What's Blooming?

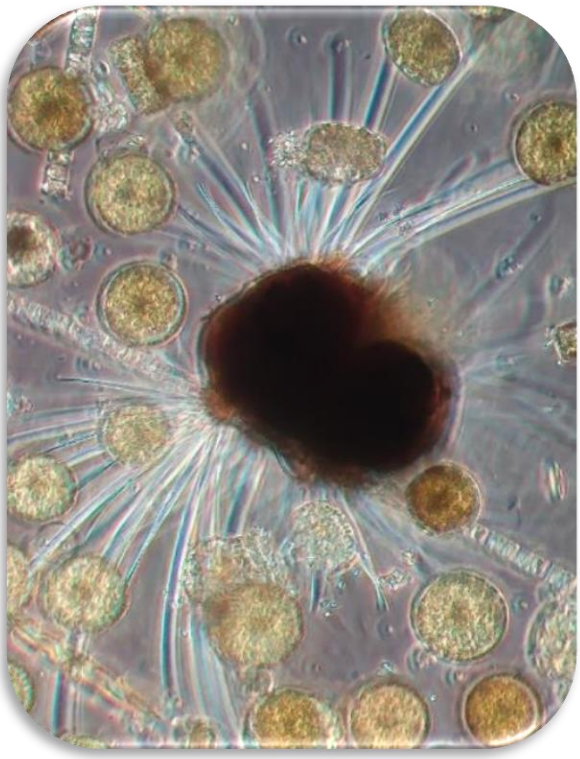
This year, PSI will sample weekly at Budd Inlet in addition to a handful of lakes throughout Thurston County. Lakes might include Long Lake, Barnes Lake, Black Lake, Ward Lake and Deep Lake (at Millersylvania SP).

Unfortunately, due to COVID-19, the public will not be allowed to collect the data nor view plankton under microscopes. Instead, we invite you to check back here each week 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 or to share your "Plot-Along-At-Home graphs."

Aimee Christy aimee@pacshell.org



Do you know what this is? This is a polychaete larvae (segmented worm) found in our plankton sample on May 20, 2020.

Sampling Schedule – Subject to Change & Persuasion ☺

- June 18 – Budd Inlet (Port Plaza)
- June 25th and 26th – Long Lake & Budd Inlet
- July 2 – Budd Inlet (Port Plaza)
- July 8th and July 9th – Budd Inlet & Black Lake
- July 16 – Budd Inlet (Port Plaza)
- July 23 – Ward Lake & Budd Inlet
- July 30 – Budd Inlet (Port Plaza)
- August 5 – Deschutes River, Budd Inlet
- August 13 – Budd Inlet
- August 19th and 20th – Long Lake & Budd Inlet
- August 27 – Budd Inlet
- September 3 – "By Request" (you decide!)

Plot-Along-At-Home

Have you been plotting along at home? If not, now is a great time to start. I've compiled **July's** "What's Blooming?" data for you in the table below.

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 one of the plankton species that is 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 see any trends?

	7/2	**7/9**	**7/16**	**7/22**	**7/30**
Water Temp (°C)					
Surface	13.3	14.8	19.2	20.6	20.8
Depth (3m)	12.5	13.3	13.0	17.3	13.9
Water Salinity (ppt)					
Surface	27.44	25.19	21.45	13.31	17.63
Depth (3m)	28.67	28.39	28.69	27.01	28.8
Oxygen (mg/l)					
Surface	6.3	10.5	9.9	8.5	9.1
Depth (3m)	6.6	11.4	4.6	10.9	5.4
pH					
Surface	7.8	8.1	8.3	8.6	8.6
Depth (3m)	8.1	8.4	8.0	8.5	8.1
HABS					
Dinophysis	476	1554	262	1786	250
Pseudo-nitzschia	7411	18482	2792	24	42
Alexandrium	30	0	0	0	0
Secchi	3.5	2.1	2.3	1.9	2.6
Blooming &	*Noctiluca*	*Amylax*	*Thalassiosira*	*Akashiwo*	*Akashiwo*
Common Species	*Pseudo-nitzschia*	*Pseudo-nitzschia*	*Noctiluca*	*Protoceratium*	*Protoceratium*
	Protoperidinium	*Noctiluca*	*Protoperidinium*	*Dinophysis*	*Scrippsiella*
	Rotifers	*Thalssiosira*	*Nitzschia acicularis*	*Protoperidinium*	*Protoperidinium*
	Oxyphysis	*Oxyphysis*	*Akashiwo*	*Noctiluca*	*Ceratium fusus*

Check out my Plot-Along-At-Home graph under the July 16th entry. We'd love to see yours! E-mail a picture of your graph to us at aimee@pacshell.org and we'll send you a deck of NOAA's Phytoplankton ID flash cards!

August 20, 2020 – Long Lake, Thurston County

Today I felt the adrenaline rush of a cyano-HAB storm chaser! ☺ I was set to sample at Millerslavania SP, but quickly changed plans when I saw that Long Lake was recently closed due to toxic algae. According to testing on 8/17/20, microcystin levels were 14 µg/L, exceeding the state standard of 8 µg/L. The Washington State Toxic Algae database indicates that Long Lake has experienced temporary algae closures in 2011, 2013, 2014, 2015, 2016, and 2017. The highest level recorded for this lake was in 2011 at 167 µg/L!

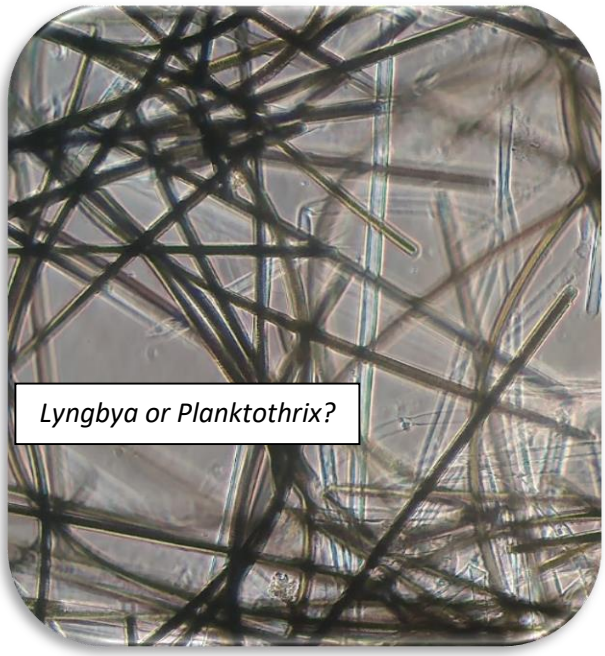
If I had checked Thurston County's Blue-Green Algae Advisory for Long Lake, I would have saved myself the time of loading the kayak onto my car. Not only is it prohibited to swim, drink, or fish in the lake, but also boat in it. When I arrived at Long Lake Park, the swimming beach was roped off with red tape and the park was eerily quiet. The WDFW boat access gate was also closed. Both locations prominently displayed Danger – Lake Closed signs. I opted to sample from the bridge leading to Holmes Island instead. When I arrived I couldn't believe my eyes or nose! The stench was repugnant and algae had accumulated in thick mats along the shoreline.

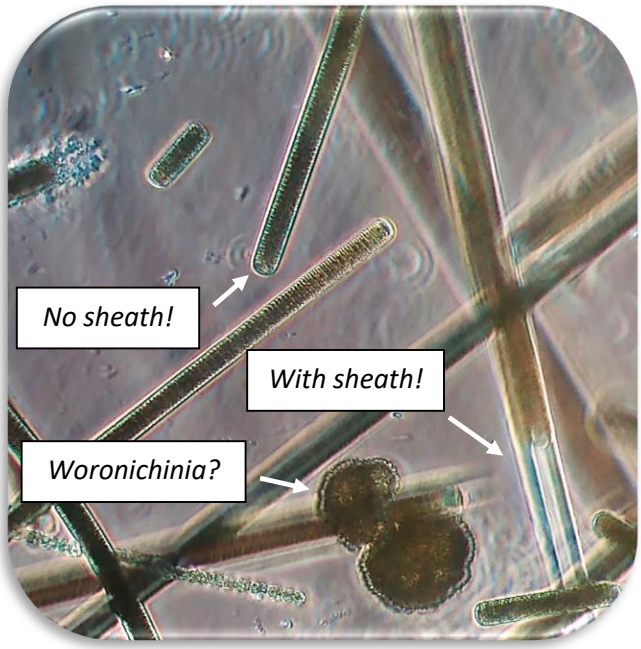
View of the water from the Holmes Island bridge.

I donned my gloves and face mask and lowered the YSI and plankton net into the water below. The lines were just long enough to reach the water. The temperature was 23°C (73°F), oxygen was 11.5 mg/l, and the pH was 9.86. The algae were clearly busy photosynthesizing! When I sampled Long Lake in June, dissolved oxygen was 8.03 mg/l and the pH was 8.48. Off to the lab to see what was in the plankton sample!

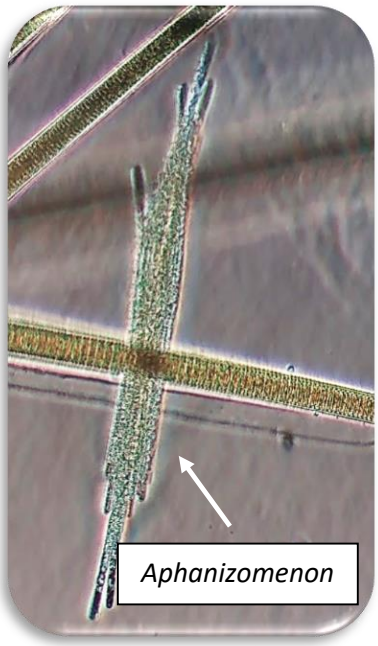
After carefully washing my equipment, I noticed that most of the algae had formed a band near the surface of the jar. Blue-green algae are interesting in that many can regulate their buoyancy allowing them to rise to more favorable light and temperature conditions. Just because microcystins are in the water, however, does not mean that the algae, *Microcystis*, is to blame. In fact, a number of species can produce microcystins including *Dolichospermum (previously Anabaena)*, *Fischerella*, *Gloeotrichia, Nodularia*, *Nostoc*, *Microcystis*, and *Planktothrix (Oscillatoria).*

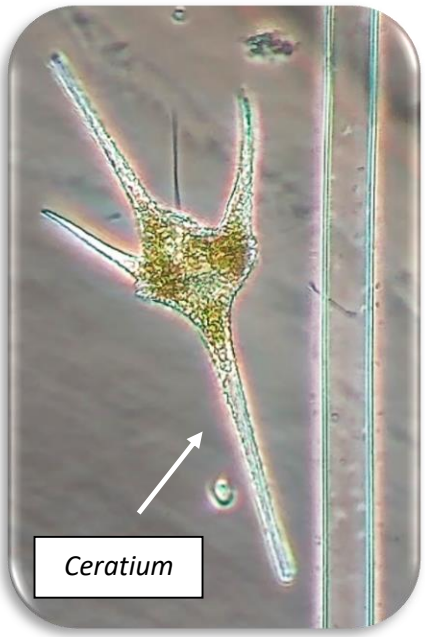
Of these contenders*, Dolichospermum* was certainly observed in the sample. But the most common species, by far, was a long filamentous species closely resembling *Lyngbya*. *Lyngbya* has a firm mucilage sheath and does not produce microcystins. *Planktothrix*, on the other hand, produces microcystins, looks like *Lyngbya*, but does not have a sheath. While I observed many cells without sheaths, *Lyngbya* is known to frequently abandon its sheath when stressed (e.g. under a hot microscope light). Basically, I believe the blooming species was *Lyngbya*, but it would make more sense if it were *Planktothrix*. Therefore, I sent photos to WA Dept. of Ecology (WDOE) for ID confirmation.

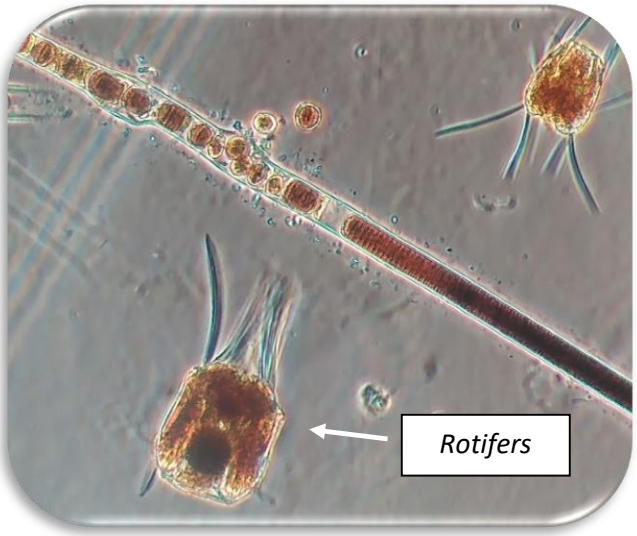




Other species observed in the plankton sample included *Woronichinia* (or *Coelosphaerium* – also waiting WDOE ID), *Aphanizomenon*, *Gonium*, *Staurastrum*, *Phacus*, *Trachelomonas*, *Vorticella*, and *Fragilaria*. The dinoflagellate, *Ceratium*, was present as well as a zippy assortment of rotifers and cladocerans (water fleas).







