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DEPARTMENT OF ECOLOGY
State of Washington

Eyes Over Puget Sound

Surface Conditions Report: Sept 8, 2021

The Pacific Sand Dollar

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

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

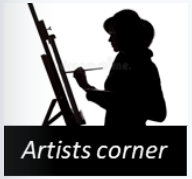
Dr. Christopher Krembs

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.

Editor: Dr. Christopher Krembs, editorial assistance: Holly Young, Valerie Partridge.

Puget Sound is beautiful and inspiring



Showcasing the natural beauty of Puget Sound through photography

"Arteries of life": North Fork of the Skagit River flowing into Skagit Bay

Puget Sound is beautiful and inspiring

"Turquoise rivulets": North Fork of the Skagit River flowing into Skagit Bay

Puget Sound is beautiful and inspiring

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

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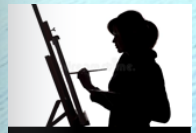
Puget Sound is beautiful and inspiring

"The green caterpillar": Memorial Highway 20, Twin Bridges

Puget Sound is beautiful and inspiring

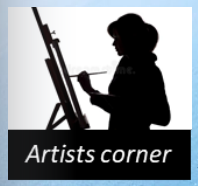
"Watching, wondering, where are we going": Noctiluca *bloom, Shilshole Marina*

Puget Sound is beautiful and inspiring



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

Puget Sound is beautiful and inspiring



"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"!

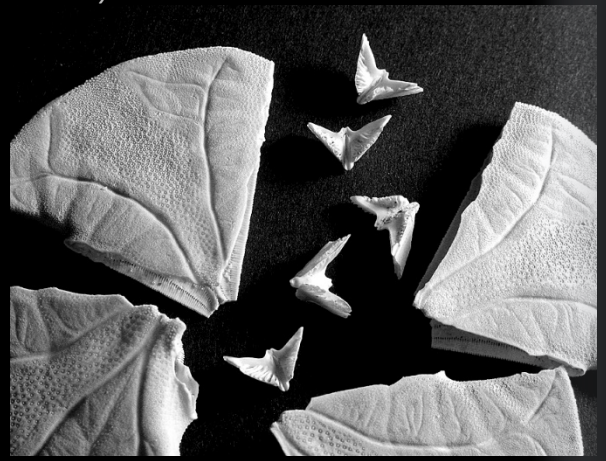
Fun Sand Dollar Facts

- 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 Siuman

Photo by Dave Cowles

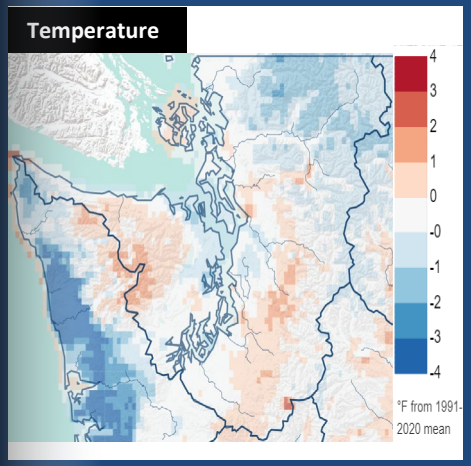
Photo by Photoholic1



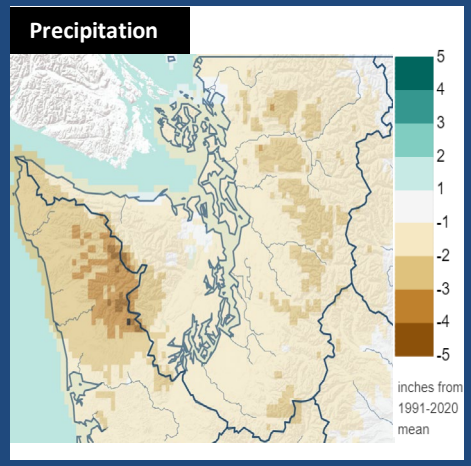
Learn more about sand dollars and other critters on Ecology's EcoConnect blog, click here

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)

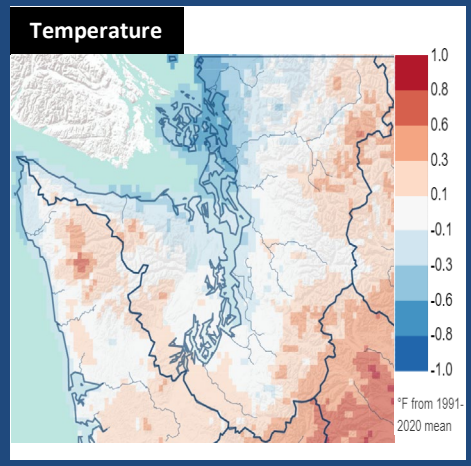


[Temperature Anomaly](#) from historical mean ranged from -3 to +3°F in the Puget Sound region during the past 30 days.

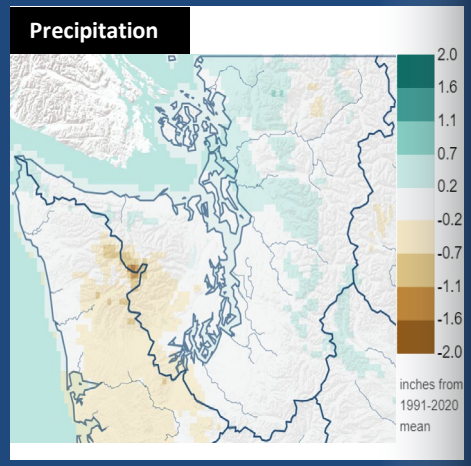


[Precipitation Anomaly](#) from historical mean ranged from 0 to -5 inches in the Puget Sound region during the past 30 days.

B. Northwest Climate Toolbox (Next 30 days)



[Temperature Anomaly](#) from historical mean is forecasted to be +/-1°F in the Puget Sound region during the next 30 days.

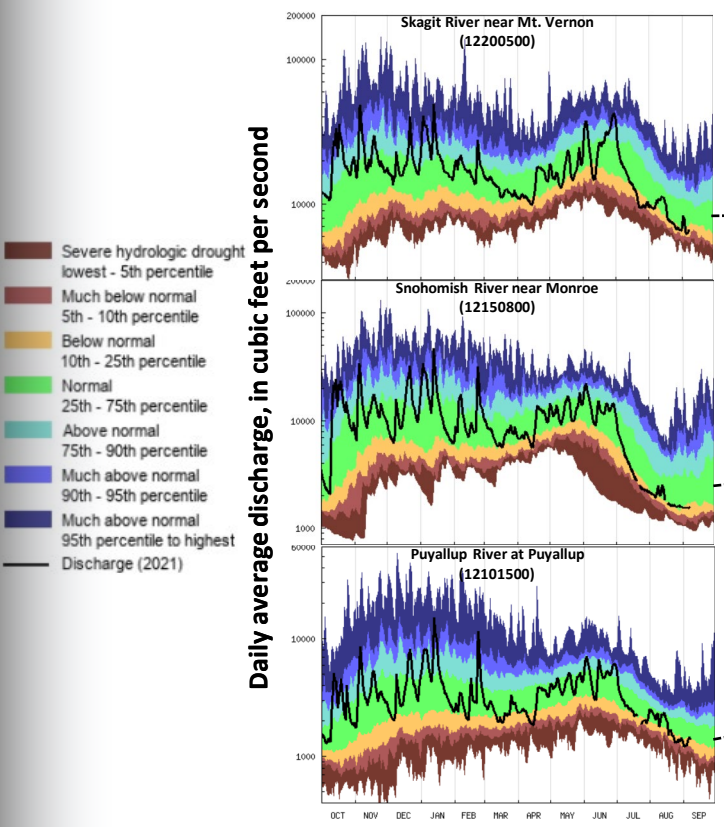


[Precipitation Anomaly](#) from historical mean is forecasted to be between -2 and +1.5 inches in the Puget Sound region during the next 30 days.

How much water flows currently into Puget Sound?

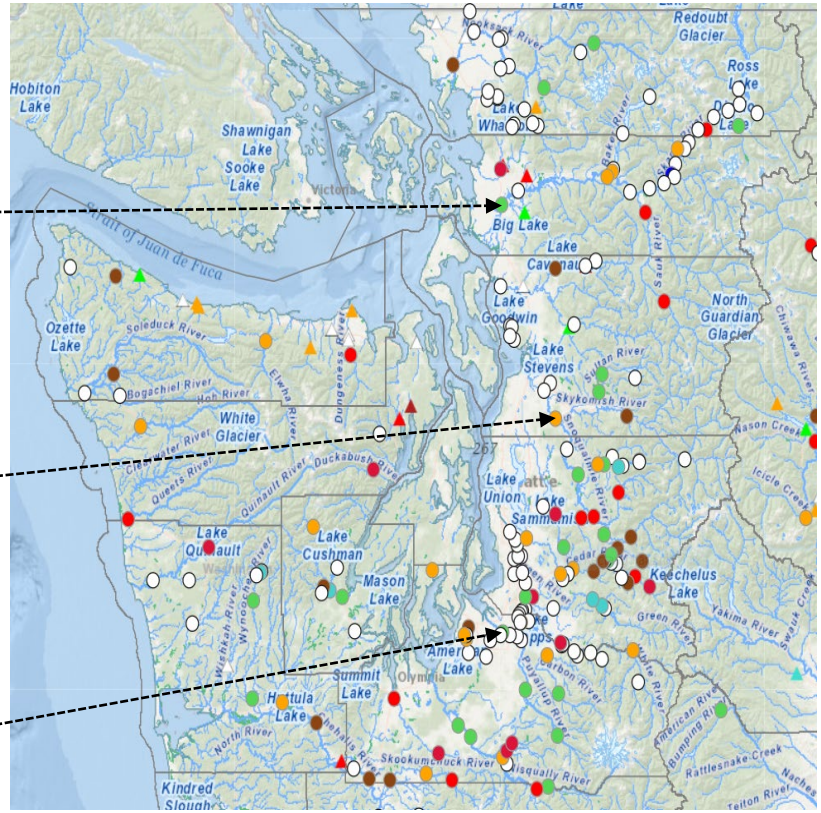
Temporal: Following extreme heat in late June, which rapidly melted snowpack, streamflow levels dropped to below normal (trend charts, left). Typically, snowmelt occurs gradually, which sustains streamflow later into the summer.
Spatial: Streamflow conditions (map, right) currently vary from normal to 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



USGS WaterWatch: CLICK HERE!

Current Streamflow Conditions as of 9/08/2021

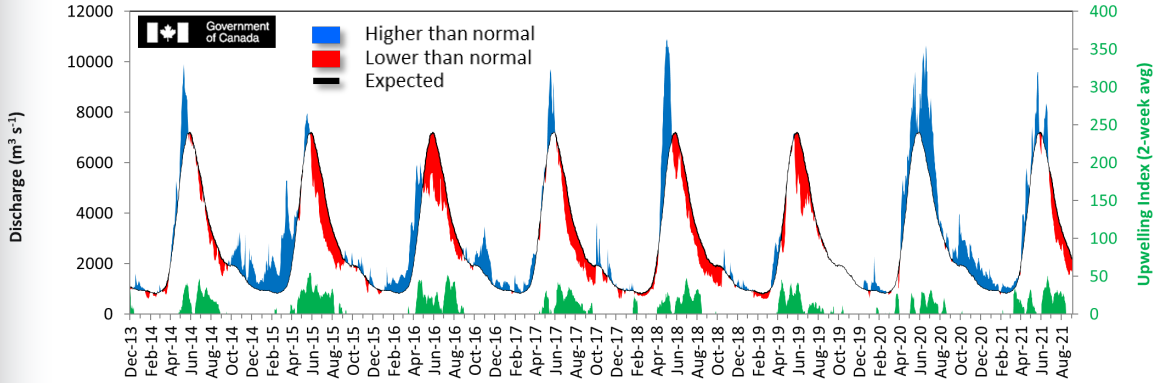


Current conditions: CLICK HERE!

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

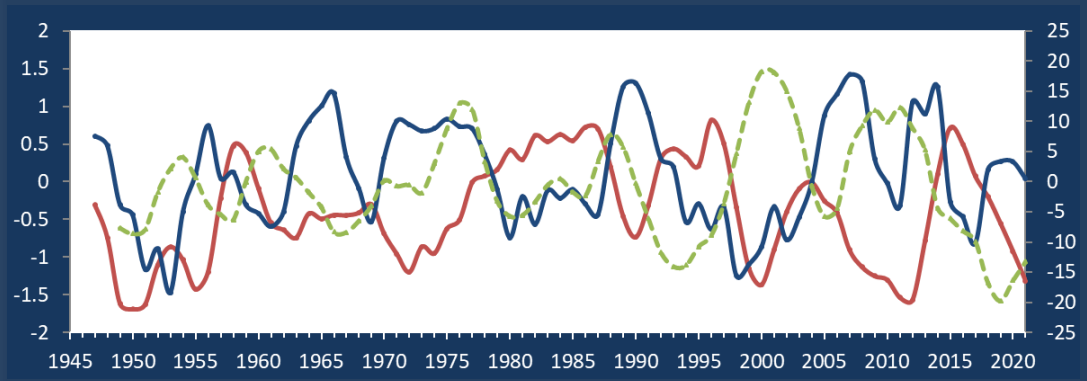
Historically, the peaks of coastal upwelling and the freshet are in sync.

Fraser River (at midnight)



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. 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?

