Publication No. 14-03-079

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

Surface Conditions Report

November 17, 2014

Start here

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

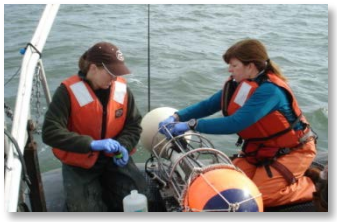
Marine conditions from 11-17-2014 at a glance

LONG-TERM MARINE MONITORING UNIT

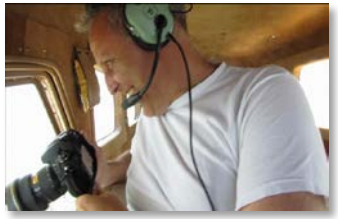
Mya Keyzers
Laura Hermanson
Joe Leatherman

Skip Albertson

Julia Bos
Suzan Pool



Dr. Christopher Krembs



Guest:
Dr. Brandon Sackmann, Integral

Please give us feedback

Editorial assistance provided by: Suzan Pool, Carol Maloy, Laura Hermanson

What is the Washington BEACH Program?

The BEACH Program helps to reduce the risk of disease for people who play in saltwater by:

Monitoring bacteria levels at popular, high risk beaches.

Notifying users when bacteria results are high.

Educating the public about risks associated with pollution and what we can do to reduce the risks.

Contact with fecal bacteria contaminated waters can result in gastroenteritis, skin rashes, upper respiratory infections, and other illnesses. The Washington BEACH Program is led jointly by the Washington State Department of Ecology and Department of Health. Our BEACH partners include county and local health jurisdictions, Tribes, and volunteers.

The BEACH program 11-17-2014

Surf the web before you surf the beach!

Stay updated about water quality at your beaches by keeping up with us on:

Fecal Matters Blog: http://ecologywa.blogspot.com/search/label/Fecal%20matters

Facebook: https://www.facebook.com/WABEACH

Twitter: https://twitter.com/ecologywa

Find public beaches and info on beach closures:
https://fortress.wa.gov/ecy/coastalatlas/










Keeping Washington beaches healthy -- we're all in this together!

Climate and natural influences before 11-17-2014

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:

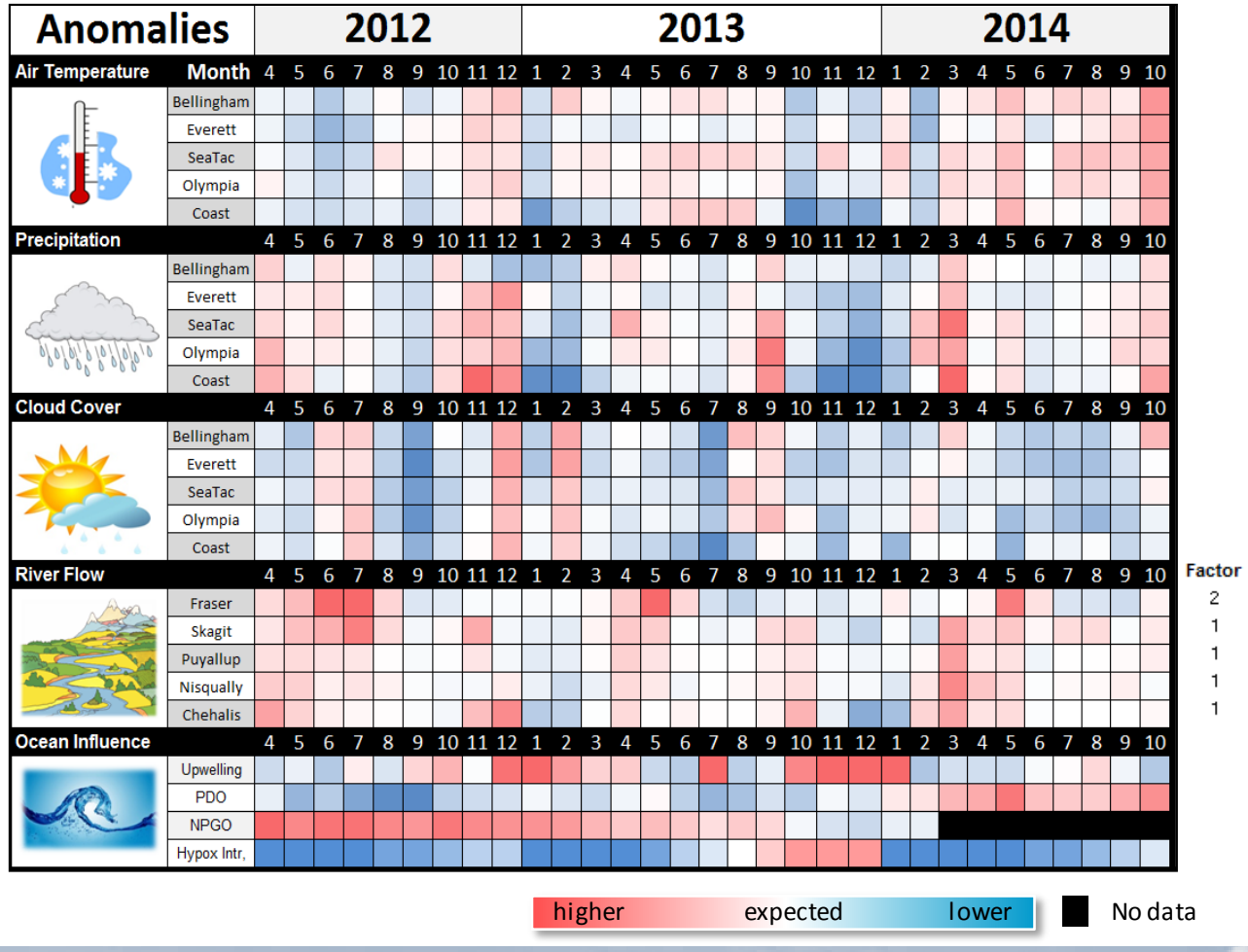
Air temperatures continue an 8-month trend, though a recent cold period introduces cold dense air into the Puget Sound lowlands.

Precipitation levels have been above normal, but nil during the past week as temperatures dropped.

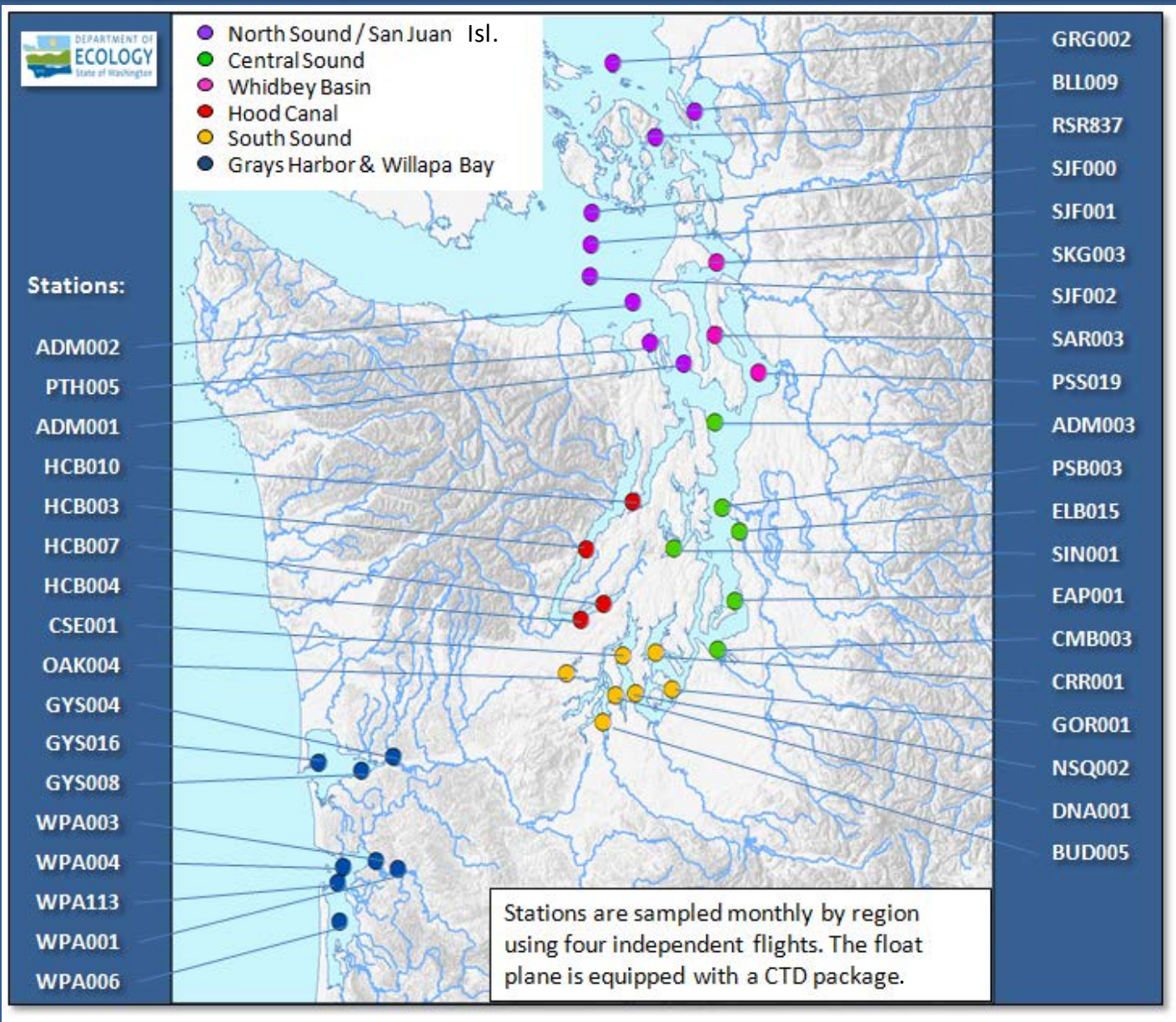
Cloud Cover has been near normal.

River flows are beginning to climb above normal across the region.

PDO remains in the warm phase, and **upwelling** is below normal.



Our long-term marine monitoring stations in Washington



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

Start here

We communicate data and environmental marine conditions using:

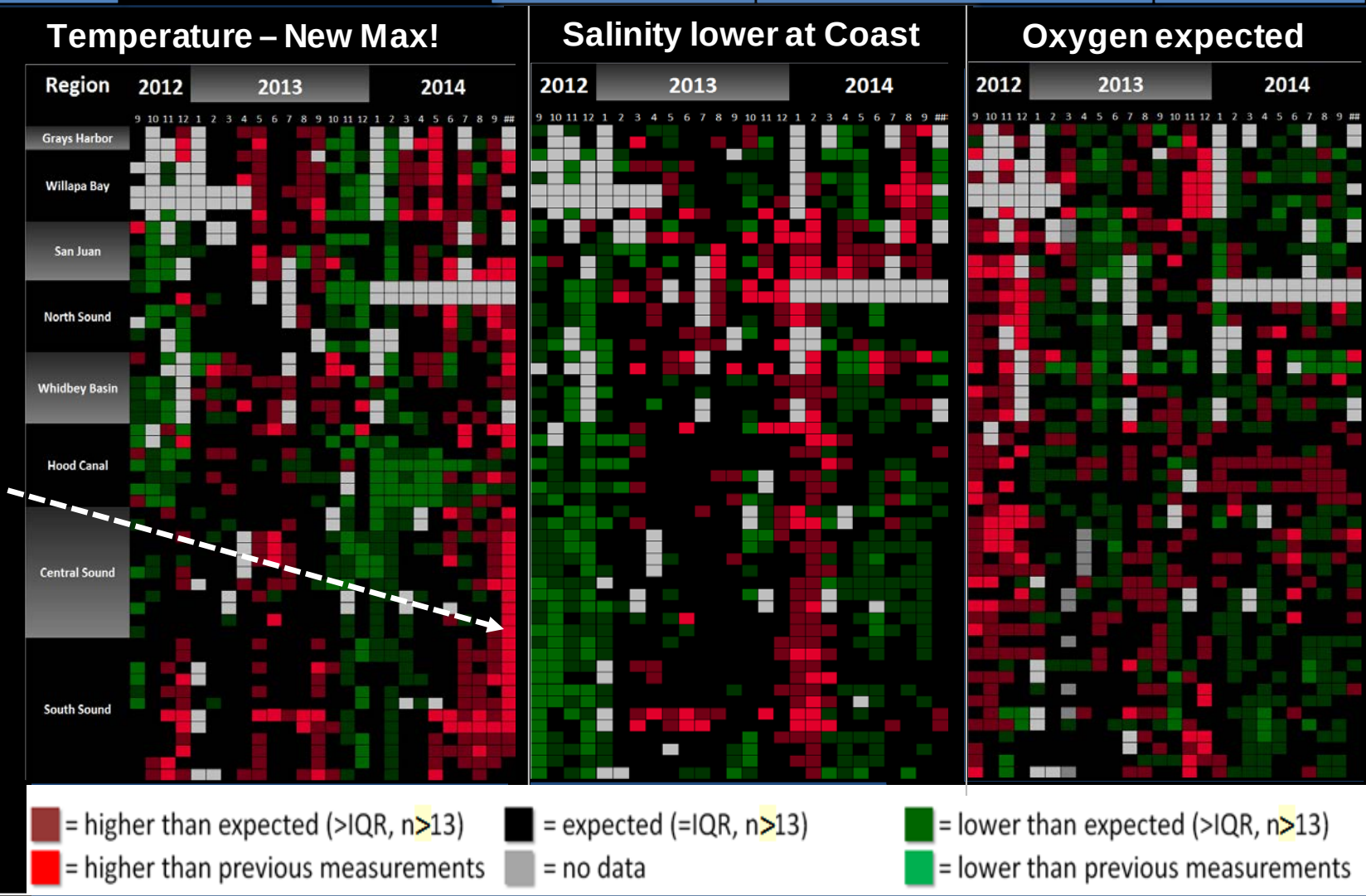
1. **Marine Water Condition Index (MWCI)**
2. **Eyes Over Puget Sound (EOPS)**
3. **Anomalies and source data**

Physical conditions tracked in statistically historic context

Oct. 2014:

Red boxes show that the water measured in October is warmer than any of our measurements since 1999

[Explore profiles at all stations]



Puget Sound is a lot warmer at the end of 2014 with new max temps observed throughout the Sound! Early 2014 started colder and saltier with lower oxygen, then became fresher and warmer. Salinity is within expected ranges and dissolved oxygen are variable throughout the regions. The higher DO anomaly in Hood Canal is disappearing.

