Publication No. 19-03-073

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report: *May and June 2019*

Guest contribution:
Anchovies provide new opportunities in Case Inlet

Photo credit Julia Bos

Up-to-date observations of water quality conditions in Puget Sound and coastal bays.

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Scientists catch anchovies in shallow and deep water of Case Inlet

Large numbers of juvenile anchovy began to appear in South Sound with warmer water in the fall of 2015 and have been present in annual fall surveys since then. Here is an example of 250K juvenile anchovies caught with only one net set.

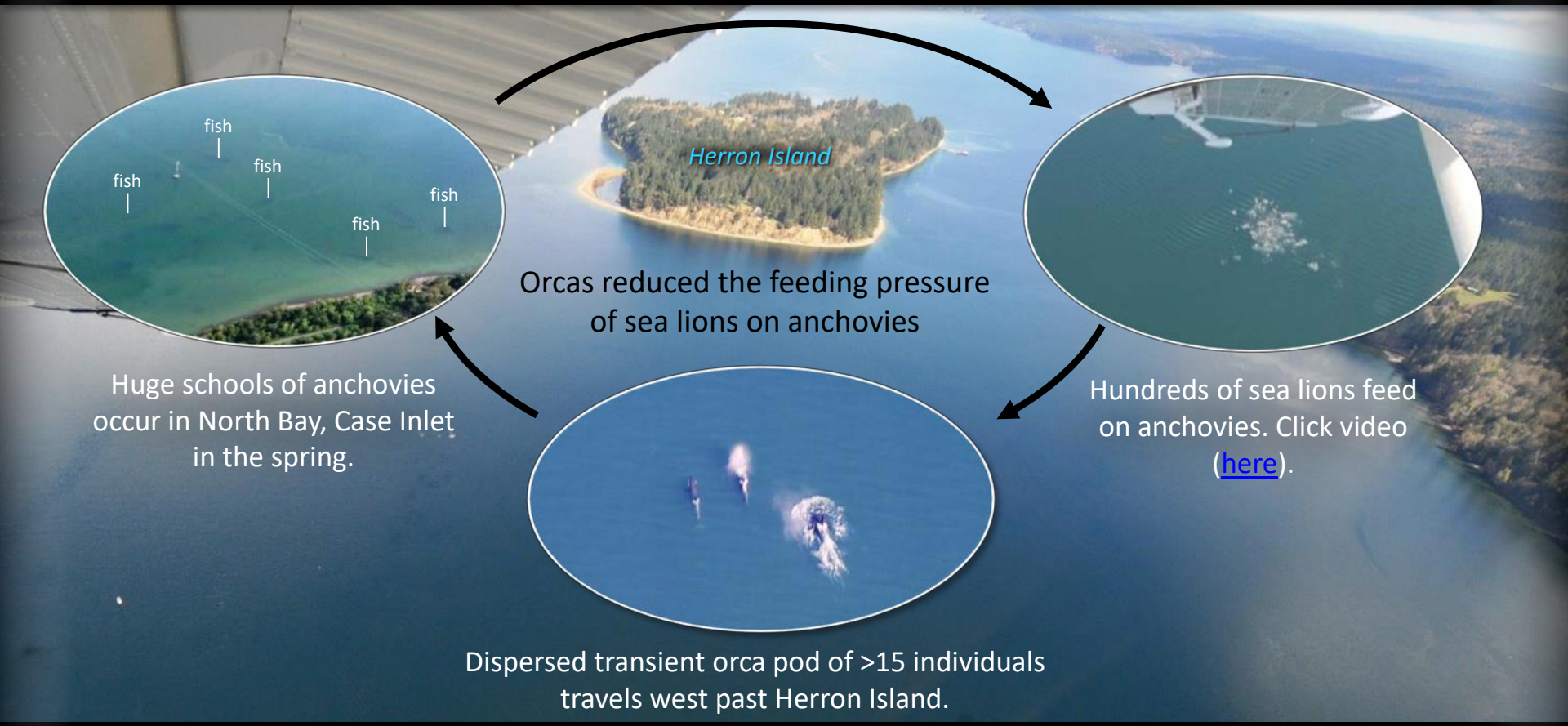
Hundreds of California sea lions forage on large schools of anchovy in Case Inlet

In February, a large group of California sea lions appeared in Case Inlet. Steve Jeffries, a seasoned Research Scientist with WDFW's Marine Mammal Investigations, knew why. Since January, he monitored, by boat, this group of 400 to 500 sea lions, harbor seals, harbor porpoise, and long-beaked common dolphins. He observed the diverse mammals worked as a team to herd schools of anchovies into deeper areas of Case Inlet. WDFW estimates 800 to 1,000 California sea lion males feed in Puget Sound and Hood Canal each year, arriving in late summer and staying until late spring when they return to rookeries in California.

Anchovies provide new opportunities in Case Inlet

What happened to the California sea lions and anchovies in Case Inlet?

The feeding frenzy on anchovies continued until a group of 25 transient killer whales moved into Case Inlet at the end of March after which only 70–80 sea lions remained south of the Tacoma Narrows.



Some anchovies appeared in scat samples of marine mammals. Some were trapped and died on beaches after predators chased them into shallow water and during outgoing tides. Yet, many remain in South Sound. Like most forage fish species in Puget Sound, the abundance of anchovies is not monitored, but this dramatic increase in abundance was hard to miss.

Washington BEACH Program – Eyes on the Beach

Julianne Ruffner & Laura Hermanson

Beach wrack can be a health risk to beachgoers.

Large piles of organic debris can wash up on beaches. This wrack lingers on beaches and shallow waters and acts as a reservoir for bacteria. If you come in contact with bacteria in wrack, sand, or water, your risk of getting sick increases. To prevent you and your family from getting exposed, the BEACH program monitors fecal indicator bacteria and advises beachgoers when bacteria numbers are high. We record the extent of wrack at a beach to better understand its potential risks to human health.

Read swimming tips to minimize your risk of illness while visiting our beaches

Signs warn of exposure risk

Advisories are issued if we see high bacteria in the water.

Washed up wrack on the beach can harbor bacteria.

Freeland County Park, Island County

What was the water visibility like for divers?

Best and worst horizontal visibility at corresponding vertical depth

Location	Best Visibility		Worst Visibility	
	Horizontal Distance (ft.)	Vertical Depth (ft.)	Horizontal Distance (ft.)	Vertical Depth (ft.)
1	11	98	6	7
2	19	39	12	20
3	16	3	12	82
4	27	89	7	26
5	18	38	14	89
6	33	95	10	5
7	26	57	11	7
8	25	85	9	7
9	49	54	11	5
10	23	20	7	43
11	44	94	3	59
12	37	85	16	41
13	33	77	6	38
14	37	94	6	5
15	9	8	6	31
16	27	49	22	16
17	25	79	17	20
18	17	7	6	43

Find depths with high/low visibility

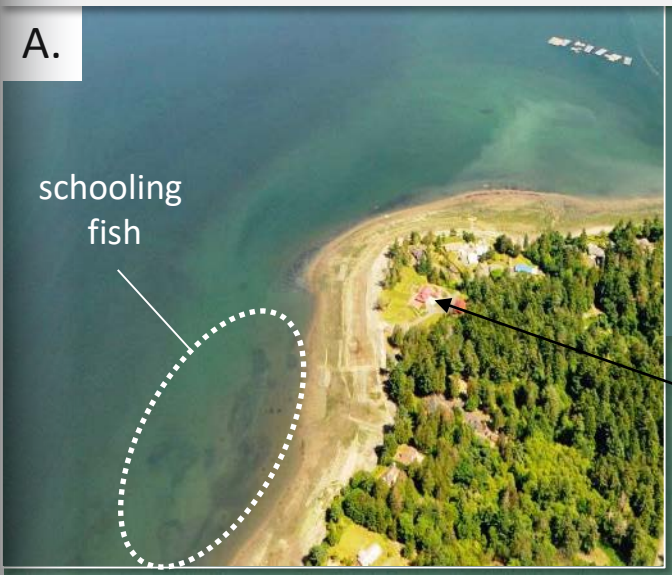
- **Best visibility** occurred in Elliott Bay near Seacrest Park (location 9) with 49 ft visibility (at 54 ft depth), despite having poor visibility near the surface.
- **Poor visibility (no diver icon)** occurred in Hood Canal near the surface (location 11) with much better visibility below.
- The poster, "Underwater Visibility Maps – a Tool for Scuba Divers," is available here

Good **Visibility** Poor

This is a new feature and we are soliciting feedback (skip.albertson@ecy.wa.gov).