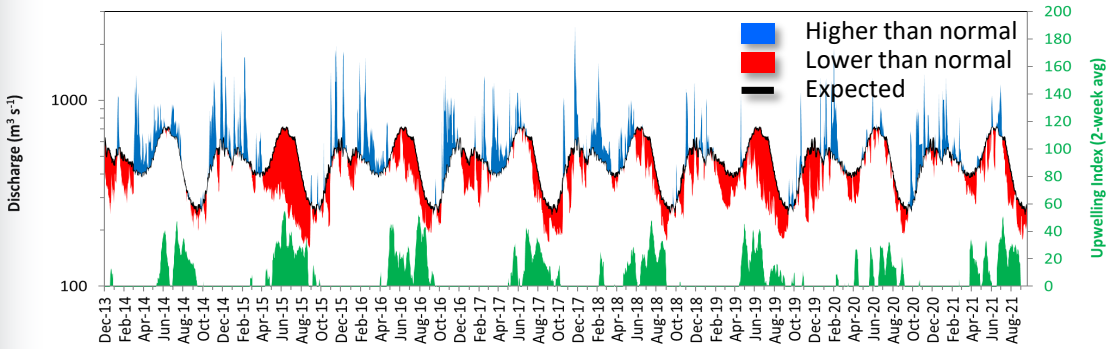
Water has gradually cooled (PDO). Upwelling (Upwelling Index anomaly) is at expected level. Productivity in the eastern Pacific is lower (NPGO) (last updated June 2021).

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

Climate: How well is Puget Sound exchanging its water?

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

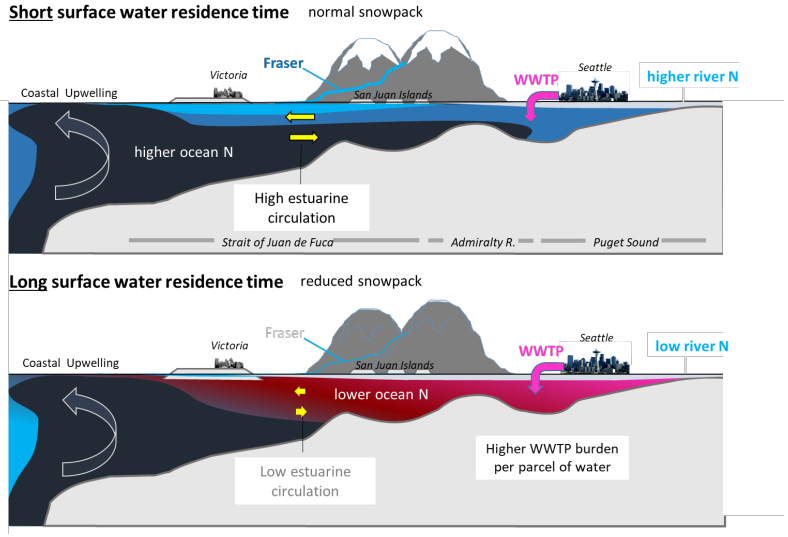
Skagit River (at midnight USGS)



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:

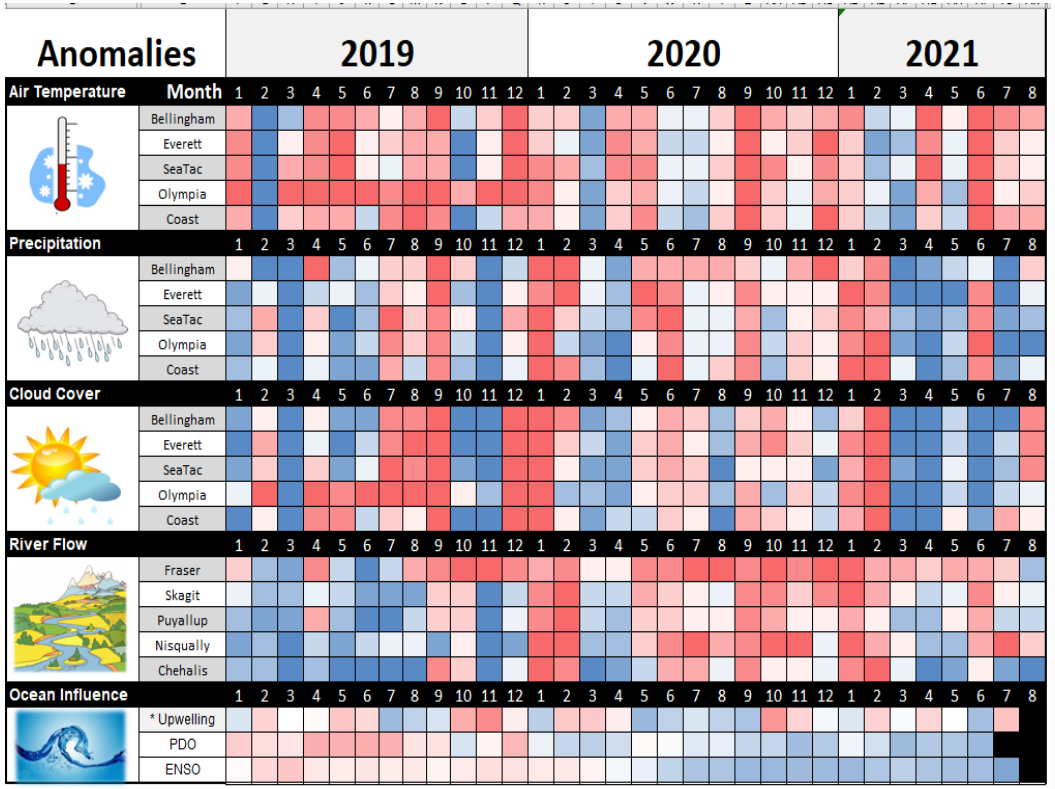
Air temperatures have been mostly warmer this summer.

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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Boundary conditions lead to salinity fluctuations

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

Coastal Bays

T: Warmer

S: Low Station

DO Attainment

Salish Sea

T: Expected with high temperatures in shallow inlets

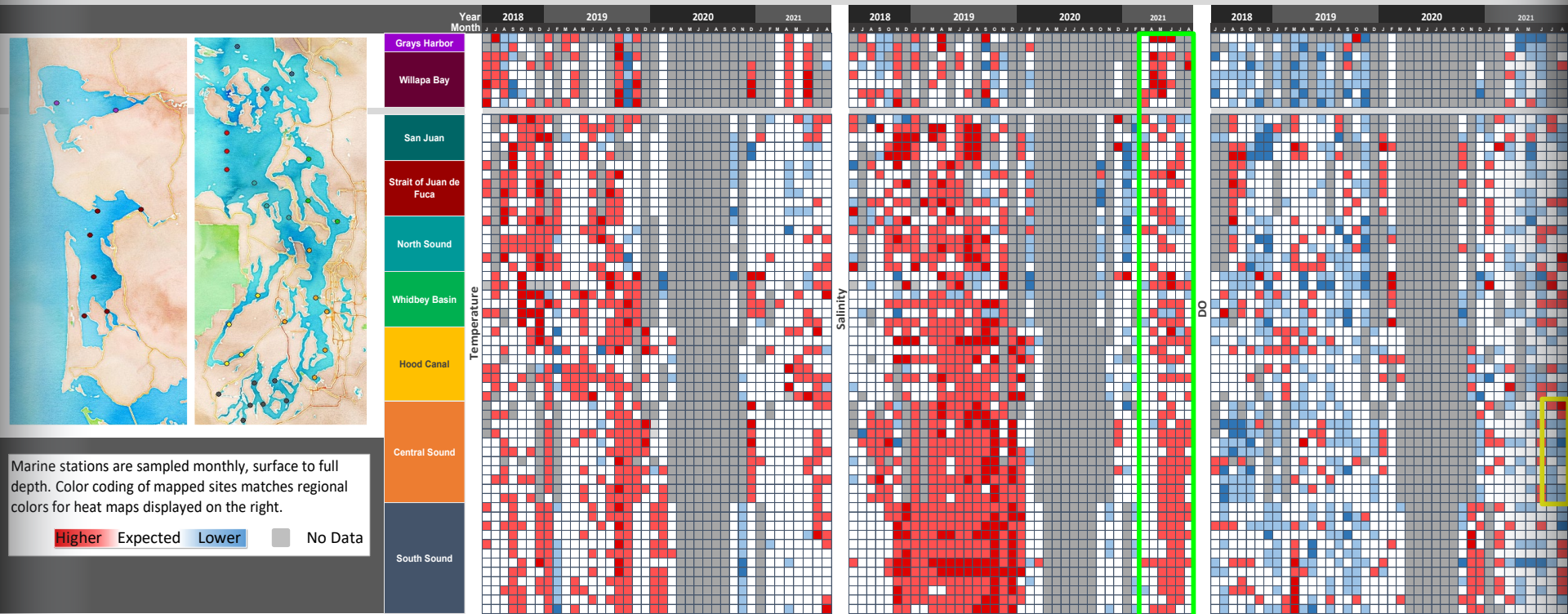
S: Salinity normalizing

DO: Variable. 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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What were the conditions at the surface on 9-8-2021

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.

Our crew in the field, Elliott Bay

Rain has returned, at last!

Start here

Front

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

Plume

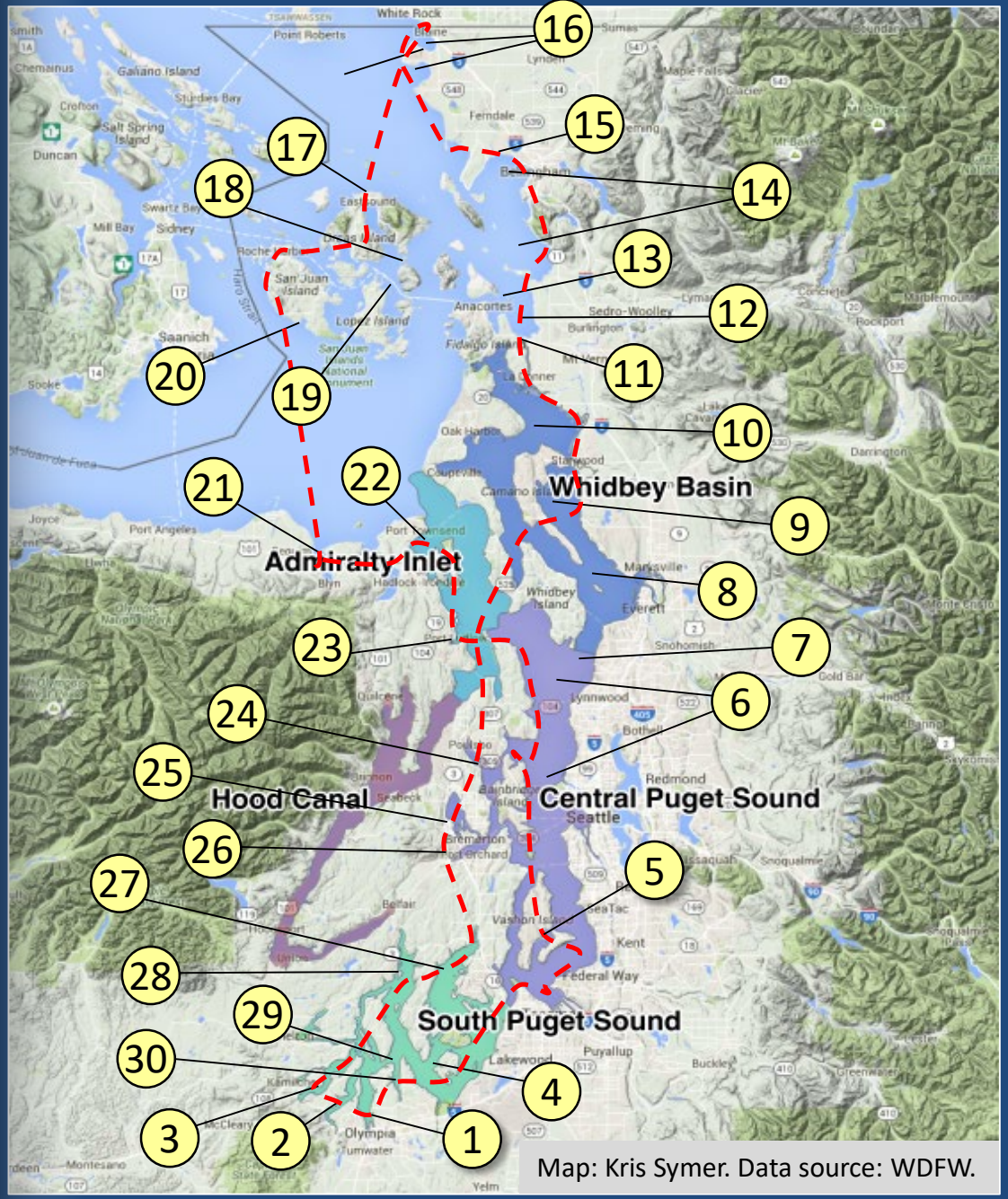
Suspended sediment:
Port Susan, and bays with glacially-fed rivers: Skagit, Nooksack, Puyallup

Bloom

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

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



Map: Kris Symer. Data source: WDFW.

