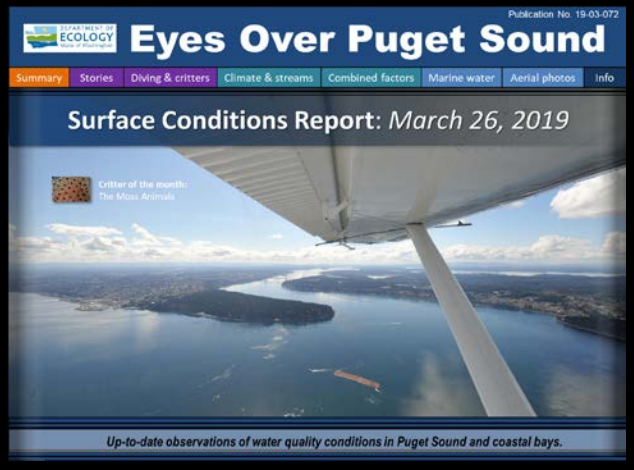
Publication No. 20-03-070

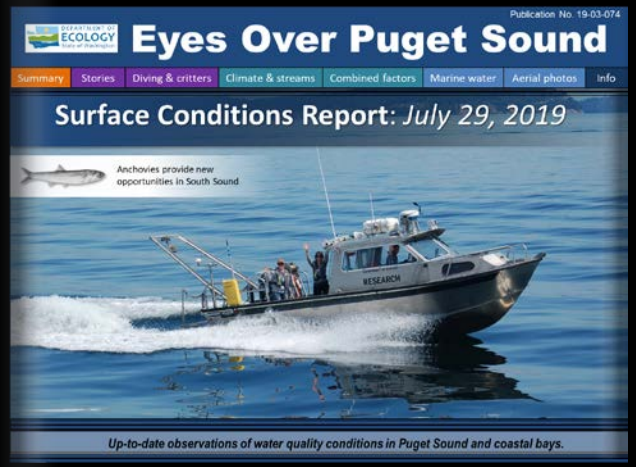
Eyes Over Puget Sound

DEPARTMENT OF ECOLOGY State of Washington

Critters | Climate and streams | Fish and food | Aerial photos | Info



2019 in Review



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

PSEMP Marine Waters Workgroup Report of 2018

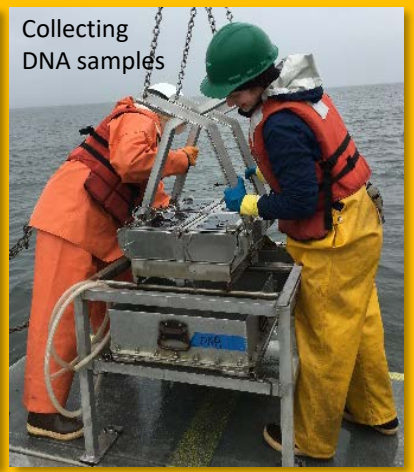
Follow up on the conditions that were leading up to 2019 in Puget Sound's comprehensive marine waters report.

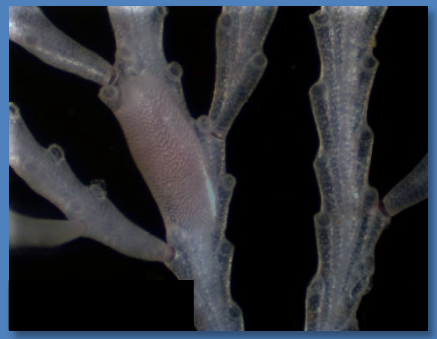
Available: https://www.psp.wa.gov/PSmarinewatersoverview.php

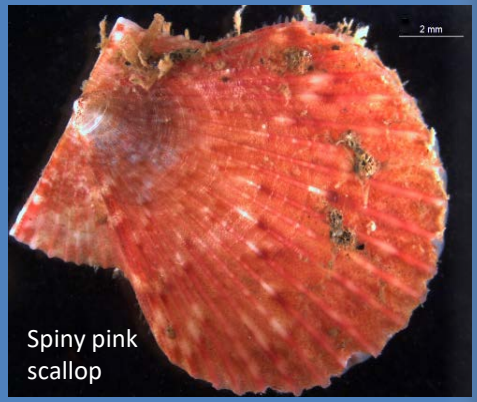
Eyes Under Puget Sound in 2019

2019 was an exciting year for the Marine Sediment Monitoring Team's "Eyes Under Puget Sound" blog! In addition to seven colorful *Critter of the Month* posts, we featured stories about Bioblitz events where we cataloged biodiversity and new DNA barcoding work that will help us identify and discover benthic species. What will 2020 have in store?


Striped nudibranch


Collecting DNA samples





Learn more about our program, including benthic critters and how we identify them on our website

OR/WA Water Year 2019 Recap & 2020 Outlook Meeting

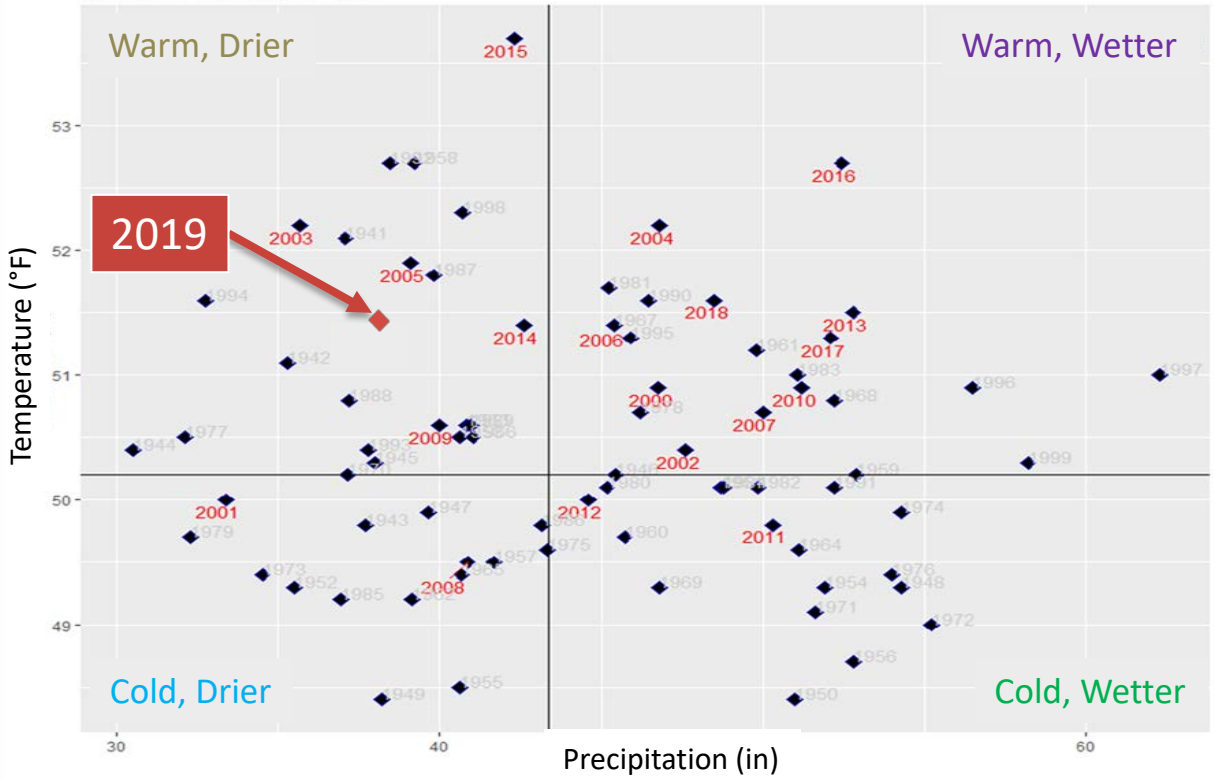
Critters | Climate and streams | Fish and food | Aerial photos | Info

Weather and climate affect water circulation and the renewal in the Salish Sea

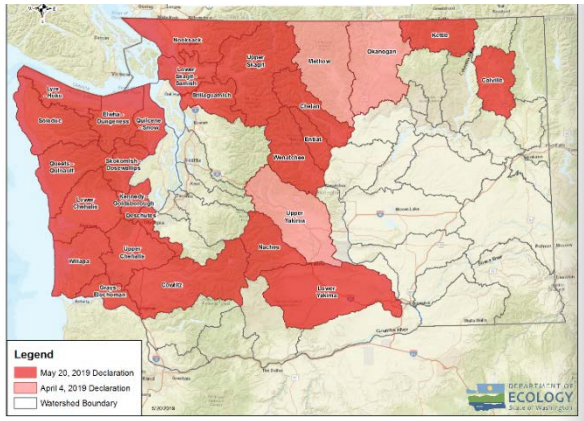
Karin Bumbaco and **Nick Bond**
Office of the Washington State Climatologist
Joint Institute for the Study of Atmosphere and Ocean, UW

Water Year: Near-normal temperatures with **below-normal precipitation** in WA. Very slow start to mountain snow accumulation in the beginning of the WY with generally warm and dry conditions. Remarkably cold and snowy February. Drought declarations for WA. Another dry NW summer but impacts tempered thanks to moderate temperatures. (click here)

Temperature vs Precipitation, Puget Sound Lowlands, Water Years 1941-2019



2019 Drought Declaration Area



-Drought declared on 4/4/2019.

-Drought areas expanded to roughly half the state on 5/20/2019.

Jeff Marti, Ecology, 2019 Drought Overview and 2020 Forecast. Columbia River Policy Advisory Group, December 12, 2019

What influences Puget Sound water quality?

