Apr 5th, 3:45 PM - 4:00 PM

Recent conditions highlight regional differences in temperature, salinity and dissolved oxygen between Strait of Juan de Fuca and Puget Sound sites under anomalous 2014-2017 climate patterns

Julia Bos
Washington (State). Department of Ecology, jbos461@ecy.wa.gov

Christopher Krembs
Washington (State). Department of Ecology, ckre461@ecy.wa.gov

S. L. Albertson
Washington (State). Department of Ecology, salb461@ecy.wa.gov

Mya Keyzers
Washington (State). Department of Ecology, mkey461@ecy.wa.gov

Allison Brownlee
Washington (State). Department of Ecology, albr461@ecy.wa.gov

See next page for additional authors

Speaker
Julia Bos, Christopher Krembs, S. L. Albertson, Mya Keyzers, Allison Brownlee, and Carol Maloy

Regional variances in temperature, salinity and dissolved oxygen between Strait of Juan de Fuca and Puget Sound.

Washington State Department of Ecology

C. Maloy, C. Krembs, J. Bos, S. Albertson, M. Keyzers, A. Brownlee, N. Schwarck, J. Dimond

Julia Bos, Salish Sea Ecosystem Conference, April 2018

Status and trends in water quality indicators

(collected monthly at 39 stations and compared to baselines)

Water Quality variables

Physical variables
- Temperature
- Salinity
- Density

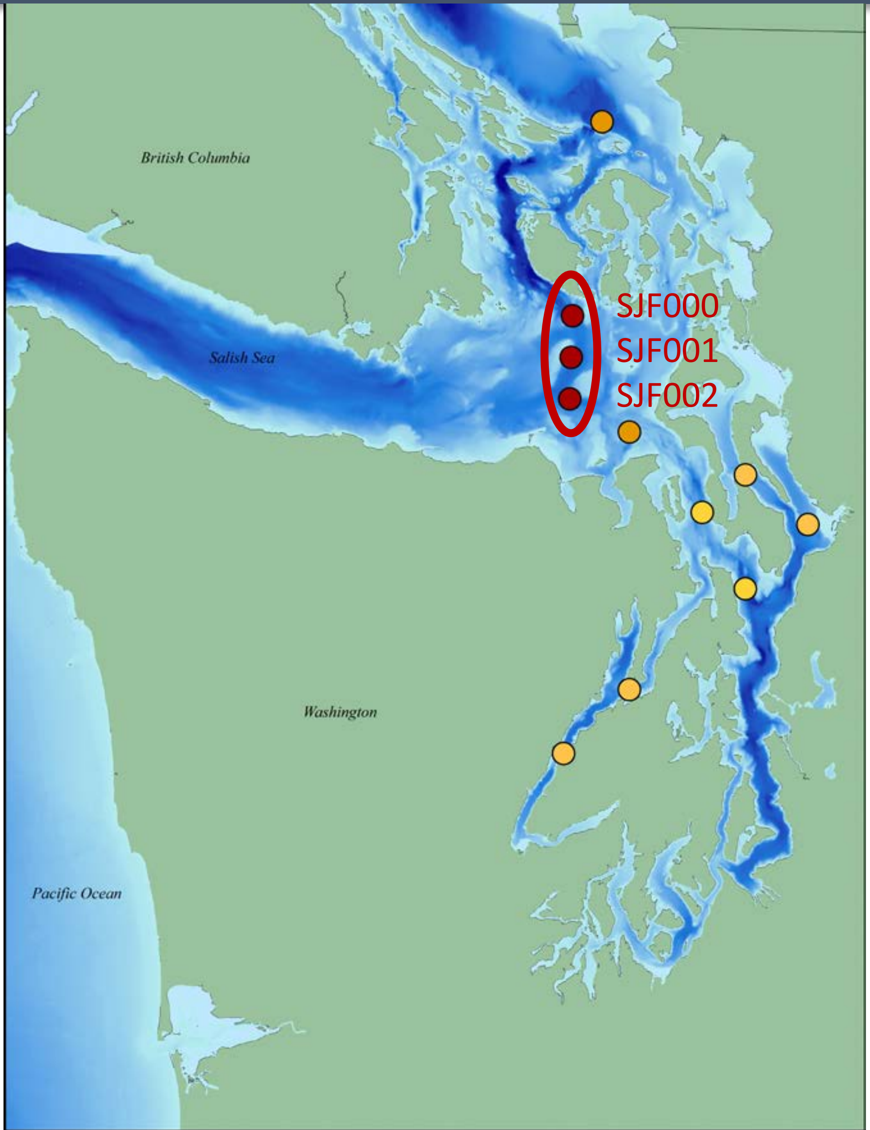
Chemical variables
- Oxygen
- Nitrate
- Silicate
- Phosphate
- Ammonium
- Nutrient ratios
- pH

Bio-optical variables
- Water clarity
- Chlorophyll a
- Euphotic depth

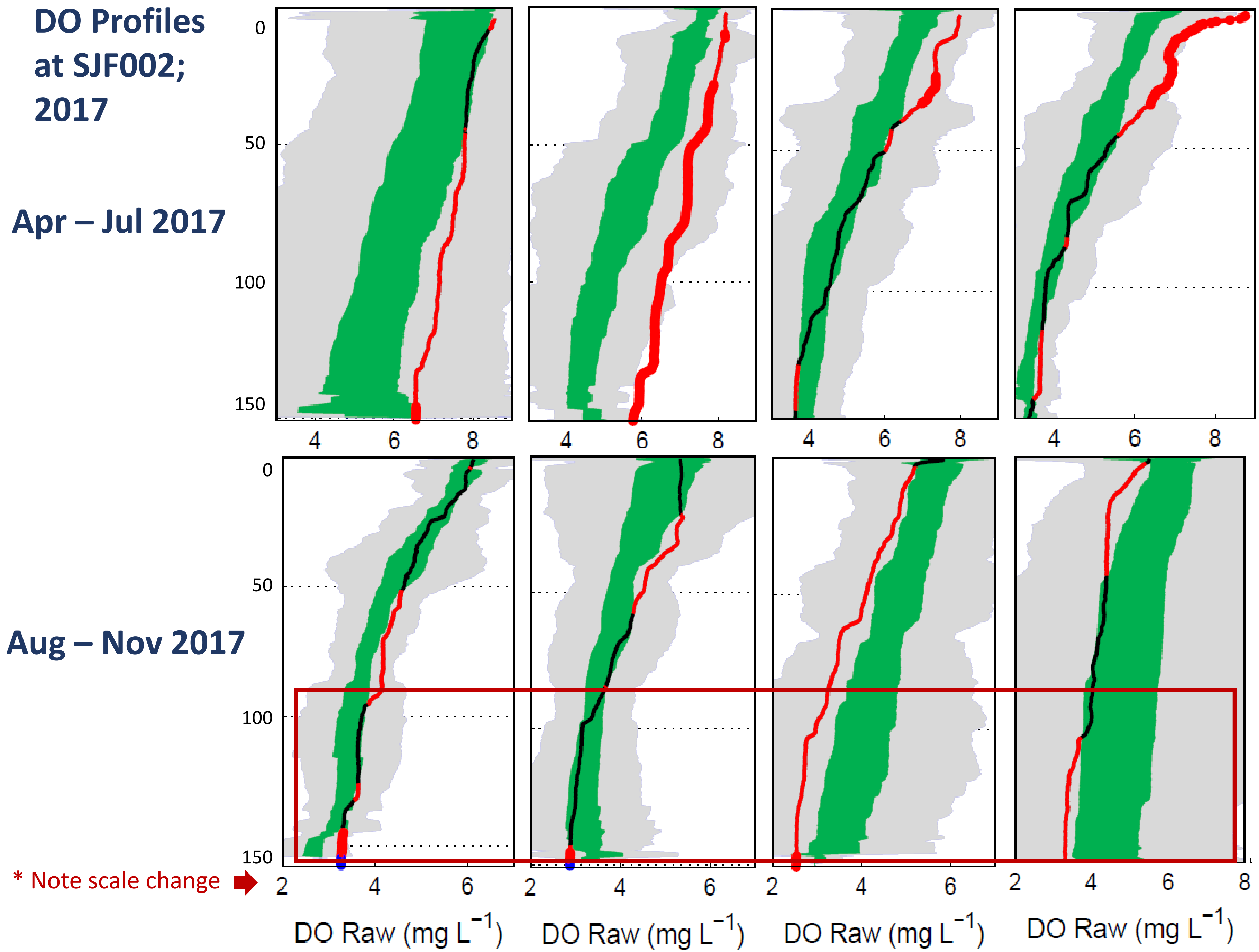
Using water mass characteristics to understand water quality in the Strait of Juan de Fuca and Puget Sound.

Low DO? ...something's come between us....

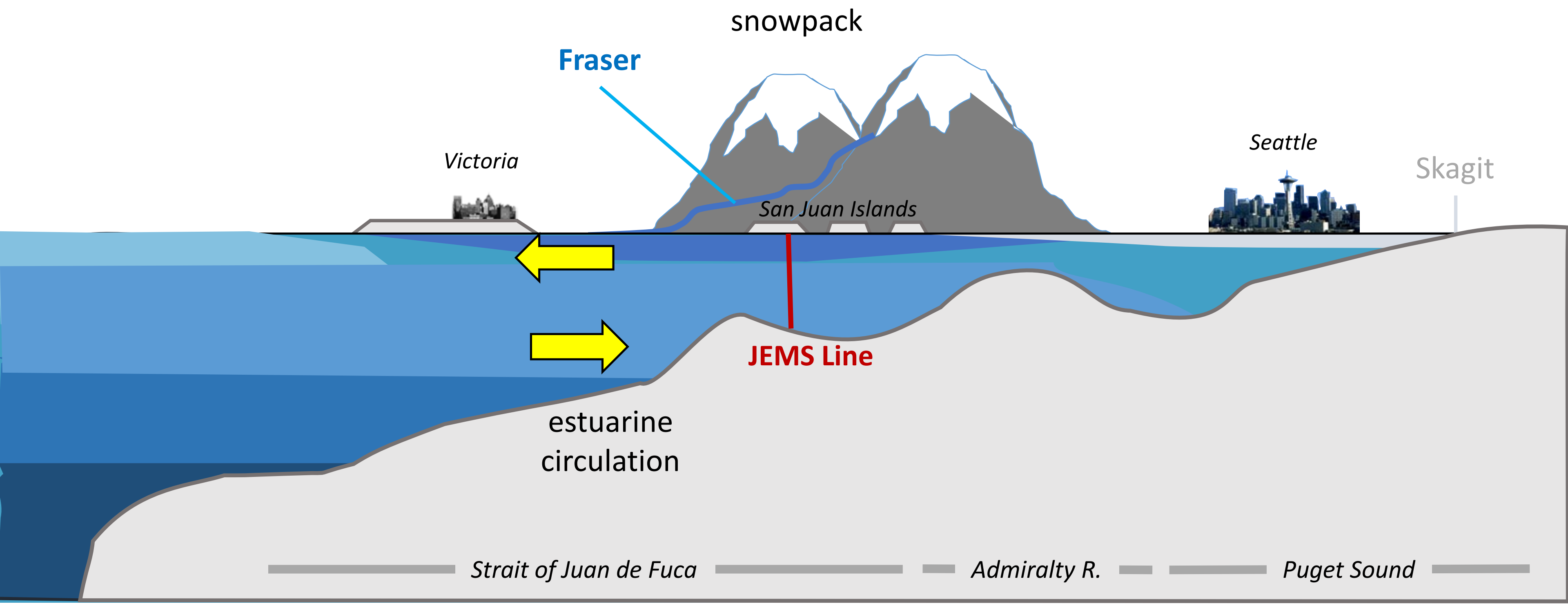
- What waters are entering Puget Sound?
- What are the key characteristics of source waters?
- When and how do these waters affect DO (and other WQ indicators?)
- Tele-effects? When do outlying regions affect nearby conditions?



