Publication No. 18-03-074

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report: *September 17, 2018*

Eyes on Education: Students are capable of high-caliber research at ORCA.

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

Start here

Summary conditions at a glance

LONG-TERM MARINE MONITORING UNIT

Julianne Ruffner
Laura Hermanson

Skip Albertson

Tyler Burks
Jim Shedd

Dr. Christopher Krembs (Editor)

Personal stories

p. 4

At times, floating organic material we see in the air ends up on the shoreline where our team documents it.

Climate & streams

p. 7

Temperatures remain above normal, while precipitation and river flows are below normal, extending the summer's unusual conditions. Recent rain provided a reprieve, but warmer and drier conditions are predicted for the fall.

Water temperature and food web

p. 11

Water temperatures were warmer in August — perhaps too warm for bull kelp and some salmon species in South Sound. These higher temperatures can increase the risk of toxin production in HABs. In contrast, Hood Canal, North Sound, and the San Juan Islands provided optimal temperature growth conditions for herring and salmon.

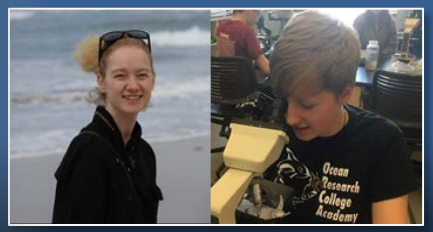
Aerial photography

p. 13

Extensive red-brown blooms are present in many terminal inlets of Puget Sound. Jellyfish patches are present in South Sound finger inlets. Floating macroalgae persist in nearshore areas of South Sound and in Useless Bay.

Editorial assistance provided by: Allison Brownlee, Carol Maloy, Suzan Pool, Ruth Froese, and Jeanne Ponzetti.

Ocean Research College Academy — Eyes on education



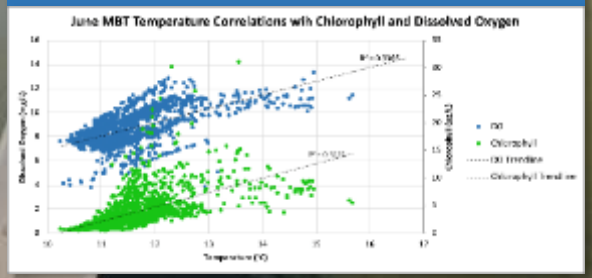
Ocean Research College Academy (ORCA) students are analyzing the data from Ecology water quality probes in Possession Sound, Whidbey Basin.

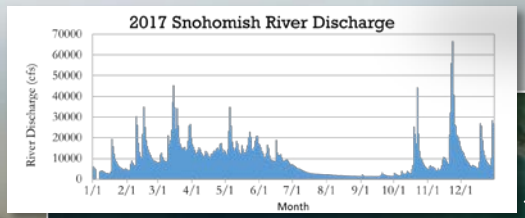
Ardi Kveven, ORCA founder and executive director. “The philosophy at ORCA is that students are capable of high-caliber research, which requires dedicated time, commitment, and relationship support.”

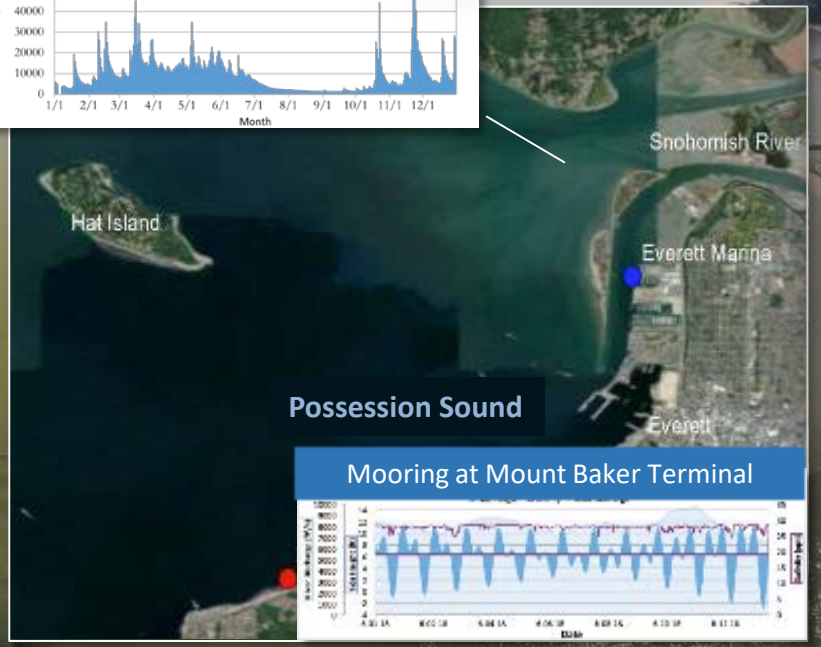
ORCA received a National Science Foundation grant to help increase the number of college students studying geoscience.

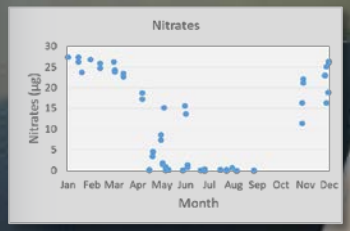
Explore student projects

Contact: akveven@everettcc.edu









What we see in the air can wash up on the beach

During EOPS flights, we see patches of seagrass, algae, and jellyfish floating in the water. Wind, tides, and currents can push them onto the beach. We record the location and extent of the debris on the beaches we visit, because beached mats of algae can act as a reservoir for bacteria and can deter beachgoers. Check out the BEACH Program website for more information.

We sample fecal indicator bacteria on beaches because contaminated water can make you sick.

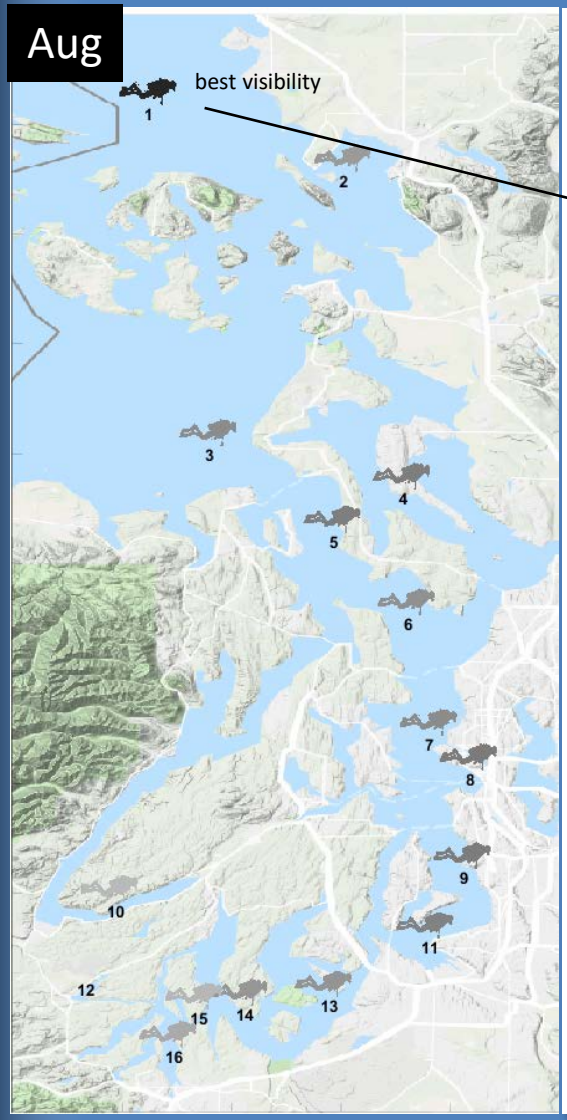
Macroalgae in Central Sound, July 2018

Beached macroalgae, Dash Point State Park, Aug 2018

Beached jellyfish, Potlach, Aug 2018

Jellyfish patches in Southern Hood Canal, June 2018

What was the visibility in the water for divers?



Best and worst horizontal visibility and corresponding depth (ft)

Station #	Best (depth)	Worst (depth)
1	51 (67)	5 (3)
2	23 (51)	6 (95)
3	26 (3)	19 (23)
4	30 (77)	5 (3)
5	29 (85)	22 (10)
6	25 (56)	8 (11)
7	26 (87)	19 (5)
8	30 (66)	18 (13)
9	30 (98)	14 (7)
10	15 (54)	4 (26)
11	29 (97)	4 (7)
12	6 (5)	5 (36)
13	24 (66)	18 (8)
14	24 (98)	16 (11)
15	16 (54)	13 (10)
16	19 (8)	2 (26)

Find depths with high/low visibility

- **Best visibility** occurred north in Georgia Strait (station 1) at over 50 ft (67 ft depth), despite having poor visibility near the surface (5 ft depth).
- **Poor visibility** occurred in Oakland Bay (station 12, near Shelton) and in Lynch Cove (station 10).
- 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 here.