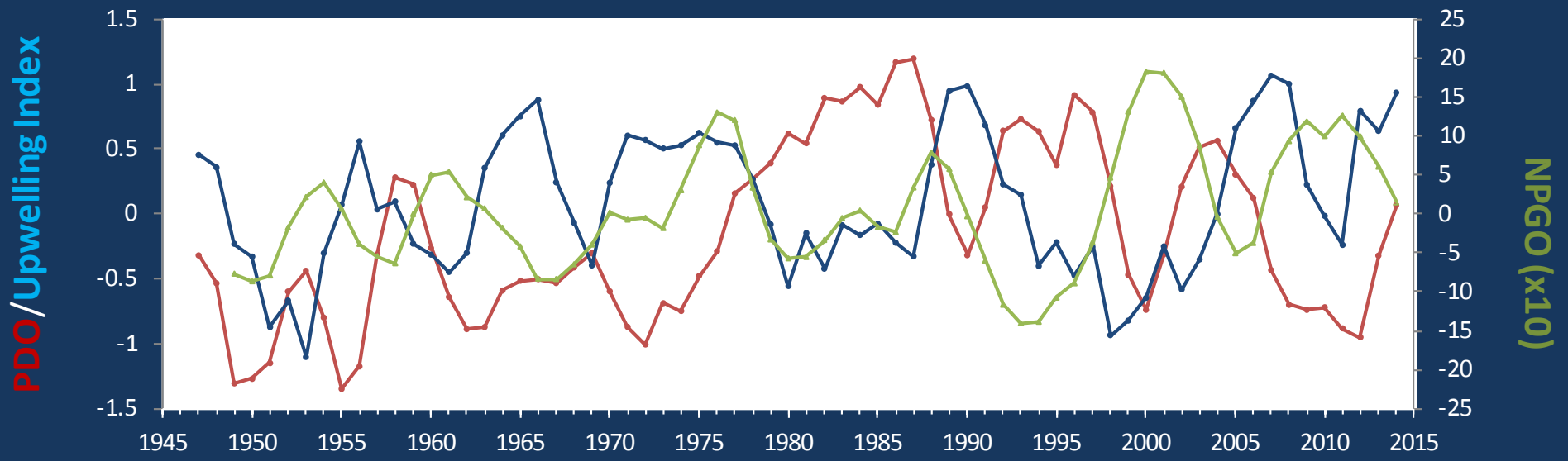
The ocean affects water quality: Ocean Climate Indices

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

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

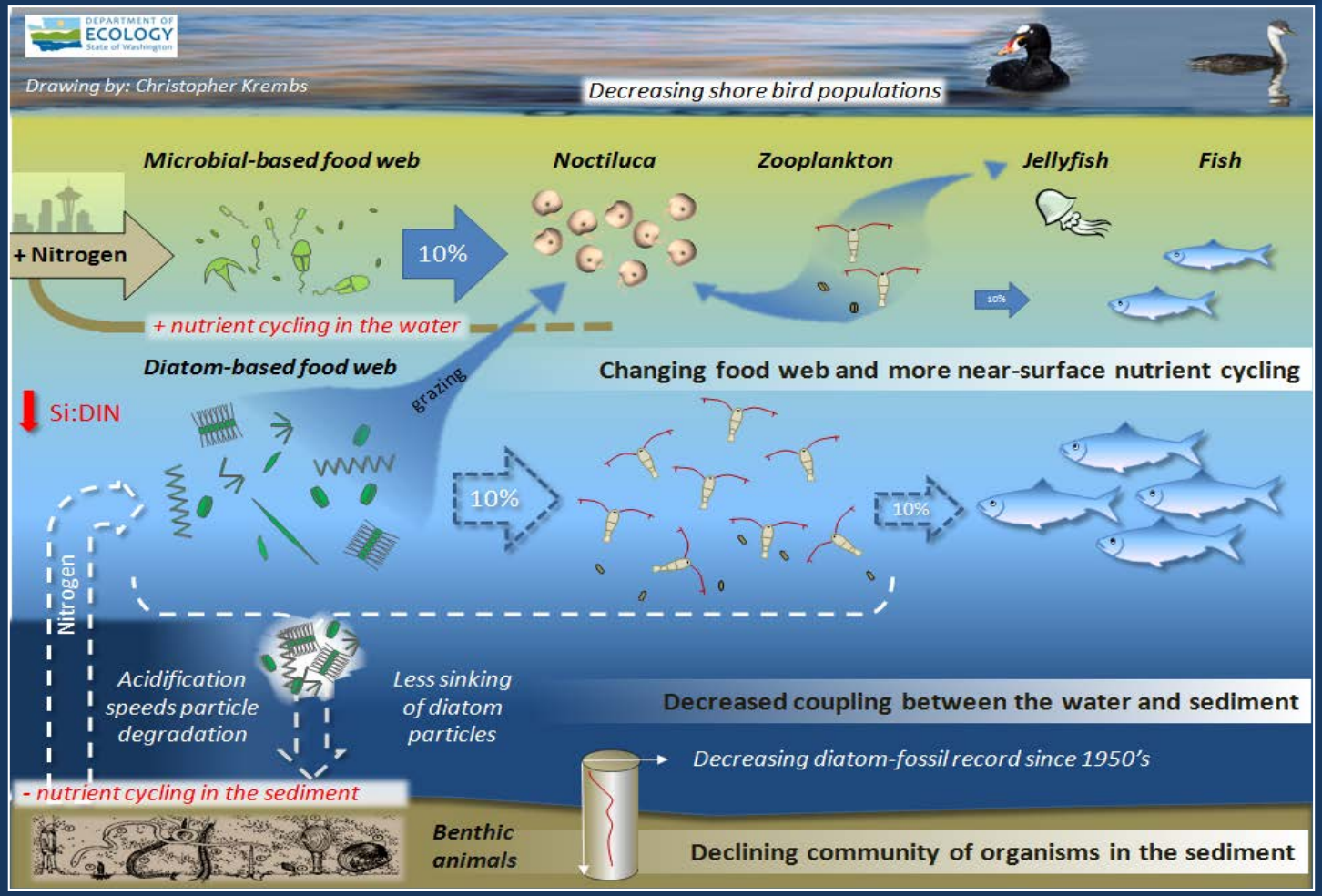
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* (explanation)

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 11-17-2014

Abundant patches of jellyfish seen in finger inlets of South Sound. Red-brown blooms remain strong in smaller bays of South Sound and coincide with jellyfish. A localized bloom seen off Tokeland. Suspended sediment increasingly visible as a result of increased rain, wind, and waves.

Start here

Mudflats near Smith Creek, Willapa Bay

Beautiful Niaviakum River, Willapa Bay

Front

Mixing and Fronts: 5 7 8 9 10 12

Developed tidal fronts and mixing visible by colored surface water. Very pronounced in Grays Harbor.

Jellyfish: 1 2 19 20 Click on numbers

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

Plume

Suspended sediment: 4 5 6 8 9 10 13 14 15 17

As a result of recent precipitation, many river influenced areas show large sediment plumes. Strong winds, tidal currents, and dredging affect sediment re-suspension regionally and locally.

Bloom

Visible blooms: 1 2 12 17 19 20

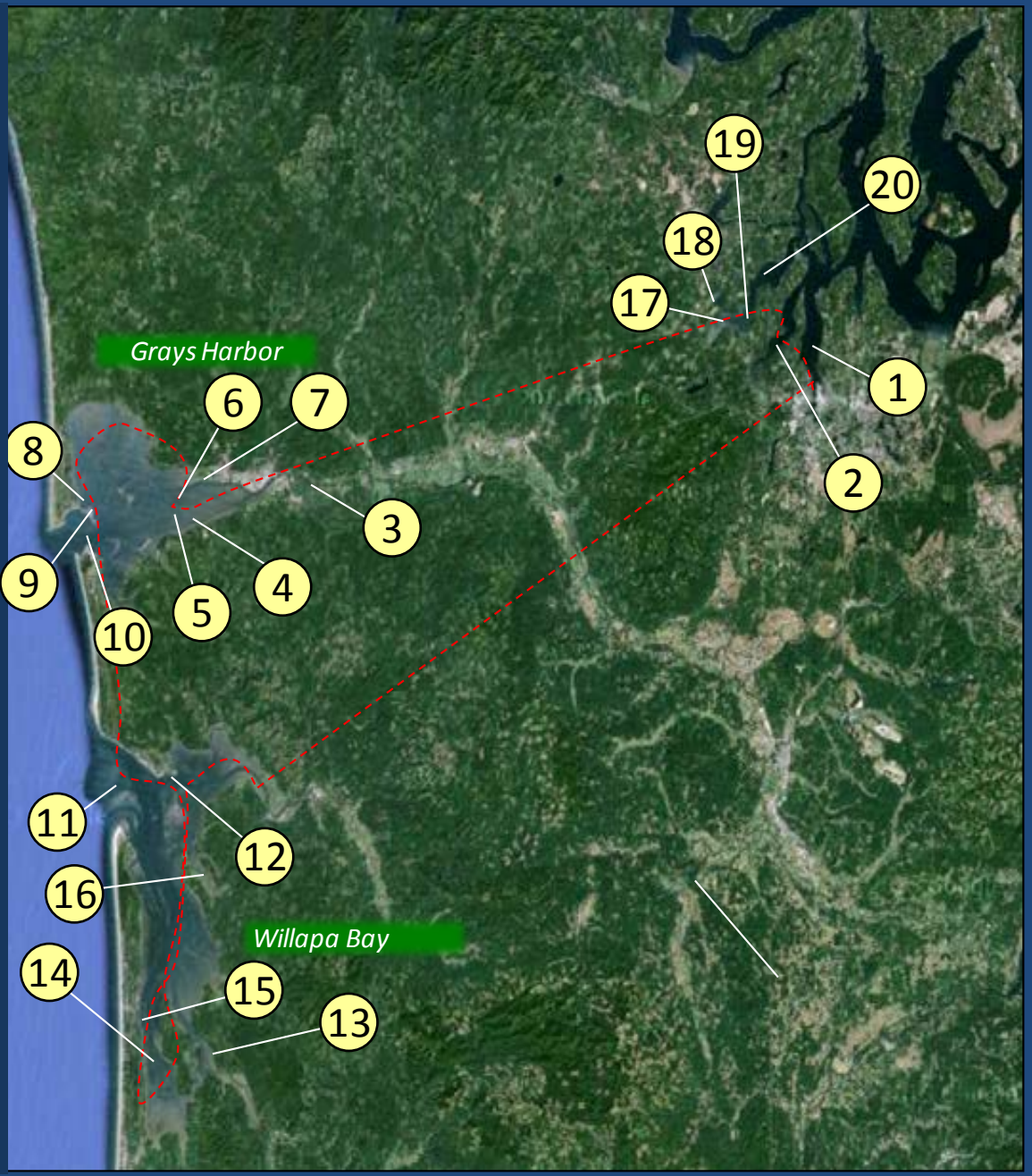
Red-brown: Southern finger inlets of South Sound and very localized near Kindred Island, Willapa Bay.

Debris

Debris: 2 3 5 7 10 11 12 13 14 17 18 20

Organic debris and foam forming in patches near mudflats, river plumes, and tidal fronts as a result of stronger winds and higher river flows.

Seattle Tides: H. tide: 1:15 AM 12:58 PM, , L. tide: 6:29 AM, 8:00 PM



Aerial photography and navigation guide

Date: 11-17-2014

Click on numbers

Flight Information:

Morning flight, photos 1-12
Sunny, cold, high visibility

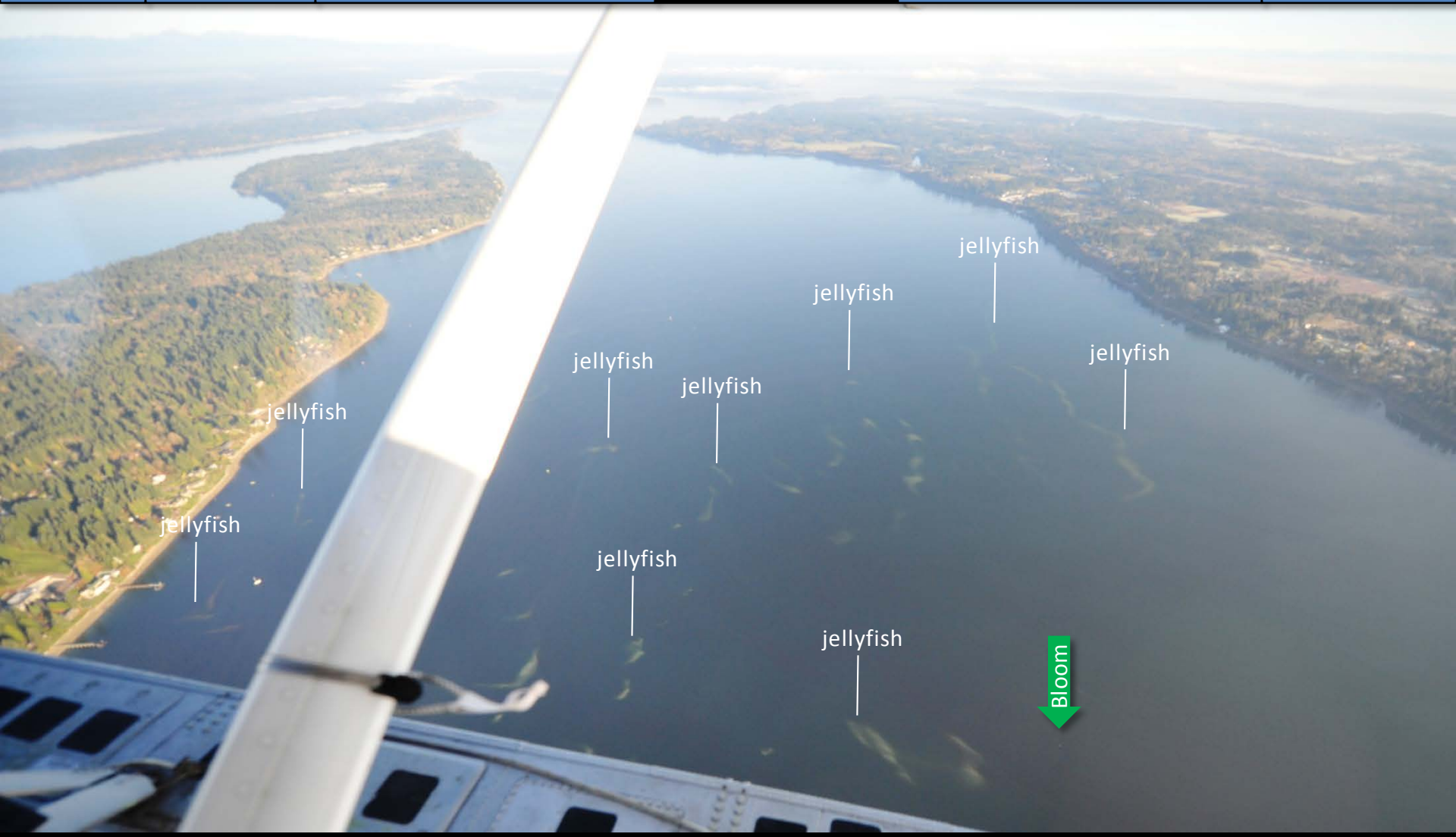
Afternoon flight, photos 13-20:
Sunny, cold, winds increasing

Flight route and fueling stop

Observation Maps:

Coast

South Sound



Numerous jellyfish smacks with underlying red-brown bloom.

