



# Eyes Over Puget Sound

Summary

Art & Critters

Climate & streams

Combined factors

Marine water

Aerial photos

Data

## Surface Conditions Report: Sept 8, 2021



*The Pacific Sand Dollar*

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

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LONG-TERM MARINE MONITORING UNIT



Photo by Grace McKenney



Artists corner

## [Artists corner, p. 3](#)

Showcasing the natural beauty of Puget Sound through photography.



Tyler Burks, Skip Albertson

## [Climate & streams, p. 11](#)

This summer river flows were generally lower than in 2020, and by August air temperatures were still warmer and precipitation was lower. Extreme heat and prolonged dry conditions led to a drought emergency declaration in July.



Julia Bos

## [Water quality, p. 16](#)

The higher salinity anomaly of the last month as a consequence of the drought is eroding away following a pulse in river water input in August. Lower oxygen conditions are developing in Central Sound by August



Dr. Christopher Krembs

## [Aerial photography, p. 17](#)

Many blooms and organic material were reported by citizens throughout summer, and by September many colorful blooms in bays across the region continue. Macroalgae and organic debris are still numerous in South and Central Sound, and in Padilla Bay. Jellyfish are occurring in unusual places.

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Artists corner

*Showcasing the  
natural beauty of  
Puget Sound through  
photography*



*“Arteries of life”: North Fork of the Skagit River flowing into Skagit Bay*

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Artists corner

*“Turquoise rivulets”: North Fork of the Skagit River flowing into Skagit Bay*

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Artists corner



*“The straight way is not always the best way”: North Fork of the Skagit River flowing into Skagit Bay*

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Artists corner



*“The green caterpillar”: Memorial Highway 20, Twin Bridges*

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Artists corner



*“Watching, wondering, where are we going”: Noctiluca bloom, Shilshole Marina*



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Artists corner



*“Shades of autumn as time flies by”: float plane shadow in red-brown bloom in Budd Inlet*



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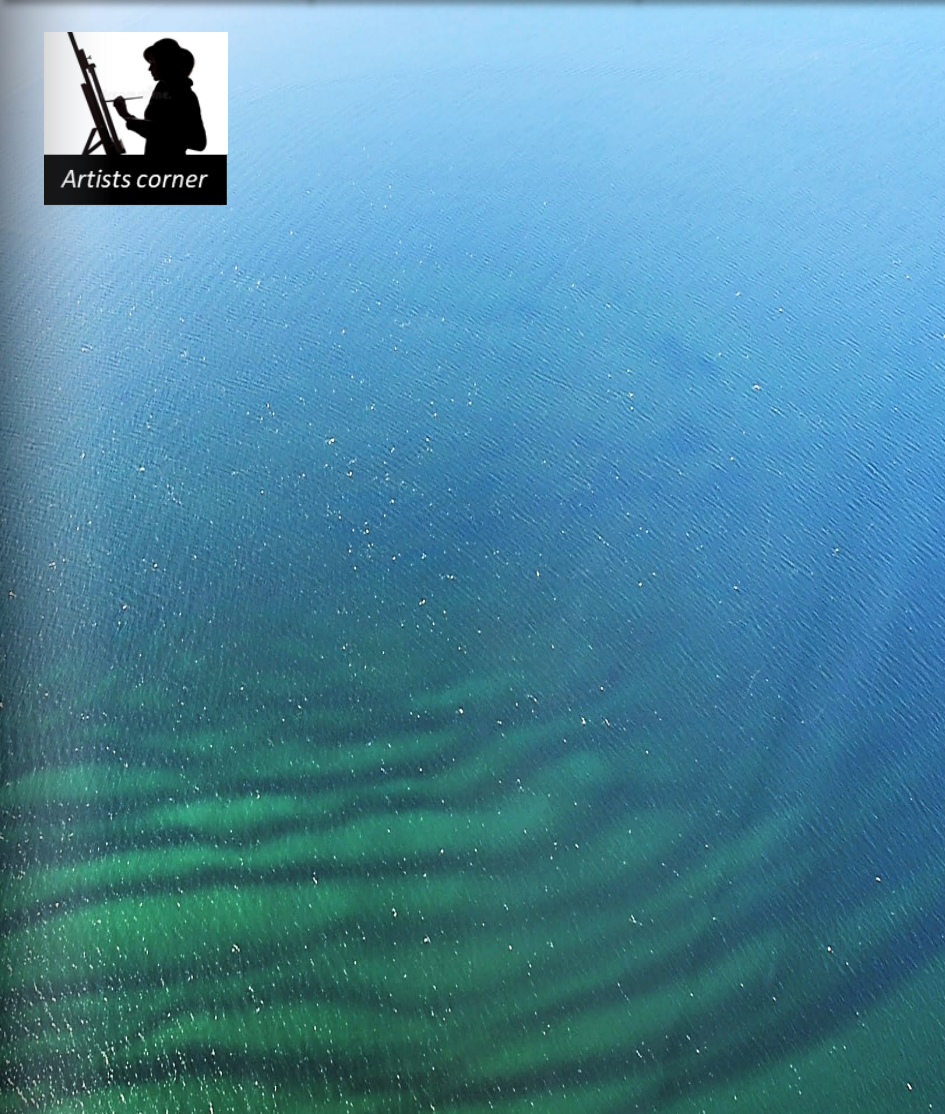
Marine water

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Artists corner



*“Internal visions”: Internal waves off Birch Point, Strait of Georgia*

## Critter of the Month – The Pacific Sand Dollar



Dany Burgess

### *Dendraster eccentricus*

The washed-up remains of this beautiful critter may be easy to find on Washington’s beaches, but sand dollars are anything but common. They can orient themselves with the water current, find their friends, and breathe through flowers. In fact, I’d say these amazing creatures are “worth their weight in sand”!

### Fun Sand Dollar Facts

- Juveniles swallow sand grains for ballast so they don’t get washed away
- You can age them like trees, by counting the rings
- They have “birds” inside of them

Photo by Chan Siunan



Photo by Dave Cowles



Photo by Photoholic1



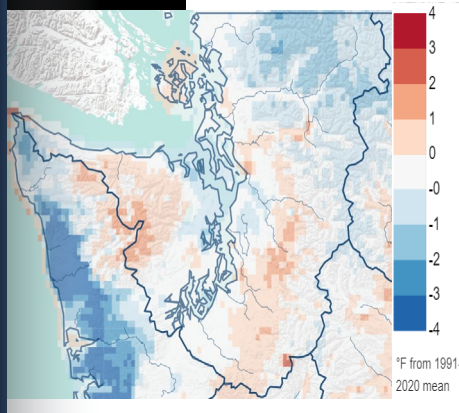


In the month of August, Puget Sound air temperatures were above normal with some north-south variability, while precipitation continued to be below normal (A). In the next 30 days, temperatures are expected to be near normal, while precipitation may be above normal in some areas (B). Extreme heat and prolonged dry conditions led to a drought emergency declaration in mid-July, but excluded the Snohomish, Duwamish-Green, and Cedar-Sammamish watersheds due to adequate storage.

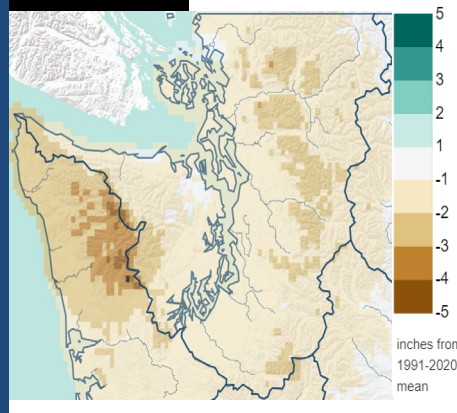
## A. Northwest Climate Toolbox (Previous 30 days)

## B. Northwest Climate Toolbox (Next 30 days)

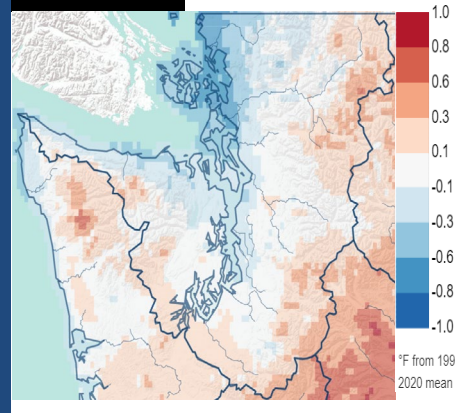
Temperature



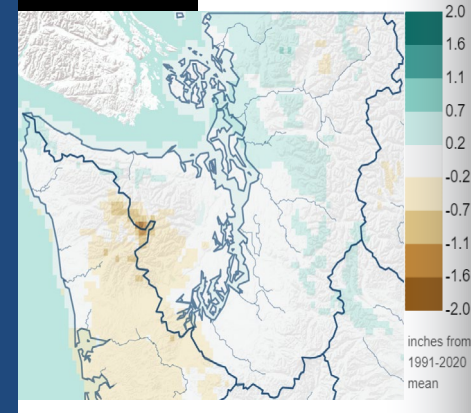
Precipitation



Temperature



Precipitation



### Temperature Anomaly

from historical mean ranged from -3 to +3°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.

### Temperature Anomaly

from historical mean is forecasted to be +/-1°F in the Puget Sound region during the next 30 days.

### Precipitation Anomaly

from historical mean is forecasted to be between -2 and +1.5 inches in the Puget Sound region during the next 30 days.



