Publication No. 19-03-071

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report: *February 21, 2019*

Critter of the month:
The Heart Cockle

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

LONG-TERM MARINE MONITORING UNIT

Julia Bos
Carol Maloy

Tyler Burks
Jim Shedd

Skip Albertson

Dr. Christopher Krembs (Editor)

Personal stories

p. 3

New publication featuring our marine monitoring data!

Climate & streams

p. 6

Fall and winter were warm, yet February was cold and snowy. Despite lowland snow, river flows were lower than expected because precipitation was generally low.

Water temperature and food web

p. 10

This time of the year, Hood Canal is a thermal refuge for cold-sensitive species.

Aerial photography

p. 11

The productive season has already started in Hood Canal and Holmes Harbor. Jellyfish are present in Eld and Budd Inlets, and we think we see some activity of spawning herring and schools of fish and many sea lions.

Editorial assistance provided by: Julianne Ruffner, Carol Maloy, Suzan Pool, Valerie Partridge, Ruth Froese.

New publication featuring our marine monitoring data!

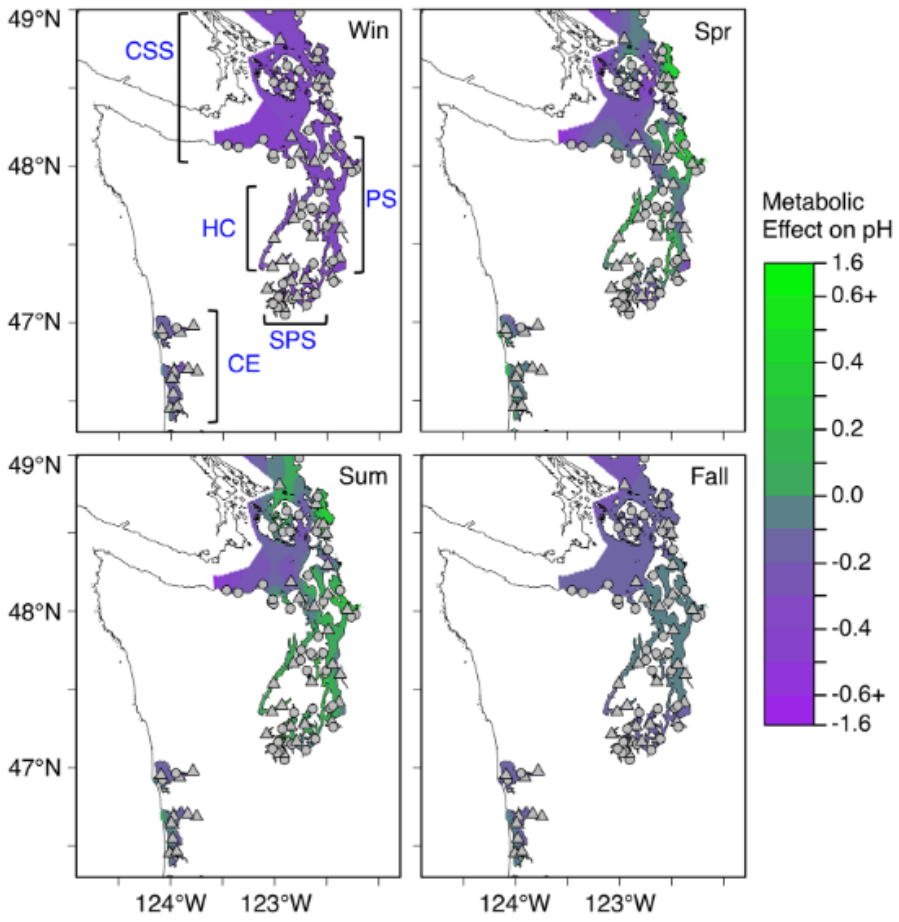


Figure 1. Seasonal mean metabolic effect on pH (observed pH minus predicted 'atmospheric equilibrium' pH) in Washington state waters, USA. Sampling location identified by dots (rotating) and triangles (core). Subregions defined in the analysis are coastal estuaries (CE), Hood Canal (HC), South Puget Sound (SPS), Puget Sound (PS) and Central Salish Sea (CSS).

"Ecosystem metabolism drives pH variability and modulates long-term ocean acidification in the Northeast Pacific coastal ocean."

Alexander T. Lowe, Julia Bos, & Jennifer Ruesink

http://www.nature.com/articles/s41598-018-37764-4

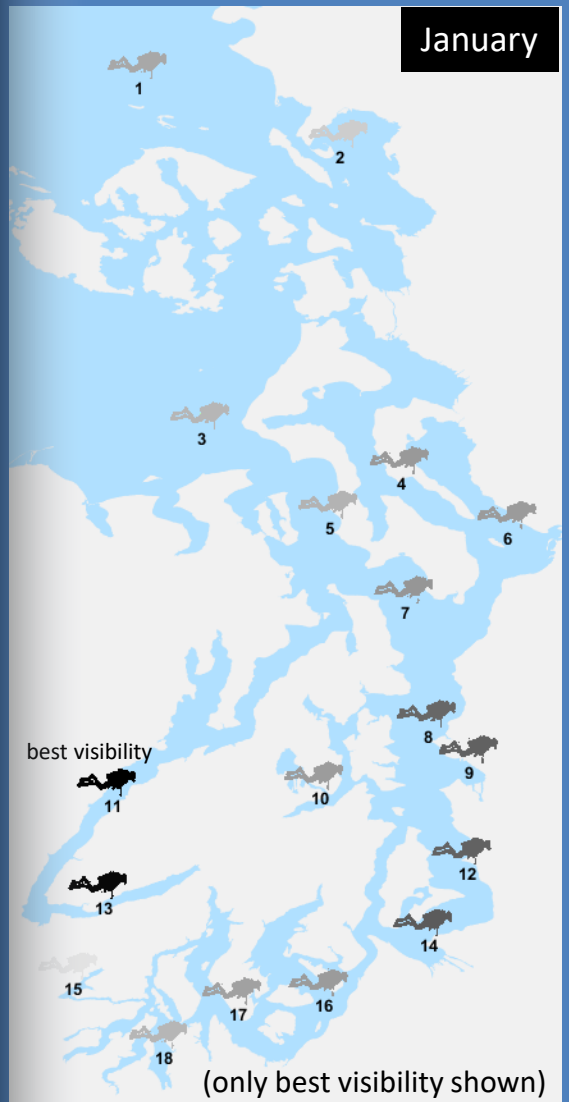
Twenty-five years of Ecology's data contribute to understanding ocean acidification.

Changes in pH over time were about five times greater than those predicted from atmospheric CO2 changes alone.

Dissolved oxygen saturation had a much greater effect on pH than atmospheric CO2, temperature, or salinity.

Collectively, these observations provide evidence that we need to understand local ecosystem processes (altered riverine inputs, eutrophication, etc.) in order to understand how ocean acidification affects our estuaries.

What was the water visibility like for divers?



Best and worst horizontal visibility at corresponding vertical depth

Location	Best Visibility		Worst Visibility	
	Horizontal Distance (ft.)	Vertical Depth (ft.)	Horizontal Distance (ft.)	Vertical Depth (ft.)
1	20	5	15	75
2	11	16	2	2
3	16	87	15	18
4	23	62	13	3
5	17	16	16	94
6	23	90	4	15
7	24	5	21	98
8	35	95	23	3
9	37	77	11	3
10	23	3	12	52
11	66	51	2	8
12	37	94	23	7
13	58	39	2	7
14	38	64	14	3
15	5	62	4	3
16	23	16	22	80
17	21	97	17	5
18	16	15	12	62

Find depths with high/low visibility

- **Best visibility** occurred in Hood Canal near Octopus Hole (location 11) with 66 ft visiblity (at 51 ft depth), despite having very poor visibility near the surface.
- **Poor visibility** occurred in Oakland Bay near Shelton (location 15) and in Hood Canal locations 11 and 13 near the surface (no diver icon)
- 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 Heart Cockle

Angela Eagleston & Dany Burgess
Marine Sediment Monitoring Team

Clinocardium nuttallii

February's critter shows that our hearts are in our work – literally! The heart cockle may look like just another ordinary bivalve, but this heart is a deep ocean of secrets. Find out more about the heart cockle's hidden talents on our latest blog!

Fun Heart Cockle Facts

- They have the amazing ability to "leap" away from danger.
- They have tiny tentacles that help them "smell" predators.
- They have something in common with trees – can you guess what it is?

