Publication No. 18-03-073

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report, *July 16, 2018*

Critter of the month:
Size matters…

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

Start here

LONG-TERM MARINE MONITORING UNIT

Juhi LaFuente

Skip Albertson

Tyler Burks
Jim Shedd

Dr. Christopher Krembs (Editor)

Personal stories

p. 3

Our Washington Conservation Corps Intern shares her many perspectives on Puget Sound.

Climate & Streams

p. 6

River flows have generally been declining, with stream gages reporting at normal or below normal levels. Precipitation levels are also below normal with abundant sunshine and warm temperatures.

Testing an infrared camera

p. 10

We've documented surface water temperatures above 15 °C from uncorrected infrared camera images. These warmer waters increase the risk of harmful algal blooms if toxin-producing species are present. Contact us if you would like to see these thermal images continued.

Aerial photography

p. 15

Extensive red-brown blooms in Bellingham and Samish Bays, as well as in East Sound, Marrowstone Island, Liberty Bay, and finger inlets in South Sound. Large rafts of macroalgae in South Sound and Central Sound, particularly in Carr Inlet, Commencement Bay, and Port Madison.

Editorial assistance provided by: Suzan Pool, Allison Brownlee, and Carol Maloy

The many perspectives of Puget Sound

Juhi LaFuente – Washington Conservation Corps Intern

Winter vs. Summer

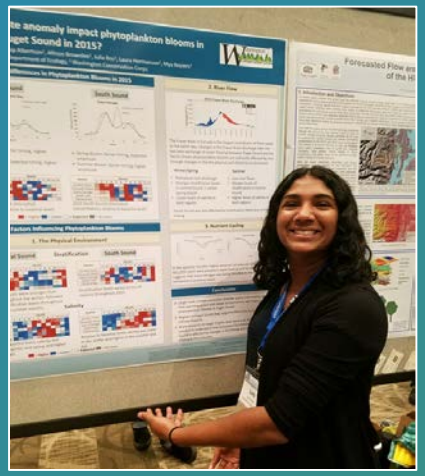
Regardless of the weather, it's always a great day when I'm out in the field! Measuring water quality from boats and planes has helped me put into perspective just how many miles of coastline there are in Puget Sound.

An aerial view of a familiar place

In addition to flying over my hometown of Port Townsend for EOPS, I also sampled there with our sediment monitoring team.

I have learned so much and have thoroughly enjoyed my WCC experience while creating new memories in familiar places throughout Puget Sound.

Putting the pieces together



Learning about a variety of topics at the 2018 Salish Sea Ecosystem Conference helped me to gain a better understanding of the Salish Sea as a whole.

To read my contribution to the conference, click here

What was the visibility in the water for divers?

June

Best and worst horizontal visibility and corresponding depth (ft)

#	Best (depth)	Worst (depth)
1	19 (98)	16 (10)
2	13 (23)	2 (7)
3	17 (98)	14 (23)
4	37 (98)	5 (23)
5	16 (98)	8 (7)
6	36 (98)	5 (23)
7	26 (59)	2 (2)
8	13 (26)	4 (3)
9	22 (89)	6 (7)
10	28 (57)	4 (34)
11	27 (98)	3 (5)
12	6 (7)	6 (34)
13	24 (98)	14 (3)
14	21 (80)	9 (8)
15	15 (94)	11 (3)
16	20 (30)	5 (13)

Find depths with high/low visibility

- **Best visibility** occurred deep in Saratoga Passage (stations 4 and 6), in about the same location as last month.
- **Poor visibility** occurred in Oakland Bay (near Shelton) and in Bellingham Bay.
- We use transmissometer readings from our CTD package and convert them into horizontal visibility. The poster, Underwater Visibility Maps – a Tool for Scuba Divers, is available at, click here.

This is a new feature and we are soliciting feedback (skip.albertson@ecy.wa.gov).

Size Matters – Biomass and Size Classification

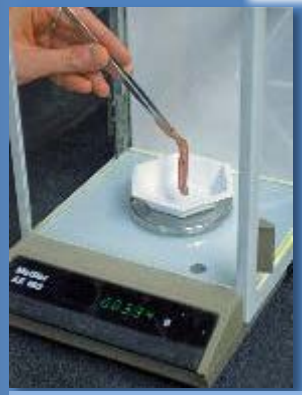
Listen to Eyes Under Puget Sound…

Dany Burgess & Angela Eagleston
Marine Sediment Monitoring Team

New Baseline Biomass Data

To examine links between environmental stressors and benthic organisms, we added biomass and size classification to our monitoring program - a first for a large scale, long-term Puget Sound study.

Find out more about this new project, including preliminary results, in our latest blog and recent poster publication.



To date, we've weighed and measured almost 7,000 individual critters!

Adult *Scalibregma*, a polychaete in Bellingham Bay, varies dramatically in size.

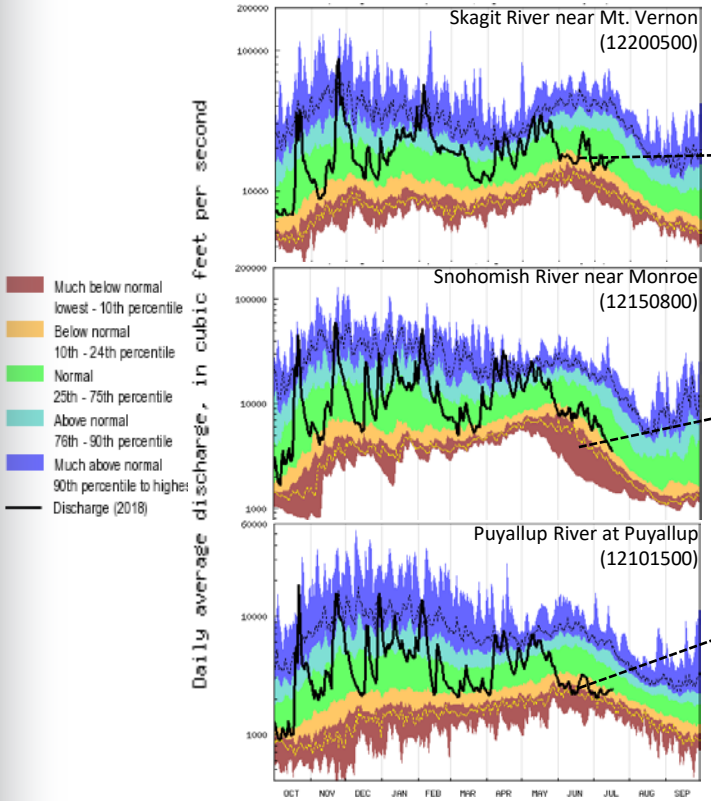
Some individuals in the "**x-large**" size class were larger than the literature range for the species. Is this just natural variability? Or, could organic enrichment or other habitat characteristics be responsible for the extra large size?

How much water flows into coastal marine waters?

Tyler Burks, Jim Shedd

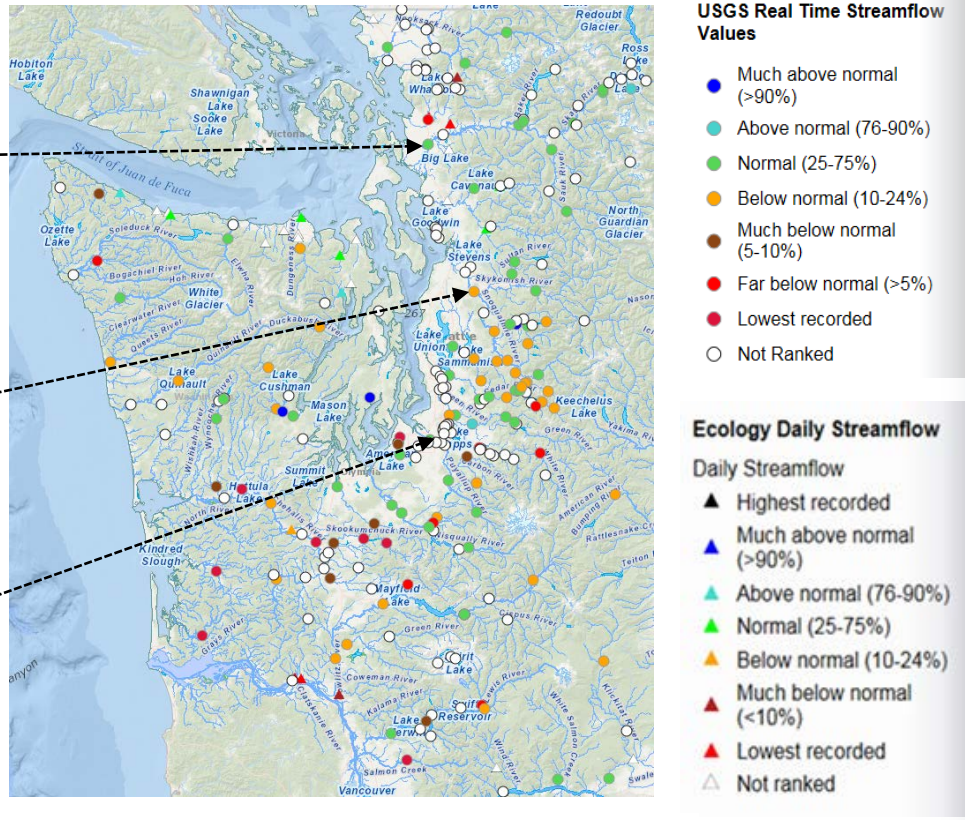
Air temperatures have been above normal, while precipitation has been well below normal, so far in July. These conditions, coupled with minimal snowmelt runoff, have resulted in generally less than normal freshwater inputs to Puget Sound. Nearly all stream gages are reporting normal or below-normal flows (map, right). Most flows reporting as normal are below the 50th percentile, especially in south Puget Sound (charts, left).

Select Puget Sound Streamflow Trends



USGS WaterWatch: Click here

Current Streamflow Conditions as of 7/18/2018

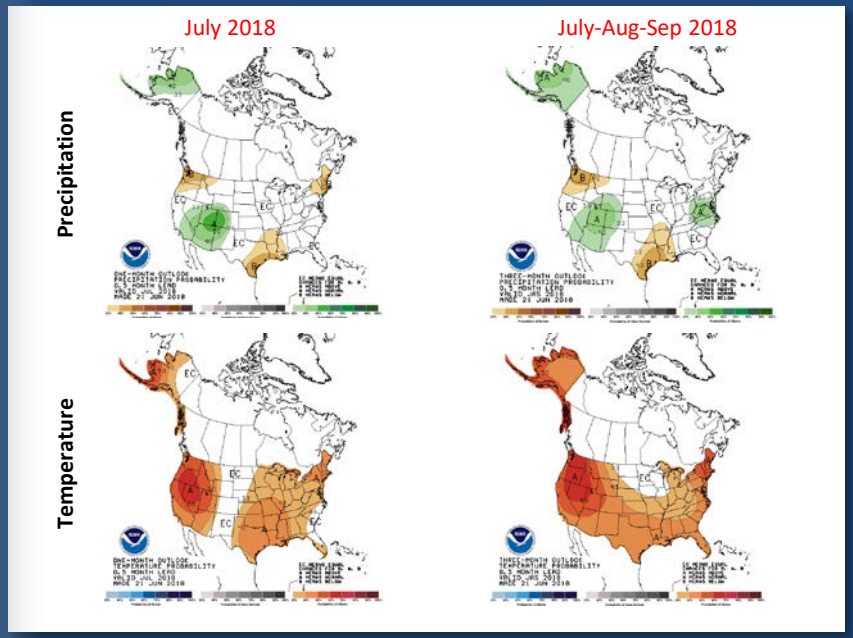


Current conditions: Click here

How much water flows into coastal marine waters?

