



DEPARTMENT OF
ECOLOGY
State of Washington

Eyes Over Puget Sound

[Summary](#)[Critters & divers](#)[Climate & streams](#)[Combined factors](#)[Marine water](#)[Aerial photos](#)[Data](#)

Surface Conditions Report: March 11, 2021



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

Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

Picture by: Jesse Miller



Margaret Dutch

Secrets of the Dead, [p. 3](#)

Leftover Mud Helps Recreate Puget Sound's Past.



Tyler Burks, Skip Albertson

Climate & streams, [p. 6-10](#)

We are in a weakening La Niña. February was cold and wet and rivers washed sediments into Puget Sound. In March, rivers are running near normal and carry clear water. At the coast downwelling has stopped.



Thank you to many

People send their observations, [p. 4. 43](#)

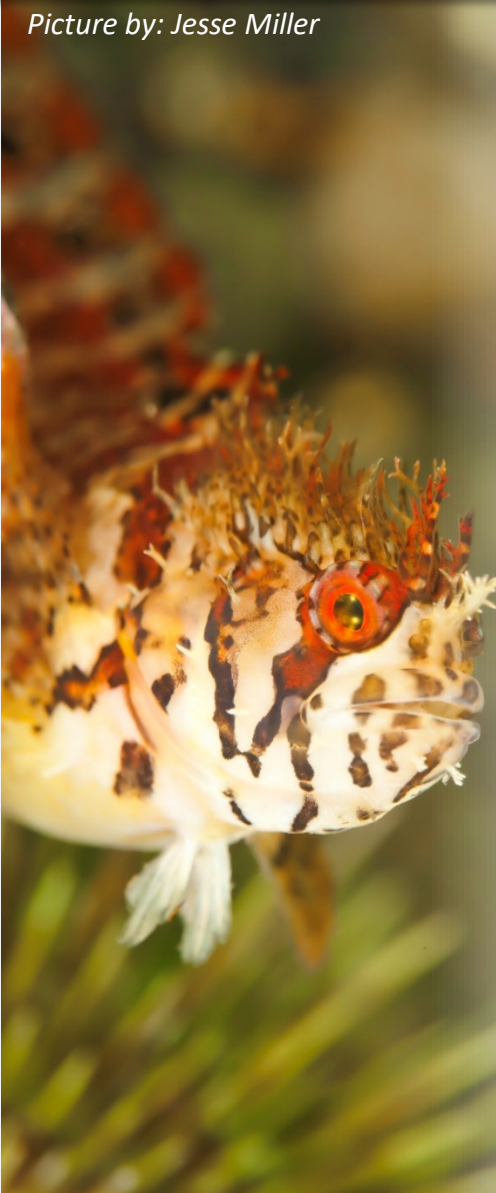
Divers share their amazing pictures in the waters of Puget Sound. It's a good time to go diving.



Dr. Christopher Krembs

The Aerial photography, [p. 13-42](#)

From mystery clouds of sediment to oil sheens. In the season of coldest water temperatures the productive season has already started and patches of jellyfish patches are visible.



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

Secrets of the Dead: Leftover Mud Helps Recreate Puget Sound's Past



Maggie Dutch
Marine Sediment
Monitoring Team

One program's trash is another's treasure...

Normally when our team sorts all the animals out of our mud samples, the leftovers go into the waste bin. But now, paleontologist Dr. Sue Kidwell and her students from the University of Chicago are using dead shells sorted from this material - known as "grunge" - to see what benthic communities might have been like in Puget Sound many years ago, and what ecosystem pressures transformed these ancient assemblages into what we see today.



Leftovers from a Budd Inlet sample contain many dead shell fragments



PhD candidate Broc Kokesh sorts and IDs the dead shells



Next step: compare the "dead" shell data with Ecology's "live" data

Learn more about this project on Ecology's EcoConnect blog, click [here](#)

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Combined factors

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Aerial photos

Data

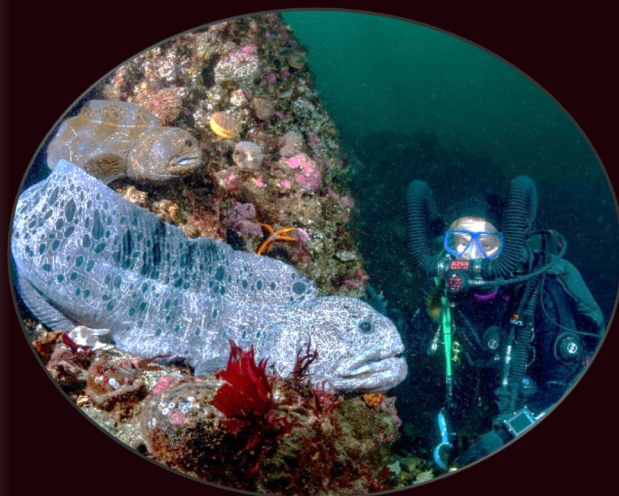


Fish-eating anemone, Strait of Juan de Fuca
By Eric Askilrud

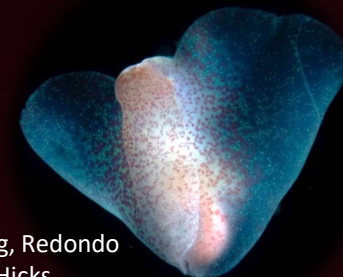
SCUBA divers in Puget Sound often encounter amazing creatures that few of us get to enjoy. Local divers shared their photos with us.



Candy striped shrimp, Anacortes
By Jessica Alexanderson



Wolf eel pair and diver, Gig Harbor
By Dave Hicks



Winged sea slug, Redondo
By Dave Hicks



Giant Pacific octopus, Redondo
By George Duncan

Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



What was the water visibility like for divers?

Only best visibility shown for **February**, in form of a small diver



Good

Visibility

Poor



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	21	13	15	69
2	10	25	4	3
3	17	97	16	10
4	19	3	17	87
5	25	74	8	5
6	29	80	6	3
7	15	30	8	51
8	44	61	26	15
9	30	80	15	5
10	29	25	12	98
11	22	61	3	7
12	8	28	2	2
13	26	85	10	7
14	27	94	19	7
15	21	31	16	44

Find depths with high/low visibility



- **Best visibility** occurred in Hood Canal near Octopus Hole at around 60 ft (Location 8).
- **Poor visibility (not indicated)** occurred in Oakland Bay near Shelton.



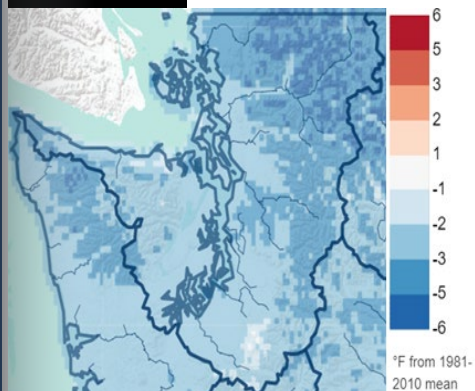
Picture by Eric Askilrud



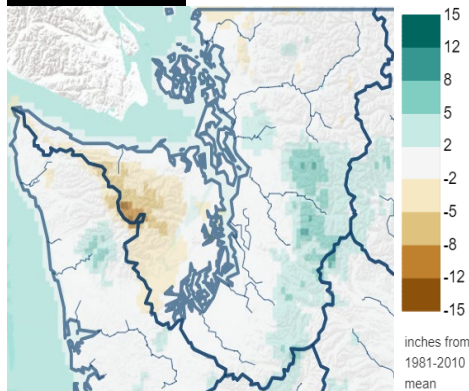
During the previous 30 days, Puget Sound air temperatures were below normal, while precipitation was generally near normal, with some spatial variation (A). With three weeks of snowpack accumulation remaining, watersheds that drain to Puget Sound hold above-normal volumes (B). Monitoring snowpack and temperature trends will be critical as we transition to spring.

