



# Eyes Over Puget Sound

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## Surface Conditions Report: *September 28, 2020*



*Citizens share their observations*



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

*Dany Burgess*



*Tyler Burks  
Skip Albertson*



*Thank you to  
many*



*Dr. Christopher  
Krembs (Editor)*



## The Common Slipper Snail

[p. 4](#)

Snuggle up and get comfortable with a little snail.

## Climate & streams

[p. 5-10](#)

A relatively warm and dry summer leads up to a smoky September in the Puget Sound lowlands, followed by strong rain.

## Citizens sending in their observations

[p. 11](#)

Many great images illustrate that this summer, a lot of organic material was being produced, especially in Central Sound. The images speak for themselves: too much of a good thing can be an indication of eutrophication.

## Aerial photography

[p. 13-36](#)

Following rain, river plumes are pronounced, especially near the Nooksack River. A few terminal bays still have red-brown blooms. Schools of fish are very abundant, and jellyfish that typically occur in fall are very sparse.

## We now have a focused ocean acidification team!



His favorite sea slug is *Melibe leonina*



Micah Horwith joined us in 2019 as Ocean Acidification Senior Scientist. CO<sub>2</sub> emissions are changing the chemistry of Washington waters. Micah is focused on understanding how oysters, crabs, and other animals will respond, and what we can do to protect them. He received his Ph.D. in Biology from the University of Washington in 2011.



Her favorite sea slug is *Acanthodoris nanaimoensis*.



Natalie's passion for marine science began by falling into a touch tank at the Monterey Bay Aquarium when she was 4. Since then, she worked at the Hatfield Marine Science Center and OSU, studied at Shannon Point Science Center and WWU, and is also our new boat pilot-in-training.



## Critter of the Month – The Common Slipper Snail



Dany Burgess

### *Crepidula fornicata*

Snuggle up and get comfortable with this month's critter: a little snail that made it all the way to Puget Sound from the east coast. This species may look slipper-like, but it does so much more than just bear the name of our favorite practical footwear.

### Common Slipper Snail Facts

- Forms stacked colonies called "chains"
- Has an amazing reproductive strategy that you have to see (or at least read about) to believe!



Photo by Ecomare/Sytske Dijkse, from Wikimedia Commons



Photo by Angela Johnson, ECY



Photo by Ecomare, from Wikimedia Commons

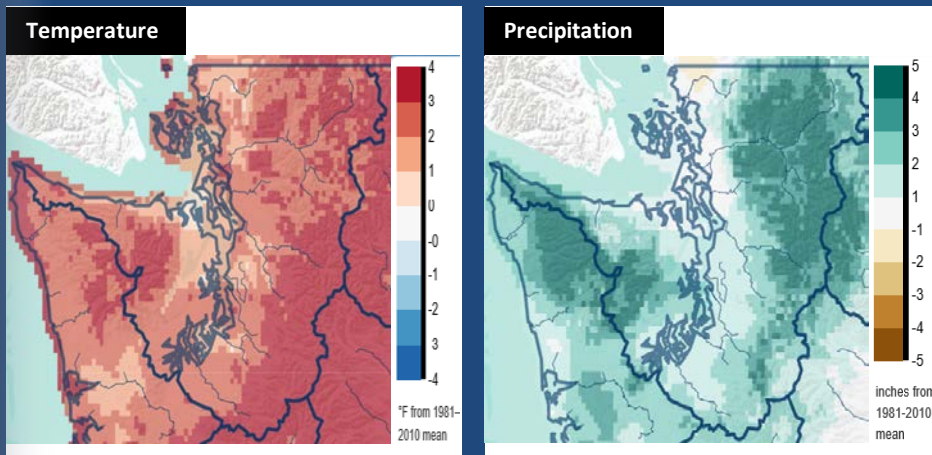
Learn more about the Common Slipper Snail and other critters on Ecology's EcoConnect blog [here](#)





During the previous 30 days, Puget Sound air temperatures and precipitation were generally above normal (A). During the next 30 days, temperature forecasts are mixed, while precipitation is expected to be above normal (B). Through the end of the year, both temperature and precipitation have a higher probability to be above normal.

## A. Northwest Climate Toolbox (Previous 30 days)



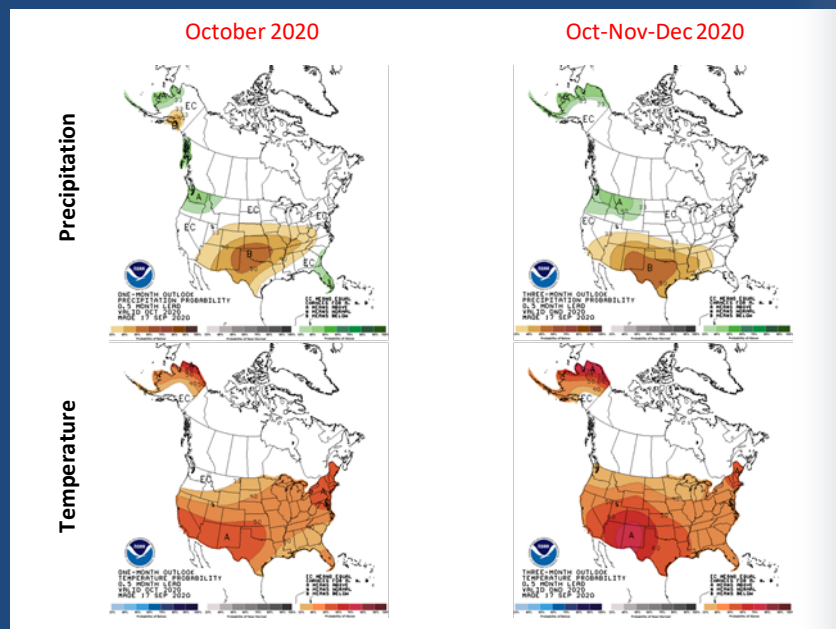
### Temperature Anomaly

from historical mean ranged from 0 to +4°F in the Puget Sound region during the past 30 days.

### Precipitation Anomaly

from historical mean ranged from -2 to +5 inches in the Puget Sound region during the past 30 days.

## B. Climate Prediction Center, NOAA

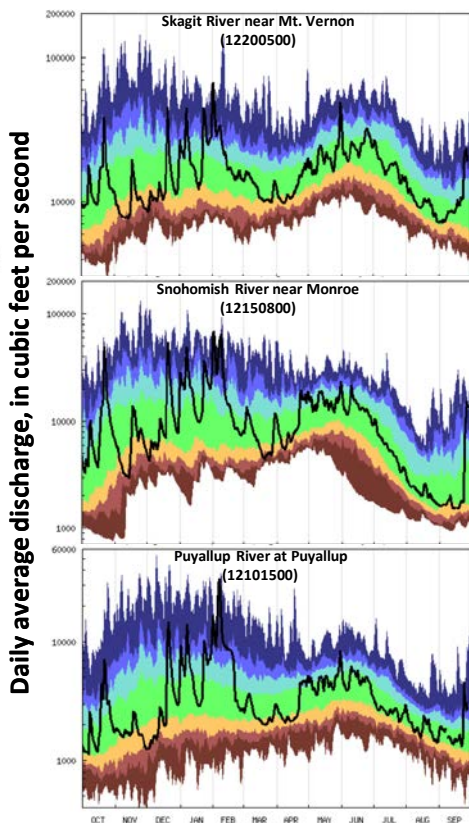


The maps on the top show higher probability of above-normal precipitation in the NW. The maps on the bottom show a higher probability of higher temperatures in the NW, [click here](#).

Following relatively normal streamflows in summer, precipitation from a strong atmospheric river increased freshwater inputs to Puget Sound quickly to above normal (trend charts, left). Rainfall during these 72-hour equaled volumes typically seen for the entire month of September and above normal streamflows were observed following the event (map, right). Expect varying conditions until the return of regular precipitation.