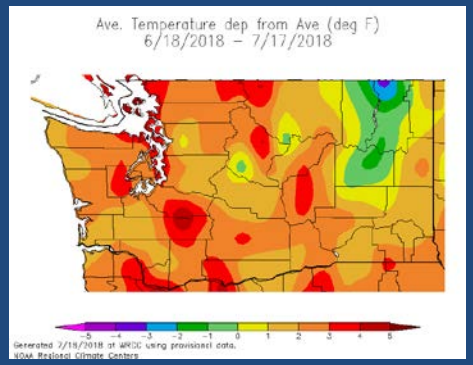
Climatologists predicted drier and warmer conditions this summer. The maps below show the temperature and precipitation predictions for the Pacific Northwest. They also show what we experienced from the start of summer through mid-July. So far, climatologists' predictions have proven true.

Climate Prediction Center, NOAA

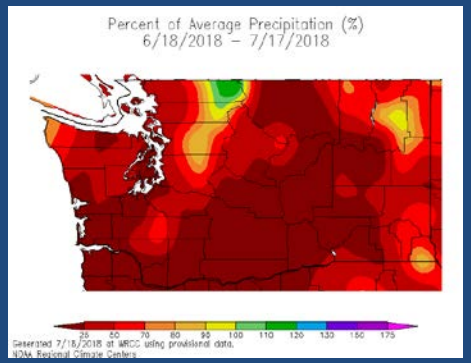


The maps on the top show higher probability of below normal precipitation in the NW. The maps on the bottom show a higher probability of higher temperatures in the NW, click here.

Western Regional Climate Center



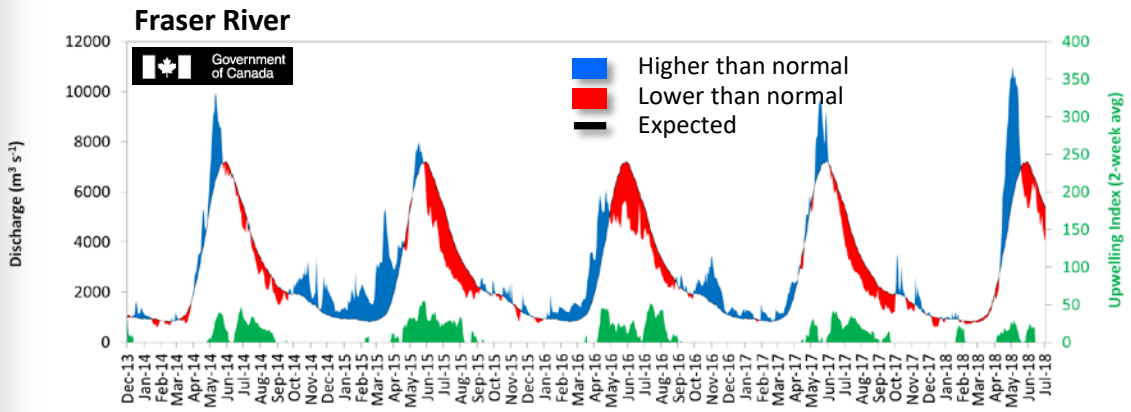
Average temperatures range from 2 to 4 °F higher than normal so far this summer in the Puget Sound Basin.



Precipitation ranges from less than 25% to about 70% of normal so far this summer in the Puget Sound Basin.

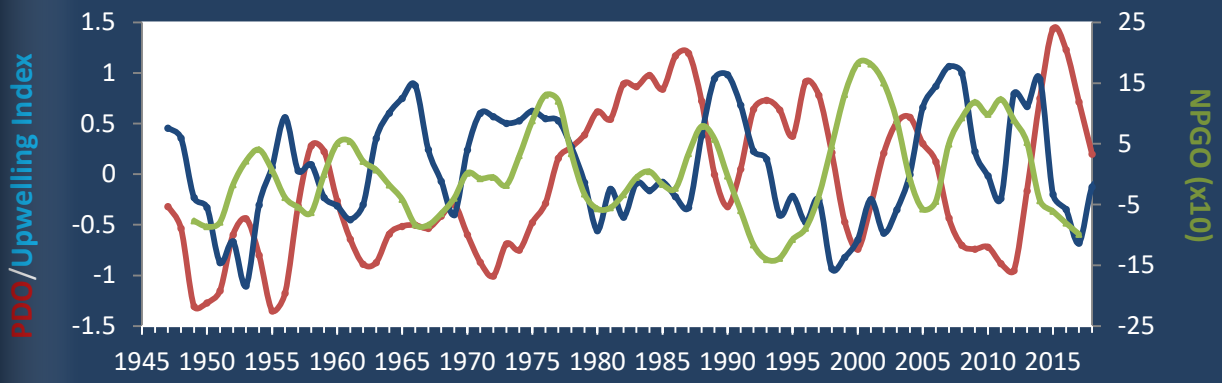
Climate influences: How well is Puget Sound exchanging its water?

Historically, peaks of coastal upwelling and the freshet are in sync. This year the freshet is early and strong?



The Fraser River is the major driver of estuarine circulation and water exchange with the ocean.
Fraser River flows have rapidly fallen and the snowpack in BC is below normal (Basin Snow Water Index).

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



How do ocean boundary conditions affect the quality of water we exchange with the ocean?
Past years' warm water is gone (PDO), upwelling is neutral (Upwelling Index anomaly), and surface productivity along the coast is lower (NPGO).

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

What's the story of influences affecting water quality?

Climate and natural influences include weather, river flows, and the adjacent ocean conditions that affect our marine waters. This graphic provides context for interpreting Puget Sound marine conditions. All data are from public sources: weather from UW GRAYSKIES; river flows from USGS and Environment Canada; indices from NOAA, UW (PDO), and E. Di Lorenzo (NPGO).

June Summary:

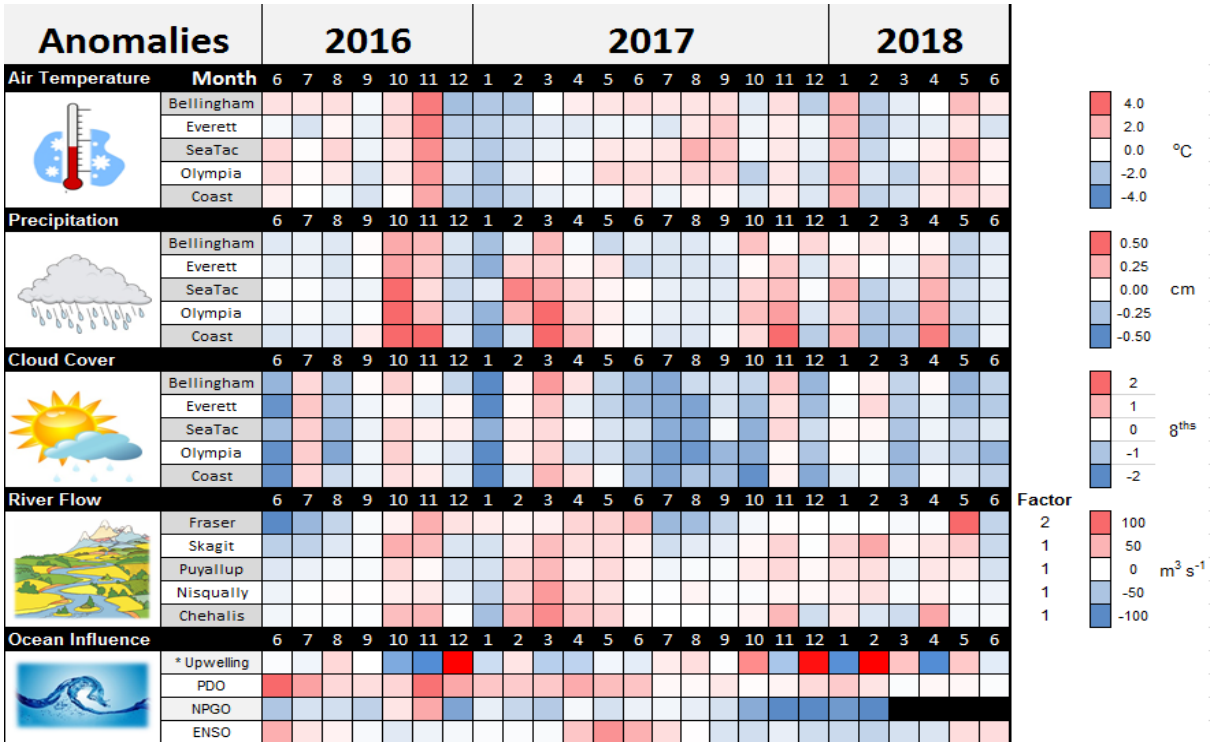
Air temperatures have generally been above normal since May.

Precipitation levels have been below normal since May.

Sunshine levels have been above normal (low cloud cover).

River flows have been much lower in June than in May, and this below-normal condition increases to the north.

Upwelling has been near normal, but lower than in May. ENSO is slightly positive, indicating the end of La Niña.



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

higher — expected — lower

No data

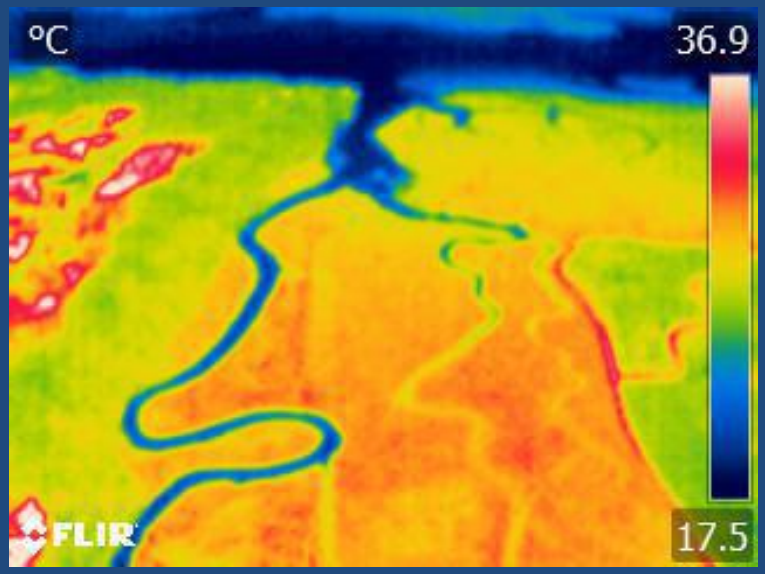
Did you know: Infrared (IR) images show what the eye can't see

Migrating juvenile fish face a complex thermal habitat in estuaries. Rivers provide a cool refuge on mudflats during sunny days.

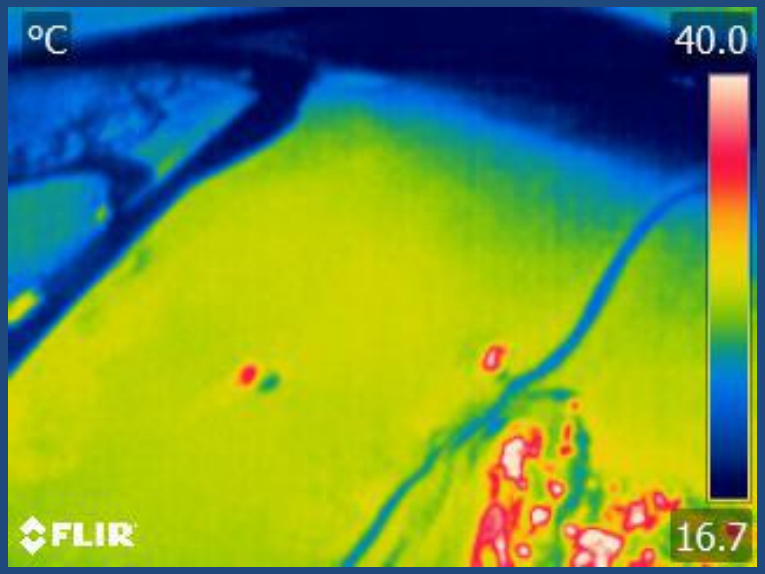
Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

The same picture with a regular camera does not reveal much of the thermal complexity and flows of cooler river water.