Location: Off Little Tykle Cove, Budd Inlet (South Sound), 9:25 AM.

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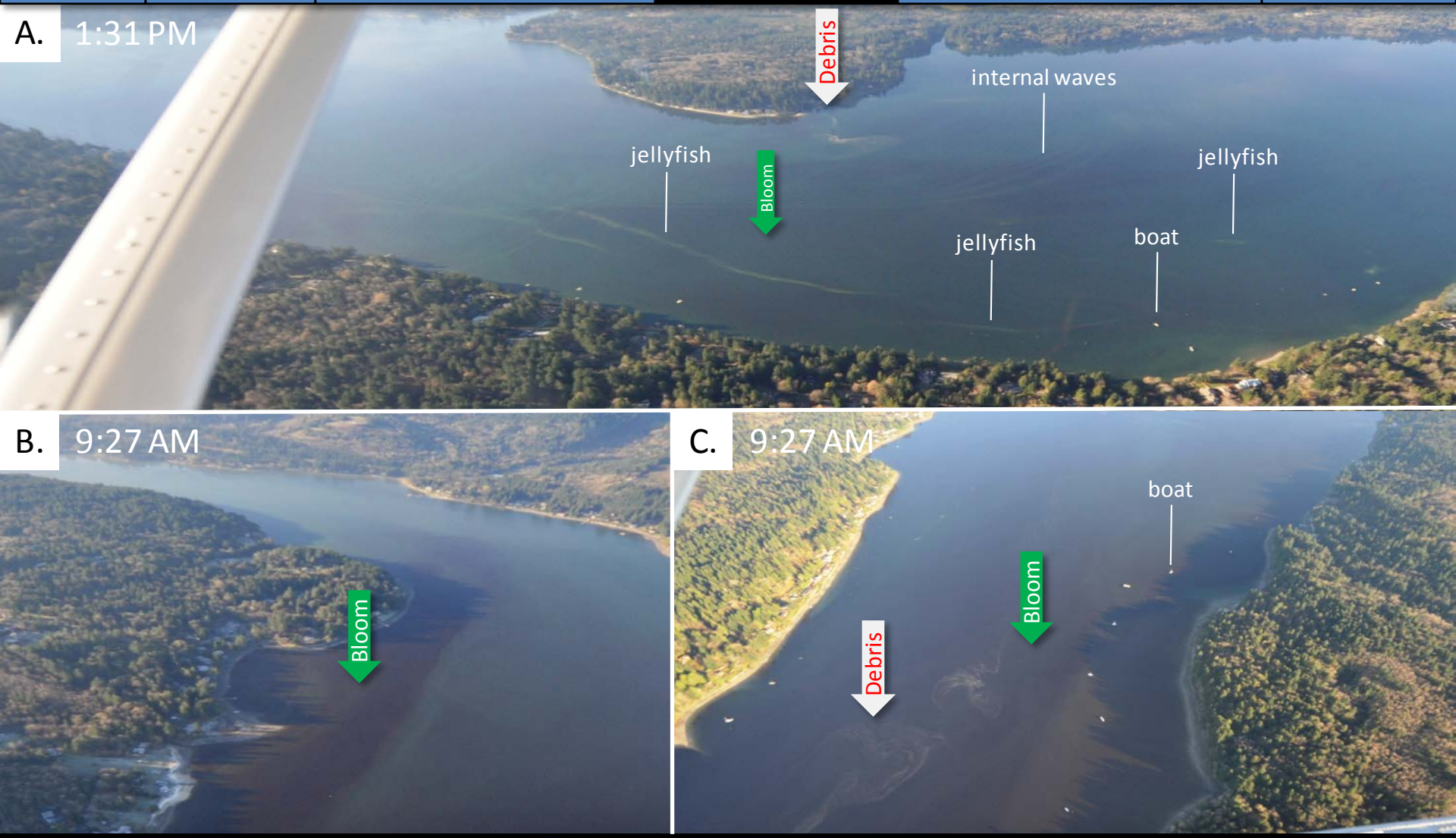
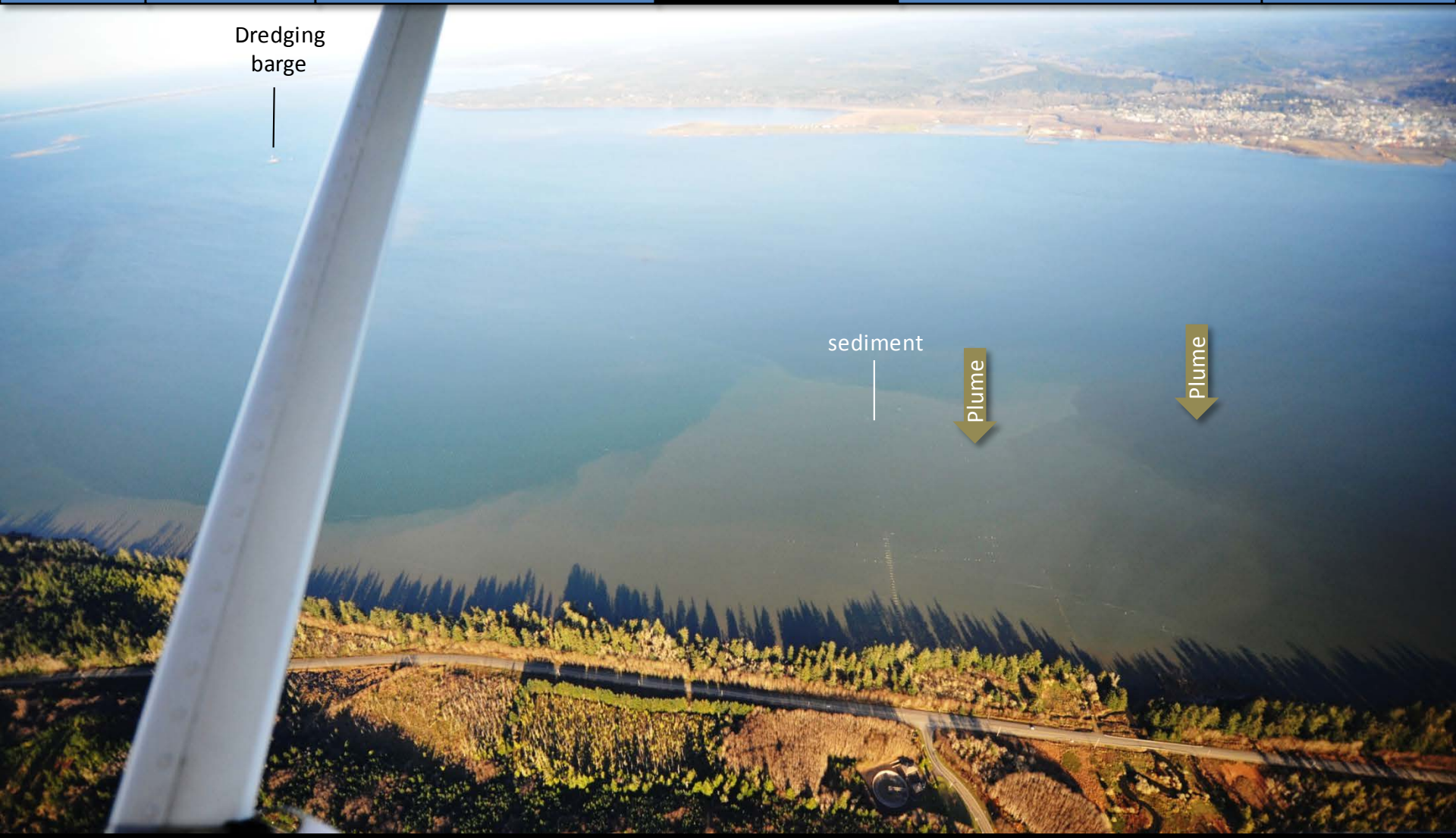
Aerial photography 11-17-2014



Red-brown bloom, organic debris, jellyfish smacks, and edge of river plume with internal waves.
Location: A. Flapjack Point, B. Shell Point, C. Snyder Cove, Eld Inlet (South Sound).

Long organic debris line in Chehalis River.
Location: Cosmopolis (Grays Harbor), 9:51 AM.



Sediment-rich river plume hugging the southern shoreline of Grays Harbor and Chehalis River water.
Location: Off Stafford Creek (Grays Harbor), 11:18 AM.

Fronts where Chehalis River and local sediment-rich river waters meet marine water.

Location: Off O'Leary Creek, south channel (Grays Harbor), 9:55 AM.

Suspended sediments from dredging.

Location: Between North and South Channel, (Grays Harbor), 9:56 AM.

Front where Chehalis River water meets Grays Harbor water.

Location: North Channel, off airport (Grays Harbor), 11:33 AM.

Dark humic-rich water entering bay and locally mixing with sediment-rich water.

Location: Armstrong Bay (Grays Harbor), 10:28 AM.

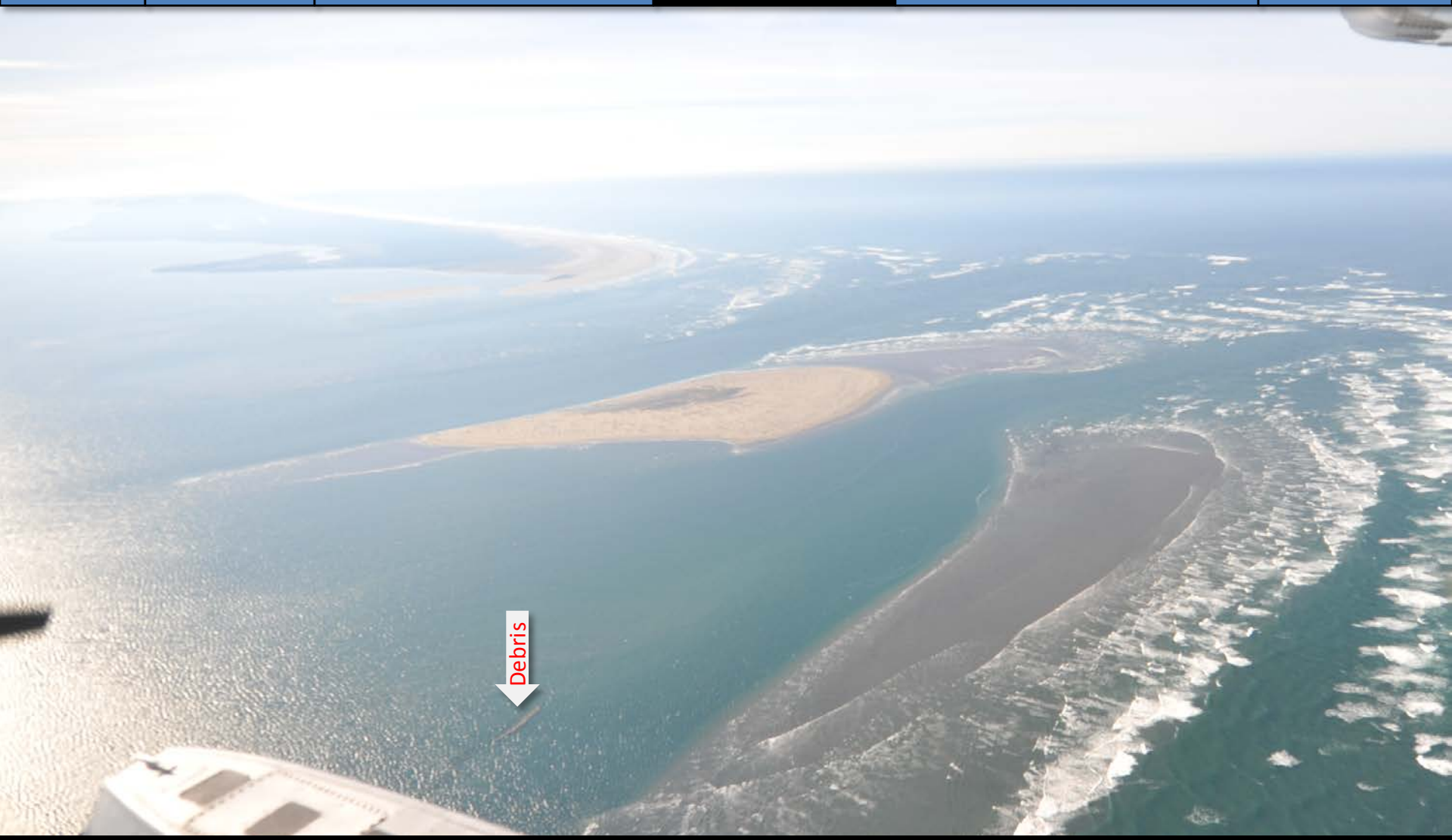
Suspended sediment from wave, tidal currents, and water from Armstrong Bay mix around the point.

