Publication No. 12-03-081

DEPARTMENT OF ECOLOGY State of Washington

Eyes Over Puget Sound

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

+ Hood Canal, Willapa Bay and Grays Harbor

Surface Conditions Report

December 13, 2012

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 12-13-2012 at a glance

LONG-TERM MARINE MONITORING UNIT

Mya Keyzers
Laura Friedenberg

Skip Albertson

Julia Bos
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Dr. Christopher Krembs

Dr. Brandon Sackmann

Personal flight log p. 4

With a new camera the idea of an eye under water will begin in 2013.

Weather conditions p. 6

The weather has been warm & cloudy with weak winds from the south. River flows are trending below normal, particularly to the north.

Water column and mooring p.7 , p.30

Much colder and still fresher Puget Sound waters. Oxygen levels are up and increasing as part of the seasonal cycle.

Aerial photography p. 8-27

Jellyfish aggregations continue to go strong in terminal inlets. Debris lines numerous near river estuaries. Nearshore suspended sediment in many places.

Ferry and satellite p. 28-29

Low fluorescence throughout Central Sound and Admiralty Inlet. Temperatures range from 8.5-9.5°C. Increased freshwater entering Central Sound near Triple Junction (min. near-surface salinity <21.5 PSU).

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

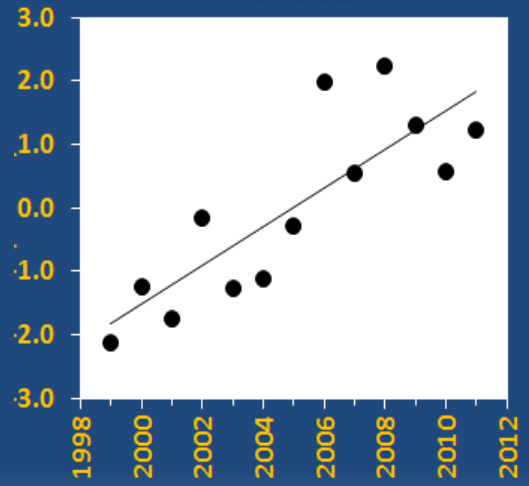
Why Eyes Over Puget Sound?

We observe increasing nutrients and algal blooms in Puget Sound:

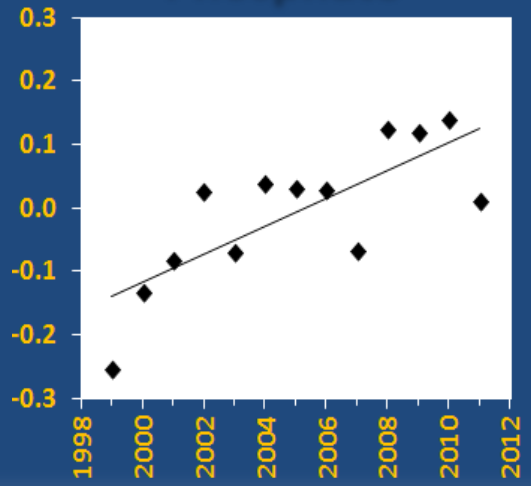
Algae bloom Budd Inlet 2010

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

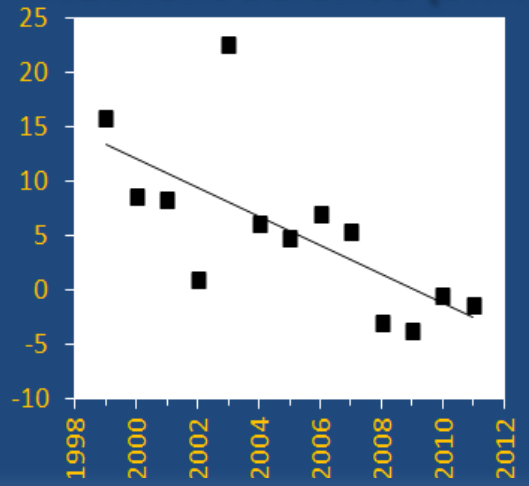
Nitrate



Phosphate



Nutrient Balance (Si:N)



Marine Flight 4 (South)

Beautiful Hood Canal

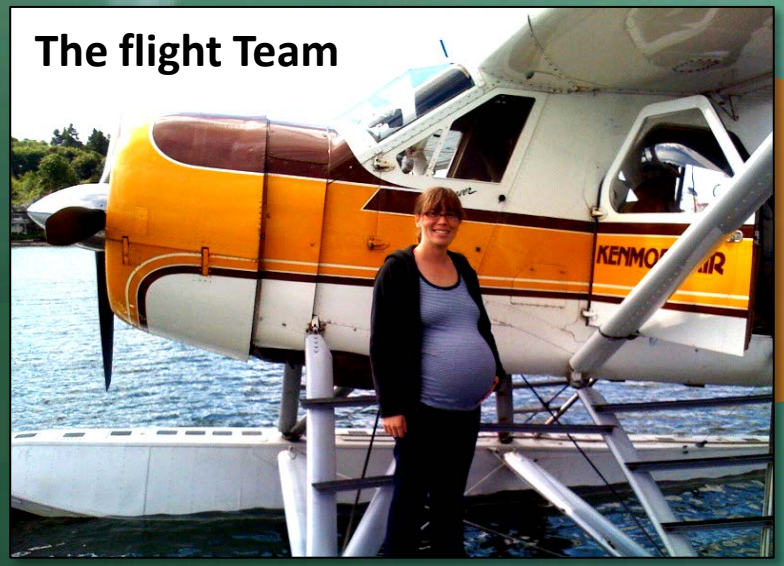
What a difference a week makes! The windy weather grounded us last week but this week has been great. We've completed 3 of our 4 flights so far. The South Sound flight was particularly beautiful with calm water and no rain.

Underwater picture of moon jelly at Swantown marina

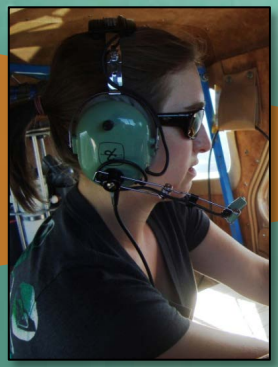
I dunked the new GoPro camera for the first time and got a moon jelly close up. We were treated to an amazing aerial display by a flock of birds in Hood Canal (sorry bird lovers - they were too quick for me to identify). It feels great to have only one flight remaining during this busy and stormy month!

Marine Flight 4 (South)

This was my fourth flight back since being on maternity leave and I guess it's like riding a bike: I didn't forget, just needed to knock the dust off. It is great to be back in the air (minus the giant belly) but it reminded me of what a demanding day it is. So I owe a big thank you to Laura Friedenberg, Julianne Ruffner and Julia Bos for keeping the data coming while I was baby bonding.



My last flight June 2012



Julia, Laura and Julianne.

