Publication No. 14-03-078

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report

October 29, 2014

Guest: Gabriela Hannach

Start here

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

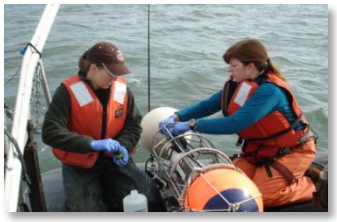
Marine conditions from 10-29-2014 at a glance

LONG-TERM MARINE MONITORING UNIT

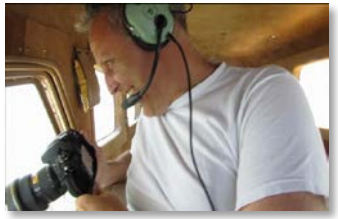
Mya Keyzers
Laura Hermanson
Joe Leatherman

Skip Albertson

Julia Bos
Suzan Pool



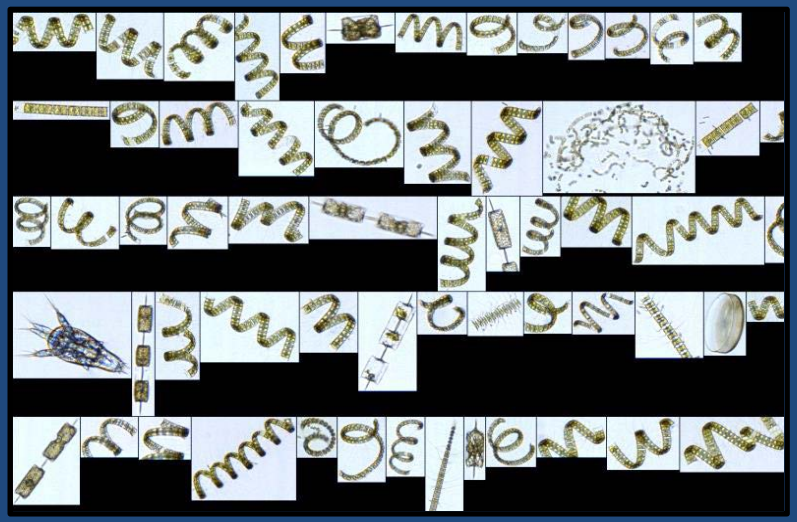
Dr. Christopher Krembs



Guest:
Dr. Brandon Sackmann, Integral

Please give us feedback

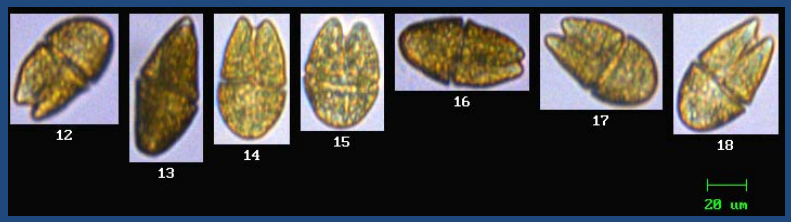
Early Fall: Phytoplankton are still in full swing!



⇧ October diatom bloom at Pt. Jefferson (north central basin), dominated by *Chaetoceros debilis* (curly chains).

FlowCAM compound images

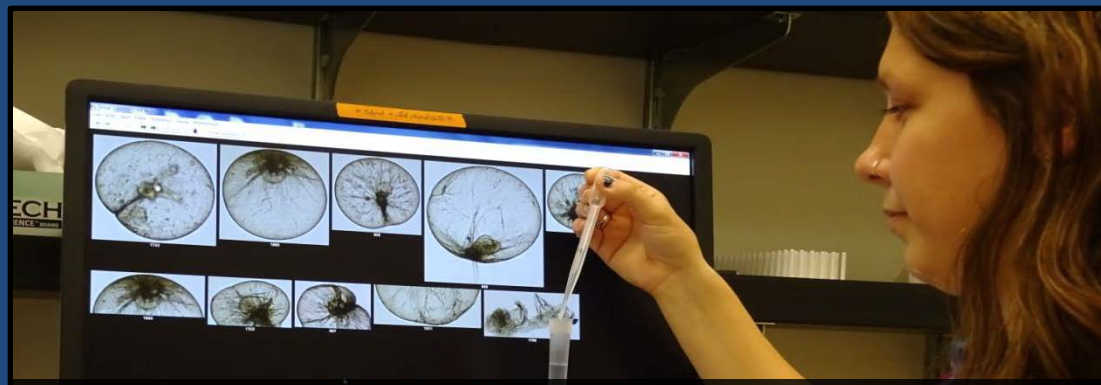
The dinoflagellate *Akashiwo sanguinea,* blooming in Quartermaster Harbor since late September. ⇩



Gabriela Hannach, King County Environmental Lab

This year's unusually mild fall weather meant an extended growth season for phytoplankton.

1. Mostly diatoms - some dinoflagellates – still forming blooms.
2. *Noctiluca* populations have declined since August.



Analysis of phytoplankton using FlowCAM

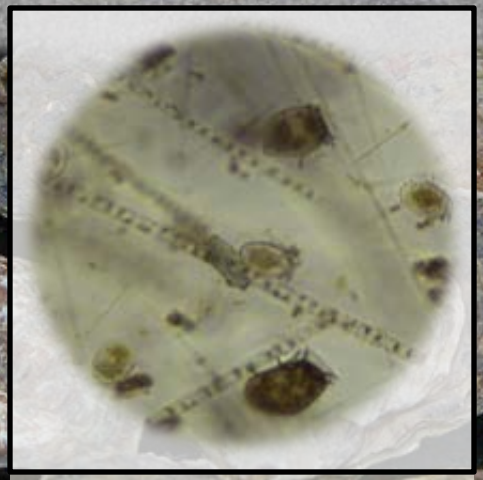
This instrument combines a **microscope** with a fast, high resolution **camera** and image analysis **software**. This technology allows for detailed imaging of the complex mixture of particles that comprises a marine plankton sample.

Data generated by FlowCAM include abundance, biovolume, size distribution, and taxonomic identity of all biological particles with an average diameter of 5 to 300 micrometers.

All About Phytoplankton: Part 2

Are Algal Blooms Harmful?

The majority of algal blooms are not harmful. However, there are several species of phytoplankton that cause Harmful Algal Blooms (HABs). HABs can negatively impact the health of humans and animals that consume shellfish (such as clams, mussels, and oysters) that are exposed to these blooms.



Bloom of the HAB species *Dinophysis*
Photo taken by Laura Hermanson

HAB species are harmful because they contain certain toxins. Since shellfish are filter feeders, they consume these harmful species in large quantities and accumulate the toxins in their tissues. These toxins do not affect the shellfish, but they can affect anyone who eats the shellfish.

What Causes Harmful Algal Blooms?

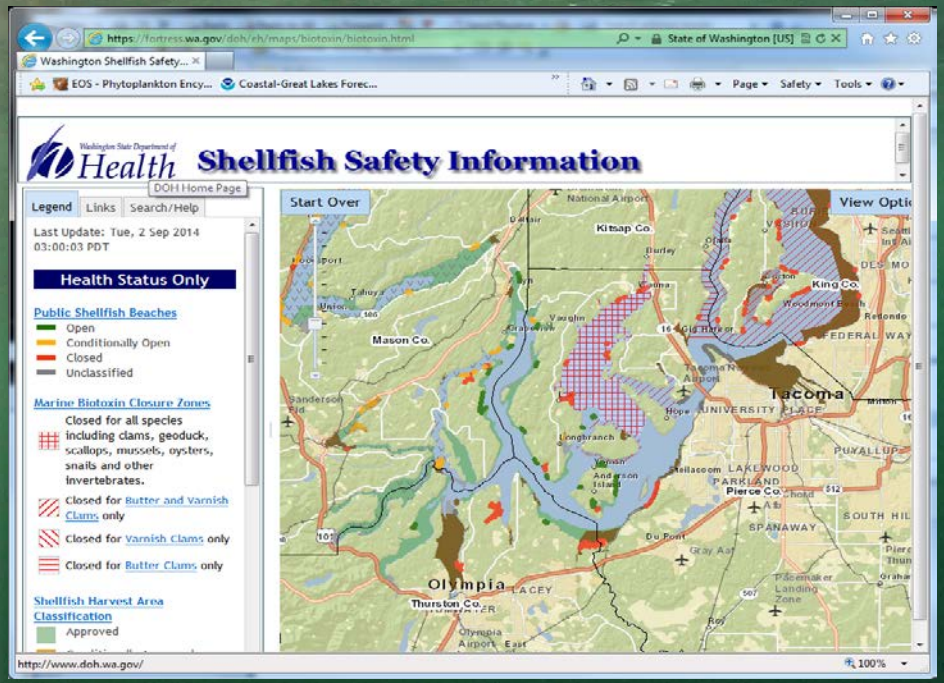
Illness caused by eating shellfish that contain HAB toxins can cause gastric distress, short-term memory loss, loss of motor control, and in extreme cases, death due to respiratory arrest. It sounds scary, but there are ways to protect yourself.

Dinophysis is a dinoflagellate that causes Diarrhetic Shellfish Poisoning (DSP).
Toxin Produced: Okadaic Acid

Alexandrium is a dinoflagellate that causes Paralytic Shellfish Poisoning (PSP).
Toxin Produced: Saxitoxin

Pseudo-nitzschia is a diatom that causes Amnesic Shellfish Poisoning (ASP).
Toxin Produced: Domoic Acid

How can you stay safe?



Know before you dig! The Department of Health makes it easy to locate areas that are safe for recreational harvest. They also monitor commercial growing areas. Visit their website for shellfish safety information and beach closure status. The Department of Ecology is now partnering with DOH to help monitor for HABs.

Shellfish Safety Website:
https://fortress.wa.gov/doh/eh/maps/biotoxin/biotoxin.html

Phytoplankton photos from King County Marine Monitoring Program:
http://green.kingcounty.gov/marine/Photos.aspx

Climate and natural influences before 10-29-2014

New section! **Climate and natural influences** are conditions that influence our marine waters, including weather, rivers, and the adjacent ocean (previously called Weather). For an explanation of the figure, see: http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html, page 26.

Summary:

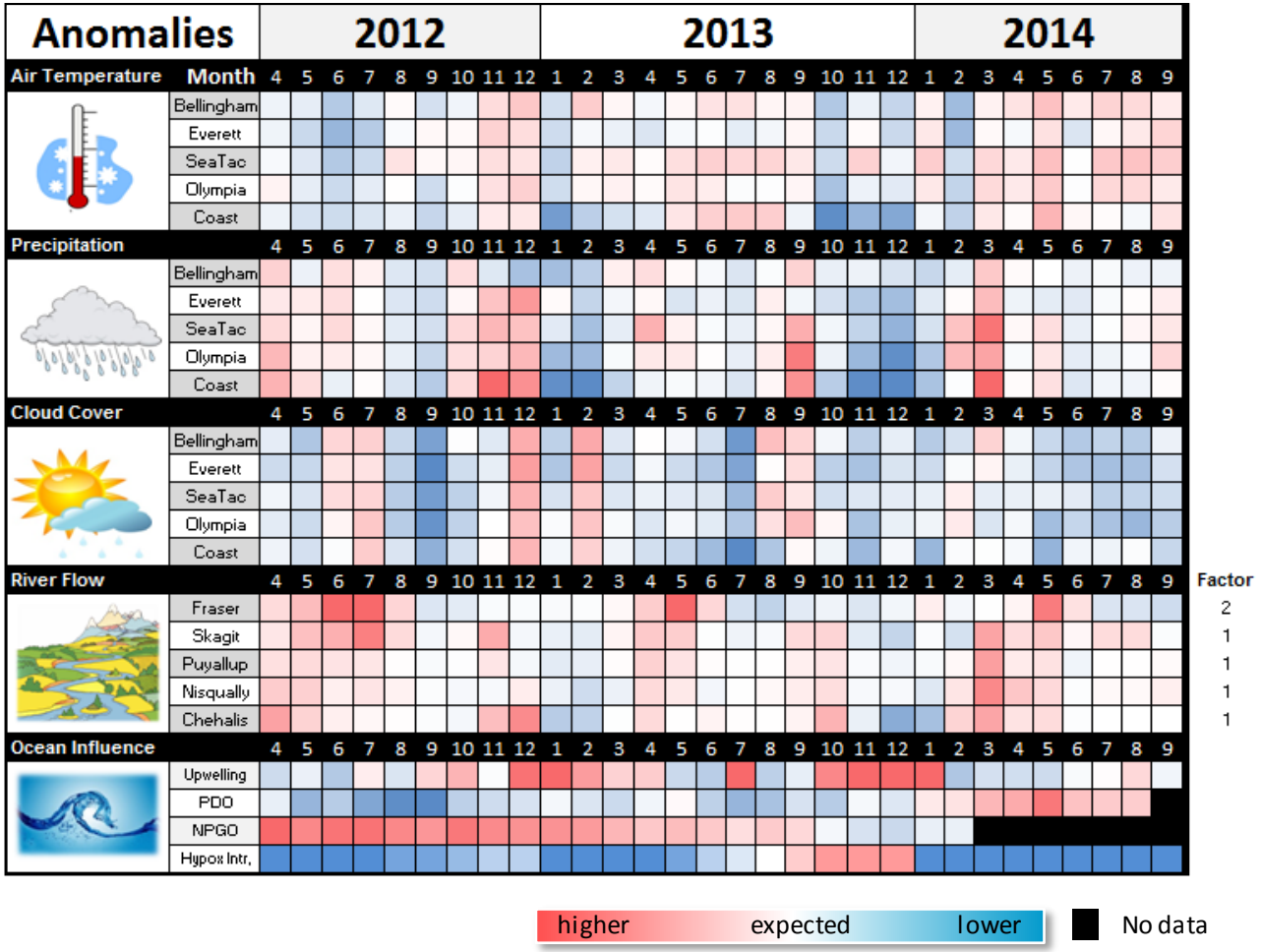
Air temperatures have generally been above normal continuing the trend of the past seven months.

