Publication No. 14-03-075

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

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

Surface Conditions Report

July 28, 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 7-28-2014 at a glance

LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
Laura Hermanson
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Skip Albertson

Julia Bos
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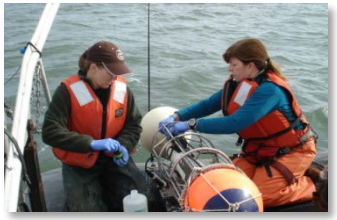
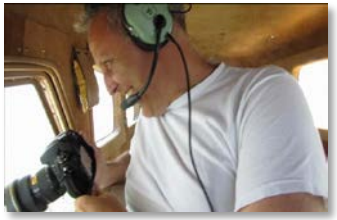
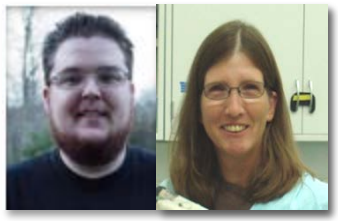


Dr. Christopher Krembs



Suzan Pool
Guest:
Dr. Brandon Sackmann, Integral



Personal field log
p. 4
By plane or by boat the Strait stays remote!

Weather conditions
p. 5
The past several days have been warmer and sunnier than normal with higher than normal river flows from the Skagit and Nisqually rivers. Winds are generally light and from the north.

Water column
p. 7
In early 2014, colder, saltier conditions developed in Puget Sound with lower oxygen in Whidbey Basin, Central and South Sound. Hood Canal remains cold but Puget Sound-wide temperatures are now warmer and less salty.

Moorings
p. 37
In the Mukilteo moorings, two dominant water masses are observed. This year, temperature is cooler and salinity is lower.

Aerial photography
p. 10
Abundant organic surface debris in Hood Canal, Padilla Bay, Eld Inlet, Carr Inlet, Port Madison, and Sinclair Inlet. Red-brown blooms in all bays of South Sound, Discovery Bay, and regions of Bellingham Bay. Different blooms in Skagit Bay, Padilla Bay, and Sinclair Inlet. Jellyfish numerous in all southern South Sound Bays.

Ferry and satellite
p. 35
Hardware upgrades on the *Victoria Clipper IV* have been completed! Impressive phytoplankton bloom observed offshore earlier in the week.

Monthly sampling in the Strait 7-28-2014

Ecology is sampling the Strait of Juan de Fuca

The Strait of Juan de Fuca connects Puget Sound to the Pacific Ocean. Long-term monitoring of these waters reveal the ocean's influence on the water quality of Puget Sound.

Seaplanes aren't able to land on rough waters in the Strait, so we sample the Strait by boat. These stations are important because they are the most seaward of our monitoring sites and give us information about oceanic conditions.

We thank Friday Harbor Labs for 13 years of dedicated sample collection!

The Straits sampling program started in 1999 with the help of numerous partners. Staff at Shannon Point Marine Center, operated through Western Washington University, currently conduct this work.

Shannon Point Marine Center staff at work

Wires woven into the winch cable transmit live data to on-deck computers.

Shannon Point Marine Center staff sample 4 sites in the Strait monthly on the R/V Zoea.

*Marine Research Technologist **Jay Diamond** records data and collects zooplankton samples for UW research.*

*Diving Safety Officer **Nate Schwarck** deploys our CTD.*

Weather of the past two weeks before 7-28-2014

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.

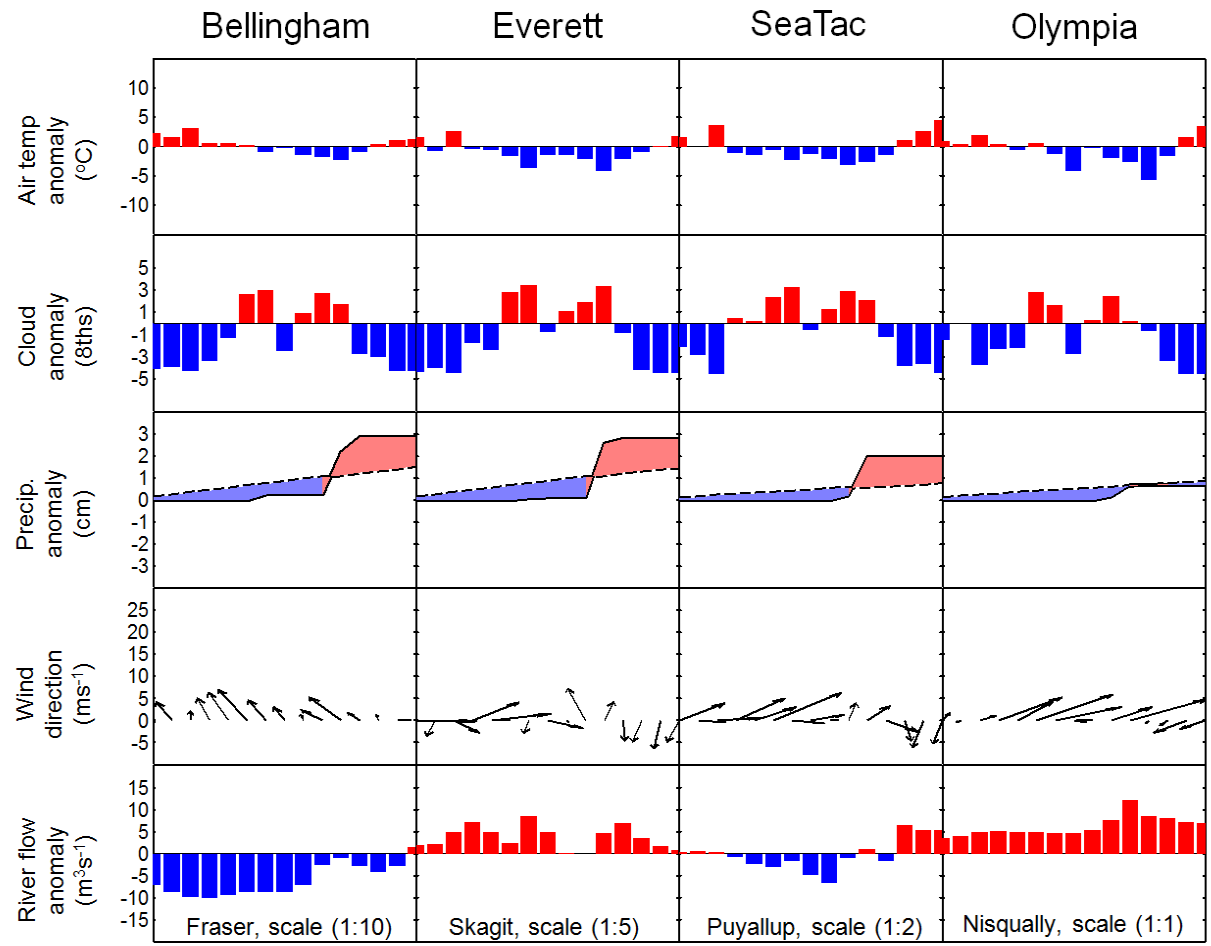
Two week summary:

Air temperatures. Daily air temperatures in the Puget Sound lowlands have been above normal for the past several days, but below average for the prior week.

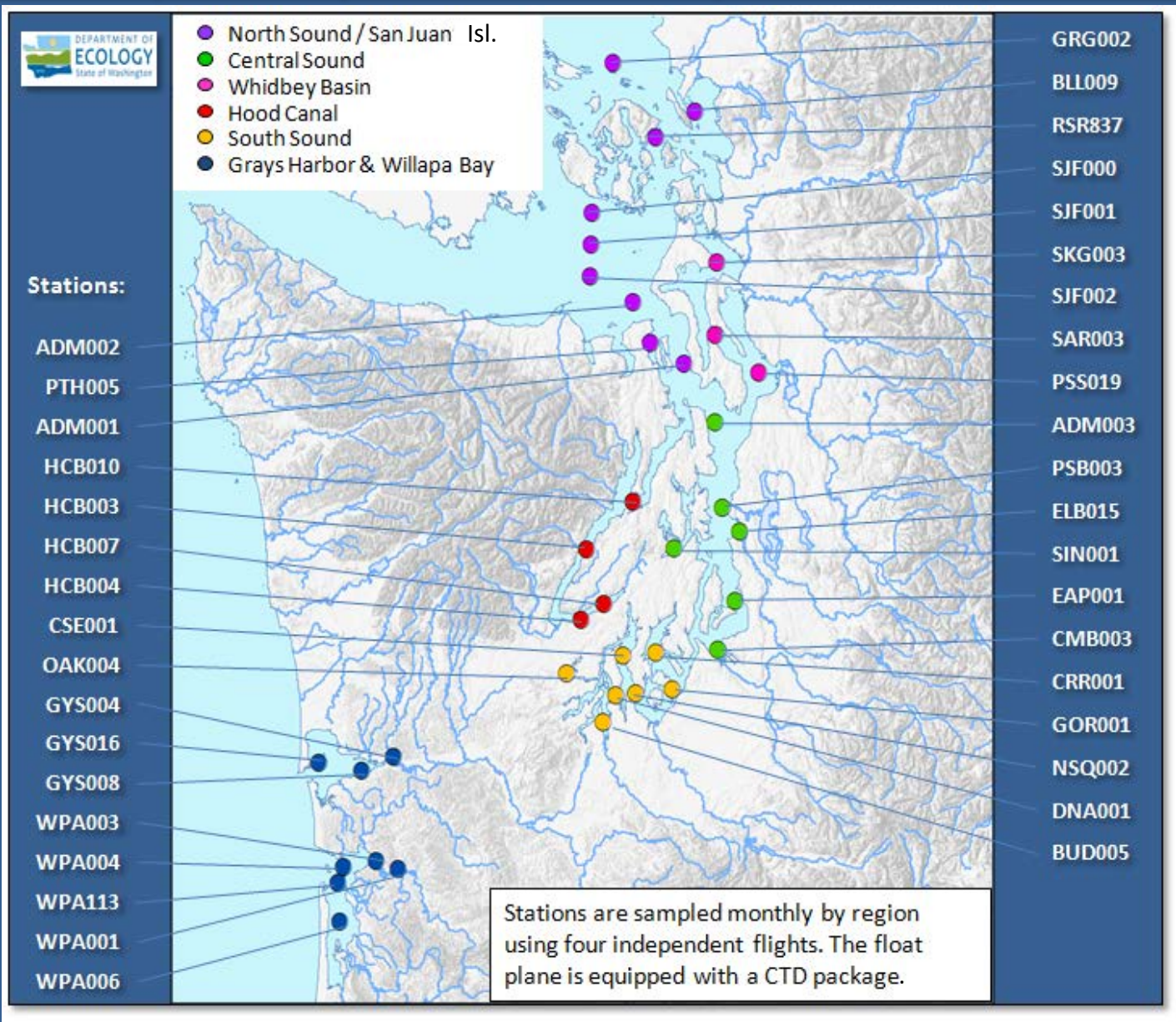
Sunshine levels have been above normal for the past four days.

River flows are above normal on the Skagit and Nisqually rivers and below normal on the Fraser and Puyallup rivers. Warm, sunny weather has generally increased flows on glacially-fed rivers.

Winds have primarily been from the north.