Weather patterns from 11-28-2012 to 12-13-2012

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

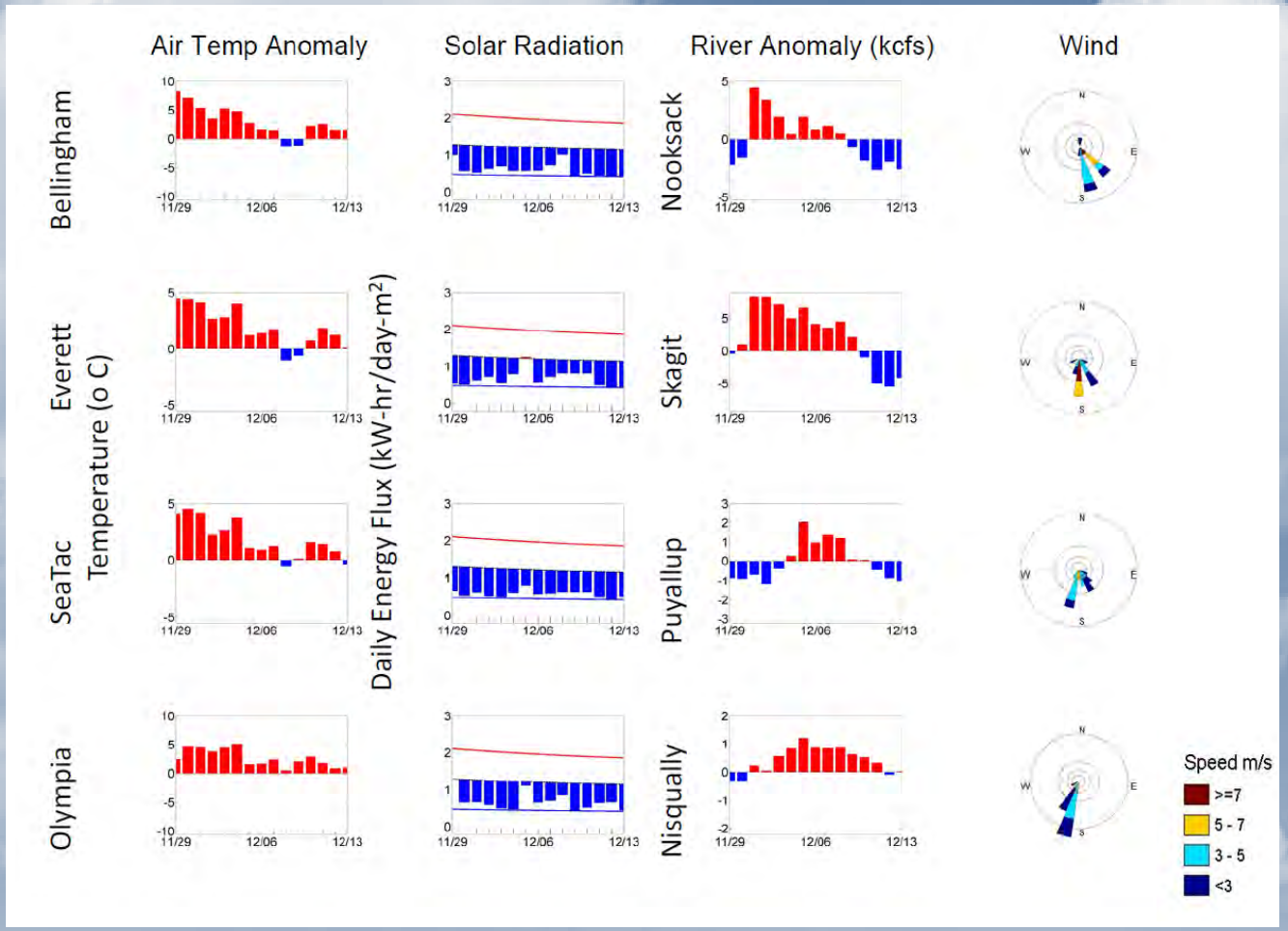
Summary:

Air temperatures have been mostly above normal.

Sunshine has been below normal.

Rivers to the north have transitioned from running above normal to running below normal, with trends continuing.

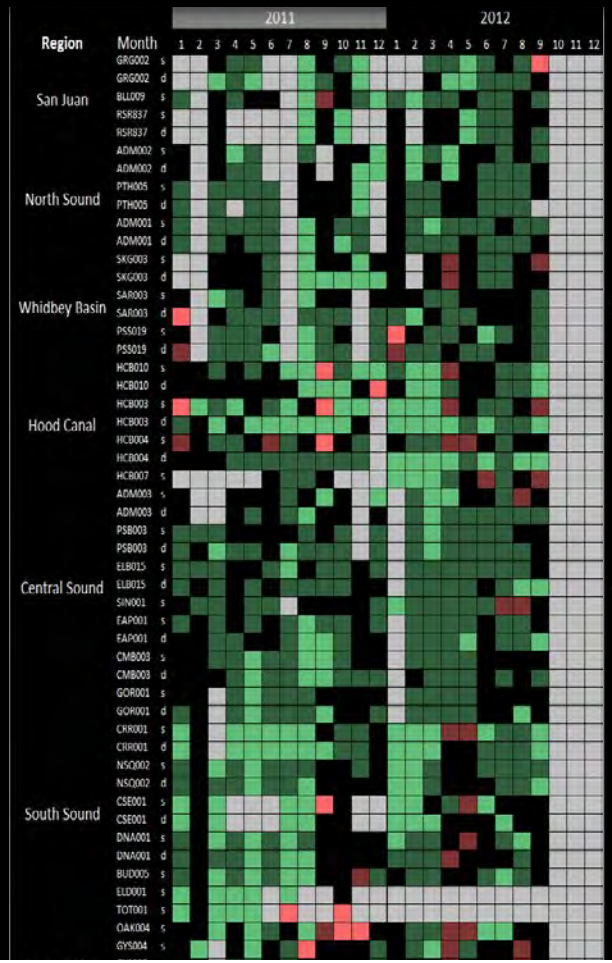
Winds have been light and predominantly from the south.



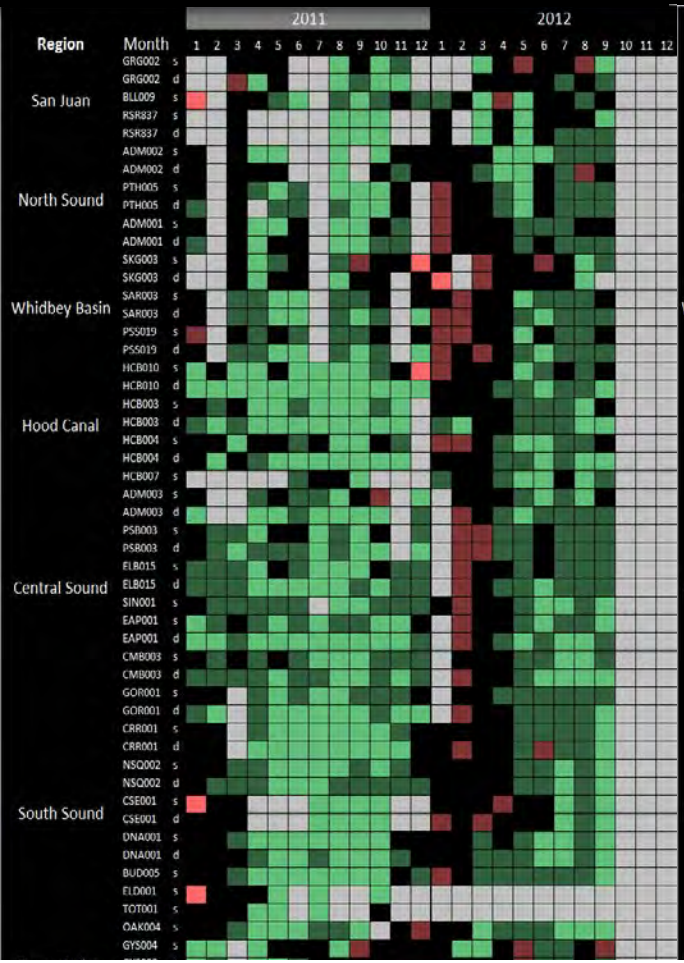
Moore et al. 2008. Local and large-scale climate forcing of Puget Sound oceanographic properties on seasonal to interdecadal timescales. Limnol. Oceanogr., 53(5), 1746–1758

