Publication No. 14-03-076

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Field log | Weather | Water column | Aerial photos | Ferry and Satellite | Moorings

MWCI

Marine Water Condition Index

Surface Conditions Report

August 18, 2014

Start here

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

Marine conditions from 8-18-2014 at a glance

LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
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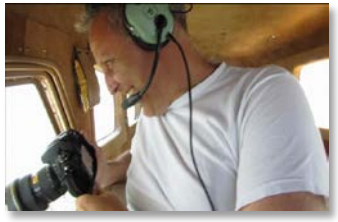


Suzan Pool
Guest:
Dr. Brandon Sackmann, Integral

Personal field log p. 4
A super colony of by-the-wind sailors is washing up on our beaches.

Weather conditions p. 5
Sunshine and warm temperatures have returned. The Fraser River flow is normal, Skagit River is below normal, but the Puyallup and Nisqually Rivers are flowing high.

Water column p. 7
In early 2014, colder, saltier conditions developed in Puget Sound with lower oxygen in some areas. Now Puget Sound is warmer and saltier with continued lower oxygen in areas. Hood Canal remains cold and salty with higher oxygen.

Moorings p. 38
In the Mukilteo moorings, we observed higher temperature, lower salinity, and lower dissolved oxygen than past few years.

Aerial photography p. 10
Organic surface debris in South and Central Sound is high. Red-brown blooms and numerous patches of jellyfish in finger inlets of South Sound, Sinclair, Dyes Inlets, and Bellingham Bay. Brown-green and green blooms in Whidbey Basin.

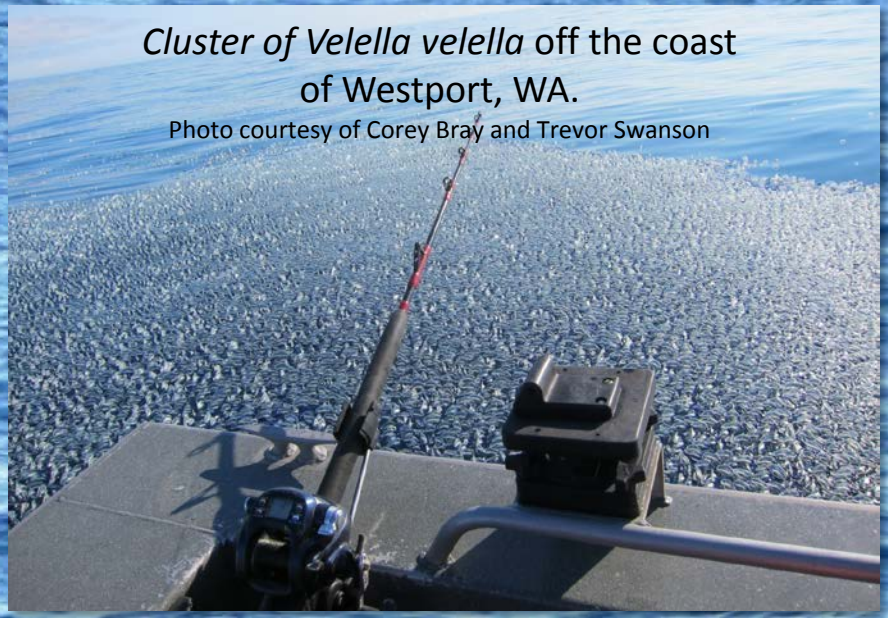
Ferry and satellite p. 35
Sea surface temperatures >15 °C. As stratification weakens, bloom in central Puget Sound begins to fade. MODIS reveals blooms in Whidbey Basin and Carr Inlet.

Previous Eyes Over Puget Sound reports: www.ecy.wa.gov/programs/eap/mar_wat/eops/

Personal flight impression 8-18-2014

What are they? - Are they harmful to humans? - Why are we seeing them?

Velella velella was spotted daily in the Pacific Ocean by Julia Bos, who recently sailed from Hawaii to Washington



Cluster of Velella velella off the coast of Westport, WA.

Photo courtesy of Corey Bray and Trevor Swanson

Velella velella on Rialto Beach, WA.

Photo courtesy of Chris Hartman

There have been recent reports of strange UFO (unidentified floating object) sightings in the waters off the coast of Washington. These small, jelly-like organisms can be found floating in clusters on the surface of the water or washed up on beaches. Beachcombers and boaters are curious as to what they are seeing.

Personal flight impression 8-18-2014

Velella velella or by-the-wind sailors

Velella velella
Photo courtesy of Julia Bos

While related to jellyfish and anemones, these creatures are actually a type of hydrozoa. Like the Portuguese man o‘ war, *Velella* is a “super colony” of tiny predatory individuals working together as one.

Are they harmful to humans?

Velella is not harmful to humans, but it would be wise to avoid touching your eyes and face if you come in contact with them.

René Lesson and Pancrace Bessa

The Portuguese man o’ war has similar stinging cells that can really hurt!

Why are we seeing them now?

Velella are found around the world, generally in warmer waters. They bloom in spring/summer, and are carried by the wind many miles before washing up on the beach.

Have you seen jellies?

Contribute to science and report your sighting: www.jellywatch.org

UFO Sighting? Email us:

lafr461@ecy.wa.gov

Weather of the past two weeks before 8-18-2014

Our new presentation of meteorological conditions! For monthly data and an explanation of the figures, see our weather webpage at: http://www.ecy.wa.gov/programs/eap/mar_wat/weather.html.

Two week summary:

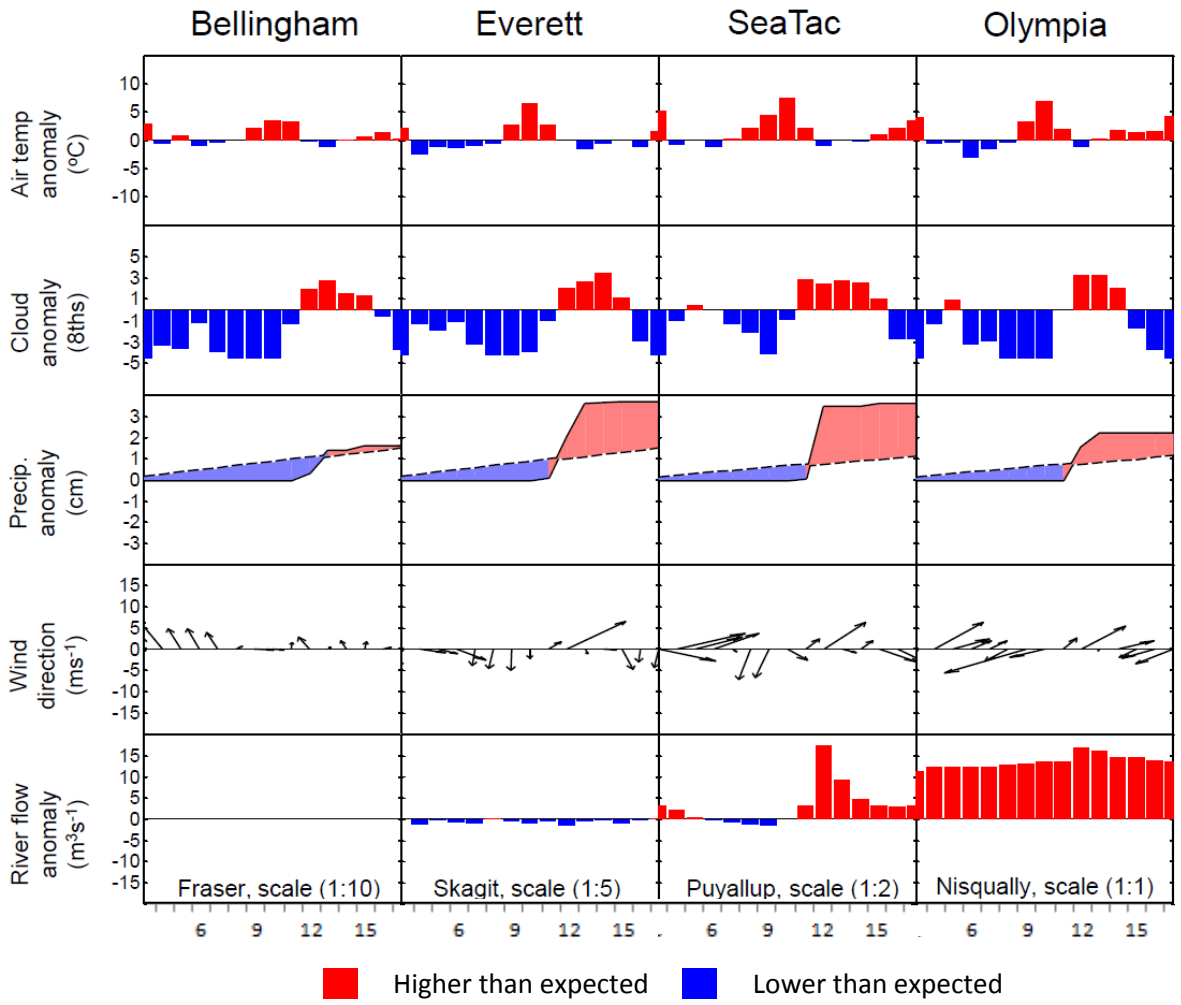
Air temperatures have been generally above normal for the past two weeks.

Sunshine levels have been above normal until the rain event last week.

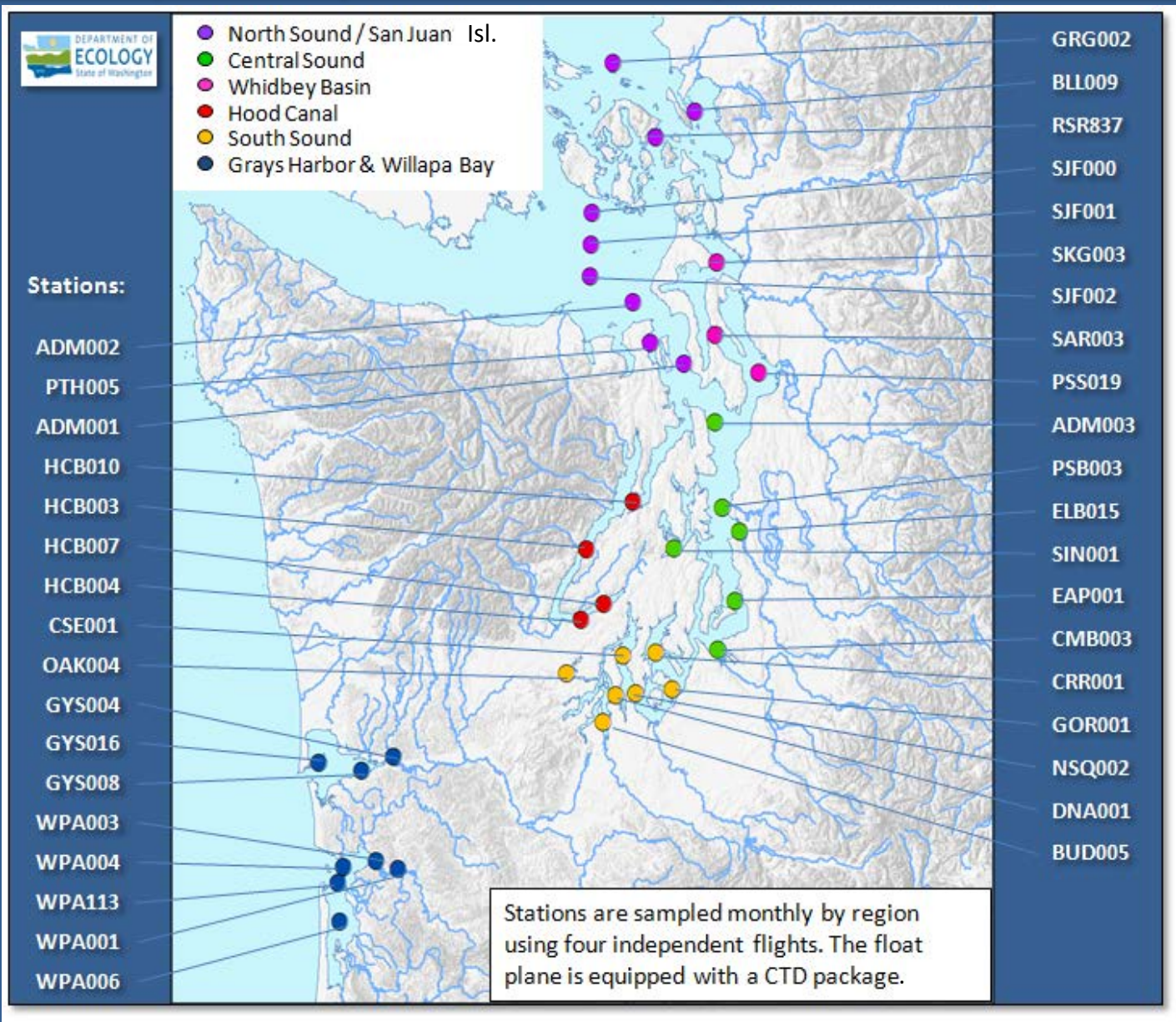
Precipitation occurred last week and was heavy in central sound.

