Publication No. 22-03-073

DEPARTMENT OF ECOLOGY
State of Washington

Eyes Over Puget Sound

Surface Conditions Report: October 2022

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

Summary conditions at a glance

LONG-TERM MARINE MONITORING UNIT

Artists corner, p. 4

Showcasing the natural beauty of Puget Sound through photography.

Thanking all staff since 1999

Nutrients & context, p. 8

A healthy food web has at its base a balance of nutrients. An imbalance can create favorable conditions for less-desirable species.

Field team: Natalie Coleman, Holly Young

Marine conditions, p. 13

Mostly expected conditions in October, with warmer and saltier water at the coast.

Dr. Christopher Krembs

Aerial photography, p. 14

Blooms continuing in multiple terminal bays. Numerous patches of jellyfish in Budd Inlet and Liberty Bay. Sediment is visibly transported by the Puyallup River. Resuspended sediment along shorelines in Totten Inlet, in some places mixed with soil. Air conditions smoky.

Editor: Dr. Christopher Krembs, editorial assistance: Valerie Partridge, Julianne Ruffner, Dany Burgess, Sandy Weakland

As in a pandemic, the battle against invasive species may well depend on early actions

By Christopher Dunagan, May 24, 2021

European green crab // Photo: Kelly Martin, Washington Sea Grant

While not a direct threat to human health, European green crabs could take a heavy toll on native shellfish, destroy eelgrass beds important to salmon and forage fish, and consume commercial clams and oysters with financial losses to the shellfish industry.

Read article

Puget Sound is beautiful and inspiring

Showcasing the natural beauty of Puget Sound through photography from engaged artists in our communities and from unique vantage points.

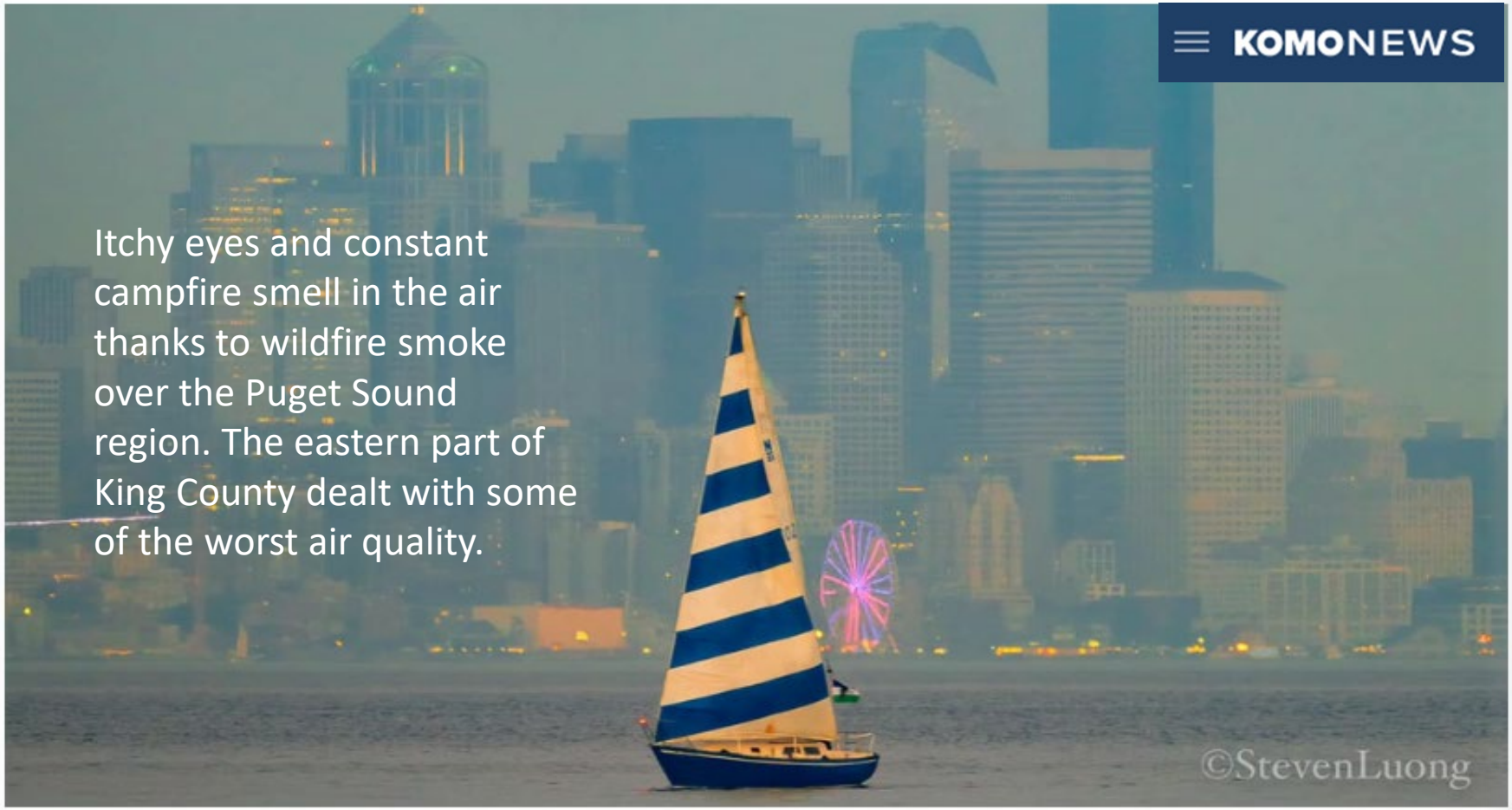
"The fish head": Am I the only one seeing a fish here?

Puget Sound is beautiful and inspiring

"The race": Speed boats passing the Tacoma Narrows bridge

Low air quality moves into Puget Sound region

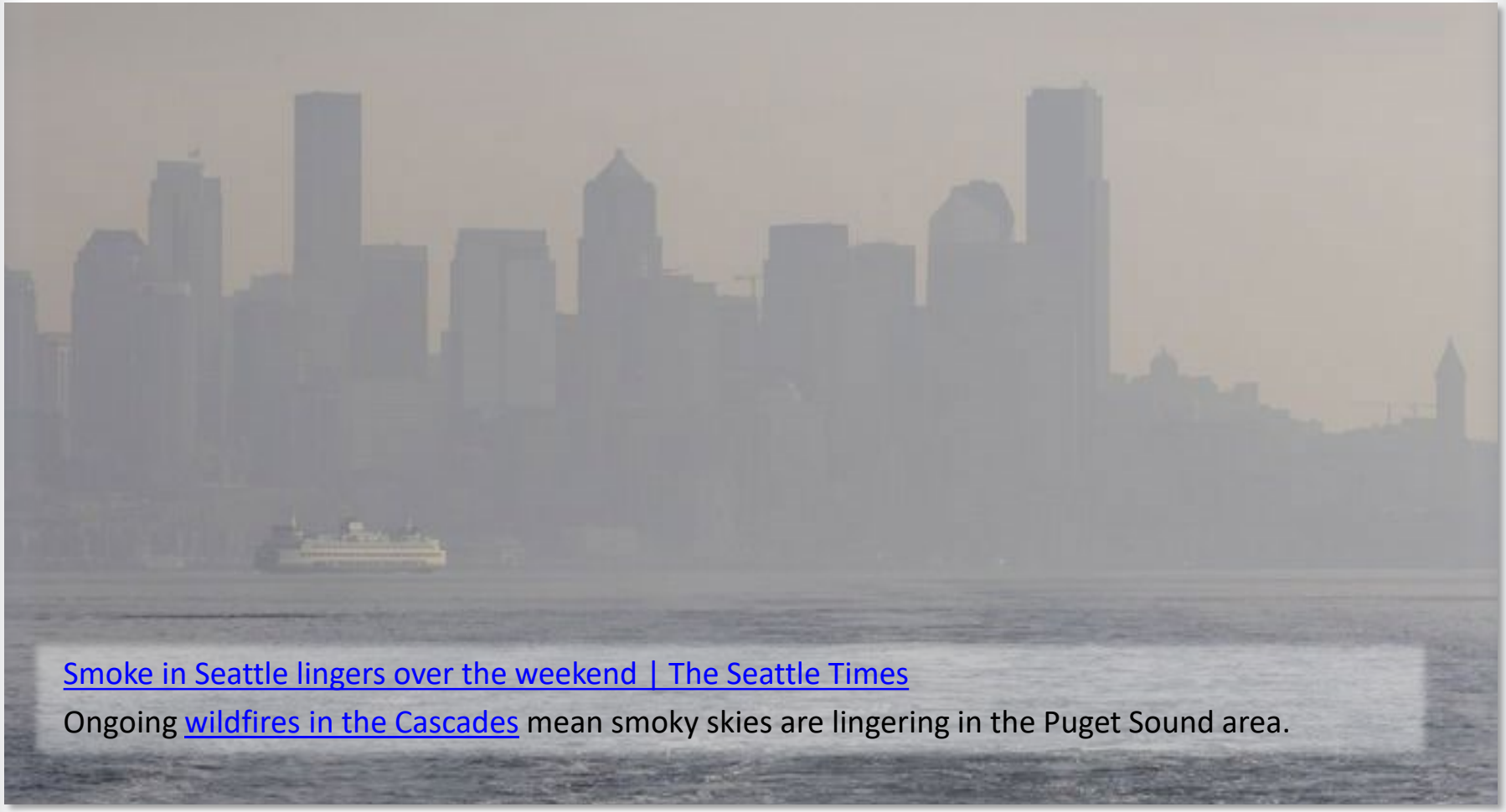
by KOMO News Staff | Monday, October 10th 2022



A smoky downtown Seattle (Photo: Steven.T.luong Photography)

Smoke in Seattle lingers over the weekend

Oct. 9, 2022 at 11:43 am Updated Oct. 10, 2022



Smoke in Seattle lingers over the weekend | The Seattle Times

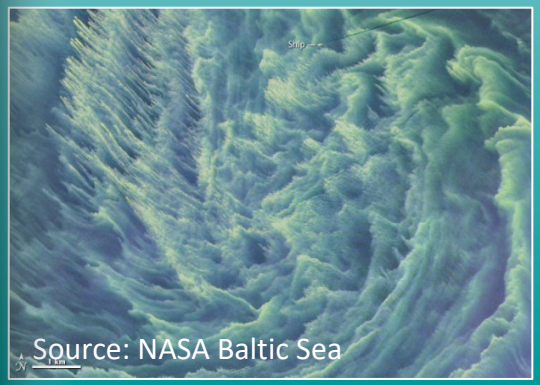
Ongoing wildfires in the Cascades mean smoky skies are lingering in the Puget Sound area.