How can we tell what might be schooling fish vs. seagrass?

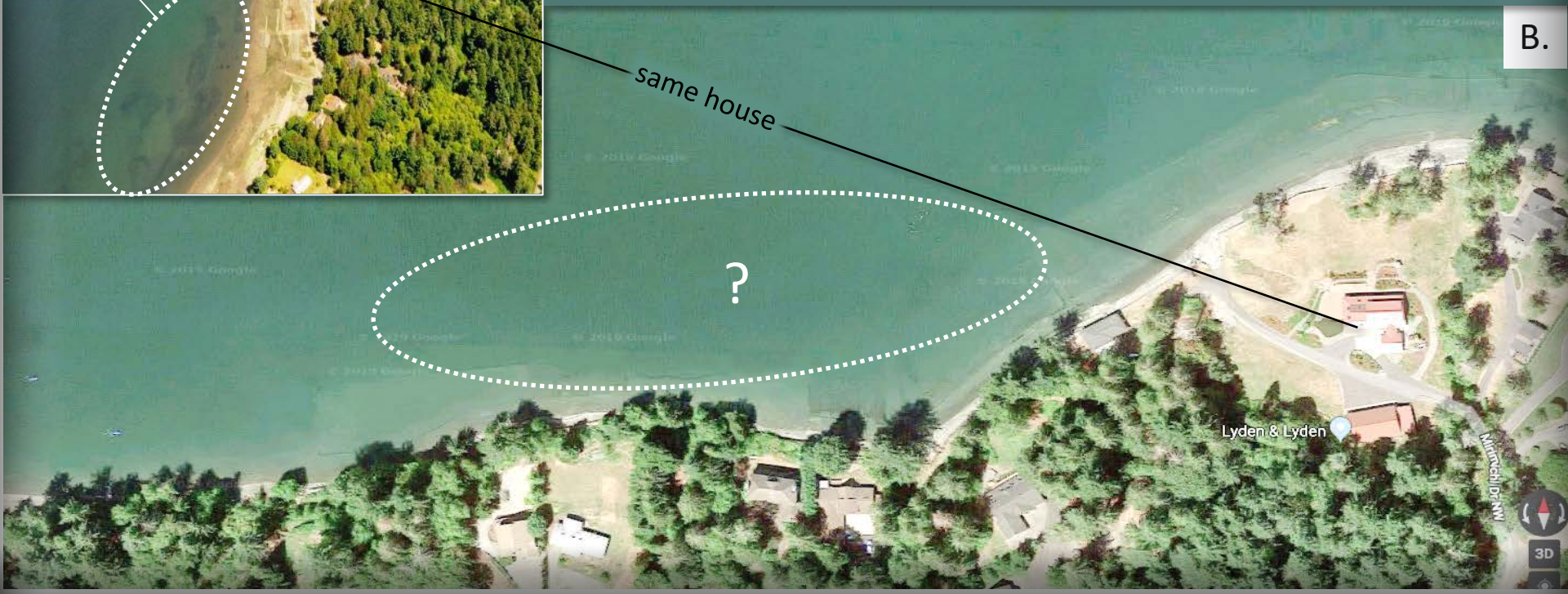
A.



Google images help us figure it out.
Fish move around whereas seagrass don't.

A. Round dark patches in photos taken on 6-4-2019 in Totten Inlet are not present in Google images (date unknown) and therefore very likely schooling fish.

B.



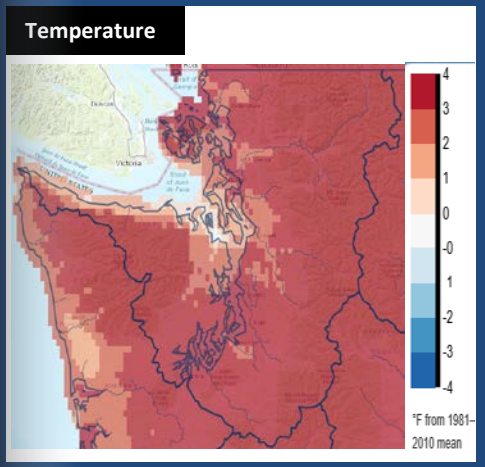
B. The dark patches are missing in Google images yet other nearshore features are preserved

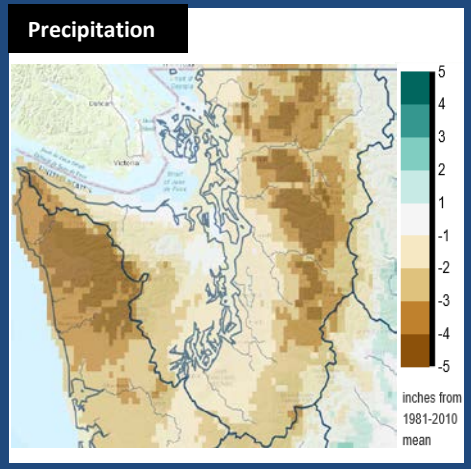
Google image

How much water did we get and what can we expect?

During the previous 30 days, Puget Sound air temperatures were above normal, while precipitation was generally below normal (A). Though some snowpack persists at higher elevations, historical monitoring sites show that overall peak mountain snow volumes in 2019 (black line) were below normal (green line) (B). Persistent warm and dry conditions this spring has also led to the snowpack melting 1-3 weeks early.

A. Northwest Climate Toolbox

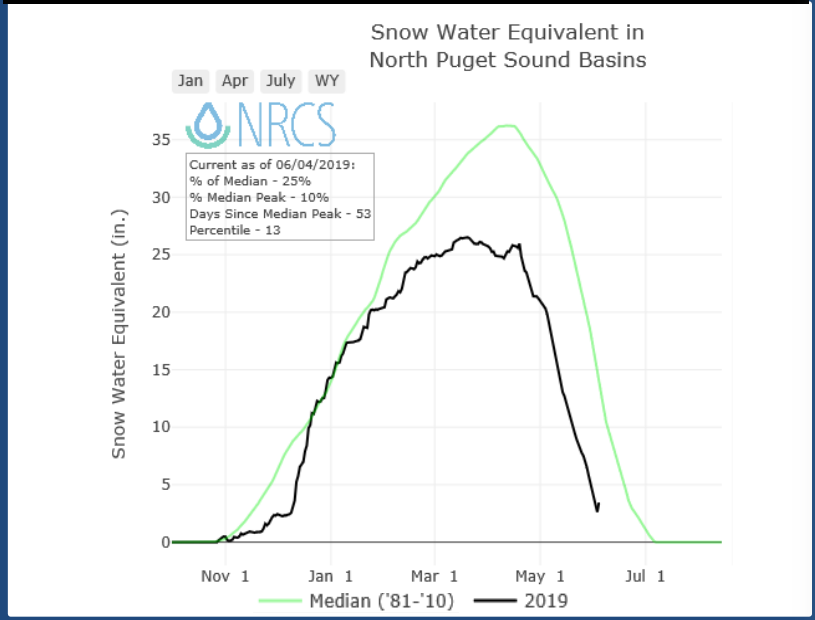




Temperature Anomaly from historical mean ranged from +1 to +4 °F in the Puget Sound region during the past 30 days.