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

Critter of the month — The bloodworm

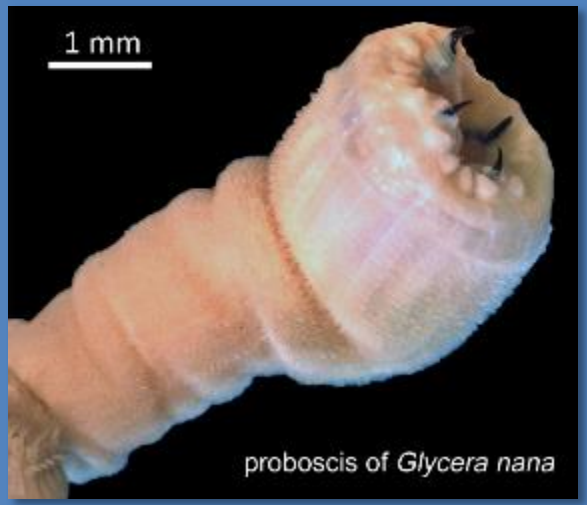
Dany Burgess & Angela Eagleston,
Marine Sediment Monitoring Team

Family Glyceridae

This critter group is one of the most common finds in our benthic samples. Bloodworms are marine segmented worms that play an important ecological role in the sediments.

Fun bloodworm facts

- Four fang-like black jaws are made of a copper-based mineral that is as hard as your tooth enamel.
- Some species can grow to over a foot long.
- They are named for how their paper-thin skin reveals red body fluid inside.



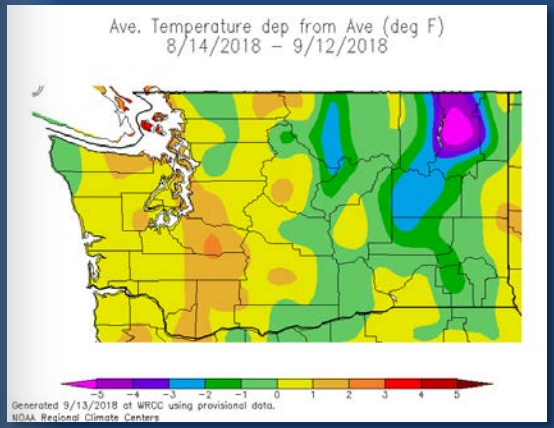
Learn more about bloodworms and other critters on Ecology's EcoConnect blog here.

How much water did we get and what can we expect?

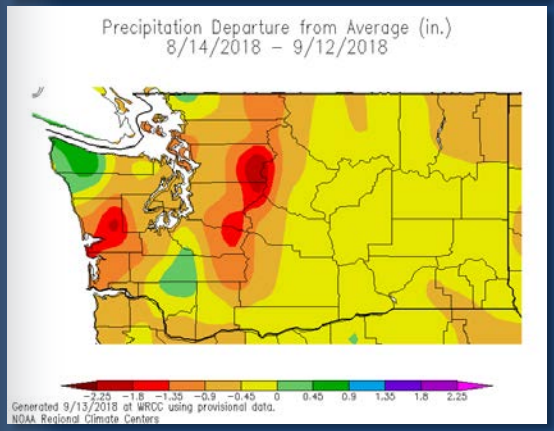
Tyler Burks, Jim Shedd

Air temperatures were above normal while precipitation was well below normal through the first part of September (A). Though recent cooler and wetter weather has given some relief, the fall climate outlook predicts warmer and drier conditions (B). This could continue to stress freshwater inputs to Puget Sound.

A. Western Regional Climate Center

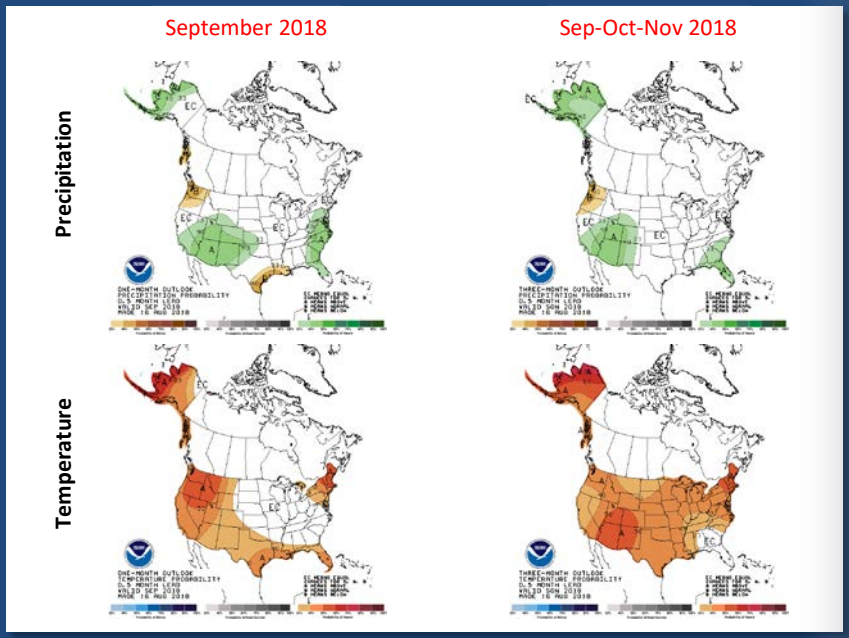


Average temperature
Departures from average ranged from -1 to +4 degrees (F) during the past 30 days in Puget Sound.



Precipitation
Departures from average ranged from about -2.0 inches to about +0.5 inches during the past 30 days in Puget Sound.

B. Climate Prediction Center, NOAA

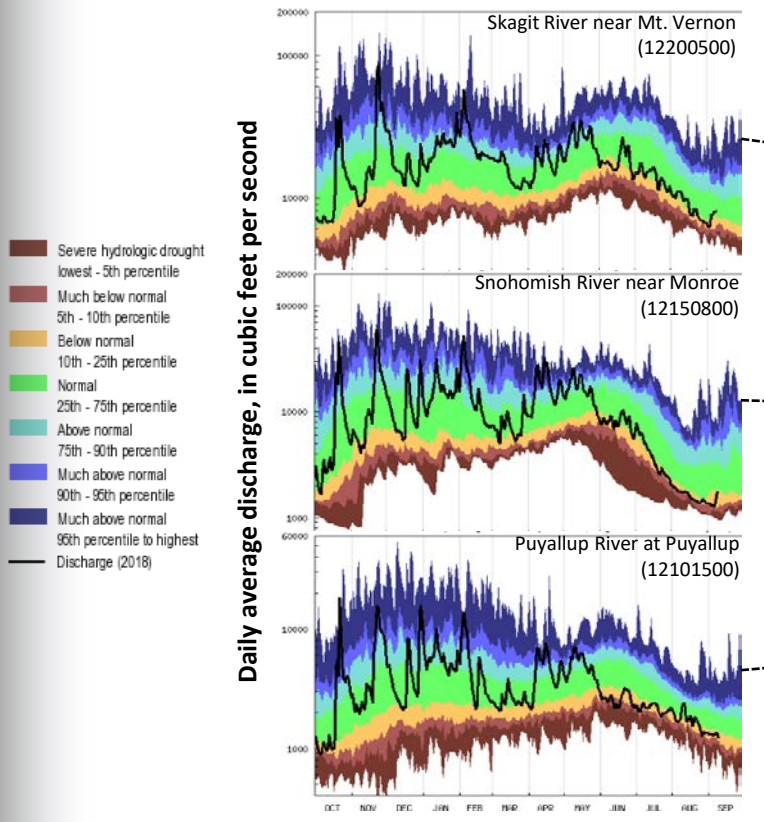


The maps on the top show higher probability of below-normal precipitation in the NW. The maps on the bottom show a higher probability of higher temperatures in the NW. Click here.

How much water flows into Puget Sound?