Precipitation levels are increasing. The remnants of Hurricane Ana affect the PNW, aided by warmer-than-normal sea surface temperatures.

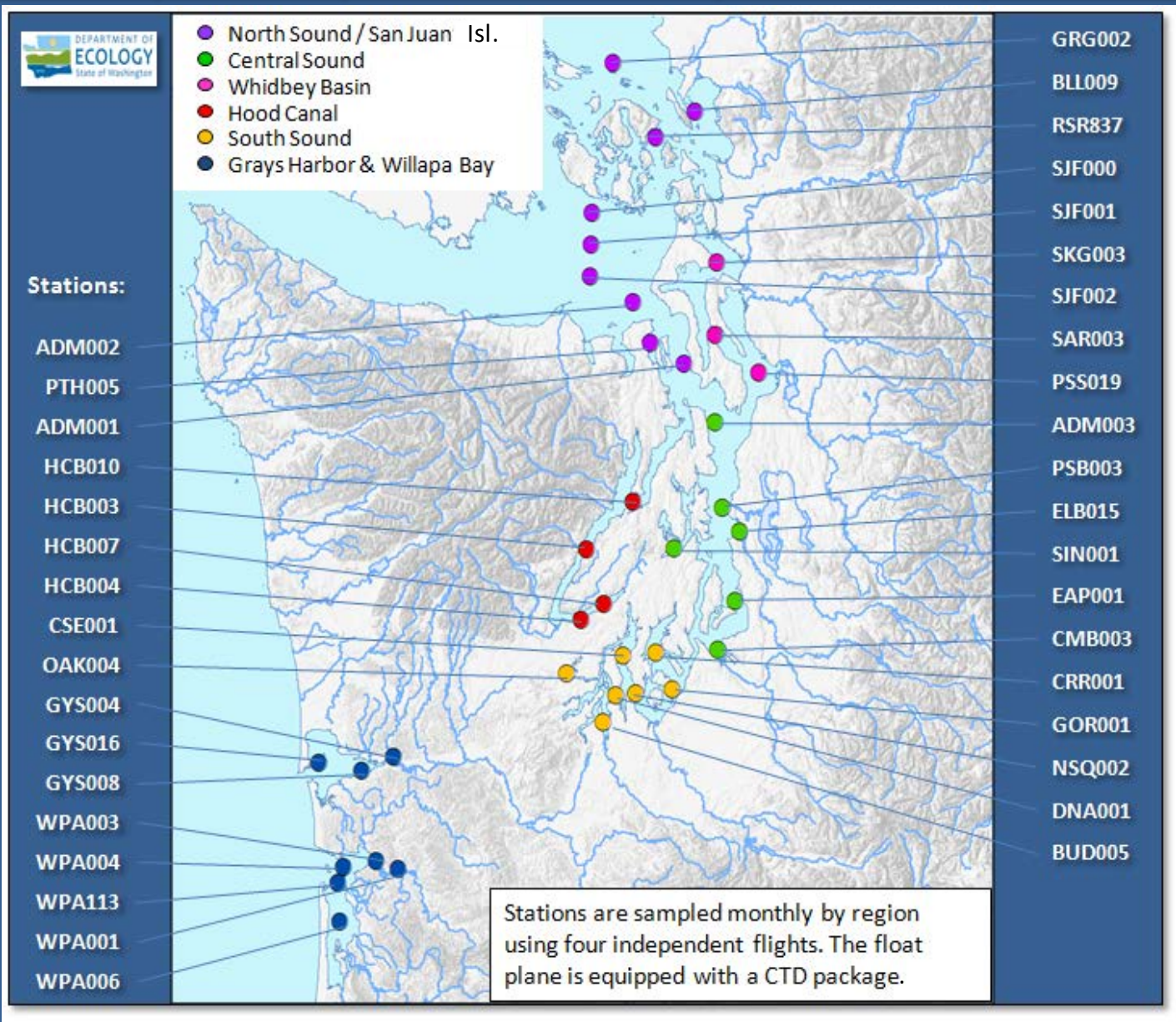
Cloud Cover has been lower than normal. Conversely sunshine has been above normal.

River flows are below normal for the Fraser River, but normal to above normal elsewhere.

PDO remains in the warm phase, and **upwelling** is below normal. Oceanic intrusions of low DO water were not predicted.



Our long-term marine monitoring stations in Washington



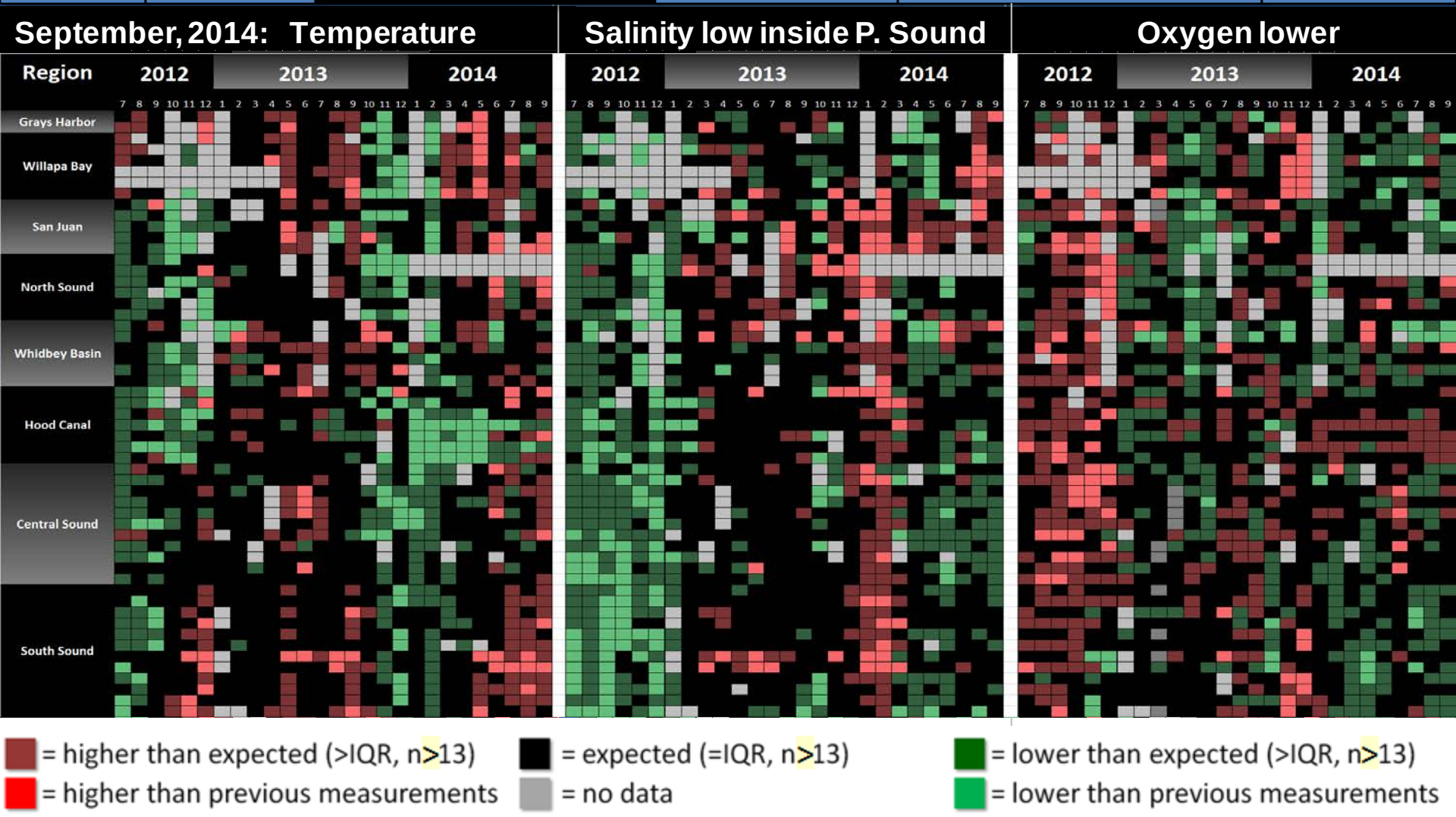
We use a chartered float plane to access our monthly monitoring stations most cost effectively.

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**

Physical conditions tracked in statistically historic context



Puget Sound was warmer in 2013 than 2014. Early 2014 started colder and saltier with lower oxygen, then became fresher and warmer. At the end of summer, temperatures are high in South Sound and salinities and dissolved oxygen are low in Central Sound. DO remains high in Hood Canal.

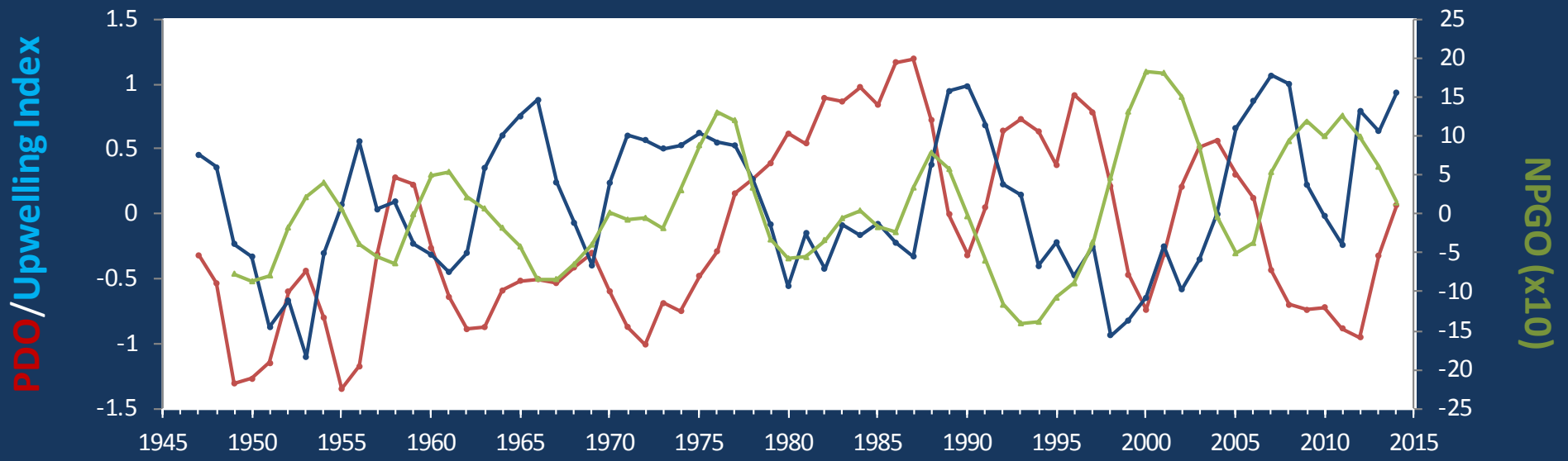
The ocean affects water quality: Ocean Climate Indices

a) *Pacific Decadal Oscillation Index (**PDO, temperature**)* (explanation)

b) *Upwelling Index (anomalies) (**Upwelling, low oxygen**)* (explanation)

