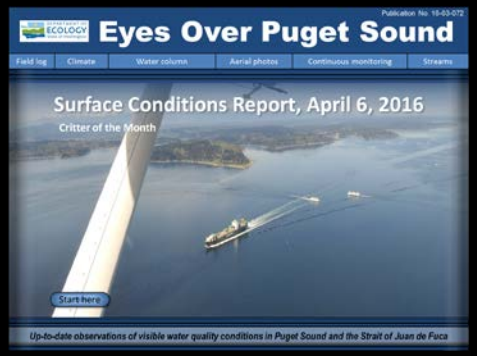
Publication No. 16-03-079

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

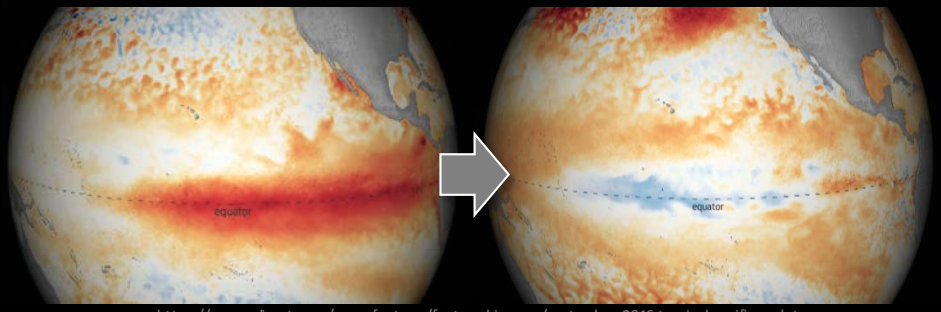
EOPS	Weather	Climate	Species Respond	Water column	Aerial photos



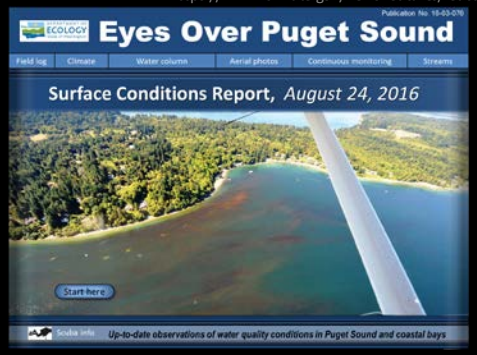
2016 Review

El Niño, January 2016

La Niña, September 2016



https://www.climate.gov/news-features/featured-images/september-2016-tropical-pacific-update



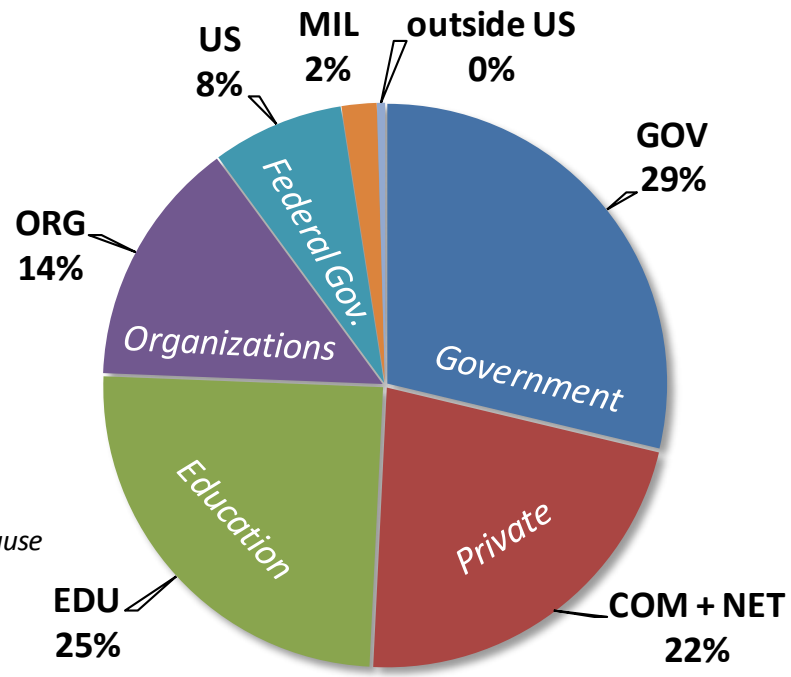
Up-to-date observations of visible water quality conditions in Puget Sound and the Strait of Juan de Fuca

2016 – The EOPS team thanks all our viewers

Ecology scientists behind EOPS

Subscribe to our dedicated email Listserv.
Join 670 users.
click here

Thanks to interested viewers, we are providing information for a diverse audience



Rivers and Streams

Jim Shedd
Markus von Prause

Tyler Burks
Don Watt

Marine

Mya Keyzers
Laura Hermanson

Skip Albertson

Suzan Pool
Julia Bos

Dr. Christopher Krembs

Carol Maloy
Julianne Ruffner

User demographics based on best guesses per e-mail extensions

2016 – Weather in review for the last years

Climate and natural influences, including weather, rivers, and the adjacent ocean, can affect our marine waters. Graphics are based on provisional data and are subject to change. http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html, page 26.

Summary:

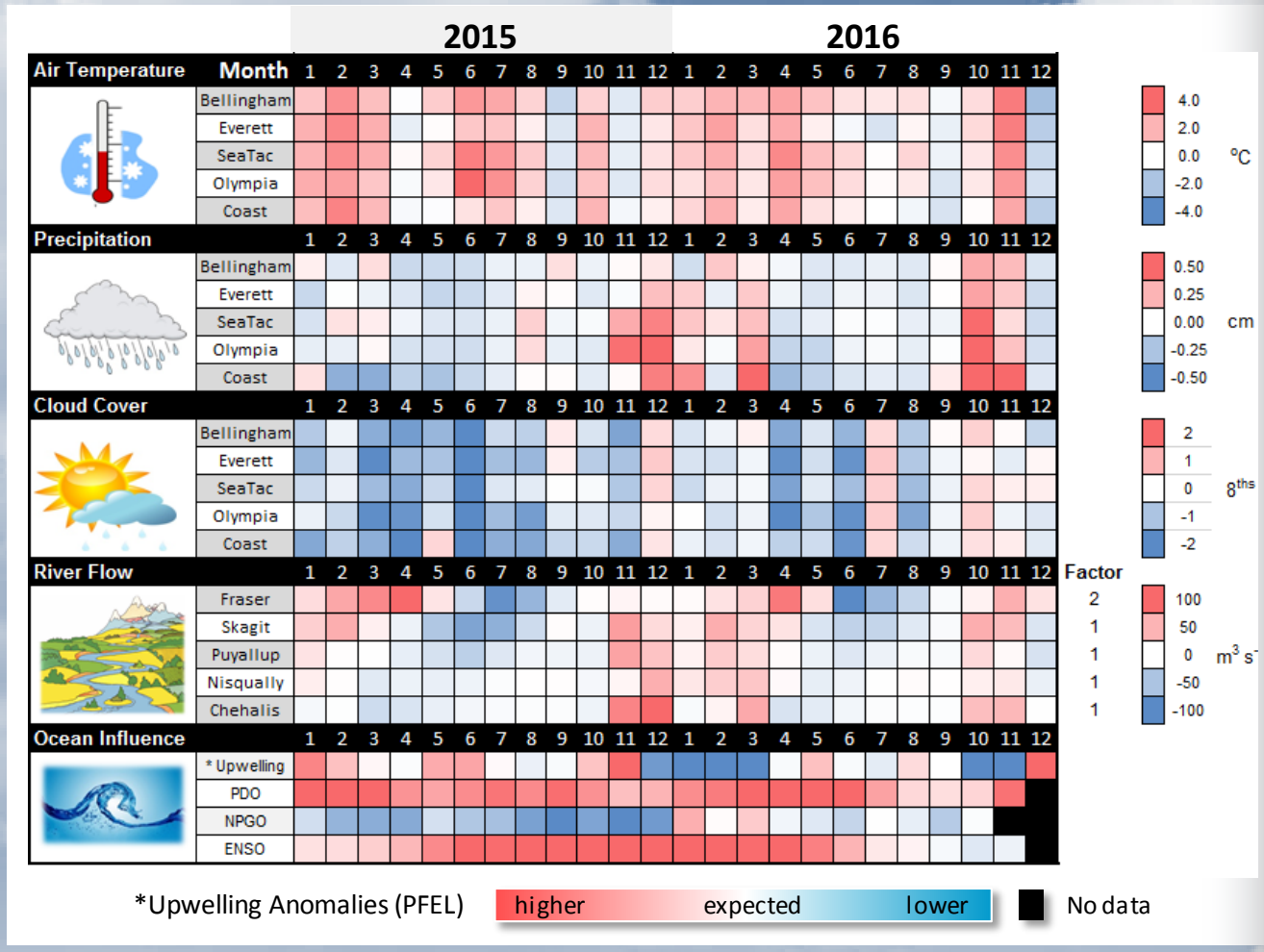
Air temperatures have dropped sharply. The end of 2016 looks like La Niña conditions.