"*The red "DANGER" sign is not common – so pay attention and keep out! This sign is only posted when laboratory tests have found very high concentrations of toxins in the water. There is a serious danger to people and pets.*

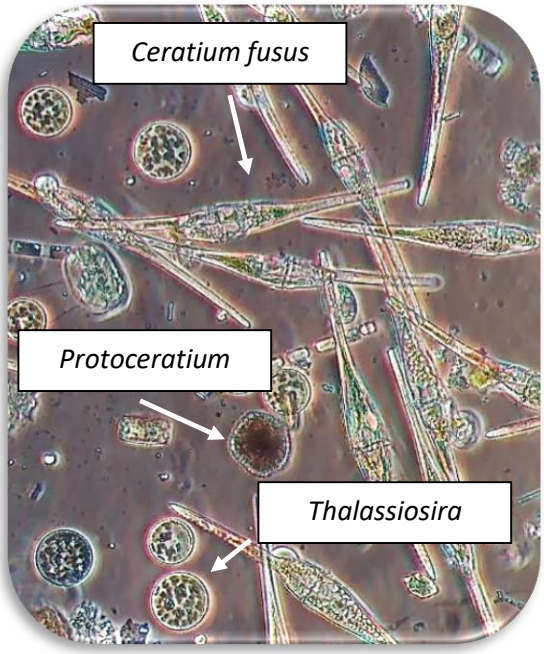
Walking around the lake is OK, but make sure you can keep your children and pets away from the water at all times. Even a short exposure to the water could make people or pets sick. Keep your dogs from contacting the water – algae will stick to their legs, and dogs will lick the algae off of their fur."

www.nwtoxicalgae.org/HealthRisks.aspx

Microcystin is primarily a hepatotoxin, or liver toxin, but can also affect the kidney and reproductive systems. Symptoms may take 30 minutes to 24 hours to appear and include nausea, vomiting, liver failure, jaundice, shock, abdominal pain, weakness, thirst, rapid/weak pulse and death. Yikes!

While Lyngbya does not produce microcystin, skin exposure can result in immediate rashes/lesions and the aerosols may cause respiratory tract irritation. When I hear back from WDOE, I'll confirm whether or not the blooming species is *Lyngbya* or *Planktothrix*. In the meantime, be safe and stay out of the lake! Exciting sampling day!

August 19, 2020 – Budd Inlet, Port Plaza



	Surface	1.5m	3m	4.5m
Temp (°C)	21.6	17.6	14.5	14.5
Salinity (ppt)	9.1	27.9	29.0	29.0
Oxygen (mg/l)	8.7	8.5	4.9	4.8
pH	8.9	8.4	8.2	8.1

Secchi disk: 2 meters

Number of species: 35

Blooming Species: *Thalassiosira, Ceratium fusus (1st time it's bloomed this summer!)*

Common Species: Diatoms (*Skeletonema, Leptocylindrus minimus)*

Dinoflagellates (*Noctiluca, Akashiwo, Protoperidinium Scrippsiella)*

Zooplankton *(tintinnids, polychaetes, rotifers)*

HAB Species:
Pseudo-nitzschia (Present) – 119 cells from net tow
Dinophysis (Present) – 42 cells/L from net tow: a mix of *D. acuminate (14%), and D. fortii (86%)*
Protoceratium reticulatum (Common) – species of concern due to production of yessotoxin
Akashiwo sanguinea (Common) – species of concern due to association with shellfish mortality events and sea bird mortality (on outer coast on rare occasions)

August 13, 2020 – Budd Inlet, Percival Landing

Hello fellow plankton lovers! I am filling in for Aimee this week as your What's Blooming in Budd sampler. As a former PSI staff member I have missed the fun of collecting and looking at plankton, so it was my treat to help out today. Percival landing was a lively place this afternoon with someone playing drums on the dock. You can kind of see part of them behind me in the photo. As well as live music, there was also a large boat playing music. I was well entertained while collecting plankton and water quality data. I apologize for not including photos of plankton today. I had technical difficulties with the camera, and could not get good photos using my phone.

Protoceratium reticulatum was the dominant species in the water today. *Protoceratium*, known for its reticulated (pattern of interlacing lines) plates is a species of concern because it is known to produce yessotoxin which has been shown to be toxic to shellfish in other regions. This biotoxin can also accumulate in shellfish tissues, but toxicity to humans has **not** been observed at this time. However, studies in mice indicate a response similar to paralytic shellfish poisoning. *Dinophysis* was also present, 190 cells/L, and *Pseudo-nitzschia* numbers increased from 42 cells/L to 202 cells/L. Data for all three of these species will be entered into the SoundToxins database.

Other dinoflagellates that were common included *Akashiwo* and *Ceratium fusus*. The zooplankton included: larvaceans, crustaceans, copepods, polychaetes, tintinnids, rotifers, and bivalves.

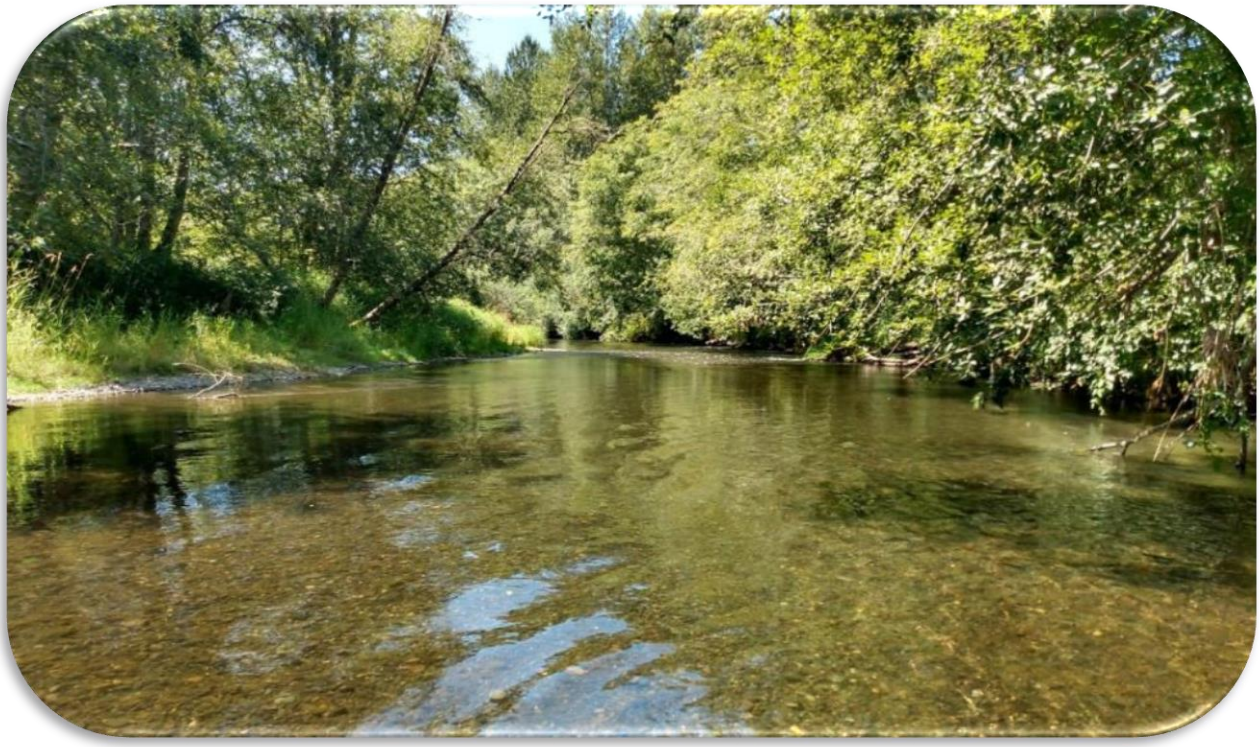
The water looked lovely today! The surface temperature decreased to 16.8°C or 62°F, likely due to the cooler weather we've been having. The water was more mixed than last week with only a little more than a 1-degree difference between the top layer and 3 meters. Dissolved oxygen levels at depth also improved, increased from 4.3 to 5.6 mg/l. With more hot weather coming this weekend these conditions are bound to change again.

	Surface	**1.5 Meters**	**3 Meters**	**4.5 Meters**
Temperature (°C)	16.8	16.4	15.4	14.9
Salinity (ppm)	27.45	27.77	28.64	28.84
Dissolved Oxygen (mg/L)	8.39	8.02	7.12	5.64
pH	8.07	8.18	8.19	8.09

Thanks for tuning in this week. Aimee will return for What's Blooming next week!

August 5, 2020 – Deschutes River, Pioneer Park

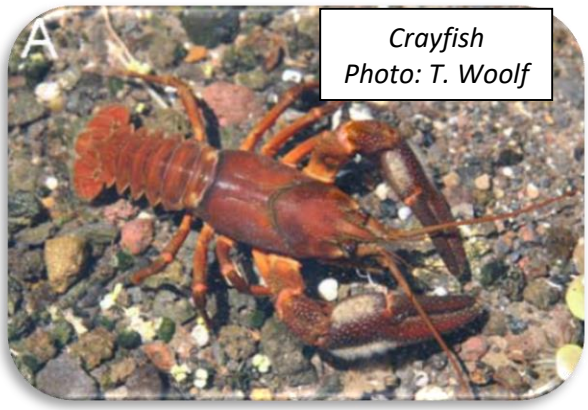
Have you ever tubed the Deschutes River at Pioneer Park in Tumwater? Not to be confused with the Deschutes River in Oregon, the "Little D" stretches 57 miles from its headwaters in the Snoqualmie National Forest to Budd Inlet, lower Puget Sound. I've lived here 20 years and never tubed it until this week. I've been every day since. If you have 1-hour to spare, I highly recommend this soothing way to calm your mind and awaken your inner naturalist. Even during the summer, a mid-afternoon week-day float might offer you a stretch of river *all to yourself!*



Prior to our tubing voyage, my son and I collected our scientific data – "work" before play!

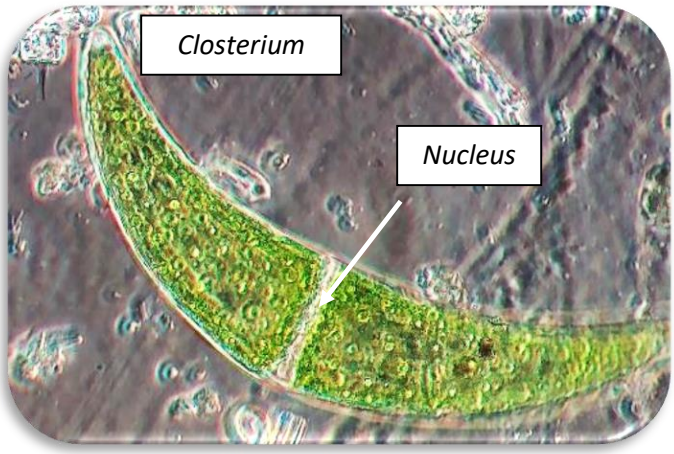
At 2:00 PM the water temperature was 18.4°C, or 65°F. Salinity was 0.07 ppt. Dissolved oxygen was 11.69 mg/l or 123%, and the pH was 7.86. While the temperature was cooler than many lakes sampled this summer, it remains quite warm for a river. Department of Ecology has done extensive water quality sampling in the Deschutes River and has listed several segments as "impaired" for dissolved oxygen, fecal bacteria and temperature. This particular segment within the northern portion of Pioneer Park is listed as "impaired" for temperature. The Washington Stormwater Center created a wonderful Story Map for the Deschutes River Watershed that includes a GIS map highlighting impaired regions. After collecting the YSI data, my son waded into the middle of the creek to collect the plankton sample. We returned the gear to the car and let the fun continue!

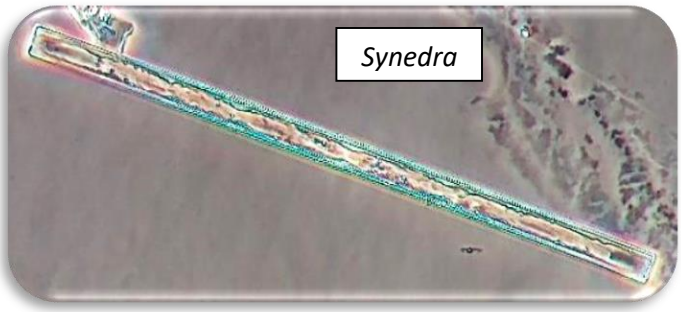
As we slowly drifted down the river, my son quickly discovered that floating on your stomach provides an ideal way to observe the aquatic world passing beneath you. We observed many small fish ranging from the length of a paperclip to a toothpick. And then Nathan shouted, "Breadbox!" Yes, a fish the length of a breadbox! I wouldn't have believed him if I hadn't seen it for myself. The river is reported to have resident and sea-run cutthroat trout as well as salmon. Some fisher(wo)men have claimed to catch 18" fish, although a rarity. The scattering of crayfish, or crawdads (What do you say?) were also entertaining to spot. Most plentiful were small snails and caddisfly larvae attached to the surfaces of the river bottom. Above water, we watched several species of dragonflies feeding on insects at the water interface. A damselfly landed on my toe. This first stretch of the float is certainly my favorite. If the river were part of the Candy Land game, it would be called Peaceful Passage.



Crayfish
Photo: T. Woolf

As you leave Peaceful Passage, you come to the first set of rapids – rapids being a strong word to describe the very shallow rippling of water over thankfully smooth rocks. Pass by Party Point (usually decent music playing) and enter Trash Alley, the accumulation zone for plastic bottles, aluminum cans, and other floating garbage. Perhaps I'll bring a trash grabber, gloves, and mesh bag for my next float! The next stretch travels through the Silty Shores S-curves where you can see firsthand the impressive amount of erosion caused by the force of the river during higher flow episodes. The Google map illustrates how the course of the river has changed, completely infringing on the old trail system through the park. From an aerial perspective you can also note how the force of the river carves on one side while leaving beach deposits on the other. Around the next bend is the Family Fun beach where kids and dog walkers will waive their hellos. The Take Out spot is just beyond. Look for a steep gravel slope down to the water and a nearby trashcan. I am still amazed that one can enjoy a leisurely 45-minute float all within the confines of Pioneer Park (at least this time of the year). A 15-minute walk back will allow you to drip dry before heading home.