A. Nisqually River delta (South Sound)



B. Swinomish Channel (Whidbey Basin)



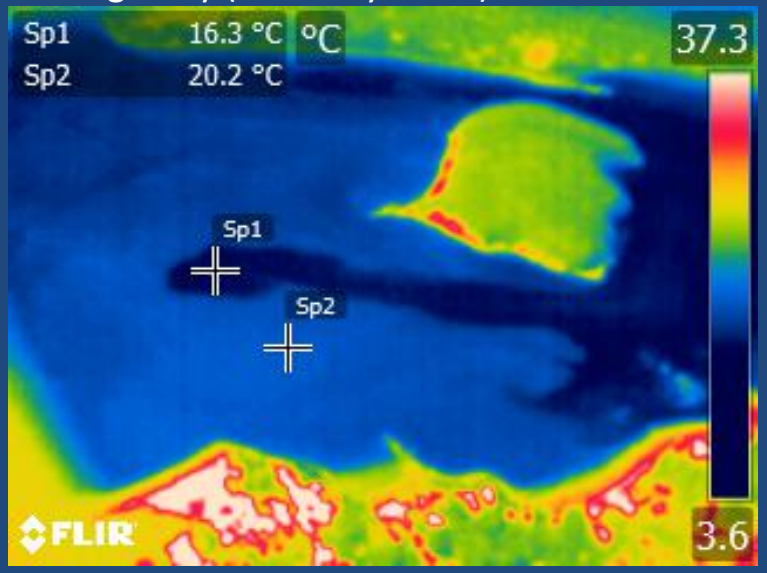
Infrared (IR) images show what the eye can't see

A. Marine surface waters can have very different temperatures, like this tidal eddy, 4 °C cooler than surrounding water.

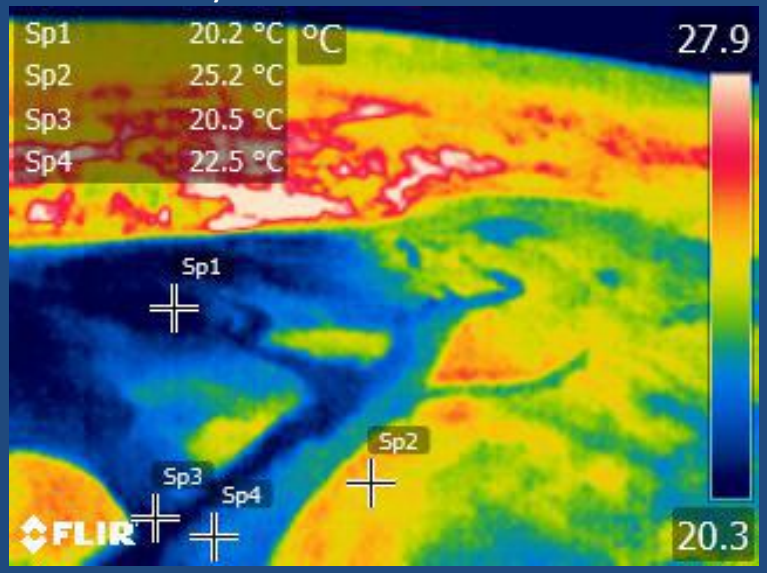
Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

B. Seagrass beds are important rearing areas for fish. During sunny days, freshwater seepage can keep some areas 5 °C cooler.

A. Skagit Bay (Whidbey Basin)



B. Padilla Bay



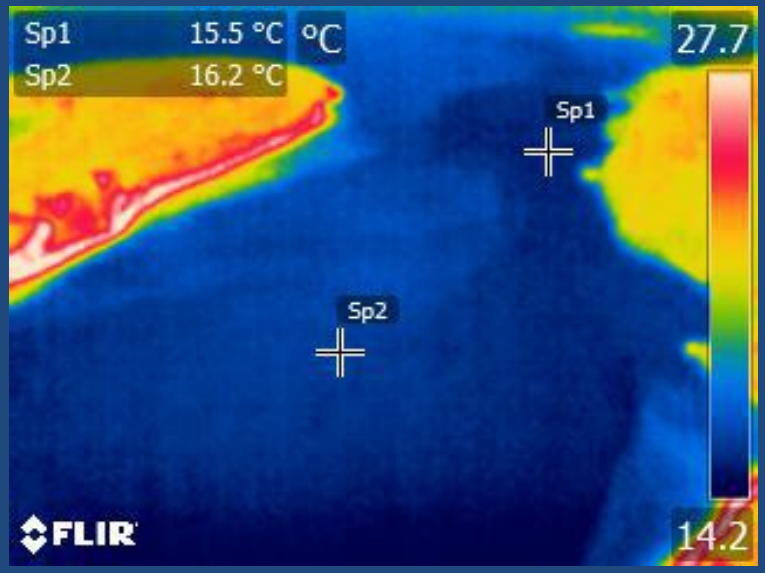
Warm water can increase harmful algal bloom toxicity

Often algae blooms in red-brown are associated with warmer water. Harmful algae blooms (HABs) can produce more toxins above 15 °C.

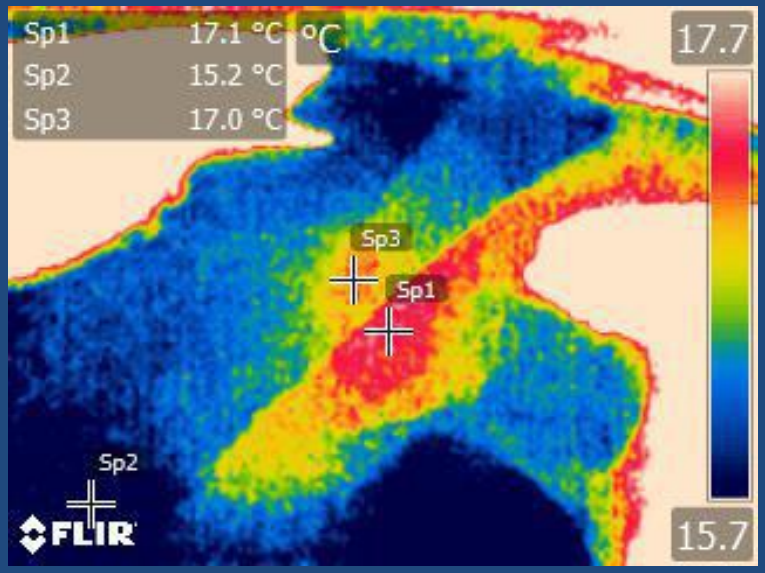
Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

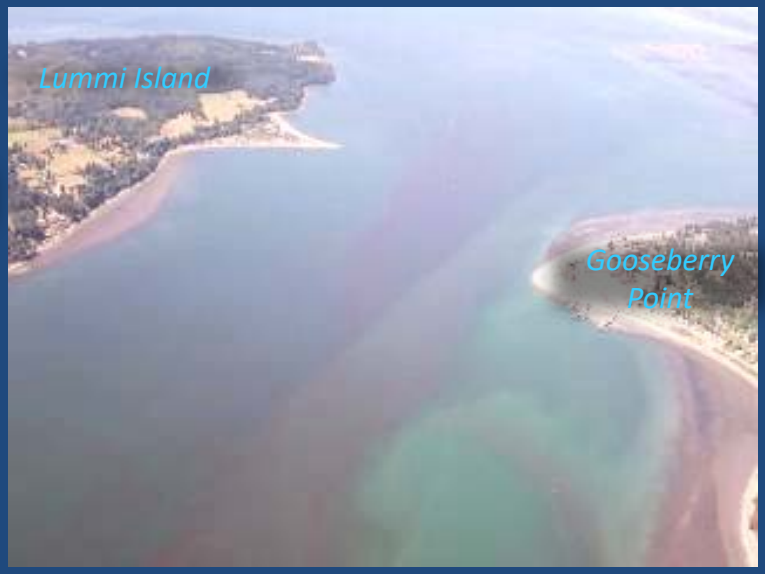
Infrared images reveal that the red-brown bloom is 1 to 2 °C above 15 °C.

A. Hale Passage, Lummi Island (looking south)



B. Hale Passage, Lummi Island (looking north)





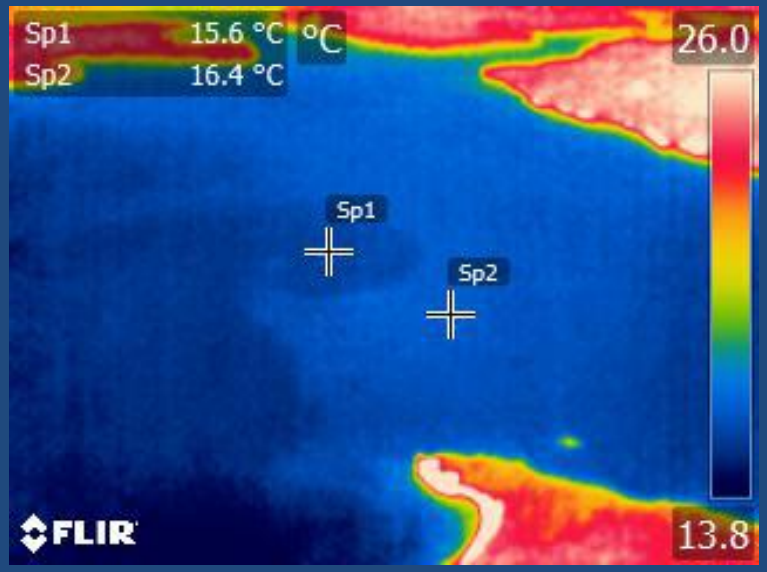
Warm water can increase harmful algal bloom toxicity

Examples of red-brown blooms associated with warmer water. HABs can produce more toxins at temperatures above 15 °C.

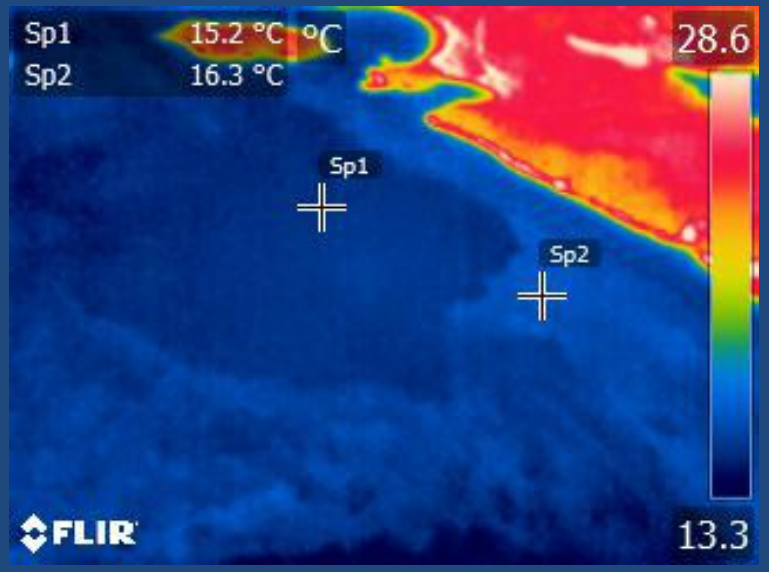
Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

Infrared images indicate that the red-brown bloom is above 15 °C. Combining IR with aerial photographs provides a useful tool to assess HABs.