DO Profiles at SJF002; 2017



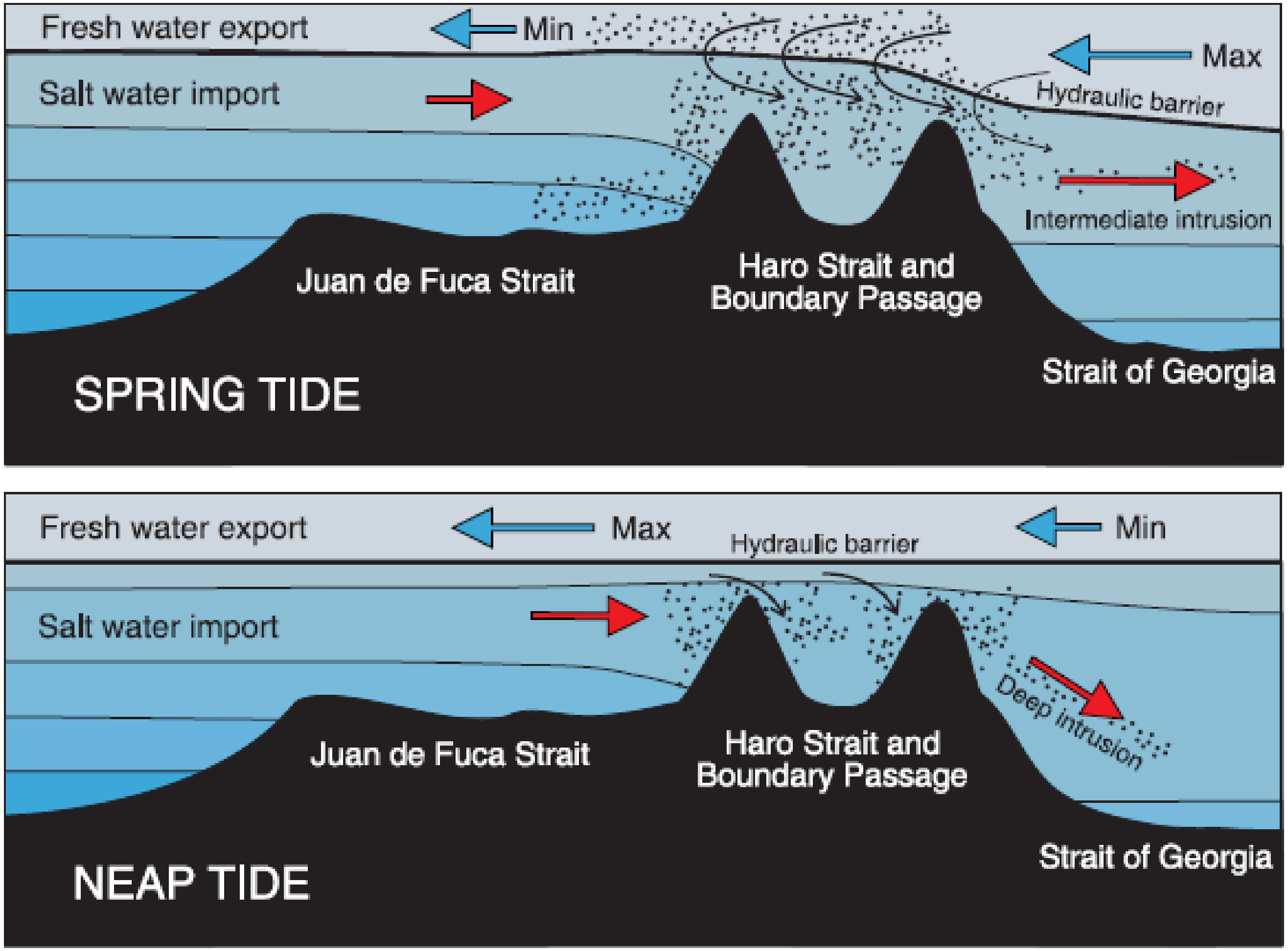
The ocean to river link in Salish Sea basins.



Estuarine circulation connects Puget Sound/Salish Sea to the ocean

The Pacific Ocean link to Salish Sea basins.

Bathymetry & freshwater outflow can act as barriers to seawater inflow.



Thomson, R.E. et al. 2007. Estuarine vs. transient flow regimes in Juan de Fuca Strait.

Redfield's Water Masses – 1950

Based on July 1931 & July 1932 data

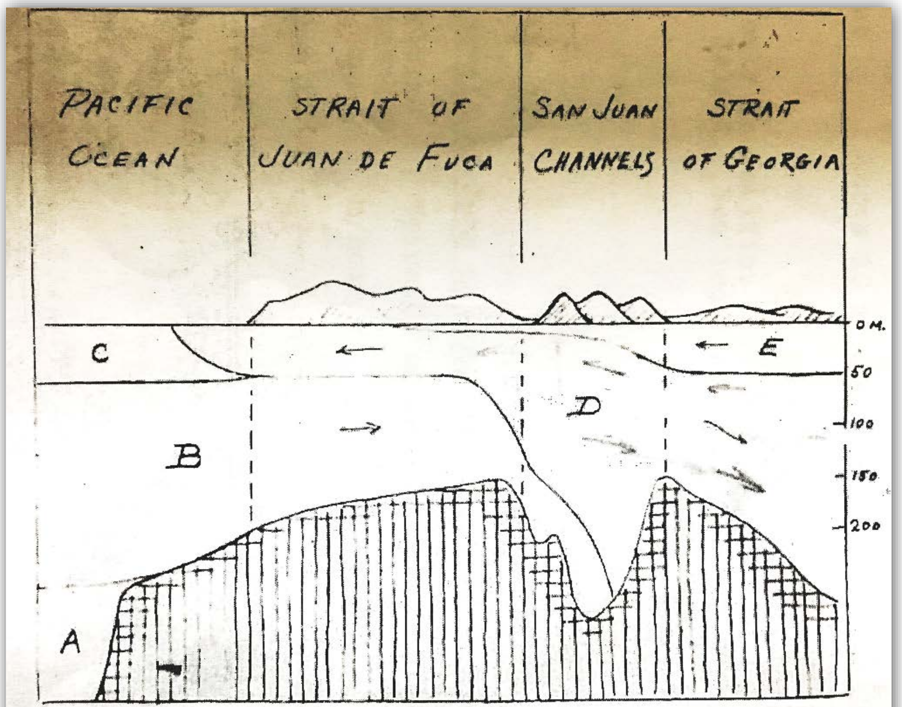


FIG. 3

Water Types:

A: Deeper Pacific water (excluded by bottom contour)

B: Pacific water (50 – 250 m depths)

C: Superficial Pacific water (excluded by net outflow of Strait)

D: Surface Juan de Fuca, San Juan Channel, deep Georgia Strait

E: Georgia Strait surface water + Type B

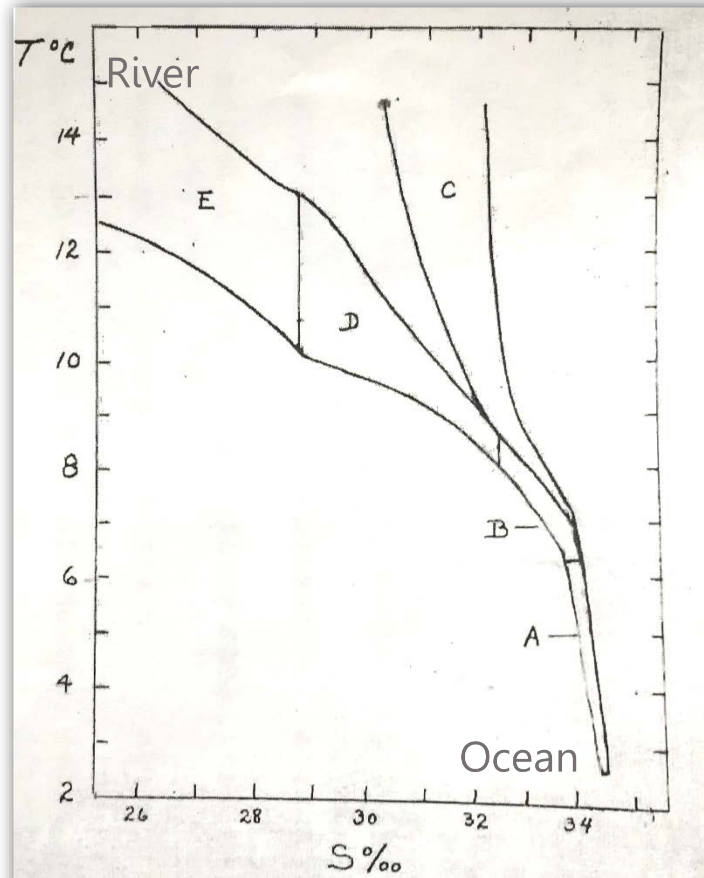


FIG. 2

Redfield, A. 1950. Notes on the Circulation of a Deep Estuary - The Juan de Fuca – Georgia Straits.

Comparing JEMS sites to Redfield's Water Masses

Water Types:

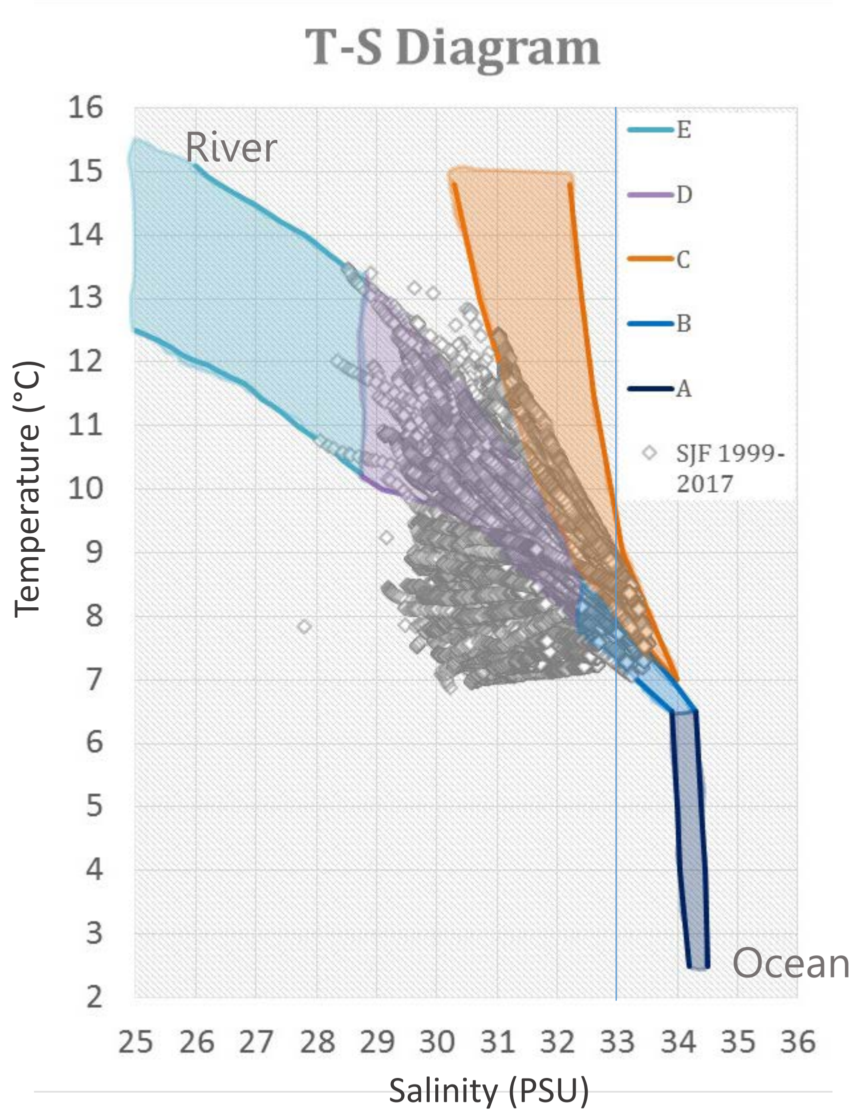
~~A: Deeper Pacific water~~

B: Pacific water (50 – 250 m depths)

C: Superficial Pacific water (all depths)

D: Superficial Juan de Fuca, San Juan, deep Georgia Strait

E: Georgia Strait surface water + Type B



JEMS 1999 – 2017; All Data

Comparing JEMS sites to Redfield's Water Masses

Water Types:

~~A: Deeper Pacific water~~

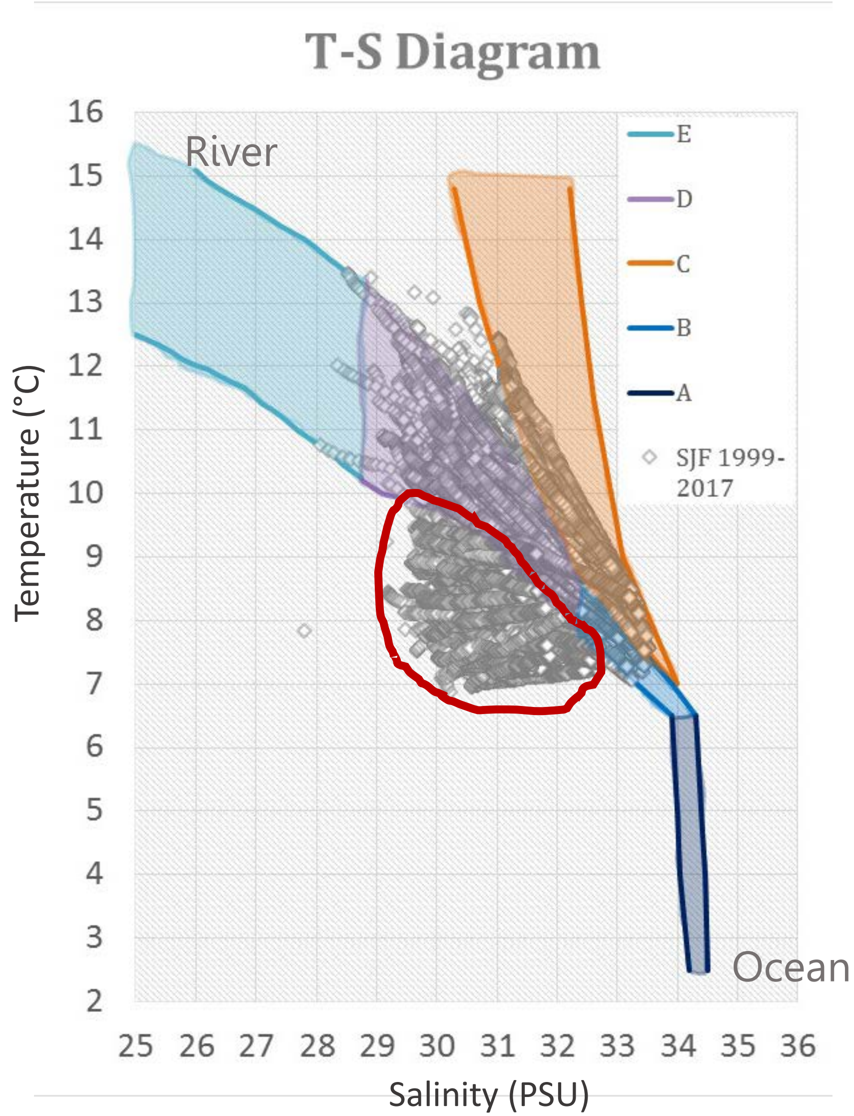
B: Pacific water (50 – 250 m depths)

C: Superficial Pacific water (all depths)

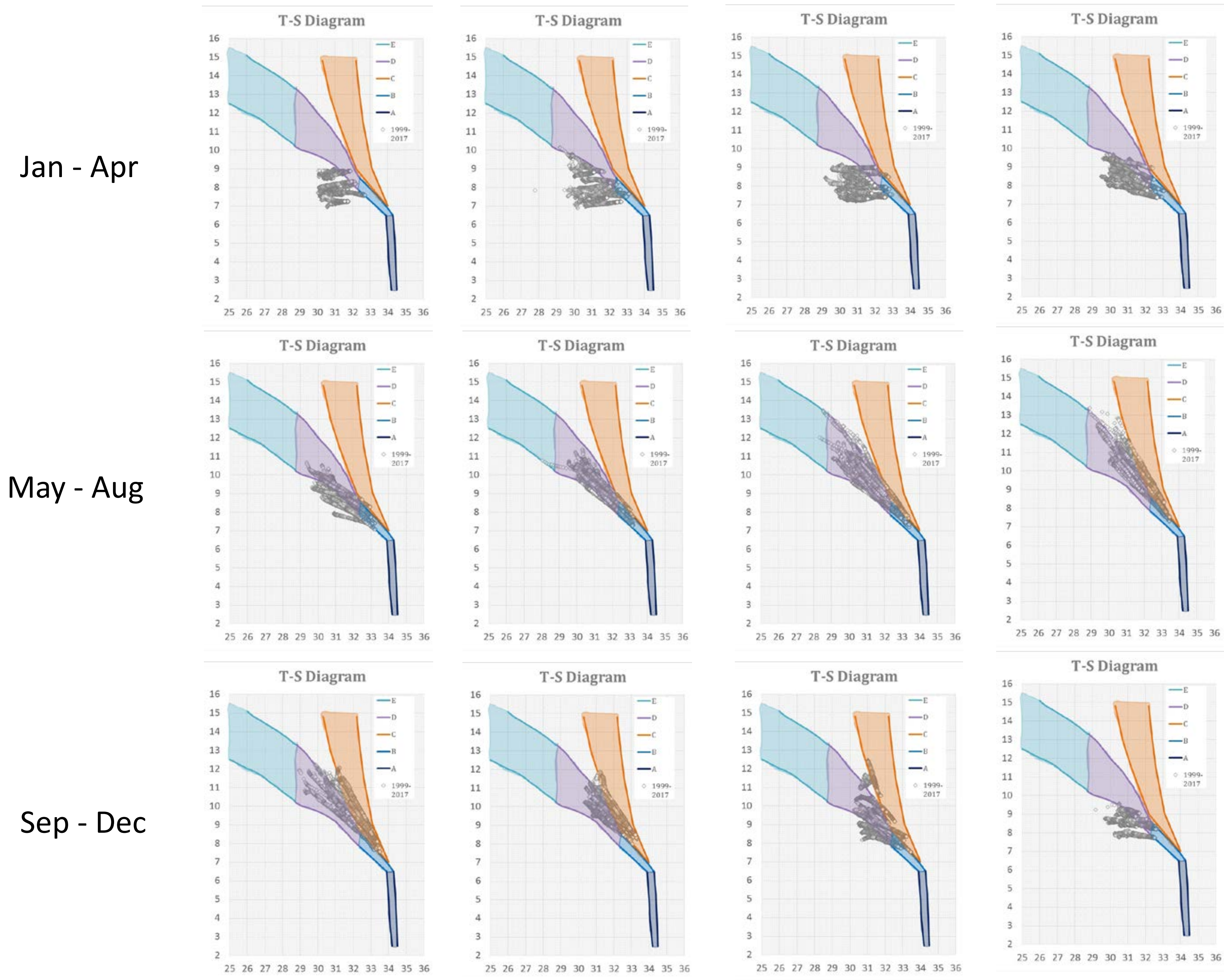
D: Superficial Juan de Fuca, San Juan, deep Georgia Strait

E: Georgia Strait surface water + Type B

+ ???



JEMS 1999 – 2017; All Data



Jan - Apr
May - Aug
Sep - Dec
T-S Diagram
E
D
C
B
A
1999-2017
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2
25 26 27 28 29 30 31 32 33 34 35 36

Analyses of Water Masses for the Straits

Source water type
SW1: River (Fraser)
SW2: Deep South (Deep Shelf/Upwelled Pacific Ocean water)
SW3: Pre-Season (Mixed Estuary "stagnant" water)
SW4: Surface South (Surface Pacific Ocean/Columbia River water)

Masson, D. 2006. Seasonal Water Mass Analysis for the Straits of Juan de Fuca And Georgia.

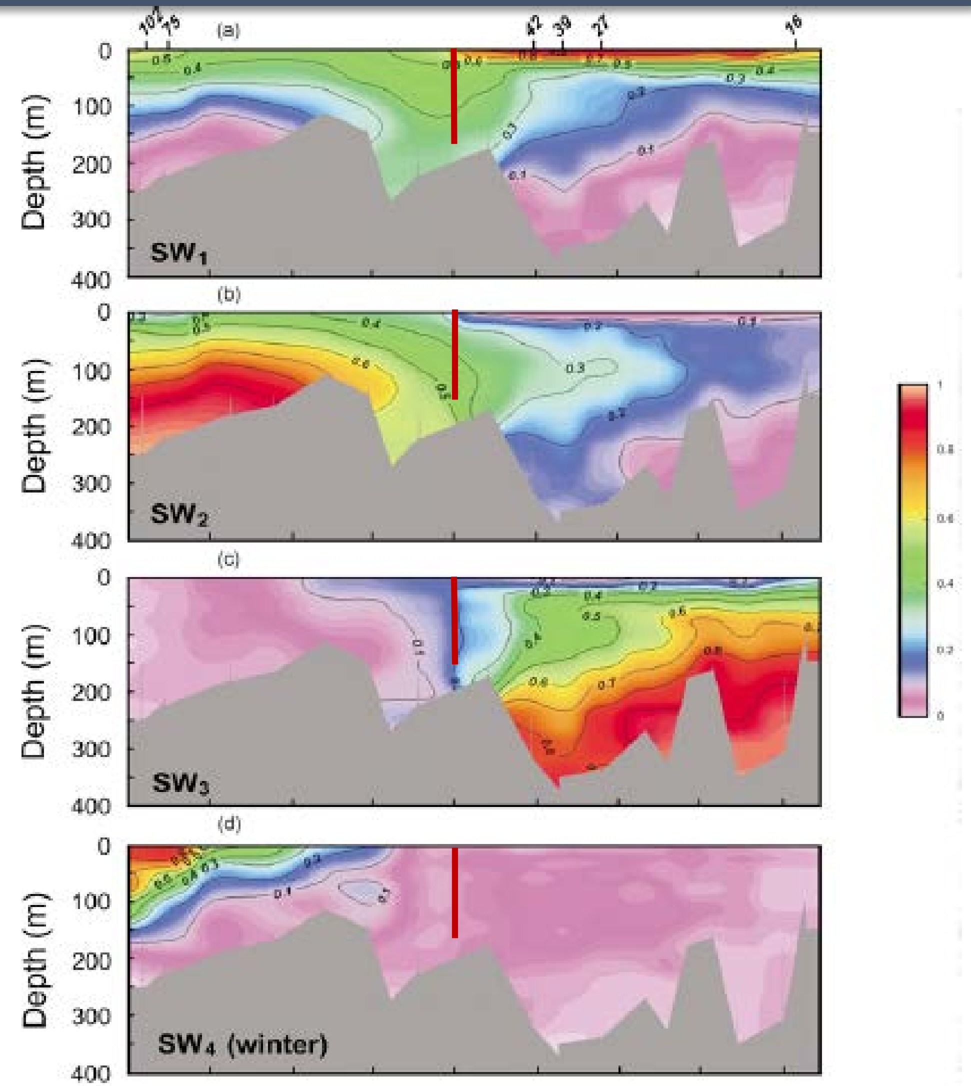


Fig. 4 Mean contributions for the source water type.

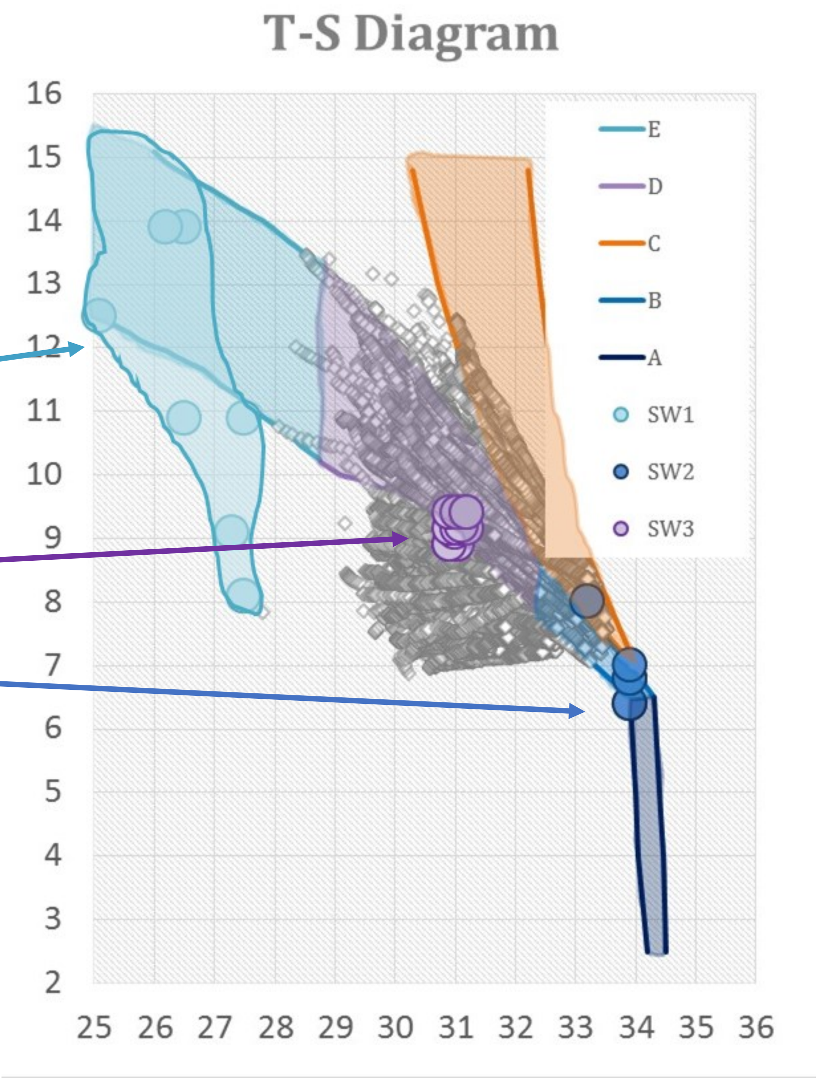
Comparison of T-S end member properties described by Redfield, Masson with JEMS data.