A healthy food web has at its base a balance of nutrients

N-limited (unbalanced)

High phosphate concentration attracts nitrogen fixers

At a nitrogen-to-phosphate ratio below about 4, blue green algae start dominating the phytoplankton community.



Blue-green algae

Balanced and productive

Lipids are major constituents of diatoms (read). Puget Sound's cold-water food web relies on diatoms and their lipids.

Fish rich in lipids

P-limited (unbalanced)

High org nitrogen concentrations supports microbial food webs

At a nitrogen-to-phosphate ratio above about 20, flagellates start dominating the phytoplankton community.

Red tides, flagellates

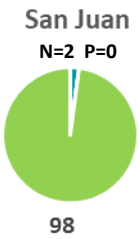
Ecology data 1999-2018

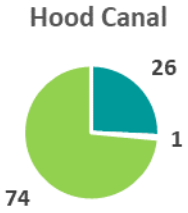
Nutrients are the building blocks for phytoplankton. When in balance, a healthy mix of species thrives.

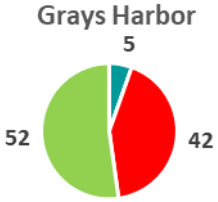
Limitation of a nutrient can result in species shifts and exclusion of beneficial species.

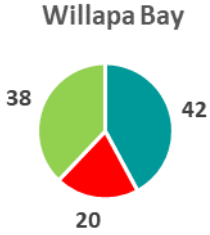
Phosphate (P) limitation can promote flagellates and HABS.

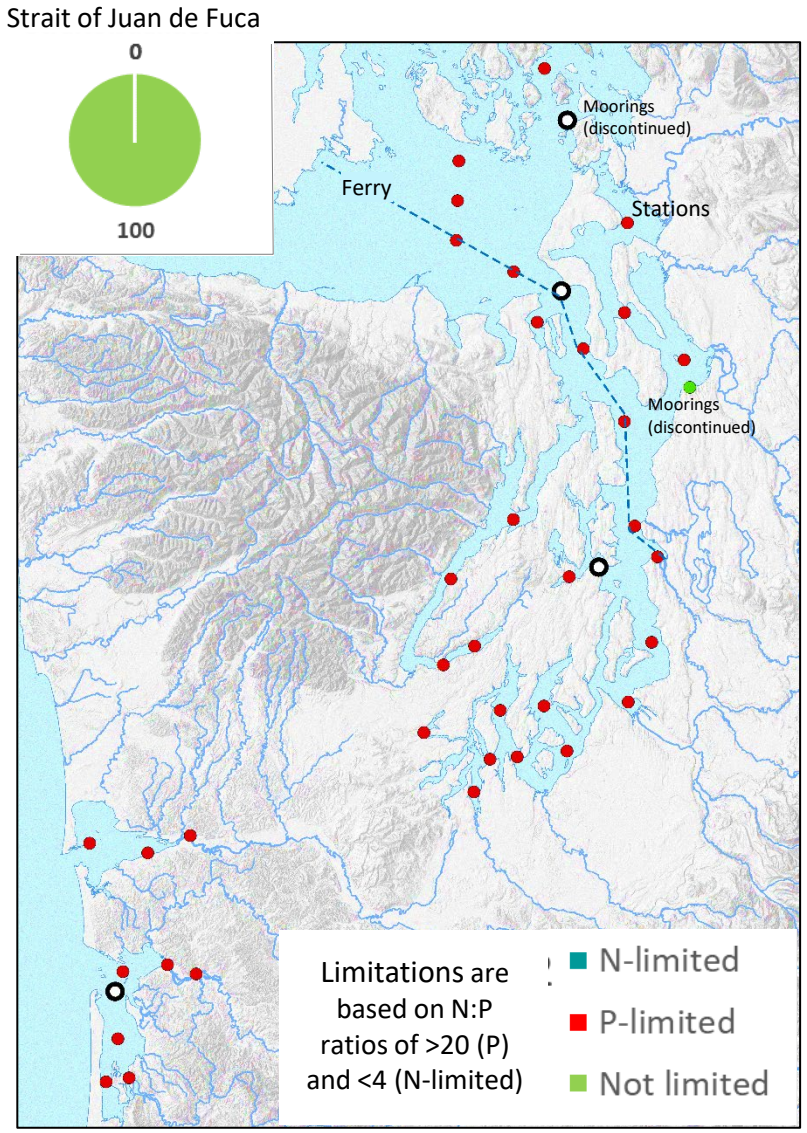
Nitrogen (N) limitation can promote blue green algae and HABs.

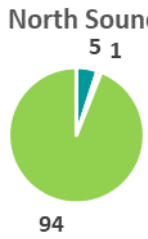


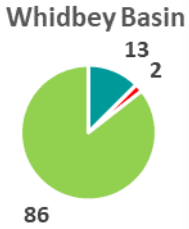


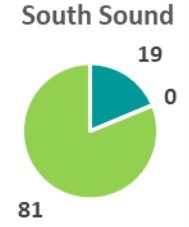








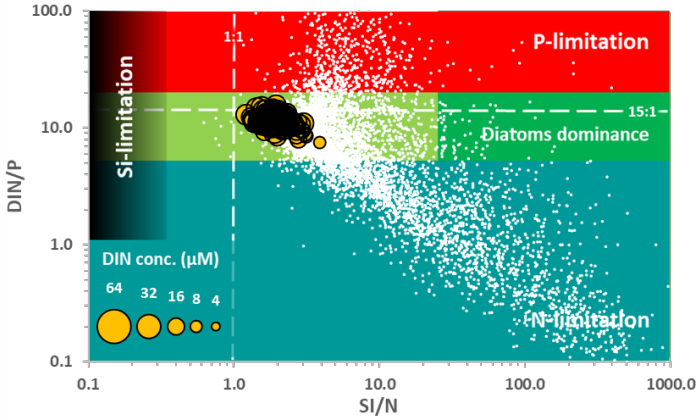




Numbers represent percentage of all samples 1999-2018 0-10 m

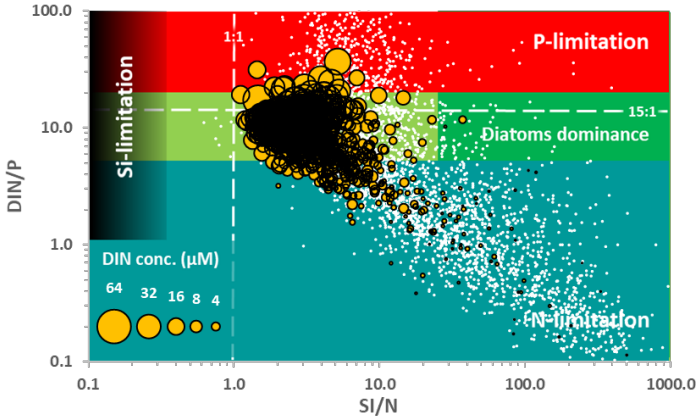
A.

Strait of Juan de Fuca, N=533



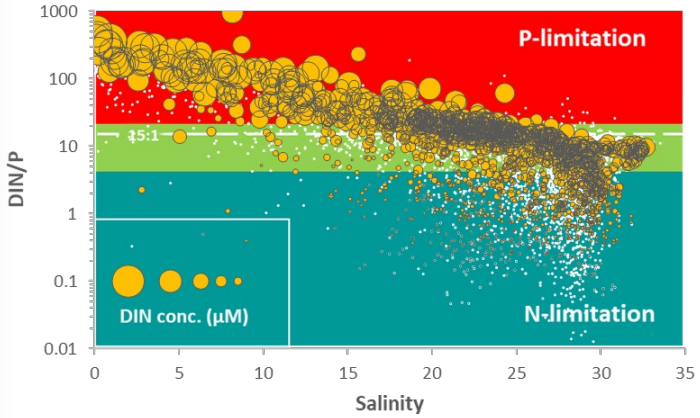
B.

Central Sound, N=2468



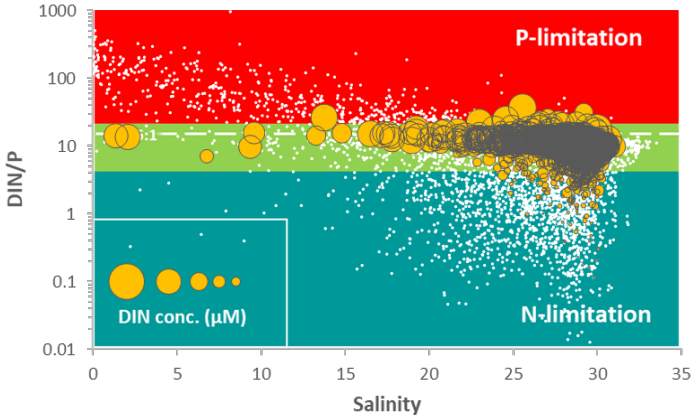
C.

Willapa Bay N-enriched defined as (>ocean background N/S ratio) N=210



D.