A. East Sound, Obstruction Pass, Orcas Island



B. Shaw Island, Canoe Island (San Juan Islands)



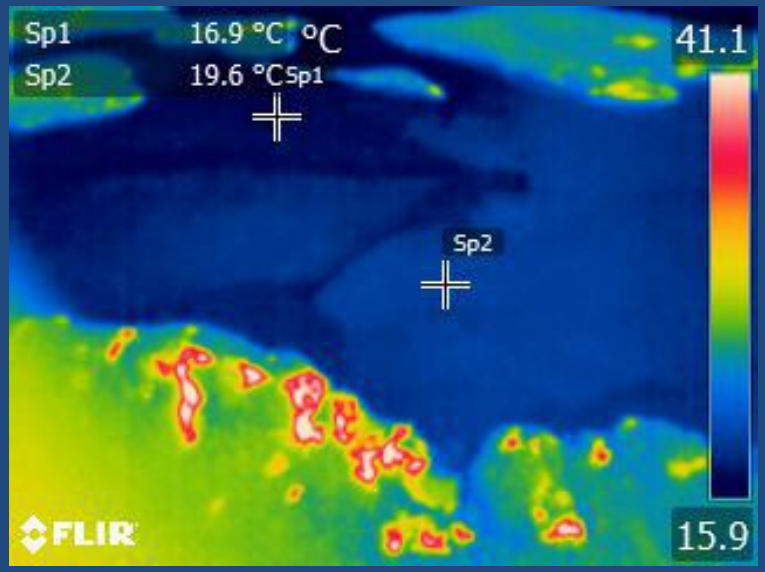
Vertical mixing at the surface can be seen on IR

A. Marine surface temperatures vary by several degrees around islands, a result of tidal advection and vertical mixing.

Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

B. Ships create vertical mixing in their wake, causing surface temperatures to vary by 5° C within only a few meters.

A. Lopez and Blakely Islands (San Juan Islands)



B. Commencement Bay (Central Sound)

What are conditions at the surface?

Extensive red-brown blooms in Bellingham and Samish Bays as well as in East Sound, Marrowstone Island, Liberty Bay, and finger inlets in South Sound. Infrared images indicate that blooms exceed water temperatures of 15 °C, increasing the risk of toxicity if the bloom is a HAB. Large rafts of macroalgae in South Sound and Central Sound, particularly in Carr Inlet, Commencement Bay, and Port Madison.

Start here

Nooksack River Delta

Macroalgae in Dyes Inlet

Front

Mixing and Fronts:
Tidal fronts visible in Dana Passage.

Jellyfish:
No jellyfish patches seen in South Sound, instead many schooling fish in Budd Inlet and Saratoga Passage.

Plume

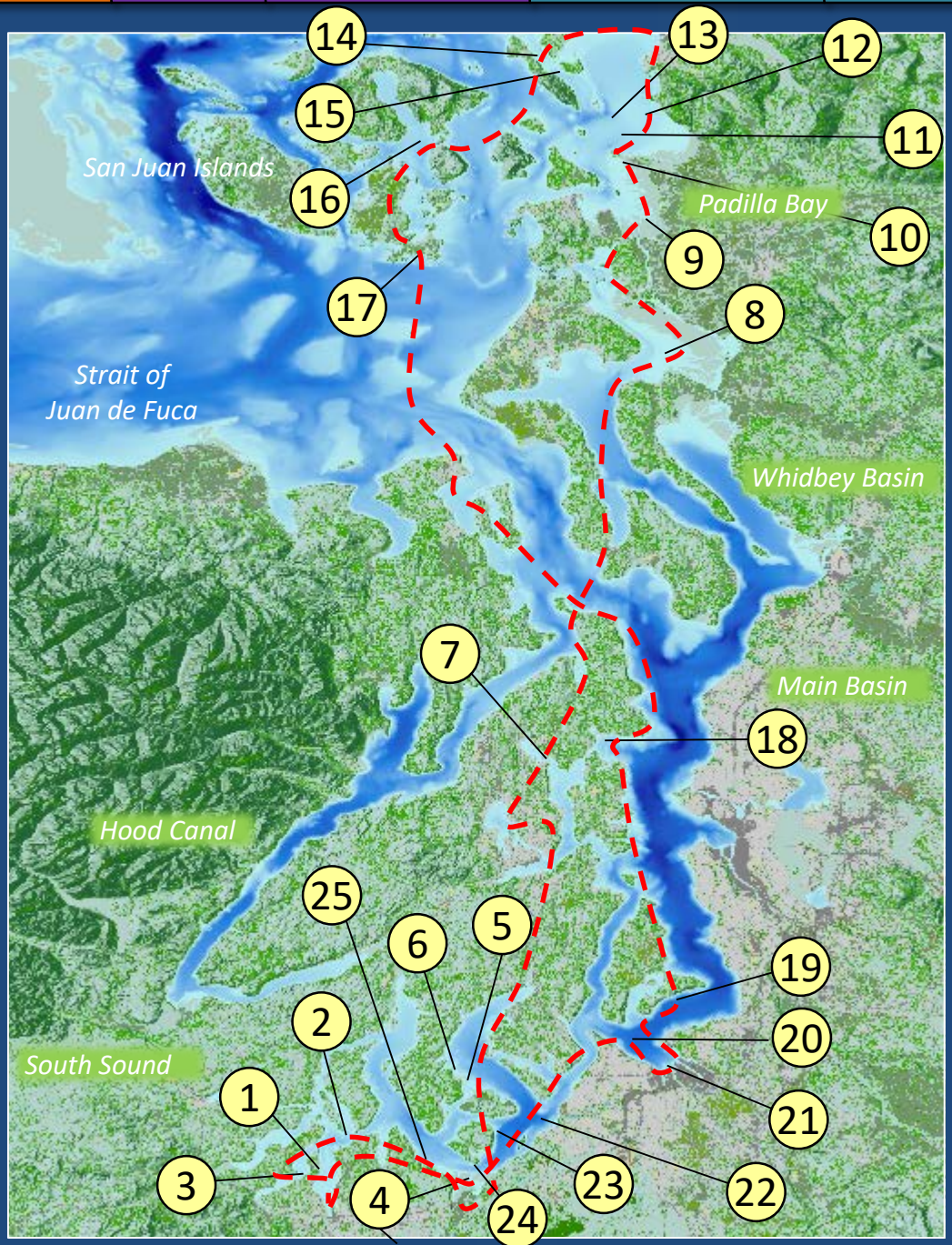
Suspended sediment:
Glacial flour of Puyallup, Skagit, and Nooksack Rivers.

Bloom

Visible blooms:
Red-brown bloom in Bellingham Bay, East Sound, Barlow Bay, Scow Bay, Liberty Bay, Quartermaster Harbor, Nisqually Reach, Eld Inlet, and Budd Inlet.
Green-brown blooms in Carr Inlet, Dana Passage, and Saratoga Passage.

Debris

Debris:
Macroalgae very abundant in Budd Inlet, Dana Passage, Carr Inlet, Commencement Bay, Port Madison, and Dyes Inlet.



Click on numbers

Aerial photography and navigation guide

Date: 7-16-2018

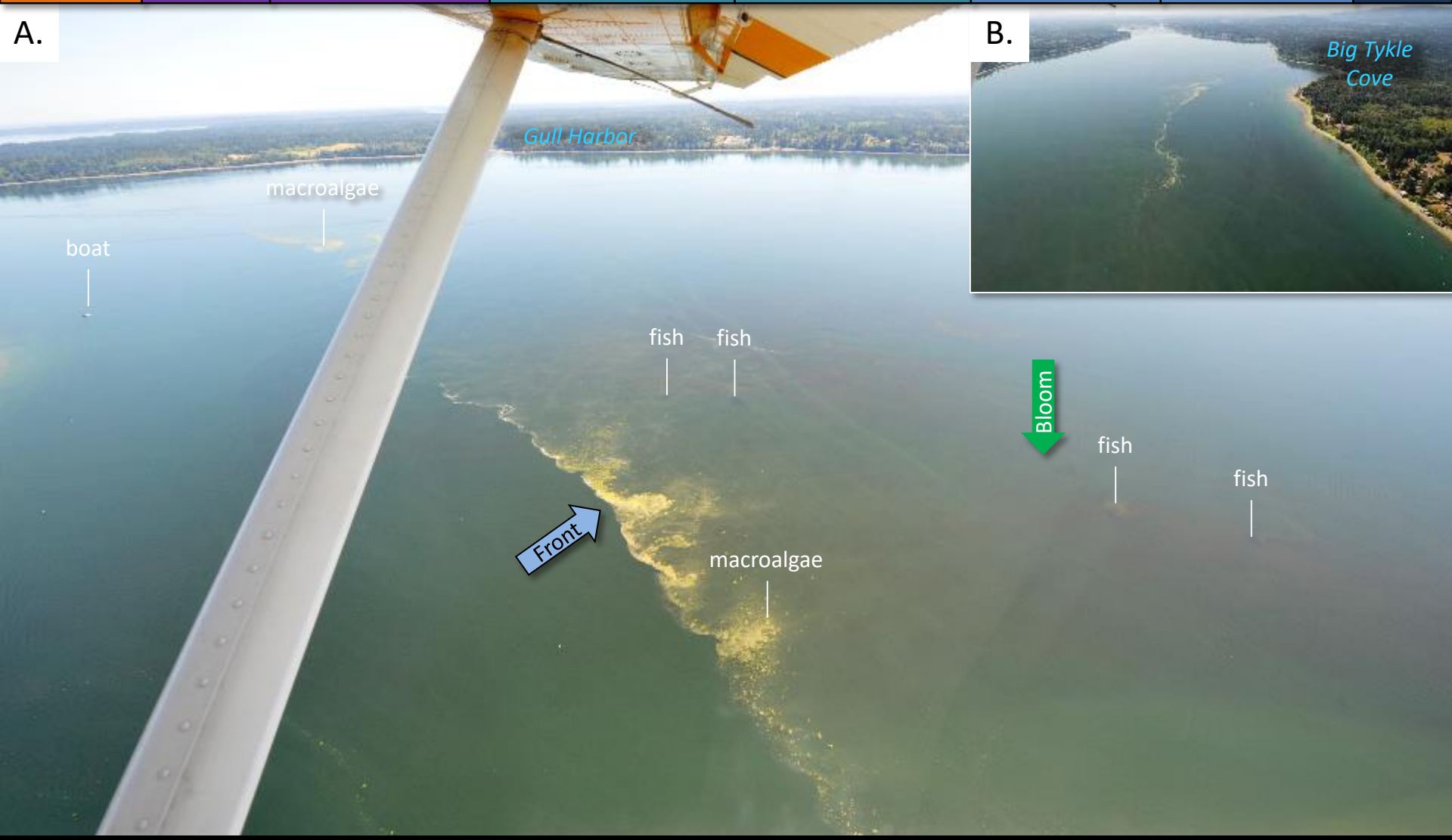
Tide data from July 16, 2018 (Seattle):

	Height (ft)	High/Low
2:53 AM	5.31	L
7:21 AM	10.29	H
2:03 PM	-1.9	L
9:12 PM	12.49	H

