/July resulting in a DSP closure. Closures, therefore, appear to occur when *D. fortii* (and possibly *D. acuminata*) are blooming regardless of the season.

Alexandrium, the species responsible for Paralytic Shellfish Poisoning (PSP) was not found in notable concentrations throughout the entire summer. This finding is consistent with previous years.

The dinoflagellate, *Protoceratium reticulatum* was present throughout most of the summer and common on August 5th – noteworthy in that it is known to produce yessotoxin and has been observed more frequently in South Puget Sound in recent years. *Akashiwo sanguinea* bloomed between late July and August 5th, tapering off during August. *Mesodinium rubrum*, a ciliated prey species of *Dinophysis*, was not observed as frequently this year when compared to 2020.



Dinophysis fortii, July 8th sample prior to the closure on July 12th.



Akashiwo and *Protoceratium*, 8/5/21

Fresh Water Lakes

PSI sampled at popular fresh water lakes throughout Thurston County including Deep, Munn, Ward and Long Lakes, in addition to Longs Pond and Woodland Creek at Woodland Creek Community Park. Similar to Budd Inlet, stormwater runoff, particularly related to nutrients, can foster algal blooms, poor visibility, lake closures, and oxygen depletion at depth. Monitoring allows the community to track water quality changes and recognize the importance of lake stewardship. The species composition at each of these locations was rich and diverse, consistently changing from week-to-week and from lake-to-lake. Similar to Budd Inlet, water samples were screened for HAB species including *Dolichospermum* (formerly named *Anabaena*), *Aphanizomenon* & *Microcystis*.

On August 27th, Long Lake was closed due to unsafe levels of toxic blue-green algae. Last year, the lake closed on August 20th. According to testing, microcystin levels were 17 µg/L, exceeding the State Advisory Level of 8 µg/L. Microcystin is a liver toxin and possible human carcinogen. While the blue-green algae, *Dolichospermum*, was observed in the sample, *Microcystis* was common. Both species are known to produce the toxin microcystin.

On August 17th, PSI surveyed water quality and pet waste at Woodland Creek Community Park, distributing Bags-On-Board to dog walkers and educating the public about the importance of cleaning up after pets to prevent bacteria and nutrient pollution. The amount of un-scooped dog waste has dramatically improved over the decade, decreasing from 143 piles in 2011 to only 33 in 2021. In Woodland Creek, the water temperature was warm (20.7°C) and DO was low (1.6 mg/l).

On July 29th, PSI sampled at Ward Lake. Water quality was very good with low algae concentrations, high visibility, and healthy oxygen and pH levels. Numerous open water swimmers were observed during sampling prompting PSI to also post the “What’s Blooming?” write-up on the Olympia Wild Swimming Facebook group.



Water quality sampling at Long Lake, a day prior to the 8/20 closure.



Plankton samples from Longs Pond (left) and Woodland Creek (right), 8/17/21.

Please refer to Appendices A (Blog posts) and B (Facebook entries) for photos and a detailed description of each week's sampling adventures.

Acknowledgements

PSI is incredibly grateful to Stream Team for financially supporting the "What's Blooming?" program over the past 10 years! This ever growing data set is now revealing its true colors and being used by researchers and students to better understand water quality and HABs in our local region and promote environmental stewardship. Thank you to the Port of Olympia for supporting research and education at Port Plaza and to Washington SeaGrant for managing the SoundToxins program. Thank you to our student interns and to all of the plankton enthusiasts that follow along each year. See you on the dock next year!



Junior scientists assisting with Budd Inlet plankton identification, 8/5/21.



Interns, Shriya and Colton, assembling the "What's Blooming?" display board.



Biologists from WDOE, WDNR, WDFW & TCD worked together to ID this plant which had been a nuisance to Budd Inlet boaters all summer: Sago



Samantha collecting water quality data and a plankton sample from Woodland Creek, 8/17/21.

Appendix A: “What’s Blooming?” Weekly Blog Entries

What’s Blooming in 2021?

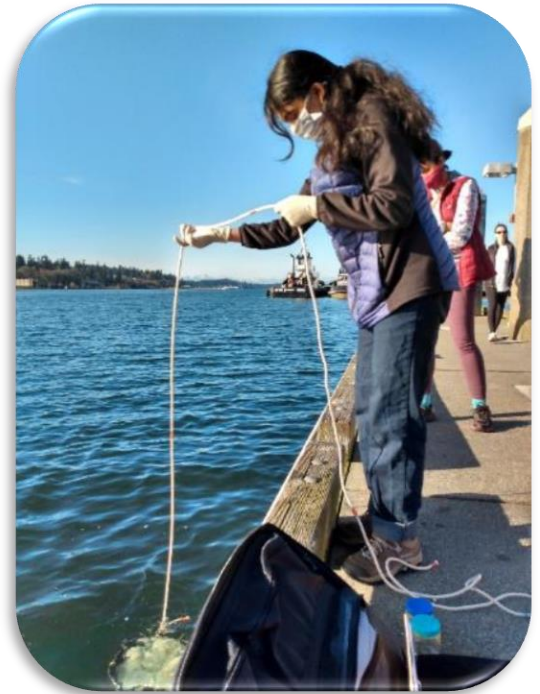
This summer, PSI will sample weekly at Budd Inlet in addition to a handful of lakes throughout Thurston County. Thank you, Steam Team, for your continued support of this fun and important work!

Unfortunately, similar to last year, What’s Blooming will be predominantly virtual. That said, if you happen to catch us at the dock or lake, you are welcome to come over and say hello, assist with sampling, and take a peek under the microscopes! Hand sanitizer and wipes for microscopes are plentiful. As always, we invite you to check here weekly to view data, photos, videos, and a commentary on our sampling experience.

Every week, plankton communities change. Every week, we see something new!

We would love to hear from you! Contact us anytime with your burning plankton questions, to request the next sampling location, or arrange for a small group presentation.

Aimee Christy, aimee@pacshell.org



Thank you, Shriya, PSI’s student intern from Olympia HS, for helping us continue our SoundToxins phytoplankton sampling throughout winter and spring.

Sampling Schedule – Subject to Change & Persuasion 😊

- June 24 – Budd Inlet (Port Plaza)
- July 1 – Deep Lake & Budd Inlet
- July 8 – Budd Inlet (Port Plaza)
- July 15 – Munn Lake & Budd Inlet
- July 22 – Budd Inlet (Port Plaza)
- July 29 – Ward Lake & Budd Inlet
- August 5 – Budd Inlet (Port Plaza)
- August 7/11 – Woodland Creek Park, Budd Inlet
- August 18 – Budd Inlet
- August 26 – Long Lake & Budd Inlet

August 26, 2021 – Long Lake Park, City of Lacey – Closed due to elevated microcystins!

The beach was empty. The only visitors enjoying Long Lake this morning were 55 geese and ducks hunkered down on the lawn and shoreline. That is, until a little girl chased them off. I'm sure some golf course, somewhere, could pay her handsomely for her work. A handful of anglers were fishing at the WDFW access where I launched my kayak.



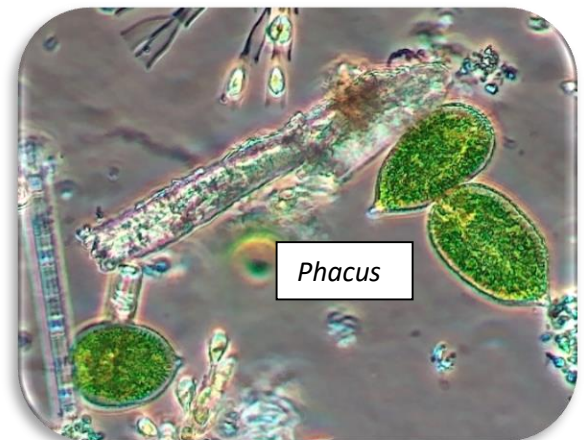
I have since learned that the lake was **very** recently **closed**. In fact, a water sample was collected on 8/25 resulting in a microcystin concentration of 17 µg/L, exceeding the closure limit of 8 µg/L. I sampled on 8/26 and the closure was posted on 8/27. I always check for lake closures prior to sampling, and the previously reported water sample was collected on 8/10 resulting in a microcystin concentration of 4 µg/L. Many cyanobacteria can produce microcystins, but two species, *Microcystis* and *Dolichospermum* were certainly both present in the water, particularly *Microcystis*.



	Surface	1.5m	3m	4.5m	5.5m (Bottom)
Temp (°C)	21.8	21.7	21.6	21.4	21.2
Salinity (ppt)	0.07	0.07	0.07	0.07	0.07
Oxygen (mg/l)	9.07	8.37	6.76	0.96	0.27
pH	8.68	8.54	8.34	7.90	7.58

I chose to sample mid-way between the swimming beach and Holmes Island where the water – a warm 21°C – was about 5 meters deep. The water was well oxygenated near the surface, but dropped sharply to anoxic levels below 3 meters. Visibility was only 1.2 meters and the plankton clogged the net quickly. When I poured the contents into a jar, the water was light green and surprisingly not particularly dense.

Under a microscope, the species responsible for the green coloration became immediately clear. The sample was

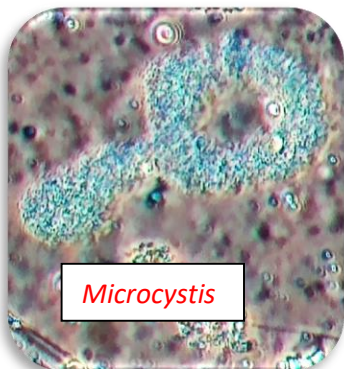
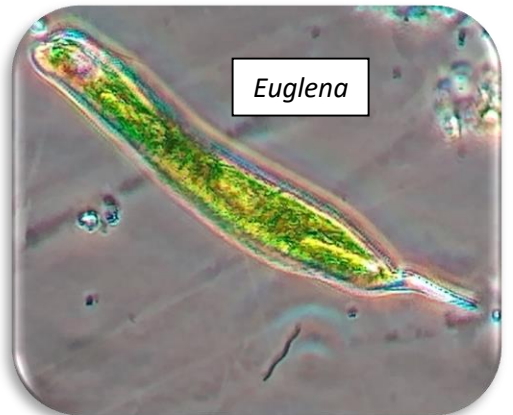
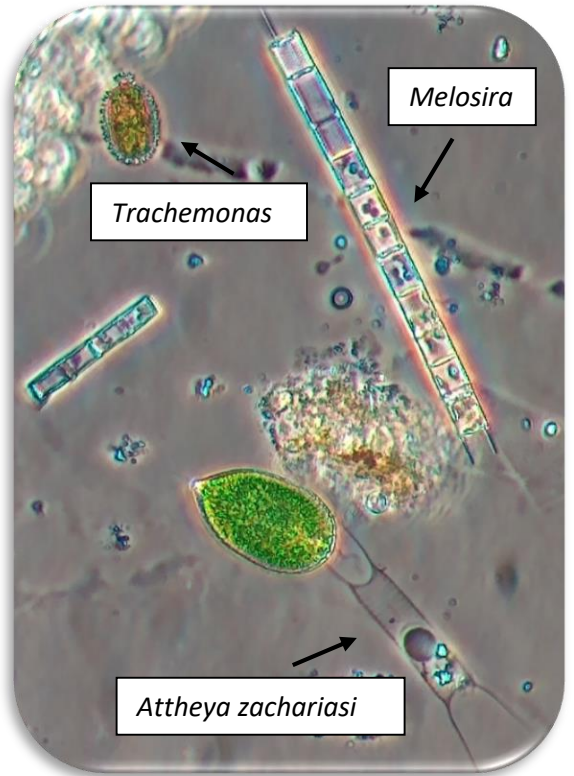
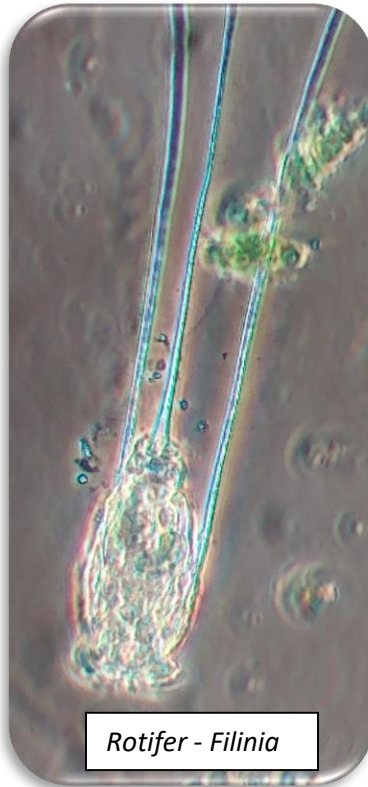


teeming with green Euglenoids – *Euglena*, *Phacus*, and *Trachemonas* (more brownish), their flagellas propelling them smoothly across the slide. Also common were long strands of *Melosira granulata* (the freshwater species look vastly different than the marine variety). Large centric diatoms and *Fragillaria* were present, in addition to *Attheya zachariasi* - an odd species that I've never seen before. The only notable dinoflagellates in the sample were *Ceratium*. I even observed one traveling across the slide WITHOUT an apical horn! What!?



At least 4 species of rotifers were present and a couple Chrysophytes - *Mallomonas* and the bouquet-like *Dinobryon*. I was mesmerized by individual *Vorticella* arranged on stalks that would quickly contract like a spring.

Long Lake was quiet & peaceful today – the gray skies marking the end of summer. Please stay safe, refrain from water contact, and keep pets out of the water until the lake re-opens.



In other very important news....

If you recall, last week, boater Jim shared his frustration with the floating stringy vegetation that had been getting tangled in his boat propeller all summer (see 8/18 entry). After circulating a photo, it was initially thought to be *Ruppia maritima*, or widgeon grass. This began a weekend plant ID “CSI effort” by an amazing (and entertaining) group of scientists dedicated to solving this mystery.

Apparently, other boaters had contacted Karin Strelieff at Thurston Conservation District about this plant. TCD shared the photo with Jeff Gaeckle at DNR prompting another DNR employee, Bart Christiaen, to run down to the Port (and Capitol Lake) to collect and photograph fresh samples. Jeff then delivered a sample to Patricia Johnson at WDOE. Wow, right? The conclusion? The plant appears to be *Stuckenia pectinata*, or **Sago Pondweed**. This species looks similar to Widgeon Grass, but the fruits look different and it lacks fused leaf sheaths, both of which were obscured in my original photo. Amazing work, Team!

Sago pondweed provides food and cover for many aquatic animals. All parts of the plant are important waterfowl food. The plant tolerates a wide range of conditions including brackish and/or nutrient-rich water. Patricia Johnson shared this helpful guide: [Introduction to Common Native and Potential Invasive Freshwater Plants in Alaska \(pdx.edu\)](http://pdx.edu).



PSI offers a new service!

Have you ever accidentally dropped anything off Port Plaza dock? If so, call PSI, or your Personal Search Investigators. A few weeks ago, a plankton net was accidentally dropped during one of our programs and sank to the floor of Budd Inlet. With the help of Saturday’s peak low tide, a GoPro, 15-foot pool pole and a rake, we performed a successful search and rescue effort!!! But the greatest surprise was a beautiful orange plumose anemone standing proud and tall beneath the dock.