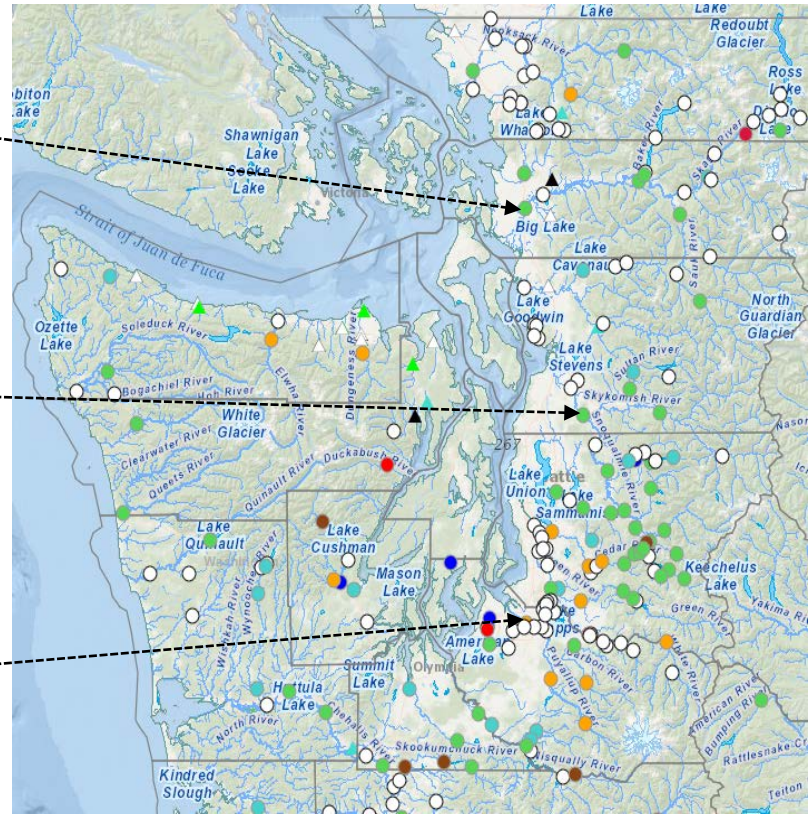
Recent rainfall has been helpful, but freshwater inputs to Puget Sound are generally below normal and, in some cases, far below normal (see trend charts). Nearly all stream gages are reporting normal or below-normal flows (see map). However, most flows reporting as normal are below the 50th percentile (see charts below where the current discharge is near the bottom of the green interquartile range).

Select Puget Sound Streamflow Trends



USGS WaterWatch: CLICK HERE!

Current Streamflow Conditions as of 9/13/2018



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

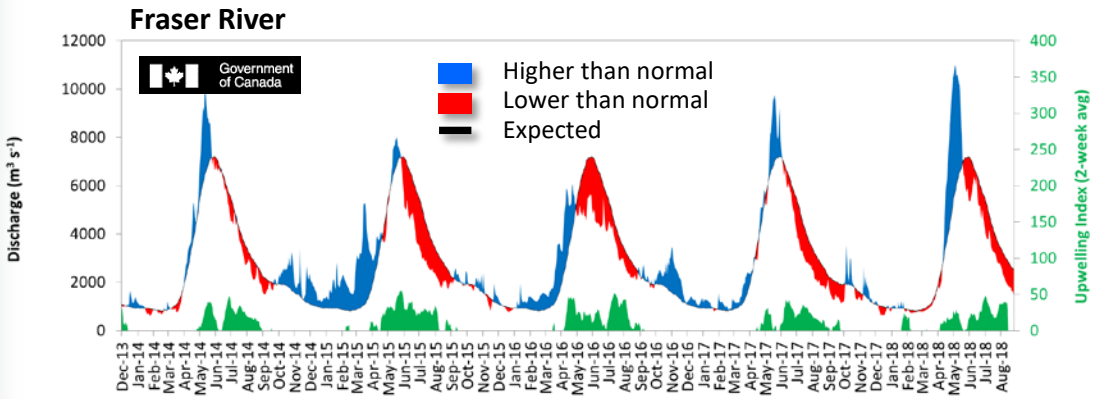
Daily Streamflow

- 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

Current conditions: CLICK HERE!

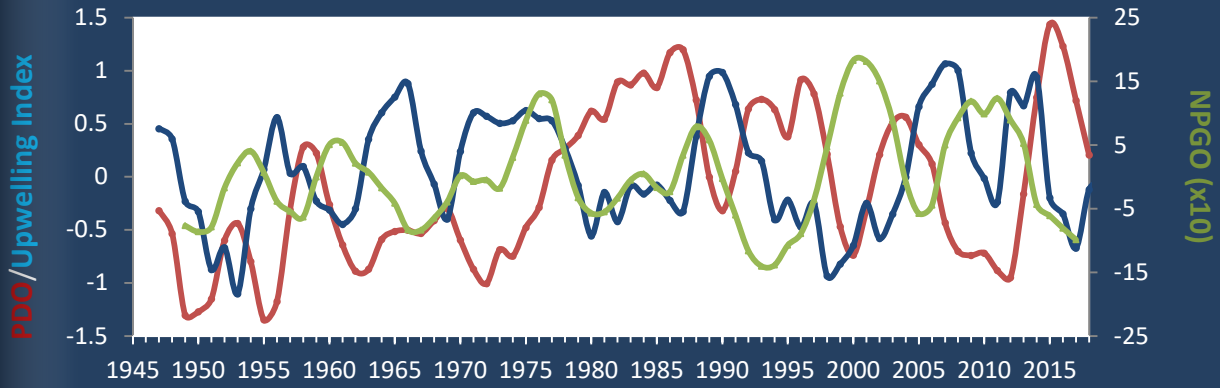
Climate influences: How well is Puget Sound exchanging its water?

Historically, peaks of coastal upwelling and the freshet are in sync. This year a strong freshet preceded low flows.



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. Fraser River flows continue to be lower than expected.

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) and upwelling is more likely (Upwelling Index anomaly). Unfortunately, reporting of the NPGO, which reflects the surface productivity along the coast, has been discontinued.

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

What influences Puget Sound's water quality?

Conditions leading up to September 2018 started similarly to those of 2017, with a cool and wet spring followed by a warm, dry, and sunny summer with low river flows. In 2018, the onset of a dry summer happened a month earlier, in May. While the pattern of sunny conditions ended earlier than in 2017, the change did not appear to influence patterns of rain or river flows, which remain below normal in August, similar to 2017.

Current conditions for August and September:

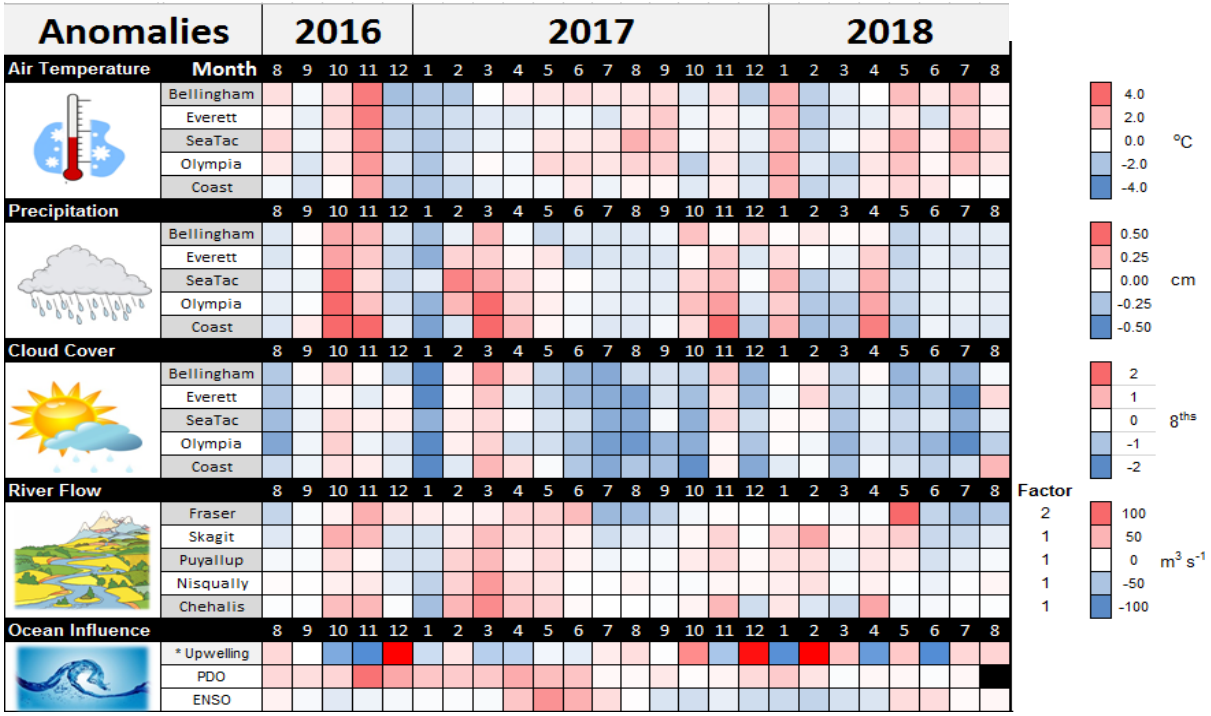
Air temperatures remain above normal, as they have since May.