## Select Puget Sound Streamflow Trends

## Current Streamflow Conditions as of 9/28/2020



Severe hydrologic drought  
lowest - 5th percentile

Much below normal  
5th - 10th percentile

Below normal  
10th - 25th percentile

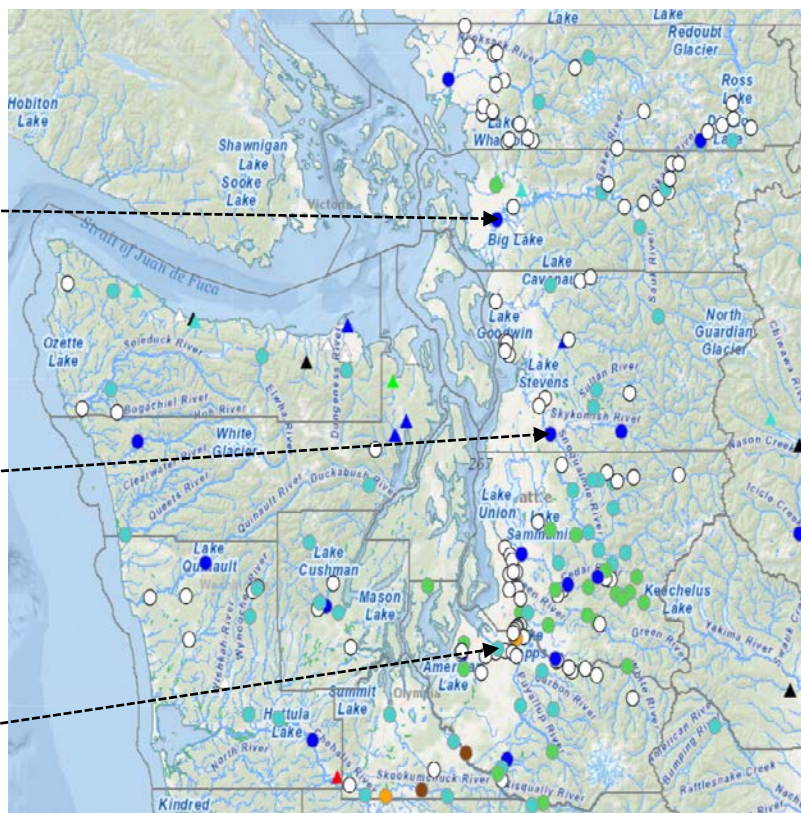
Normal  
25th - 75th percentile

Above normal  
75th - 90th percentile

Much above normal  
90th - 95th percentile

Much above normal  
95th percentile to highest

Discharge (2020)



### USGS Real Time Streamflow Values

- Much above normal (>90%)
- Above normal (76-90%)
- Normal (25-75%)
- Below normal (10-24%)
- Much below normal (5-10%)
- Far below normal (>5%)
- Lowest recorded
- Not Ranked

### Ecology Daily Streamflow

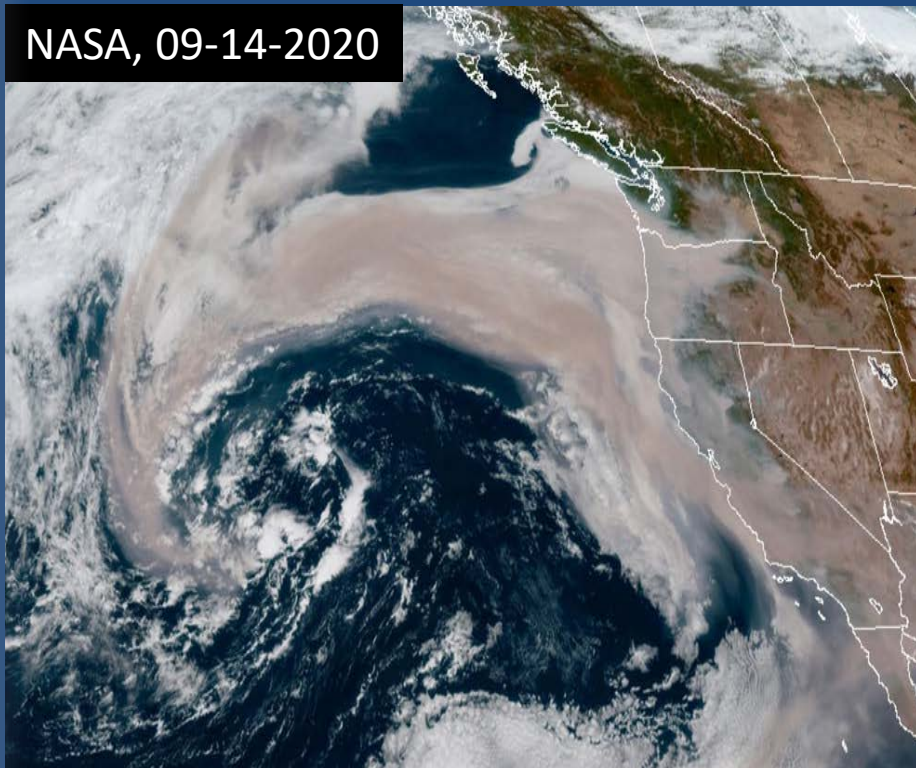
#### Daily Streamflow

- ▲ Highest recorded
- ▲ Much above normal (>90%)
- ▲ Above normal (76-90%)
- ▲ Normal (25-75%)
- ▲ Below normal (10-24%)
- ▲ Much below normal (<10%)
- ▲ Lowest recorded
- △ Not ranked



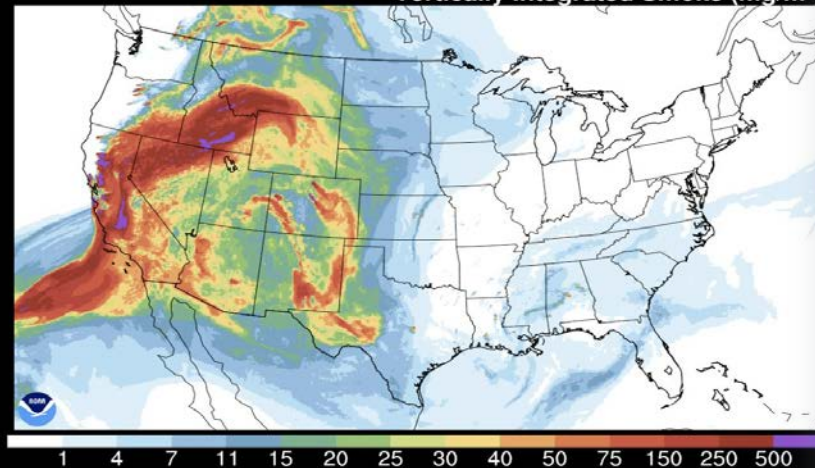
## Large wildfires along the west coast brought much smoke to the region.

NASA, 09-14-2020

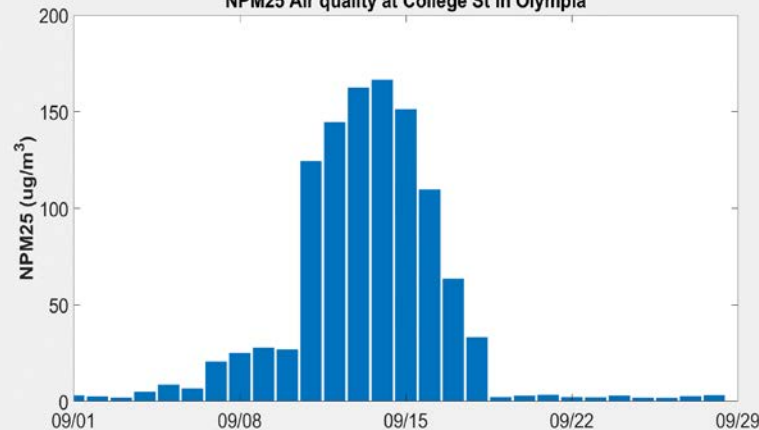


Air quality and visibility were very low in the Puget Sound region during September because of wildfire-related smoke. This can lower air and water temperatures and may affect other aspects of water quality.