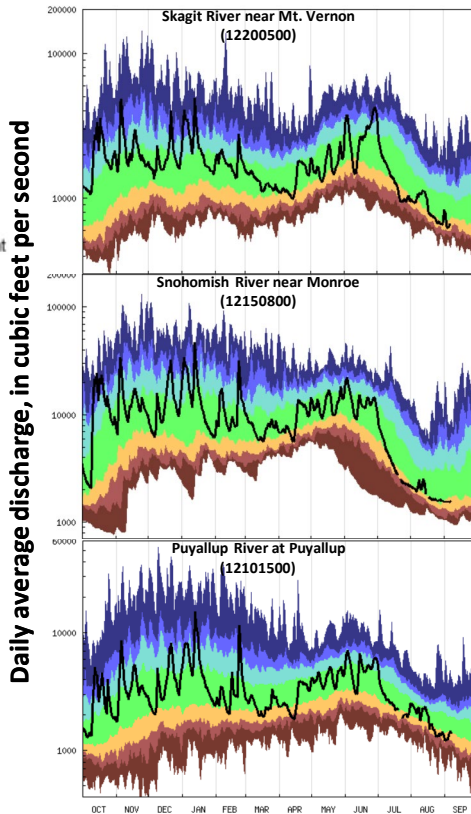
Summary	Art & Critters	Climate & streams	Combined factors	Marine water	Aerial photos	Data
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**Temporal:** Following extreme heat in late June, which rapidly melted snowpack, streamflow levels dropped to below normal (trend charts, left). Typically, snowmelt occurs gradually, which sustains streamflow later into the summer.

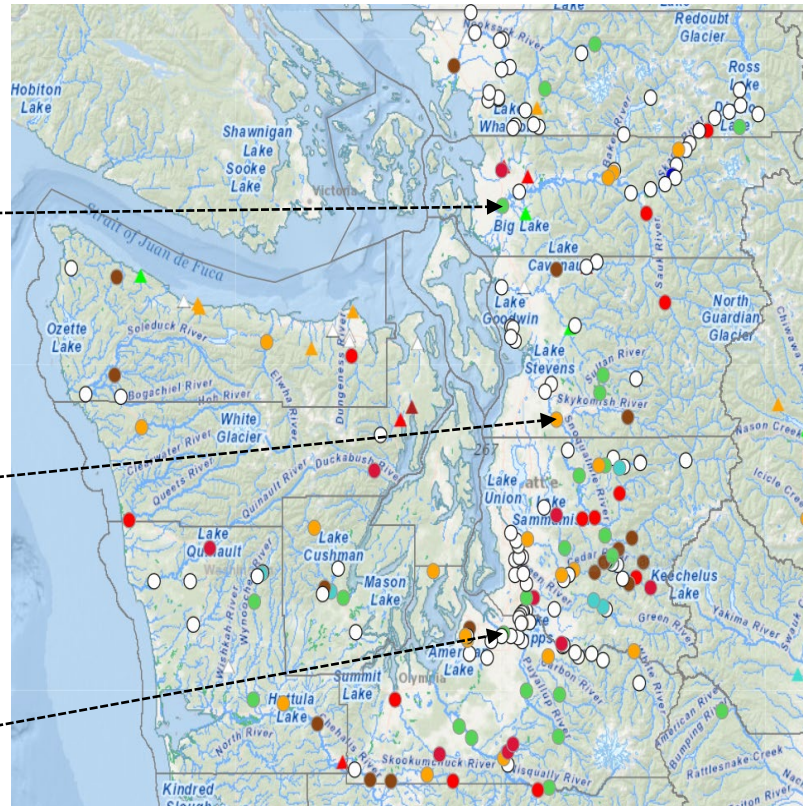
**Spatial:** Streamflow conditions (map, right) currently vary from normal to the lowest recorded for a particular date at that location. Normal flow conditions are found at snow-dominated watersheds with reservoir storage, while low-flow conditions are found in rain-dominated watersheds, or those without reservoirs that can gradually release water.

## Select Puget Sound Streamflow Trends

## Current Streamflow Conditions as of 9/08/2021



USGS WaterWatch: [CLICK HERE!](#)



Current conditions: [CLICK HERE!](#)

### USGS Real Time Streamflow Values

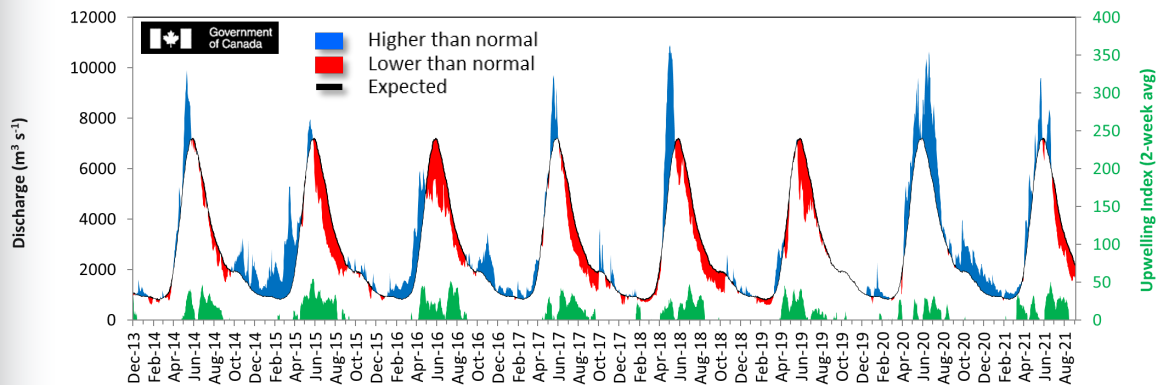
- Much above normal (>90%)
- Above normal (76-90%)
- Normal (25-75%)
- Below normal (10-24%)
- Much below normal (5-10%)
- Far below normal (>5%)
- Lowest recorded
- Not Ranked

### 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

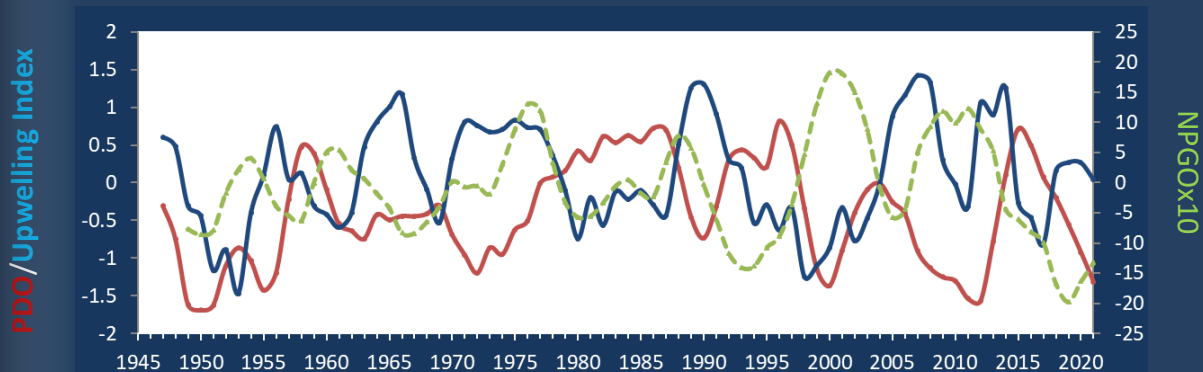
Historically, the peaks of coastal upwelling and the [freshet](#) are in sync.

## 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 in summer 2021 were lower than expected. Upwelling off the coast appears earlier.

## 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 gradually cooled (PDO). Upwelling (Upwelling Index anomaly) is at expected level. Productivity in the eastern Pacific is lower (NPGO) (last updated June 2021).

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



Summary

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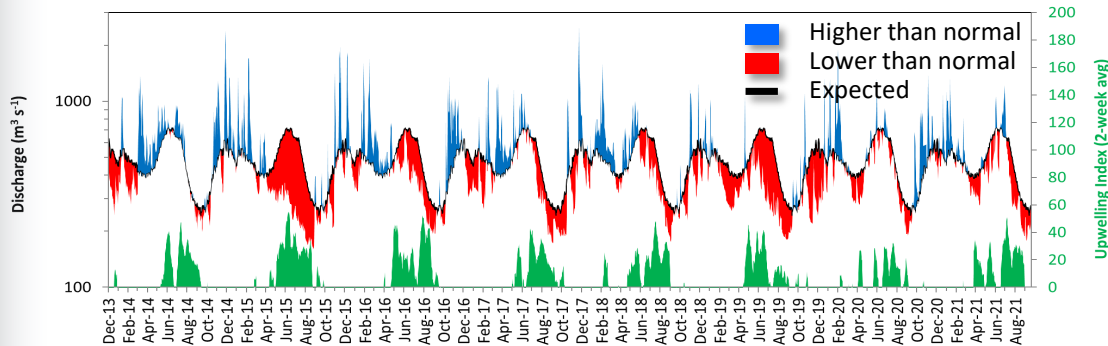
Marine water

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

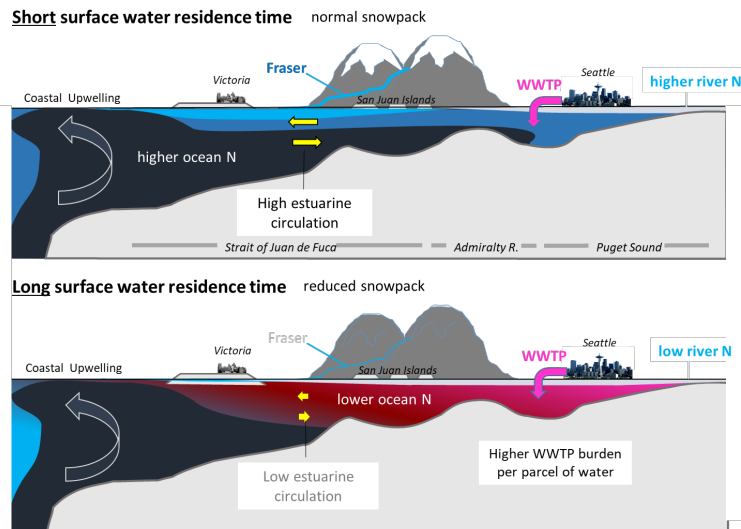
## Skagit River (at midnight USGS)



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 2021, flows are lower.