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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

North West Environmental Moorings real-time data

Navigate

Connect aerial observation with data from ORCA moorings

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

[NANOOS NVS Data Explorer]

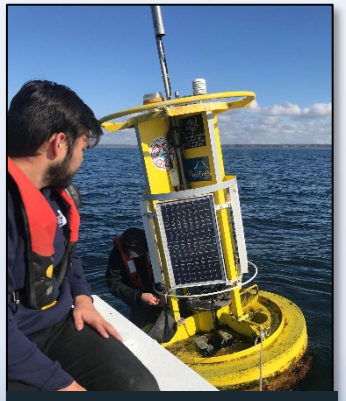
View products by mooring

Puget Sound

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

Salish Sea

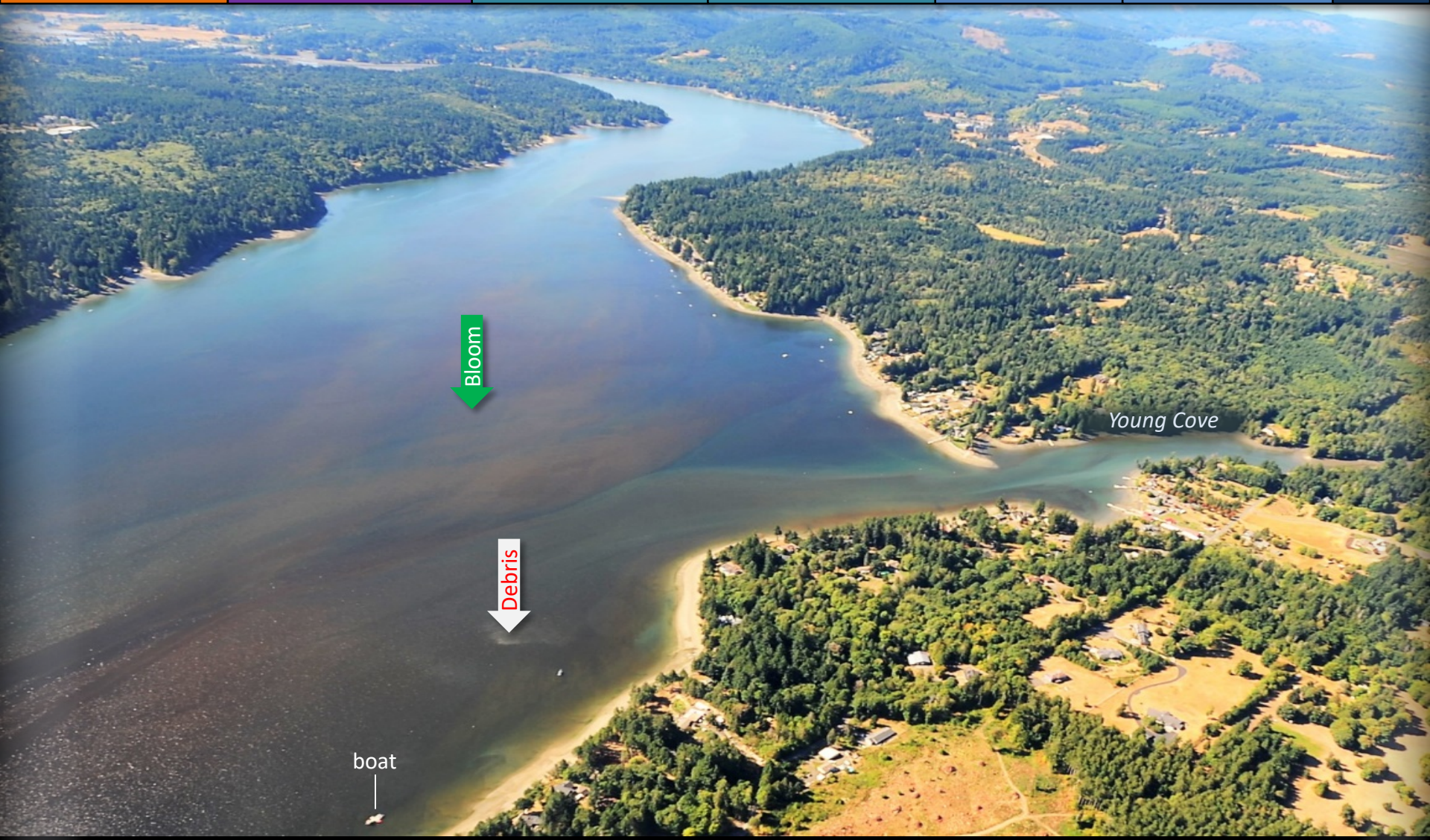
7. Bellingham Bay
8. Friday Harbor



Thayne Yazzie, NWIC, Robert Daniels, UW/APL

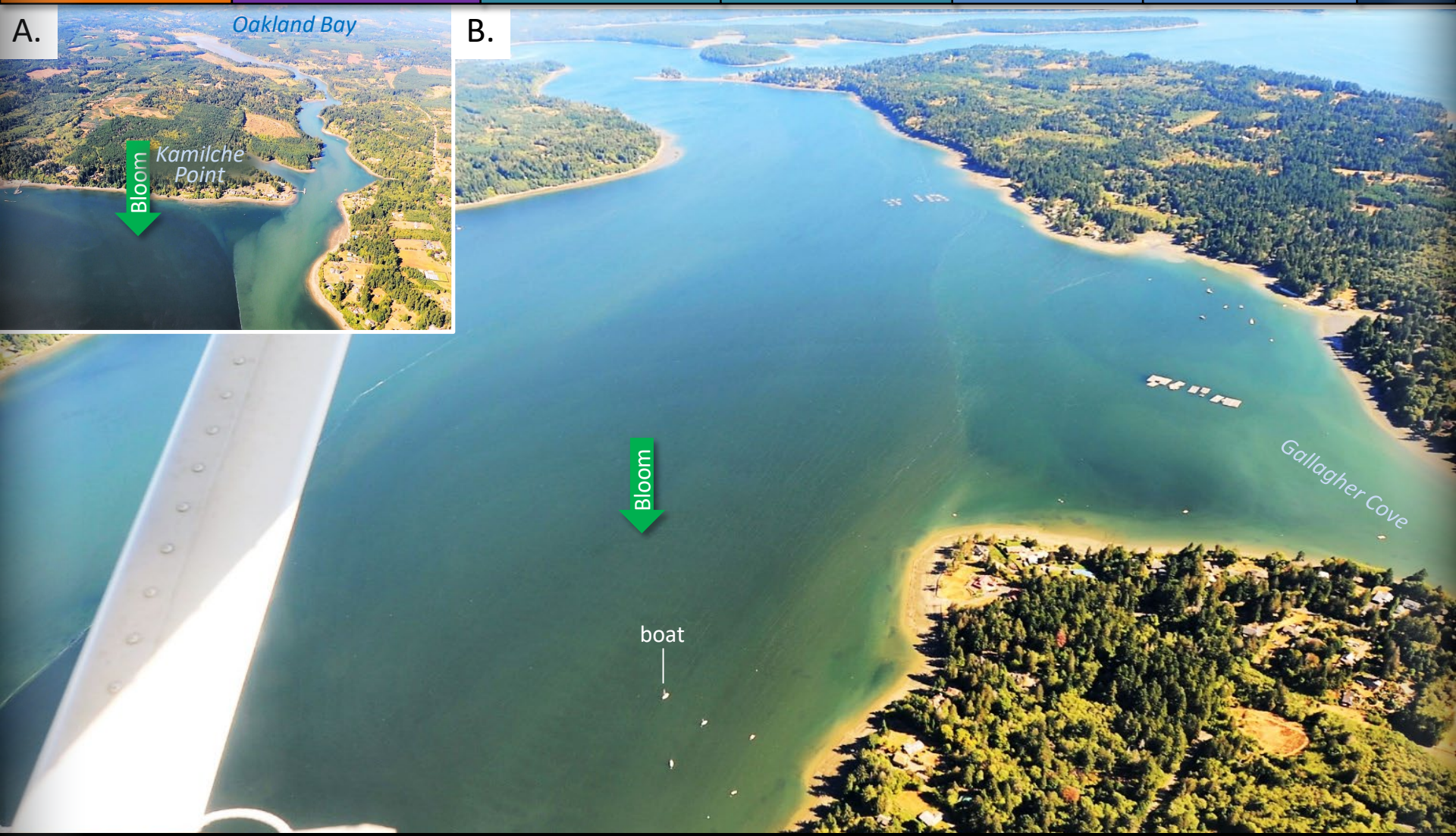
Aerial photography 9-8-2021

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



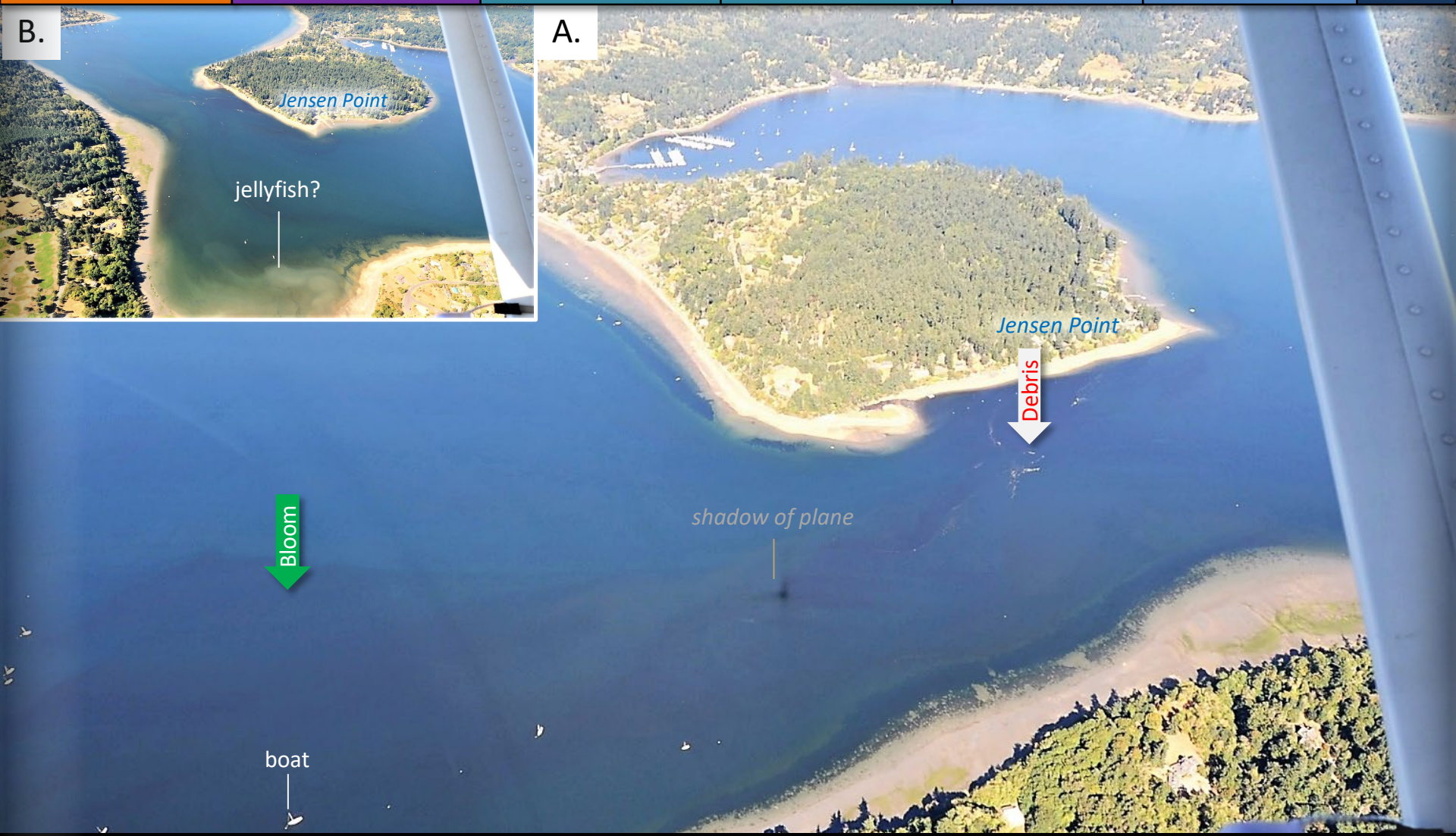
Red-brown bloom and milky-white water originating in Young Cove. Location: Eld Inlet (South Sound), 11:35 AM

Aerial photography 9-8-2021



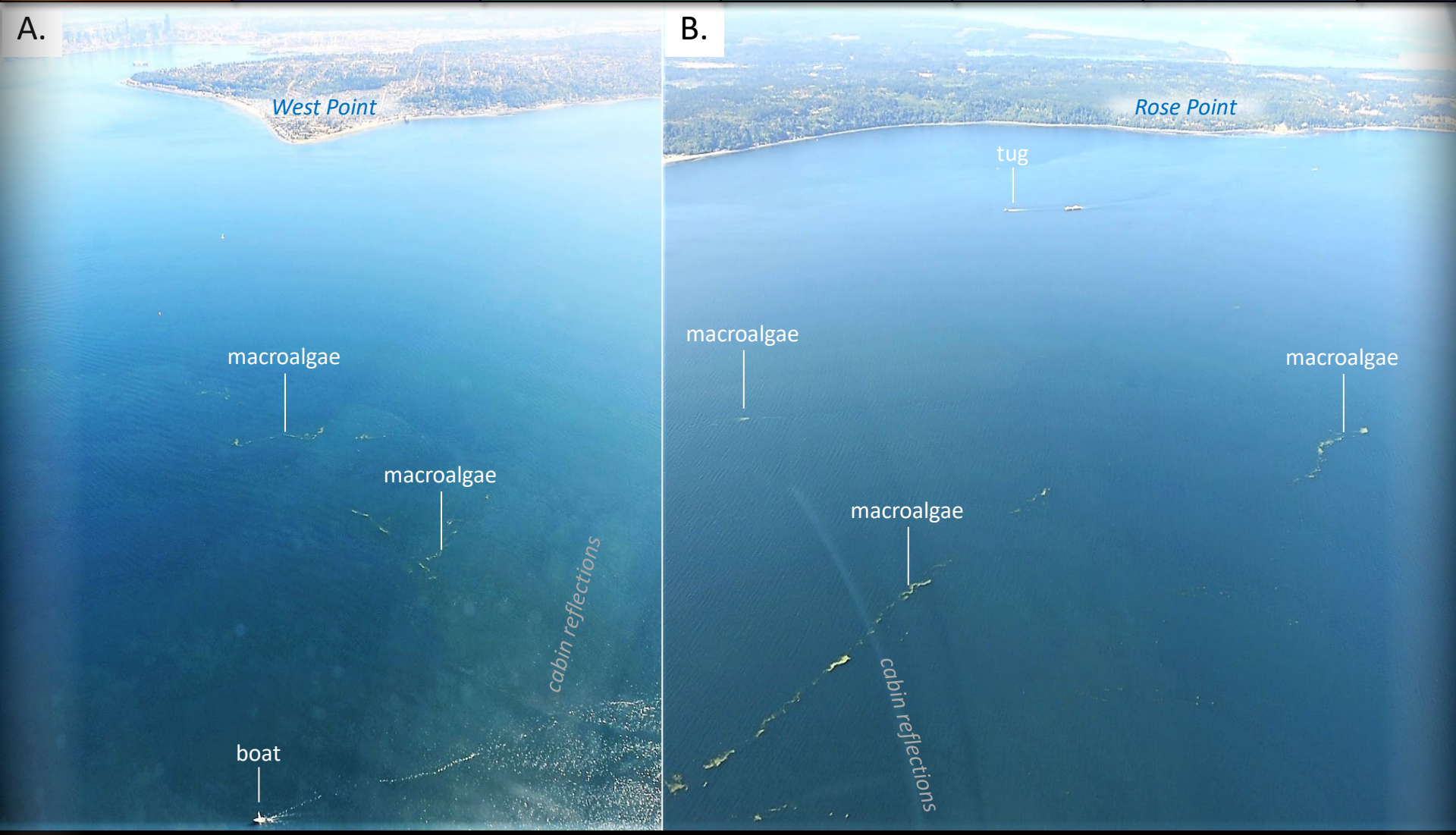
Different-colored water originating from A. Oakland Bay. B. Water remaining separated while flowing north.
Location: Totten Inlet (South Sound), 11:38 AM