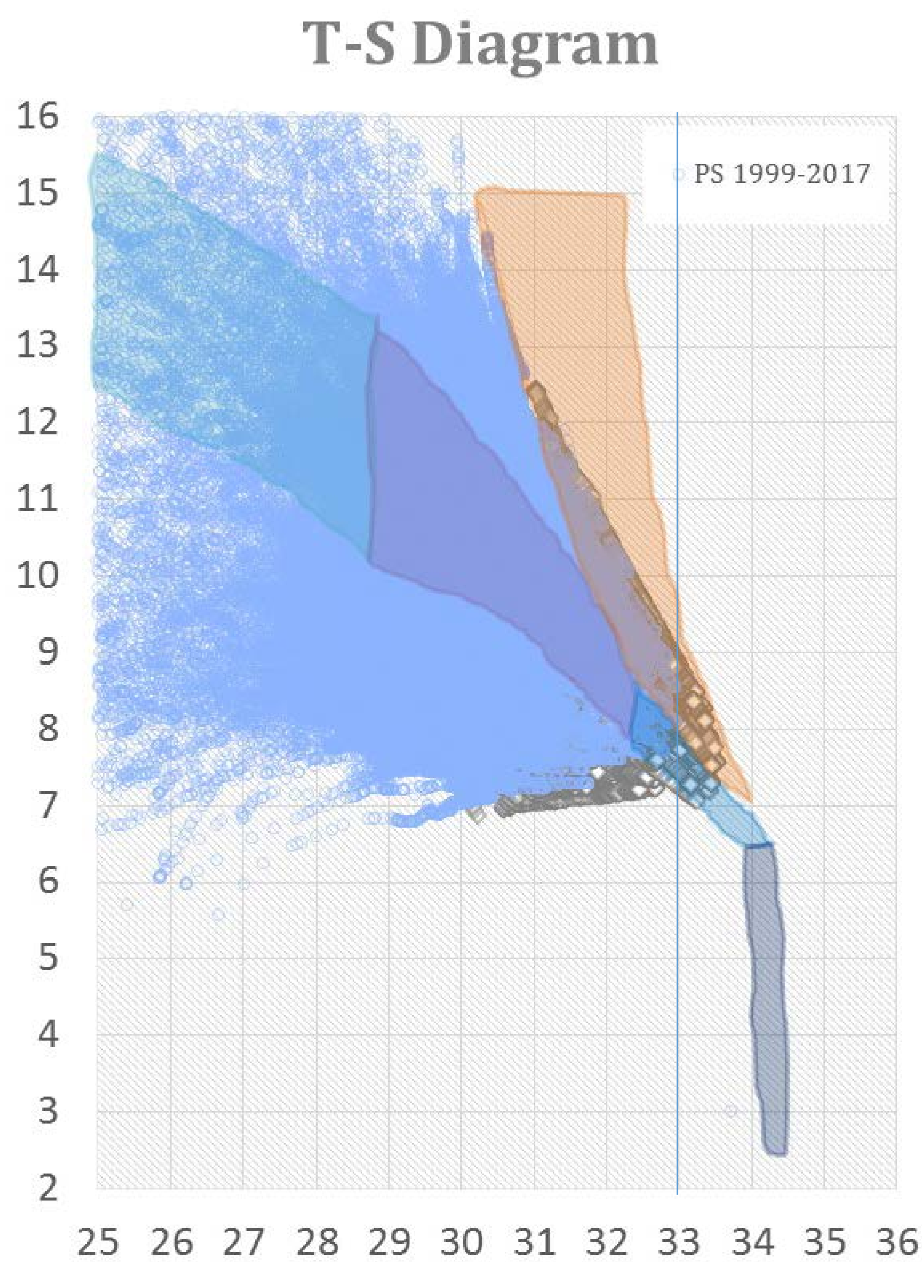
Masson:

SW1 (river)

SW3 (“pre-season”/mixed estuary water)

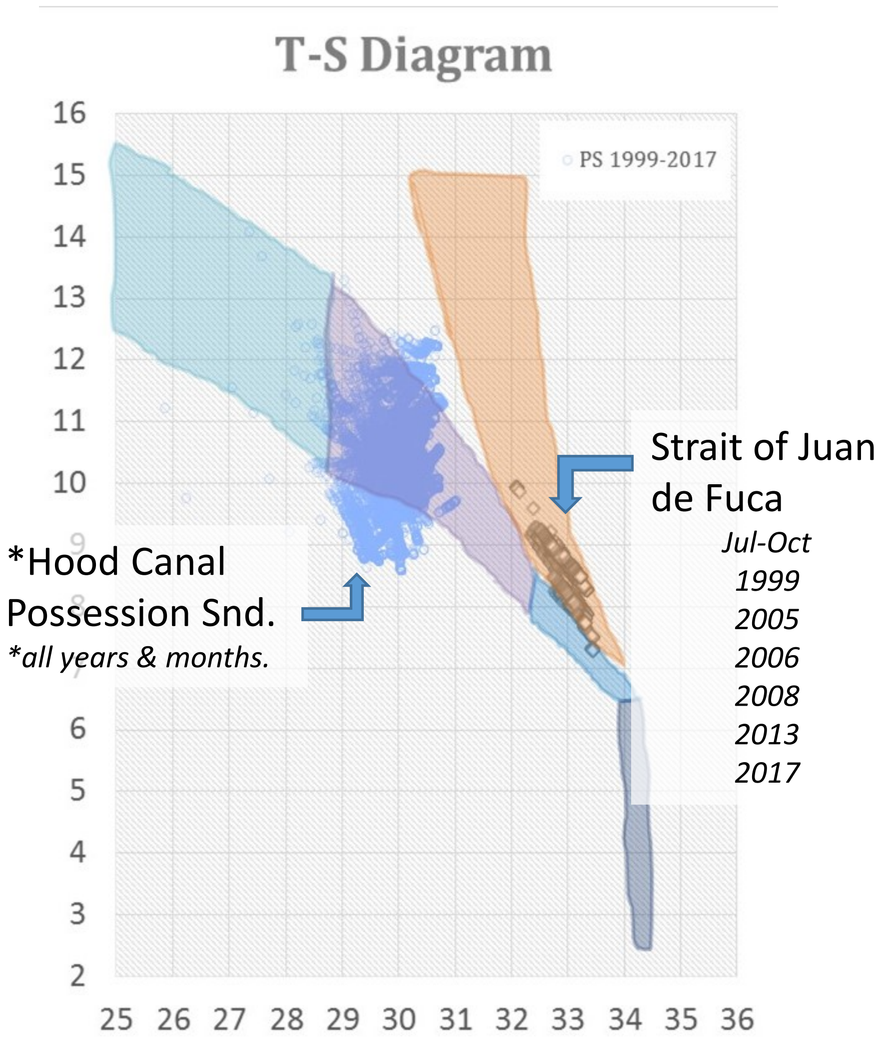
SW2 (Pacific ocean water)

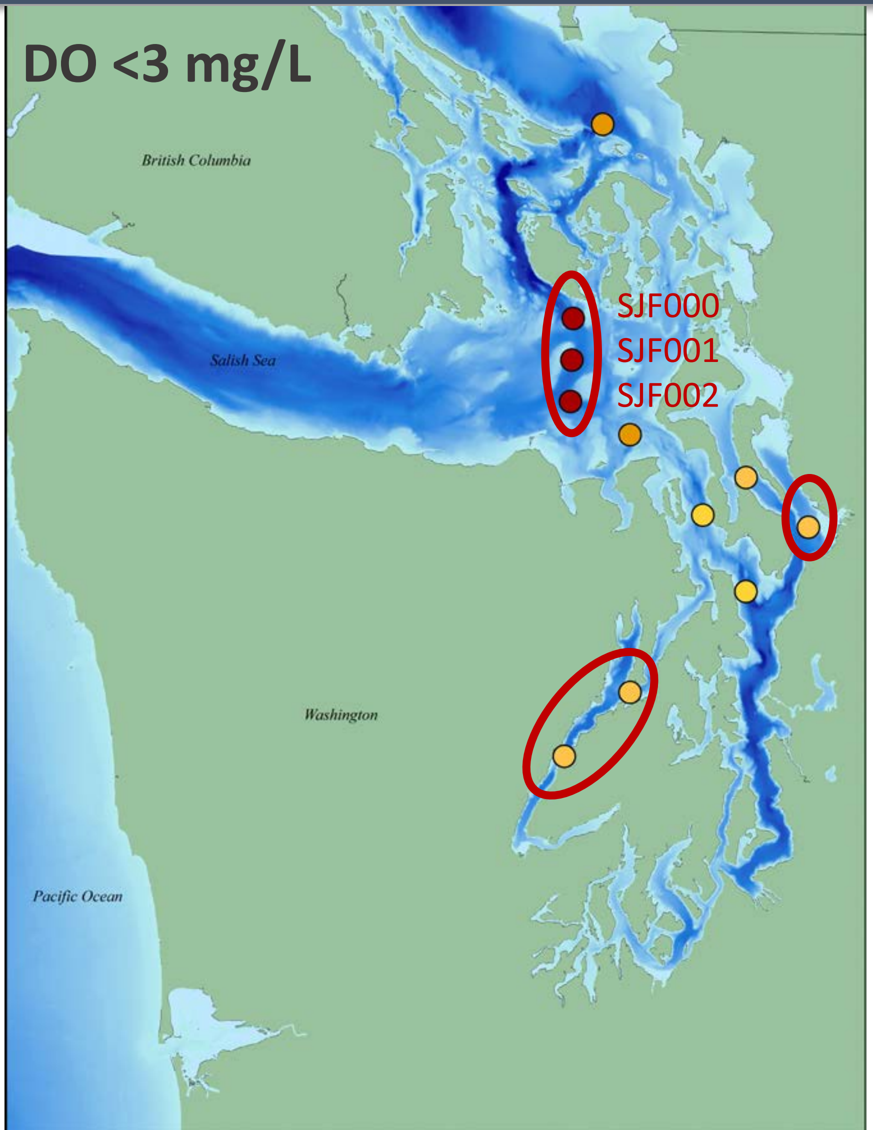




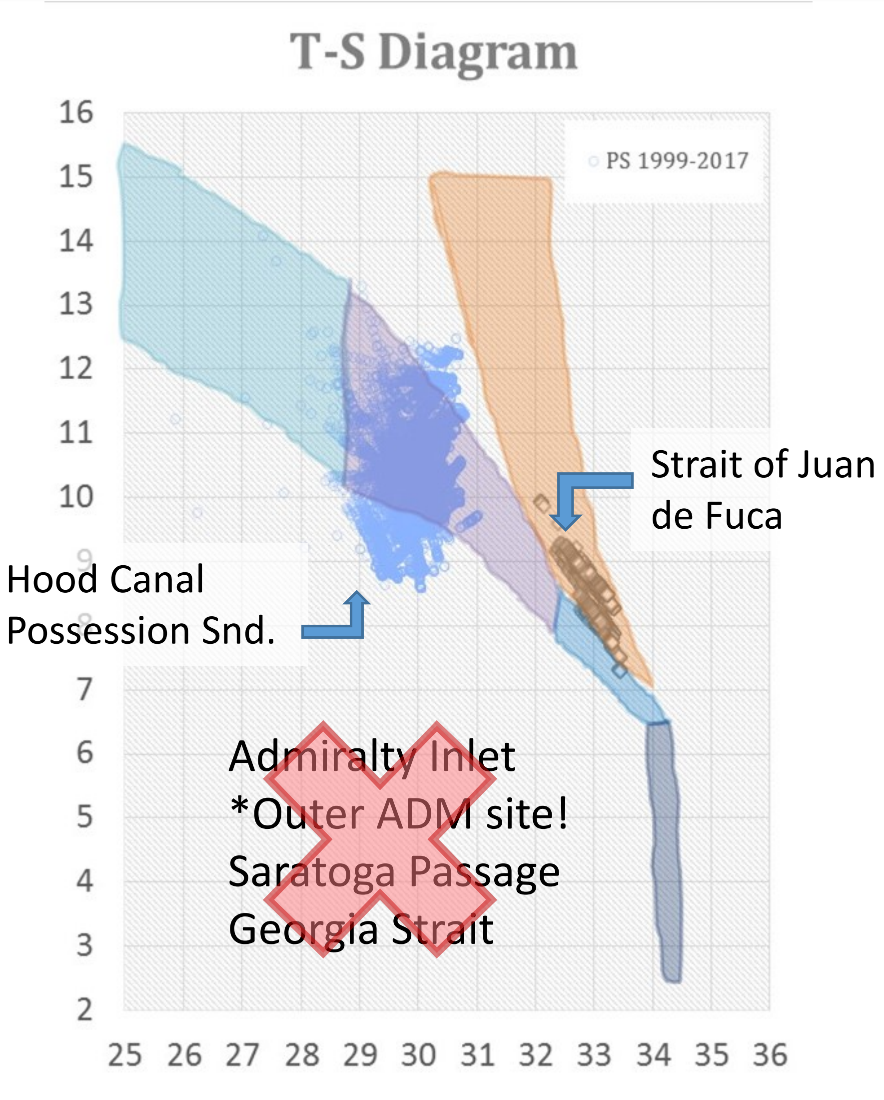
T-S Diagram
PS 1999-2017
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
25 26 27 28 29 30 31 32 33 34 35 36