Winds have been primarily from the north for the past few days, but from the south during the rain event.

River flows are normal for the Fraser, below normal for the Skagit, and above normal for the Nisqually and Puyallup.



Our long-term marine monitoring stations in Washington



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

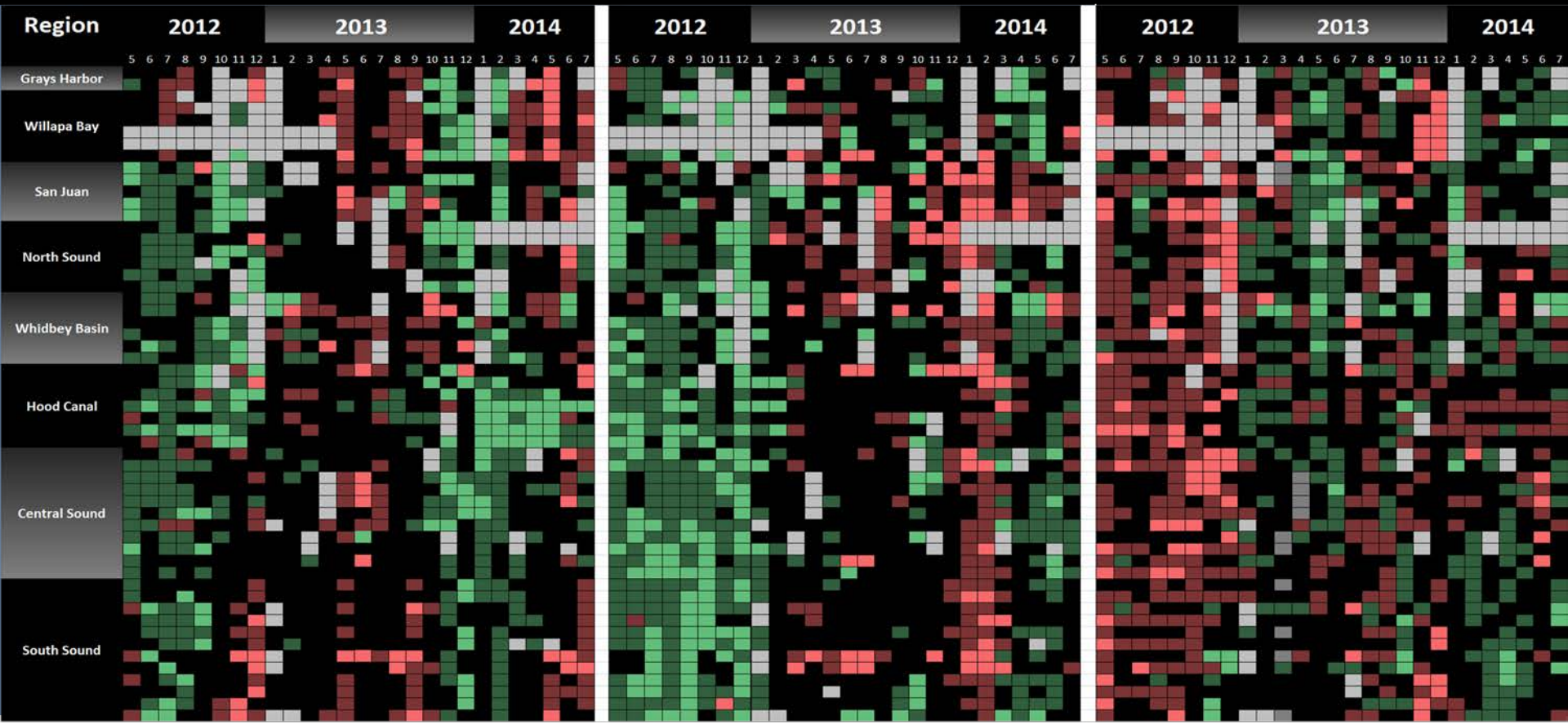
Start here

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

July 2014: Temperature increasing Salinity Increasing Oxygen Stays Lower



= 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

In 2013, Puget Sound was warmer with normal salinity. Early 2014 brought colder, saltier conditions to Puget Sound with lower oxygen in several basins. Starting in March, Puget Sound-wide salinities were lower due to high rain events in the spring. Now temperatures are warmer, salinity is increasing, DO stays lower, and Hood Canal remains unusually cold and salty with higher DO.

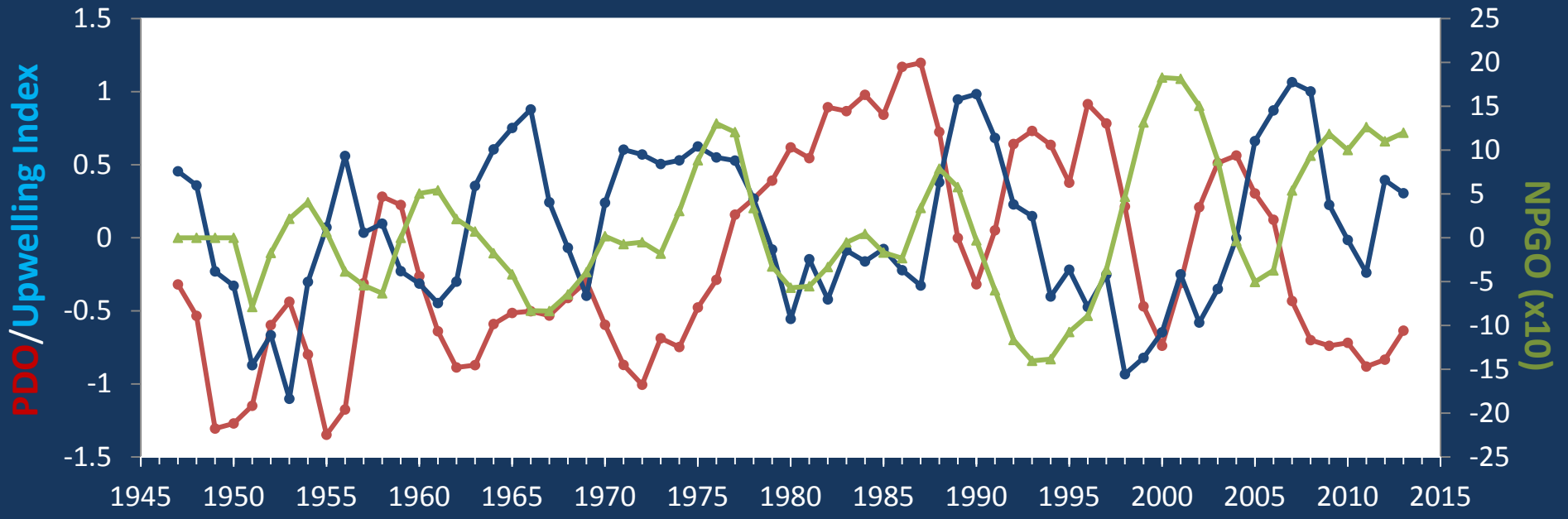
The ocean affects water quality: Ocean Climate Indices

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

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

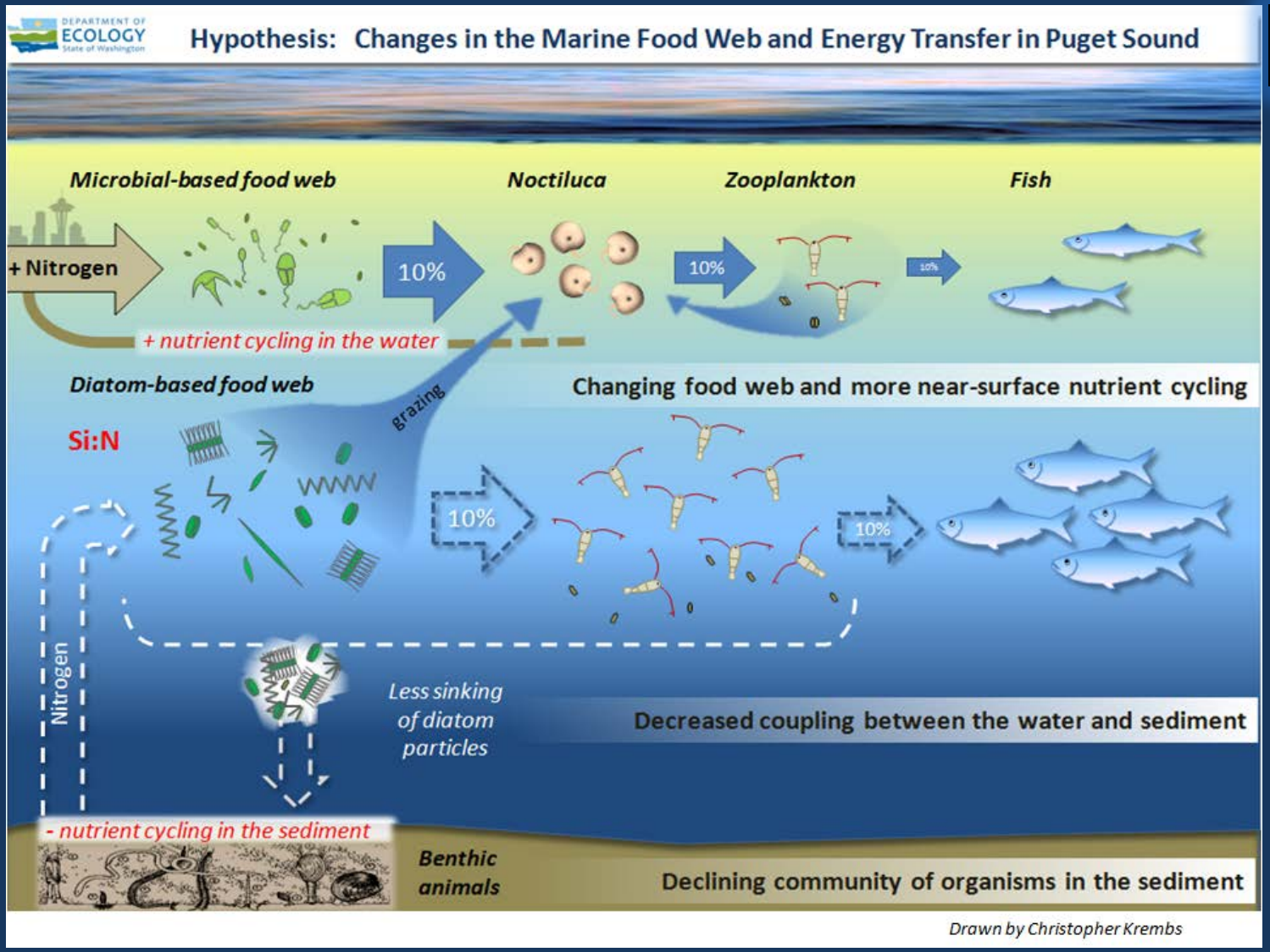
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* *(explanation)*

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?

Is the food web changing in Puget Sound?



Hypothesis!

Should we pay greater attention to nutrient ratios, energy transfer, and material cycling in Puget Sound?

Noctiluca blooms are a visible harbinger of a changing microbial food web in Puget Sound's waters.