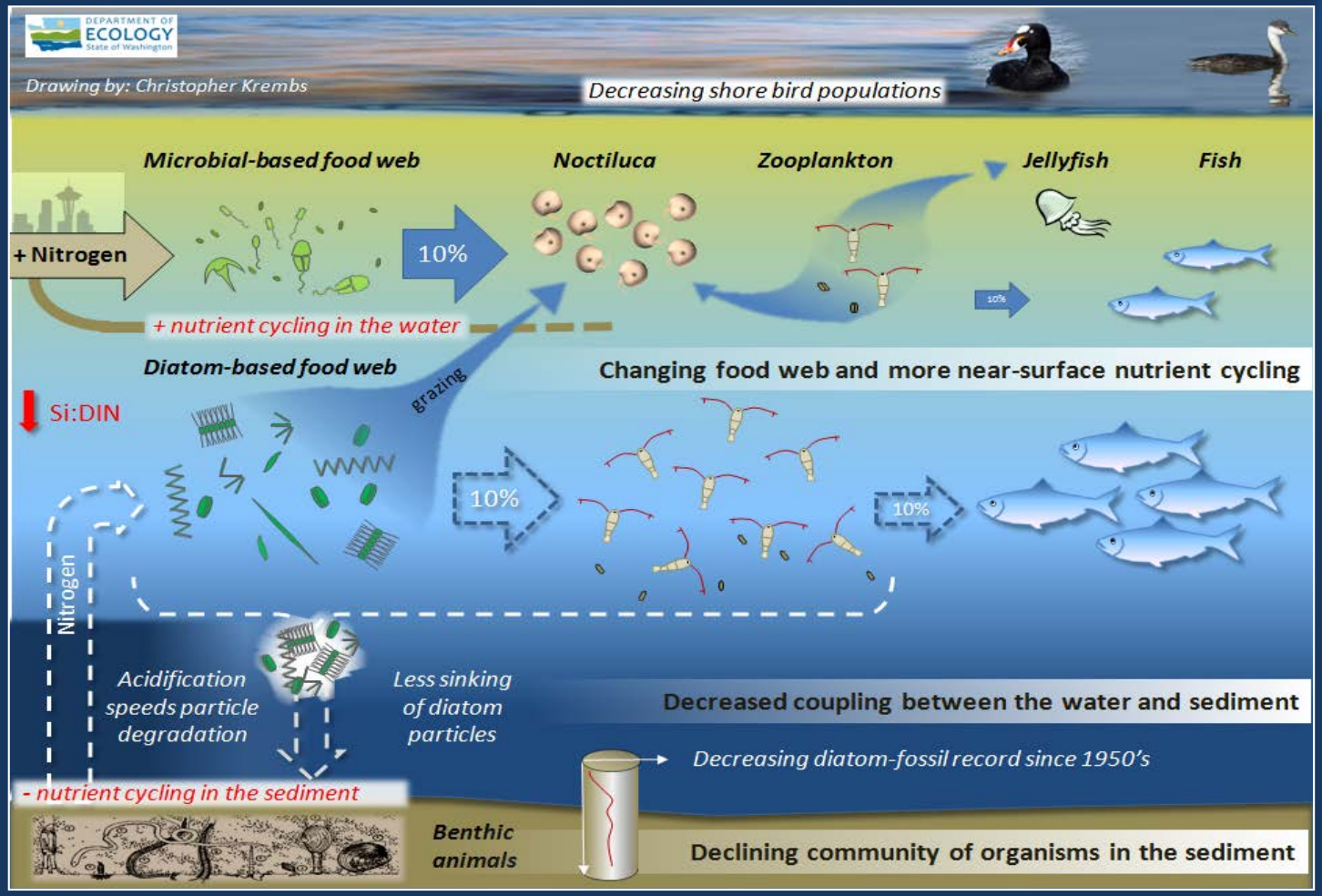
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* (explanation)

Three-year running average of PDO, Upwelling, and NPGO indices scores



Ocean boundary conditions have been favorable for water quality in Puget Sound: (a) colder water (PDO), (b) less upwelled low oxygen and high nutrient ocean water reaching Puget Sound (Upwelling Index), and (c) higher surface productivity along the coast (NPGO). Where are we heading next?

Hypothesis for combining a series of recent observations affecting energy and material transfer to higher trophic levels



Hypothesis!

Increases in nitrate concentrations could be caused by a top-down control on phytoplankton biomass.

***Noctiluca* a visible harbinger of a food web change?**

Are changes in higher tropic levels part of a story of the low food web?

[Follow the experts WebEx]

Summary: Aerial photography 10-29-2014

Very dense and large patches of jellyfish seen in finger inlets of South Sound. Red-brown blooms remain strong in smaller bays inside Puget Sound, particularly South Sound. Suspended sediment increasingly visible.

Start here

Moon jelly smack next to plane, Budd Inlet

Moon jelly smack next to plane, Budd Inlet

Front

Mixing and Fronts: 1 2 7 9 13 14

Developed fronts and mixing visible by colored surface water. Very pronounced in Dabob Bay, Hood Canal, and Samish Bay.

Jellyfish: 15 16 17 18 19 20 Click on numbers

Jellyfish patches very large, dense, and numerous in southern inlets of South Sound (Totten, Eld, and Budd Inlets).

Plume

Suspended sediment: 1 5 6 8 9

Suspended sediments near shore due to wind and waves or rivers. Port Susan, Skagit and Samish Bays rich with sediment.

Bloom

Visible blooms: 1 2 4 12 15 16 17 18 19 20

Green-brown: Oakland Bay, Saratoga Passage.

Red-brown: Southern finger inlets of South Sound, Sinclair Inlet.

Debris

Debris: 1 2 3 8 13 16 17

Organic debris still numerous in Whidbey Basin and finger inlets of South Sound.

Seattle Tides: H. tide: 10:10 AM 8:53 PM, , L. tide: 2:58 AM, 4:01 PM

Aerial photography and navigation guide

Date: 10-29-2014

Click on numbers

Flight Information:

Morning flight, photos 1-8
Overcast low visibility, rain wind

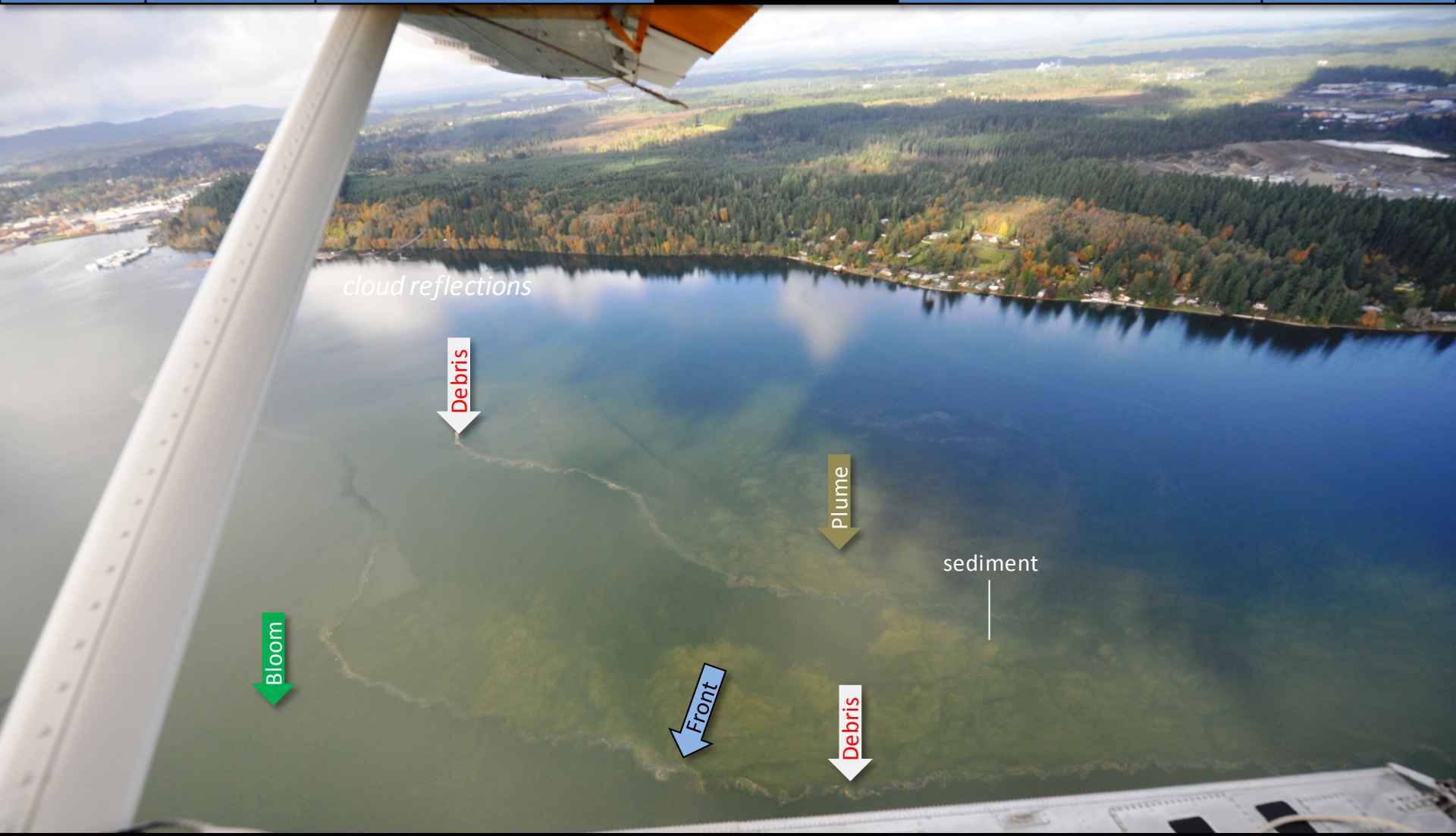
Afternoon flight, photos 9-20:
Overcast, hazy, cloudy, wind

– – – Flight route and fueling stop

Observation Maps:

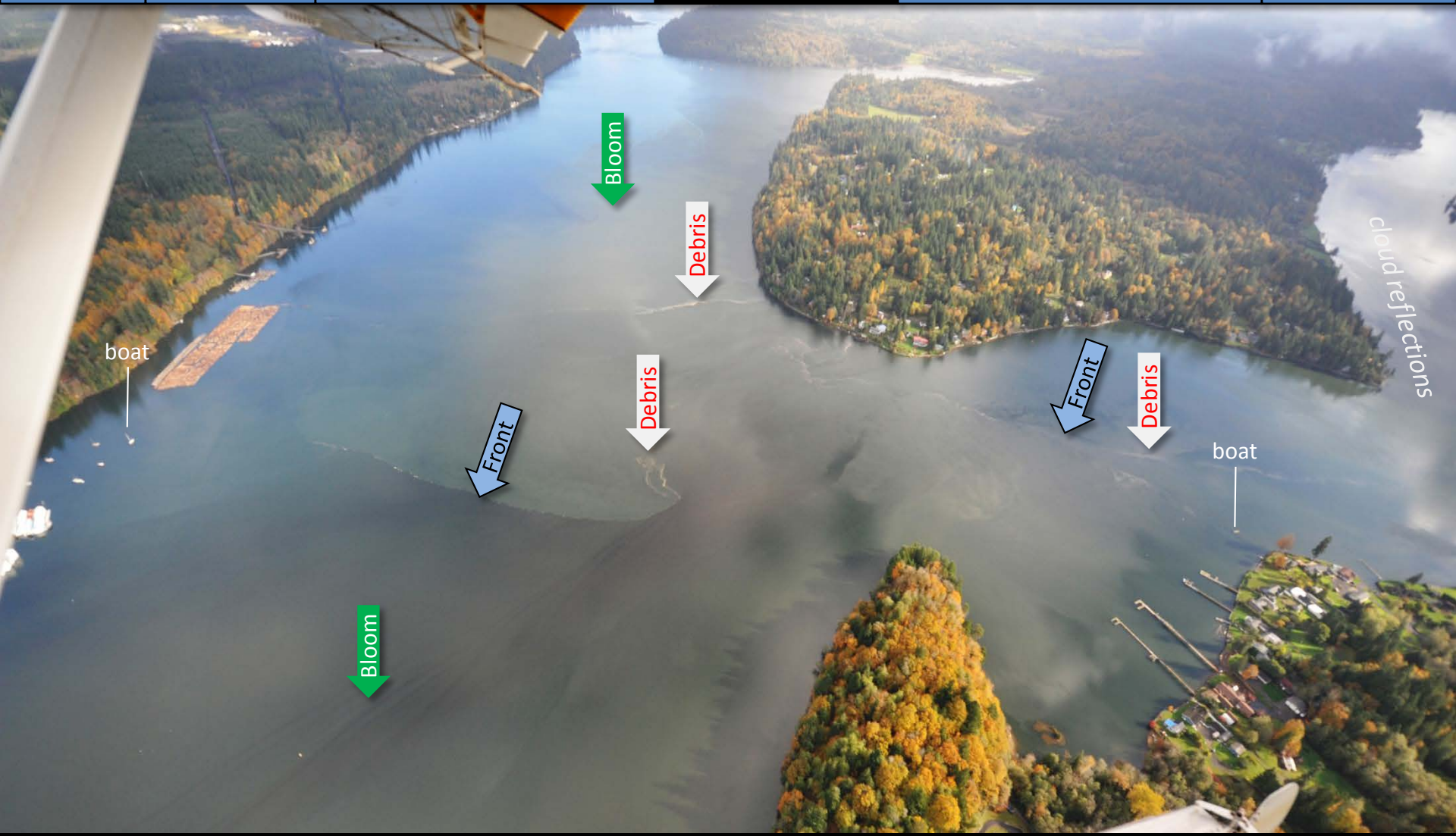
Central and North Sound

South Sound



Tidal mixing of sediment-rich water with green-brown bloom bordered with lines of organic debris.