Precipitation levels remain below normal, a pattern that started in May.

Sunshine levels have changed in August and are variable.

River flows continue to be below normal (see pages 7 and 8).

Upwelling and ENSO (MEI) were neutral to slightly positive in August.



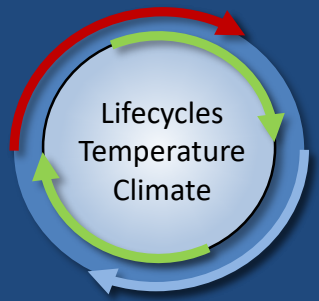
*Upwelling/downwelling Anomalies (PFEL)
PDO = Pacific Decadal Oscillation
ENSO = El Niño Southern Oscillation

higher — expected — lower

No data

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

Water temperature affects ecosystem performance



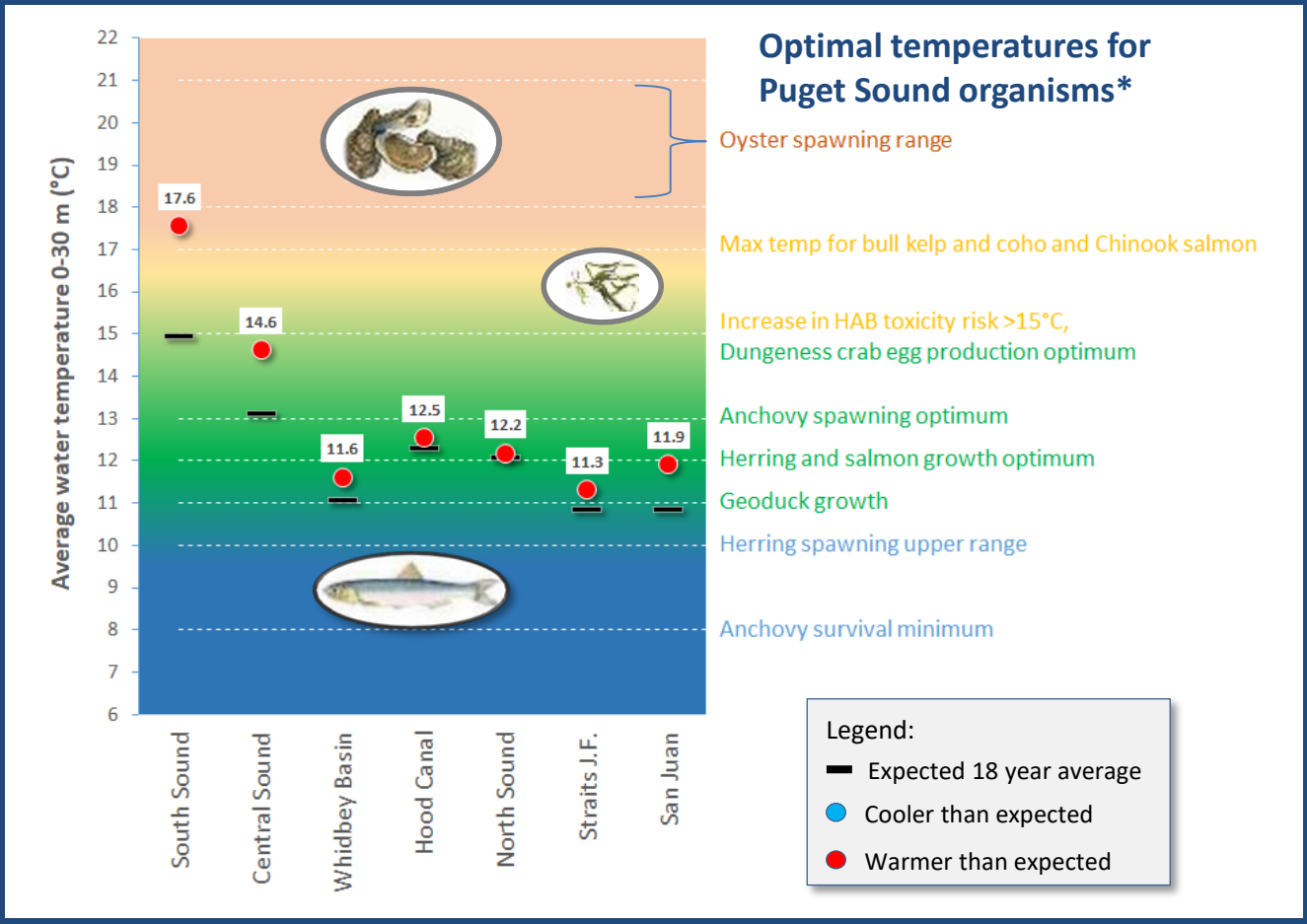
Can organisms thrive and survive?

The life cycles of organisms respond to temperatures. In order to be successful, the timing of early life stages has to line up with good growth conditions.

Temperature is important for growth, but also dictates if certain organisms can overwinter in Puget Sound (e.g., northern anchovy)

* Help us get these right. We scoured the literature for temperatures important for the success and survival of marine organisms.

In August, water temperatures were warmer, particularly in the surface waters of South Sound. Temperatures for coho and Chinook salmon as well as bull kelp were above optimal levels, and the risk of HAB toxin production was higher. In contrast, Hood Canal, North Sound and the San Juan Islands provided optimal growth conditions for herring and salmon. Oysters like it warm!



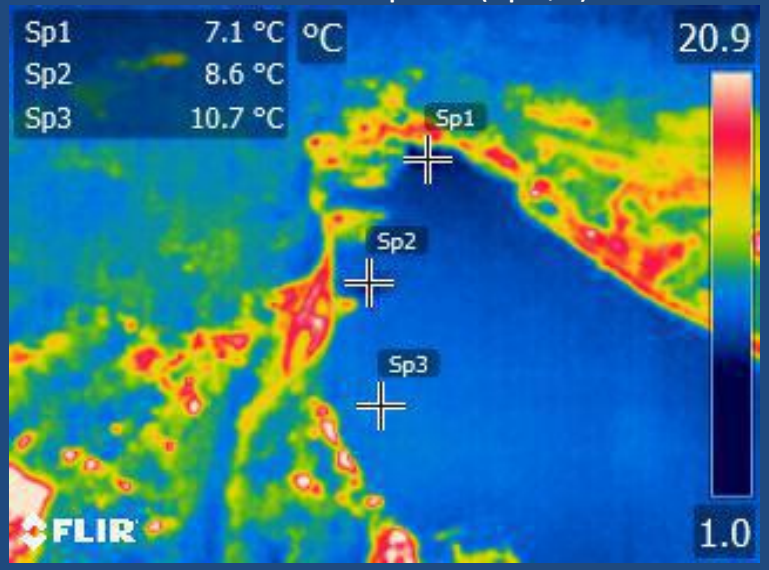
Infrared (IR) images show what the eye can't see

A. Temperatures in marine surface waters can vary by more than 3 °C as shown in this image from Sinclair Inlet.

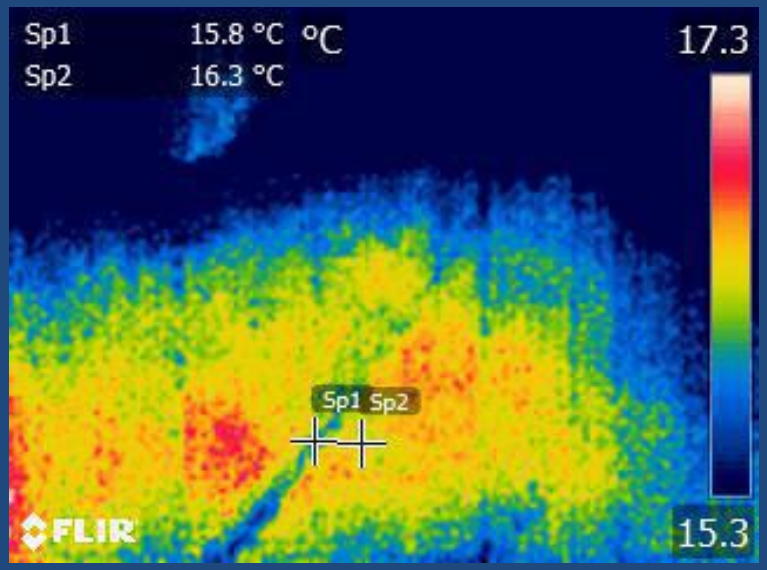
Disclaimer: IR images are not corrected for sky condition, humidity, air temperature, emissivity, and subject distance.