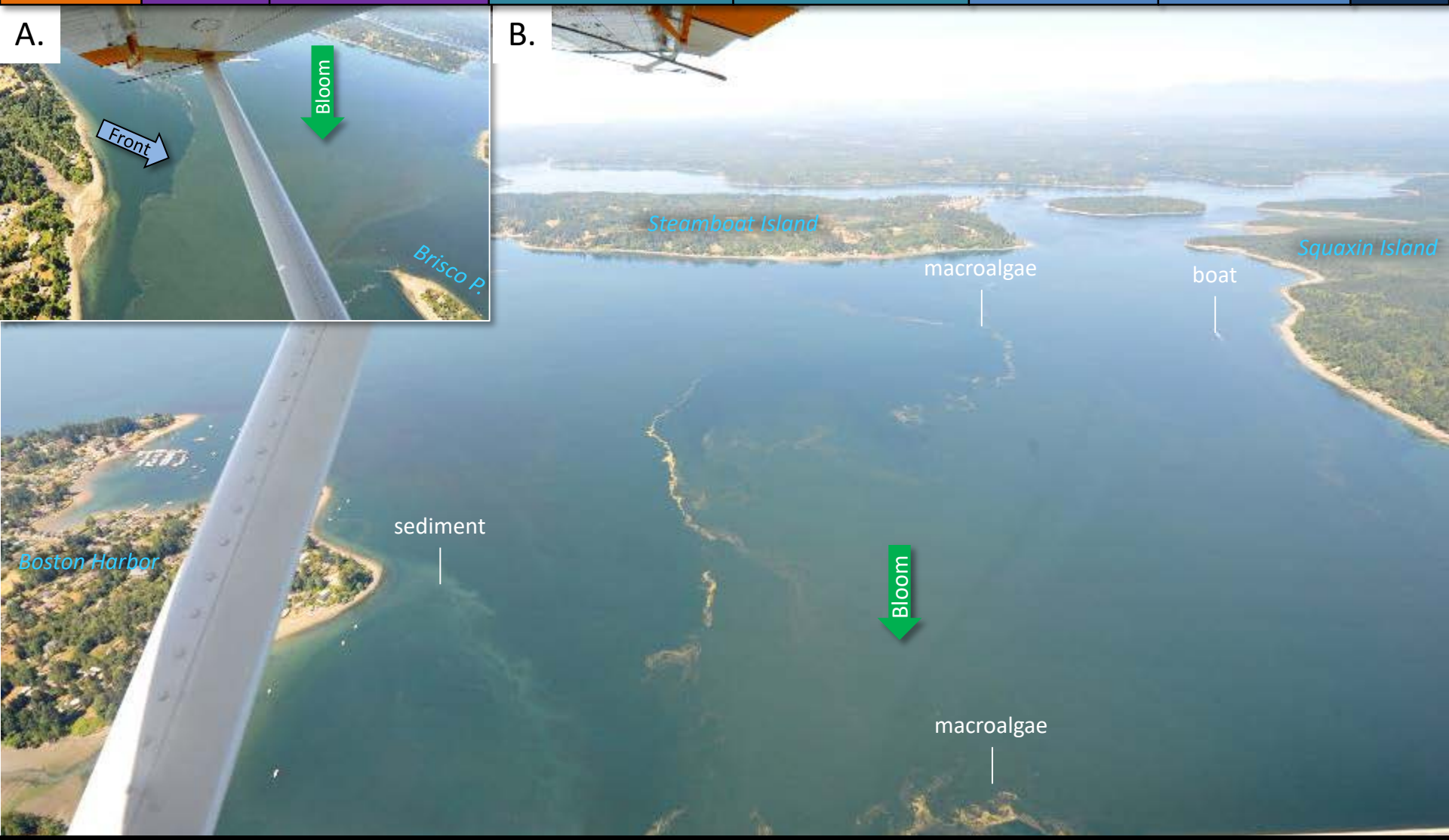
Flight Information:

Excellent visibility.

Flight routes



A. Large mats of macroalgae accumulating at front, red-brown bloom, and schools of fish. B. From altitude.
Location: Budd Inlet (South Sound), 12:36 PM

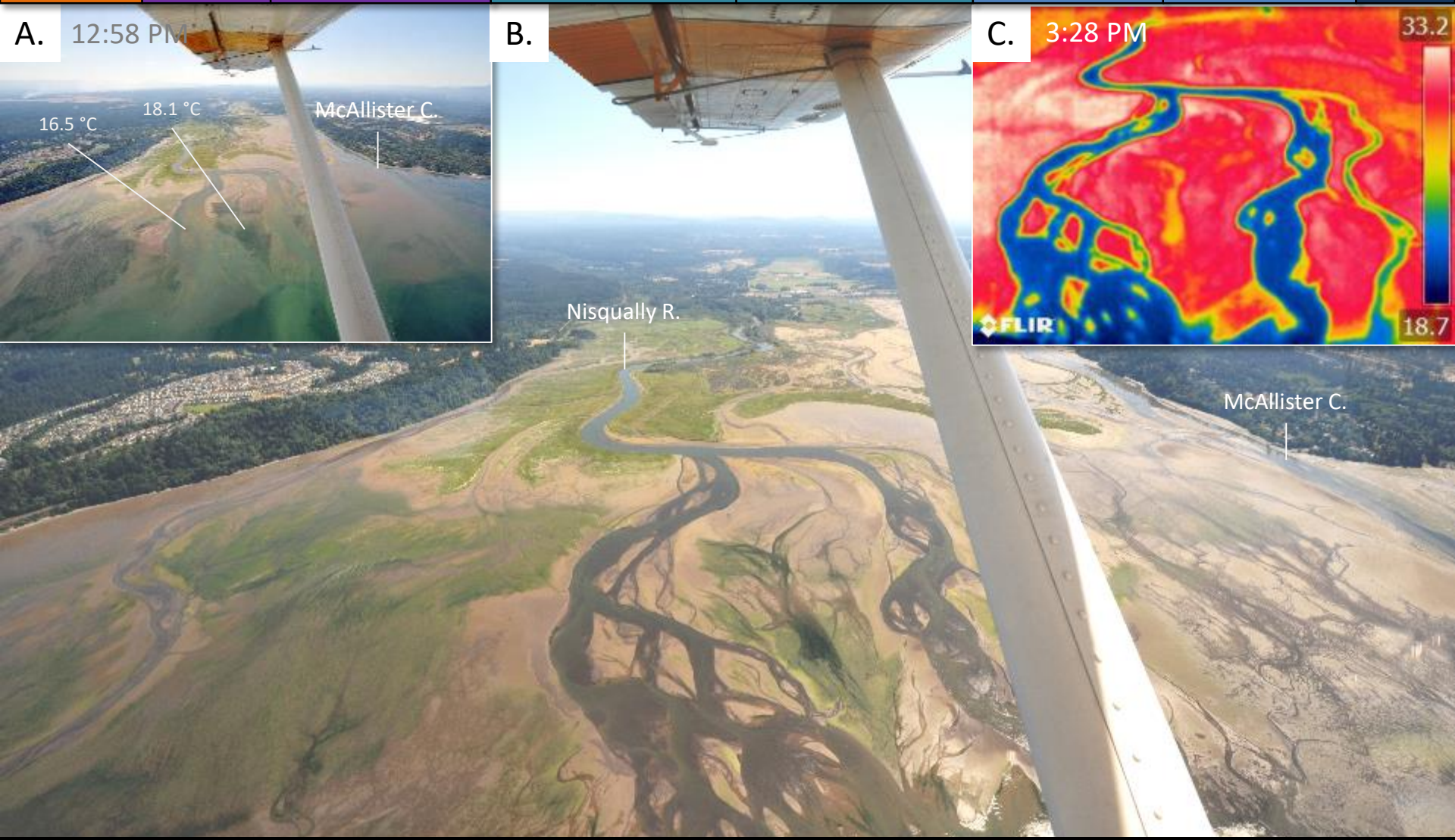


A. Bloom in green and red flowing north with tide. B. Large mats of macroalgae along tidal front.
Location: Dana Passage (South Sound), 12:40 PM

DOH Expert Jerry Borchert:
bloom consisting of 95% of the species *Ceratium fucus* and 5% of *Dinophysis*

Red-brown bloom and organic surface debris flowing north with outgoing tide.
Location: Eld Inlet (South Sound), 12:47 PM

Aerial photography 7-16-2018



Water on and over mudflats during ebb tide (A) and low tide (B) vary considerably in temperature (C).

Location: Nisqually River Delta (South Sound), 3:28 PM

Aerial photography 7-16-2018

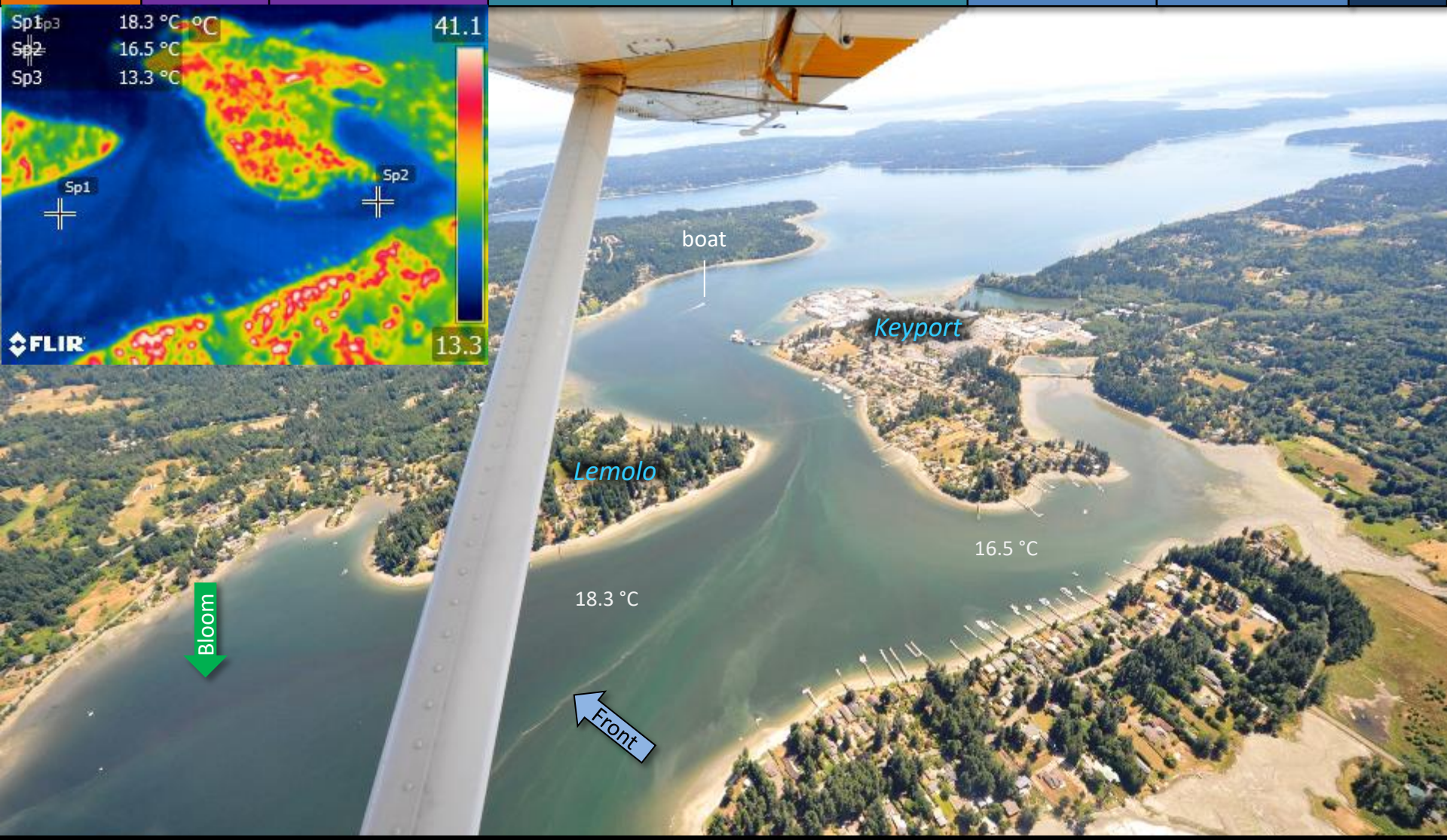
Large mats of macroalgae accumulating at tidal front at entrance to Pitt Passage.