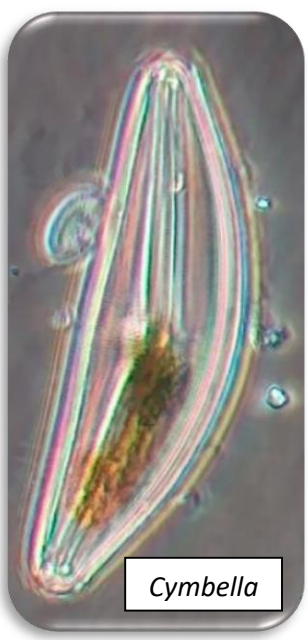


So what microscopic critters were we sharing the river with? The sample did not have the abundance of plankton often found in calm lakes that provide the perfect conditions for rapid cell growth and division. Still, an assortment of solitary pennate (pen or boat shaped) diatoms, chain forming diatoms, and a few dinoflagellates were observed. Only a few zooplankton (rotifers) were seen zipping across the slide. In all, the river offered a very different assemblage than what we've detected in our previously sampled lakes.

My favorite plankton of the day was the green banana-shaped protist, *Closterium*. *Closterium* has 2 giant chloroplasts with the tips containing granules of gypsum (calcium sulfate). According to the *Guide to Microlife*, by Kenneth Rainis and Bruce

Russell, if you watch the cell poles closely, the granules will appear to vibrate, or dance. Their purpose is yet unknown.

Other diatoms included the long *Synedra*, *Tabellaria, Navicula, Licmophora* and possibly *Surirella* and *Cymbella*. The sample also had two types of stalked ciliates.



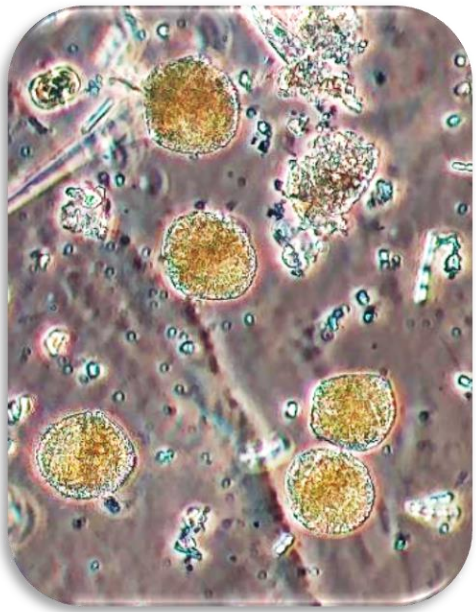
The Deschutes River is a local gem to be treasured. Many actions can be taken to protect water quality, particularly actions that prevent bacterial pollution and litter from entering the river and ultimately Puget Sound.

First, please **pick up after your dogs**. And if you don't have a dog, please gently remind others to do so. Pioneer Park is NOT an off-leash park. It is often challenging to locate dogs' deposits once they've roamed off the main trail. Several years ago, students from Komachin Middle School picked up litter and flagged poop piles during their "Day of Caring." They flagged and scooped over 50 piles of poop along one small portion of the park! Picking up after dogs prevents excess nutrients, fecal bacteria, and pathogens from entering the River. Thanks kids!

Litter can be another problem at this park. The City of Tumwater does a *wonderful* job keeping the upper park clean. The lower reaches along the side trails, however, are consistently full of garbage. Since 2014, PSI and the City of Tumwater have co-hosted cleanups at Pioneer Park for the International Coastal Cleanup and Earth Day. Students and community members have picked up over 3,500 items along these trails with the top 5 items being cigarette butts (611), aluminum cans (713), plastic bottles (343), food wrappers (312) and glass bottles (296). **See some garbage? Pick it up!** Use a Trash BINGO sheet to make it more fun!

Thanks for joining me this week to discover What's Blooming in the Deschutes. If you've considered floating this stretch of the river, I hope you'll try it! It's an amazing way to appreciate our local flora and fauna.

August 5, 2020 – Budd Inlet, Port Plaza



Visibility was 1 meter! Water had a greenish hue with macro-algae accumulation against edge of dock (left). Bloom of Protoceratium reticulatum (right). Sample also contained quite a bit of detrital matter.

	Surface	1.5m	3.0m	4.5m
Temp (°C)	22.0	21.8	17.0	15.2
Salinity (ppt)	21.1	24.8	27.9	28.9
Oxygen (mg/l)	9.6	9.8	6.5	5.1
pH	8.4	8.5	8.2	8.1

Secchi disk: 1.0 meters

Number of species: 31

Blooming Species: *Protoceratium reticulatum*

Common Species: Diatoms (*Chaetoceros, Melosira, Skeletonema, Thalassiosira)*

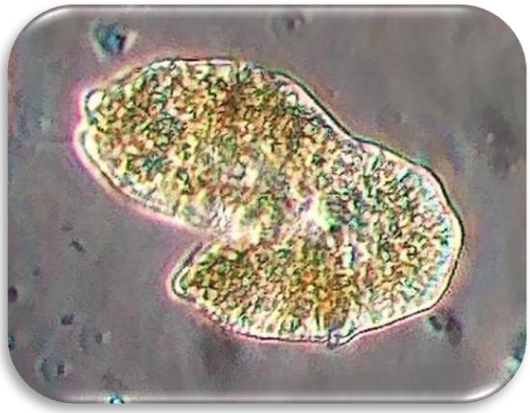
Dinoflagellates (*Scrippsiella)*

HAB Species:

Pseudo-nitzschia (155 cells/L from net tow)
Dinophysis (125 cells/L) – a mix of *D. acuminate (52%), D. fortii (43%),* and *D. parva* (5%)
Protoceratium reticulatum (Blooming) – species of concern due to production of yessotoxin
Akashiwo sanguinea (Present) – species of concern due to association with shellfish mortality events and sea bird mortality (on outer coast on rare occasions)

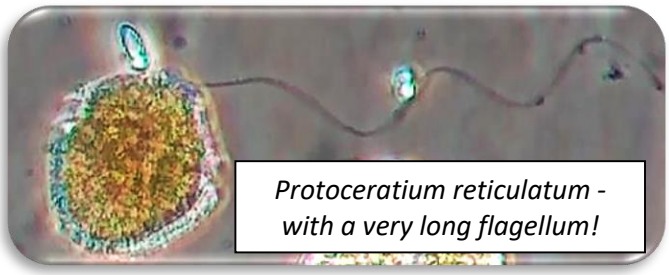
July 30, 2020 – Budd Inlet, Port Plaza

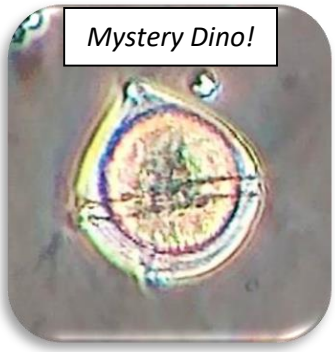
Do you ever wish you could clone yourself? Perhaps on those days when you're pulled in a million directions or, hey, when the world just needs more of you! Ha! Well, the dinoflagellate, *Akashiwo sanguinea,* is blooming this week and it's cloning itself like crazy! Or, more scientifically, the cells are asexually reproducing by **binary fission**, or the separation of one body into two new bodies. The cell simply duplicates its DNA and then divides into 2 cells, with each cell getting its own copy of the DNA. For some reason, this is the first year that I have noticed this rapid cell reproduction among *Akashiwo*. They're taking over Budd Inlet's planktonic world! In fact, I watched one cell almost split into two before my eyes! If I could have cloned myself I would have waited long enough to celebrate the "big split!" Look how close to dividing some of these cells are!

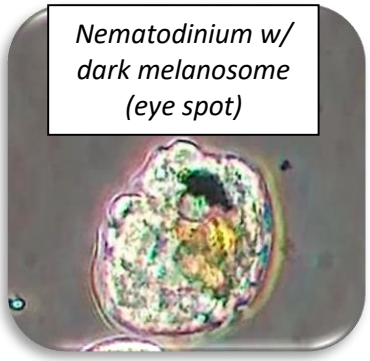


Akashiwo wasn't the only species blooming. *Protoceratium reticulatum* was also in very high numbers. *Protoceratium*, known for its reticulated (pattern of interlacing lines) plates is a species of concern because it is known to produce yessotoxin which has been shown to be toxic to shellfish in other regions. This biotoxin can also accumulate in shellfish tissues, but toxicity to humans has **not** been observed at this time. However, studies in mice indicate a response similar to paralytic shellfish poisoning. *Dinophysis* was present (250 cells/L), although less than last week's spike (1,786 cells/L). And *Pseudo-nitzschia* was almost entirely gone (42 cells/L). Data for all four of these species will be entered into the SoundToxins database.

Other dinoflagellates that were common included *Scrippsiella*, *Protoperidinium* and *Ceratium fusus*. Plankton samples from this week and last also included a large **pink** dinoflagellate that I'm guessing is a type of *Protoperinium*, but am not sure. Does anyone know what this mystery dino is? Gerardo Chin-Leo, professor at The Evergreen State College, observed many of these in his sample from Boston Harbor last week as well. The zooplankton, like always, were very entertaining to watch and included: larvaceans, barnacles, crustaceans, copepods, polychaetes, and bivalves. Later in the day, I poured the sample back into the Sound so they could grow and reach their full potential. ☺



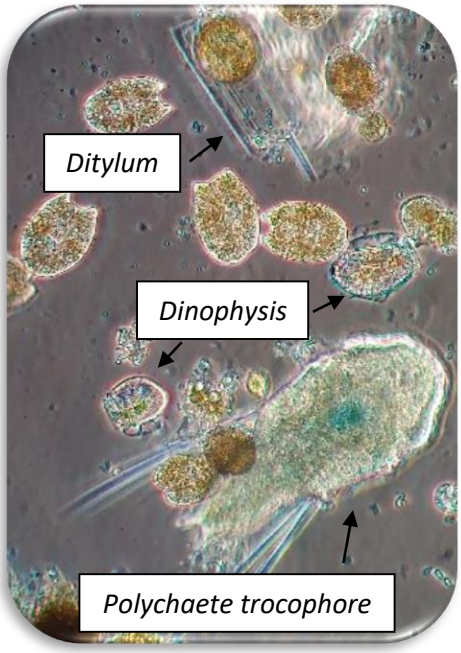




	Surface	1.5m	3.0m	4.5m
Temp (°C)	20.8	17.8	13.9	13.7
Salinity (ppt)	17.6	25.9	28.8	28.8
Oxygen (mg/l)	9.5	11.4	5.4	4.3
pH	8.6	8.6	8.2	8.1

So, how did the water look this week? The frothy scum along the shore was gone and winds were calm. Due to the heat, only a few people…and passing harbor seal…ventured to the dock. The surface water temperature was warmer than it's been all summer at 20.8°C, or 69°F. In fact, the water was very stratified with a 7°C difference in temperature between surface and 3m depth! The warm, stratified conditions seemed to contribute to low dissolved oxygen (4.3 mg/L) at depth. This reading was collected 4.5 meters deep (~15 feet), 6 feet off the bottom. Hopefully, mixing conditions are in the near future to help oxygenate these bottom waters.

Thanks for tuning in this week. Next Thursday, we're sampling at a lake again…site TBD. Have a suggestion? Let me know!



July 23, 2020 – Ward Lake (WDFW Access)

I love lakes in the summertime, so when Natalie S. suggested Spider Lake for this week – a good hour drive from Olympia – I actually plan on taking her up on it! But not this week. This week, I drove 3 minutes to sample at Ward Lake, a popular destination for open water swimmers, fisher(wo)men, paddle boarders, kayakers, rafters, and yes, inner tubers! It is not uncommon to spot a bald eagle soaring overhead this 65-acre lake, quite possibly checking out the bass, rainbow trout, and reportedly kokanee found here.

Ward Lake is a deep glacial depression, or kettle, that is fed by groundwater with no surface inlet or outlet. While it may reach 67 feet at its deepest location, the average depth is 33 feet. If you've ever swam in a lake, then I don't need to tell you how stratified they can get during the summer. While surface temperatures may be comfortably warm, they turn frigid with depth. Very little oxygen exchange takes place between the surface and depth which can sometimes lead to oxygen depletion, or anoxic waters, below. This, similar to Budd Inlet, is due to the decomposition of organic matter.

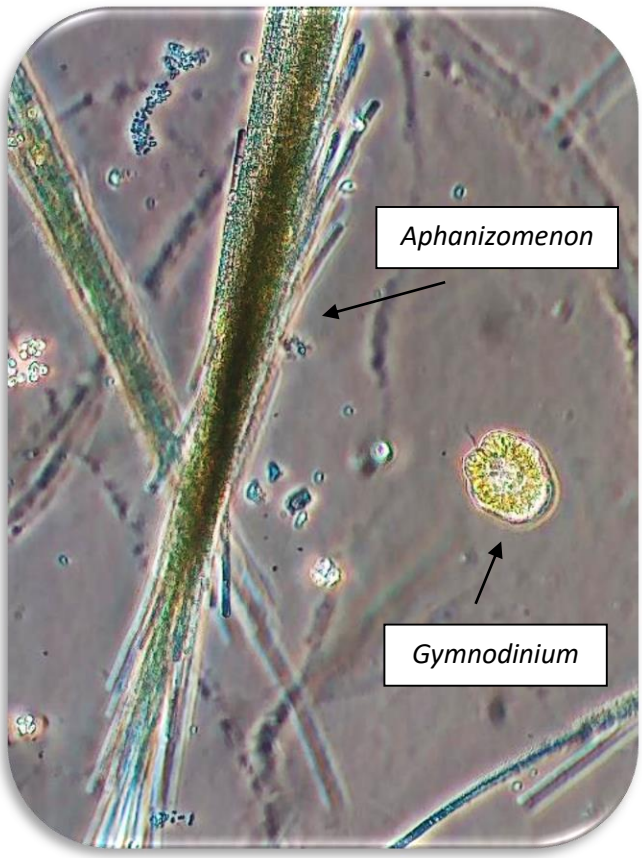
Being curious about what the temperature, oxygen, and pH profiles would look like (and not having access to a dock), we decided to collect our data via kayak and inner tube. After all, SCIENCE IS TUBULAR! ☺ So, my hypothesis was that the temperature would be warm at the surface and quickly cool with depth. I also hypothesized that the dissolved oxygen levels and pH would drop considerably at depth due to decomposition. Here's what we discovered….