Image, Dave Cowles, wallawalla.edu

Image, Dave Cowles, wallawalla.edu

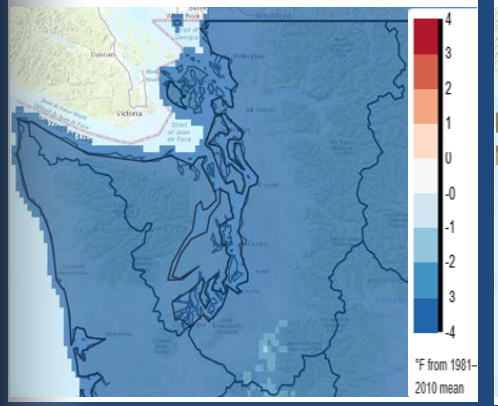
Learn more about the heart cockle and other critters on Ecology's EcoConnect blog here

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

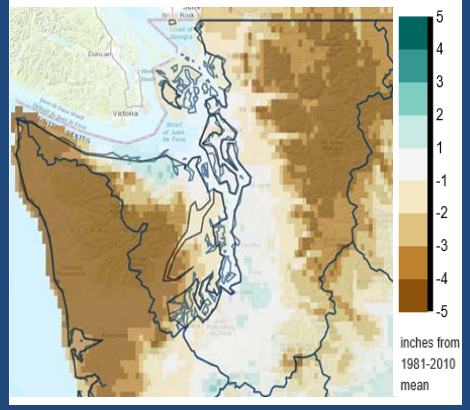
In February, Puget Sound air temperatures were below normal and precipitation remained mostly below normal despite lowland snow (A). The spring climate outlook predicts above-normal temperature, while the precipitation prediction is mixed (B). Snowpack remains below normal despite recent gains (not shown) and could lead to summer streamflow deficits.

A. Northwest Climate Toolbox

Temperature



Precipitation



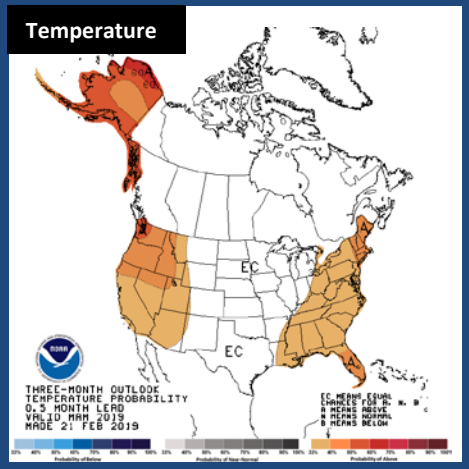
Temperature Anomaly from historical mean daily ranged from -2 to -4 °F in the Puget Sound region during the past 30 days.

Precipitation Anomaly from historical mean ranged from -5 to +3 inches in the Puget Sound region during the past 30 days.

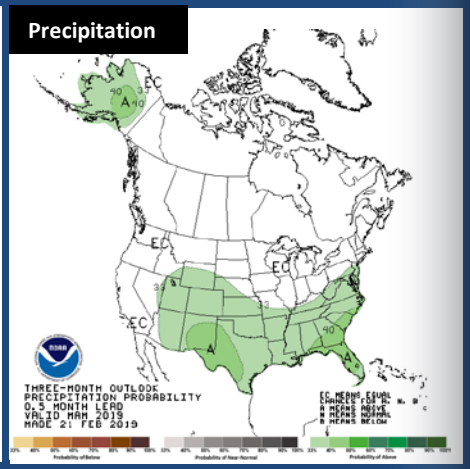
B. Climate Prediction Center, NOAA

March-April-May2019

Temperature



Precipitation



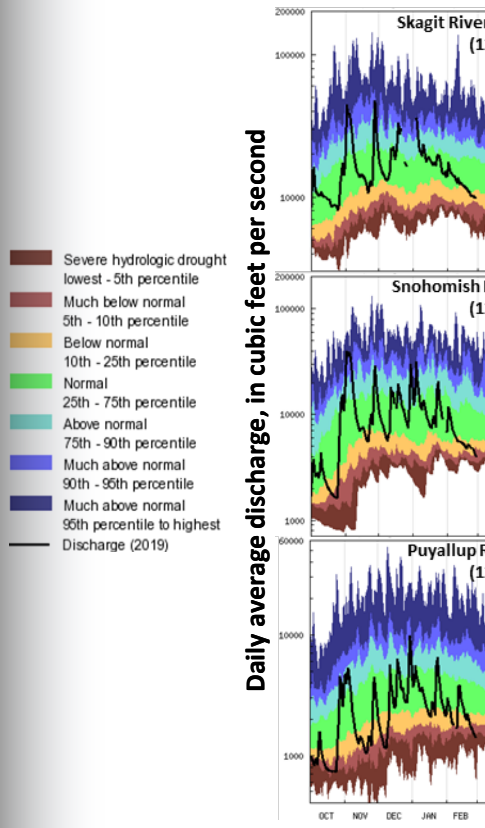
Climate outlook for spring predicts there is an elevated probability that temperature will be above normal in Puget Sound.

There is an equal probability that precipitation will be above, normal, or below average.

How much water flows into Puget Sound?

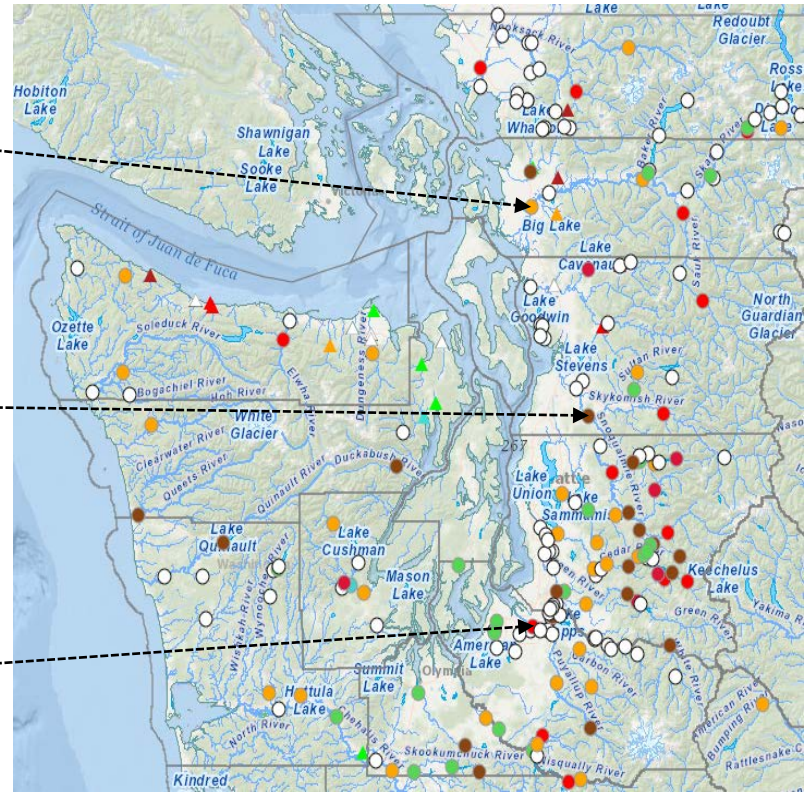
Despite lowland snow, streamflow levels have continued to decline during February due to cold and dry conditions (see trend charts). Nearly all stream gages are reporting flows below 10% of normal, except for those with melting low-elevation snow (see map). Cold conditions are reducing snow-melt runoff at a larger range of elevations than is typically experienced this time of year, especially with reduced precipitation.

Select Puget Sound Streamflow Trends



USGS WaterWatch: CLICK HERE!

Current Streamflow Conditions as of 2/28/2019



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

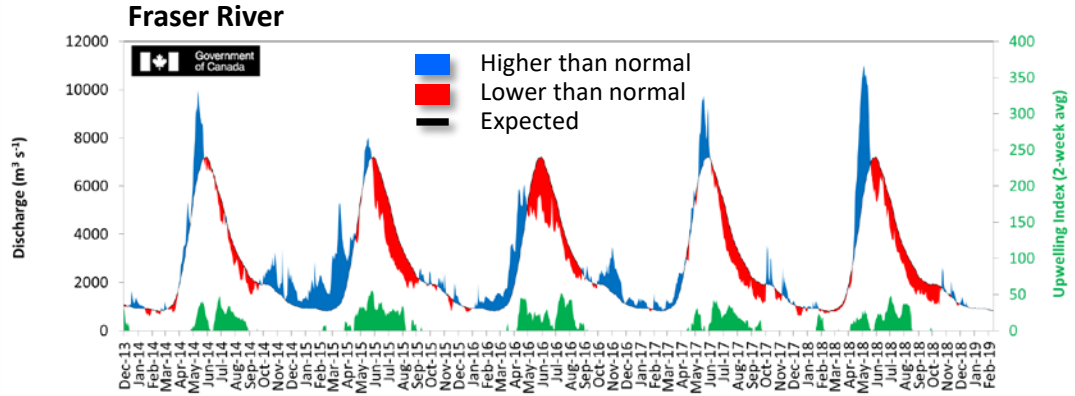
Daily Streamflow

- 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!