Location: Carr inlet (South Sound), 1:03 PM

Large mats of macroalgae accumulating off beaches in southwestern portions of Carr Inlet.

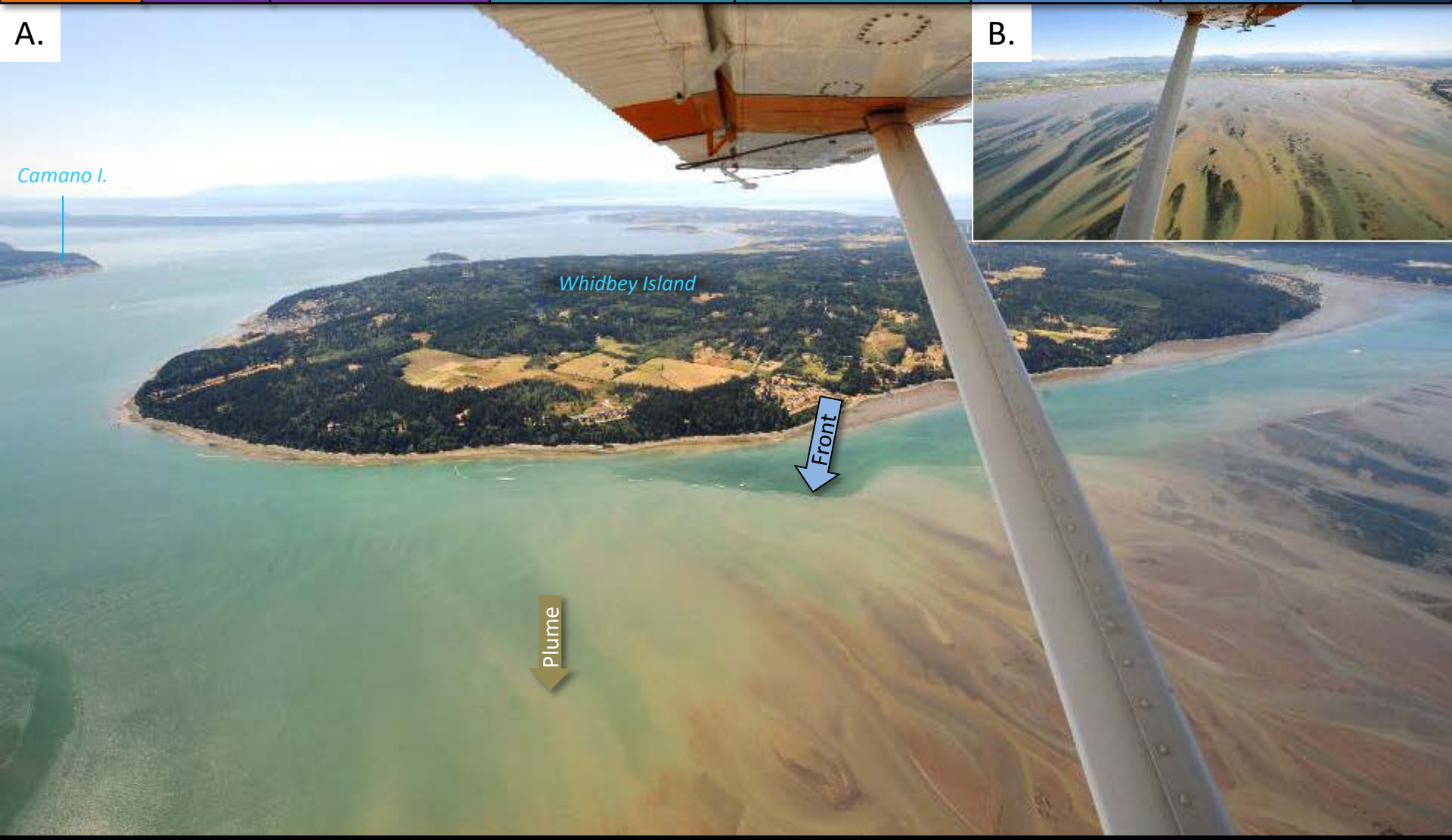
Location: Carr inlet (South Sound), 1:03 PM

Aerial photography 7-16-2018



Red-brown bloom in warm water of 18 °C leaving with outgoing tide.

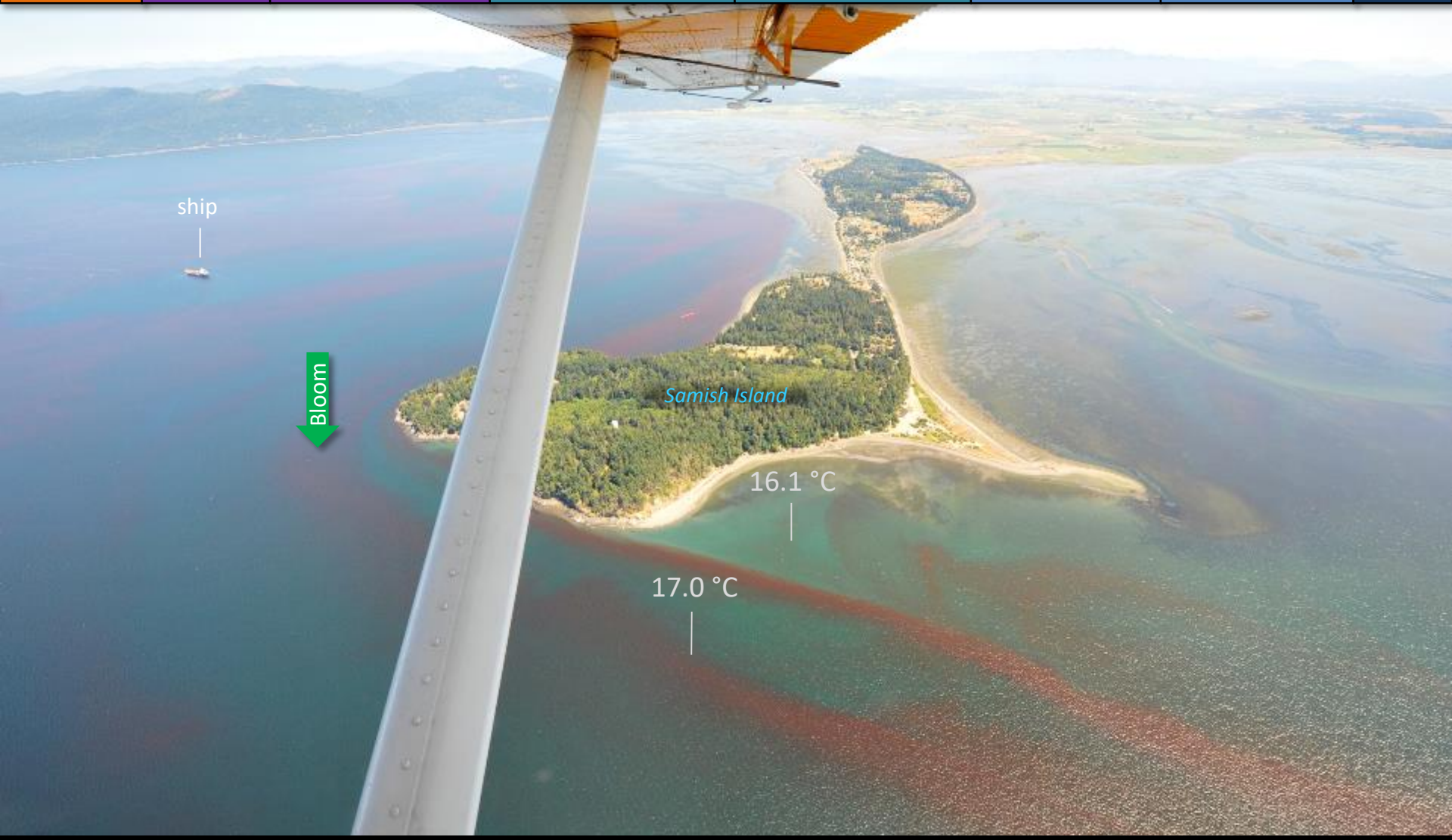
Location: Liberty Bay (Central Basin), 1:25 PM



A. Sediment-rich water from the South Fork Skagit River flowing over the mudflats, B. Entering Skagit Bay.
Location: Skagit Bay (Whidbey Basin), 1:51PM

Seagrass beds of different colors in Padilla Bay. Southern extent of red-brown bloom in Bellingham Bay.

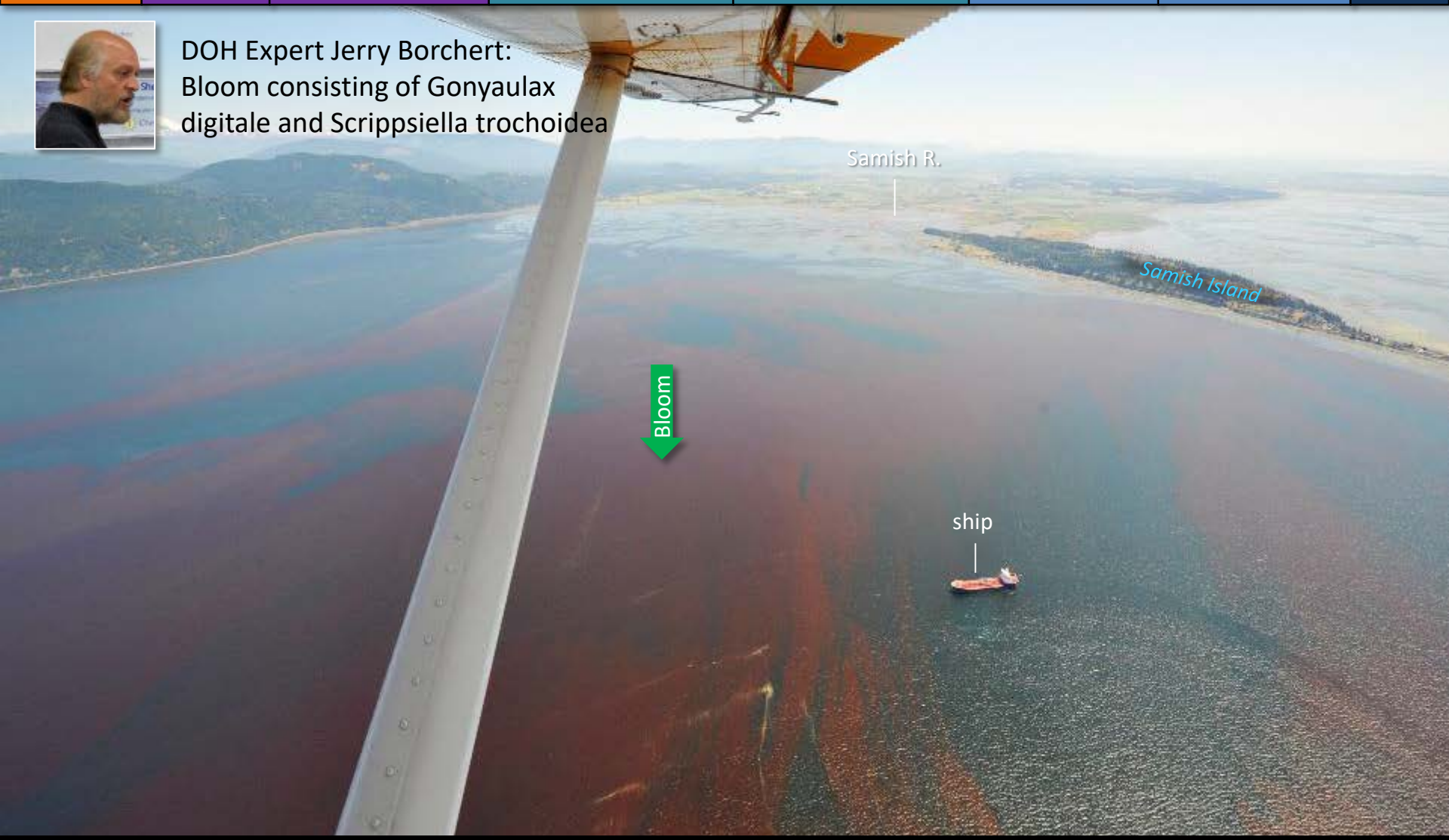
Location: Padilla Bay (North Sound), 1:59 PM



Red-brown bloom extending in long ribbons from Samish Bay into Padilla Bay.