A. Northwest Climate Toolbox

Temperature

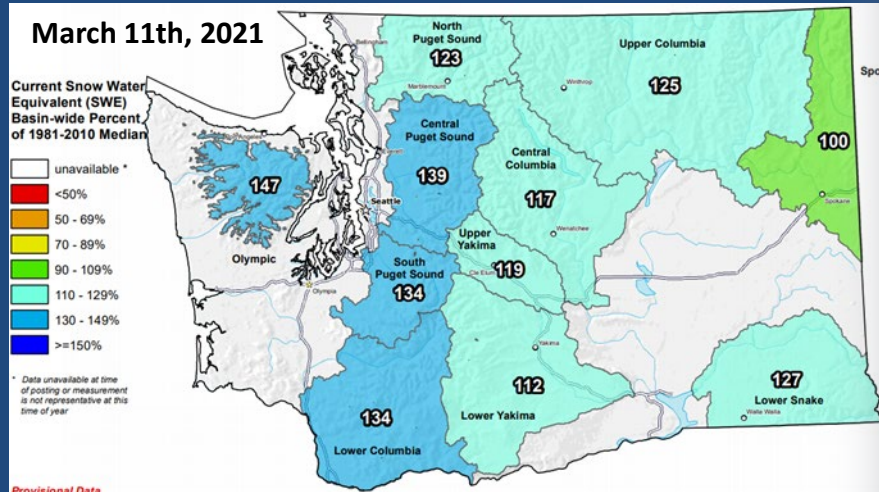


Precipitation



B. Washington SNOTEL, USDA/NRCS

March 11th, 2021



Temperature Anomaly

from historical mean daily ranged from 0 to -6 °F in the Puget Sound region during the past 30 days.

Precipitation Anomaly

from historical mean ranged from -12 to +12 inches in the Puget Sound region during the past 30 days.

Snow water equivalent

percent of median for watersheds draining to Puget Sound are above normal. As we move towards the typical peak of seasonal snowpack accumulation, April 1st, snow water equivalents are at 136% of the historical median.

Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

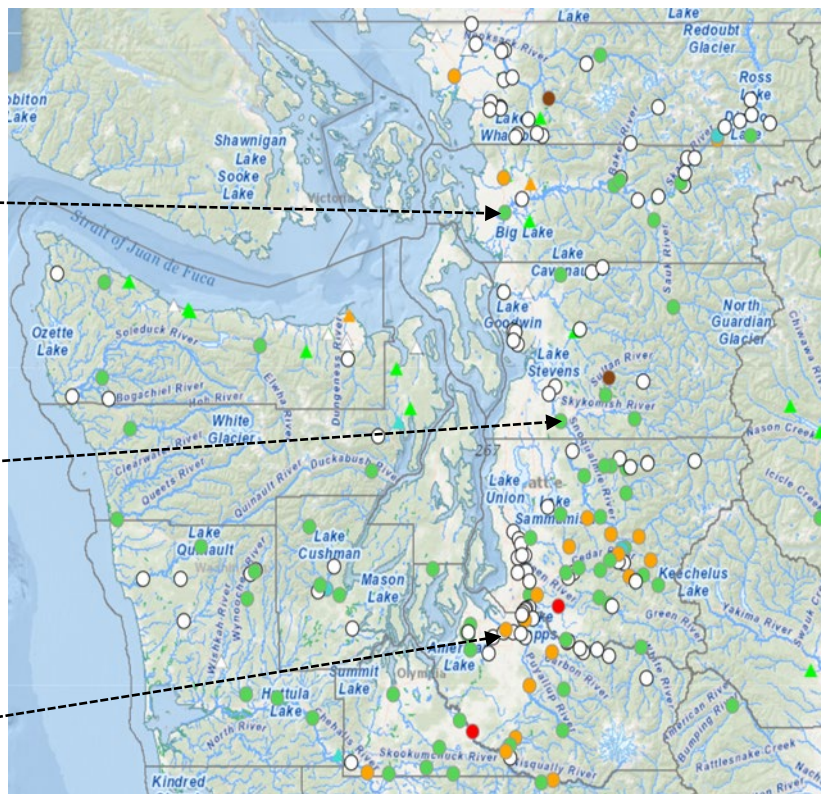
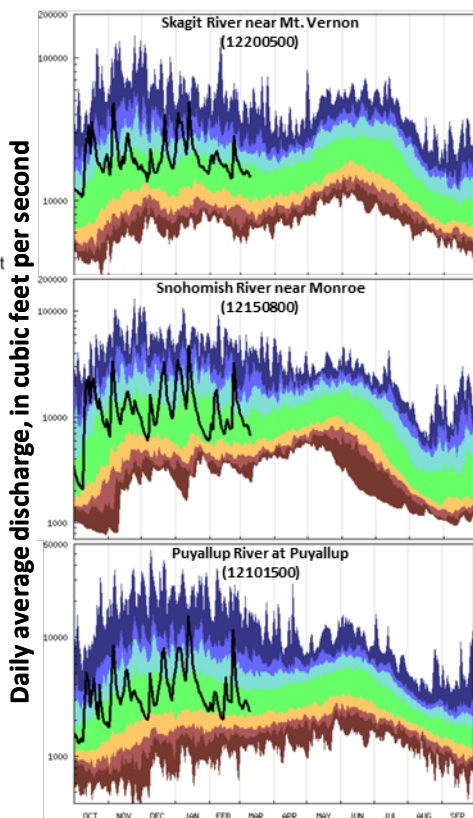
Data

Temporal: Following a series of precipitation events, including lowland snow, a dry period resulted in a return to normal freshwater inputs from major Puget Sound rivers to Puget Sound (trend charts, left).

Spatial: Geographic variation in streamflow (map, right) is dependent on the distribution of precipitation, and likely the low temperatures, leading to normal and below-normal conditions.

Select Puget Sound Streamflow Trends

Current Streamflow Conditions as of 03/11/2021



USGS Real Time Streamflow Values

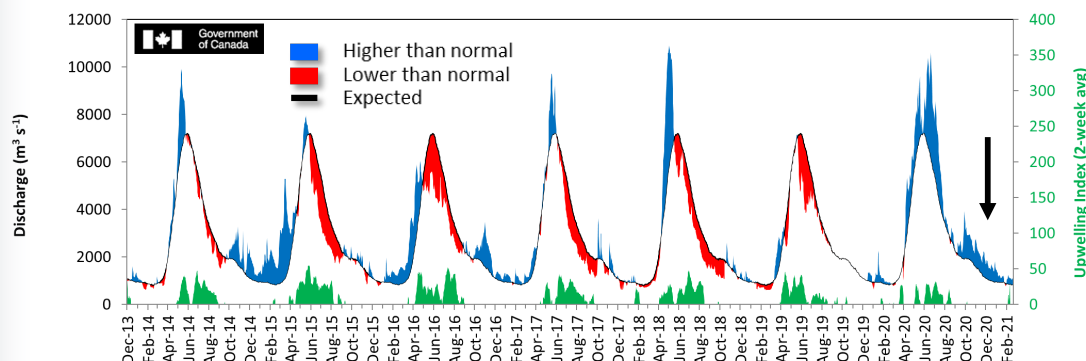
- Much above normal (>90%)
- Above normal (76-90%)
- Normal (25-75%)
- Below normal (10-24%)
- Much below normal (5-10%)
- Far below normal (>5%)
- Lowest recorded
- Not Ranked

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

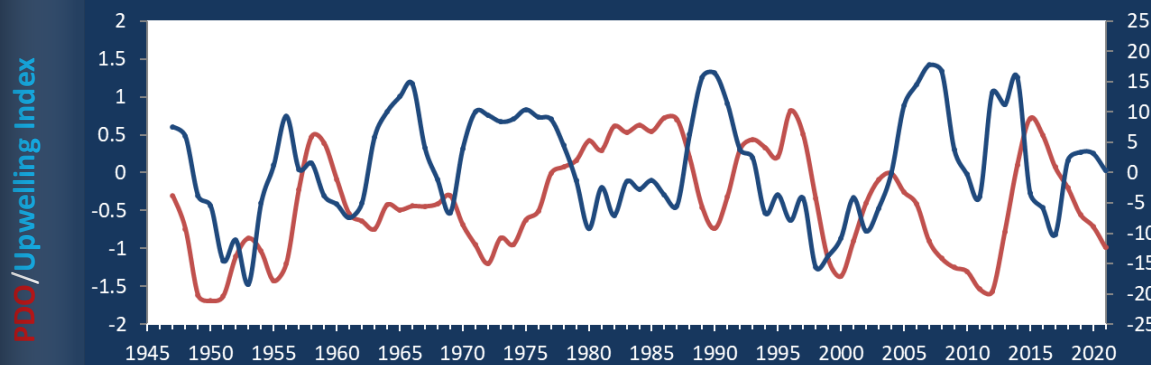
Historically, the peaks of coastal upwelling and the [freshet](#) are in sync..

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 flows normalize after high flows in 2020 and winter 2021.

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?

Water has gradually cooled (PDO).
Upwelling (Upwelling Index [anomaly](#)) is expected.

Pacific Decadal Oscillation Index (**PDO**, **temperature**, [explanation](#)).

Upwelling Index (anomalies) (**Upwelling**, **low oxygen**, [explanation](#)).