Location: Off Bell Road, Oakland Bay (South Sound), 10:55 AM.

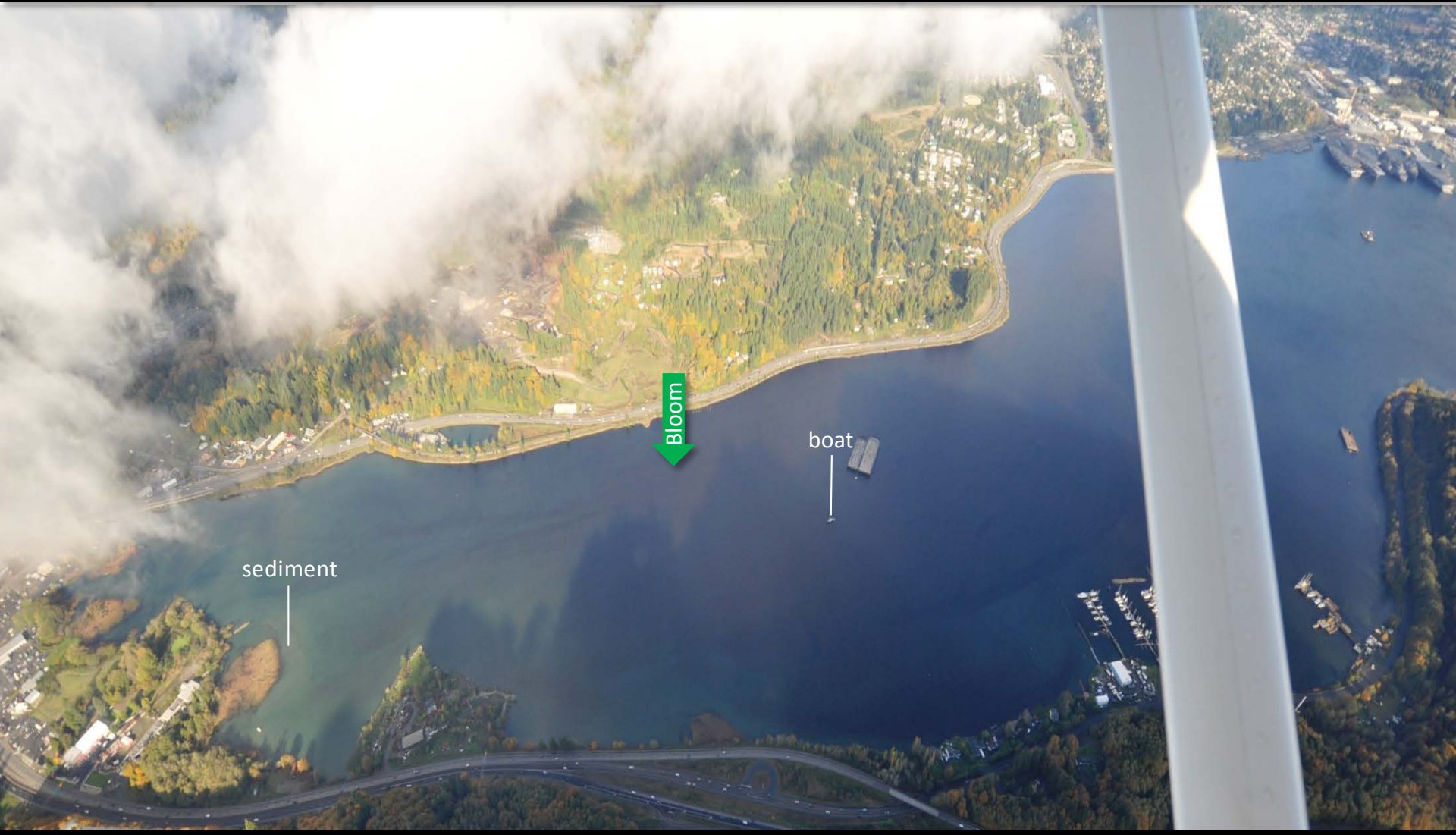


Red-brown bloom and green-brown bloom separated by tidal fronts that accumulate organic debris.

Location: Off Eagle Point, Oakland Bay (South Sound), 10:56 AM.

Long organic debris line and boggy freshwater entering into cove from Union River.

Location: Lynch Cove (Hood Canal), 11:08 AM.



Red-brown bloom in inner Inlet.

Location: Sinclair Inlet (Central Sound), 11:18 AM.

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Aerial photography 10-29-2014

Suspended sediments detaching from shoreline due to currents.

Location: Off Fay Bainbridge Park, Bainbridge Island, Port Madison (Central Sound), 11:25 AM.

Suspended sediments from river and/or shore erosion being transported northward.

Location: Off Glendale Road, south Whidbey Island (Whidbey Basin), 11:33 AM.

Aerial photography 10-29-2014

Northerly winds pushing back Whidbey Basin water. Strong front delineating sediment-rich water.

Location: Mukilteo (Whidbey Basin), 11:33 AM.

Black surface debris and sediment-rich water.

Location: Near Triangle Cove, Port Susan (Whidbey Basin), 12:35 PM.

Aerial photography 10-29-2014

Sediment-rich water originating in Samish Bay flowing front. Water upwells and mixes near island.

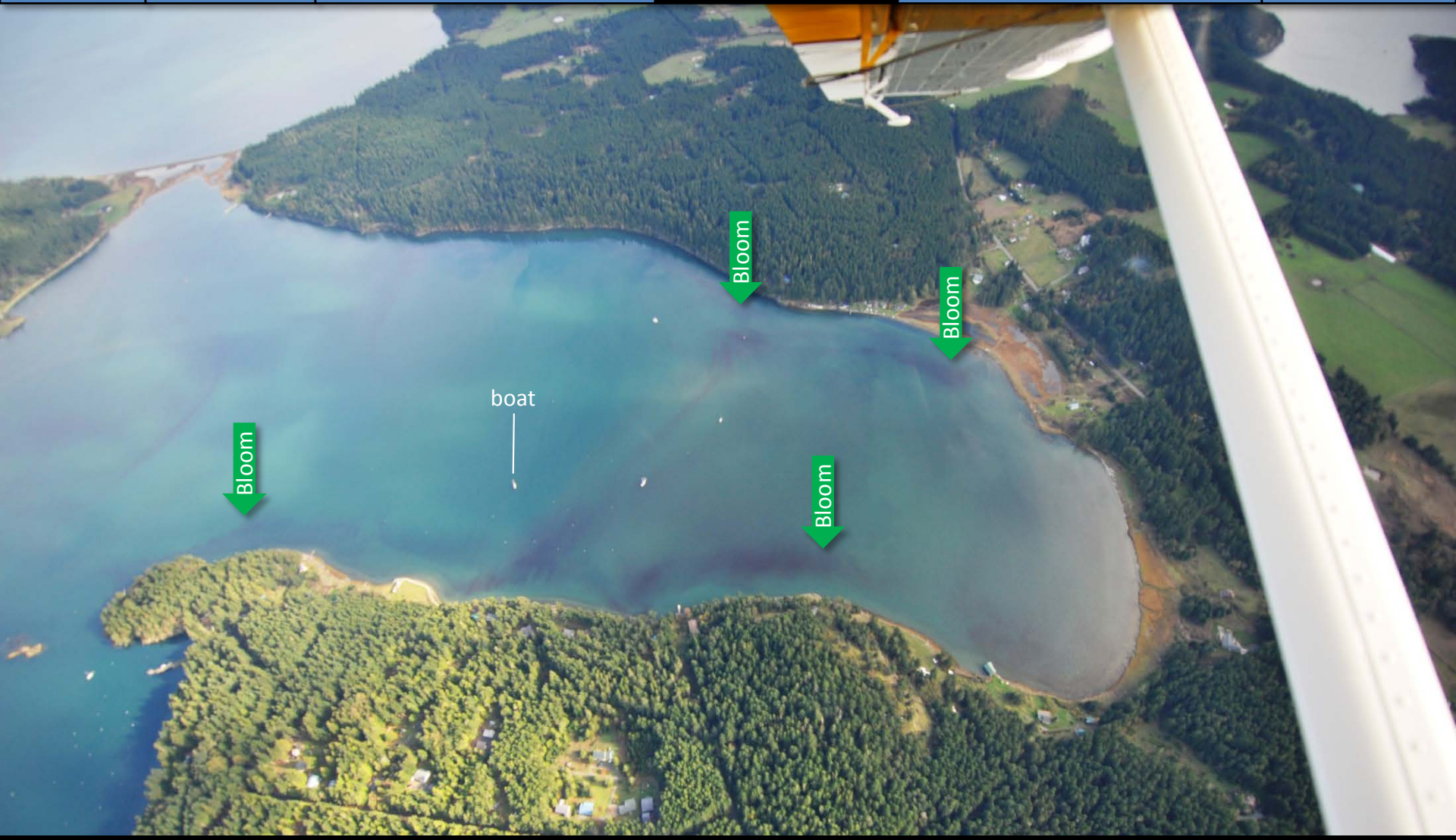
Location: Vendovi Island, Samish Bay (North Sound), 1:38 PM.

Sediment-rich water mixes into Rosario Strait.

Location: West of Lummi Island (North Sound), 2:05 PM.

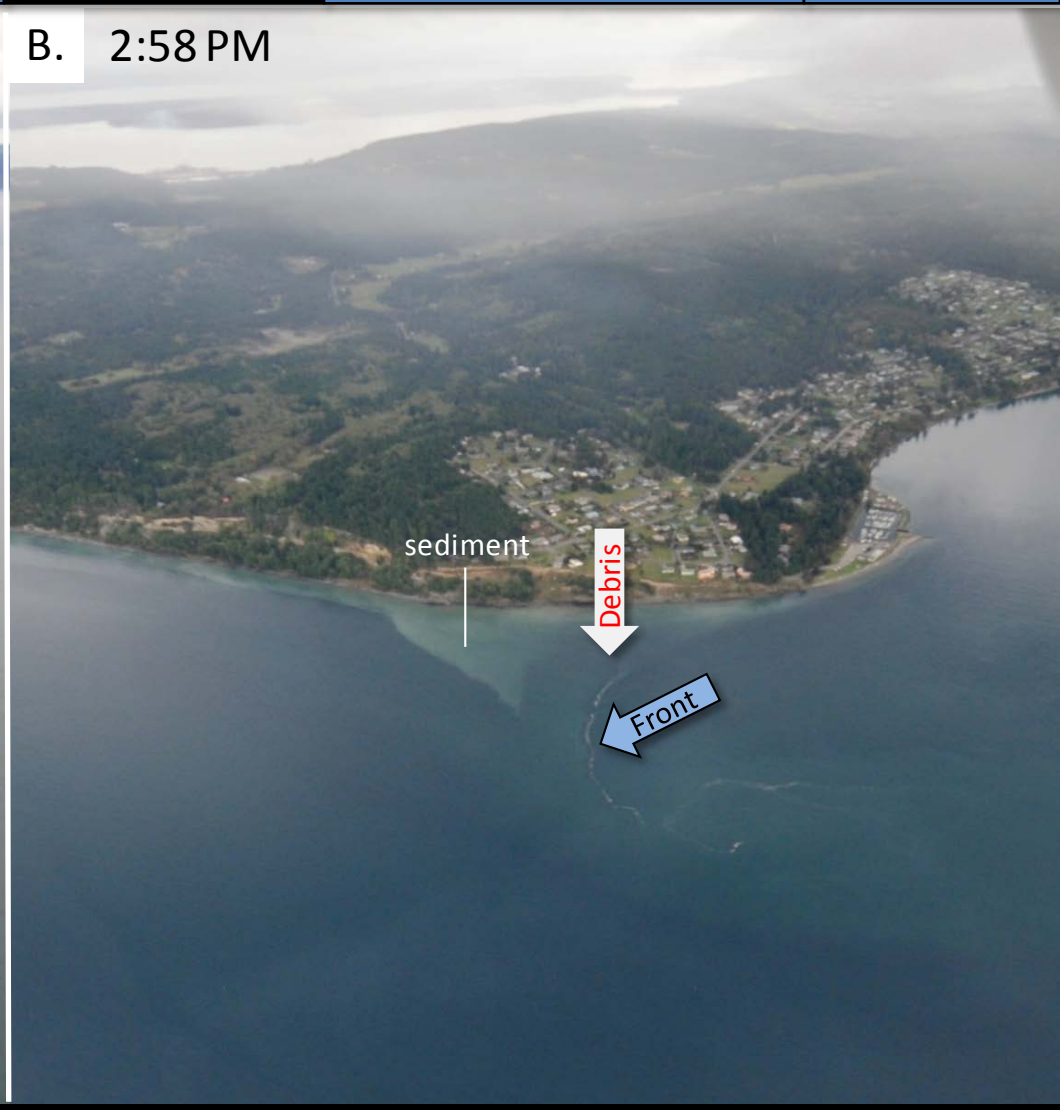
Turquoise water of Lopez Sound with shadows from clouds.