[The story in 5 min]

[Explore the data]

[Follow the experts]

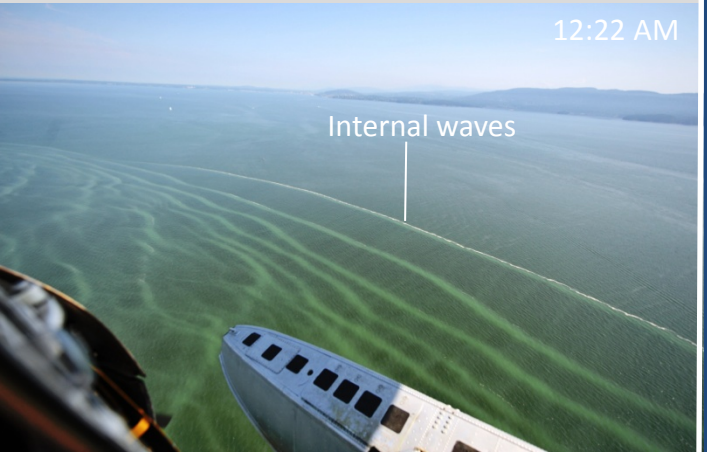
Summary: Aerial photography 8-18-2014

Organic surface debris in South and Central Sound is very high. Strong red-brown blooms and numerous patches of jellyfish seen in finger inlets of South Sound, Sinclair and Dyes Inlets, and Bellingham Bay. Brown-green and green blooms in Whidbey Basin. Yellow-green blooms in the Sucia Islands and Scow Bay.

Start here

Lake Union, Seattle. A city perspective.

Internal waves in Bellingham Bay.



Front

Mixing and Fronts:
Developed fronts near Lummi Island and Boundary Pass.
8 10 12 13 14 18 Click on numbers

Jellyfish: Jellyfish patches numerous in all southern inlets of South Sound. 1 2

Suspended sediment:
Sediment in glacier-fed rivers, such as the Fraser, Puyallup, and Nooksack, is visible and influences a wide area.
2 7 8 11 12 13 14 18

Plume

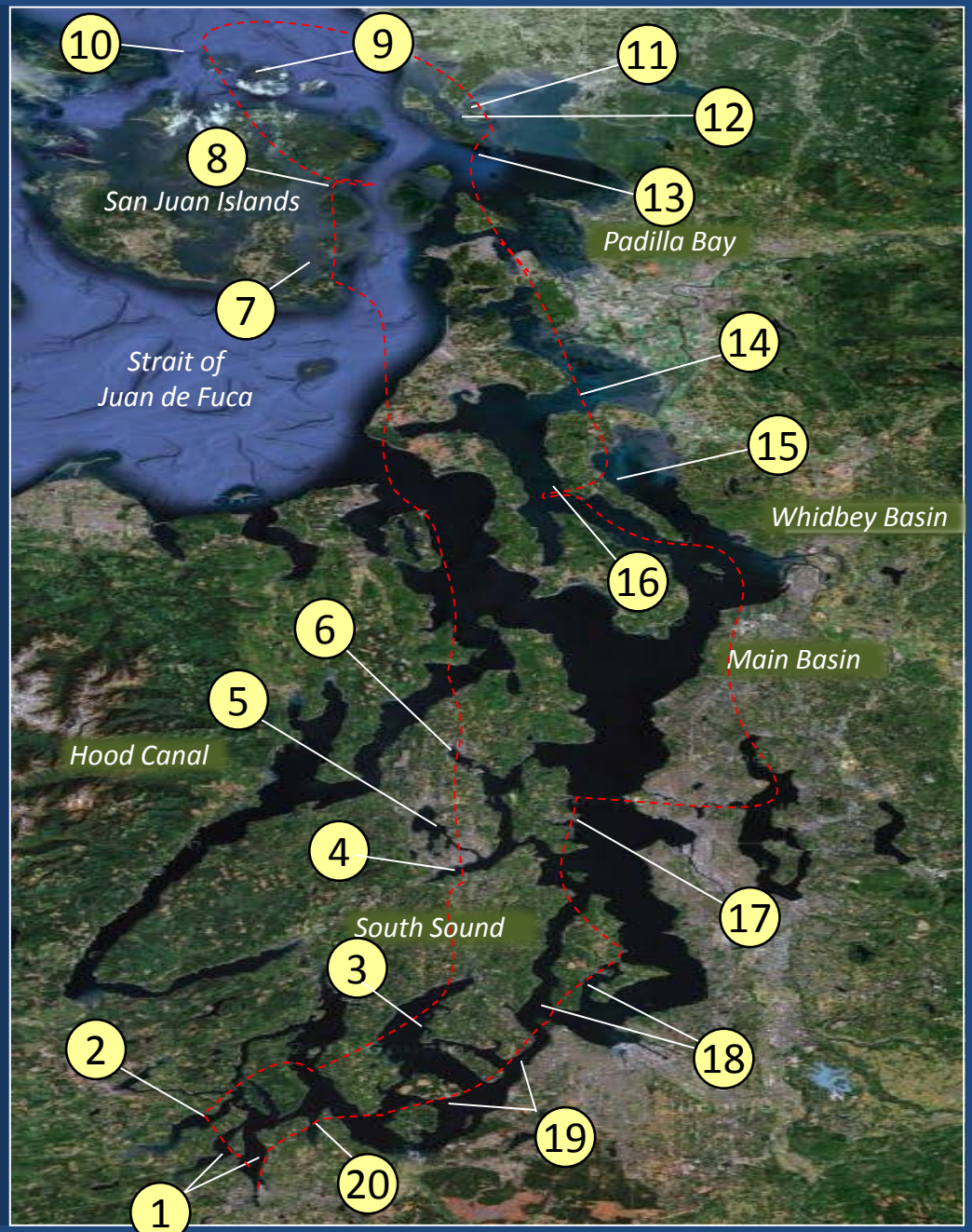
Bloom

Visible blooms:
Green-brown: Skagit Bay
Red-brown: Inlets of South Sound, Sinclair, and Dyes Inlets.
Yellow and Green: Port Susan, Sucia Islands, Scow Bay.
Green macro-algae: All of South and Central Sound.
1 2 3 4 5 6 9 10 11 12 13 14 15 16 19 20

Debris

Debris:
Very abundant in South and Central Sound. Long lines around Lummi Island. 1 2 4 5 10 11 12 13 17 18 19

Seattle Tides: H. tide: 1:33 PM 11:57 PM, , L. tide: 5:59 AM, 6:34 PM



Aerial photography and navigation guide

Date: 8-18-2014

Click on numbers

Flight Information:

Morning flight, photos 1-10
Blue sky, high visibility, calm

Afternoon flight, photos 11-20:
Blue sky, hazy, wind increasing

– – – Flight route and fueling stop

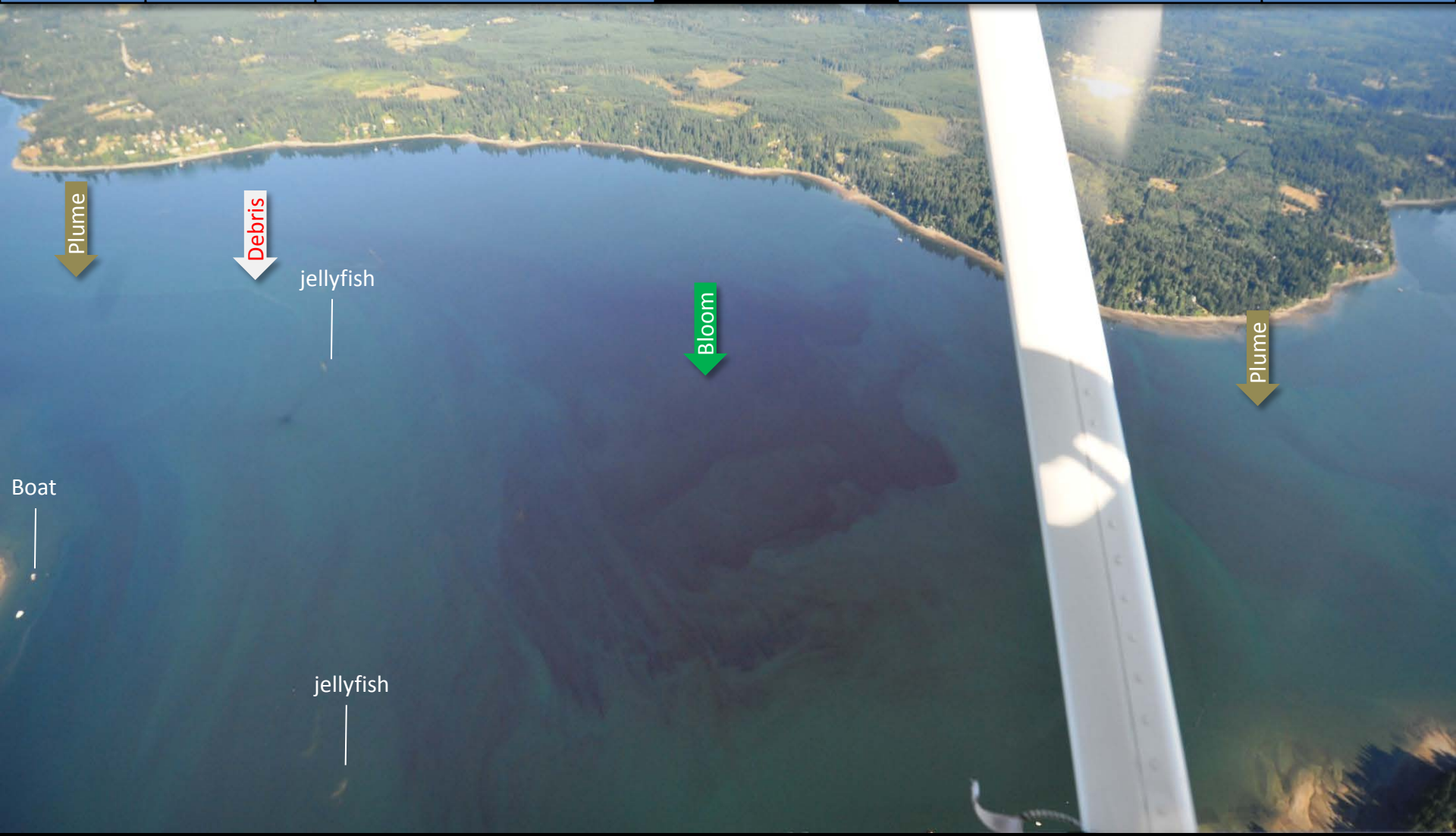
Observation Maps:

Central and North Sound

Hood Canal and South Sound

Red-brown bloom and numerous patches of jellyfish.

Location: A. Flapjack Point, Eld Inlet. B. Across Butler Cove, Budd Inlet (South Sound), 9:14 AM.



Red-brown bloom mixed in with water rich in suspended sediment. Jellyfish patches present.

Location: Near Windy Point, Totten Inlet (South Sound), 9:21 AM.

Green bloom inside bay.

Location: Raft Island, Carr Inlet (South Sound), 9:34 AM.

Red-brown bloom and organic debris lines following current inside the inlet.

Location: East of Ross Point, Sinclair Inlet (South Sound), 9:45 AM.

Aerial photography 8-18-2014

Red-brown bloom lining green bloom mixed to the surface by tidal currents. Large patches of organic material. Location: Off Rocky Point, Dyes Inlet (Central Sound), 9:48 AM.

Red-brown bloom and signs of brown bloom and suspended sediment inside bay.
Location: Poulsbo, Liberty Bay (Central Sound), 9:53 AM.

Suspended sediment following current pattern inside Lopez Sound.

Location: Across Hunter Bay, Lopez Sound (San Juan Islands), 10:25 AM.

Tidal current carrying water containing phytoplankton from East Sound into Rosario Strait.

Location: Deer Point, Obstruction Pass (San Juan Islands), 11:14 AM.

Intense yellow-green phytoplankton bloom inside bay.

Location: Fossil and Mud Bays, Sucia Island (San Juan Islands), 11:22 AM.