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



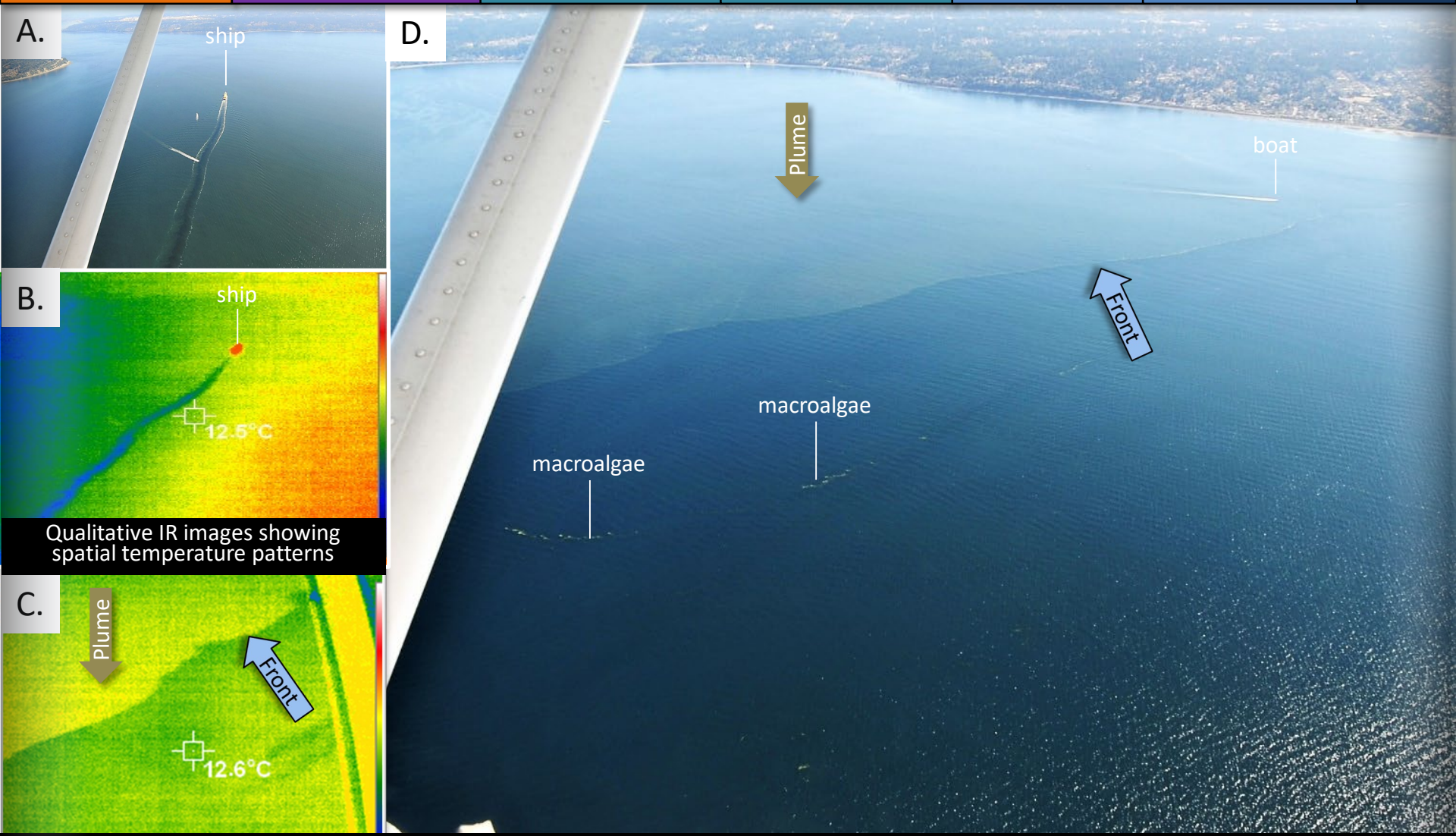
A. Weak brown-reddish bloom near Dockton. B. Whitish water, perhaps jellyfish, in Rabbs Lagoon.
Location: Quartermaster Harbor (Central Sound) 11:55 AM

Aerial photography 9-8-2021



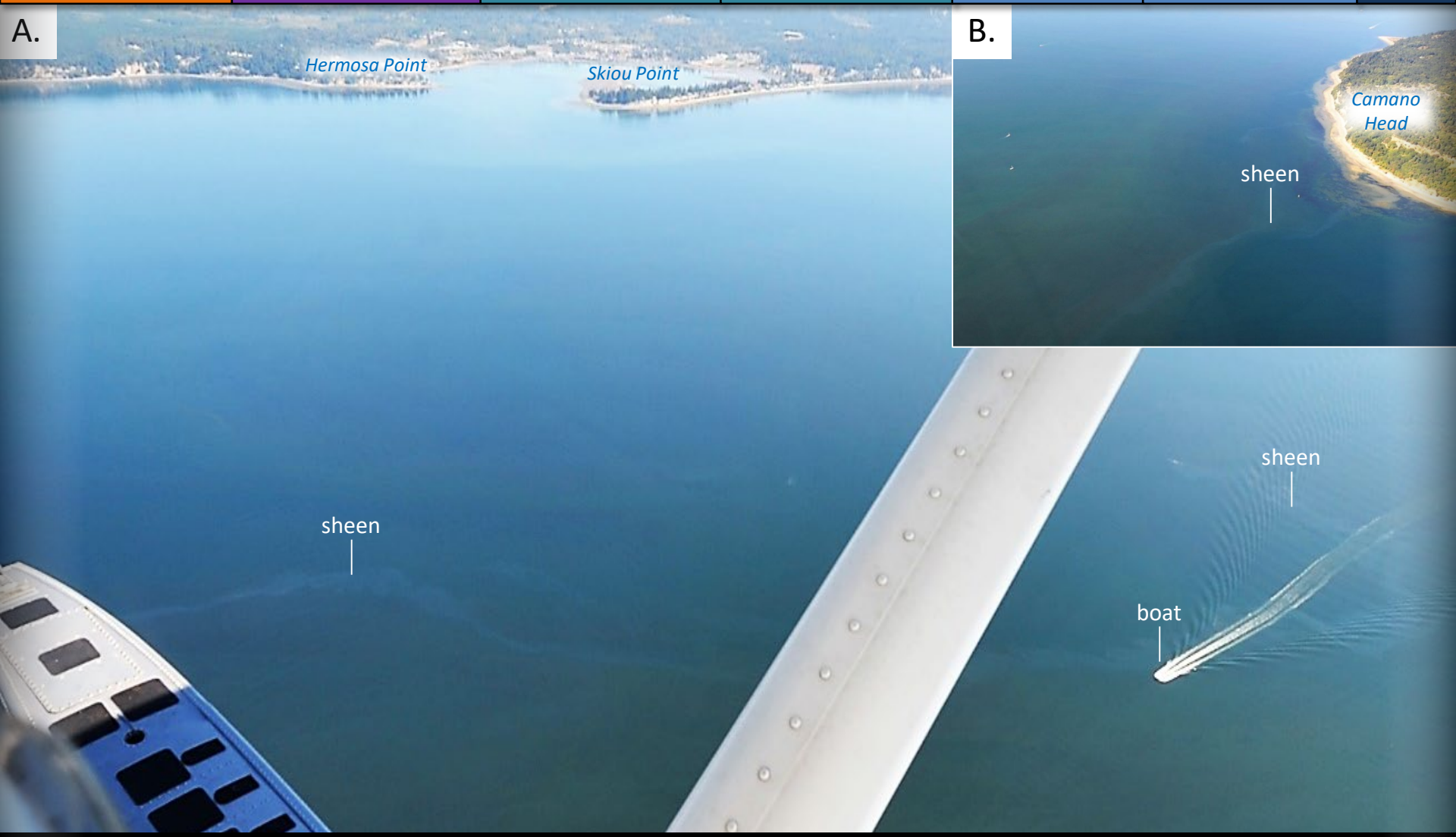
Large of organic debris drifting between A. West Point and B. Kingston.
Location: Carr Inlet (Central Sound), 12:01 PM

Aerial photography 9-8-2021



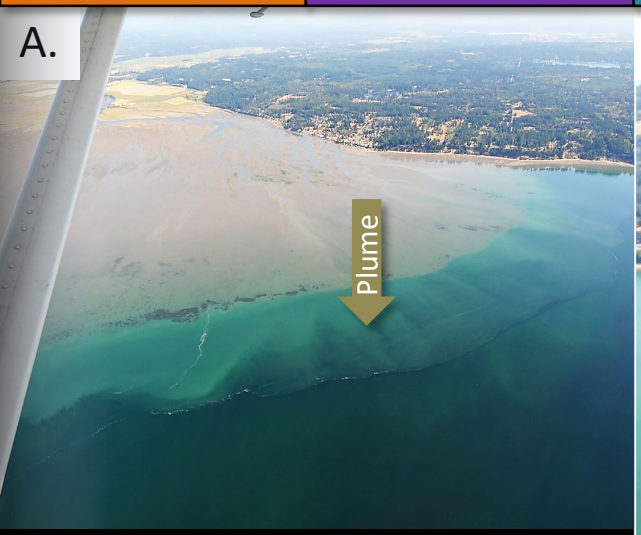
The wake of a boat reveals A. a thin surface layer of lower-density water and B-C. slightly warmer water from Whidbey Basin entering Central Sound. Location: Edmonds (Central Sound), 12:12 PM

Aerial photography 9-8-2021

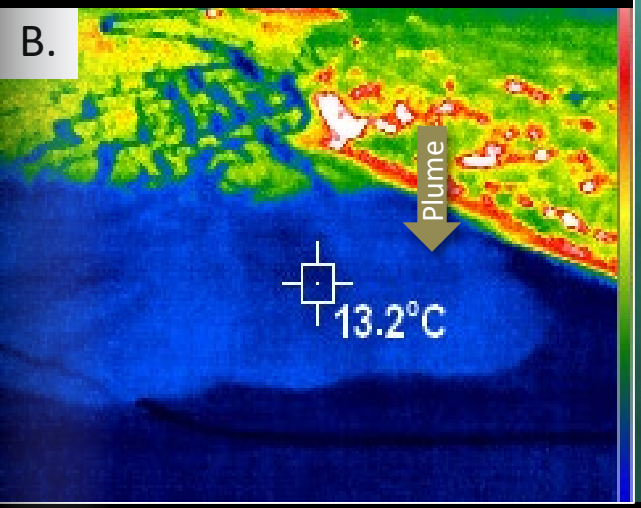


Long oil sheen stretching from Hat Island to Camano Head.
Location: Entrance to Port Susan (Whidbey Basin), 12:17 PM

Aerial photography 9-8-2021



Qualitative IR image showing spatial temperature patterns



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

Aerial photography 9-8-2021

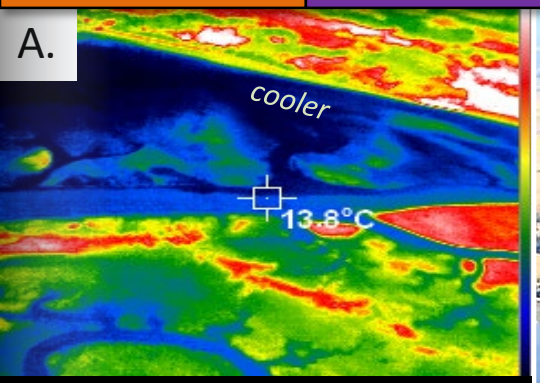
Organic material accumulating at edge of Skagit River plume.

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

Aerial photography 9-8-2021

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

A.



Qualitative IR image showing spatial temperature patterns

B.

