Publication No. 13-03-071

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

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

Surface Conditions Report

February 26, 2013

Guest: Ardi Kveven, *State of Possession Sound Cruise*

We have a new website (http://www.ecy.wa.gov/programs/eap/mar_wat/)

Start here

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

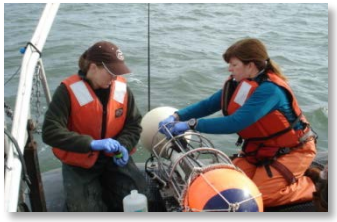
Marine conditions from 2-26-2013 at a glance

LONG-TERM MARINE MONITORING UNIT

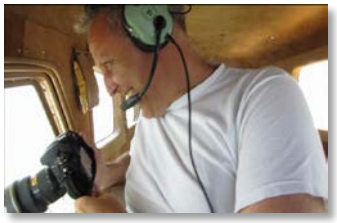
Mya Keyzers
Laura Friedenberg
Joe Leatherman

Skip Albertson

Julia Bos
Suzan Pool
David Mora



Dr. Christopher Krembs



Guest: Dr. Brandon Sackmann

Personal flight log p. 6

Better than a cup of coffee: Marine monitoring on the morning radio! Listen to marine flight technician Mya Keyzers discuss EOPS.
http://www.youtube.com/watch?v=jEkLTSlkI6I

Weather conditions p. 8

Air temperatures are above normal in the extreme north and at or below normal for Central & South Puget Sound. The weather has been cloudier than normal. Rivers are running below normal. Winds have been predominantly out of the south.

Water column and mooring p. 9, p.31

Does the 2-year pattern of colder, fresher and more oxygenated Puget Sound water persist? Possession Sound has very predictable dissolved oxygen layer at 11-16m depth.

Aerial photography p. 10-26

Many large tidal eddies. Jellyfish aggregations continue to persist this winter in many inlets. Early bloom in Hood Canal and Eld Inlet. Multiple oil sheens in Seattle waterways.

Ferry and satellite p. 27

Victoria Clipper IV moved to shipyard for annual maintenance. No data available.

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

Why Eyes Over Puget Sound?

We observe increasing nutrients and changing algal biomass patterns in Puget Sound:

Algae bloom Budd Inlet 2010

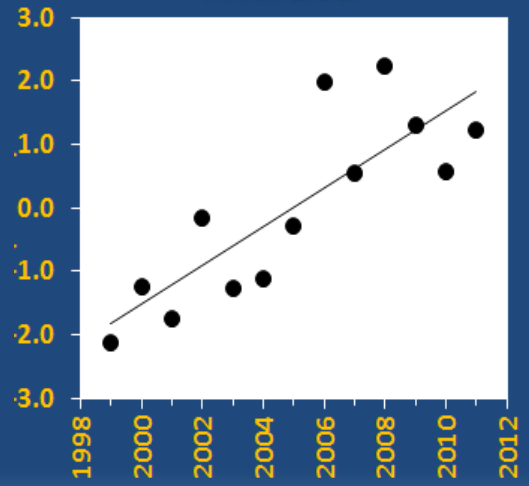
Nitrate

Phosphate

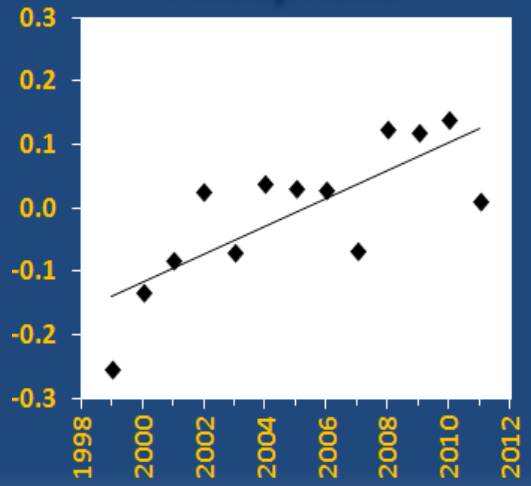
Changing Nutrient Balance

Nutrients in Puget Sound are increasing, read http://www.ecy.wa.gov/programs/eap/mar_wat/trends.html

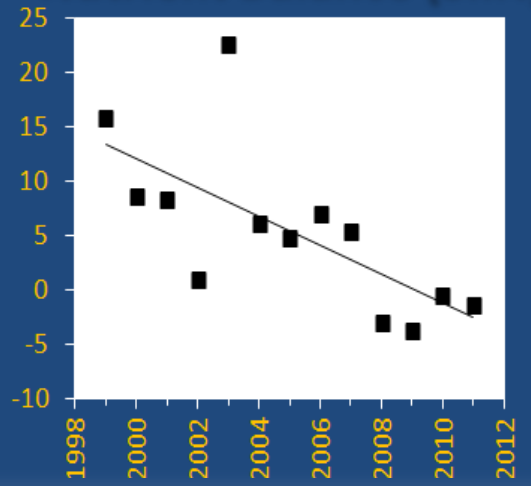
Nitrate



Phosphate



Nutrient Balance (Si:N)



Early college students monitoring estuarine dynamics

State of Possession Sound Research

Water access directly from the ORCA campus

ORCA maximizes learning opportunities by conducting in-depth research with students in the Snohomish River Estuary.

We charter a private passenger ferry monthly to provide a platform for our State of Possession Sound project.

On board, students collect and analyze similar water quality metrics collected by Ecology's marine waters monitoring program (dissolved oxygen, temperature, salinity, pH, chlorophyll, and nutrients). Additional sampling incorporates biogeochemical aspects to help students integrate course material with what they observe in the field.

Guest: Ardi Kveven (ORCA)

ORCA is an early college/dual enrollment program at Everett Community College for high school juniors and seniors.

Students earn two years of college credit while completing high school.

link

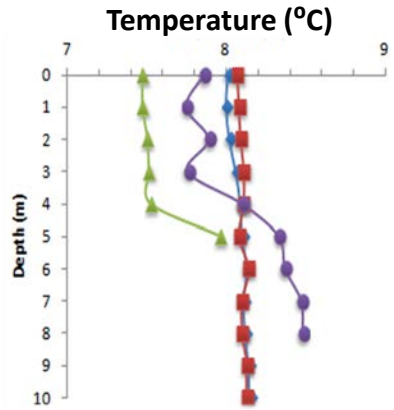
We developed a project based on the State of the Sound publication (2004) that integrated core oceanography content and field methods with mathematical analysis and English composition.

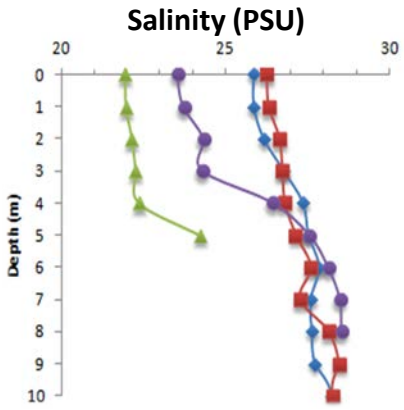
From this work, we developed a partnership with Ecology to support the installation and maintenance of a fixed mooring at Mt. Baker Terminal, (see data).

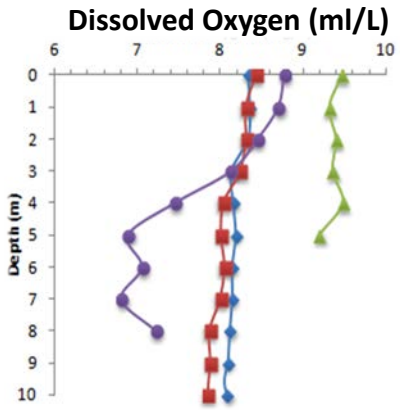
This innovative project was the catalyst for NSF funding for a student research lab.

www.everettcc.edu/orca

State of Possession Sound (SOPS) Cruise 58, 2-13-2013







In addition to water chemistry, students monitor marine bird abundance and distribution, targeting the at-risk populations, identified by the State of the Sound (*Surf Scoters, Marbled Murrelets, Cormorants, Great Blue Herons, Bald Eagles and Western Grebes*).