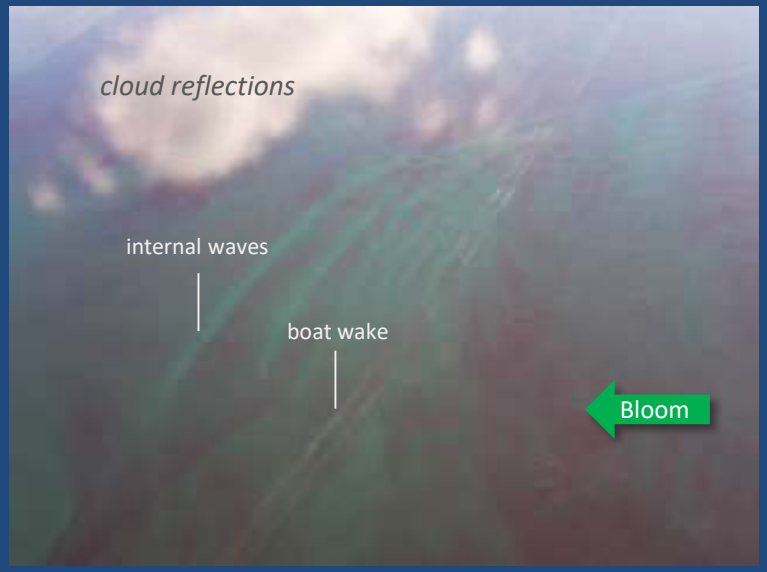
B. A boat wake leaves a thermal footprint, bringing cooler water to the surface. The internal waves are not visible in the IR image.

A. Sinclair Inlet: river inputs (Sp1,2)



B. Budd Inlet: a boat wake and internal waves





What are the conditions at the surface?

Red-brown blooms are present in many terminal inlets of Puget Sound. Jellyfish patches are in the South Sound finger inlets and likely in Sinclair Inlet and Scow Bay. Remnants of floating mats of macroalgae persist in various nearshore areas of South Sound and southwest Whidbey Island.

Start here

Green bloom, Higgins Slough, Swinomish Channel

Unverified oil sheen north of Perego's Lagoon

Front

Mixing and fronts:
Tidal fronts are pronounced in Admiralty Reach.

Jellyfish:
Jellyfish patches are in Eld and Budd Inlets, and also likely in Sinclair Inlet and Scow Bay (latter unconfirmed).

Plume

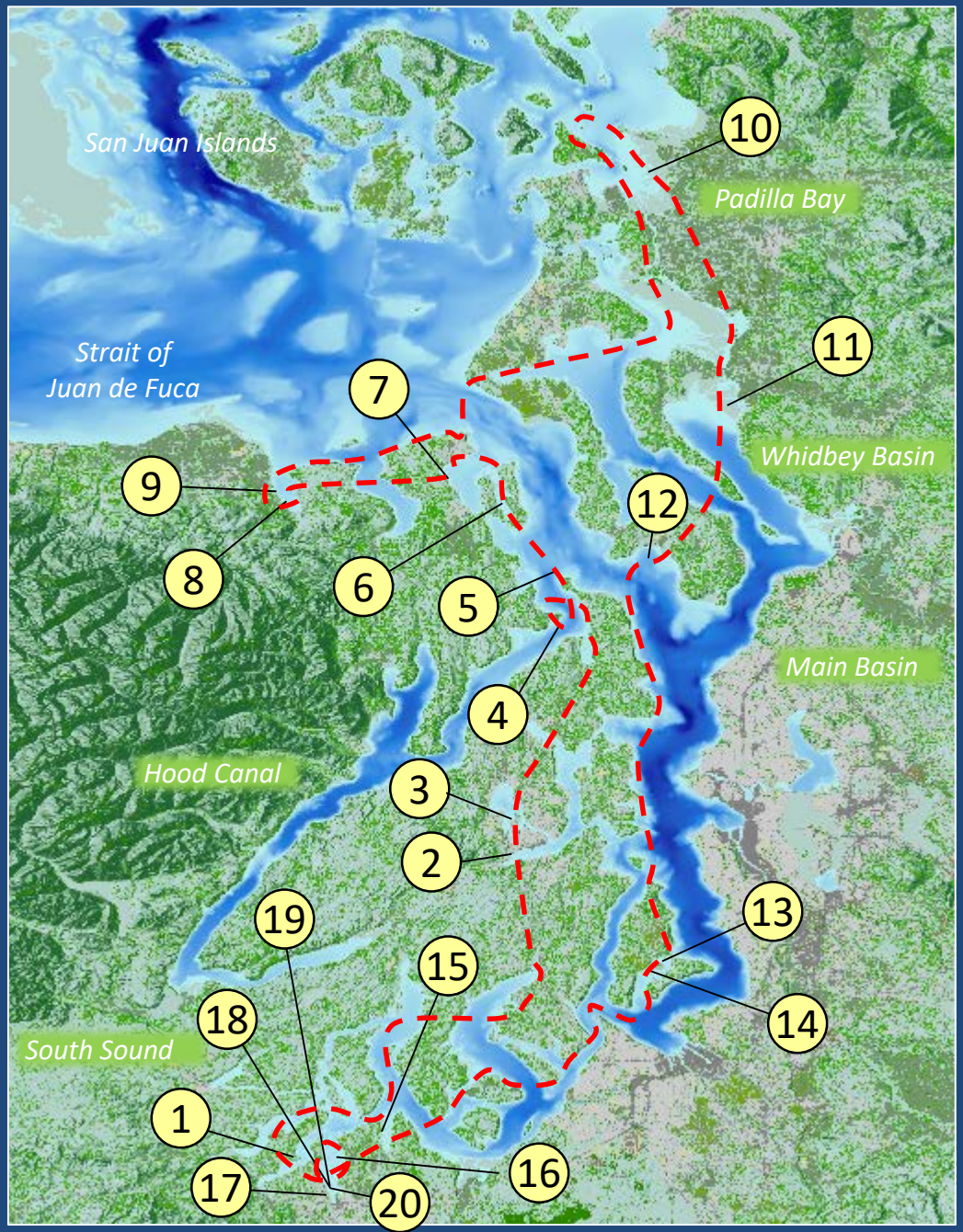
Suspended sediment:
Stillaguamish River is rich in sediment following recent rain.

Bloom

Visible blooms:
Red-brown blooms are present in Eld, Budd, Henderson, Sinclair, and Dyes Inlets. They were also observed in Quartermaster Harbor, northern Hood Canal, Kilisut Harbor, and Sequim Bay.

Debris

Debris:
Macroalgae are still seen in Useless Bay (southwest Whidbey Island) and in the nearshore areas of Case Inlet (South Sound). Rafts of organic material are present in Padilla Bay.



Click on numbers

Aerial photography and navigation guide

Date: 9-17-2018

Tide data from September 17, 2018 (Seattle):

	Height (ft)	High/Low
5:25 AM	1.18	L
1:15 PM	9.65	H
7:04 PM	6.74	L
11:35 PM	8.66	H

