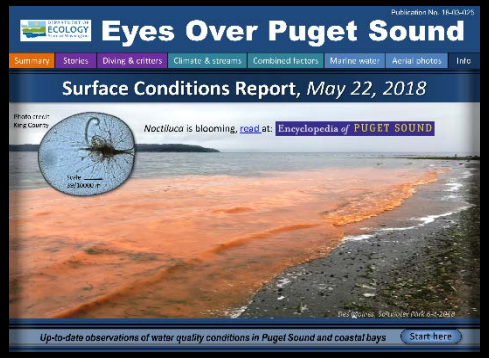
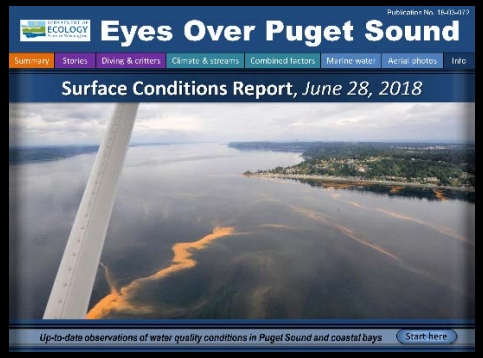
Publication No. 19-03-070

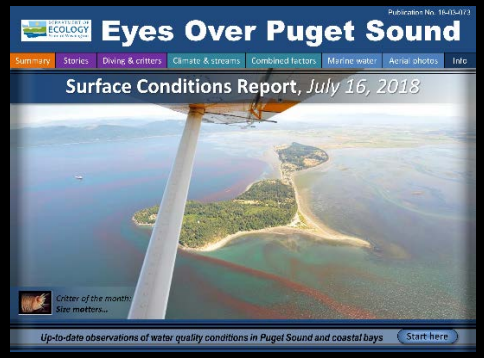
Eyes Over Puget Sound

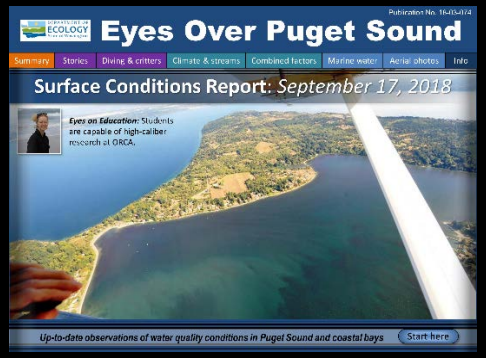
DEPARTMENT OF ECOLOGY State of Washington

Food for thought | Climate and streams | Fish and food | Aerial photos | Info





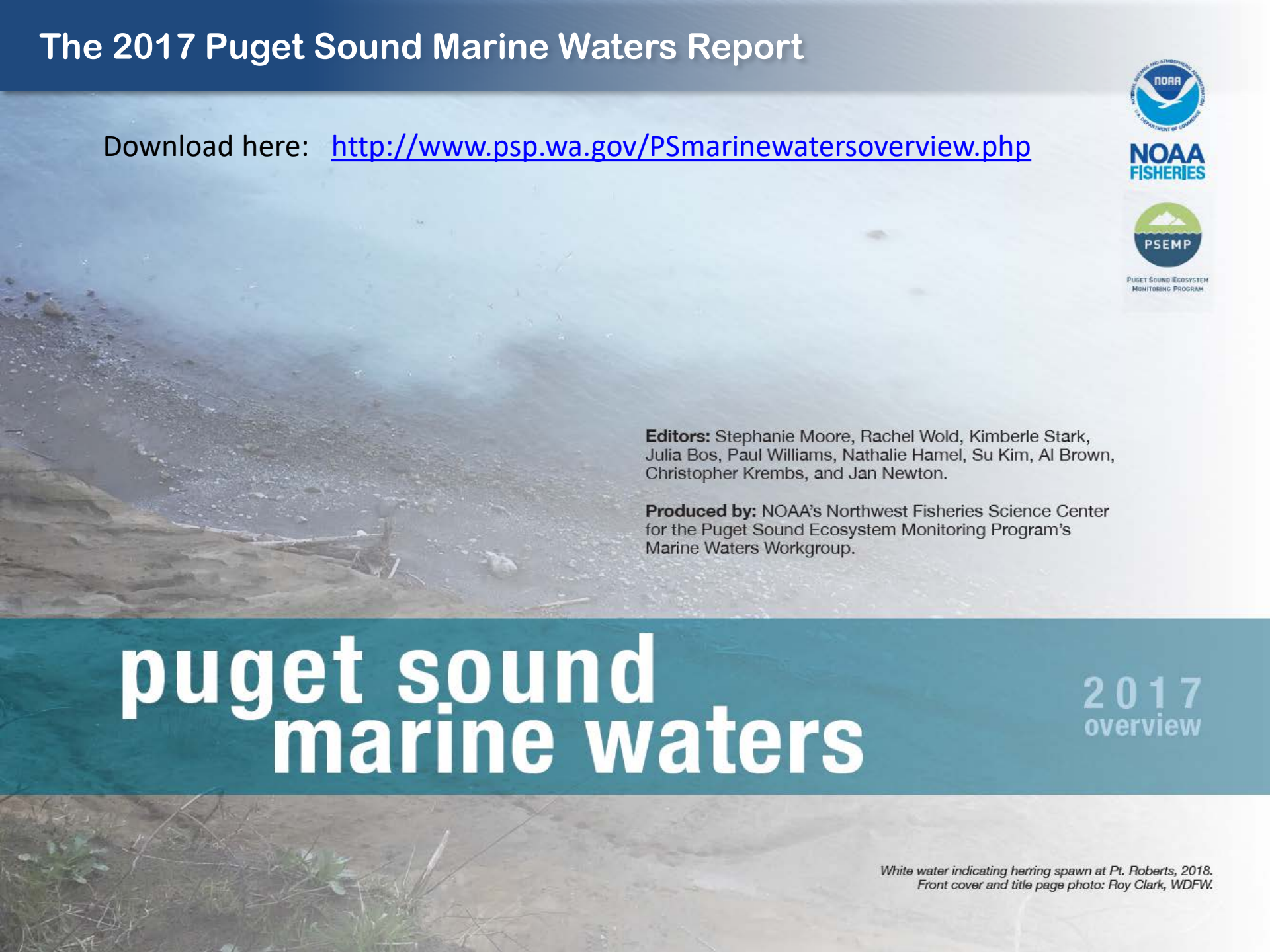




Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca

The 2017 Puget Sound Marine Waters Report

Download here: http://www.psp.wa.gov/PSmarinewatersoverview.php



Editors: Stephanie Moore, Rachel Wold, Kimberle Stark, Julia Bos, Paul Williams, Nathalie Hamel, Su Kim, Al Brown, Christopher Krembs, and Jan Newton.

Produced by: NOAA's Northwest Fisheries Science Center for the Puget Sound Ecosystem Monitoring Program's Marine Waters Workgroup.

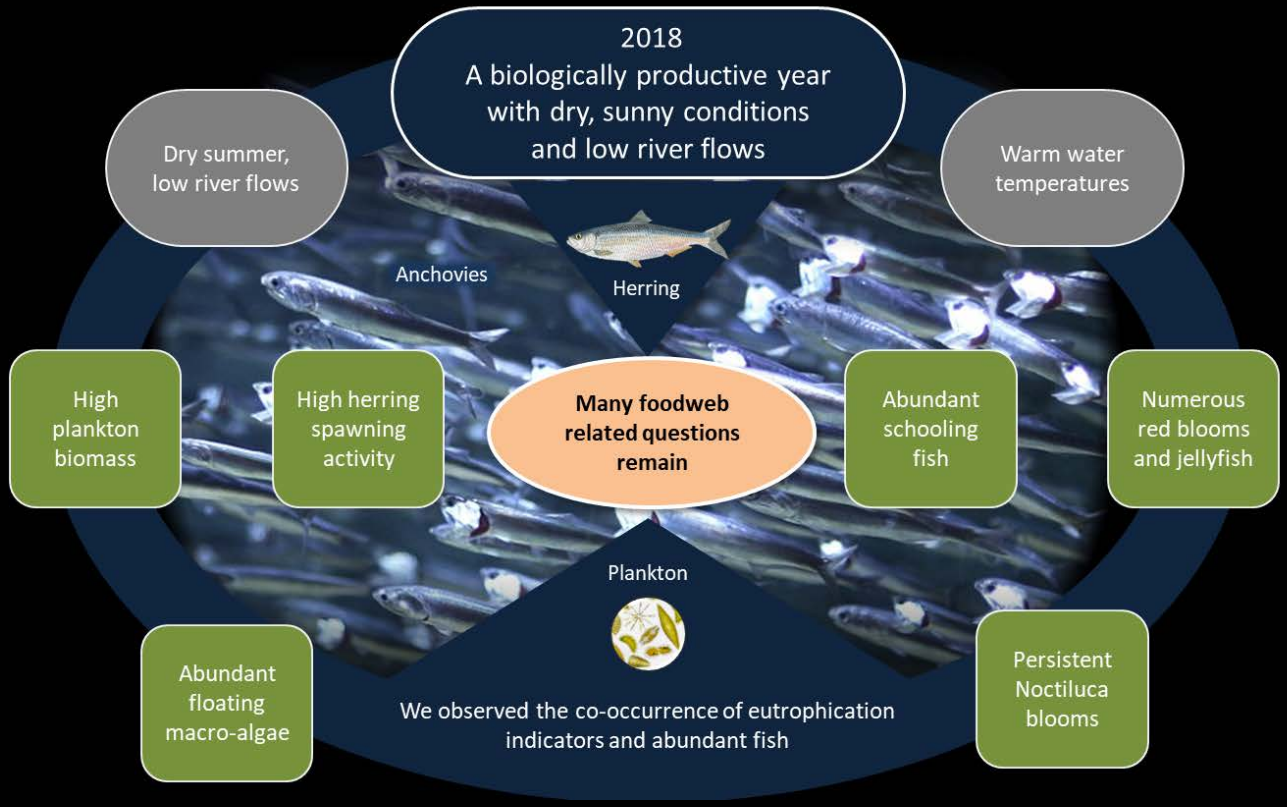
puget sound marine waters

2017 overview

White water indicating herring spawn at Pt. Roberts, 2018. Front cover and title page photo: Roy Clark, WDFW.

EOPS observations provide food for thought

In 2018, water temperatures were slightly warmer than normal, and aerial photos revealed an abundance of spawning herring and baitfish. We saw abundant macroalgae across Puget Sound and a two-month-long Noctiluca bloom in Central Sound. Countless blooms occurred in bays of South Sound, the Kitsap Peninsula, Sequim, and Bellingham Bay. Despite many visible eutrophication indicators, bait fish appeared to be abundant.