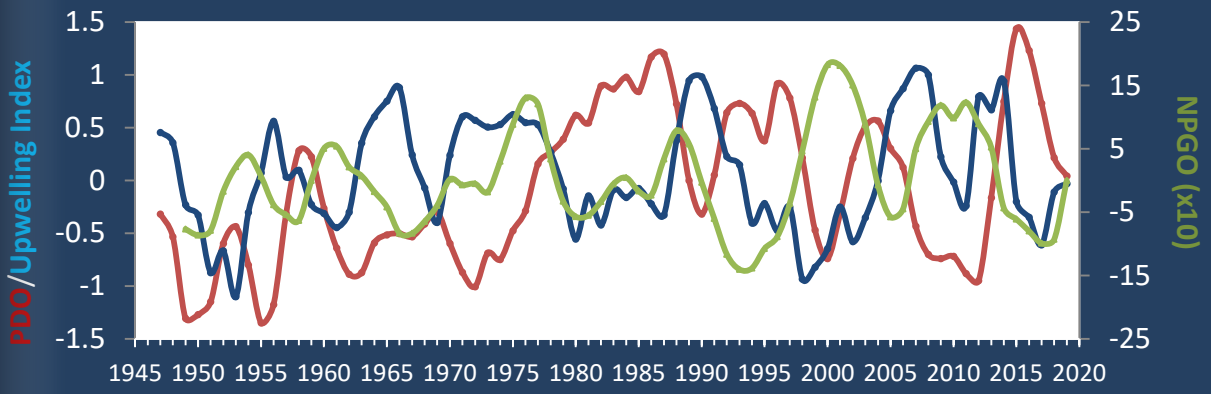
Climate influences: How well is Puget Sound exchanging its water?

Historically, the peaks of coastal upwelling and the freshet are in sync. In 2018 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 are currently very much 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 expected (Upwelling Index anomaly). NPGO, which reflects the surface productivity along the coast, is expected as well.

*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?

In the anomaly plot we want to connect different factors influencing water quality in context of space and time. Conditions leading up to February 2019 were warmer and slightly drier. This is different than fall and winter 2017, where conditions were cooler but wetter. In 2018, fall and early winter were generally sunnier than the year before. February, however, is breaking this pattern (see page 6).

Conditions leading up to February:

Air temperatures have generally been warmer for the past several months in fall 2018, and are also warmer than fall 2017.

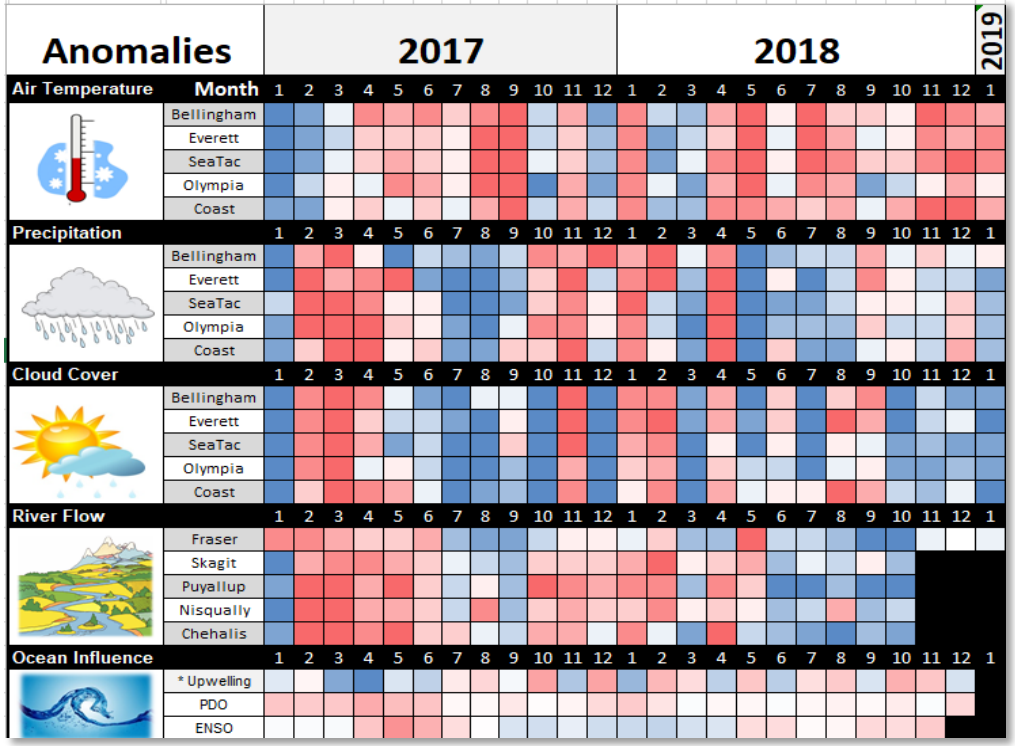
Precipitation for the past four months has been lower than in 2017.

Sunshine (opposite of cloud cover) has been consistently higher than the previous winter.

River flows from USGS were recently unavailable.

Upwelling and ENSO (MEI) were more moderate in 2018 than 2017.

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



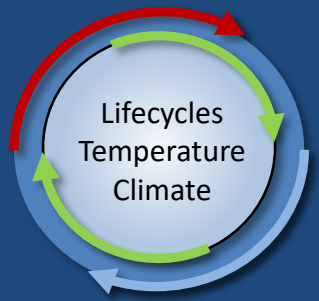
No data because of government shutdown

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

higher — expected — lower

No data

Water temperature affects ecosystem performance



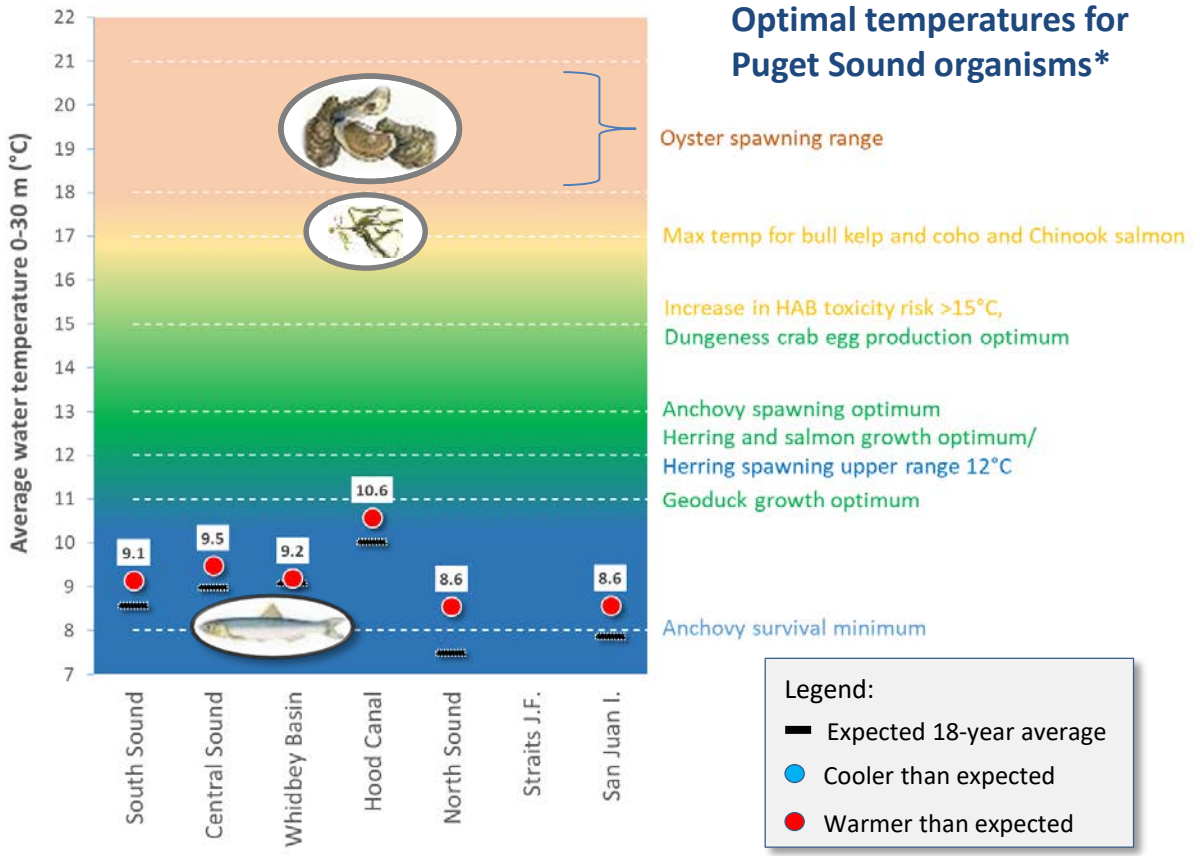
Can organisms thrive and survive?