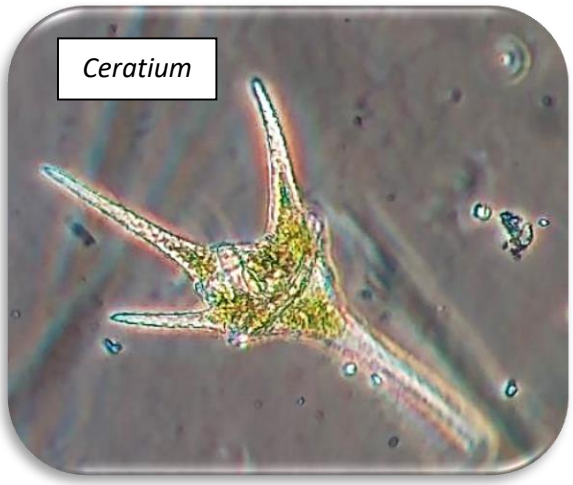
	Surface	5 ft	10 ft	15 ft
Temp (°C)	22.4	22.4	22.4	15.6
Salinity (ppt)	0.0	0.0	0.0	0.0
Oxygen (mg/l)	8.3	8.0	8.0	16.1
pH	8.1	7.8	7.8	9.9

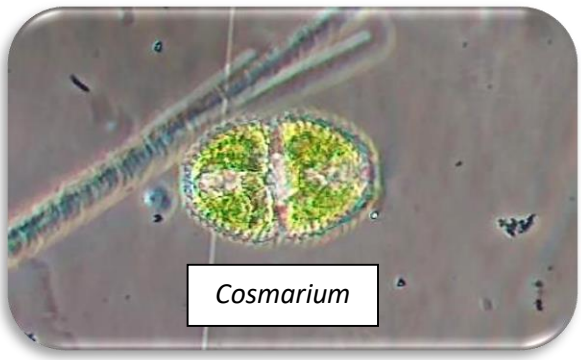
As expected, the surface temperature was warm (22.4°C = 72°F) and dropped sharply somewhere between 10 and 15 feet to 15.6°C, or 59°F (Brrrr!). This transition zone in temperature is called the thermocline.

But for oxygen and pH, my hypothesis was completely REJECTED!!! What!??? I love it when science surprises me. According to the 2017 Ward Lake Water Quality Report, oxygen levels at depth were anoxic (very low!) throughout the entire June to October sampling period. So why are we observing *significantly* increased oxygen (8 mg/L to 16 mg/L) and pH (8 to 9.9) at depth? One reason may be that cold water holds more oxygen (increased solubility of oxygen). A second reason may be that the phytoplankton are hanging out a bit lower in the water column – their photosynthesizing producing oxygen and utilizing carbon dioxide (increasing the pH). Perhaps oxygen levels will decrease at depth in late August when the temperature heats up and microbial activity is at its peak. We'll see! You know I have to go back and check!

For all you open water swimmers, here's who you've been sharing the water with! The water was teeming with small dinoflagellates – *Gymnodinium* (round and smooth), *Peridinium* (more reticulated and edgy looking), and *Ceratium*. Also common were *Aphanizomenon* (straw-like), ciliates like *Vorticella* and *Bursaria* (so cool!), and TONS of rotifers (at least 4 different species), copepods, and water fleas (Cladocerans).







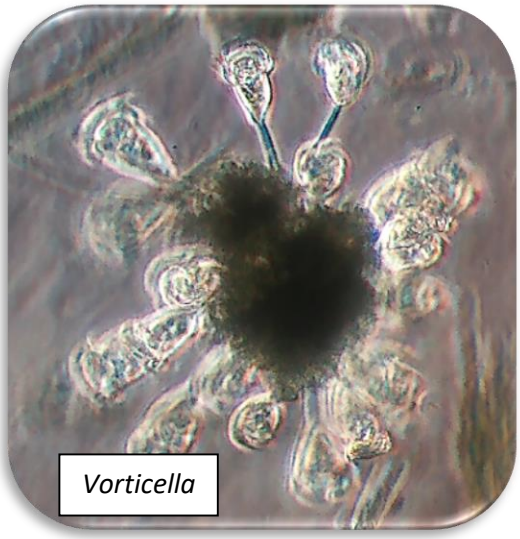
Rotifer - Keretella

Rotifer

Rotifer - Asplanchna

The HAB species, *Aphanizomenon*, was quite common, but this does not mean that it is producing biotoxin. In fact, according to the WA State Toxic Algae Database, Ward Lake has NEVER ONCE exceeded the State Guidelines for any of the 3 tested biotoxins since 2010. This spring, Ward Lake experienced a shoreline bloom of cyano-bacteria. I snapped this photo along the western edge of the lake on May 10th. Blooms of cyano-bacteria can sometimes look like paint was spilled into the water. The water was tested for biotoxins between March and May. Results from May 20th detected 0.15 µg/L of microcystin, a liver toxin, but well below the state recreational advisory levels of 8 µg/L.

Ward bloom, May 10, 2020



Vorticella


Dolichospermum, 2012

While Ward Lake does not have a history of toxic plankton blooms, it has experienced thick blooms of concern. Who remembers the big bloom of 2012!? During the summer, water visibility plummeted to dangerously thick concentrations. I recall dangling my feet over the kayak and not being able to see my toes! Prior to the lake closure, I went swimming and collected a plankton sample that was full of *Anabaena* (renamed *Dolichospermum*). Do they look like brains to you? Swimming through them actually felt like swimming through oxygenated bubbly brains. Fortunately, water testing results for all 3 toxins throughout the summer remained below the MDL, or method detection limit.

In 2012, Thurston County Environmental Health did, however, report spikes in Total Nitrogen, Total Phosphorous, and Chlorophyll. And in late August the lake was closed to swimming after fecal coliform bacteria levels were 12 times the State's limit of 50 fcb/100 ml!!!!

In 2017, Thurston County Environmental Health published the Ward Lake Water Quality Report indicating that water quality was quite good and had returned to normal between 2012 and 2017 for Total Nitrogen (0.877 to 0.313 mg/L), Total Phosphorous (0.015 to 0.008 mg/L), and Chlorophyll (15.98 to 4.15 µg/L). Great news for this gem of a lake!

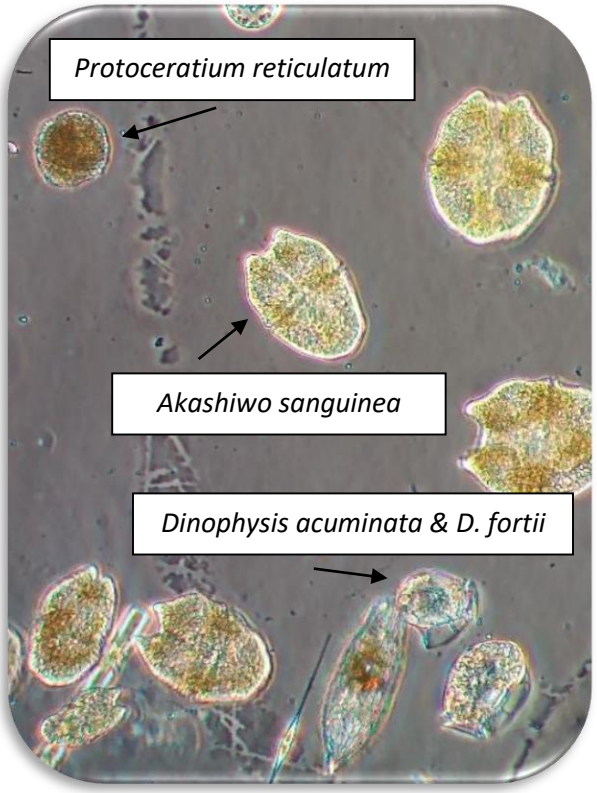
To keep lakes healthy and prevent the overgrowth of microscopic algae and nuisance aquatic weeds like pondweed, elodea, and milfoil, nutrient reduction best management practices are key! Always remember to responsibly clean up after your dogs. If you are fortunate to live on a lake, you can safeguard water quality by protecting shoreline habitat buffers, following proper fertilizer application procedures, and maintaining your septic system. Thank you!

The water looked great today! It was wonderful seeing so many people fishing and open water swimming.

Do you have a favorite lake within Thurston County that you would like us to feature? Send me your suggestion at aimee@pacshell.org.

July 22, 2020 – Budd Inlet, Port Plaza

After looking at the plankton, I returned them to Budd Inlet. Here's the lovely view from the dock by the Hearthfire Restaurant.



	Surface	1.5m	3m	4.5m
Temp (°C)	20.6	17.6	17.3	15.4
Salinity (ppt)	13.3	25.8	27.0	28.0
Oxygen (mg/l)	8.5	9.3	10.9	6.6
pH	8.6	8.4	8.5	8.2

Secchi disk: 1.9 meters

Number of species: 37

Blooming Species: *Akashiwo sanguinea, Dinophysis*

Common Species: Diatoms (*Thalassisira*, *Cylindrotheca, Melosira, Nitschia acicularis)*

Dinoflagellates (*Noctiluca, Protoperidinium, Protoceratium, Scrippsiella*)

Zooplankton (*Tiarina*)

HAB Species:

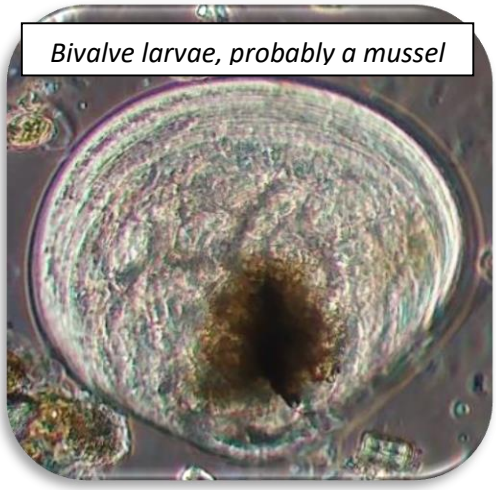
Pseudo-nitzschia (24 cells/L from net tow; 0 cells/L from whole water sample concentrated 10X.
Dinophysis (1,786 cells/L) – a mix of *D. acuminata, D. fortii, D. norvegica,* and *D. parva*
Protoceratium reticulatum (Common) – species of concern due to production of yessotoxin
Akashiwo sanguinea (Blooming) – species of concern due to association with shellfish mortality events and sea bird mortality (on outer coast on rare occasions)

July 16, 2020 – Budd Inlet, Port Plaza

What's not to love about Olympia in the summertime? The weather was perfect this afternoon – breezy and warm – and the view of the water made me feel like I was on vacation. Folks were rowing, kayaks dotted the shoreline, and a great blue heron sat quietly observing.

The YSI instrument measured the warmest surface temperatures so far this summer – 19.2°C, or 66°F. This was up from 14.8°C last week! (It sprinkled if you recall). Interestingly, while the oxygen level was 9.9 mg/l near the surface, it dropped to 4.6 mg/l at 3-meter depth suggesting that decomposition of settled organic matter was taking place in bottom waters. Water clarity was similar to last week (a little over 2 meters) and the plankton sample was a nice golden hue. As the jar sat for a few moments, the bioluminescing dinoflagellate, *Noctiluca,* formed a thick band near the surface. They are definitely still common, but not at high enough concentrations to turn the water a bright tomato soup color. The shoreline was lined with a bit of sea foam – possible due to the combination of wind and the dinoflagellate *Akashiwo sanguinea*. This species can produce a frothy surfactant-like foam when disturbed leading to seabird mortalities on the outer coast on rare occasion.