In the anomaly plot below, we graphically connect different factors influencing water quality in an attempt to provide context. For this purpose we used anomalies indicated by color. Conditions in 2019 were generally drier, with lower river flows. Early-onset upwelling was a factor in both 2018 and 2019.

Conditions in 2019:

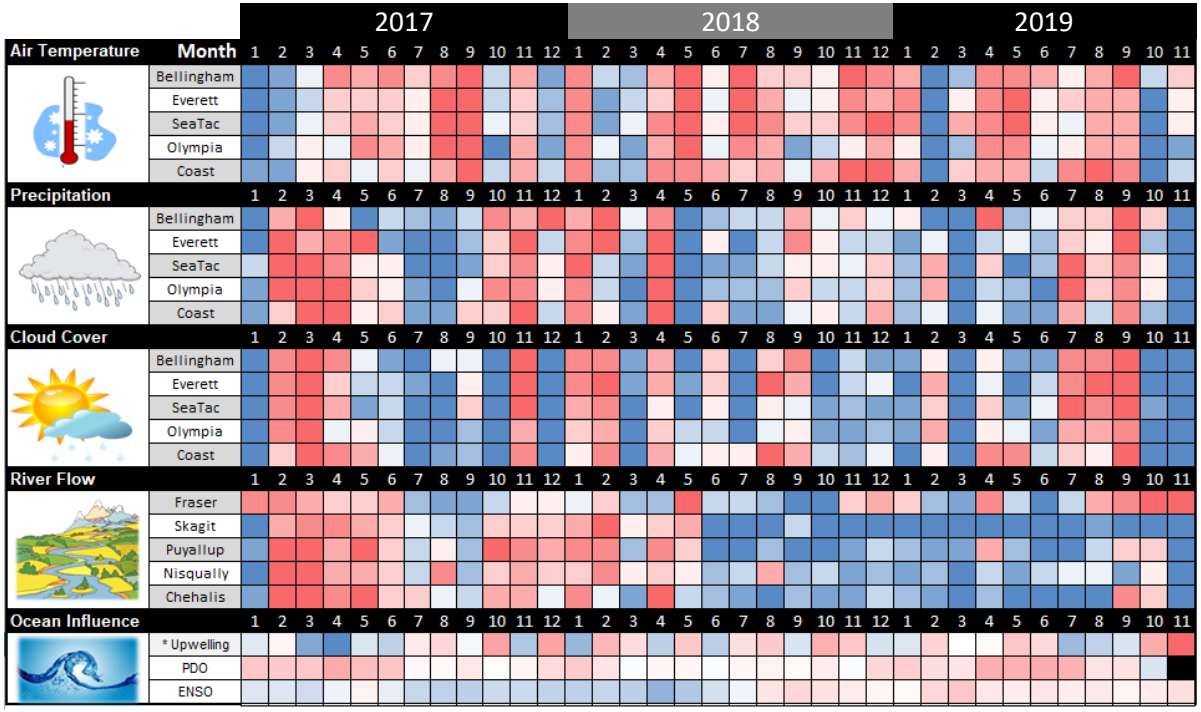
Air temperatures were slightly warmer, except in February, early March, and October.

Precipitation was much lower than normal. (The red in summer months were anomalies which constituted only a very small amount of rain.)

Sunshine (opposite of cloud cover) levels have largely been higher.

River flows have been low since last June 2018, except for the Fraser.

Upwelling started in early spring during 2018 and 2019.



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

higher — expected — lower

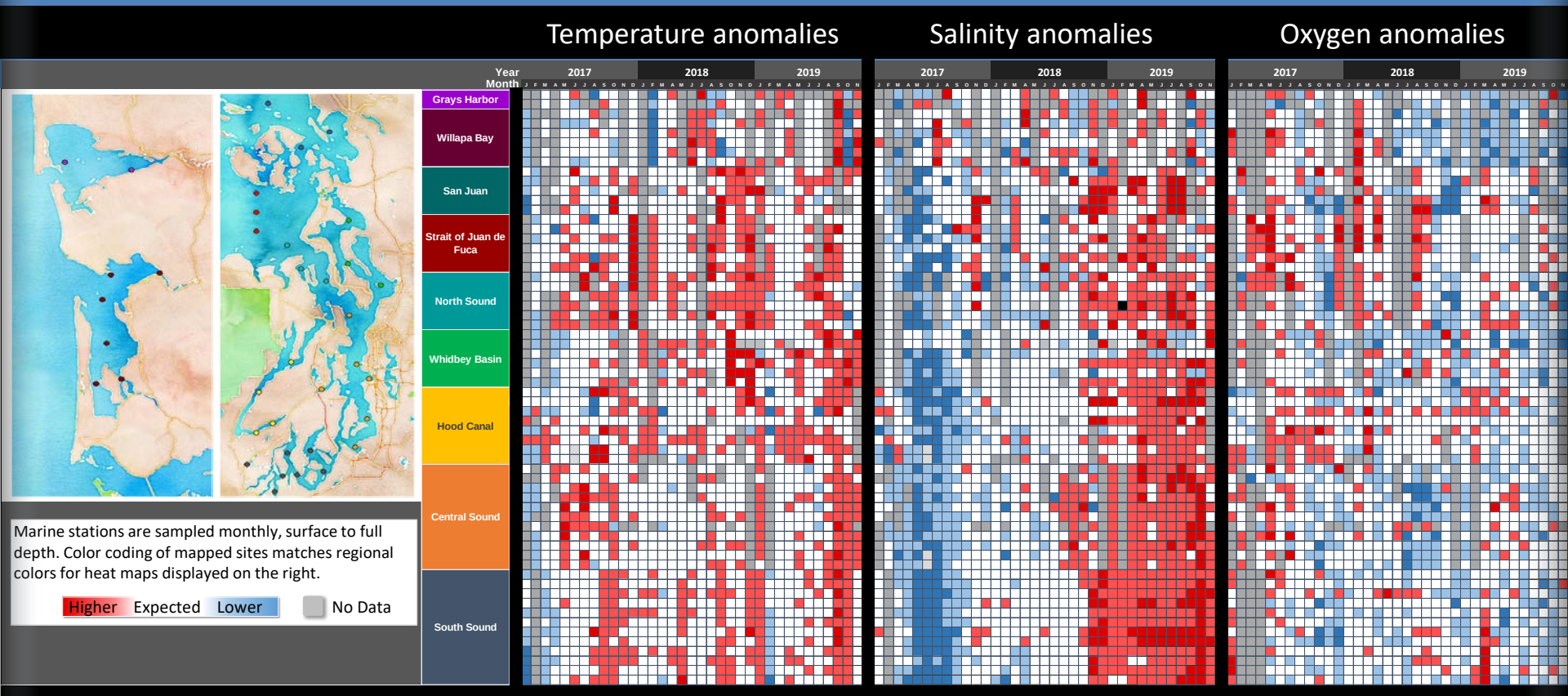
No data

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

Climate signal in Ecology's long-term monitoring data

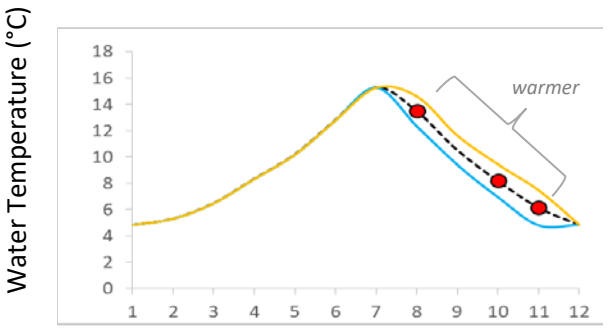
Julia Bos

In 2019, record-high salinity (red) persisted, especially in Central and South Sound. Values were typically >30.5 psu, measuring 0.5 psu above 20-year historical medians. This contrasts to 2017, which was characterized by low salinities (blue). Temperatures in late summer were once again warmer than normal, continuing a pattern seen the previous few years. For example, in September Nisqually Reach reached temperatures >15 °C, which exceeded values seen during the marine heat wave of 2014-2016. Dissolved oxygen remained variable, with a weak tendency toward lower values (absence of red).

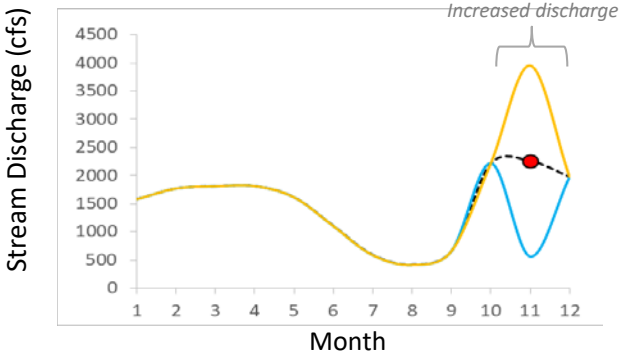


Climate signal in Ecology's long-term monitoring data

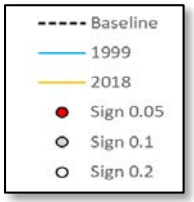
River & Streams monitoring data (P. Sound watersheds)



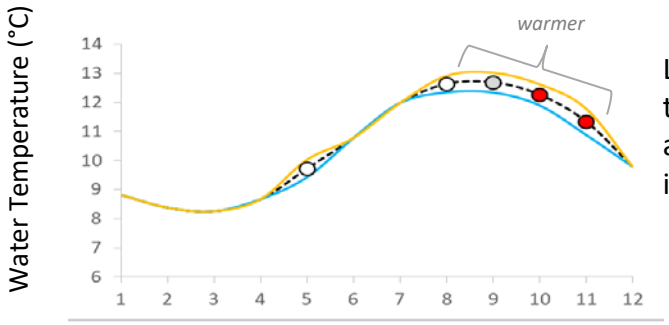
Late summer temperatures are increasing in rivers.