Padilla Bay National Estuarine Research Reserve

Habitat map

sediment

seagrass

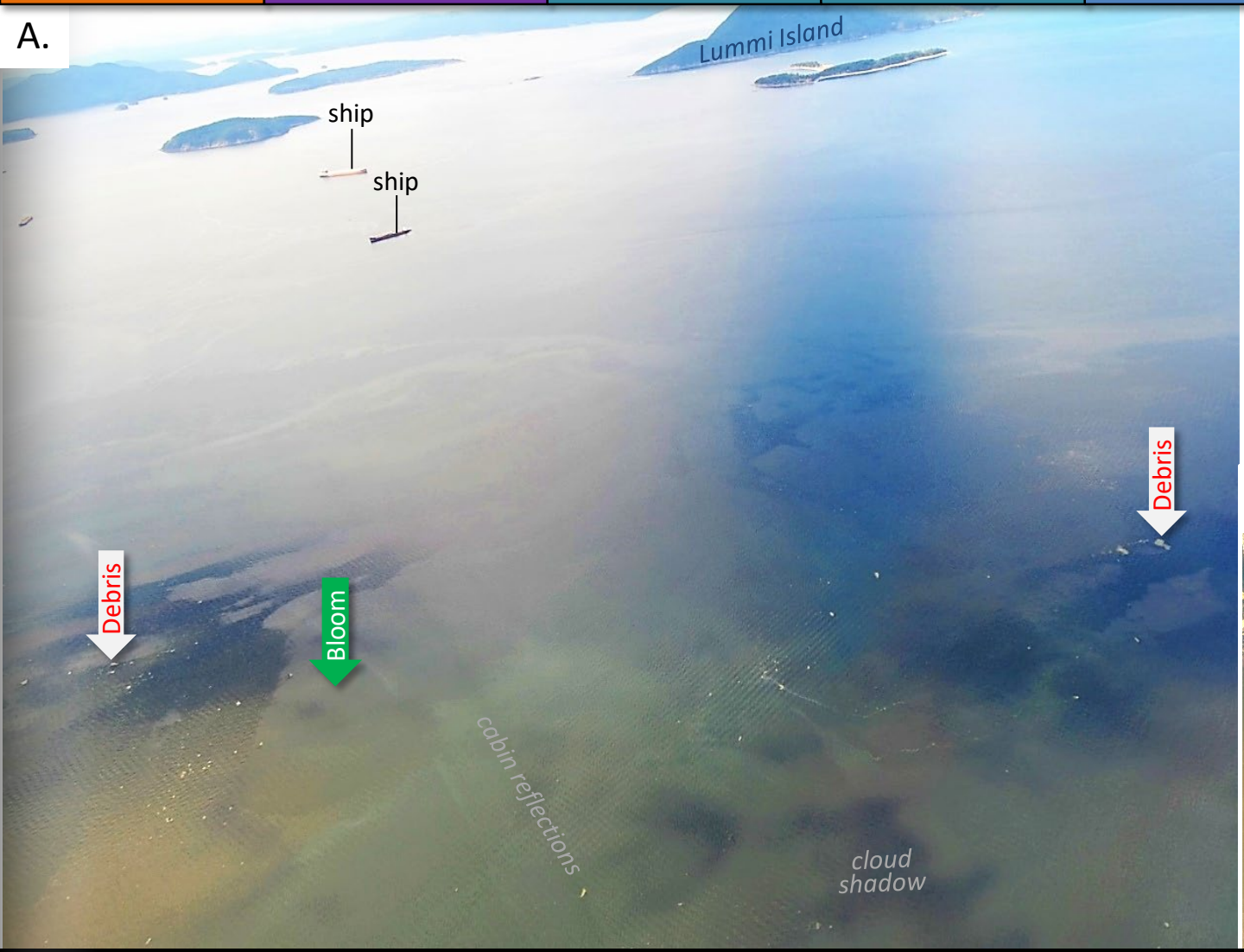
seagrass

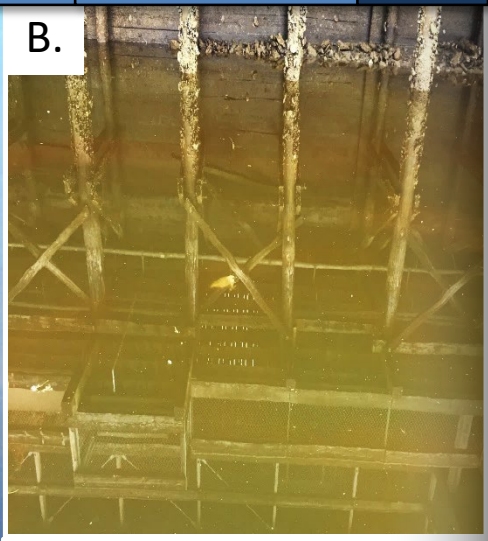
Padilla Bay seagrass experiences much cooler temperatures north of the tidal gully. Sediment from south of the gully discolors the water. Location: Padilla Bay (North Sound), 12:35 PM

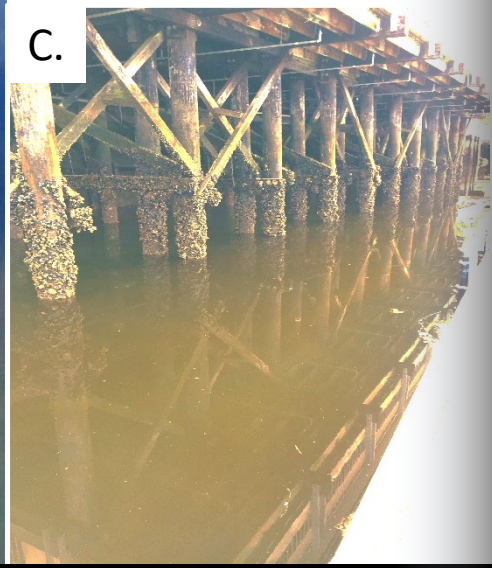
Aerial photography 9-8-2021

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

Aerial photography 9-8-2021



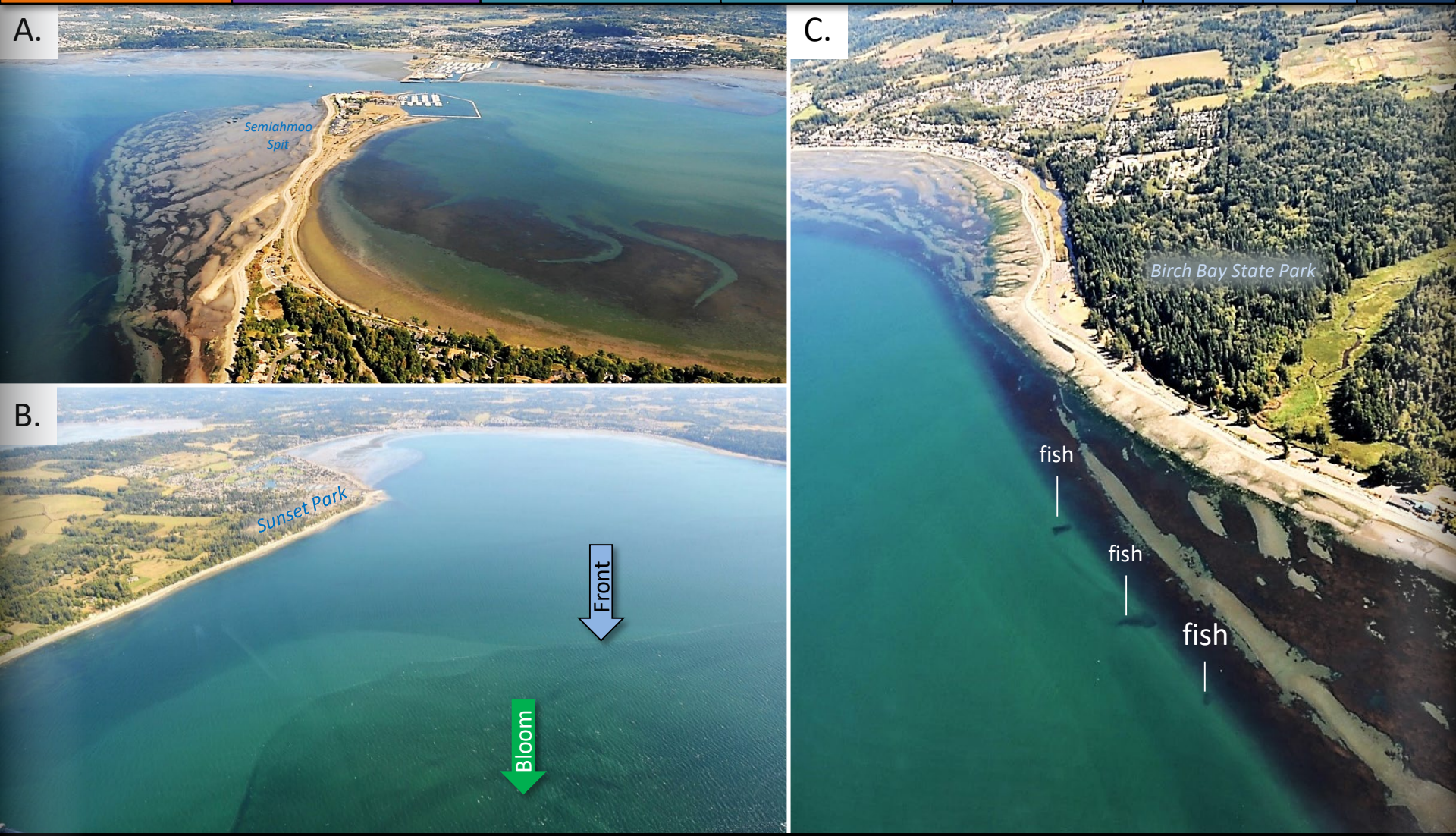




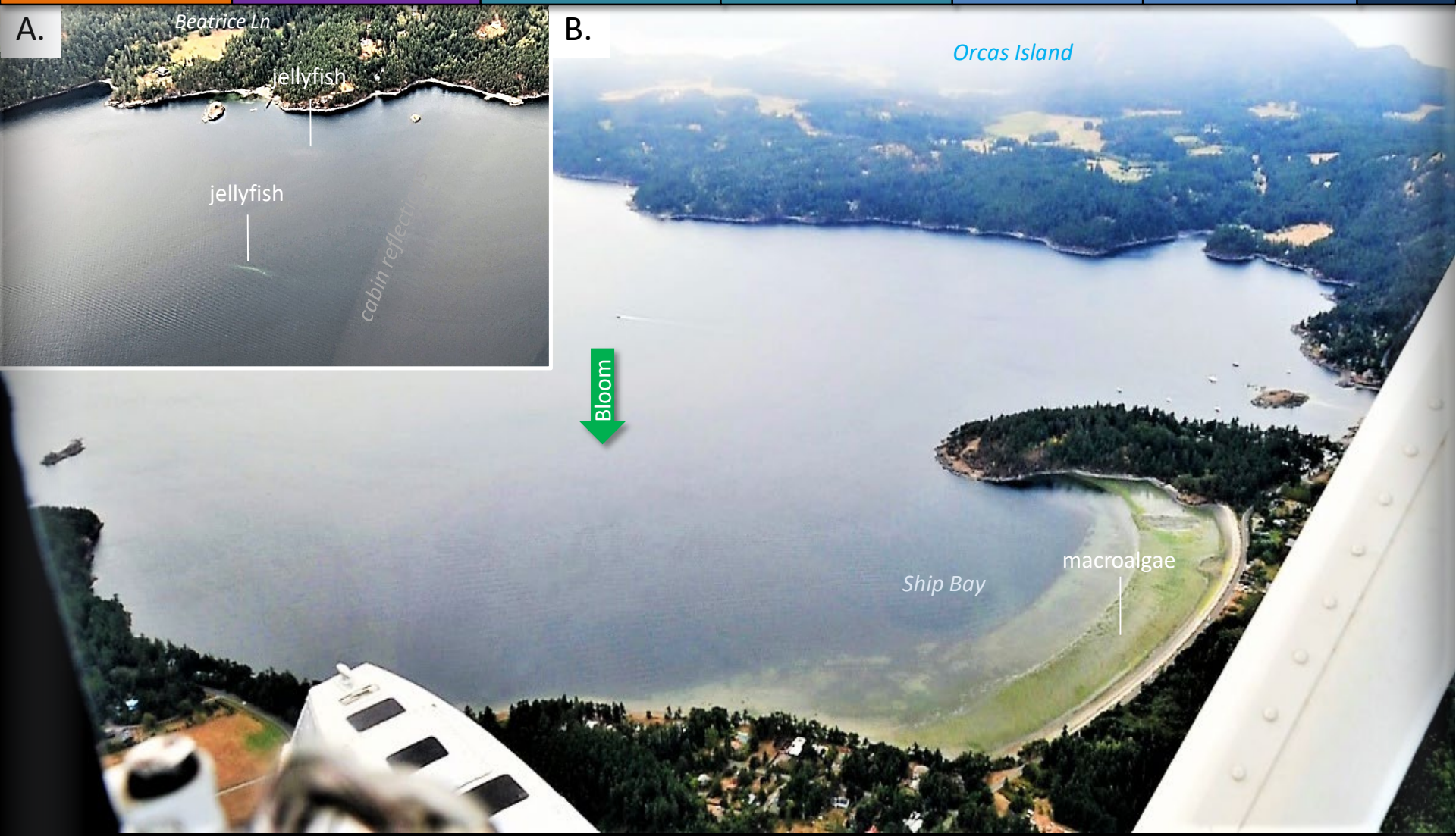
A. Strong red bloom and drifting organic material in Samish Bay. B-C. Red-brown bloom in Squalicum Harbor.
Location: A. Samish Bay, B-C. Bellingham Bay (North Sound), 12:40 PM