Location: Frost Island, Lopez Sound (San Juan Islands), 2:41 PM.



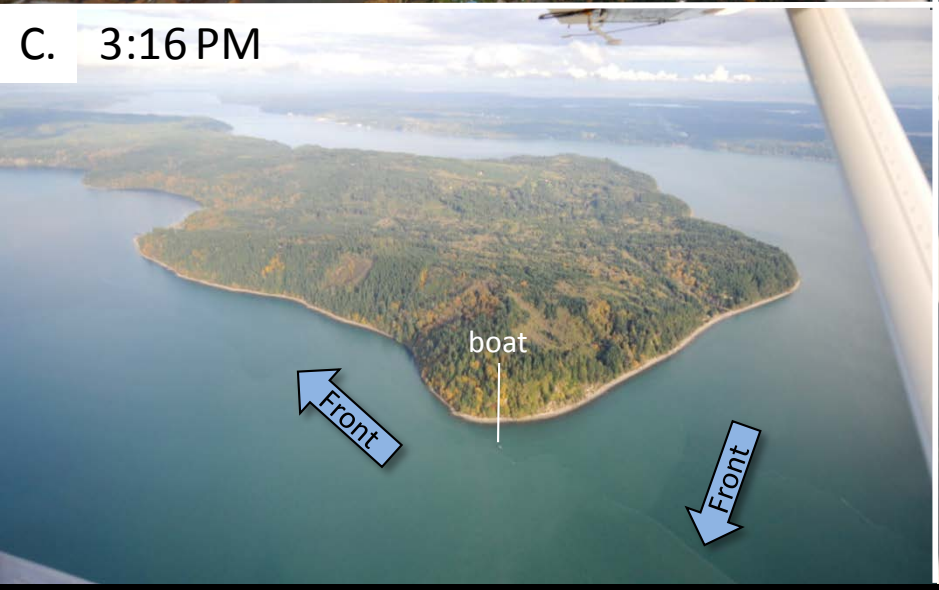
Red-brown bloom in distinct patches in bay.

Location: Mud Bay, Lopez Sound (San Juan Islands), 2:45 PM.

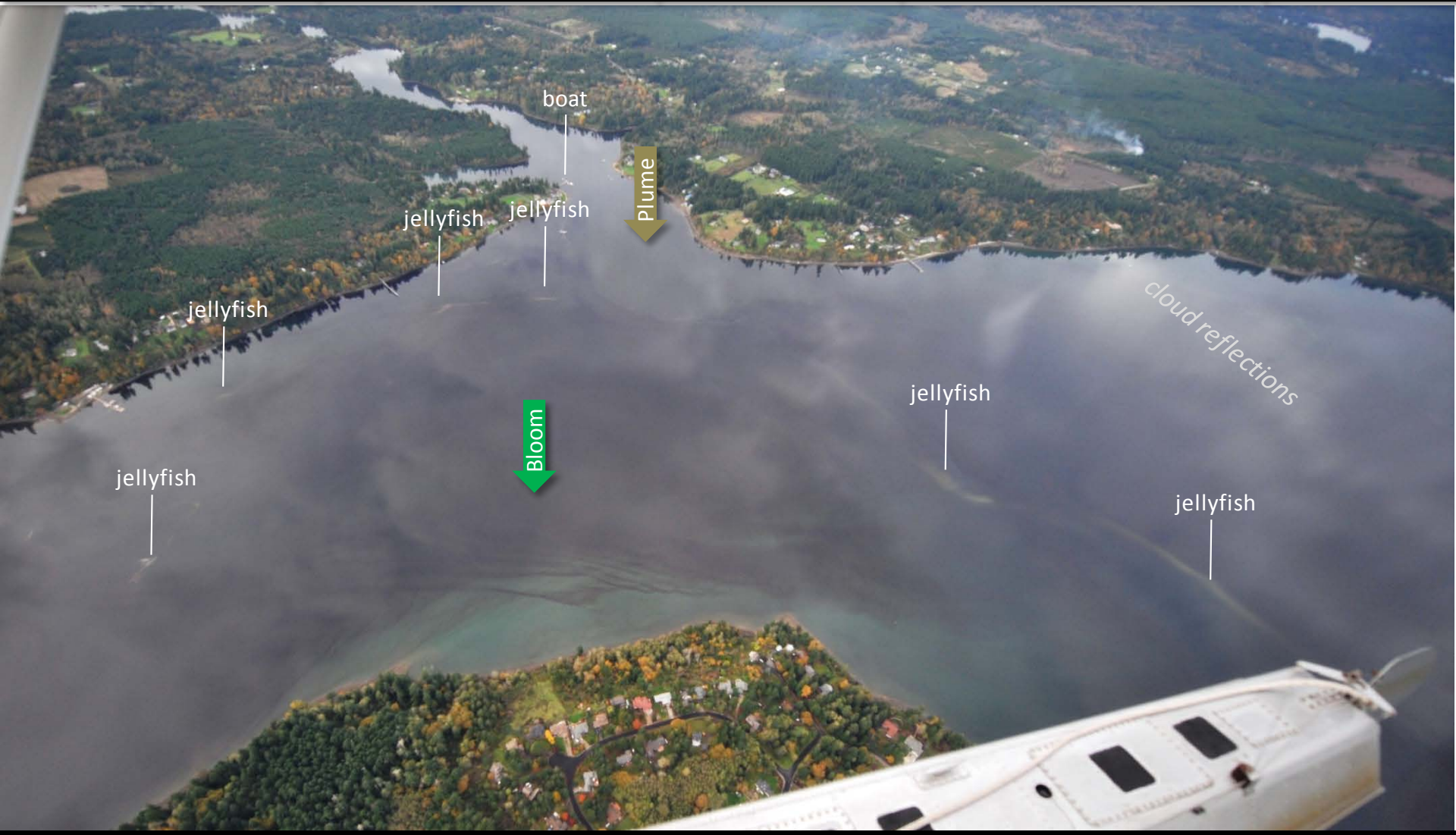


Beach erosion due to waves; kelp beds and debris lines.

Location: A. Smith Island, B. Cape George, Discovery Bay (Strait of Juan de Fuca), 1:22 PM.

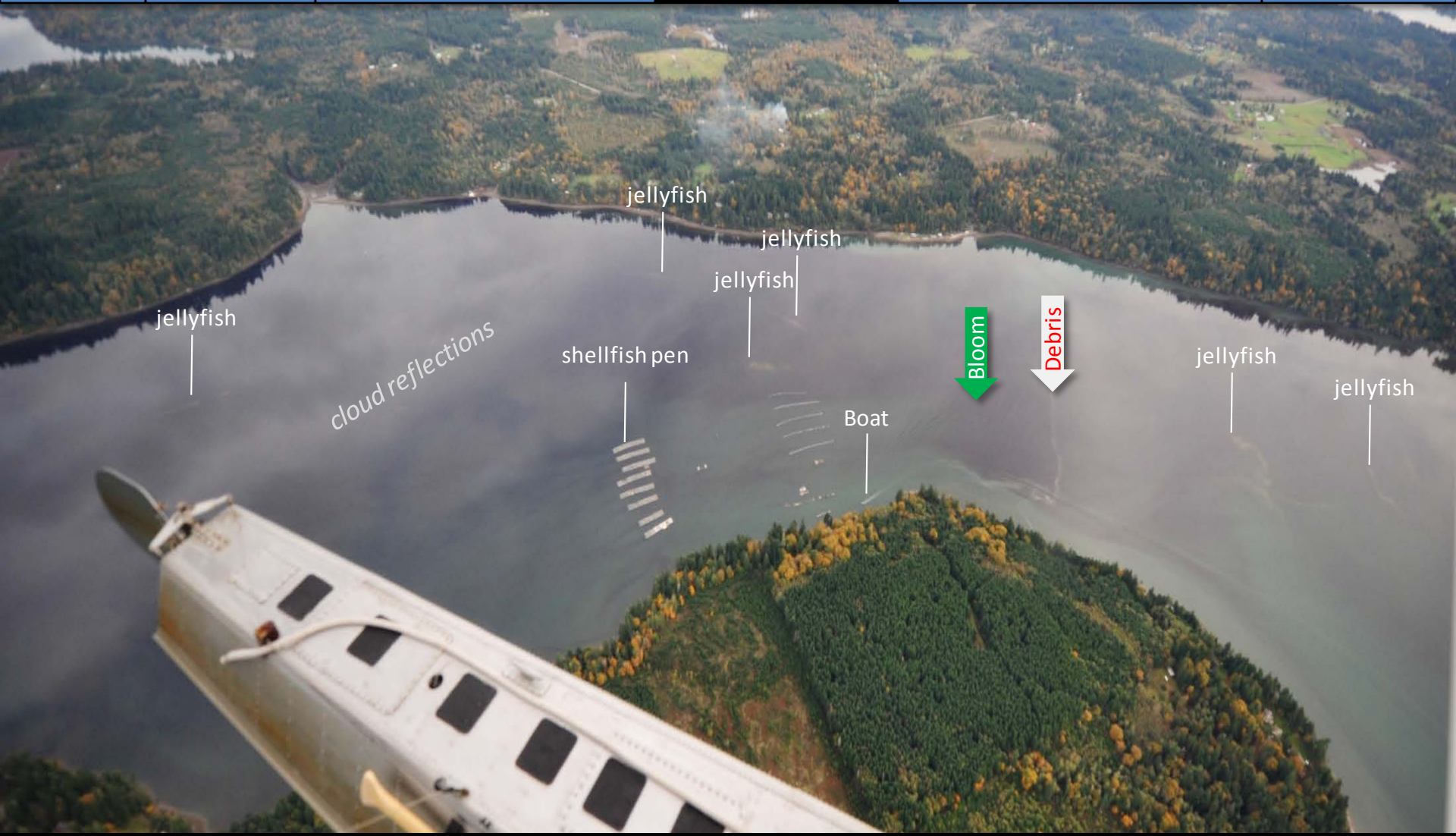


Complex surface water patterns outlining water structure and transport. Location: A. Quilcene Bay, B. Dosewallips State Park, C. Tskutsko Point, D. Quadsap Point, Dabob Bay (Hood Canal), 3:11, 3:16. 3:17 PM.



Strong red-brown bloom, suspended sediment, turquoise water, and jellyfish patches.

Location: Off Baron Point, Totten Inlet (South Sound), 3:41 PM.

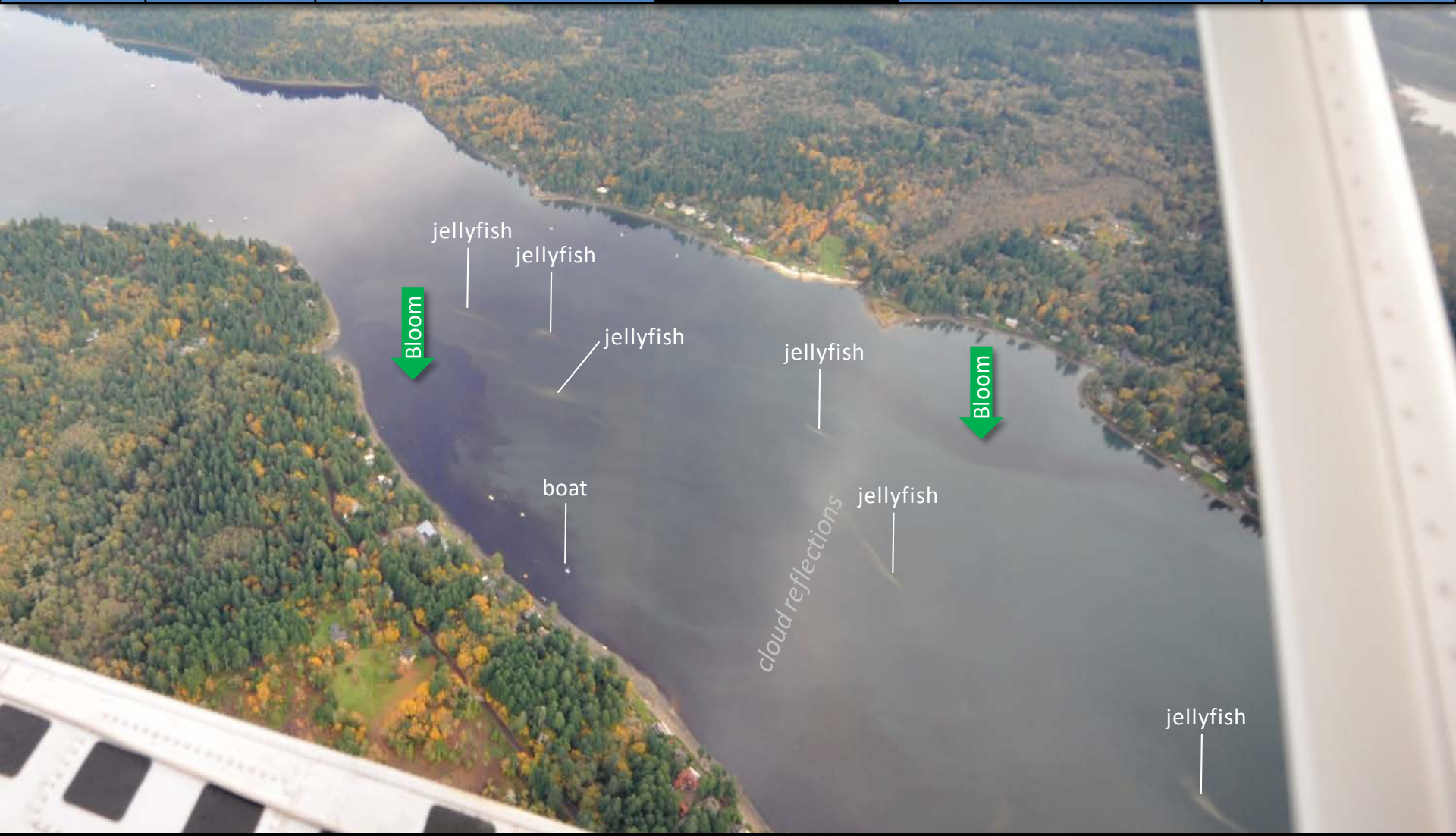


Strong red-brown bloom, suspended sediment, turquoise water, and jellyfish patches.