Summary

Critters & divers

Climate & streams

Combined factors

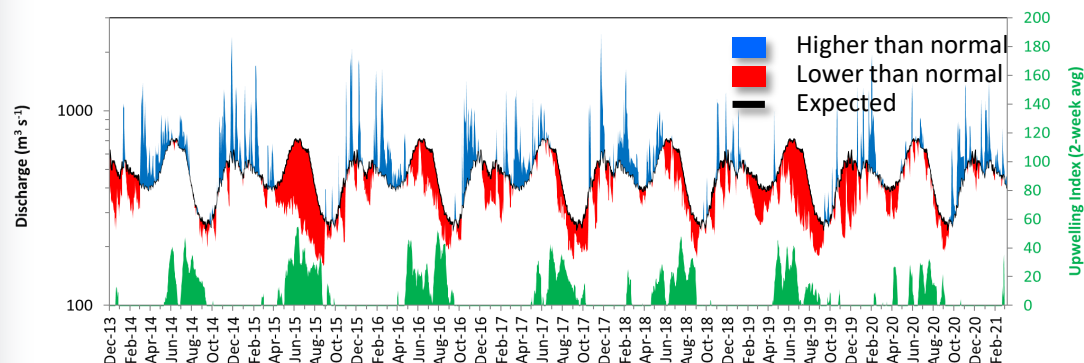
Marine water

Aerial photos

Data

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

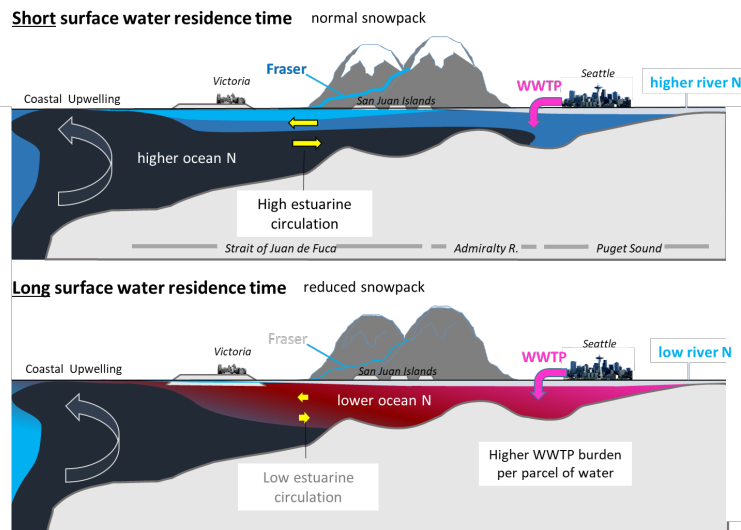
Skagit River (at midnight USGS)



The Skagit River freshet is no longer clearly pronounced, because it is a regulated system for hydroelectric power generation. However, drought years and low flows can be seen in the river's discharge data. In the last year flows of the Skagit appear more normal.

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

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

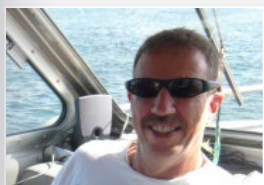


River flows and upwelling in the summer influence our water quality.

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. For recent river and stream inflow, [see page 6](#).

Conditions leading up to March:

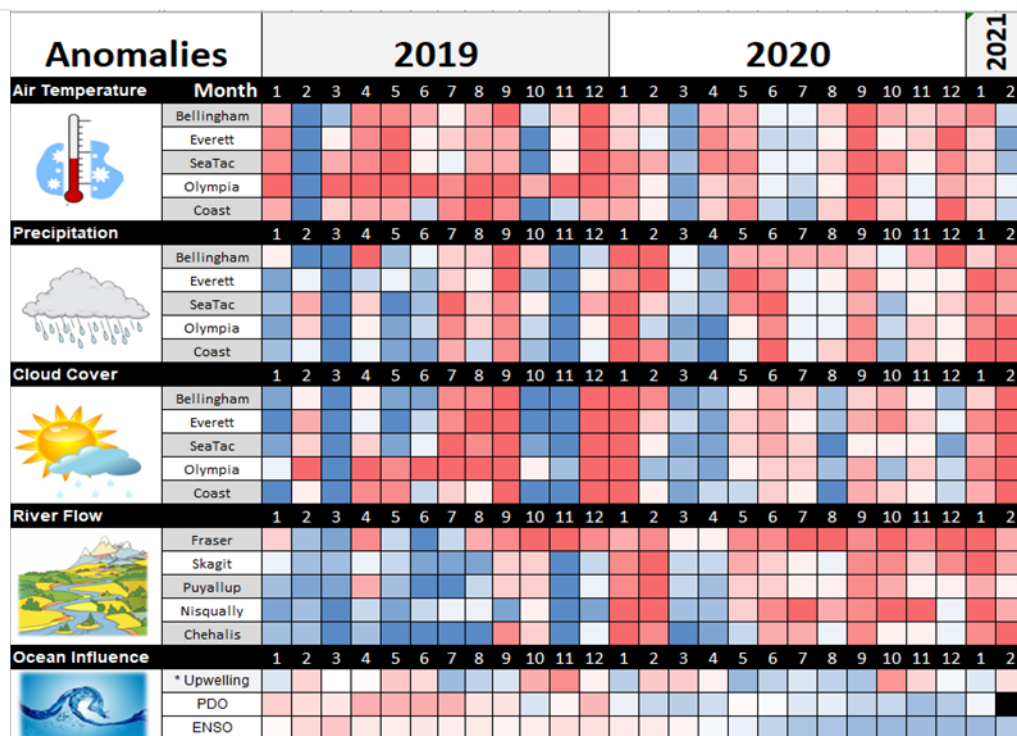
Air temperatures were generally warmer this winter, but February was cold.

Precipitation has been above normal after October.

Cloud cover levels were slightly above normal, generally being closer to normal in 2020 than in 2019.

River flows have remained higher than normal for most of the past year.

Downwelling was less pronounced in February. PDO is lower and La Niña remains.



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

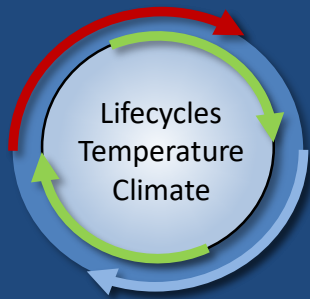
*Upwelling/downwelling Anomalies (PFEL)

PDO = Pacific Decadal Oscillation

ENSO = El Niño Southern Oscillation

higher expected lower

No data



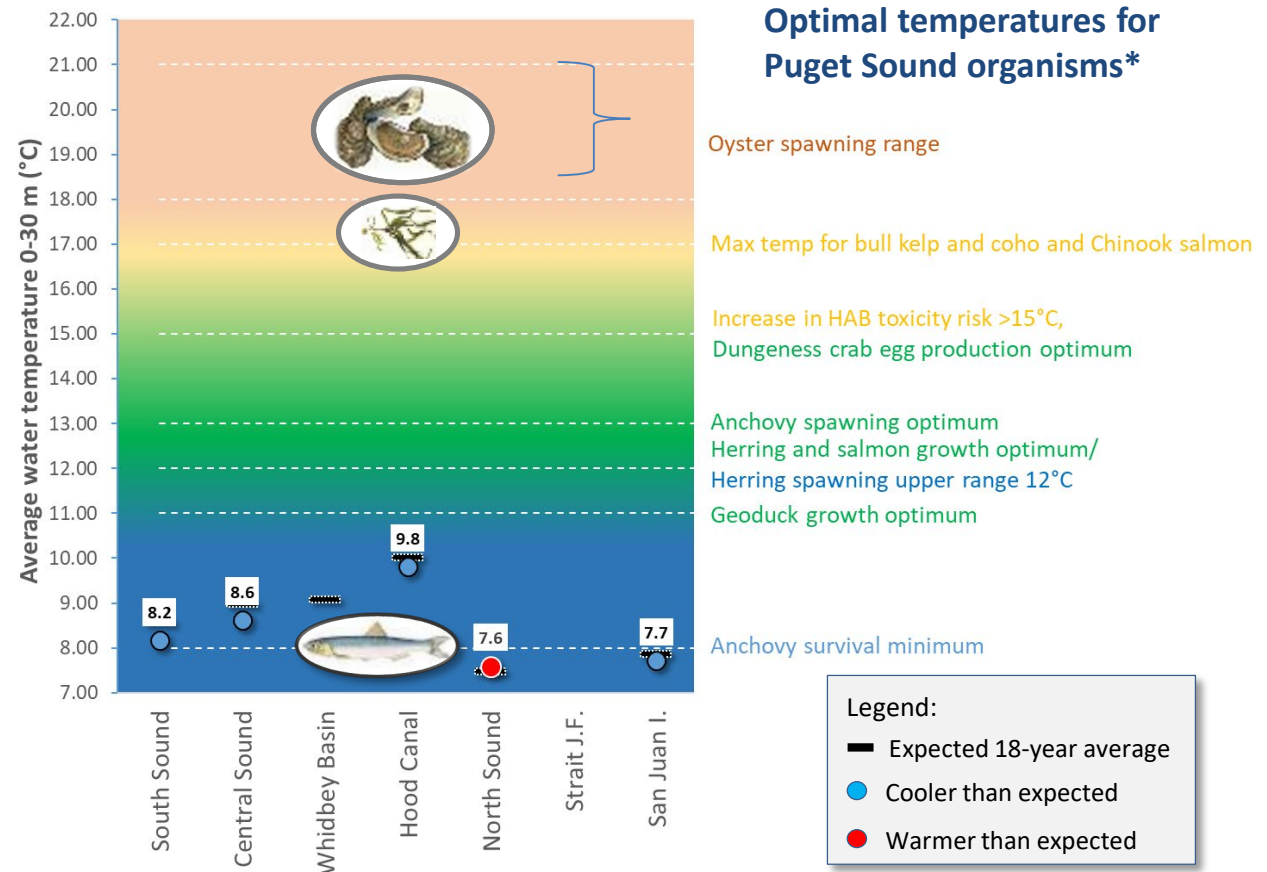
Can organisms thrive and survive?