It is hard to believe that today is the final week of this summer's "What's Blooming?" program. Over the next couple of weeks, we will compile and analyze this summer's data for the Final Report, which will include summary graphs of temperature, salinity, oxygen, pH, water clarity and HABs. We will add this final piece to the end of this report as well, so check back if you are interested.

While "What's Blooming?" is ending for the season, the plankton will "keep on keeping on" throughout the fall. PSI will continue sampling weekly for NOAA's SoundToxins program. If you have any questions about what you're seeing in the water, feel free to send us an e-mail.

Thank you, StreamTeam, for supporting another fun and informative "What's Blooming?" season!! We look forward to seeing everyone on the dock next year!



*Olympia High School students, Shriya and Colton, assisting with sampling.
Thank you for your help! Photo: Michele Burton*

August 23, 2021 – Budd Inlet, Port Plaza – Still Closed to DSP!

This evening's SoundToxins sample was shared with Northwest Youth Corps "kids" at Capitol Land Trust's Inspiring Kids Preserve. These kids spent all day carving out a beautiful trail to be used for K-12 environmental education. The sample was incredibly diverse and full of a diverse mixture of diatoms, dinoflagellates and zooplankton. *Ceratium fusus* dominated the sample, but the copepods, rotifers and polychaete larvae stole the show. The most exciting surprise was an **anemone larva**!! *Noctiluca* were also Common, so the kids were excited to watch the bioluminescence come night fall. So cool! Thank you for your incredible work, kids!

YSI data:

	Surface	1.5m	3m
Temp (°C)	17.8	16.4	16.1
Salinity (ppt)	28.92	28.92	28.98
Oxygen (mg/l)	4.50	4.41	4.67
pH	7.64	7.67	7.72

Secchi disc: 4.7 meters

Number of Species: 39

Blooming Species: *Ceratium fusus*

Common Species: Dinoflagellates (*Noctiluca*, *Scrippsiella*, *Protoperidinium*); Diatoms (*Actinoptychus*, *Cylindrotheca*, *Nitzschia acicularis*)

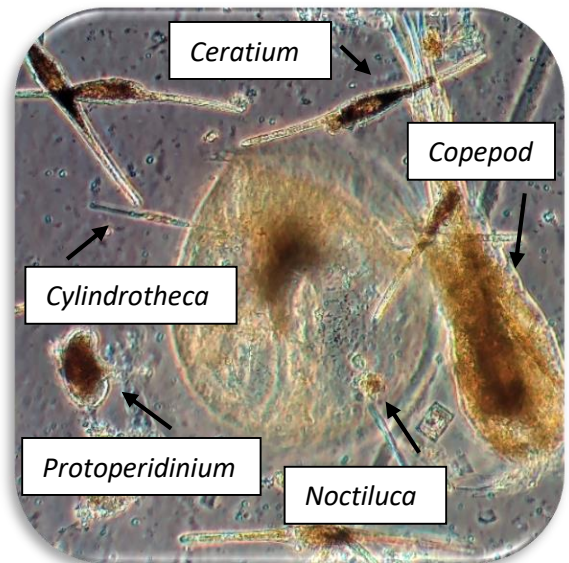
Zooplankton: (crustacean nauplii, larvaceans, tiarina, rotifers, tintinnids, polychaetes, bivalves, anemone, copepods)

HAB Species:

Dinophysis (Present) – 119 cells/L: a mix of *D. acuminata* (65%), *D. fortii* (20%), *D. parva* (10%), *D. odiosa* (5%).

Pseudo-nitzschia – (Present) – 536 cells/L

Akashiwo sanguinea (Present) – 6 cells/L.



August 18, 2021 – Budd Inlet, Port Plaza – Still Closed to DSP!

The weather was in the low 70s this afternoon – a blissful day for sampling. Before we dive into “What’s Blooming?” and some seasonal HAB summaries, let’s talk about this mystery plant/algae! While it was present last year in early August, it seemed worse this year and has been the nemesis of boaters – getting tangled in their props. After circulating this photo, Stephanie Bishop’s team response from Noll Steinweg (WDFW) seems to be a close match: widgeon grass, *Ruppia maritima*.

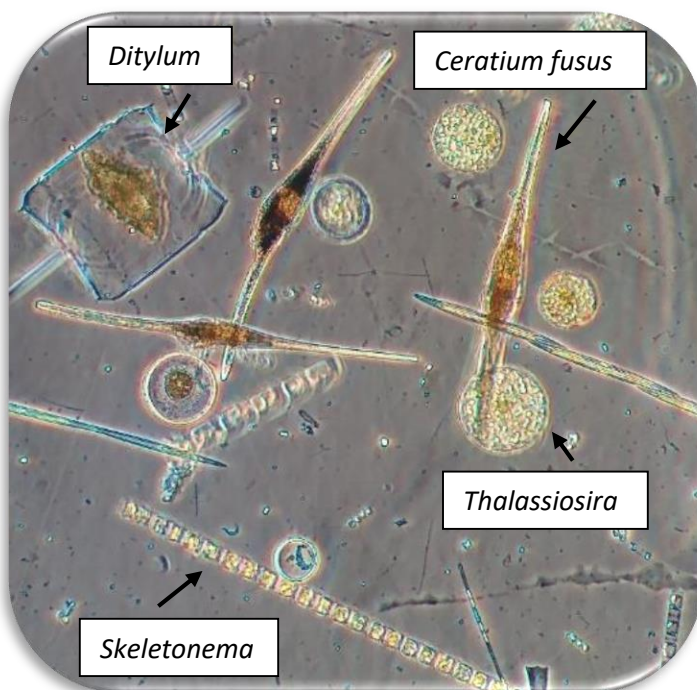
The plankton community composition has been completely changing from week to week recently. During the 1st week of August, the plankton was dominated by *Akashiwo*. Last week, visibility dramatically improved (2.4 meters to 4.5 meters) and *Akashiwo* were replaced by *Ceratium fusus* and the diatom *Skeletonema*. This week, diatoms have taken center stage including *Pseudo-nitzschia*,



Could this mystery plant be our native widgeon grass?
<http://biology.burke.washington.edu/herbarium/image/collection/taxon.php?Taxon=Ruppia%20maritima>

Skeletonema, *Chaetoceros*, *Thalassiosira* and many others.

The plankton composition changes in response to its surrounding environment. The transition from dinoflagellates to diatoms often takes place when strongly stratified, or layered, waters dissipate (usually at the onset of fall or after a storm). Dinoflagellates thrive under stratified conditions. During the 1st week in August, there was a 7.6°C difference between temperatures measured at the surface (23.2°C) and at 3-meter depth (15.6°C). During the 2nd week, this difference dropped to 2.6°C. The cooling surface temps were in response to cooler weather overall. These conditions, in addition to some

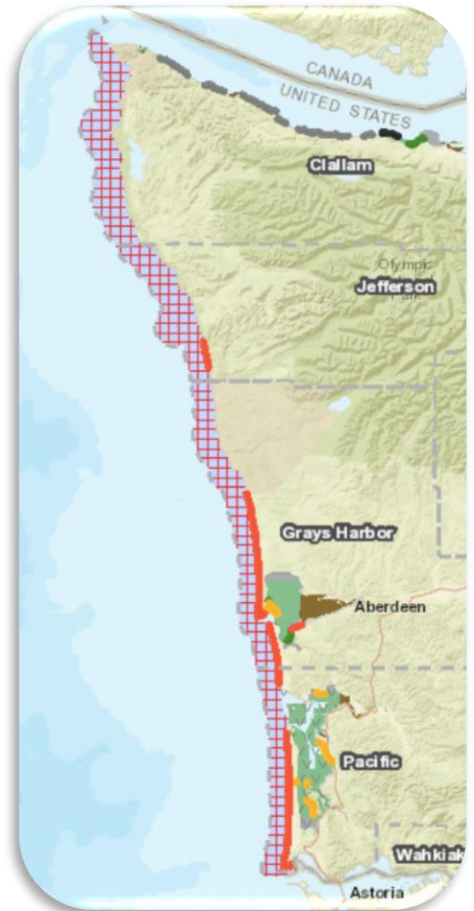


While some dinoflagellates like *Ceratium* remain, diatoms certainly dominated this week.

extremely short-lived rain showers, likely provided a pulse of nutrients to Budd Inlet supporting the rapid proliferation of diatoms.

Pseudo-nitzschia, the HAB species responsible for Amnesic Shellfish Poisoning (ASP), was one of the blooming diatoms this week. Its concentration jumped from 100 to 300 to **10,000 cells/L** over the last 3 weeks! Is this a big bloom? According to our archives, cell concentrations have exceeded 10,000 cells/L twice since 2013 – 22,000 cells/L in 2015 and 18,500 in 2020.

Interestingly, while *Pseudo-nitzschia* is quite common in south Puget Sound, it rarely, if ever, produces biotoxin. This is definitely not the case for the outer coast where shellfish closures due to ASP are unfortunately quite common. In fact, the entire coast is currently closed to shellfish harvesting due to this biotoxin (red hatched area on the map).

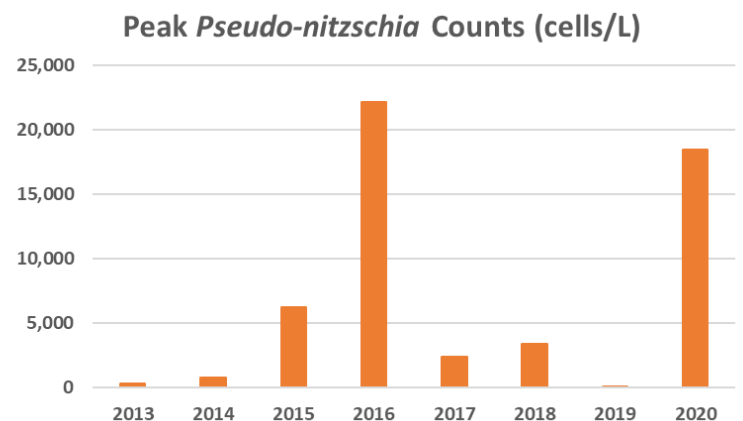
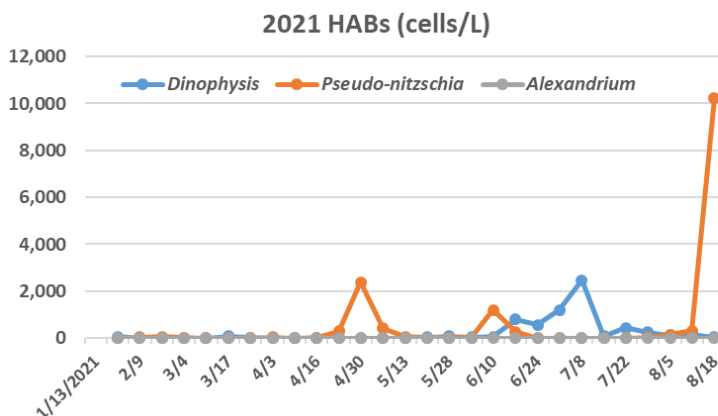


WDOH's Washington Shellfish Safety Map, 8/19/21.

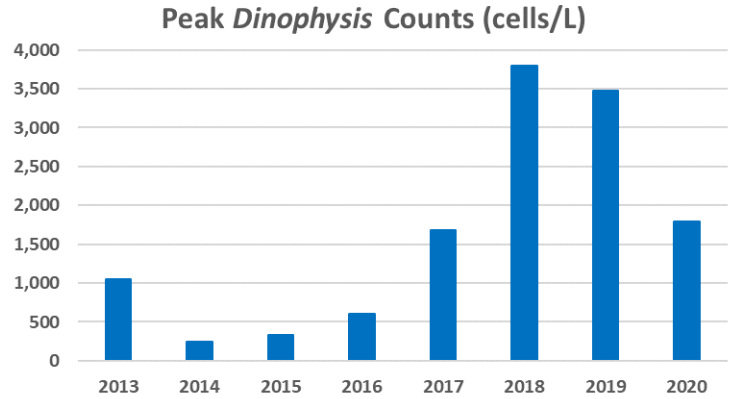


	Surface	1.5m	3m	4.5m
Temp (°C)	20.0	17.4	16.3	15.8
Salinity (ppt)	21.62	28.58	28.90	28.93
Oxygen (mg/l)	7.38	5.68	3.74	2.66
pH	7.92	7.86	7.74	7.68

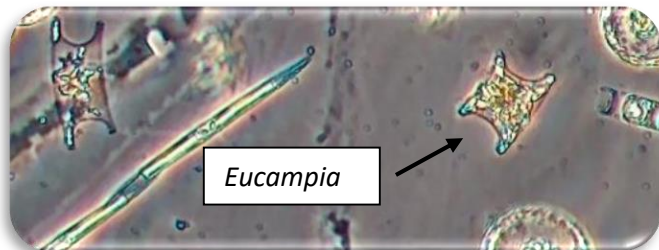
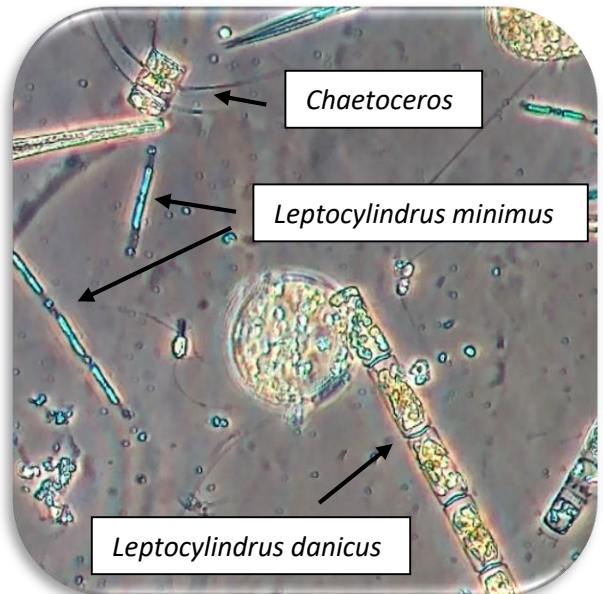
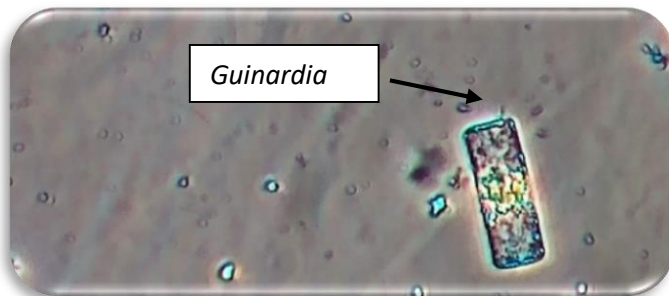
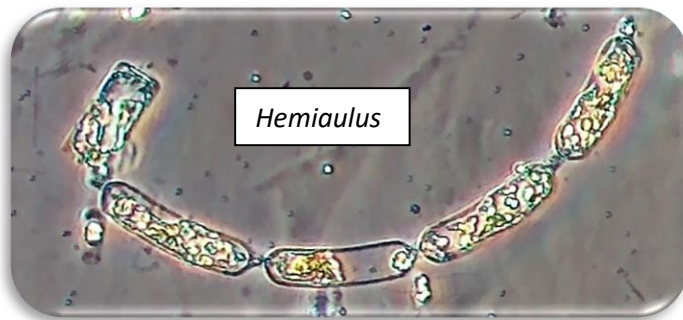
← This week's YSI data...