Precipitation levels dropped from November to December, which is atypical for La Niña.

Sunshine in December is close to normal.

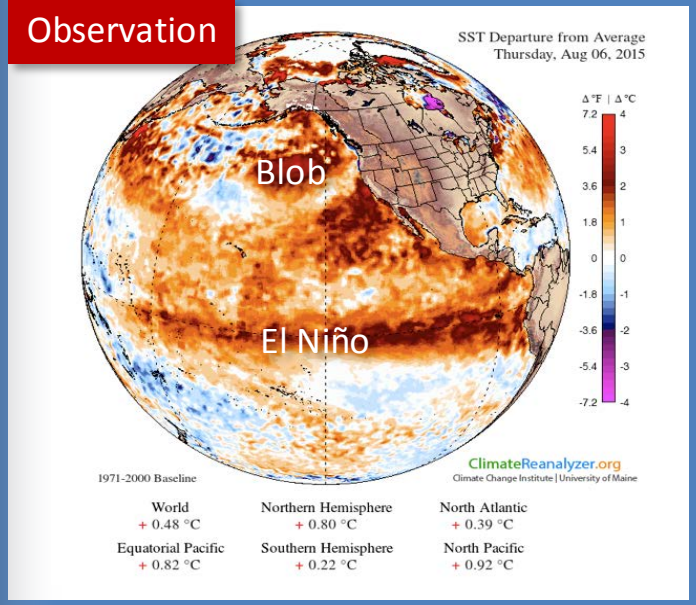
River flows in December are falling again below normal in response to low precipitation, except for the Fraser River.

Downwelling (opposite of upwelling) is weak in December, following two strong downwelling months (Oct and Nov).



Global Climate affects Salish Sea Water Quality

Observation

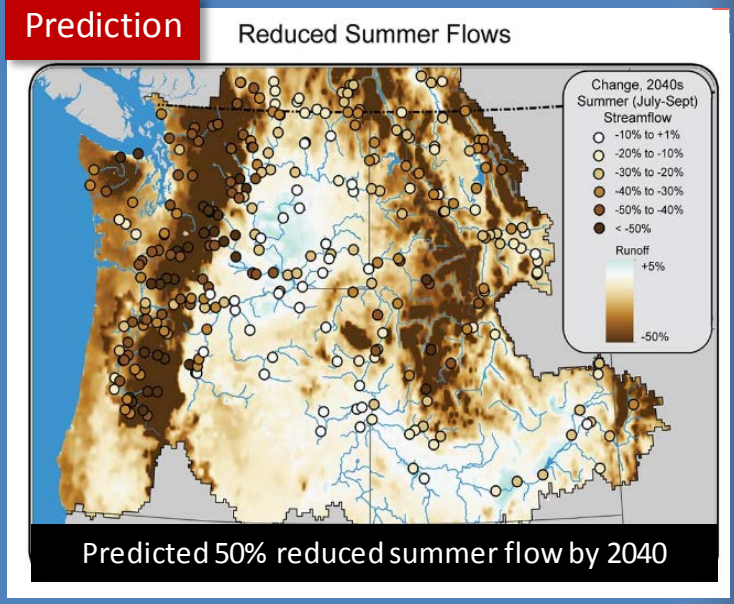


http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html

Reduced summer flows in snow-fed rivers affect water renewal and water quality in Puget Sound in 2015-16, a glimpse into the future

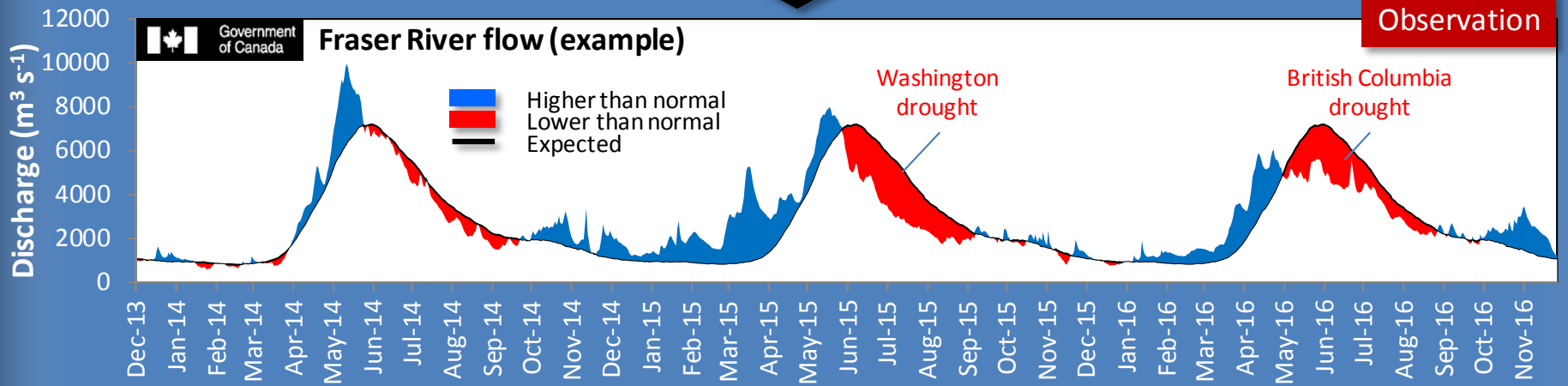
-50%

Prediction



http://nca2014.globalchange.gov/report/regions/northwest:

Observation



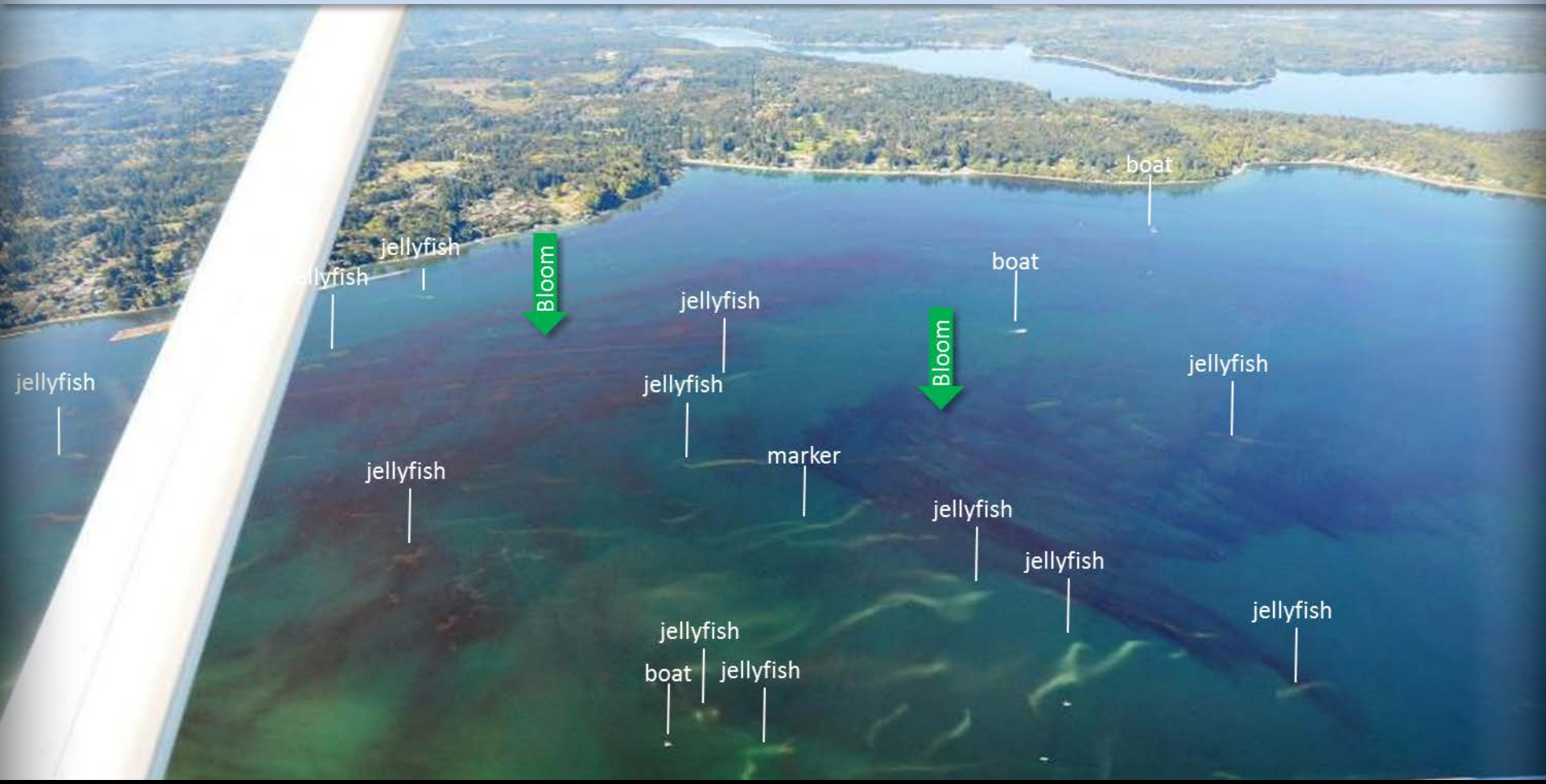
2016 – Species indicating eutrophication

Where do all the **macro-algae** end up after July? A lot of the material ends up on beaches.

Algae washed up on beaches in thick layers and rotting.
Location: Edmonds Underwater Park, Snohomish County, July 2016.

2016 – Species indicating eutrophication

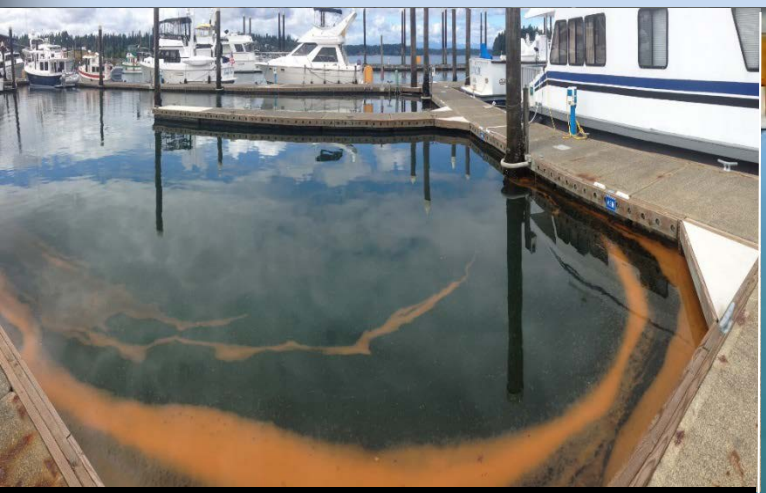
Jellyfish and red-brown dinoflagellate blooms thriving in warm, stagnant water in late summer.



Two differently colored red-brown blooms and abundant jellyfish patches.
Location: Budd Inlet (South Sound), September 2016.

2016 – Species indicating at eutrophication

Noctiluca thriving in eutrophic, stagnating water in many places, May-August 2016.

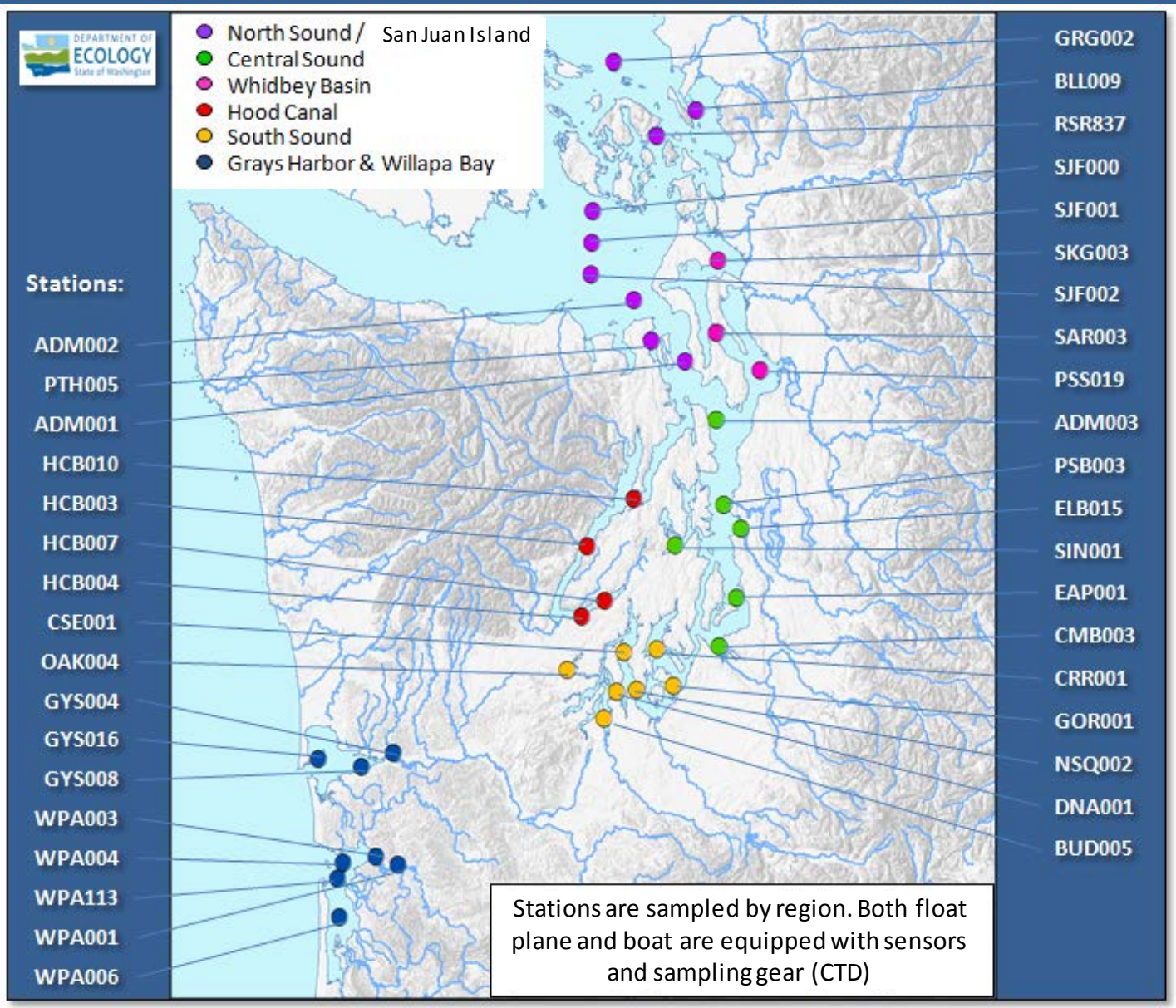


Noctiluca bloom, marine in Budd Inlet

Noctiluca bloom Pickering Passage, Case Inlet

Noctiluca and organic material accumulating near Boston Harbor Entrance to Budd Inlet (South Sound),.