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 February, average surface water (0 – 30 m) temperatures were slightly below expected across many regions. Water temperatures were in ranges for spawning for herring, but were reaching minimum survival temperature for anchovies of about 8.2 °C in South Sound, North Sound, and the San Juan Islands. Coldest water temperatures in North Sound are approaching 7.6 °C. Hood Canal could be a thermal refuge as it is still above 9 °C.



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

Stay up-to-date on unfolding stories relevant to our region



The **Marine Waters Work Group** (PSEMP) releases a summary of its bimonthly **Marine Condition Update**, covering the Puget Sound region, coastal waters, and the North Pacific.

To participate in the webinar every other month, join our email list by emailing Iris Kemp (ikemp@ltnk.org) or the Marine Waters Work Group (marinewaters@psemp.org).

Stay plumbed into the the information stream...

What's the story so far?

Go to the [webpage](#) and read detailed discussion summaries.

Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Southern Hood Canal and Southern inlets with organic debris. Jellyfish persist at yearly water temperature minima in finger inlets in South Sound and Sinclair Inlet. Oil sheen and wastewater diffuser plume are visible in North Sound. Rivers deliver clear water but biological activity creates localized plumes of suspended sediment in shallow areas. First blooms appear.

Start here

You have to love Portage Island, Bellingham Bay.



Keeping an eye on False Bay this year, Friday Harbor



Mixing and fronts:

Tidal eddies around Hope Island; distinct tidal fronts north of Patos Island and off Marrowstone Point.



Jellyfish and fish:

Occasional patches of jellyfish in Sinclair Inlet, Budd Inlet, Henderson Inlet, and Eld Inlet.



Suspended sediment:

Many places with suspended sediment in the nearshore with potential of biological origin. Brown plume in Birch Bay. Brown sediment plume in Joe Leary Slough.



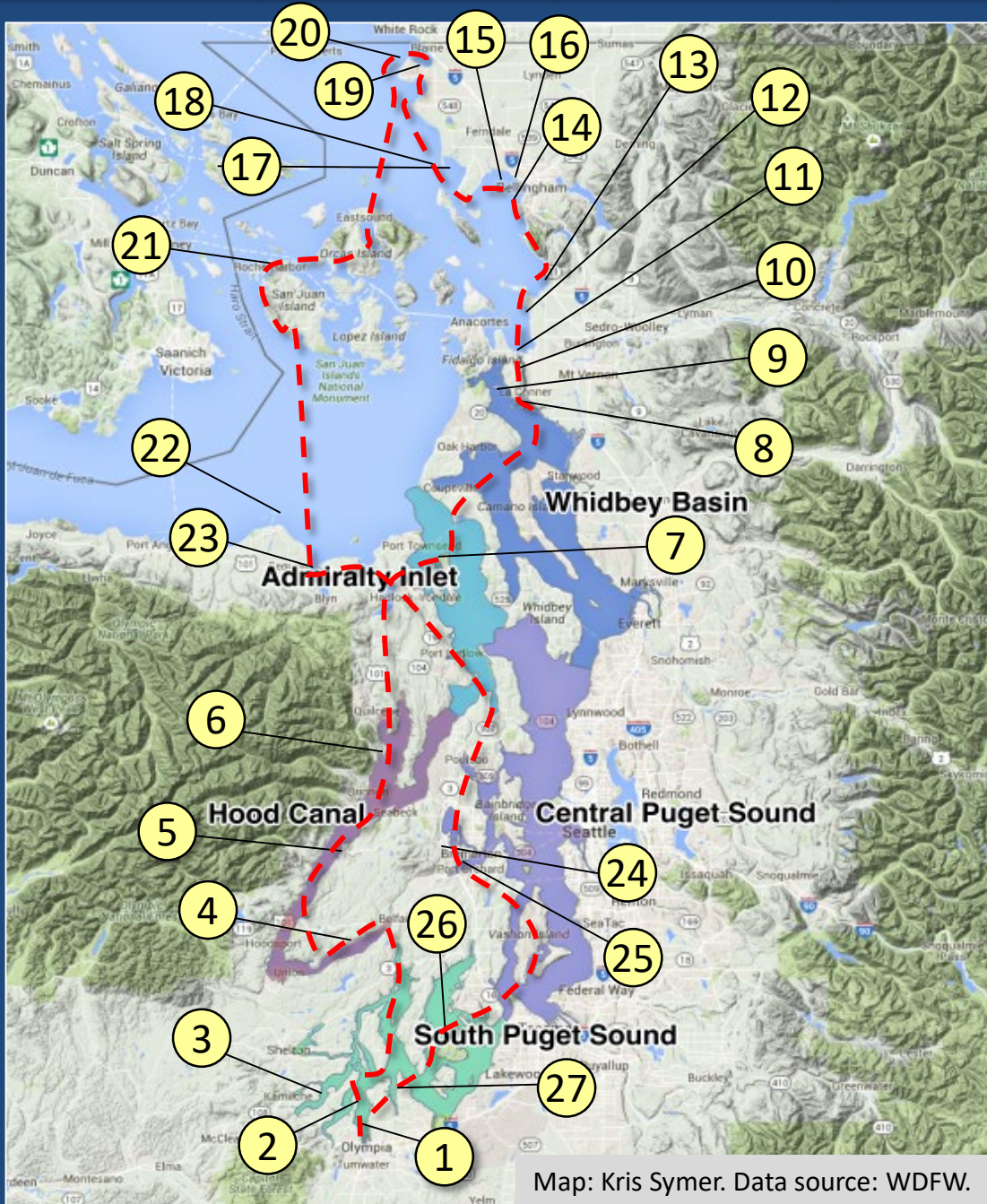
Visible blooms:

Visible dark bloom in East Bay, Westcott Bay, and Southern Hood Canal. Green discoloration and signs of increased productivity in many places.



Debris:

Organic debris in Budd and Eld Inlets, southern and central Hood Canal.



DEPARTMENT OF
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State of Washington



Aerial navigation guide

Date: 3-11-2021

Click on numbers

Flight Observations

South Sound: low clouds; north of
Tacoma: broken ceiling, sunny.

Contribute observations

iNaturalist



CALIFORNIA
ACADEMY OF
SCIENCES



NATIONAL
GEOGRAPHIC

Tide data from 3-11-2021 (Seattle):

Time	Pred (ft)	High/Low
01:47 AM	8.03	H
07:52 AM	1.92	L
03:10 PM	11.25	H
09:39 PM	3.82	L

[Summary](#)[Critters & divers](#)[Climate & streams](#)[Combined factors](#)[Marine water](#)[Aerial photos](#)[Data](#)

Connect aerial observation with data from ORCA moorings



Nick Michel-Hart,
John Mickett, UW/APL.