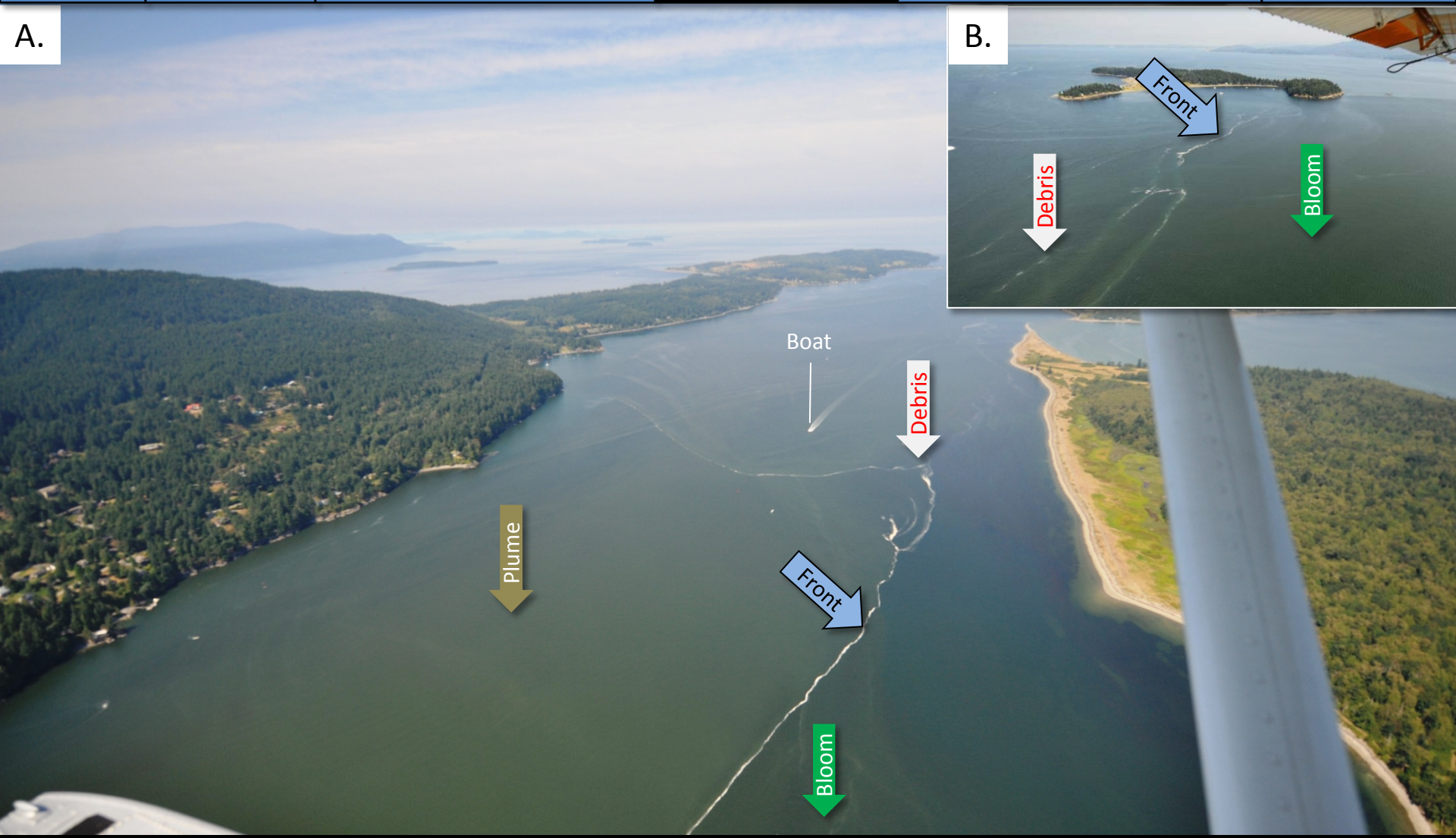
Aerial photography 8-18-2014

Strong tidal front and currents separating incoming tide from phytoplankton bloom.

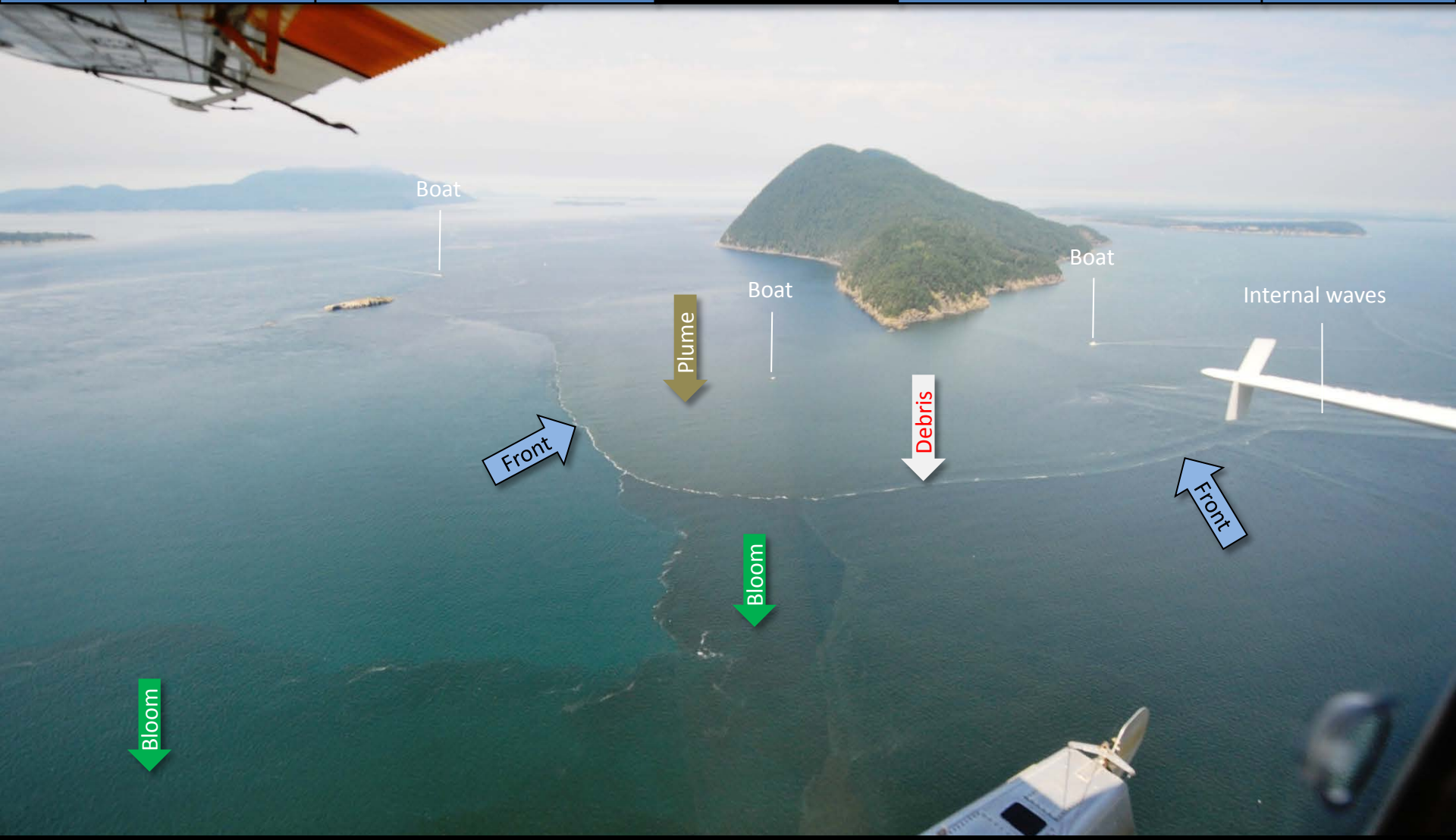
Location: Between Patos and Tumbo Islands, Boundary Pass (San Juan Islands), 11:24 AM.

Gold-green bloom and lines of organic surface debris inside Portage Bay.

Location: Bellingham Bay (North Sound), 12:19 PM.



Long debris line spanning from Eliza to Portage Island. Brown-colored bloom in Bellingham Bay.
Location: A. East of Lummi Island, B. West of Eliza Island (Bellingham Bay), 12:22 and 12:44 PM.



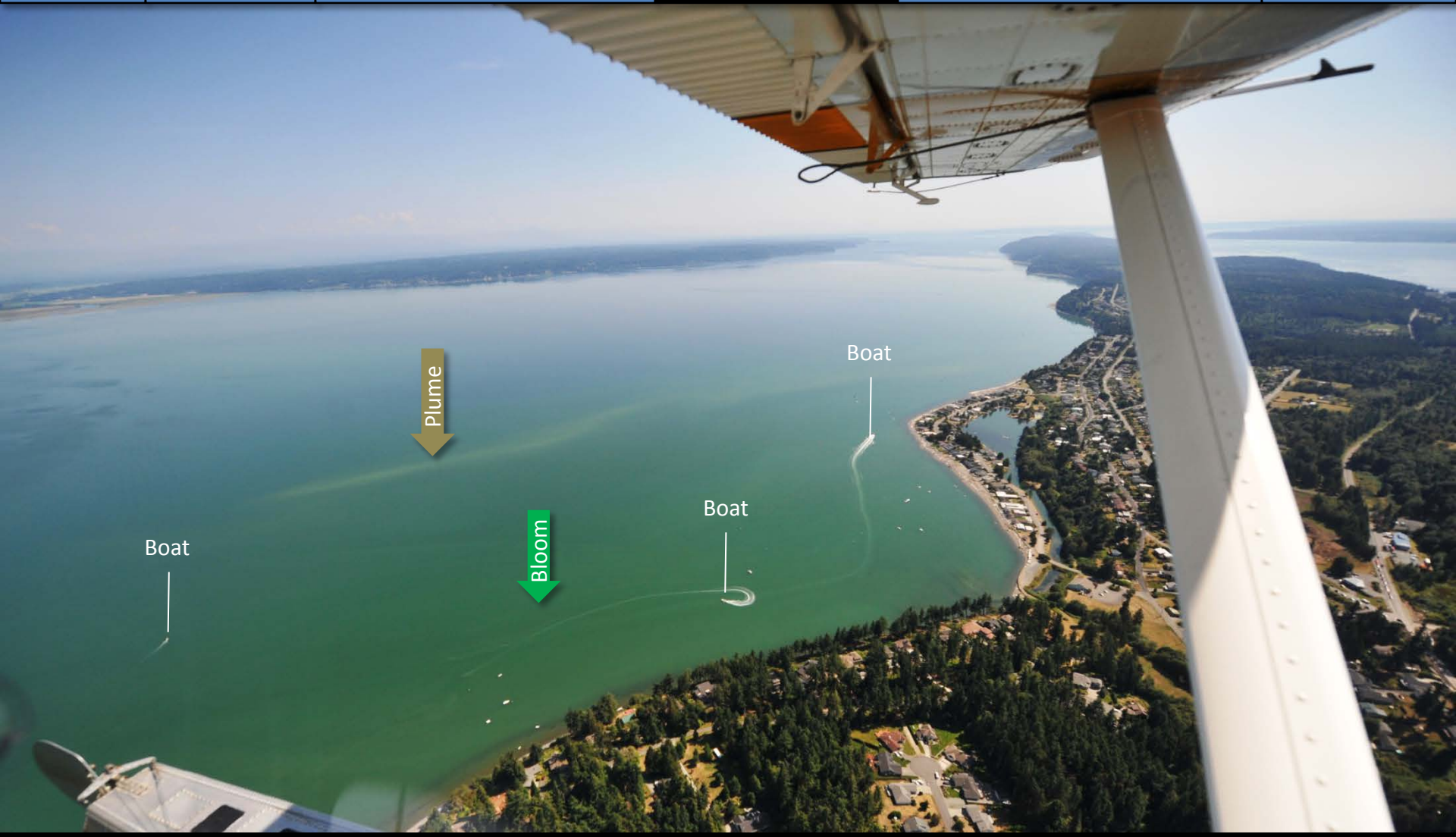
Structured surface water debris lines and fronts with red-brown bloom and sediment-rich water.

Location: South of Lummi Island (Bellingham Bay) 3:28 PM.

Bloom overlain with sediment-rich Skagit River water creating many fine internal waves.

Location: Off Brown Point, Skagit Bay (Whidbey Basin), 1:44 PM.

Aerial photography 8-18-2014



Strong green bloom and isolated band of suspended sediment.

Location: Off Beach Drive, Port Susan (Whidbey Basin), 5:20 PM.