Location: Samish Island (North Sound), 2:01 PM

DOH Expert Jerry Borchert:
Bloom consisting of Gonyaulax digitale and Scrippsiella trochoidea



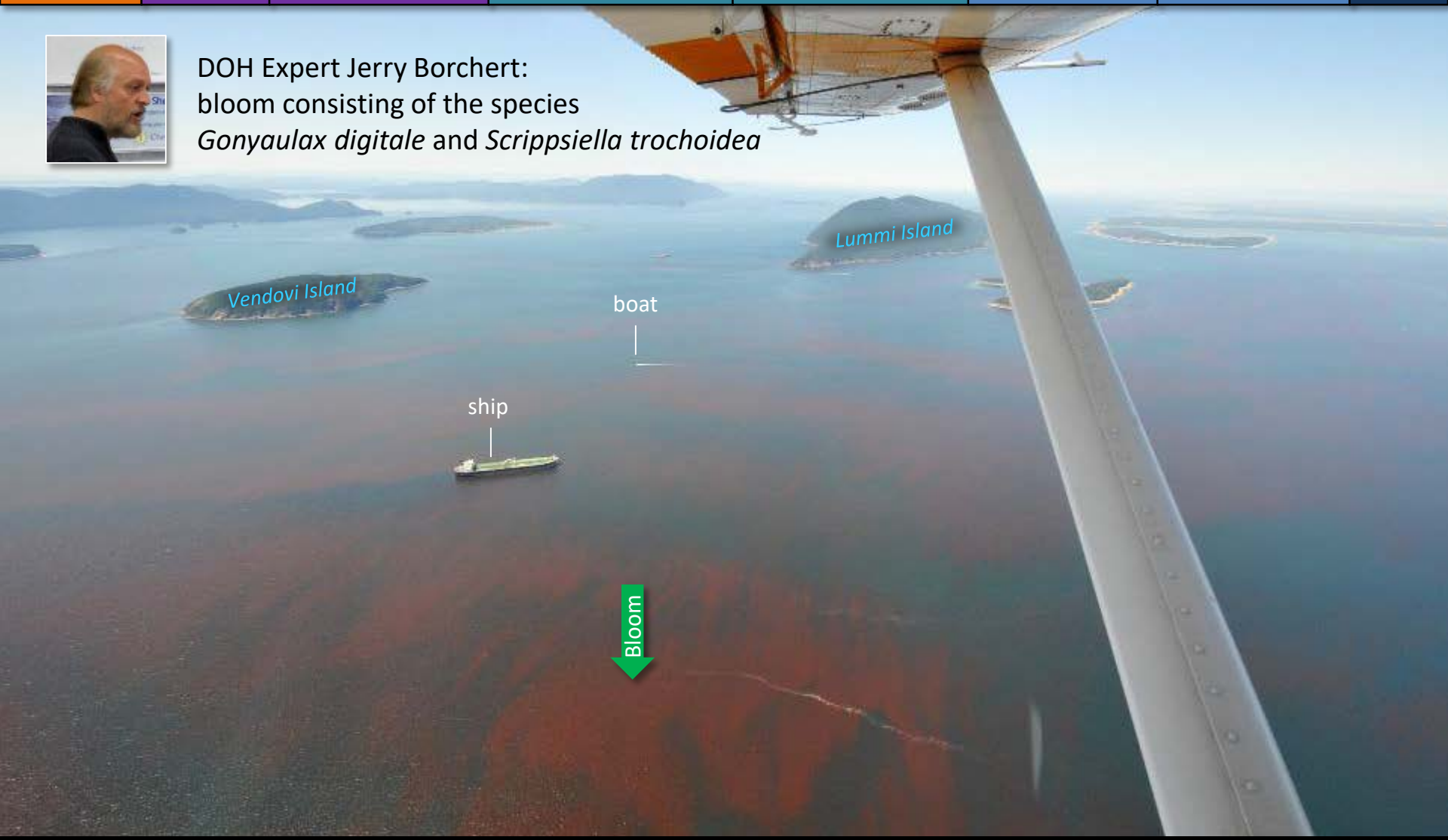
Large and very patchy red-brown bloom.
Location: Samish Island (North Sound), 2:03 PM

Aerial photography 7-16-2018

Large and very patchy red-brown bloom appearing to be comprised of different species.

Location: Samish Island (North Sound), 2:04 PM

DOH Expert Jerry Borchert:
bloom consisting of the species
Gonyaulax digitale and *Scrippsiella trochoidea*



Large and very patchy red-brown bloom at transition from Samish River to Bellingham Bay.
Location: Bellingham Bay (North Sound), 2:04 PM

Red-brown bloom of two colors entering Hale Passage from the north.

Location: Lummi Island (North Sound), 2:14 PM

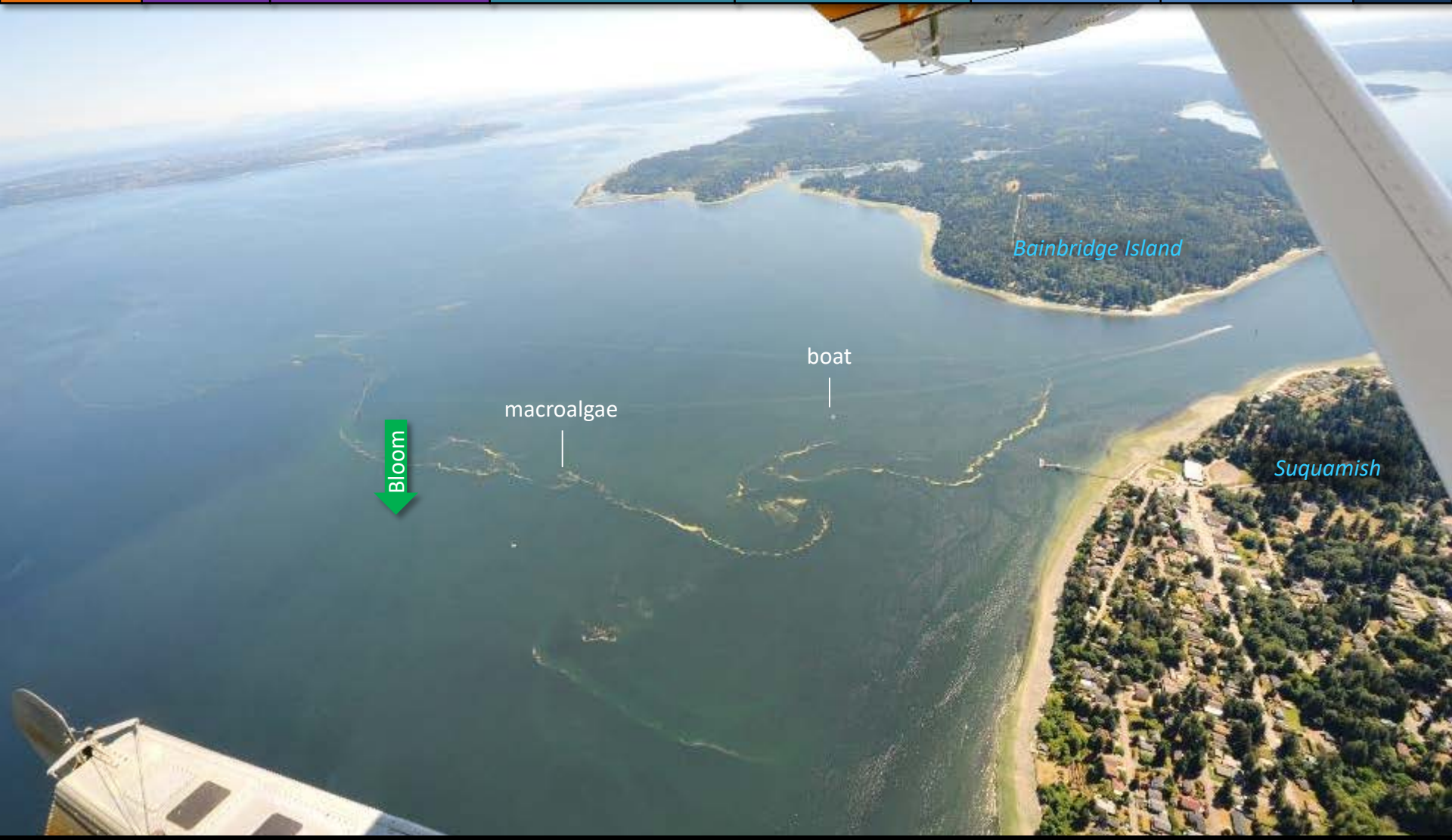
Red-brown bloom of two colors entering Bellingham Bay via Hale Passage.

Location: Lummi Island (North Sound), 2:14 PM

Red-brown bloom in East Sound mixing with cooler sediment-rich water entering via Obstruction Pass.

Location: Orcas Island (North Sound), 2:20 PM

Red-brown and yellow-green blooms in Barlow Bay.
Location: Mackaye Harbor, Lopez Island (North Sound), 2:28 PM



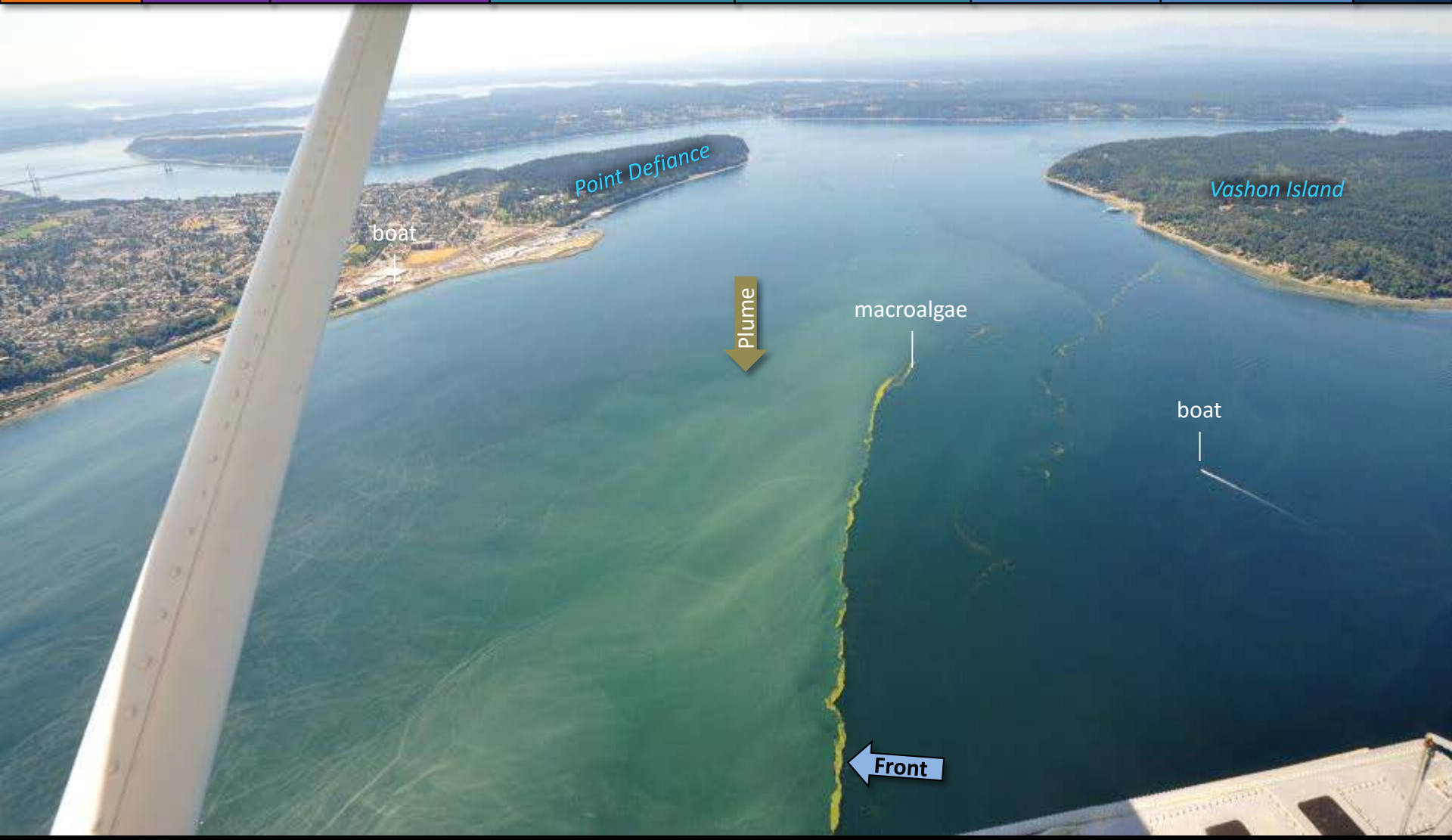
Large mats of macroalgae accumulating along tidal fronts.