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

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

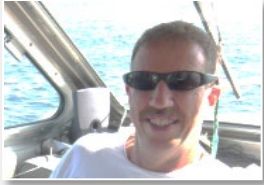


River flows and upwelling in the summer influence our water quality.

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

### Conditions leading up to September:

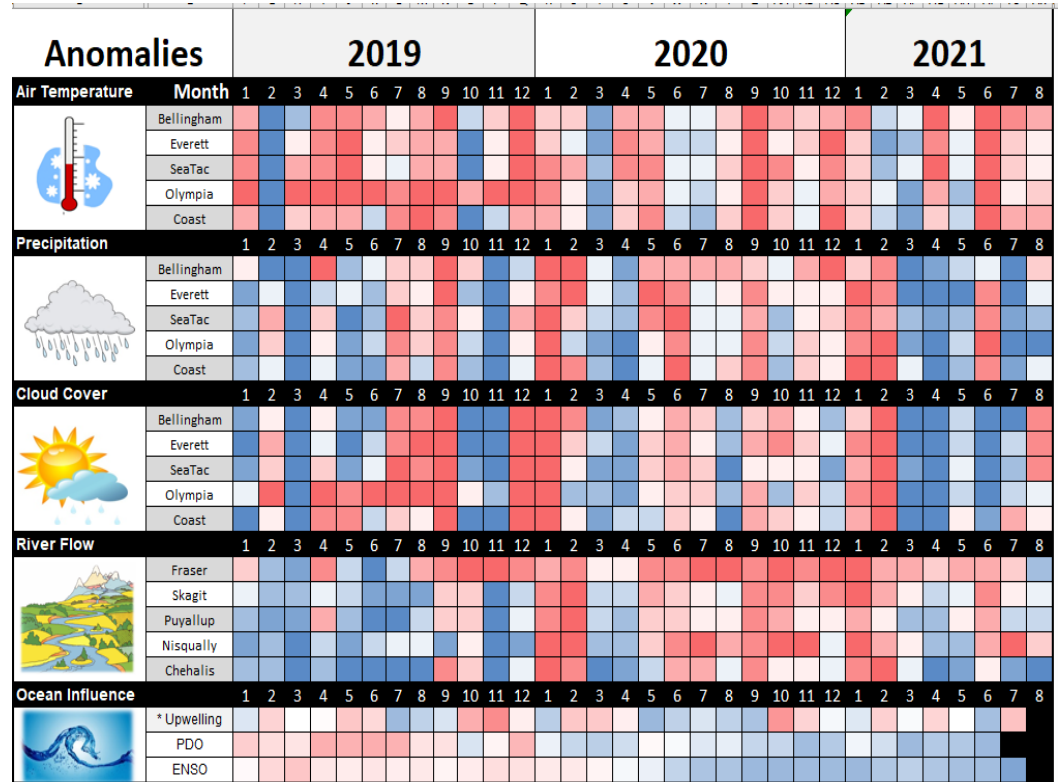
**Air temperatures** have been mostly warmer this summer.

**Precipitation** has been much below normal since March, and is markedly lower than in 2020.

**Cloud cover** - Low cloud cover (sunny condition) follows low precipitation in 2021.

**River flows** are lower in 2021 than in 2020.

**Upwelling** has been variable this summer. PDO & ENSO are in cold phase (La Niña).



higher | expected | lower | No data

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

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## Marine Water Conditions: 2021 temperature, salinity, and dissolved oxygen

### Coastal Bays

T: *Low*

S: *Station*

DO: *Attainment*

### Salish Sea

T: Expected with high temperatures in shallow inlets

S: Salinity normalizing

DO: Variable with lower conditions in Central Basin (**box**).

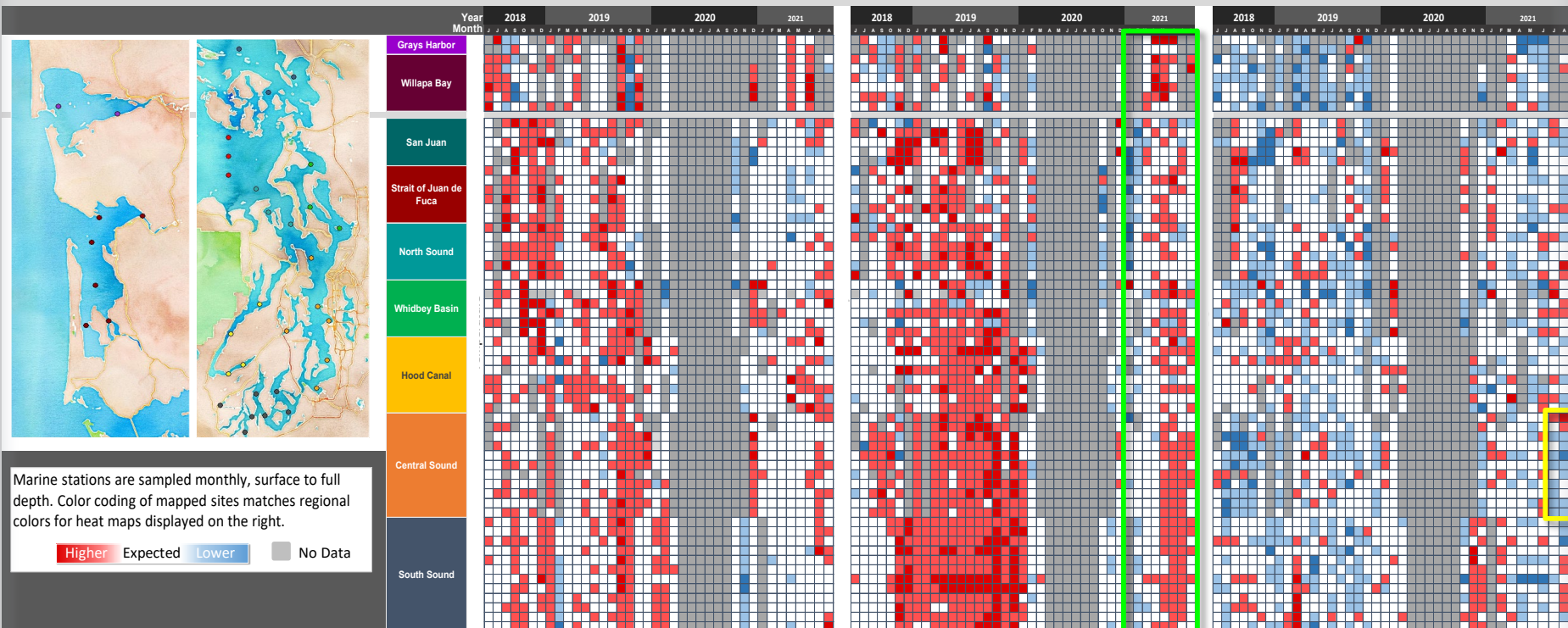
In July, a sizable pulse of melt water from the Fraser and Skagit weakened the positive salinity anomaly (**box**). Oxygen in Central Sound was lower than expected in August.

Baseline: 1999-2020 (expanding)

Temperature

Salinity

Dissolved Oxygen





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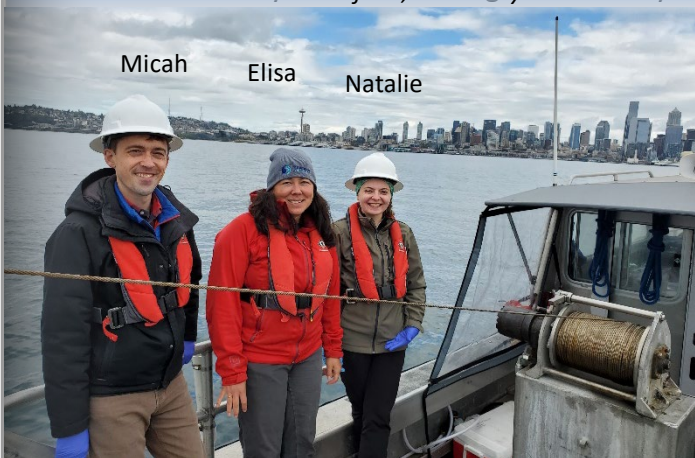
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Colorful red and red-brown blooms occur in many bays across the region. Liberty Bay has a green bloom. Jellyfish occur in unusual places (Dyes Inlet, Carr Inlet) and are absent in typical places. Macroalgae and organic debris still numerous in South, Central Sound and Padilla Bay.

Start here

Our crew in the field, Elliott Bay



Rain has returned, at last!