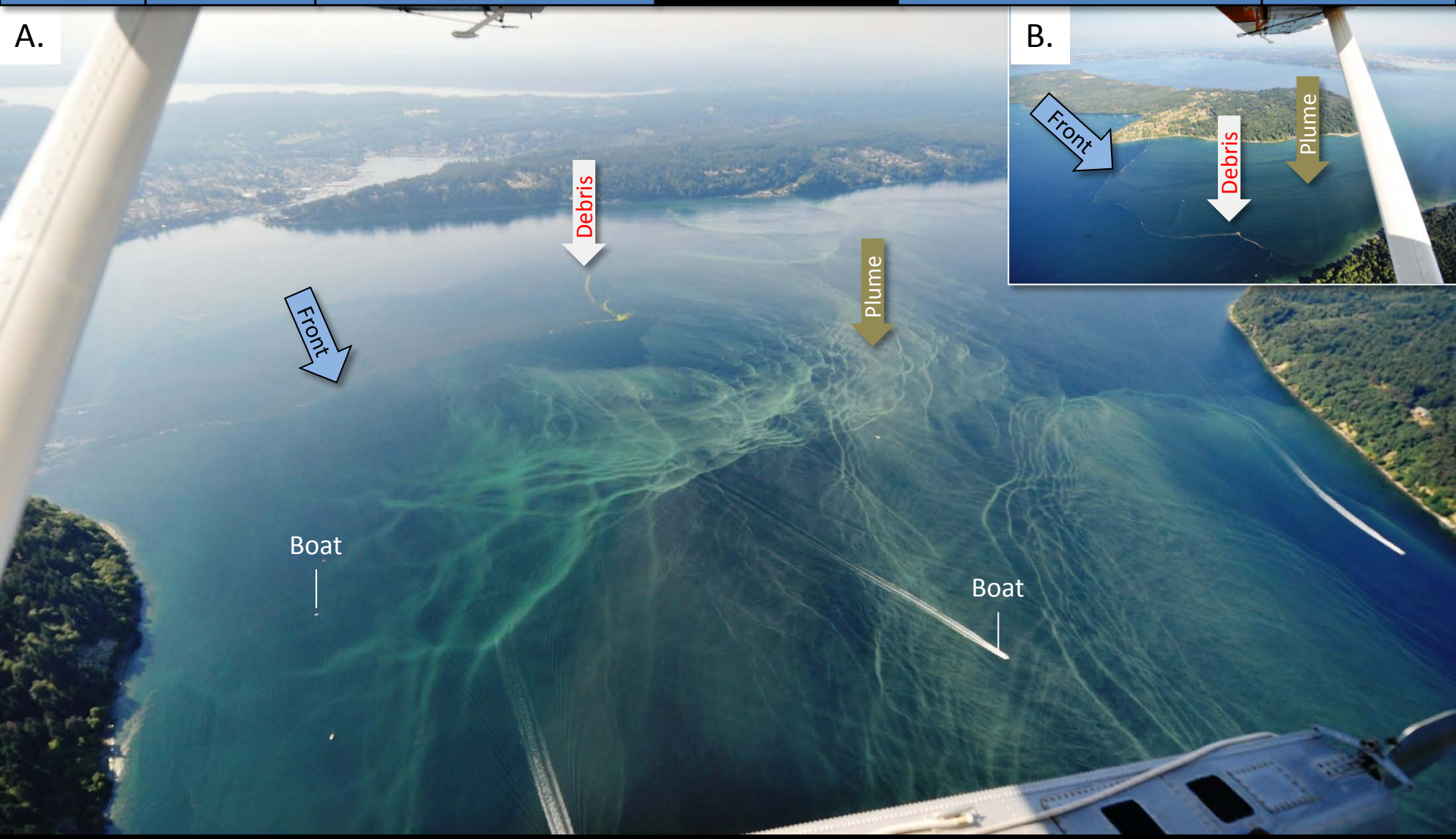
Strong brown-green bloom near surface.

Location: East of Cama Beach State Park, Saratoga Passage (Whidbey Basin), 1:51 PM.

Large and numerous patches of organic surface debris across from Seattle.

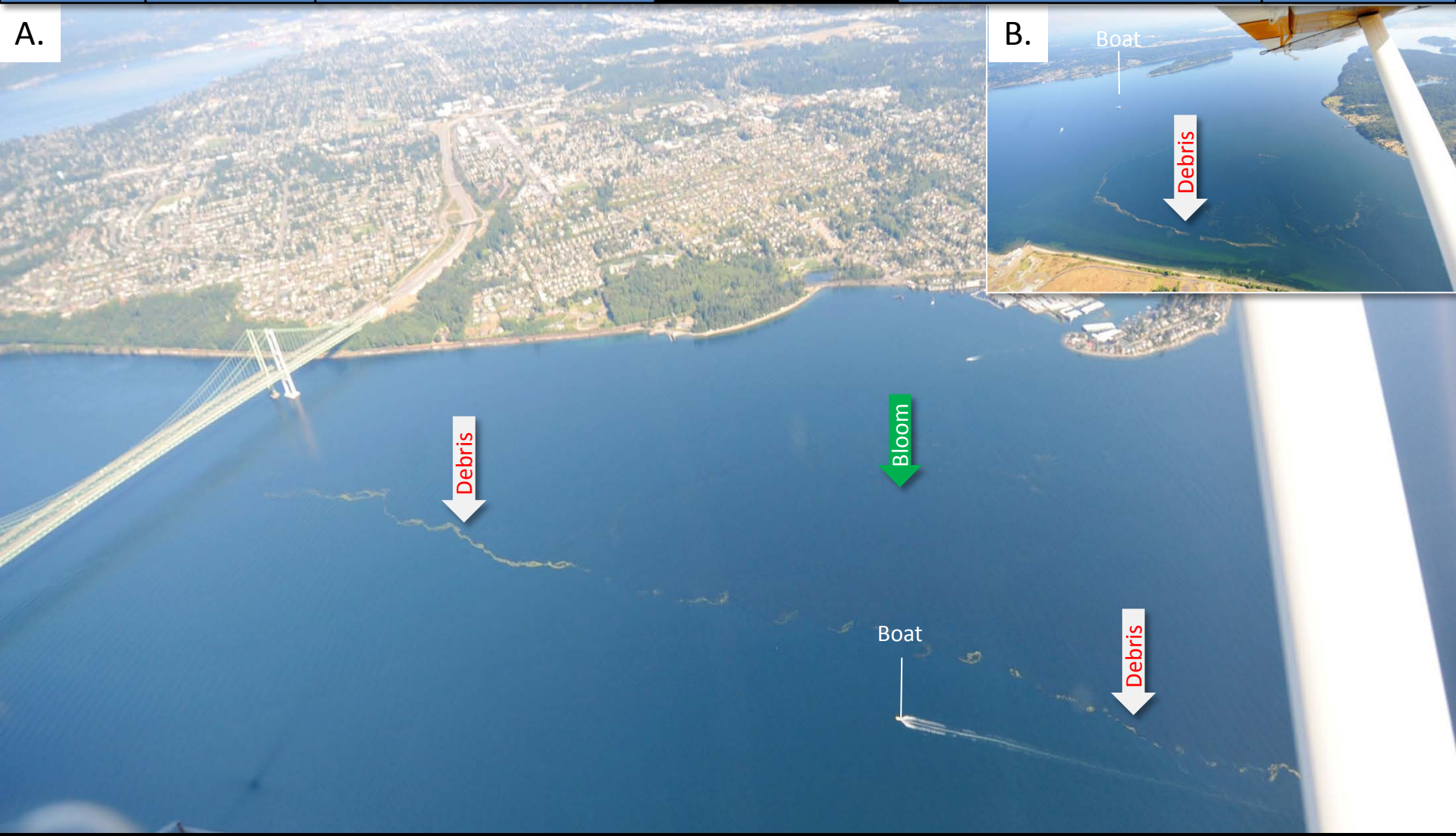
Location: Eagle Harbor, Bainbridge Island (Central Sound), 4:20 PM.

Aerial photography 8-18-2014



Organic surface debris and patterns of Puyallup River sediments at surface affecting large area.

Location: A. Off Point Defiance, B. Quartermaster Harbor (Central Sound), 4:30 PM.



Long lines of organic surface debris being advected through Tacoma Narrows.
Location: A. Tacoma Narrows, B. Off McNeil Island (South Sound), 4:35 PM.

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 8-18-2014

Red-brown blooms covering much of the bay.

Location: A. Budd Inlet, B. Henderson Inlet (South Sound), 4:42 PM.

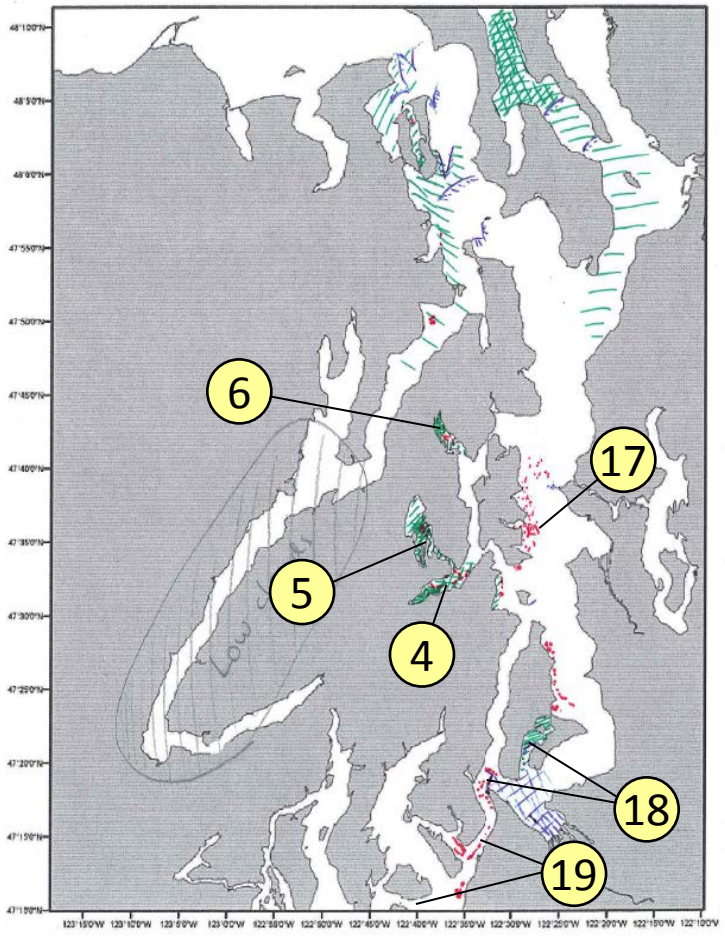
DEPARTMENT OF ECOLOGY State of Washington