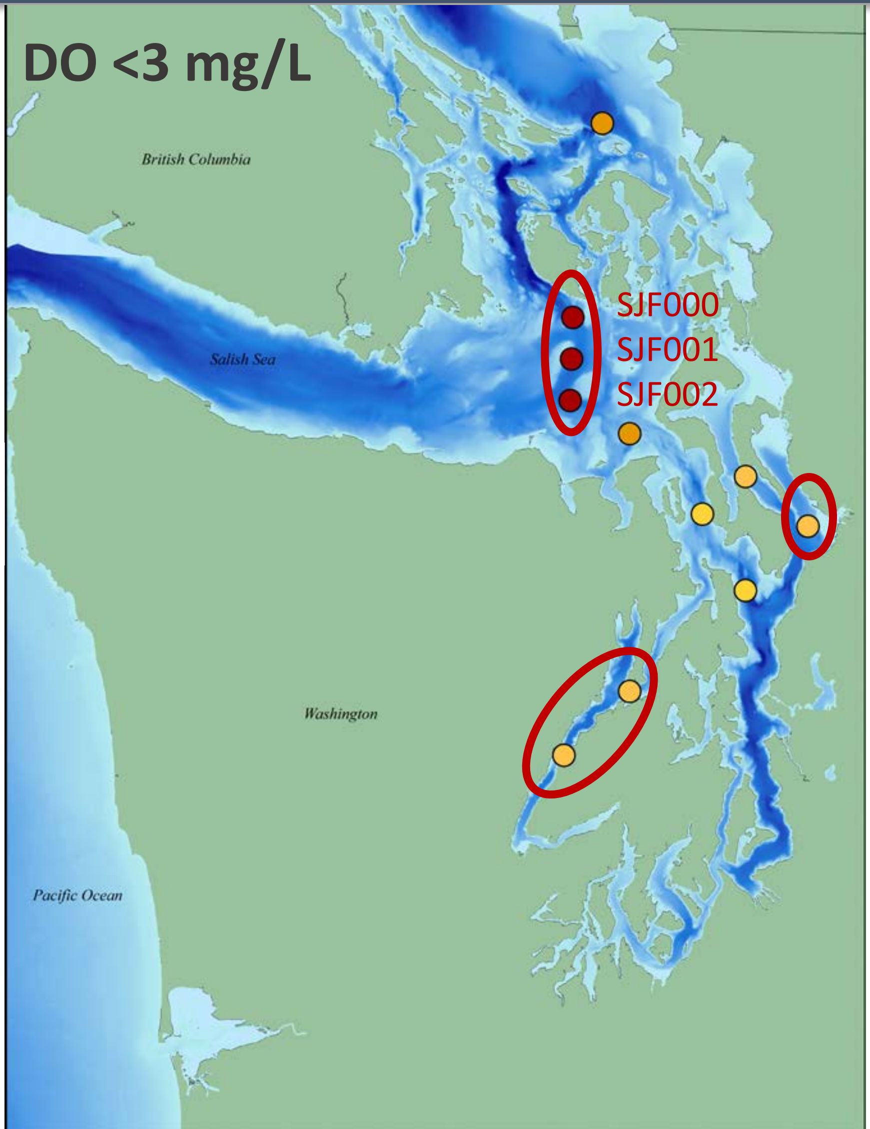
Mapping DO using water mass characteristics at sites.

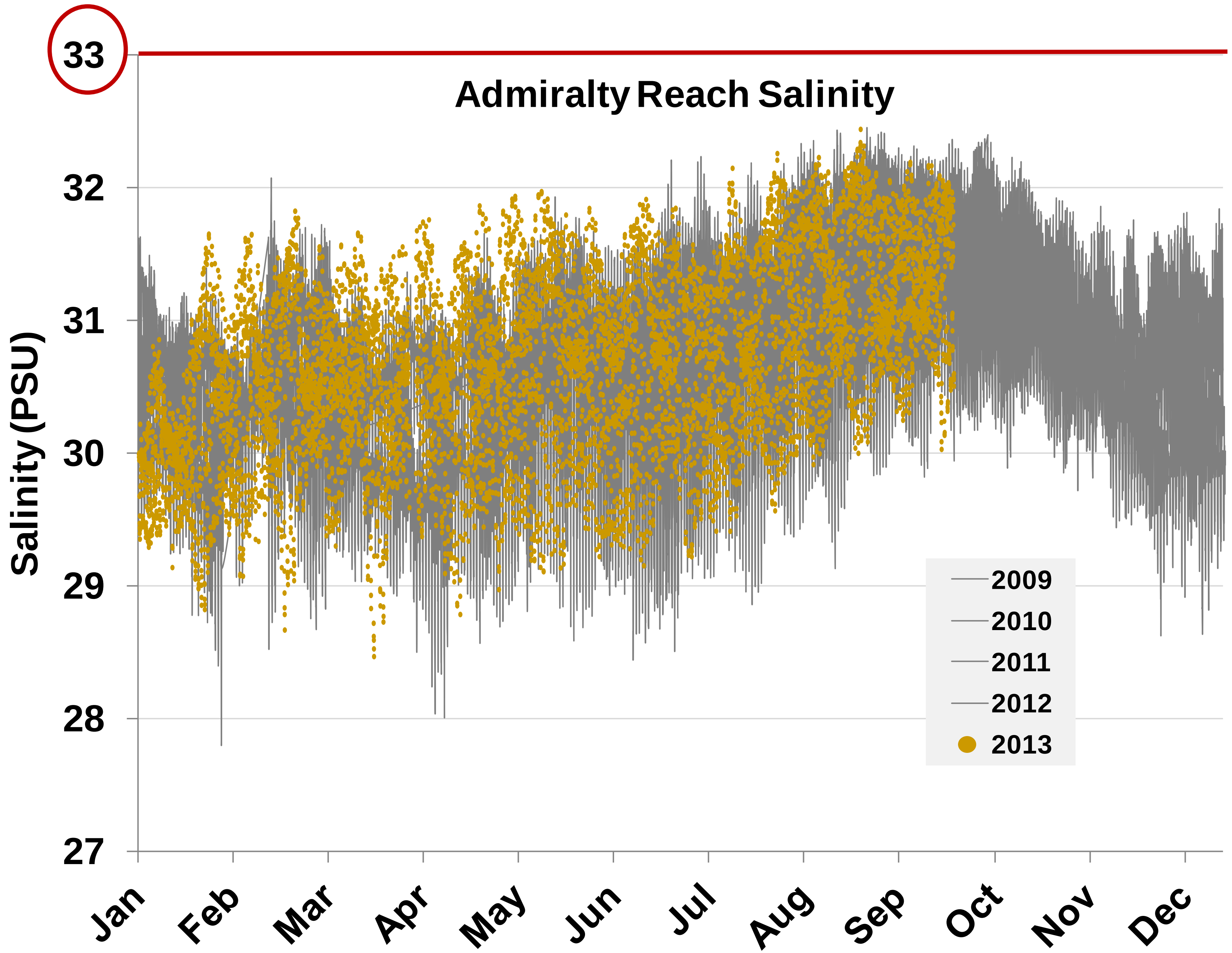




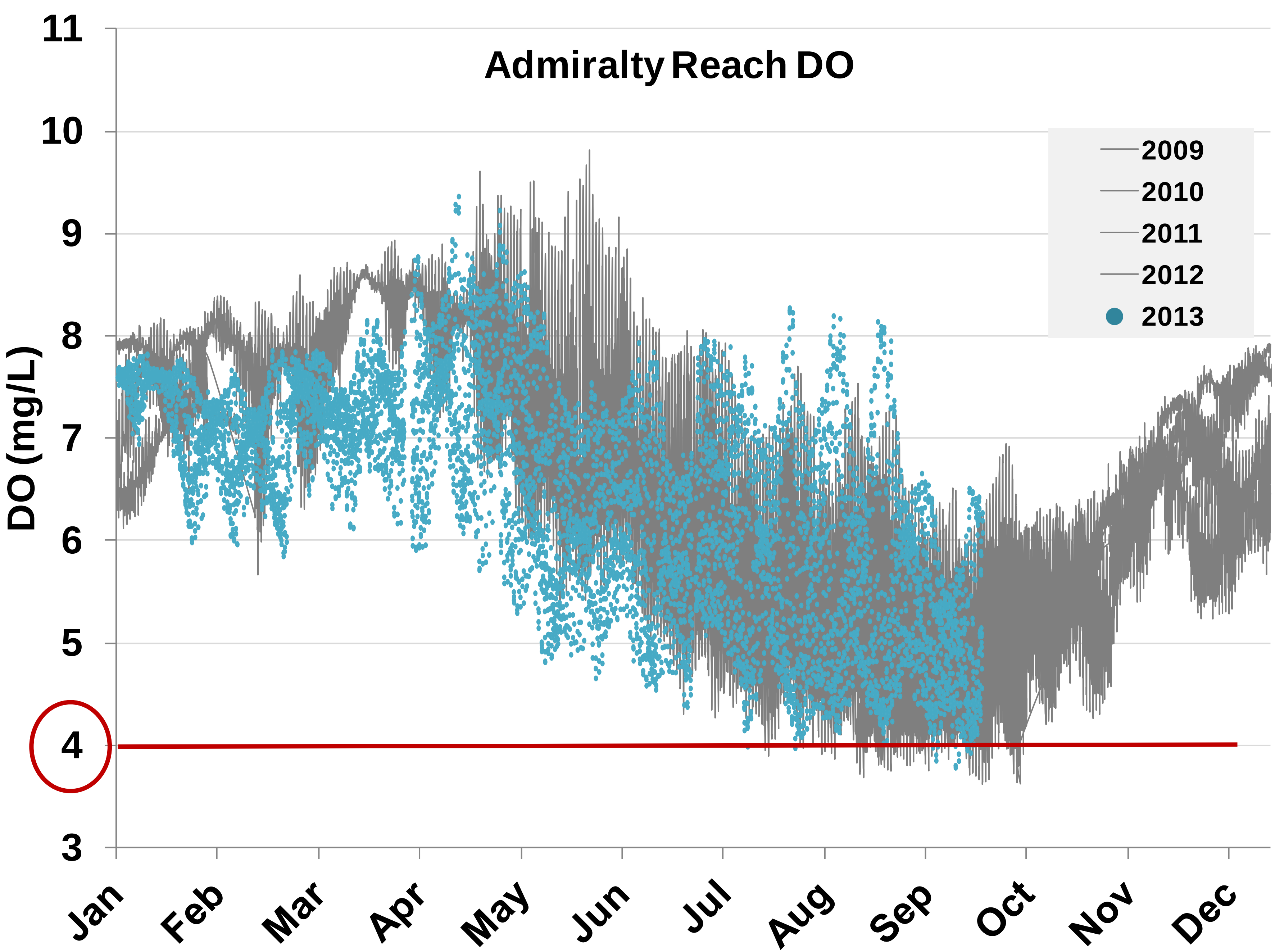
Mapping DO using water mass characteristics at sites.