[NANOOS NVS Data Explorer](#)



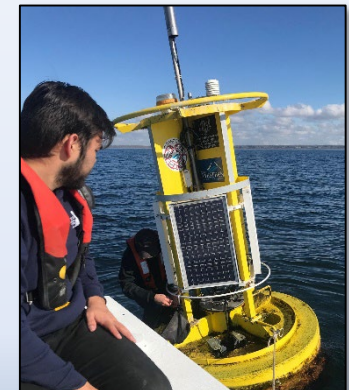
View products by mooring

Puget Sound

- ① [Carr Inlet](#)
- ② [Dabob Bay](#)
- ③ [Hoodsport](#)
- ④ [Hansville](#)
- ⑤ [Point Wells](#)
- ⑥ [Twanoh](#)

Salish Sea

- ⑦ [Bellingham Bay](#)



Thayne Yazzie, NWIC,
Robert Daniels, UW/APL



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

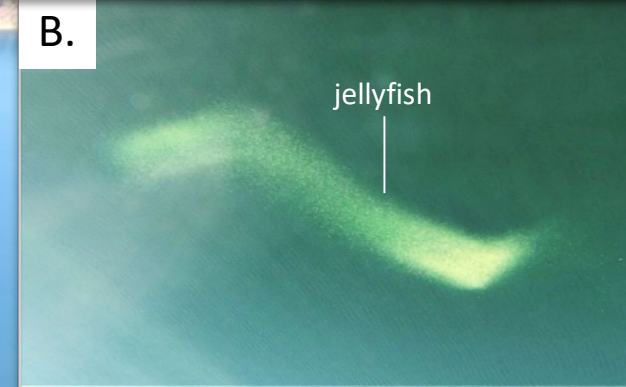
Aerial photos

Data

A.



B.



A. Jellyfish patches in plume of the Deschutes River. B. Close-up of one patch, where it's possible to see individual animals. Location: Budd Inlet (South Sound), 11:23 AM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Distinct front with organic debris accumulating north of the front.
Location: Off Beverly Beach Dr. NW, Budd Inlet (South Sound), 11:25 AM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended material from aquaculture activities
Location: Totten Inlet (South Sound), 11:30 AM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

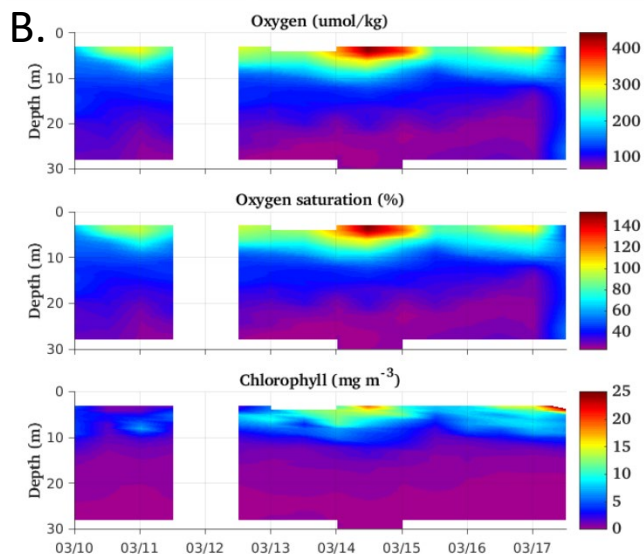
Aerial photos

Data

A.



B.


[Click to mooring](#)


cabin reflections

A. Large patches of organic surface debris following a bloom. B. Nearby ORCA mooring with coincident data.
 Location: East of Twanoh State Park (southern Hood Canal), 11:49 AM



Summary

Critters & divers

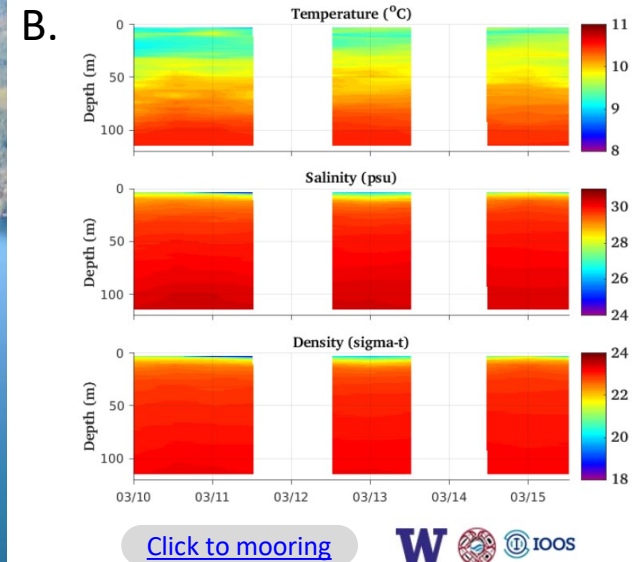
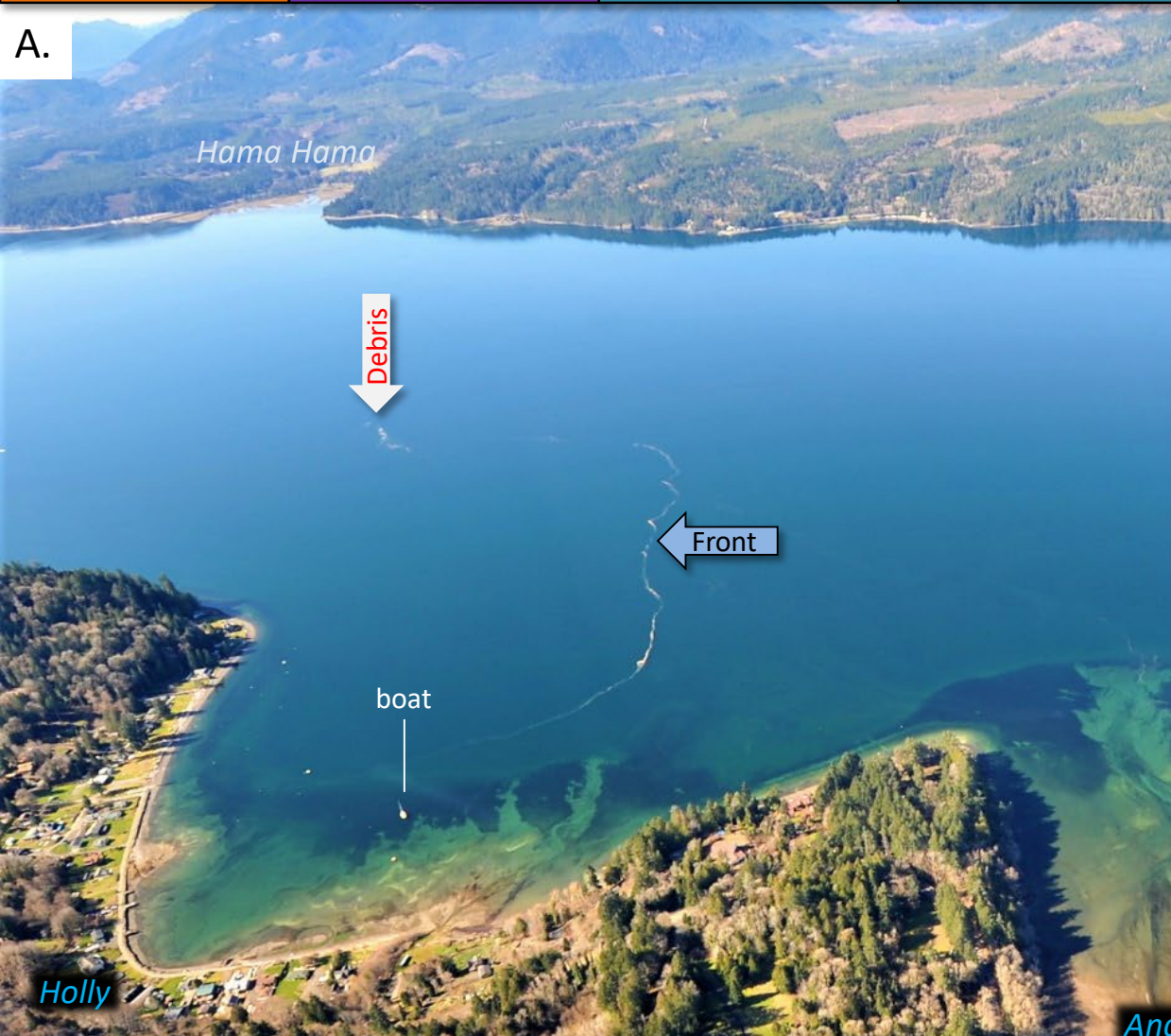
Climate & streams

Combined factors

Marine water

Aerial photos

Data



A. Organic surface debris following front. B. Nearby ORCA mooring with coincident data.
Location: Near Anderson Cave (central Hood Canal), 12:01 PM