Observations in Central and North Sound

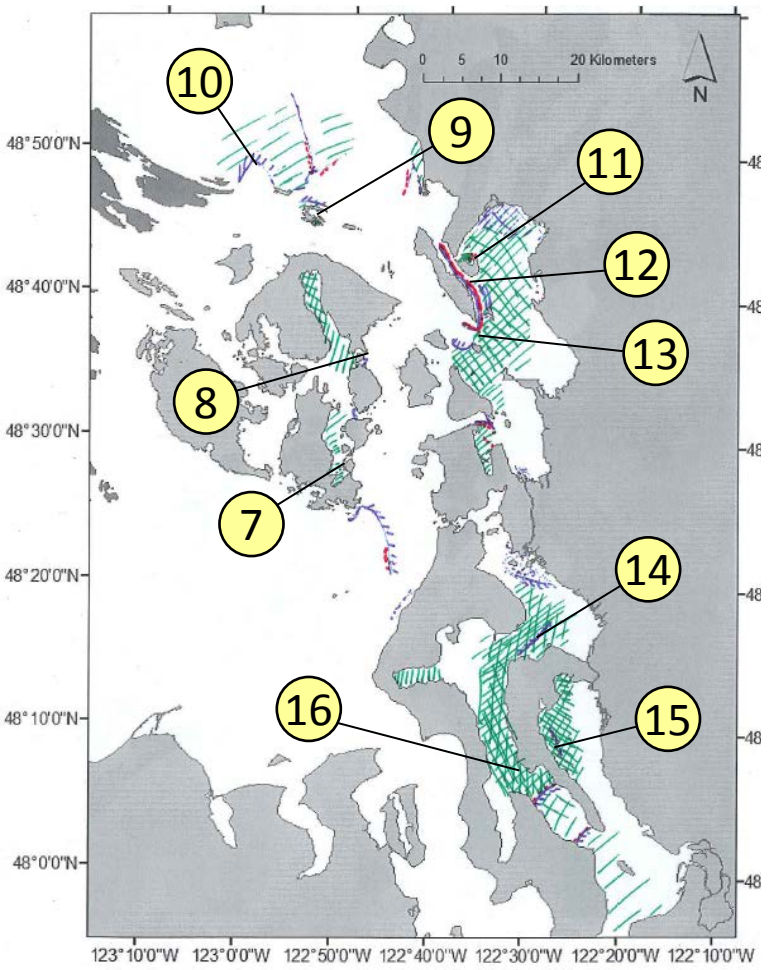
Navigate

Date: 8-18-2014

Central Sound



North Sound/San Juan Islands



Numbers on map refer to picture numbers for spatial reference

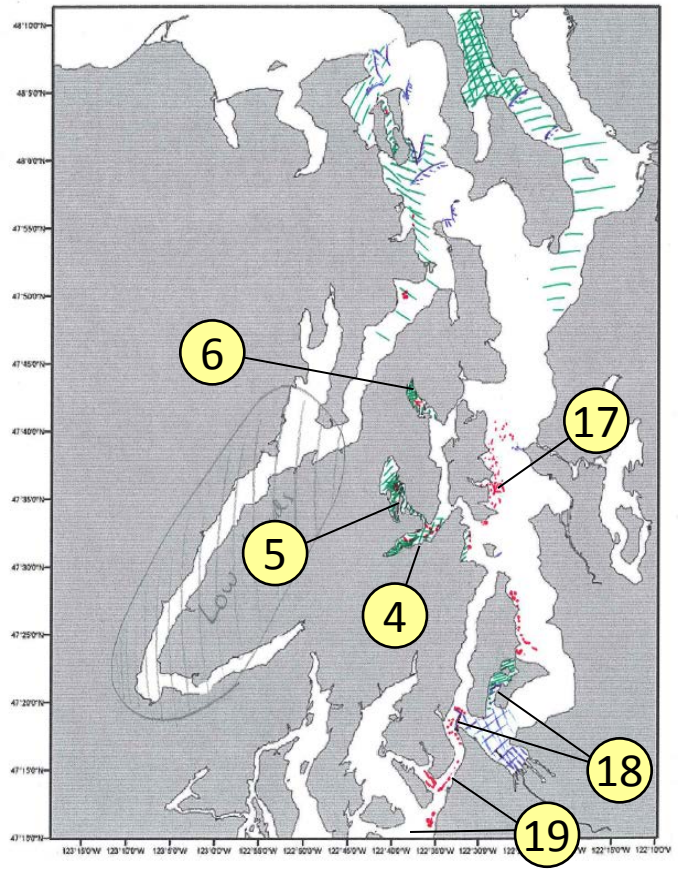
DEPARTMENT OF ECOLOGY State of Washington

Observations in Hood Canal and South Sound

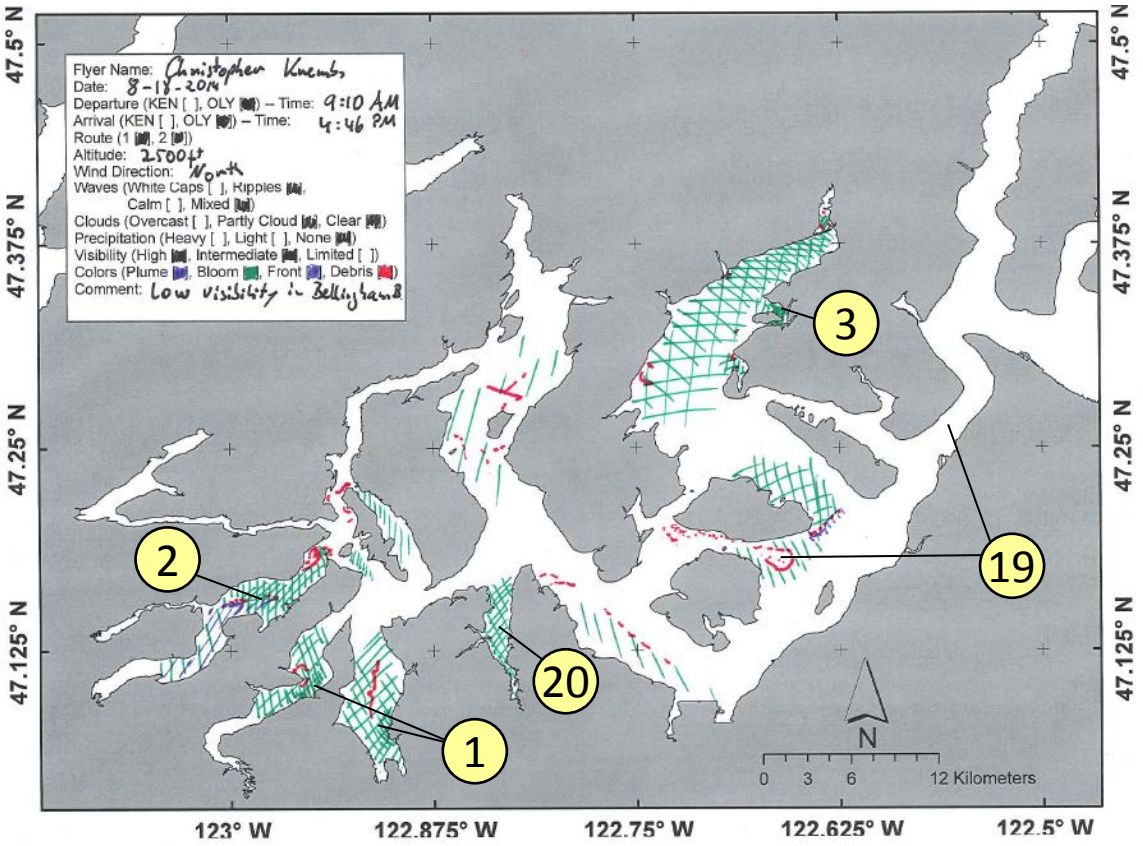
Navigate

Date: 8-18-2014

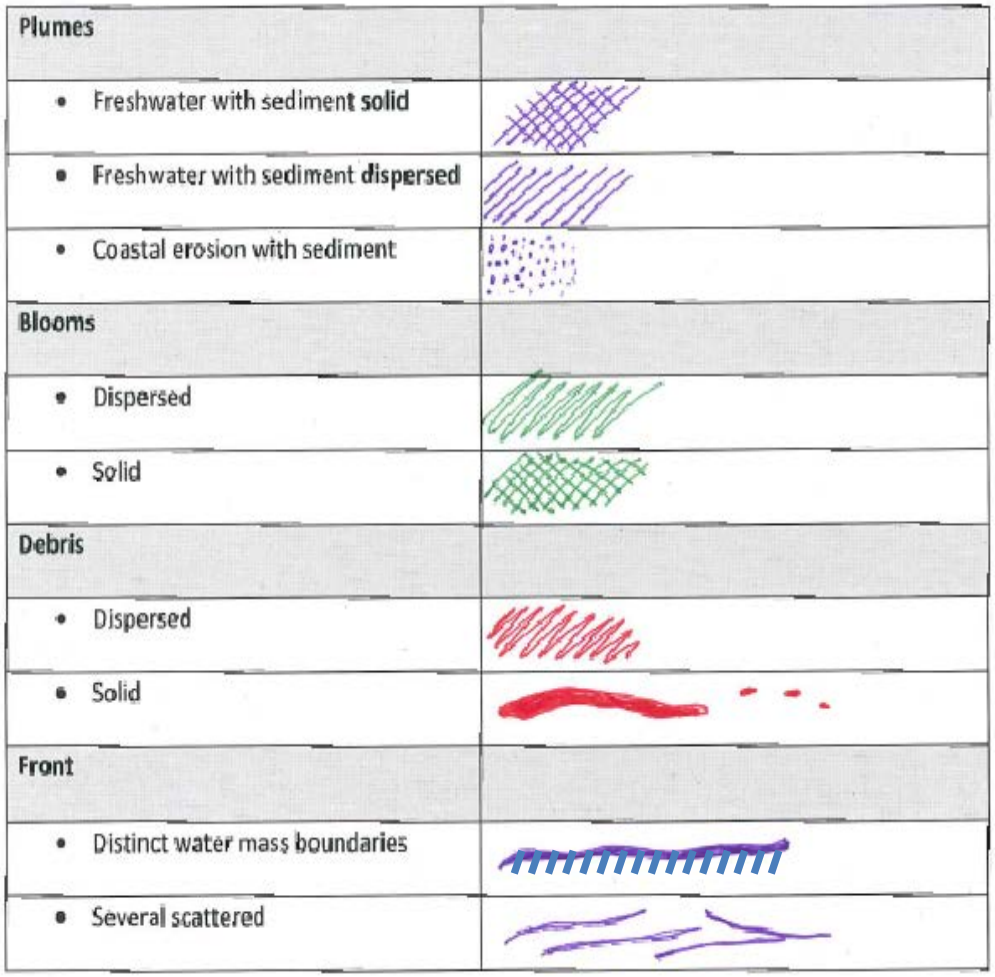
Hood Canal (cloudy)



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 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”.

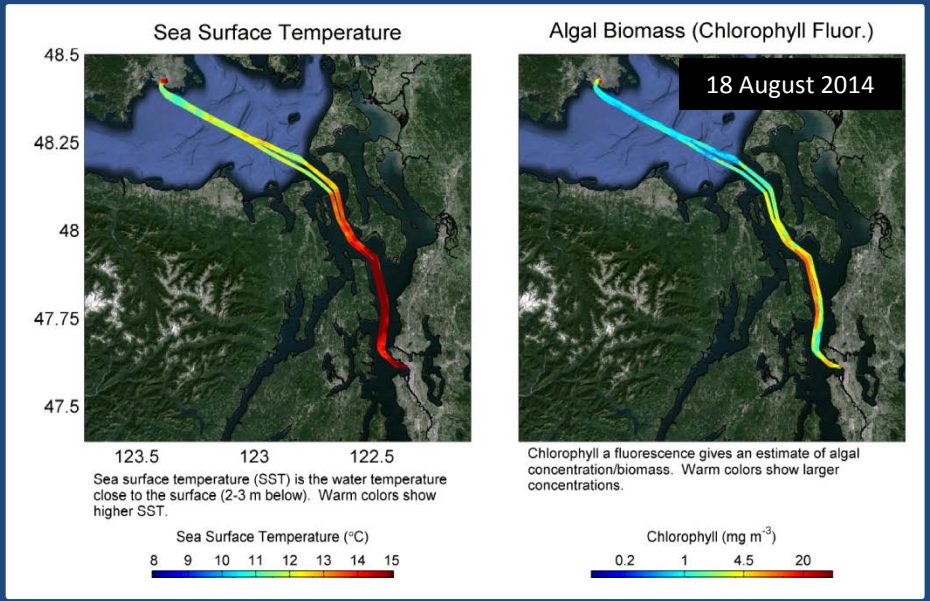
S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1): 83–88.