Our long-term marine monitoring stations in Washington



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

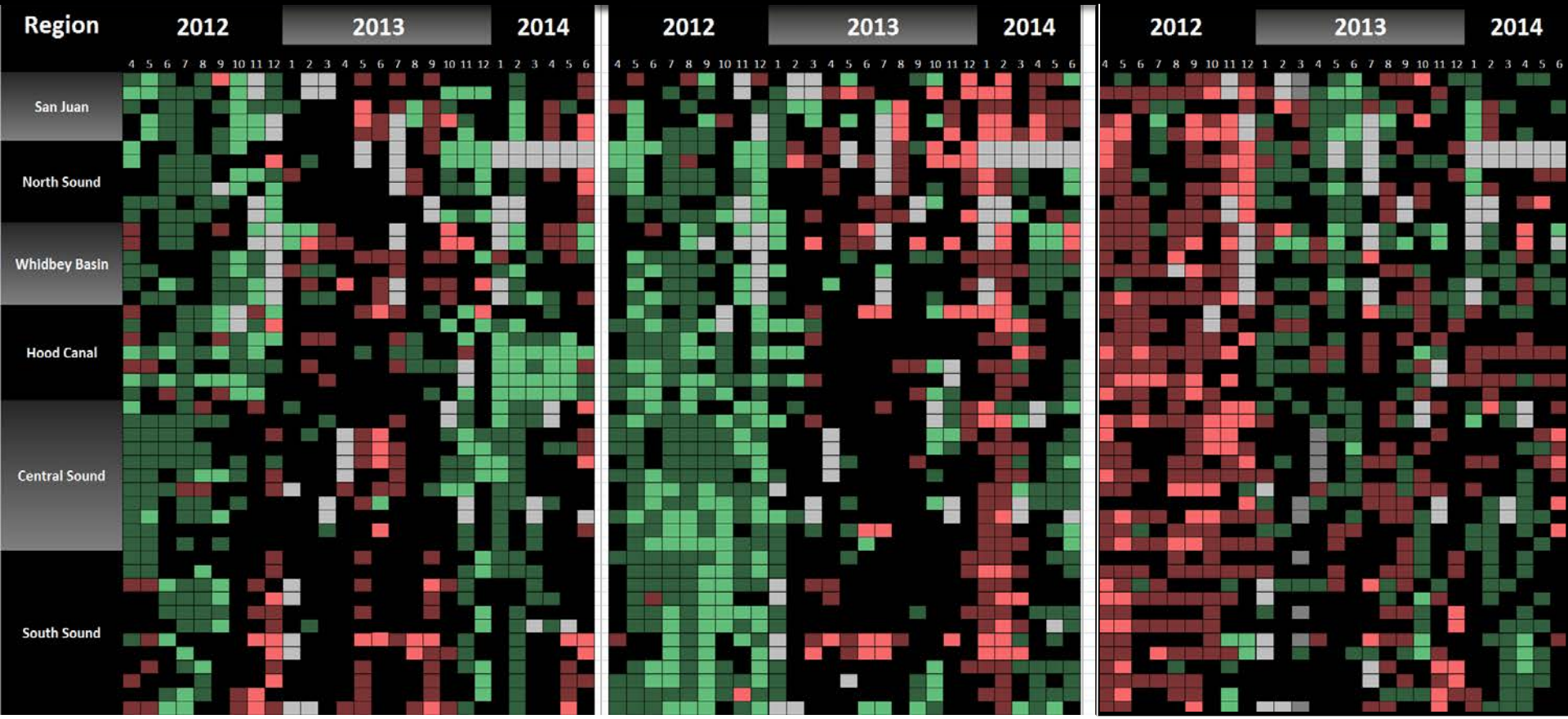
Start here

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

June 2014: Temperature increasing Salinity decreasing Oxygen increasing



= 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

The 2012 colder, fresher, higher oxygen conditions are gone. In 2013, Puget Sound was warmer, with normal salinity. In early 2014, colder, saltier conditions developed throughout Puget Sound with lower oxygen in Whidbey Basin, Central and South Sound. Hood Canal remains unusually cold but Puget Sound-wide, temperatures are warmer and salinities are now lower than expected.

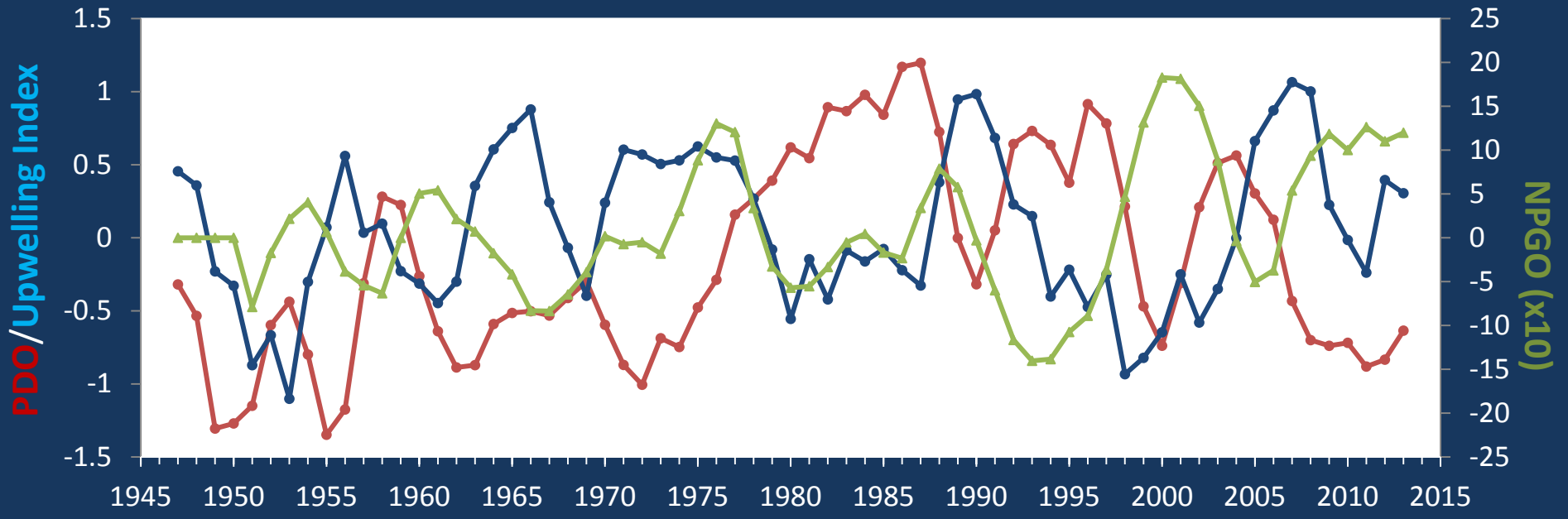
The ocean affects water quality: Ocean Climate Indices

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

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

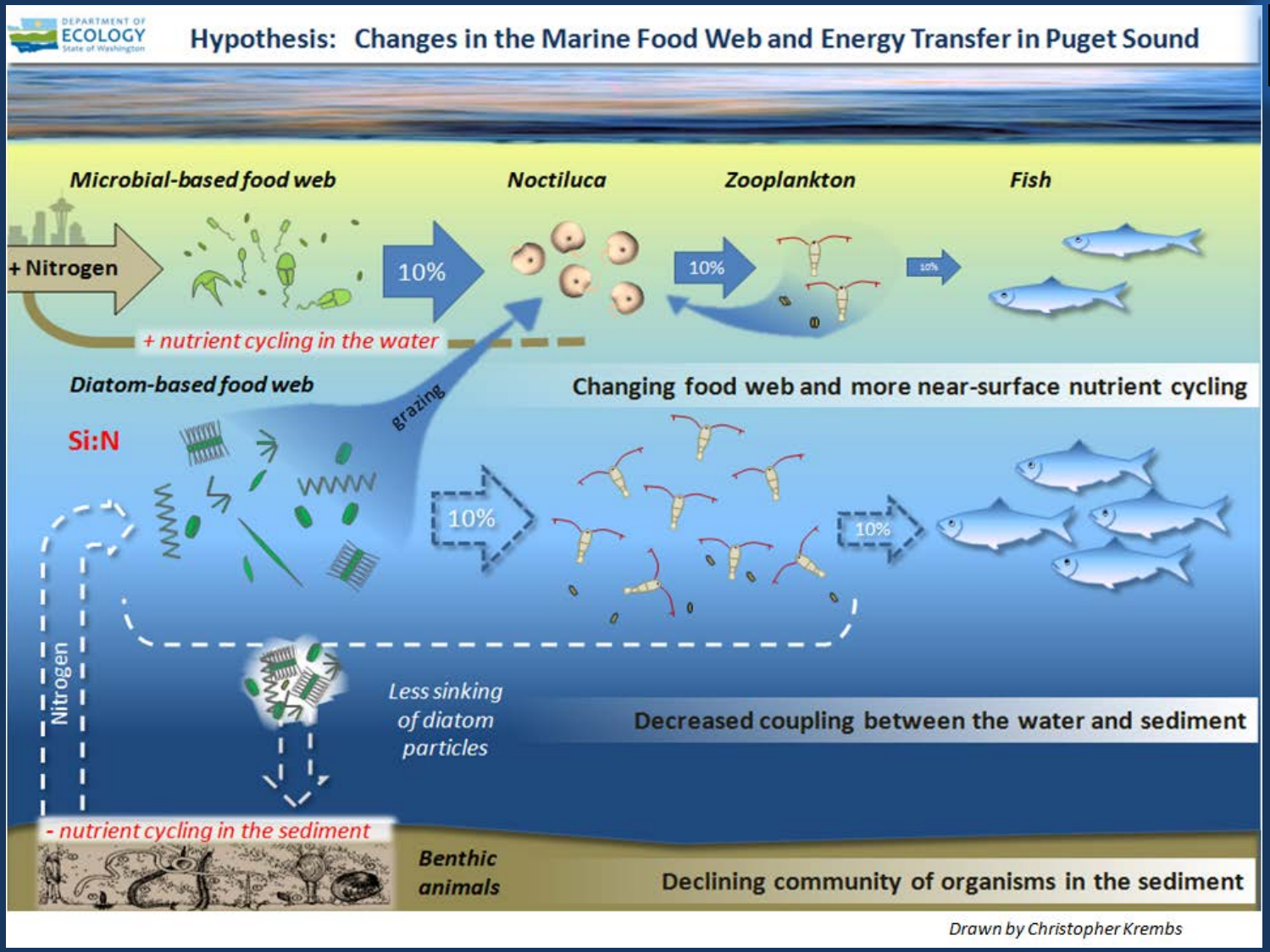
c) *North Pacific Gyre Oscillation Index (**NPGO, productivity**)* *(explanation)*

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 7-28-2014

Abundant organic surface debris in Hood Canal, Padilla Bay, Eld Inlet, Carr Inlet, Port Madison, and Sinclair Inlet. Strong red-brown blooms in all bays of South Sound, Discovery Bay, and regions of Bellingham Bay. Brown-green or green blooms in Skagit Bay, Padilla Bay, and Sinclair Inlet. Jellyfish numerous in all southern South Sound bays.