Speaking of HABs, Budd Inlet remains closed to harvesting (since July 12th) due to the DSP closure. This summer's data provided valuable clues about DSP closures. After the June 28-29 heat wave, *Dinophysis* counts spiked to 2,476 cells/L on July 8th. A closure immediately followed. Since 2013, archived data indicates that cell counts have been higher in both 2018 and 2019 (3,500 cells/L+). These blooms, however, did not result in closures. What was different about this year's bloom? The species! This summer, the toxic bloom was comprised of *D. fortii* and *D. acuminata* as opposed to *D. norvegica*. In fact, *D. fortii* has been blooming during every DSP closure since 2013...if I'm going to point fingers...and I am! 😊



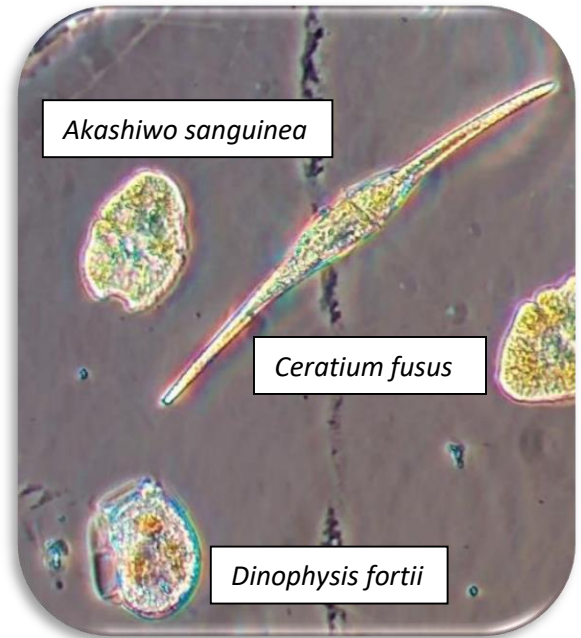
Next week is the last week of the "What's Blooming?" season – hard to believe! We'll be sampling at Long Lake! Check back to discover what microscopic critters you're swimming with!



August 11, 2021 – Budd Inlet, Port Plaza – Still Closed to DSP!

Thank you Evie, Rachel and Mary for covering for me while I enjoyed some vacation time! The PSI crew was once again joined by campers from Olympia Yacht Club’s sailing program. Thank you, kids, for collecting data!

Visibility was much better this week at 4.5 meters. The *Akashiwo sanguinea* bloom had dissipated and was replaced by a *Ceratium fusus* bloom. These two species are often found together throughout many south Puget Sound inlets during the summer and into fall. Also blooming was the diatom, *Skeletonema*. Over 30 additional species were noted on the SoundToxins data sheet (thank you, Mary!) including the following zooplankton: rotifers, tiarina, tintinnids, crustacean nauplii and larvaceans.



	Surface	1.5m	3m
Temp (°C)	19.9	18.3	17.3
Salinity (ppt)	21.82	27.89	28.73
Oxygen (mg/l)	3.98	5.08	3.91
pH	7.61	7.75	7.72

I hope this improves! Seems low for a surface measurement. May indicate a more “mixed” column.

Secchi disc: 4.5 meters **Number of Species:** 30

Blooming Species: *Ceratium fusus*

Common Species: Dinoflagellates (*Akashiwo sanguinea*); Diatoms (*Skeletonema*)

Zooplankton: (crustacean nauplii, larvaceans, tiarina, rotifers, tintinnids)

HAB Species:

Dinophysis (Present) – 161 cells/L: a mix of *D. acuminata* (48%), *D. fortii* (44%), *D. acuta* (4%), Other (4%).

Pseudo-nitzschia – (Present) – 310 cells/L

Protoceratium reticulatum (Present) – 119 cells/L. Species of concern due to production of yessotoxin.

Akashiwo sanguinea (Common) – 298 cells/L. Species of concern due to association with shellfish mortality events.

August 17, 2021 – Woodland Creek Community Park, Lacey

No. Woodland Creek Community Park does not have a swimming hole. It is, however, home to 2 bodies of water – Longs Pond and Woodland Creek – that should make an interesting plankton and water quality comparison. Longs Pond offers fishing year-round and hosts the annual Family Fish-In every April. Boating and swimming are prohibited. The pond also has a new fishing dock! If you’ve ever wondered what happened to the dock at Long Lake, wonder no more. It was re-located to Longs Pond in 2019.

City of Lacey StreamTeam and dedicated volunteers have worked together to dramatically improve habitat and water quality conditions at the park. To this end, they have planted, watered and mulched trees and vegetation along the banks of Woodland Creek. In 2013, the City of Lacey constructed an [Aquifer Recharge Enhancement Area](#) in the southwest corner of the park, increasing creek flows to improve dissolved oxygen levels, temperatures and habitat for Chinook salmon. The City has also installed pet waste stations throughout the park.

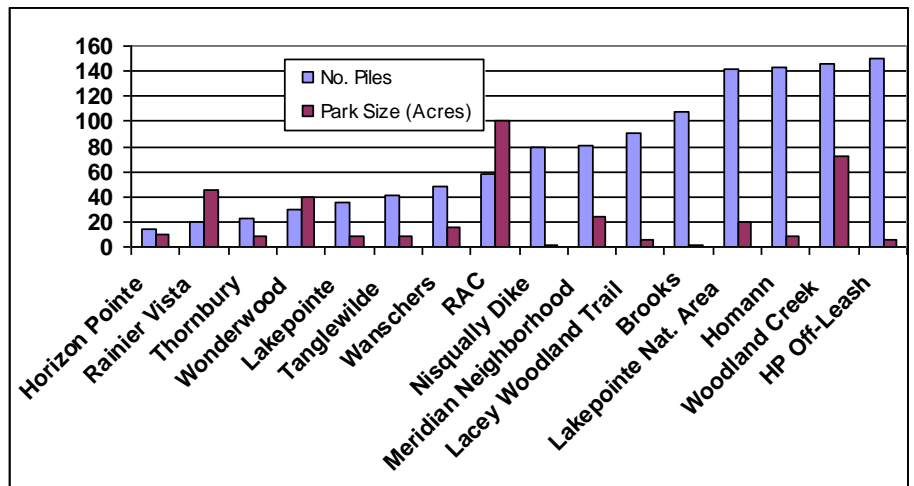
A decade ago, pet waste was a significant problem at Woodland Creek Park. In 2011, PSI conducted the Scoop-to-Win campaign to promote responsible scooping behaviors, survey parks for poop piles and reward individuals observed cleaning up after their pets. During the 1-month campaign, PSI surveyed 16 locations within the Henderson Inlet/Nisqually shellfish Protection Districts **scooping over 1200 piles of dog poop totaling more than 125 pounds.**



Plankton samples from Longs Pond (left) and Woodland Creek (right).



Poop piles flagged along the banks of Woodland Creek during the Scoop to Win campaign, Sept. 2011.



Unfortunately, Woodland Creek Park earned 2nd place in the “Poopy Shoe” award with 143 piles of poop being flagged in just the southern portion of the park. Most piles were in close proximity to Woodland Creek that flows into Henderson Inlet. At the time, the southern fields were used as an unofficial off-leash dog park and have since been converted into a nine-hole disc golf course.



Today, my daughter and I flagged and scooped 33 piles of mostly desiccated poop (quality time!). This was an **incredible** improvement since the last survey! The park was teeming with both dog walkers and disc golfers – both enjoying the park in harmony. Almost all dogs were on-leash and almost all owners had bags responsibly affixed to their leashes. We passed out “Bags-On-Board,” or BOBs, to those that wanted them. One disc-golfer stopped to share how he helped mulch and water the Christmas trees that were replanted throughout the park through the City’s “live” Christmas tree program. How wonderful!!

Let’s take a look at the water! Samantha and I sampled at Longs Pond first. We sampled from the end of the fishing dock where the water depth was only 1.3 meters (4-ft). The secchi disc, which measures water clarity, disappeared at 0.25 meters, or 10 inches!!! What?!!! So much plankton! Temperatures were very warm and the oxygen and pH were elevated due to the hordes of photosynthesizing algae. Oxygen levels decreased slightly to 8.4 mg/l off-bottom, but remained nice and high.

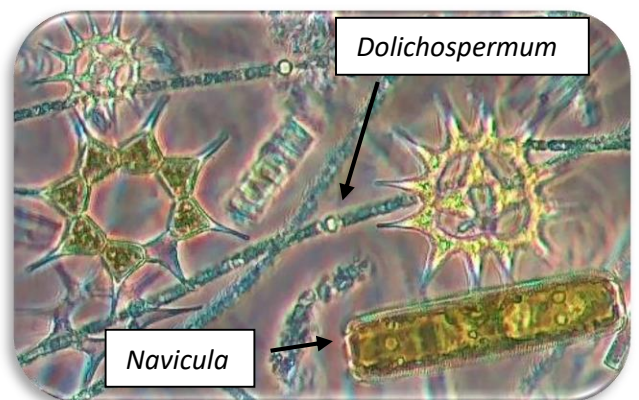
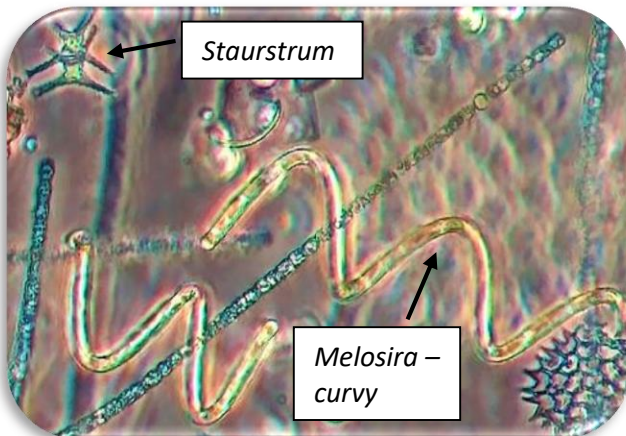
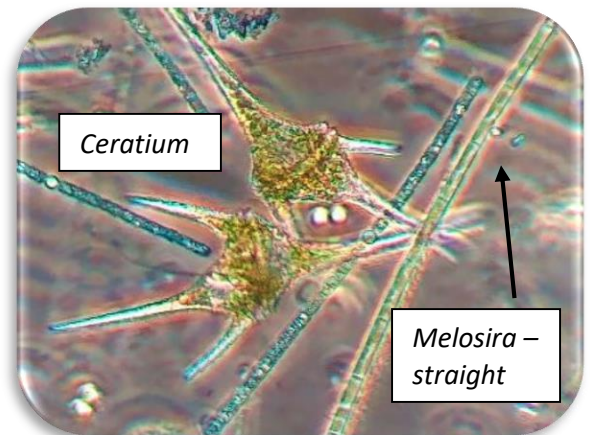
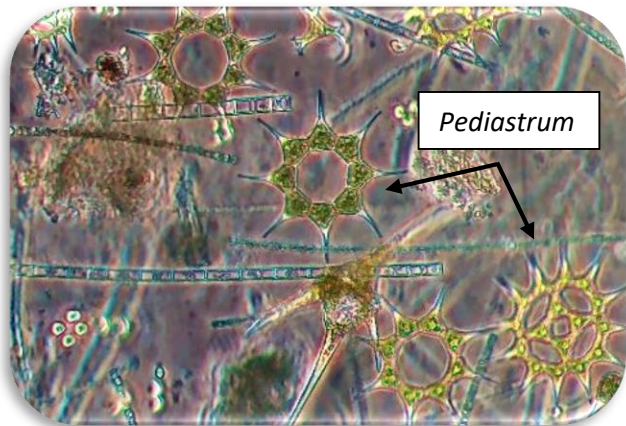
	Longs Pond	Woodland Creek
Temp (°C)	23.9	20.7
Salinity (ppt)	0.05	0.07
Oxygen (mg/l)	9.2	1.6
pH	9.7	7.8



Sam collecting the plankton sample, Longs Pond.

Woodland Creek was very shallow – approximately 6-8 inches – and only slightly cooler at 20.7°C. Samantha sampled from the middle of the creek where flows were slow, but moving. What was surprising was the incredibly low oxygen concentration at 1.6 mg/l! We moved the YSI probe to the center of a green algae mat growing along the banks and the oxygen level jumped to 10.6 mg/l!!! Fascinating. Next, we submerged the plankton net and allowed water to flow through it for 2-minutes. The resulting plankton sample remained fairly clear. So, what’s blooming?

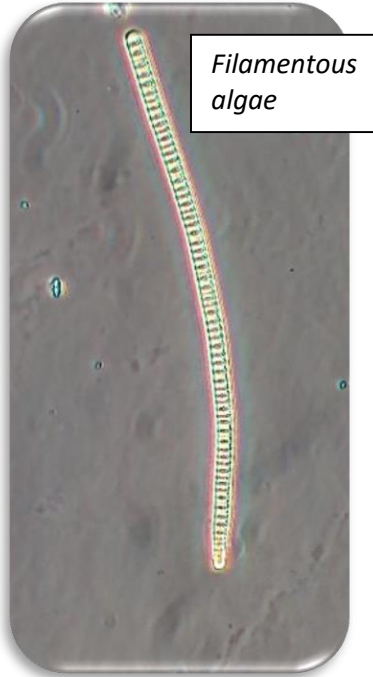
In Longs Pond, *Pediastrum* (bike cogs!) were blooming in many different shapes and sizes. Also mixed in was *Melosira granulata* (both in spiral and straight form), and *Dolichospermum* as well as *Ceratium*, *Scenedesmus*, *Staurastrum*, *Navicula*, Rotifers and Cladocerans. Many of these species belong to the Chlorococcales Order, or the “Greens,” hence the green coloration of the water.



Woodland Creek plankton, on the other hand, were sparse. Of the species observed, many were *Euglena*, a green protest. Small pennate diatoms and the larger *Synedra* were present as well as a few round dinoflagellates...perhaps *Gymnodinium*. Narrow filaments as well as the larger *Spirogyra* were found in small numbers. Overall, a very quiet assemblage.



Euglena



Filamentous algae



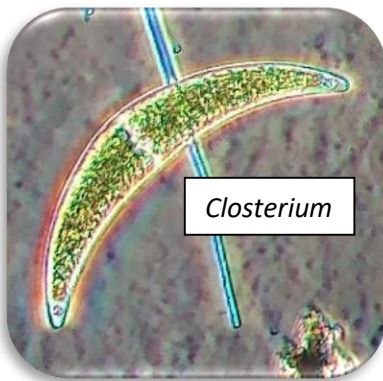
Spirogyra



Dinoflagellate



Small pennate



Closterium



Synedra

Woodland Creek Park is such a great asset to the community. Folks of all ages were here today walking dogs, throwing discs, celebrating birthdays, barbecuing, playing at the playground and walking the trails. The City has done a commendable job improving habitat along Woodland Creek and educating the public about the importance of cleaning up after their pets. Thank you to all the volunteers who continue to care for this wonderful park. Now, if we could just get those geese to use the restrooms! 😊

August 5, 2021 – Budd Inlet, Port Plaza – Still Closed to DSP!

This week, I was joined by Evie – PSI’s book-keeper, field and lab biologist and all-around helpful cohort. Evie and Mary Middleton will be taking over next week while I am away on vacation. Thank you! So, this week’s focus is on training, both on the dock and in the lab.