Central Sound N-enriched defined as (>ocean background N/S ratio), N=788

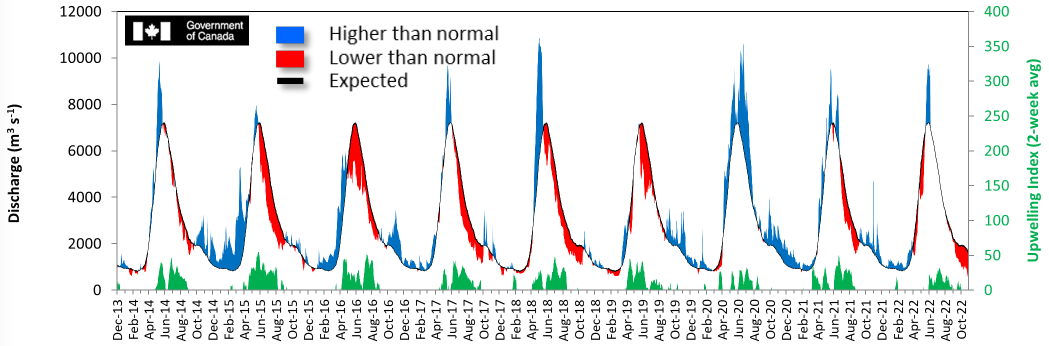


A, B. Nutrient N and P limitation has been observed in our data from 1999-2018 (white dots = all data). Silica limitation (<1) has not been observed. Lower DIN concentrations (bubble plots) and optimal Redfield N-to-P and Si-to-N ratios are desired. A. Examples of balanced nutrient ratios near Redfield 15:1. B. & D. Occasional above Redfield 15:1 at a salinity of 25. C. N-to-P ratios above Redfield 15:1 at low salinity, suggesting river N sources.

Climate: How well is the Salish Sea exchanging its water?

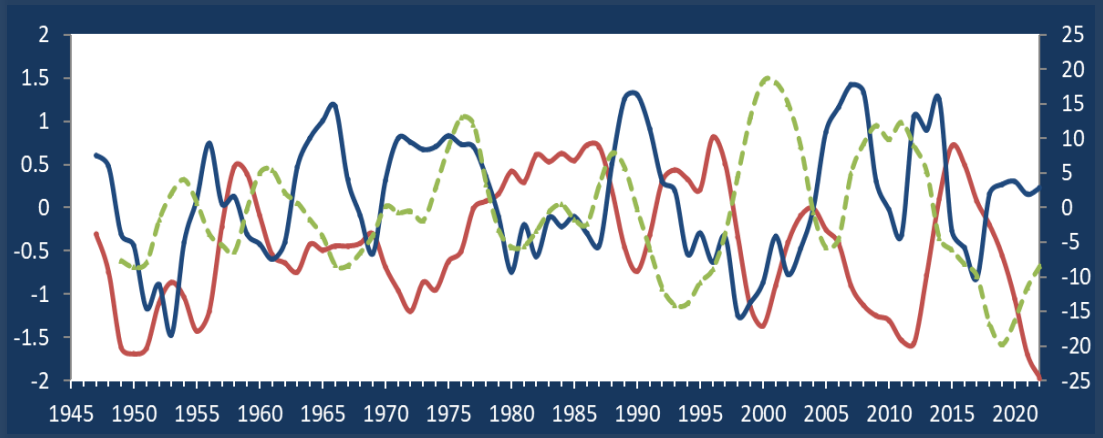
Historically, the peaks of coastal upwelling and the freshet are in sync.

Fraser River (at midnight)



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. Fraser River flows in October were lower than normal. Upwelling off the coast was also weaker this year suggesting less upwelled water entrainment into Puget Sound.

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



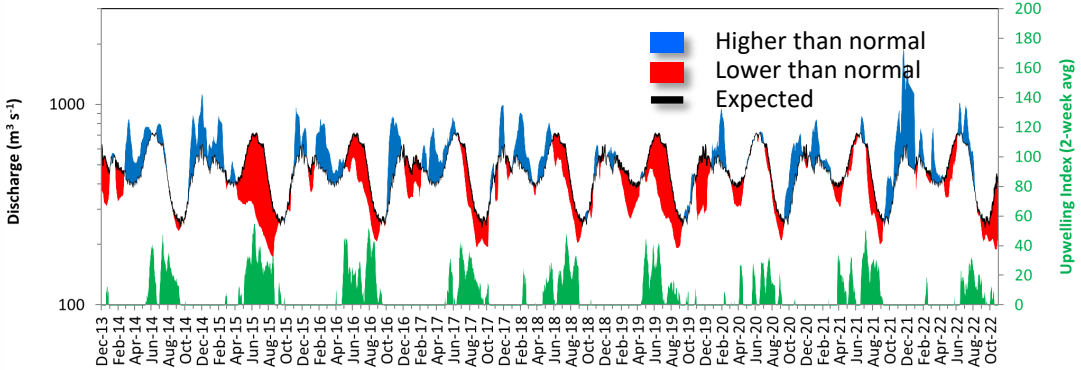
How do ocean boundary conditions affect the quality of water the Salish Sea exchanges with the ocean?
Water has cooled (PDO). Upwelling (Upwelling Index anomaly) is around expected level. Productivity in the eastern Pacific is low but increasing again (NPGO; last updated Sep 2022).

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

Climate: How well is Puget Sound exchanging its water?

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

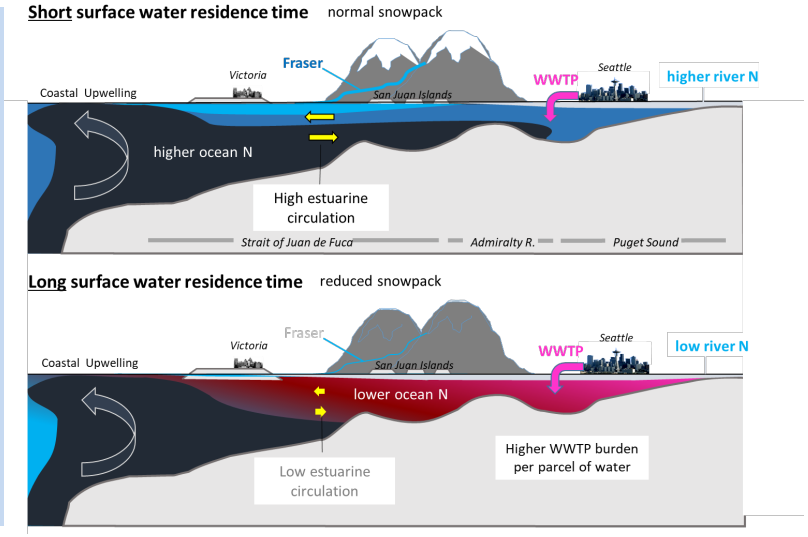
Skagit River (at midnight USGS)



The Skagit River freshet is no longer clearly pronounced because the river is a regulated system for hydroelectric power generation. However, drought years and low flows can be seen in the river's discharge data. In 2022, flows dropped below normal in fall. Upwelling was weak in 2022.

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).

DEPARTMENT OF ECOLOGY
State of Washington

Marine Conditions and Anomalies

Field team: Natalie Coleman, Holly Young

Marine Water Conditions: 2022 temperature, salinity, and dissolved oxygen

Coastal Bays

T: *Higher*
S: *Higher*
DO: *Variable*

Salish Sea

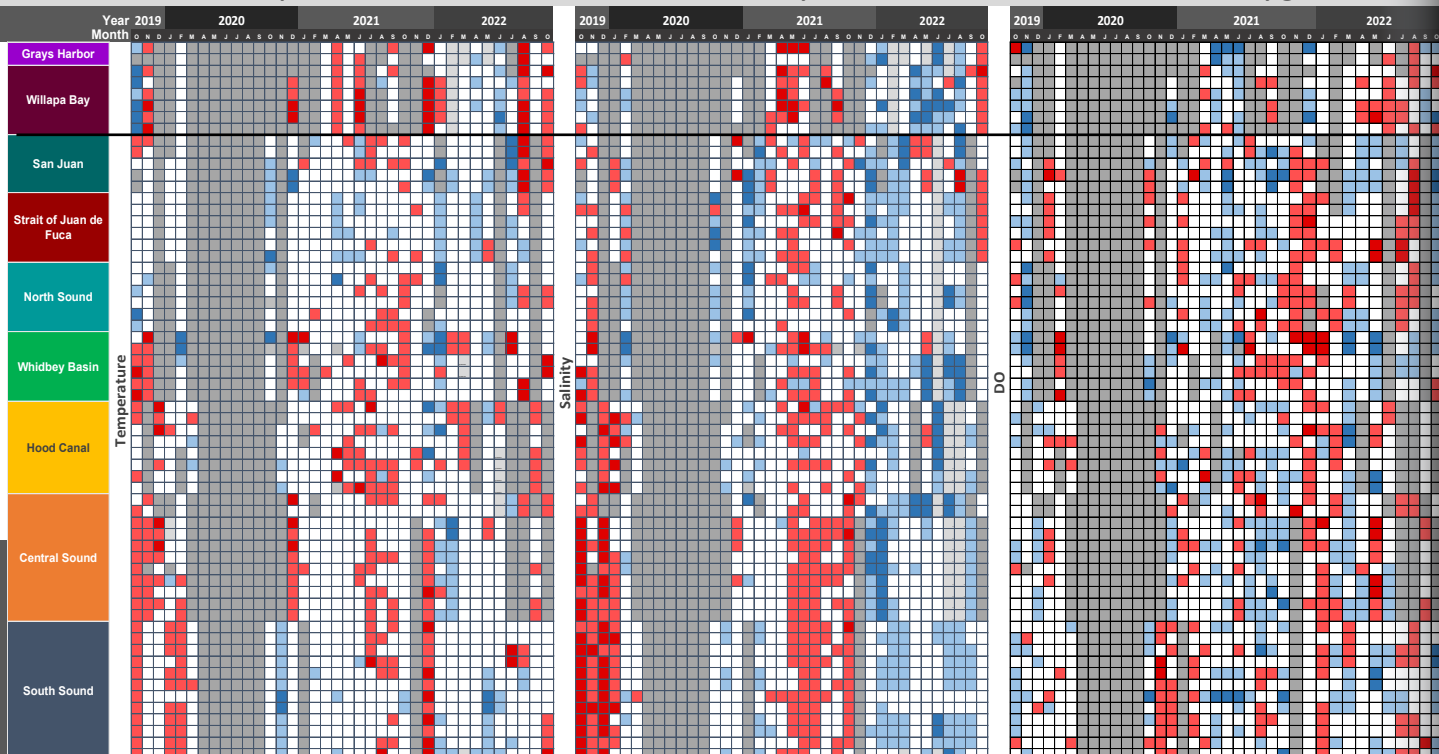
T: Expected
S: Mostly expected, higher in the Straits & San Juans
DO: Expected

The year 2022 was relatively normal for temperature and oxygen concentrations and lower in salinity, reflecting a lot of rain in spring. In contrast, 2019 and 2021 were saltier.