Ferry and satellite observations 8-18-2014

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

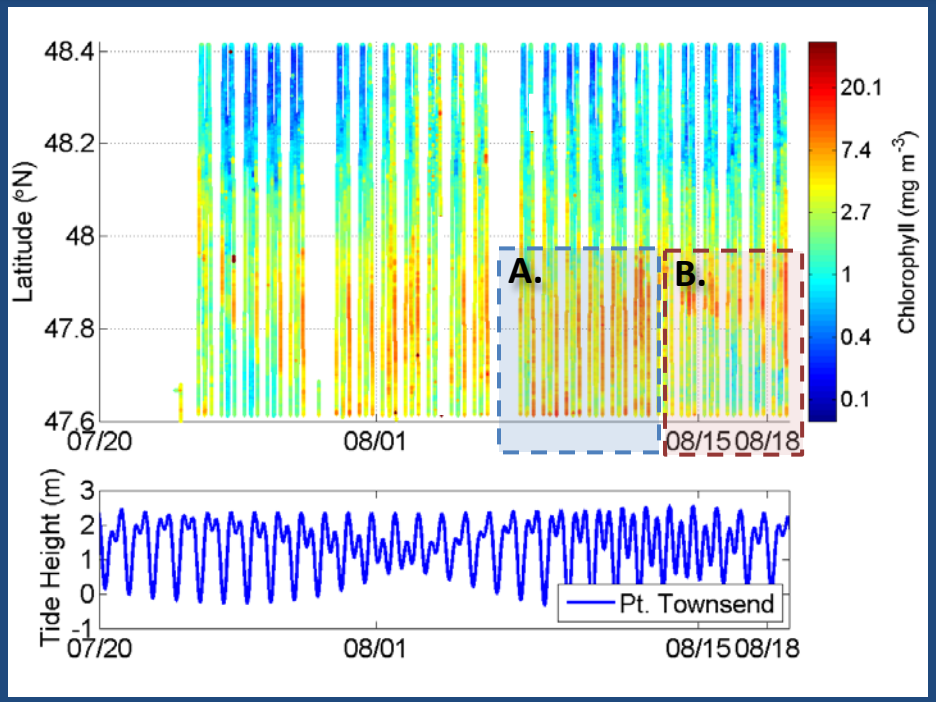
Start here

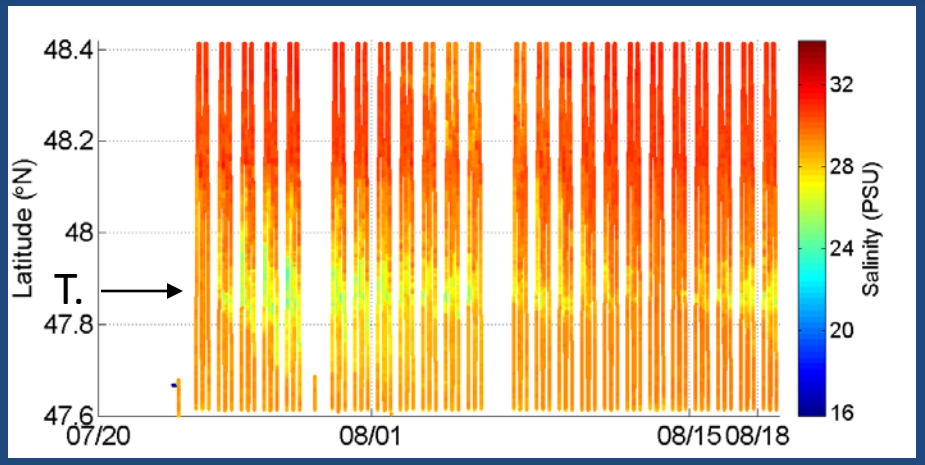


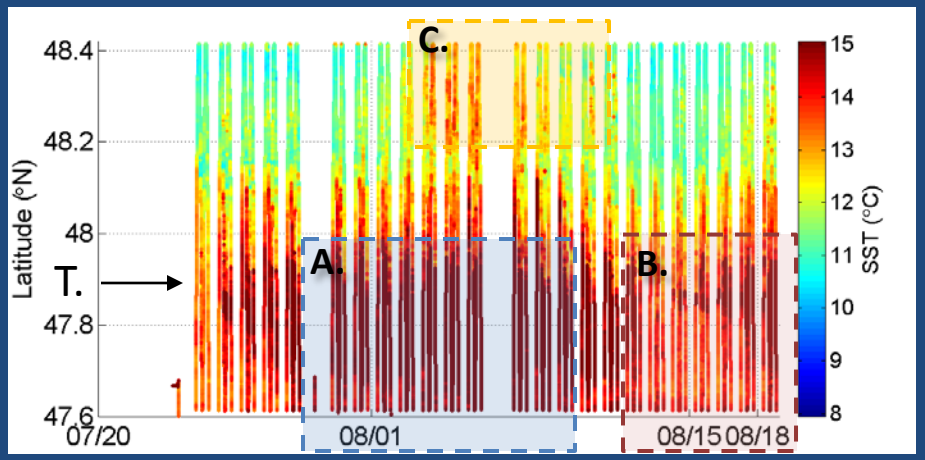
Current Conditions:

Warm, fresh water entering central Puget Sound from Whidbey Basin. Sea surface temperatures > 15 °C. Moderate fluorescence and turbidity near Triple Junction associated with phytoplankton bloom.

Ferry and satellite observations 8-18-2014







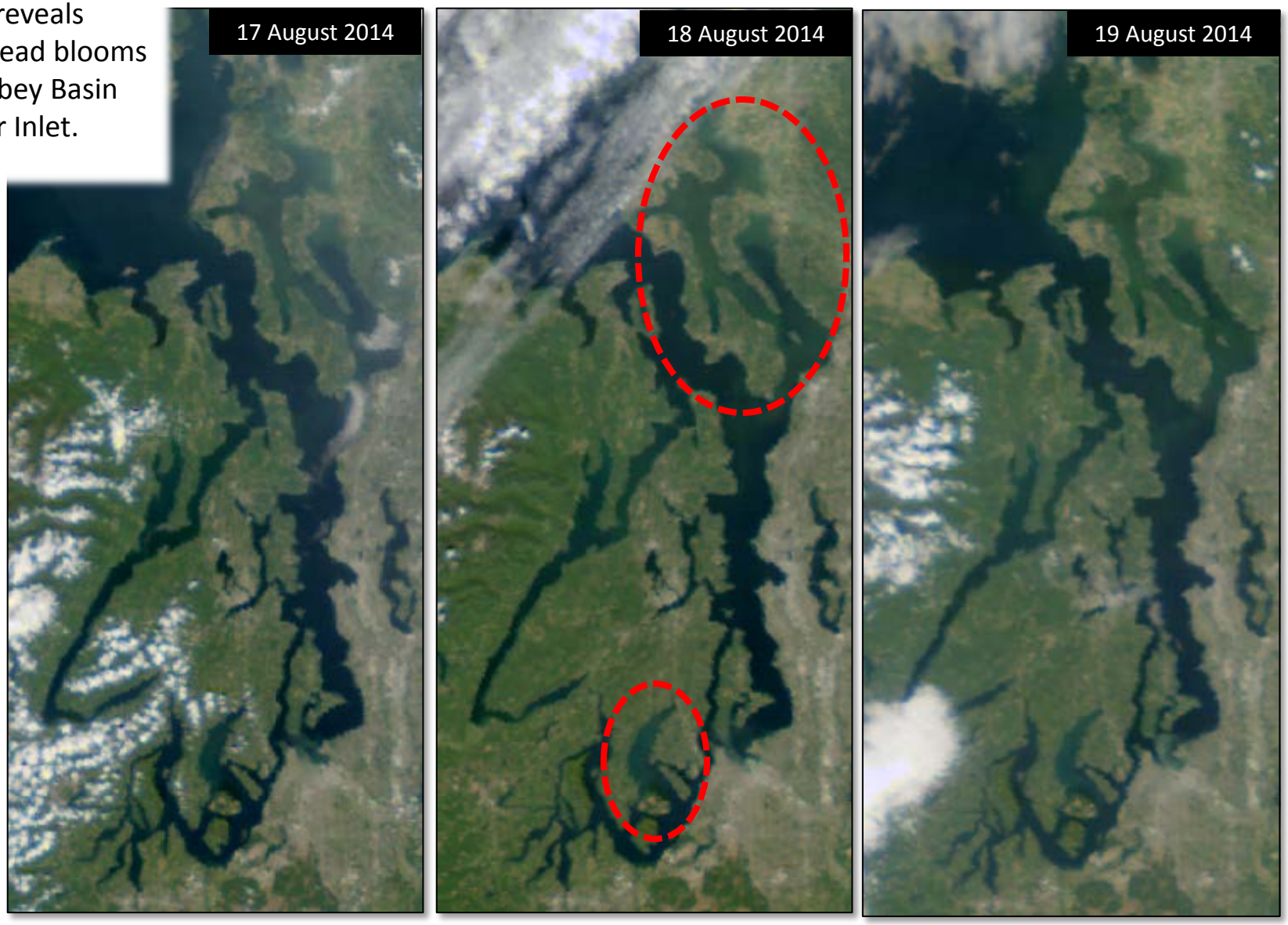
A. Warm temperatures in central Puget Sound in early August lead to stratification and promote algal growth.

B. Stratification shows signs of weakening (temperature reduced, salinity increased) and elevated fluorescence is limited to Triple Junction (**T**).

C. Weak tides associated with warmer temperatures export from Puget Sound into Strait of Juan de Fuca.

Ferry and satellite observations 8-18-2014

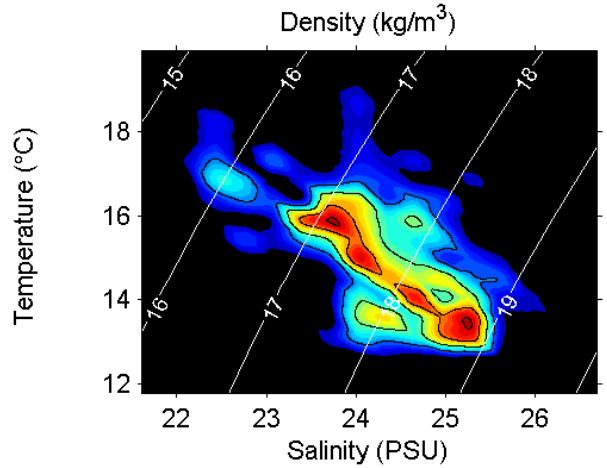
MODIS reveals widespread blooms in Whidbey Basin and Carr Inlet.



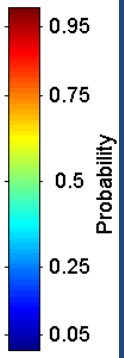
Mooring observations and trends 8-6-2014 to 8-18-2014

At Mukilteo, we observed strong vertical gradients between our upper and lower moorings based on temperature, salinity, and dissolved oxygen. Consistent winds from the north and reduced river flows lessen the export of freshwater leaving Puget Sound. Two rainfall periods, July 23 and August 13, and heightened tidal range contributed to temporary increases in river discharges and lower salinity.

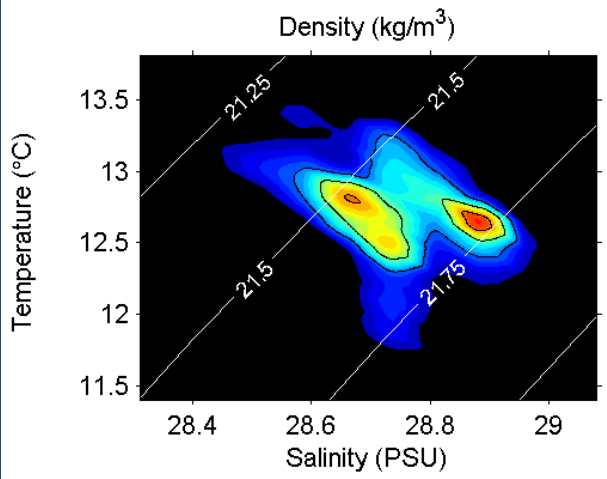
2-6 m depth

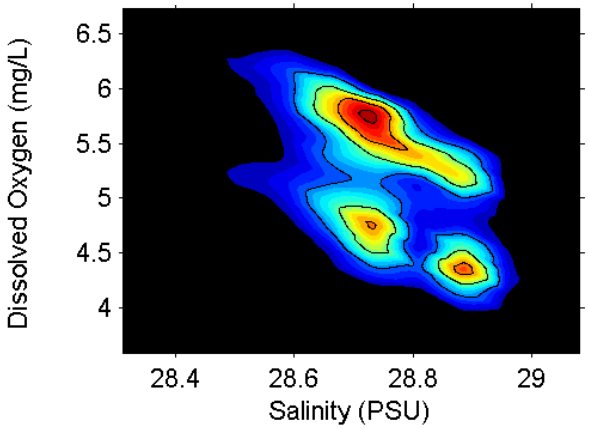


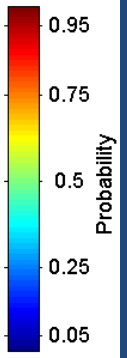
Dissolved oxygen not measured



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.