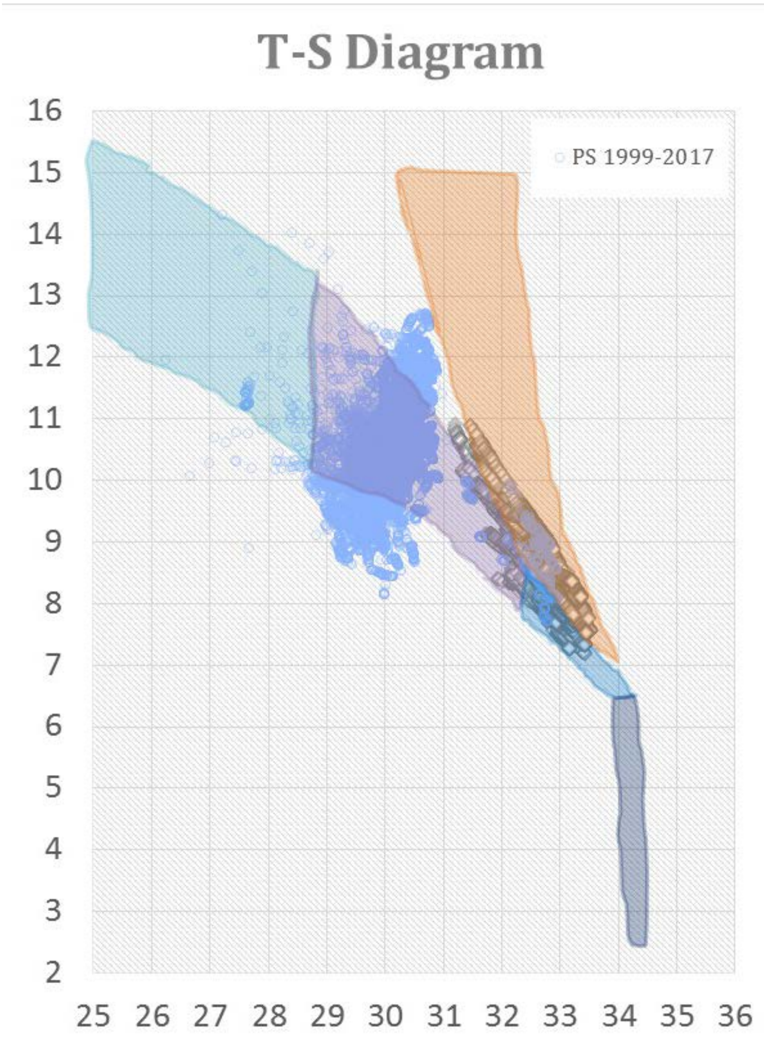


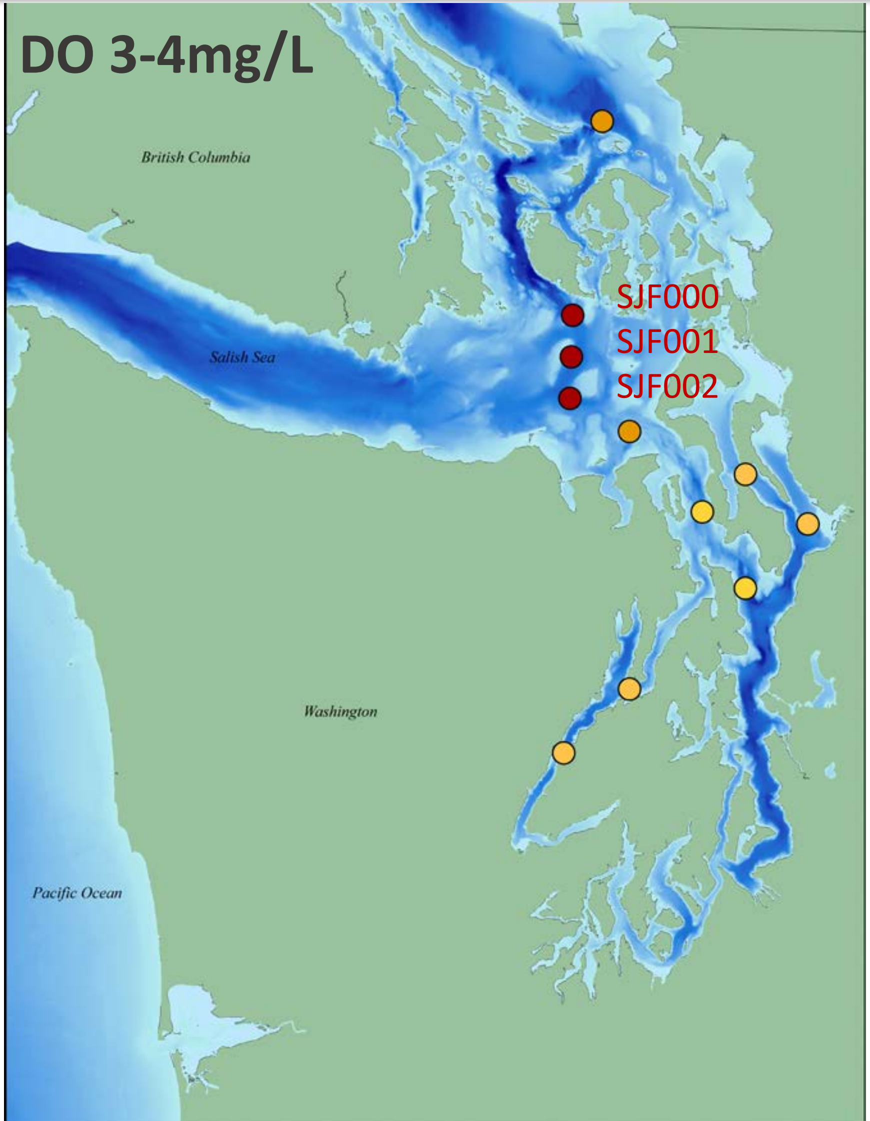


33
Admiralty Reach Salinity
Salinity (PSU)
32
31
30
29
28
27
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2009
2010
2011
2012
2013

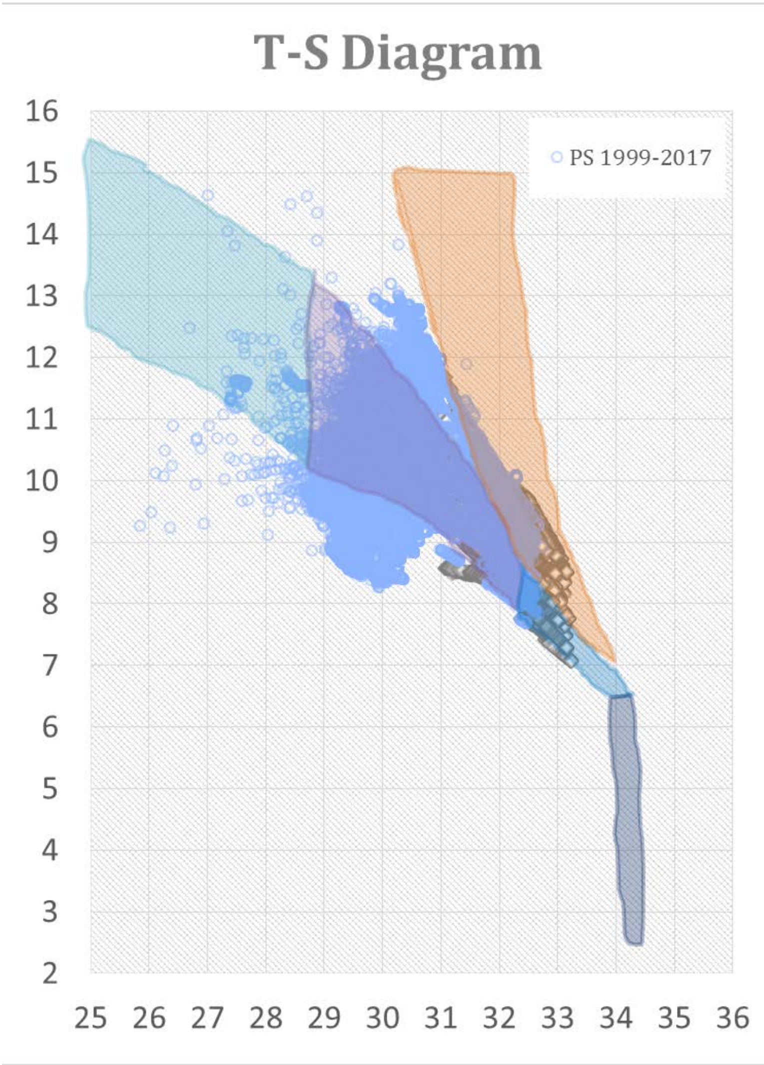

Admiralty Reach DO
DO (mg/L)
11
10
9
8
7
6
5
4
3
2009
2010
2011
2012
2013
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

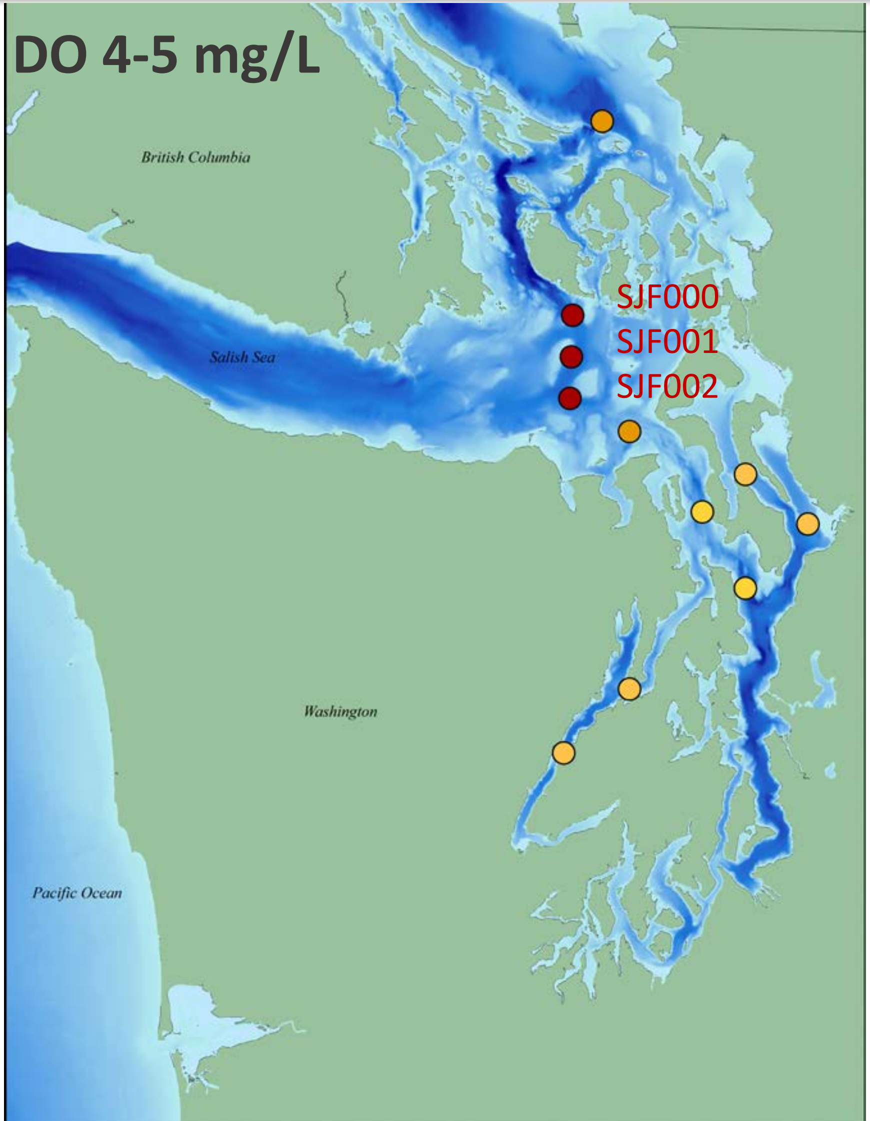
Mapping DO using water mass characteristics at sites.