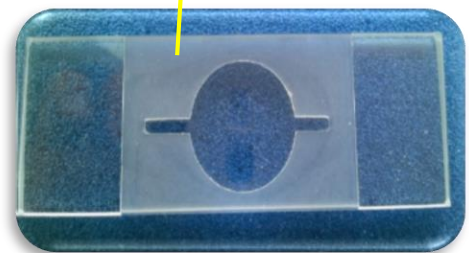
Turns out, it became a training for 8 young scientists that quickly and enthusiastically (!!) jumped in to help collect data and identify microscopic critters.

This would also be a nice time to pause and reflect on why we are doing the “What’s Blooming?” sampling (besides the fact that it’s ridiculously fun and interesting!). This year marks the **10th year** of the “What’s Blooming?” program!! Yahoo! We now have 10 years of consistent water quality and plankton data for Budd Inlet allowing us to begin detecting trends and patterns. The program connects us to our watershed and supports NOAA’s SoundToxins phytoplankton monitoring program.

The goal of SoundToxins is to provide warning of harmful algal blooms (HABs) to minimize risks to human health and economic losses to fisheries. Data help determine which environmental conditions promote blooms and which can be used for early warning of HAB events. The program has grown over the years and now includes over 35 Puget Sound sites managed by academic institutions, tribes, community groups, government agencies, and shell(fish) interests. PSI manages the lower Budd Inlet site. The Evergreen State College (Gerardo Chin-Leo) manages Boston Harbor. Sampling is performed weekly and bi-monthly (off-season).



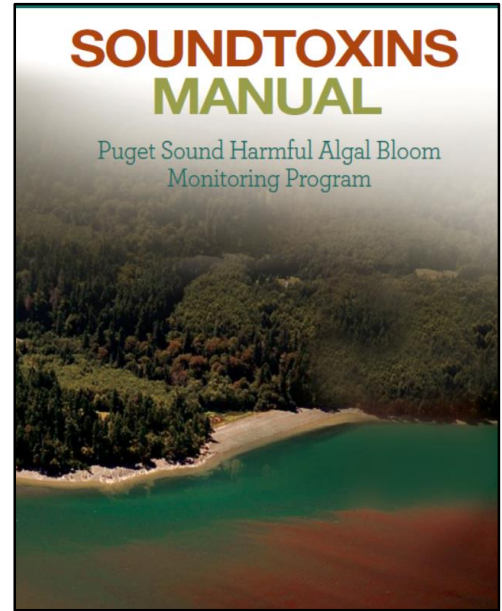
PSI's Olympus Inverted Microscope



This Palmer-Maloney counting chamber holds 0.1-mls of water and is used to quantify HAB cells.

In a nutshell, we record information on the tide, weather, winds, water clarity, water temperature, salinity, dissolved oxygen and pH. We collect plankton samples – both a net tow and whole water sample – and perform cell counts for HAB species including *Alexandrium*, *Dinophysis*, *Pseudo-nitzschia*, *Heterosigma*, *Akashiwo*, *Phaeocystis* and *Protoceratium*. Data is entered into the SoundToxins database and any “Alerts” are immediately reported to Washington SeaGrant who immediately notifies WDOH and other appropriate entities.

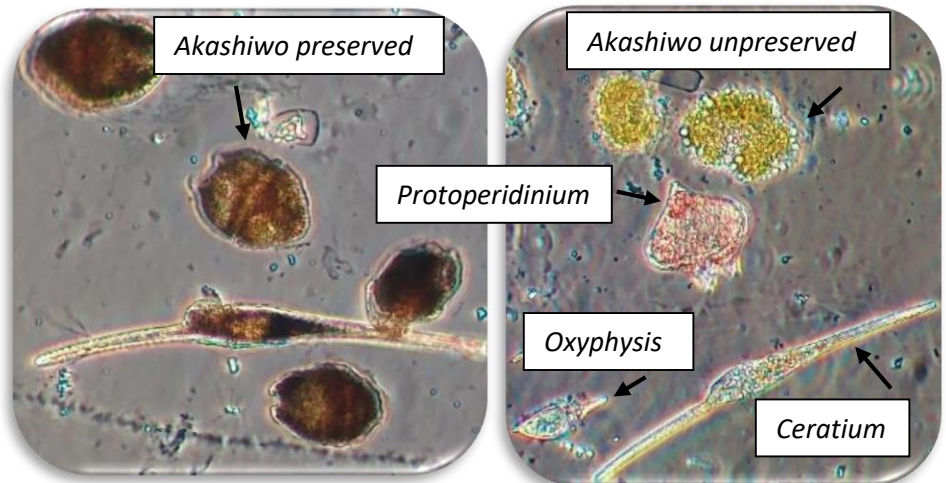
Visit www.soundtoxins.org to learn more. If you dive into the site, you will also find the [SoundToxins Manual](#) in its entirety. Check it out! The manual includes great information and photos!



What’s Blooming in Budd today? The dinoflagellate, *Akashiwo sanguinea*, continued to dominate the plankton community. Other species were common including the dinoflagellates *Ceratium fusus*, *Noctiluca*, *Prorocentrum*, and *Protoperidinium*; and the diatoms *Cerataulina* and *Leptocylindrus*. Zooplankton such as copepods, polychaete worms, bivalve larvae, tiarina, larvaceans and rotifers were also present, although quite sluggish in this heat.

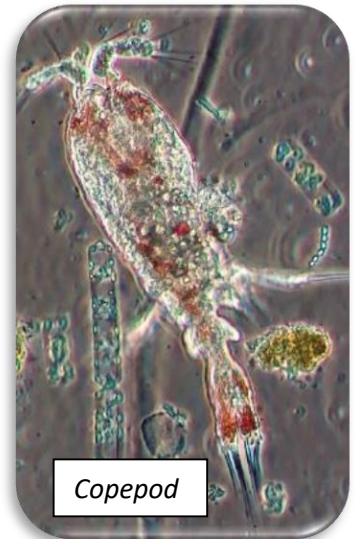
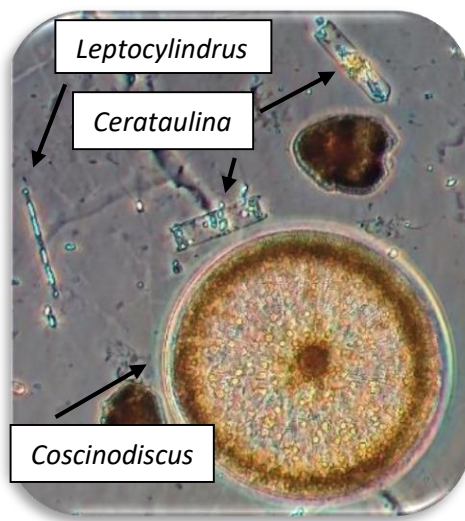
Did you notice that most of the plankton photographs are a dark brown/orange color this week? The cells were immediately preserved in an iodine solution called Lugols. This preservative is preferred because it’s less toxic than formalin (formaldehyde based), however it masks some identifying characteristics such as color or plate patterns. The weather has been so hot lately, that the *Akashiwo* have been completely degraded by the time they reach the lab, despite being kept on ice. This reason has to do with plates.

Most dinoflagellates’ cell walls are made of cellulose plates (like the pink *Protoperidinium*). If plates are present, the cells are armored. If plates are absent (like *Akashiwo*), the cells are unarmored...or

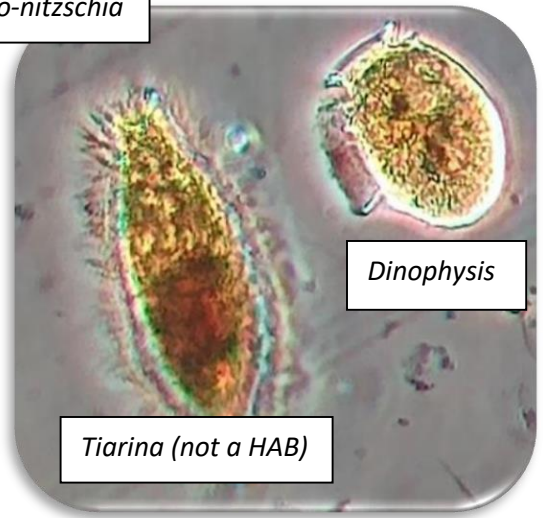


Unarmored Akashiwo cells immediately preserved in Lugols (left); Akashiwo cells not preserved after 15 minutes in heat (right). The pink Protoperidinium, Oxyphysis and Ceratium are armored and remain completely intact.

naked! The naked *Akashiwo* cells simply don't hold up in the heat and quickly turn to "mush."
 Here are a few species noted from today's sample....



And the Harmful Algal Bloom species (HABs)



And the YSI data.... (Super warm temps near the surface and very low oxygen levels at depth)



	Surface	1.5m	3m	4.5m
Temp (°C)	23.2	17.8	15.6	15.4
Salinity (ppt)	19.96	27.81	28.83	28.81
Oxygen (mg/l)	10.7	7.3	2.9	2.4
pH	8.2	8.1	7.8	7.6

July 29, 2021 – Ward Lake, Olympia, WDFW Access

If you want to know which lakes have the best water quality, look for open water swimmers! Three swimmers were coming out of the water when I arrived at 10 AM. One noted that the water is so clean this year, he doesn't even need to shower afterwards. A second swimmer, Tom St Clair, a science teacher at Black Hills HS, asked me to check the water's temperature – guessing it to be 24°C. He nailed it! Swimmers are an impressive bunch.

Ward Lake is a 65-acre deep glacial depression, or kettle, fed by groundwater with no surface inlet or outlet. Unlike Deep Lake, this lake is actually deep reaching 67 feet at its deepest point. The lake is a popular destination for paddlers, swimmers and anglers. WDFW routinely stocks the lake with rainbow trout, but bass and even kokanee are reportedly found here.

If you frequent Ward Lake, you have likely noticed five flagged buoys spaced around the lake. After months of curiosity, I finally e-mailed WDFW to find out what they are for. According to Riley Freeman, South Puget Sound Fish Biologist with WDFW, *“the buoys are marking acoustic receivers that were deployed to track the movement of tagged rainbow trout that were stocked back in April. The primary goal of this study is to assess any possible differences in behavior and catch rates of diploid versus triploid rainbow trout in stocked lakes. We plan to leave the receivers in Ward for another few months to continue listening to the pings of the remaining trout to see what they do and where they go in the lake during the warm summer season.”* In other words, Riley Freeman knows where all the fish are! Ha! 😊

If you catch a trout, you are asked to report your catch so that it will be included in the study. Look for belly stitches to determine if the fish has a tracking tag and note if it is diploid (unclipped adipose fin) or

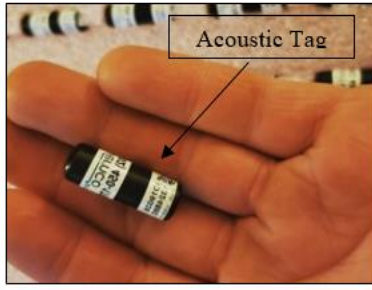
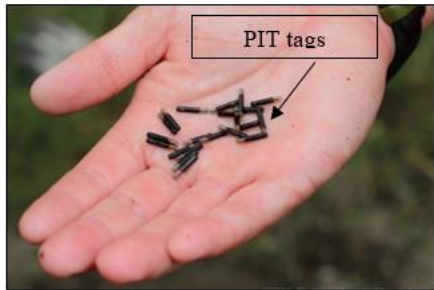
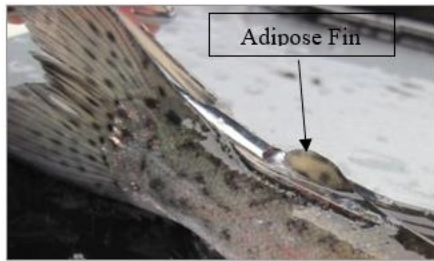


Shriya measuring water clarity with the secchi disc.



WDFW Research buoys for tracking trout movement throughout the lake.

triploid (clipped adipose fin). To report, contact WDFW @ (360) 280-1762 or use the Angler Reporting Tool link: <https://waregion6reportingtool.shinyapps.io/AnglerReportingTool/>



Shriya and I paddled out to the same location that Michelle Stevie and I sampled last year on July 23rd, 2020. We lowered the YSI probe and noted that the temperature was almost 3°C warmer this year. At 11 AM, the surface temperature was 25.3°C, or 77.5°F. Last year, gray clouds filled the sky and the water temperature was 22.4°C. We noted a distinct thermocline between 4.5 – 6.0-meter depth where the temperature quickly

Images provided by WDFW and posted on the kiosk at Ward Lake.

dropped to 13.1°C (11.5°C off-bottom). Dissolved oxygen levels were a touch over 8 mg/l in the upper 10 feet, bumping up slightly near the thermocline suggesting that the dinoflagellates and other plankton might be perched on this layer. Oxygen levels dropped sharply off-bottom (2.0 mg/l) due to bacterial decomposition.