Location: Damon Point (Grays Harbor), 10:30 AM.

Aerial photography 11-17-2014

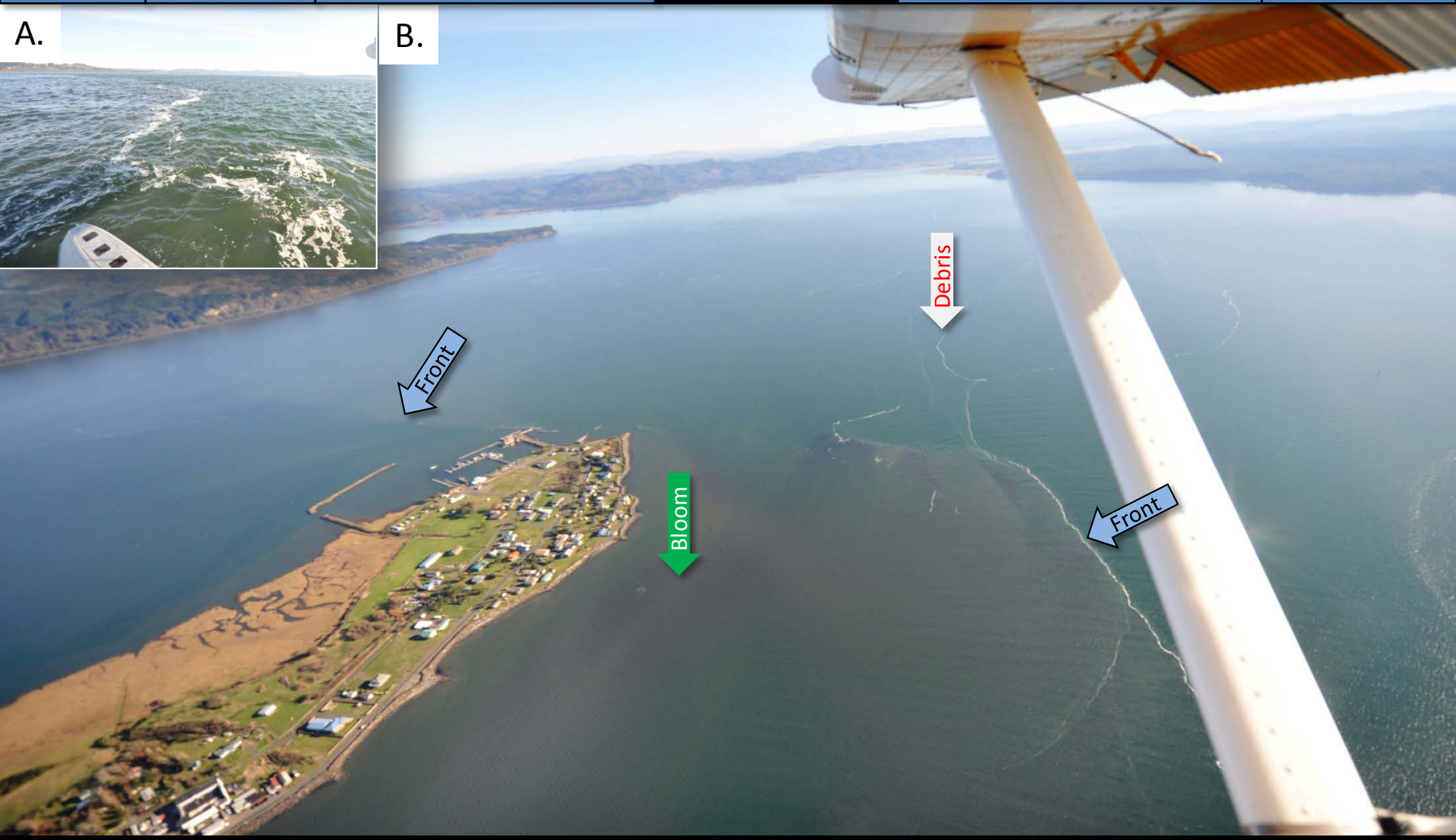
Surface water of different origins (South and North Bay) meeting at the entrance to Grays Harbor.
Location: Damon Point (Grays Harbor), 10:30 AM.

Aerial photography 11-17-2014



Large patch of organic debris near tidally exposed sandbars at the entrance to Willapa Bay.

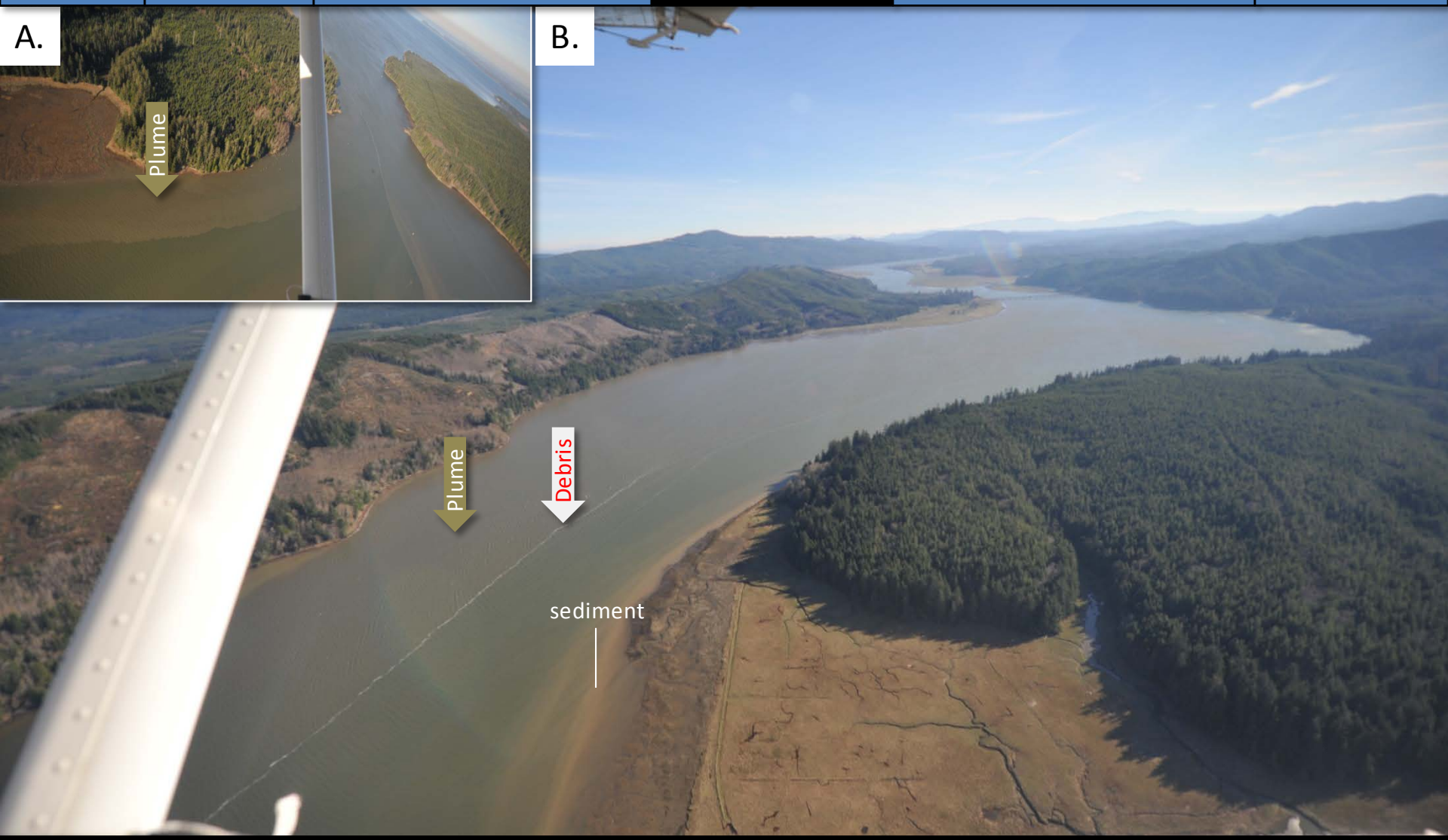
Location: Entrance to Willapa Bay (Willapa Bay), 10:39 PM.



Red-brown bloom mixed with local humic-rich, dark freshwater and organic debris along tide lines.

Location: A. On the water, B. Above Tokeland (Willapa Bay), 10:44 AM.

Aerial photography 11-17-2014



Suspended sediment and debris line along Naselle River plume blown by strong wind.

Location: A. Long Island Slough, B. Chetlo Harbor, Naselle River (Willapa Bay), 12:20 PM.

Water with increasing suspended sediment content towards Ocean Park as a result of southeasterly winds.

Location: Nahcotta Channel (Willapa Bay), 12:25 PM.

Aerial photography 11-17-2014

Sediment-rich water meeting dark humic-rich water of the Espy Slough.

Location: Off Port of Peninsula, Ocean Park (Willapa Bay), 12:26 PM.

Aerial photography 11-17-2014

Exposed mudflats where Palix and Niawiakum rivers meet.

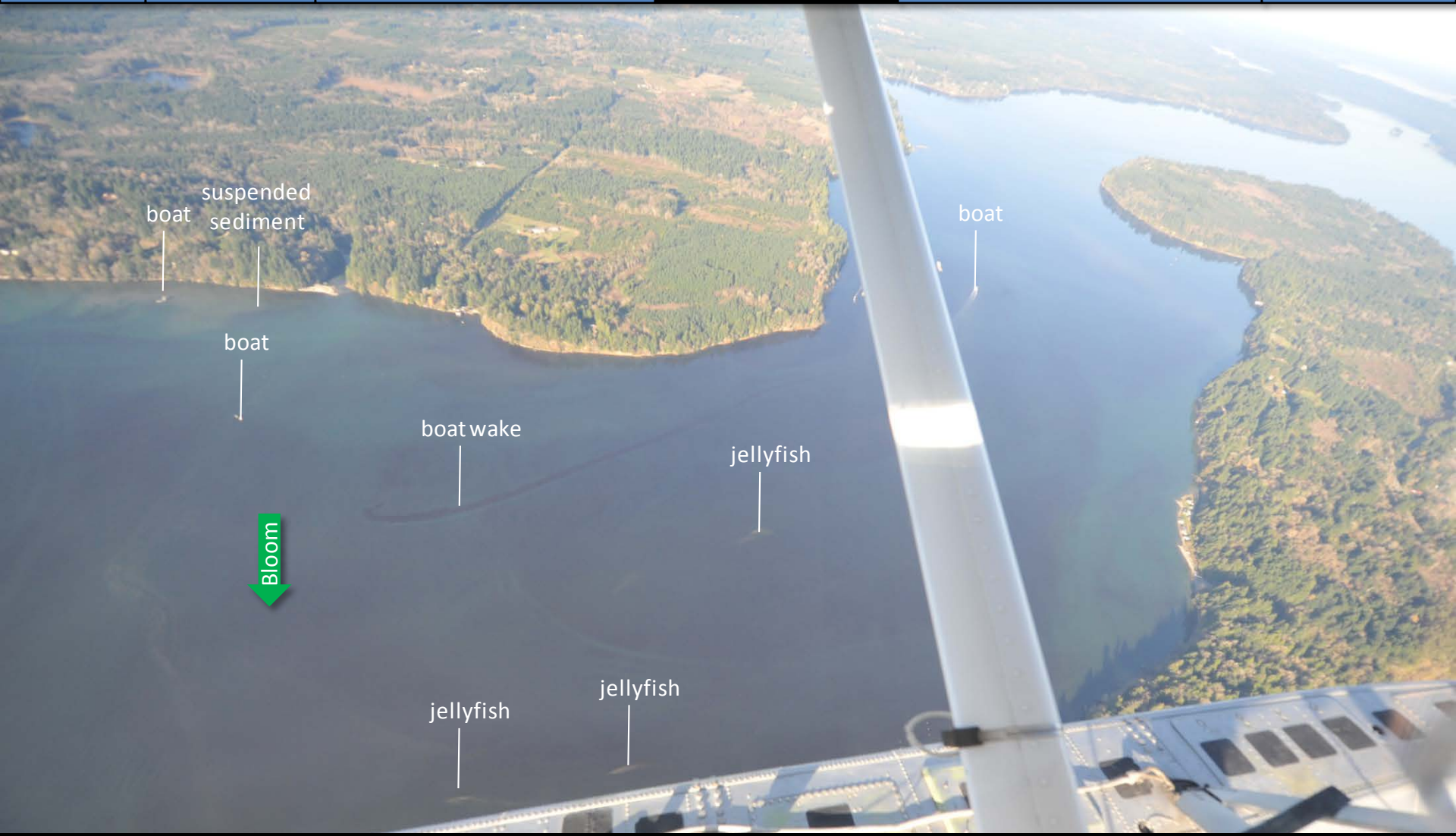
Location: Bay Center (Willapa Bay), 12:31 PM.

Red-brown bloom and water with suspended sediment meet at head of bay.

Location: Oyster Bay, Totten Inlet (South Sound), 1:25 PM.

Long organic debris line in tidally flooded head of bay.