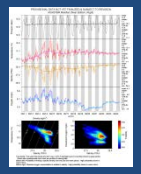
Mooring observations and trends 7-16-2014 to 8-18-2014

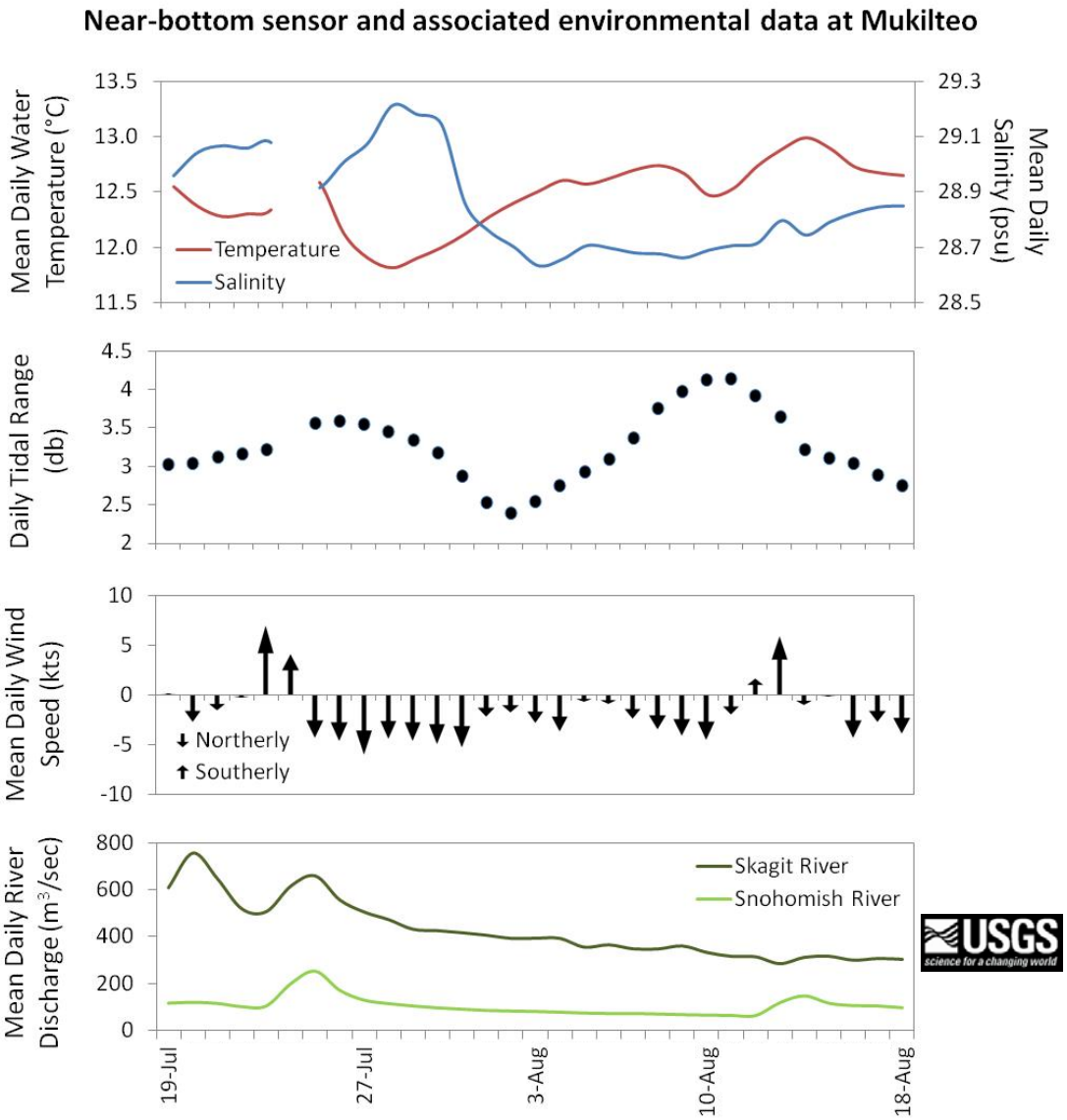
Our mooring station in Mukilteo is located in Whidbey Basin near Everett. It is also located at the transition between Possession and Central Sounds at a depth that is influenced by the Skagit and Snohomish River discharges, prevailing winds, and tidal mixing.

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





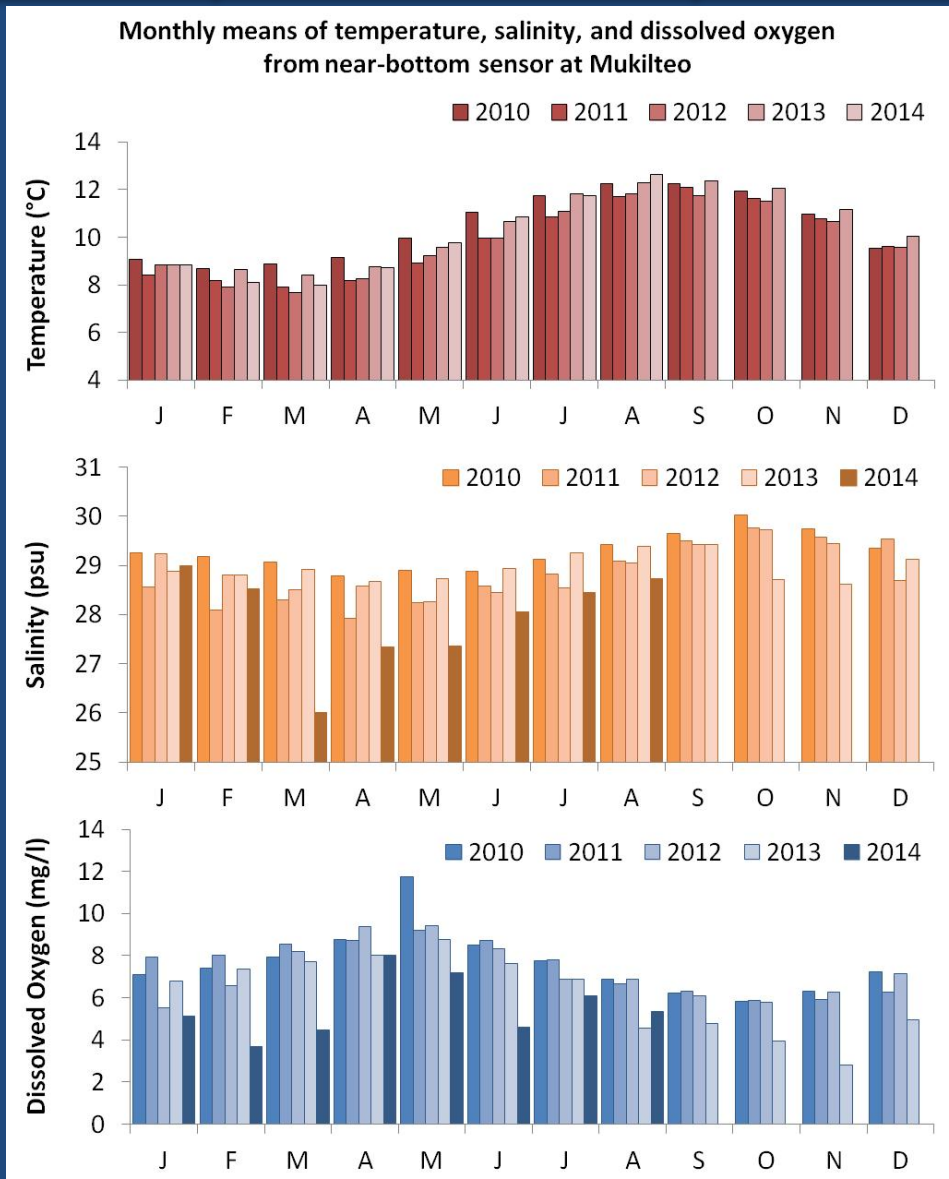
Mooring observations and trends Mukilteo 2010 to 2014

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 a 4.5-year period. All three variables show strong seasonality.

In 2014, trends in salinity and dissolved oxygen appear to decline whereas trends in temperature are similar to 2013. 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

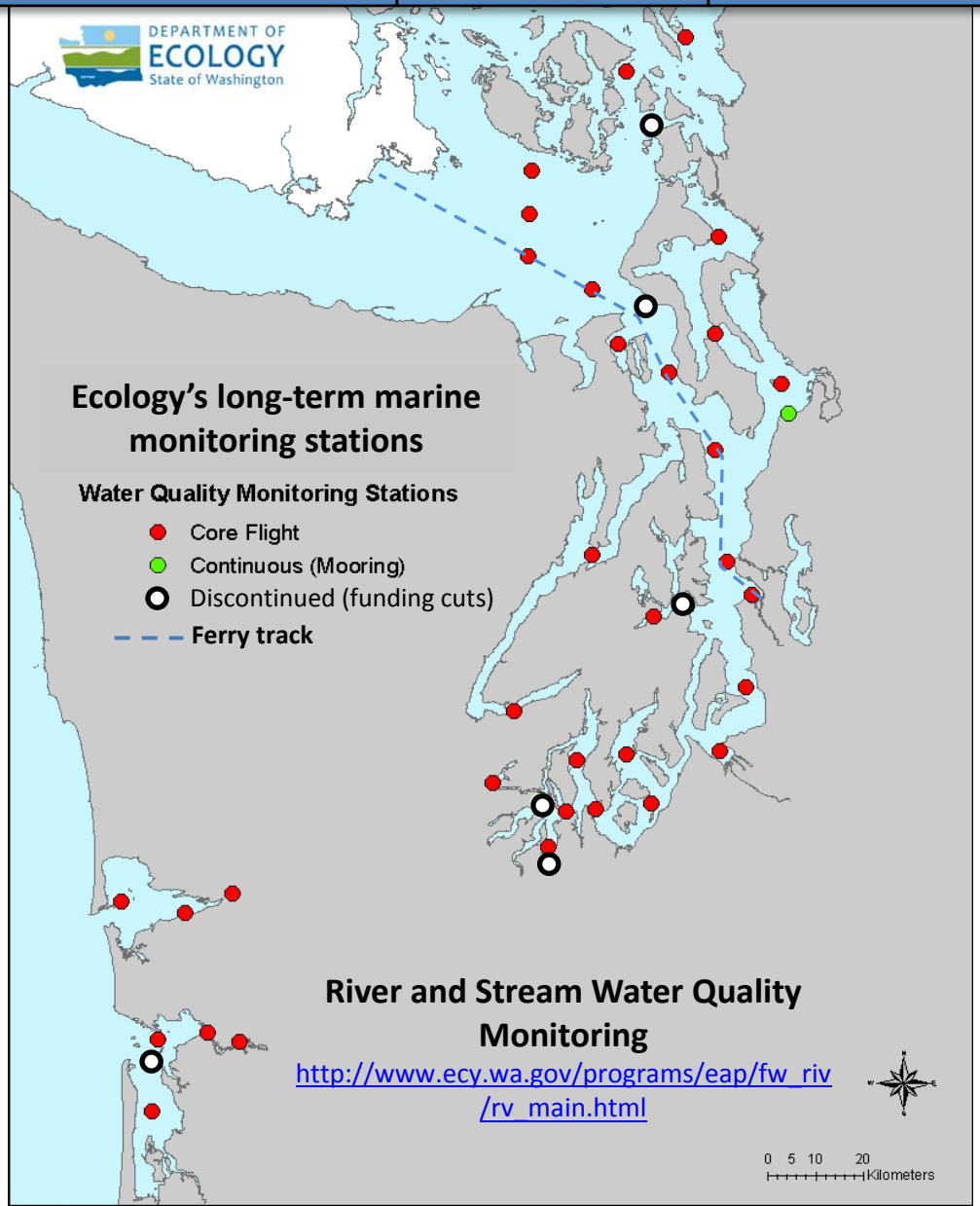
Field log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

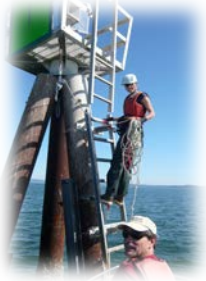
Access core monitoring data:

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.