Observations include sightings of marine mammals (*harbor seals, sea lions, gray whales and harbor porpoises*).

North Sound Flight

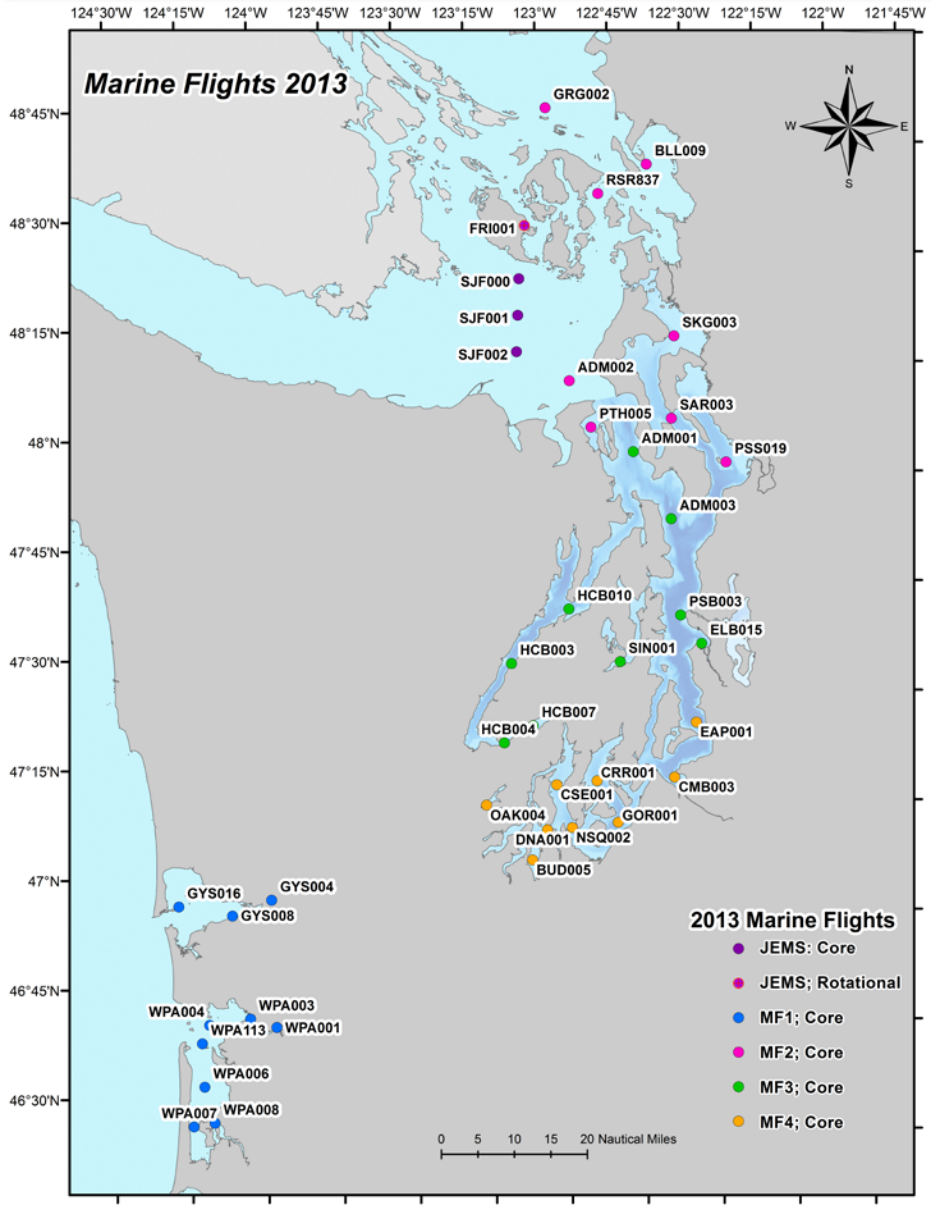
Cloud bank near Orcas Island.

We completed the North Sound flight on February 19th. On this day we saw many different weather patterns. It was very overcast in South Sound but as we made our way north, the weather kept getting better. It was beautiful in the San Juan Islands until we flew over Orcas Island to reach our Strait of Georgia station (GRG002).

We hit an interesting wall of clouds and noticed a change in the sea surface conditions. There was a big swell and we were not able to land at this station. As we made our return approach into Budd Inlet we looked over to Eld Inlet, Totten Inlet and Oakland Bay and could see rain in addition to patches of sun.

This reminded me that spring is just around the corner.

Personal flight log 2-19-2013



Every January we change our routes and rotational stations. We divide our stations into four regions (sampled monthly):

MF1 – Coast (Willapa Bay & Grays Harbor)
MF2 – North Sound
MF3 – Central Sound
MF4 – South Sound

This year we added back two stations in Willapa Bay:

1. Long Island, near Jenson Pt (WPA007):

- Last sampled in 2008 and represents Southwest Willapa Bay.

2. Naselle River (WPA008):

- Last sampled in 2008 and represents Southeast Willapa Bay.

Weather patterns from 1-1-2013 to 2-26-2013

Meteorological conditions typically explain up to half of the variance in observed marine variables (Moore et al. 2008), particularly in shallower waters like those of South Puget Sound. I summarized the specific conditions prevalent during the past two weeks, from north to south. Source: http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html

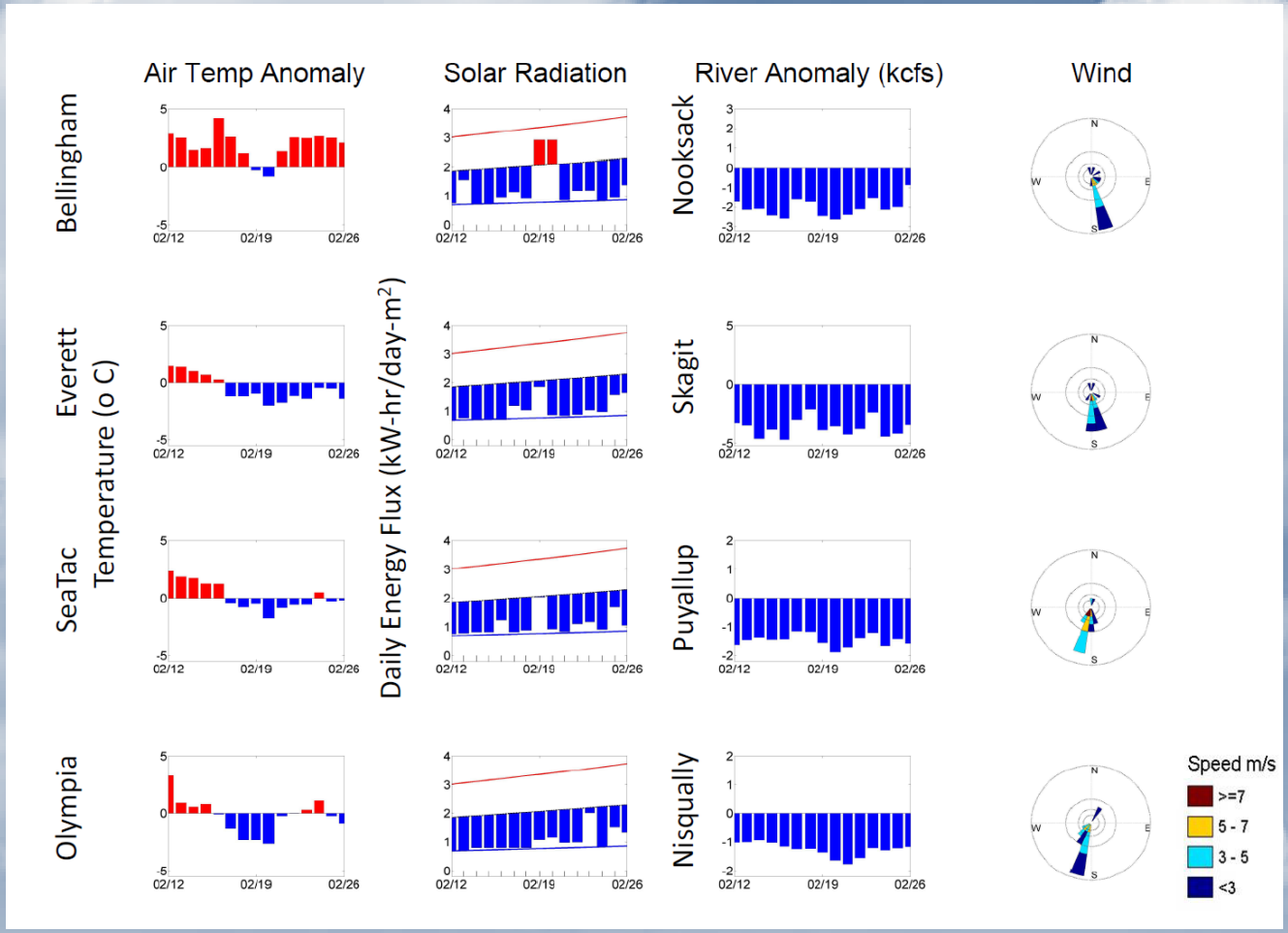
Summary:

Air temperatures have been above normal to the north in Bellingham and at or below normal in the Central and South Puget Sound lowlands.

Sunshine levels have been below normal.

Rivers have been running below normal.

Winds have been consistently from the south.



Moore et al. 2008. Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales. Limnol. Oceanogr., 53(5), 1746–1758

2011-2012 Temperature, salinity are down and oxygen is up

Colder water

Fresher water

More oxygen

Each horizontal line is a station in Puget Sound. Each color dot is 1 out of 12 sampling event per year

- = 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

Summary: Aerial photography 2-26-2013

Many large tidal eddies. Jellyfish aggregations continue to go strong in many inlets. Early bloom in Hood Canal and Eld Inlet. Multiple oil sheens in Seattle waterways.

Start here

Barge and tuck boats in Sinclair Inlet

Herring spawning in Henderson Inlet?

Front

Mixing and Fronts: 10 11 13

Many large tidal eddies in South Sound. Large fronts in Central Basin.

Jellyfish: 2 9

Abundant in Budd, Eld, Henderson and Sinclair Inlets.

Plume

Suspended sediment: 1 10 11 12

In many wind-exposed, near-shore locations and within tidal eddies.

Bloom

Visible blooms: 2 3 4 5 6 7

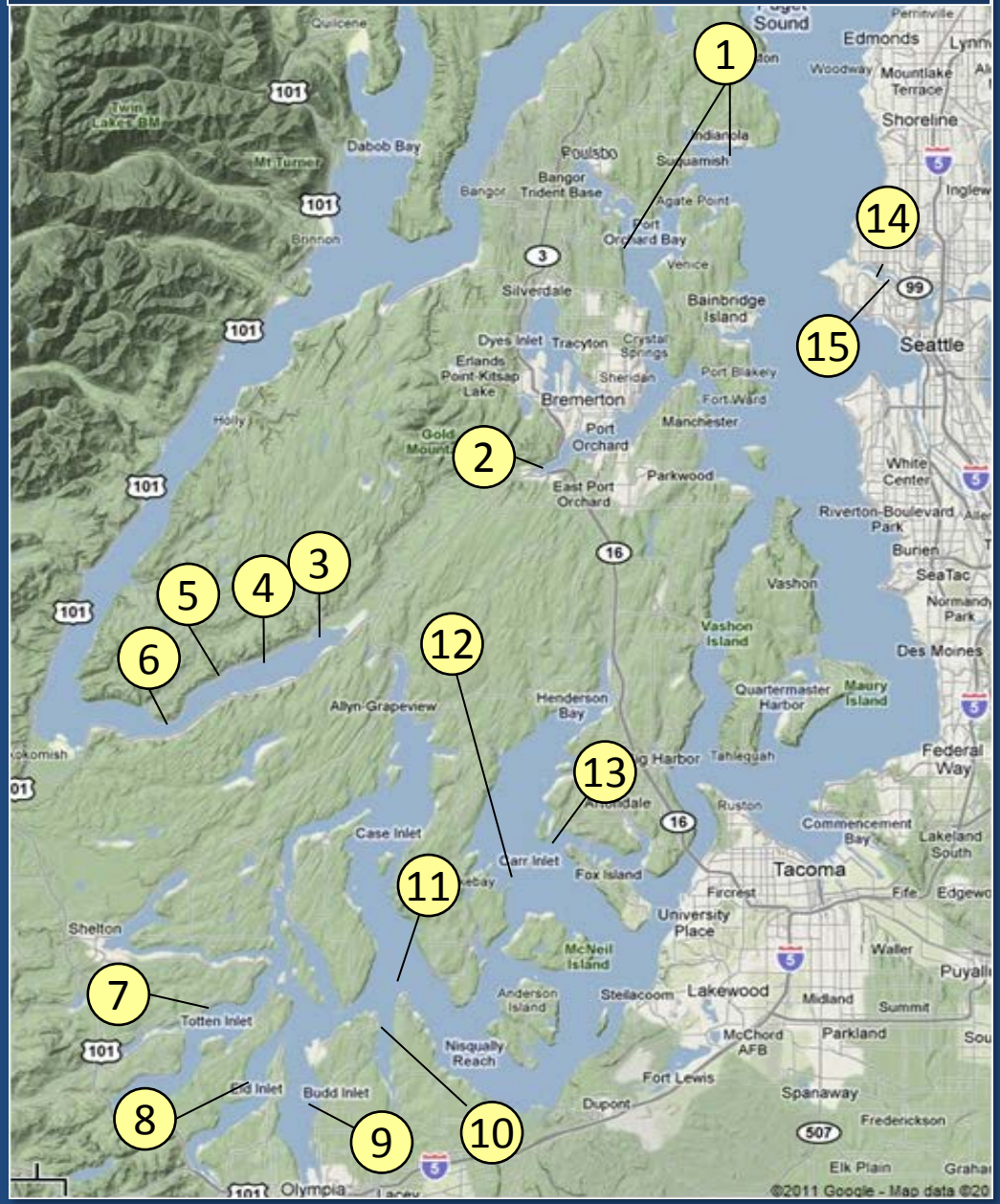
Red-brown blooms in Hood Canal and Eld Inlet.

Debris

Debris: 7 8 9 10 11

Occasional debris lines. Large debris lines associated with tidal eddies.

High tides: 5:21 AM, 5:07 PM Low tides: 11:23 AM, 11:21 PM



Aerial photography navigation guide, 2-26-2013

Click on numbers

Flight Information:

Noon flight:
Variable visibility, snow falling Over Hood Canal, windy (from SW) and waves.

Observation Maps:

Central Sound

South Sound

Aerial photography 2-26-2013

Suspended sediment hugging shoreline.