Could the future of climate change offer more opportunities than we tend to think?

What influences Puget Sound water quality?

Climate conditions for 2018 were marked by a cool and wet spring followed by a warm, dry, and sunny summer with lower river flows. The onset of a dry summer spell started in May, one month earlier than in 2017. In the fall, conditions were sunnier and drier than the previous year, which also led to lower river flows through October 2018.

Conditions Jan 2017 to Dec 2018:

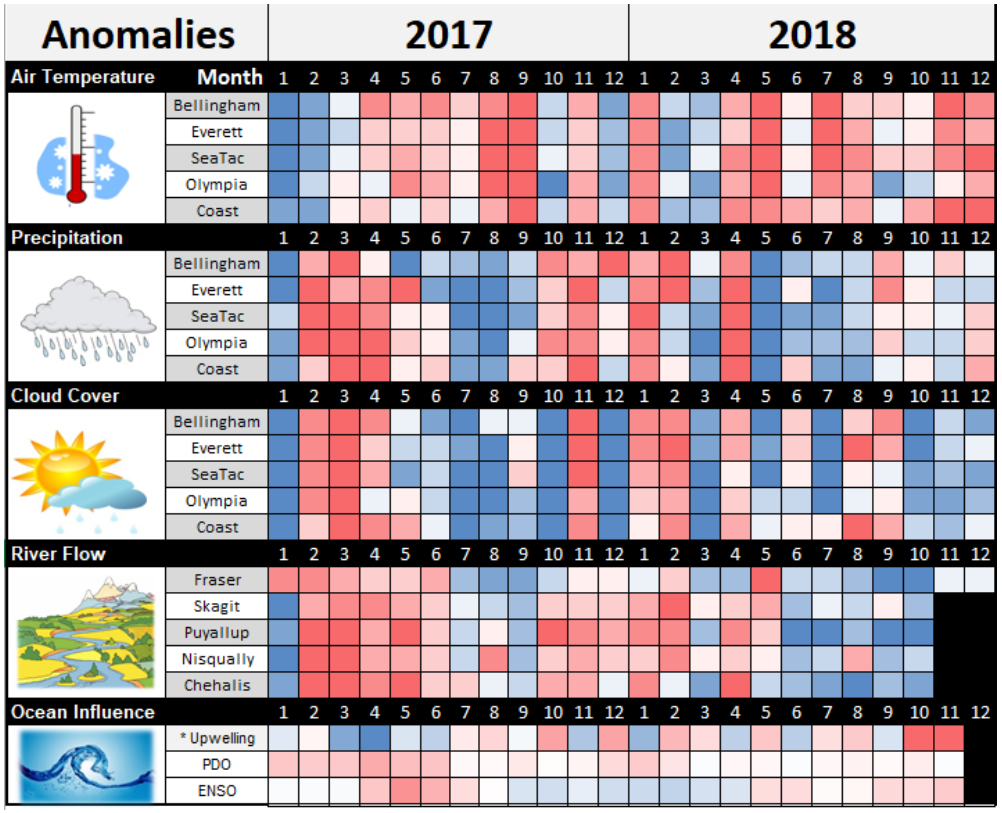
Air temperatures were generally slightly above normal since April 2018, repeating the pattern of 2017.

Precipitation was lower in summer of 2018 and similar to 2017. Fall rain in 2018 was low.

Sunshine, the opposite of cloud cover, was higher in the fall of 2018, also leading to drier conditions.

River flows were noticeably lower in the summer of 2018 than in 2017.

Upwelling and ENSO have been positive.



Data not available due to federal government shutdown

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

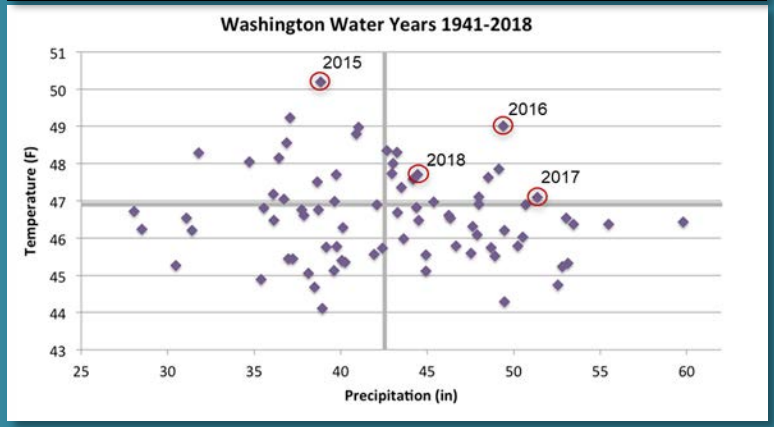
higher — expected — lower

No data

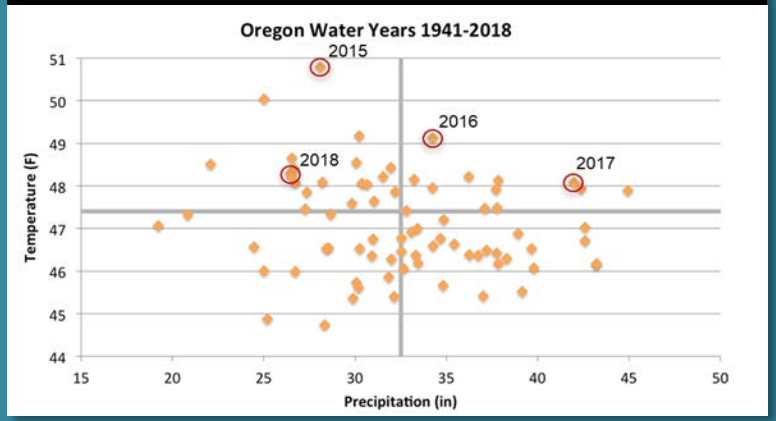
All data are from public sources: UW GRAYSKIES; river flows from USGS and Environment Canada; indices from NOAA & UW (PDO).

Washington State compared to Oregon State in 2018

Washington was not as dry as Oregon in 2018



Oregon was very dry in 2018



Paired temperature and precipitation data for Washington and Oregon

Near-normal temperatures for both states
(compared to 1981-2010)

WA: +0.8°F anomaly

OR: +0.9°F anomaly

Differences in precipitation between WA and OR

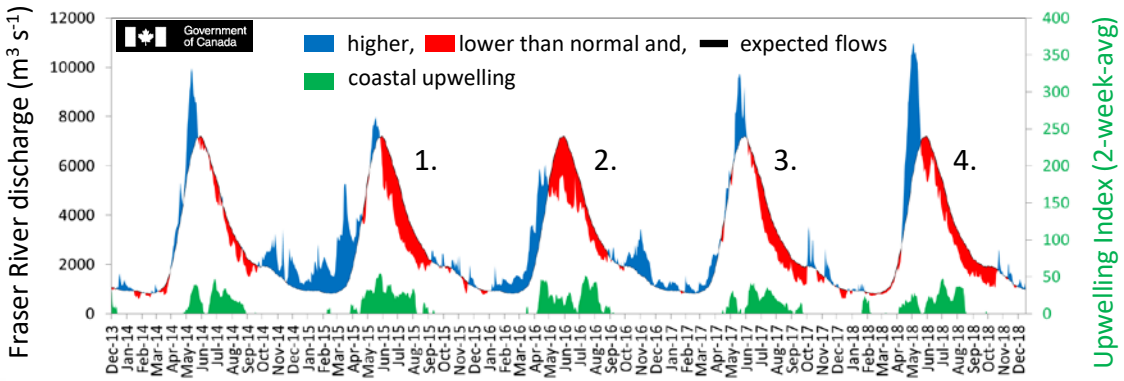
WA: +1.90” anomaly

OR: 16th driest Water Year (since 1895)

Courtesy of Karin Bumbaco and Nick Bond
Office of the Washington State Climatologist
Joint Institute for the Study of Atmosphere and Ocean
University of Washington
November, 2018

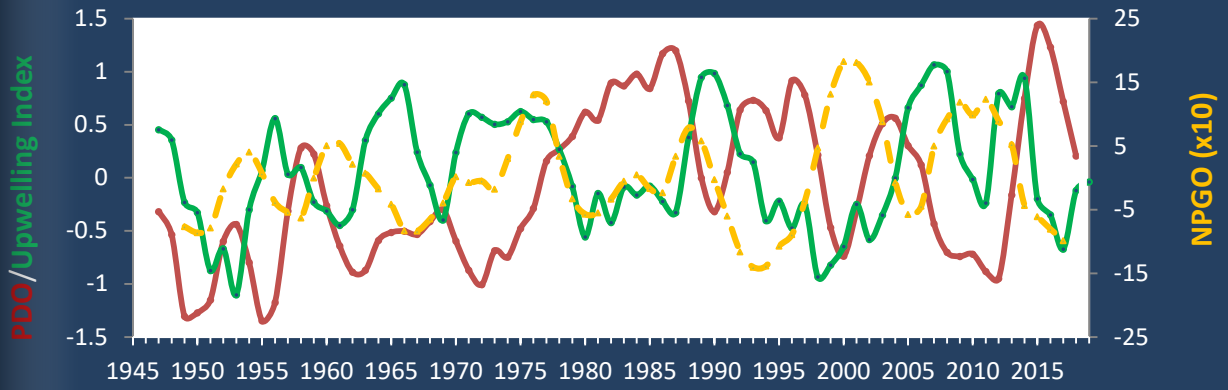
Climate influences: How well is Puget Sound exchanging its water?

Historically, the peaks of coastal upwelling and the freshet are in sync. Climate shifts the relative timing of both processes.