Location: Hudson Cove, Totten Inlet (South Sound), 3:42 PM.

Strong red-brown bloom, suspended sediment, turquoise water, and jellyfish patches.

Location: Burns Point, Totten Inlet (South Sound), 3:44 PM.



Red-brown bloom and patches of jellyfish.

Location: Off Shell Point, Eld Inlet (South Sound), 3:46 PM.

Red-brown bloom and extensive smacks of moon jellies both in size and density.

Location: A. Outer bay, B. Inner bay of Budd Inlet (South Sound), 3:50 PM.

Aerial photography 10-29-2014

A.

Extensive smacks of moon jellies both in size and density with pinkish tint.

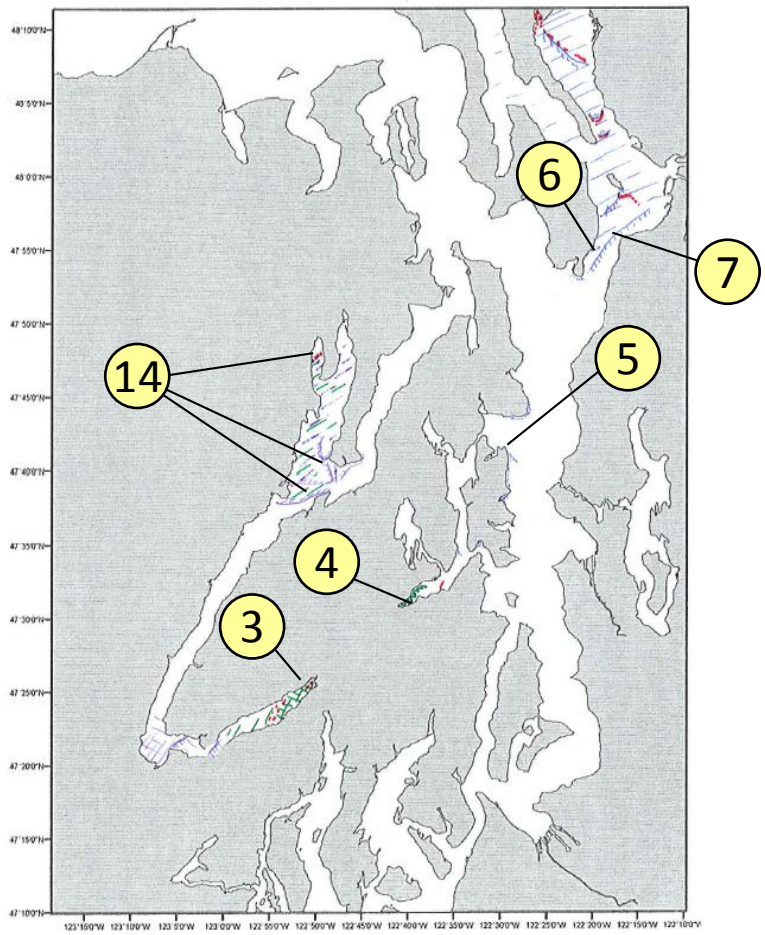
Location: A. On the water, B. From air showing location on the water, Budd Inlet (South Sound), 3:50 PM.

Observations in Central and North Sound

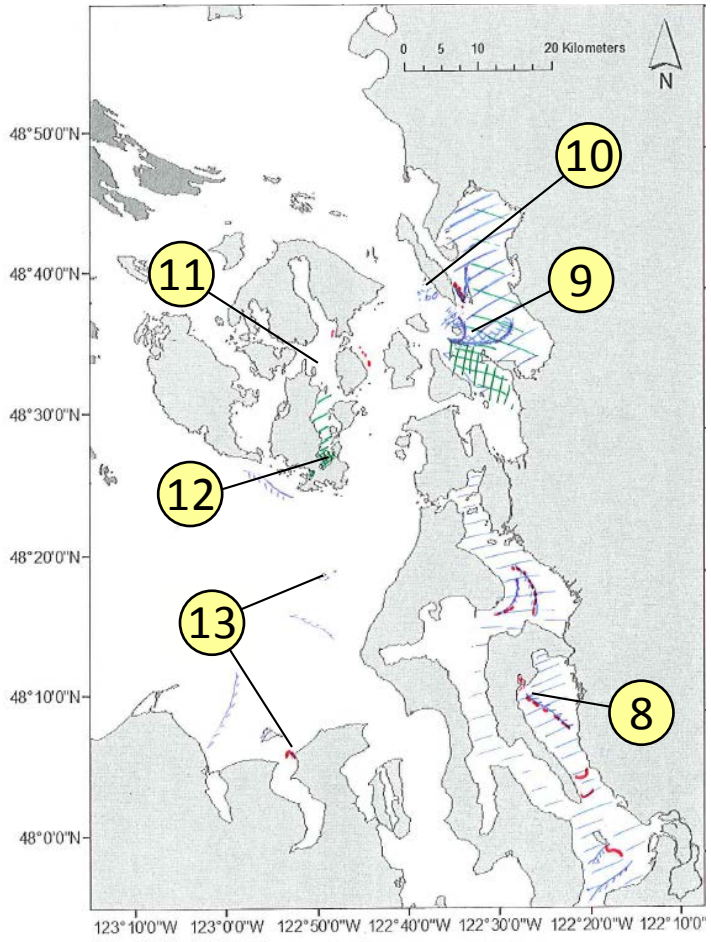
Navigate

Date: 10-29-2014

Central Sound



North Sound/San Juan Islands



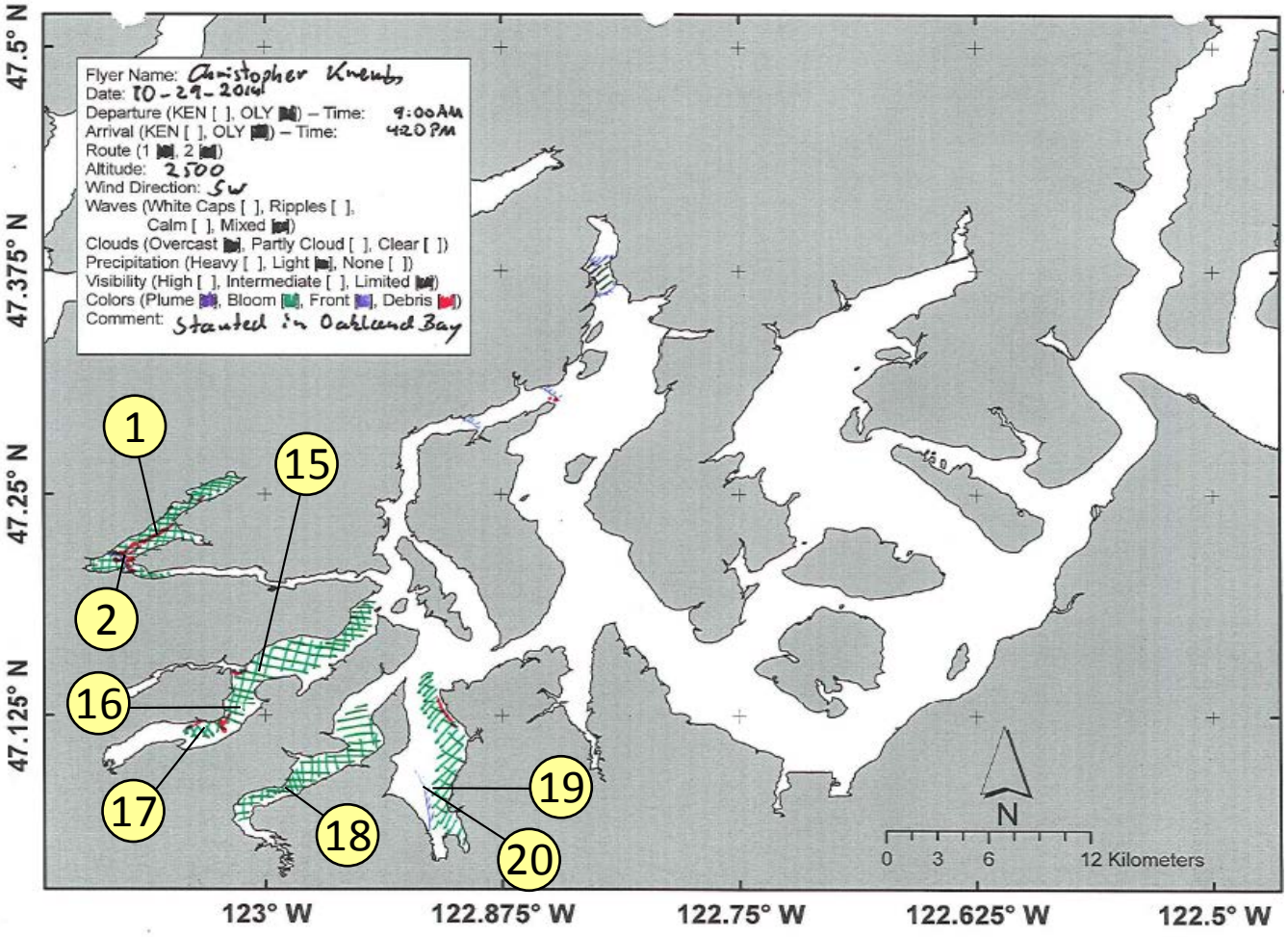
Numbers on map refer to picture numbers for spatial reference