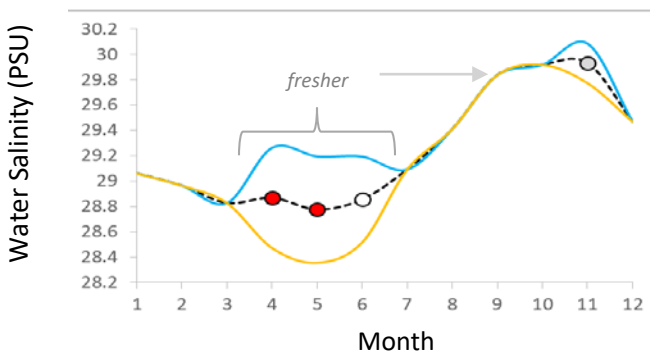
Fall discharges are increasing in rivers.



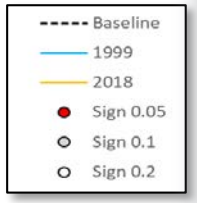
Marine monitoring data (Puget Sound stations)



Late summer temperatures are increasing in Puget Sound.



Salinities in spring are decreasing.



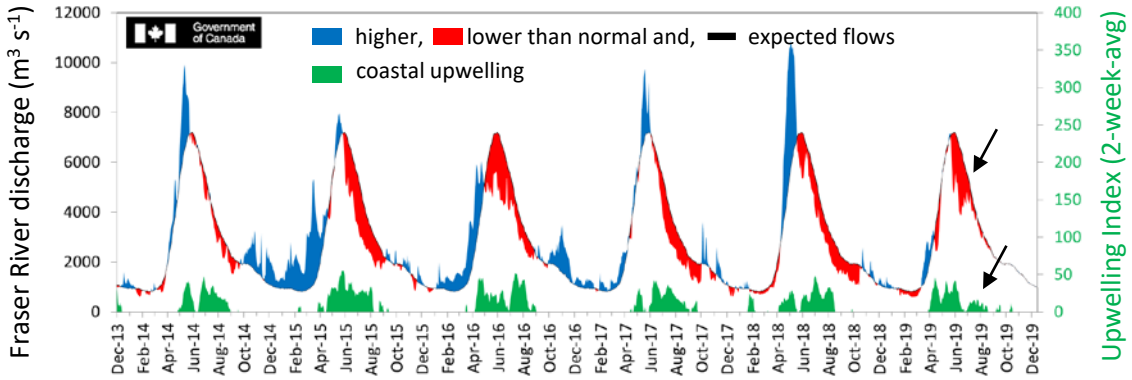
Graphs illustrate the average seasonal patterns of temperature, discharge, and salinity between 1999-2018. Where significant trends exist (significance level (p-value) level illustrated by dot using Spearman Rank correlations) the magnitude of change from 1999 to 2018 is illustrated by the distance between 1999 (blue) and 2018. (yellow) lines.

The US climate assessment report 2014.

Projections of climate change can already click link to access the report online nd stream temperature, discharge, and Puget Sound temperatures and salinity. Illustrated are the seasonality and, if significant, the magnitude of the existing trend in monitoring data of the Puget Sound watershed region based on Ecology's extensive marine and freshwater station networks between 1999-2018. NW projections include: (1) Decreased snowpack, (2) Shift from snow- to rain-dominated systems, (3) Increased stream temperatures, (4) Earlier peak stream flows, (5) More winter flood events.

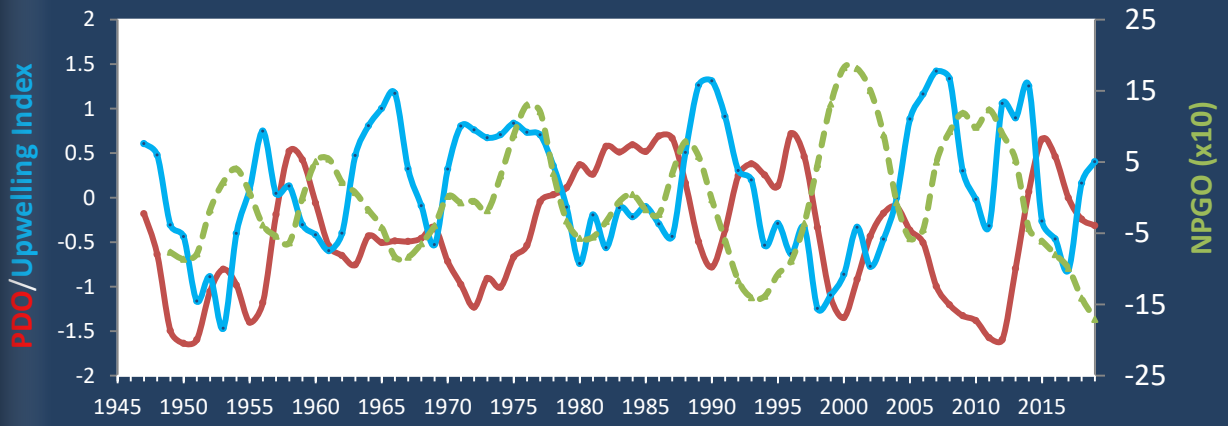
Climate influences: How well is Puget Sound exchanging its water?

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. Entry of upwelled water into Puget Sound was likely weaker in the summer of 2019 than in years without drought.

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

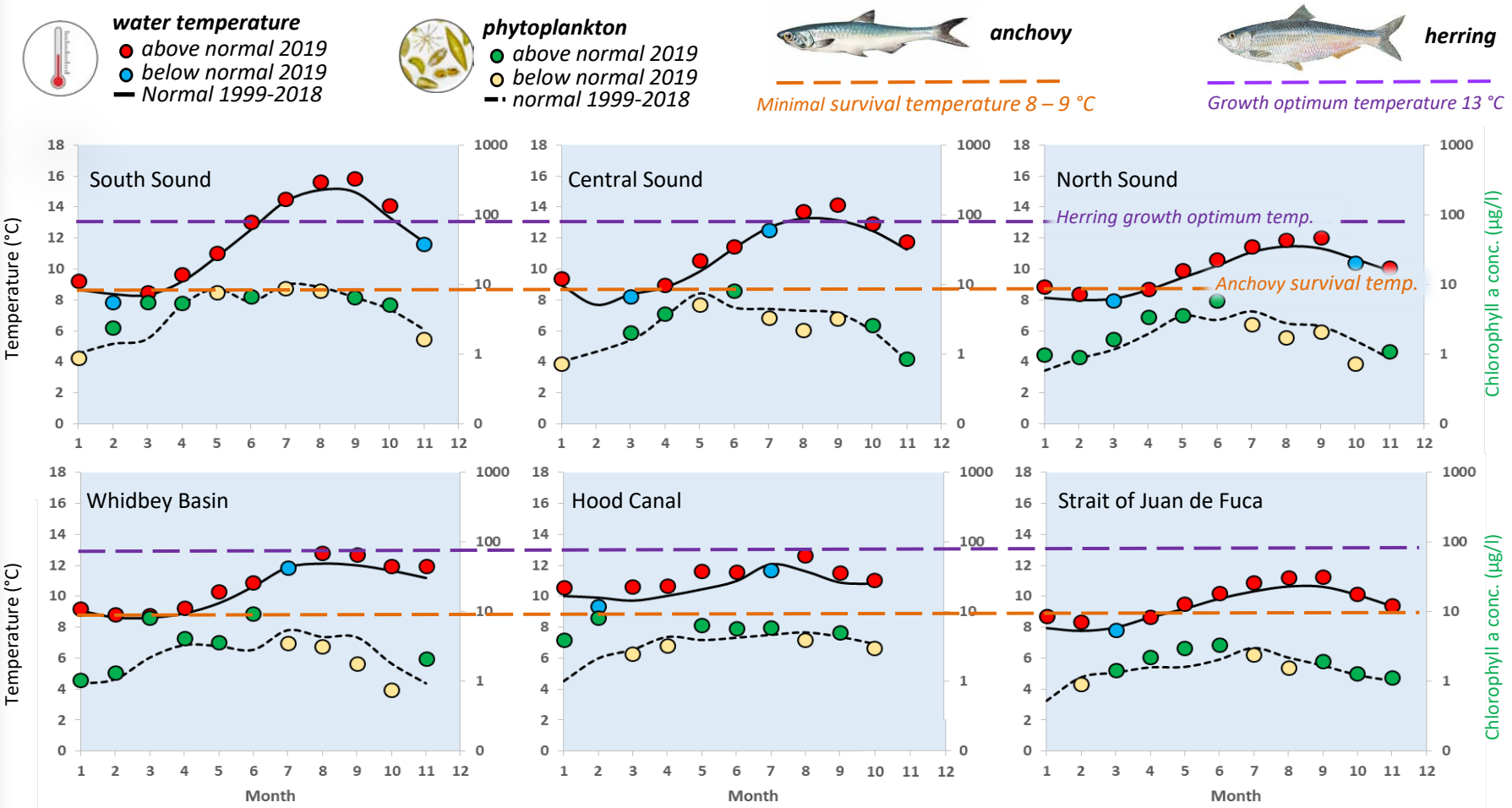


Large-scale boundary conditions begin to move away from neutral

Past year's 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. The data that are available suggest reduced coastal productivity.