The Fraser River is the major driver of estuarine circulation and water exchange between the Salish Sea and the ocean. Climate forecasts predict earlier snowmelt and earlier delivery of water to the Salish Sea. This affects how well water renews and exchanges with ocean water. **Do we see four years of climate impact since 2015?**

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



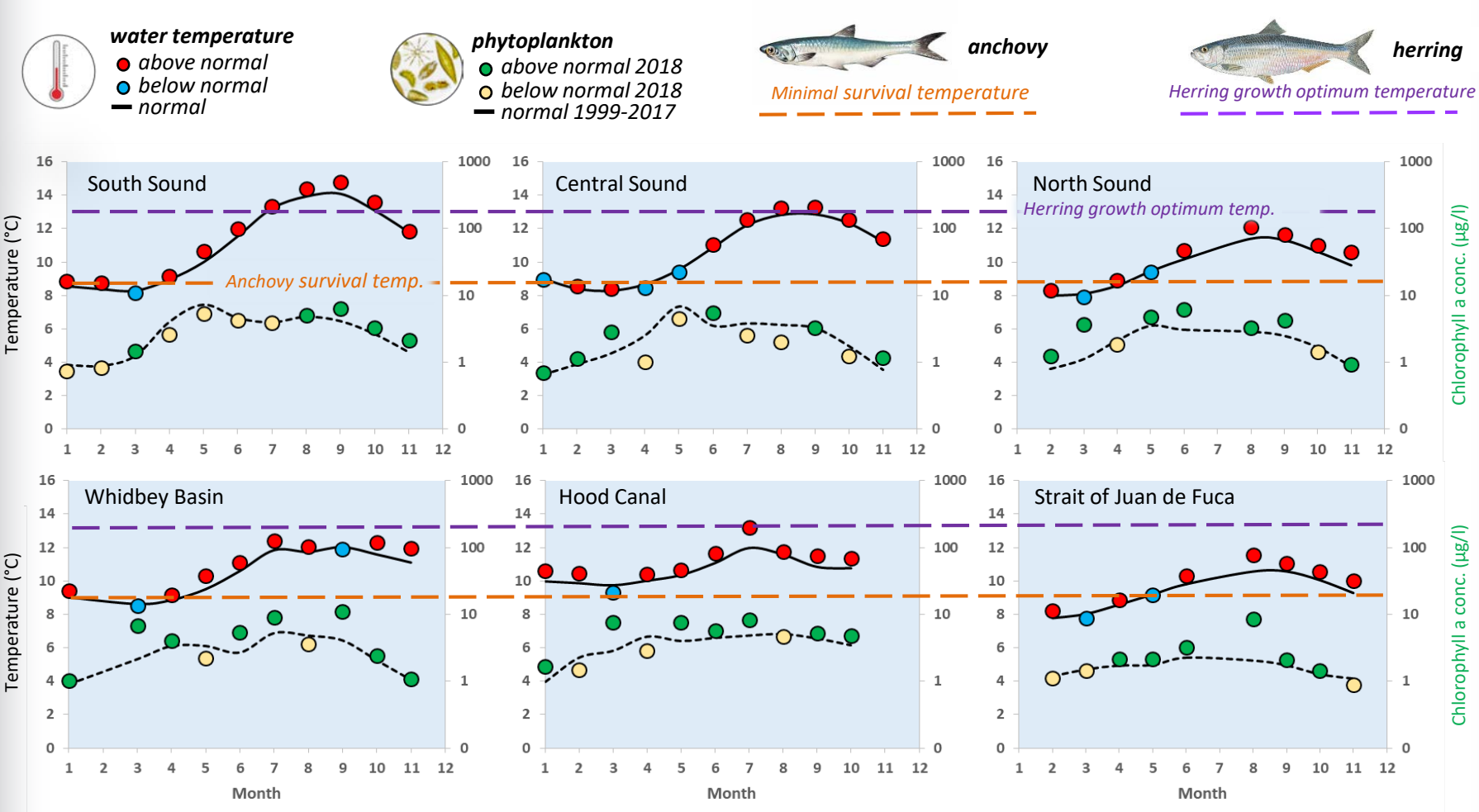
Large scale boundary conditions are currently relatively neutral.

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 temporarily discontinued.

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

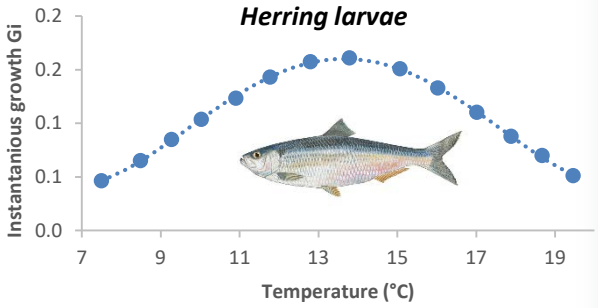
Temperature and food can affect fish growth

South Sound (**black line** = baseline 1999 – 2018) generally offers prolonged periods near the herring growth optimum. In winter, Hood Canal generally offers the warmest overwintering temperatures (8 – 9 °C water kills anchovies). This year, surface water temperatures (0 – 30 m) were consistently above normal (red dots). Phytoplankton supporting the food chain were consistently higher (green) than normal (**dashed line**) in adjacent basins of Puget Sound and north. (Chlorophyll *a* is used as a proxy for phytoplankton biomass).



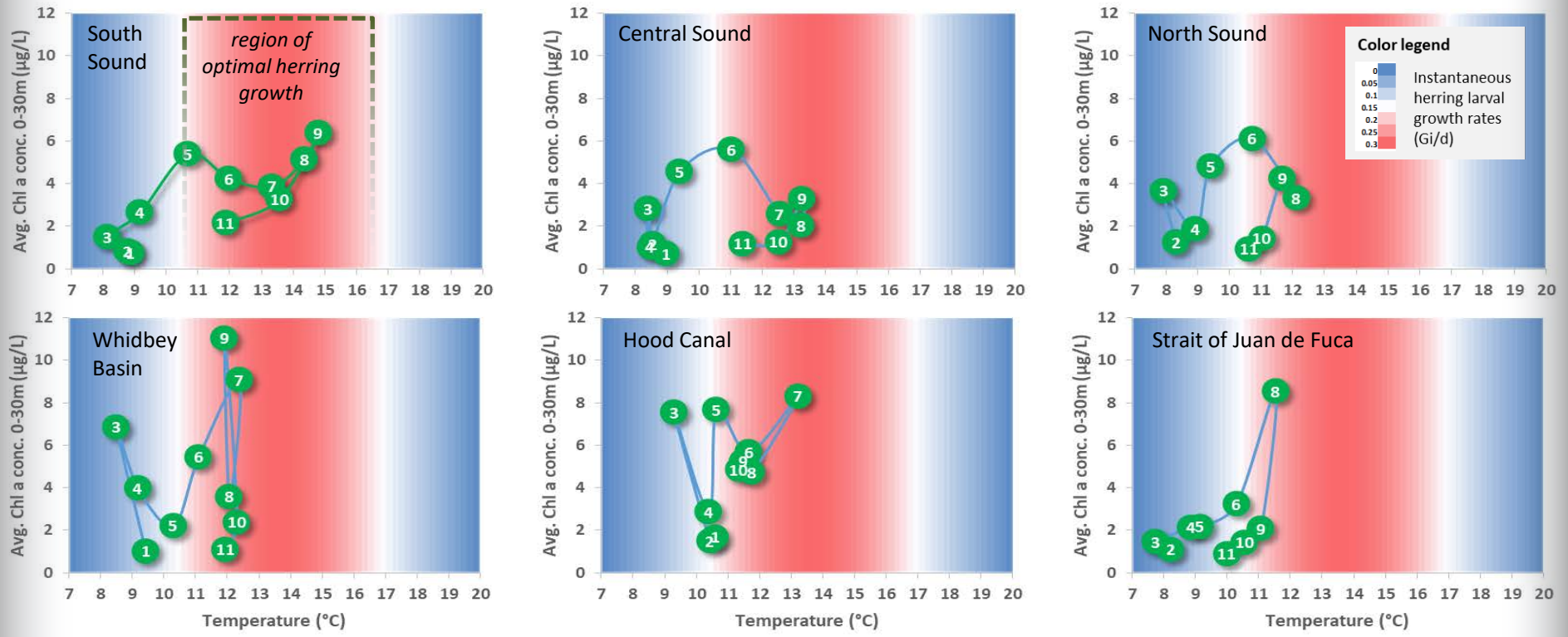
Temperature and food can affect herring growth

Fish need optimal water temperatures (red) and food to grow.
Assuming that phytoplankton biomass is a reflection of the amount of zooplankton that fish eat, South Sound and Hood Canal in 2018 stand out for having had prolonged good growth conditions for juvenile fish in terms of both food and water temperatures. Whidbey Basin provided high but inconsistent phytoplankton biomass in summer, and water temperatures took longer to reach optimal growth conditions.



=Month | Optimal growth

Paulsen *et al. Helgol Mar Res (2016) 70:17* DOI 10.1186/s10152-016-0470-y



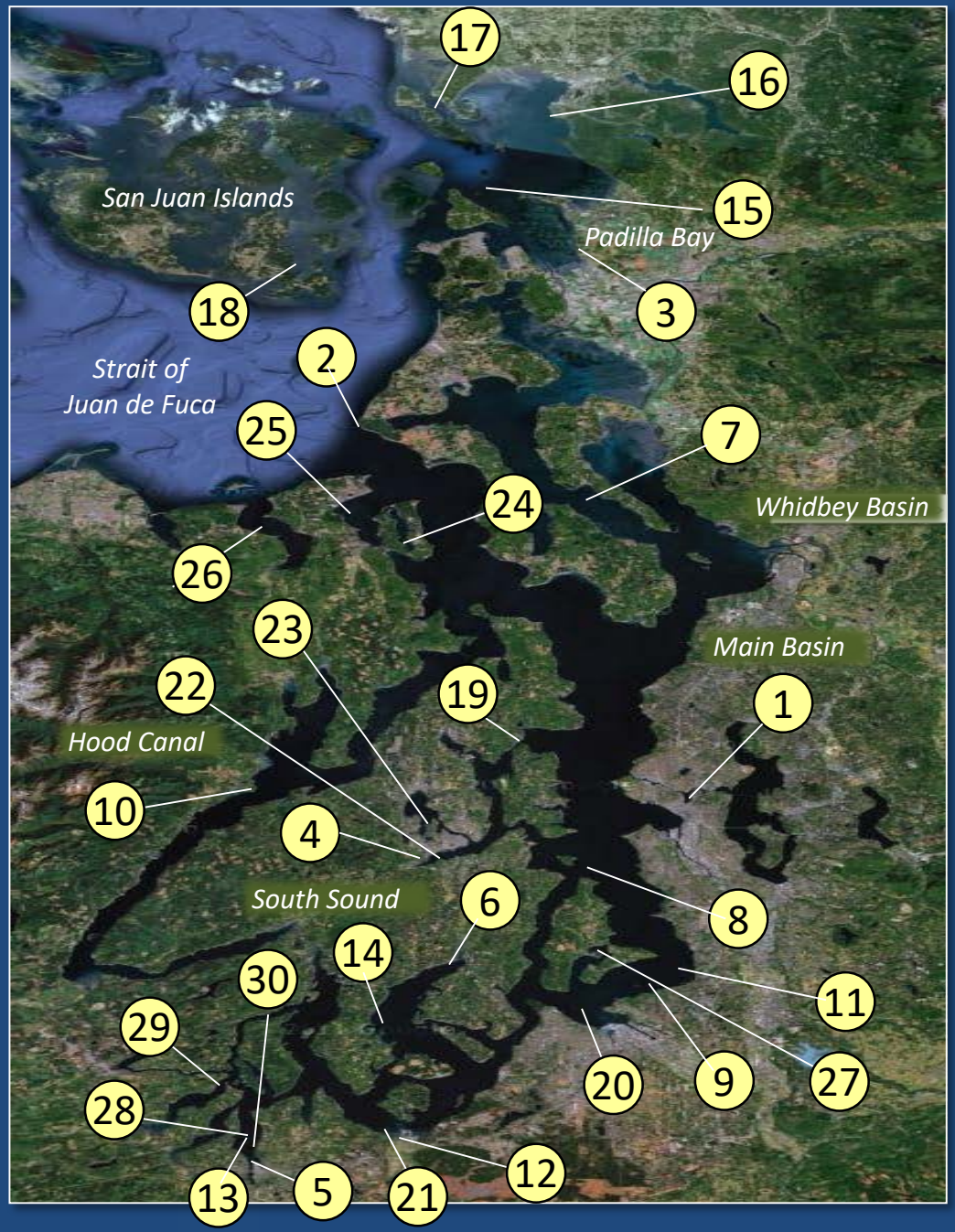
2018 Year in Review: Aerial photography

The year 2018 stood out as a biologically highly productive year.