Start here

Green bloom, Scow Bay, Mystery Bay

McMicken Island, Case Inlet

Front

Mixing and Fronts:
Tidal fronts in Admiralty Reach, large eddy in Sinclair Inlet.
5 6 11 Click on numbers

Jellyfish: Jellyfish patches numerous in all southern inlets of South Sound. 1 2 3 4

Plume

Suspended sediment:
Sediment in glacier-fed rivers, such as Skagit River, are visible.
3 4 8 9 10 11

Bloom

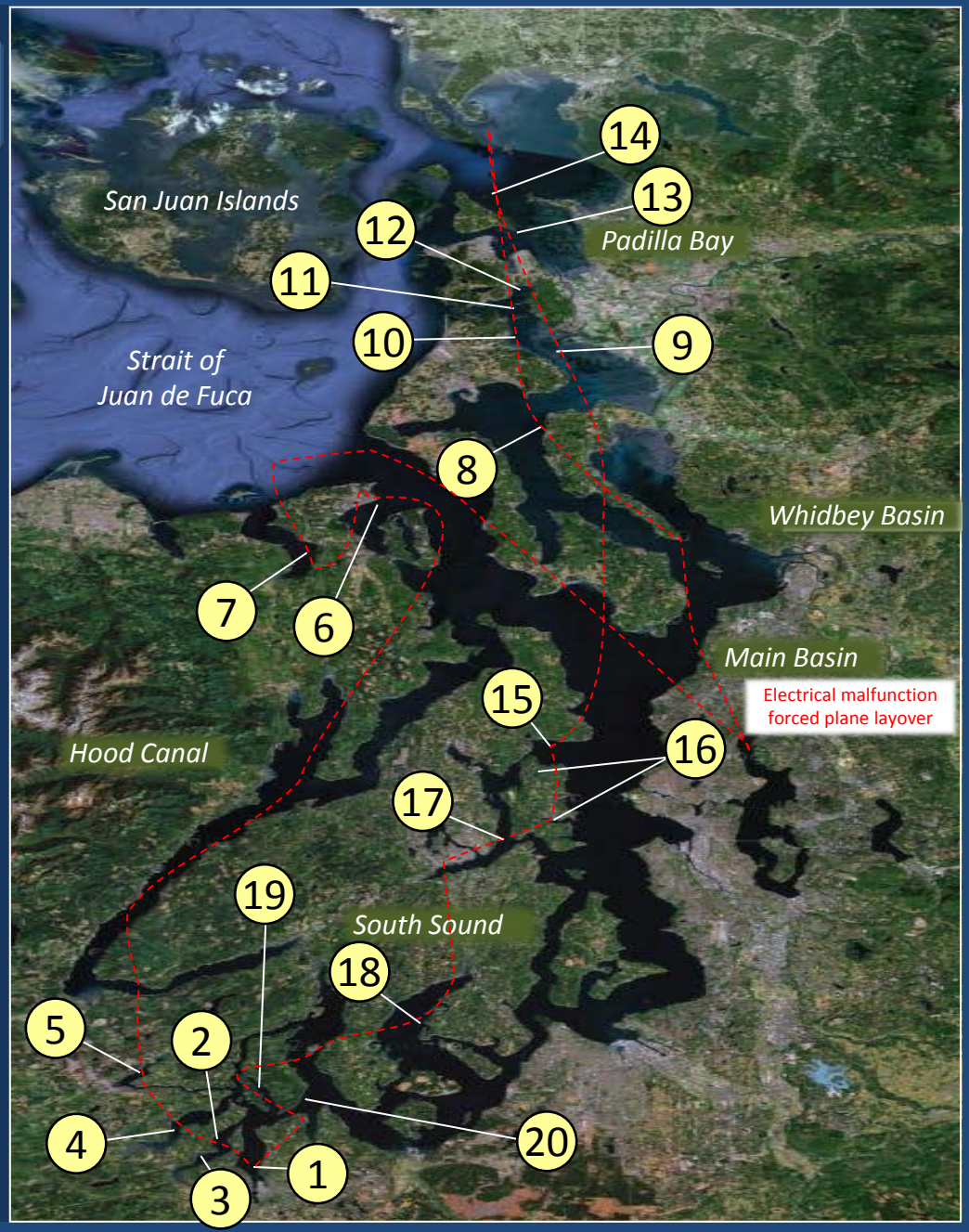
Visible blooms:
Green-brown: Sinclair Inlet, Saratoga Passage, Carr Inlet
Red-brown: Discovery Bay, all south Sound Bays
Green: Fidalgo Bay, Scow Bay
Green macro-algae: Hidden Cove, Delano Bay
1 2 3 4 5 6 7 10 11 12 13 14 16 17 18 19 20

Debris

Debris:
Very abundant in Padilla Bay, Hood Canal, Sinclair Inlet, Eld Inlet, Budd Inlet. 1 2 9 11 15 16 17 18 20

Tides

Seattle Tides: H. tide: 5:53 AM 7:29 PM, , L. tide: 12:50 AM, 12:27 PM



Aerial photography and navigation guide

Date: 7-28-2014

Click on numbers

Flight Information:

Morning flight, photos 1-7
Blue sky, high visibility, calm

Afternoon flight, photos 8-20:
Blue sky, high visibility, waves

– – – Altered flight route!

Observation Maps:

Central and North Sound

Hood Canal and South Sound

A. Red-brown bloom and large organic debris lines. B. Suspended sediment from bay mix into bloom.
Location: A. Entrance Channel, Budd Inlet. B. Gull Harbor, Budd Inlet (South Sound), 10:24 AM.

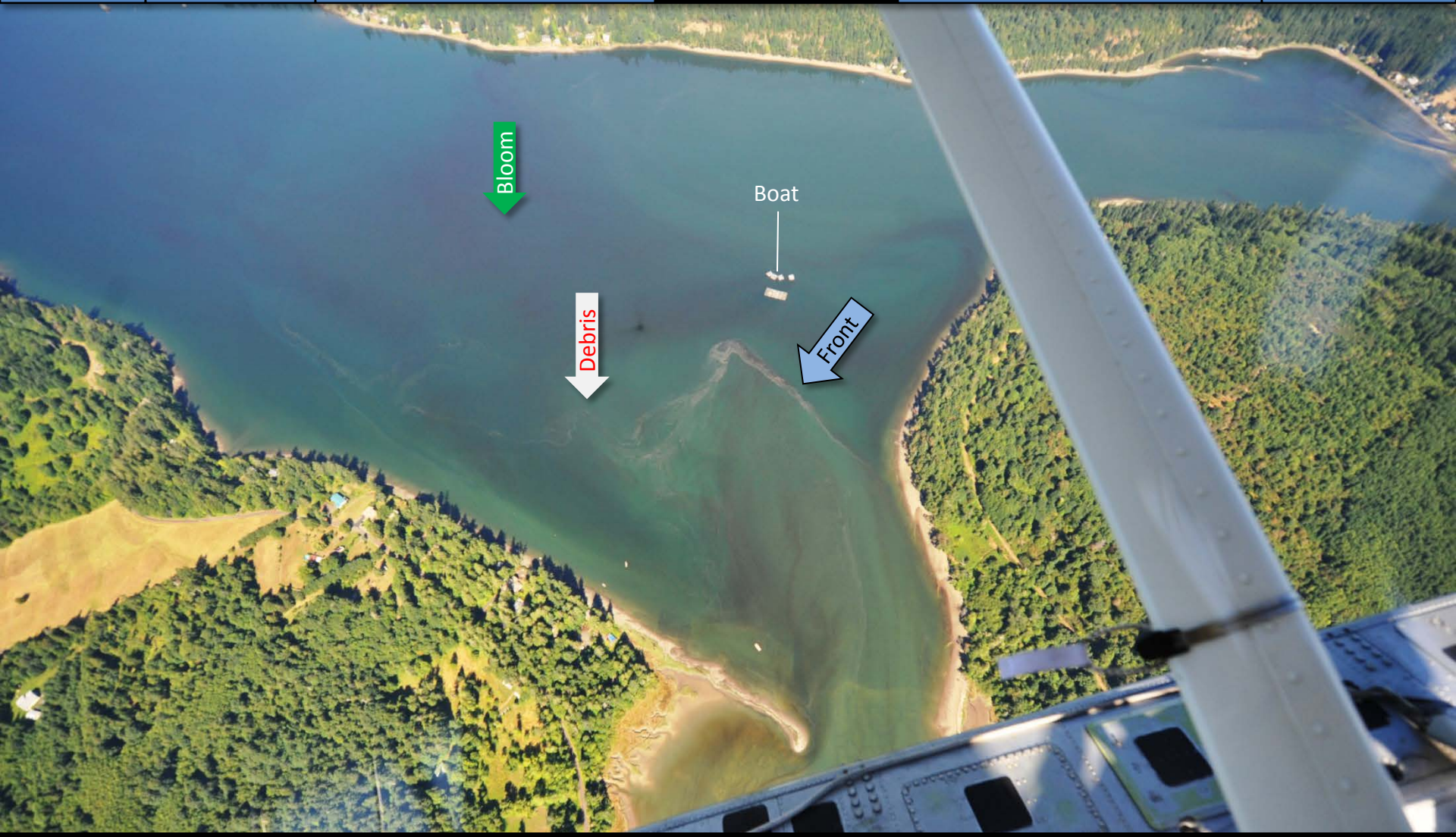
Red-brown bloom and large organic debris patches. Jellyfish patches present.

Location: Green Cove, Eld Inlet (South Sound), 10:26 AM.

Red-brown bloom, jellyfish, and sediment-rich river plume with internal waves at its fringes.
Location: Snyder Cove, Eld Inlet (South Sound), 10:26 AM.

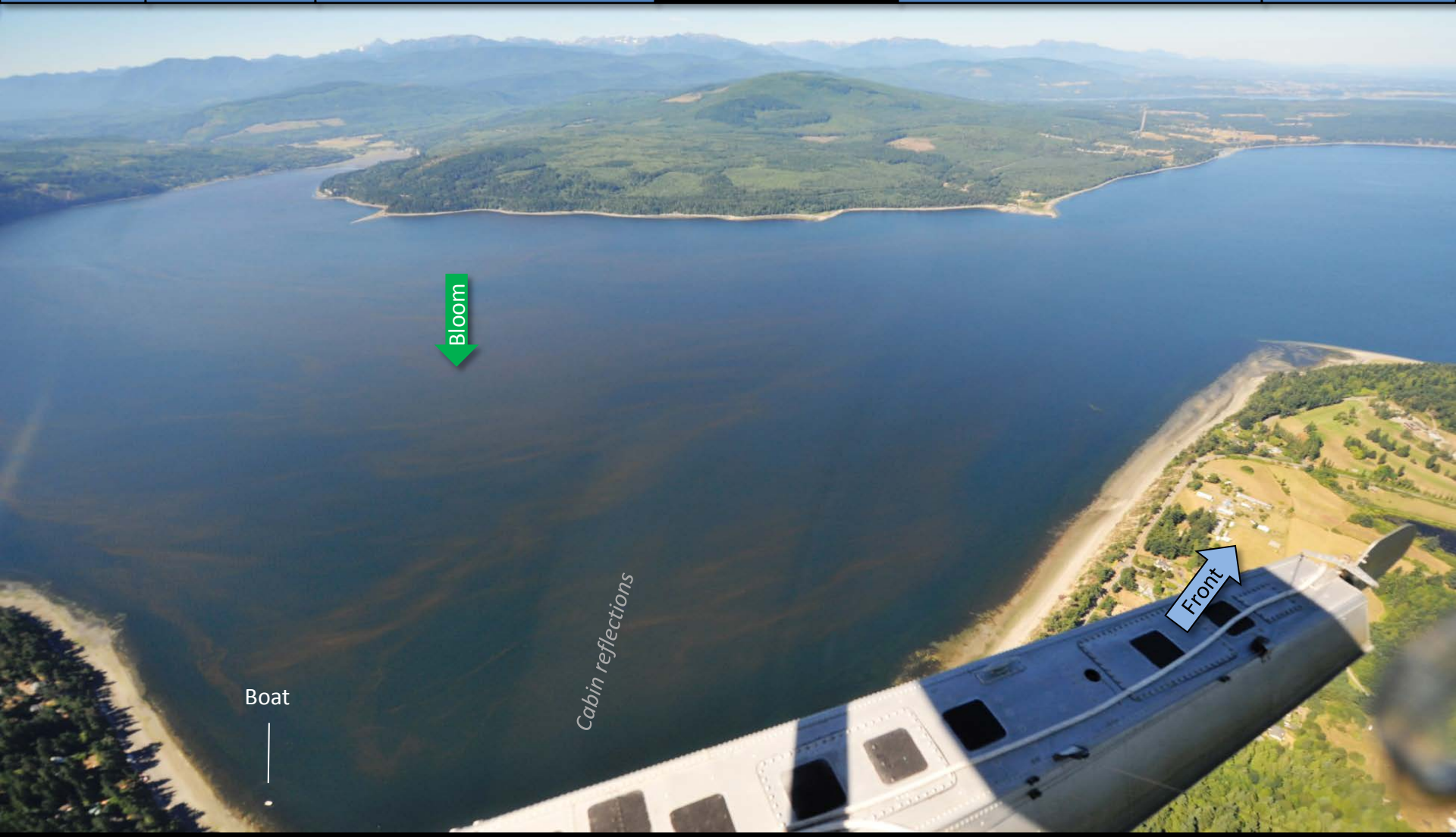
Red-brown bloom mixed into sediment-rich river plume. Jellyfish patches.