2011-12 Temperature, salinity is down and oxygen is up

Colder



Fresher



More Oxygen

= higher than expected (>IQR, n=13)
= expected (=IQR, n=13)
= lower than expected (>IQR, n=13)
= higher than previous measurements
= no data
= lower than previous measurements

Read about the details: http://www.ecy.wa.gov/programs/eap/mar_wat/pdf/Poster_Long_Live_The_Kings.pdf

Summary: Aerial photography 12-13-2012

Jellyfish aggregations continue to go strong in terminal inlets. Debris lines numerous near river estuaries. Nearshore suspended sediment in many places.

Start here

Erosion SW of Bay Center Rd., Willapa Bay

Shore erosion next to Discovery Park

Front

Mixing and Fronts:
Large cross-basin fronts in Central Basin, Nisqually Reach and between Budd and Eld Inlets.

Jellyfish:
Budd, Eld, Henderson and Sinclair Inlets.

Plume

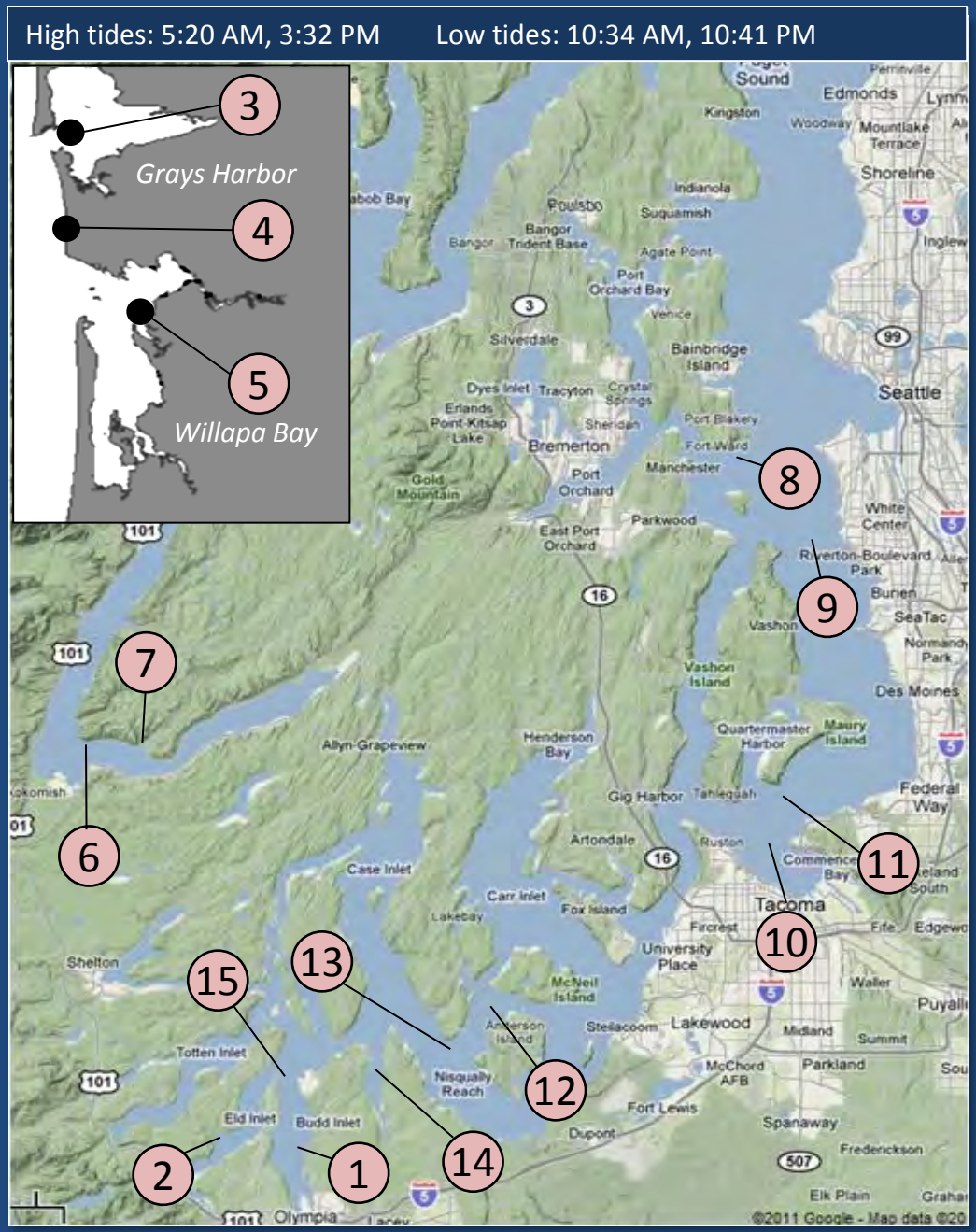
Suspended sediment:
At many wave exposed shores (see maps).

Bloom

Visible blooms:
Small olive-brown localized bloom in surf of ocean beach.

Debris

Debris:
Long debris lines in many locations often associated with river plumes in Central and South Sound.



Aerial photography navigation guide, **12-13-2012**

Click on numbers

Flight Information:

- **Day-long flight:**
  High visibility, waves, very high tide

Observation Maps:

Central Sound

South Sound

DEPARTMENT OF ECOLOGY State of Washington

Aerial photography 12-13-2012

Jellyfish patches persist in South Sound Bays. Location: Budd Inlet, 10:50 AM

Jellyfish patches persist in South Sound Bays. Location: Eld Inlet, 10:52 AM

Strong incoming tide replacing sediment rich water. Location: Mouth of Grays Harbor, 12:25 PM

Nearshore algae bloom. Location: Grayland Beach State Park (Coast), 12:31 PM

Aerial photography 12-13-2012

Willapa shellfish grower applying local ground up oyster shells to improve clam substrate.