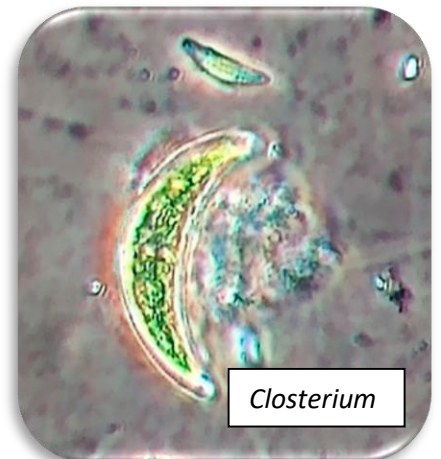
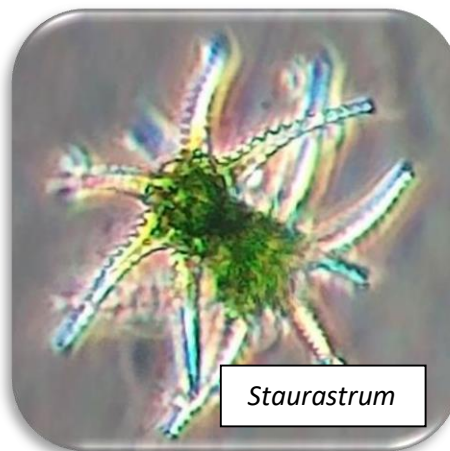
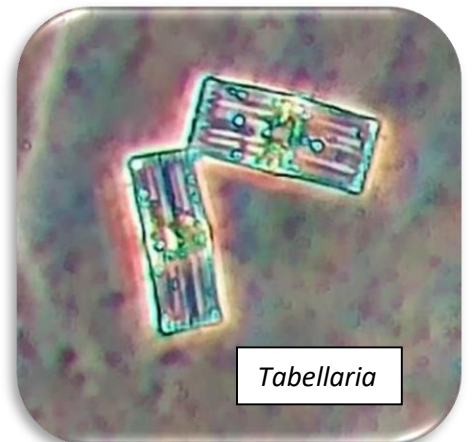
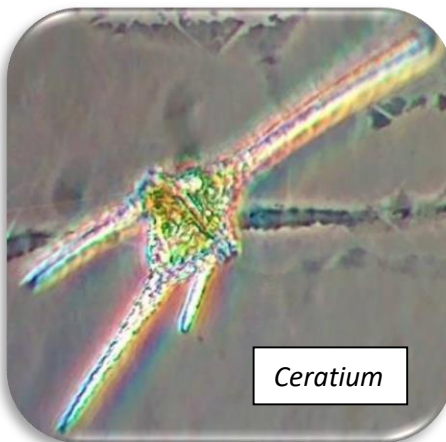
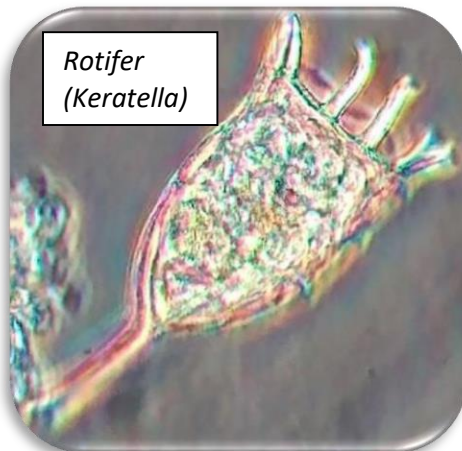
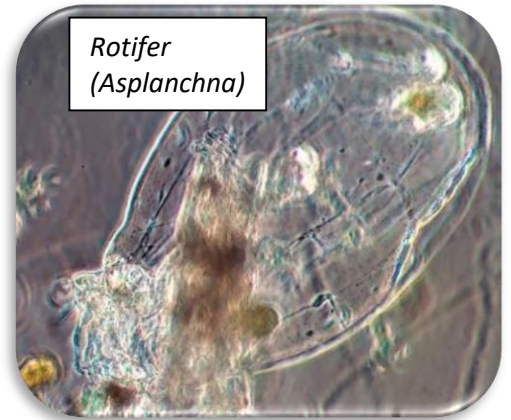
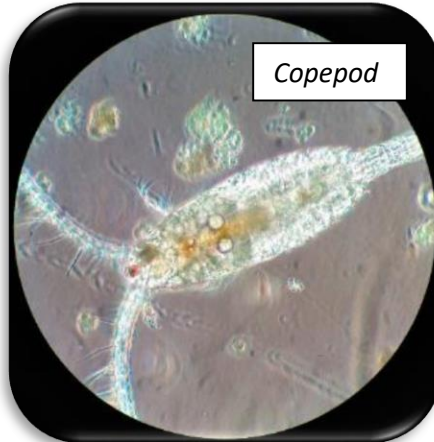
	Surface	1.5m	3m	4.5m	6m	7.5m
Temp (°C)	25.3	25	24.9	21.9	13.1	11.5
Salinity (ppt)	0.01	0.01	0.01	0.01	0.01	0.01
Oxygen (mg/l)	8.3	8.3	8.1	10.5	10.0	2.9
pH	7.9	7.8	7.7	7.6	7.6	6.9

Water clarity (secchi disc reading) was high at 5.6 meters, or 18 feet. Even after towing the plankton net behind the boat for a minute, the sample was still practically clear. Similar to last year, the sample was dominated by small rolling dinoflagellates – a combination of golden colored *Gymnodinium* and *Peridinium*. The golden chloroplasts producing valuable oxygen via photosynthesis. Every once in a while, a



rotifer (3 species observed), copepod, or cladocera would dart across the slide – delicious fish food! Other species were certainly present, but sparse throughout the sample.

If you're looking for a great place to swim look no further! Come swim among the tagged rainbow trout. I look forward to learning the results of this interesting local research!



July 28, 2021 – Budd Inlet, Port Plaza – **Still Closed to DSP!**

Thank you Olympia Yacht Club campers for sailing over to help sample for SoundToxins this week! What a great team! Our nets clogged quickly, were streaked with orange, and felt super slimy due to the *Akashiwo sanguinea* bloom. When one species almost entirely dominates the sample, it's called a **monospecific bloom**. That's what we had!!! We did observe some other dinoflagellates and zooplankton swimming around in the sample, but it was mostly a sea of *Akashiwo*!

YSI data:

	Surface	1.5m	3m
Temp (°C)	22.1	18.9	16.1
Salinity (ppt)	25.08	27.33	28.75
Oxygen (mg/l)	10.4	11.3	7.1
pH	8.3	8.3	8.0

Secchi disc: 2.1 meters **Number of Species:** 30

Blooming Species: *Akashiwo sanguinea*

Common Species: Dinoflagellates (*Ceratium*, *Protoperdinium*, *Prorocentrum*); Diatoms (*Cerataulina*, *Leptocylindrus*)

Zooplankton: (*polychaete larvae*, *copepods*, *crustacean nauplii*, *larvaceans*, *tiarina*)

HAB Species:

Dinophysis (Present) – 256 cells/L: a mix of *D. acuminata* (74%), *D. fortii* (10%), *D. norvegica* (10%), Other (6%).

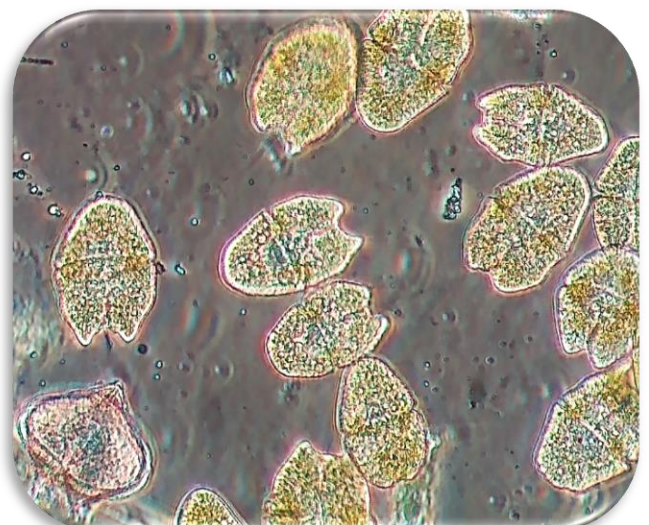
Pseudo-nitzschia – (Present) – 36 cells/L

Protoceratium reticulatum (Present) – 167 cells/L.

Species of concern due to production of yessotoxin.

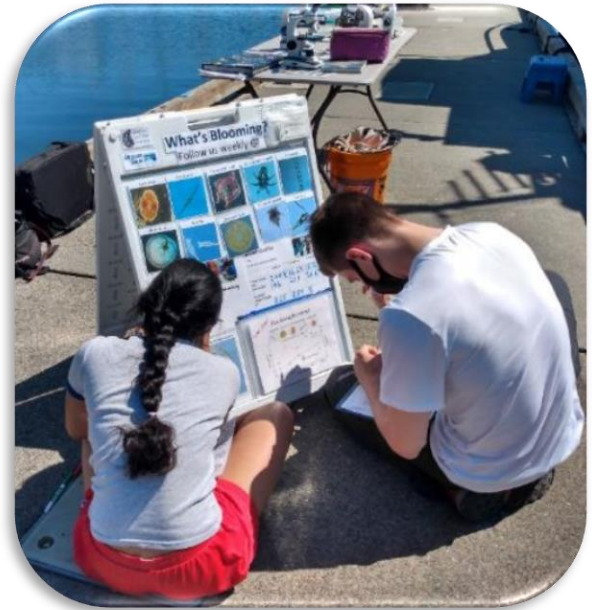
Akashiwo sanguinea (Blooming) – **41,429 cells/L.**

Species of concern due to association with shellfish mortality events.



July 22, 2021 – Budd Inlet, Port Plaza

What a fun afternoon! I was joined by two Olympia High School interns/volunteers, Shriya and Colton. They did a wonderful job collecting data, preparing the A-frame with photos and interesting information for the public, and stumping me with great questions. For example, how does the YSI instrument translate what the probes are measuring to the digital format displayed on the screen? No idea. Anyone want to chime in with that one?! E-mail me! I was also thrilled to have Michelle Stevie (City of Olympia Stream Team), Seren (our youngest scientist at age 4 ½!) and photographer Michele Burton along. Thanks for your help everyone!”

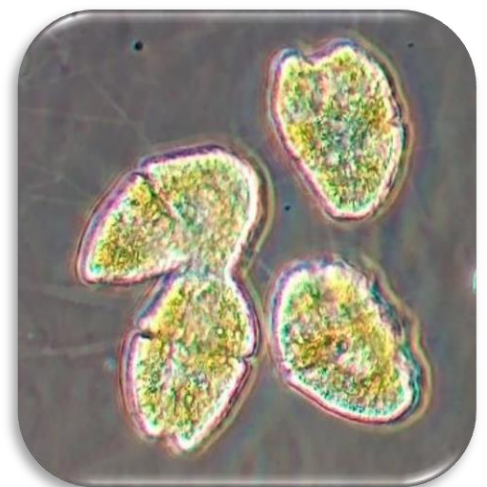


We used the YSI to sample from the surface all the way to the bottom today. If the oxygen level drops from 10.9 mg/l to 5.6 mg/l at 3 meters, you just HAVE to find out how low it gets off-bottom, right!? (It dropped to 4.4). At this time last year, oxygen levels were 4.6 mg/l at 3 meters, and then bounced back up a week later, so hopefully this is just a temporary drop.

And what was blooming?.....

AKASHIWO SANGUINEA....and lots of it!!! We also found quite a bit of *Ceratium fusus*, and *Protoperdinium* (the lovely pink one) in addition to 27 other species. But *Akashiwo* was clearly the front runner. Similar to last week, *Protoceratium reticulatum* was also present.

	Surface	1.5m	3m	6m
Temp (°C)	20.0	16.6	15.2	14.8
Salinity (ppt)	14.6	28.1	28.67	28.74
Oxygen (mg/l)	9.5	10.9	5.6	4.4
pH	8.7	8.5	8.1	8.2



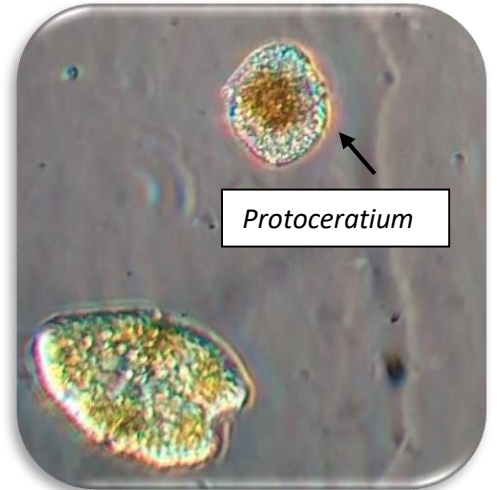
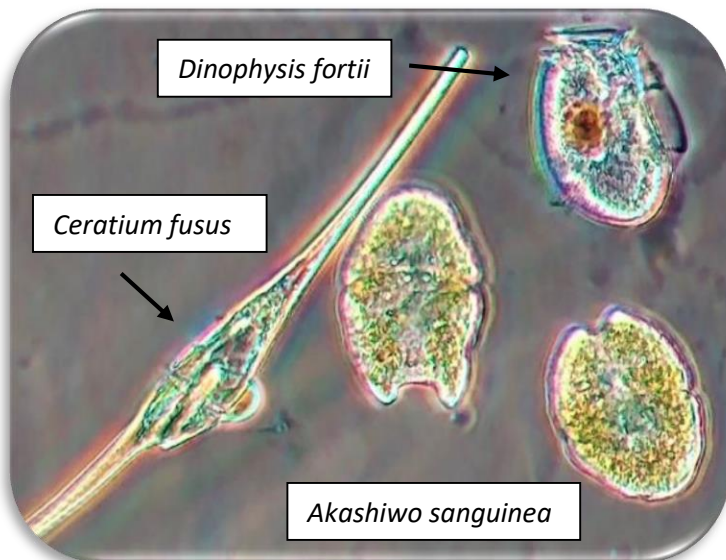
Akashiwo sanguinea – some actively reproducing by binary fission!

Given the presence of *Akashiwo* and *Protoceratium* this week, I would like to take this opportunity to highlight an article, [“Hiding in plain sight: Shellfish-killing phytoplankton in Washington State,”](#) published recently in the *Harmful Algae* journal (King, T. L. et al 2021). When we think of harmful algal blooms (HABs), we typically think of the phytoplankton that produce powerful biotoxins. These biotoxins can accumulate in

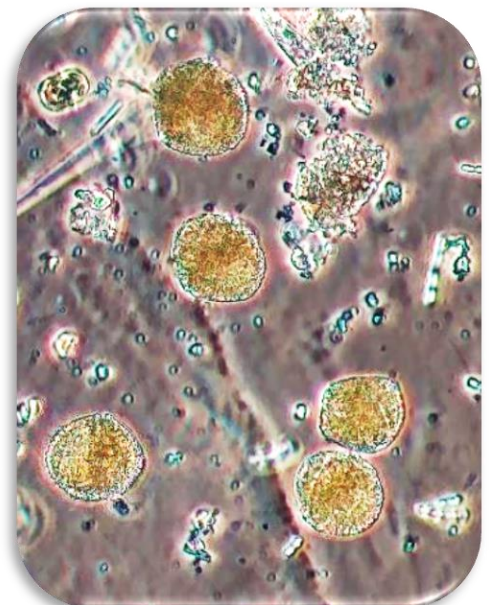
shellfish tissue making humans, and other mammals, very sick if ingested. These biotoxins tend to not harm the shellfish. Other HAB species, however, can result in harm (i.e. mortality!) to the shellfish themselves. The SoundToxins program began adding these species to the “Alert” list several years ago. These include *Protoceratium reticulatum*, *Akashiwo sanguinea* and *Phaeocystis*.

In this article, SoundToxins data was used to pinpoint very specific shellfish mortality events that coincided with blooms of *Protoceratium reticulatum* (yessotoxin producer) as well as *Akashiwo sanguinea* (surfactant producer). For example, in July, 2019, surfacing, gaping manila clams were observed in Rocky Bay, during a *Protoceratium* bloom resulting in the loss of 30% of the clam stock. Histology samples revealed extensive damage to digestive gland tissue – likely the result of yessotoxin exposure. Similarly, significant mussel mortality events were observed in 2010 and 2017 in Totten Inlet during extensive blooms of *Akashiwo*. Accounts of *Akashiwo* being associated with Olympia oyster mortality events date back as early as the 1930s.

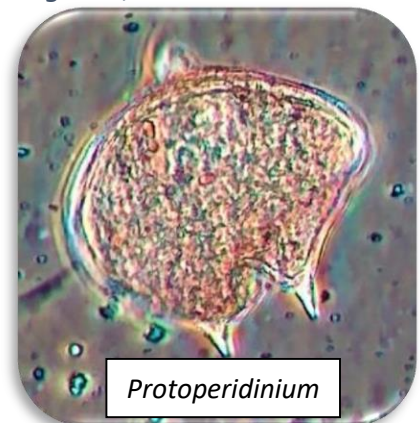
According to our “What’s Blooming in Budd?” data from July 22nd of last year, *Akashiwo* was Blooming, and *Dinophysis* and *Protoceratium* were Common. *Protoceratium* was Blooming by month’s end. Will *Protoceratium* bloom again this year? We’ll see! Either way, it’s fascinating that these species are beginning to display some annual trends. ☺



Akashiwo bloom & presence of *Protoceratium*, July 22, 2021.