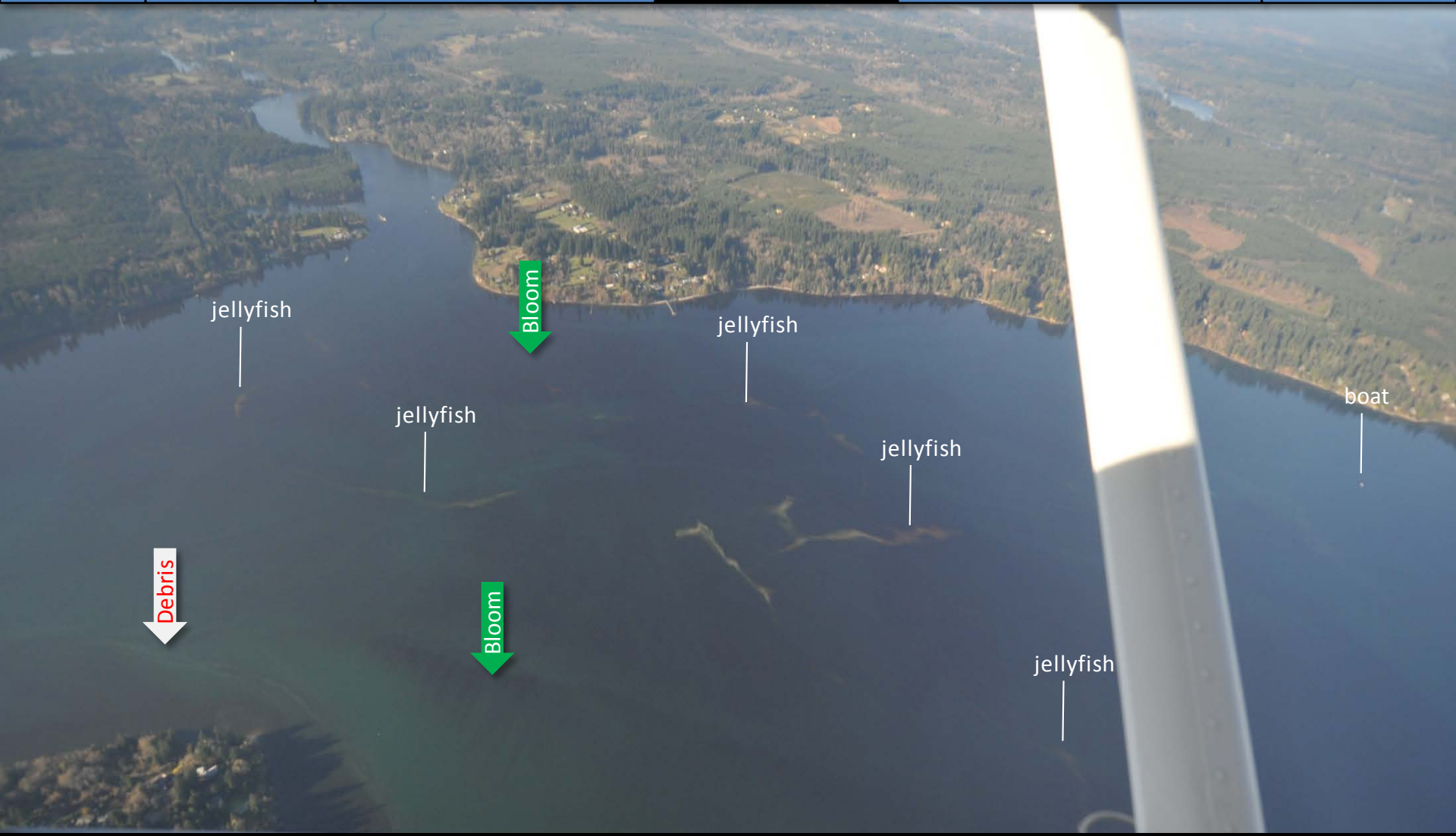
Location: Little Skookum Inlet, Eld Inlet (South Sound), 1:26 PM.



Red-brown bloom being stirred by motorboat. Jellyfish and suspended sediment from shellfish operations.

Location: Off Deepwater Point, Totten Inlet (South Sound), 1:25 PM.

Aerial photography 11-17-2014



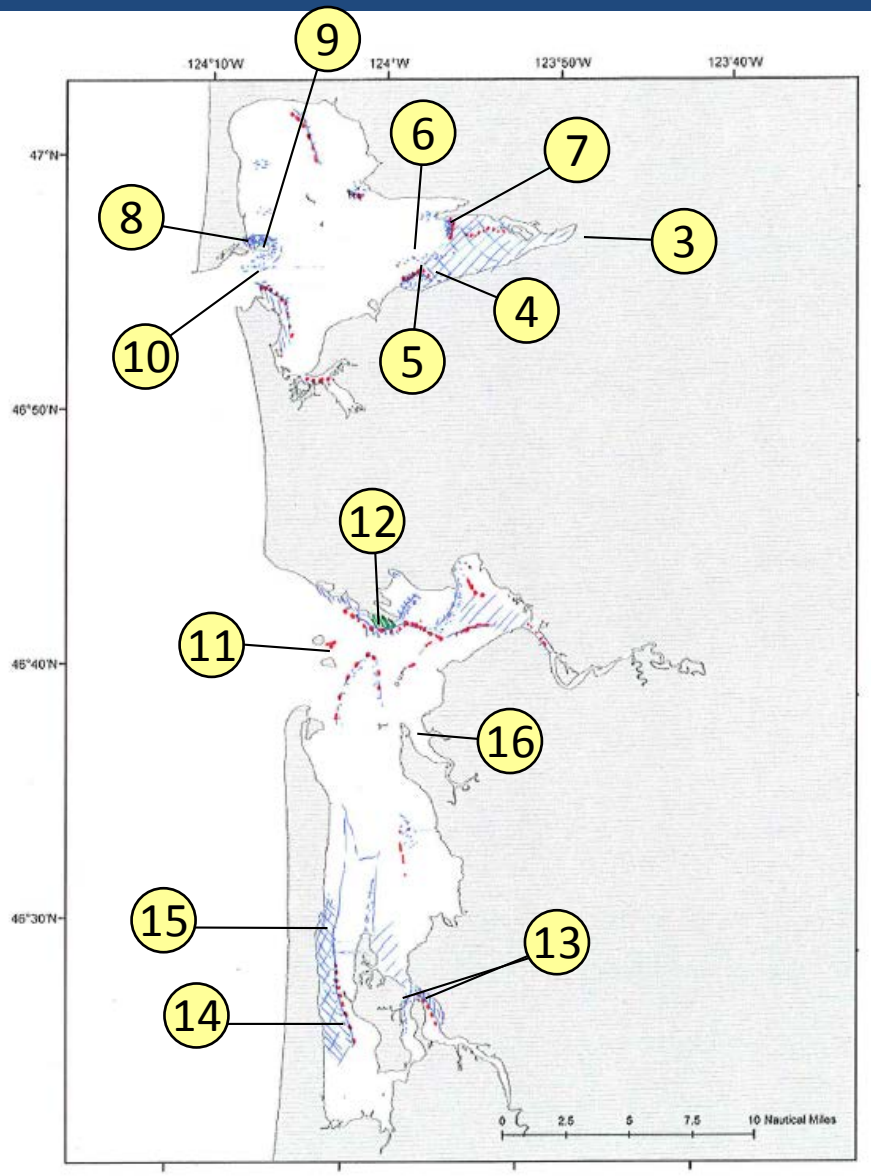
Large smacks of jellyfish, red-brown bloom, and turquoise water.

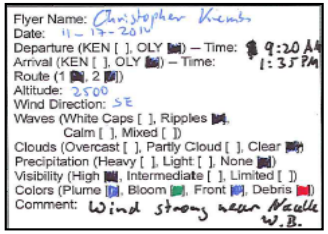
Location: Off Baron Point, Totten Inlet (South Sound), 1:29 PM.

DEPARTMENT OF ECOLOGY State of Washington

Observations in Central and North Sound

Navigate




Flyer Name: Christopher Krembs
Date: 11-17-2014
Departure (KEN [ ], OLY [x]) – Time: 9:20 AM
Arrival (KEN [ ], OLY [x]) – Time: 1:35 PM
Route (1 [x], 2 [ ])
Altitude: 2500
Wind Direction: SE
Waves (White Caps [ ], Ripples [x], Calm [ ], Mixed [ ])
Clouds (Overcast [ ], Partly Cloud [ ], Clear [x])
Precipitation (Heavy [ ], Light [ ], None [x])
Visibility (High [x], Intermediate [ ], Limited [ ])
Colors (Plume [x], Bloom [ ], Front [ ], Debris [ ])
Comment: Wind strong near Nacelle W.B.

Coast

Date: 11-17-2014

Numbers on map refer to picture numbers for spatial reference

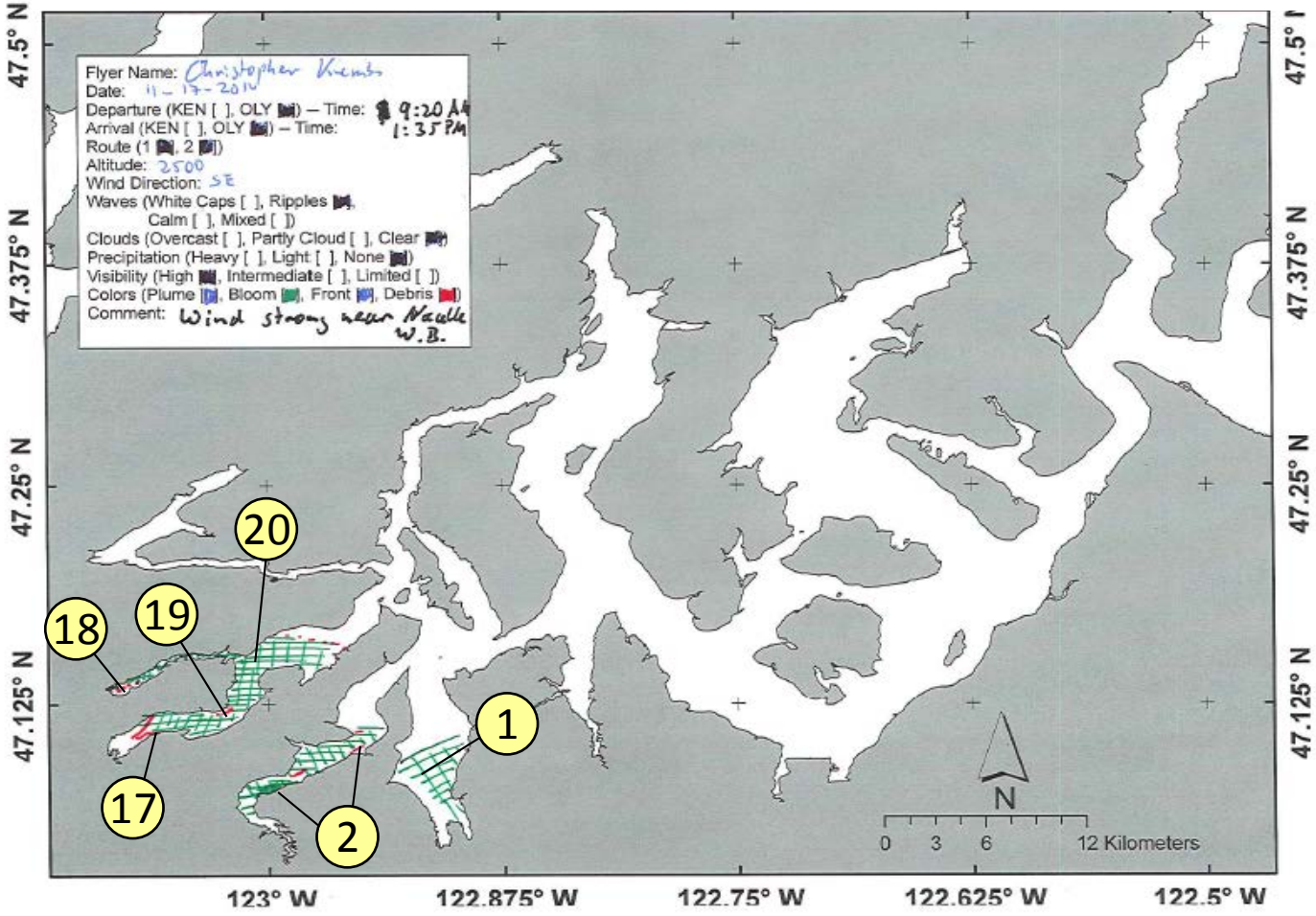
DEPARTMENT OF ECOLOGY State of Washington