Location: West of Bone River (Willapa Bay), 12:53 PM

Skokomish river plume and debris. Location: Across Union (Hood Canal), 2:18 PM

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Aerial photography 12-13-2012

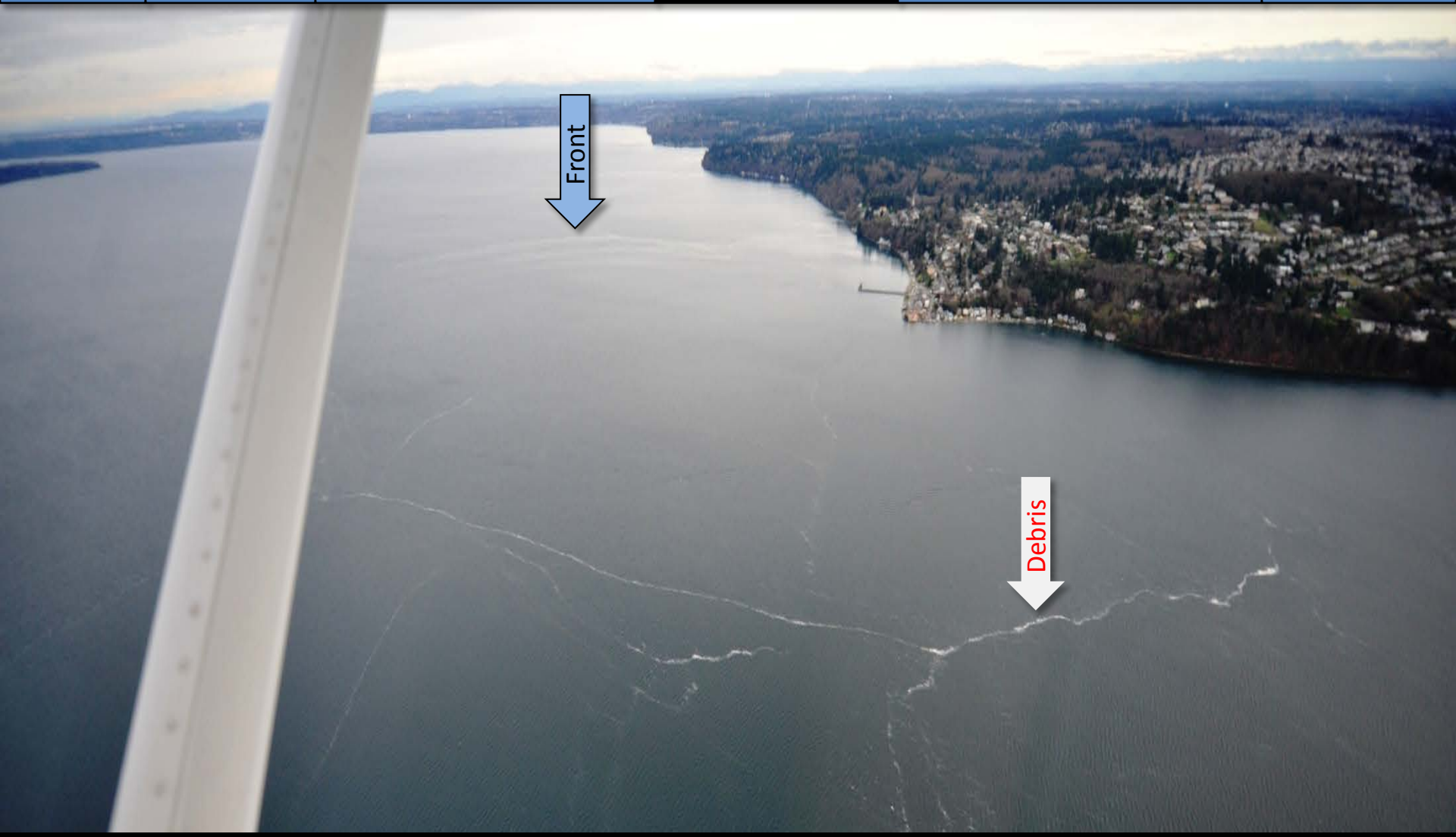
Debris line. Location: Tahuja (Hood Canal), 2:19 PM

Debris lines delineating greener water leaving Sinclair Inlet.

Location: South Bainbridge Island, (Central Sound), 2:39 PM

Large front across central sound running across to Lincoln park.

Location: Blake Island (Central Sound), 2:46 PM



Debris lines highlighting complex surface water structure.

Location: Browns Point (southern Central Sound), 3:46 PM

Debris lines highlighting complex surface water structure of Puyallup river plume.

Location: Vashon Island (southern Central Sound), 3:46 PM

Eddy with different water and debris lines. Location: Filucy Bay (South Sound), 3:58 PM

Strong debris lines form at peninsula head. Location: Nisqually Reach (South Sound), 3:59 PM

Aerial photography 12-13-2012

Jellyfish aggregations and green water. Location: Henderson Inlet (South Sound), 4:02 PM

Aerial photography 12-13-2012

Debris lines highlighting complex surface water structure.

Location: Budd Inlet/Eld Inlet (South Sound), 4:04 PM

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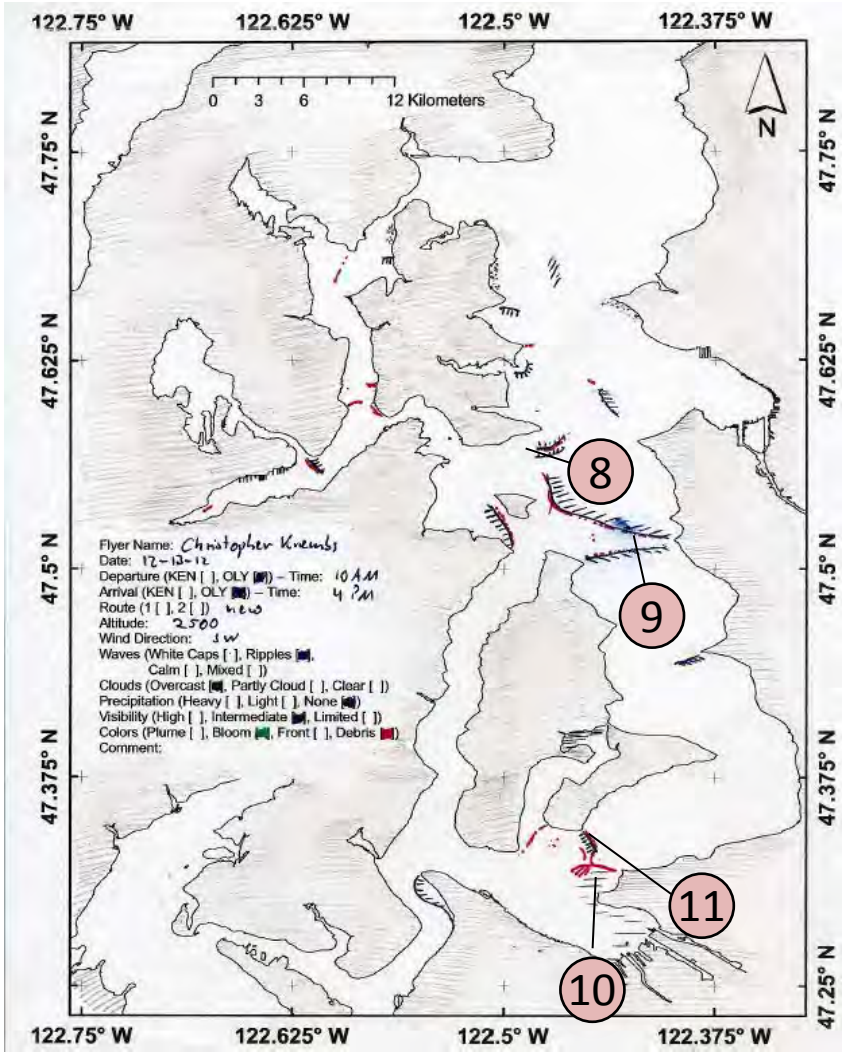
Aerial photography observations in Central Sound