HRRR-SMOKE 2020-08-20 16 UTC 4h fcst - Experimental Valid 08/20/2020 20:00 UTC  
Vertically Integrated Smoke (mg/m<sup>2</sup>)

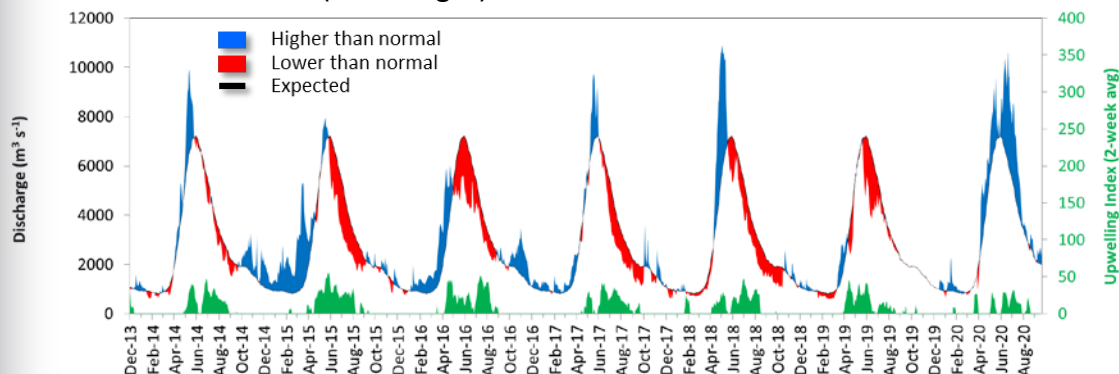


NPM25 Air quality at College St in Olympia



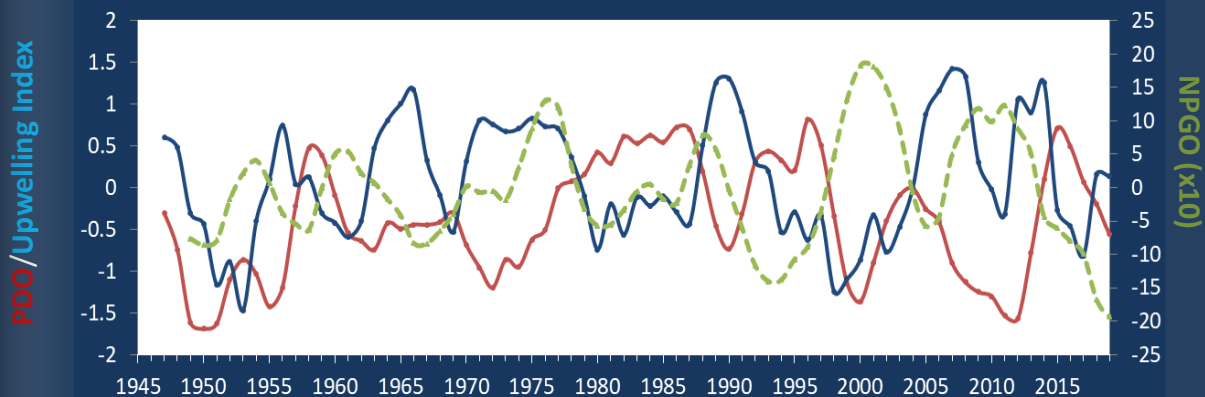
Historically, the peaks of coastal upwelling and the [freshet](#) are in sync. In early 2020 Fraser R. flows were at expected levels.

**Fraser River (at midnight)**



The Fraser River is the major driver of [estuarine circulation](#) and water exchange between the Salish Sea and the ocean. The Fraser River was flowing consistently high this year.

**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?**

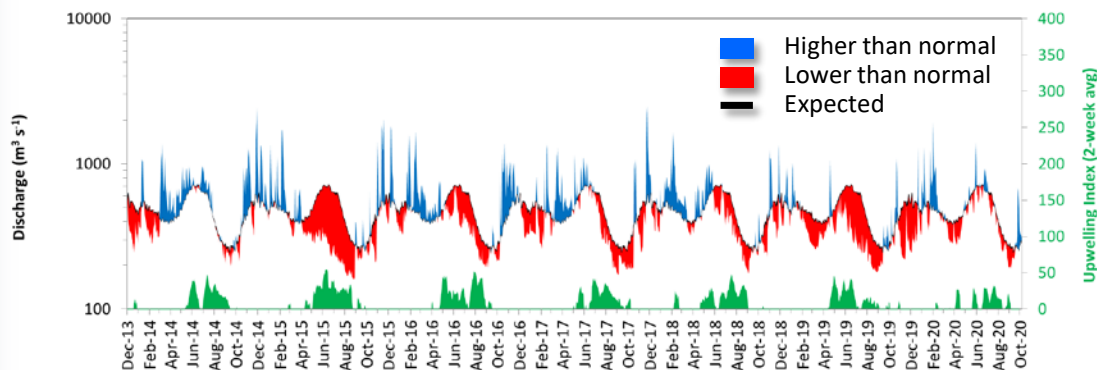
Recent years' warm water is mostly gone (PDO). Upwelling (Upwelling Index [anomaly](#)) is relatively expected. NPGO, which reflects the surface productivity along the coast, has fallen to one of its lowest numbers.

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



The Skagit River is the largest freshwater source for Puget Sound. It is a river that is regulated.

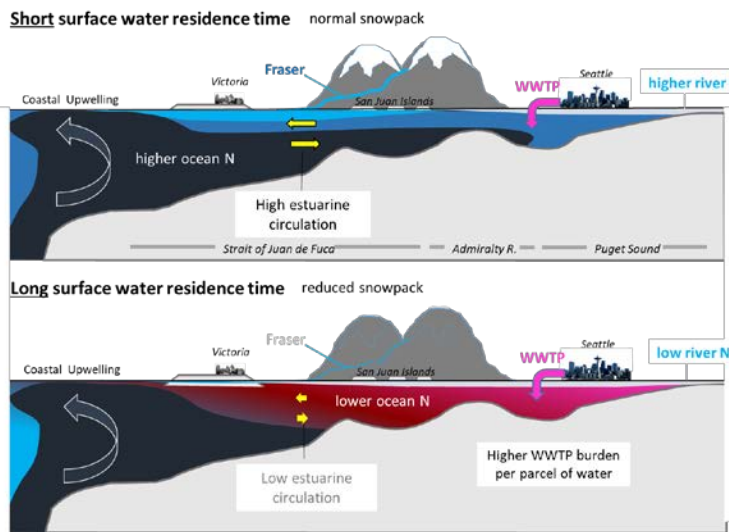
**Skagit River** (at midnight USGS)



The Skagit River freshet is no longer clearly pronounced, because it is a regulated system. However, drought years and low flows can be seen in the river's discharge data. This year, flows of the Skagit were close to normal.

Normal river flows drive **“natural”** nutrient inputs and keep the **water cool**.

Low river flows change the **nutrient balance** and make **water warmer**.



River flows and upwelling in the summer influence our water quality.

Rivers strengthen estuarine circulation in the Salish Sea. This is important in the summer.

Upwelled ocean water provides cool, nutrient-rich water.

For that to happen, we need northerly winds and good river flows (a good snowpack) during periods of water-exchange through Admiralty Reach (neap tides).



In the anomaly plot, we want to connect different factors influencing water quality in the context of space and time. We do this with a heat map and anomalies by month for selected regions from north to south. The past year has generally been warmer and drier. For recent river and stream inflow, [see page 5](#).