Our long-term marine monitoring stations



We use a boat and chartered float plane to access our monthly monitoring stations most cost effectively.

Start here

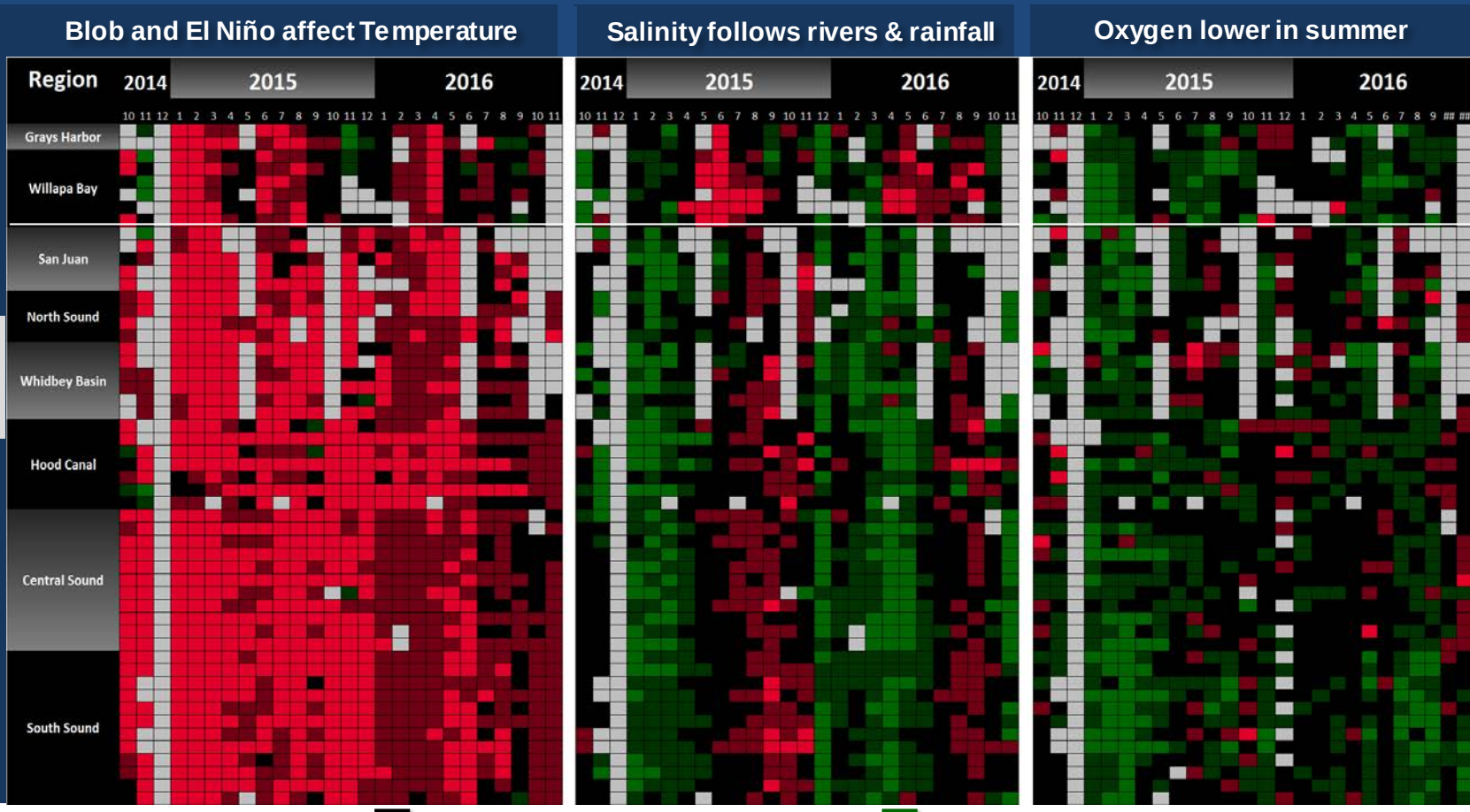
We communicate data and environmental marine conditions using:

1. **Marine Water Condition Index (MWCI)**
2. **Eyes Over Puget Sound (EOPS)**
3. **Anomalies and source data**

Much Warmer! Fresher to Saltier Shifts. Lower DO.

In 2016 **temperatures were still remarkably high in Puget Sound due to El Niño conditions following effects of the 2015 Blob event**. Warmer temperatures both years forced shifts in hydrology with more winter rainfall creating fresher conditions while drought effects in summer led to higher than normal salinity levels. In 2016, oxygen levels were lower than normal, particularly in South Sound.

Explore profiles at all stations



= higher than expected (>IQR, n=13)
= higher than previous measurements
= expected (=IQR, n=13)
= no data
= lower than expected (>IQR, n=13)
= lower than previous measurements

2016 Year in Review: Aerial photography

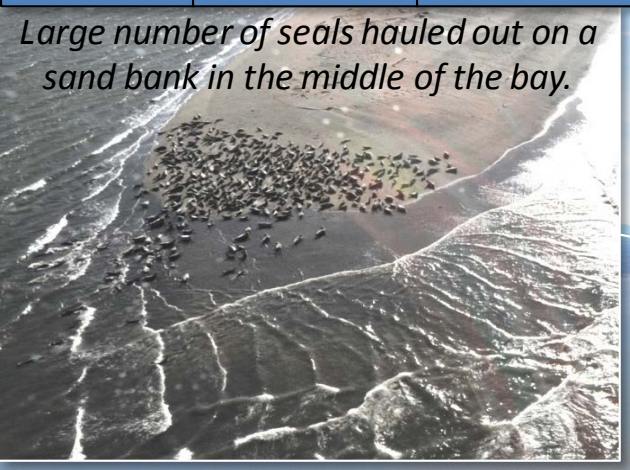
Jellyfish patches persisted with continued record warm temperatures. *Noctiluca*, jellyfish, and macro-algae occurred in high numbers. The Fraser River dropped to very low flows, slowing summertime water renewal in the Salish Sea. South Sound had unusually low oxygen.

1 2	**Feb.**	Snowpack declines in response to warm air from El Niño. Jellyfish patches prevail through winter. Start here
3 4	**Mar.**	Rivers are flowing high, salinities are low, and water temperatures remain at record levels. First blooms appear and jellyfish patches prevail. Strong rain brings sediment into Puget Sound.
5 6	**Apr.**	Water is warm and fresher, the spring phytoplankton bloom spreads across Central and South Sound. Jellyfish patches are very numerous. Herring are spawning.
7 8	**May.**	Jellyfish occur in high numbers. The spring phytoplankton bloom is in full swing extending into the Straits. Organic material is floating at the surface in large quantities, including Noctiluca. Record warm water continues.
9 10	**June**	Salinity is much lower than usual and temperatures are still at record highs. Oxygen is lower while drifting organic material and Noctiluca appear at the surface on a large scale in unusual places.
11 12	**Jul.**	River flows decrease. Macro-algae and other organic debris proliferate in large quantities at the surface where water temperatures climb above 15°C. Conditions are ripe for HABS.
13 14 15	**Aug.**	Red-brown blooms spread, jellyfish and Noctiluca thrive. July precipitation improves stream flows, while a drought in B.C. impacts the Fraser River in the north, resulting in slower water renewal in the Salish Sea system.
16 17 18	**Sept.**	Jellyfish patches reach very high densities. Red-brown blooms are abundant in South Sound and oxygen levels are much lower. In contrast, algal abundance in Central Sound is low.
19 20	**Nov.**	El Niño fades as wet and warm weather conditions prevail. Water temperatures finally return to normal after two years. Salinities, oxygen, and stream flows are normalizing. Yet, jellyfish are abundant in South Sound.