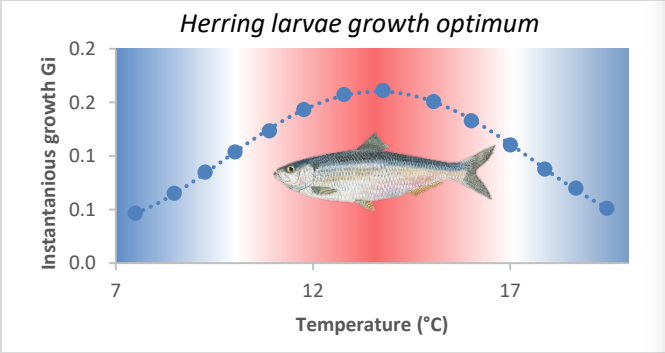
*Pacific Decadal Oscillation Index (**PDO, temperature**, explanation). Upwelling Index (anomalies) (**Upwelling, low oxygen**, explanation). North Pacific Gyre Oscillation Index (**NPGO, productivity**, explanation).*

South Sound generally offers prolonged periods near the herring growth optimum. In winter, Hood Canal generally offers the warmest overwintering temperatures. In 2019, surface water temperatures (0 – 30 m) were consistently above normal. Chl a, a proxy for the biomass of phytoplankton supporting the food chain, was generally higher than normal in spring.



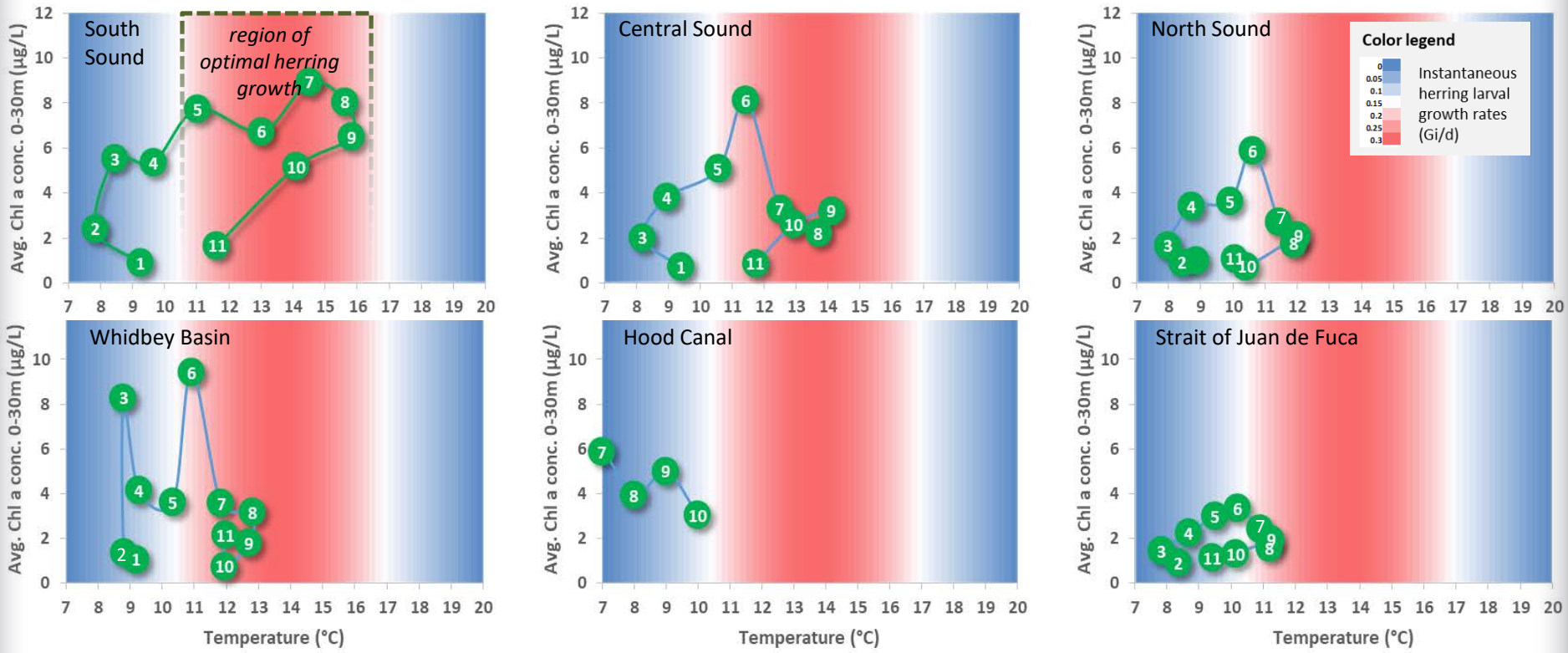
Temperature and food can affect herring growth

Fish need optimal water temperatures and food to grow.
Places and times when good growth conditions are met occur when both temperatures and food is not limiting. Assuming that Chl a is a rough proxy of phytoplankton and zooplankton that fish eat, South Sound stands out for having prolonged good growth conditions for juvenile fish in 2019. Whidbey Basin, Central and North Sound provided high phytoplankton biomass in June.



=Month | Optimal growth

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



The year 2019 supported anchovies, macroalgae, *Noctiluca*, and coccolithophores

Christopher Krembs

In 2019 large schools of anchovies congregated in South Sound, attracting marine life, whereas jellyfish numbers remained lower compared to previous years. *Noctiluca* bloomed in many places, followed by large amounts of macroalgae. A coccolithophore bloom occurred again in Hood Canal. Colored water nicely visualizes physical surface processes.

Anchovies — Large schools of anchovies congregated as early as February in Case Inlet and were seen throughout South Sound during 2019. Start here

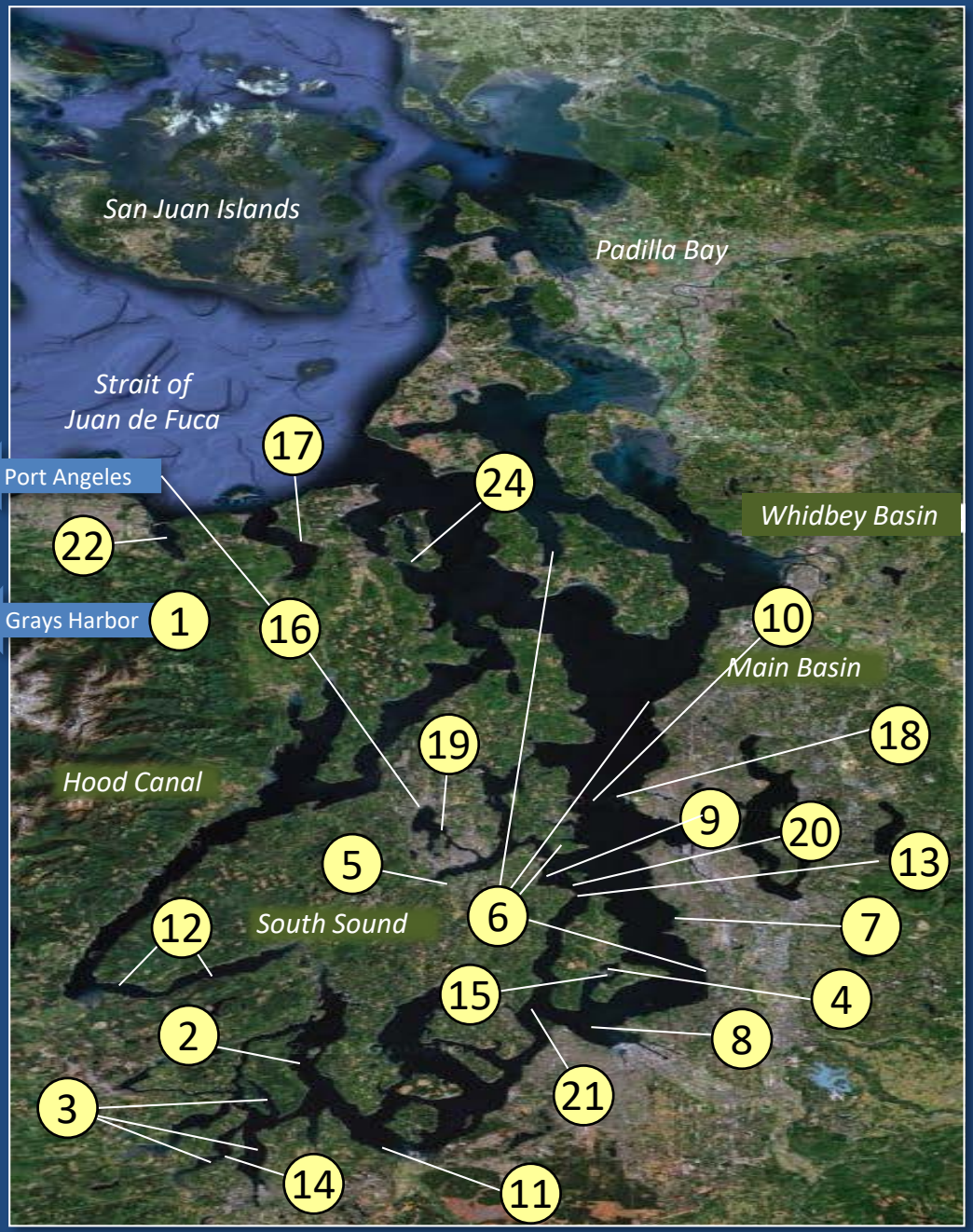
Jellyfish — Jellyfish patches (smacks), though present, occurred in lower numbers in South Sound and Sinclair Inlet, yet were abundant in Quartermaster Harbor and around Orcas Island.

Noctiluca — A large *Noctiluca* bloom persists for two months (May -June) in Central Sound. South Sound and other places also produced smaller *Noctiluca* blooms.

Macroalgae — Macroalgae were very abundant in Central and South Sound, and also occurred in Whidbey Basin and Bellingham Bay.