Summary

Critters & divers

Climate & streams

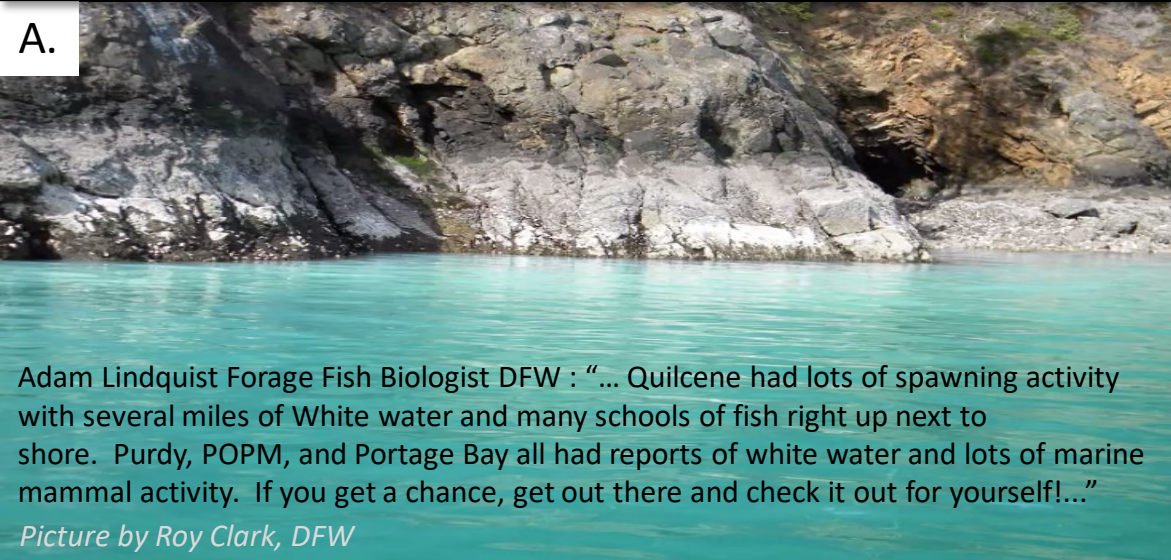
Combined factors

Marine water

Aerial photos

Data

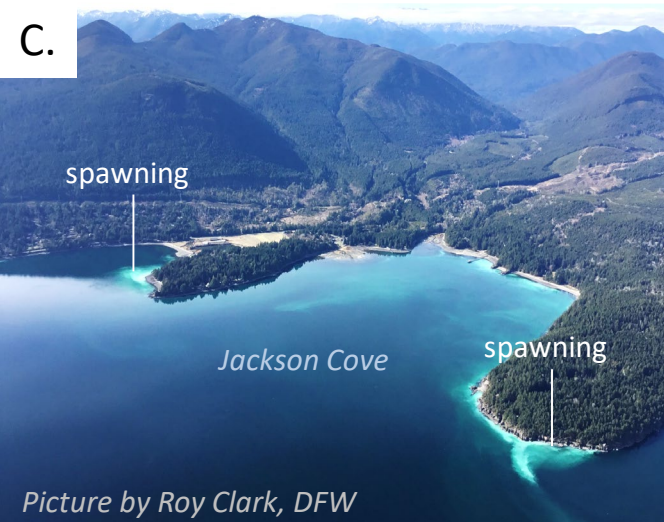
A.



B.



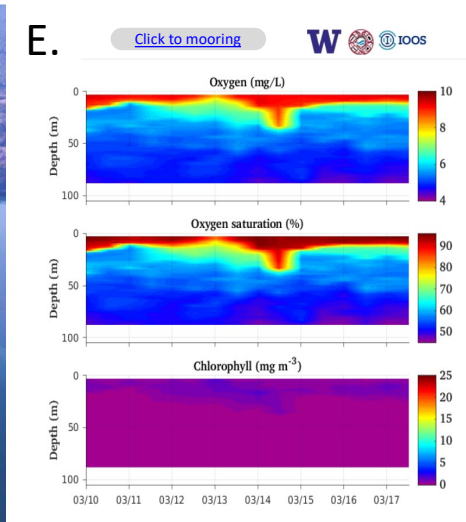
C.



D.



E.



Department of Fish and Wildlife reports: A-B. Quilcene herring spawning and eggs deposited on macro-algae between C-D. Jackson Cove and Pt Whitney. E. ORCA mooring data. Location: Quilcene Bay (Hood Canal)



Summary

Critters & divers

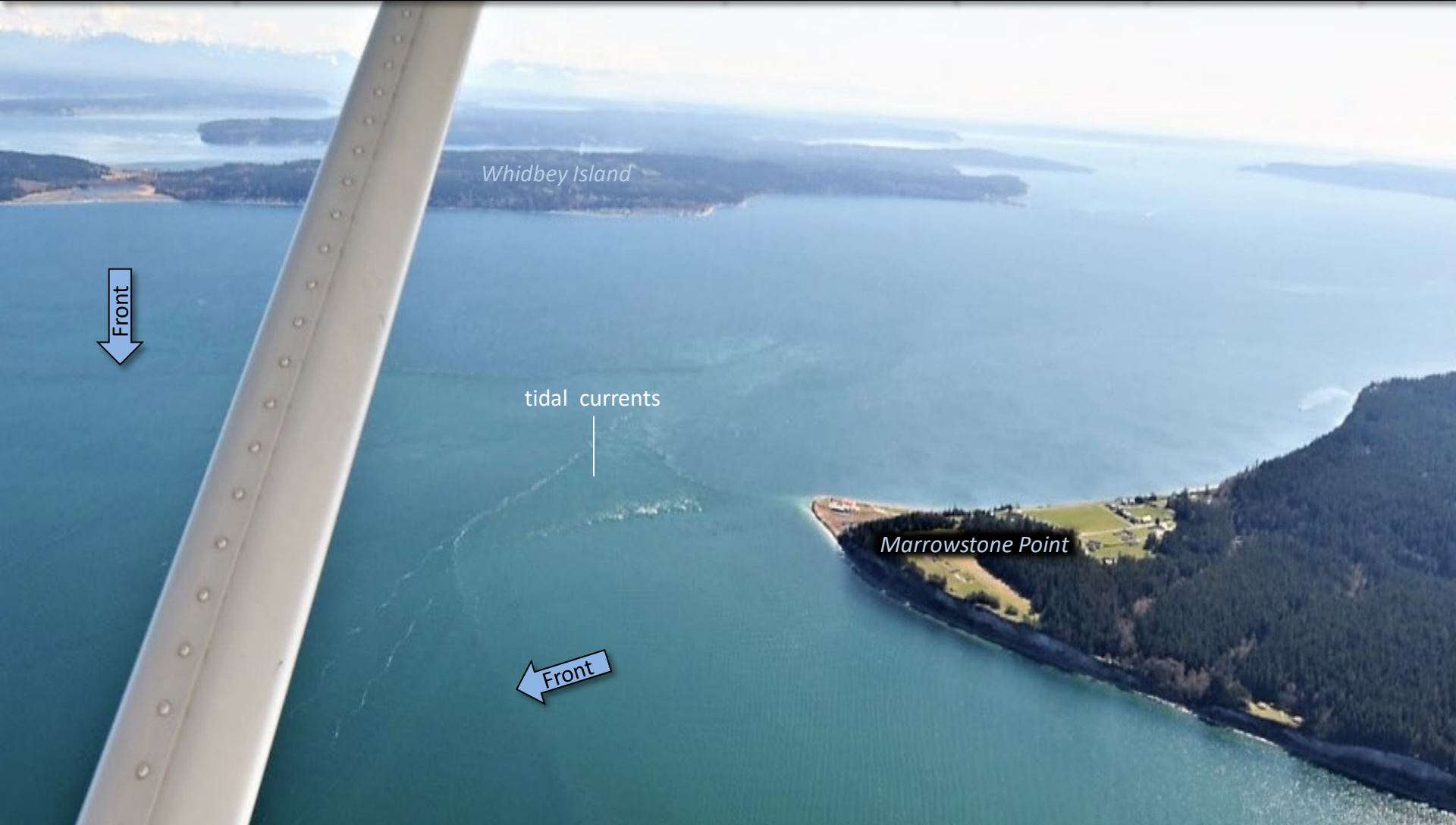
Climate & streams

Combined factors

Marine water

Aerial photos

Data



Strong tidal currents at Marrowstone Point during an incoming tide.
Location: Marrowstone Island (Central Sound), 12:25 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment in the nearshore environment, likely biological in origin.
Location: North Fork of the Skagit River, Skagit Bay (Whidbey Basin), 12:48 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Tidal eddy with more turbid water forming south of Hope Island.

Location: Swinomish Reservation, Skagit Bay (Whidbey Island), 12:29 PM



Summary

Critters & divers

Climate & streams




Combined factors

Marine water

Aerial photos

Data

**Water with different colors**

-  Old Channel
-  Higgins Slough
-  Swinomish Channel

Water can be very differently colored in this region depending on salinity, sediment load, and flow.