Location: Port Madison (Central Sound), 2:56 PM

Large mats of macroalgae accumulating along edges of Puyallup River plume.

Location: East of Maury Island (Central Sound), 3:09 PM

Aerial photography 7-16-2018

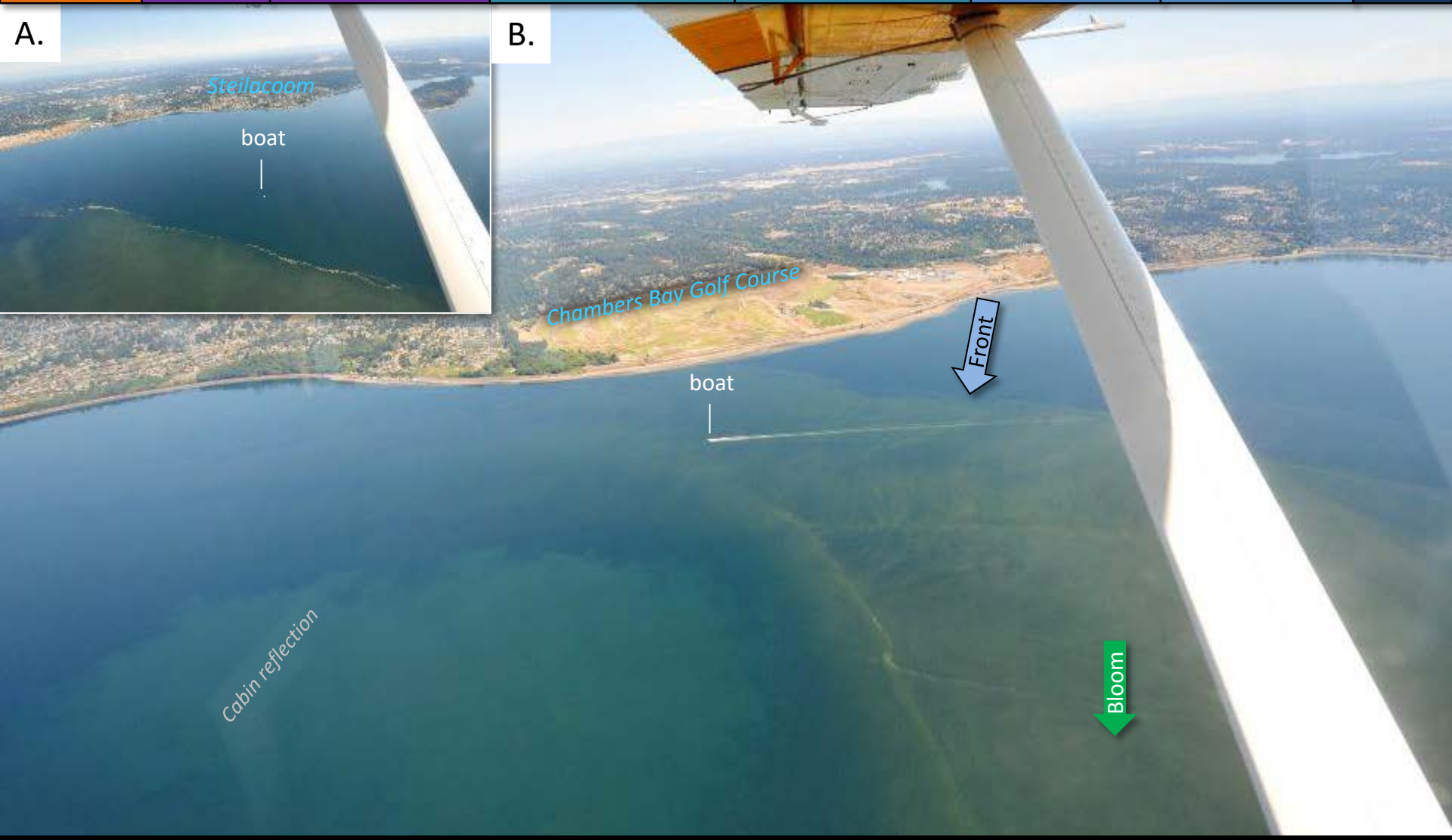


Large mats of macroalgae accumulating along edges of Puyallup River plume.

Location: Commencement Bay (Central Sound), 3:12 PM

Glacial flour stains the Puyallup River plume ochre-green. Small bloom in Sitcum Waterway.

Location: Commencement Bay (South Sound), 3:14 PM



A. Organic debris accumulating on front and B. a brown-green bloom leaving Carr Inlet with tide.
Location: Gordon Point (South Sound), 3:22 PM

Mats of macroalgae east of Anderson Island.
Location: Anderson Island (South Sound), 3:24 PM

Organic debris accumulating along Nisqually River plume flowing north with outgoing tide.

Location: Nisqually Reach (South Sound), 3:27 PM

Red-brown bloom in southern portions of Nisqually Reach.

Location: Nisqually Reach (South Sound), 3:29 PM

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Recommended Citation (*example from August 2017*)**:**

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Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

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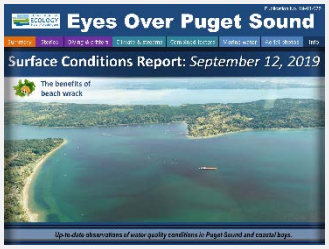

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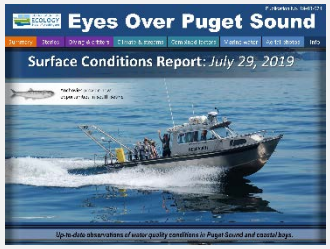

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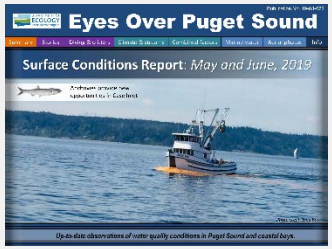

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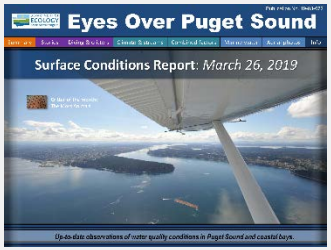

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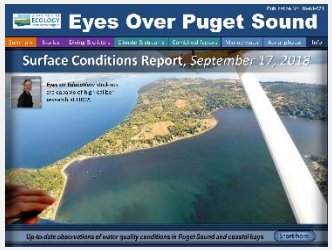

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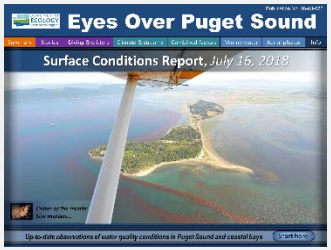

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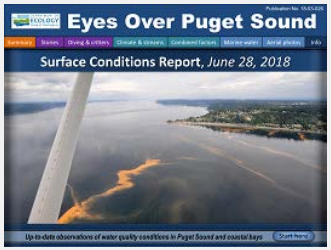

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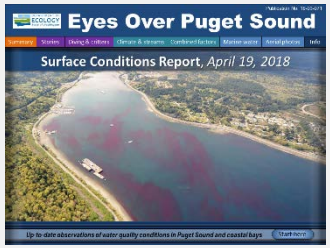

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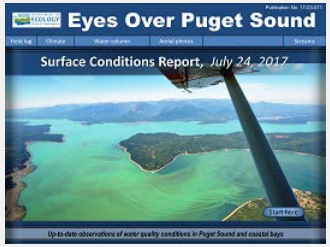

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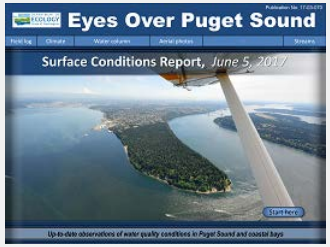

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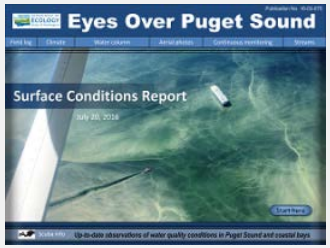

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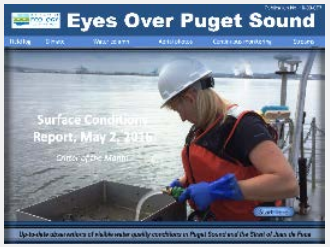

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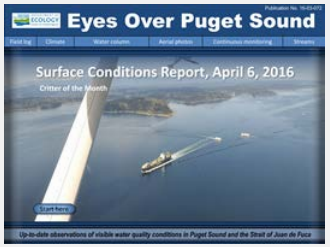

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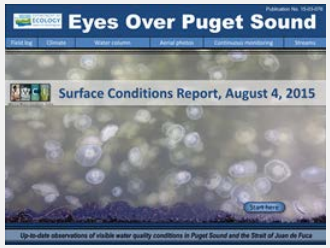

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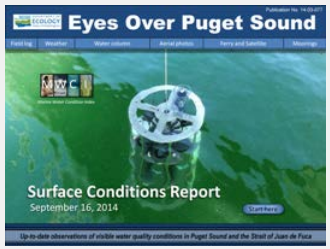

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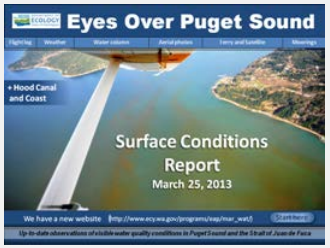

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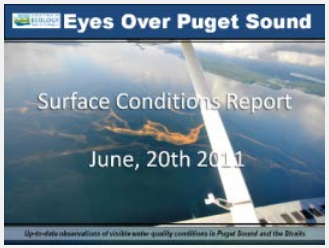

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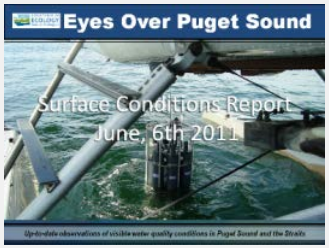

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