## Conditions leading up to September:

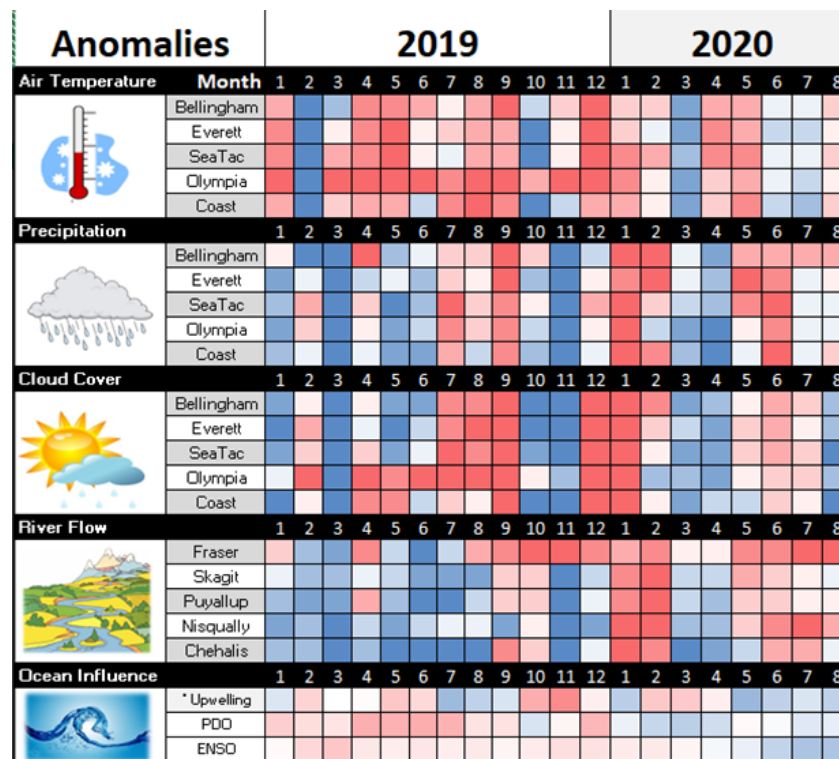
**Air temperatures** have generally been warmer this summer, except in June and July.

**Precipitation** was mostly below normal, except in May and June

**Sunshine** (opposite of cloud cover) levels have largely been higher in August.

**River flows** have been expected, except for the higher flows in the Nisqually and Fraser rivers.

**Upwelling** started in early spring during 2020, as in 2018 & 2019. La Nina is gaining strength.



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



# A big thank-you to citizens contributing their observations



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We are grateful for the wonderful contributions from so many citizens who shared their observations on the water with us. EOPS was suspended from April to August due to COVID-19. We could not have had this EOPS without you!



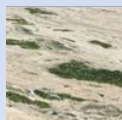
*Noctiluca* blooms (June and August), [pages 13, 14](#).  
Central Sound, Holmes Harbor, Chuckanut Bay, and Saddleback Island.



Red-brown bloom of *Protoceratium* (July), [page 16](#).  
Case Inlet, especially in the north.



Bright green bloom in Bowman Bay (July), [page 15](#).



Mucus and decaying organic material (August and September):  
In Central Sound from Redondo Beach to Edmonds, [pages 17, 18](#).



Decaying shellfish (September):  
In Carr Inlet, Burley Lagoon, [page 19](#).

①



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Des Moines Marina, 6/7/20 (Robin Beck)



Three Tree Point, 6/7/2020 (Elisa Rauschl)



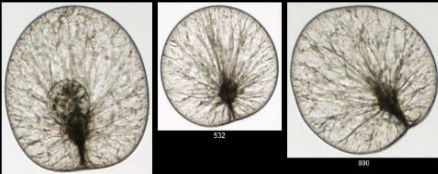
Lincoln Park 6/10/2020 (Ben Budka)



Holmes Harbor, 6/16/2020 (Christine Goodwin)



Off Redondo Beach, 8/25/2020 (Cliff Coombe)



Central Basin, King County, Marine Monitoring program, 6/10/2020:  
 “We have a ton of *Noctiluca* in our samples, >1000 cells per L, which is a lot for Central Basin “(Gabriella Hannach).

*Noctiluca is a putative eutrophication indicator that thrives when excess organic material is present.*



②



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Chuckanut Bay, Bellingham Bay, 8/4/2020 (Steve Tuckerman)



Chuckanut Bay, Bellingham Bay, 8/4/2020 (Steve Tuckerman)



Saddlebag Island, 8/11/2020  
(Kathryn Sobocinski)

*Noctiluca is a putative eutrophication indicator that thrives when excess organic material is present.*



③



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Bowman Bay, 7/16/2020 (Julie Morse)



Bowman Bay, 7/16/2020 (Julie Morse)



*Algae blooms can come in all colors. Bright yellow-green blooms occasionally occur in some bays.*





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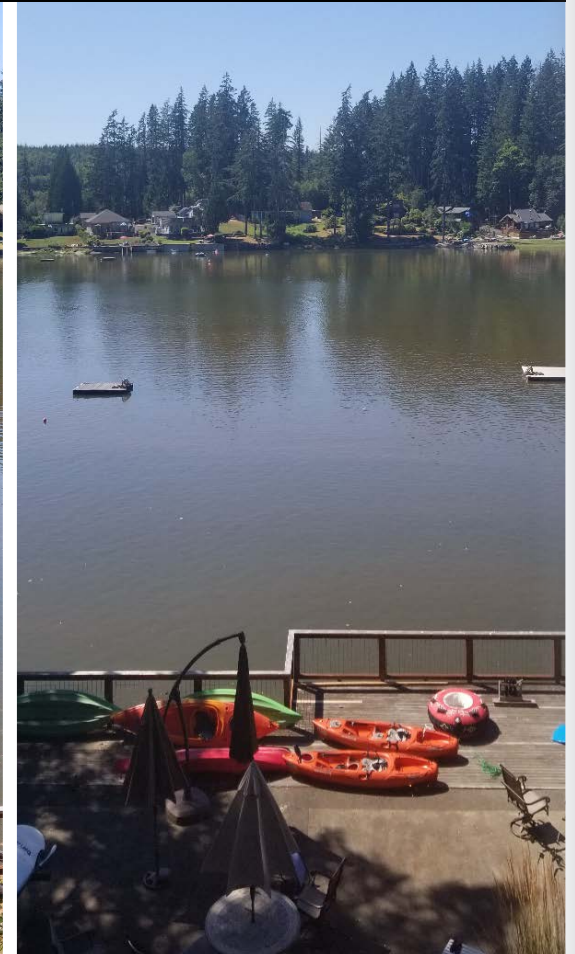
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Sound Toxins:  
Case Inlet had a wide-spread  
bloom of *Protoceratium  
reticulatum* which started in  
the middle of June.

Bloom was stronger in the  
north end of Case Inlet all the  
way south to  
Joemma State Park and to  
the Harstine Island bridge  
(Teri King)

Allyn-Grapeview, Case Inlet, 7/29/2020 (Michael Joffe)



*Blooms can persist for a long time, as was the case this year in Case Inlet. Fish perhaps benefit from it.*




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Redondo 9/1/2020 (Cliff Coomber)



Dash Point State Park, 8/30/2020 (Katharine Ellingson)



Redondo 9/1/2020 (Cliff Coomber)



Tramp Harbor Docton, 8/27/2020 (Karlisa Rickerson)

Sound Toxins monitors determined it was mucus and dead plankton with active *Akashiwo*, *prorocentrum*, *lazy pleurosigma*, *striatella* and *Nematodinium*.