Baseline: 1999-2021 (expanding)

Marine stations are sampled monthly, surface to full depth. Color coding of mapped sites matches regional colors for heat maps displayed on the right.

Higher | Expected | Lower | No Data



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What were the conditions at the surface on 10-10-2022?

Blooms, some colorful, are continuing in multiple terminal bays. Numerous patches of jellyfish are seen in Budd Inlet and Liberty Bay. Sediment is visibly transported by the Puyallup River and resuspended along shorelines in Totten Inlet, in some places mixed with soil. It was smoky!

Landing over Swantown Marina, Olympia

Start here

Front

Mixing and fronts:
Small fronts along freshwater plumes of creeks and rivers.

Jellyfish and fish:
In Budd Inlet and Liberty Bay.

Suspended sediment:
Sediment is visibly transported by the Puyallup River and resuspended along shorelines in Totten Inlet, in some places mixed with soil.

Plume

Bloom

Visible blooms:
Red-brown blooms in Budd, Henderson and Sinclair Inlets and Liberty Bay.
Turquoise bloom in Quartermaster Harbor and parts of Budd Inlet.

Debris

Debris:
Pretty much absent.

Ongoing wildfires in the Cascades mean smoky skies lingered in the Puget Sound area

Too smoky north of here

Whidbey Basin

Admiralty Inlet

Hood Canal

Central Puget Sound

South Puget Sound

4 5 6 19 20 7 8 9 18 16 10 17 25 11 21 24 22 15 14 13 12 23 1 2 3

Map: Kris Symer. Data source: WDFW.

DEPARTMENT OF ECOLOGY
State of Washington

Aerial navigation guide

Date: 10-10-2022

Click on numbers

26 27 28 29

Flight Observations

Intermediate visibility, Central Sound under thick smoke blanket

Tide data from 10-10-2022 (Seattle):

Time	Pred	High/Low
06:00 AM	10.66	H
11:49 AM	2.85	L
05:45 PM	11.51	H

Connecting aerial observation with data from ORCA moorings

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

[NANOOS NVS Data Explorer]

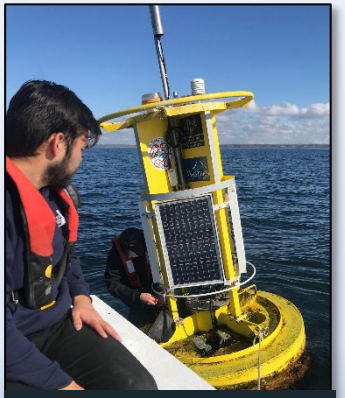
View products by mooring:

Puget Sound

1. Carr Inlet
2. Dabob Bay
3. Hoodsport
4. Hansville
5. Point Wells
6. Twanoh

Salish Sea

7. Bellingham Bay
8. Friday Harbor

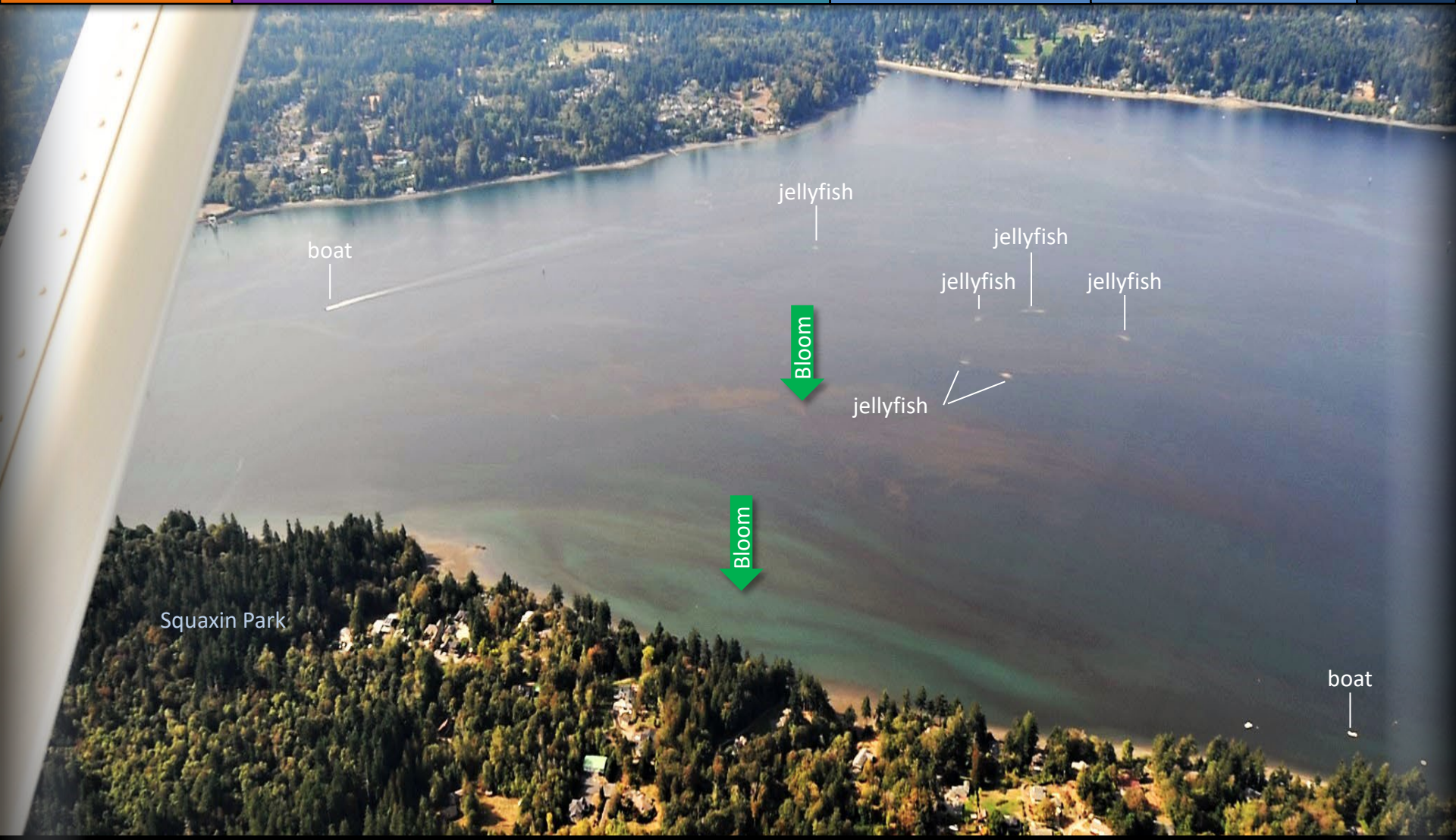


Thayne Yazzie, NWIC, Robert Daniels, UW/APL

Aerial photography 10-10-2022

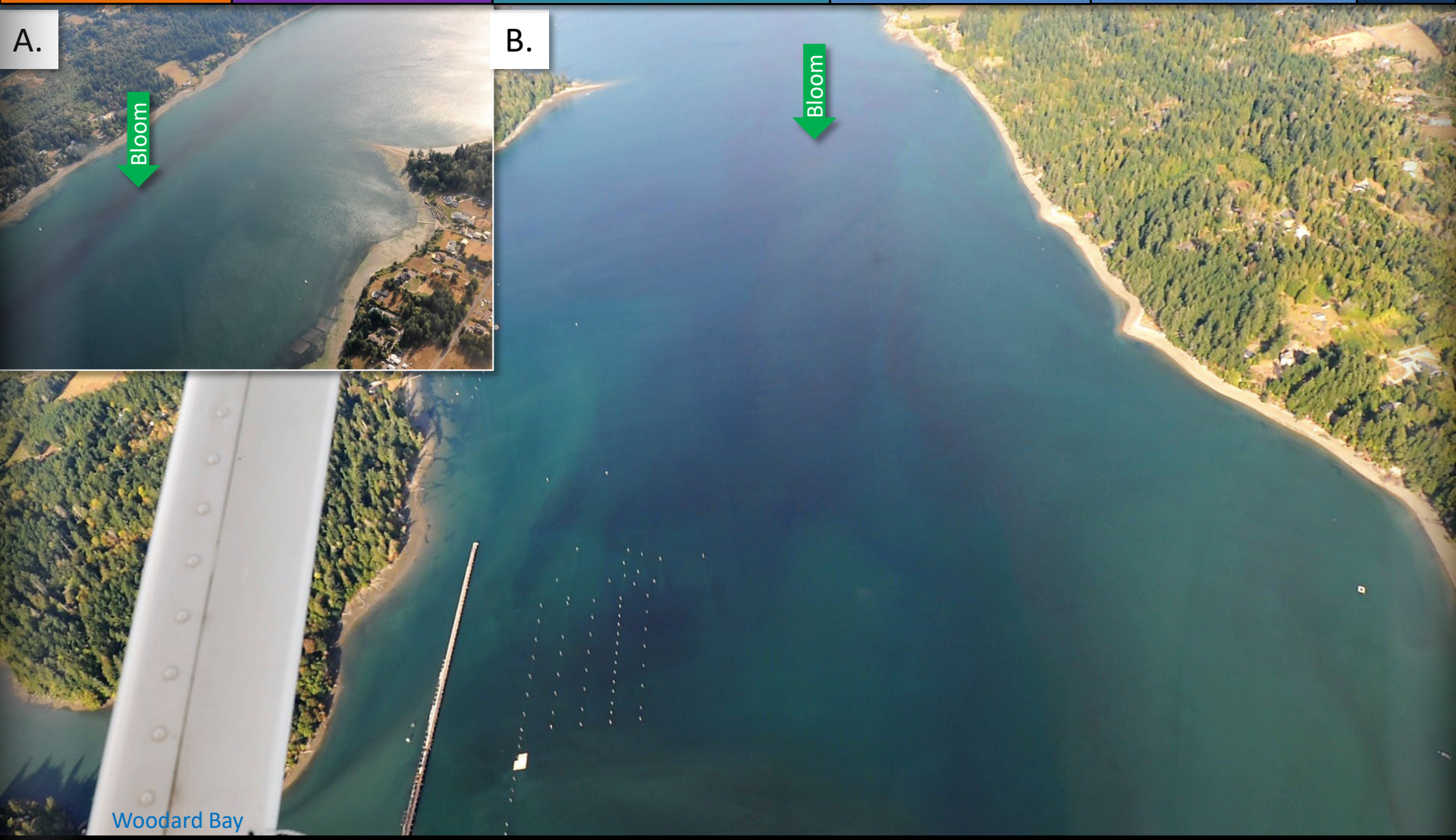
Patches of jellyfish and a red-brown and turquoise blooms. Location: Budd Inlet (South Sound), 11:57 AM

Aerial photography 10-10-2022



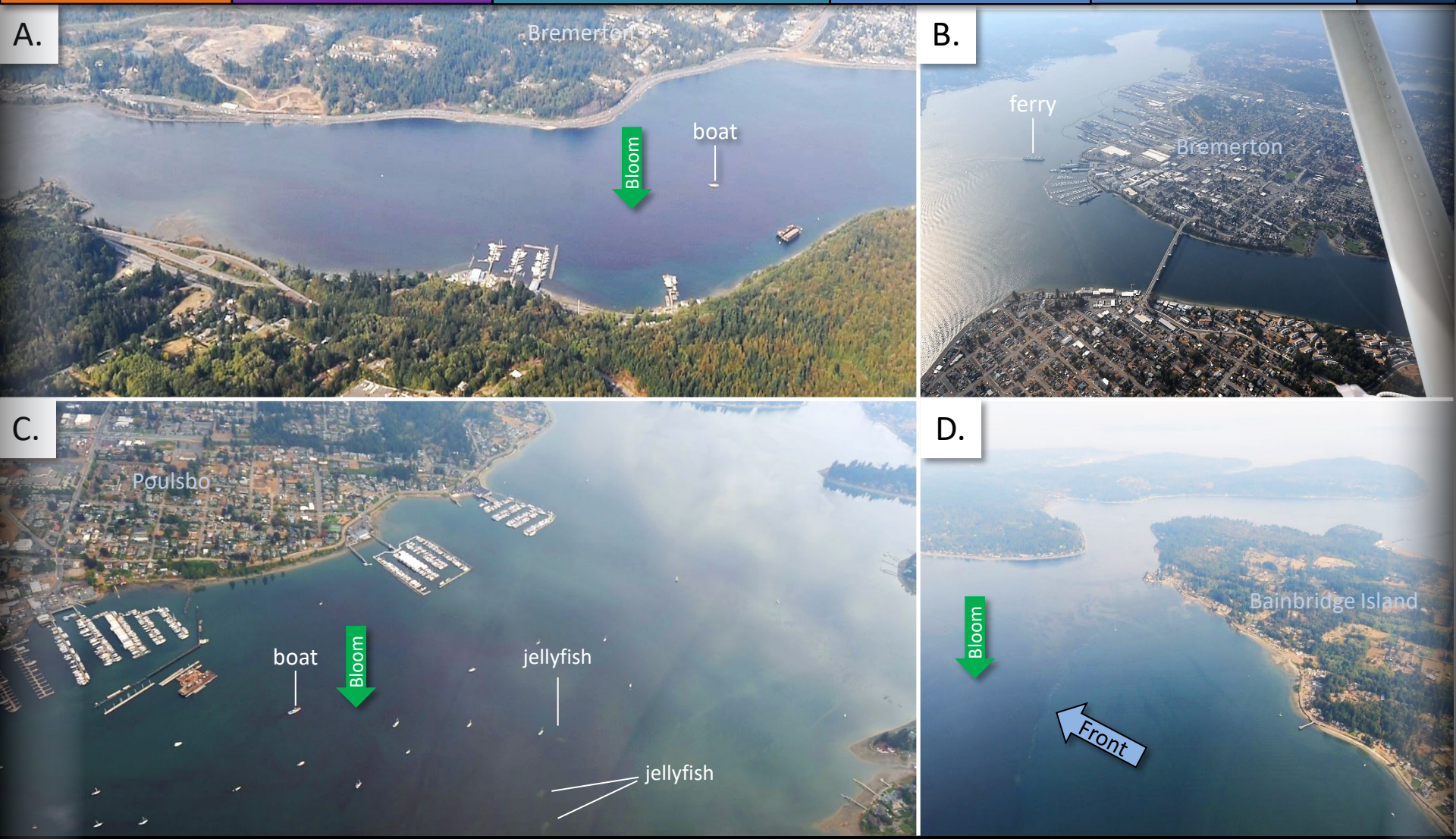
Patches of jellyfish and a red-brown and turquoise blooms. Location: Budd Inlet (South Sound), 11:54 AM

Aerial photography 10-10-2022



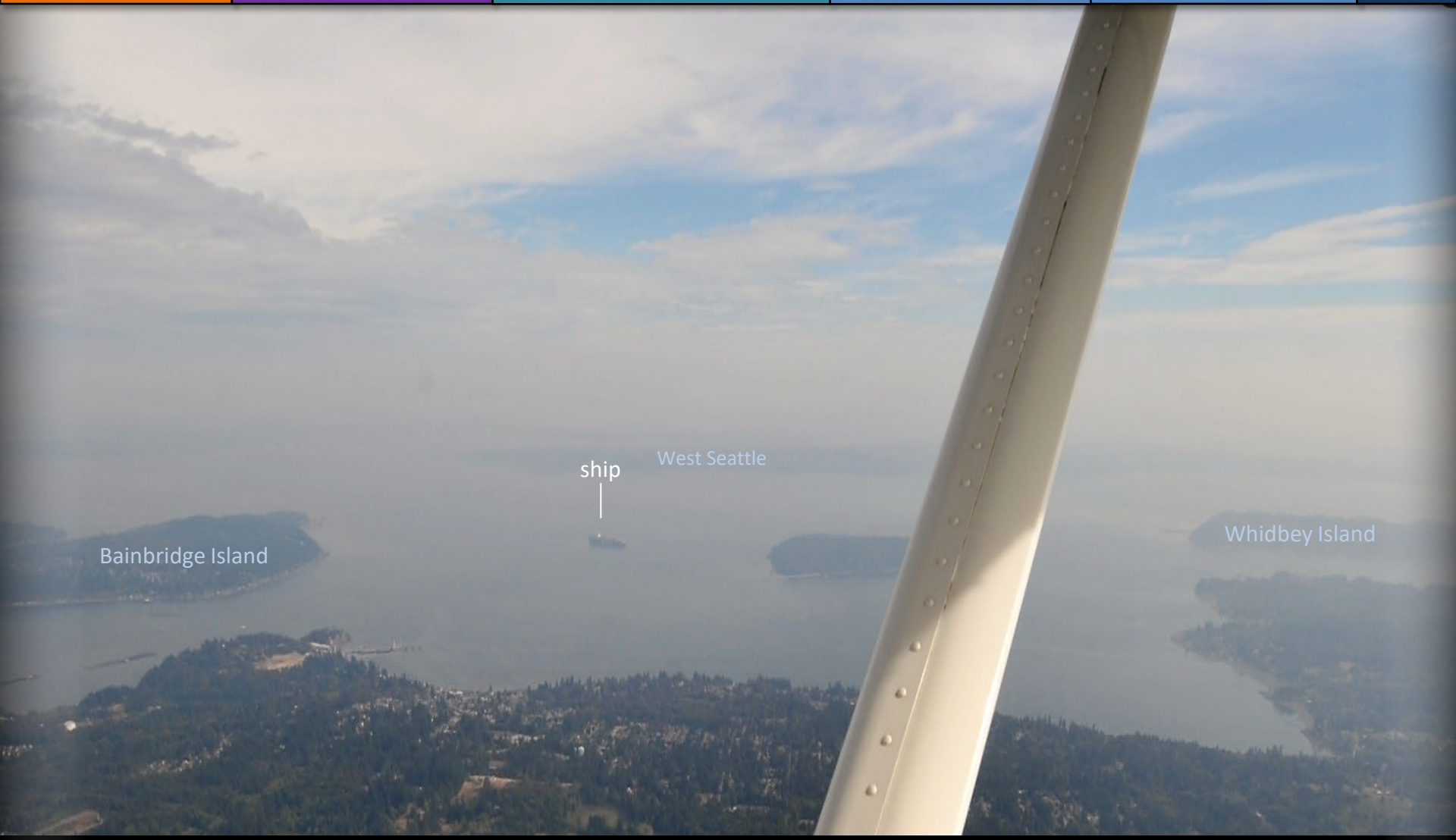
A. Long ribbon of red bloom parallel to the shore of the outer bay, B. Patchy red-brown bloom inside the bay.
Location: Henderson Inlet (South Sound), 12:03 PM