Location: Deepwater Point, Totten Inlet (South Sound), 10:27 AM.



Red-brown bloom and line of organic debris accumulating on tidal front.
Location: Chapman Cove, Oakland Bay (South Sound), 10:31 AM.

Red-brown bloom flowing out of Port Townsend Bay.
Location: Port Townsend (Central Sound), 11:10 AM.



Strong and patchy red-brown bloom and cabin reflections on airplane window.
Location: Across Karlset Point, Discovery Bay (Strait of Juan de Fuca), 11:15 AM.

Internal waves breaking at surface. Effect seen because of sediment-rich water overlaying red-brown bloom.

Location: Across Penn Cove (Whidbey Basin), 3:16 PM.

Patchy mosaic of sediment-rich water from the glacier-fed Skagit River against Mount Baker backdrop.
Location: Skagit Bay (Whidbey Basin), 3:20 PM.

Green bloom developing along shallow water edge.

Location: Dugualla Bay, Skagit Bay (Whidbey Basin), 3:22 PM.

Aerial photography 7-28-2014

Red-brown bloom nested between Hope and Skagit islands despite incoming tide from Deception Pass.

Location: Kiket Bay (Whidbey Basin), 3:23 PM.

Aerial photography 7-28-2014

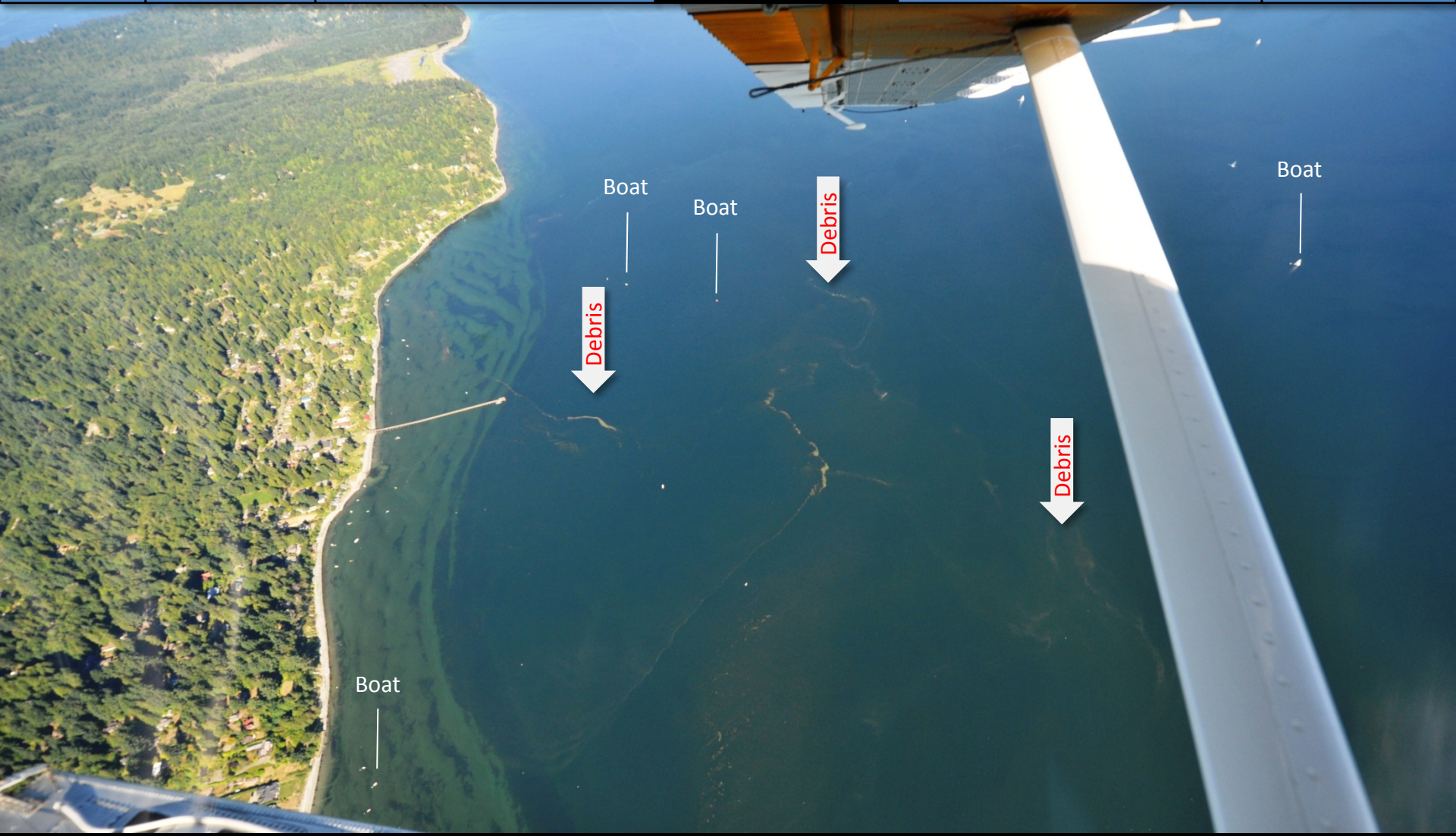
Golden brown and red-brown blooms.

Location: Similk Bay (Whidbey Basin), 3:24 PM.

A. Patches of organic surface debris above eelgrass beds. B. Bloom advecting in from Fidalgo Bay.
Location: A. Guemes Channel, Hat Island, Anacortes (Padilla Bay), B. Fidalgo Bay, 3:28 PM.

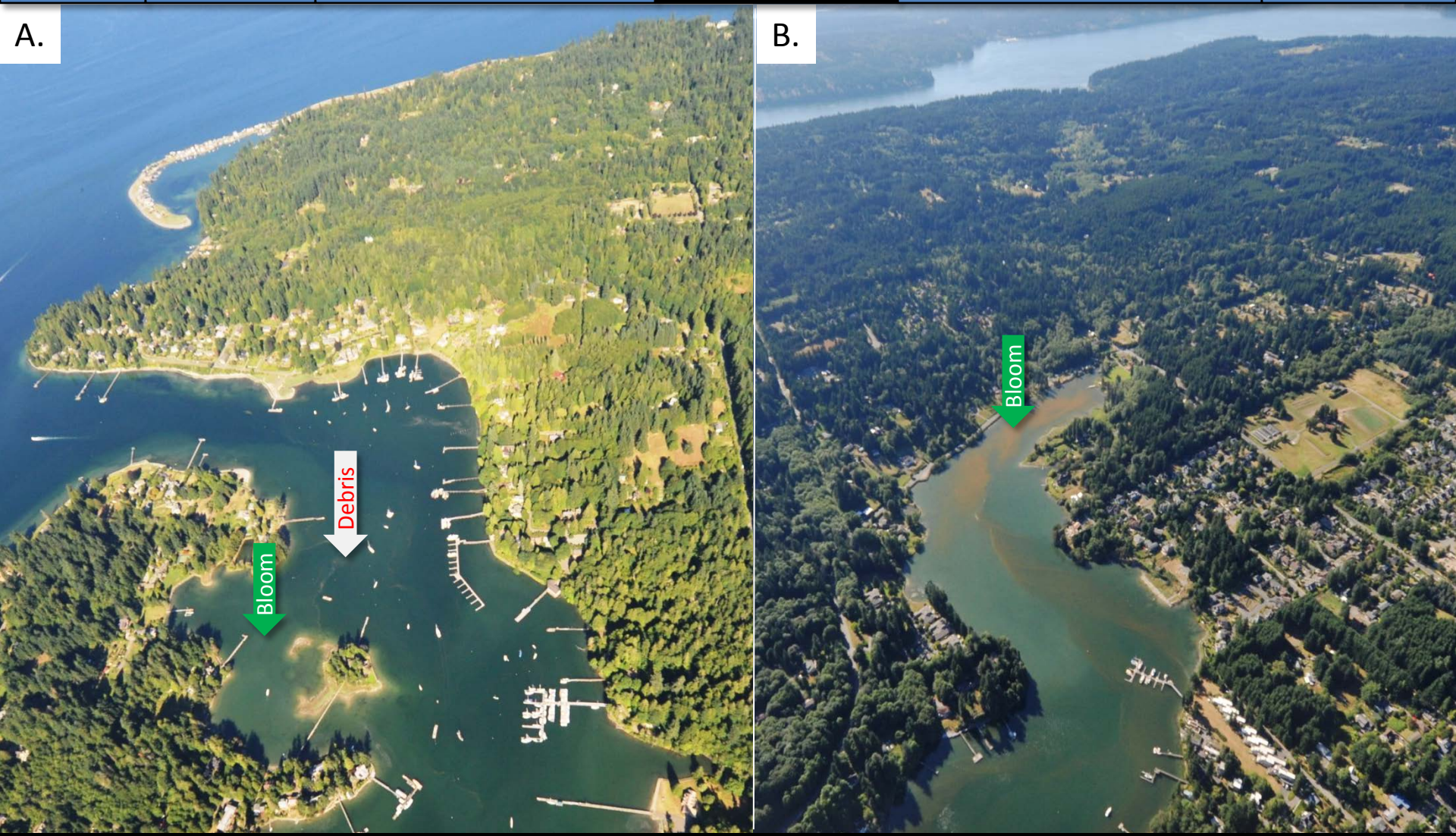
Patches of red-brown bloom diverging around Jack Island due to tides.

Location: North of Guemes Island (North Sound), 3:31 PM.



Large mats of floating organic surface debris near Miller Bay.
Location: Port Madison (Central Sound), 5:20 PM.

Aerial photography 7-28-2014



A. Green bloom and patches of organic surface debris. B. Red-brown bloom.

Location: A. Treasure Island, Hidden Cove, B. Eagle Harbor (Bainbridge Island, Central Sound), 5:21 PM.