### Mixing and fronts:

Strong tidal front north of Lopez Sound and mixing west of Obstruction Pass



### Jellyfish and fish:

Abundant jellyfish in Dyes Inlet, and potentially in Carr Inlet and Quartermaster Harbor; also present in East Sound



### Suspended sediment:

Port Susan, and bays with glacially-fed rivers: Skagit, Nooksack, Puyallup



### Visible blooms:

**Green:** Liberty Bay, Port Susan

**Red:** Marrowstone Island, Case and Henderson Inlets

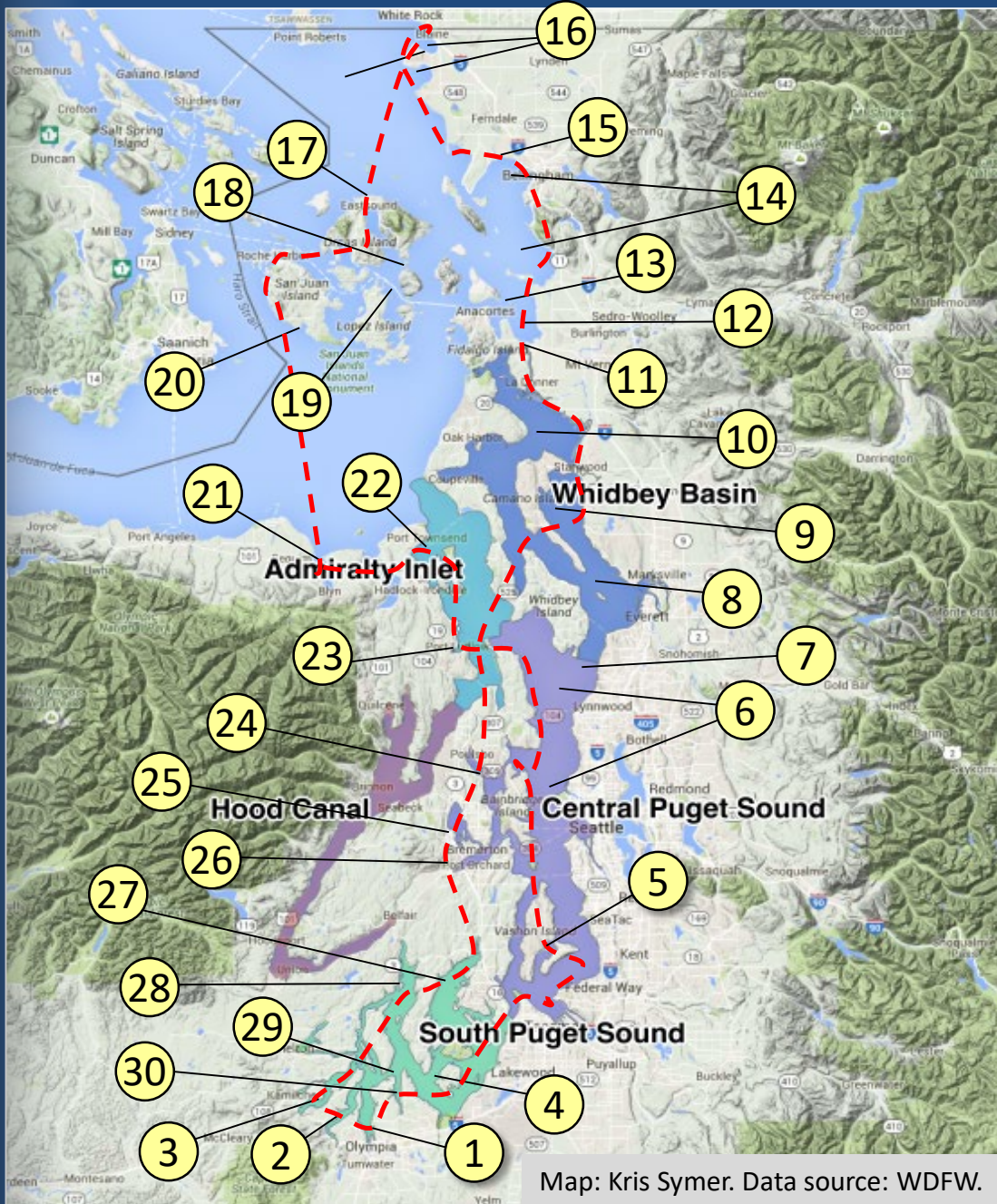
**Red-brown:** Budd, Eld, and Sinclair Inlets; Sequim and Samish Bay; East Sound

**Brown:** Lopez Sound



### Debris:

Numerous patches of macroalgae and organic debris in South and Central Puget Sound, Port Susan, Padilla and Samish Bays



DEPARTMENT OF  
**ECOLOGY**  
State of Washington



## Aerial navigation guide

Date: 9-8-2021

Click on numbers

### Flight Observations

High visibility, rain over San Juan Islands

### Contributed observations



Tide data from 9-8-2021 (Seattle):

Time		High/Low
12:28 AM	3.47	L
06:06 AM	10.45	H
12:28 PM	0.23	L
06:58 PM	11.63	H



## Connect aerial observation with data from ORCA moorings



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



[NANOOS NVS Data Explorer](#)



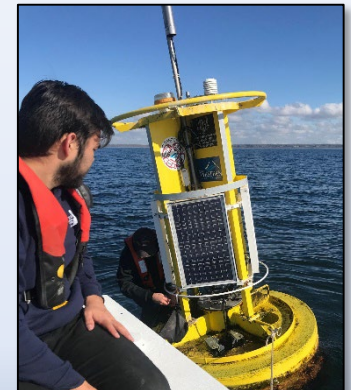
### View products by mooring

#### Puget Sound

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

#### Salish Sea

- ⑦ [Bellingham Bay](#)
- ⑧ [Friday Harbor](#)



Thayne Yazzie, NWIC,  
Robert Daniels, UW/APL



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*Strong red-brown bloom.* Location: Budd Inlet (South Sound), 11:34 AM



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*Red-brown bloom and milky-white water originating in Young Cove. Location: Eld Inlet (South Sound), 11:35 AM*



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*Different-colored water originating from A. Oakland Bay. B. Water remaining separated while flowing north.  
Location: Totten Inlet (South Sound), 11:38 AM*



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*Large raft of organic material.* Location: Anderson Island (South Sound ), 11:46 AM



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A. Weak brown-reddish bloom near Dockton. B. Whitish water, perhaps jellyfish, in Rabbs Lagoon.  
 Location: Quartermaster Harbor (Central Sound) 11:55 AM





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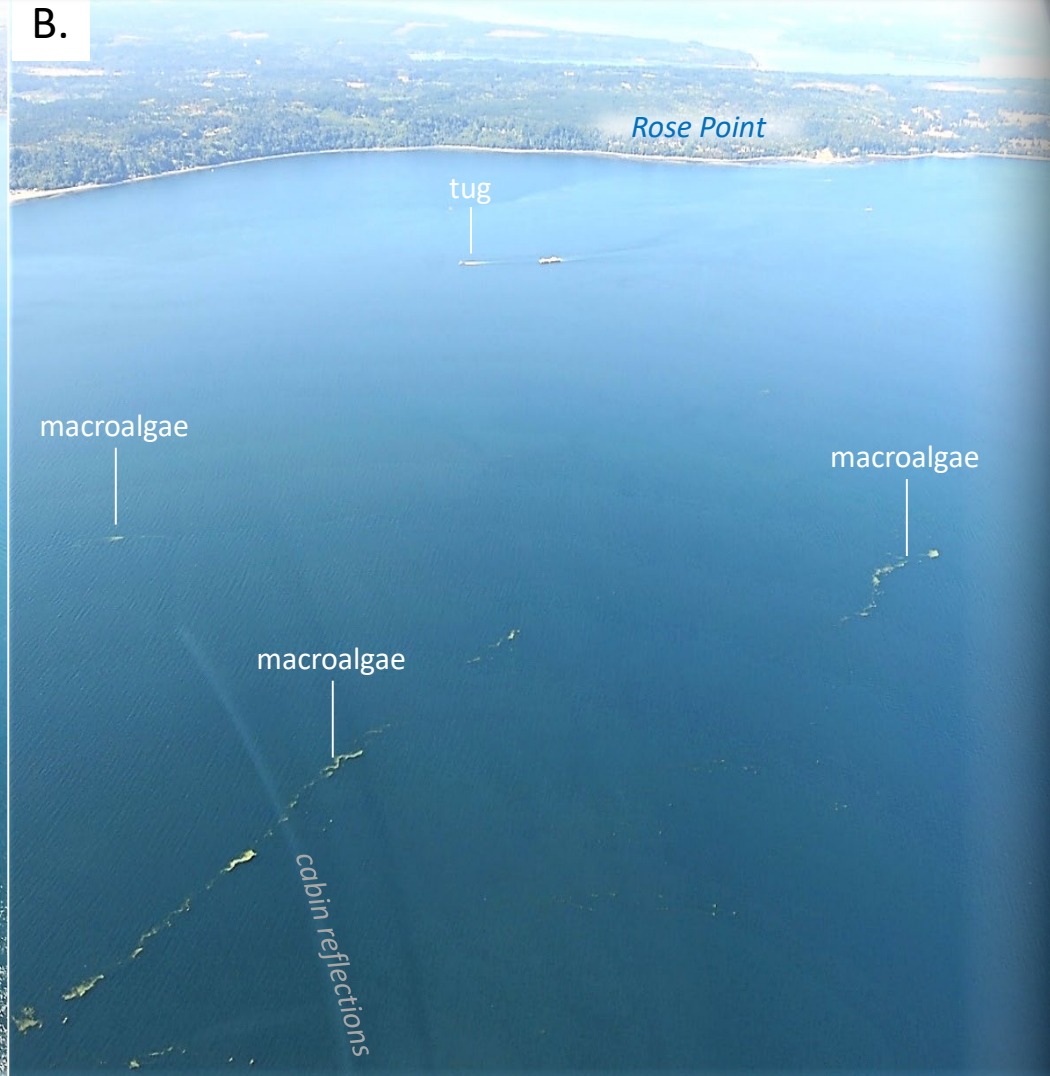
Aerial photos

Data

A.



B.