Akashiwo sanguinea

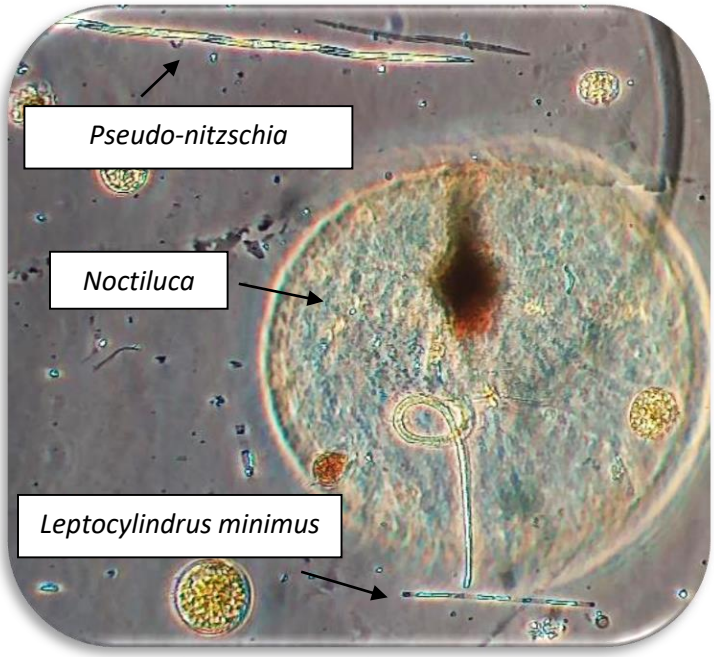


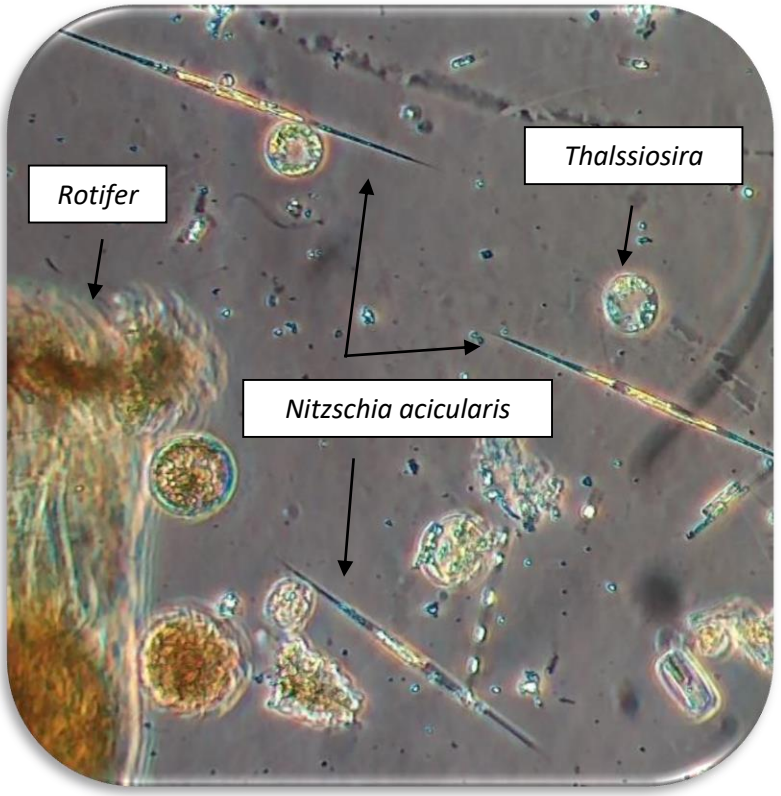
Bivalve larvae, probably a mussel

The rain event in early July (and last week's showers) likely carried nutrients into Budd Inlet via mixing of the water column and river flow from the Deschutes. It was, therefore, not surprising to observe more diatoms in today's sample. *Thalassiosira* was blooming and *Nitzschia acicularis* and *Pseudo-nitzschia* were quite common. Common dinoflagellates included *Noctiluca*, *Protoperidinium*, *Dinophysis* and *Nematodinium*. Zooplankton were plentiful including tintinnids, rotifers, tiarina, barnacles, polychaetes,

copepods and bivalve larvae. A total of 39 species were recorded.

The harmful algal bloom species, *Pseudo-nitzschia* (2,792 cells/L) and *Dinophysis* (262 cells/L) were still common, but significantly reduced from last week. Most *Pseudo-nitzschia* cells looked unhealthy with faded chloroplasts or completely empty frustules.





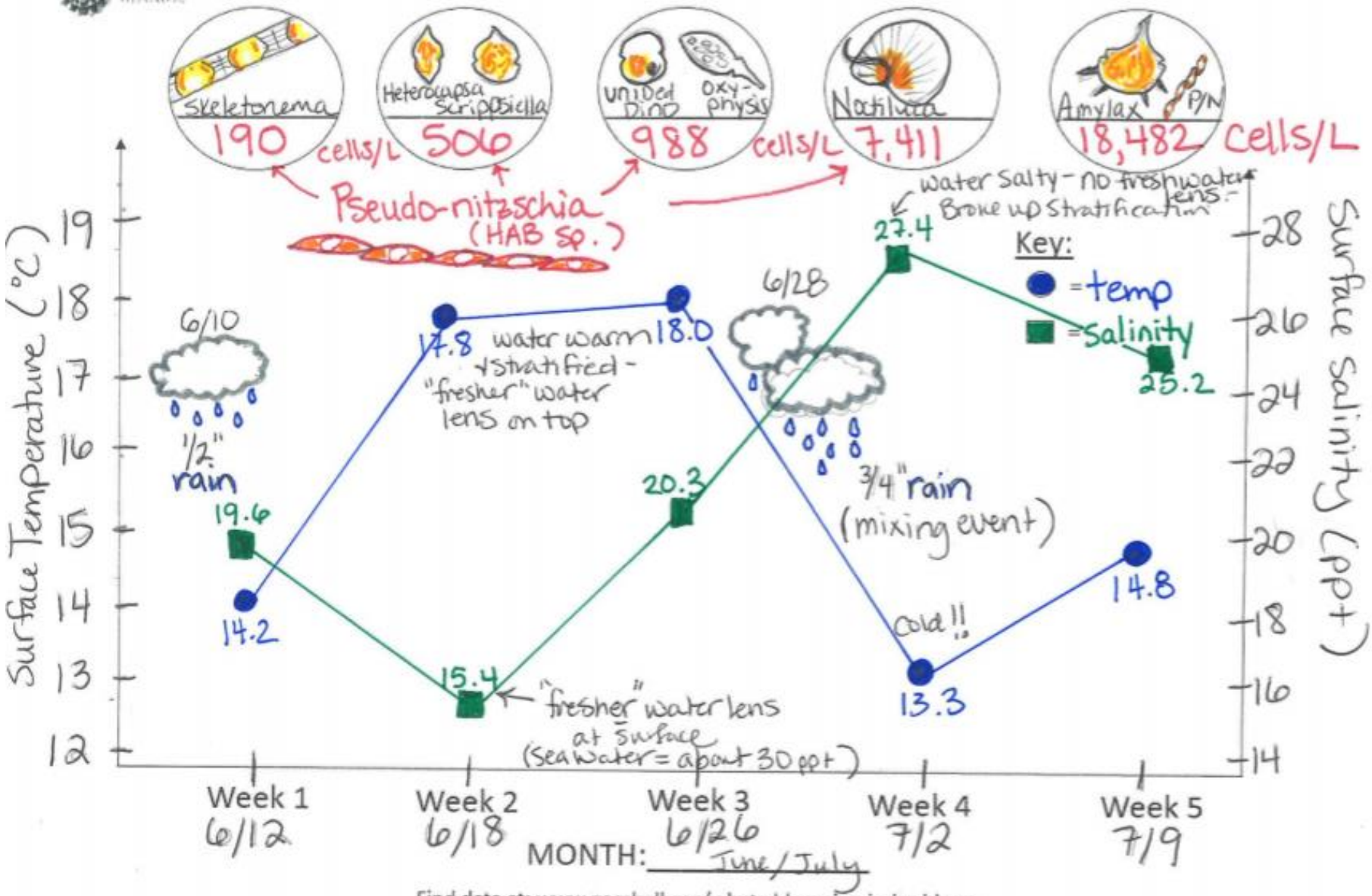
Plot-Along-At-Home

As we enter the 6th week of the 2020 "What's Blooming?" program, the amount of data is also blooming! As scientists, it is not uncommon to collect a daunting amount of information during the "field season." How do we make sense of all of these numbers on our spreadsheets? One way to visually illustrate the data is to graph it. Once the numbers are plotted, they begin to tell a story. Interpreting graphs can be like a puzzle and it's our job to try to scout out changes and patterns.

Why don't you give it a try! Now is a great time to Plot-Along-At-Home. This week, I started to play around with the data. I chose to plot surface temperature and salinity. The first thing I noticed was a huge drop in temperature (18°C to 13°C) that occurred between 6/26 and 7/2. At the same time, the salinity increased from 20 ppt to 27 ppt. Why did the water suddenly get so cold and salty? If you answered, "a storm," then you are correct. I looked up rainfall data and sure enough, it rained 0.78 inches on 6/28, a few days prior to sampling. The stormy weather dropped air temperatures and mixed the water column bringing colder, saltier bottom waters to the surface. I drew clouds and rainfall data on my graph to depict the storm event. I also sketched plankton that were blooming. Since *Pseudo-nitzschia* concentrations had been on the rise, I plotted those numbers as well. Crane your neck sideways and check out my graph…

Pacific Shellfish Institute

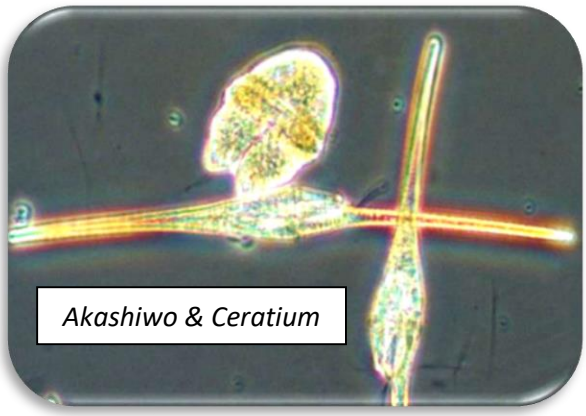
PLANKTON & WATER QUALITY MONITORING - BUDD INLET



Find data at: www.pacshell.org/whats-blooming-in-budd.asp

Typically, plankton shift from mostly diatoms in the spring to mostly dinoflagellates during the summer. As explained during Week 1, this shift is due in part to the water becoming stratified during the warm, calm "dog days of summer." Diatoms in the surface layer thrive, but eventually deplete dissolved nutrients (like nitrates and phosphates) and peter out. Whereas, dinoflagellates are able to migrate to deeper waters to access nutrients using their flagellas giving them a competitive advantage. When a mid-summer storm rolls through, water column mixing and river inputs provide a new pulse of nutrients. This can create a flurry of diatom growth particularly if the storm is followed by nice sunny weather allowing cells to bask in the sun-lit surface waters and multiply. Eventually, the diatoms are outcompeted (and grazed down) once again by mostly dinoflagellates.

So, does our "What's Blooming?" data support this pattern? I think so. At the beginning of the season (Week 1), *Skeletonema* and other diatoms dominated the sample. Water temperatures quickly heated up leading to stratification and a shift to mostly dinoflagellates during Weeks 2 and 3. After the 6/28 storm, the secchi disk reading increased from 1.7 to 3.5 meters reflecting a well-mixed water column with less plankton overall. Although nutrients may have been high, it's difficult for diatoms to multiply while active mixing is taking place. I'm actually surprised that *Noctiluca* was blooming during this time!



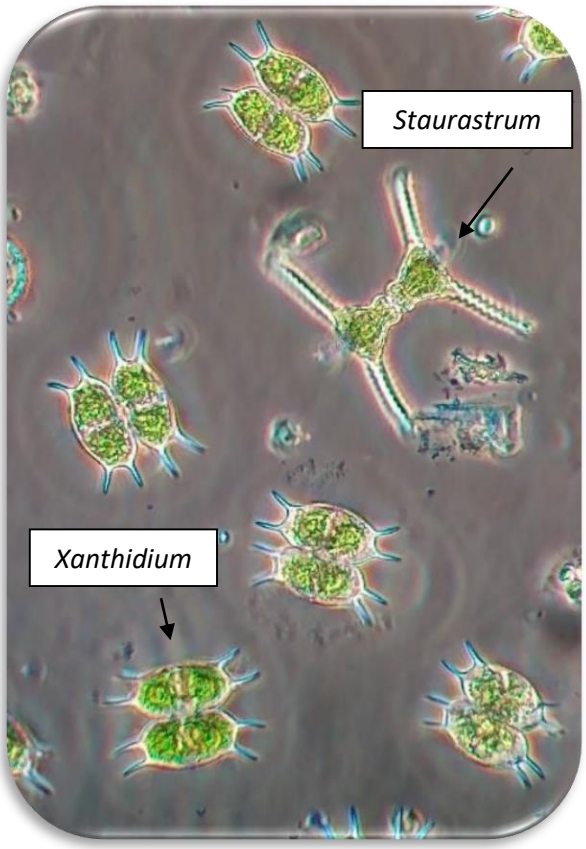
The diatom, *Pseudo-nitzschia*, also skyrocketed post-storm, increasing from 988 cells/L to 7, 411 to 18,000! However, these counts had been slowly increasing since the beginning of the summer, so I'm not sure if the nutrient pulse was entirely responsible. The week following the rain event, the diatom, *Thalassiosira*, started blooming (Weeks 5 and 6 – not sketched). As the weather continues to heat up, I predict that the plankton will shift to almost entirely *Akashiwo sanguinea* and *Ceratium fusus* as it has in past years. Their numbers are on the rise already! Stay tuned to find out!

Why don't you plot some data? It's fun! Share your Plot-Along-At-Home graph with us and we'll send you a deck of **NOAA's Phytoplankton Flash Cards!**

Visit us next week as we head to a local swimming lake! Where's your favorite place to swim? Let us know and we'll feature it next Thursday!

July 9, 2020 – Black Lake – Kenneydell County Park

Originally I was supposed to sample at Barnes Lake today. Last night, however, I realized that there is no public access to this lovely lake right in the heart of Tumwater. So, by special request (!!) I decided to sample Black Lake at Kenneydell Park. Thank you, Bonnie B., for e-mailing this wonderful suggestion. If you haven't been to this park, I highly recommend it. As the rain came down, only 4 brave souls decided to jump in for a swim. If you look closely, you might be able to spot them. The water temperature was 66°F, so I only heard shouts of initial discomfort before their bodies acclimated. At the surface, the pH was 8.15 and the oxygen was 9.71 mg/L. At the end of the dock, the water depth was 6 feet. This is where the secchi disk hit bottom when I tried to measure water clarity, so the visibility is greater than 2 meters. In fact, the water looked great and I was tempted to jump in myself. The plankton tow revealed a nice green hue. I wonder what's blooming in Black Lake?



Whoa!! I've never seen the species that was blooming and had to look it up – *Xanthidium*. Aren't they amazing?! They really pop out with those protrusions jutting off the sides. *Staurastrum* was common, as well as *Fragilaria* and *Aulacoseira*. Rotifers were also extremely plentiful. In fact, I noted at least 3 types – *Keratella*, *Kellicottia* and particularly the one pictured below.