Observations in Hood Canal and South Sound

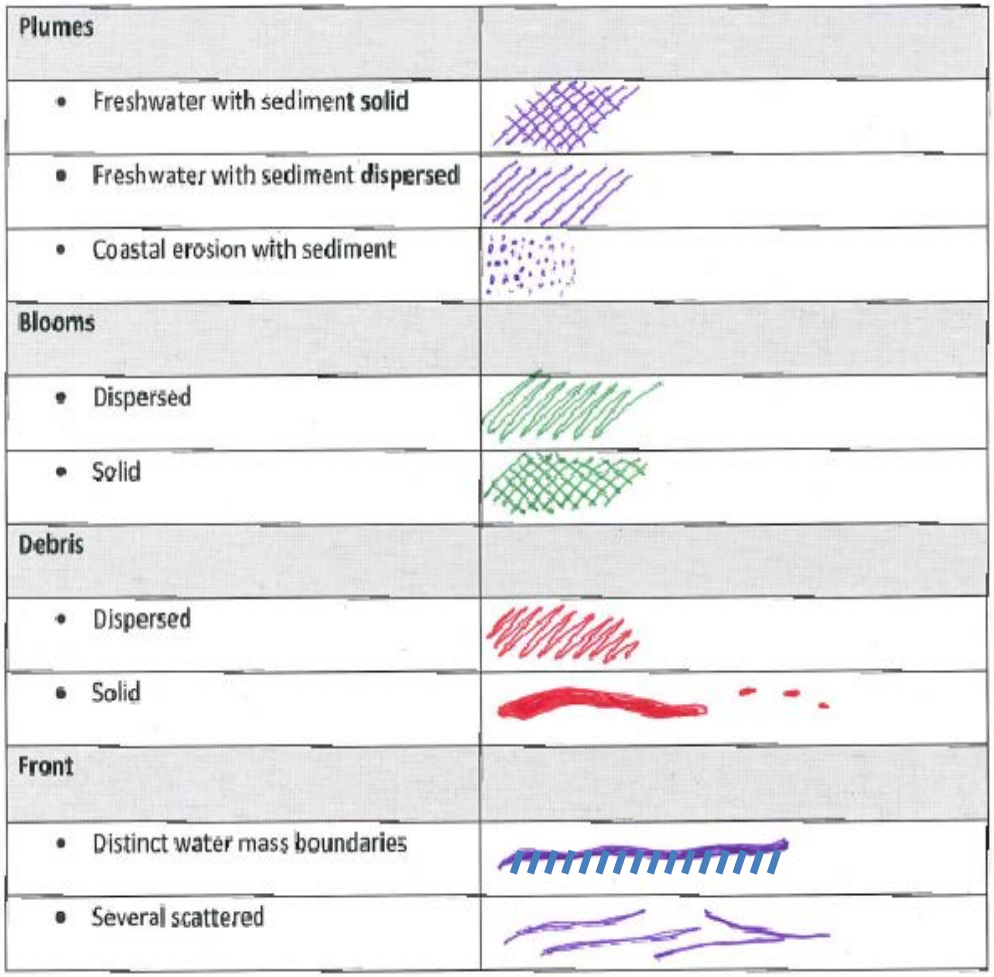
Navigate

Date: 10-29-2014

South Sound



Numbers on map refer to picture numbers for spatial reference

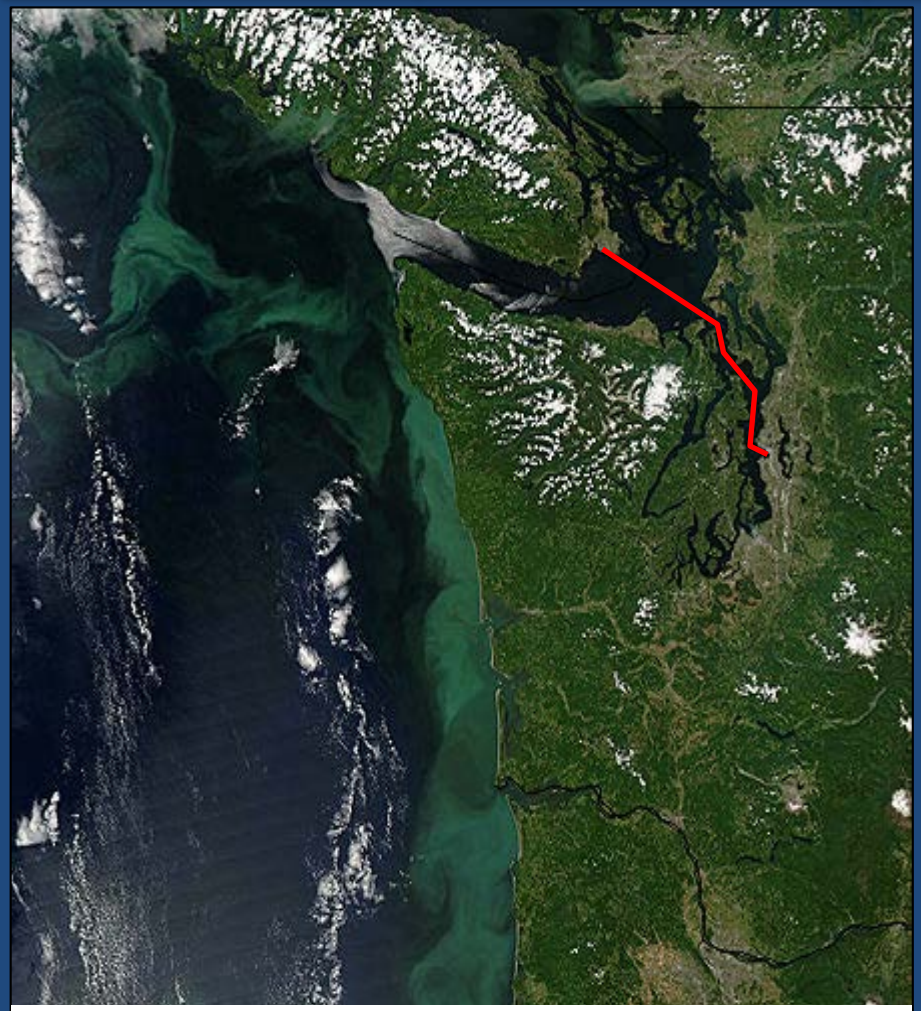


Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

Debris:
Debris can be distinguished into natural and anthropogenic debris floating at the surface *sensu* Moore and Allen (2000). The majority of organic debris in Puget Sound is natural and mixed with discarded man-made pieces of plastic, wood, etc. From the plane, we cannot differentiate the quality of debris at the surface and therefore, call it for reasons of practicality just “debris”.

S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1): 83–88.

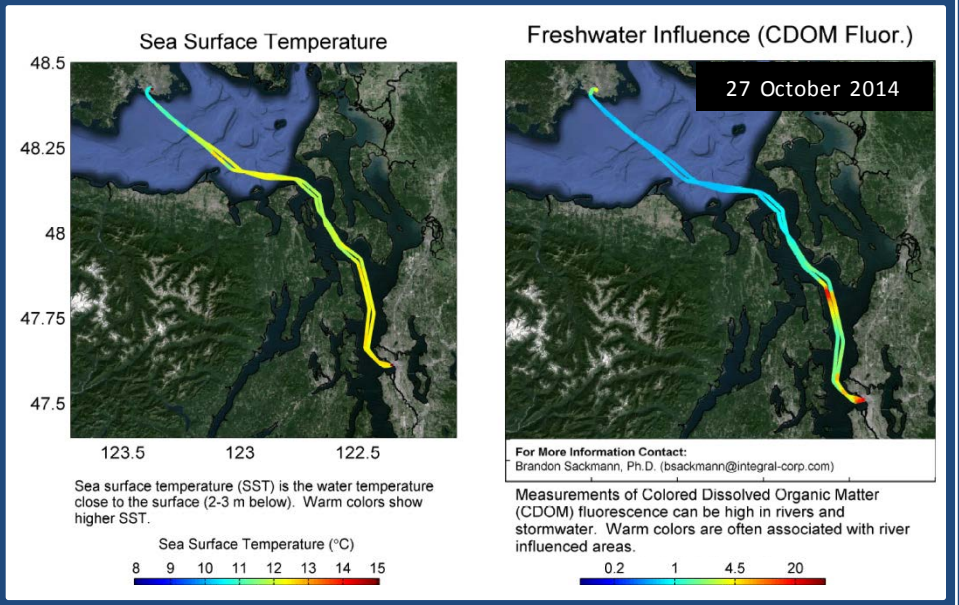
Ferry and satellite observations 10-29-2014



Hardware upgrades on the *Victoria Clipper IV* successfully restored near real-time data collection as of July 23, 2014; we are back online!

Brandon Sackmann
Contact: bsackmann@integral-corp.com

Start here

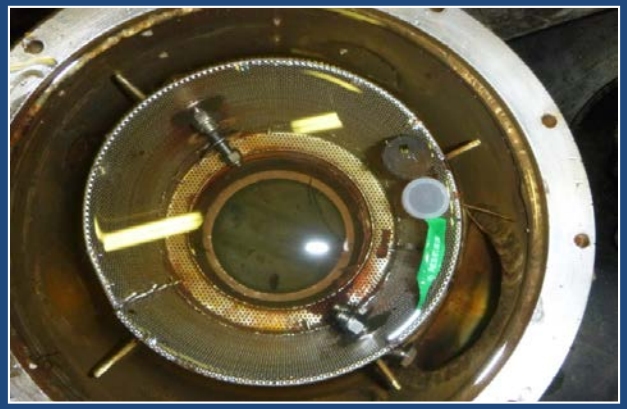


Current Conditions:

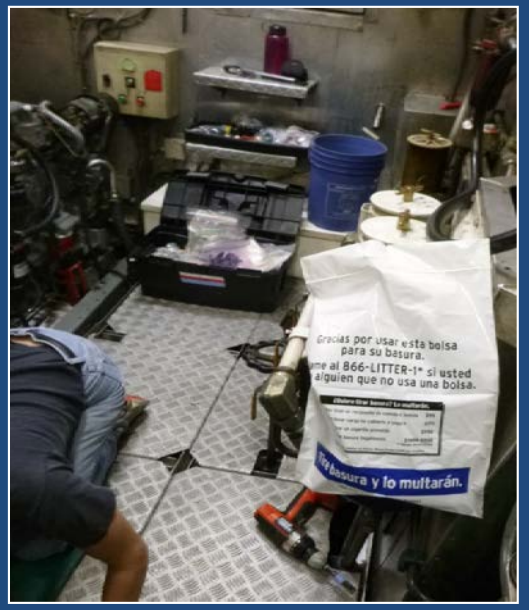
Cooler temperatures and an increased fresh water at the triple junction in Central Sound are seen in the salinity and color characteristics of the water (CDOM).

Ferry and satellite observations 10-29-2014

The data logging upgrade that was done in July continues to be very successful!
Data are uploaded daily to: http://107.170.217.21/VictoriaClipper30/level0/.



When we serviced our fluorometer on Tuesday, we found plastic pieces in the sea chest and aquatic plant on the sensor. We have also found feathers, small fish, sea grass, etc.



Tools and gear are set up for easy access.

One optical lens on the fluorometer has UV rays, so we wear safety glasses with UV protection.

Removing bolts from the sea chest to access the fluorometer.

Mooring observations and trends 10-17-2014 to 10-30-2014

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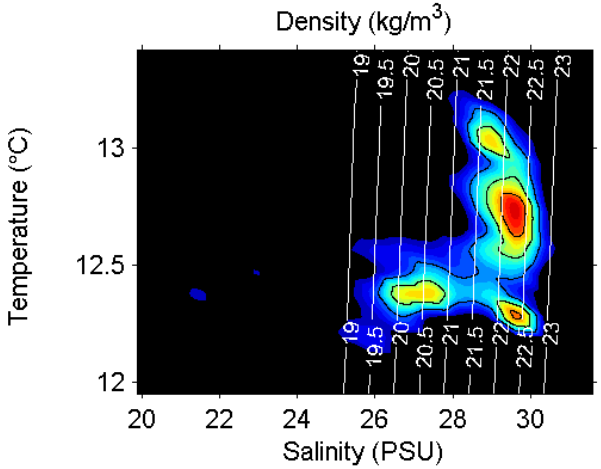
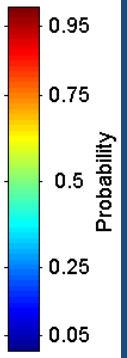
NANOOS

At Mukilteo, recent rains increased river flows and brought fresh water to our moorings during outgoing tides. In the upper mooring, tidal influences can be seen in the upper left plot. The deeper mooring measured high salinity and increased oxygen. For the entire month of October, temporal trends of temperature followed somewhat similarly to the tidal cycle (see next slide).

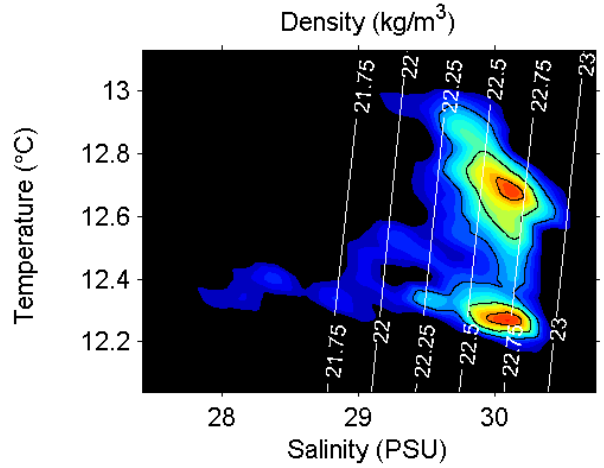
2-6 m depth

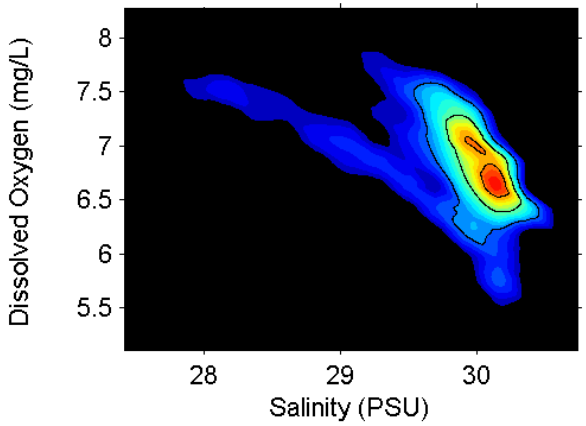


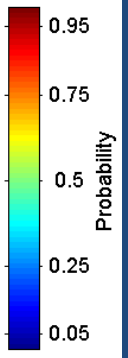
Dissolved oxygen not measured



12-16 m depth







These plots show the probability of observations over the past two-week period. High probability shown in warm colors.

Left Panels: Density is defined by salinity and temperature.

Right Panel: Dissolved oxygen concentration in relation to salinity.