*Large of organic debris drifting between A. West Point and B. Kingston.  
Location: Carr Inlet (Central Sound), 12:01 PM*



Summary

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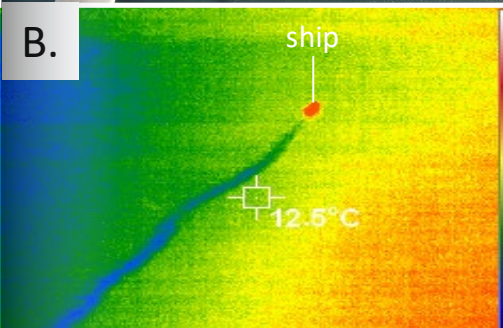
Climate &amp; streams

Combined factors

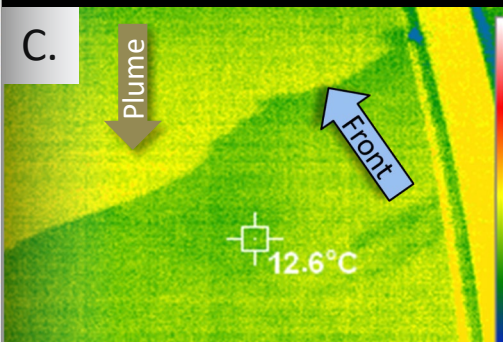
Marine water

Aerial photos

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Qualitative IR images showing spatial temperature patterns



The wake of a boat reveals A. a thin surface layer of lower-density water and B-C. slightly warmer water from Whidbey Basin entering Central Sound. Location: Edmonds (Central Sound), 12:12 PM



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*Long oil sheen stretching from Hat Island to Camano Head.*  
Location: Entrance to Port Susan (Whidbey Basin), 12:17 PM



Summary

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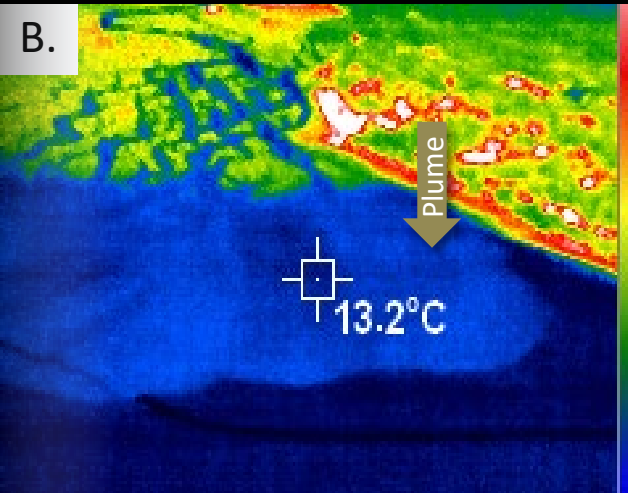
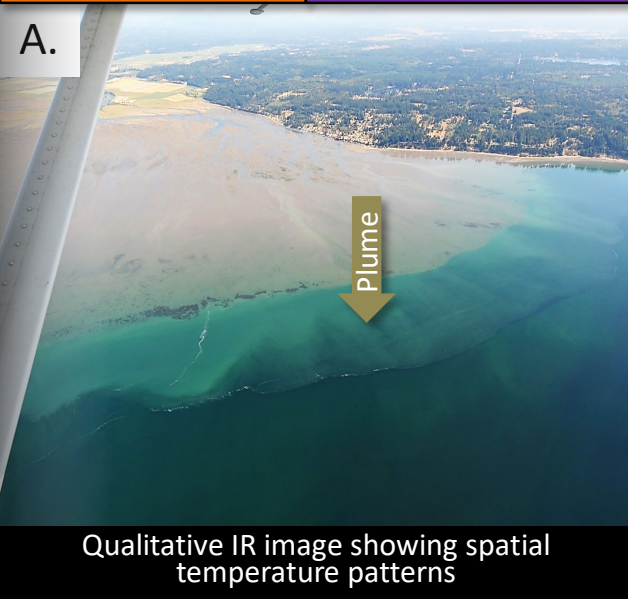
Climate &amp; streams

Combined factors

Marine water

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A. Stillaguamish estuary with B. relatively cool tideflat despite sunshine. C. Large rafts of organic material of different color and composition. Location: Port Susan (Whidbey Basin), 12:23 PM



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*Organic material accumulating at edge of Skagit River plume.*

Location: Skagit Bay (North Sound), 12:28 PM



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Very green bloom in an old disconnected slough. Very different water colors in Telegraph and Blind Sloughs and as the water enters the Swinomish Channel. Location: Swinomish Channel (North Sound), 12:33 PM



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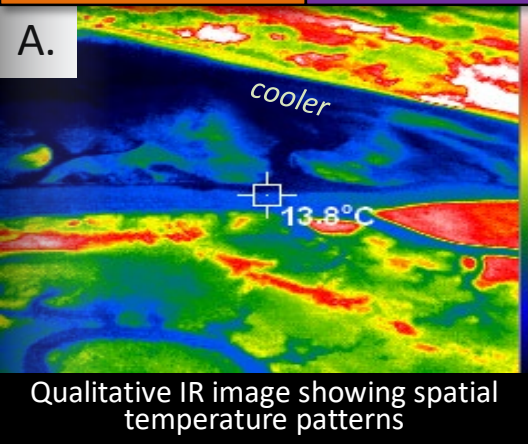
Combined factors

Marine water

Aerial photos

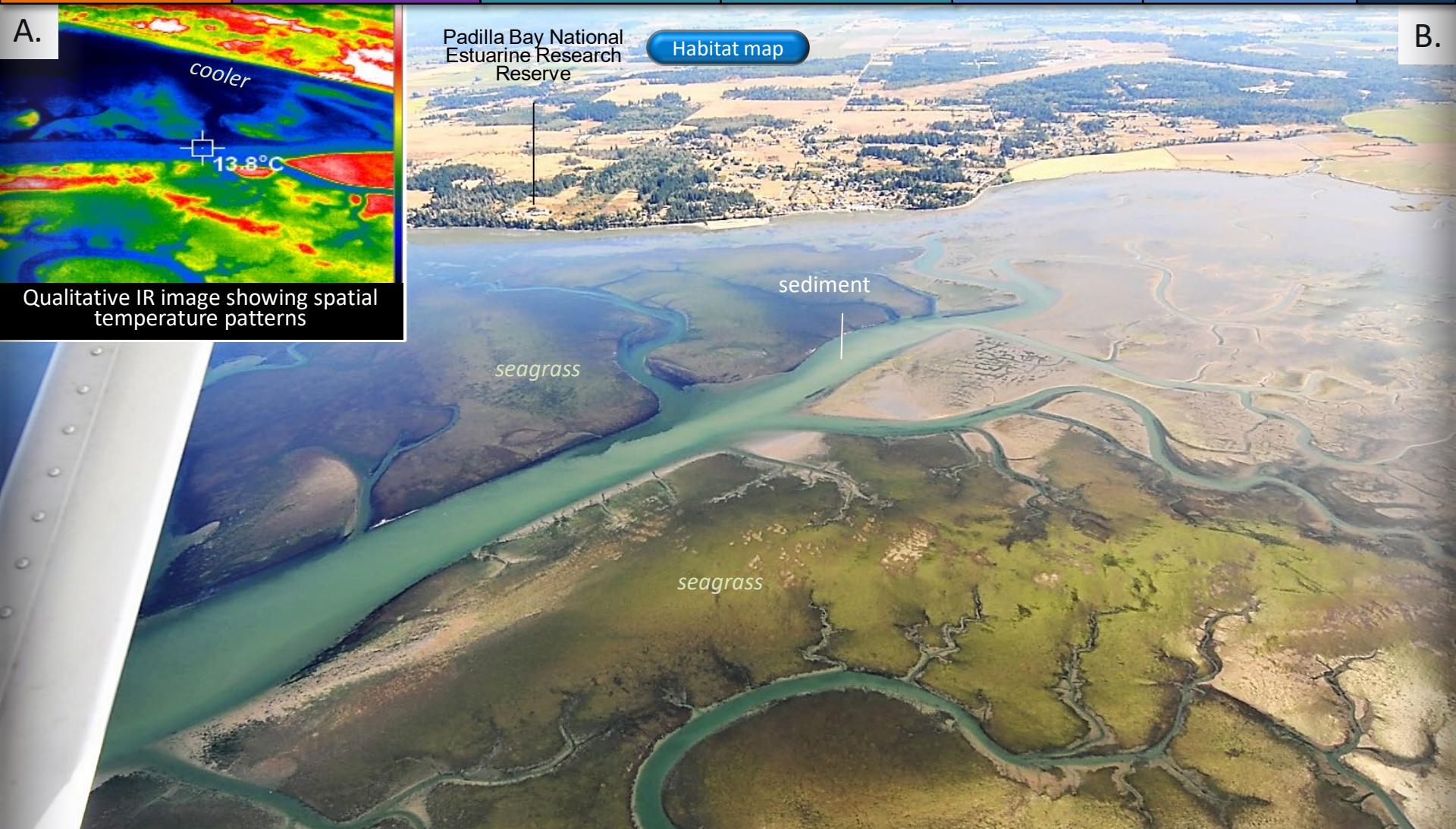
Data

A.


 Padilla Bay National  
 Estuarine Research  
 Reserve

Habitat map

B.



*Padilla Bay seagrass experiences much cooler temperatures north of the tidal gully. Sediment from south of the gully discolors the water. Location: Padilla Bay (North Sound), 12:35 PM*



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*Large rafts of organic material drifting in water discolored by a bloom.*  
 Location: Padilla Bay (North Sound), 12:36 PM





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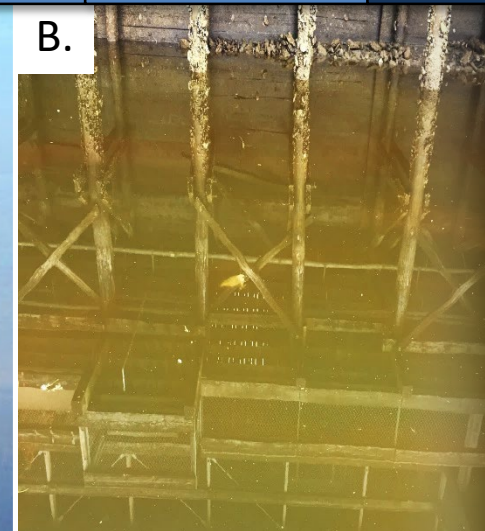
Aerial photos

Data

A.