Aerial photography & navigation guide

Date: 2016

Click on numbers



Large number of seals hauled out on a sand bank in the middle of the bay.

suspended sediments

suspended sediment

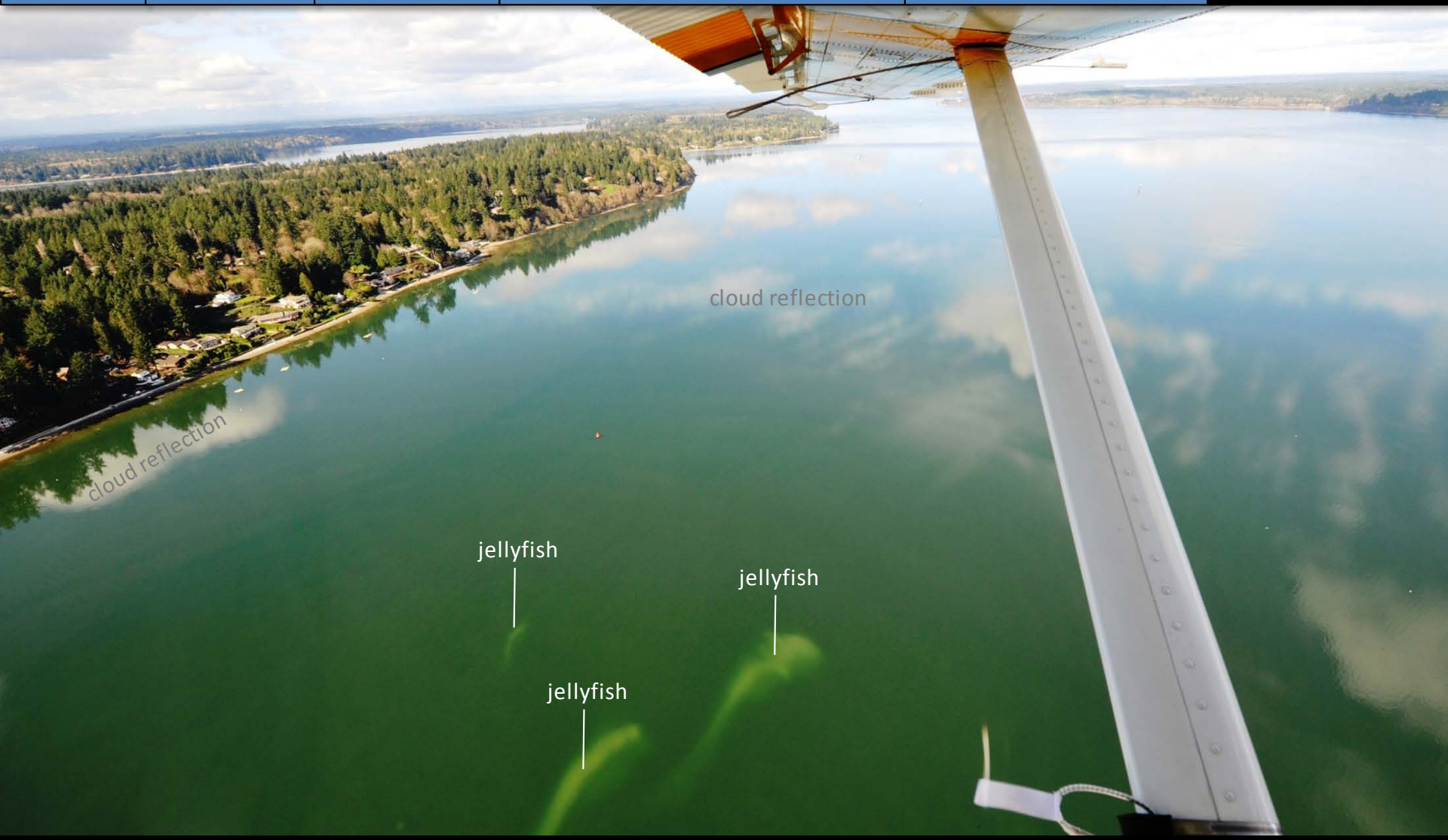
Plume

Brown-colored water of Duck Lake stained by humus (soil/organic material) flowing into coastal bays.

Location: Ocean Shores (Grays Harbor), 10:46 AM.

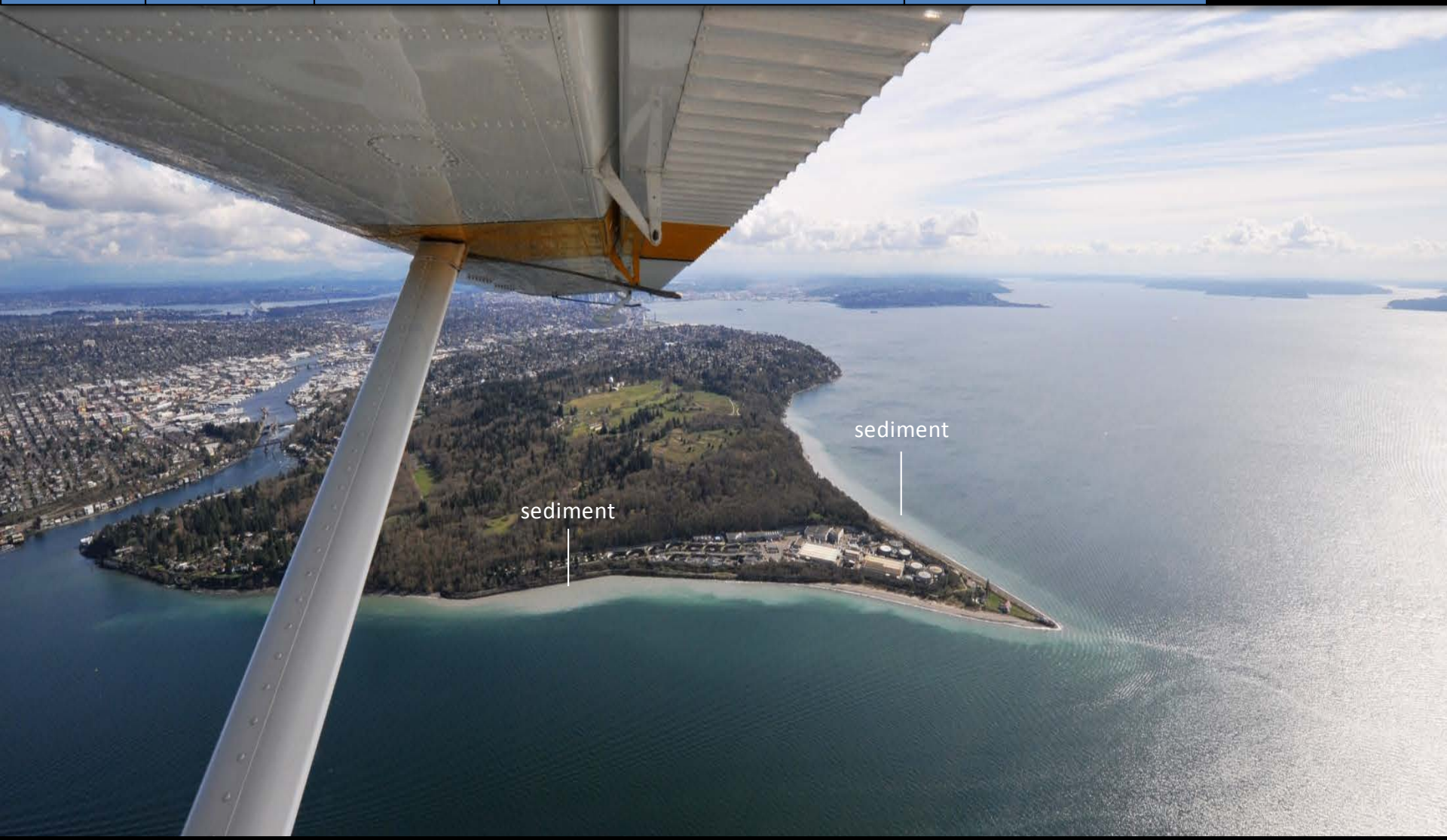
Incoming tide at the entrance to Grays Harbor. Colors indicate three different water masses.