Navigate

Date: 12-13-2012

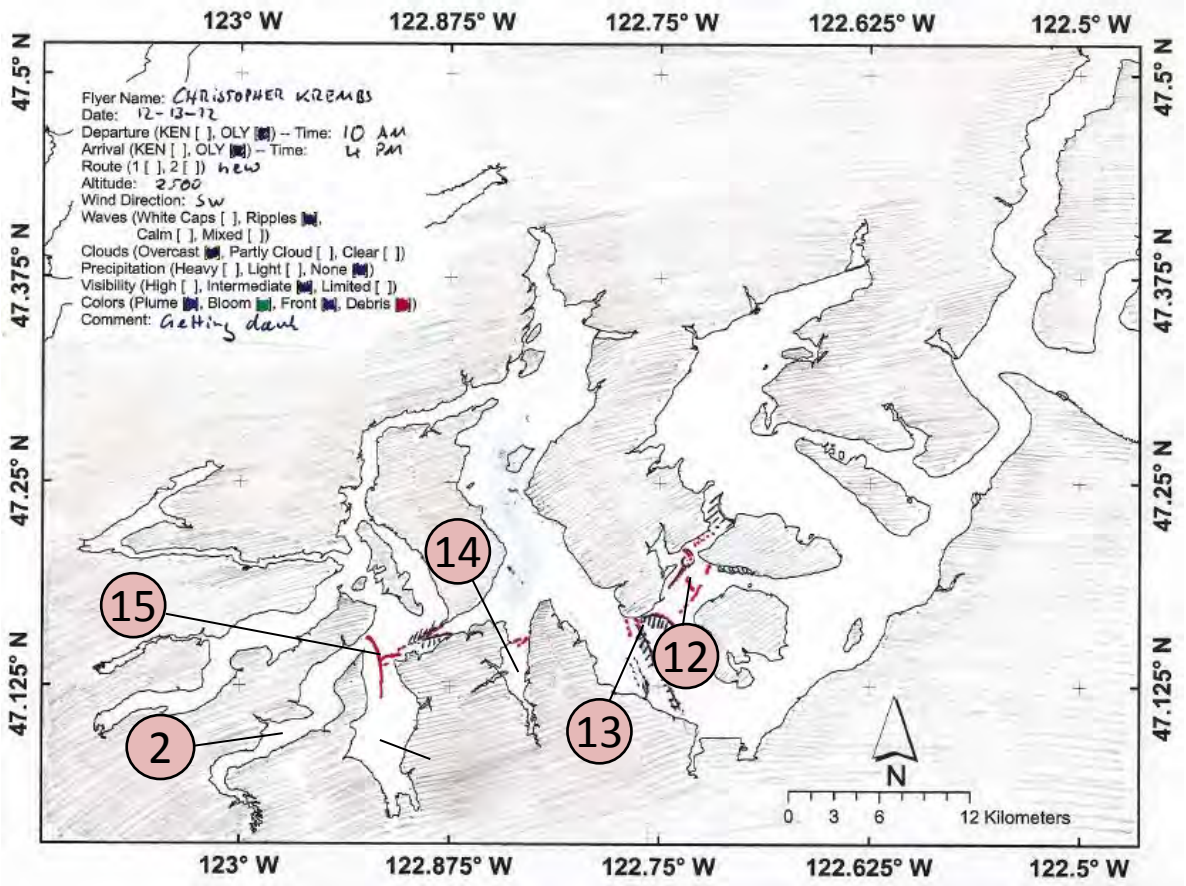


Numbers on map refer to picture numbers for spatial reference

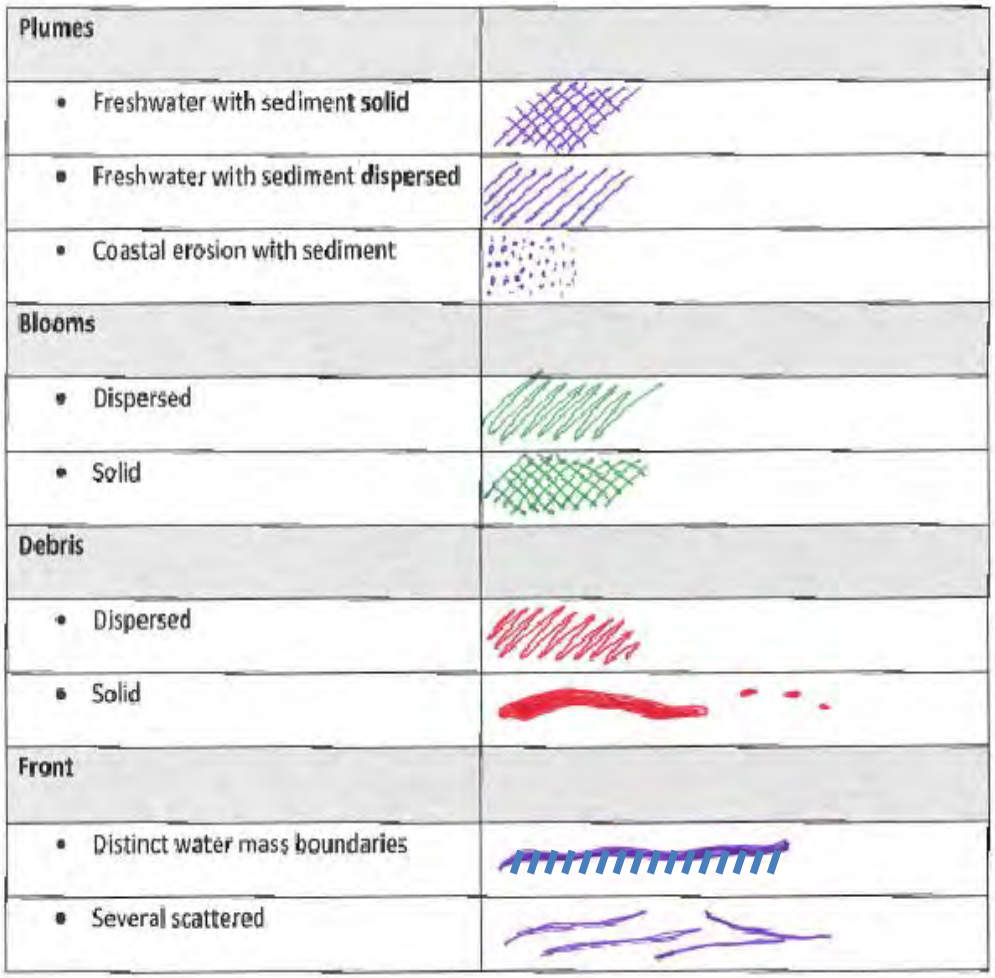
Navigate

Aerial photography

Observations in South Sound: 12-13-2012



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.