Christopher Krembs

In 2018, water temperatures were still slightly above normal, and aerial photos revealed an abundance of spawning herring and baitfish. We saw abundant macroalgae across Puget Sound and a two-month long Noctiluca bloom in Central Sound. Countless blooms occurred in bays of South Sound, the Kitsap Peninsula, Sequim and Bellingham Bay. We reported incidents of failing effluent diffusers (Port Townsend) and oil sheens in waterways of Seattle (Salmon Bay).

Jan. – Feb.	Oil sheens on the water remained a recurring sight in Salmon Bay. Start here
Mar.	Milky water caused by spawning herring occurred more abundantly than usual.
Apr.	Some red-brown blooms appeared very early this year in Sinclair Inlet. We documented brown blooms that we have not seen before near Padilla Bay.
May	Strong blooms developed with lots of organic material drifting at the surface. Unusually numerous schools of baitfish were seen from the air at many shallow terminal bays.
Jun.	A strong Noctiluca bloom extended across southern portions of Central Puget Sound and a large coccolithophore bloom in Hood Canal. Large rafts of macroalgae developed on beaches and started to drift across Puget Sound.
Jul.	Macroalgae were extremely abundant on the water especially in South and Central Sound. An intense red bloom engulfed Bellingham Bay and adjacent regions. Many smaller bays showed red or yellow-green blooms.
Sep.	Number of red blooms had intensified in bays of the Kitsap Peninsula, Marrowstone Island, and Sequim Bay. Jelly fish patches became distinctly visible from the air in terminal inlets of smaller bays.
Nov.	Large schools of baitfish and jellyfish were still present in South Sound, as were red-brown algal blooms.



Aerial photography & navigation guide

Date: 2018

Click on numbers

The map is a navigation guide to quickly find areal pictures in a region. The numbers depict locations in chronological order of when they were taken in 2018.

Aerial photography 2-13-2018

Repeated oil sheen on water near Seattle Fire Station, Dock 3.
Location: Salmon Bay, Seattle (Central Sound), 2:25 PM

White cloudy water stretching from Point Partridge past Perego's Lagoon. Spawning herring?

Location: Admiralty Reach (North Sound), 1:52 PM

Aerial photography 4-19-2018

A. Bright brown water leaving Joe Leary Slough. B. Is this a brown bloom following the tidal channel?

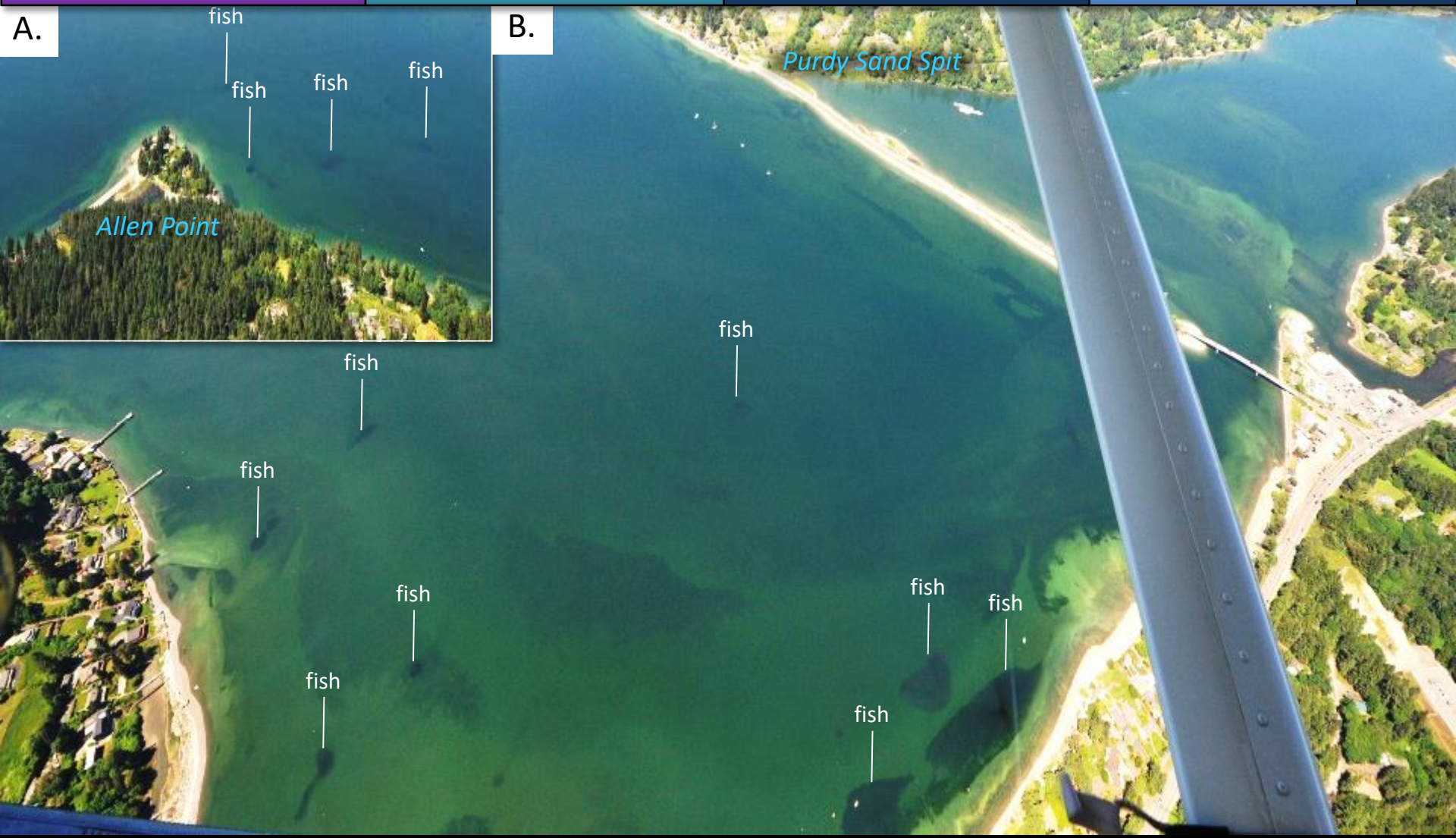
Location: Padilla Bay (North Sound), 12:54 PM

Aerial photography 4-19-2018

Bright red-brown-purple bloom with an occasional jellyfish patch.
Location: Sinclair Inlet (Central Sound), 1:49 PM

Aerial photography 5-22-2018

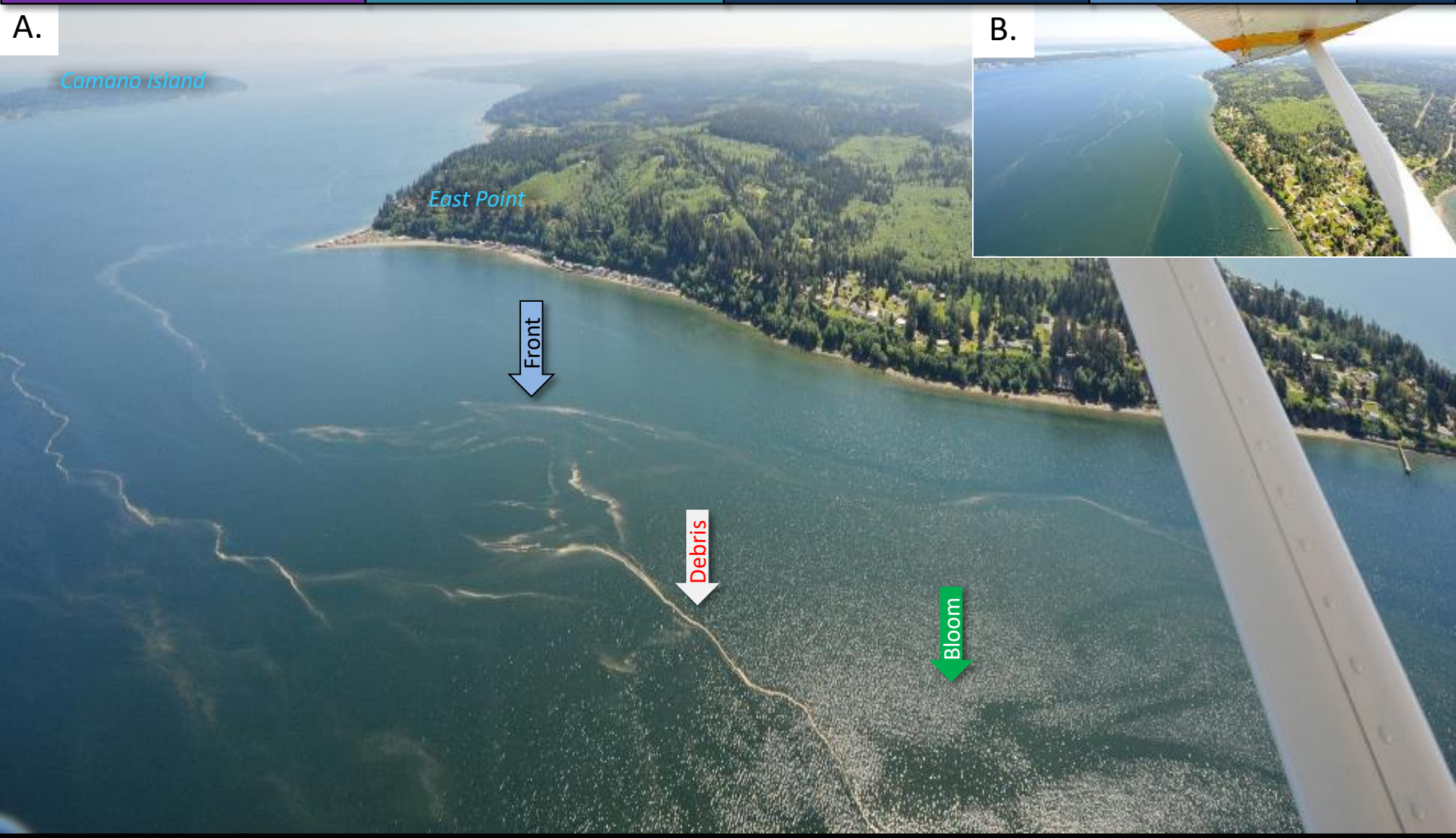
A. Noctiluca bloom surfacing near Priest Point Park, low altitude. B. At higher altitude.
Location: Budd Inlet (South Sound), 12:12 PM