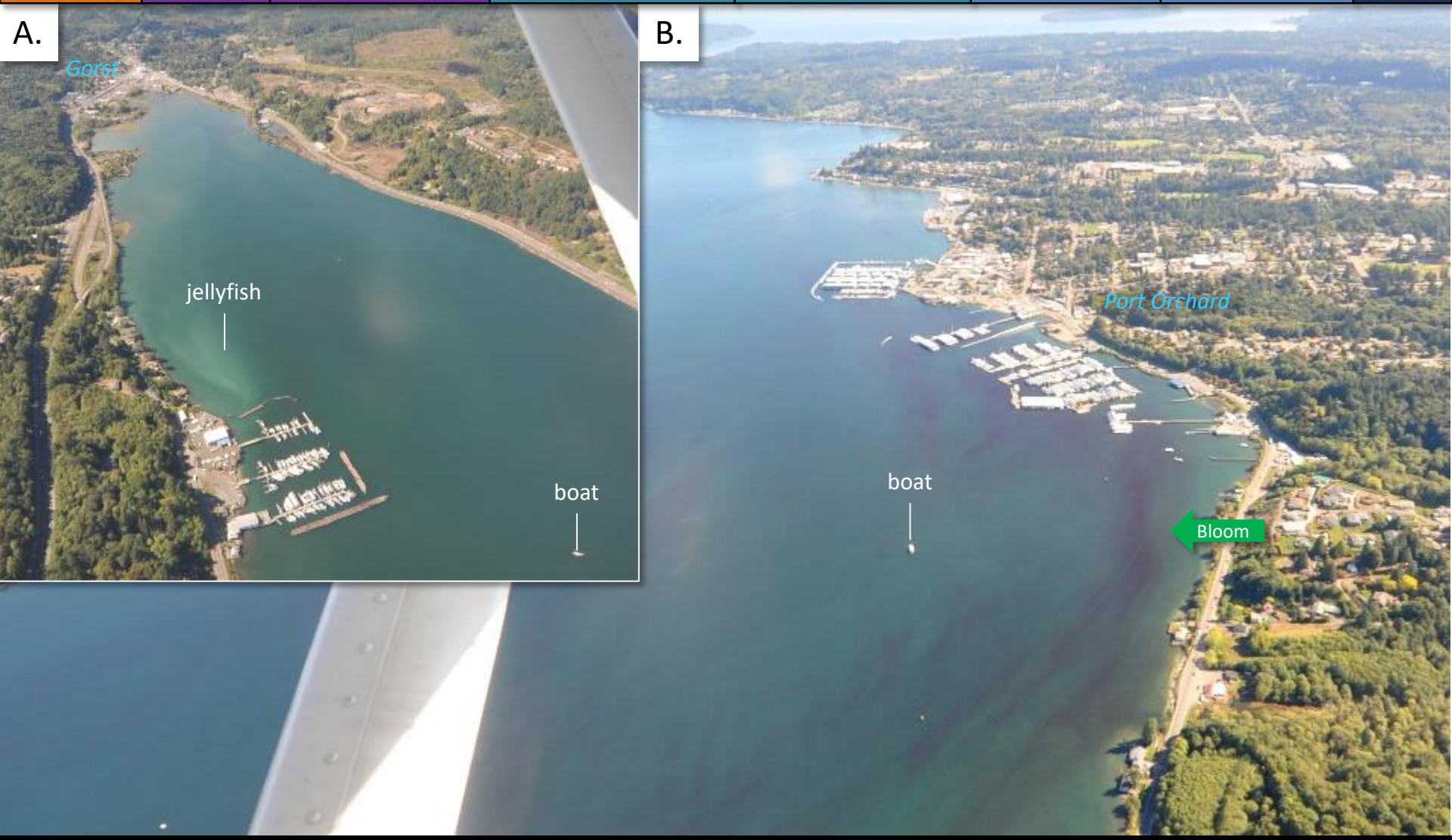
Flight Information:

Broken cloud ceiling.

Flight routes

Jellyfish are back and occurring with a red-brown bloom, partially covered by cloud reflections.

Location: Eld Inlet (South Sound), 12:24 PM



A. Likely jellyfish, but not confirmed. B. Large red-brown bloom near Port Orchard.
Location: Sinclair Inlet (Central Sound), 12:48 PM

Aerial photography 9-17-2018

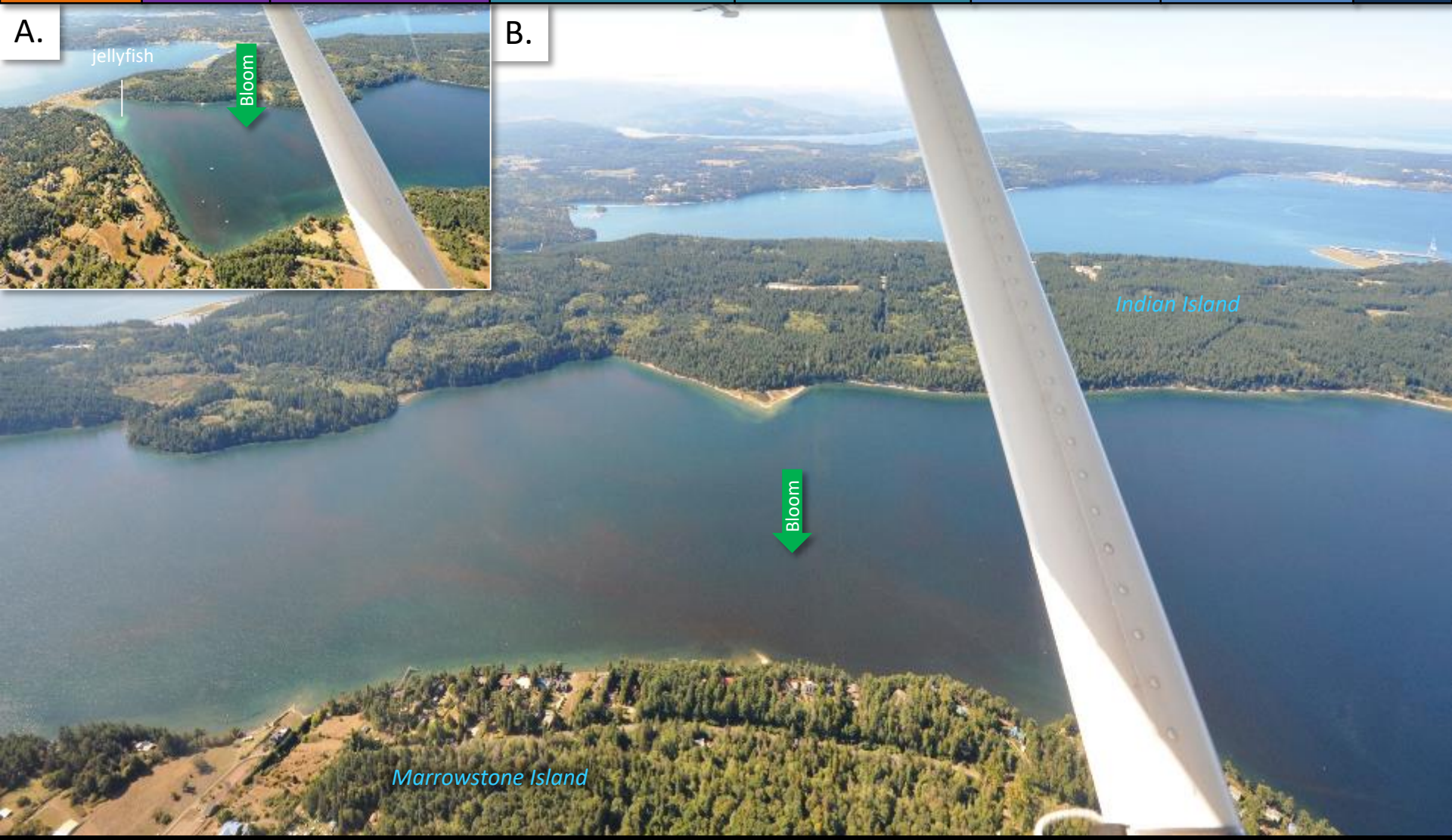
Red-brown bloom and organic surface debris in various places in Dyes Inlet.

Location: Dyes Inlet (Central Sound), 12:50 PM

Red-brown bloom in Bywater Bay.

Location: Hood Head (northern Hood Canal), 1:07 PM

Red-brown bloom from northern Hood Canal, extending into Admiralty Reach.
Location: Admiralty Reach (North Sound), 1:11 PM



A. Red-brown bloom with white milky patch, likely jellyfish. B. Bloom extending north into Kilisut Harbor.
Location: A. Scow Bay. B. Marrowstone Island (North Sound), 1:15 PM

Water with surfacing turbidity, likely from an underwater diffuser.

Location: Port Townsend Bay (North Sound), 1:25 PM

Vivid red-brown bloom covering large portions of Sequim Bay.
Location: Sequim Bay (Strait of Juan de Fuca), 1:26 PM

Vivid red-brown bloom covering large portions of Sequim Bay north to Pitship Point.