Precipitation Anomaly from historical mean ranged from 0 to -5 inches in the Puget Sound region during the past 30 days.

B. Washington SNOTEL, USDA/NRCS

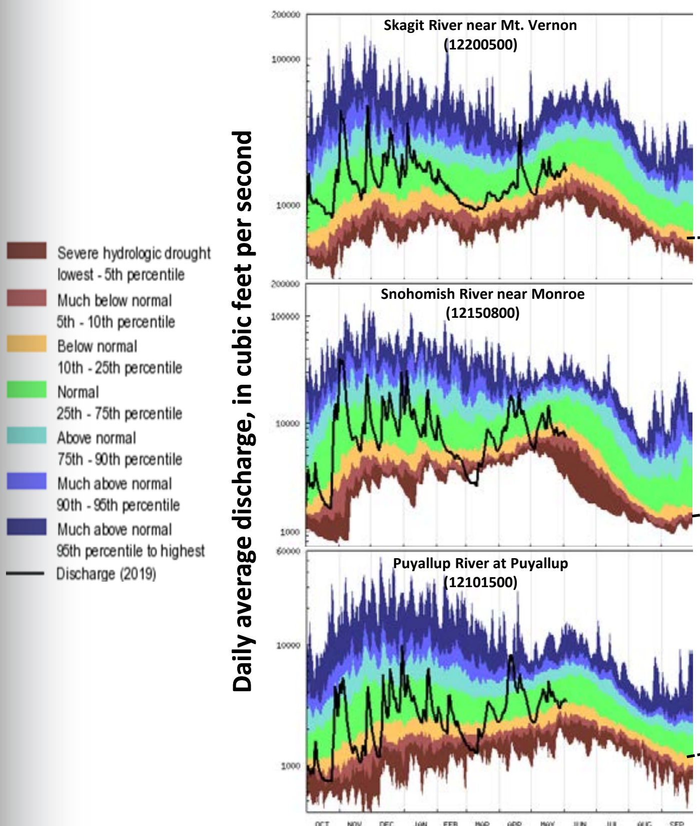


Snow water equivalents for watersheds draining to Puget Sound were below the historical median in 2019 (only showing North Puget Sound). SNOTEL (snow telemetry) monitoring sites indicate that snowpack is nearly gone.

How much water flows into Puget Sound?

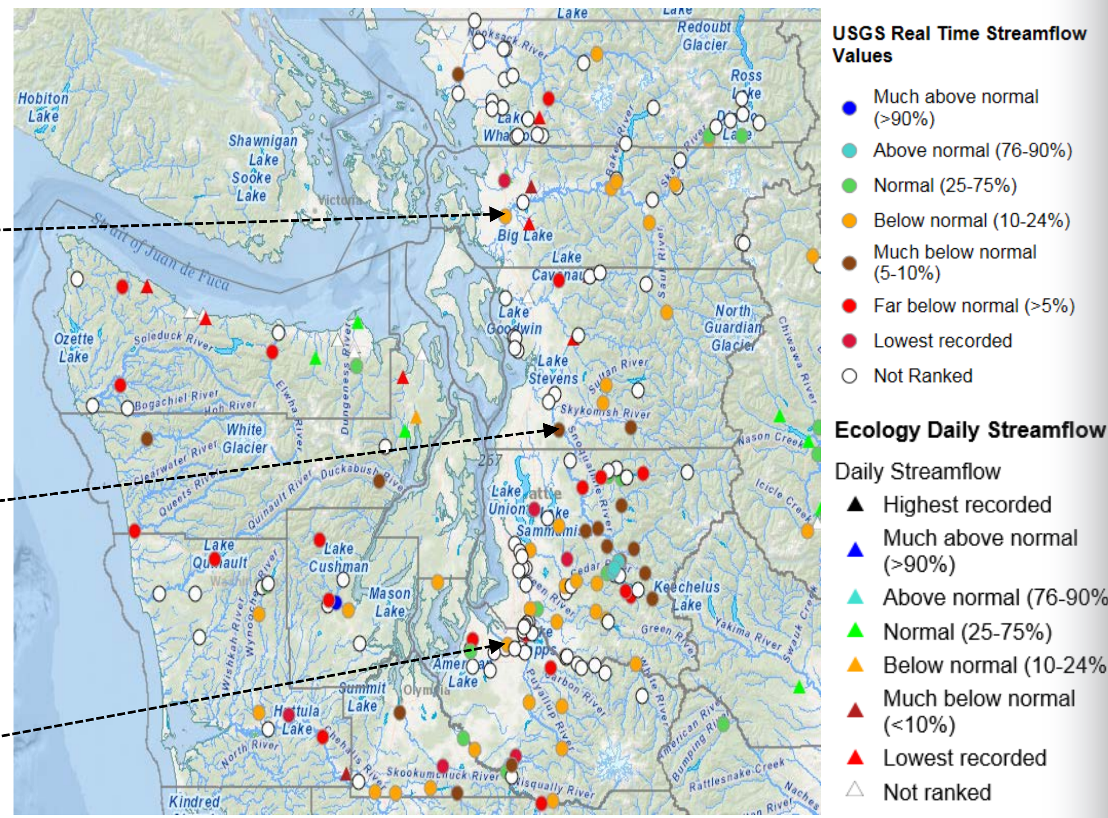
Continued warm and generally dry conditions has led to rivers receiving early and generally reduced peaks in snowmelt, unless coupled with additional precipitation (trend charts, left). Most stream gages are reporting below normal flows and some are the lowest recorded for the date (map, right). These conditions led to drought declarations in some Puget Sound watersheds to occur as early as May 20th, 2019.

Select Puget Sound Streamflow Trends



USGS WaterWatch: CLICK HERE!

Current Streamflow Conditions as of 6/4/2019

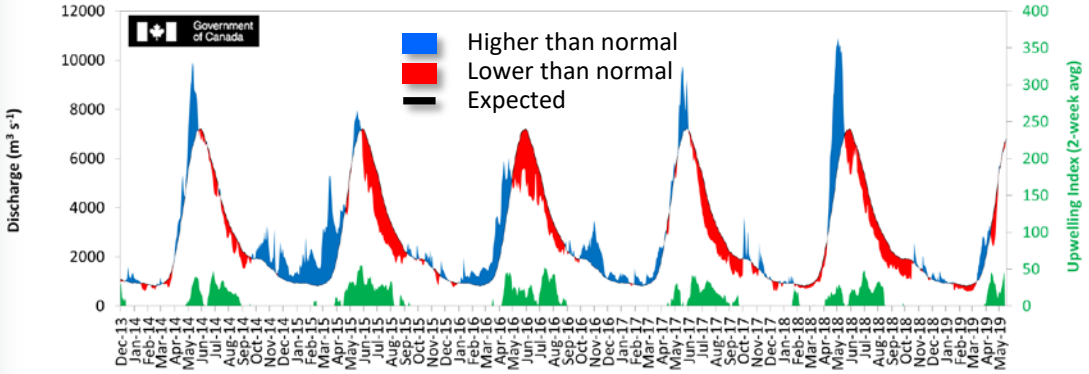


Current conditions: CLICK HERE!

Climate influences: How well is Puget Sound exchanging its water?