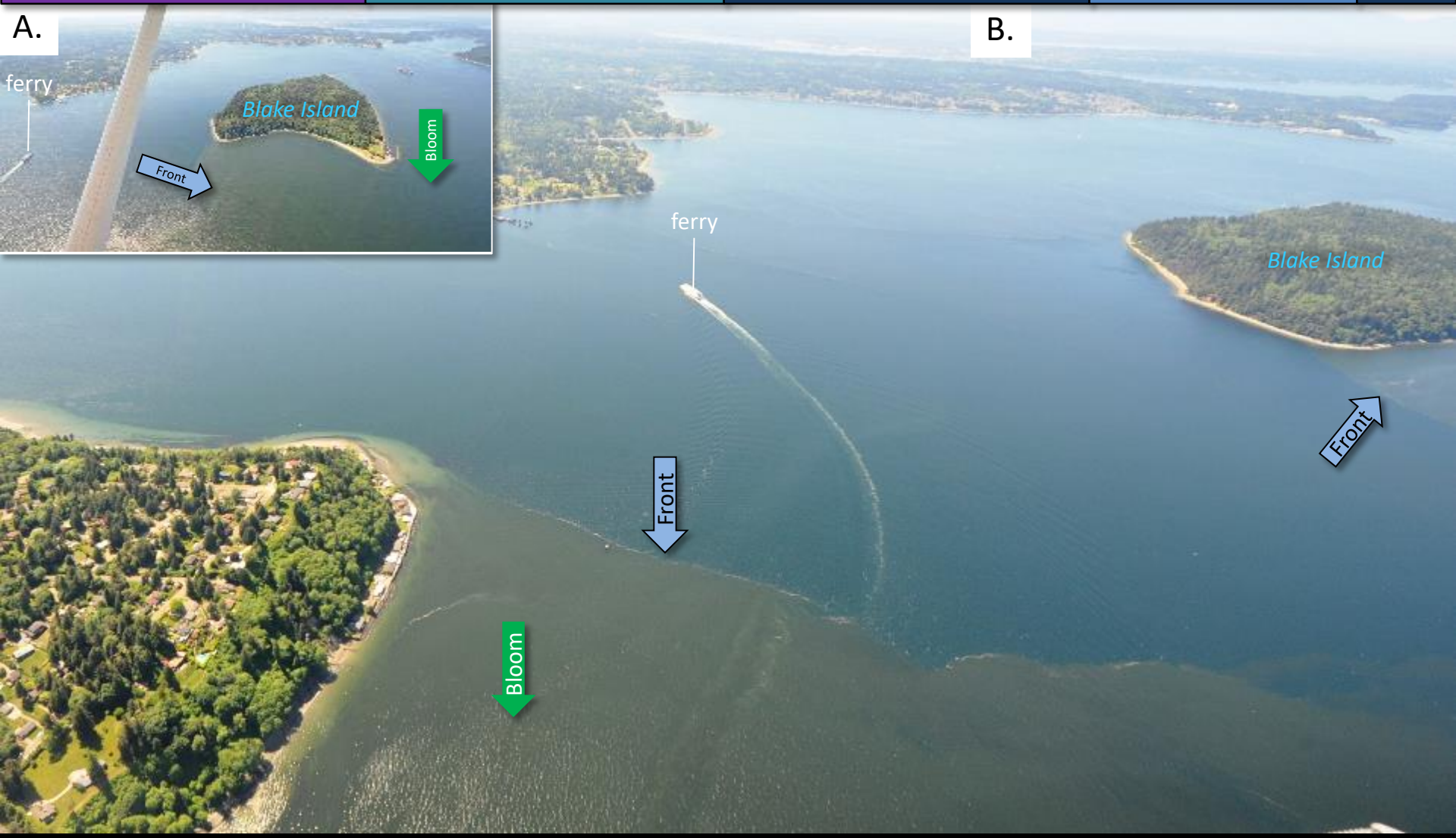
Many patches of schooling fish.

Location: A. Near Allen Point. B. Near Purdy Sand Spit (South Sound), 12:00 PM

Aerial photography 5-22-2018



A. Large ribbons of organic material, likely Noctiluca. B. Algal bloom extending north.
Location: Saratoga Passage (Whidbey Basin), 1:44 PM



A & B. Strong algal bloom and tidal fronts in Main Basin contrasted against Colvos Passage blue water.
Location: Blake Island (Central Basin), 2:40 PM

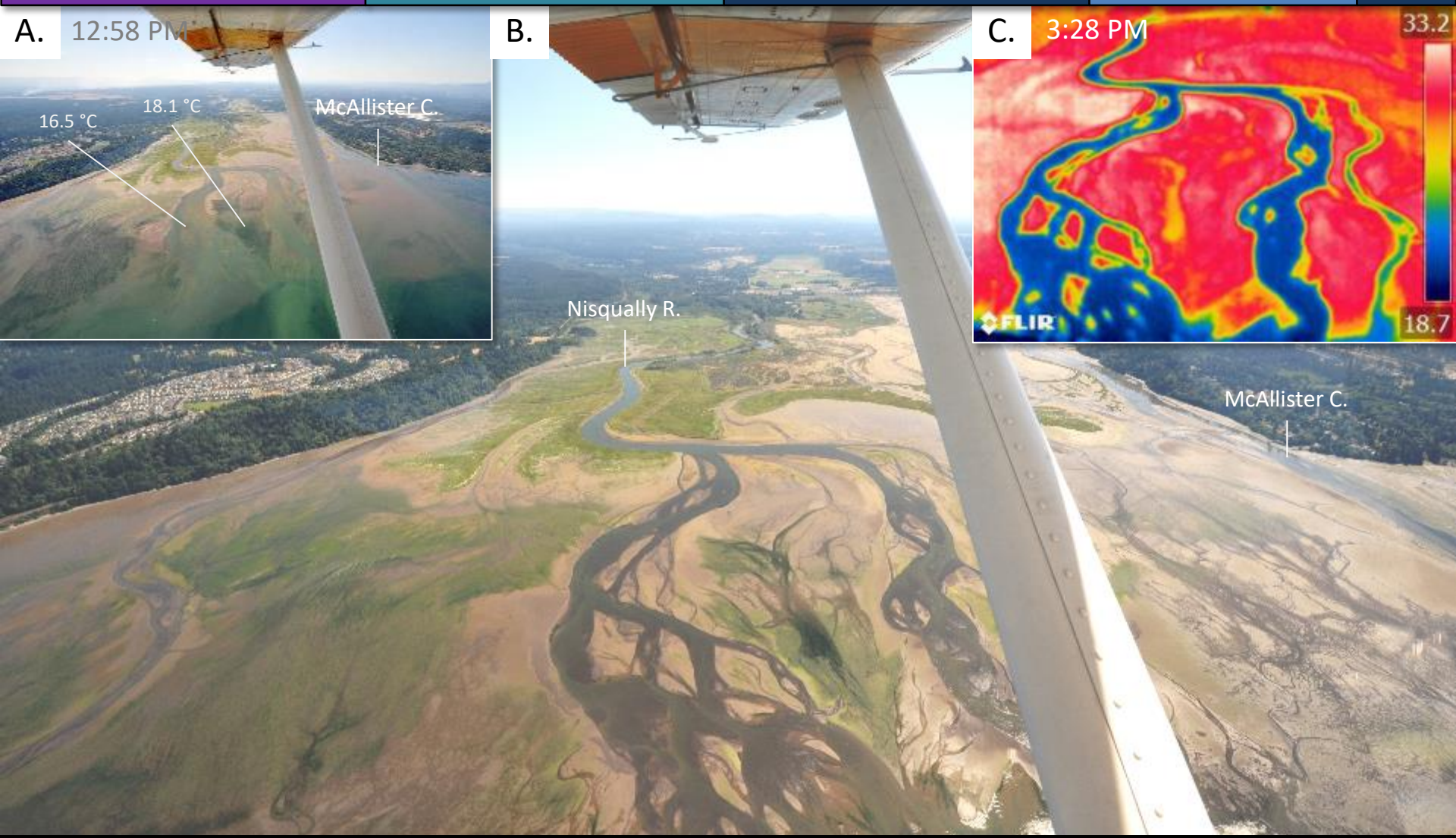
Noctiluca bloom surfacing and accumulating along tidal fronts.
Location: North of Commencement Bay (Central Sound), 10:16 AM

Duckabush River delta at very low tide exposing macroalgae. Turquoise coccolithophore bloom