B.



C.



A. Strong red bloom and drifting organic material in Samish Bay. B-C. Red-brown bloom in Squalicum Harbor.  
 Location: A. Samish Bay, B-C. Bellingham Bay (North Sound), 12:40 PM



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*Plumes of the forks of the Nooksack River moving in opposite directions.*  
Location: Bellingham Bay (North Sound), 12:46 PM



Summary

Art & Critters

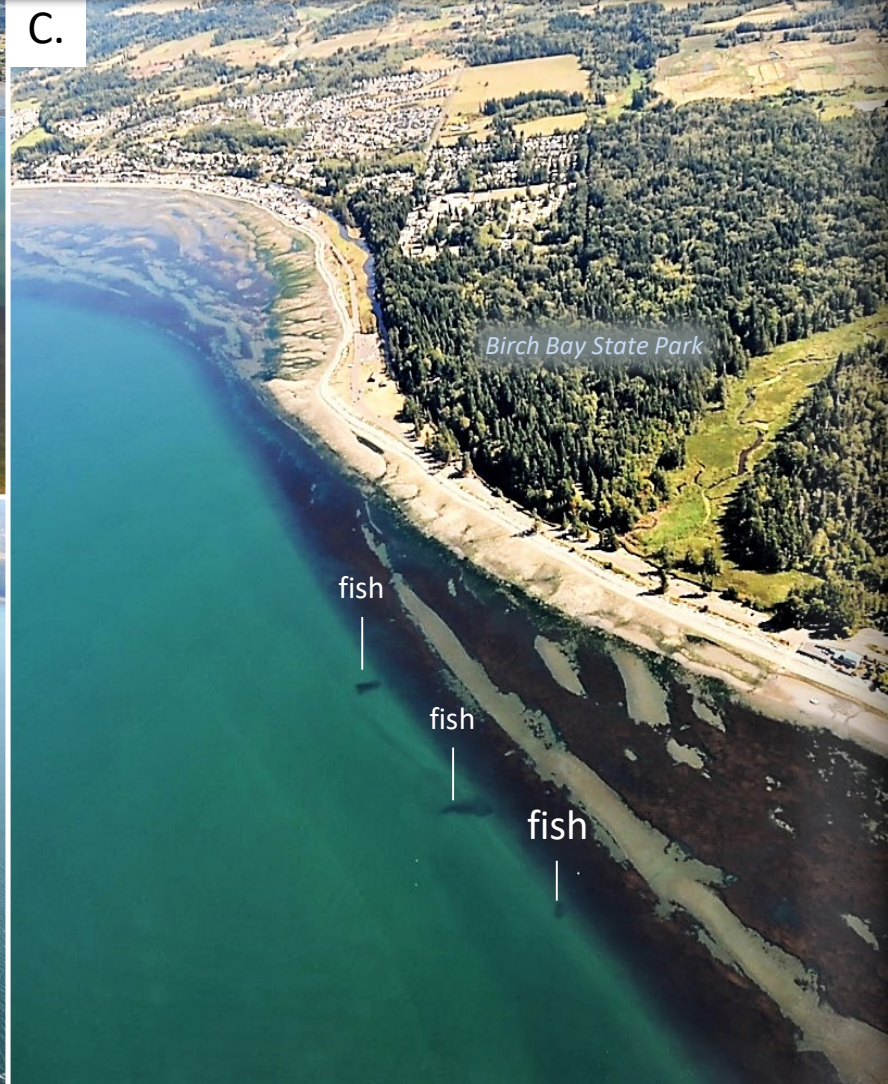
Climate & streams

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A. Drayton Harbor with seagrass. B. Front and different water masses at entrance to Birch Bay. C. Schools of fish near seagrass bed. Location: A. Drayton Harbor, B-C. Birch Bay (North Sound), 12:53 PM



Summary

Art &amp; Critters

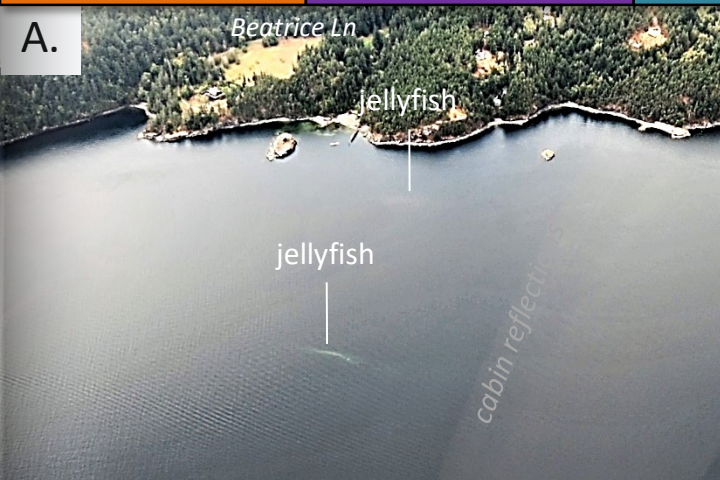
Climate &amp; streams

Combined factors

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A. Patches of jellyfish, red-brown bloom (low visibility due to rain) and B. macroalgae on beach in Ship Bay.  
 Location: East Sound, Orcas Island (North Sound), 1:07 PM



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*Red-brown algae bloom from East Sound mixing with clearer water entering via Obstruction Pass.  
Location: East Sound, Orcas Island (North Sound), 1:12PM*



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*Strong brown bloom and organic material accumulating at a distinct front.  
Location: Shoal Bay (North Sound), 1:12 PM*



Summary

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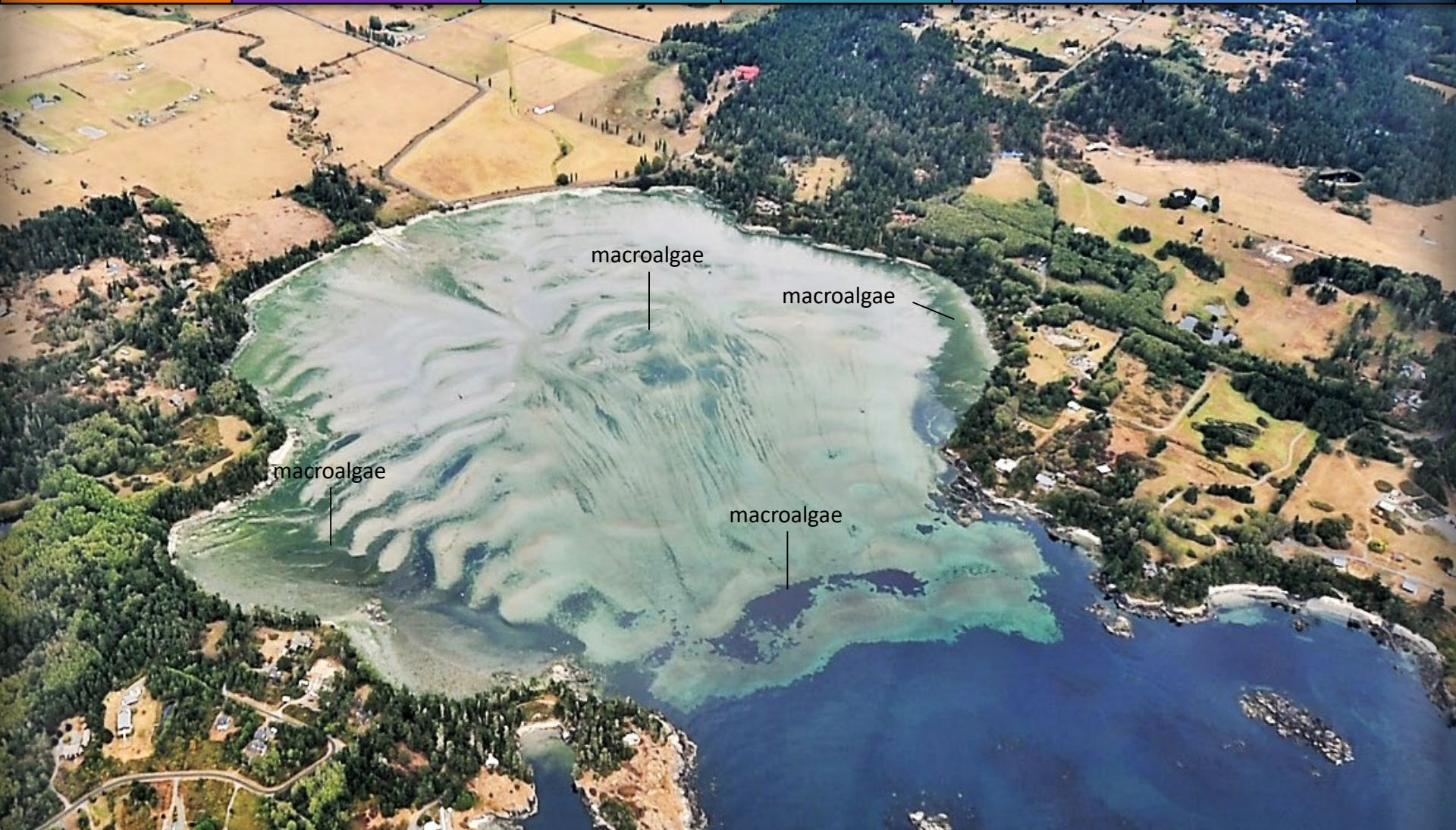
Climate &amp; streams

Combined factors

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*Macroalgae growing around perimeter of False Bay.*  
Location: San Juan Island (San Juan Islands), 1:24 PM