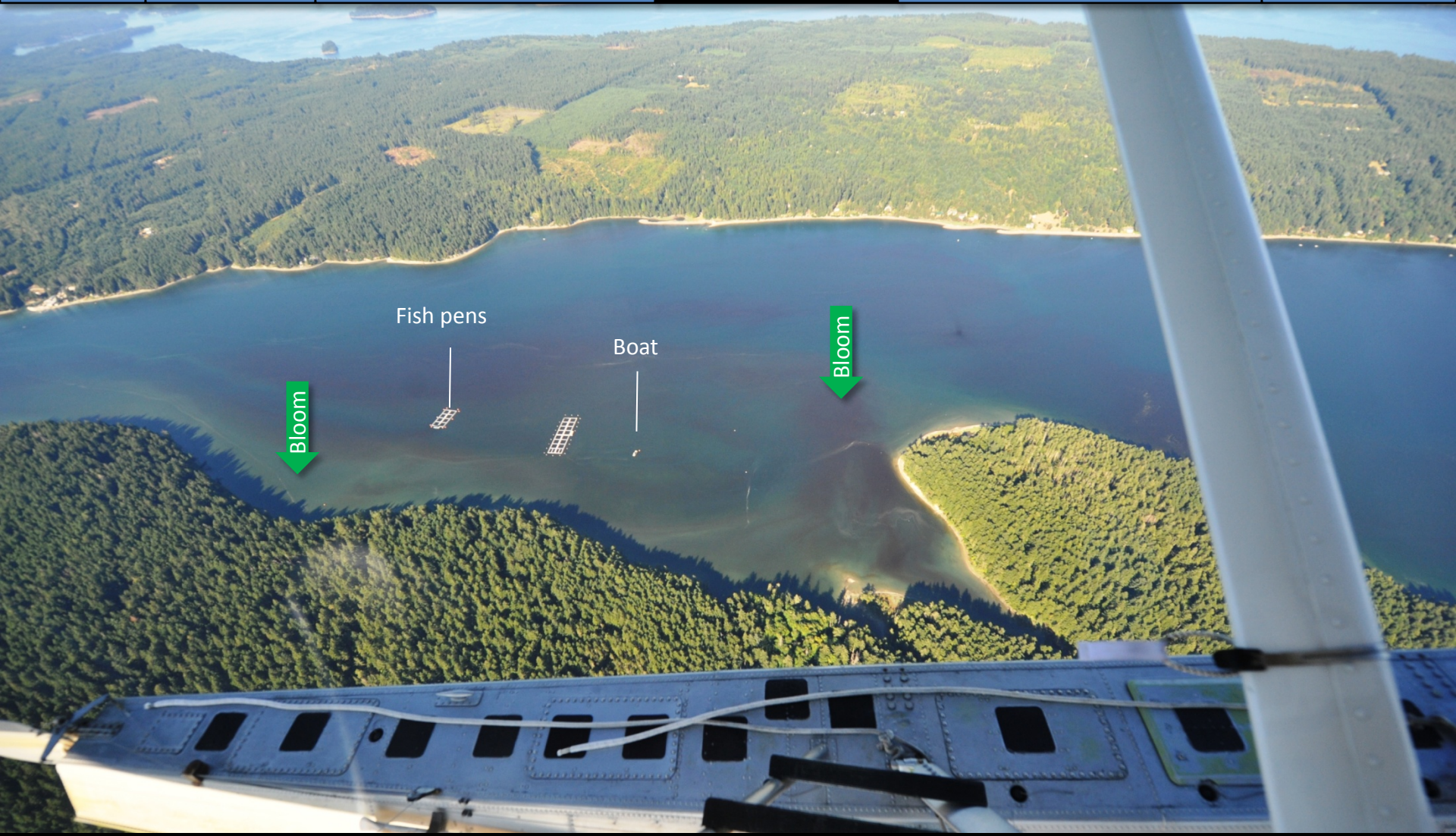
"Our first algae-crop circle"

Large tidal eddy with organic surface debris accumulated inside. Brown-green bloom mixing around eddy.

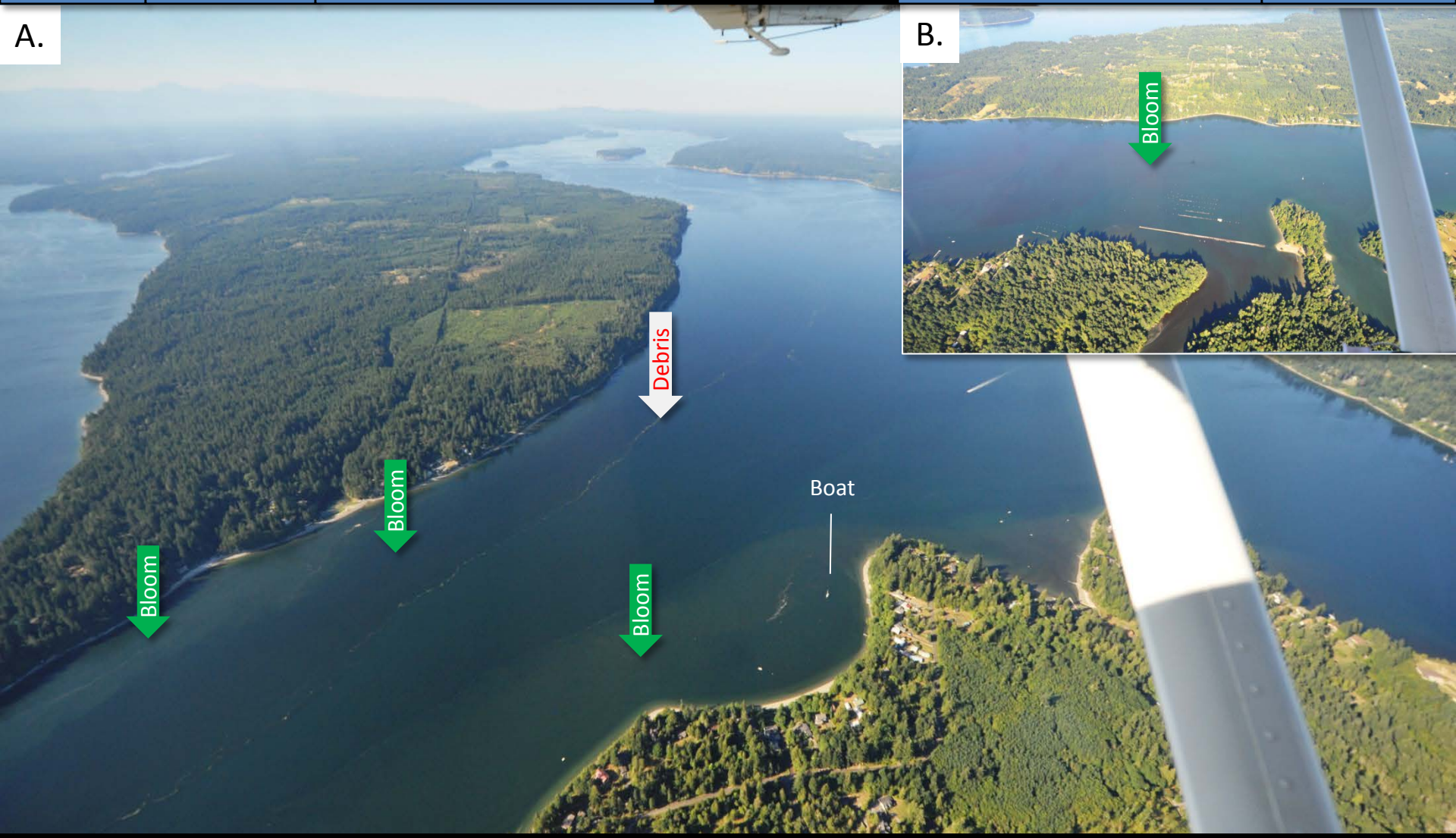
Location: Off Point White, Bainbridge Island, Sinclair Inlet (Central Sound), 5:26 PM.

Red-brown blooms in Carr Inlet and eastern smaller bays (Horsehead Bay and Raft Island).

Location: Horsehead Bay, Carr Inlet (South Sound), 5:39 PM.



Red-brown phytoplankton bloom mixed in turquoise bloom along shore.
Location: Peale Passage (South Sound), 5:46 PM.



A. Red-brown and green-brown blooms border incoming tide. B. Red-brown bloom in Henderson Inlet.
Location: A. Dana Passage, B. Henderson Inlet (South Sound), 5:47 PM.

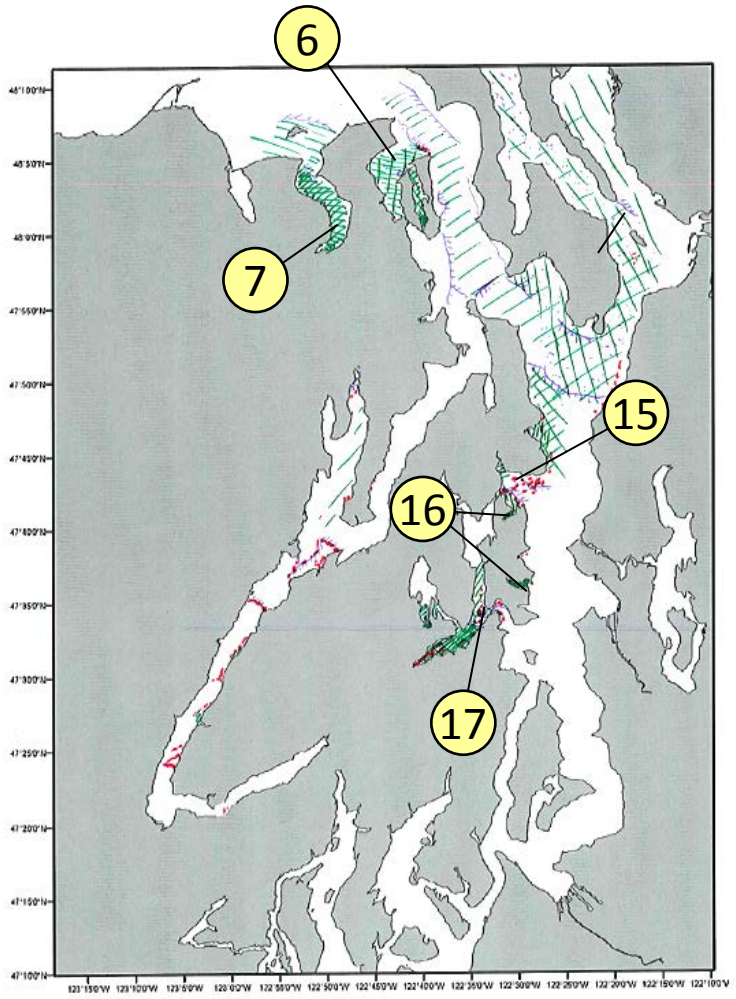
DEPARTMENT OF ECOLOGY State of Washington