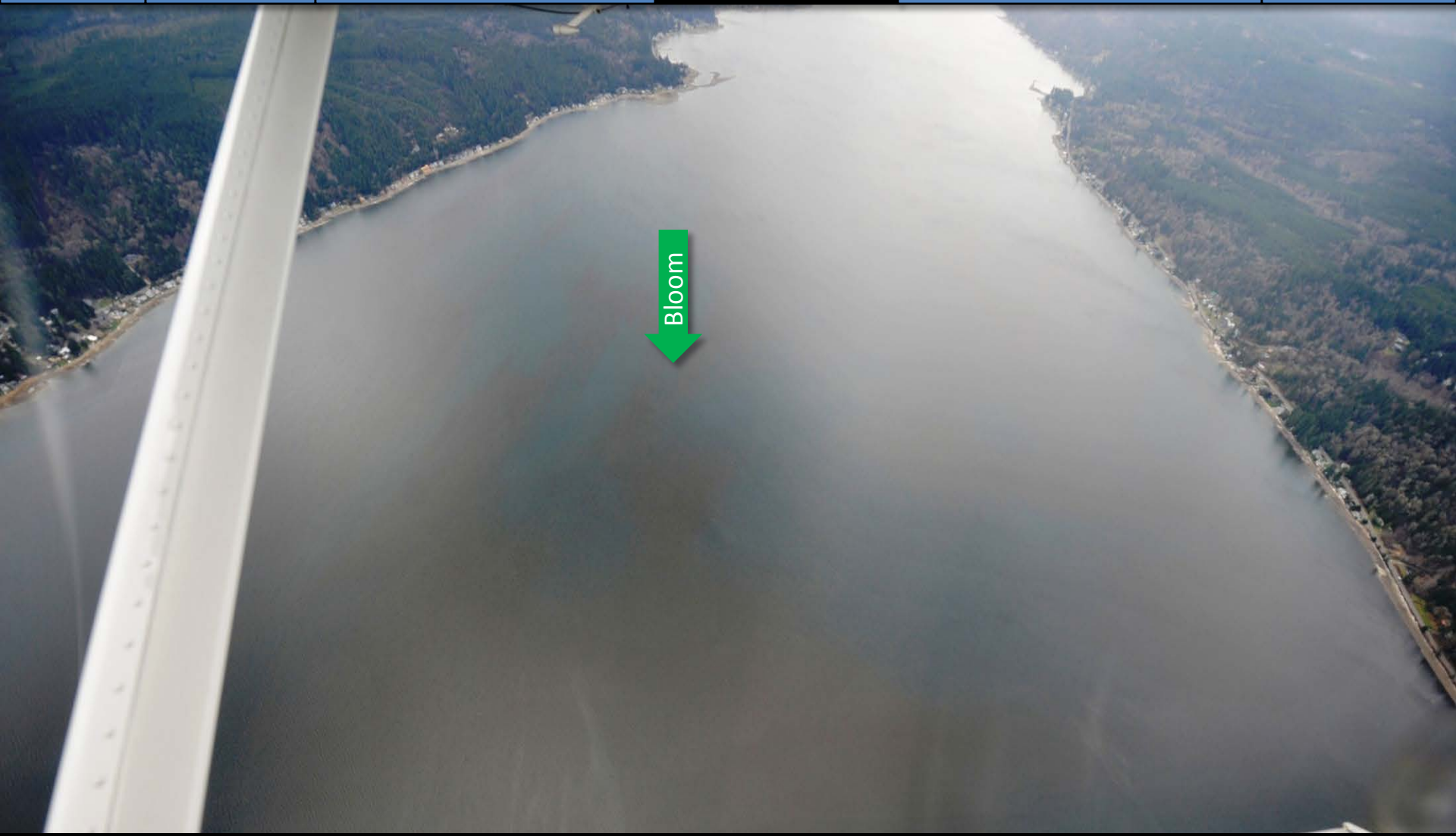
Location: A. Port Madison, B. Agate Passage (Central Sound), 2:24 PM

Patches of jellyfish in the head of the inlet. Location: Sinclair Inlet, 2:35 PM

Aerial photography 2-26-2013

Early near-surface spring plankton bloom. Location: Hood Canal, 2:42 PM

Aerial photography 2-26-2013



Early near-surface spring plankton bloom. Location: Hood Canal, 2:44 PM

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 2-26-2013

Early near-surface spring plankton bloom separating from shore.
Location: West of Lynch Cove, Hood Canal, 2:45 PM

Early near-surface plankton bloom away from the south shore.

Location: Hood Canal, 2:48 PM

Likely spawning herring near shore and beginning phytoplankton bloom.

Location: Totten Inlet (South Sound), 2:59 PM

Long debris line and smoke from fire. Location: Eld Inlet (South Sound), 3:00 PM

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 2-26-2013

Jellyfish still persist, forming bands on the eastern side.

Location: Budd Inlet (South Sound), 3:05 PM

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 2-26-2013

Tidal eddy carrying suspended sediment next to debris line.

Location: Henderson Inlet (South Sound), 3:07 PM

Aerial photography 2-26-2013

Large tidal eddy carrying suspended sediment with debris lines.

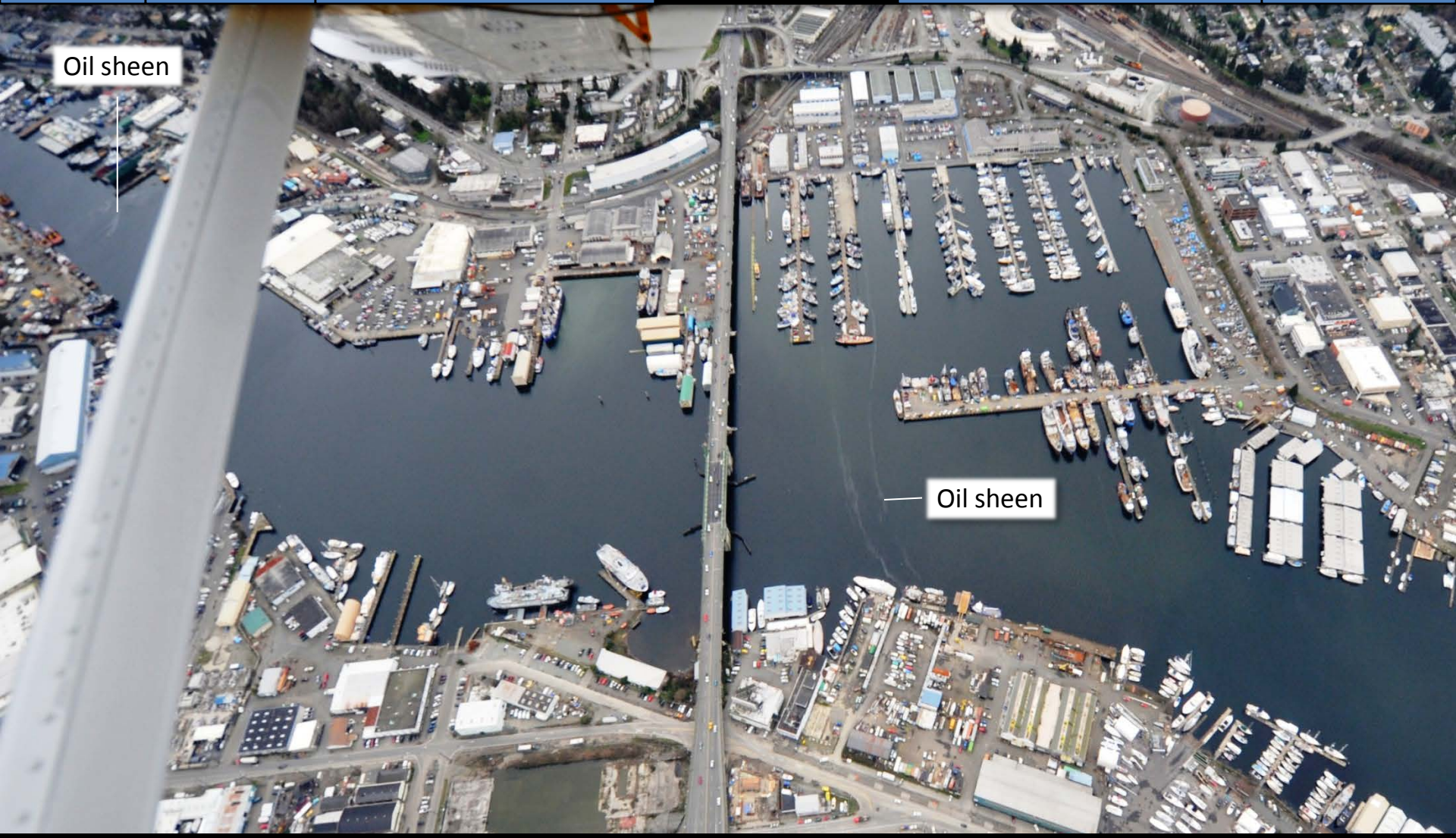
Location: Nisqually Reach looking into Dana Passage (Central Sound), 3:08 PM

Aerial photography 2-26-2013

Suspended sediment surrounding peninsula head.