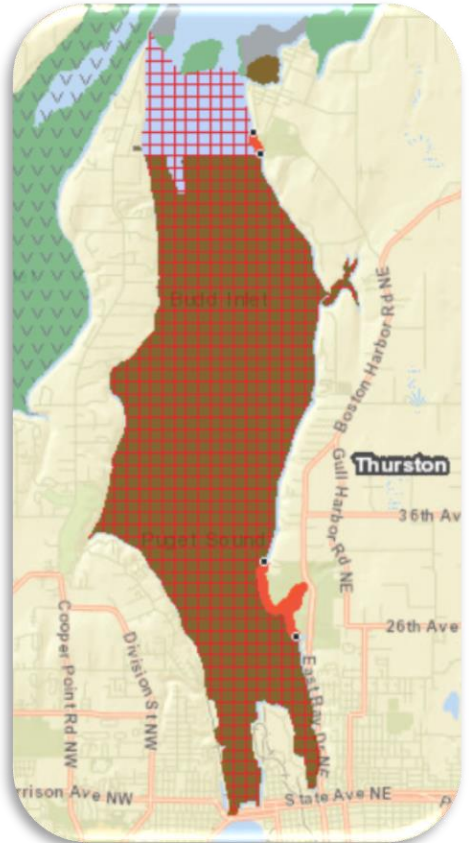
Protoceratium reticulatum bloom; August 5, 2020.



Another new development has taken place since our last Budd Inlet coverage on 7/8. First, WDOH **CLOSED** Budd Inlet to shellfish harvesting on July 12th due to elevated levels of DSTs (Diarrhetic Shellfish Toxins) in blue mussels. Shellfish measured 28 $\mu\text{g}/100\text{ g}$ tissue, exceeding the closure limit of 16. If you recall, *Dinophysis* cell counts had been doubling for 3 weeks straight. The *Dinophysis* species blooming at the time were *D. acuminata* and *D. fortii*. *D. fortii* is often observed during Budd Inlet biotoxin closures. Cell counts were moderate this week at 446 cells/L.

In other news...

What is the #1 item collected during International Coastal Cleanups? Did you guess cigarette butts? In case you missed it, Olympia Surfriders recently hosted a downtown cigarette butt cleanup event. Thank you Surfriders and all who attended! Cigarettes contain over 4,000 chemicals, including lead and arsenic. Butts are not biodegradable and over 90% contain plastic filters. I was sad to miss the cleanup and inspired to participate. So, Shriya, Colton, Michelle and I did a mini-cleanup at Port Plaza. We collected a whole container of butts in about 15 minutes! Once you get started, it's hard to stop. The more you look, the more you find. Thanks for the inspiration, Olympia Surfriders!



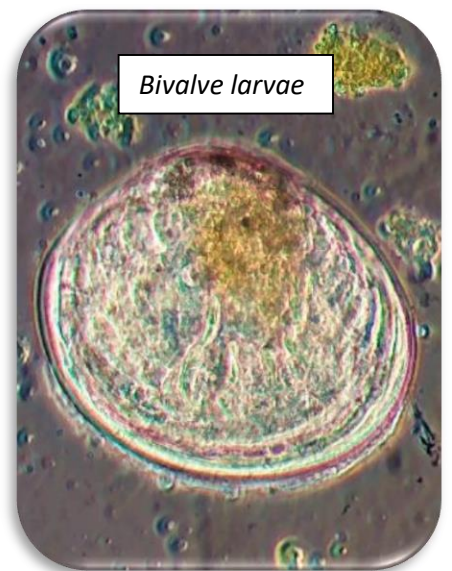
Red boxed area indicates a closed Marine Biotoxin Zone, Budd Inlet, July 22, 2021. WA Shellfish Safety Map



Butt Ugly!!



Melosira



Bivalve larvae

July 15, 2021 – Munn Lake, Thurston County



Munn Lake, Thurston County, June 22, 2020 (left) and July 15, 2021 (right).

This week, I planned on sampling at Barnes Lake – wanting to represent a lake in the City of Tumwater. However, after searching for an acceptable access site via Google maps and driving around the lake, I could only catch peek-a-boo glimpses of this lovely hidden lake. Instead, I sampled at Munn Lake. While technically in Thurston County, it is quite close to the Tumwater City limits – just a few blocks southeast of Pioneer Park and a rocks throw from tiny Susan Lake to its west. If you blink, you just might miss the WDFW Fishing Access sign.

Munn Lake is a 30-acre lake with an average depth of 19 feet. It was named after Edwin Munn, a dairy farmer in the early 20th century. The lake was surveyed in the late 90s and described as Eutrophic, or having high nutrient concentrations, abundant plant and algae growth, and low water clarity. It is popular for its year-round fishing. I spoke to 3 anglers today that were fishing for rainbow trout. The lake is also a common destination for open water swimmers and paddlers (both a swimmer and a gaggle of kayakers from Camp Waya were enjoying the lake today). The lake is typically peaceful and you're likely to spot a bald eagle or two.

Without dock access, I decided to do my "What's Blooming?" sampling by boat. I dragged my river kayak out of the shed disturbing a few large black spiders that scurried further into the boat. I was only able to relocate one, taking the remaining "passengers" with me. Not wanting

to drop any equipment into the water (I love spiders, but might panic if one crawls across my lap!), I used shoelaces to secure all of the equipment onto the boat.

I paddled out to the center of the lake and lowered the YSI into the water. The temperature was about 73°F in the upper 5 feet dropping to 59°F near the bottom. The dissolved oxygen levels were quite surprising! While oxygen was adequate in this upper layer (7.6 mg/l), it dropped to dangerously low levels near the bottom (0.7 mg/l)!!! I've never actually measured levels this low. Bacterial decomposition is certainly at play.

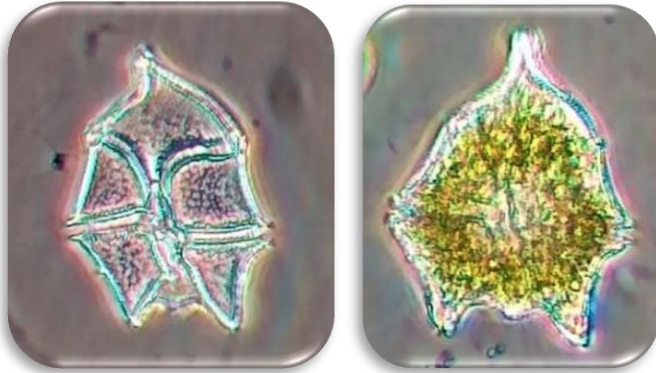
	Surface	1.5m	3m	3.5m
Temp (°C)	22.5	22.6	16.9	15.1
Salinity (ppt)	0.01	0.01	0.01	0.01
Oxygen (mg/l)	7.6	7.5	0.7	0.3
pH	8.4	8.2	7.4	7.0

Water clarity was low at 1.2 meters (~4 feet). This lake always appears dark in color. In fact, my kids won't swim here (their loss!) claiming the water is dark and creepy. Similar to Lake Saint Clair, I suspect the naturally dark color is due to tannins. But when I pulled the net through water, the plankton sample was bright green! The anglers and campers were quite surprised to see the water come to life under the microscope. In fact, you could even see tiny critters darting around the jar with your unaided eye. So, what's Blooming?!

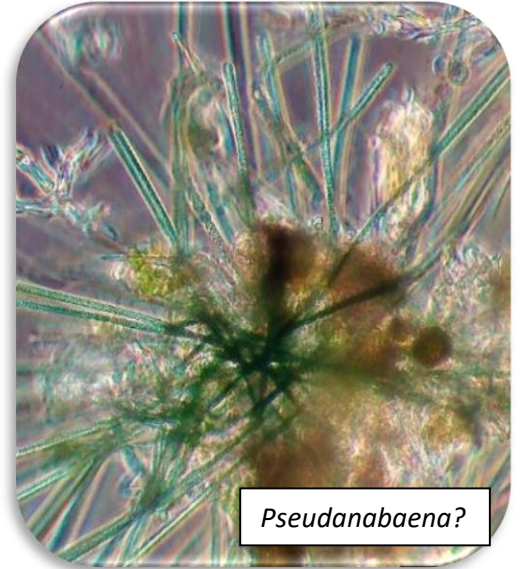
The golden orange dinoflagellates were the first to catch my eye. I have never seen a bloom of *Peridinium* before, but they were quite striking with their cellulose plates and horns.



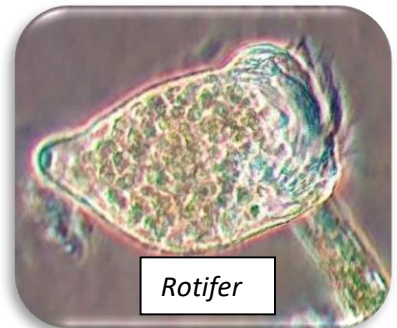
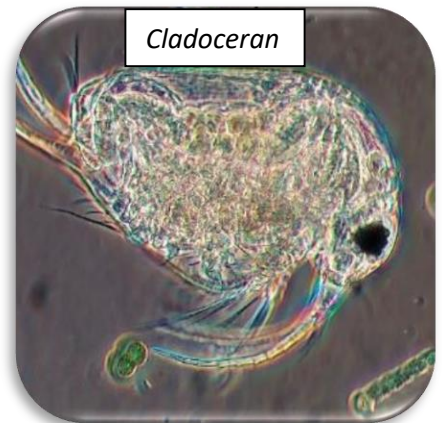
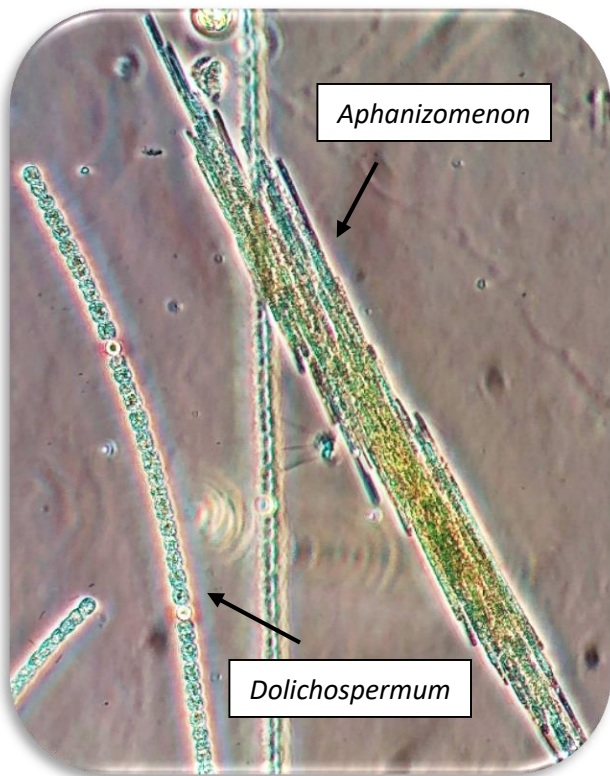
Secchi disc visible at 0.5 meters, disappearing at 1.2 meters (left); plankton net; green plankton (right)!



Peridinium limbatum - dead cell showing plates (left), live cell showing golden chloroplasts (right).

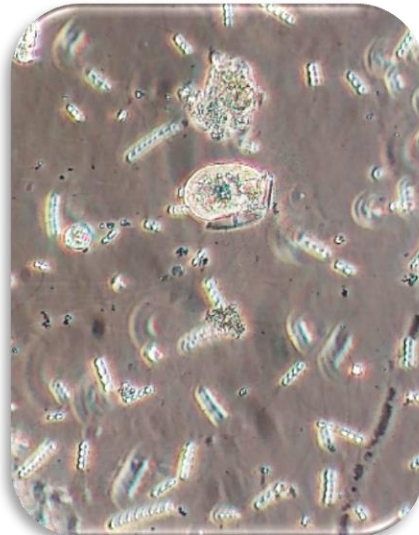


While the dinoflagellates *Peridinium* and *Ceratium* were plentiful, they didn't explain the green color. The color was instead caused by a skinny, long strands of filamentous green algae (maybe *Pseudanabaena*?). Strands of *Anabaena* (renamed *Dolichospermum*) were also common, in addition to *Aphanizomenon* – both of which are known to produce a suite of biotoxins including Microcystins, Anatoxin-a, Cylindrospermopsins and Saxitoxins. However, their presence today does not indicate that they are producing biotoxins. Water fleas, or cladocerans, were plentiful as well as copepods and multiple species of rotifers and ciliates. To view a 30-second video of this microscopic world, watch here: <https://youtu.be/iYLnnsqIcA>.



So many water fleas – so many compound eyes! As I often do after admiring plankton under the microscope, I returned the sample back to Munn Lake. Be free little ones!

July 13, 2021 – Budd Inlet, Port Plaza – Closed to DSP!



Secchi disc covered in macroalgae with surface scum along edge of dock (left). Small *Chaetoceros* sp. blooming (middle). Surface scum sample (right).

	Surface	1.5m	3m
Temp (°C)	22.1	22.5	21.7
Salinity (ppt)	13.41	20.53	26.88
Oxygen (mg/l)	11.61	11.94	14.31
pH	8.75	8.67	8.79

Surface water was unusually warm, even to a depth of 3m! At this time last year, the temperature was 19.2°C, up from 14.8°C.

Visibility was low, but the plankton sample did not appear orange, or thick, in color. Instead, the sample consisted of a bloom of very small *Chaetoceros*. Despite their small size, oxygen levels and pH were significantly elevated.

Secchi disc: 1.2 meters

Number of species: 39

Blooming Species: small *Chaetoceros* sp., small unidentified dinoflagellates

Common Species: *Prorocentrum gracile*, tintinnids, euglenoids, *Ebria*, *Oxyphysis*

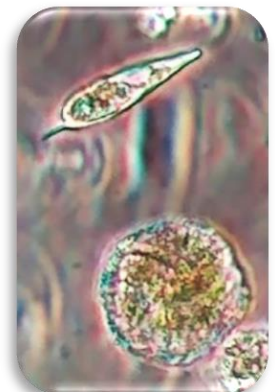
HAB Species:

Dinophysis (Present) – 89 cells/L net tow: *Alexandrium* (Present) – 6 cells/L
Protoceratium reticulatum (Present) – 60 cells/L; species of concern due to yessotoxin.

Akashiwo sanguinea (Present) – 274 cells/L; species of concern due to association with shellfish mortality.



Surface scum (200X)- detrital matter w/ no identifiable cells.



Prorocentrum (top) & *Protoceratium*

July 8, 2021 – Budd Inlet, Port Plaza

Wow! This has been quite a week for shellfish, water quality and plankton. Now that we are cooling off slightly after the **triple digit heat dome** that inundated our region during the tail end of June, we are left trying to understand the repercussions. Here are a few interesting developments that surfaced over the week.

First, Washington State Department of Ecology and local health departments issued swimming advisories for 10 beaches across four counties including Burfoot County Park, and Belfair, Twanoh and Potlach State Parks. The advisory for Burfoot County Park was issued on July 2nd after samples collected the day prior showed an average of 7,335 enterococci bacteria colonies per 100 mls of water, exceeding the advisory level of 104 colonies. Yikes! While heat and heavy beach use may be responsible, testing will continue this week to try to identify potential sources. In the meantime, stay safe and refrain from swimming at this park until further notice. Keep tabs on Thurston County beach advisories [here](#) or check Ecology's BEACH program [here](#).