Location: Swinomish Channel (North Sound), 12:41 PM



Summary

Crittters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment in the nearshore environment, likely biological in origin.

Location: Padilla Bay (North Sound) 12:42 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



A. Close up of slough with very brown water and sediment. B. Padilla Bay with long front line.

Location: Padilla Bay (North Sound) 12:44 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Samish River estuary. With suspended sediment in the nearshore, likely due to biological activity.

Location: Samish Bay (North Sound), 12:45 PM



Summary

Critters & divers

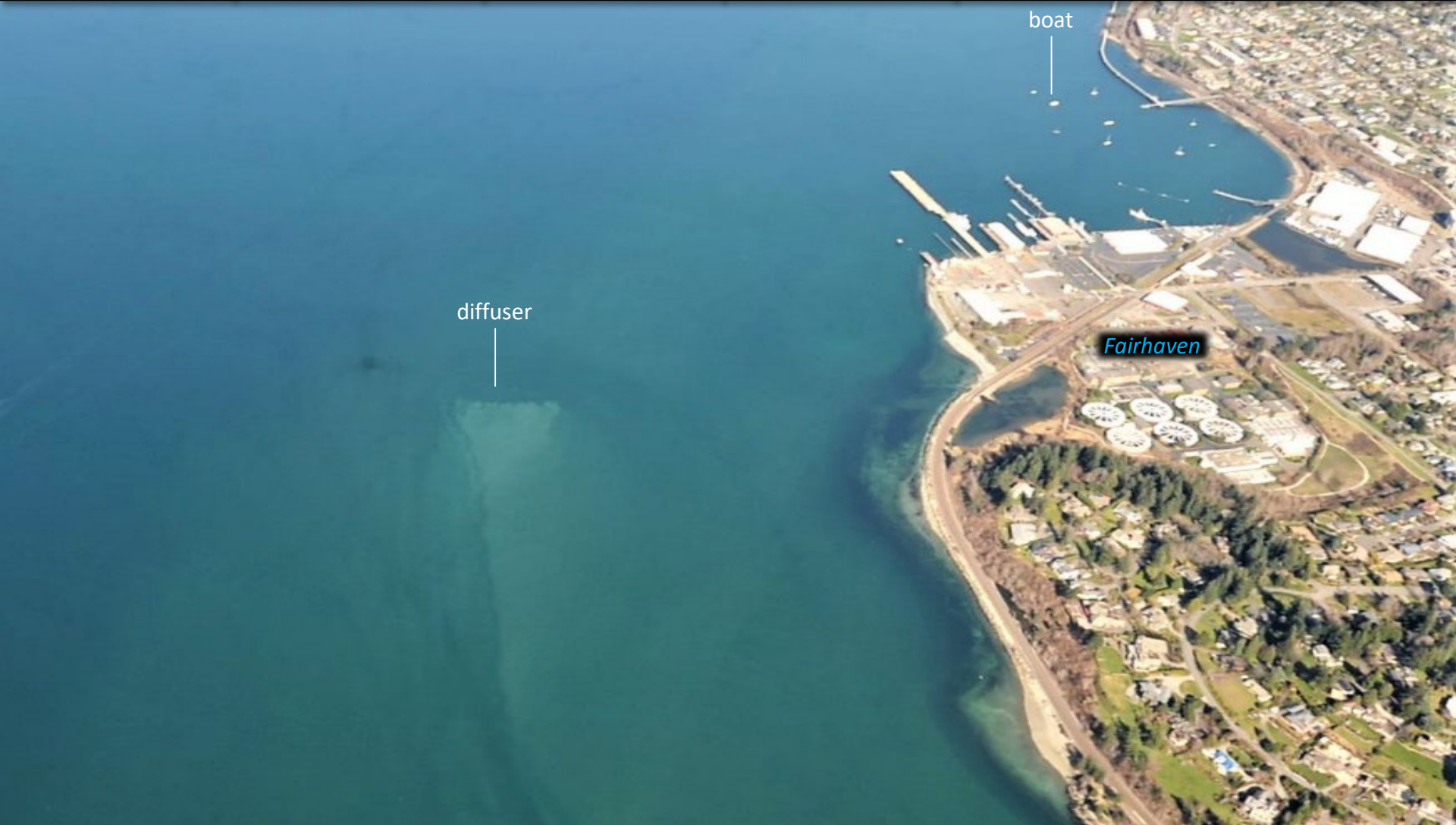
Climate & streams

Combined factors

Marine water

Aerial photos

Data



Diffuser of the Fairhaven Wastewater treatment plant. Effluent can be seen miles to the south.
Location: Fairhaven Bellingham Bay (North Sound), 12:52 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment near the Nooksack delta, likely biological in origin. Nooksack river water is clear in contrast.
Location: Bellingham Bay (North Sound), 12:54 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment at the entrance to Squalicum Harbor.

Location: Bellingham Bay (North Sound), 12:55 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment near the Lummi river delta. Likely biological in origin.

Location: Lummi Bay (North Sound), 1:02 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Oil sheen about ¼ mile long. Location: outside Lummi Bay (North Sound), 1:04 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

A.



B.



C.



D.



A-B. Brown water from Terrel creek in Birch Bay. C. Diatom mats in shallows of Drayton Harbor
Location: A-B. Birch Bay, C-D. Drayton Harbor (North Sound), 1:12 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

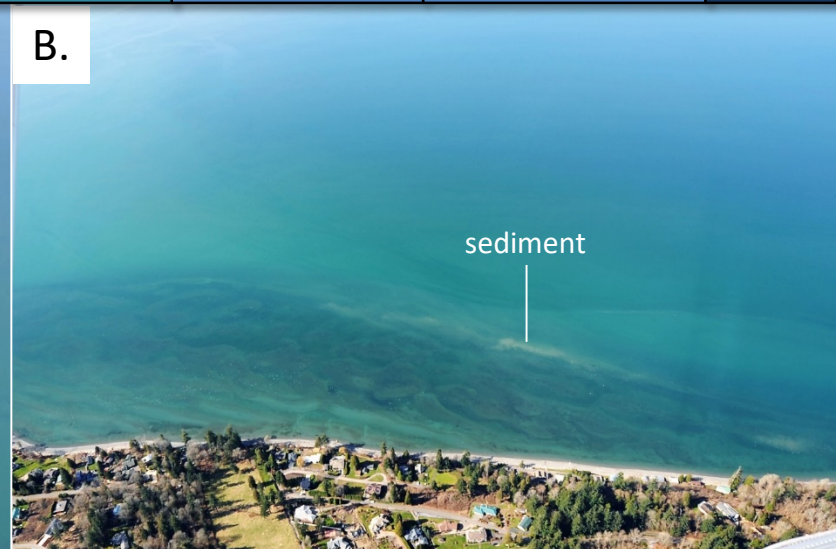
Aerial photos

Data

A.



B.



A. White water and seagulls likely indicate spawning herring B. Small patches of grey water with sediment.

Location: North of Birch Point (North Sound), 1:16 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Beginning algal bloom in Westcott Bay

Location: Friday Harbor (San Juan Islands), 1:35 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Suspended sediment movement helps spit grow.
Location: Dungeness Spit (Straits of Juan de Fuca) 1:51 PM

[Summary](#)[Critters & divers](#)[Climate & streams](#)[Combined factors](#)[Marine water](#)[Aerial photos](#)[Data](#)

Beautiful entrance to Sequim Bay. Nothing to report other than beauty.

Location: Sequim (North Sound), 1:54 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

A.



B.



Jellyfish aggregations and early signs of phytoplankton growth.
Location: Oyster Bay, Dyes Inlet (Central Sound), 2:19 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Three patches of jellyfish. Location: Sinclair Inlet (Central Sound), 2:21 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

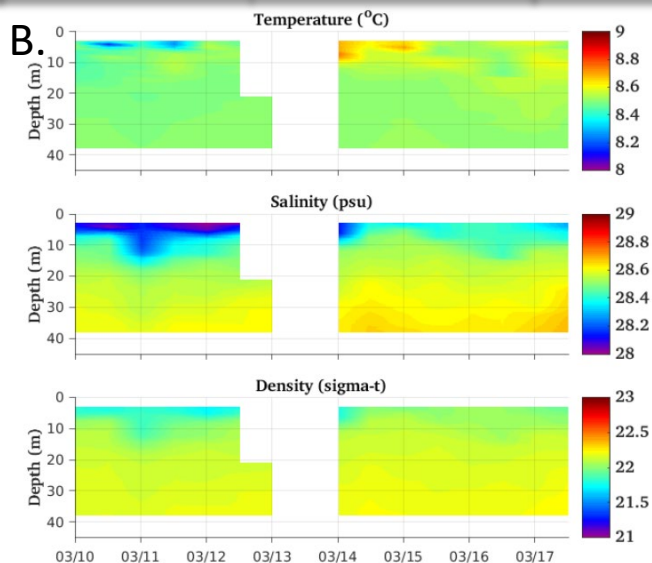
Aerial photos

Data

A.