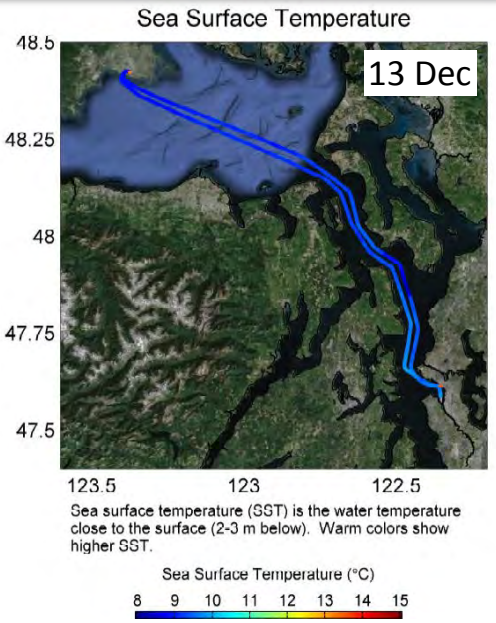
Debris: Debris can be distinguished into natural and anthropogenic debris *sensu* Moore and Allen 2000. The majority of debris in Puget Sound is natural mixed with discarded man made pieces of plastic, wood etc. From the plane we can't differentiate the quality of debris at the surface and therefore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

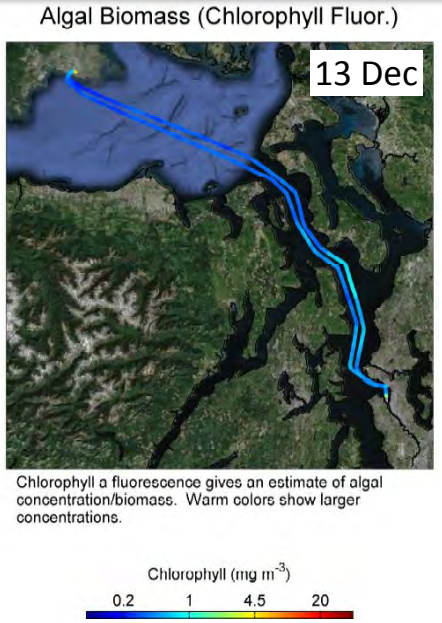
S.L. Moore, M. J. Allen. 2000. Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of the Southern California Bight. Marine Pollution Bulletin, 40(1), 83–88.

Daily ferry and satellite observations in Central Sound, 12-13-2012

Contact: brandon.sackmann@ecy.wa.gov

MERIS True Color image used for spatial context (19 February 2011). Image is not coincident with ferry data shown on right.





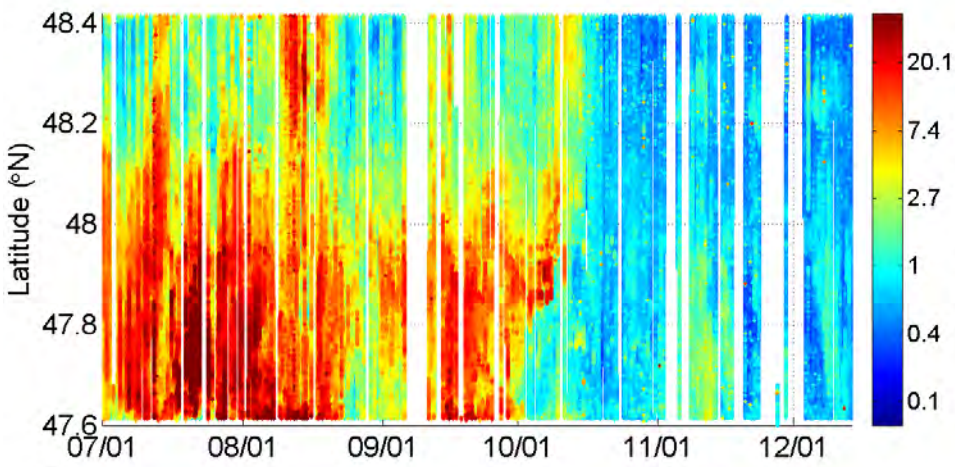
Current Conditions: Low fluorescence throughout Central Sound and Admiralty Inlet. Temperatures range from 8.5-9.5°C. Increased freshwater entering Central Sound near Triple Junction (minimum near-surface salinity <21.5 PSU).

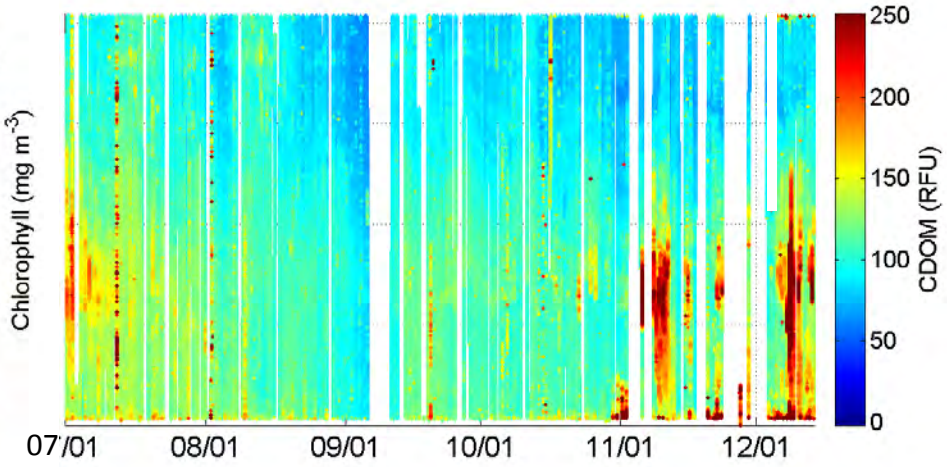
--- Daily 'Quick-Look' Products Available ---

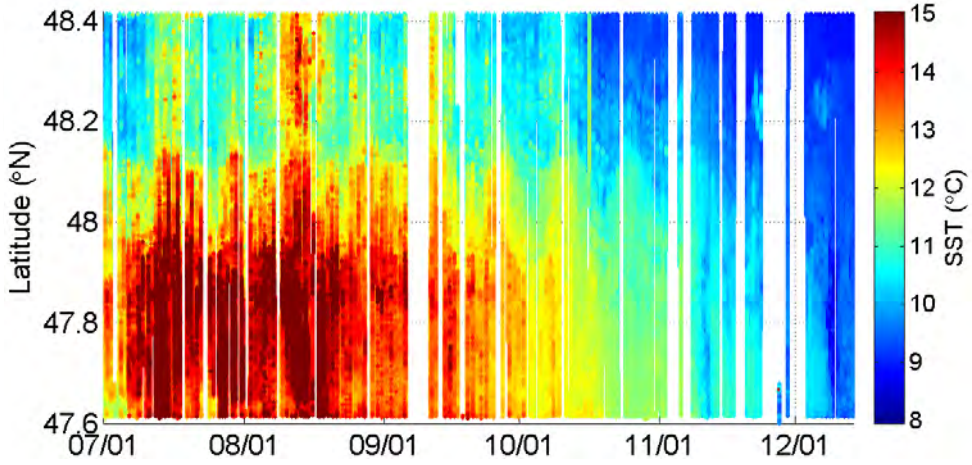
(http://www.ecy.wa.gov/programs/eap/mar_wat/eops/clipper.html)

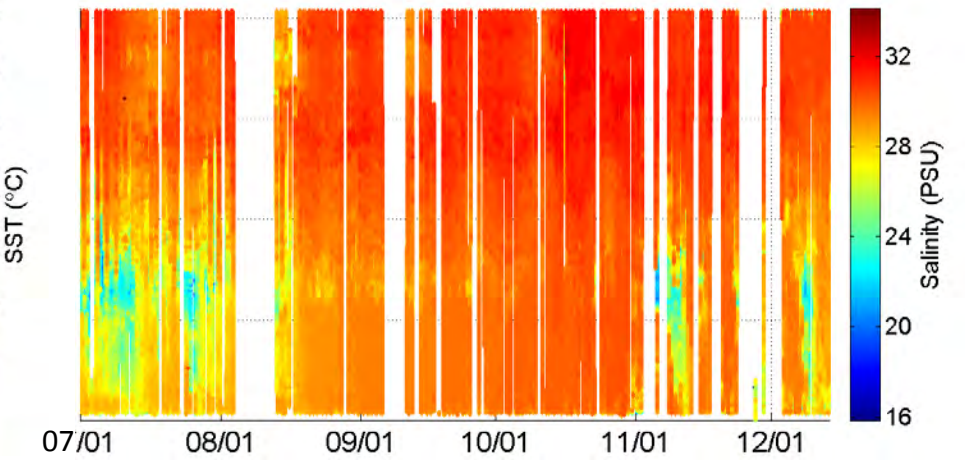
Ferry & satellite observations 12-13-2012

- Spatial temperature gradient between Main Basin and Strait of Juan de Fuca continues to weaken.
- Increased river discharge from recent precipitation and storm activity has allowed fresher and highly-colored water to enter Main Basin from Whidbey Basin.