*When organic material and debris from excessive amounts of algae die, it washes onshore as mucus.*



⑥



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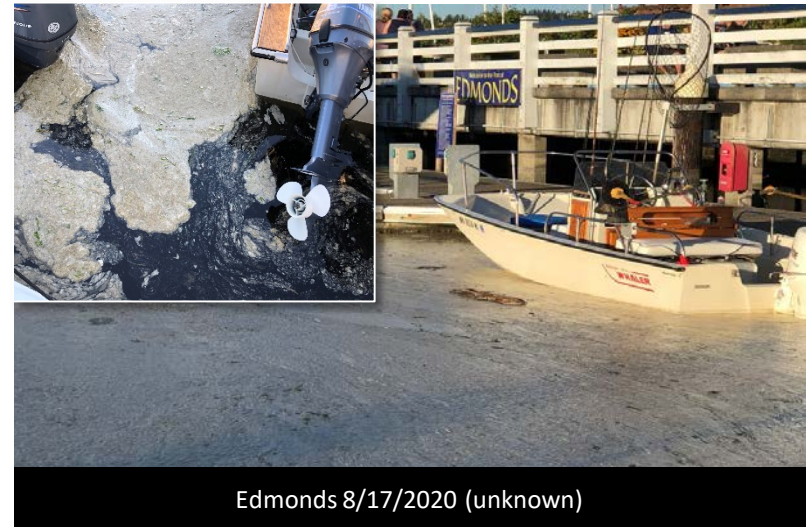
Edmonds underwater park, 8/24/2020 (Tim Ellis)



Edmonds underwater park, 8/24/2020 (Tim Ellis)



Edmonds 8/17/2020 (unknown)



Edmonds 8/17/2020 (unknown)

*Mucus and beach wrack can smother the system and often lead to smells emanating from decaying material*





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Burley Lagoon, 9/3/2020, when the stench from dying organisms was unbearable (Karen McDonell)



Seaweed matting on top of nets



Tens of thousands of clams on the surface of the beach

*Typically, shellfish can bury deeper in the sediment to avoid heat stress at low tide during warm sunny days. Burley Lagoon experienced strong odors of decaying organisms that remained exposed to heat.*



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Christopher  
testing N95  
mask required  
on the flight



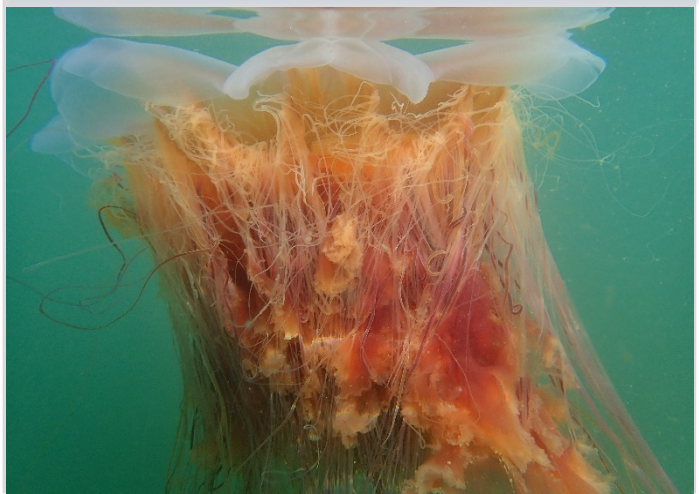
Following rain, river plumes are pronounced, especially near the Nooksack River. A few terminal bays still have red-brown blooms. Schools of fish are very abundant, and jellyfish that typical occur in fall are very sparse.

Start here

Red-brown bloom in Port Gamble



Lion's mane in Peale Passage, 7/28/2020 (Katie Remine)



## Mixing and fronts:

Tidal eddy in Lopez Sound, tidal fronts, and fronts due to heavy rain and large river plumes.



## Jellyfish and fish:

Jellyfish very sparse and only seen in Dyes Inlet. Schooling fish, on the other hand, very abundant in Case Inlet, Hood Canal, and western side between Port Madison and Kingston.



## Suspended sediment:

Sediment in suspension covering large regions in Bellingham Bay, and to a lesser extent Commencement Bay, following days of strong precipitation.



## Visible blooms:

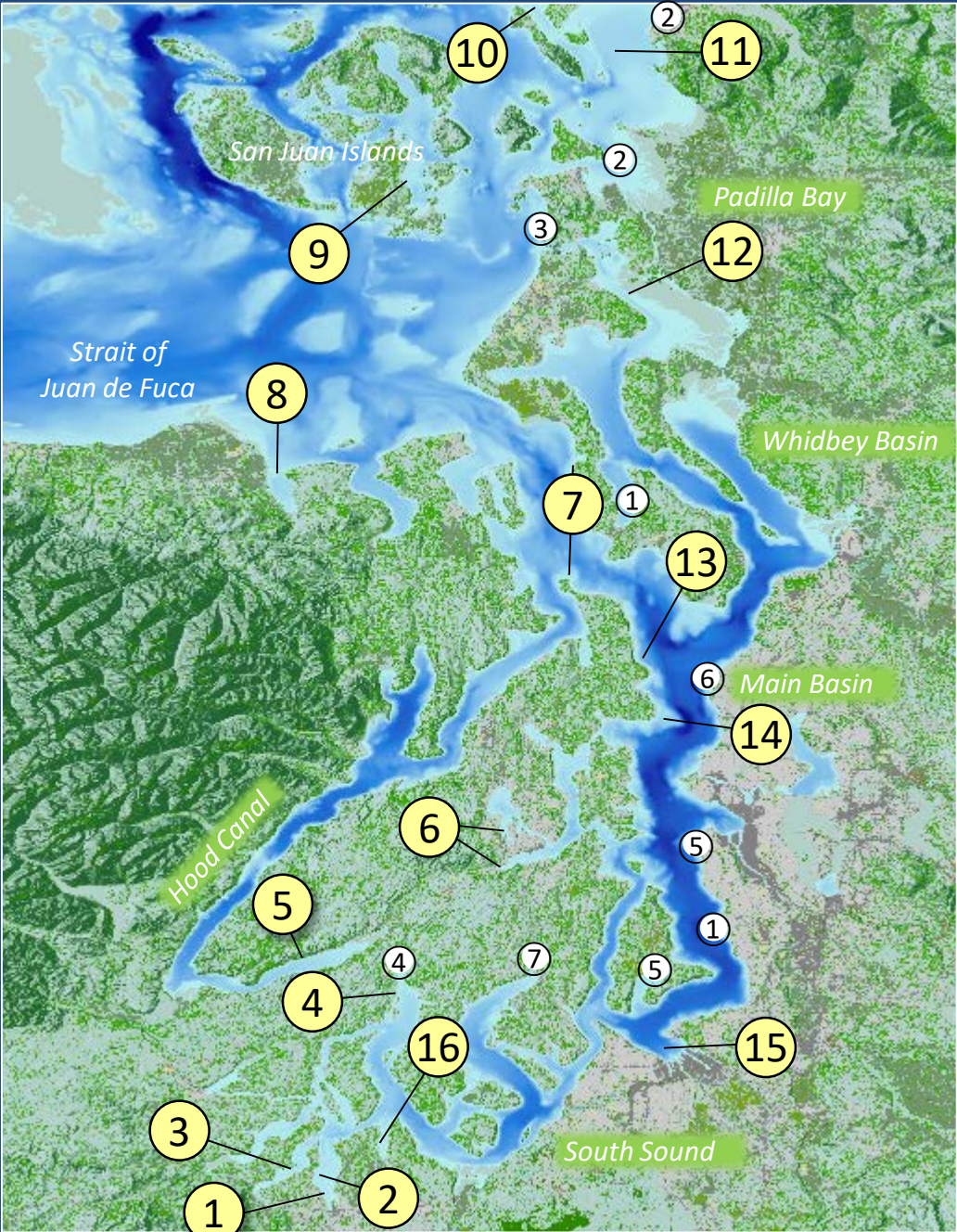
Red-brown blooms in terminal inlets and bays, typical for the season.



## Debris:

Some organic debris in Port Madison; otherwise little.