Location: Carr Inlet (South Sound), 3:13 PM

Large tidal eddy west of Fox Island.
Location: Carr Inlet (South Sound), 3:14 PM



Oil sheen extending into waterway from a vessel at northern shore.
Location: Salmon Bay (Seattle), 3:30 PM

Second oil sheen extending into waterway from a vessel on southern shore.
Location: Ballard (Seattle), 3:30 PM

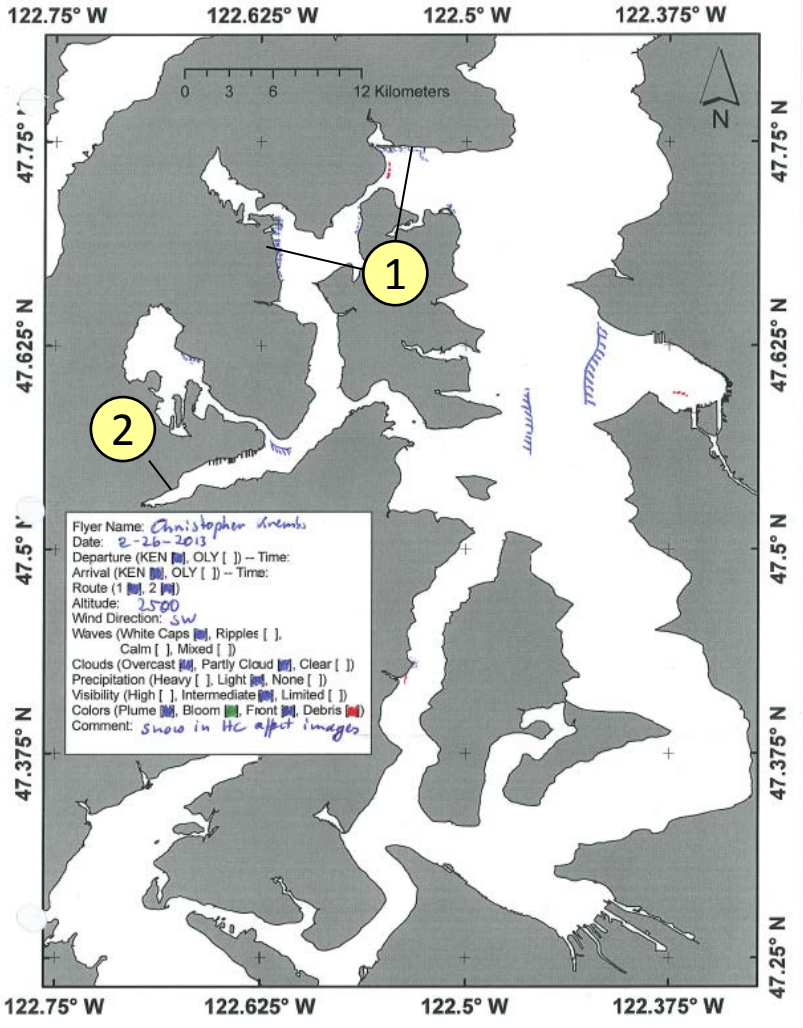
DEPARTMENT OF ECOLOGY State of Washington