Observations in Hood Canal and South Sound

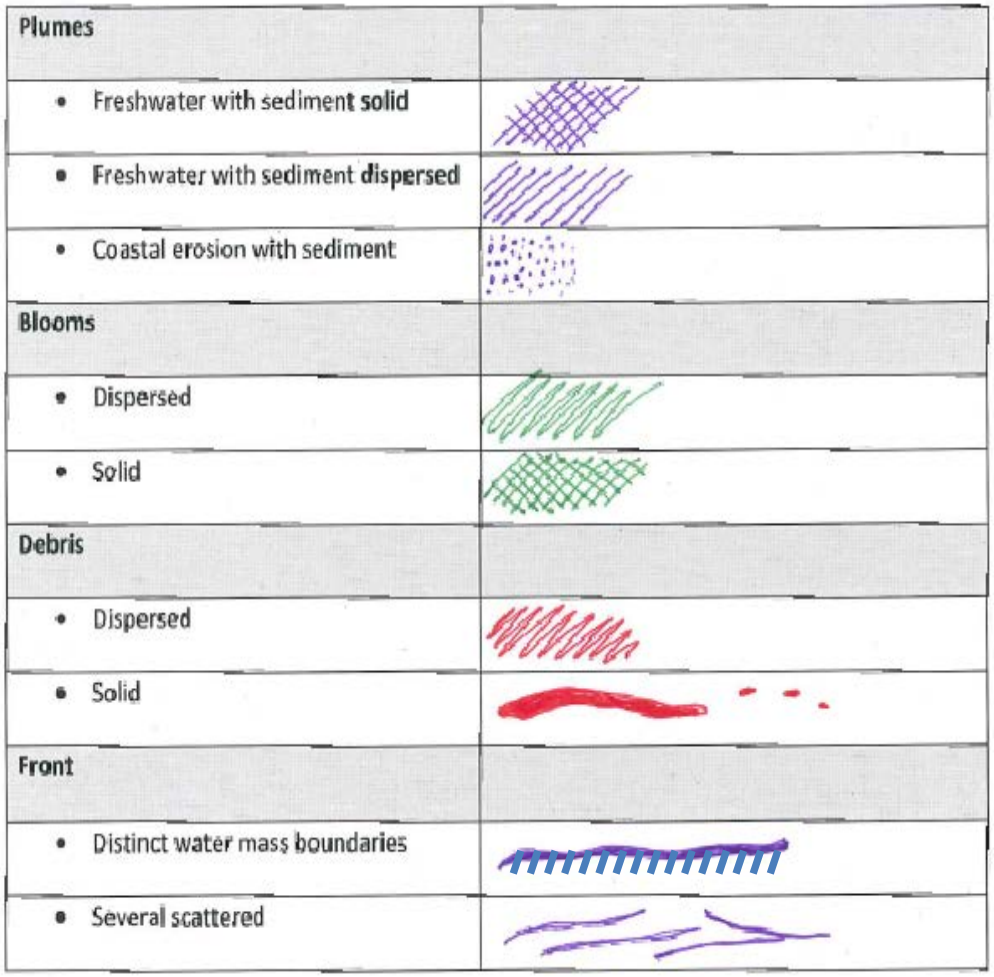
Navigate

Date: 11-17-2014

South Sound



Numbers on map refer to picture numbers for spatial reference

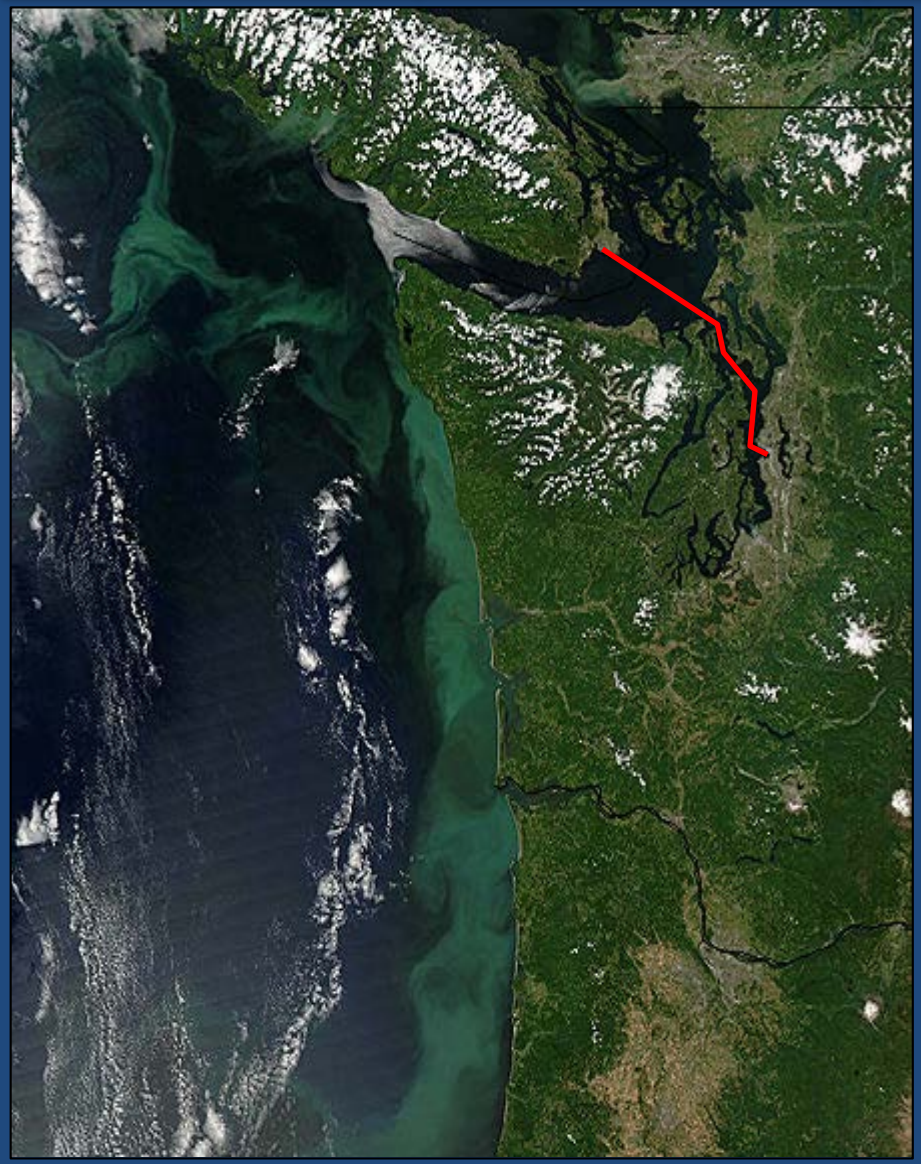


Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

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”.

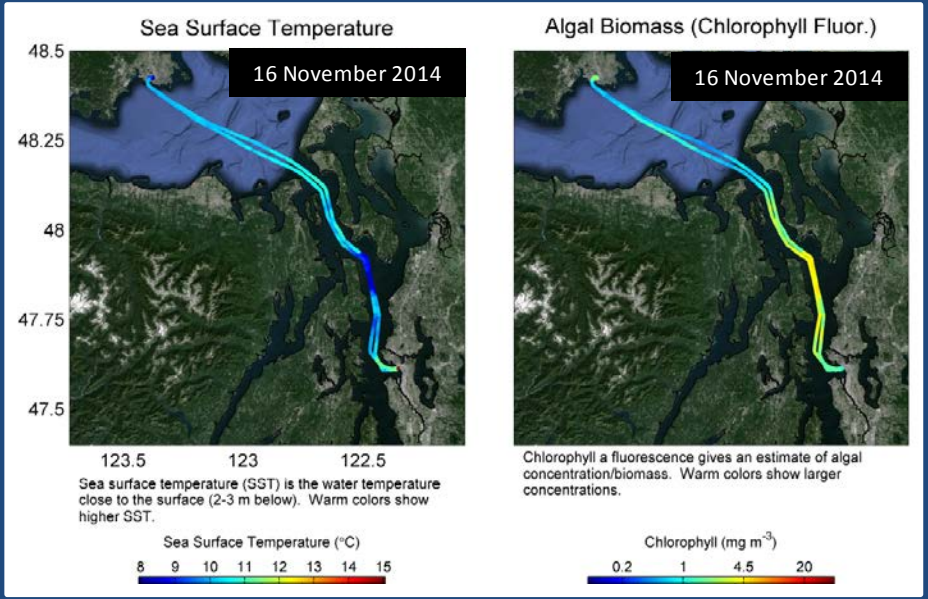
S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1): 83–88.

Ferry and satellite observations 11-17-2014



Brandon Sackmann
Contact: bsackmann@integral-corp.com

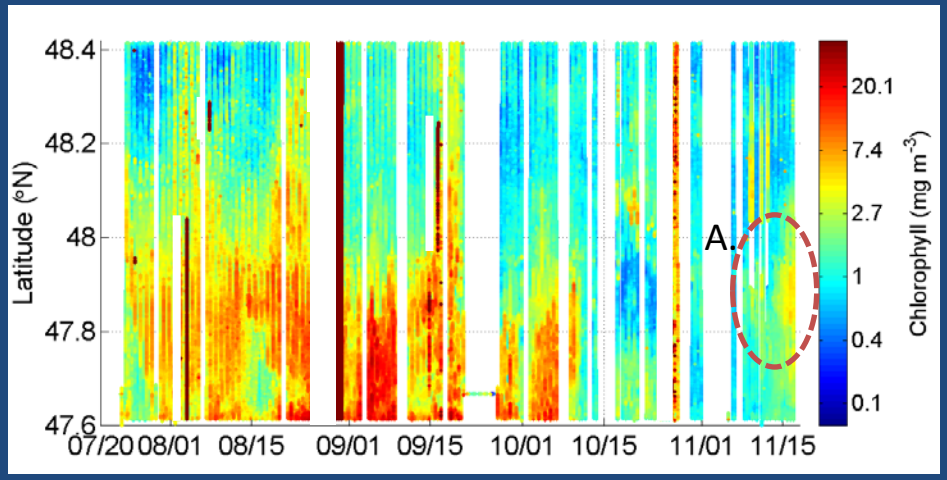
Start here

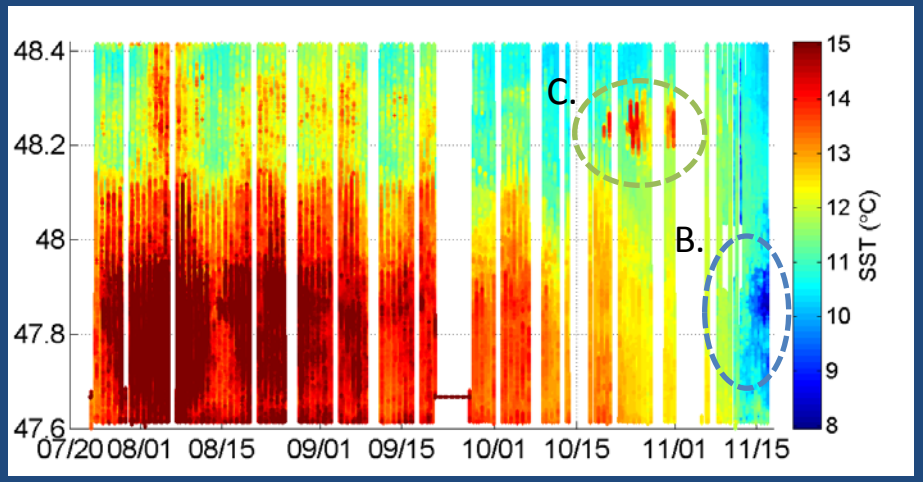


Current Conditions:

Cold water from Whidbey Basin moves into Puget Sound at the Triple Junction; associated with moderate levels of chlorophyll fluorescence. Increased turbidity seen throughout the Strait of Georgia.

Ferry and satellite observations 11-17-2014





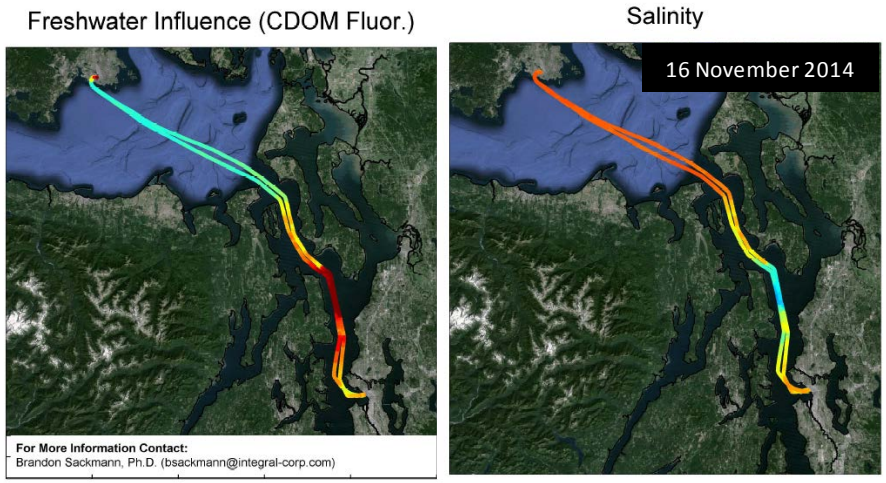
The *Victoria Clipper IV* carries sensors in its sea chest. The sensors allow us to get surface transects of temperature, chlorophyll, salinity, and other bio-optical measurements between Seattle and Victoria, BC twice per day.

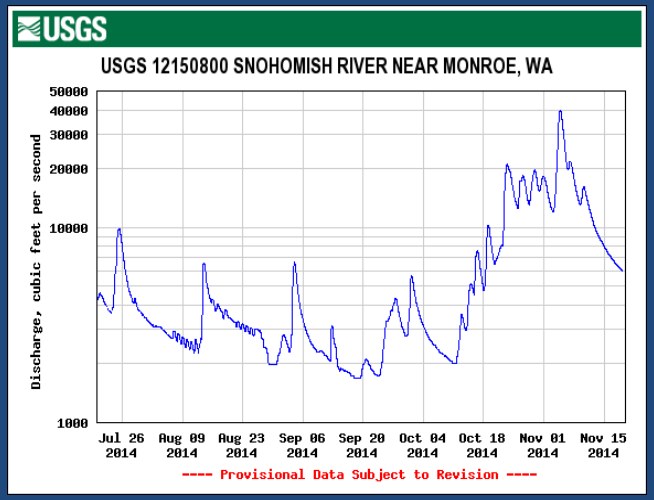
A. Colder water in Whidbey Basin enters Main Basin near Triple Junction (Edmonds , B.); associated with moderate levels of chlorophyll fluorescence A.

B. Cool sea surface temperatures (SST) throughout Puget Sound in November; falling below 11°C.

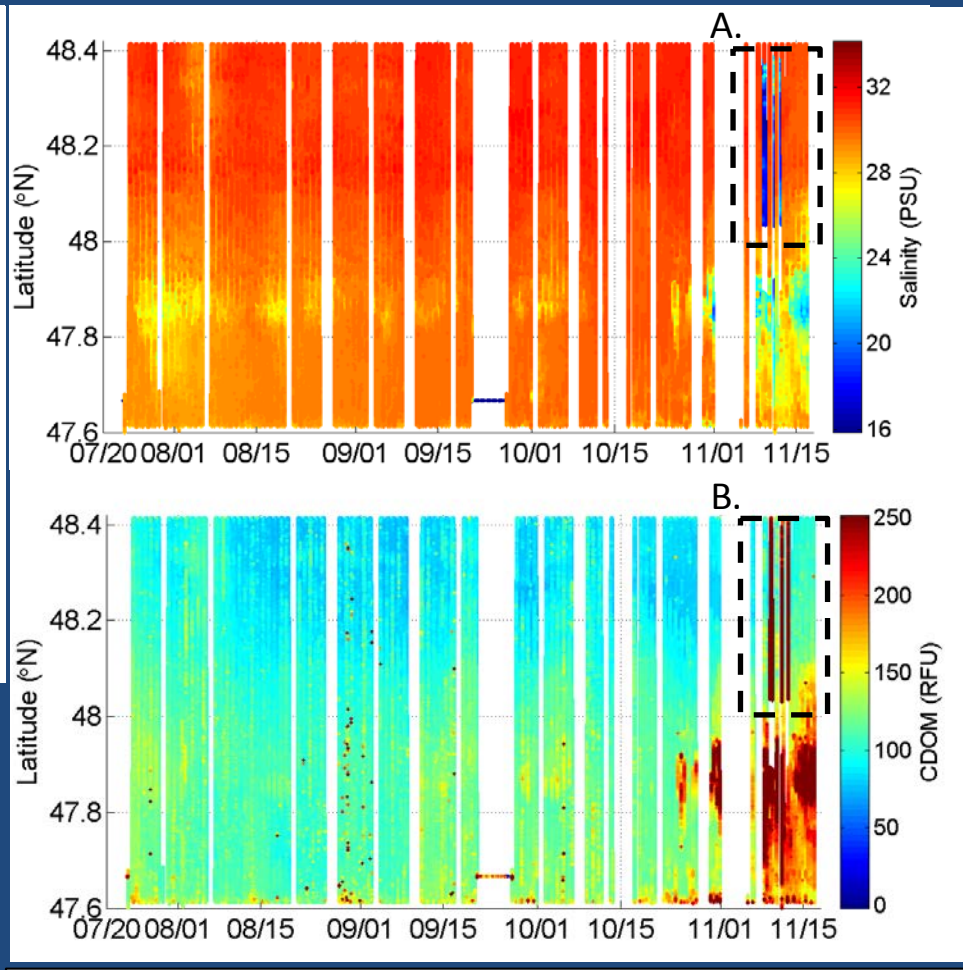
C. Warm temperature anomaly detected in the Strait of Juan de Fuca during the last half of October.