Observations in Central and North Sound

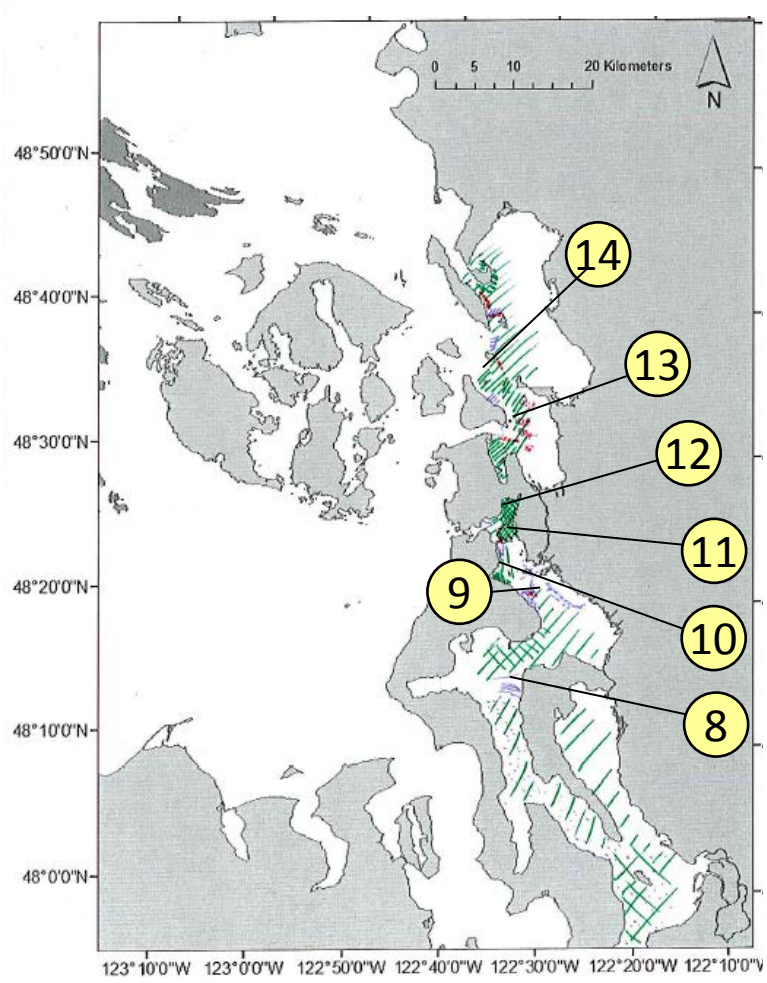
Navigate

Date: 7-28-2014

Central Sound



North Sound/San Juan Islands



Numbers on map refer to picture numbers for spatial reference

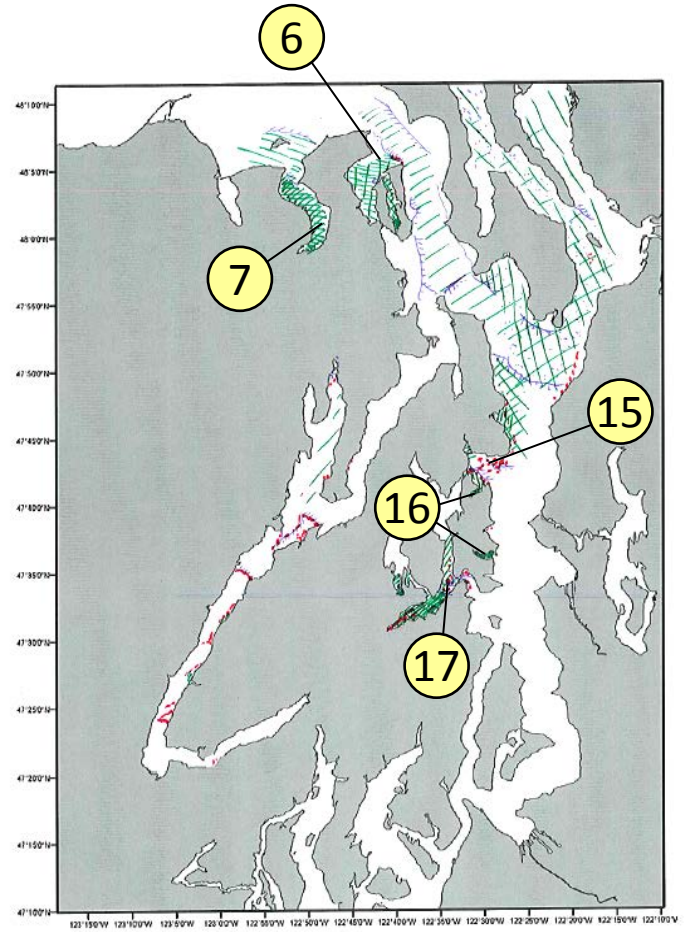
DEPARTMENT OF ECOLOGY State of Washington