Aerial photography observations in Central Sound

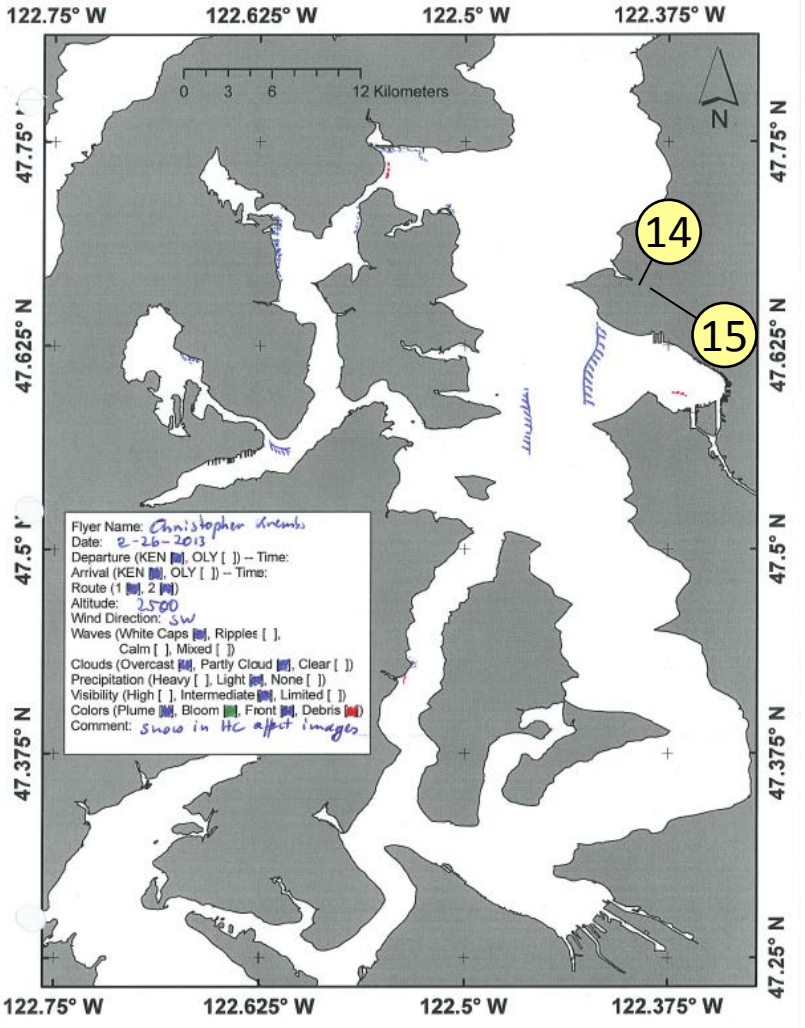
Navigate

Date: 2-26-2013

Noon



Afternoon



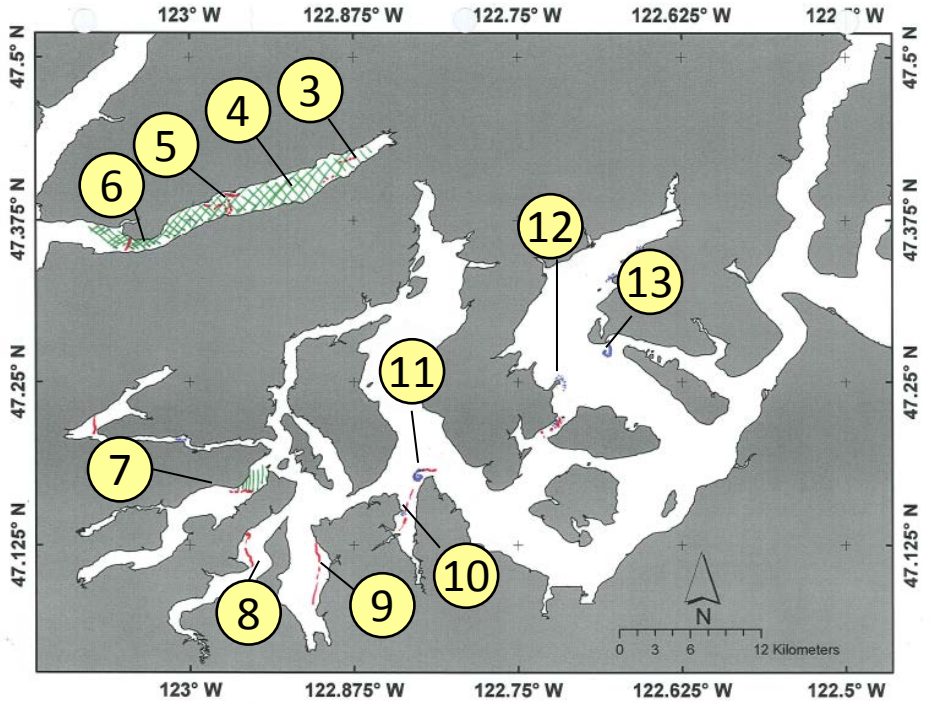
Numbers on map refer to picture numbers for spatial reference

Navigate

Aerial photography

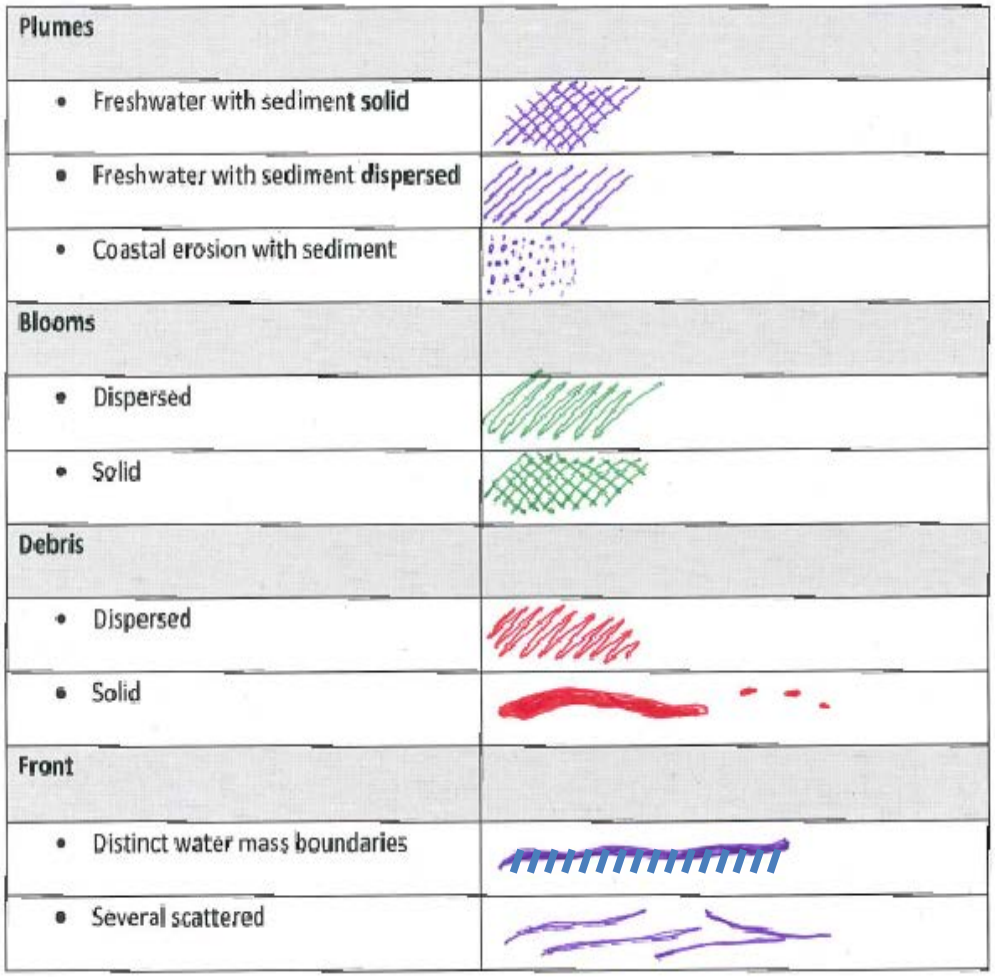
Observations in South Sound: 2-26-2013

Noon



DEPARTMENT OF ECOLOGY State of Washington

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”.

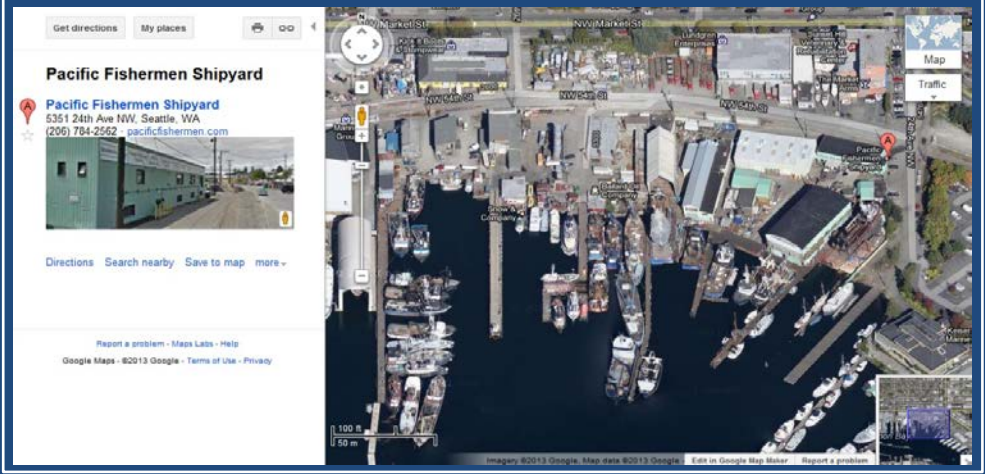
S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1), 83–88.

Ferry and satellite observations: 2012 in review

Brandon Sackmann
Contact:
bsackmann@integral-corp.com

Current Conditions: Victoria Clipper IV moved to a shipyard for annual maintenance. No data available.

Annual Maintenance. No Data Available.



MERIS True Color image used for spatial context (19 February 2011) of the Victoria Clipper en route monitoring route (red dashes on map).

Mooring observations and trends 2-12-2013 to 2-26-2013

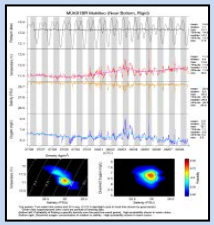
Summary: Dissolved oxygen continues increase, while water temperature and salinity decrease. Higher dissolved oxygen is associated with colder water temperature, though not as strongly as in January. Manchester near-bottom data not available for this report.