Ferry and satellite observations 11-17-2014



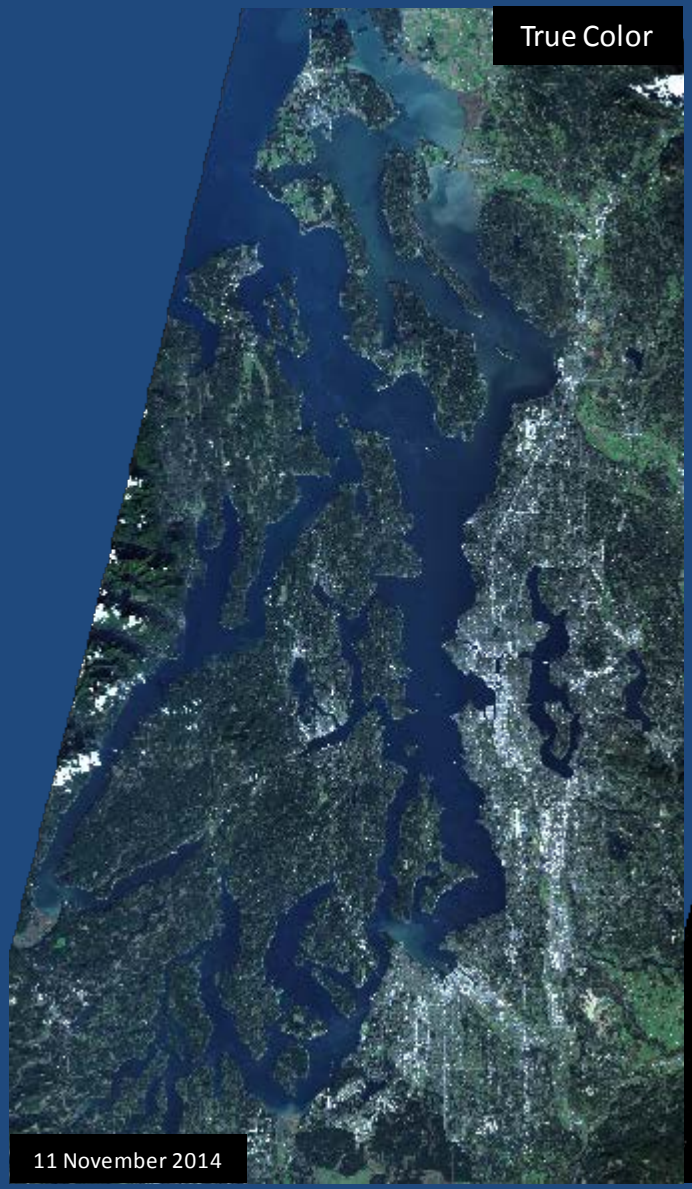


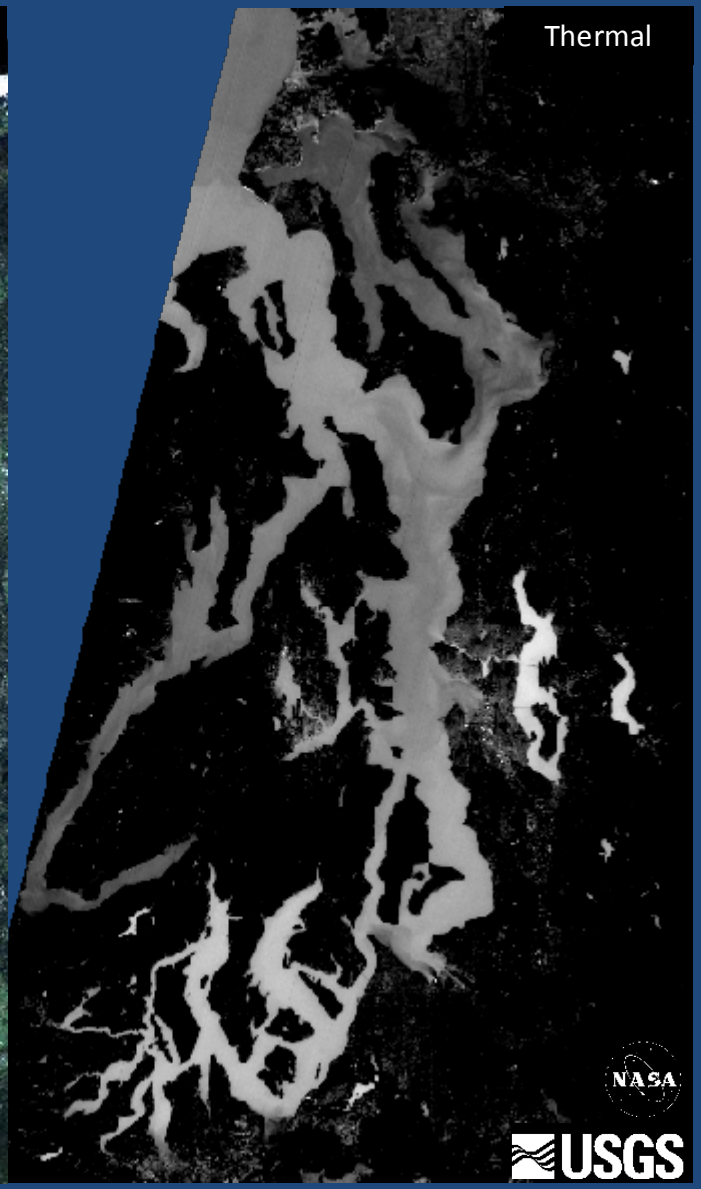
Increased river flows since 15 October are bringing in cold/fresh and highly colored water into Main Basin from Whidbey Basin.



Note in reference to figure above:
Data from alternate route through Whidbey Basin in early November results in: A. lower salinity and B. high colored dissolved organic material (CDOM).

Ferry and satellite observations 11-17-2014

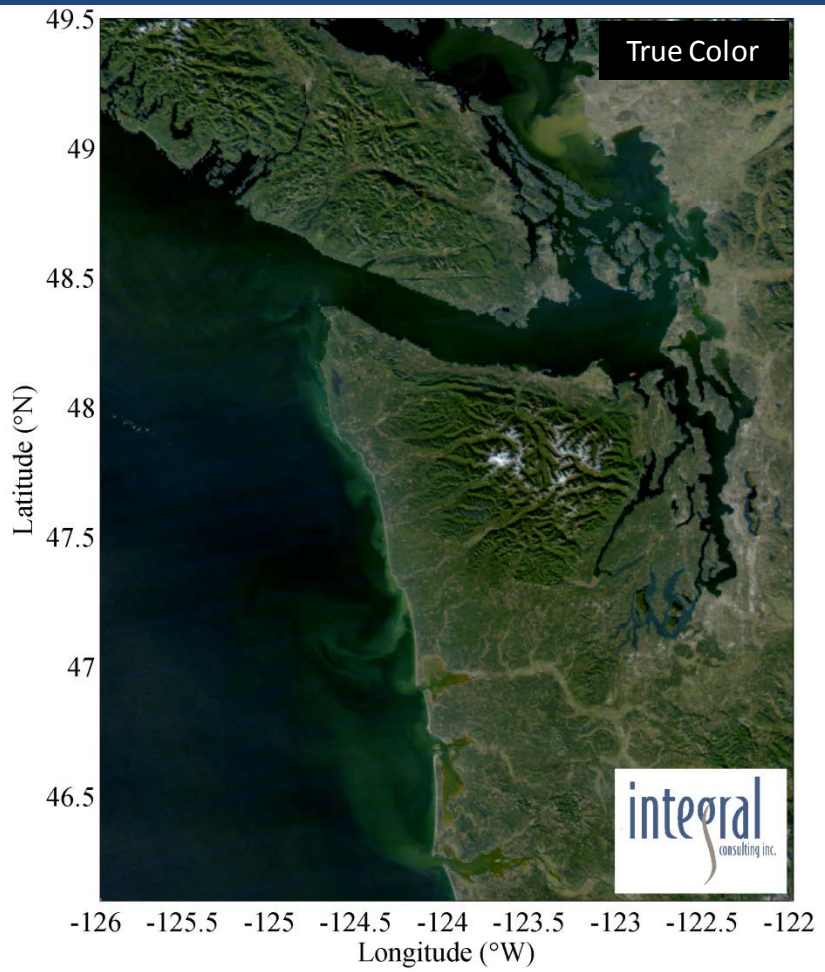


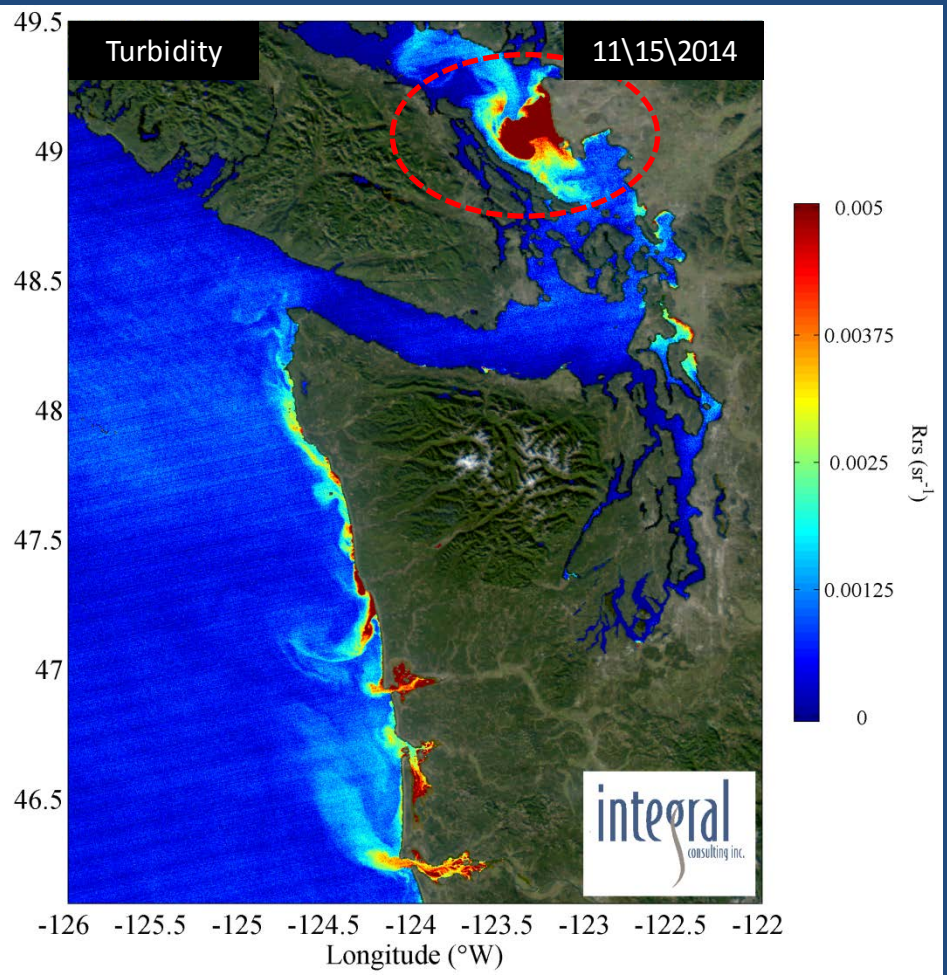


Thermal imagery from Landsat 8 shows warmer waters in South Puget Sound, Lake Washington, and Lake Sammamish.

Cooler waters in Whidbey Basin and southern end of Hood Canal.

Ferry and satellite observations 11-17-2014





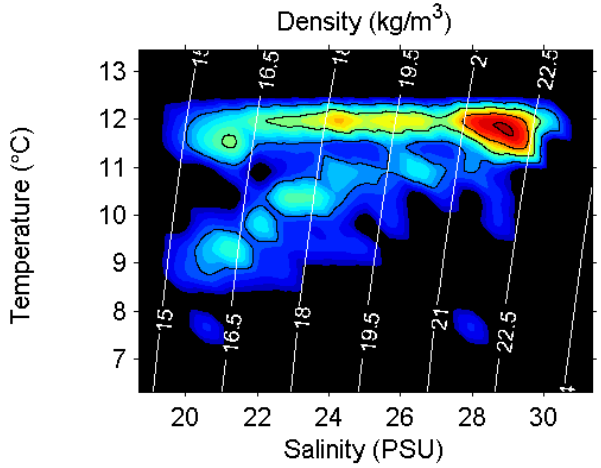
MODIS-Aqua imagery from 15 November show sediment transport off the coast of Washington and turbid waters throughout the Strait of Georgia.

Imagery obtained from NASA's OceanColor WEB, http://oceancolor.gsfc.nasa.gov/

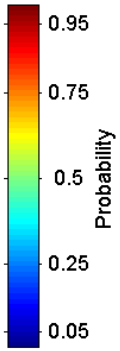
Mooring observations and trends 11-04-2014 to 11-17-2014

At Mukilteo, water temperature is decreasing for the winter and this accompanies reduced river flows of the past week. In the upper mooring, water mixing appears reduced to tidal influences. The deeper mooring detected more than one water mass. During the past month, an early November shift from SW storms to cold and dry weather influenced variability in salinity (see next slide).