Observations in Hood Canal and South Sound

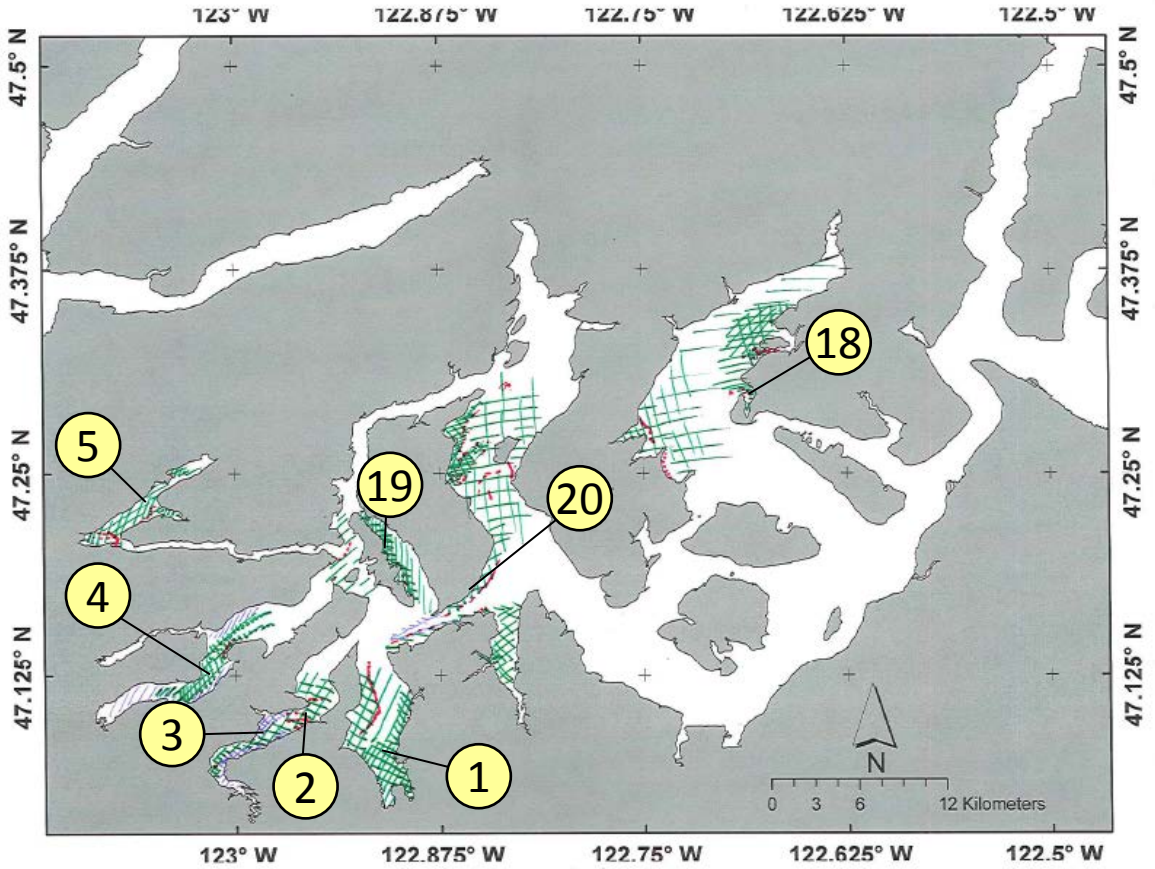
Navigate

Date: 7-28-2014

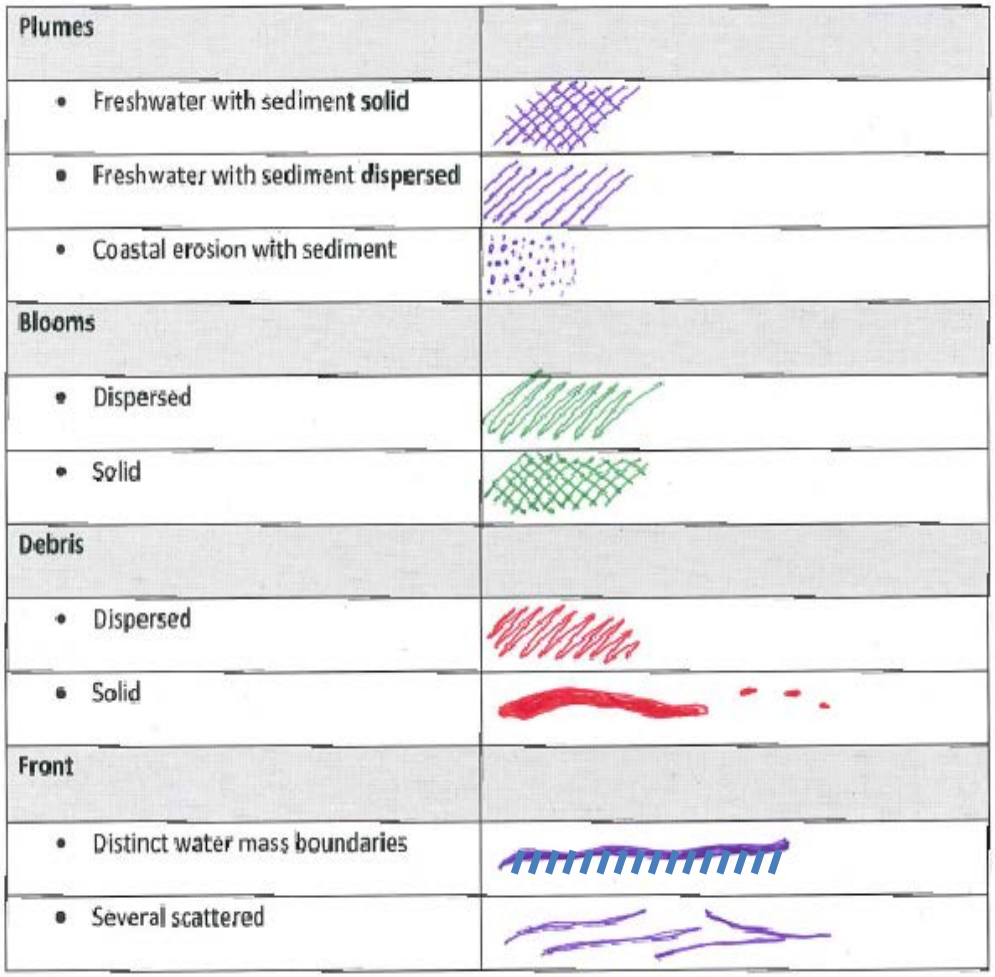
Hood Canal



South Sound



Numbers on map refer to picture numbers for spatial reference



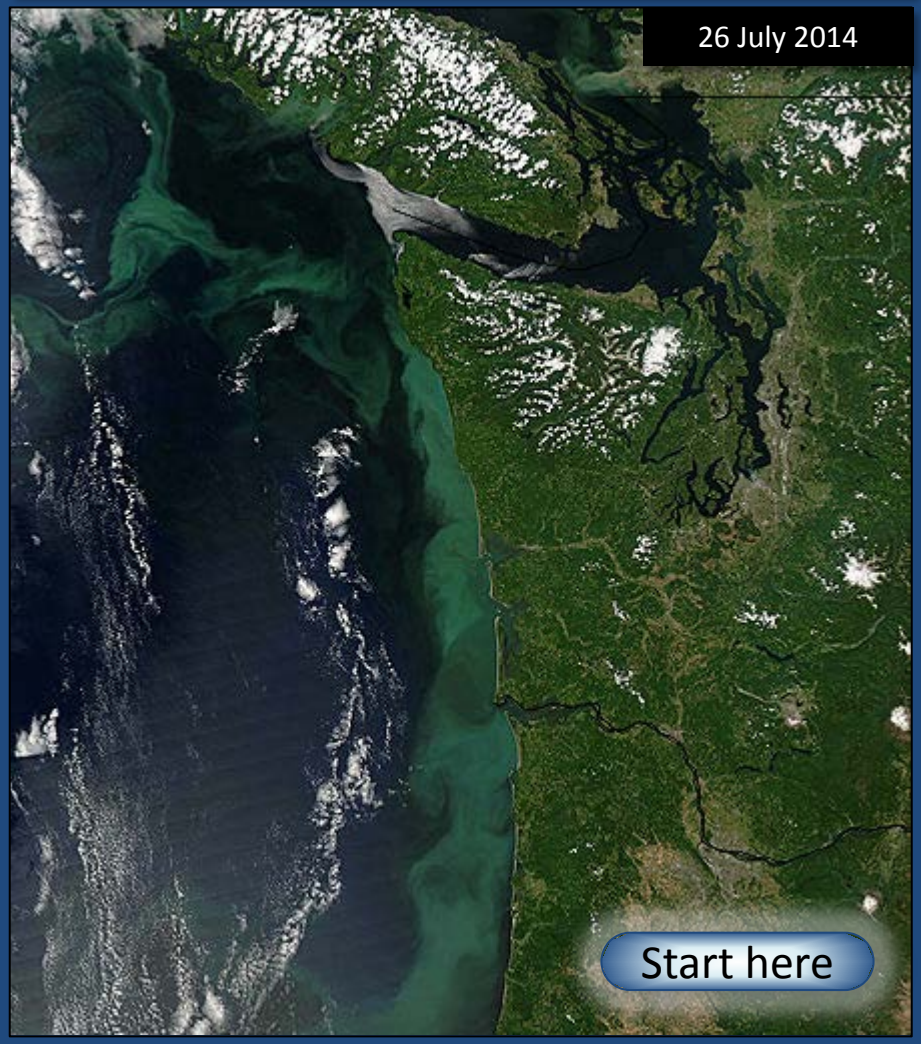
Comments:
Maps are produced by observers during and after flights. They are intended to give an approximate reconstruction of the surface conditions on scales that connect to and overlap with satellite images in the section that follows.

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.

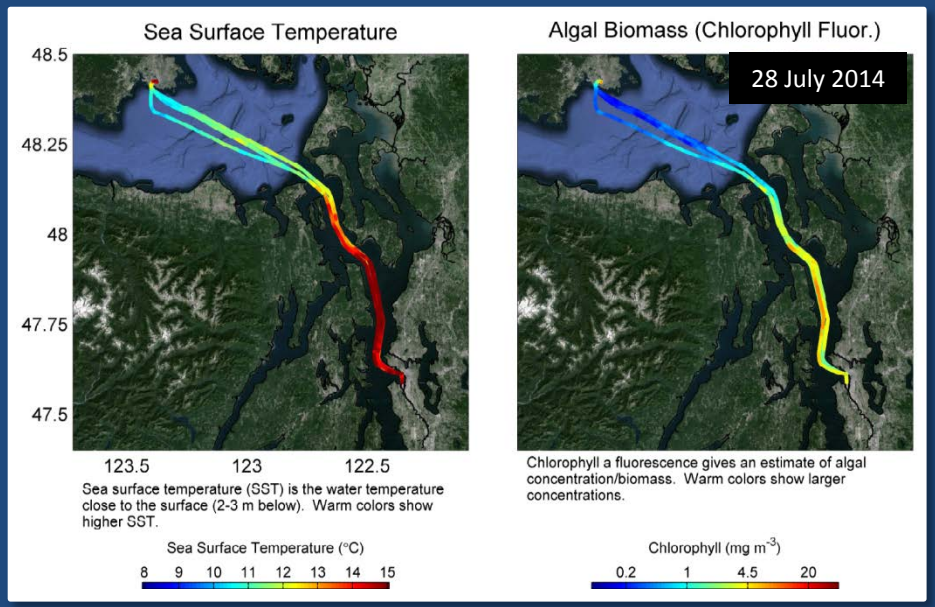
Ferry and satellite observations 7-28-2014

Impressive Phytoplankton Bloom off the Washington Coast!



Left: Dr. Brandon Sackmann:
bsackmann@integral-corp.com

Right: Suzan Pool
suzan.pool@ecy.wa.gov

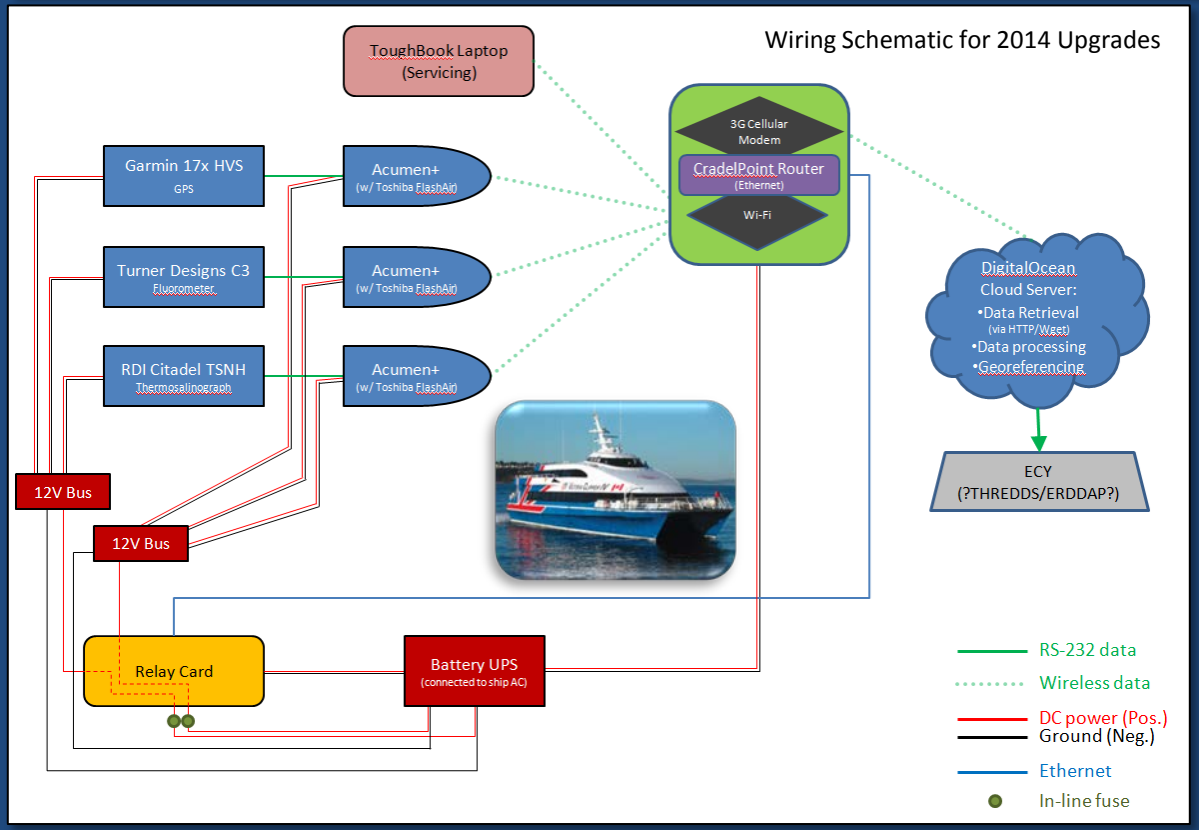


Present Conditions:

Warm, fresh water entering central Puget Sound from Whidbey Basin. Sea surface temperatures > 15 °C. Moderate fluorescence in central Puget Sound. Upwelling-favorable winds promote phytoplankton bloom off the Washington coast.

Ferry and satellite observations 7-28-2014

Hardware upgrades simplify data logging and telemetry using wireless technology!



Brandon, Suzan in the belly of the ship.

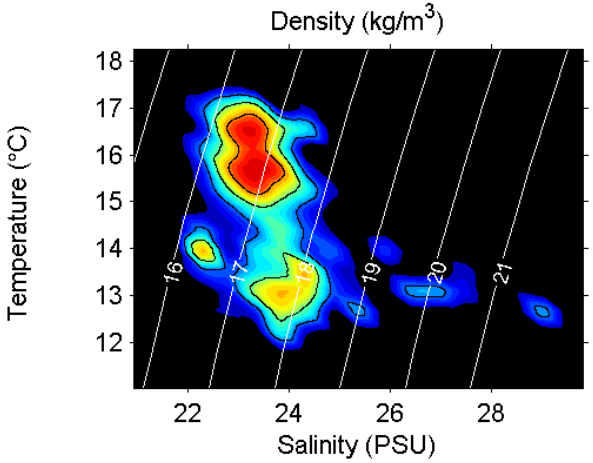
Hardware upgrades on the Victoria Clipper IV have been completed!

(Near real-time data restored as of July 23, 2014)

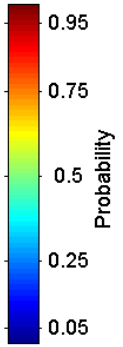
Mooring observations and trends 7-16-2014 to 7-28-2014

At Mukilteo we observed strong vertical gradients between our upper and lower moorings based on temperature, salinity, and dissolved oxygen. Large Skagit river discharge and strong northerly winds hasten the export of freshwater leaving Puget Sound.

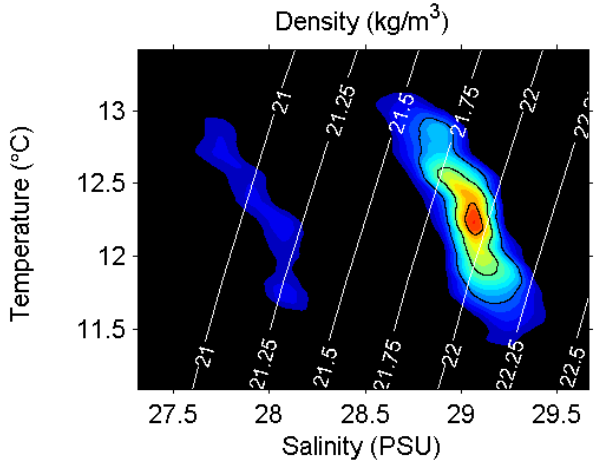
2-6 m depth

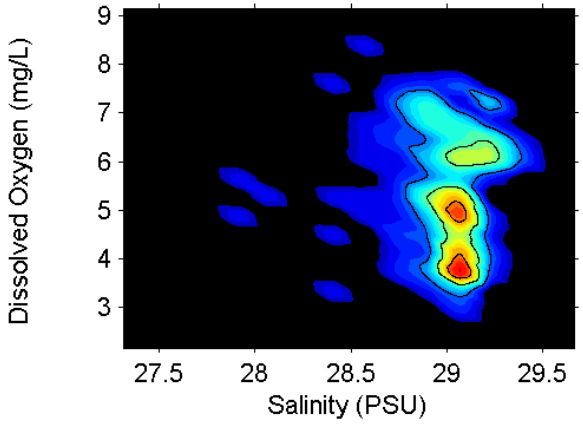


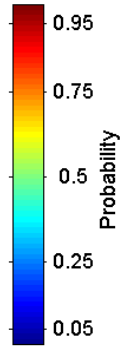
Dissolved oxygen not measured



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.

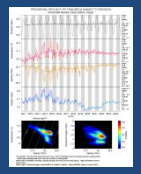
Mooring observations and trends 7-16-2014 to 7-28-2014

Our mooring station in Mukilteo is located in Whidbey Basin near Everett. The mooring is 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.