Aerial photography 9-8-2021

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



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

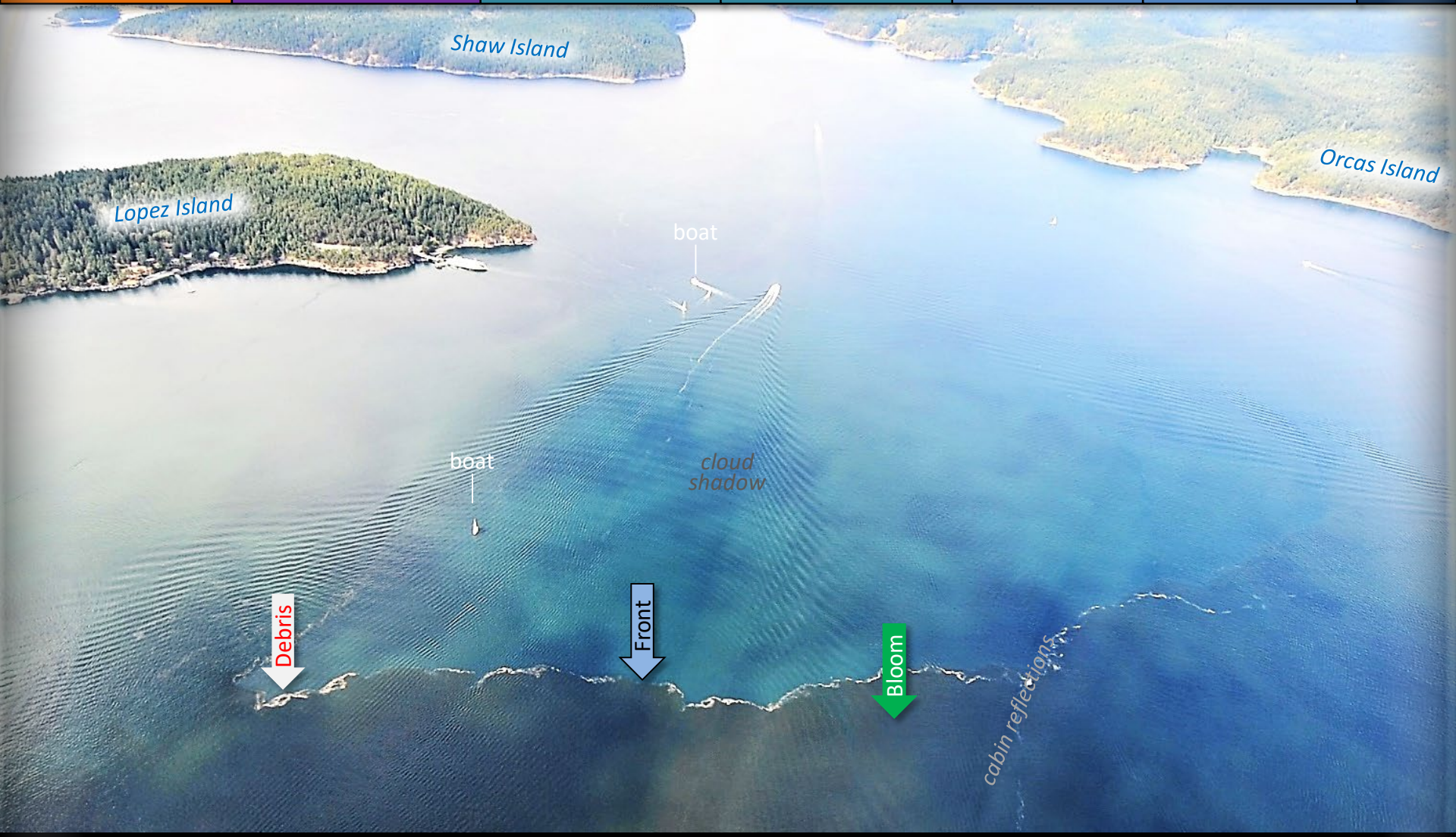


A. Patches of jellyfish, red-brown bloom (low visibility due to rain) and B. macroalgae on beach in Ship Bay.
Location: East Sound, Orcas Island (North Sound), 1:07 PM

Aerial photography 9-8-2021

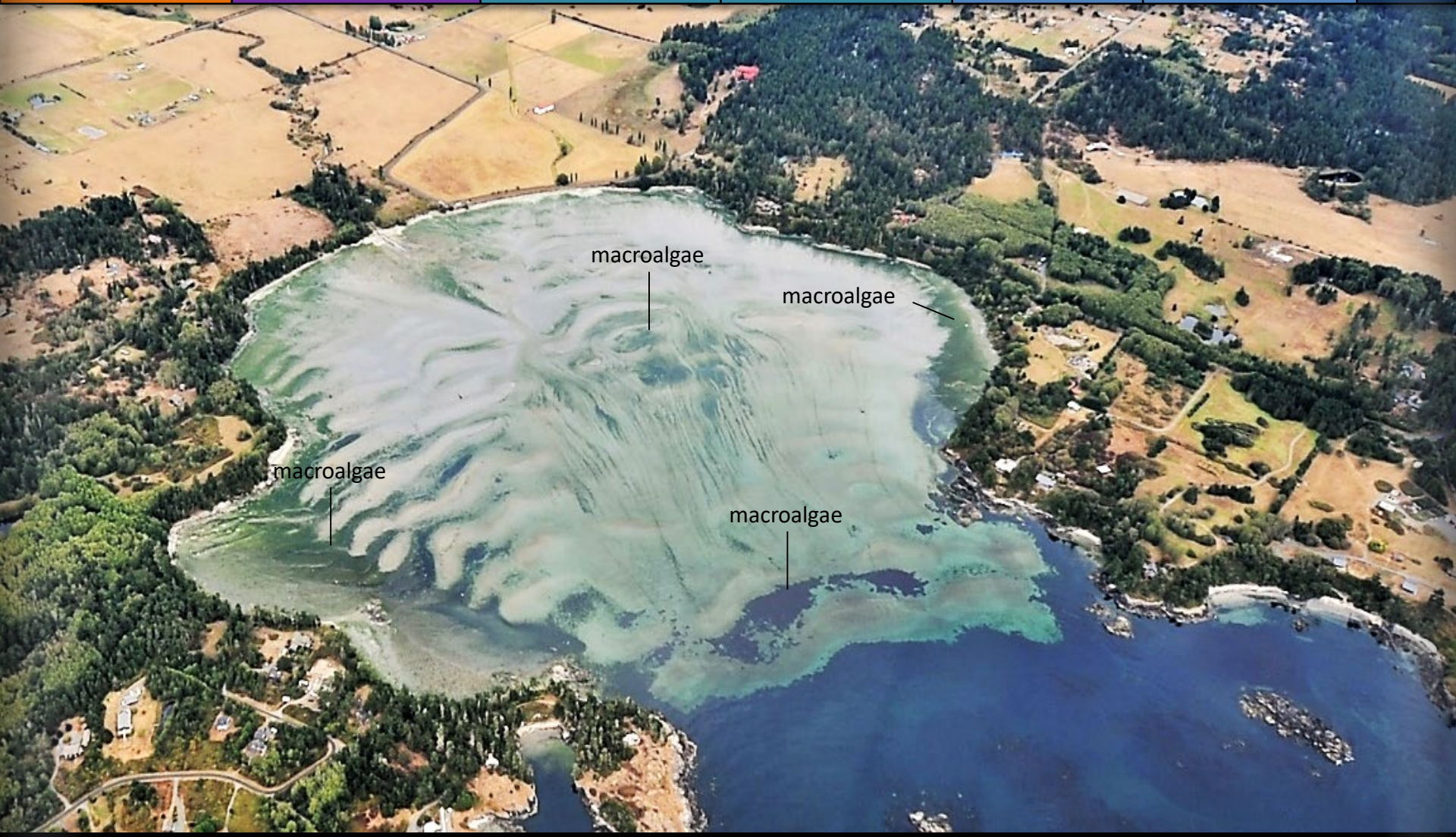
Red-brown algae bloom from East Sound mixing with clearer water entering via Obstruction Pass.
Location: East Sound, Orcas Island (North Sound), 1:12PM

Aerial photography 9-8-2021



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

Aerial photography 9-8-2021



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

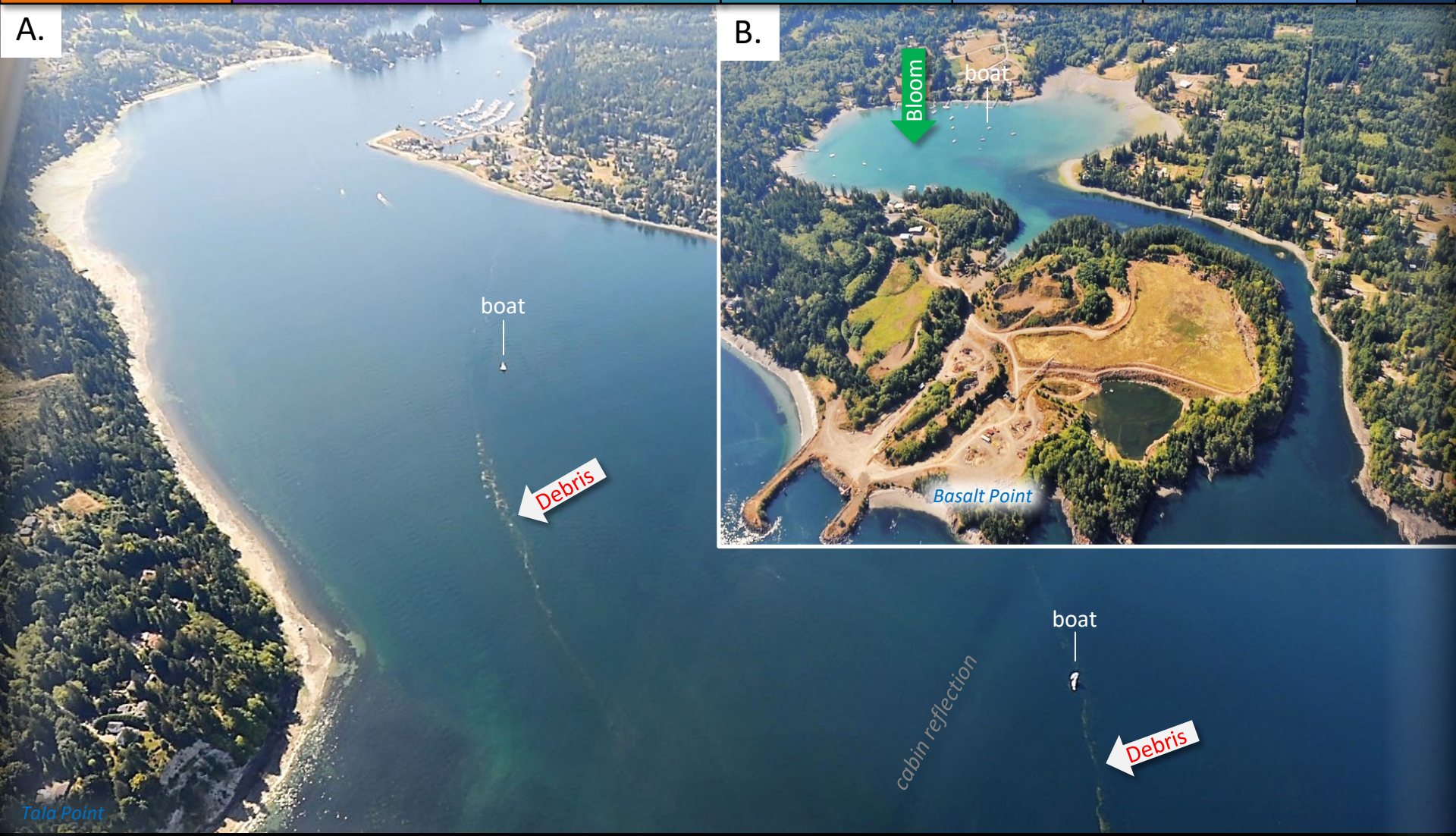
Aerial photography 9-8-2021

Bloom, tidal front, organic material, and suspended sediment near western shoreline.
Location: Sequim Bay (North Sound), 1:40 PM

Aerial photography 9-8-2021

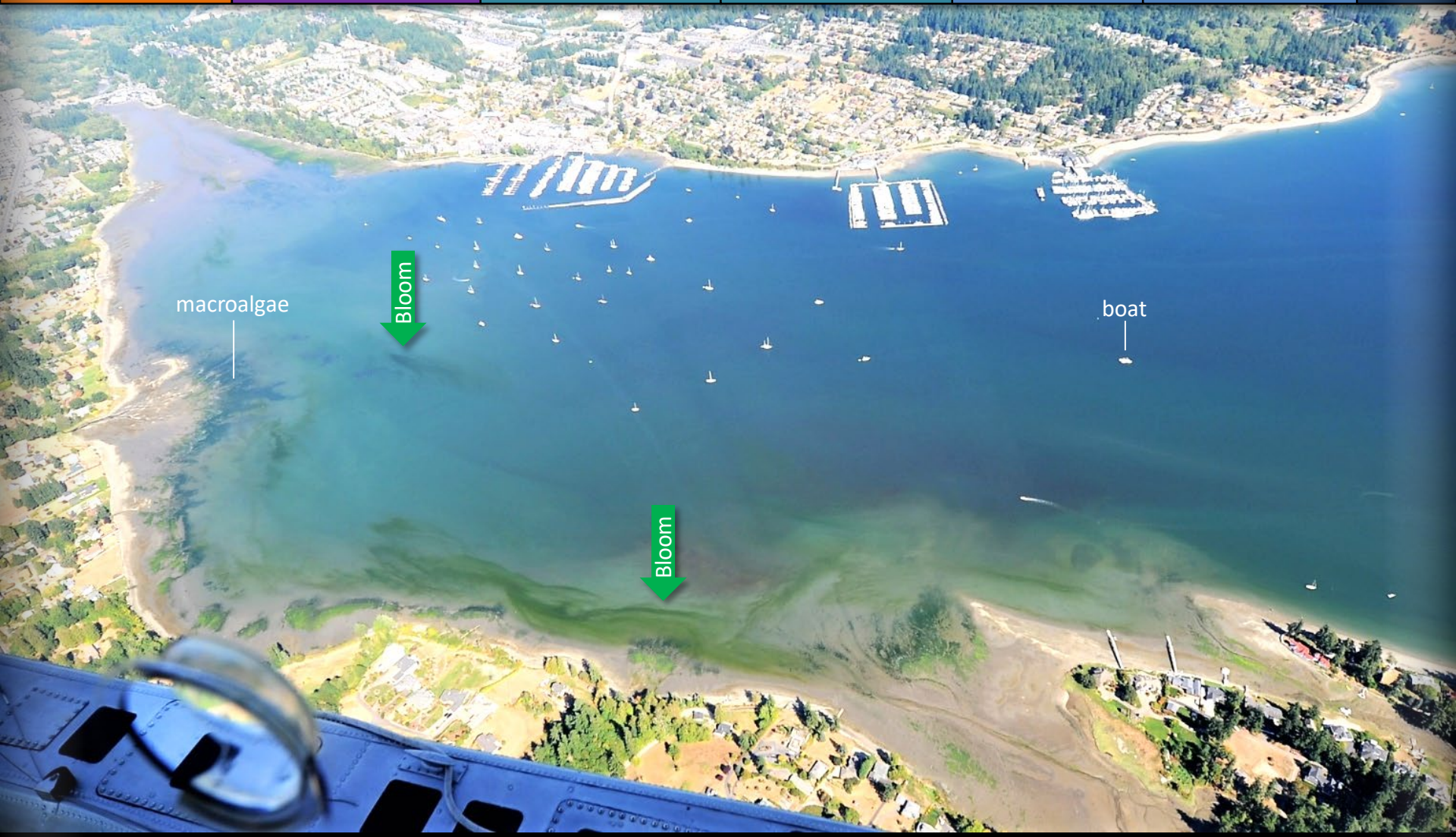
Very red-brown bloom spanning the entire length of Kilisut Harbor, from the entrance of the bay to Scow Bay.
Location: Marrowstone Island (Central Sound), 1:50 PM