Mooring observations and trends 11-29-12 to 12-13-12

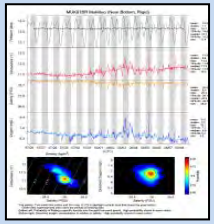
Summary: Dissolved oxygen increasing and water temperatures decreasing. Dissolved oxygen negatively correlated with salinity and water temperature. Temperature is now positively correlated with salinity.

Mukilteo, Whidbey Basin near Everett:

Mukilteo Dissolved Oxygen Conditions (12-16 m)

DO Max	8.1 mg/L	on 12/6	at 26.1 PSU	9.5 C	13.9 db
DO Min	6.1 mg/L	on 11/29	at 29.8 PSU	10.5 C	14.6 db

DO Avg	7.0 mg/L
DO Trend	+0.5 mg/L
DO-Sal Corr	-0.82
DO-Temp Corr	-0.77



Real-time data online (click)

Mukilteo Salinity (Sal) Conditions (12-16 m)

Sal Max	29.8 PSU	on 11/29	at 10.5 C	15.1 db
Sal Min	26.1 PSU	on 12/6	at 9.5 C	13.9 db

Sal Avg	28.9
Sal Trend	-0.3 PSU

Mukilteo Temperature (T) Conditions (12-16 m)

T Max	10.5 C	on 11/29	at 29.8 PSU	13.8 db
T Min	9.4 C	on 12/12	at 27.3 PSU	11.64 db

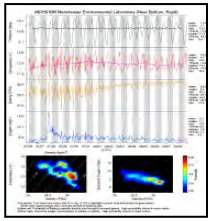
T Avg	10.0 C
T Trend	-0.3 C

Manchester, near Clam Bay:

Manchester Dissolved Oxygen Conditions (8.6-12.7 m)

DO Max	7.8 mg/L	on 12/10	at 27.5 PSU	9.2 C	12.4 db
DO Min	5.9 mg/L	on 11/29	at 29.6 PSU	10.5 C	12.7 db

DO Avg	6.3 mg/L
DO Trend	+ 0.3 mg/L
DO-Sal Corr	-0.81
DO-Temp Corr	-0.79



Real-time data online (click)

Manchester Salinity (Sal) Conditions (8.6-12.7 m)

Sal Max	29.8 PSU	on 12/7	at 10.2 C	13.0 db
Sal Min	27.5 PSU	on 12/10	at 9.2 C	12.4 db

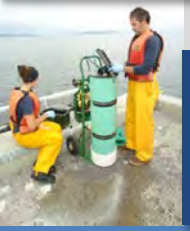
Sal Avg	29.4
Sal Trend	No trend

Manchester Temperature (T) Conditions (8.6-12.7 m)

T Max	10.5 C	on 11/29	at 29.6 PSU	12.8 db
T Min	9.2 C	on 12/10	at 27.5 PSU	12.4 db

T Avg	10.2 C
T Trend	-0.4 C

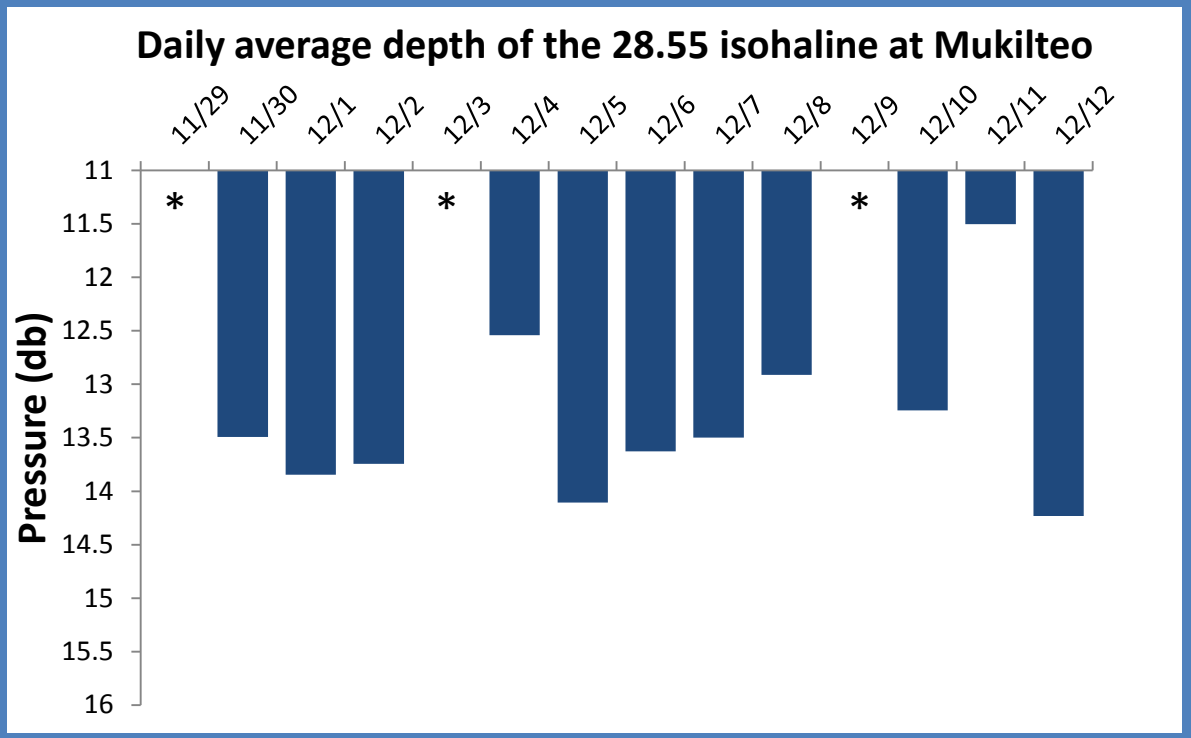
Mooring observations and trends 11-29-12 to 12-13-12



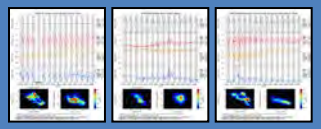
Go to our mooring site at: http://www.ecy.wa.gov/programs/eap/mar_wat/moorings.html

Summary: River flows are beginning to seasonally increase, though lower than expected. Therefore a consistent freshwater layer is not yet detected by the near bottom sensor.

This month we report on thickness of the fresh water layer by monitoring our near-bottom sensor. Pycnocline <11m outside of sensor depth range (*).



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).