# Aerial navigation guide

Date: 9/28/2020

Click on numbers

Flight Observations  
Sunny, little waves and wind,  
good visibility

## Citizen observations

①②③④⑤⑥⑦



Tide data from 9/28/2020 (Seattle):

Time	Pred (ft)	High/Low
05:11 AM	7.02	L
10:28 AM	10.26	H
05:37 PM	0.24	L





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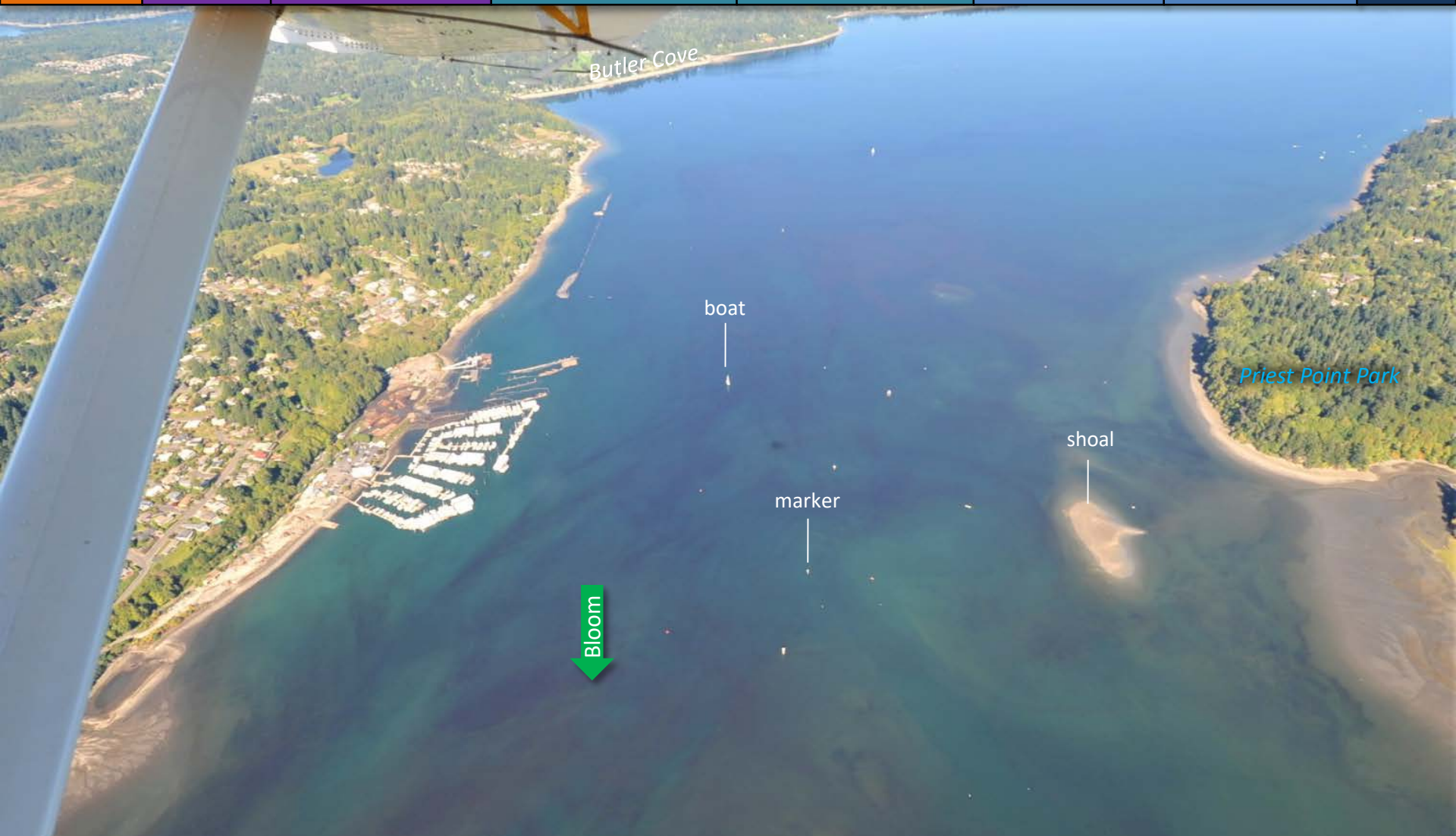
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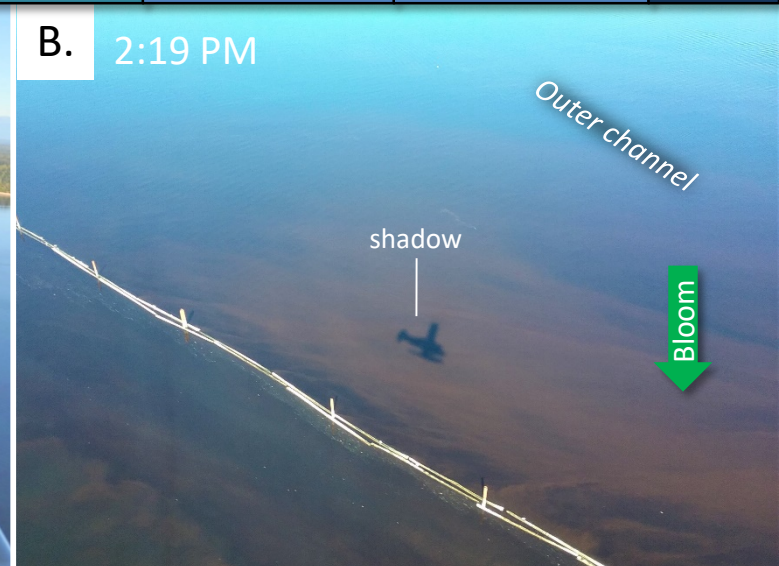
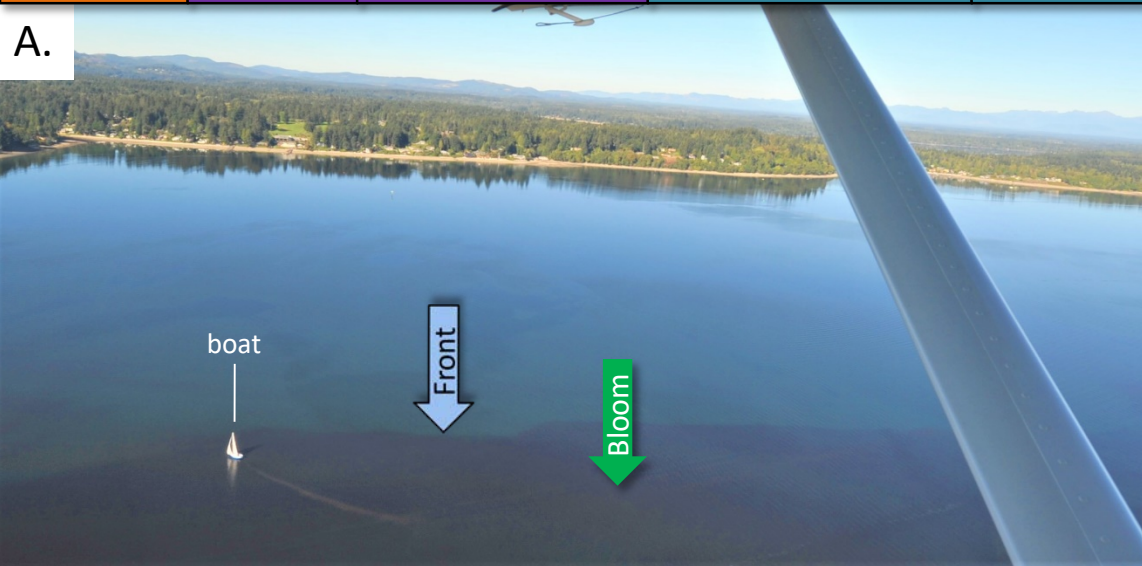


*Red-brown bloom.* Location: Budd Inlet (South Sound), 11:28 AM





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*Red-brown bloom.* Location: A. Butler Cove, B. West Bay, C. Gull Harbor, D. Priest Point Park, Budd Inlet (South Sound), 11:23 AM





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*Red-brown bloom and organic debris floating at surface.*

Location: Eld Inlet (South Sound), 11:29 AM



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*Isolated red-brown bloom surrounded by schools of fish.*  
Location: North Bay, Case inlet (South Sound) 11:47 AM





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A.