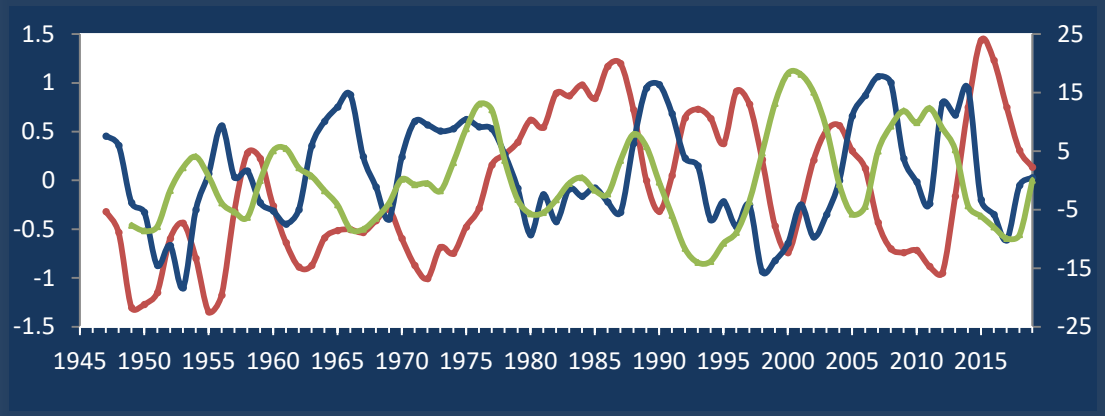
Historically, the peaks of coastal upwelling and the freshet are in sync. In 2018, a strong freshet preceded low flows.

Fraser River



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. Fraser River flows are close to expected levels. Dramatic snow melt in May resulted in well below normal snow pack in British Columbia (here).

Three-year running average of PDO, Upwelling, and NPGO Indices



How do ocean boundary conditions affect the quality of water we exchange with the ocean?

Recent years' warm water is gone (PDO) and upwelling is expected (Upwelling Index anomaly). NPGO, which reflects the surface productivity along the coast, is expected as well.

*Pacific Decadal Oscillation Index (**PDO, temperature**, explanation). Upwelling Index (anomalies) (**Upwelling, low oxygen**, explanation). North Pacific Gyre Oscillation Index (**NPGO, productivity**, explanation).*

What influences Puget Sound's water quality?

In the anomaly plot, we want to connect different factors influencing water quality in the context of space and time. Conditions leading up to June 2019 were drier with lower river flows than in Spring 2018. The recent winter has been warmer than the previous two winters, but this February was much colder. Early onset upwelling was a factor in both 2018 and 2019. For recent river and stream inflow, see page 9.

Conditions leading up to June:

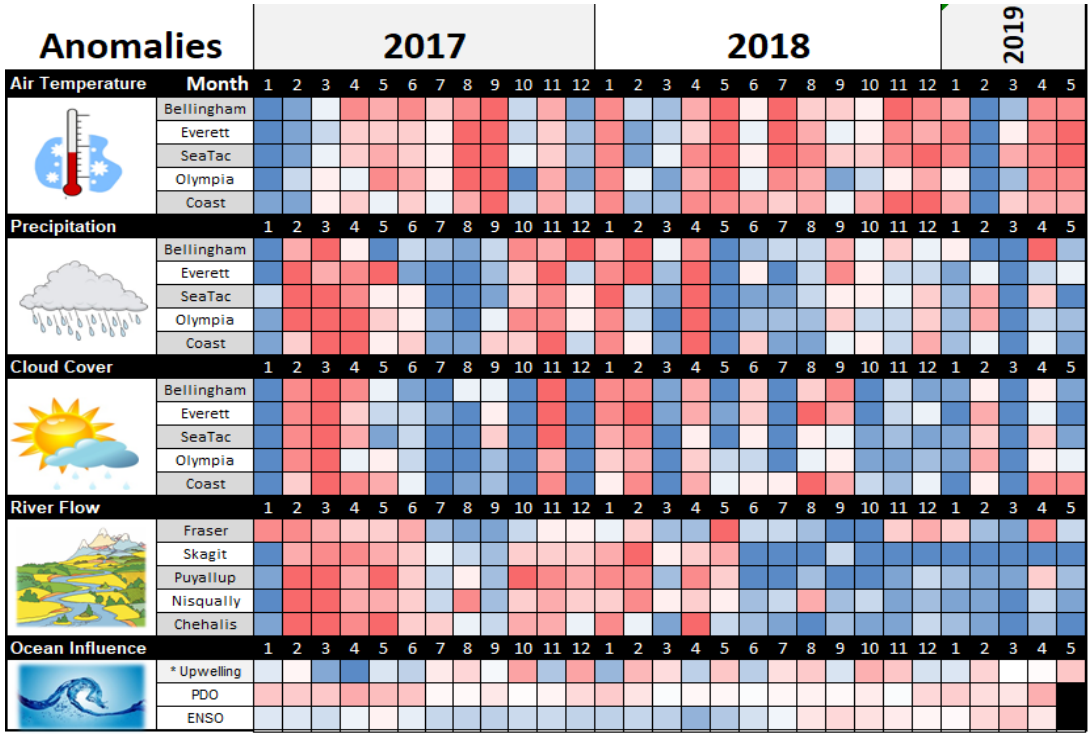
Air temperatures were generally warmer this year, except in February and early March.

Precipitation for the past five months was lower than in 2018.

Sunshine (opposite of cloud cover) was higher than the previous winter in all areas except near the coast.

River flows were low through the winter.

Upwelling was more summer-like in early spring during 2018 and 2019. ENSO (MEI2) has showed warming.



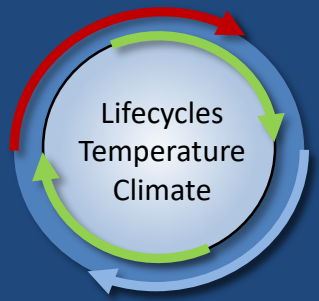
All data are from public sources: UW GRAYSKIES; river flows from USGS and Environment Canada; indices from NOAA & UW (PDO).

*Upwelling/downwelling Anomalies (PFEL)
PDO = Pacific Decadal Oscillation
ENSO = El Niño Southern Oscillation

higher — expected — lower

No data

Water temperature affects ecosystem performance



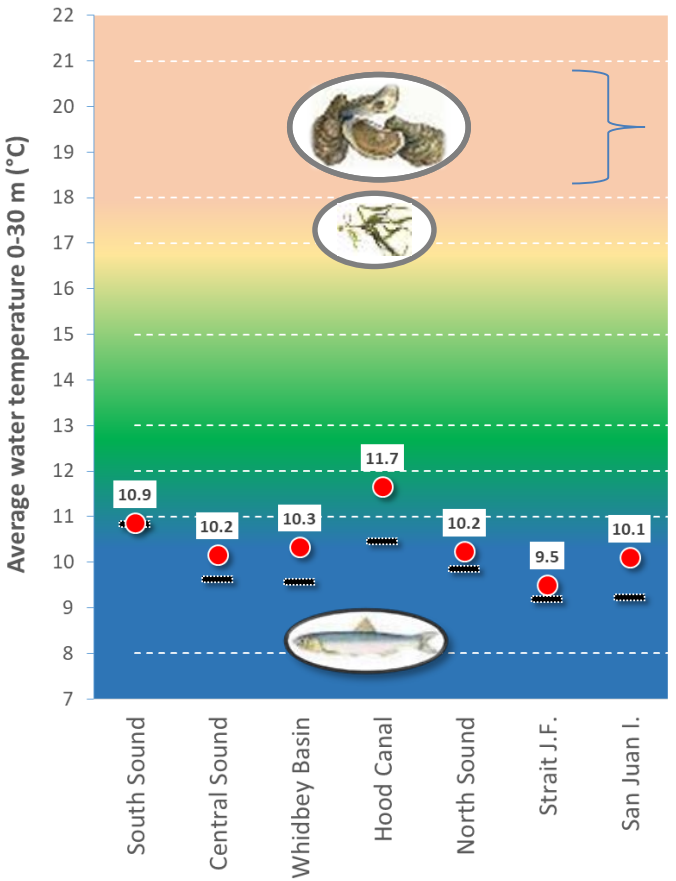
Can organisms thrive and survive?

The life cycles of organisms respond to temperature. To be successful, the timing of early life stages must line up with good growth conditions.

Temperature is important for growth, but also dictates if certain organisms can overwinter in Puget Sound (e.g., Northern anchovy).