Location: Sequim Bay (Strait of Juan de Fuca), 1:26 PM

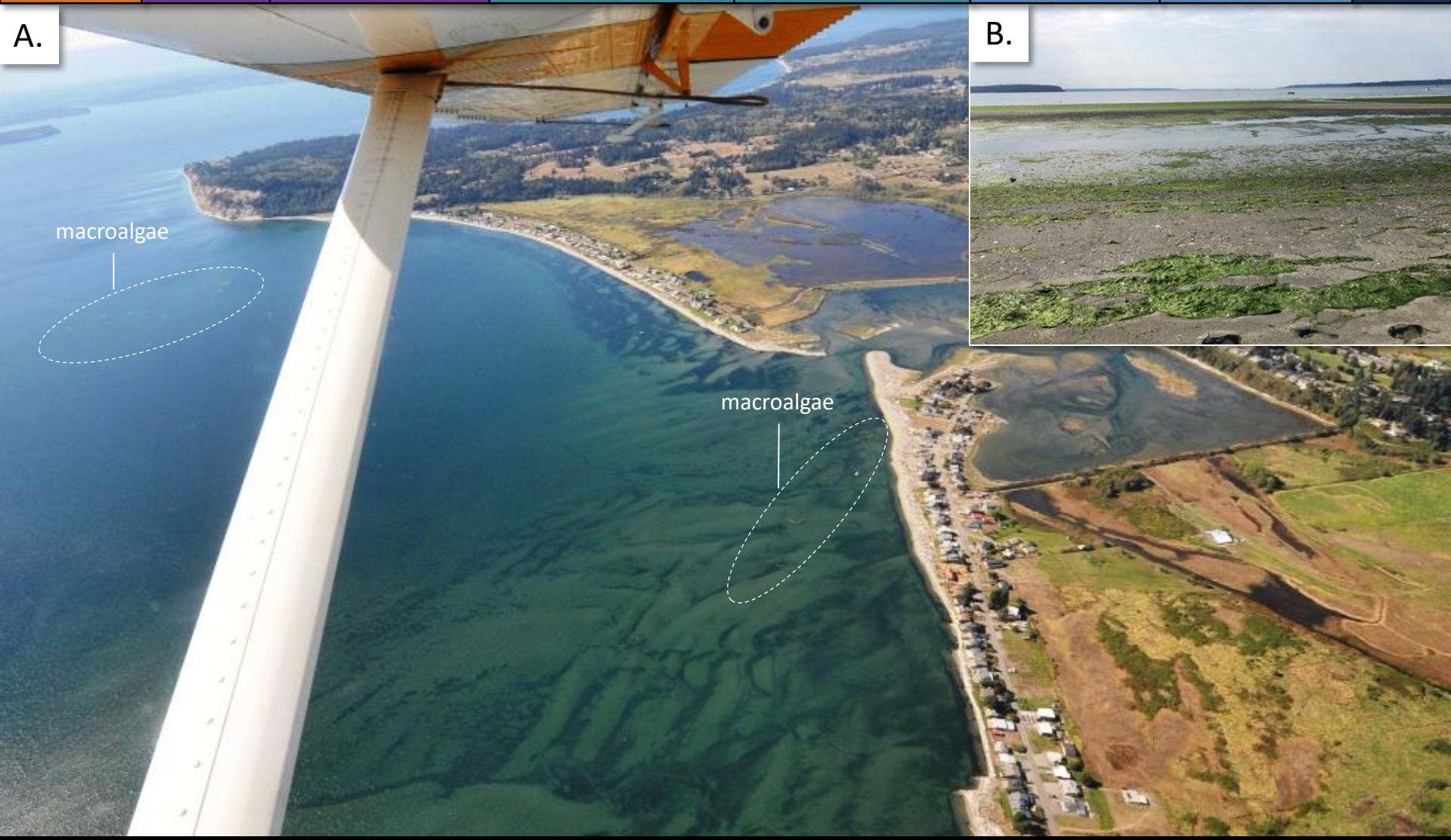
Mats of organic debris floating above seagrass beds and submerged tidal channels.

Location: Padilla Bay (North Sound), 2:07 PM

Following an episode of rain, large amounts of sediment enter Puget Sound with the Stillaguamish River.

Location: Port Susan (Whidbey Basin), 2:03 PM

Aerial photography 9-17-2018



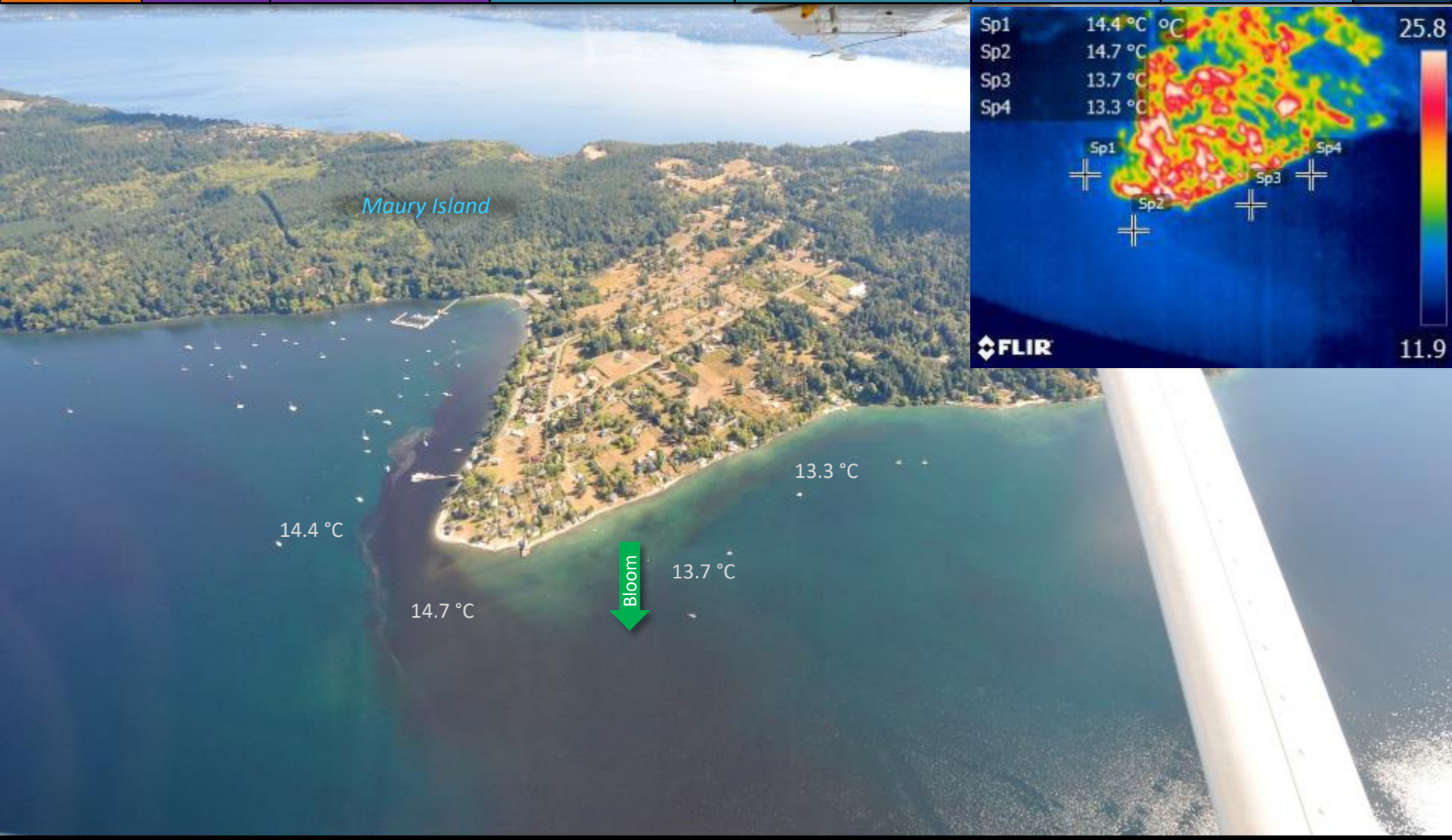
Patches containing large mats of macroalgae. B. Citizen provided image of macroalgae to us on Aug. 15.

Location: Useless Bay (North Sound), 2:27 PM

Red-brown bloom and river plume revealing interesting flow pattern in surface water.

Location: Quartermaster Harbor (Central Sound), 2:48 PM

Aerial photography 9-17-2018



Large red-brown bloom originating off the town of Dockton in locally warmer water.

Location: Quartermaster Harbor (Central Sound), 2:49 PM

Red-brown bloom in Henderson Inlet.