Blooms — Overall, the spring bloom appeared stronger than the 20-year average. A distinct turquoise coccolithophore bloom re-occured in Hood Canal this year. Fall blooms, staining the water red-brown, were less strong than in previous years, with the exceptions of Discovery and Sequim Bays.

Physics — The processes of water and sediment transport are very important to the Puget Sound ecosystem. At times they are beautifully visible from the air. See what they look like from above.

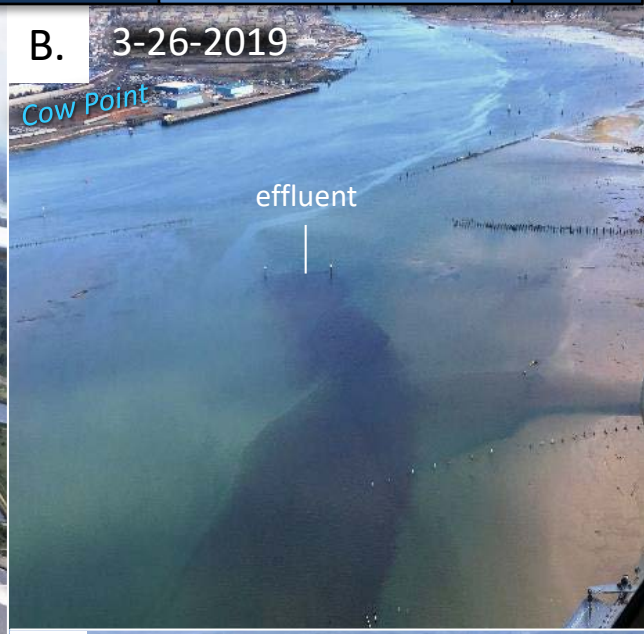


Aerial photography & navigation guide

Date: 2019

Click on numbers

The map is a navigation guide to quickly find aerial pictures in a region. The numbers depict locations ordered by topics: human impacts 1, anchovies 2-3, jellyfish 4-5, Noctiluca 6-8, macroalgae 9-11, blooms 12-17, and physics 18-22.

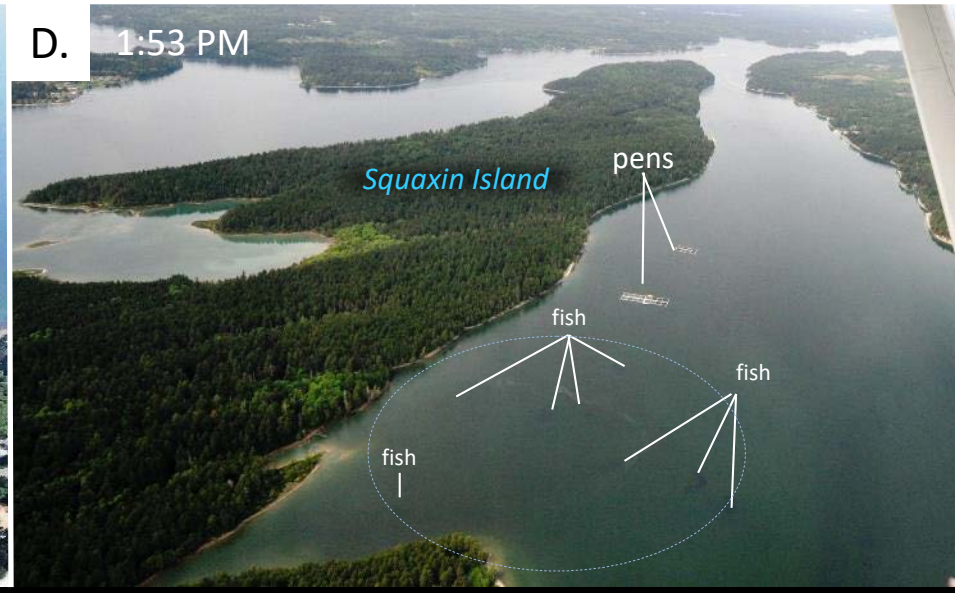


A. Effluent from Cosmo Specialty Fiber rises to the surface. June 2019. B. March 2019. C. September 2018.
Location: Aberdeen (Grays Harbor)

Scientists catch anchovies in shallow and deep water of Case Inlet

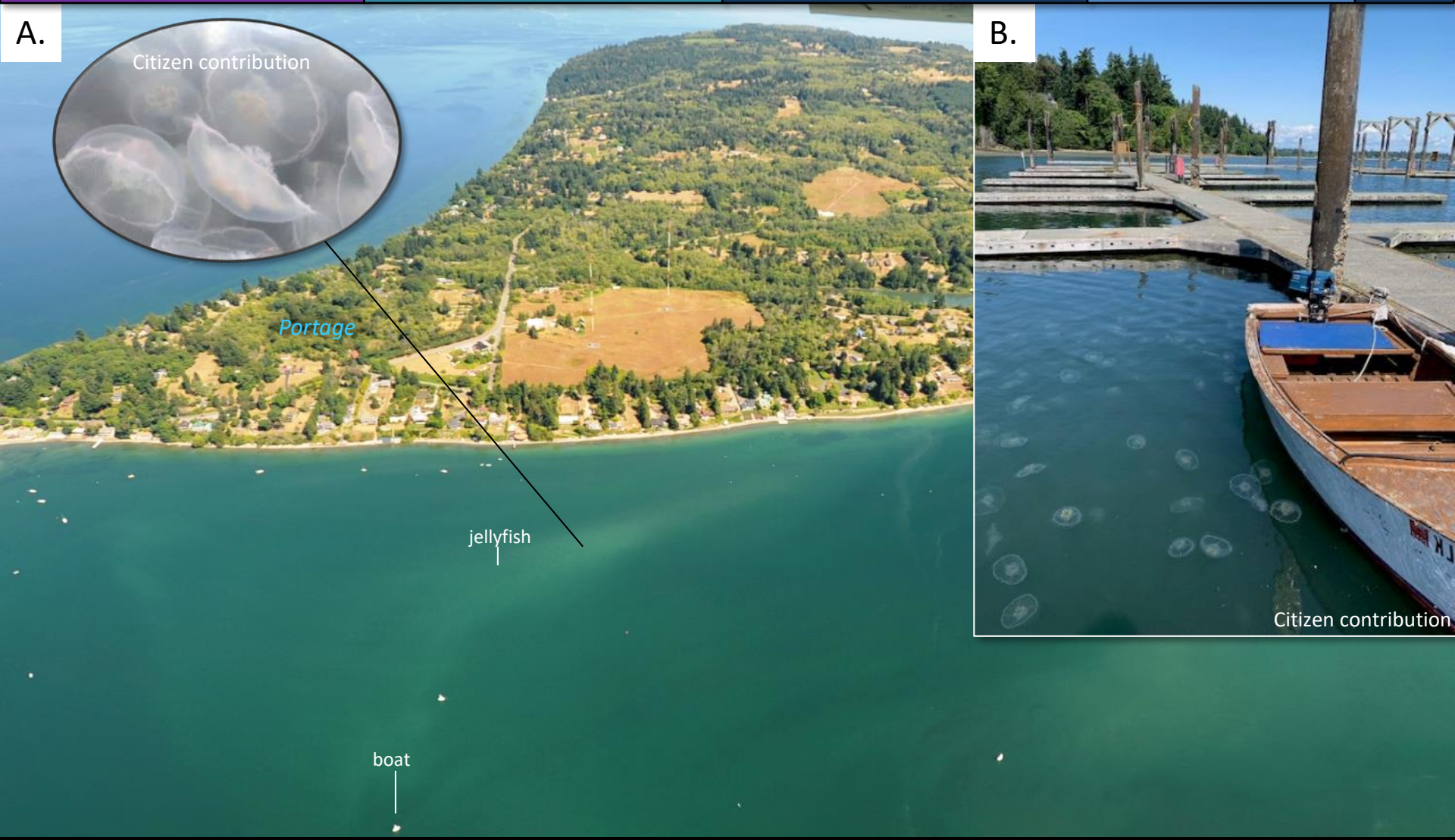
Large numbers of juvenile anchovy began to appear in South Sound with warmer water in the fall of 2015 and have been present in annual fall surveys since then. Here is an example of 250K juvenile anchovies caught with only one net set.

Aerial photography 5-13-2019



Schools of fish in shallow regions of South Sound.

Location: A. Budd Inlet, B. Eld Inlet, C. Case Inlet (North Bay), D. Peale Passage (South Sound)



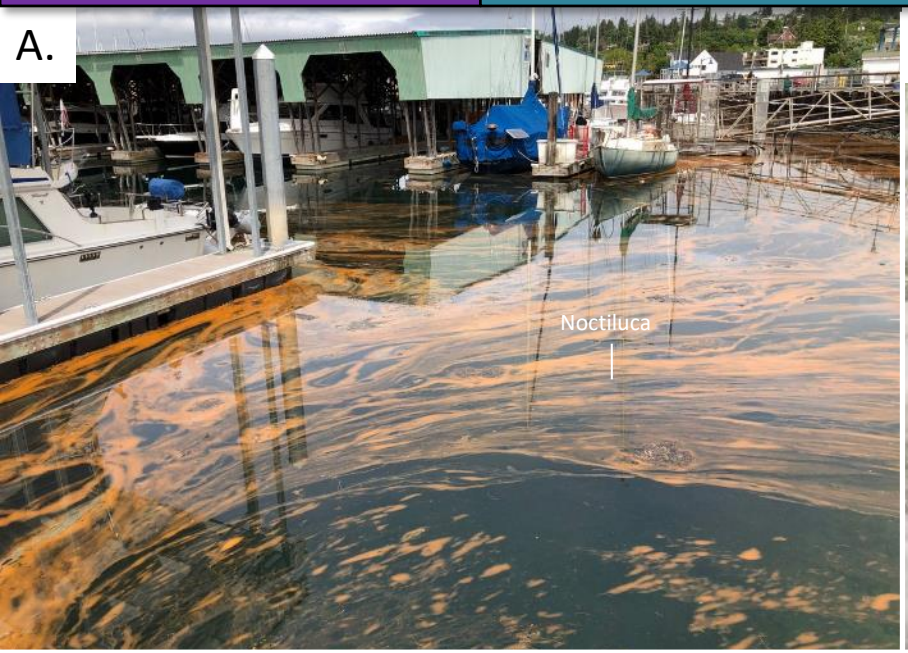
A. Large aggregations of moon jellies in several locations of the inner bay. B. Citizen contribution.
Location: Quartermaster Harbor (Central Sound), 2:53 PM

Patches of jellyfish and red-brown bloom mixed with what appears to be turquoise water.