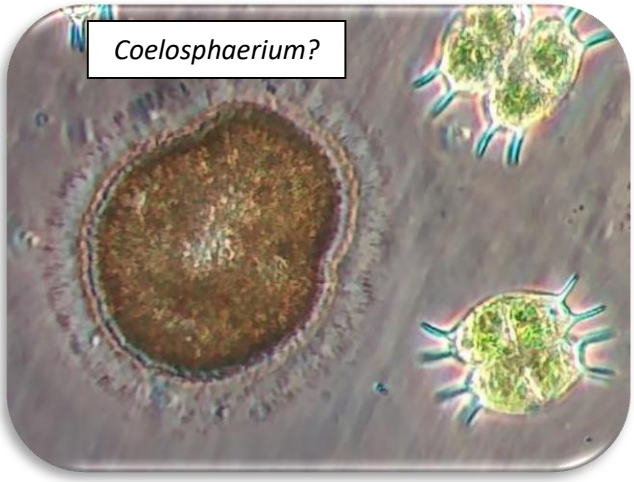
A total of 25 species were identified. Some, species, however, I was unable to assign a name, so I placed a question mark after my best guess. Do you

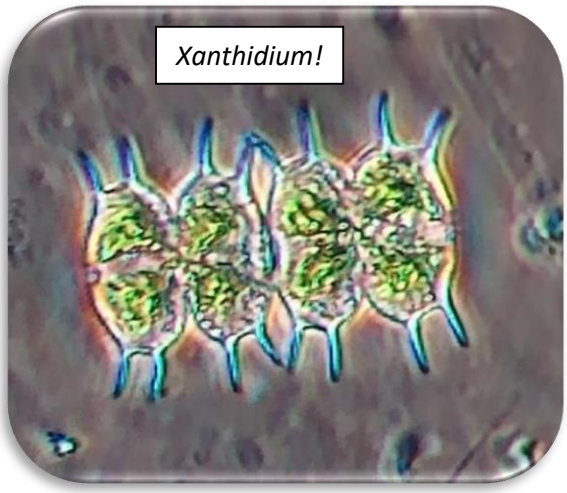
know what they are? There must be a few freshwater plankton taxonomists out there in the audience. I'd love to hear from you! You can reach me at aimee@pacshell.org.

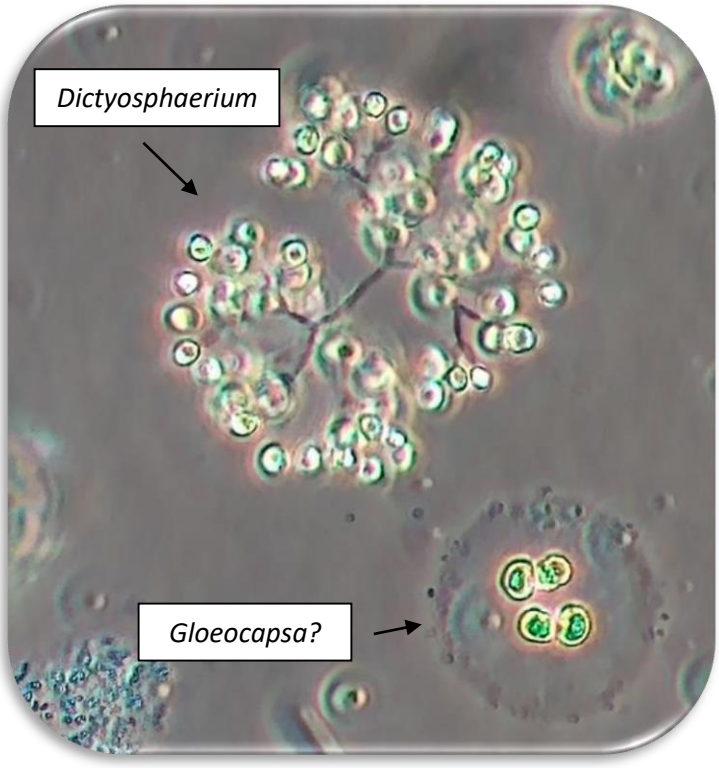
As far as cyano-HABs, or the species that can produce biotoxins, I observed *Dolichospermum* and *Aphanizomenon*, but in very small quantities.

It's quick n' easy to look at historical toxicity data for a particular lake. A visit to Ecology's state-wide lake map, www.nwtoxicalgae.org, revealed that Black Lake was closed due to the microcystin toxin in 2010, 2011, 2012, 2014 and 2015, but not since. The last time the lake was tested was October, 2019. We can all do our part to keep excess nutrients out of lakes and Puget Sound by minimizing our use of synthetic fertilizers, picking up pet waste, and properly maintaining septic systems. No need to "feed" the algae, especially those harmful algal bloom species!

That's all for this week. Sunny days are right around the corner, so go swim with those ***Xanthidium*** and rotifers!







July 8, 2020 – Budd Inlet, Hearthfire Restaurant Dock

Secchi disk: 2.1 meters

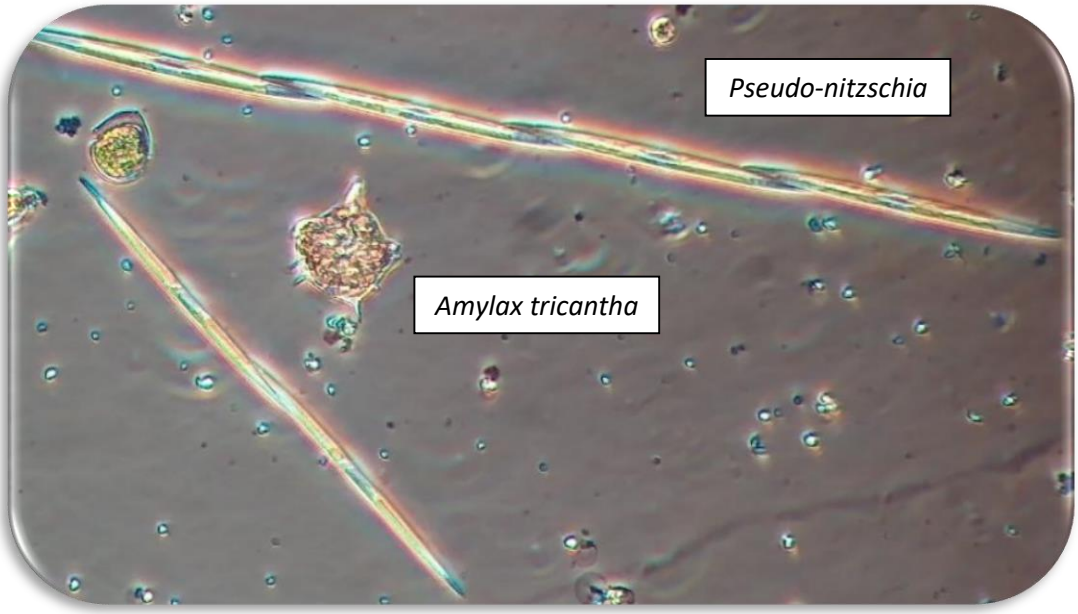
	Surface	1.5 m	3 m
Temp (°C)	14.8	13.5	13.3
Salinity (ppt)	25.2	28.3	28.4
Oxygen (mg/l)	10.5	11.7	11.4
pH	8.11	8.33	8.37

Number of species: 35

Blooming Species: *Pseudo-nitzschia, Amylax tricantha*

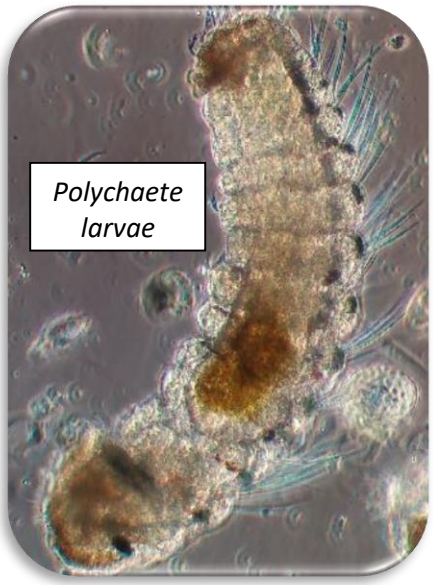
Common Species: Diatoms (*Thalassionema*, Dinoflagellates (*Noctiluca, Oxyphysis, Ceratium fusus*), Zooplankton (*tintinnids, tiarina, Mesodinium rubrum*).

HAB Species:
Pseudo-nitzschia (18,482 cells/L from net tow; 34,000 cells/L from whole water sample concentrated 10-fold).
Dinophysis (1,554 cells/L) – a mix of *D. acuminata, D. fortii, D. norvegica,* and *D. parva* from net tow.
Akashiwo sanguinea present from net tow.

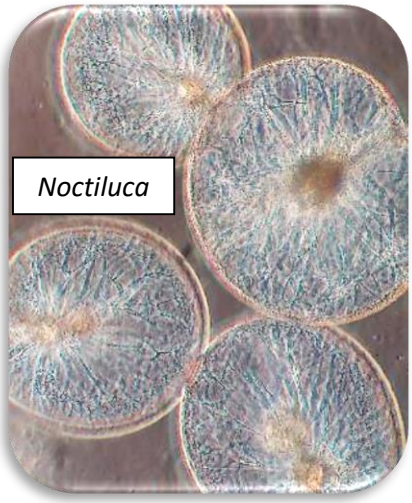


July 2, 2020 – Budd Inlet

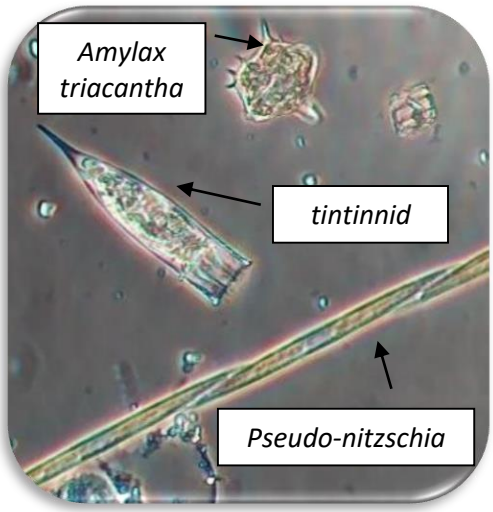
What can I say?! It's a zoo in there! Today's sample was full of ciliates and zooplankton including polychaete worms (adorable), rotifers, mussel larvae, tintinnids, tiarina, barnacle larvae, copepods, crustacean larvae and larvaceans. It was a whirlwind of activity and I wished that you-all were on the dock with me looking through microscopes! Patience…we'll get there again.



This week, there are two important things to note. First, *Noctiluca* are blooming! After the jar of plankton sat for a bit, all the *Noctiluca* floated to the surface in a nice thick orange band. That's right you bioluminescent lovers – the time is here! The water will sparkle for the 4th of July (especially if we can get some clouds to cover the full moon). Splash around and enjoy the light show.



Second, the harmful algal bloom species (HABs) are ramping up in numbers. Among the hordes of ciliates and zooplankton, I couldn't help but notice *Dinophysis* and *Pseudo-nitzschia* spread throughout. Over the past 3 weeks, *Pseudo-nitzschia* cell counts, the species responsible for Amnesic Shellfish Poisoning, have increased from 500 cells/L to 1000 cells/L to 7,400 cells/L! Tomorrow I will perform cell counts from a whole water sample for more accuracy. *Dinophysis*, the species responsible for Diarrhetic Shellfish Poisoning, also increased from 50 cells/L to 500 cells/L.

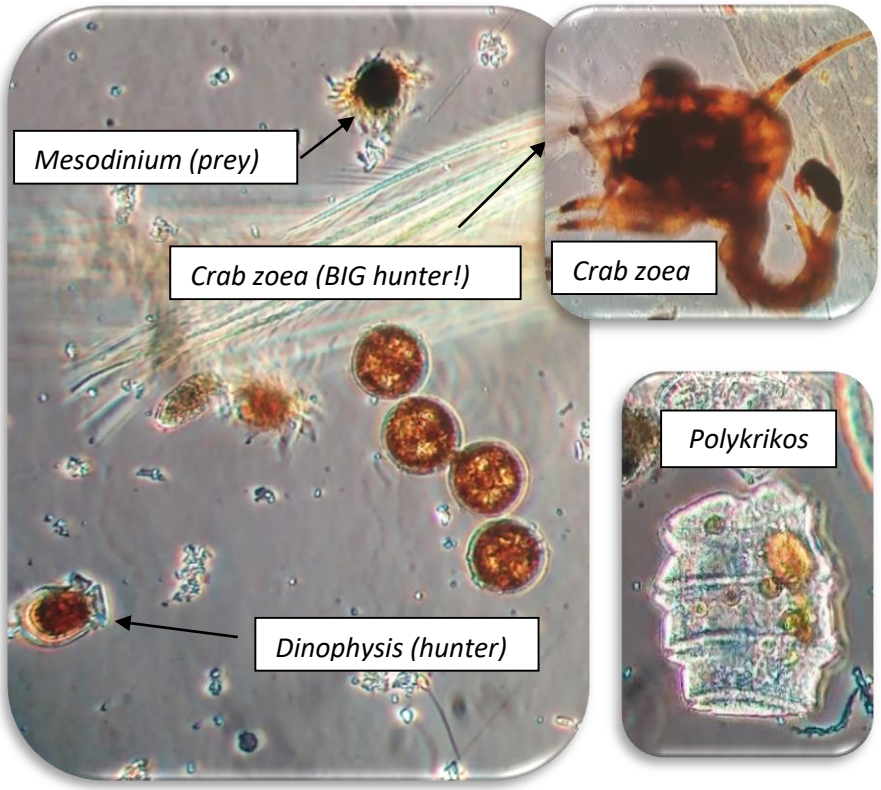


Today I had one additional task. I shipped water samples to NOAA: 2-L whole water, 125 ml jar of concentrated net tow sample, and a vial of preserved net tow sample. The reason behind the shipment requires a bit of explaining….