Aerial photography 9-8-2021



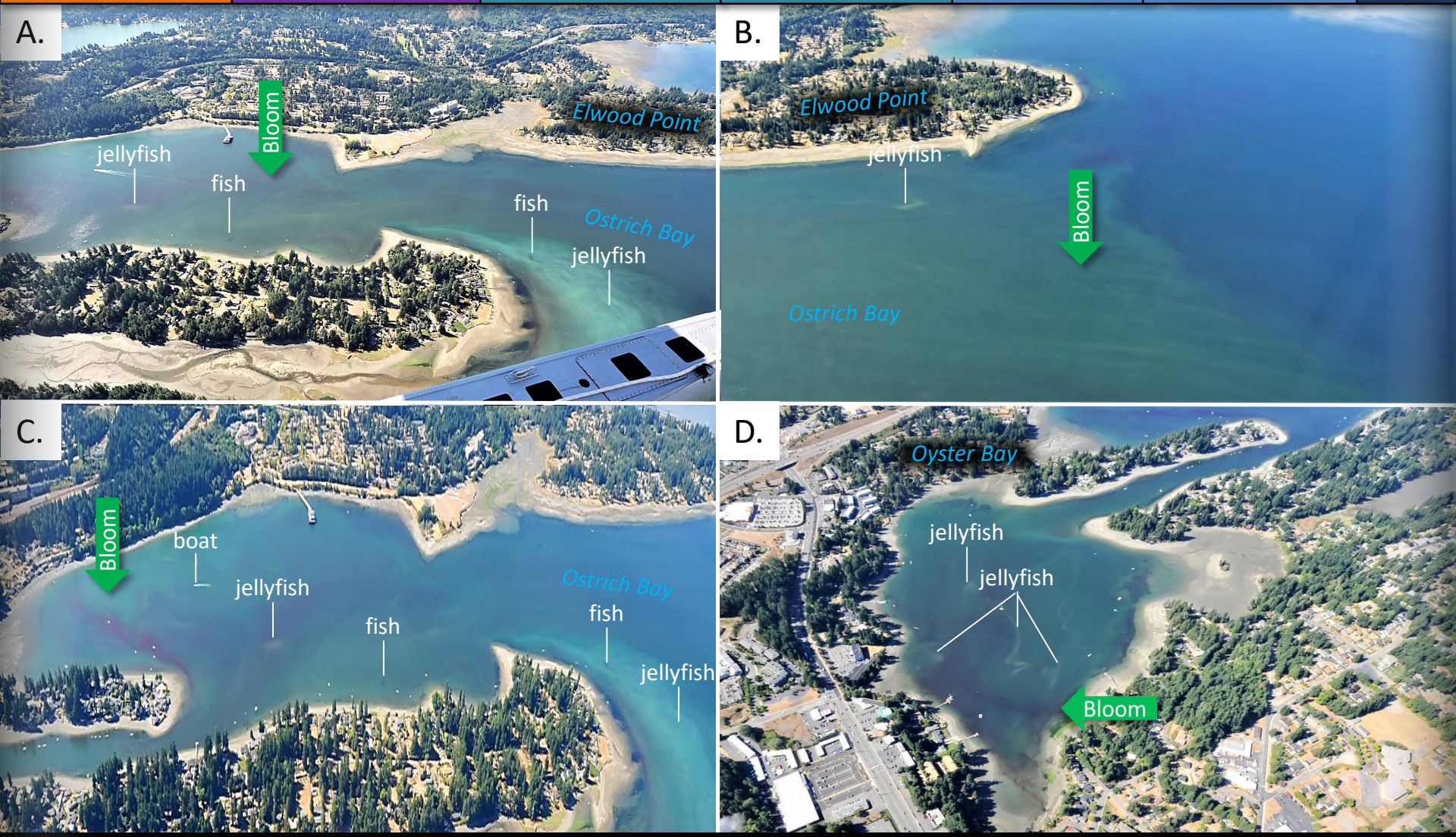
A. Long ribbons of organic material drifting at surface. B. Turquoise-colored water in Mats Mats Bay.
Location: A. Port Ludlow, B. Mats Mats Bay (Central Sound), 1:54 PM

Aerial photography 9-8-2021



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

Aerial photography 9-8-2021



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

Aerial photography 9-8-2021

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

Aerial photography 9-8-2021

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

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

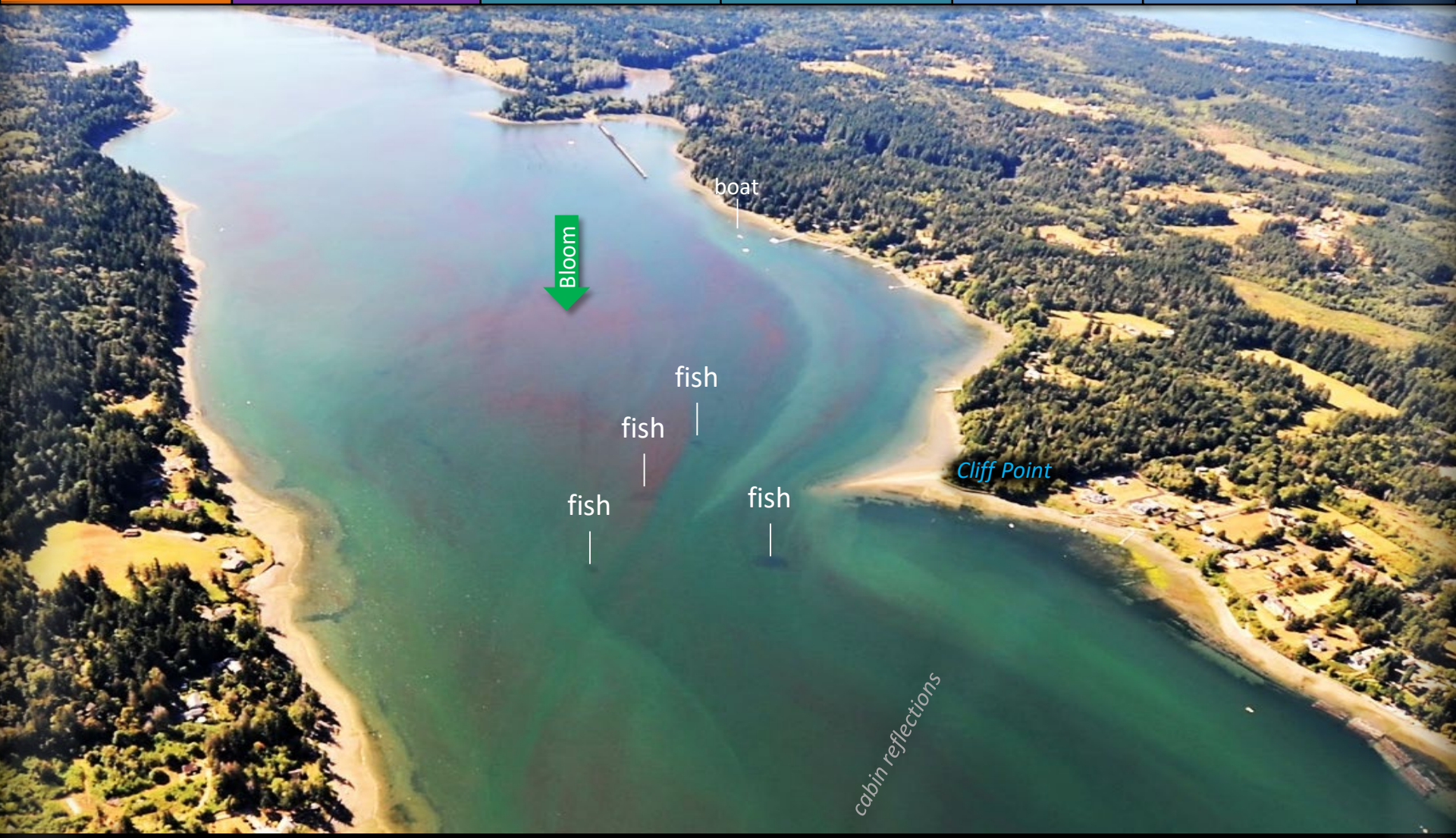
A. Red-brown and red bloom. B. It matters on which side of the bridge one takes a plankton sample!

Location: Case Inlet (South Sound), 2:22 PM

Aerial photography 9-8-2021

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

Aerial photography 9-8-2021



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

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.

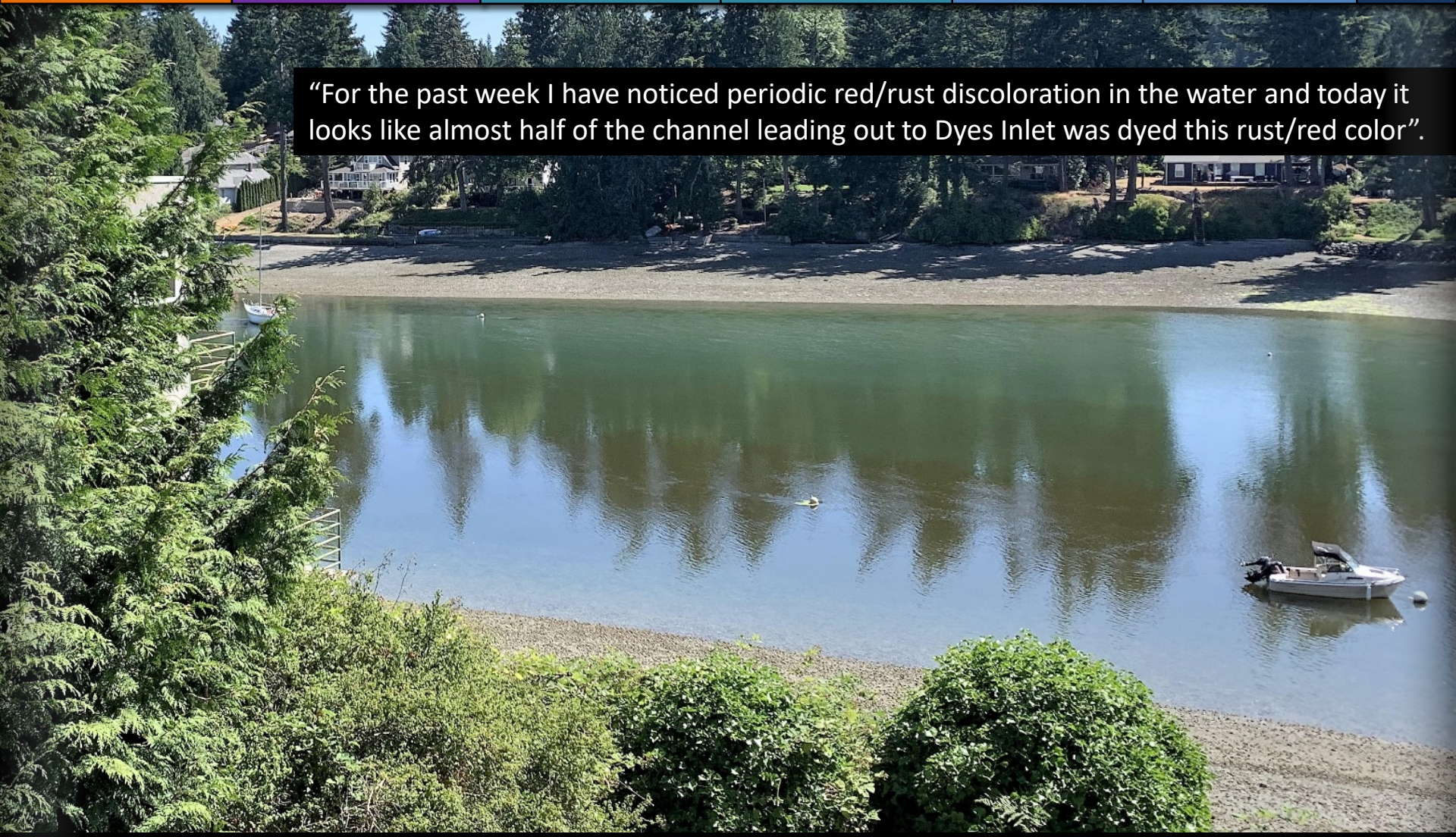
Mya Keyzers, 7/14/2021, East Sound, Orcas Island