Mukilteo, Whidbey Basin near Everett:

Dissolved Oxygen Conditions (12-16 m)

DO Max	8.6 mg/L	on 02/24	at 26.7 PSU	8.2 °C	12 m
DO Min	6.7 mg/L	on 02/12	at 29.2 PSU	9.0 °C	14.1 m

DO Avg	7.4 mg/L
DO Trend	+0.9 mg/L
DO-Sal Corr	-0.54
DO-Temp Corr	-0.82



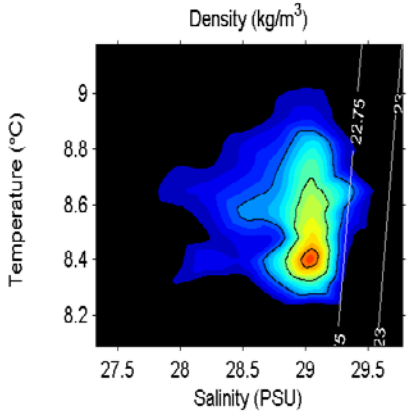
Real-time data online (click)

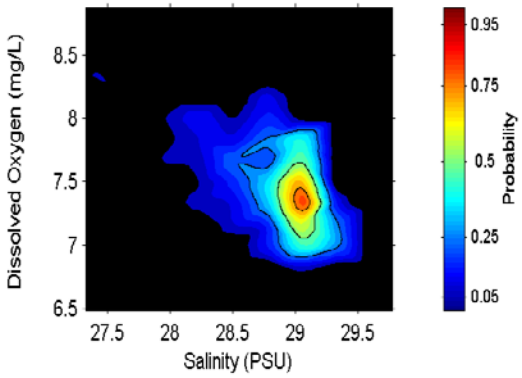
Mukilteo Salinity Conditions (12-16 m)

Sal Max	29.3 PSU	on 02/12	at 9 .0 °C	14.7 m
Sal Min	26.4 PSU	on 02/24	at 8.3 °C	12.3 m
Sal Avg	28.9 PSU			
Sal Trend	-0.3 PSU			

Mukilteo Temperature Conditions (12-16 m)

T Max	9.1 °C	on 02/12	at 29 PSU	14.9 m
T Min	8.2 °C	on 02/24	at 26.7 PSU	12.0 m
T Avg	8.6 °C			
T Trend	-0.5 °C			





Left Panel: Probability of finding a specific density over the past two-week period. High probability shown in warm colors.

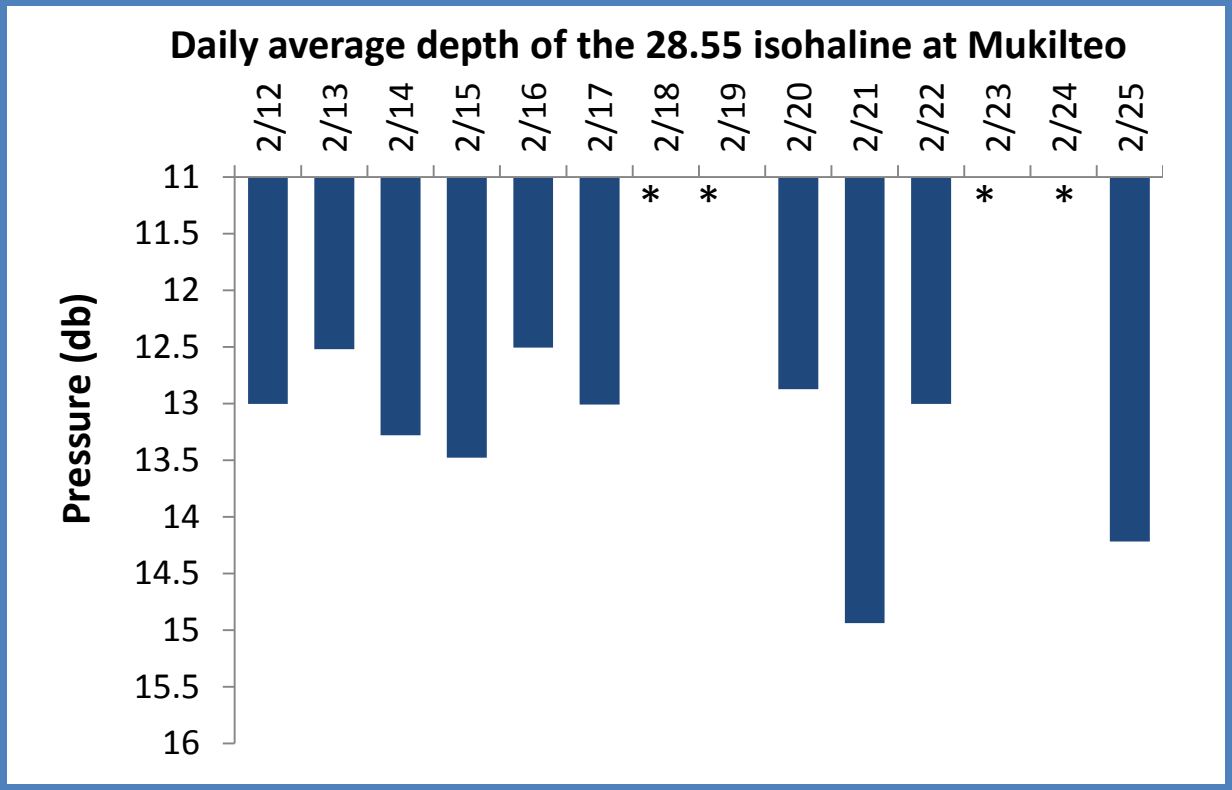
Right Panel: Dissolved oxygen concentration in relation to salinity. High probability shown in warm colors.

Mooring observations and trends 2-12-2013 to 2-26-2013

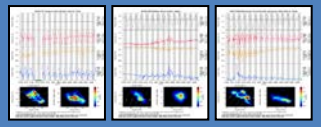
Go to our mooring website at: http://www.ecy.wa.gov/programs/eap/mar_wat/moorings.html

Summary: The freshwater layer is currently increasing its thickness in Possession Sound, almost by a meter. In February, the freshwater layer ranged from 12 - 15 m, while in January the range was 11 - 14 m.

We report on thickness of the fresh water layer by monitoring our near-surface sensor. The pycnocline is often near the surface sensor (*). This is another way to interpret the amount of freshwater entering Puget Sound.

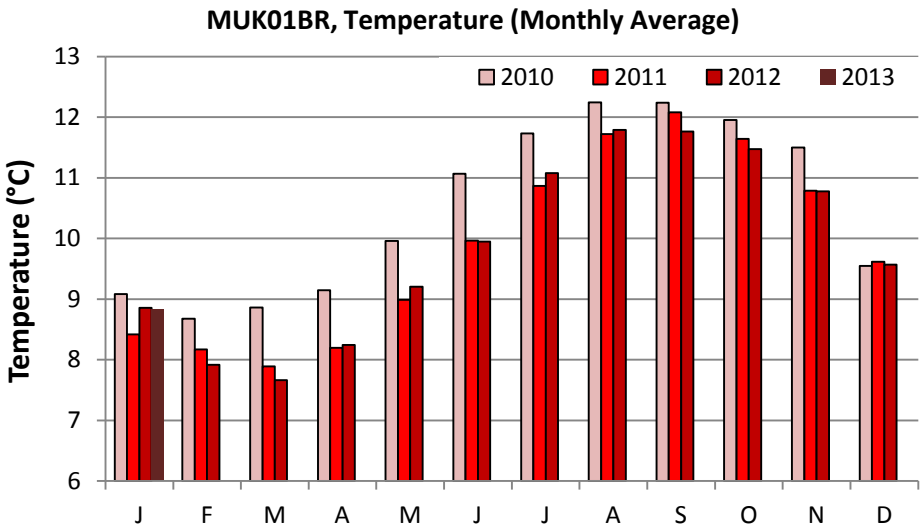


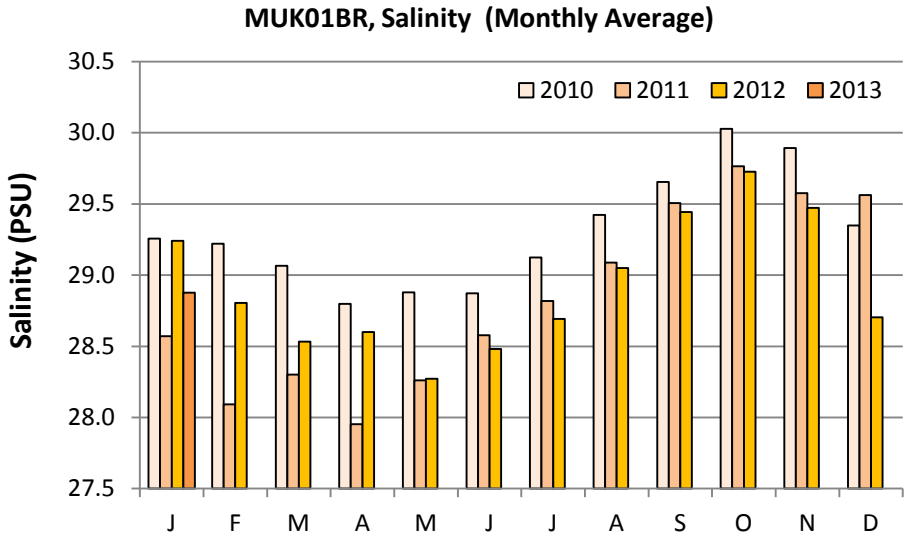
We track the depth of the isohaline where salinity is 28.55 (±0.05) to measure the thickness of the freshwater layer at our Mukilteo station. The near-surface sensor experienced tidal pressure variations of 11.0 to 16.0 meters (or dbar).