Location: Sinclair Inlet (Central Sound), 1:51 PM

Citizen photography 5-13-2019

A.



B.

C.

D.

E.

We share people's experiences with Noctiluca *on the water. Thank you for the great contributions.*

Location: A. Des Moines Marina, B. Holmes Harbor, C. Edmonds, D. Port Blakely, E. Central Sound

Large Noctiluca *bloom stretching from Poverty Bay to West Point.*
Location: Shorewood (Central Sound), 2:15 PM

Noctiluca*, dark brown bloom, and glacial flour in the Puyallup River plume reaching westward.*
Location: Commencement Bay (Central Sound), 11:51 PM

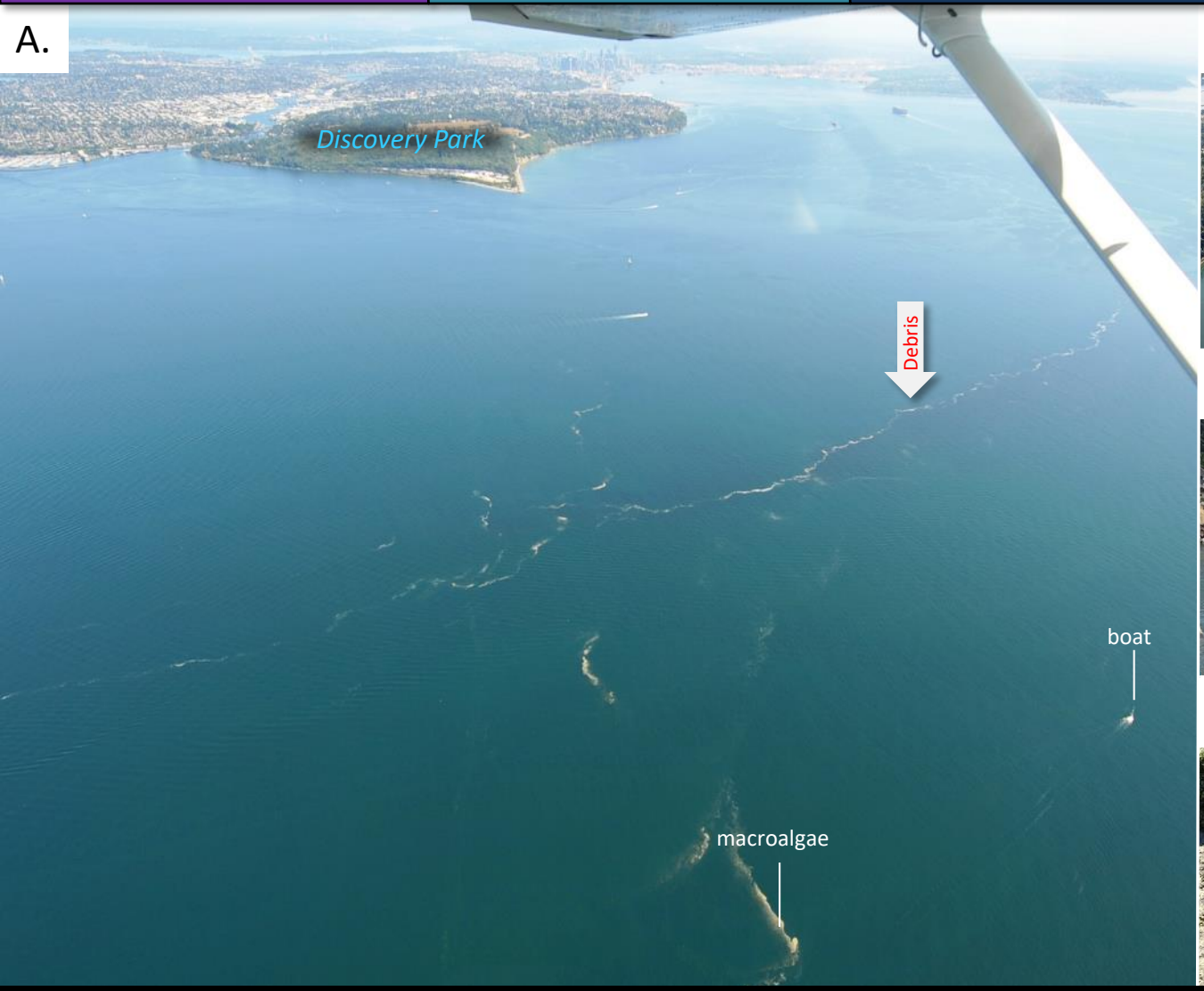
Aerial photography 7-29-2019

Large rafts of macroalgae stretching along the shores of Manchester.

Location: Manchester (Central Sound), 2:41 PM

Aerial photography 7-29-2019

A.



B.

C.

D.

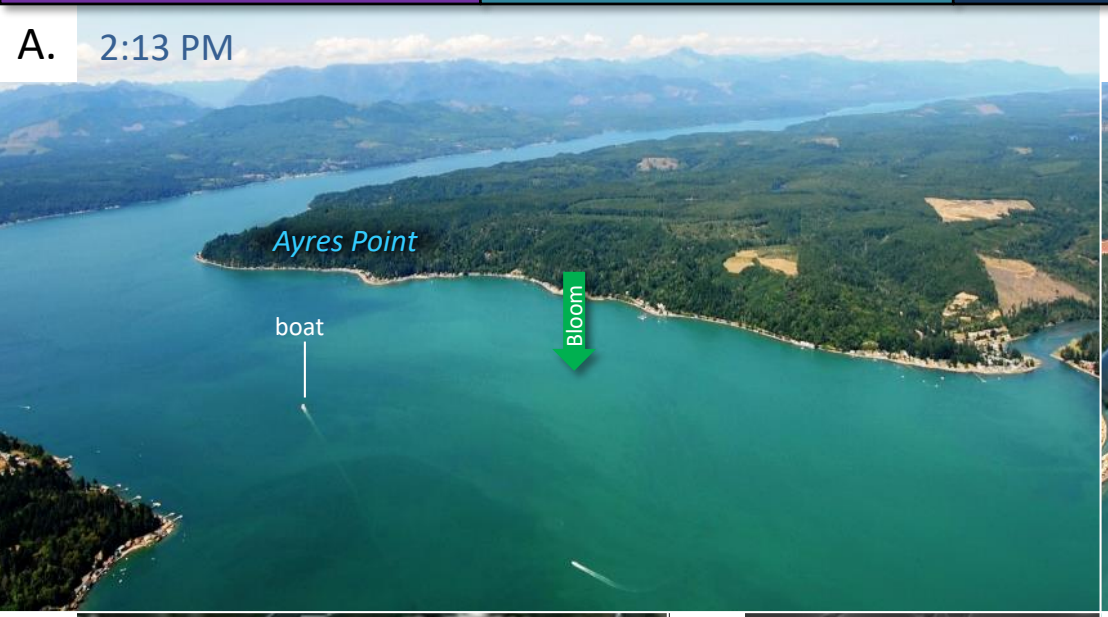
A. & B. Large rafts of macroalgae. C. Macroalgae washing onto beaches. D. Beachgoers touching macroalgae.
Location: A. Across Discovery Park, B. Blakely Harbor, C. Burien, D. Dash Point (Central Sound), 2:39 PM

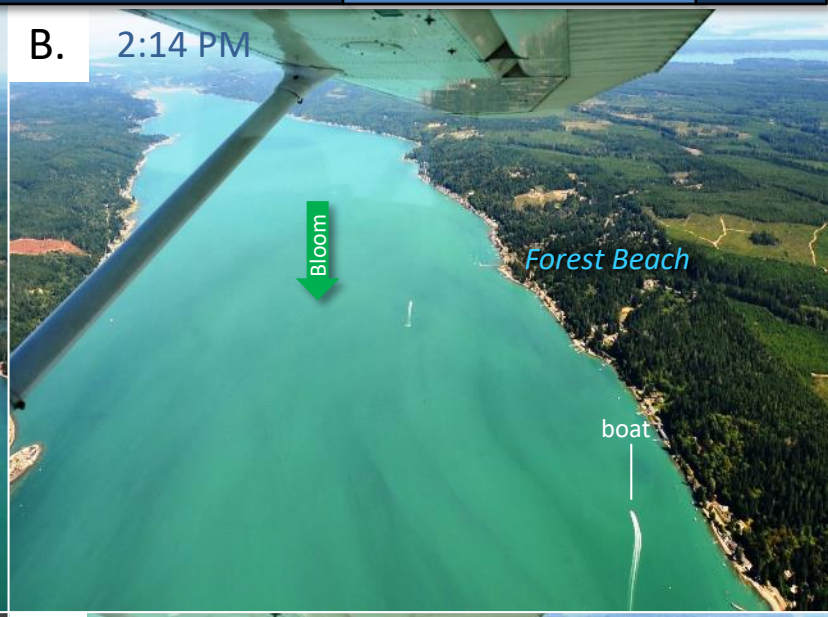
Aerial photography 7-29-2019

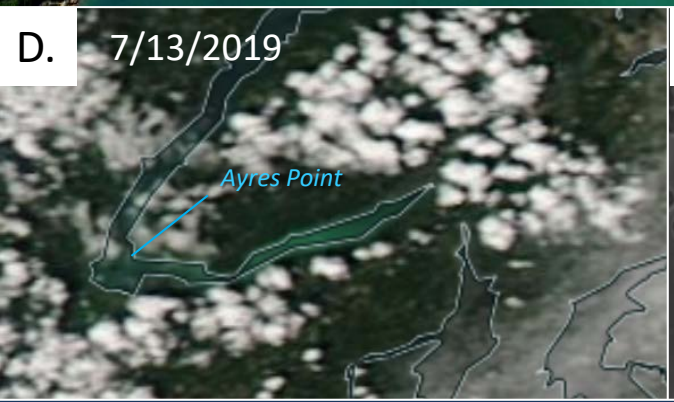
Macroalgae accumulating along tidal front.