Were you taught that phytoplankton are microscopic plants and zooplankton are microscopic animals? I was, and only recently learned that's not completely true. A more accurate statement would be that phytoplankton are microscopic plant-**like** organisms.

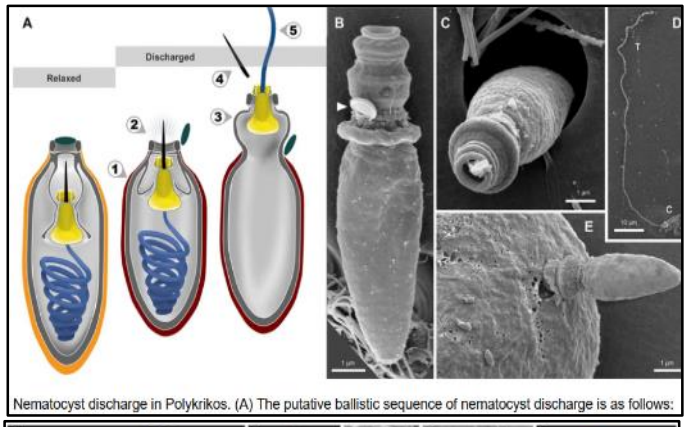
Phytoplankton are actually protists. If you're like me, you might have to web-search "protist" to remember what that is. A **protist** is essentially a single-celled eukaryote (organism with a nucleus) that is such an oddity that it can't be grouped as a plant, animal, or fungi. They include diatoms, dinoflagellates, coccolithophores, ciliates, and a few other groups.

Yes, it is true that diatoms are plant-like. They are **autotrophs** meaning they make their own food using chloroplasts to photosynthesize. Some dinoflagellates are also plant-like using chloroplasts to make their food. However, this is where the similarities stop. Dinoflagellates have 2 whip-like flagella for locomotion (not very plant-like). Many are also **mixotrophs**, meaning they obtain their nutrients in a mixture of ways – photosynthesizing like a plant and hunting like an animal. For a microscopic single-celled organism, I find this very impressive! This week, the water is teeming with mixotrophic dinoflagellates: *Dinophysis, Oxyphysis, Polykrikos, Nematodinium*, and *Noctiluca*. A sea full of hunters!

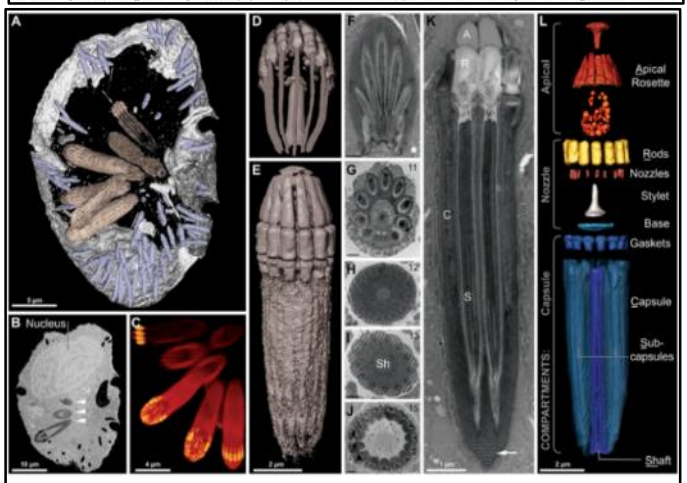


Take *Dinophysis*, for example. Featured in Scientific American as a "Tiny Killer," this mixotrophic protist derives its energy by both hunting and photosynthesizing. *Dinophysis* are selective in their prey, feeding on ciliates like *Mesodinium rubrum* by piercing them with a straw-like feeding tube and sucking out their insides. Researchers would love to study this

Gavelis G.S. et al. recently discovered that *Polykrikos* and *Nematodinium* (both in our sample today) use "two fundamentally different types of ballistic mechanisms" to discharge nematocysts (coiled or barbed often venomous threads used for defense or capturing prey). "One type relies on a single pressurized capsule for propulsion, whereas the other type launches 11-15 projectiles from an arrangement similar to a Gatling gun." What?!! Very un-plantlike. ☺



Nematocyst discharge in Polykrikos. (A) The putative ballistic sequence of nematocyst discharge is as follows:



Reconstruction of the nematocysts in Nematodinium sp. (A to E) Images derived from single-cell FIB-SEM. (A)

2017. Gavelis, G.S. et al. *Microbial arms race: Ballistic "nematocysts" in dinoflagellates represent a new extreme in organelle complexity*. Science Advances, Vol 3, #3.

fascinating creature in the lab, but this is complicated by the fact that *Dinophysis* can't be cultured in a typical nutrient broth with light. They also require their favorite food, *Mesodinium*.

I've seen *Mesodinium* in Budd Inlet samples, which isn't surprising since Budd is consistently home to *Dinophysis* and a hotbed of DSP activity. Last month, I shipped bottles of Budd Inlet water to Brian Bill at NOAA NWFSC and he successfully isolated a few cells of both species in the lab. Nicely done!

Today, I shipped another batch of water because of an accidental discovery. Last week, the SoundToxins program asked me to collect a whole water surface sample (in addition to the net tow) to perform *Pseudo-nitzschia* cell counts. This method is more accurate for quantification, especially for diatom species (no cells sticking to the net among other reasons). I concentrated the sample 10-fold, loaded 0.1 mls onto a counting chamber and looked under the microscope. Since the Deschutes River creates a nice brackish, warm surface lens, I didn't expect to find much. Surprise!!! The sample consisted almost entirely of *Mesodinium* (66,000 cells/L). So this is where you've been hanging out, my little ciliated friends. ☺

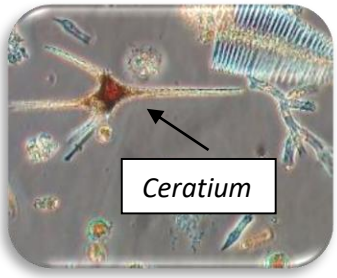
So off goes another shipment of water (hopefully full of *Mesodinium* and *Dinophysis!*) to Brian.

That's all for today! Join us next week as we go for a swim and collect plankton from Barnes Lake!

June 25, 2020 – Long Lake

What a beautiful day at Long Lake! The water was relatively clear (slightly golden brown) and the perfect temperature for swimming (22.1°C or 71.6°F). I predicted by the oxygen levels (8.03 mg/l) and the pH (8.48) that the water would be teaming with phytoplankton, but definitely not blooming. As I waded out into the water I watched schools of small fish dart along the shore in unison. I cast the plankton net out into the water and pulled it towards me – towing it about 6 inches below the surface. I did this twice and then emptied my sample into a jar. The water was a light golden color - not too sparse, not too thick, but just right.

Using my field microscope, I started screening for plankton species and attaching pictures onto the "What's Blooming?" display board. It didn't take long to find my first 10 species. Oh my gosh… freshwater plankton are amazing!!! At first I noticed mostly centric diatoms (*Stephanodiscus*), pennate diatoms (*Fragellaria, Asterionella*), and dinoflagellates (*Ceratium*). The freshwater variety of *Ceratium* has 3 horns!!! Then, zooplankton began darting all over the slide – rotifers, cladocerans (water fleas), and crustacean larvae (I suspect an early life stage of a copepod). I also noticed 2 harmful algal bloom (HAB) species in my sample – *Dolichospermum* (formerly named *Anabaena*) and *Aphanizomenon,* both blue-green algae.

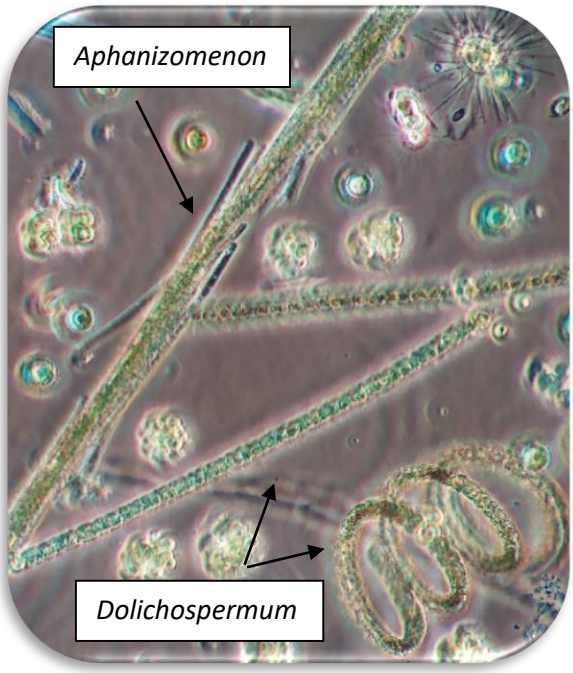


Blue-green algae, also known as **cyanobacteria**, are primitive life forms closely related to bacteria. When light, warm temperatures, and nutrients are available, they can bloom, or rapidly multiply. Nutrient rich water can support the rapid growth of cyanobacteria, turning a lake green in just a few days. Thick blooms of cyanobacteria caused swimming beach closures at Long Lake the past 2 summers. During the "What's Blooming?" sampling events, we measured water clarity values as low as 3 to 5 feet!

Cyanobacteria can produce toxins at levels that are harmful to humans, pets, and wildlife. Some produce nerve toxins, liver toxins, and toxins that affect the skin & gastrointestinal tract. Lakes

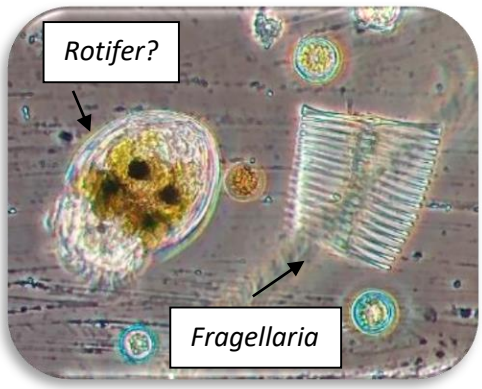
are tested for toxins through a partnership between **Thurston County** and **Washington Department of Ecology**. Check lake advisories by visiting Thurston County's Blue-Green Algae Page at: www.co.thurston.wa.us/health/ehadm/swimming/blue_green_algae.html. You can also find the most recent toxin data for your lake using Ecology's state-wide map at www.nwtoxicalgae.org.

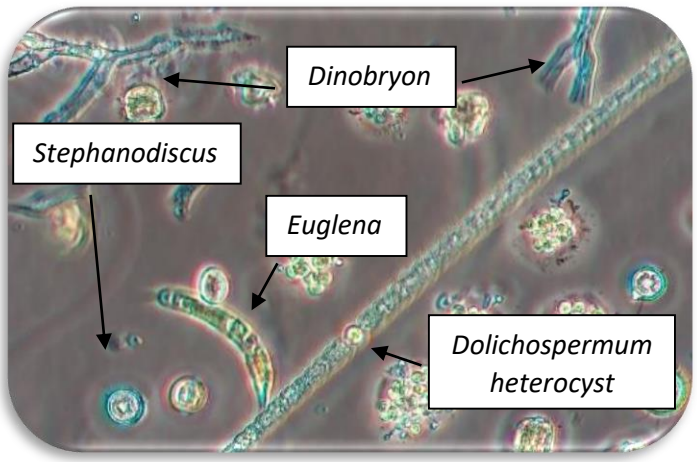
Back at PSI, I took another peek at the plankton sample. A peek turned into 2 hours of being completely mesmerized by the diversity and movement within the sample. When I pulled myself away from the scope I had identified 35 species. I'm sure there were many more. I have to be honest. I have been identifying marine phytoplankton for 20 years and while there is always more to learn (!), I am fairly confident in my skills. Freshwater plankton identification, however, is more of a hobby. I started learning how to identify these species when I began open-water swimming several years back. I've attended workshops and own a handful of books, but my ID skills are definitely not as strong (so many green rolling balls!). If there are any freshwater taxonomist out there, please feel free to set me straight if I make an error!



That said, here are some photos from today's catch….

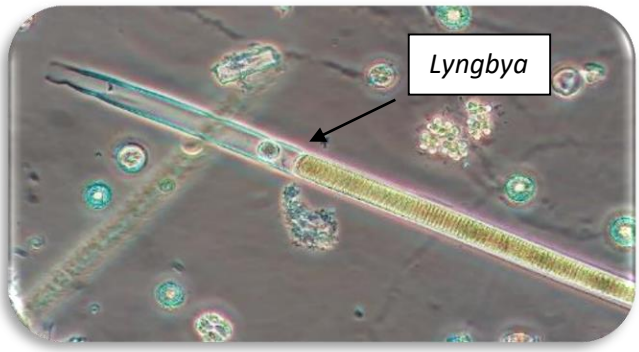
This first photo shows the 2 cyano-HAB species: *Dolichospermum* (formerly named *Anabaena*) and *Aphanizomenon*. Remember, similar to marine HABs, these species can exist in the water without producing biotoxins. Each strand of *Dolichospermum* is called a trichome. The trichomes can be straight, curvy or coiled. This photo shows both straight and coiled. They can also have **heterocytes** (heterocysts), or sites of nitrogen fixation. *Aphanizomenon* looks a bit like clumps of matted straw.





Can you believe that all of these organisms are sharing the lake with you when you go swimming? Amazing! It's hard to look at a lake, or any body of water, the same after you discover the microscopic world of plankton!

Next week, we return to the marine world of Budd Inlet. Until then, enjoy the wonderful sunny weather! The plankton are!



June 26, 2020 – Budd Inlet

Secchi disk: 1.7 meters

	Surface	1.5 m	3 m
Temp (°C)	18.0	13.3	13.2
Salinity (ppt)	20.3	28.1	28.2
Oxygen (mg/l)	10.8	9.7	9.2
pH	8.2	8.2	8.3

Number of species: 36

Blooming Species: An unidentified dinoflagellate that looks like *Gymnodinium or Nematodinium* (awaiting ID confirmation from NOAA).