The life cycles of organisms respond to temperature. To be successful, the timing of early life stages must 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 to the success and survival of marine organisms.

In January, average water temperatures in surface water 0 – 30m were warmer than the baseline (1999 – 2016). Hood Canal remained the warmest, providing a thermal refuge for cold-water intolerant species. North Sound and San Juan Islands were cooler. If cooling continues, anchovies that only tolerate temperatures above 8 °C will be trapped in Hood Canal.



What are the conditions at the surface?

The productive season has already started in Hood Canal and Holmes Harbor (Whidbey Basin), despite colder temperatures. Jellyfish are present in Eld and Budd Inlets. We saw indications of spawning herring and schools of fish in Dabob Bay, Squaxin Island, and places near Admiralty Reach. Suspended sediment makes the distinction between sediment and spawning fish prone to error.

Start here

Large sea lion aggregation > 50 individuals, Case Inlet

Steven Jeffries, DFW: "There are 150 – 250 sea lions in South Sound since November feeding on anchovies." Click for video (here).

Different water masses entering Colvos Passage on low tide

Front

Mixing and fronts:
Distinct fronts in Admiralty Reach, Port Madison, and Commencement Bay.

Jellyfish and fish:
Jellyfish patches in Eld and Budd Inlets. Spawning herring in Quilcene Bay, Squaxin Island, and Skunk Bay. Schooling fish in Scow Bay.

Plume

Suspended sediment:
Suspended sediment in North Sound. Suspended sediment of Nisqually River does not extend far into Nisqually Reach this winter. Brown water of smaller creeks is visible in many places as it enters Puget Sound.

Bloom

Visible blooms:
Strong red-brown bloom in Holmes Harbor. Some turquoise discoloration suggesting fine sediments, not blooms in South and Central Sound.

Debris

Debris:
Unusual patches of organic material for February in Budd Inlet, Hood Canal, and Commencement Bay near Vashon Island.

Aerial navigation guide

Date: 2-21-2019

Click on numbers

Tide data from February 21, 2019 (Seattle):

Time	Pred	High/Low
06:25 AM	12.80	H
12:21 PM	3.71	L
5:56 PM	11.24	H

Flight Observations

Sunny and windy toward north

Map Key

Flight route

Large ribbon of reddish-orange material accumulating at front.

Location: Budd Inlet (South Sound), 11:25 AM

Jellyfish aggregations of this size appear early this year. Boggy water entering from Green Cove Creek.

Location: Eld Inlet (South Sound), 11:31 AM

Suspended sediment over mussel beds appears to have been applied by boat to shellfish beds.

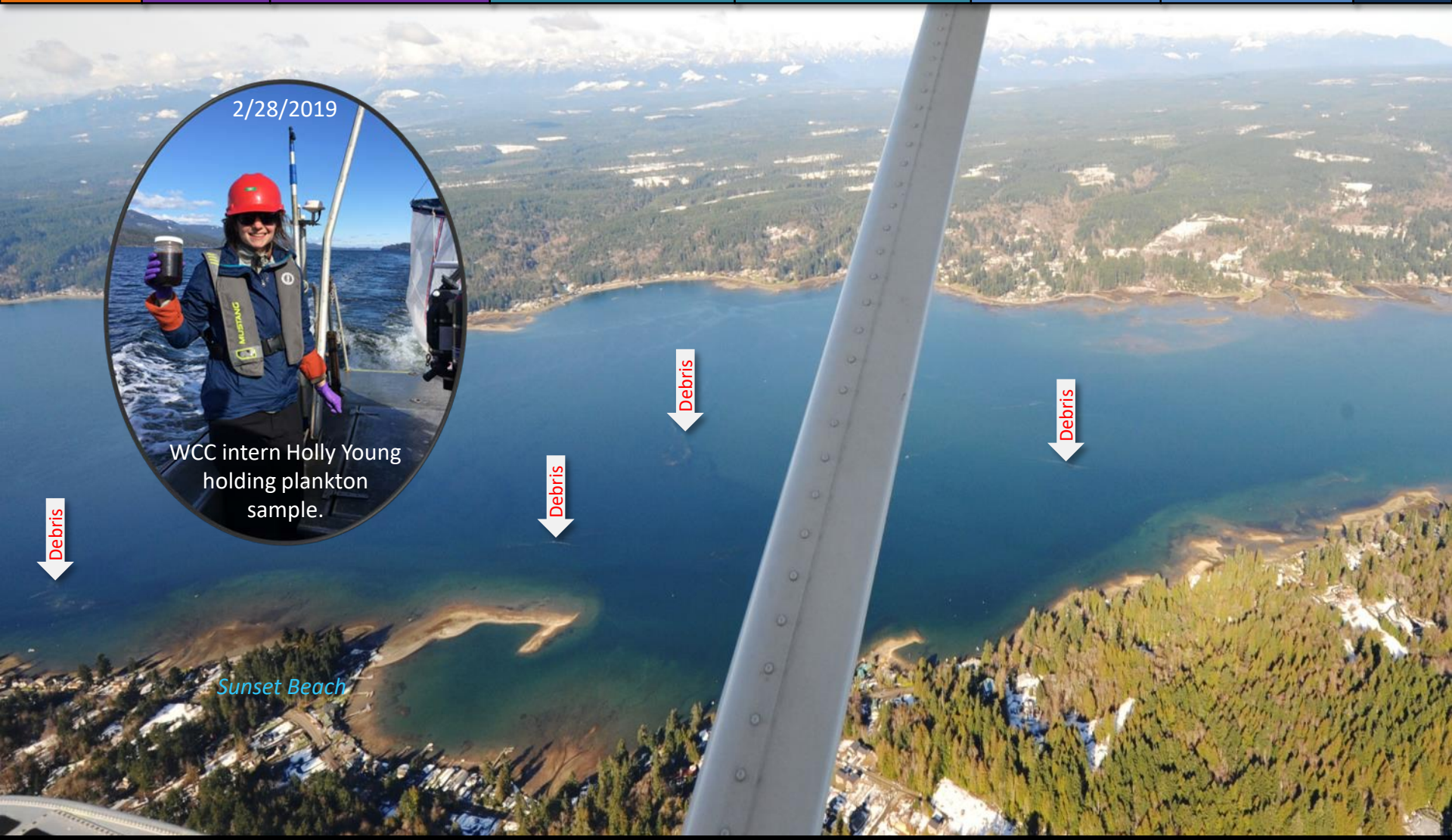
Location: Hudson Cove, Totten Inlet (South Sound), 11:32 AM

Aerial photography 2-21-2019

Orange organic debris and what appears to be spawning herring.

Location: Squaxin Island (South Sound), 11:37 AM

Plume of the Sherwood Creek extending across North Bay.
Location: Case Inlet (South Sound), 11:56 AM



Sizable rafts of organic material present in Hood Canal from Belfair State Park to Lilliwaup.

Location: Sunset Beach, (Hood Canal), 11:58 AM

Coloration difference between suspended sediment and what appears to be spawning herring.