* Help us get these right. We scoured the literature for temperatures important to the success and survival of marine organisms.

In May, average surface water temperatures (0 – 30 m deep) were +0.6 °C warmer than the baseline (1999 – 2016). Optimal temperatures for geoduck growth were reached in both South Sound (at expected temperatures) and Hood Canal (at +1.2 °C above baseline). All basins remained at water temperatures needed for herring to spawn.



What are the conditions at the surface?

The productive season with big algal blooms is in full swing. *Noctiluca* takes advantage of blooms in Central Sound and, to a lesser extent, in Hood Canal and Carr Inlet. Case and other finger inlets in South Sound enjoy a huge number of anchovies that attract marine mammals. Jellyfish are present in Budd and Eld Inlets, and macro-algae form along many beaches.

State ferry crossing a tidal eddy in Rich Passage

Bloom leaving shallow North Bay at low tide

Start here

Front

Mixing and fronts:
Tidal eddies in Rich Passage. Fronts at the fringes of large river plumes. Mixing of effluent water to the surface in Grays Harbor.

Jellyfish and fish:
Jellyfish patches present in Budd and Eld Inlets and absent in other places. Numerous schools of fish in south sound inlets.

Plume

Suspended sediment:
Glacial flour entering with the Puyallup River.

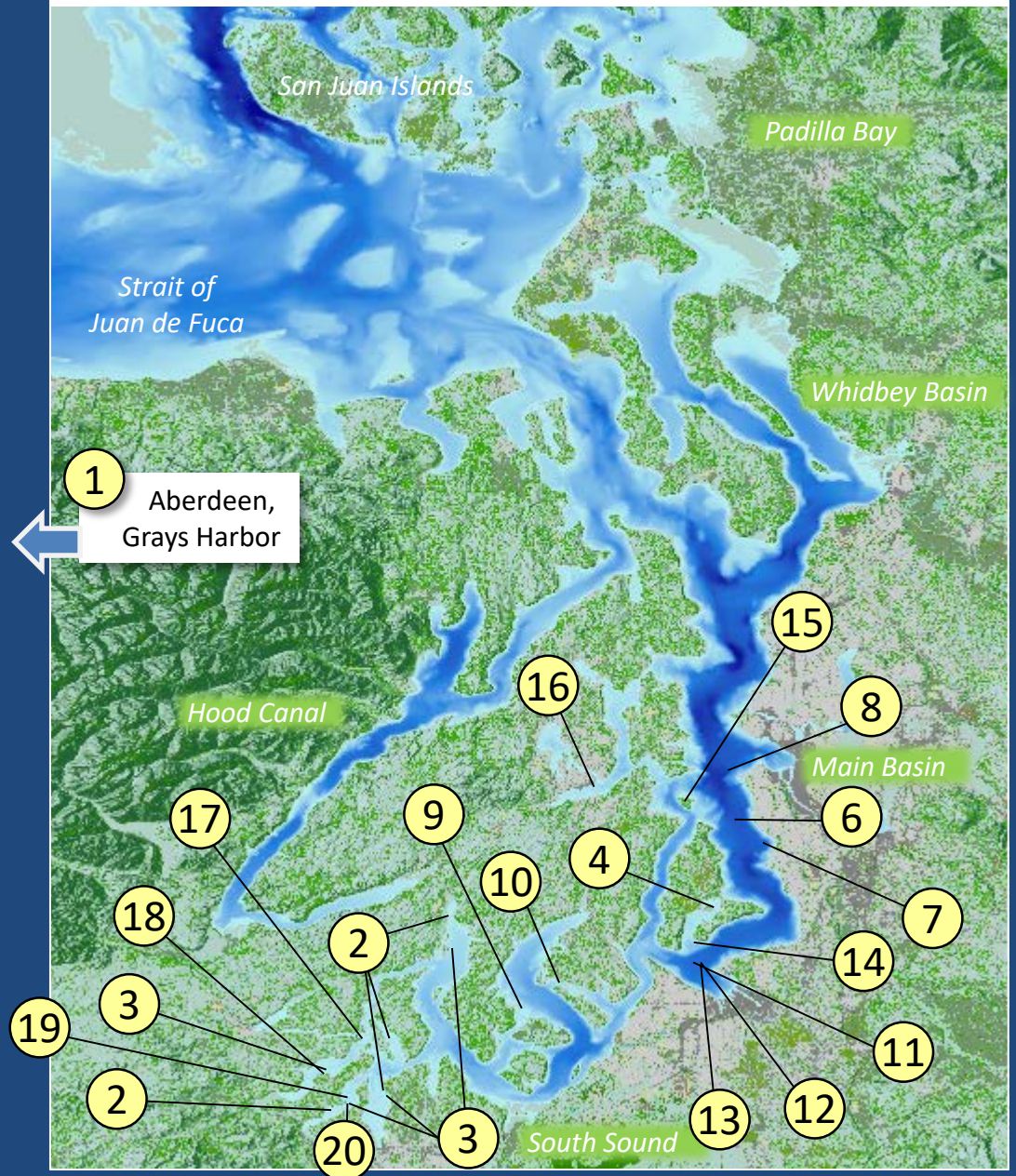
Bloom

Visible blooms:
Strong brown-green blooms in Central Sound.
Red-brown bloom in Sinclair Inlet and North Bay (Case Inlet).
Green bloom in Carr Inlet and Quartermaster Harbor.
Noctiluca bloom (bright orange) in Central Sound.

Debris

Debris:
Orange-colored organic material of *Noctiluca* on a large scale in Central Sound and a smaller scale in Carr Inlet and southern Hood Canal.

Composite map from two flight dates



Aerial navigation guide

Date: 5-13-2019 and 6-4-2019

Click on numbers

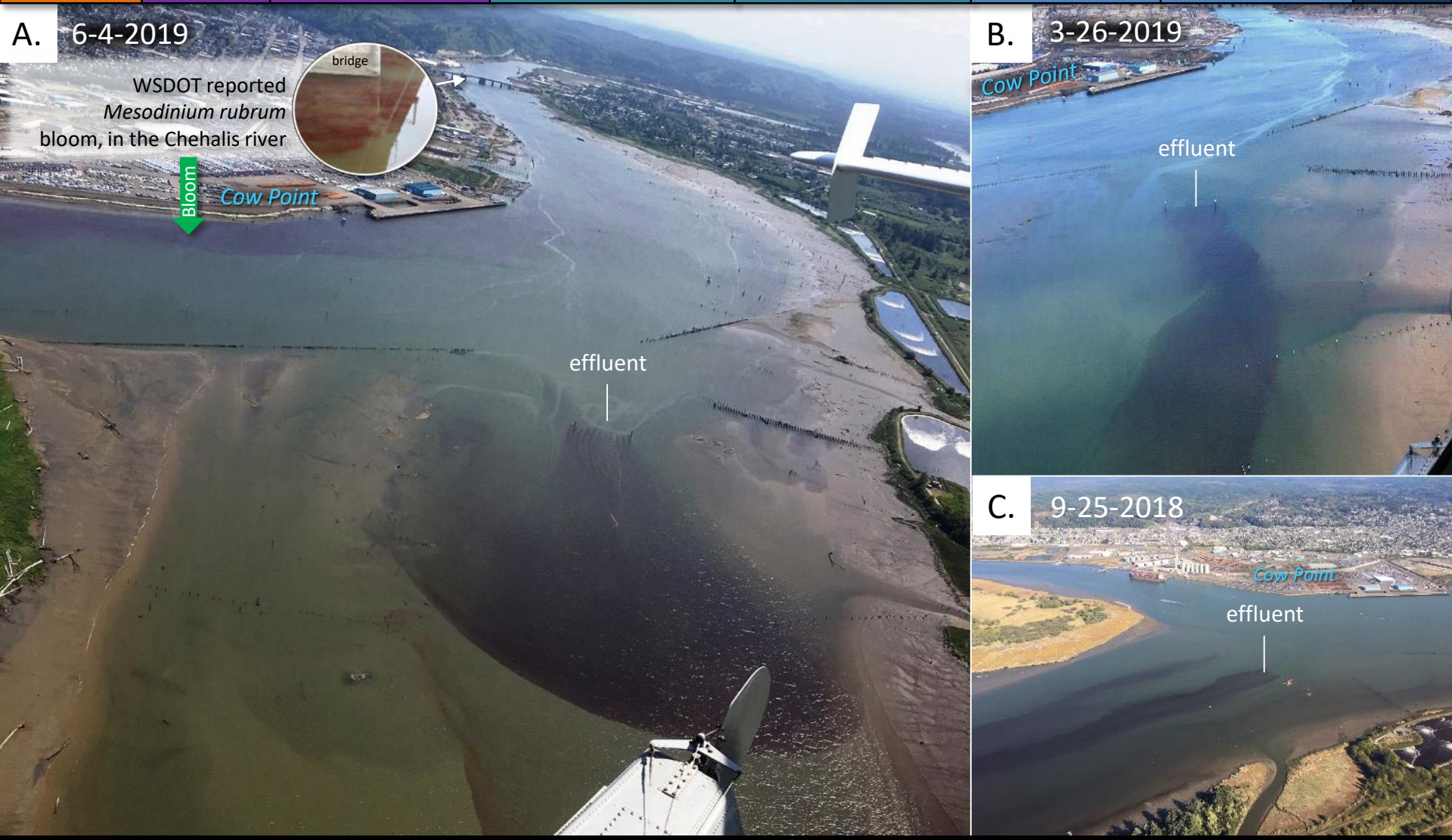
Tide data from 6/4/2019 (Seattle):