People contribute their observations

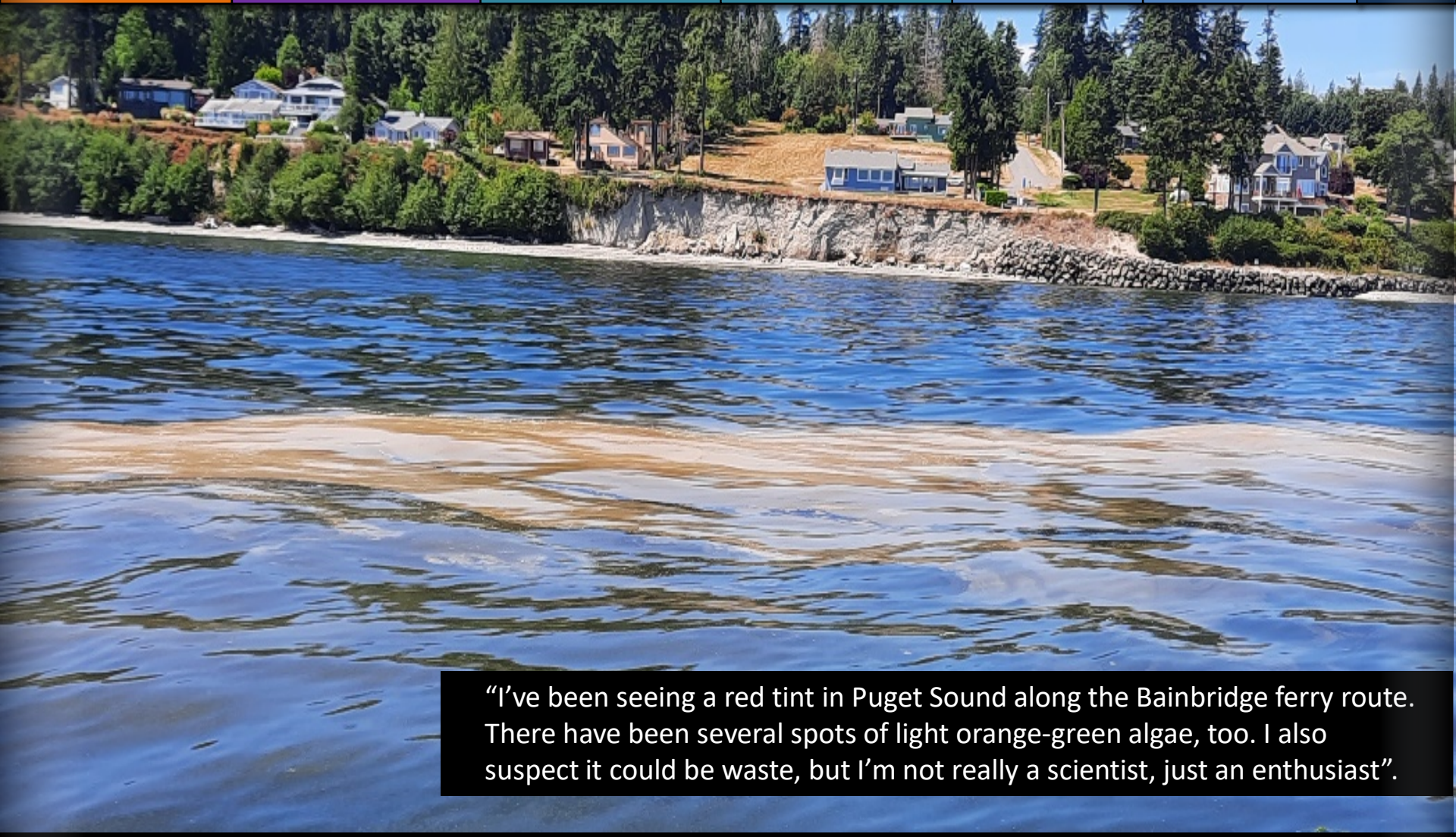
"On July 20, 2021, I visited the Bay Club in Port Ludlow to investigate a citizen complaint (COM2021-00112, ERTS#708105) regarding water quality concerns in Port Ludlow Bay. I observed brown water, floating algae, and a strong dead fish and shellfish odor".

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

People contribute their observations



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



"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".

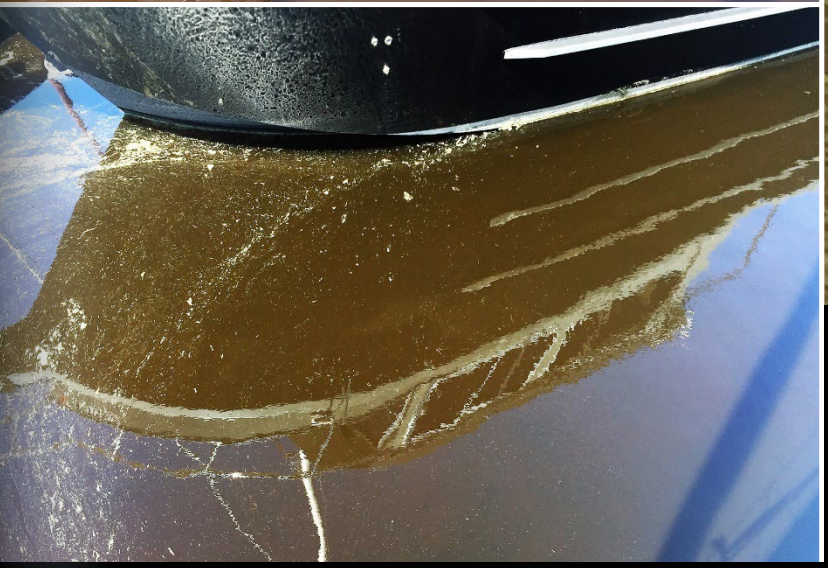
Eryn Craig, 8/9/2021, Bainbridge ferry route

People contribute their observations

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

“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



"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

People contribute their observations

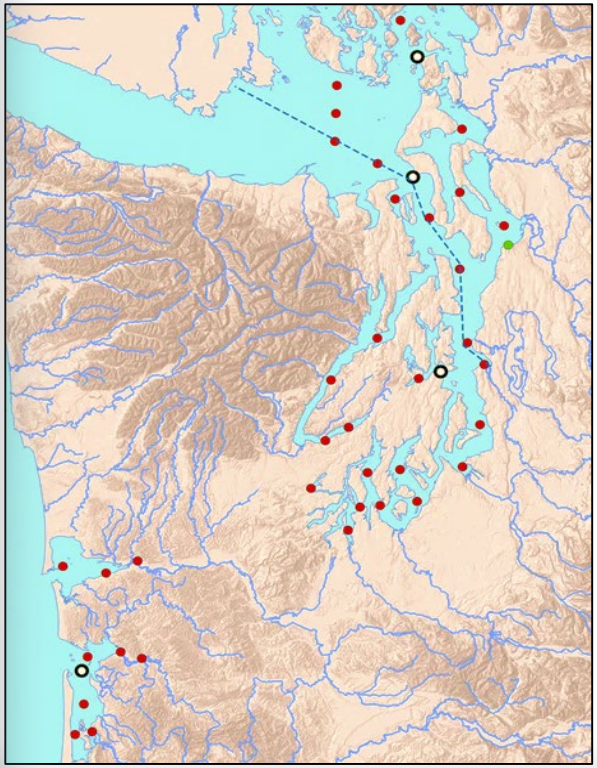
Aerial picture,
Mike McKay

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

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

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

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

Find past editions of EOPS on the next pages

We have published 94 editions!

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

Recommended Citation (example for September 2018 edition):

Washington State Department of Ecology. 2018. Eyes Over Puget Sound: Surface Conditions Report, September 17, 2018. Publication No. 18-03-075. Olympia, WA. https://fortress.wa.gov/ecy/publications/documents/1803075.pdf.

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Environmental Assessment Program
Washington State
Department of Ecology

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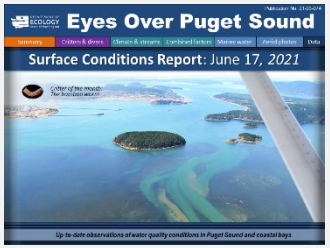
September_8_2021
Publication No. 21-03-075



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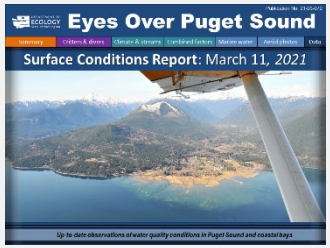

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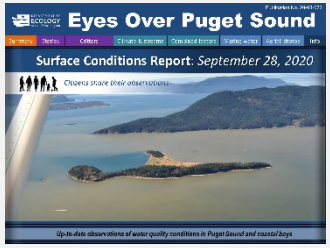

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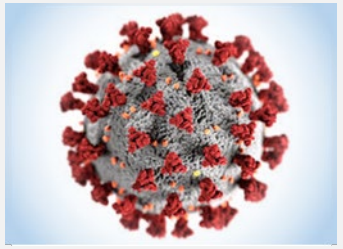

No coverage due to COVID-19 pandemic from April-September

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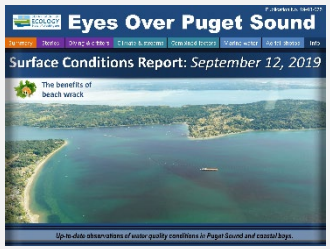

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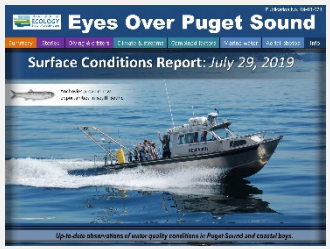

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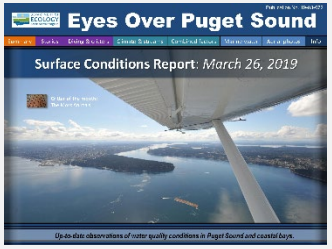

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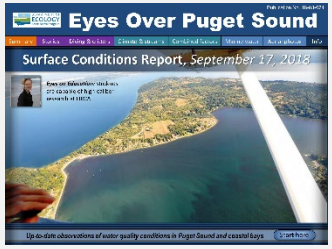

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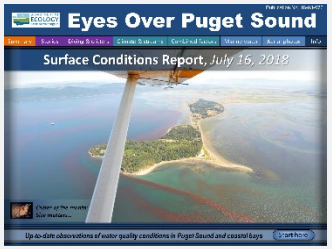

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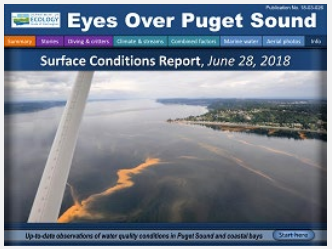

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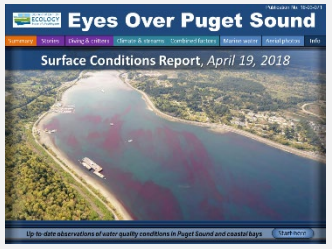

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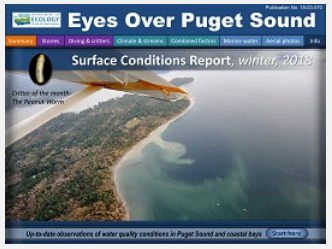

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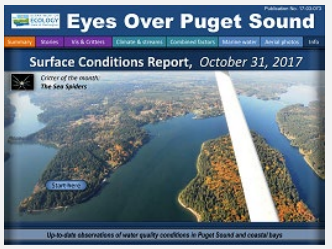

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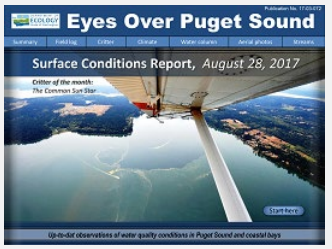

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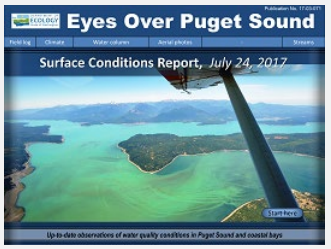

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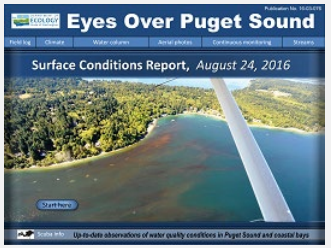

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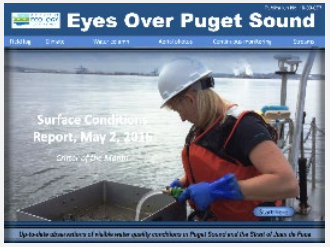

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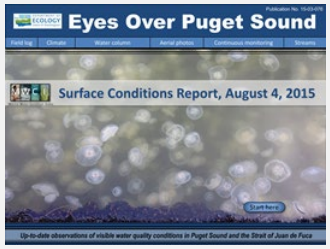

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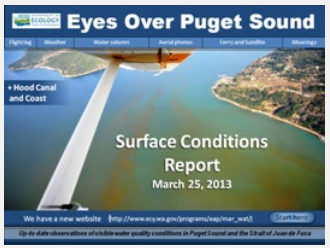

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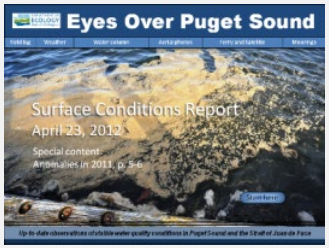

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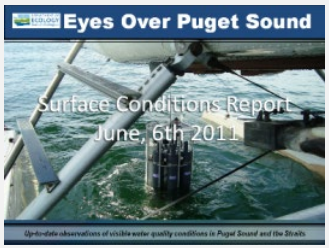

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