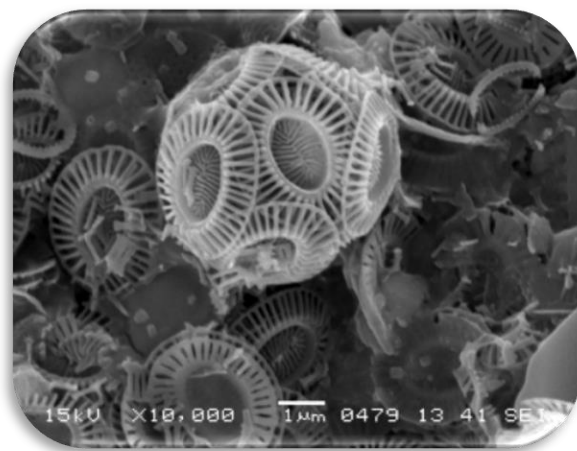
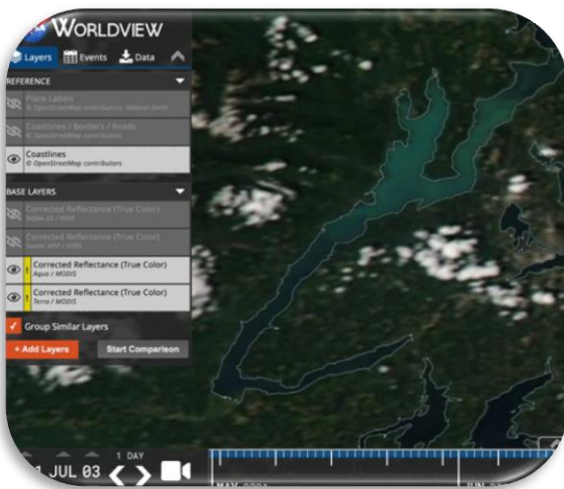
Clams stressed by the heat during low tide at Hama Hama and Totten Inlet, June 27, 2021; Photos: Hama Hama Oysters & Andy Suhrbier

Second, reports of shellfish mortality events have been pouring in from areas around South Sound and Hood Canal. The extreme heat on June 27th and 28th was most intense during late afternoon low tides leaving no reprieve for the poor bivalves. The Washington Post published an article on July 8th titled, "Crushing heat wave in the Pacific Northwest and Canada cooked shellfish alive by the millions." Here

are a few photos of some very sad clams. Have you witnessed significant shellfish mortality events yourself? You can report these to Washington SeaGrant at wsgcanal@uw.edu or complete an oyster mortality event form found on [PSI's homepage](#).



Coccolithophore bloom, taken from the east cliffs over Tskutsko Point in Dabob Bay, July 3, 2021. Photo: Hunter Fisher, shared by Teri King.



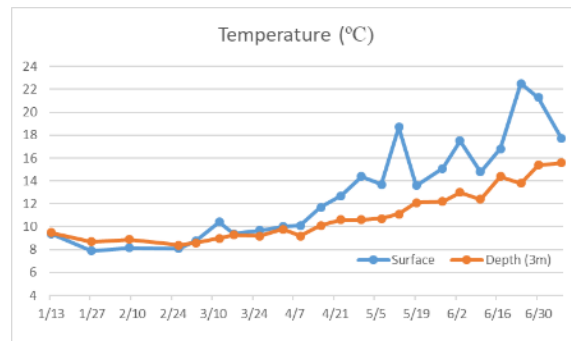
Emiliana huxleyi. Photo: Gerardo Chin-Leo (TESC)

And third, check out this tropical looking coccolithophore bloom that has been developing in Hood Canal over the past week. The single-celled coccolithophore, *Emiliana huxleyi*, is comprised of calcium carbonate platelets that reflect light casting a turquoise glow across the canal. The blooms have occurred annually since 2016, usually appearing in June and July when the waters become warm, calm, and stratified.

While beautiful to look at, the blooms remain a concern to shellfish biologists from the Skokomish Tribe. Blair Paul and Seth Book observed greater-than-usual shellfish mortality and cessation of feeding among geoduck clams during the 2017 bloom. According to Book, “We are concerned with potential reduction in primary productivity due to reflection and light attenuation, which means less food for shellfish. We have started to call it an ecosystem-disrupting harmful algal boom. Not toxic that we know of, but it appears to have impacts other than pretty water.” But yes, the water is pretty.

You can find more information about all of these unusual occurrences from this past week by visiting Washington SeaGrant’s [Bivalves for Clean Water Facebook page](#).

But now.... back to What’s Blooming in Budd!? Fortunately, the surface waters were surprisingly cooler today dropping to 17.7°C. The last 2 weeks were both well over 20.0°C (22.5°C and 21.3°C). Oxygen levels were much lower, however, decreasing from 10 mg/l to 5.01 mg/l.

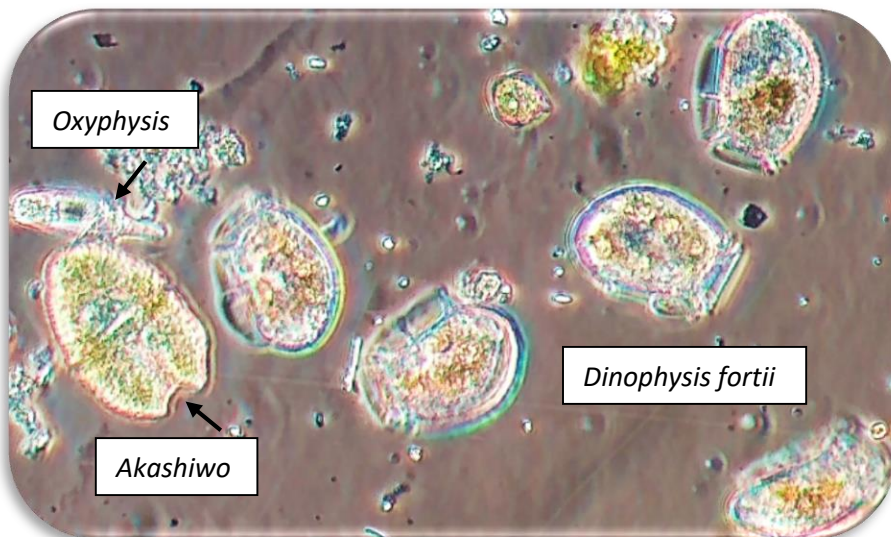


There were quite a few folks enjoying the waterfront today – both locals and even some visiting from Texas! It was fun to have the public peeking through microscopes again. So much to see!!! What's Blooming in Budd became quickly apparent. *Dinophysis*!! And a lot of it! The number of *Dinophysis*, the species responsible for Diarrhetic Shellfish Poisoning (DSP), has been doubling over the past 3 weeks: 565 cells/L, 1,196 cells/L, **2,476 cells/L**.

According to our database (2013 to present), *Dinophysis* in Budd Inlet has only exceeded this amount twice since 2013 (~3,500 cells/L in early summers of 2018 and 2019). Both times, *Dinophysis norvegica* was blooming. Today, *Dinophysis fortii* (53%) and *Dinophysis acuminata* (44%) were blooming.

Budd Inlet has been closed to shellfish harvesting due to DSP for a portion of every year since 2015. All closures started in late summer/early fall, extending until the following winter/spring. The only exception was in June of 2016 when 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. (This closure also started during fall 2015 but persisted until the following July). During each of the toxic events, *D. fortii* has always been the dominant species present. Will this bloom produce biotoxins? Who knows? In July 2013 & July 2017, *D. fortii* almost caused a closure. Stay tuned!

Other common species found in today's sample included the dinoflagellates *Akashiwo sanguinea*, *Ceratium fusus*, and *Scrippsiella*. And plenty of zooplankton zipping around, too!



Budd Inlet closed due to DSP on 7/12/21!!!

July 1, 2021 – Deep Lake, Millersylvania State Park



Spoiler alert! Deep Lake is not actually deep. At its deepest, the lake is 17 feet, but averages only 12! Today I sampled off the dock near the boat launch, where the depth was only 6 feet and little bluegill fish were swimming among the submerged vegetation. Have you ever had one of those moments where you feel like the luckiest person ever!? If not, head over to Millersylvania State Park. Every time I visit this park – to walk the trails (8-miles worth!), admire the skunk cabbage wetlands and try to spot beavers, or look out at the lake – I can't believe this place is literally in-our-backyards for Thurston County residents. We are all so lucky! Thank you, John Miller, for giving "Miller's Glade" to the State in 1921 to use as a future park. What a treasure!

Practically undeveloped on all sides, the water quality is quite good in Deep Lake. According to the 2018 Water Quality Report for Deep Lake by Thurston County Environmental Health, the lake is oligotrophic. This means that the lake is relatively low in plant nutrients and contains abundant oxygen at depth. At this time of the year, the lake typically has moderate oxygen levels (~11 mg/L) in the warm surface layer (epilimnion), increasing to super-saturation levels (~25 mg/L!!) in the cooler deep layer (hypolimnion) due to oxygen production by macrophytes and algae. From the dock, I lowered the YSI probe a foot below the surface and recorded a

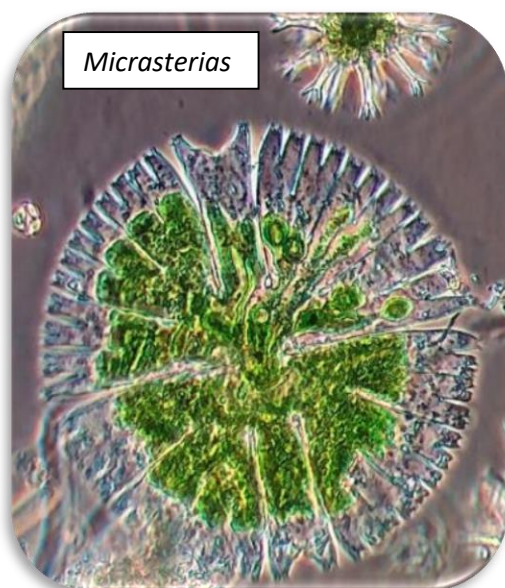
temperature of 25°C, salinity of 0.03ppt (yep, fresh), oxygen at 9.78 mg/L and pH of 8.6. The secchi disc, which measures water clarity, was clearly visible when it hit bottom at 2 meters.

I dragged the plankton net through the surface waters and loaded a few drops of water onto a slide. Rolling green balls and *Ceratium* moved across the slide, interrupted frequently by darting rotifers. I passed the field microscope to a gentleman fishing nearby and we marvelled at the rich life in the water. “*We really need to take care of this place,*” he said. What struck me was that a woman said those exact words to me last week while sampling in Budd Inlet. Yes, we do. What is it about spending time near the water that makes us express these words? As famous oceanographer, Jacques Cousteau once said, “People protect what they love.” As I made my way home, I thought about how I can take care of this place. How do you? Share your thoughts with me (aimee@pacshell.org) and perhaps we can inspire others in next week’s edition of What’s Blooming?



Back at the lab, I poured over ID books, getting lost in the microscopic world before me. I called my co-worker over for a peek when I came across *Volvox* and *Micrasterias*. I laughed when my Guide to Microlife (by K. Rainis and B. Russell) read, “Did you Know?...*Micrasterias* is one of the most beautiful microlife forms.” Fact or opinion? What do you think? *Volvox* is always a treat to observe. The large balls are actually colonies consisting of up to 50,000 individual cells, each with a flagella facing outward and swimming in a coordinated fashion. Many colonies contain daughter colonies. *Volvox* typically indicates waters rich in nitrogen.

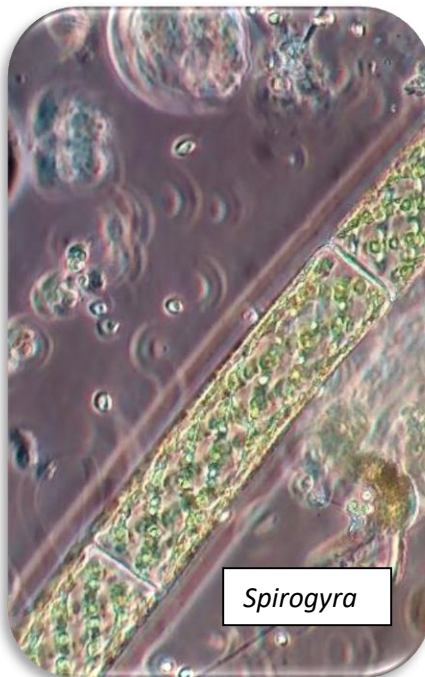
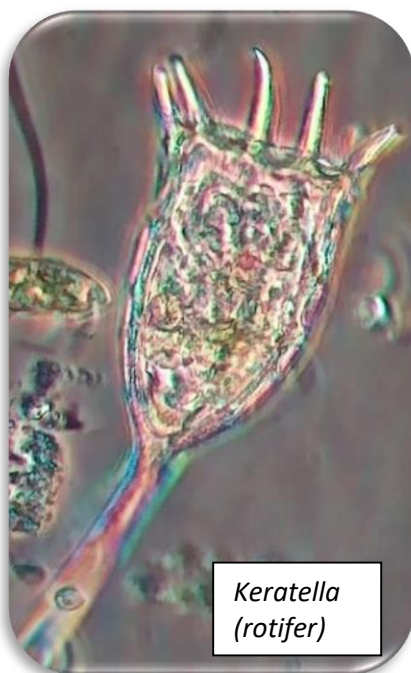
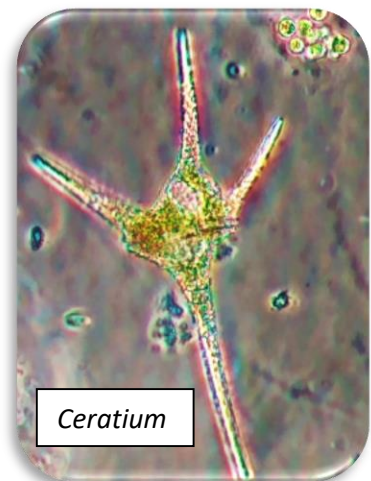
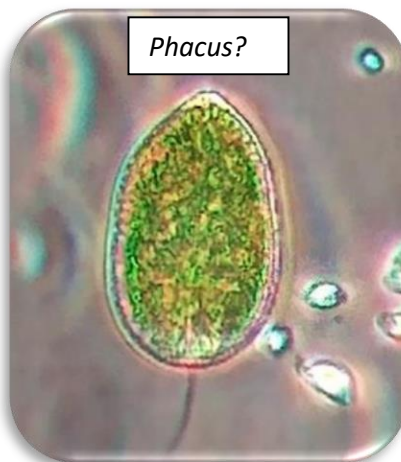
Other rolling ball-like colonies were also present included *Eudorina*, *Synura*, *Aphanocapsa* and others. These “balls” continue to challenge my identification



skills, so please (!) let me know if I ever misidentify these. Zooplankton were plentiful including nematodes, rotifers (3 types) and cladocera (water fleas). No harmful cyano-bacteria were observed. In fact, according to Ecology's Washington State Toxic Algae database, Deep Lake rarely experiences lake closures due to toxic algae. The last closure occurred during fall of 2015 when microcystin levels were 72 µg/l, exceeding the limit of 8. All has been "quiet" since. May it stay that way!