Time	Pred	High/Low
12:15 AM	6.99	L
5:09 AM	10.78	H
12:17 PM	-2.83	L
7:43 PM	11.77	H

Flight Observations

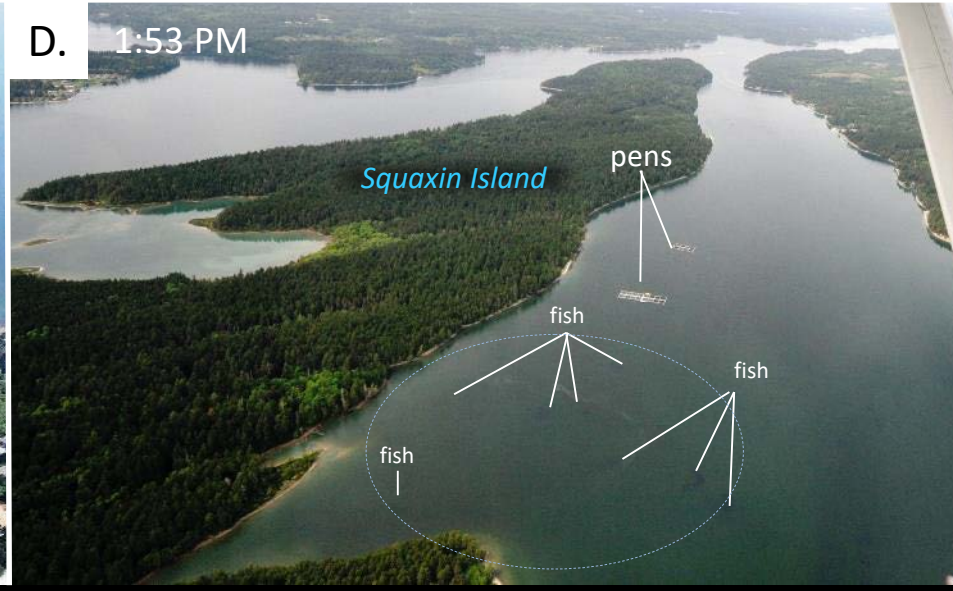
Sunny and hazy

People sharing images



A. Effluent from Cosmo Specialty Fiber rises to the surface. June 2019. B. March 2019. C. September 2018.
Location: Aberdeen (Grays Harbor)

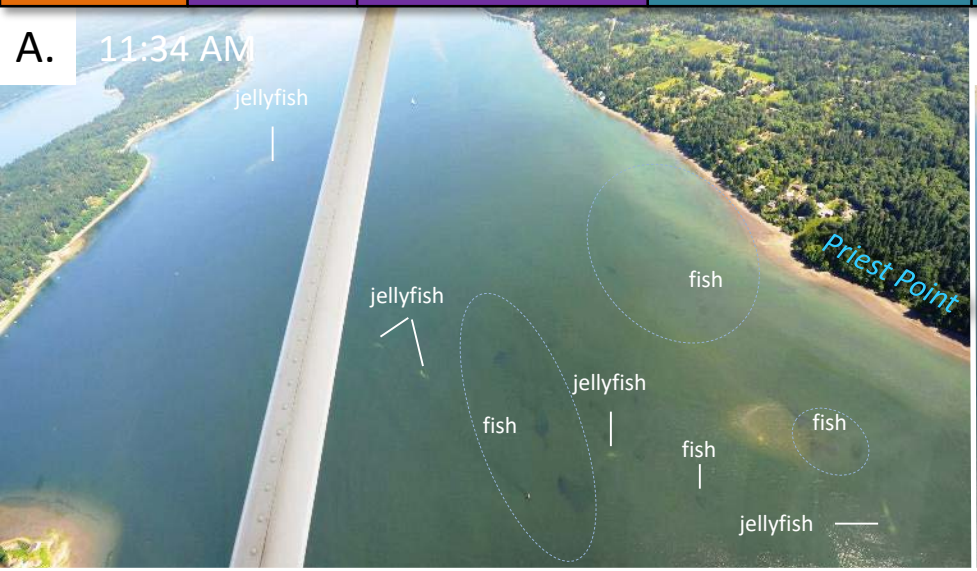
Aerial photography 5-13-2019

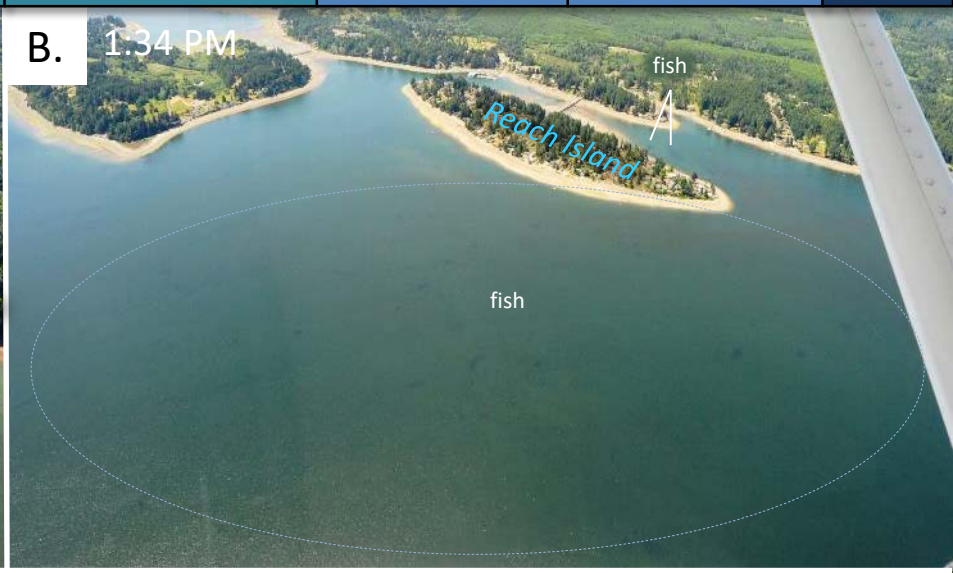


Schools of fish in shallow regions of South Sound. How do we know it's fish?