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*Bloom, tidal front, organic material, and suspended sediment near western shoreline.*

Location: Sequim Bay (North Sound), 1:40 PM





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Very red-brown bloom spanning the entire length of Kilisut Harbor, from the entrance of the bay to Scow Bay.  
Location: Marrowstone Island (Central Sound), 1:50 PM



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A. Long ribbons of organic material drifting at surface. B. Turquoise-colored water in Mats Mats Bay.  
Location: A. Port Ludlow, B. Mats Mats Bay (Central Sound), 1:54 PM



Summary

Art &amp; Critters

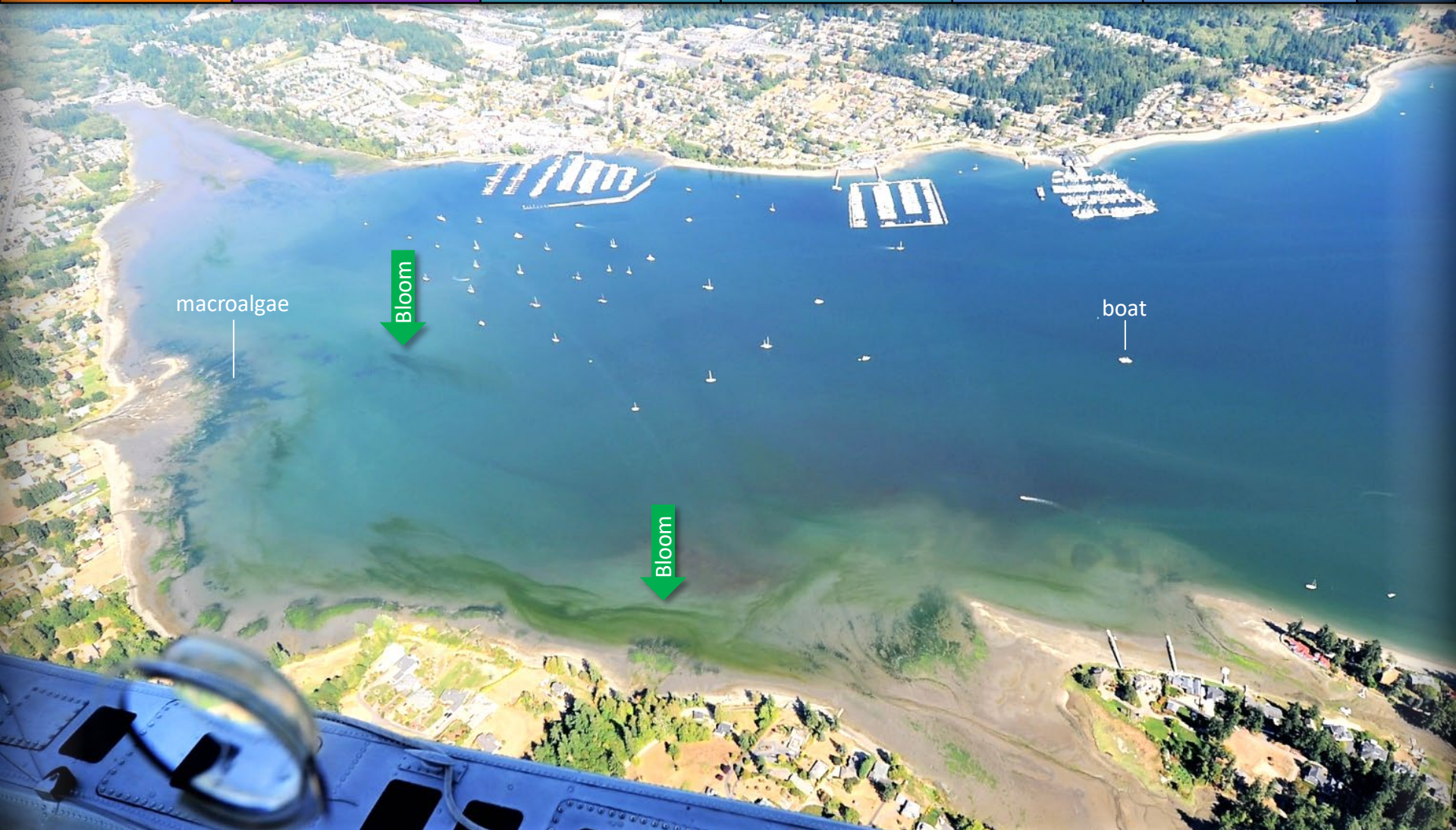
Climate &amp; streams

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*Bright-green bloom patches in shallow portions of Liberty Bay.*  
Location: Liberty Bay (Central Sound), 2:02 PM



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A. Milky-white patches and red-brown bloom in Ostrich Bay. B-D. Jellyfish patches in Ostrich and Oyster Bays.  
 Location: Dyes Inlet (Central Sound), 2:08 PM



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*Strong red-brown bloom, but no jellyfish.* Location: Sinclair Inlet (Central Sound), 2:11 PM



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*Turquoise patch that appeared granular, which could be a diffuse patch of jellyfish.*

Location: Carr Inlet (Central Sound), 2:18 PM



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A. Red-brown and red bloom. B. It matters on which side of the bridge one takes a plankton sample!  
Location: Case Inlet (South Sound), 2:22 PM



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*Strong red-brown bloom with turquoise water mixing in from Chapman bay.  
Location: Henderson Inlet (South Sound), 2:30 PM*





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*Strong red-brown bloom with turquoise water mixing in from Chapman bay. Schools of fish near Cliff Point.  
Location: Henderson Inlet (South Sound), 12:42 PM*



Summary

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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.



Summary

Art &amp; Critters

Climate &amp; streams

Combined factors

Marine water

Aerial photos

Data





Summary

Art &amp; Critters

Climate &amp; streams

Combined factors

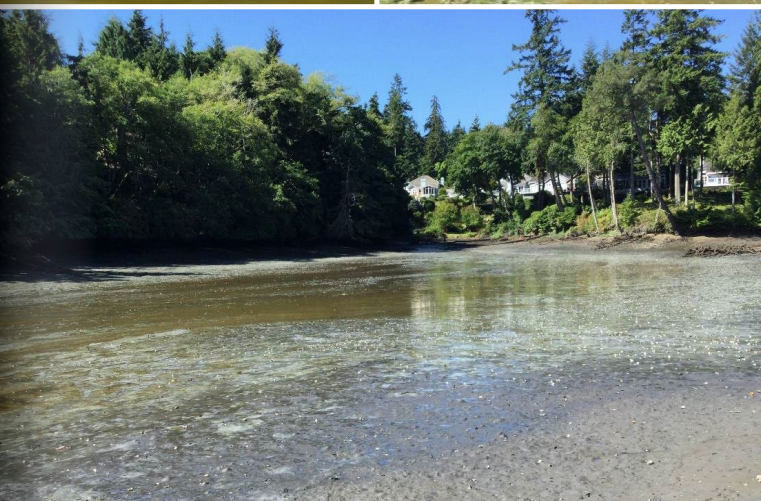
Marine water

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Data



“On July 20, 2021, I visited the Bay Club in Port Ludlow to investigate a citizen complaint (COM2021-00112, ERTS#708105) regarding water quality concerns in Port Ludlow Bay. I observed brown water, floating algae, and a strong dead fish and shellfish odor”.



Jacquelyn Stenman and Michael Dawson, 7/20/2021, Port Ludlow, stench complaint (ERTS#708105)



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“For the past week I have noticed periodic red/rust discoloration in the water and today it looks like almost half of the channel leading out to Dyes Inlet was dyed this rust/red color”.

Josephine Strauss, 7/23/2021, Oyster Bay, Madrona Point and channel that leads out to Dyes Inlet