The sample was so entertaining, I decided to take video images. I hope you enjoy this 1-minute clip featuring a cast of this week's microscopic characters! <https://youtu.be/7KMTzFa100A>

Thanks for tuning in this week. If you haven't visited Millersylvania SP recently, I highly recommend it...year-round! And remember to get out and "enjoy what you love!"



June 30, 2021 – Budd Inlet, Port Plaza



What a stunning evening on the water! We had a break from the heat wave and Lady Washington graced us with her presence!

	Surface	1.5m	3m
Temp (°C)	21.3	19.4	15.4
Salinity (ppt)	17.98	25.41	28.09
Oxygen (mg/l)	10.85	13.08	7.80
pH	8.39	8.54	8.40

Secchi disc: 1.6 meters

Number of species: 39

Blooming Species: *Ceratium fusus*, small *Chaetoceros* sp., *Dinophysis*

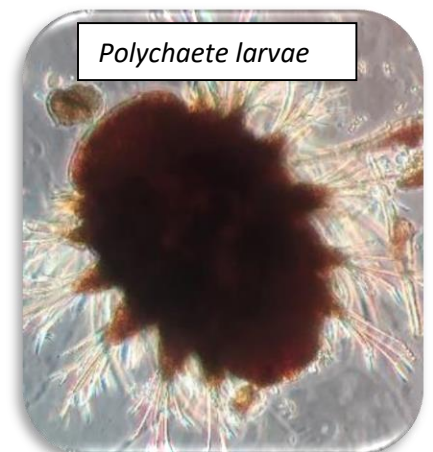
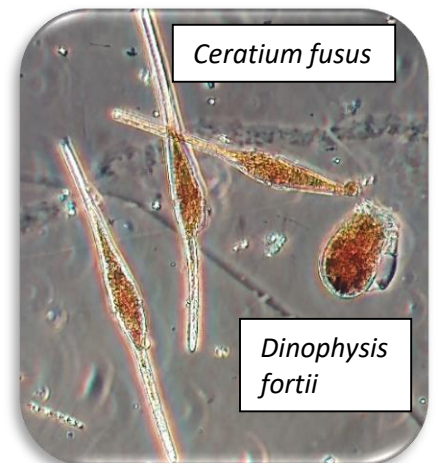
Common Species: Dinoflagellates (*Noctiluca*, *Protoperdinium* spp., *Scrippsiella*, *Prorocentrum*)

Zooplankton: (*tintinnids*, *polychaete larvae*, *rotifers*, *copepods*, *crustacean nauplii*, *larvaceans*, *bivalve larvae*, *gastropod larvae*, *tiarina*)

HAB Species:

Dinophysis (Blooming) – 1,196 cells/L from net tow: a mix of *D. acuminata* (83%), and *D. fortii* (14%), Other (3%)

Prorocentrum gracile (Common) – species of concern due to production of yessotoxin.



June 24, 2021 – Budd Inlet, Port Plaza

Wahoooo!!! I'm so excited to kick off the 10th season of "What's Blooming!!!" Are you-all giddy with anticipation about what we're going to discover this summer? I'm looking forward to visiting a handful of new lakes that we've never sampled at before: Deep Lake, Munn Lake, and Lake Saint Clair. And as always, we will continue our weekly sampling at Port Plaza, Budd Inlet, as part of the [SoundToxins](#) phytoplankton monitoring program.

This year, in addition to our typical HAB species, we will be adding a few additional species of concern: *Protoceratium reticulatum*, *Akashiwo sanguinea*, and *Phaeocystis*. We will continue tracking *Noctiluca* and jellyfish blooms, as these species seem to thrive under climate changing conditions. I will definitely be keeping an eye on *Dinophysis*, the species responsible for Diarrhetic Shellfish Poisoning! This spring, PSI compared our *Dinophysis* cell count data against Washington Department of Health's shellfish toxicity data from 2013 to present. The results were fascinating!!! They are starting to show patterns that will help us forecast WHEN toxin blooms occur and WHICH species are responsible for toxin production. Perhaps this year we will discover WHAT conditions trigger cells to produce toxins.



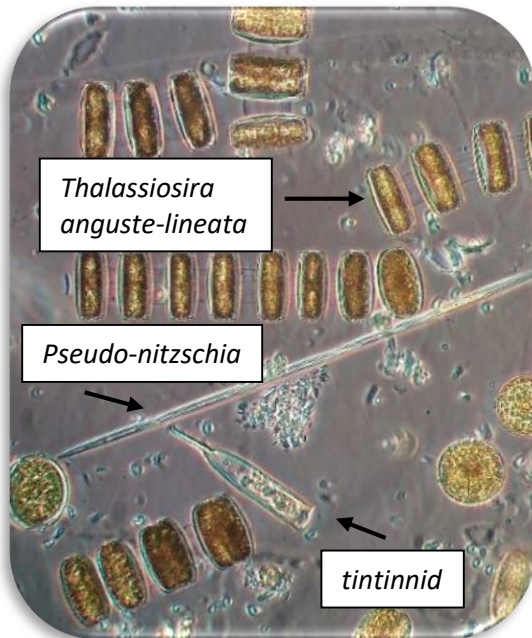
We are certainly starting the year off **HOT** (!!), with temperatures expected to rise into the triple digits over the weekend. Will extreme heat set us up for exceptionally stratified waters? Will the shift from diatoms to dinoflagellates occur earlier than usual? Will temperatures climb as high as they did during the warm water "Blob" of 2015-2016 (24°C) – the same year that Budd Inlet set the national record for DSP in mussels at 250 µg/100g tissue?

So many questions! So little time! So, let's get sampling!

Today, I was thrilled to have Shriya, our Olympia High School intern, join me to kick off the season. The first time I met Shriya was on the dock back

in February – both of us bundled in warm winter coats! Today, I observed as she collected the YSI data, secchi disc reading (water clarity) and plankton samples; posting photos of observed plankton species on the sandwich board. Thank you, Shriya! You're a plankton pro now!

The water was incredibly warm and stratified (layered) with surface temperatures reaching 22.5 °C (72.5 °F), dropping to 13.8 °C (56.8 °F) at 3-meters depth – a 16°F change over 10 feet! It was only 2 weeks ago that the weather was spastically alternating between rainy and sunny with chain forming diatoms like *Thalassiosira* and *Pseudo-nitzschia* dominating the sample.

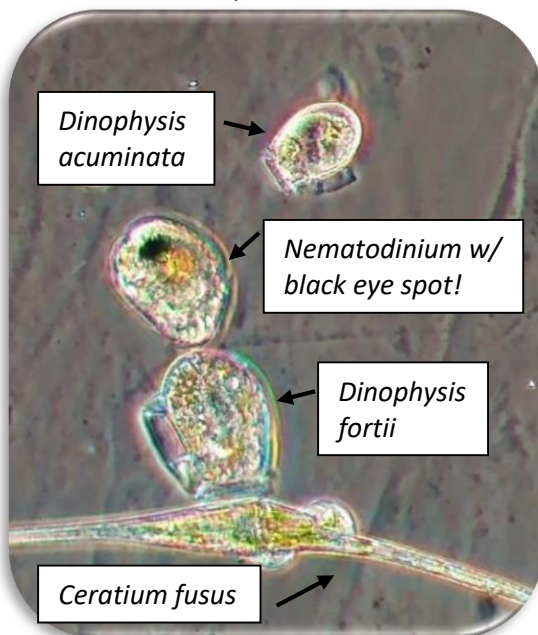


Budd Inlet sample, June 10, 2021.

This week, similar to last year, the species composition had already shifted from diatoms to predominantly dinoflagellates and zooplankton. Stratified waters favor dinoflagellate species. Their flagellas help them to move up and down in the water column providing them with access to nutrients at depth – nutrients out of reach to non-mobile, sun-loving diatoms.

Dinophysis was plentiful, but decreased slightly from last week's cells counts (800 to 550 cells/L). Other common dinoflagellates included *Ceratium fusus*, *Heterocapsa*, *Scrippsiella*, *Protoperidinium* and our lovely bioluminescent *Noctiluca*!

The zooplankton were wildly abundant – copepods, crustacean nauplii, polychaete larvae (so cute!!!), larvaceans, molluscan veliger larvae and more! It was a zoo in there!



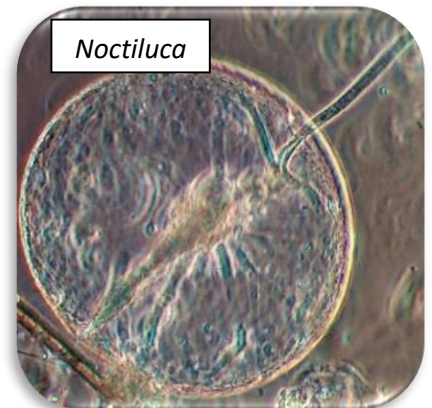
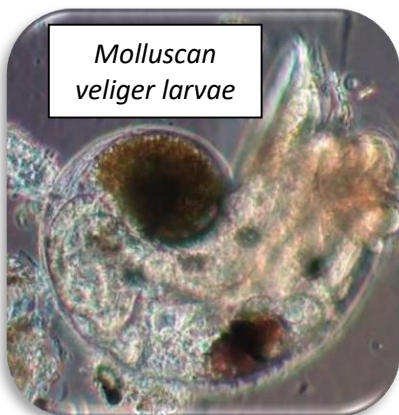
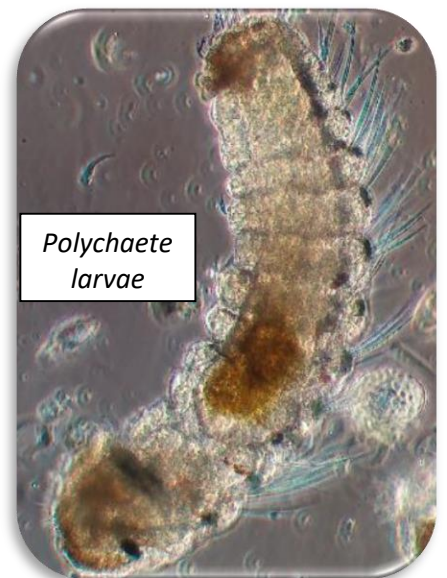
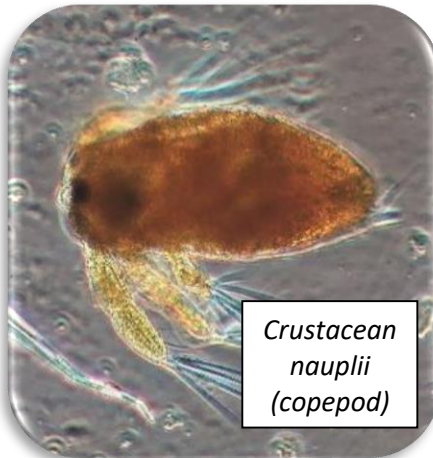
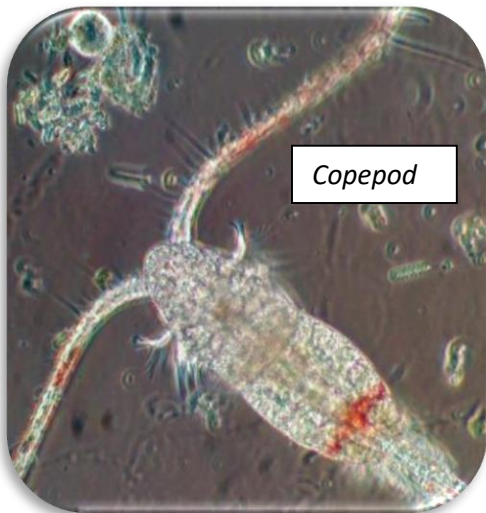
Budd Inlet sample, June 24, 2021.

The zooplankton might become a tasty meal for the spring-released Chinook salmon fry embarking on their long journey northward. Last week, as I walked down the ramp to the Port Plaza dock, I had the AMAZING good fortune of witnessing hundreds, if not thousands, of tiny barred fry (developing smolts?) hugging the shoreline in a long, seamlessly never-ending school. I took pause and wished them a safe journey. May you return to spawn, or help nourish other marine life including our beloved Orcas.



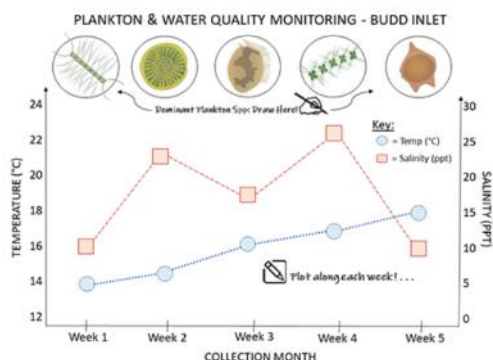
Thanks for tuning in to this week's "What's Blooming?"

Do you ever wonder what microscopic organisms you're swimming with at your favorite swimming hole? I do. Join us next Thursday as I take a dip in Millersylvania State Park's Deep Lake, collect a plankton sample, and discover what's blooming!



Plot-Along-At-Home

Do you have a burning plankton question that you would like to investigate? Help identify trends and patterns by starting your own “Plot-Along-At-Home” graph! Use one of our templates or create your own graph depending on your individual research question. For example, are you curious what plankton are blooming when oxygen levels are at their lowest? What water quality is like during biotoxin closures? I’ve compiled 5 weeks of data to complete the season.



1. Print a [Plot-Along-At-Home template](#). You can select a blank template or one that is already designed to track temperature/salinity or oxygen/pH. If you don’t have a printer, sketch your own template.
2. Plot your data.
3. Finally, sketch plankton species that are blooming each week. You can find pictures of most of these species by clicking on the [Phytoplankton ID Guide](#) and the [Zooplankton ID Guide](#). Do you notice any trends yet?

2021 Budd Inlet Data					
	7/28	8/5	8/11	8/18	8/23
Water Temp (°C)					
Surface	22.1	23.2	19.9	20.0	17.8
Depth (3m)	16.1	15.6	17.3	16.3	16.1
Water Salinity (ppt)					
Surface	25.08	19.96	21.82	21.62	22.30
Depth (3m)	28.75	28.83	28.73	28.90	28.98
Oxygen (mg/l)					
Surface (1m)	10.42	10.68	3.98	7.38	4.50
Depth (3m)	7.13	2.86	3.91	3.74	4.67
pH					
Surface (1m)	8.29	8.17	7.61	7.92	7.64
Depth (3m)	8.02	7.77	7.72	7.74	7.72
HABS					
<i>Dinophysis</i>	256	131	161	48	119
<i>Pseudo-nitzschia</i>	36	143	310	10226	536
<i>Alexandrium</i>	0	12	0	6	0
Secchi (m) visibility	2.1	2.4	4.5	3.2	4.7
Species Diversity	30	37	30	37	39
Blooming & Common Species	<i>Akashiwo</i>	<i>Akashiwo</i>	<i>Ceratium</i>	<i>Pseudo-nitzschia</i>	<i>Ceratium</i>
	<i>Ceratium</i>	<i>Cerataulina</i>	<i>Akashiwo</i>	<i>Skeletonema</i>	<i>Noctiluca</i>
	<i>Protooperidium</i>	<i>Leptocylindrus</i>	<i>Skeletonema</i>	<i>Ceratium</i>	<i>Scrippsiella</i>