Location: Duckabush River (Hood Canal), 12:18 PM

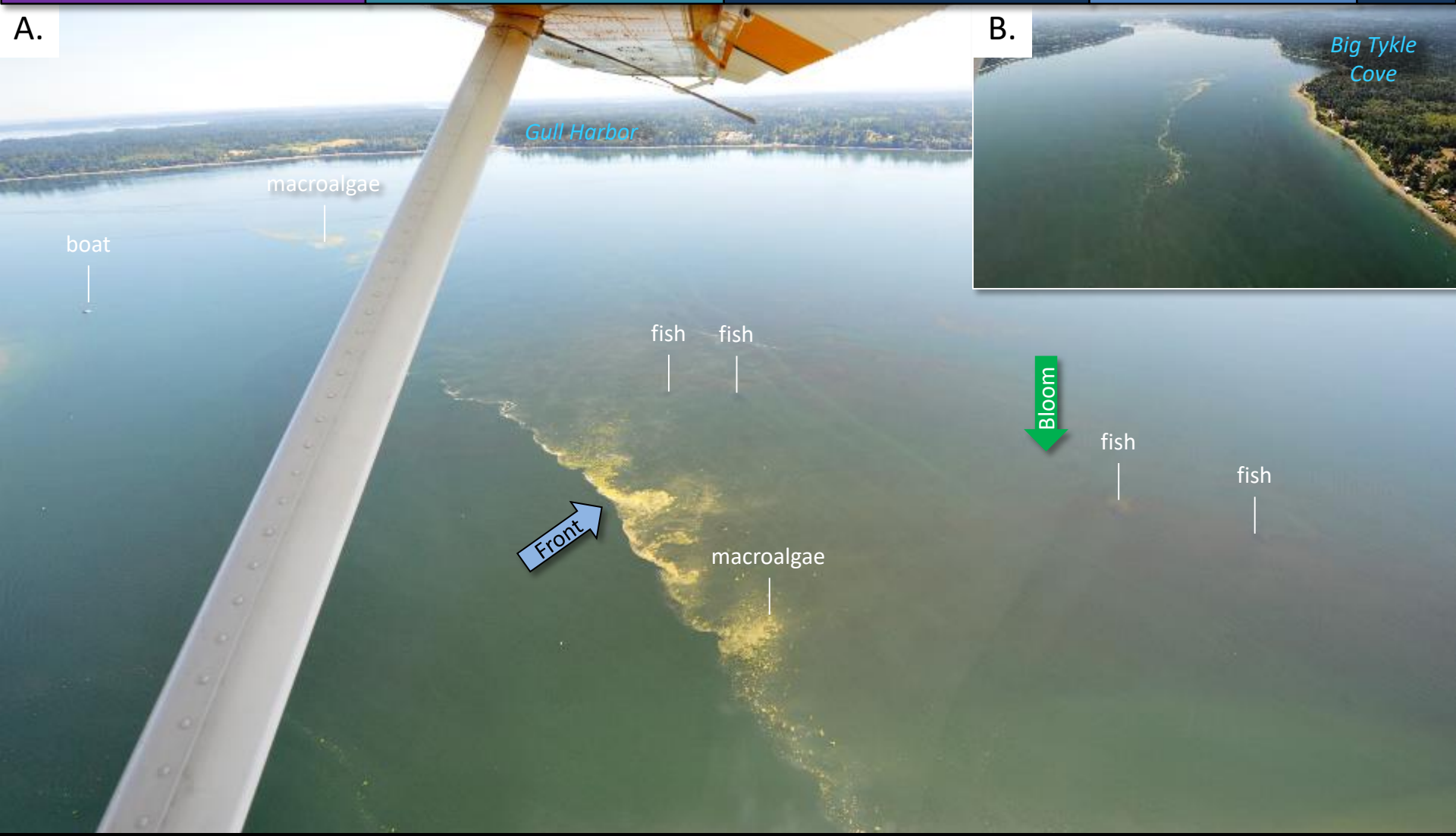
Large ribbons of Noctiluca and macroalgae accumulating at the surface.
Location: Poverty Bay (Central Sound), 1:34 PM

Aerial photography 7-16-2018



A. Mudflats during ebb tide and (B.) low tide. C. Temperatures vary considerably across the estuary.
Location: Nisqually River Delta (South Sound), 3:28 PM

Aerial photography 7-16-2018

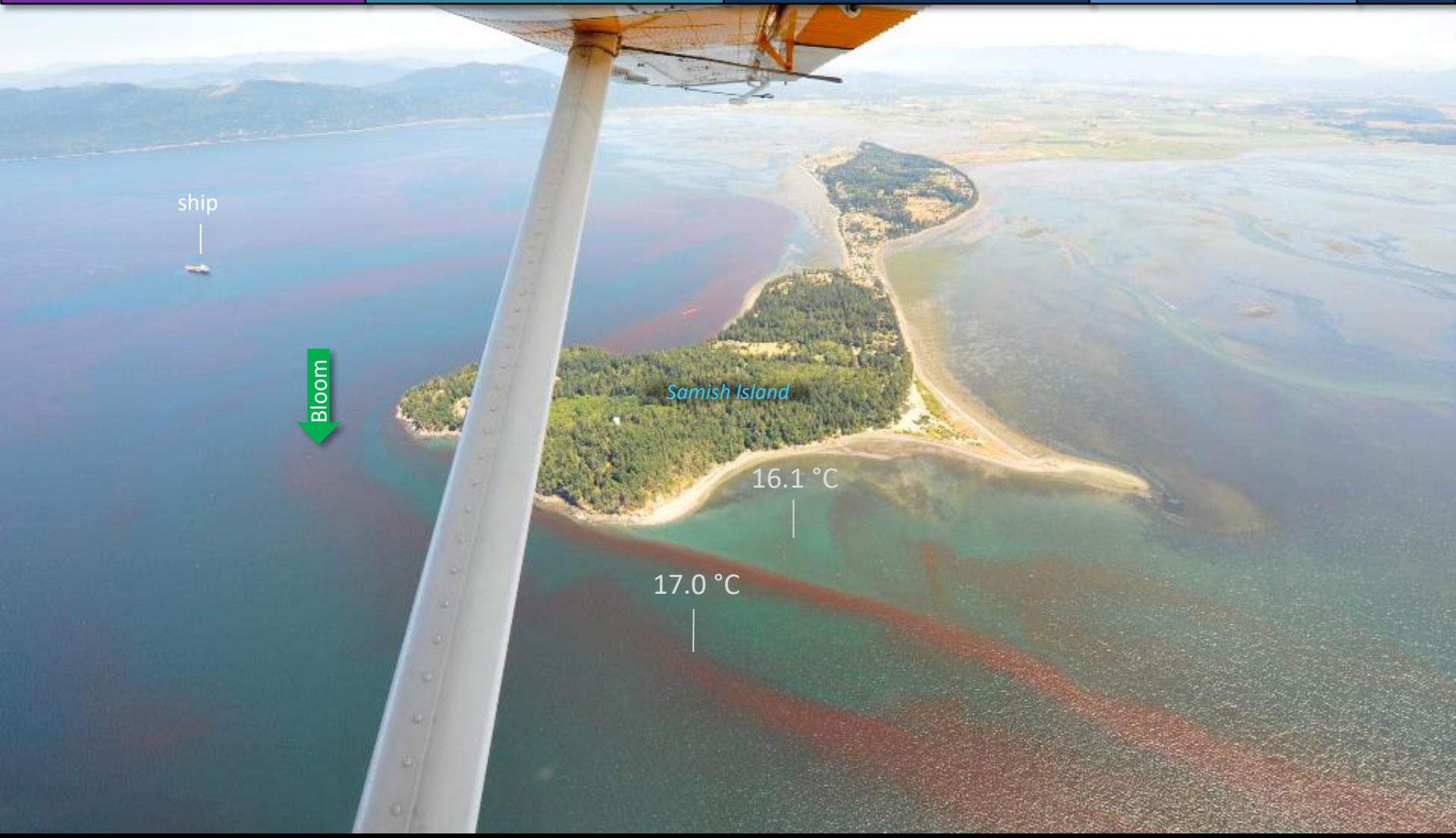


A. Large mats of macroalgae accumulating at front, red-brown bloom, and schools of fish. B. From altitude.
Location: Budd Inlet (South Sound), 12:36 PM

Aerial photography 7-16-2018

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

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



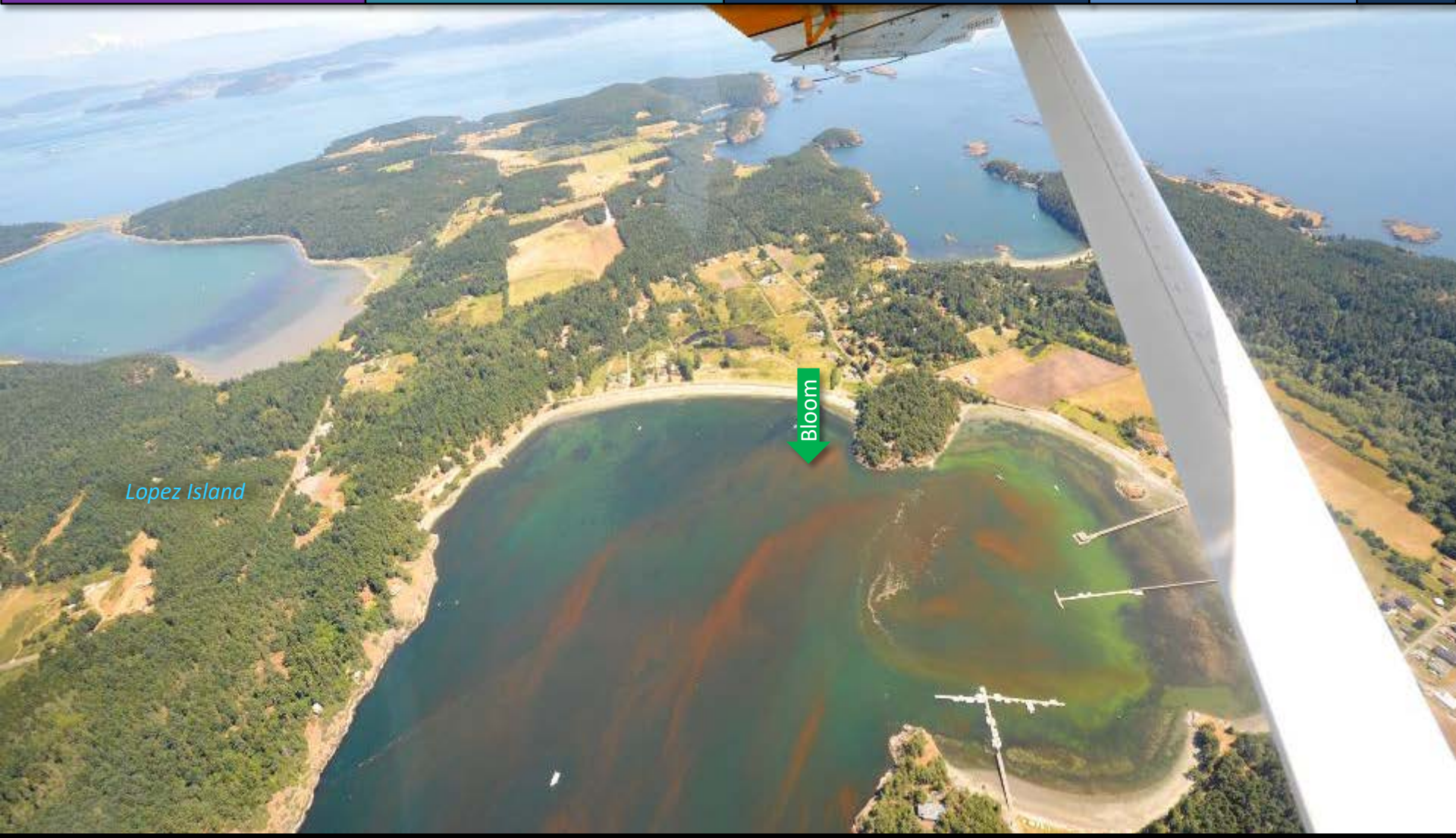
Red-brown bloom extending in long ribbons from Samish Bay into Padilla Bay.
Location: Samish Island (North Sound), 2:01 PM