Location: Westhaven State Park (Westport), 10:48 AM.



Jellyfish patches in green water, colored by a spring bloom.
Location: Budd Inlet (South Sound), 3:16 PM.

Aerial photography 3-16-2016



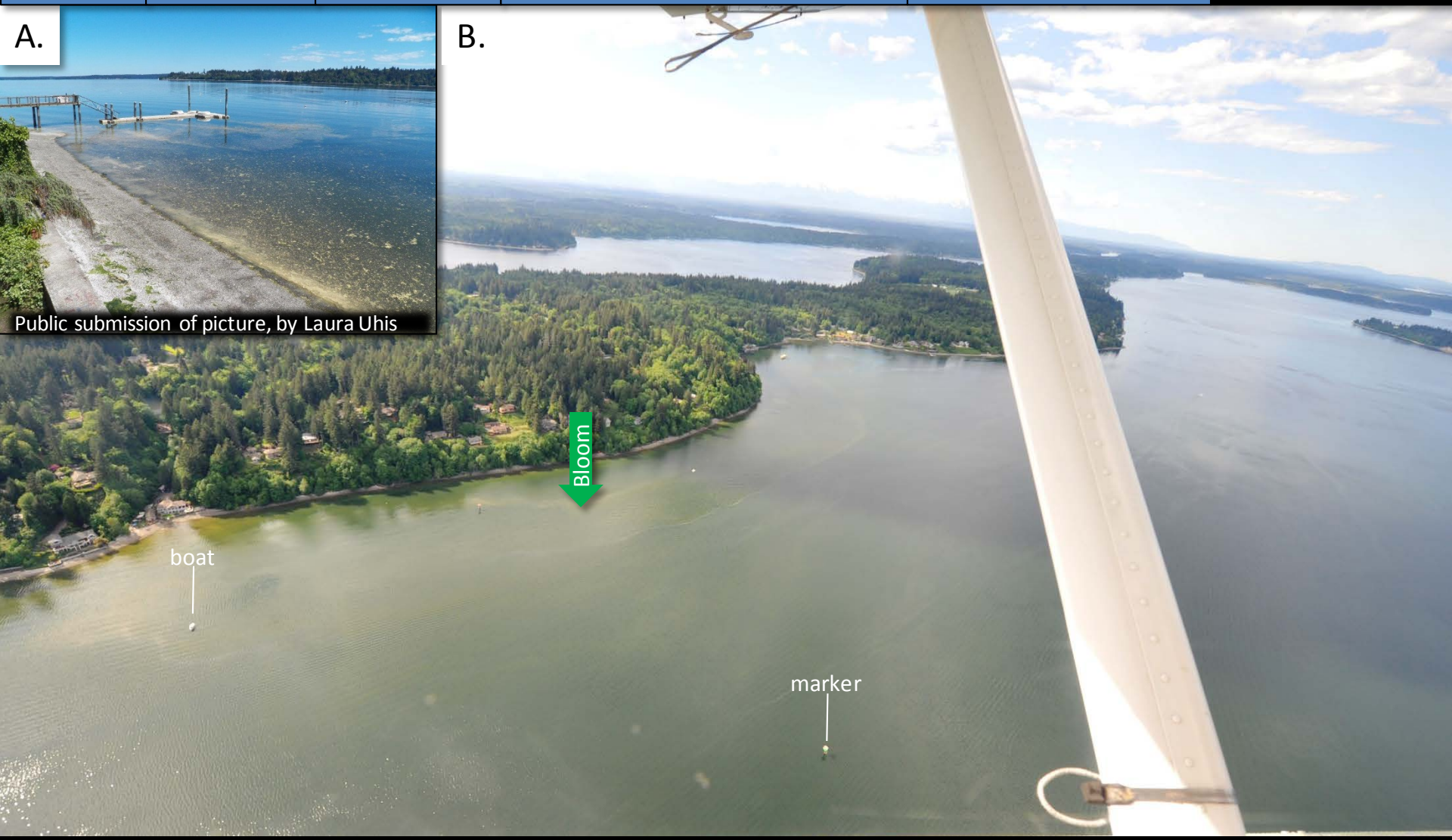
Suspended fine sediments lining all beaches around Discovery Park.

Location: Seattle (Central Sound), 2:42 PM.

Water rich in phytoplankton from Peale Passage flowing past Boston Harbor.
Location: *Off Dover Point,* near Dana Passage (South Sound), 12:33 PM.

A. Schooling fish or eelgrass, keeping them apart remains a guessing game! B. Internal waves in bay.
Location: A. Battle Point, B. Manzanita Bay, Bainbridge Island (Central Sound), 1:01 PM.

Aerial photography 5-2-2016



A. Organic material washing onto beaches and decaying. B. Very strong spring bloom conditions.
Location: West side of Budd Inlet (South Sound), 4:44 PM.

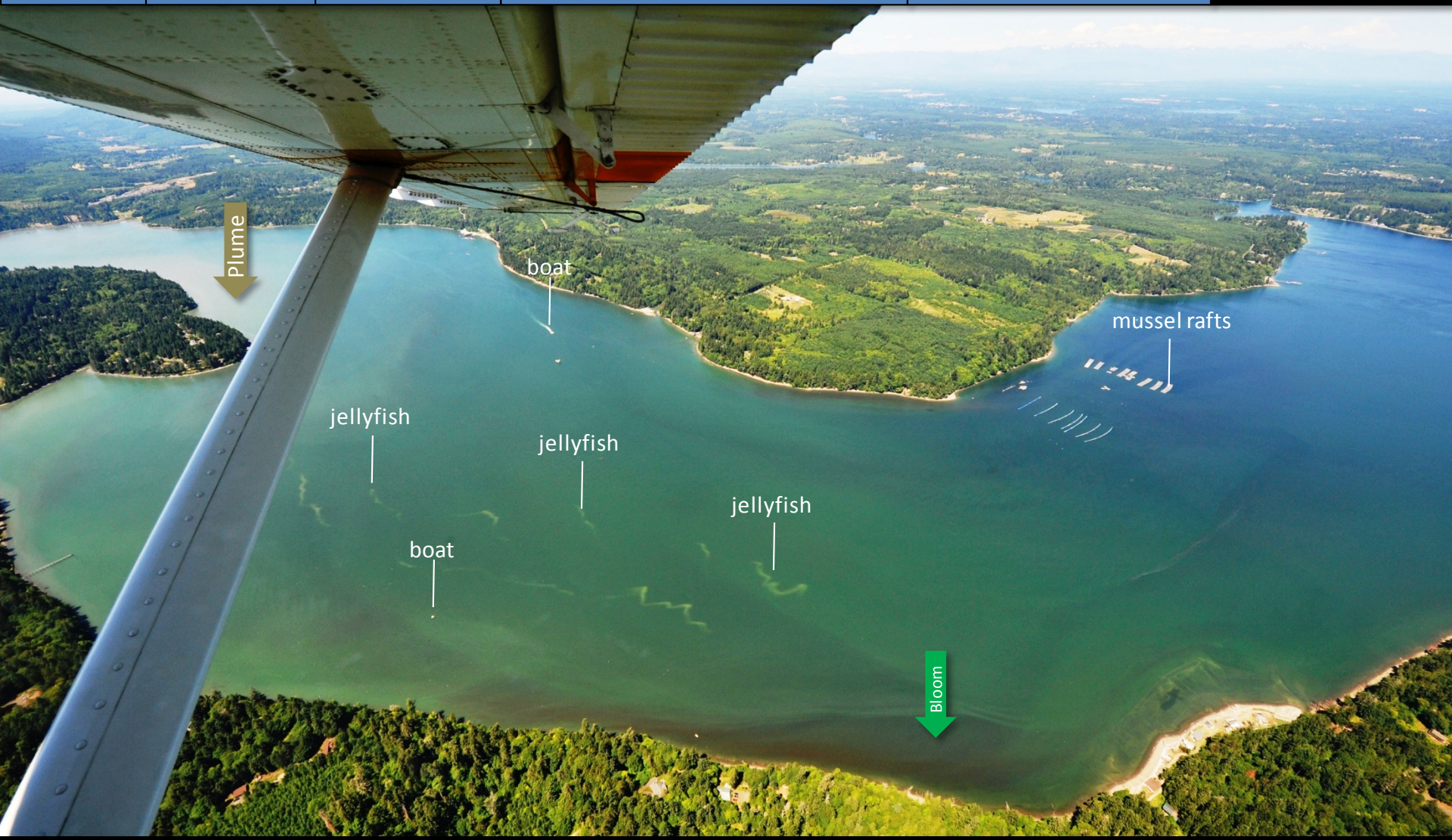
Large and numerous accumulations of organic material at the surface. Phytoplankton bloom.
Location: Dyes Inlet (Central Sound), 5:19 PM.