Location: A. Budd Inlet, B. Totten Inlet, C. Case Inlet (North Bay), D. Peale Passage (South Sound)

Aerial photography 6-4-2019





Schools of fish in shallow regions of South Sound. How do we know its fish?

Location: A. Budd Inlet, B. Case Inlet, C. Totten Inlet, D. Eld Inlet (South Sound)

Organic debris floating at surface.

Location: Quartermaster Harbor (Central Sound), 2:08 AM

A.

B.

C.

D.

E.

We share people's experiences with Noctiluca *on the water. Thank you for the great contributions.*

Location: A. Des Moines Marina, B. Holmes Harbor, C. Edmonds, D. Port Blakely, E. Central Sound

Large Noctiluca *bloom stretching from Poverty Bay to West Point.*
Location: Arroyo Heights, Fauntleroy (Central Sound), 2:14 PM

Large Noctiluca *bloom stretching from Poverty Bay to West Point.*
Location: Shorewood (Central Sound), 2:15 PM

Large Noctiluca *bloom stretching from Poverty Bay to West Point.*
Location: Alki Point, West Seattle (Central Sound), 2:25 PM

Red-brown and turquoise bloom and organic material at the surface. Macro-algae developing on beaches.

Location: Pitt Passage, McNeil Island (Carr Inlet), 11:43 PM

Water with red-brown bloom flowing around Fox Island Sand Spit.

Location: Fox Island (Carr Island), 11:45 AM

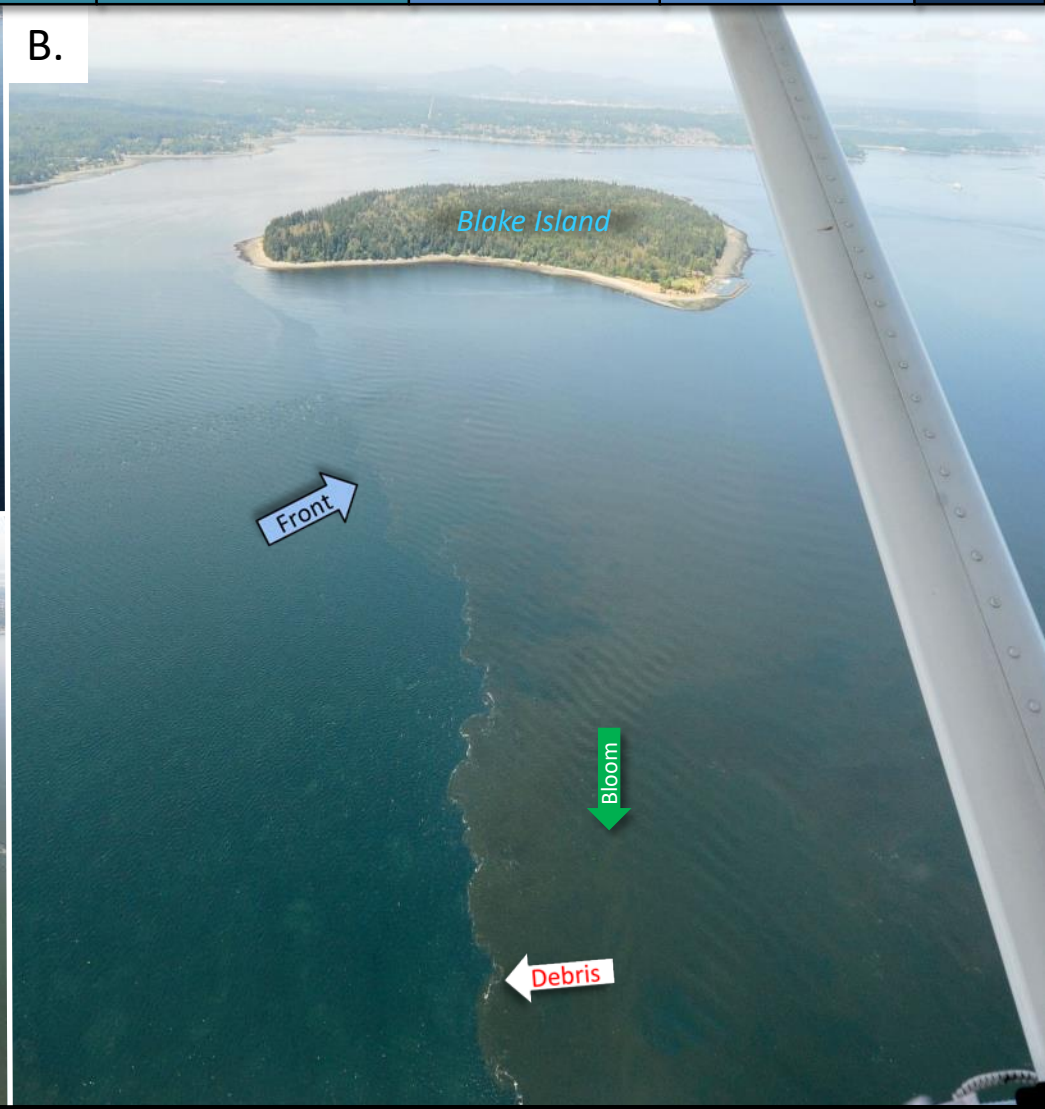
Noctiluca, *dark brown bloom, and glacial flour in the Puyallup River plume reaching westward.*
Location: Commencement Bay (Central Sound), 11:51 PM

Greenish bloom and glacial flour in the Puyallup River plume extending northward.

Location: Commencement Bay (Central Sound), 11:51 PM

Greenish bloom and glacial flour in the Puyallup River plume might be Noctiluca *prior to surfacing.*
Location: Commencement Bay (Central Sound), 11:52 AM

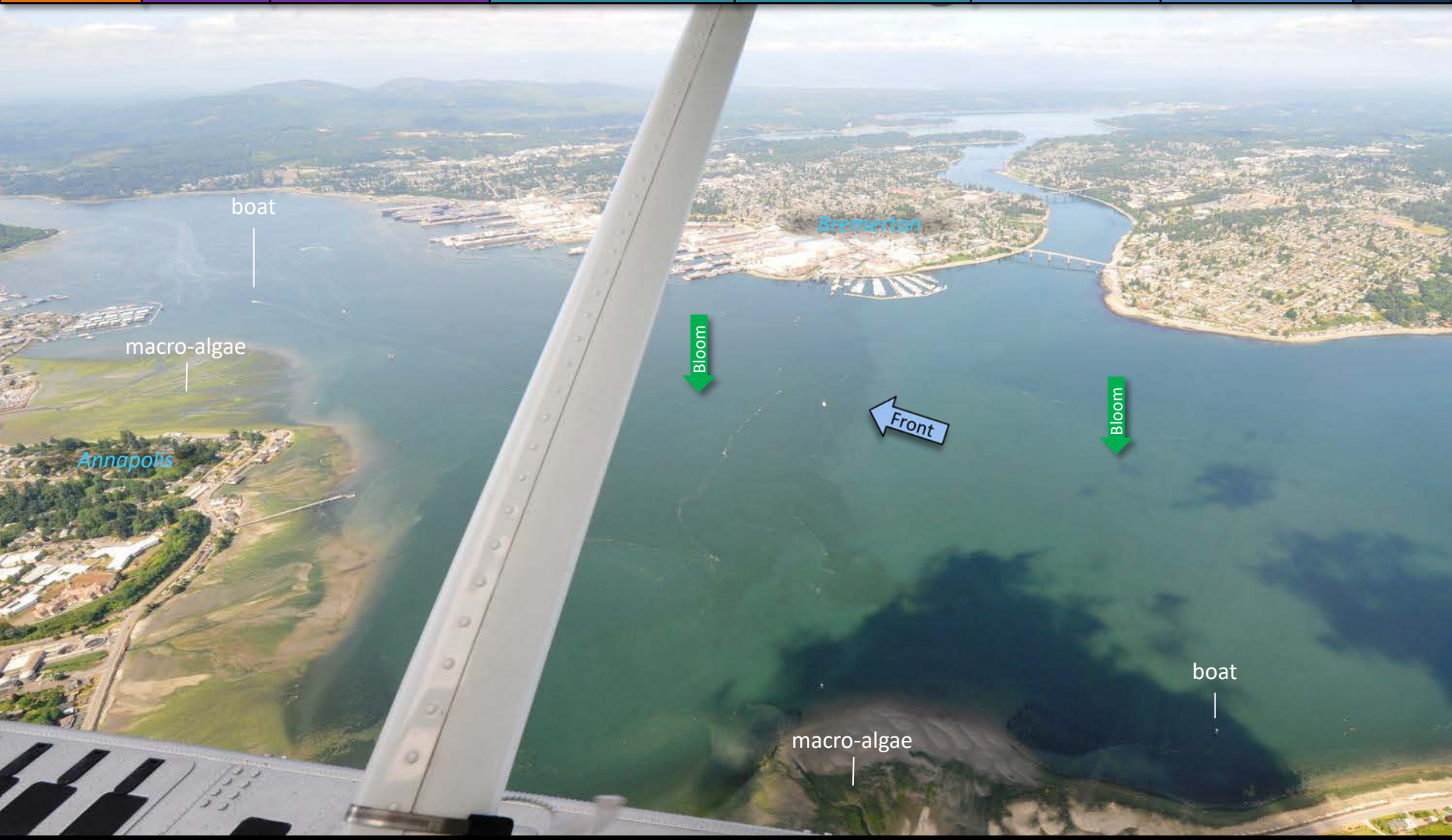
Noctiluca *and glacial flour in the Puyallup River plume.*
Location: Maury Island (Central Sound), 11:52 AM