B.



A. Schools of fish near the surface, likely pushed up by low oxygen front, and B. internal waves.  
Location: Twanoh State Park, (Hood Canal), 11:58 AM





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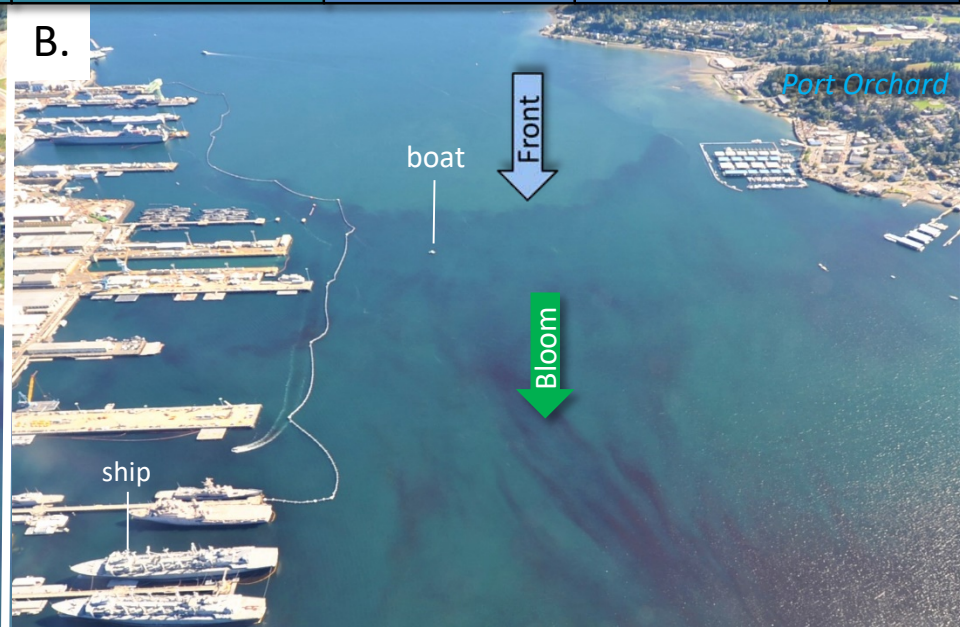
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*Red-brown blooms in patches.*

Location: A-B. Sinclair Inlet, C-D Dyes Inlet (Central Sound) 12:12 PM





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*Tidal front and dark unexplained spots (fish submerged vegetation).*

Location: Foulweather Bluff (Central Sound), 12:26 PM



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*Water mixing with bloom.*

Location: Sequim Bay (North Sound), 12:40 PM





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*Two large tidal eddies with sediment-rich water.*

Location: Across Center Island, Lopez Sound (North Sound), 12:55 PM



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*Red-brown bloom in Hale Passage, and sediment-rich plume of the Nooksack River in Bellingham Bay.*  
Location: Hale Passage (North Sound), 1:09 PM





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C.



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A-C. The Nooksack River plume covering a wide area. D. The sediment layer is thin, as seen in the ship wake.  
Location: Bellingham Bay (North Sound), 1:15 PM





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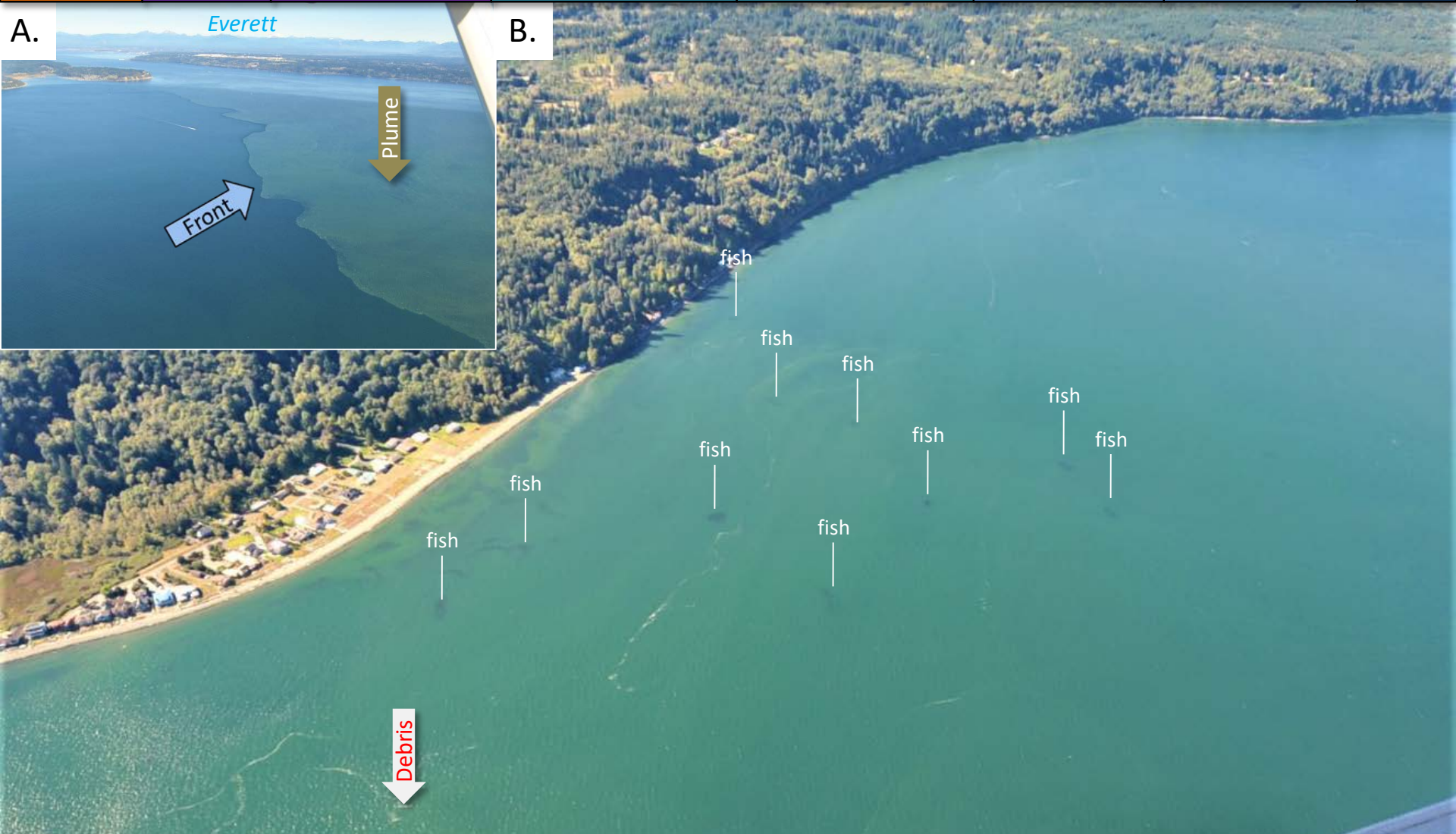
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*Potentially schools of fish in sediment-rich water coming from the Skagit River South Fork.*  
Location: Skagit Bay (Whidbey Basin), 1:27 PM





*A. Plume of Whidbey Basin spanning across to Kingston. B. Schools of fish in the plume.*  
Location: North of Kingston (Central Sound), 1:46 PM



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*Several large schools of fish around Point Jefferson.*  
Location: Port Madison (Central Sound), 1:49 PM