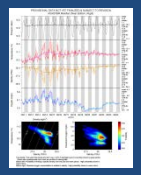
Mooring observations and trends 9-29-2014 to 10-29-2014

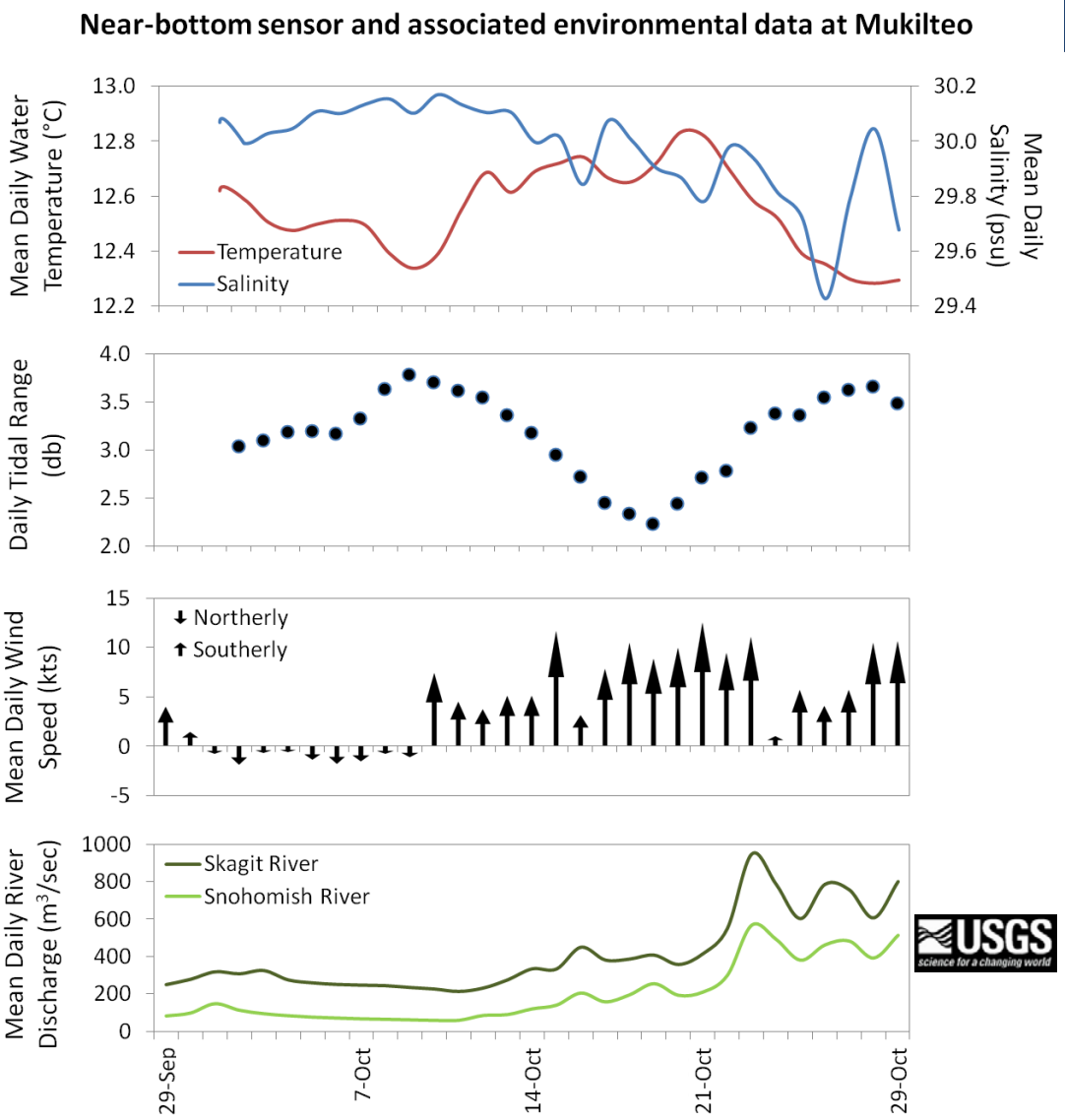
Our mooring station in Mukilteo is located in Whidbey Basin near Everett. It is also located at the transition between Possession and Central Sounds at a depth that is influenced by the Skagit and Snohomish river discharges, prevailing winds, and tidal mixing.

As the largest regional contributor of freshwater to Puget Sound, understanding the timing and magnitude of the Skagit river flow is important.

We present data of daily means for the past 31 days. Data are plotted in Pacific Standard Time. Wind data are from Paine Field in Everett. River flow data are from USGS.

Click on icon to view real-time data of the moorings





Mooring observations and trends Mukilteo 2010 to 2014

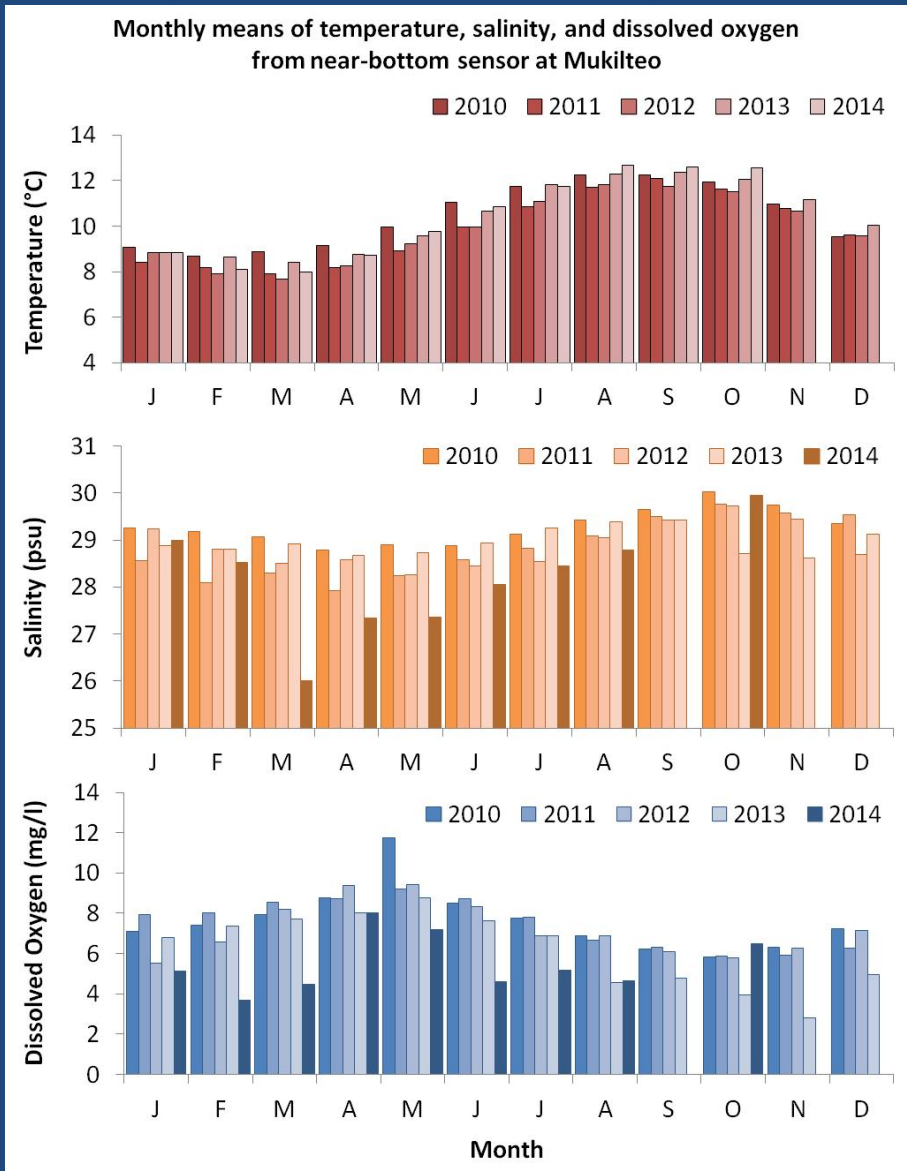
At the Mukilteo mooring, we use the near-bottom sensor (12-16 m deep) to measure significant inter-annual variability in temperature, salinity, and dissolved oxygen.

Inter-annual variability is shown over an almost 5-year period. All three variables show strong seasonality.

Through 2014, trends in salinity and dissolved oxygen appear to decline whereas trends in temperature are similar to 2013. For October, temperature and oxygen are higher than the past four years.

September 2014 data for salinity and oxygen are invalid after we found the sensor sitting on sediment. Our bath verifications indicated the dissolved oxygen sensor failed in early July and thus, dissolved oxygen data for July 2014 is from latter half of the month.

Please note that data are provisional. Data are in GMT.



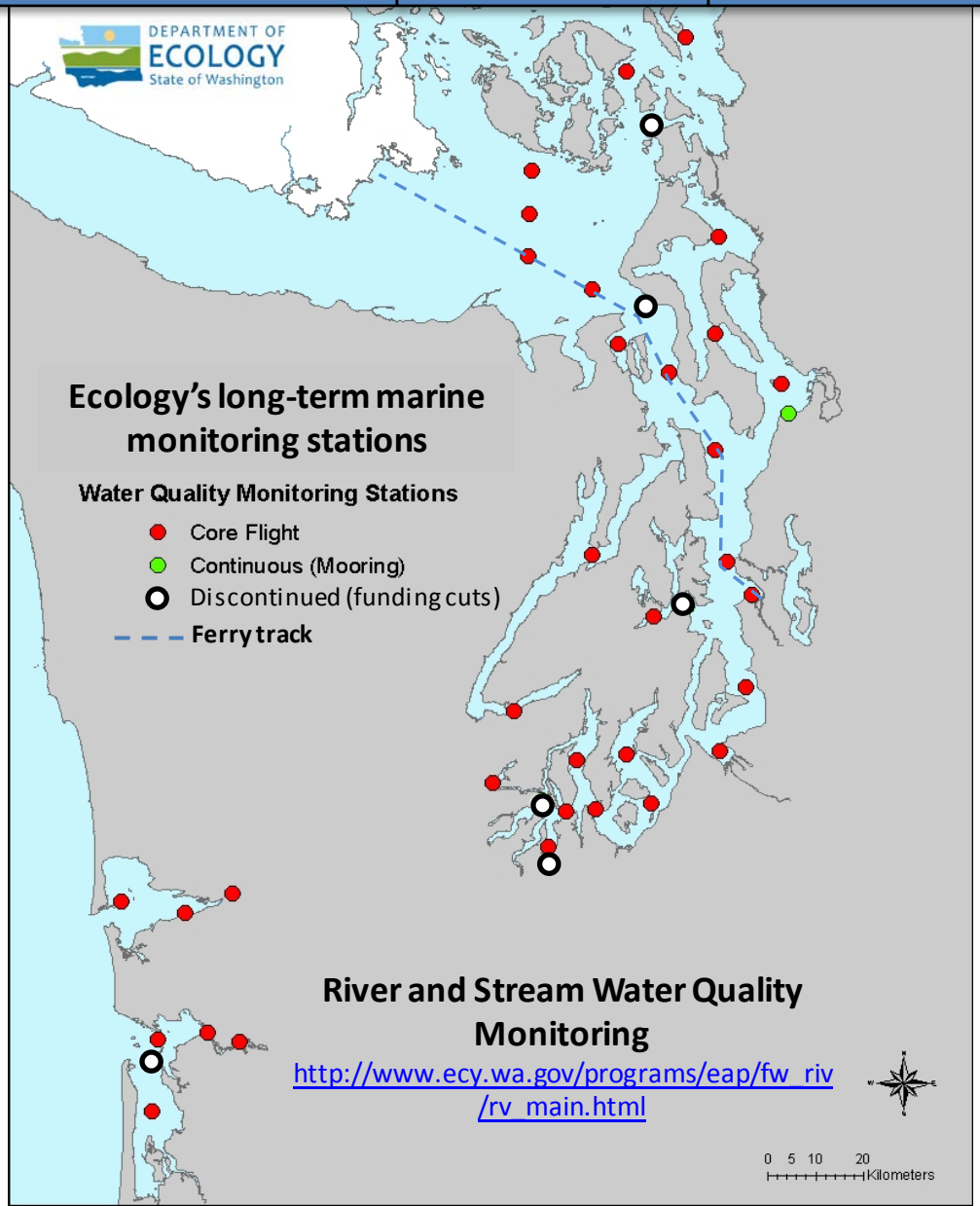
Get data from Ecology's Marine Monitoring Programs

Field log	Climate	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

Access core monitoring data:
http://www.ecy.wa.gov/apps/eap/marinewq/mwdataset.asp



Real–Time Sensor Network

Suzan.Pool@ecy.wa.gov

Access mooring data:
ftp://www.ecy.wa.gov/eap/Mooring_Raw/Puget_Sound/

You may subscribe or unsubscribe to the Eyes Over Puget Sound email listserv by going to:
http://listserv.wa.gov/cgi-bin/wa?A0=ECOLOGY-EYES-OVER-PUGET-SOUND

We are looking for feedback to improve our products.

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Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

Many thanks to our business partners: Clipper Navigations, Swantown Marina, and Kenmore Air.