B.

[Click to mooring](#)

A. Suspended sediment or spawning herring. B. Nearby ORCA mooring data coincident with overflight.
Location: Delano Bay, Carr Inlet (South Sound) 2:36 PM



Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data



Small patch of jellyfish, plume and front near Woodard Bay. Location: Henderson Inlet (South Sound) 2:42 PM



Help us cover important events in Puget Sound



Navigate

Summary

Critters & divers

Climate & streams

Combined factors

Marine water

Aerial photos

Data

iNaturalist



Help us to document important environmental events and places on Puget Sound's waters and beaches.

Jellyfish



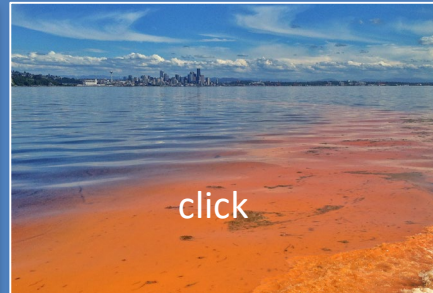
click

Algal blooms



click

Noctiluca blooms



click

Macro-algae



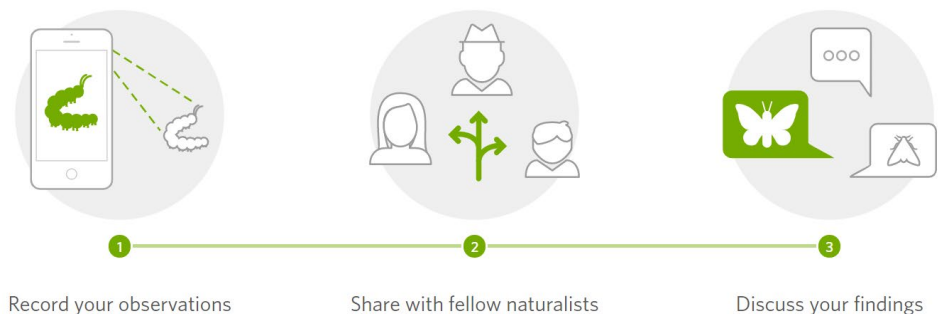
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How It Works



Summary

Critters & divers

Climate & streams

Combined factors

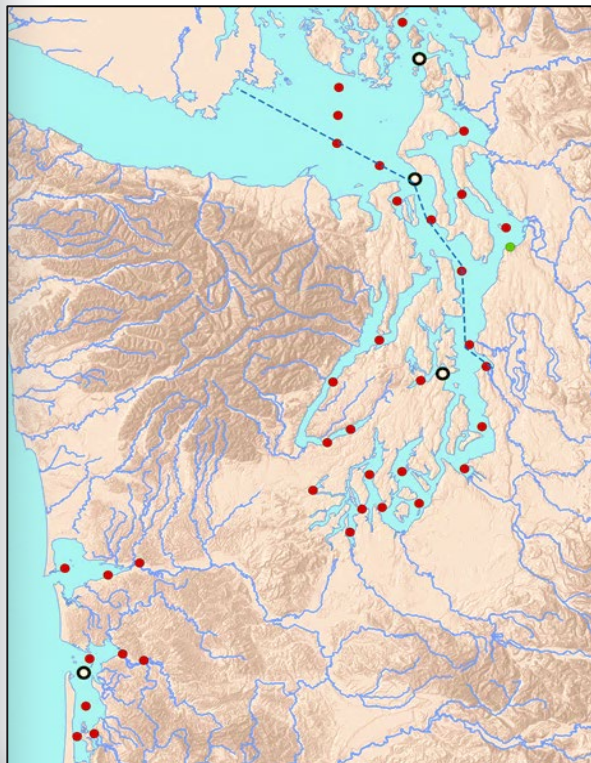
Marine water

Aerial photos

Data

Long-term monitoring data from Puget Sound and Coastal Bays

- 39 stations sampled monthly
- 16 physical, chemical, biogeochemical parameters
- data from 1999-present



[Summary](#)[Critters & divers](#)[Climate & streams](#)[Combined factors](#)[Marine water](#)[Aerial photos](#)[Data](#)

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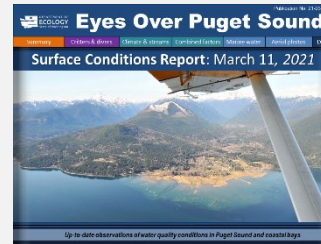


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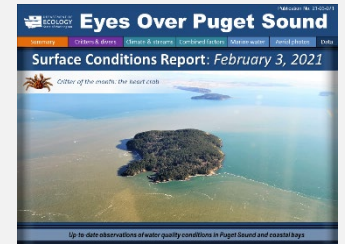
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Marine Monitoring Unit
Environmental Assessment Program
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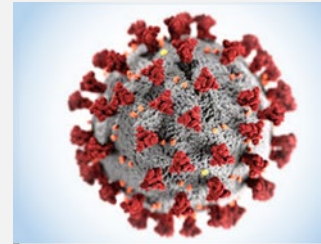
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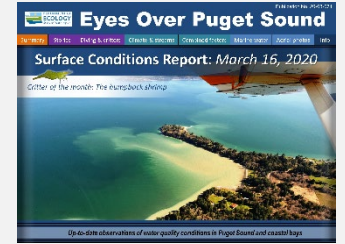
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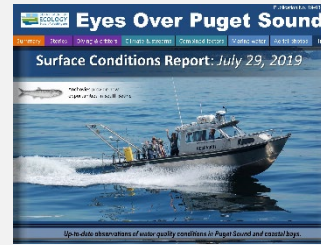
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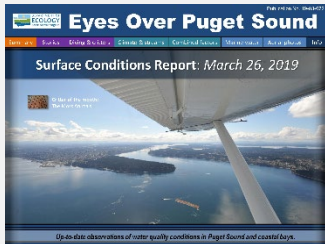
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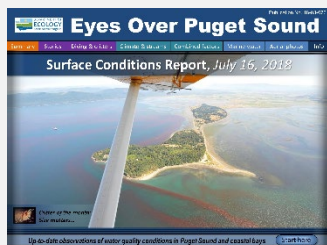
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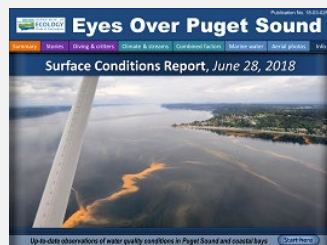
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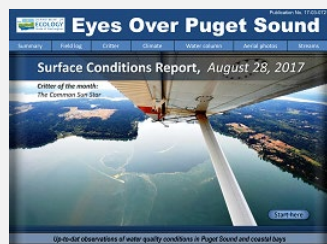
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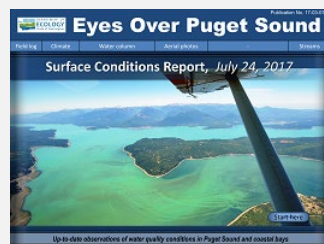
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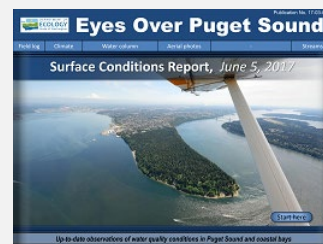
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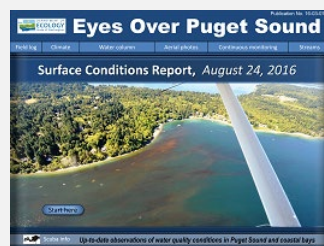
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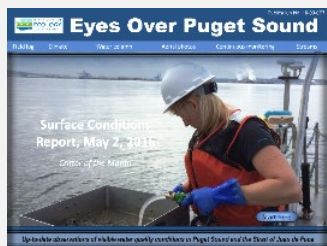
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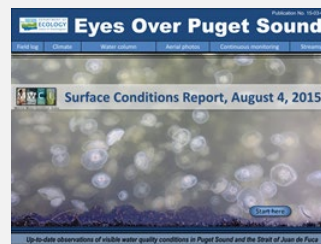
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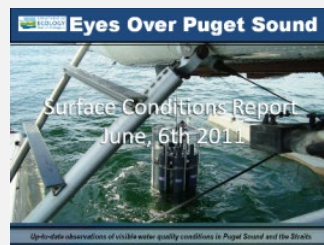
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