Location: Henderson Inlet (South Sound), 3:03 PM

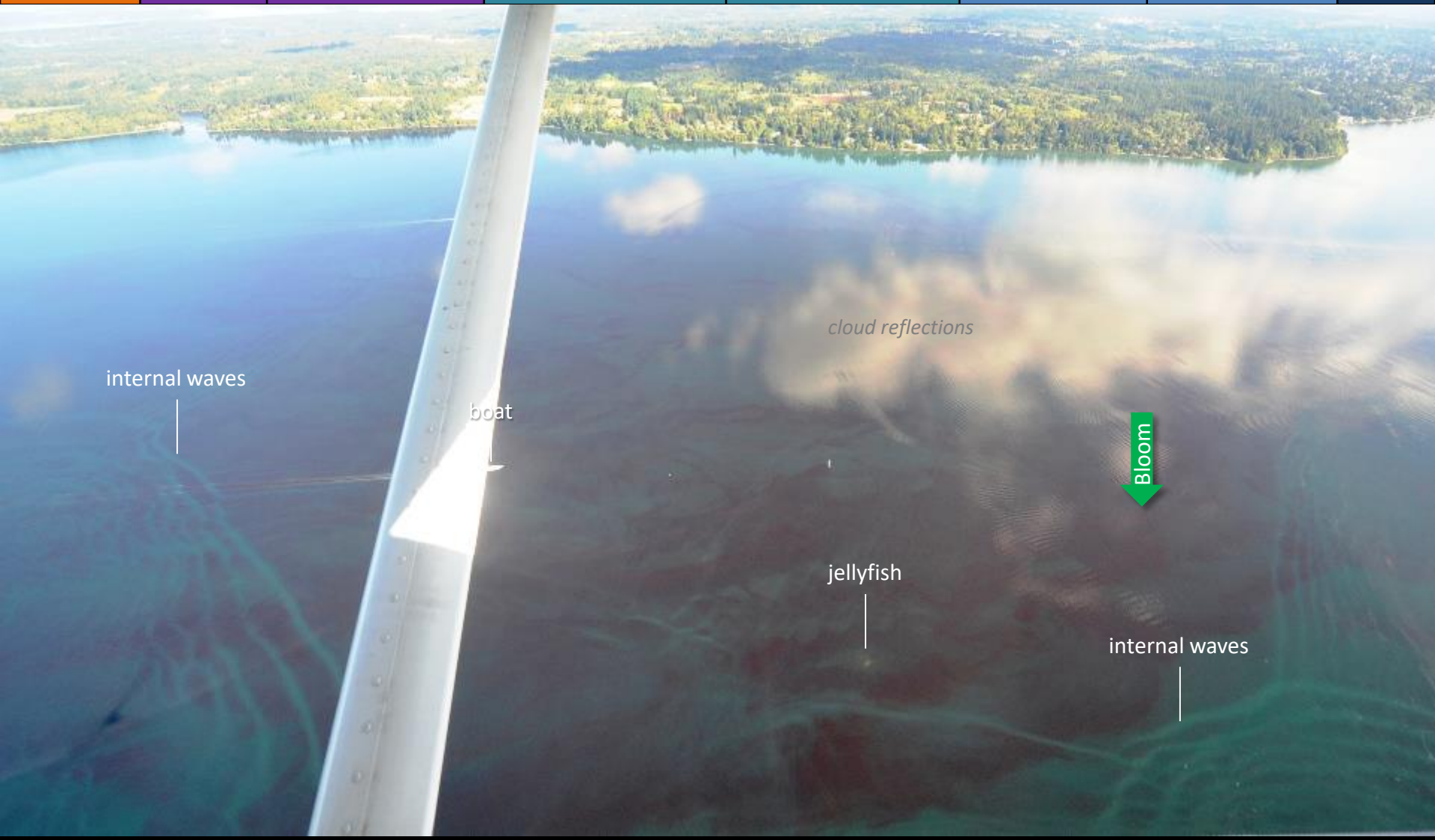
Red-brown bloom highlighting the patchy nature that blooms sometimes have.

Location: Budd Inlet (South Sound), 3:05 PM

Red-brown bloom and patches of jellyfish near entrance channel and East and West Bays.
Location: Budd Inlet (South Sound), 3:07 PM

Internal waves traveling through a red-brown bloom reveal that the bloom is at the water surface.

Location: Budd Inlet (South Sound), 3:08 PM



Large red-brown bloom with jellyfish and internal waves.

Location: Budd Inlet (South Sound), 3:09 PM

Internal waves reveal that flagellate red-brown blooms are often at the water surface.

Location: Budd Inlet (South Sound), 3:09 PM

Find past editions of EOPS

We have published 76 editions!

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

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Contact:
Dr. Christopher Krembs
Christopher.Krembs@ecy.wa.gov
Marine Monitoring Unit
Environmental Assessment Program
Washington State
Department of Ecology

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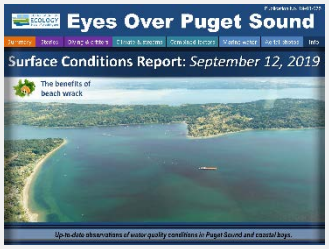

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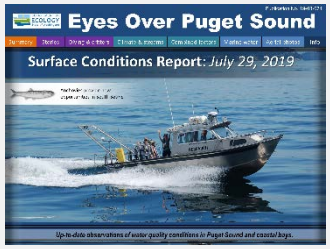

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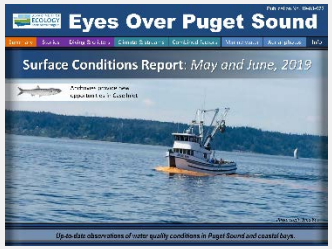

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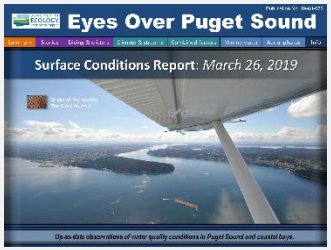

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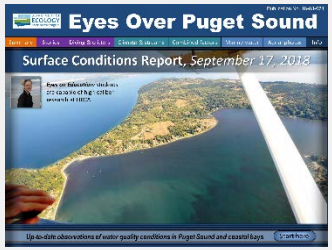

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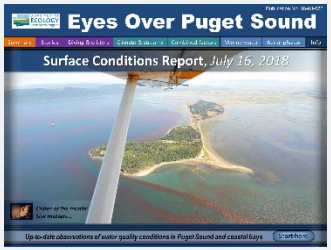

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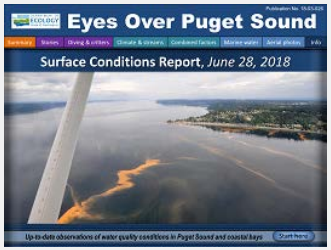

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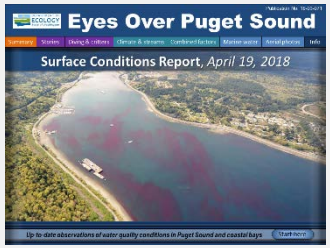

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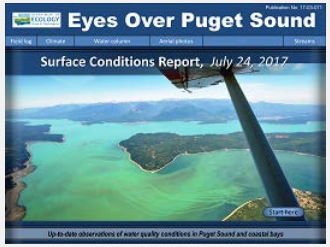

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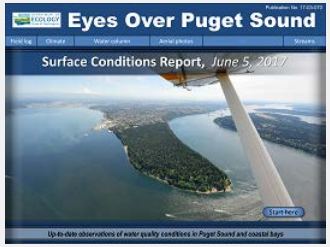

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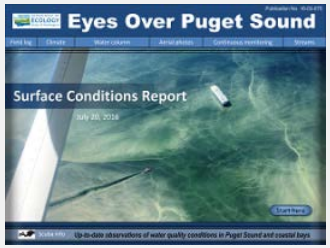

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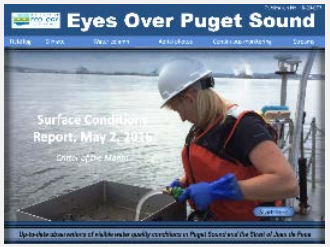

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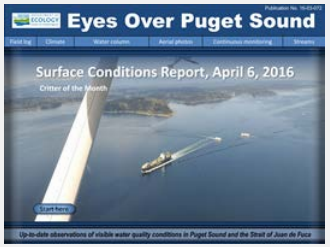

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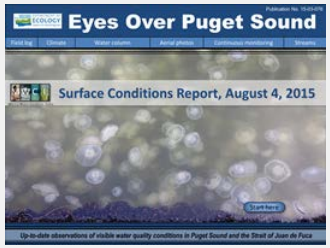

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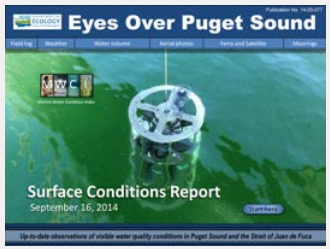

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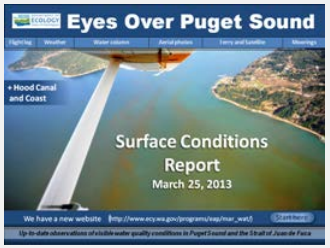

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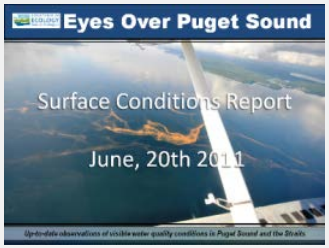

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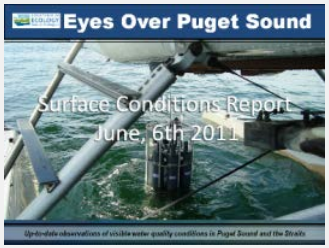

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