Aerial photography 10-10-2022



A Red bloom inside inlet B. Smoky air, C. Red bloom and jellyfish patches. D. Red-brown bloom north of front.
Location: A. Sinclair Inlet, B. Bremerton, C. Liberty Bay, D. Entrance to Rich Passage (Central Sound). 12:20 PM

Aerial photography 10-10-2022



Smoky air moving in from the north forced the EOPS flight to return to South Puget Sound

Location: Rich Passage- Blake Island (Central Sound), 12:35 PM

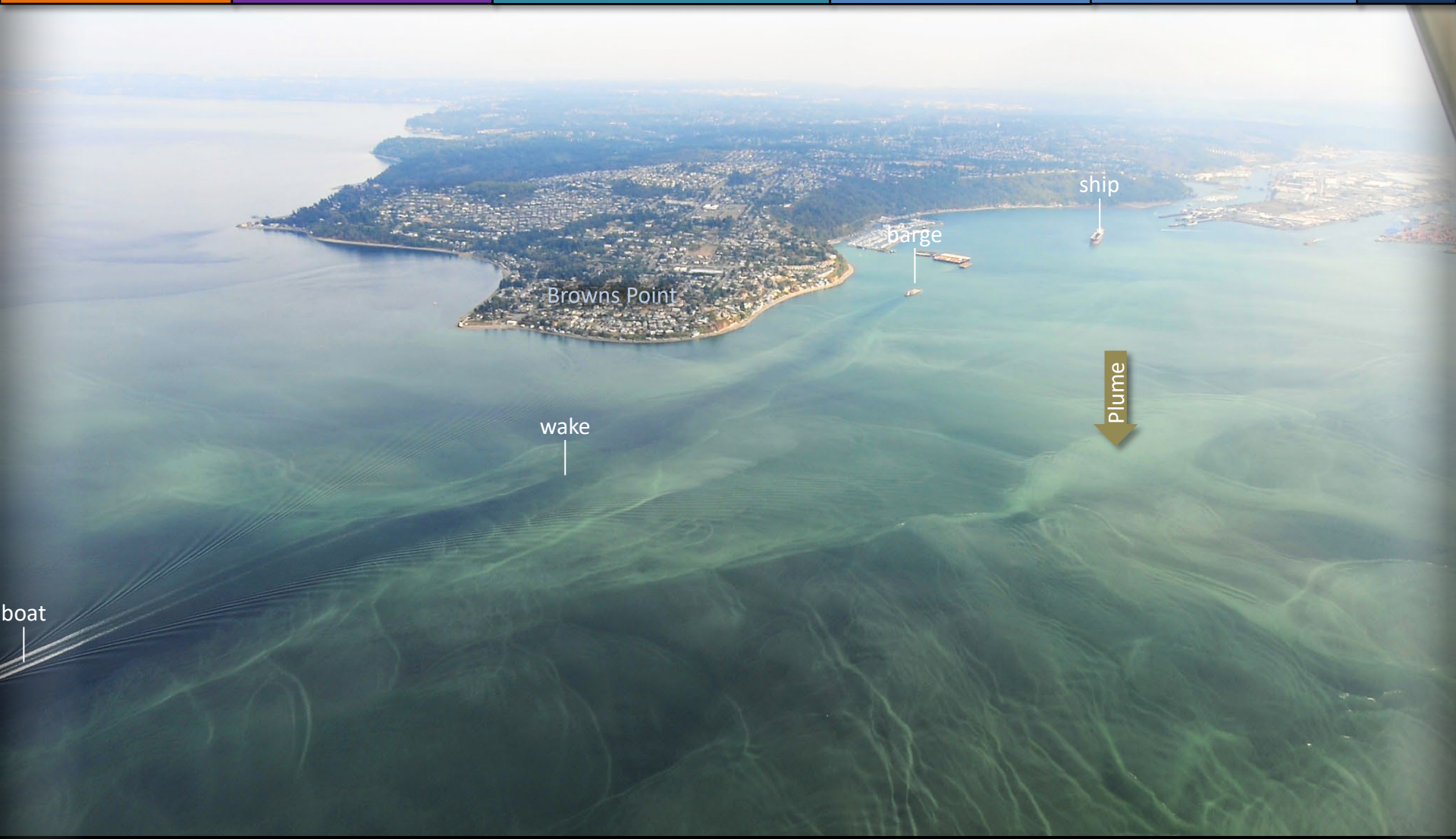
Aerial photography 10-10-2022

Strong turquoise-green-brown bloom. Location: Quartermaster Harbor (South Sound), 12:40 PM

Aerial photography 10-10-2022

Puyallup River plume, rich in glacial flour, discharging into Commencement Bay.
Location: Commencement Bay (Central Sound), 12:44 PM

Aerial photography 10-10-2022

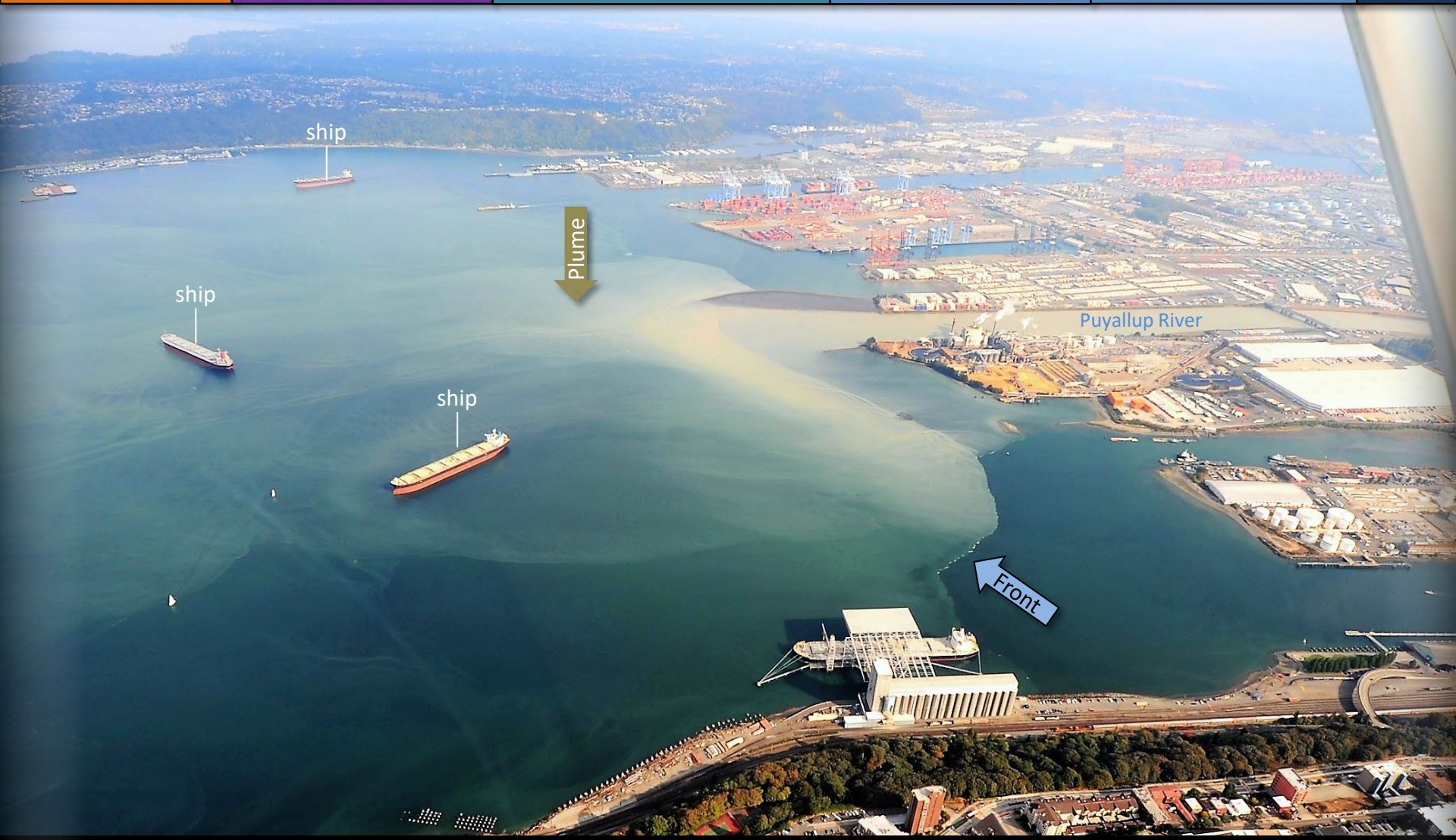


A wake left by a barge reveals how thin the sediment-laden Puyallup River plume is.
Location: Commencement Bay (Central Sound), 12:45 PM

Aerial photography 10-10-2022

The Puyallup River plume, with internal waves and patchy structure.
Location: Commencement Bay (Central Sound), 12:45 PM