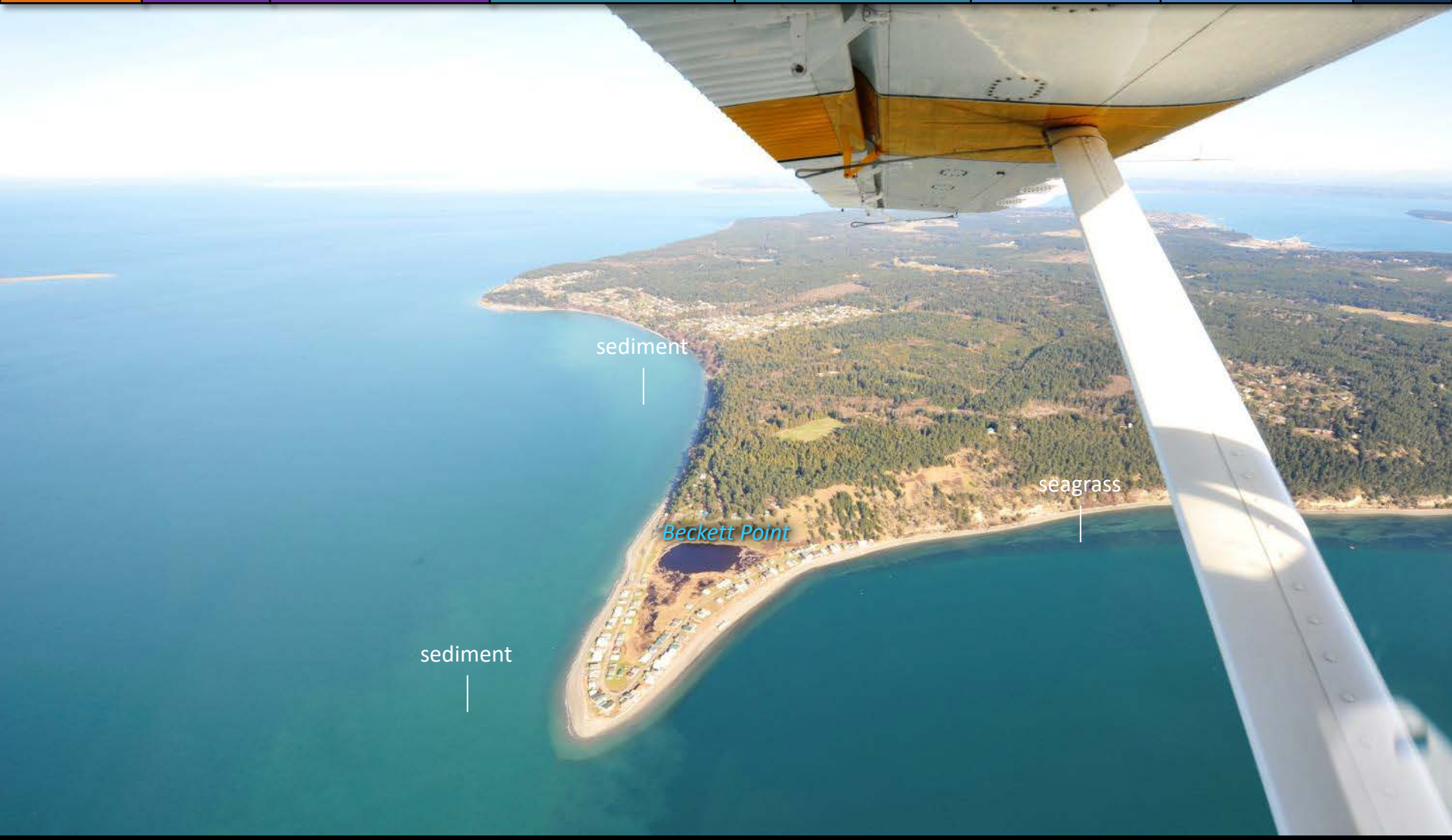
Location: Quilcene Bay, Dabob Bay (Hood Canal), 12:23 PM

Whitish glow at deeper fringes of the seagrass bed: spawning herring or something else?

Location: Dabob Bay (Hood Canal), 12:23 PM

Incoming tide suspending fine sediment flowing past Klapot Point into Sequim Bay.

Location: Sequim Bay (North Sound), 12:40 PM

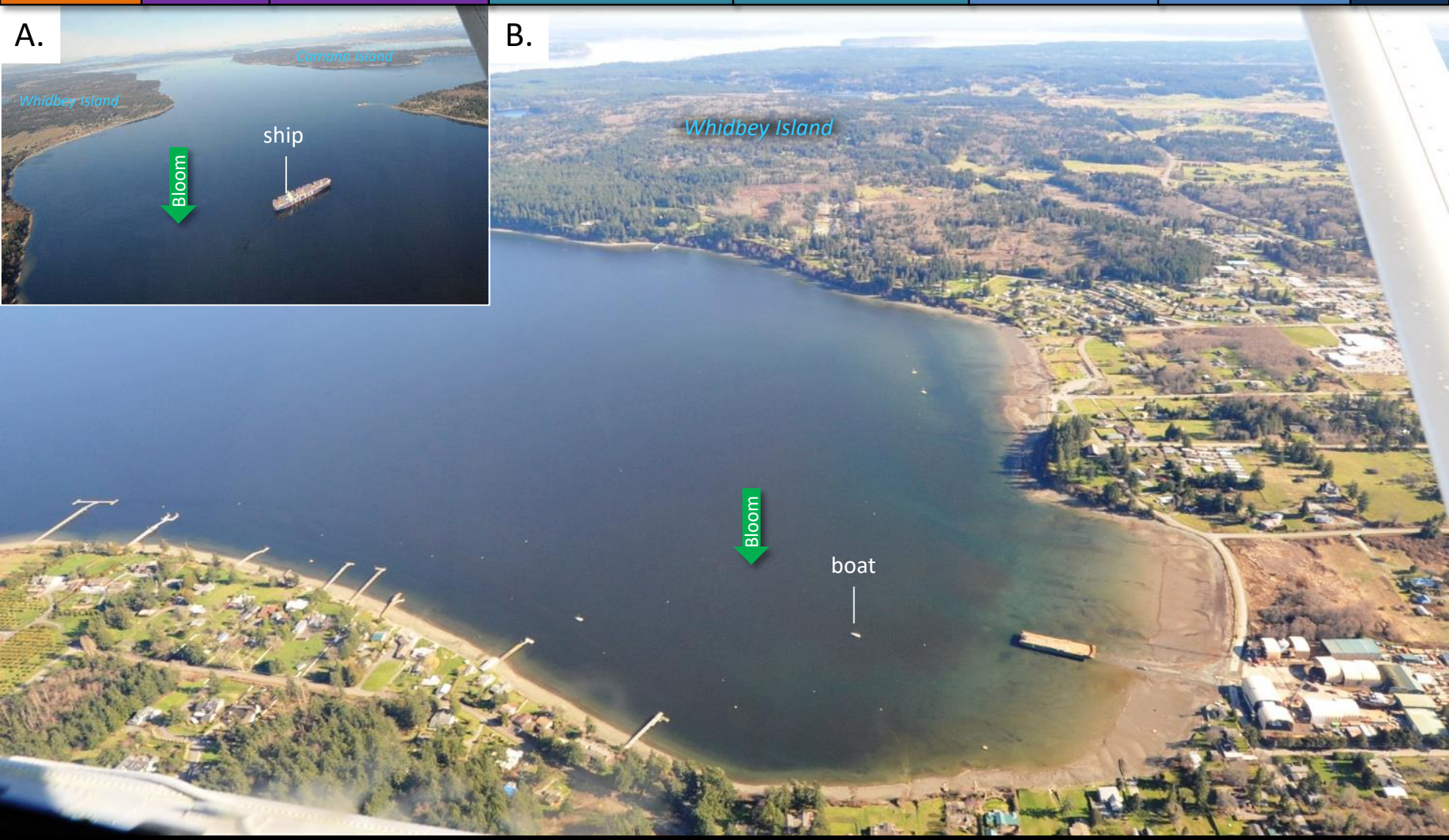


Suspended sediment along shoreline facing waves and northerly winds makes spotting herring impossible.