Aerial photography 6-27-2016

Organic material accumulating in large ribbons along tidal front at the entrance to Budd Inlet.

Location: Across from Boston Harbor, Budd Inlet (South Sound), 12:51 PM.

Aerial photography 6-27-2016



Large patches of jellyfish, sediment-rich river plume, and red-brown bloom near eastern shore.

Location: Totten Inlet (South Sound), 12:59 PM.

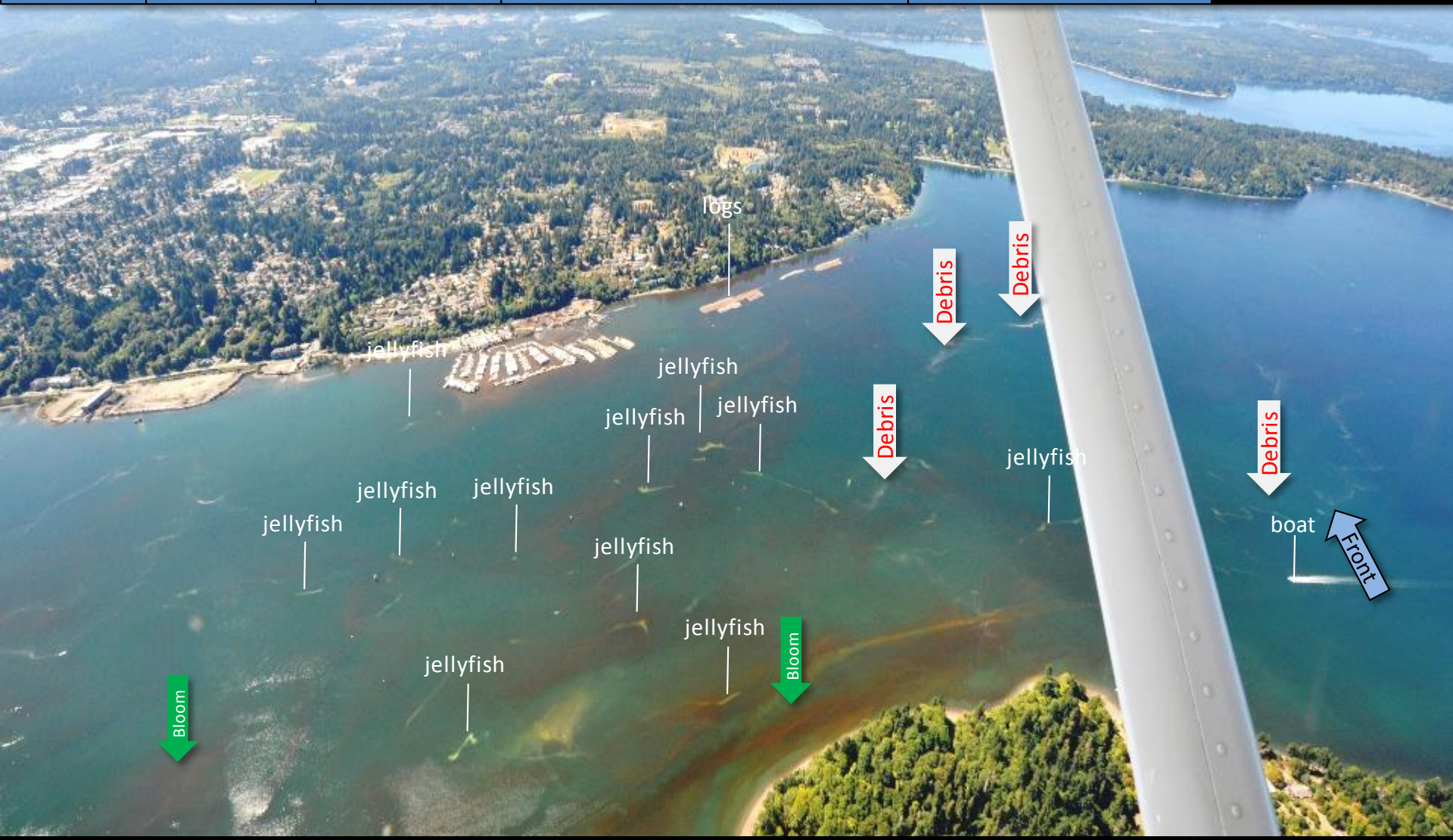
Aerial photography 7-20-2016

Red-brown bloom and large patches of jellyfish. Turquoise water is likely freshwater.

Location: Across from Young Cove, Eld Inlet (South Sound), 3:08 PM.