Location: Nisqually Reach (South Sound), 3:10 PM

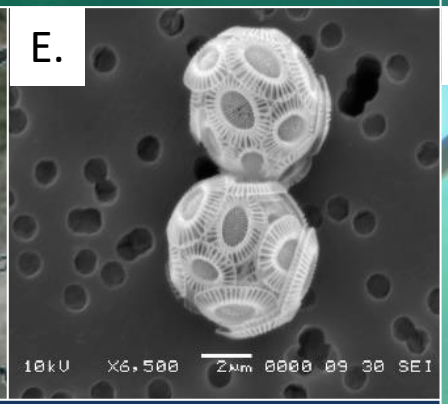
Aerial photography 7-29-2019



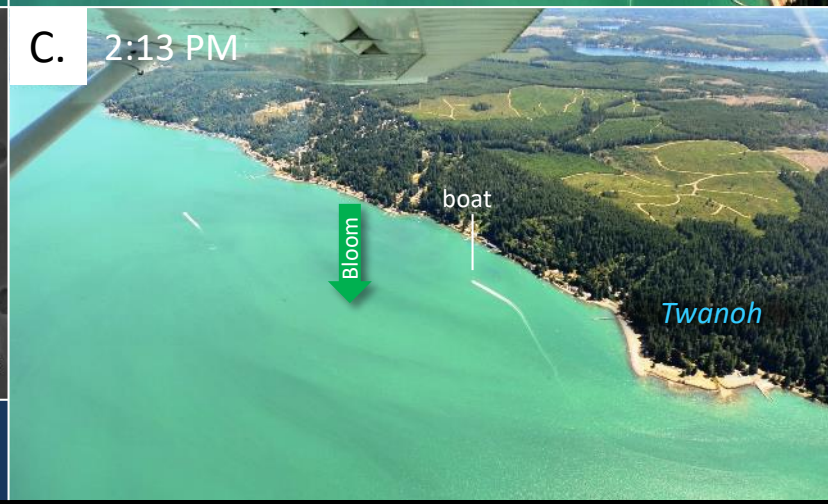




D. NASA satellite image southern Hood Canal



E. Microscopic coccolithophore



Strong coccolithophore bloom stretching from Union (A) to Lynch Cove (B). C. Twanoh State Park.

Location: A–D. Southern Hood Canal (Hood Canal)

Aerial photography 6-4-2019

A.

B.

C.

Dark brown bloom (diatoms) organic material stretching from Edmonds to Commencement Bay.

Location: A. Southworth, B. Blake Island, C. Across Elliott Bay (Central Sound), 12:00 PM

Aerial photography 7-29-2019

Red-brown bloom, schooling fish, and a patch of jellyfish.

Location: Eld Inlet (South Sound), 1:49 PM

Red-brown bloom and very turbid water.

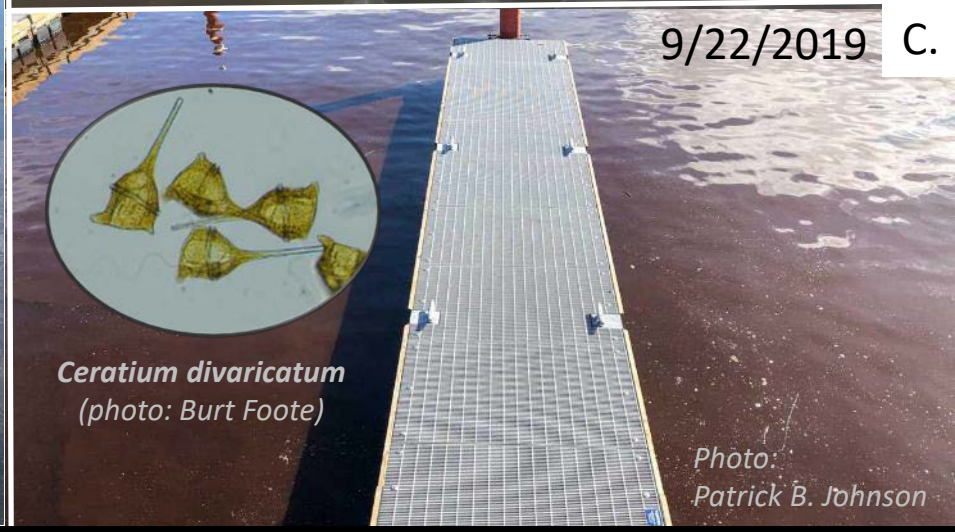
Location: Quartermaster Harbor (Central Sound), 2:20 PM

Citizen photography, October 2019

A. 10/30/2019

10/5/2019 B.

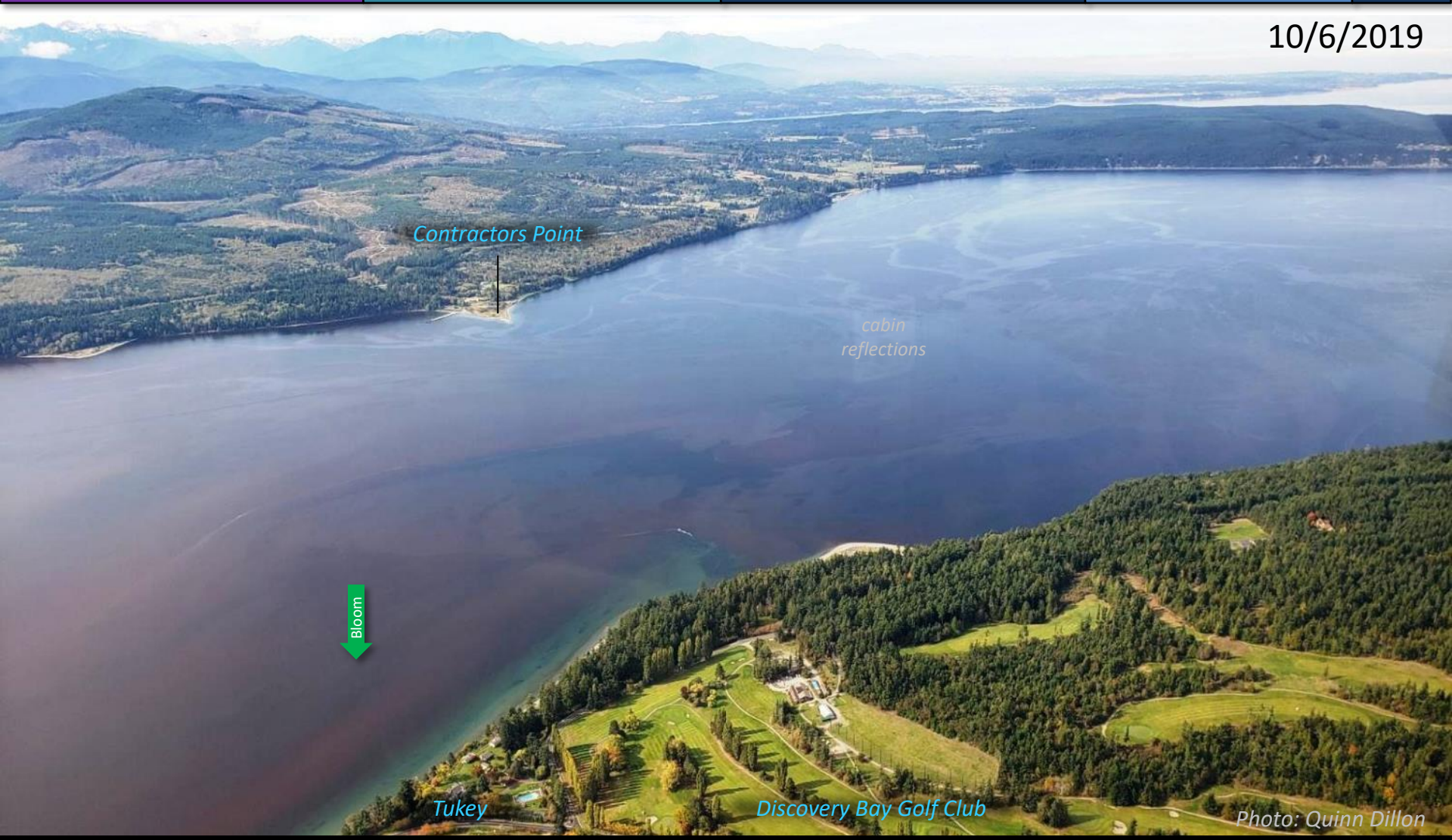
9/22/2019 C.



A. Patch of organic debris, B. Jellyfish, C. Red-brown bloom.

Location: A. Dyes Inlet, Silverdale, B. Quartermaster Harbor, C. Hollywood Beach, Port Angeles

Aerial photography, October 2019



Red-brown bloom.