Location: Discovery Bay (North Sound), 12:44 PM

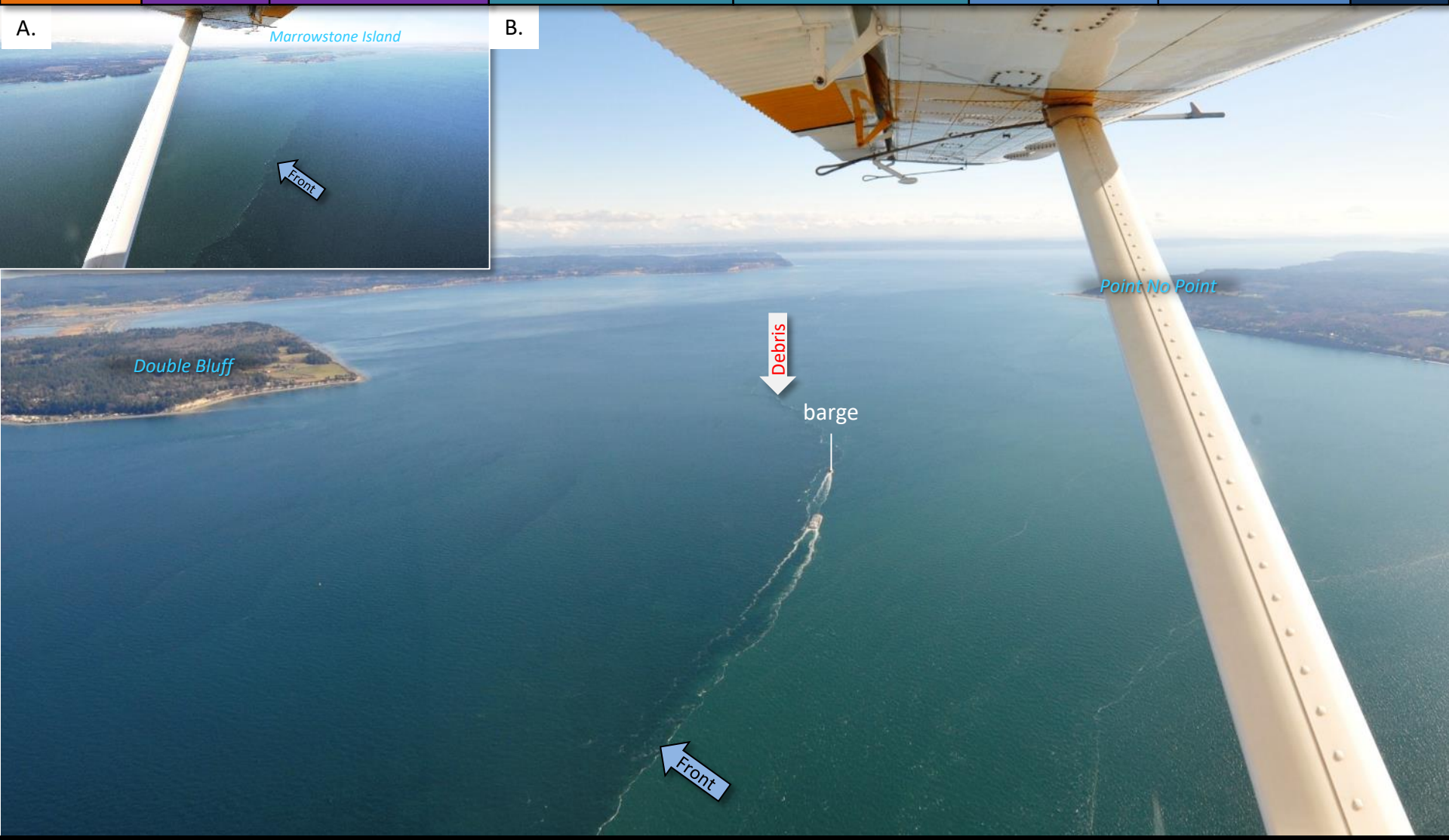
Schooling fish, likely herring, in Scow Bay. Suspended sediment.

Location: Between Marrowstone and Indian Island (Central Sound), 12:51 PM



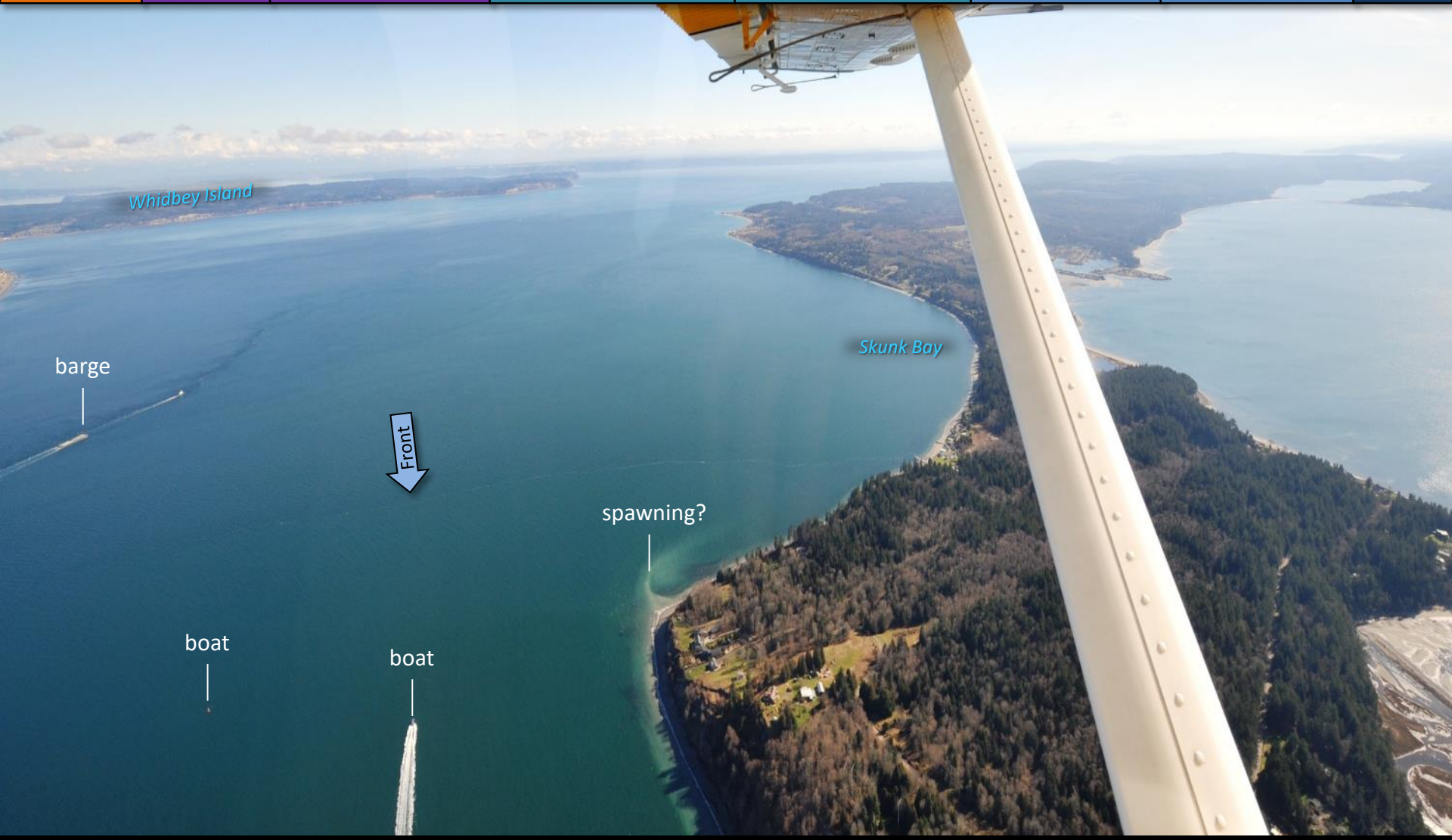
A. Large container ship anchored in Holmes Harbor. B. Red-brown bloom in across entire bay.

Location: Holmes Harbor (Whidbey Basin), 12:58 PM



Large tidal front stretching from Marrowstone Island A. to Point No Point B.