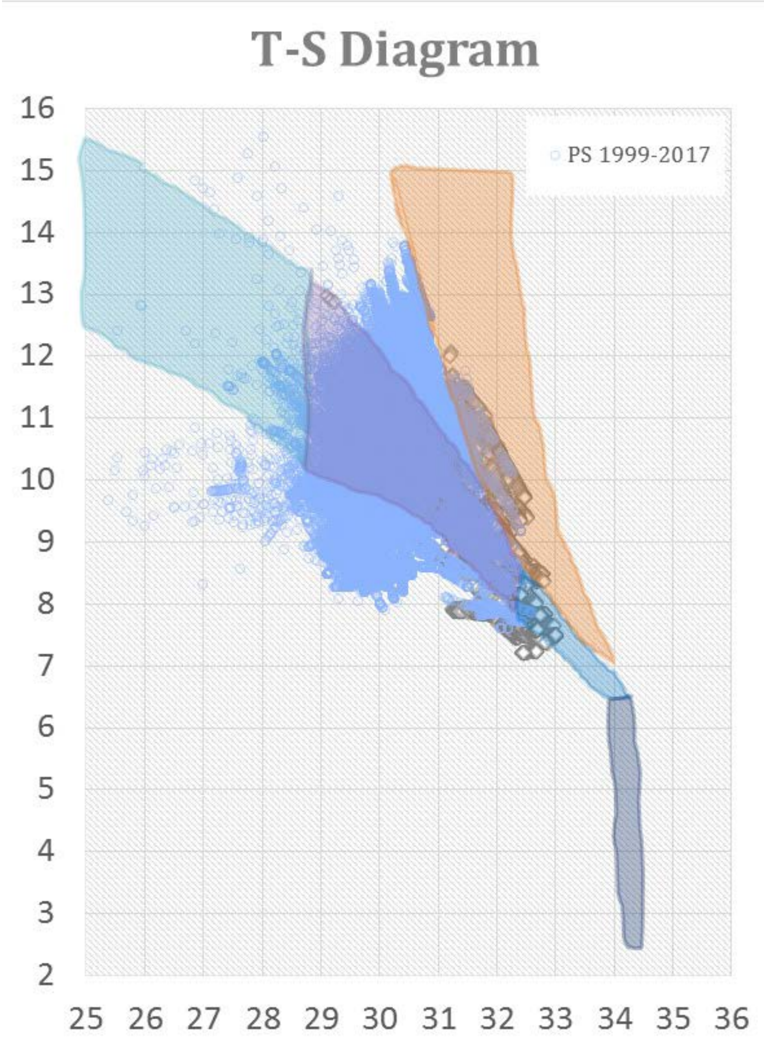


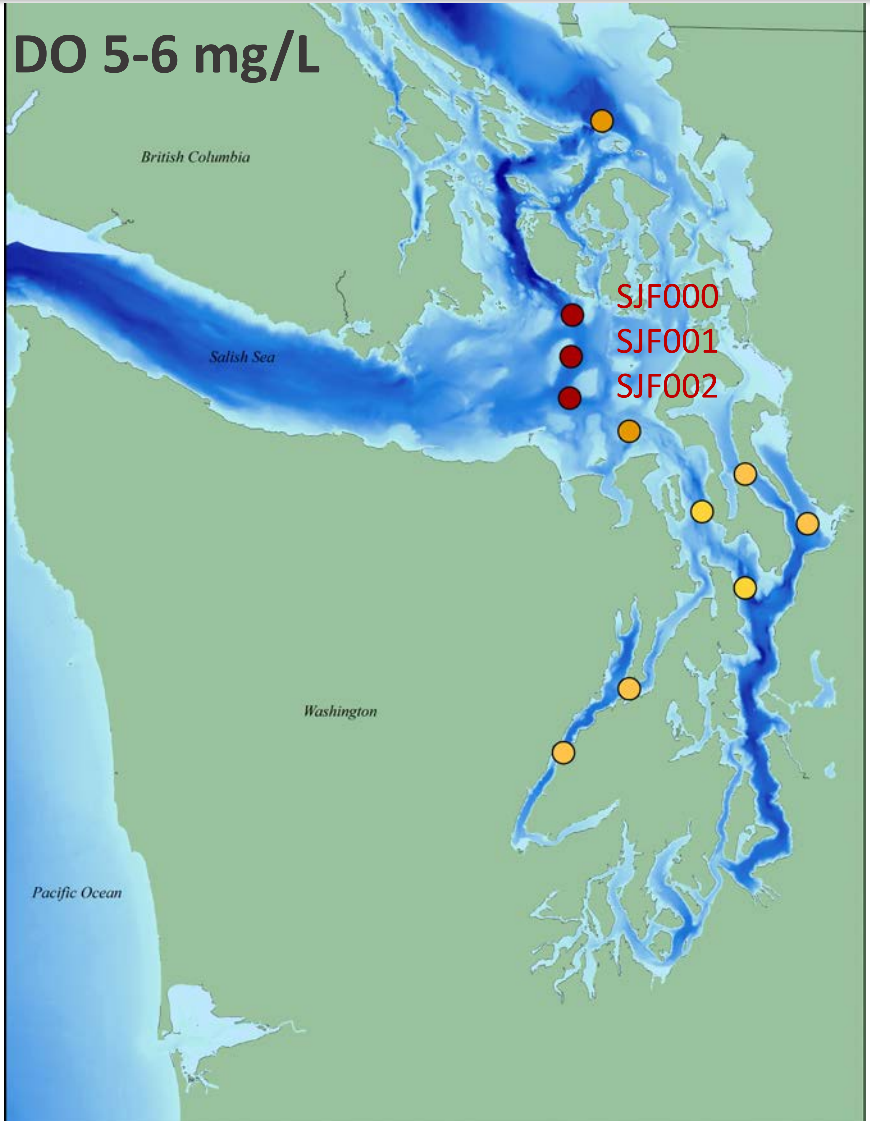
Mapping DO using water mass characteristics at sites.



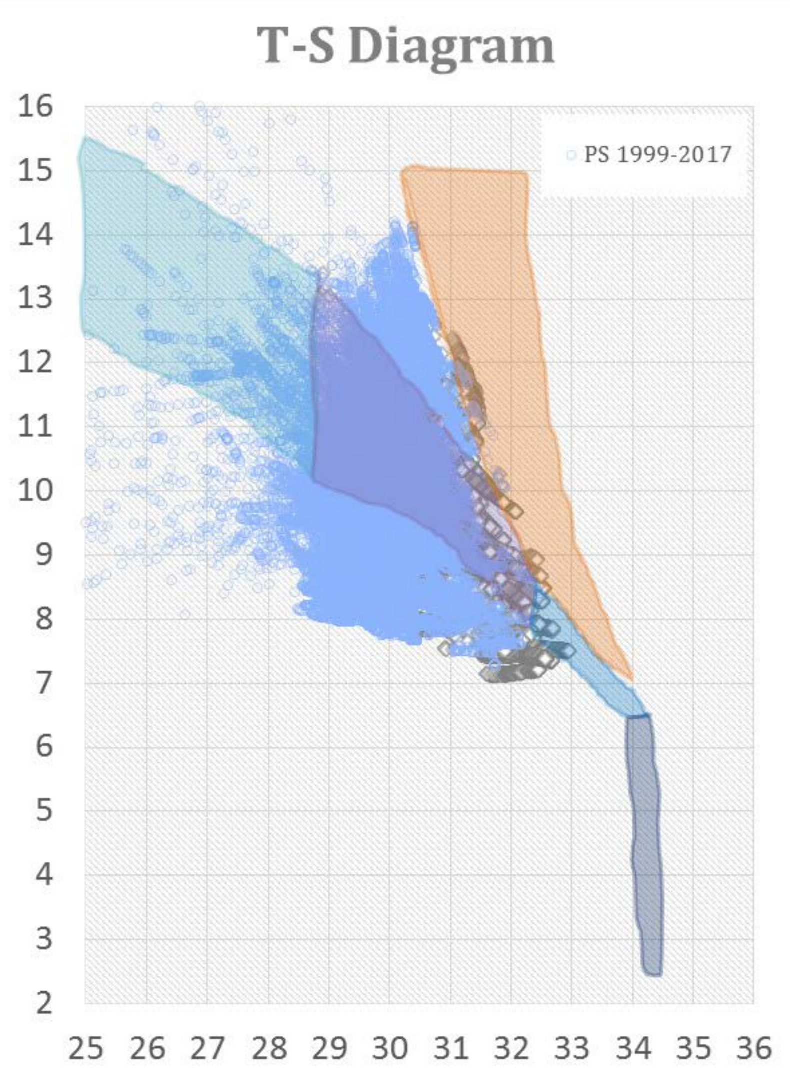


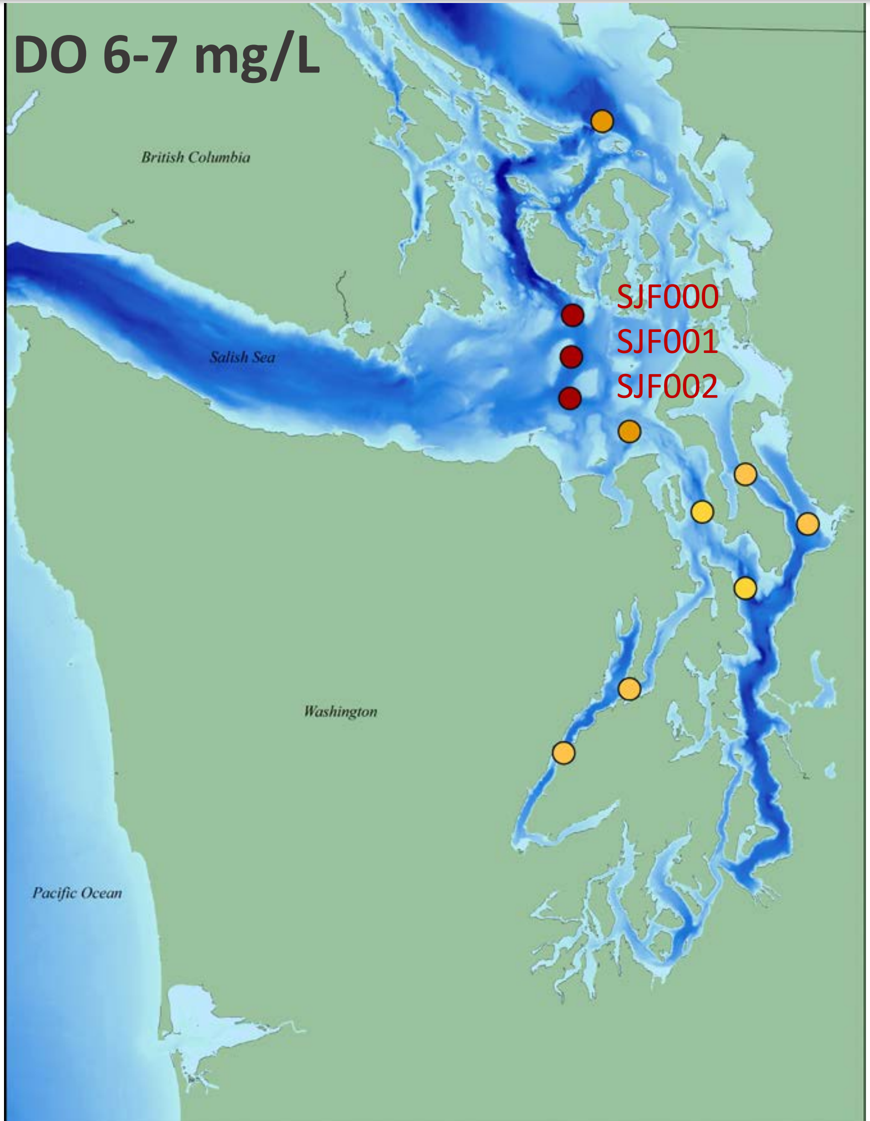
Mapping DO using water mass characteristics at sites.