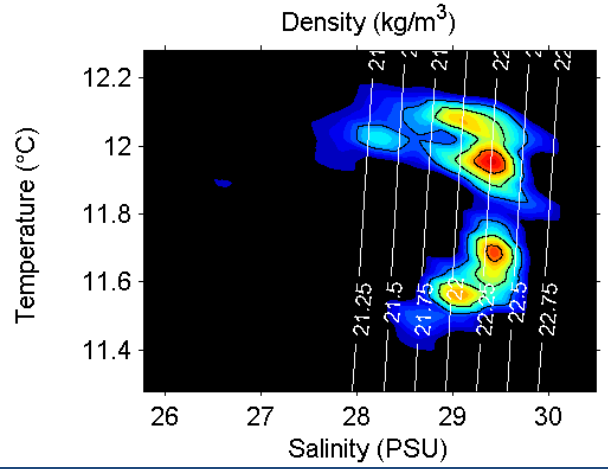
2-6 m depth

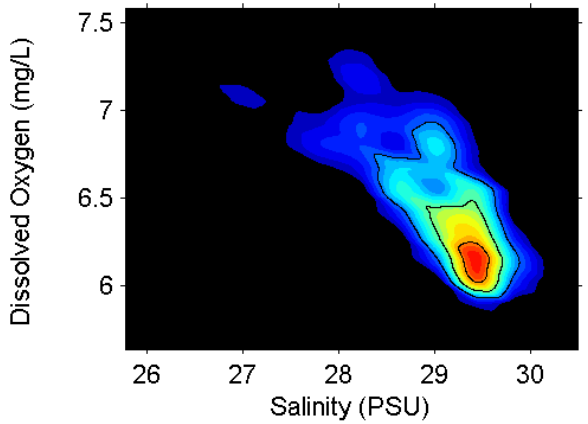


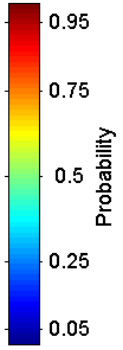
Dissolved oxygen not measured



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.

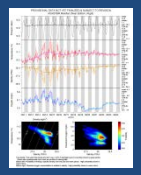
Mooring observations and trends 10-18-2014 to 11-17-2014

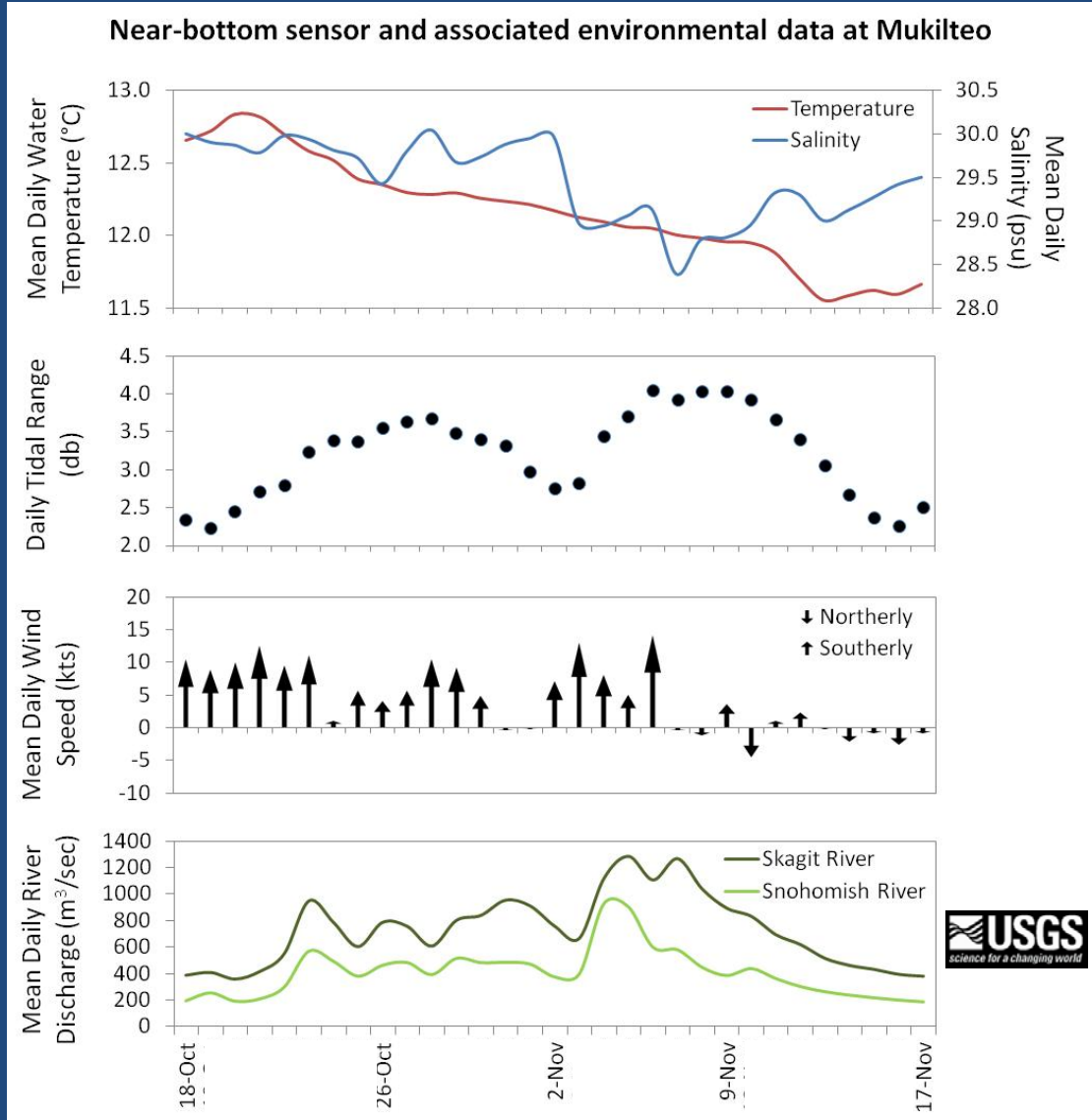
Our mooring station in Mukilteo is located in Whidbey Basin near Everett. It is also located at the transition between Possession and Central Sounds at a depth that is influenced by the Skagit and Snohomish river discharges, prevailing winds, and tidal mixing.

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

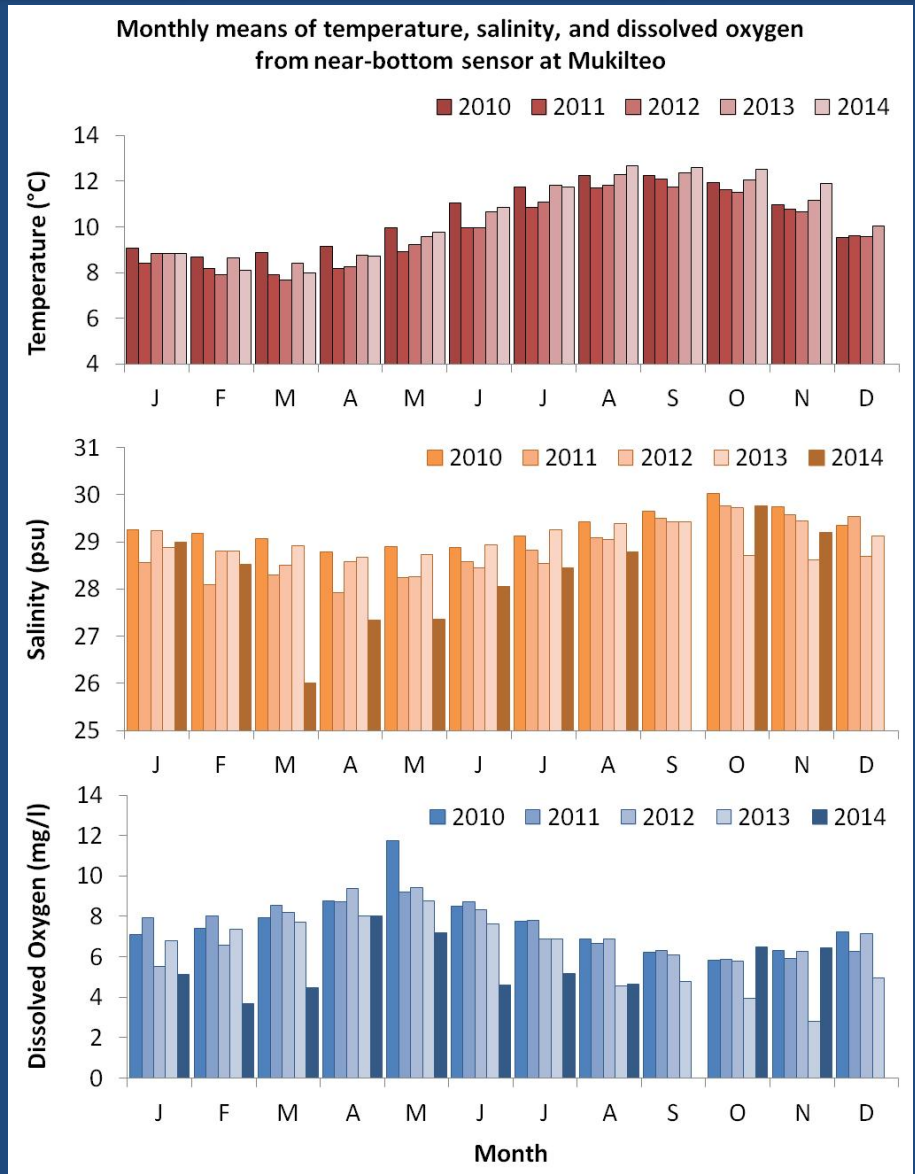
At the Mukilteo mooring, we use the near-bottom sensor (12-16 m deep) to measure significant inter-annual variability in temperature, salinity, and dissolved oxygen. This is typically near the pycnocline and the water with a high residence time in Whidbey Basin.

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

Since August, water temperature has been warmer than past years. In October and November, salinity is similar to or lower than past years and dissolved oxygen is higher than or similar to past years.

September 2014 data for salinity and oxygen are invalid after we found the sensor sitting on sediment; data were removed. A sensor performance verification indicated the dissolved oxygen sensor failed in early July and thus, dissolved oxygen data for July 2014 are from latter half of the month.

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



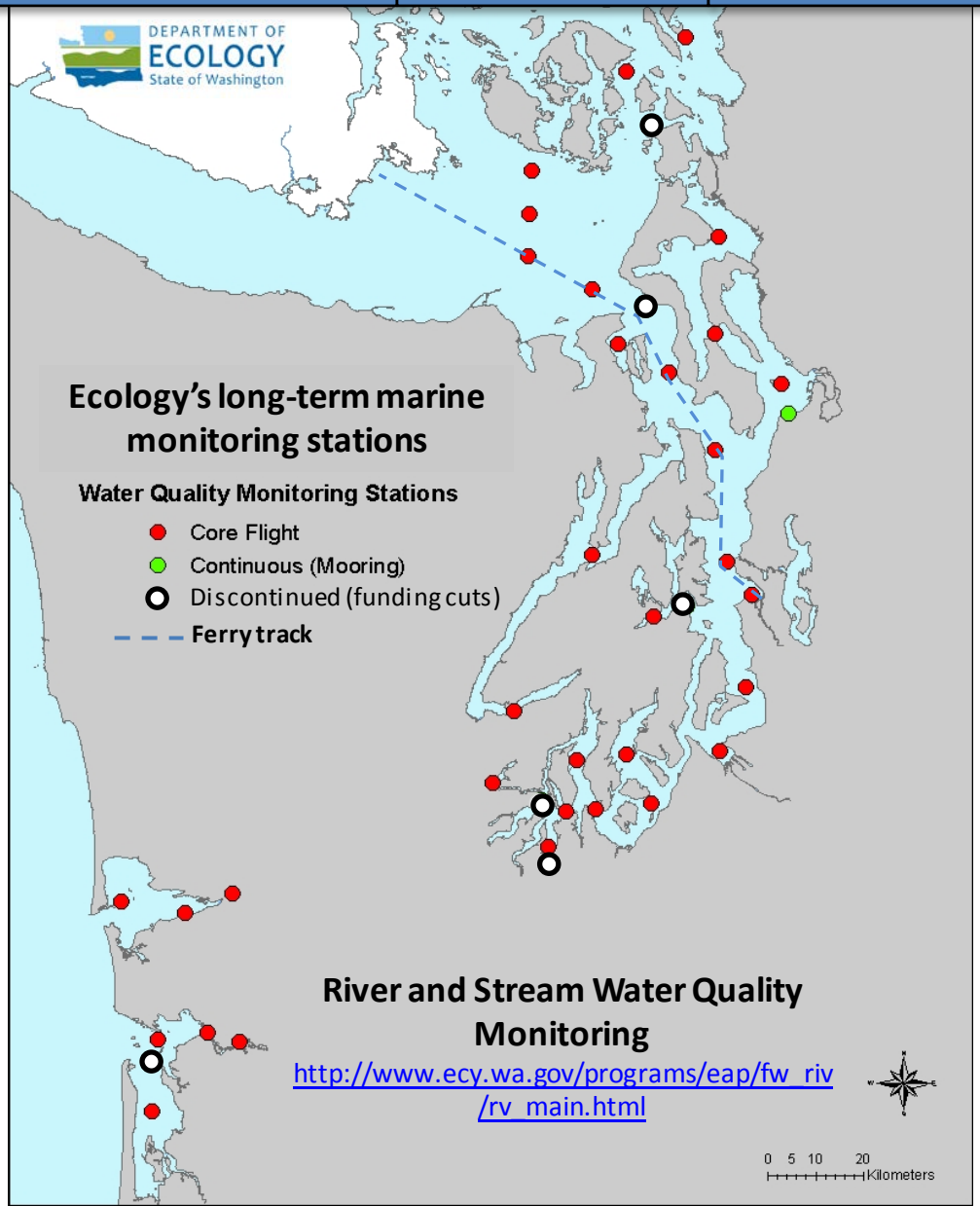
Get data from Ecology's Marine Monitoring Programs

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.

Dr. Christopher Krembs
christopher.krembs@ecy.wa.gov

Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

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