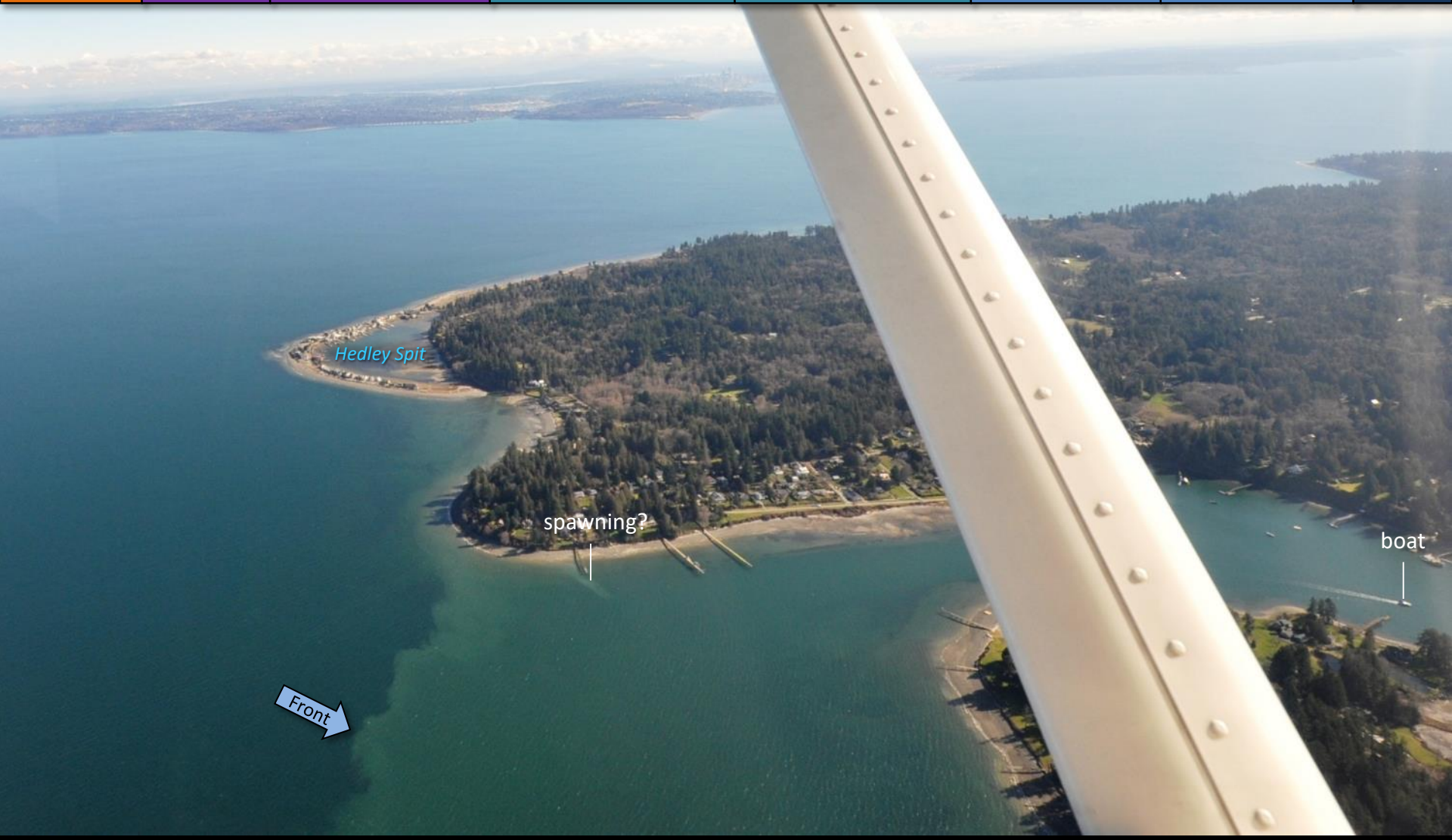
Location: Admiralty Reach (Central Sound), 1:01 PM



Could this be spawning herring north of Skunk Bay (not confirmed)?

Location: Admiralty Reach (Central Sound), 1:01 PM

Aerial photography 2-21-2019



Two distinct water masses at the entrance to Port Madison. Potentially spawning herring near dock?

Location: Port Madison (Central Sound), 1:09 PM

Image shows how ribbons of river plumes can extend far. Here a plume reaches into Keyport lagoon.

Location: Liberty Bay (Central Sound), 1:11 PM

Aerial photography 2-21-2019

Very boggy water from Curley Creek entering Yukon Harbor.

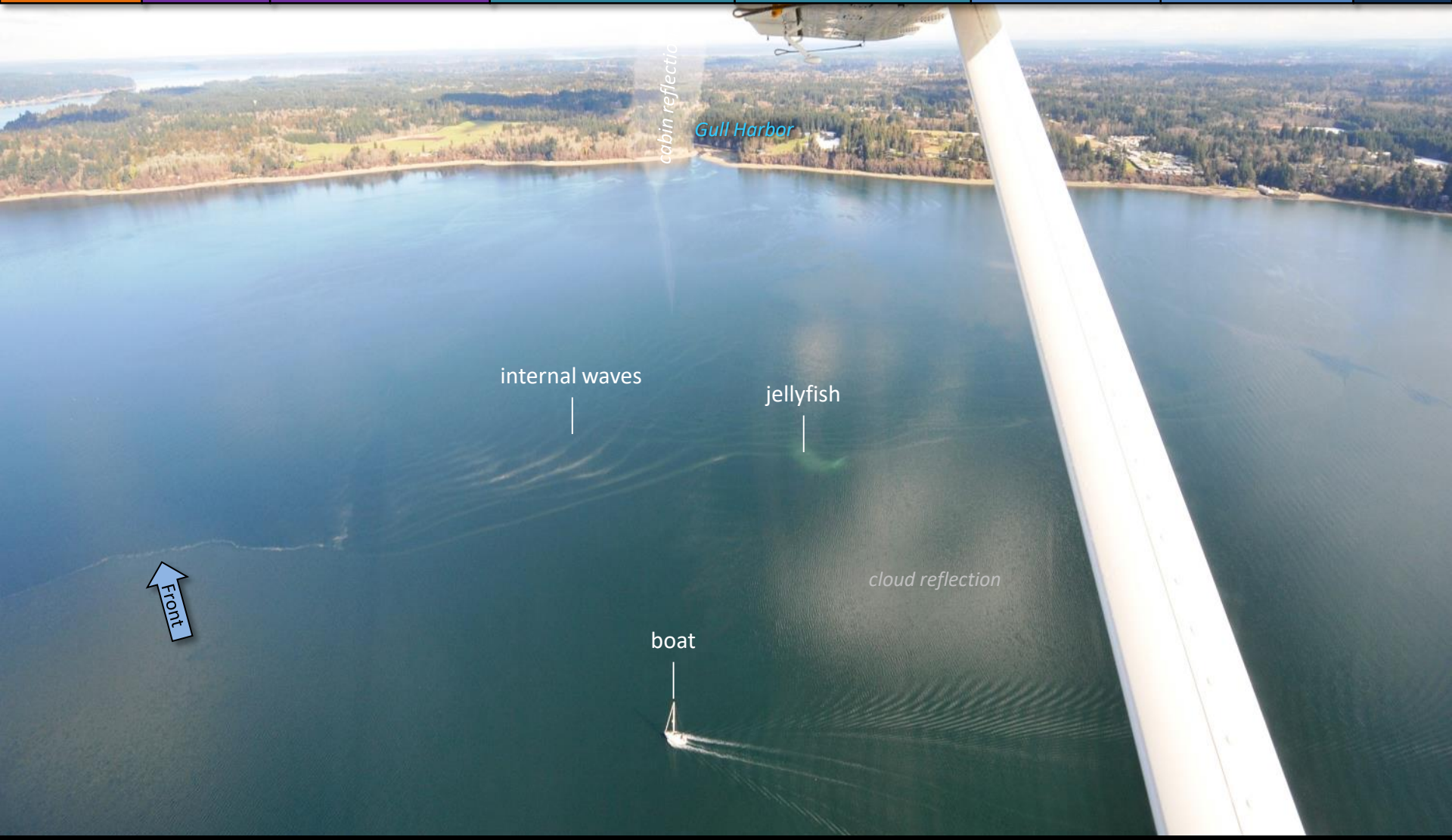
Location: Budd Inlet (Central Sound), 1:22 PM

Suspended sediment and potentially spawning herring at Neill Point. Debris aggregating at fronts.

Location: Vashon Island, Commencement Bay (Central Sound), 1:29 PM

Strong front outlining the Nisqually River plume carrying sediment.

Location: Nisqually Reach (South Sound), 1:39 PM



Jellyfish patch and internal waves at the margins of the Deschutes River plume.

Location: Budd Inlet (South Sound), 1:44 PM

Find past editions of EOPS on the next pages

We have published 79 editions!

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

Recommended Citation (example e.g., September):

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

Many thanks to our business partners:
Shannon Point Marine Lab (WWU), Swantown Marina, Kenmore Air.

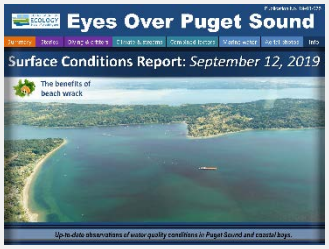
Contact:
Dr. Christopher Krembs
Christopher.Krembs@ecy.wa.gov
Marine Monitoring Unit
Environmental Assessment Program
Washington State
Department of Ecology

Subscribe to the Eyes Over Puget Sound email listserv.