Common Species: Diatoms (*Thalassionema, Thalassiosira, Actinastrum, Pseudo-nitzschia*), Dinoflagellates (*Noctiluca, Oxyphysis*), Zooplankton (*tintinnids, tiarina, Mesodinium rubrum*).

HAB Species:
Pseudo-nitzschia (988 cells/L from net tow; 8,000 cells/L from whole water sample concentrated 10-fold).
Alexandrium (12 cells/L) from net tow.
Dinophysis (54 cells/L) – a mix of *D. acuminate, D. fortii, D. norvegica, D. parva* and *D. rotundata* from net tow.
Akashiwo sanguinea present from net tow.

June 18, 2020 – Budd Inlet

Today is the kick-off of the "What's Blooming?" season and what a beautiful afternoon to sample! Michelle Stevie from Olympia StreamTeam joined me for some socially distanced plankton monitoring.

The first data we collected was water clarity. The secchi disk disappeared at a depth of 1.9 meters suggesting that there was quite a bit of plankton in the water. With the recent rains (carrying nutrients into the Inlet) followed by sunshine, the phytoplankton should be very happy!

Next, using a YSI instrument, we collected water quality data readings from the surface to a depth of 3 meters.

Here are the numbers:

	Surface	0.5 m	1 m	1.5 m	2 m	2.5 m	3 m
Temp (°C)	17.8	17.0	17.2	15.0	13.3	12.9	12.1
Salinity (ppt)	15.4	16.5	18.4	26.3	27.9	28.3	28.5
Oxygen (mg/l)	8.6	9.2	10.0	12.2	9.7	9.9	7.4
pH	8.2	8.3	8.4	8.4	8.3	8.4	8.2

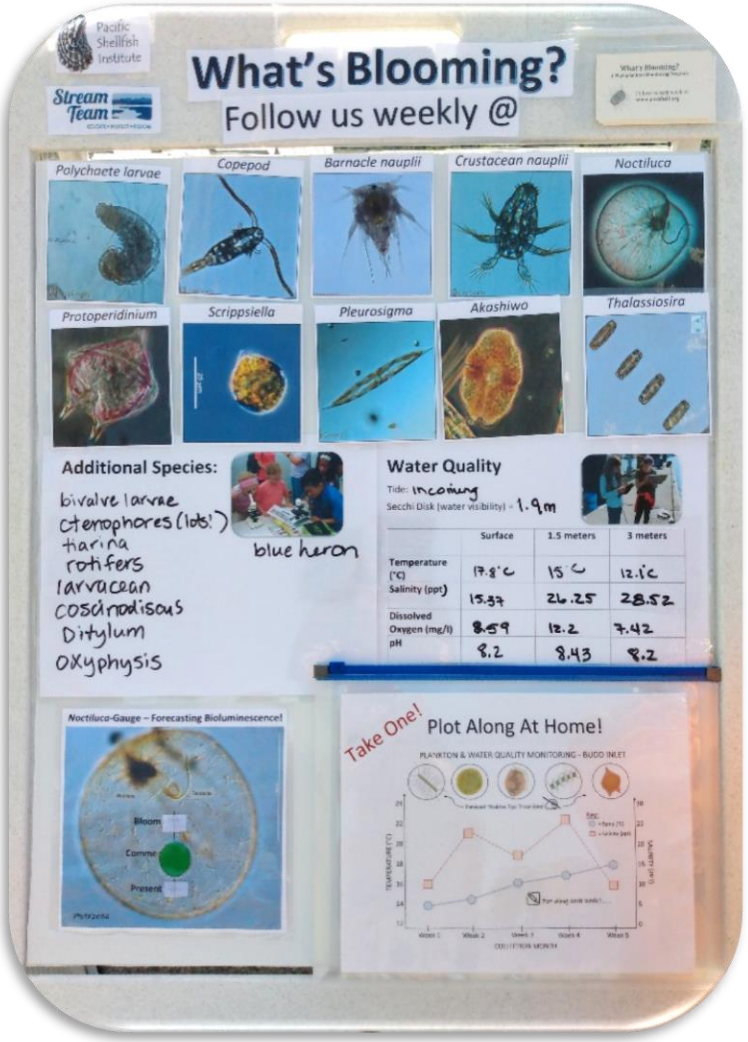
Notice how the temperature dropped from 18°C (64°F) at the surface to 12°C (54°F) 3 meters below the surface. Observe the rapid increase in salinity between 1-m and 1.5-m (18 ppt to 26.3 ppt). Wow! The water was stratified with warmer fresher water sitting above a cooler, saltier layer. At this interface, you will typically find the highest concentration of plankton. Judging from the elevated dissolved oxygen concentrations (10-12 mg/l) at this same depth, that appears to be the case! As phytoplankton photosynthesize, they release dissolved oxygen into the

water. At the same time, they utilize carbon dioxide removing it from the water which increases the pH slightly. Isn't it interesting how these numbers can give us clues as to the overall quantity and location of phytoplankton?!

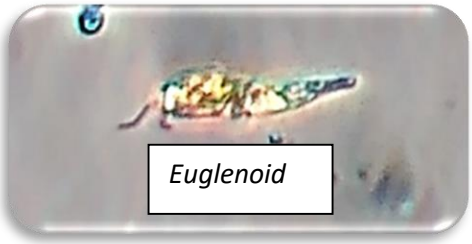
As I pulled the net up from a 3m depth, I was surprised that the water wasn't golden orange from the phytoplankton. I was also surprised to find a jar full of round ctenophores, or goose berries! Their beating cilia cast radiating rainbow colored bands down their sides. Holding the jar up to the light, Michelle and I could see that there were a lot of plankton, but not dominated by plankton with golden orange chloroplasts. What did we catch!?

We loaded the sample onto a field microscope and discovered that species diversity was high, but not with chain-forming diatoms like in previous weeks, but rather dinoflagellates and zooplankton! "The switch" is happening!

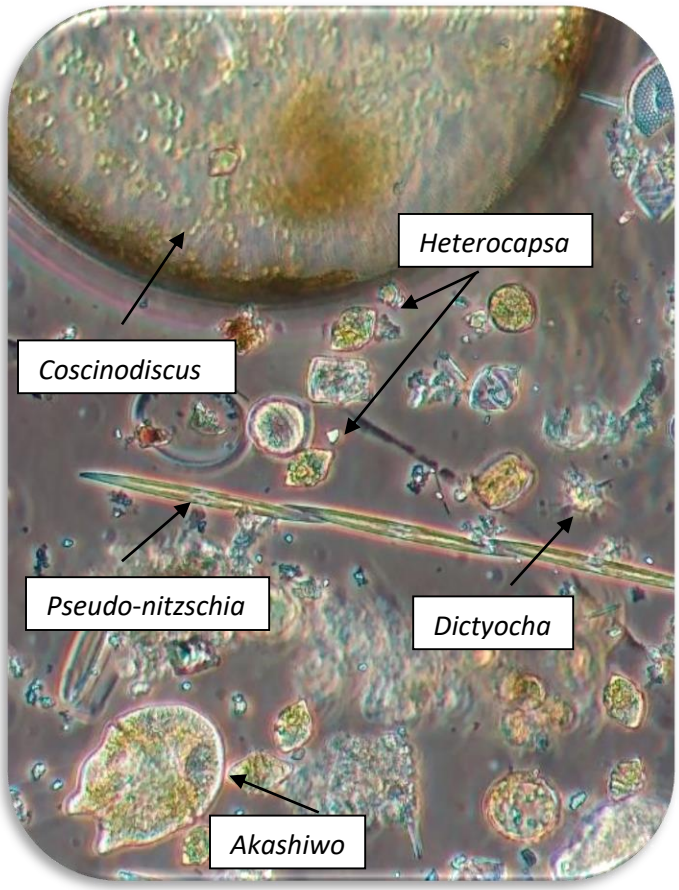
By the switch, I am referring to a change in species composition that takes place every summer in lower Budd – a change from chain forming diatoms to predominantly dinoflagellates. This natural progression occurs as surface temperatures warm and spring mixing dissipates creating stratified conditions. Diatoms may initially thrive in this surface layer, but they eventually deplete their nutrient supply. Unable to actively swim to nutrients at depth, the diatoms are soon replaced by dinoflagellates. With their 2 whip-like flagella, dinoflagellates are able to migrate vertically accessing nutrients at depth giving them a competitive advantage.



Each week we update this sandwich board and leave it at the Port Plaza dock for the remainder of the day. The other side of the board provides information about harmful algal bloom species.

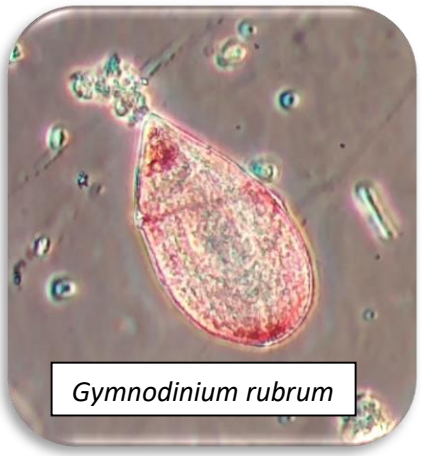


Back at PSI's lab, I looked at the sample more carefully under the microscope and identified over 43 species. Many diatom species (18+) were present, but the most common were dinoflagellates such as *Heterocapsa*, *Noctiluca*, *Oxyphysis*, *Protoperidinium*, *Scrippsiella*, *Akashiwo, and Dinophysis*. Also common were zooplankton species such as tiarina, tintinnids, ctenophores, and rotifers. A few copepods, bivalve larvae, barnacle nauplii, and polychaete larvae were also in the mix.



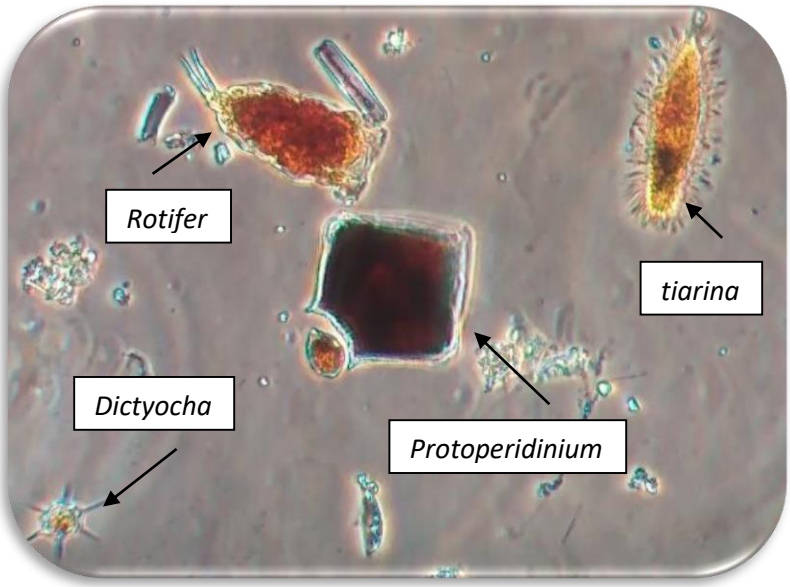
Finally, the sample was screened for harmful algal bloom species for SoundToxins. *Pseudo-nitzschia*, the species responsible for Amnesic Shellfish Poisoning, was present (506 cells/L) as well as *Dinophysis* (387 cells/L), the species responsible for Diarretic Shellfish Poisoning. Budd Inlet has been closed to shellfish harvesting due to elevated DSP levels in shellfish tissue since November 2019. For more information about *Dinophysis*, check out the article in the most recent StreamTeam newsletter!

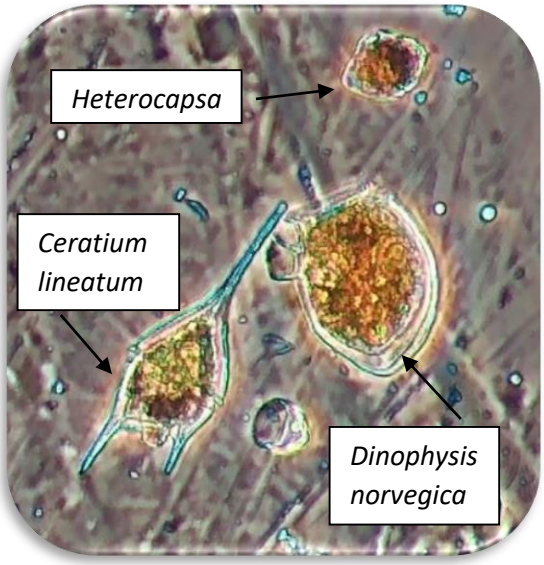
Akashiwo sanguinea was also common. *Akashiwo* is a "species of concern" for the SoundToxins program. This species can cause seabird mortality on the outer coast and as is also associated with shellfish mortality events in south Puget Sound. *Akashiwo* typically becomes dominant in lower Budd Inlet by mid-late summer, but this is the first week that I have seen more than a few scattered cells.



Every time I sample, I typically encounter a few species that surprise me. This week, *Gymnodinium rubrum* was a lovely pink surprise. Euglenoids were also quite common. While euglenoids are not rare, I haven't seen them in some time. *Scrippsiella* cysts were also present. Check out the Mystery Photo. Do you know what this is? Let me know if you do! Perhaps it's a curled up copepod with its tail tucked under its head?

Are you curious about plankton? Do you have a burning research question that you would like to investigate? Now would be a great time to start a **"Plot-Along-At-Home"** graph! Each week, plot temperature, salinity, DO, or pH (your choice!) alongside sketches of blooming plankton species. You can even 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? Do you want to know what water temperature coincides with peak *Noctiluca* blooms (the species that bioluminesces)? So many questions, so little time! Send us a photo of your completed graph and we'll send you a deck of NOAA Phytoplankton Flash Cards!





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