Dark brown bloom (diatoms) organic material stretching from Edmonds to Commencement Bay.

Location: A. Southworth, B. Blake Island, C. Across Elliott Bay (Central Sound), 12:00 PM

Aerial photography 6-4-2019



Water in dark and light green meeting along front. Macro-algae on beaches.

Location: Annapolis, Sinclair Inlet (Central Sound), 12:26 PM

Water with red-brown and turquoise bloom meeting along front.

Location: Totten Inlet (South Sound), 1:54 PM

Red-brown bloom and schools of fish.

Location: Totten Inlet (South Sound), 1:54 PM

Jellyfish aggregations.

Location: Eld Inlet (South Sound), 1:57 PM

Patches of a red-brown bloom, schools of fish, and jellyfish.

Location: Eld Inlet (South Sound), 1:57 PM

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We have published 81 editions!

Find all previous Eyes Over Puget Sound editions at the end of this document.

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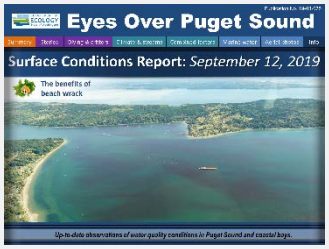

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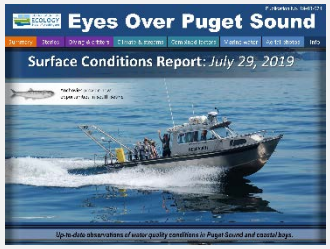

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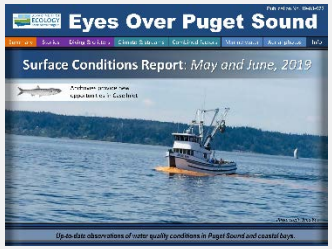

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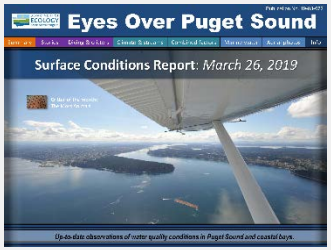

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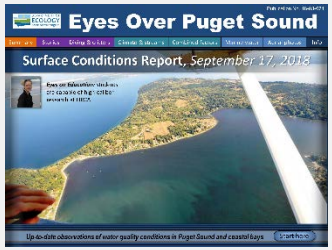

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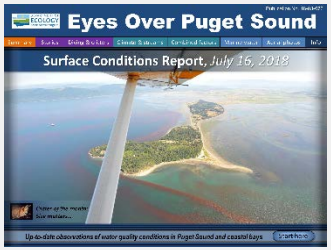

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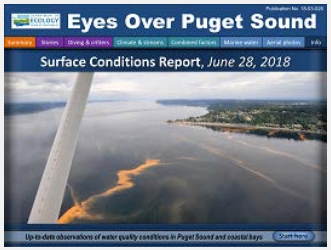

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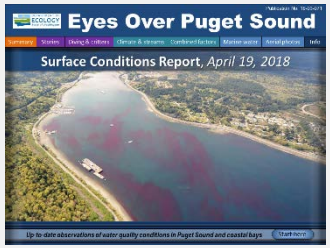

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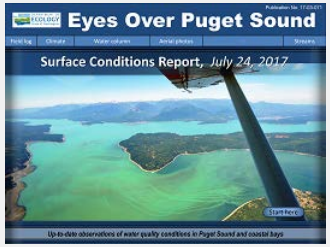

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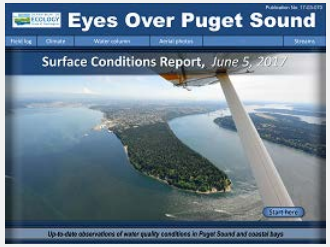

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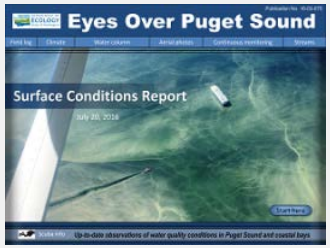

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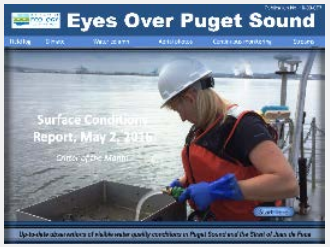

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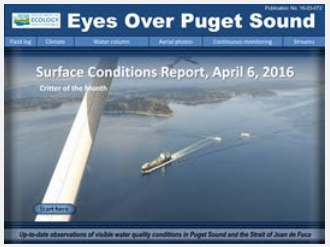

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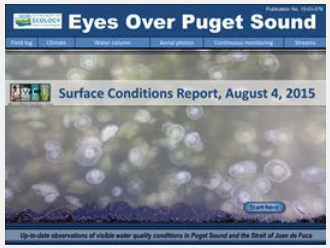

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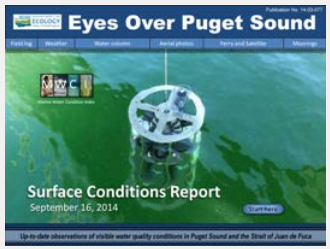

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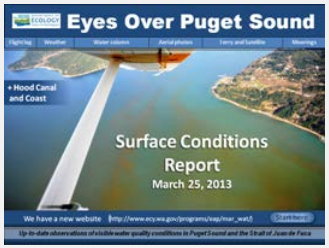

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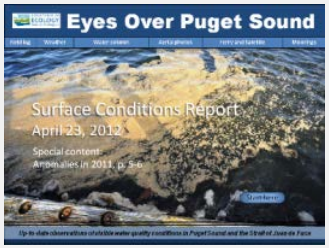

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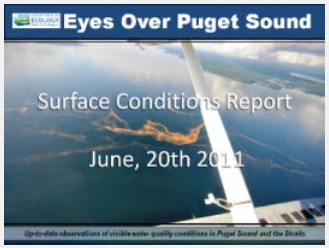

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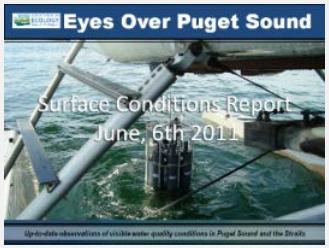

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