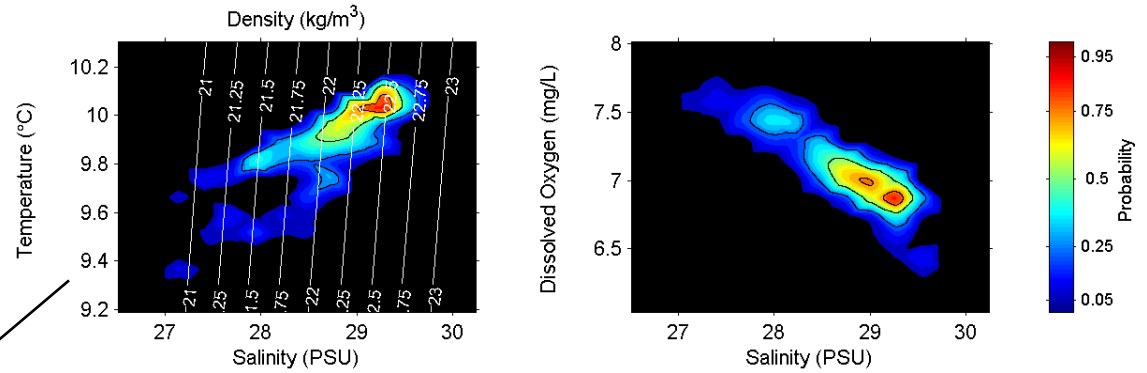
Real-time data online (click)

Mooring observations and trends 11-29-12 to 12-13-12

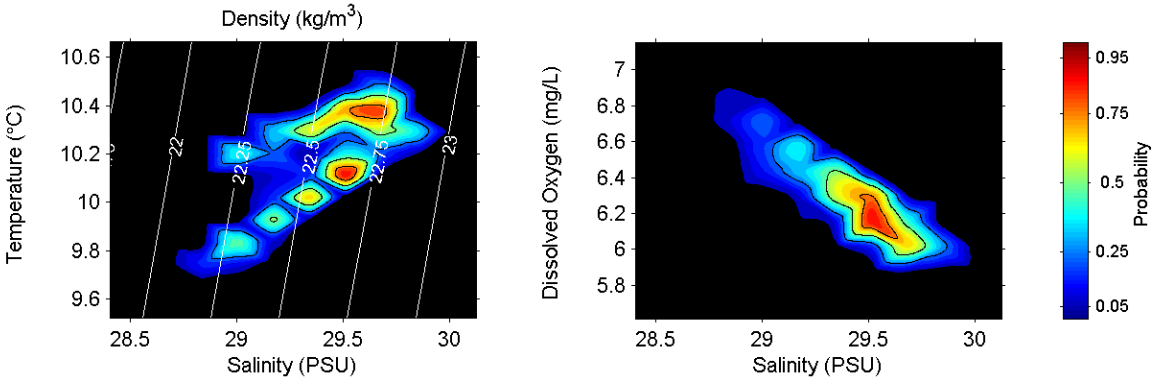
DEPARTMENT OF ECOLOGY State of Washington

NANOOS

Change in DO (mg /L) over the last 2 weeks



At Mukilteo, the lowest dissolved oxygen concentrations were associated with the water mass of highest salinities.



At both stations, salinity and temperature now positively correlate implying that Puget Sound is keeping shallow bays warmer.

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.

Get data from Ecology's Monitoring Programs

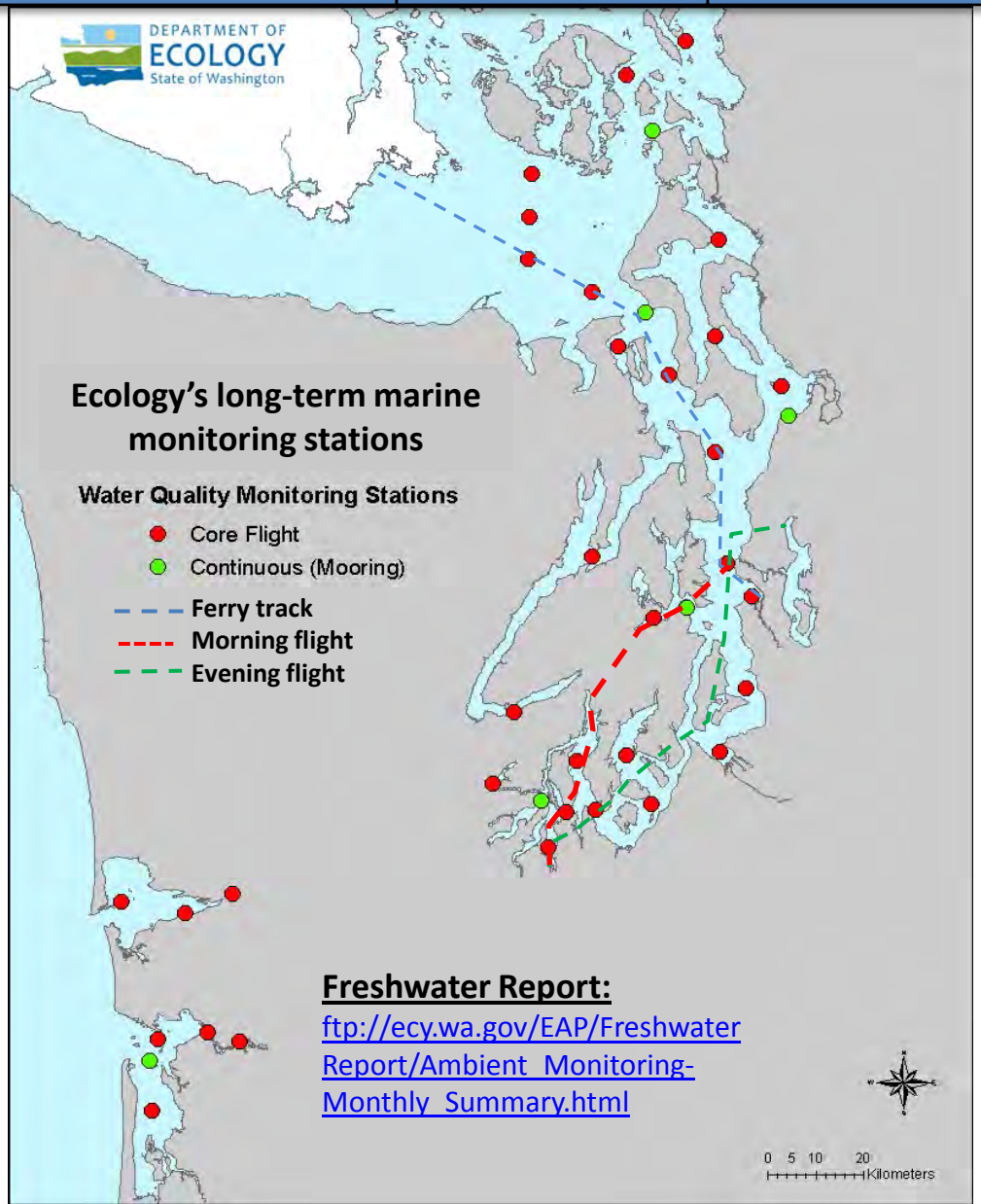
Flight log	Weather	Water column	Aerial photos	Ferry and Satellite	Moorings

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.

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Marine Monitoring Unit
Environmental Assessment Program
WA Department of Ecology

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