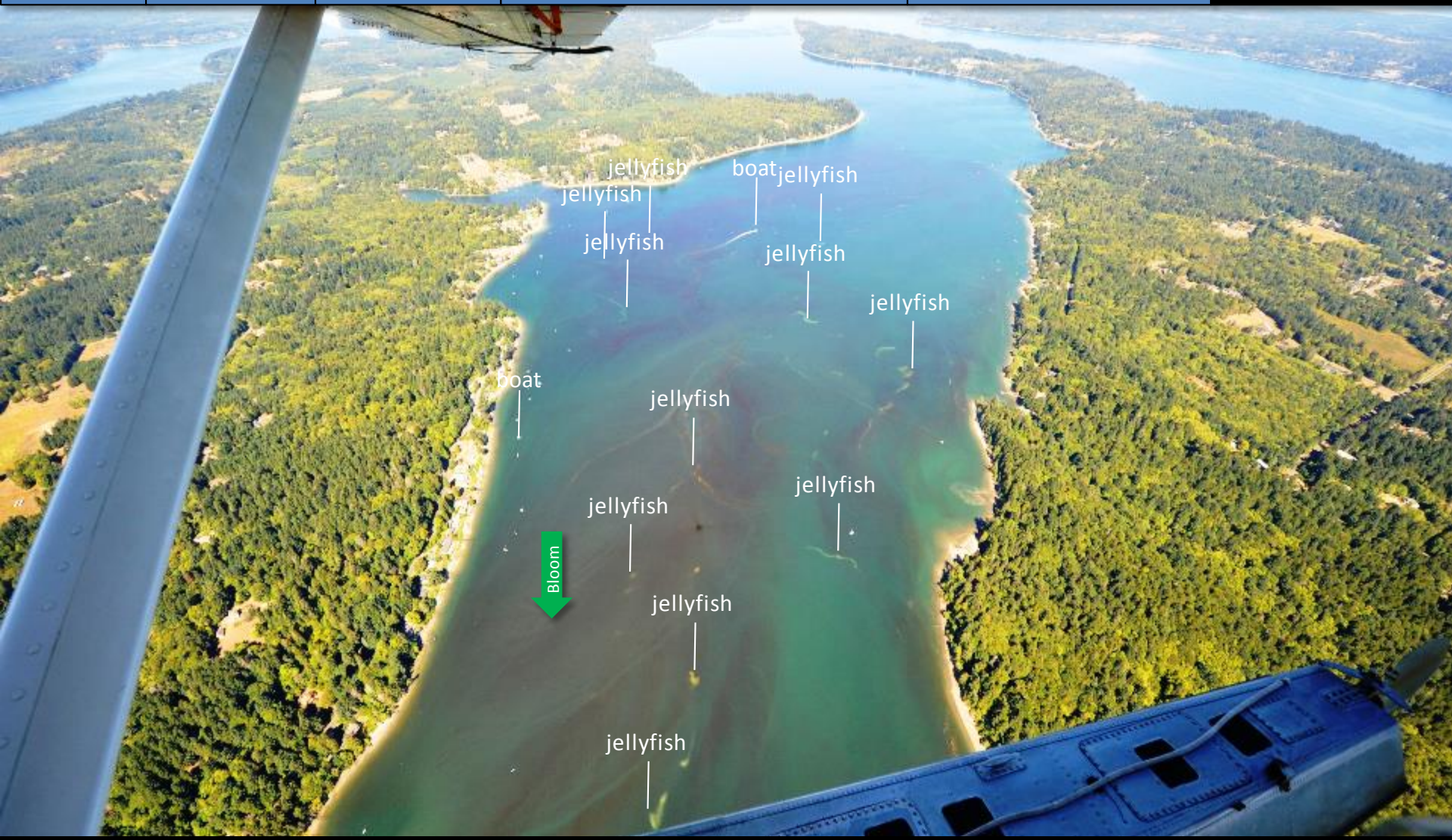
Very large mats of organic material drifting in Port Madison and adjacent parts of Central Basin.
Location: Point Monroe, Bainbridge Island (Central Sound), 3:58 PM.

Aerial photography 8-24-2016



Strong red-brown bloom, abundant jellyfish patches and organic debris at surface.

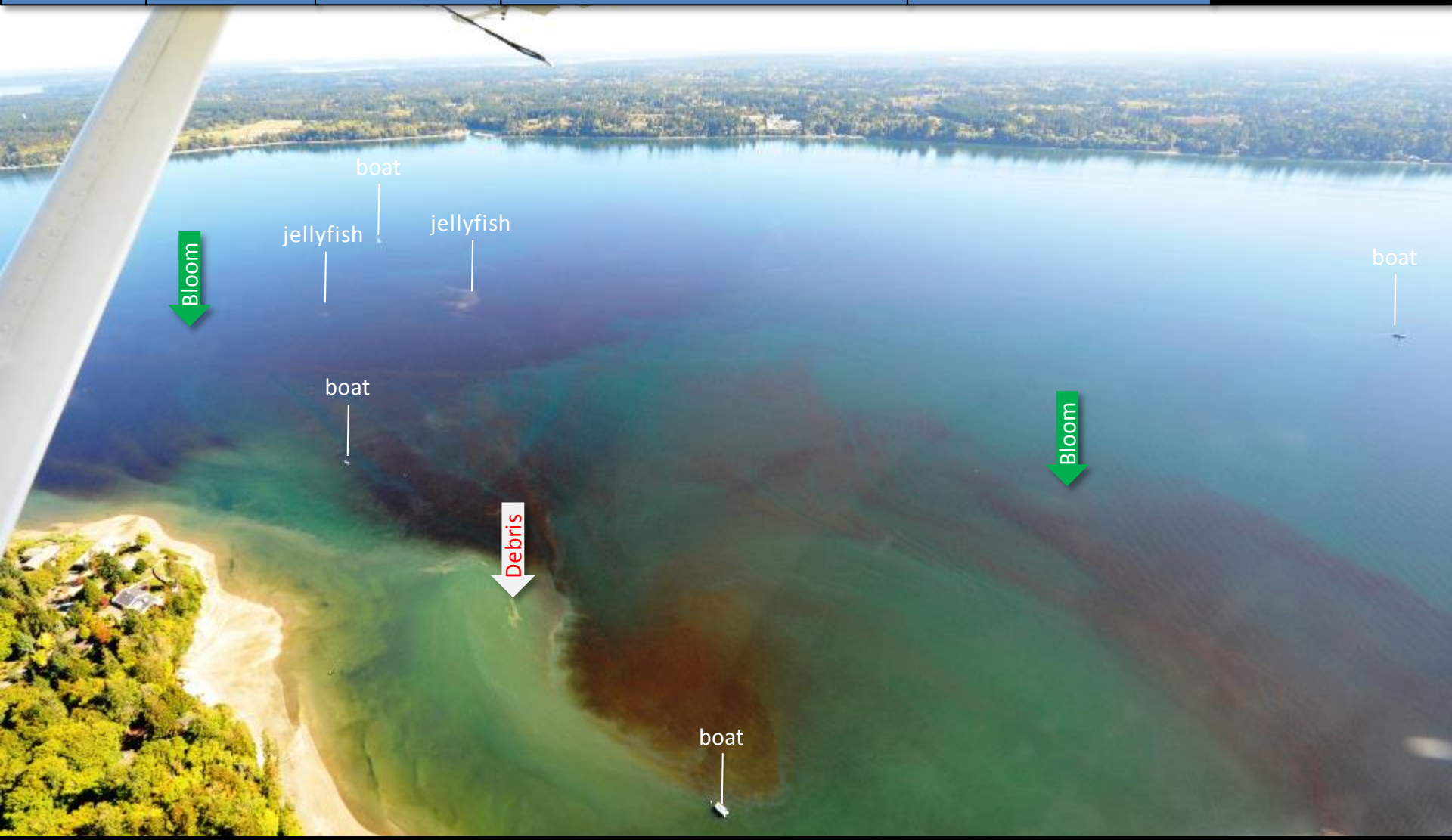
Location: Budd Inlet (South Sound), 2:25 PM.



Strong red-brown bloom and abundant jellyfish patches.

Location: Eld Inlet (South Sound), 2:28 PM.

Large accumulations of a Noctiluca bloom at an unusual time of the year.
Location: Entrance to Pickering Passage, Case Inlet (South Sound), 2:48 PM.



Strong red-brown bloom, jellyfish patches, and organic debris at surface.

Location: Near Big Tykel Cove, Budd Inlet (South Sound), 12:28 PM.

Aerial photography 9-26-2016

Large tidal eddy and water with different colored blooms.

Location: Liberty Bay (Central Sound), 1:01 PM.

Aerial photography 9-26-2016

Red-brown bloom and flood tide setting off eddy. River plume with suspended sediment on eastern shore.
Location: Port Gamble (Hood Canal), 1:06 PM.

Abundant jellyfish patches.

Location: Budd Inlet (South Sound), 12:18 PM.

Large quantities of suspended sediment and eddies off eastern shores of Steamboat Island.
Location: Squaxin Passage (South Sound), 12:31 PM.

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http://listserv.wa.gov/cgi-bin/wa?A0=ECOLOGY-EYES-OVER-PUGET-SOUND