Aerial photography 10-10-2022

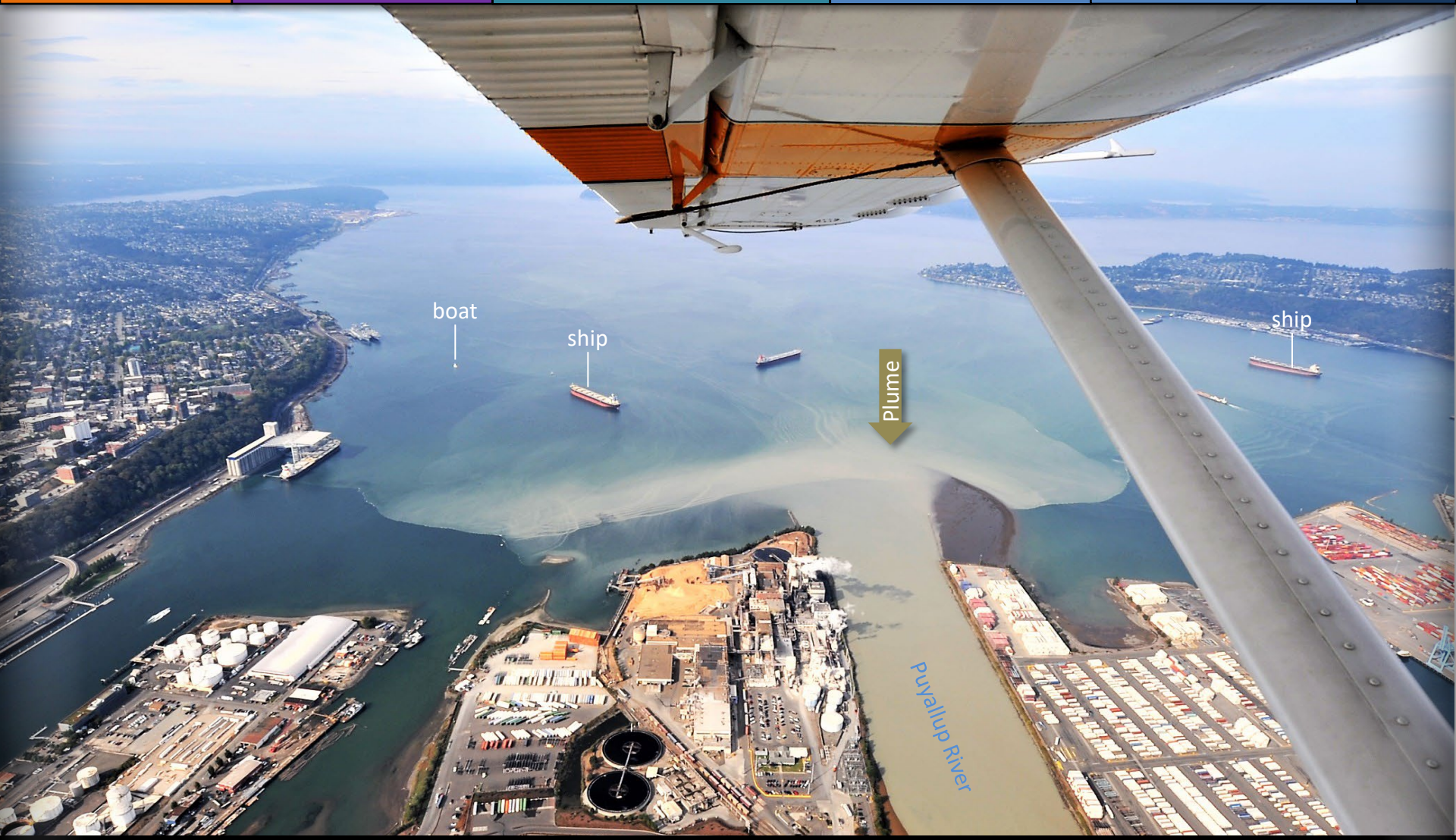


A well-defined plume and fronts at the mouth of the Puyallup River.
Location: Commencement Bay (Central Sound), 12:46 PM

Aerial photography 10-10-2022

Puyallup River plume, carrying fine sediments (not reaching into the Voss Waterway).
Location: Commencement Bay (Central Sound), 12:46 PM

Aerial photography 10-10-2022



Puyallup River plume, seen from the river side.
Location: Commencement Bay (Central Sound), 12:47 PM

Aerial photography 10-10-2022

Puyallup River plume seen from the river side.
Location: Commencement Bay (Central Sound), 12:47 PM

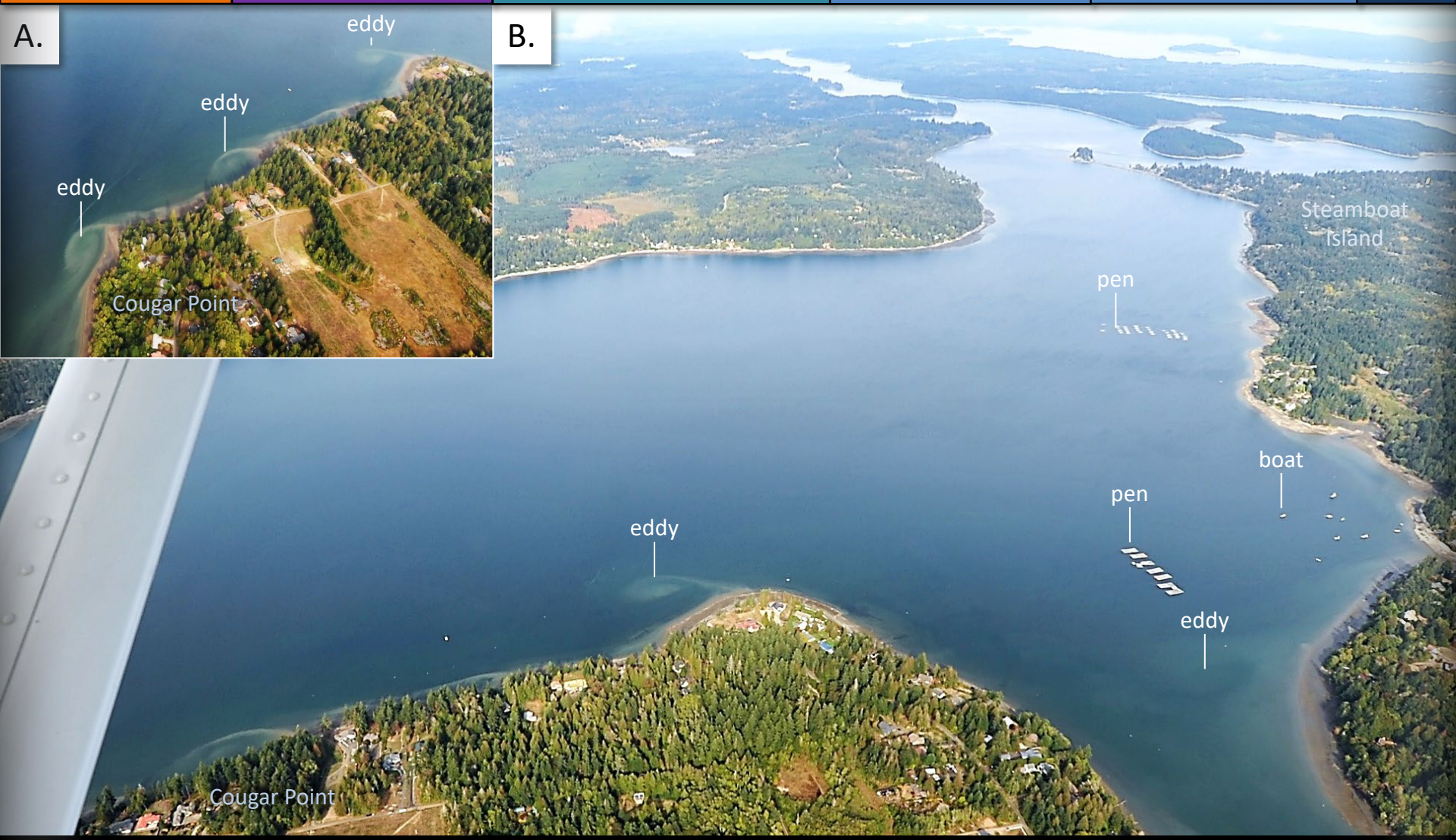
Aerial photography 10-10-2022

Puyallup River, a highly urbanized waterway.
Location: Commencement Bay (Central Sound), 12:47 PM

Aerial photography 10-10-2022

A wake left by a barge illustrates how the thin sediment-laden Puyallup River plume spreads across the bay.
Location: Commencement Bay (Central Sound), 12:49 PM

Aerial photography 10-10-2022



A. Nearshore eddies with sediment suspension and deposition. B Larger geographical context.
Location: Totten Inlet (South Sound), 1:10 PM

Aerial photography 10-10-2022

Oakland Bay seen from above Shelton, with Goldsborough Creek estuary.
Location: Oakland Bay (South Sound), 1:15 PM

Aerial photography 10-10-2022

Plume of Goldsborough Creek extending into the bay.
Location: Oakland Bay (South Sound), 1:15 PM

Aerial photography 10-10-2022

Oakland Bay looking onto Shelton, with Goldsborough Creek estuary and Sierra Pacific Sawmill.
Location: Oakland Bay (South Sound), 1:15 PM

Aerial photography 10-10-2022

A. Exposed mudflats in western portions of the bay. B-C. Chapman Cove with aquaculture rafts at low tide. Exposed mudflats with water from Campbell Creek. Location: Oakland Bay (South Sound), 1:17 PM

Aerial photography 10-10-2022

Exposed mudflats of the southern portions of the bay during low tide.
Location: Little Skookum Inlet (South Sound), 1:22 PM

Aerial photography 10-10-2022

Exposed mudflats of the southern portions of Oyster Bay during low tide.
Location: Totten Inlet (South Sound), 1:24 PM

Aerial photography 10-10-2022

Exposed mudflats of the southern portions of the bay during low tide, with epibenthic diatom mats (brown).
Location: Totten Inlet (South Sound), 1:25 PM

Aerial photography 10-10-2022

Very brown suspended nearshore sediment on both sides of the bay. Plume of Kennedy Creek.
Location: Totten Inlet (South Sound), 1:25 PM

A. Suspended nearshore sediment on the eastern side of the bay (Hudson Cove). B. Aquaculture pens.
Location: Totten Inlet (South Sound), 1:25 PM

People contributing their own observations

We add your observations to EOPS because we believe they matter.