Location: Discovery Bay (North Sound)

Suspended sediment from bluff erosion fanning out far offshore along a front.

Location: West Point (Central Sound), 1:18 PM

Aerial photography 7-29-2019

Noctiluca *and tidal eddies bringing in algal bloom from Sinclair Inlet and mixing into water of Dyes Inlet.*
Location: Dyes Inlet (Central Sound), 2:30 PM

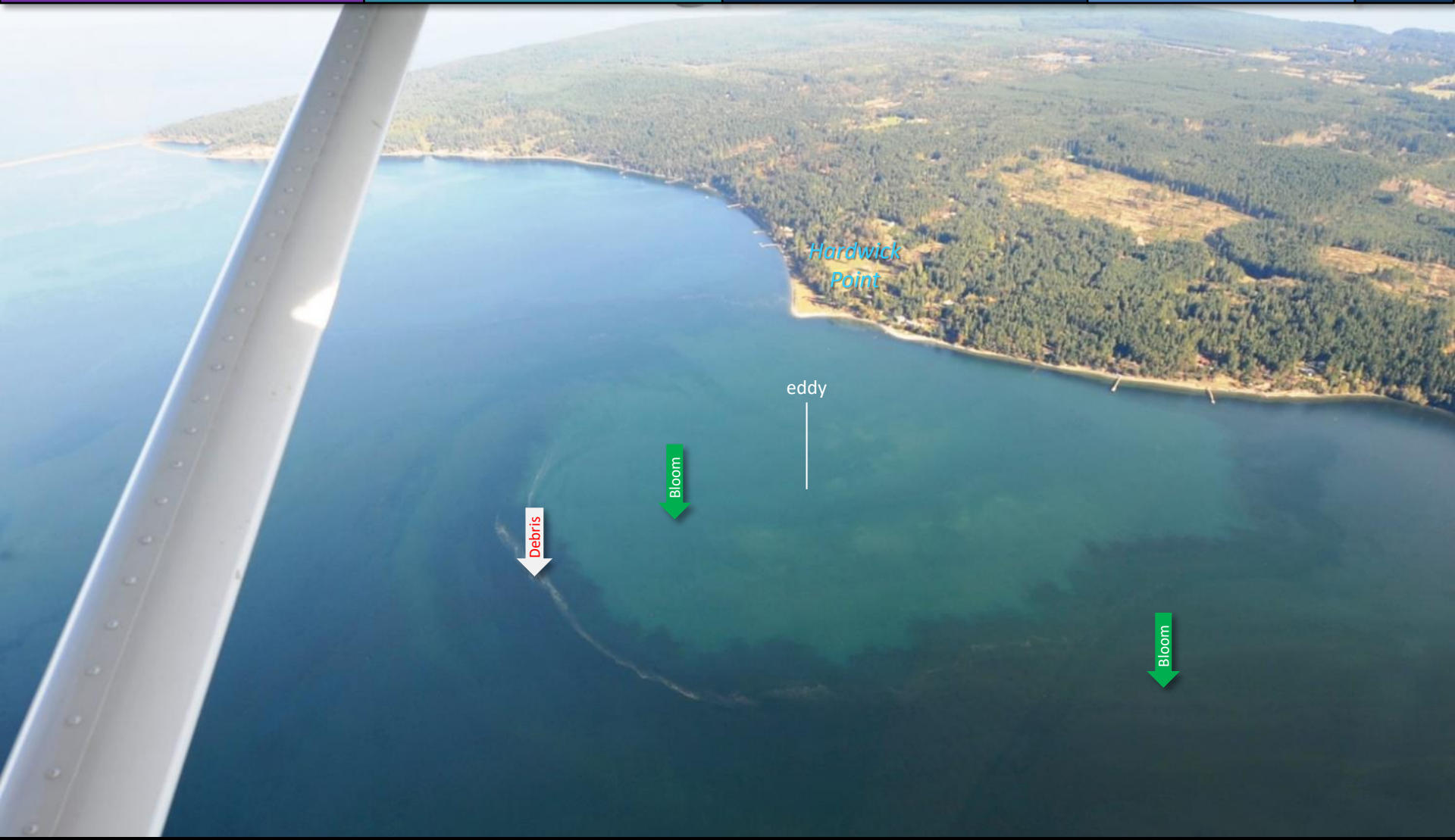
Aerial photography 7-29-2019

Water lined with macroalgae and stained by bloom circulating in large eddy.

Location: Blake Island A. looking North B. looking East (Central Sound), 2:46 PM

Puyallup River plume lined by macroalgae flowing into the Tacoma Narrows during incoming tide.

Location: Vashon Island (Central Sound), 2:57 PM



Large eddy of greenish water surrounded by a maroon-colored bloom.

Location: Sequim Bay (North Sound), 12:22 PM

We have published 85 editions!

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

Recommended Citation (example, September 2018):

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, and Kenmore Air.

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Environmental Assessment Program
Washington State
Department of Ecology

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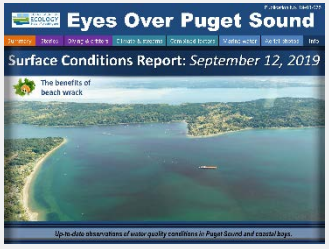

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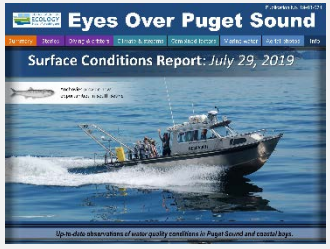

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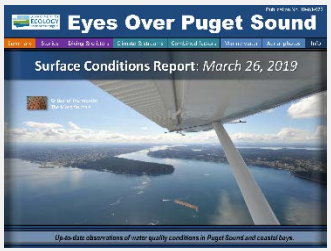

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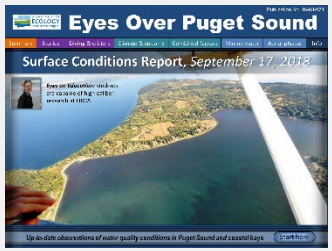

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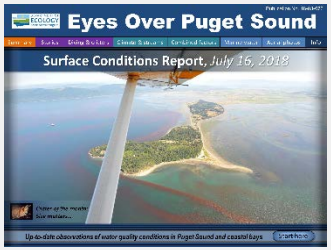

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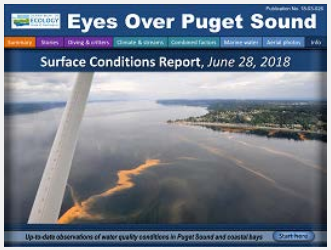

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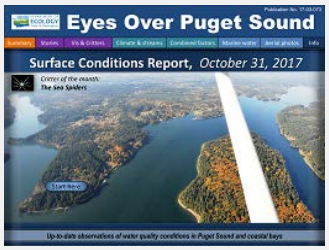

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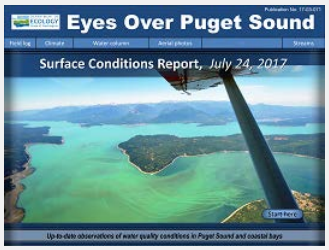

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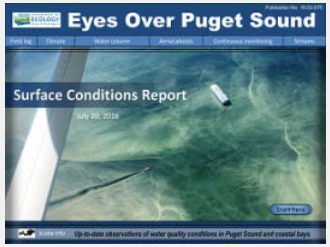

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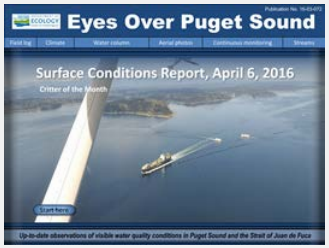

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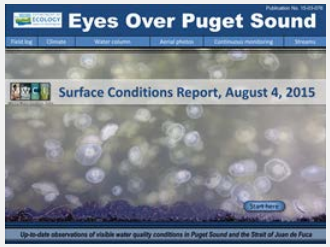

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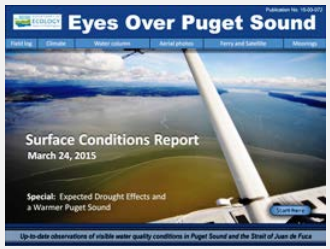

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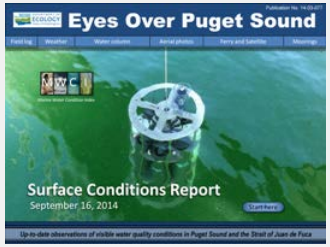

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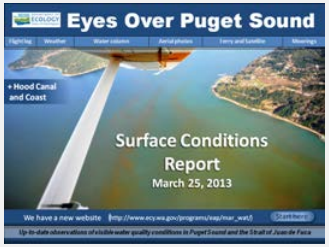

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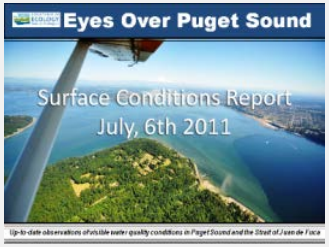

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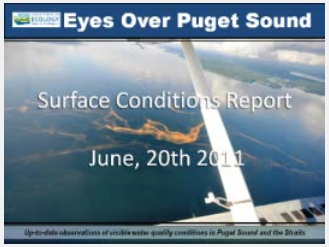

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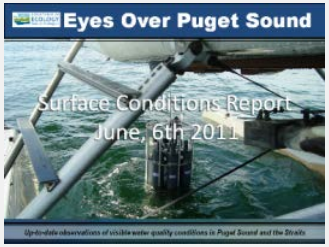

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