Summary

Art &amp; Critters

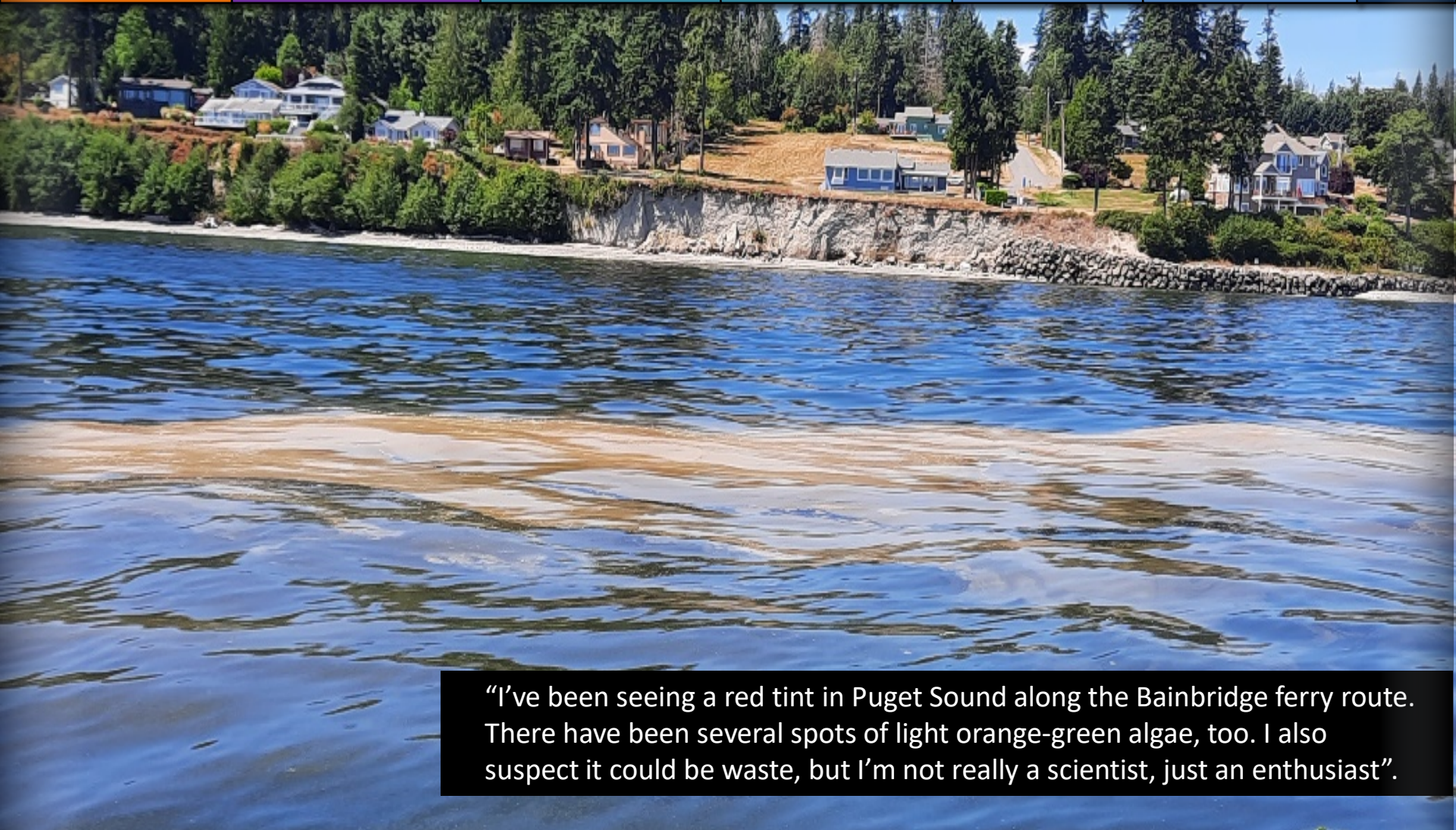
Climate &amp; streams

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“I’ve been seeing a red tint in Puget Sound along the Bainbridge ferry route. There have been several spots of light orange-green algae, too. I also suspect it could be waste, but I’m not really a scientist, just an enthusiast”.

Eryn Craig, 8/9/2021, Bainbridge ferry route



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Jim Baker, 8/4/2021, organic material rafts, Port Orchard



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“Nearly an everyday occurrence here. The water glowed blue effervescent, probably because of the algae. Never seen that before?.”



Maria Mason, 8/5/2021, Bainbridge Island facing West Point





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“The bloom extended into Shilshole Bay - West Point and Meadow Point with patches of decaying material at the surface – everywhere! A sailing teammate told me that he and his wife have been going out on their paddleboards at night to see the bioluminescence”. [Click here bioluminescence in Puget Sound](#)

Julia Boss, 8/11/2021, Shilshole Marina



Summary

Art &amp; Critters

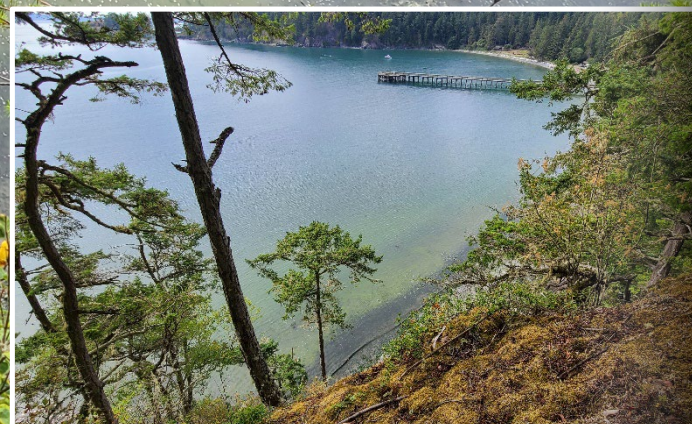
Climate &amp; streams

Combined factors

Marine water

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Grace McKenney, 8/12/2021, green bloom in Bowman Bay

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Alysha Dotson, 8/16/2021, macroalgae in Elliott bay



Summary

Art & Critters

Climate & streams

Combined factors

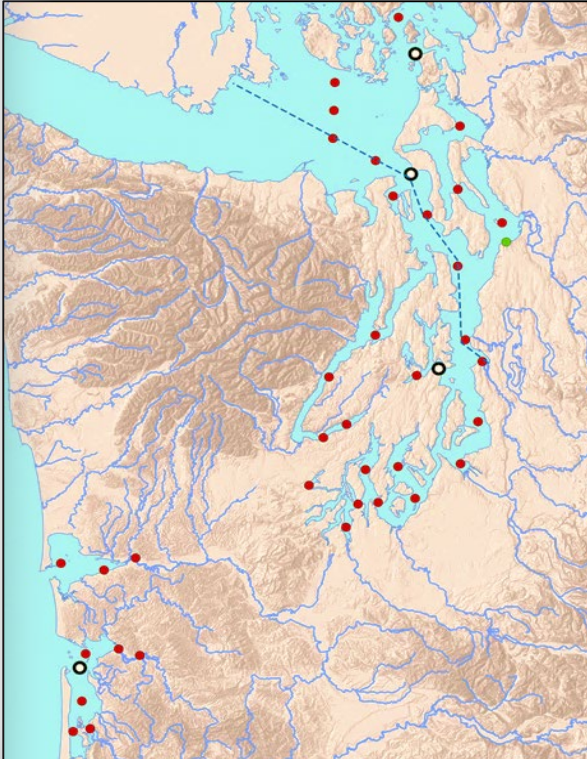
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Aerial photos

Data

## Long-term monitoring data from Puget Sound and coastal bays

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



Get your data

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

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Marina, and Kenmore Air.

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Marine Monitoring Unit  
Environmental Assessment Program  
Washington State  
Department of Ecology

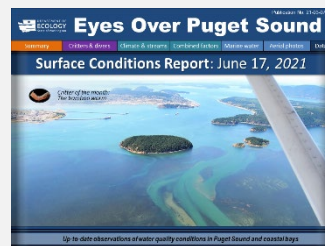
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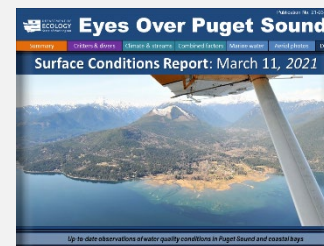
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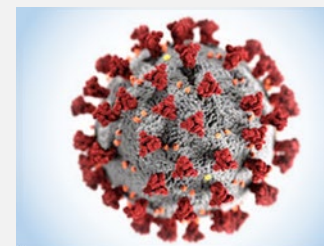
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No coverage due to COVID-19  
 pandemic from April-September



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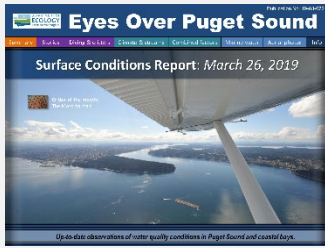
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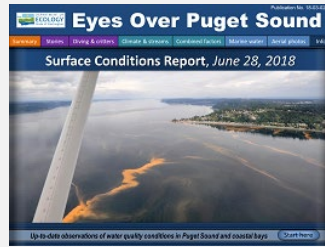
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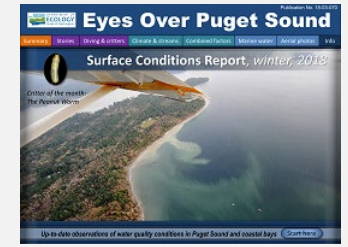
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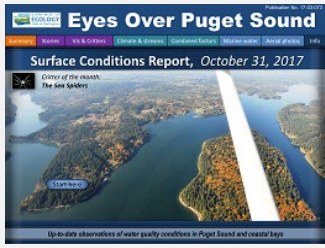
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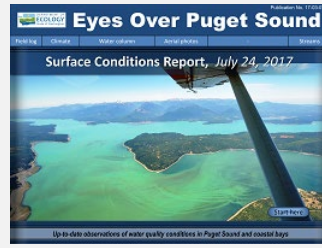
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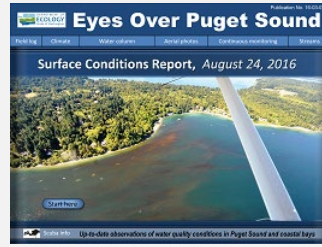
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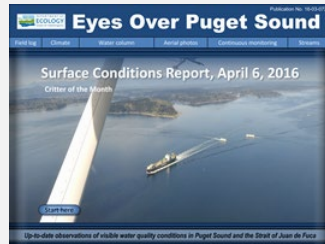
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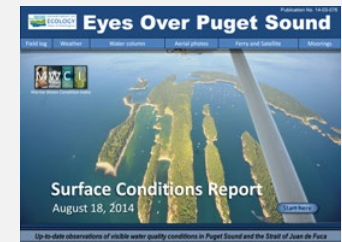
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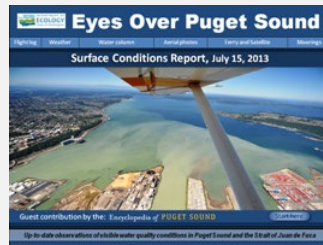
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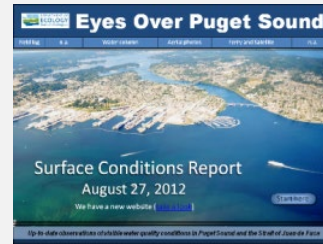
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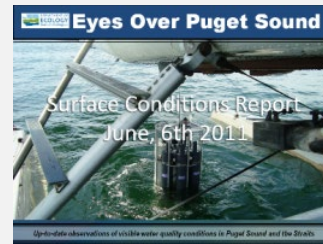
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