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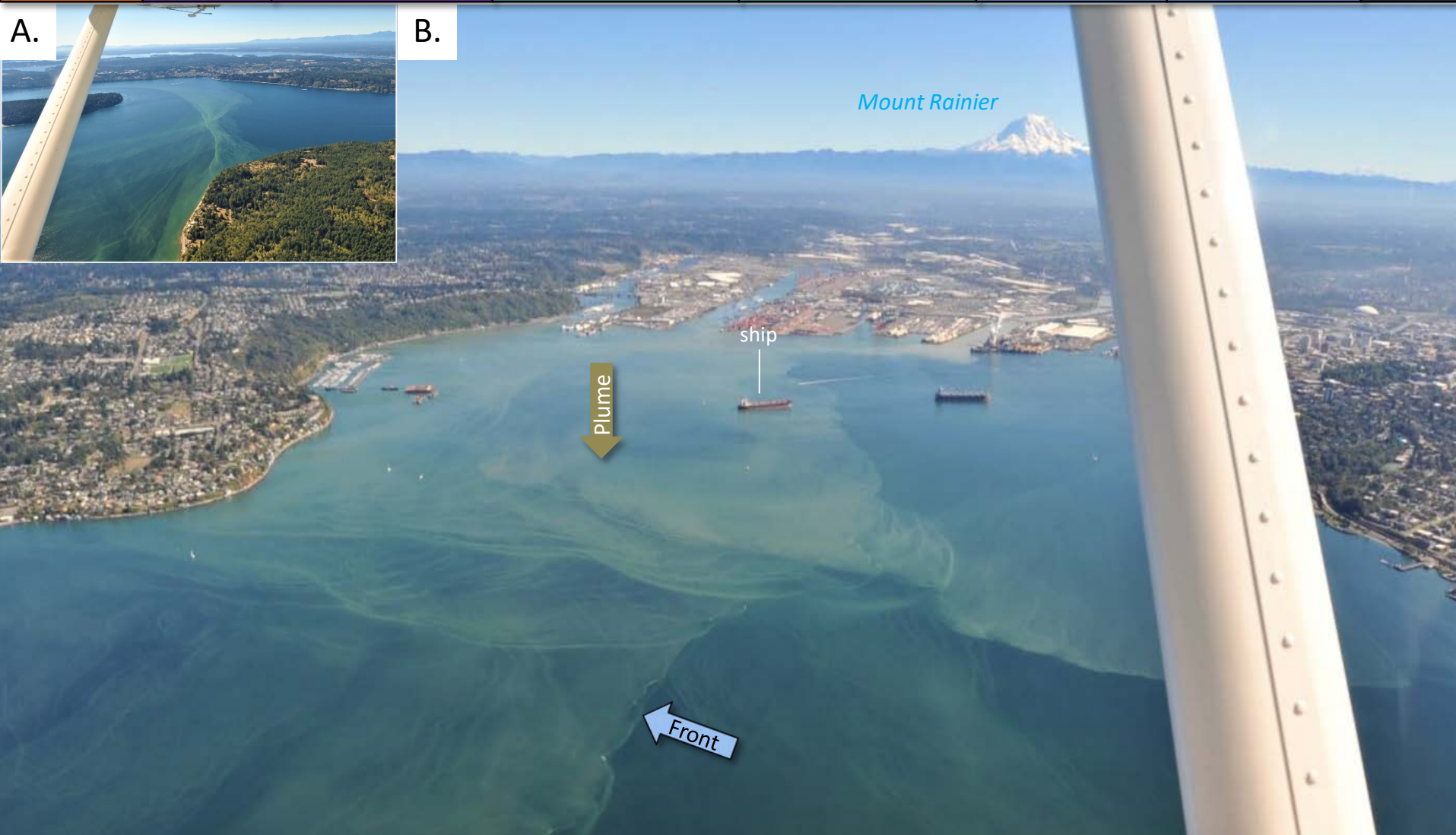
Marine water

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B.



A. Sediment from the Puyallup River getting pulled into the Tacoma Narrows. B. Puyallup River plume.  
Location: Commencement Bay (Central Sound) 2:04 PM

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*Red-brown bloom and several small fronts from small rivers.*

Location: Henderson Inlet (South Sound) 2:17 PM



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<https://fortress.wa.gov/ecy/publications/documents/1803075.pdf>.

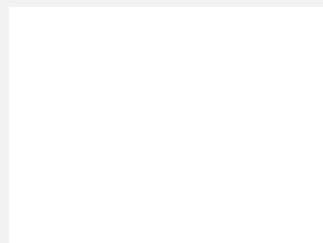
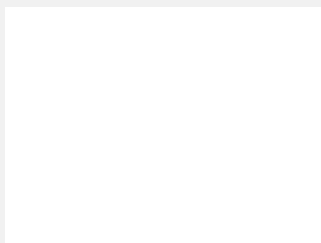


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Marina, and Kenmore Air.

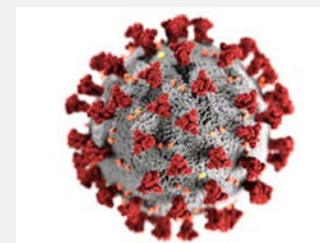
**Contact:**

Dr. Christopher Krembs  
[Christopher.Krembs@ecy.wa.gov](mailto:Christopher.Krembs@ecy.wa.gov)  
Monitoring Unit  
Environmental Assessment Program  
Washington State  
Department of Ecology

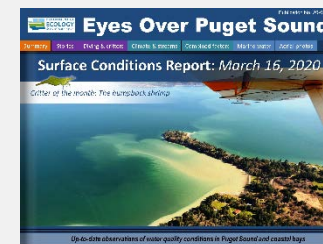
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**September\_28\_2020,**  
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**No coverage due to COVID-19  
pandemic from April-September**



**March\_16\_2020,**  
[Publication No. 20-03-071](#)



**Jan\_10\_2020,**  
[Publication No. 20-03-070](#)



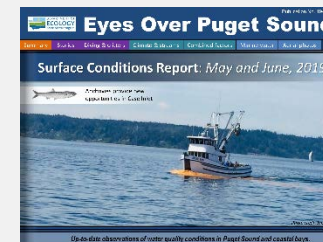
**October\_30\_2019,**  
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**September\_12\_2019,**  
[Publication No. 19-03-075](#)



**July\_29\_2019**  
[Publication No. 19-03-074](#)



**June\_4\_2019**  
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**February\_21\_2019**  
[Publication No. 19-03-071](#)



**January\_10\_2019**  
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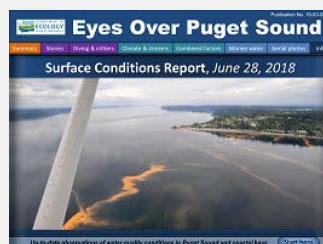
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**September\_17\_2018,**  
[Publication No. 18-03-074](#)



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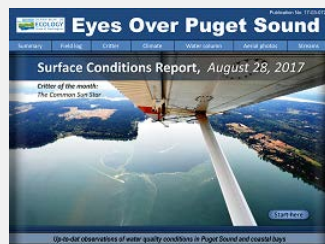


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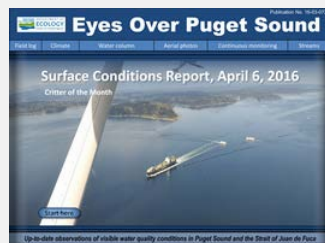
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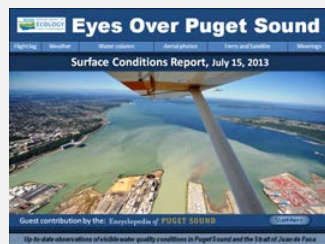


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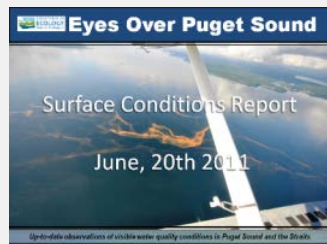
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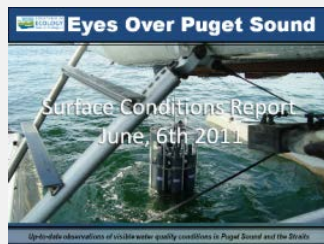
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