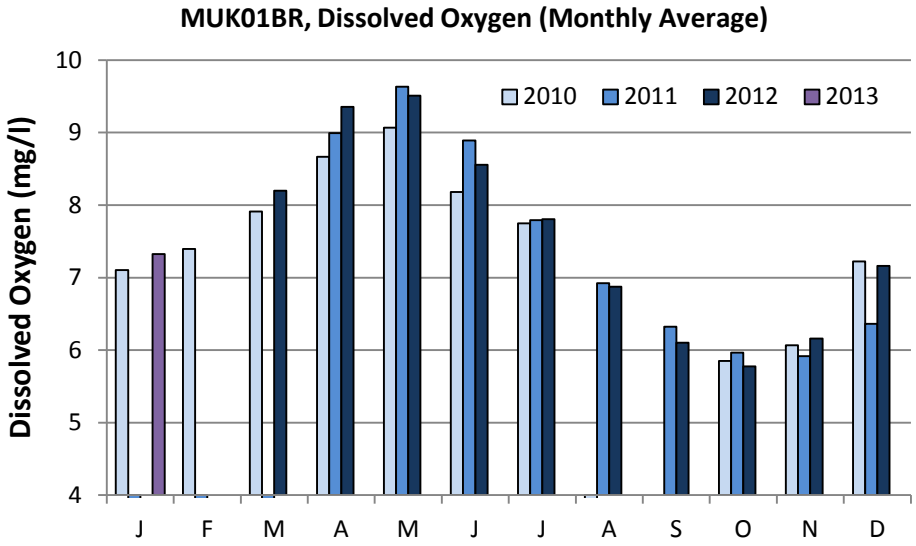


Real-time data online (click)

Mooring observations and trends Mukilteo 2010 to 2013







In Possession Sound (11-16 m), we measure significant inter-annual variability in temperature and salinity (*2011 and 2012 being colder and fresher than the previous years*). These observations match anomaly data from the water column, (see, p. 9).

All three variables show strong seasonality, yet are shifted in phase.

Dissolved oxygen at the 11-16 m depth (including the 28.55 PSU isohaline) is behaving predictably from year to year. Above and below this depth, variability is much larger.

Get data from Ecology's Monitoring Programs

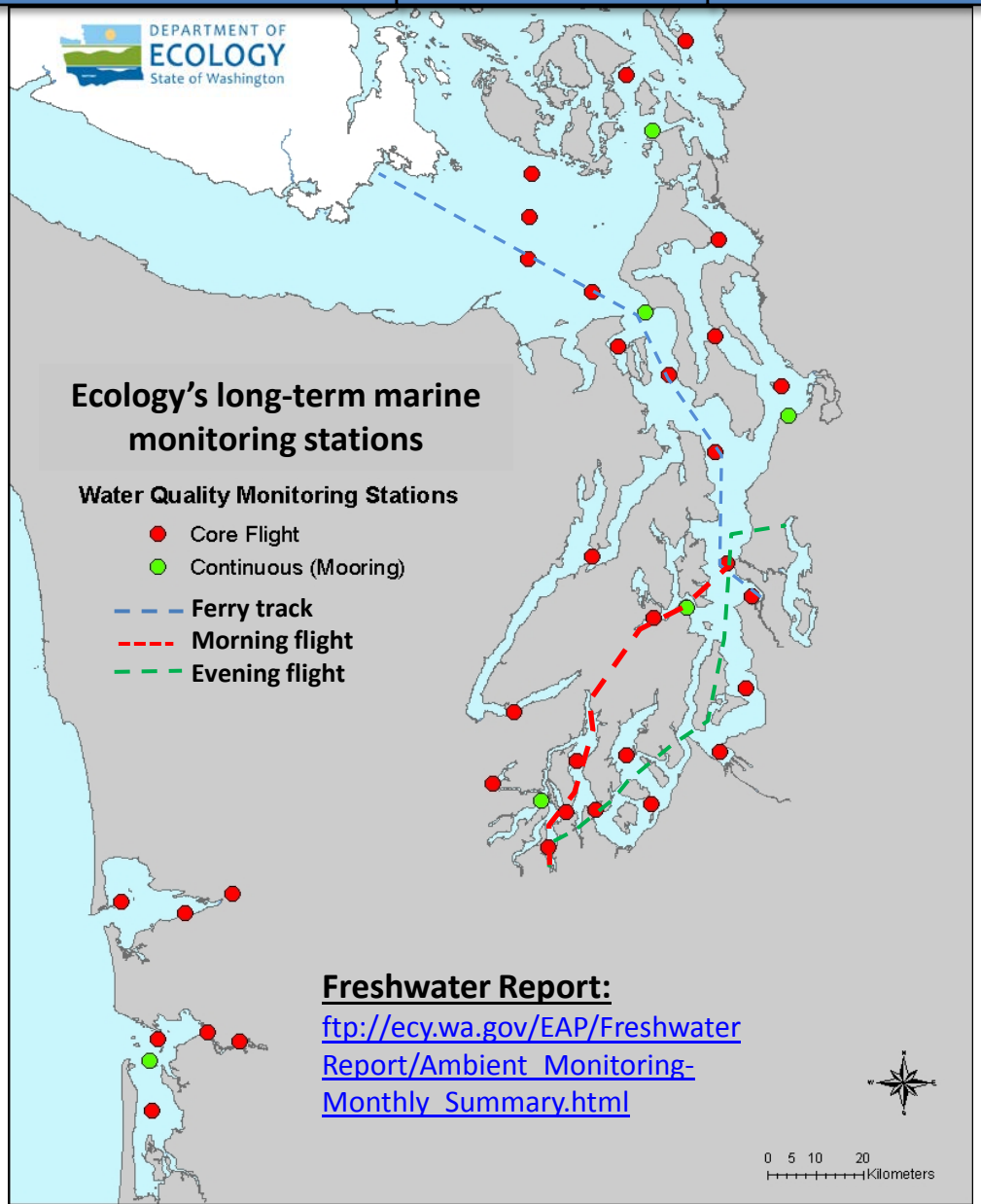
Flight log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

Long–Term Monitoring Network

christopher.krembs@ecy.wa.gov

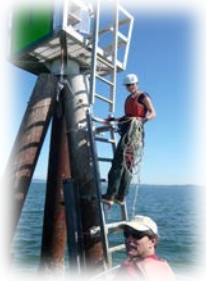
Access core monitoring data:

http://www.ecy.wa.gov/apps/eap/marinewq/mwdataset.asp



Real–Time Sensor Network

brandon.sackmann@ecy.wa.gov



Access mooring data:

http://www.ecy.wa.gov/programs/eap/mar_wat/-.html

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 Navigation, Swantown Marina, and Kenmore Air.