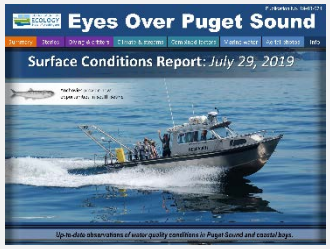
March_16_2020,
Publication No. 20-03-071

Jan_10_2020,
Publication No. 20-03-070

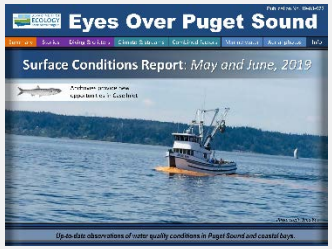
October_30_2019,
Publication No. 19-03-076



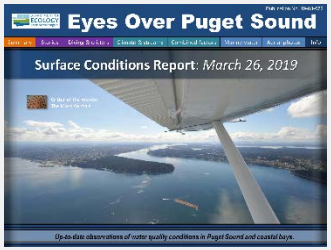
September_12_2019,
Publication No. 19-03-075



July_29_2019
Publication No. 19-03-074



June_4_2019
Publication No. 19-03-073

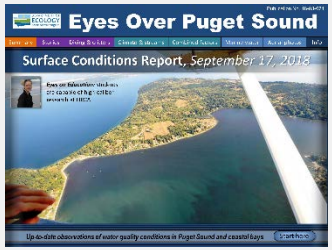


March_26_2019
Publication No. 19-03-072

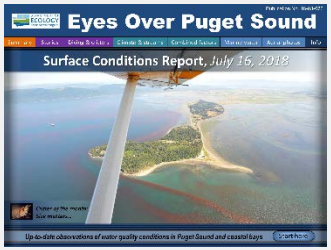
February_21_2019
Publication No. 19-03-071

January_10_2019
Publication No. 19-03-070

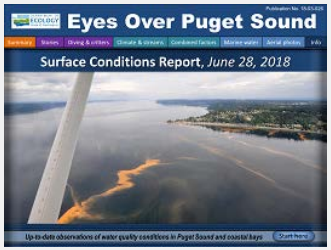
November_6_2018,
Publication No. 18-03-075



September_17_2018,
Publication No. 18-03-074

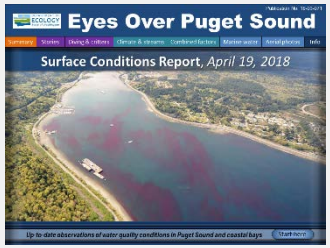


July_16_2018,
Publication No. 18-03-073



June_28_2018,
Publication No. 18-03-072

May_22_2018,
Publication No. 18-03-025

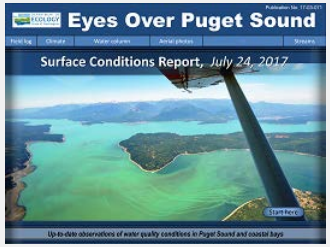


April_19_2018,
Publication No. 18-03-071

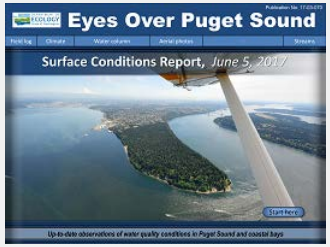
Winter_2018,
Publication No. 18-03-070

October_31_2017,
Publication No. 17-03-073

August_28_2017,
Publication No. 17-03-072



July_24_2017,
Publication No. 17-03-071



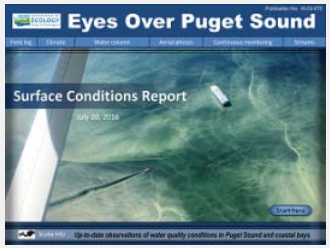
June_6_2017,
Publication No. 17-03-070

December_31_2016,
Publication No. 16-03-079

November_22_2016,
Publication No. 16-03-078

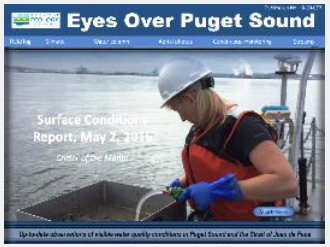
September_26_2016,
Publication No. 16-03-077

August_24_2016,
Publication No. 16-03-076

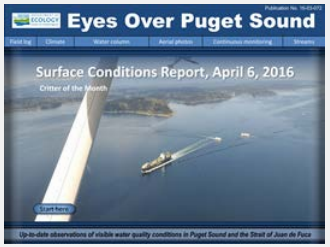


July_20_2016,
Publication No. 16-03-075

June_27_2016,
Publication No. 16-03-074



May_2_2016,
Publication No. 16-03-073



April_6_2016,
Publication No. 16-03-072

March_16_2016,
Publication No. 16-03-071

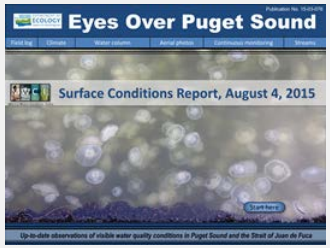
February_8_2016,
Publication No. 16-03-070

December_30_2015,
Publication No. 15-03-080

December_14_2015,
Publication No. 15-03-079

October_6_2015,
Publication No. 15-03-078

September_21_2015,
Publication No. 15-03-077



August_8_2015,
Publication No. 15-03-076

July_6_2015,
Publication No. 15-03-075

June_8_2015,
Publication No. 15-03-074

April_29_2015,
Publication No. 15-03-073

March_24_2015,
Publication No. 15-03-072

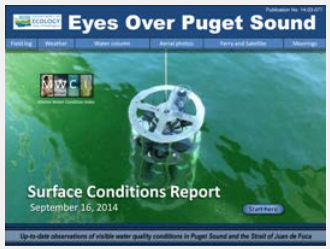
February_17_2015,
Publication No. 15-03-071

January_28_2015,
Publication No. 15-03-070

December_30_2014,
Publication No. 14-03-080

November_17_2014,
Publication No. 14-03-079

October_29_2014,
Publication No. 14-03-078



September_16_2014,
Publication No. 14-03-077

August_18_2014,
Publication No. 14-03-076

July_28_2014,
Publication No. 14-03-075

June_23_2014,
Publication No. 14-03-074

May_12_2014,
Publication No. 14-03-073

April_21_2014,
Publication No. 14-03-072

March_24_2014,
Publication No. 14-03-071

February_4_2014,
Publication No. 14-03-070

December_31_2013,
Publication No. 13-03-081

November_21_2013,
Publication No. 13-03-080

October_28_2013,
Publication No. 13-03-079

September_11_2013,
Publication No. 13-03-078

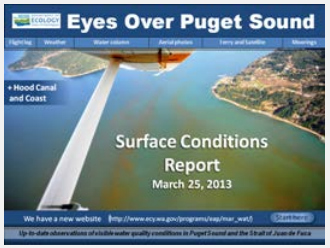
August_21_2013,
Publication No. 13-03-077

July_15_2013,
Publication No. 13-03-076

June_17_2013,
Publication No. 13-03-075

May_20_2013,
Publication No. 13-03-074

April_8_2013,
Publication No. 13-03-073



Mar_25_2013,
Publication No. 13-03-072

February_26_2013,
Publication No. 13-03-071

January_15_2013,
Publication No. 13-03-070

December_13_2012,
Publication No. 12-03-081

November_8_2012,
Publication No. 12-03-080

October_8_2012,
Publication No. 12-03-079

September_11_2012,
Publication No. 12-03-078

August_27_2012,
Publication No. 12-03-077

July_31_2012,
Publication No. 12-03-076

June_12_2012,
Publication No. 12-03-075

May_14_2012,
Publication No. 12-03-074

April_23_2012,
Publication No. 12-03-073

March_19_2012,
Publication No. 12-03-072

February_27_2012,
Publication No. 12-03-071

January_30_2012,
Publication No. 12-03-070

December_5_2011,
Publication No. 11-03-082

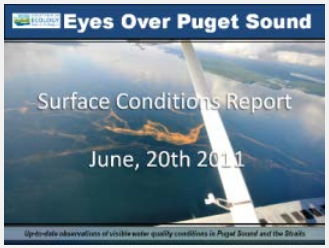
November_15_2011,
Publication No. 11-03-081

October_17_2011,
Publication No. 11-03-080

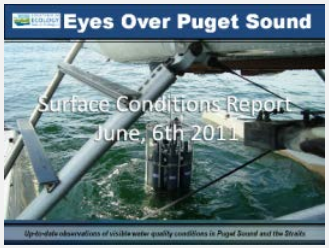
September_12_2011,
Publication No. 11-03-079

August_8_2011,
Publication No. 11-03-078

July_6_2011,
Publication No. 11-03-077



June_20_2011,
Publication No. 11-03-076



June_6_2011,
Publication No. 11-03-075

May_4_2011,
Publication No. 11-03-074

April_27_2011,
Publication No. 11-03-073