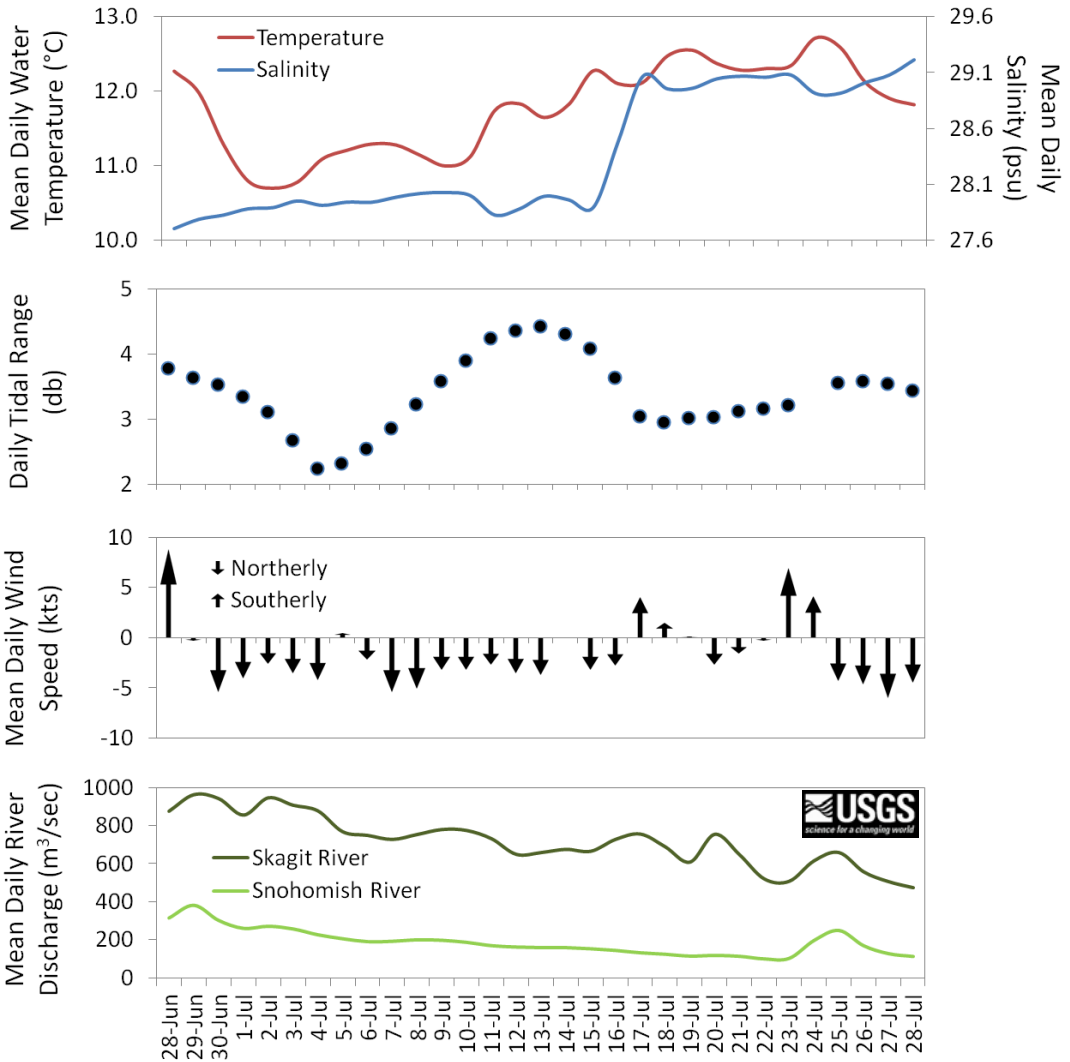
As the largest regional contributor of freshwater to Puget Sound, understanding the timing and magnitude of Skagit river flow is important.

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



Near-bottom sensor and associated environmental data at Mukilteo



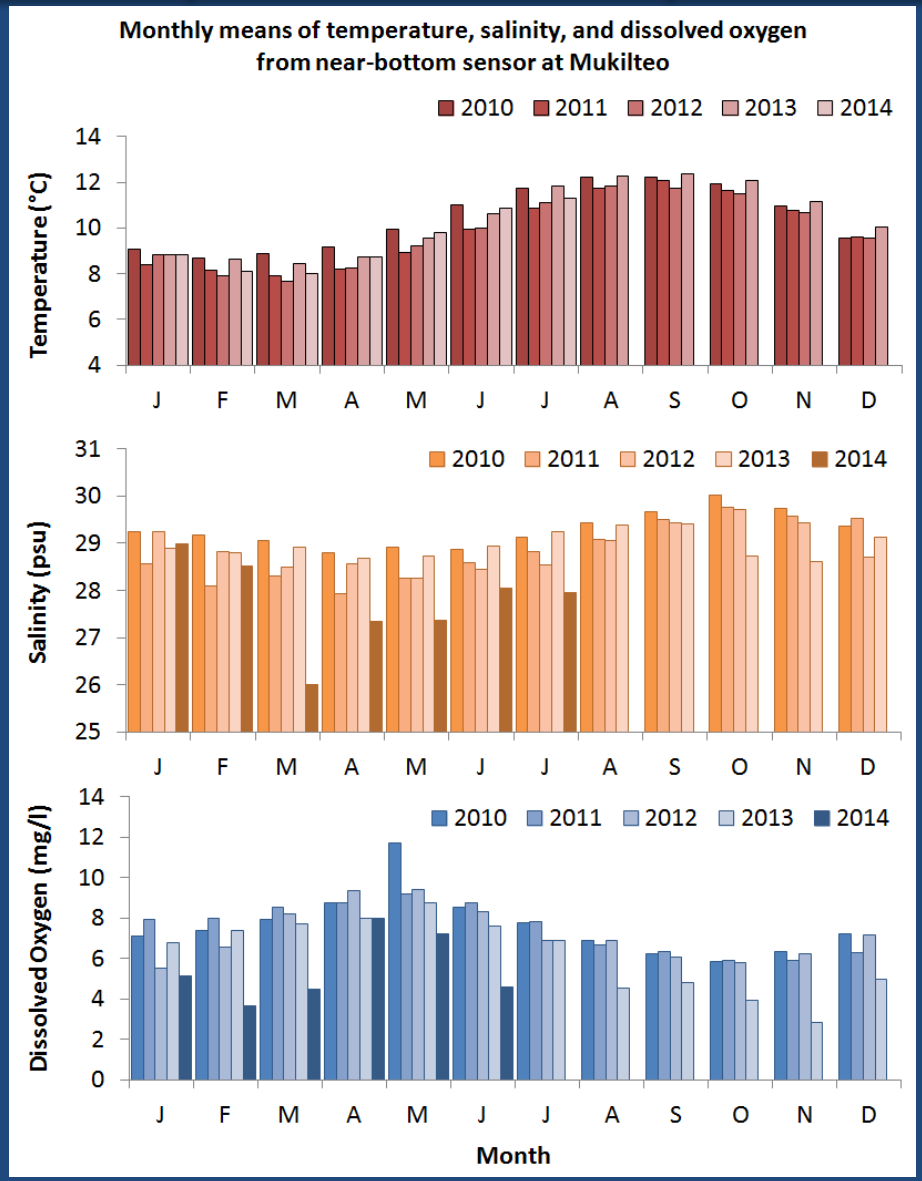
Mooring observations and trends Mukilteo 2010 to 2014

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 calibrations indicated the dissolved oxygen sensor failed in early July and thus is not being reported.)

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



Get data from Ecology's Marine Monitoring Programs

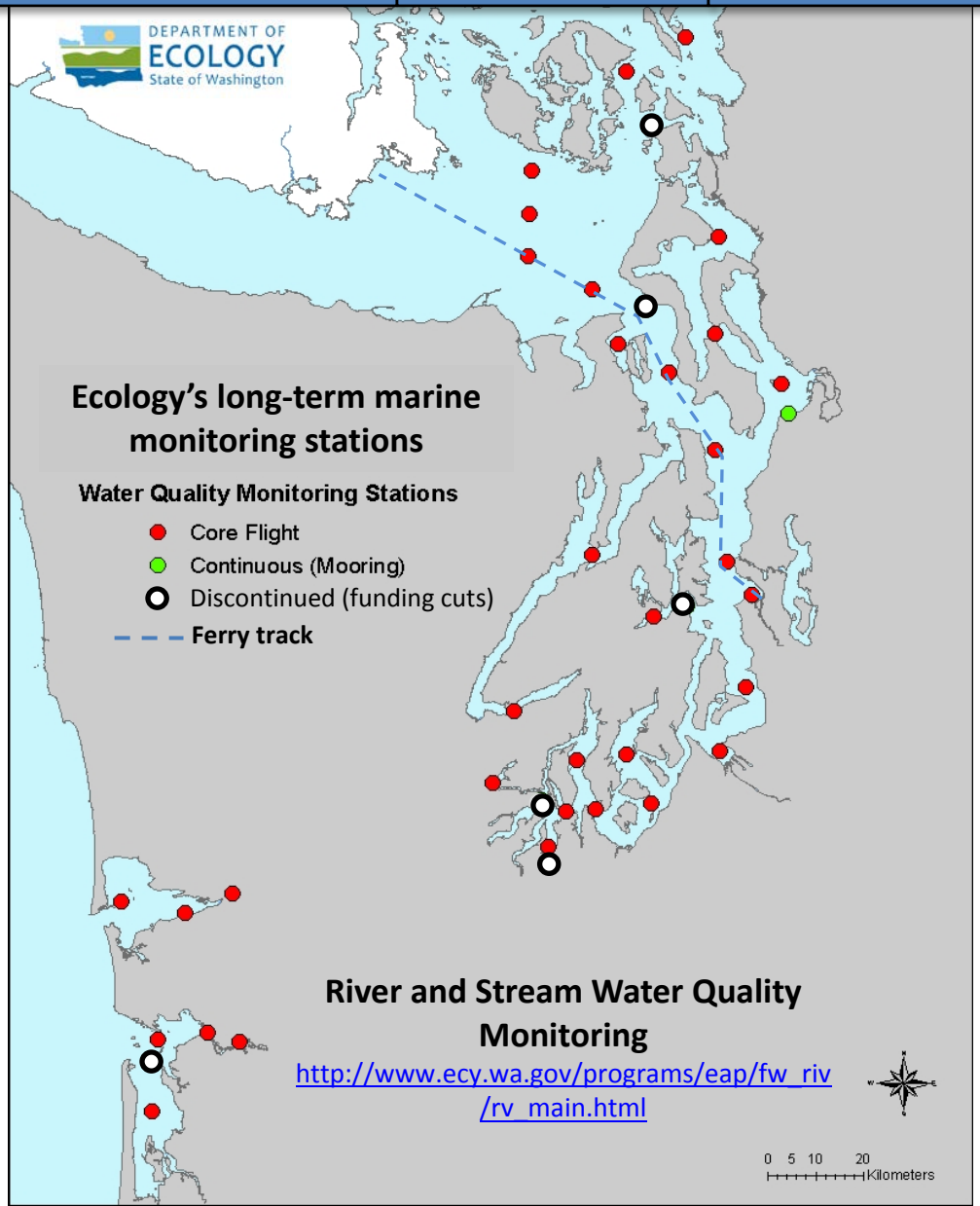
Field log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

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

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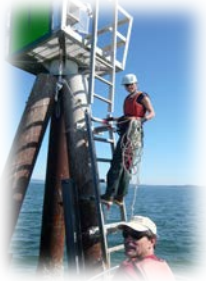

Access mooring data:

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

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