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

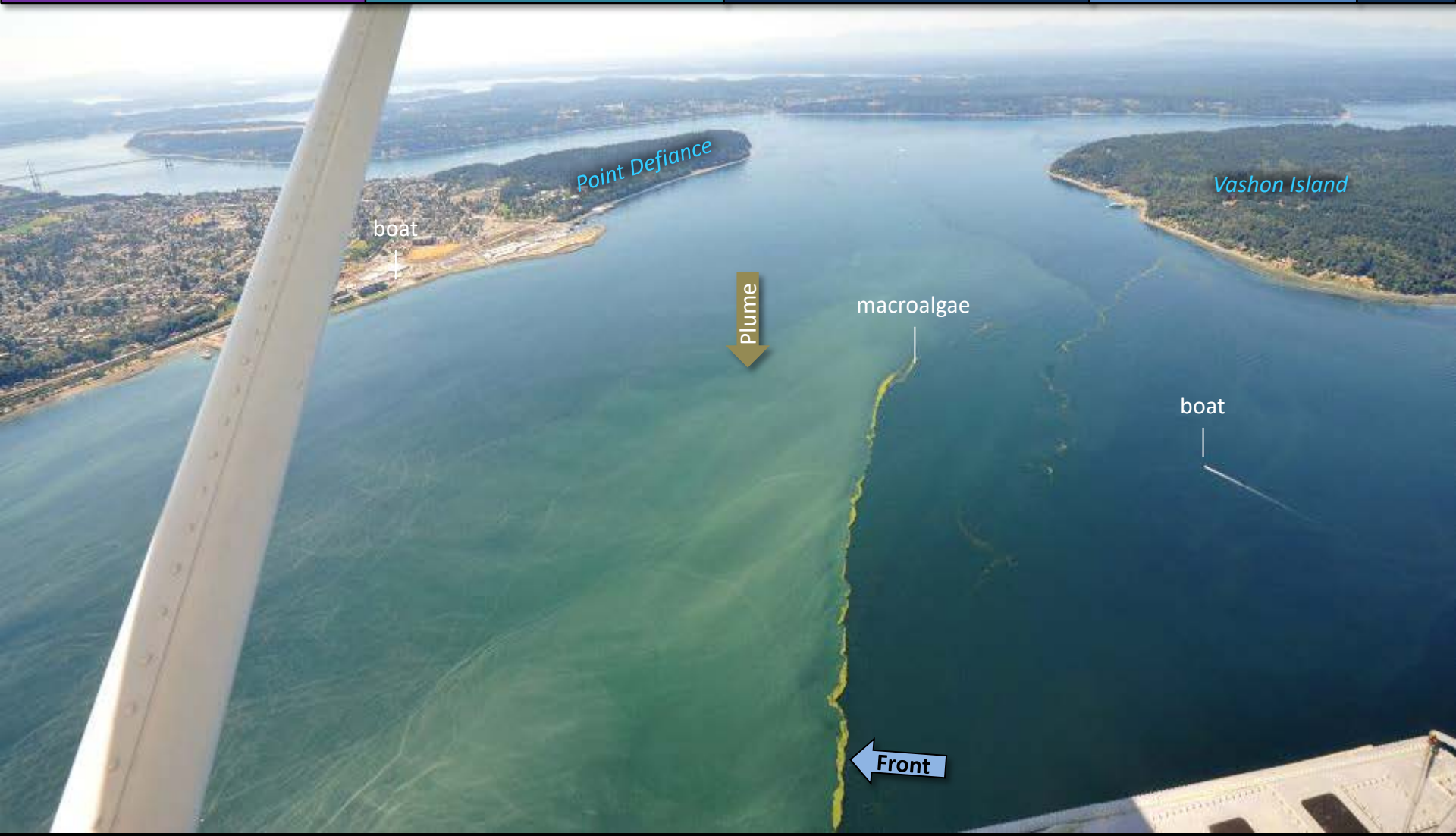
Red-brown bloom of two colors entering Bellingham Bay via Hale Passage.
Location: Lummi Island (North Sound), 2:14 PM



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

Aerial photography 7-16-2018

Large mats of macroalgae accumulating along tidal fronts.
Location: Port Madison (Central Sound), 2:56 PM

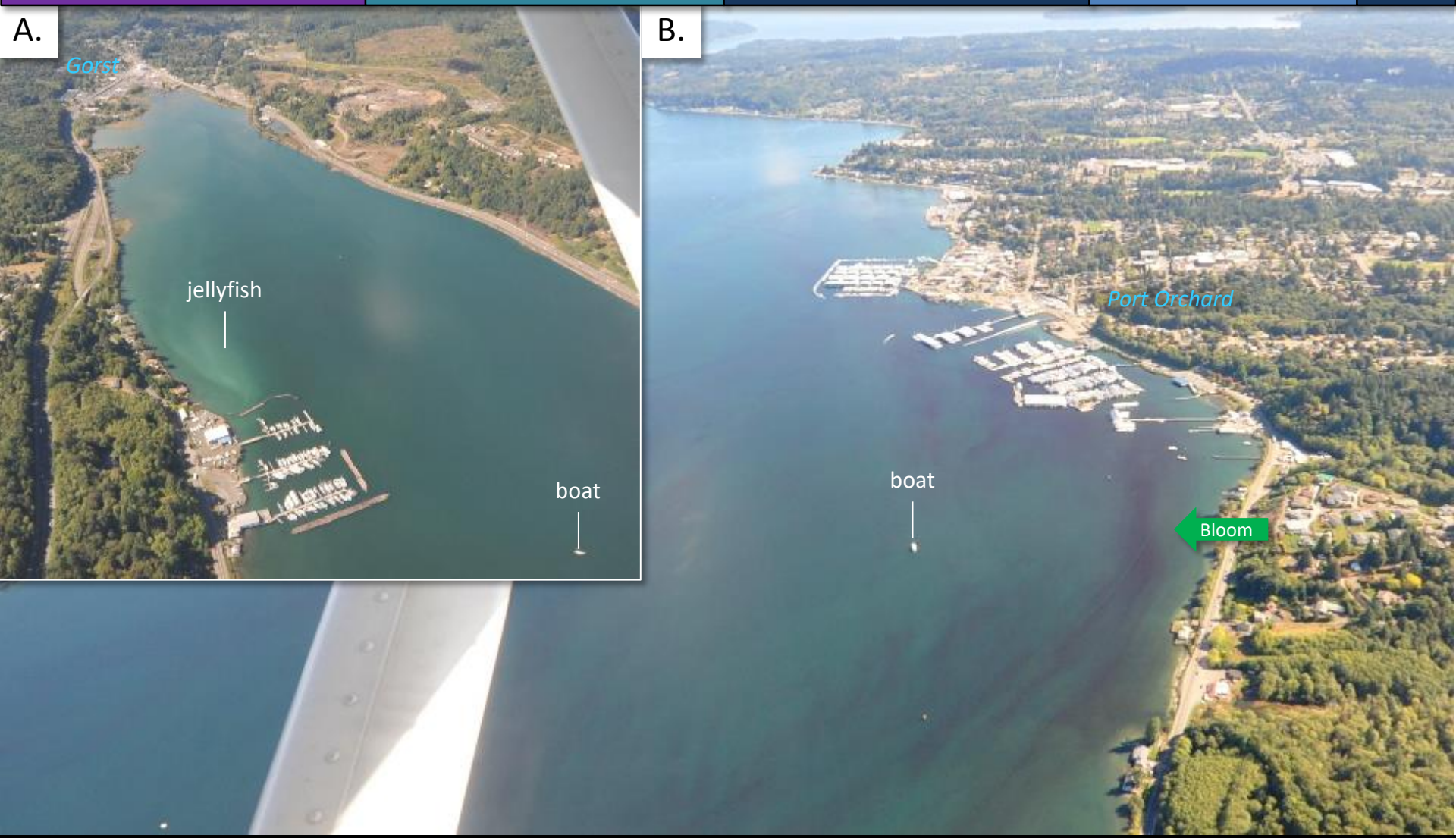


Large mats of macroalgae accumulating along edges of Puyallup River plume.
Location: Commencement Bay (Central Sound), 3:12 PM

Aerial photography 7-16-2018

Red-brown bloom in southern portions of Nisqually Reach.
Location: Nisqually Reach (South Sound), 3:29 PM