- In the following pages you will find water quality issues that engaged and concerned citizens submitted to us.
- We feel that your observations should be shared side-by-side with aerial photo records.
- We encourage you to share your observations with us. Together we can document more.

Wikipedia (shortened text):
Coccolithophores microscopic phytoplankton cells that are ecologically important and play significant roles in the carbon cycle. They are of interest to those studying global climate change because their coccoliths are a carbon sink. Management strategies are being employed to prevent eutrophication-related coccolithophore blooms, as these blooms lead to a decrease in nutrient flow to lower levels of the ocean.

Natalie Coleman 9/1/2022

A coccolithophore bloom from Hood Canal staining the water turquoise, observed and sent in by Natalie.

Aurelia sp.

"There was a HUGE smack of moon jellies in Sequim Bay that I saw this AM. Thousands. Went from north of the state park south to just before Schoolhouse Point. Closer to the Western shore". - Amy Holms

Amy Holms 10/11/2022

A.

Bright green, fine-textured, soupy something in the usually clear waters of Bowman Bay. ~Robin Farrand

B.

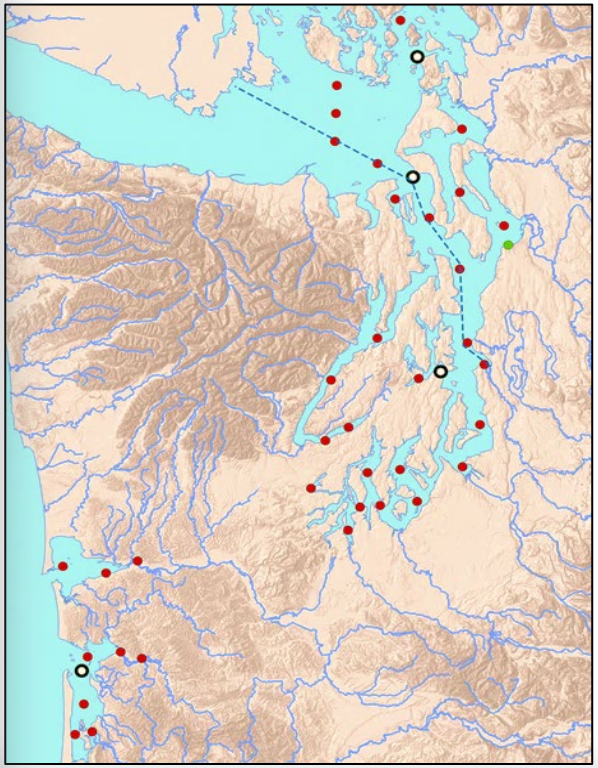
Robin Farrand 9/20/2022

Bright green bloom reoccurring near Deception Pass. Location: Bowman Bay, Fidalgo Island

Get your marine monitoring data from us

Long-term monitoring data from Puget Sound and coastal bays

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



Natalie and Holly on our new Research Vessel, **Salish SeaCat**

Get your data

https://apps.ecology.wa.gov/eim/search/SMP/MarineAmbientSearch.aspx?StudyMonitoringProgramUserId=MarineAmbient&StudyMonitoringProgramUserIdSearchType=Equals

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We have published 99 editions!

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Washington State
Department of Ecology

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DEPARTMENT OF ECOLOGY
State of Washington

Eyes Over Puget Sound past and present publications

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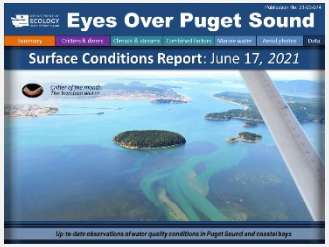
October_10_2022
Publication No. 22-03-073

June_14_2022
Publication No. 22-03-072

February_25_2022
Publication No. 22-03-071

January_7_2022
Publication No. 22-03-070

September_8_2021
Publication No. 21-03-075



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April_1_2021
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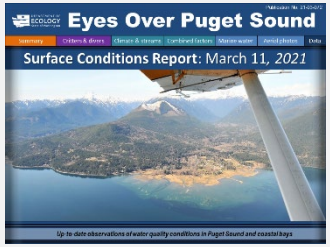

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February_3_2021
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January_14_2021
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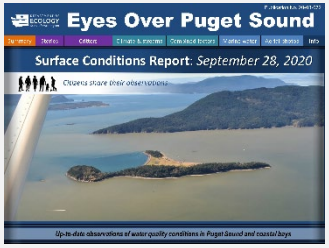
October_26_2020,
Publication No. 20-03-073



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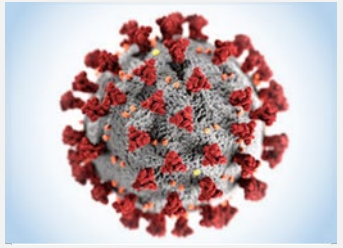

No coverage due to COVID-19 pandemic from April-September

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Jan_10_2020,
Publication No. 20-03-070

October_30_2019,
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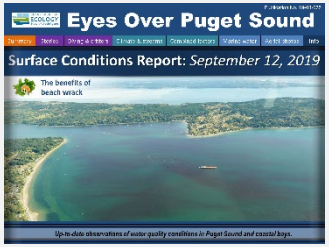

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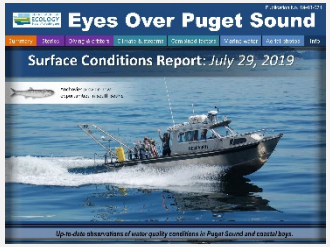

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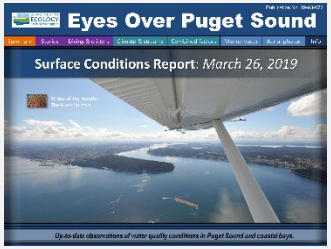

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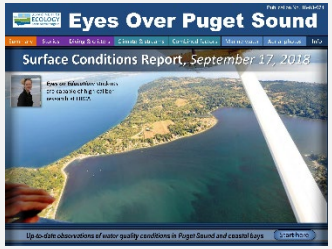
Publication No. 18-03-075



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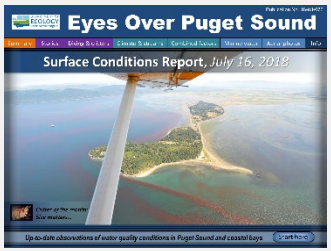

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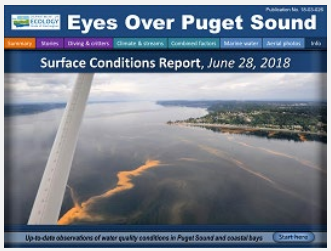

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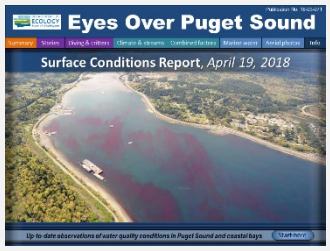

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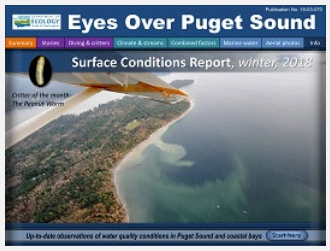

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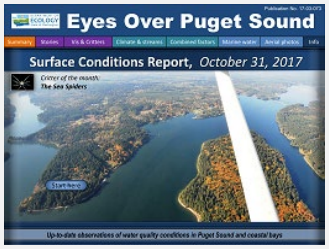

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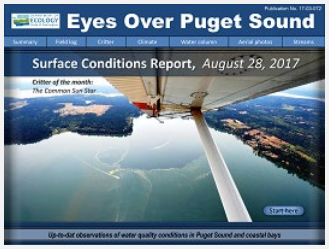

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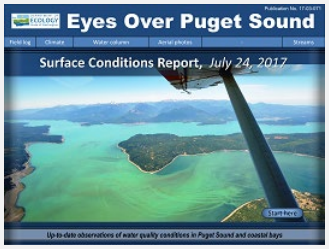

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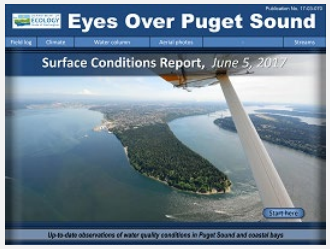

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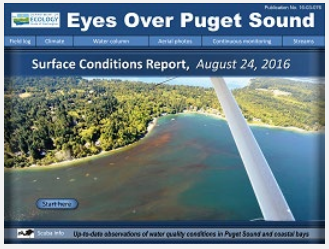

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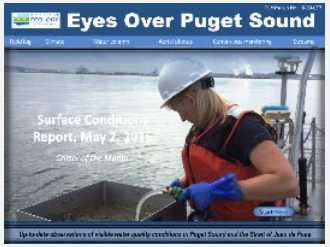

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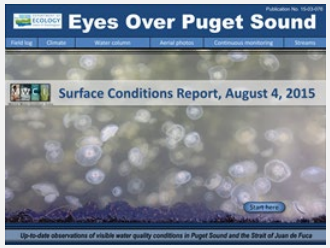

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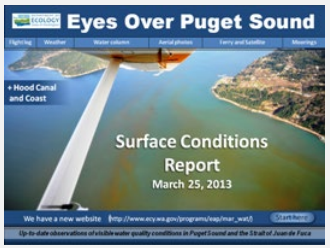

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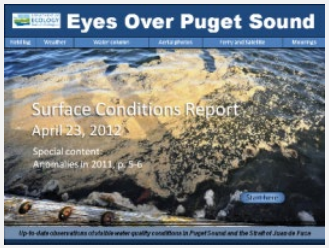

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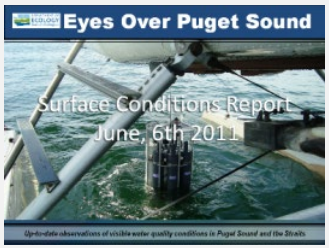

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