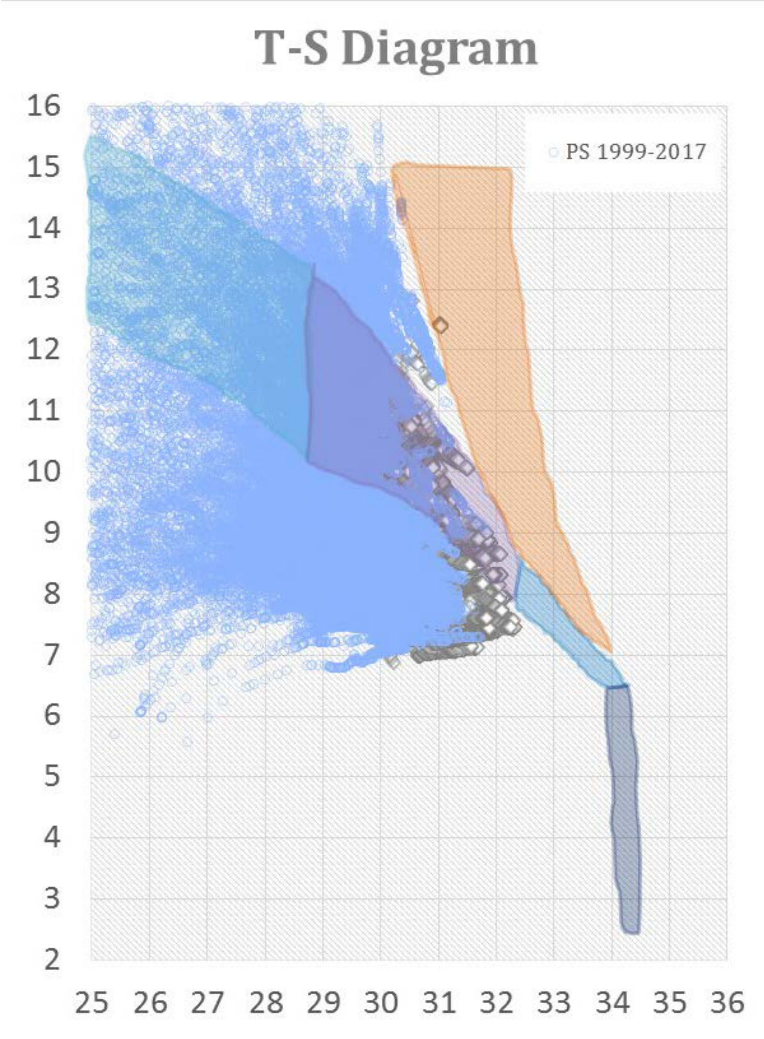


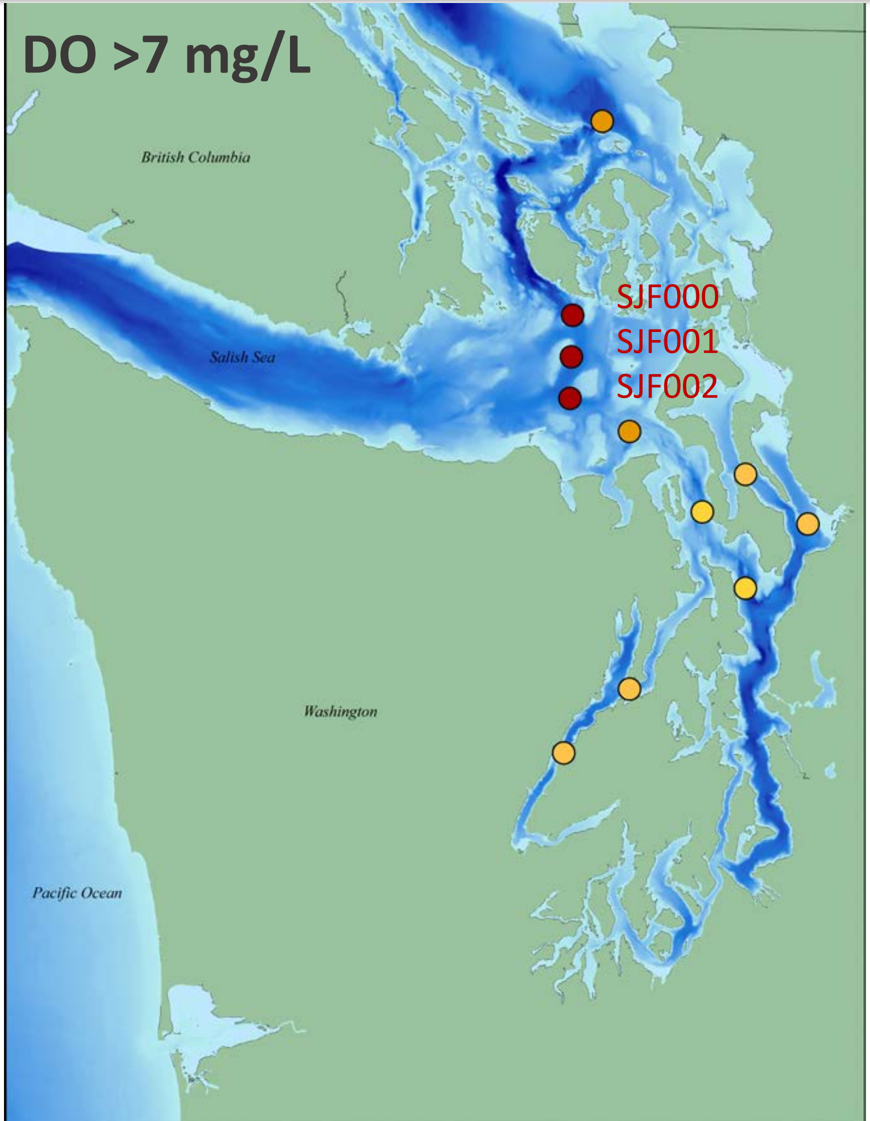
Mapping DO using water mass characteristics at sites.



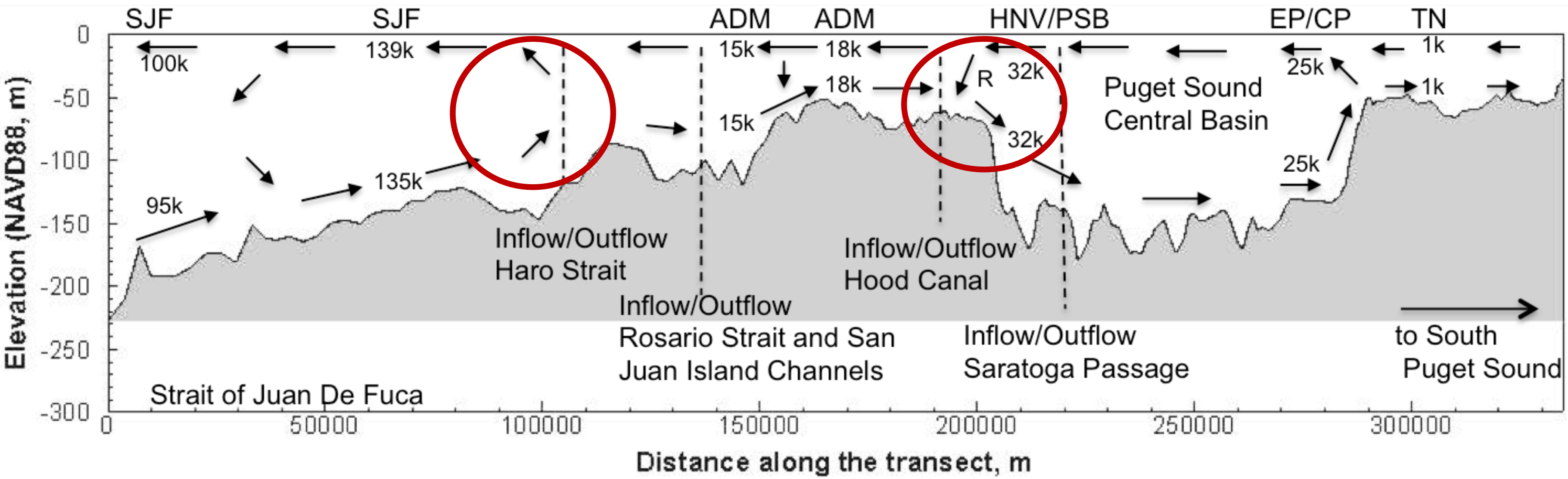


Mapping DO using water mass characteristics at sites.





Salish Sea model quantifies exchange and shows reflux occurring at sills.



SJF = Strait of Juan De Fuca
ADM = Admiralty Inlet
HARO = Haro Strait
R = Reflux Flow at Admiralty Sill (estimated at 19 k, ≈ 60% of surface outflow)

HNV/PSB = Hansville, Puget Sound
EP/CP = East Passage / Colvos Passage
TN = Tacoma Narrows

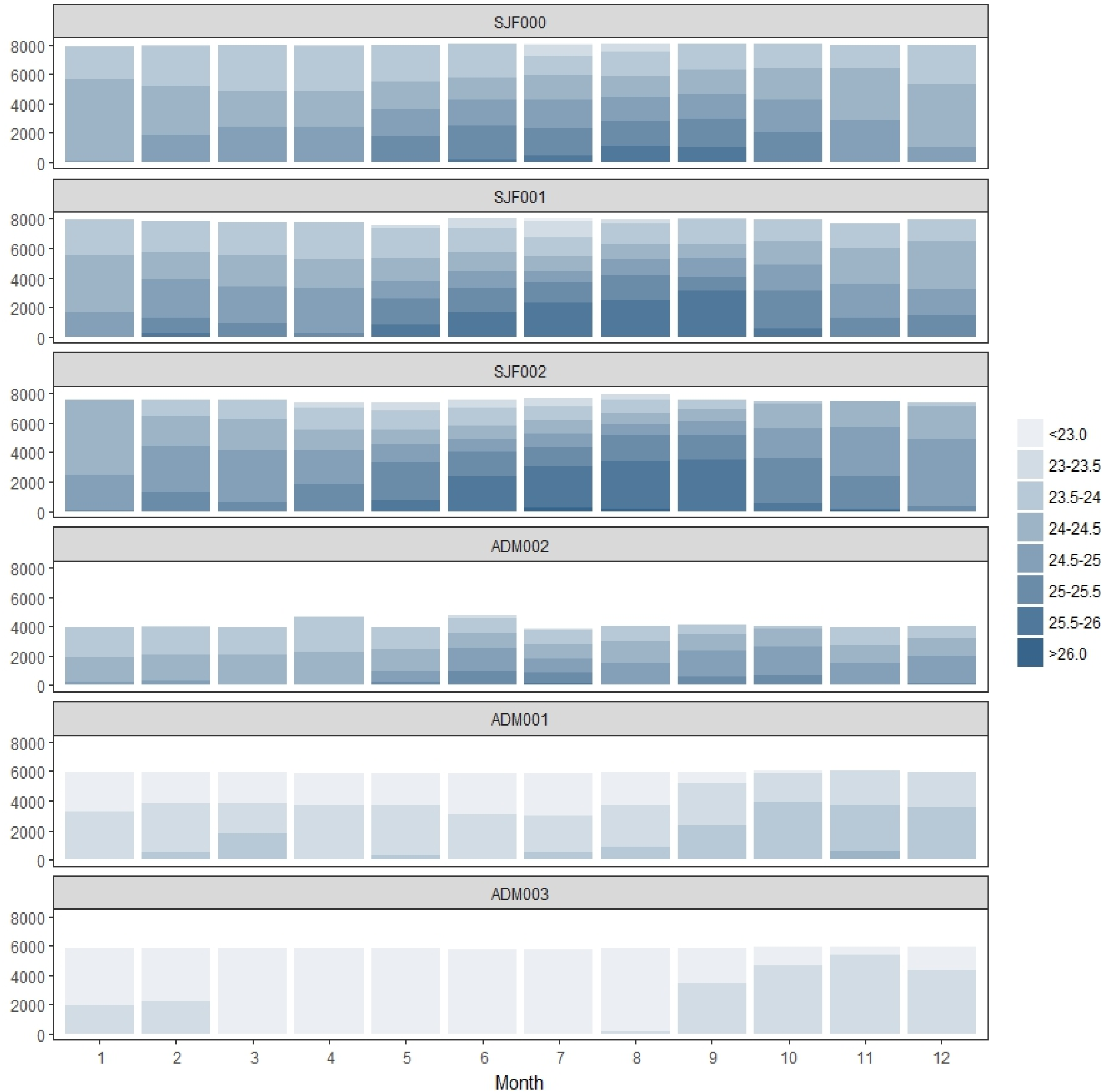
Khangaonkar, T. 2018. https://salish-sea.pnnl.gov/SSM/model/circulation-maps.stm

Density Frequency

N

Strait of Juan de Fuca

Admiralty Inlet (mid – sill)



Summary:

- Admiralty sill is a barrier to exchange of very salty (>33 PSU), low DO (<3 mg/L) water into Puget Sound.
- Water masses are transformed & oxygenated between the ocean & Puget Sound.
- Sites with the lowest DO are distant & separated from low DO ocean water and thus issues are locally driven.
- Reflux (pre-season) water is impacting water quality!