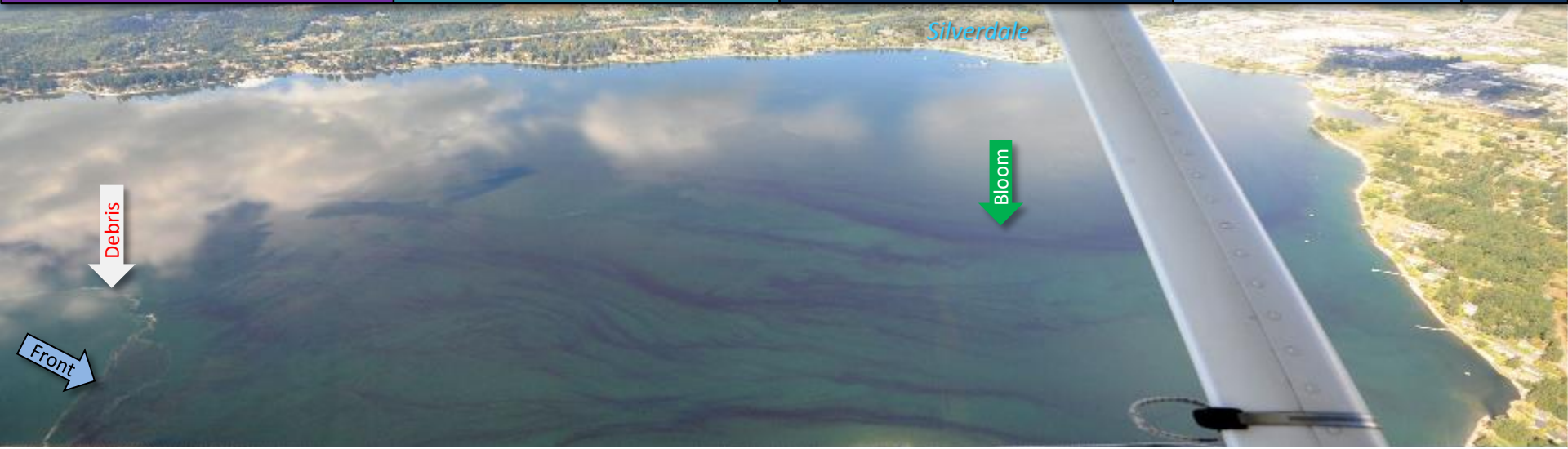
Aerial photography 9-17-2018



A. Likely jellyfish, but not confirmed. B. Large red-brown bloom near Port Orchard.

Location: Sinclair Inlet (Central Sound), 12:48 PM

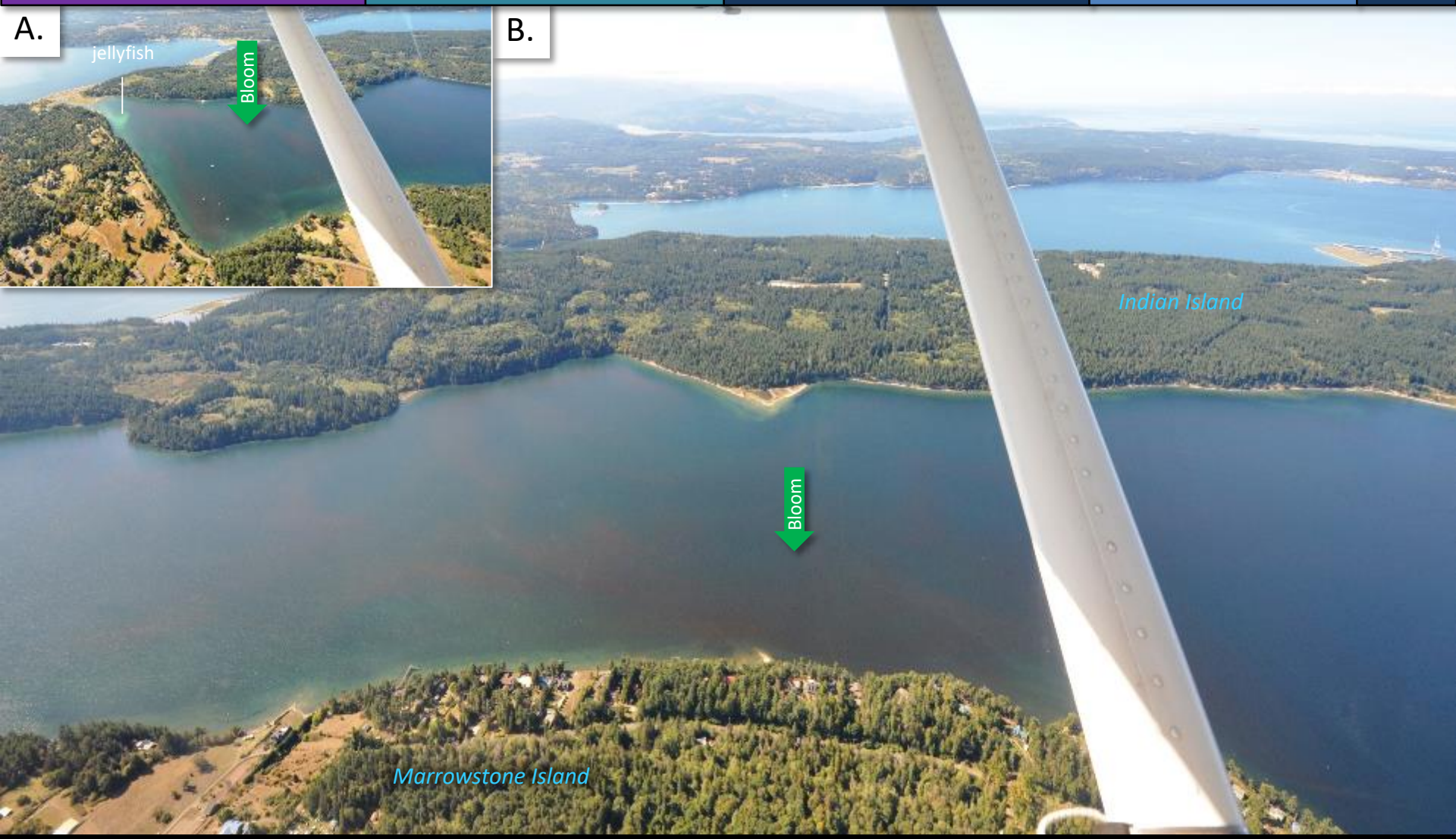
Aerial photography 9-17-2018



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

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

Aerial photography 9-17-2018



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

Aerial photography 9-17-2018

Water with surfacing turbidity, likely from an underwater diffuser.

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

Aerial photography 9-17-2018

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

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

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

Aerial photography 11-6-2018

Numerous schools of fish.

Location: Totten Inlet (South Sound), 12:41 PM

Long ribbons of jellyfish stretched along the direction of tidal flow.
Location: Budd Inlet (South Sound), 1:00 PM

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Environmental Assessment Program
Washington State
Department of Ecology

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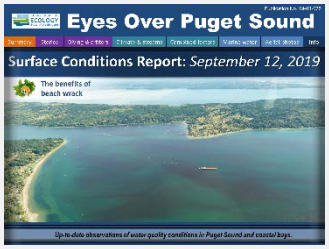

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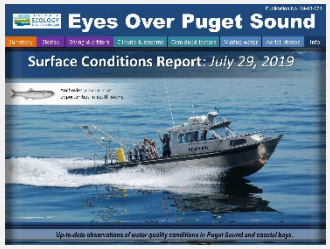

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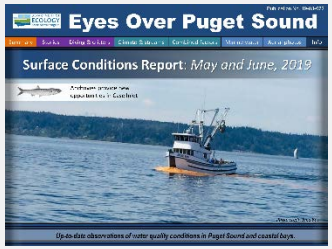

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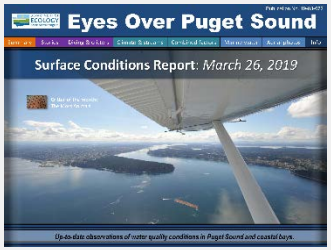

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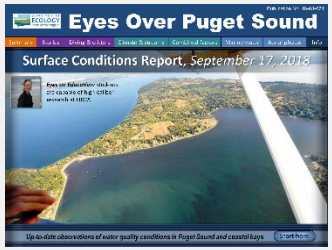

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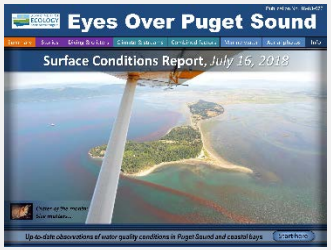

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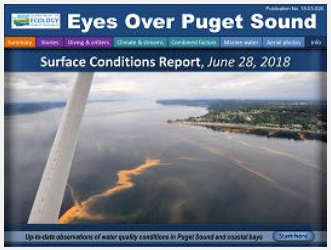

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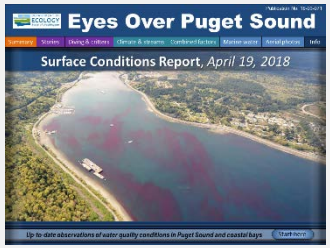

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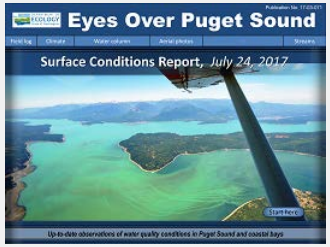

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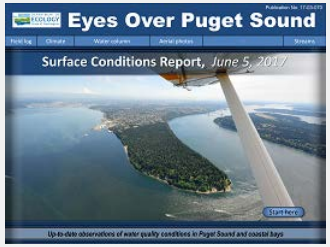

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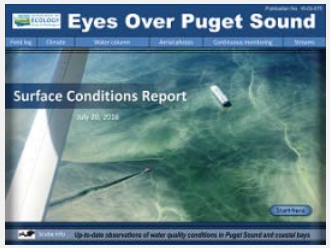

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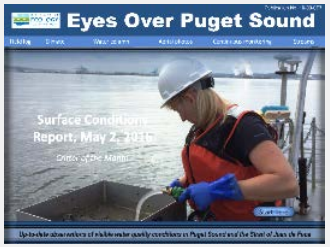

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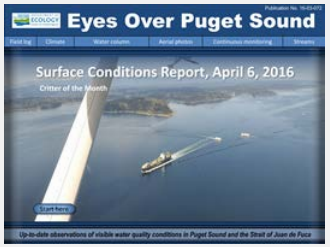

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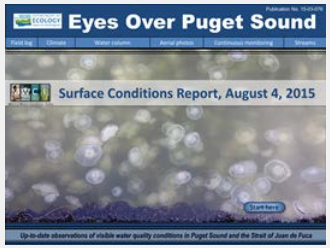

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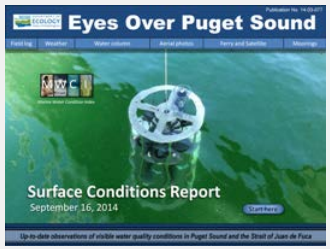

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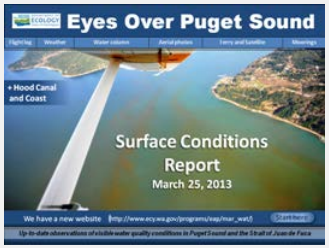

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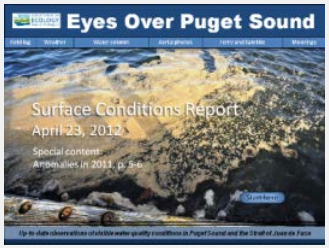

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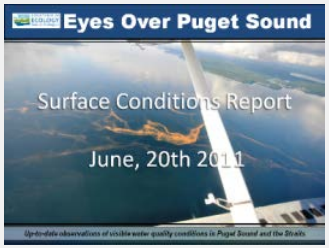

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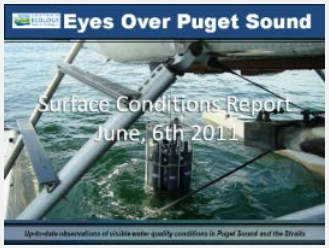

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