

Transport of Heat, Salt, Oxygen, and Freshwater within the Southernmost Extent of South Puget Sound: Year 2010 in Review

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Background

The Department of Ecology has maintained a continuous mooring station in Squaxin Passage at the Carlyon Beach Marina since 2006 (Figure 1). We monitor temperature, salinity, dissolved oxygen, conductivity, pressure, and density every 15 minutes. Our preliminary data are transmitted and posted on our FTP site: ftp://ecy.wa.gov/eap/Mooring_Raw as well as the NANOOS website: www.nanoos.org/nvs

The southern inlets of Puget Sound are unique ecological microclimates that are subject to strong seasonal variation such as low salinity in winter and high temperatures in summer. Our station is located at the confluence of several passages and therefore captures the signal of water masses moving in and out of the southern inlets.

Are shallow southern bays net sources or sinks of heat, salinity, and dissolved oxygen?

To answer this question, we explore how water mass characteristics change with the tidal cycle and over the year. We seek to understand the dynamic and seasonal variability of these fundamental ecological parameters.

Conclusions

Water masses passing through our station carried distinct signals that are indicative of the net transport of heat, salinity, and dissolved oxygen. The influence of shallow bays on heat, salinity, and oxygen changed over a yearly cycle. Ebbing waters from inlets:

- Heated the Sound during summer.
- Conserved heat during winter.
- Freshened the Sound during winter.

Ebbing waters from inlets often featured resolved signals (strengthen peaks) for heat, salinity, and oxygen.

- Figure 2: Ebb tides often featured a very sharp maximum (sharp peak) in salinity, while flood tides showed more diffuse salinity peaks.
- Figure 3: Ebb tides featured sharpened dissolved oxygen peaks. Statistical analysis indicated that the shallow southern bays were a moderate dissolved oxygen source during summer.

Significant seasonal transitions in principal water masses are evident when viewed on temperature-salinity plots (Fig.4). Moving from early spring into summer, the two principal water masses showed a shift from distinct salinity components to distinct temperature components.

South Sound waters were fresher in summer 2010, compared to summer 2009.



Figure 1. Squaxin mooring station, located on the peninsula between Totten and Eld Inlets, features continuous monitoring.

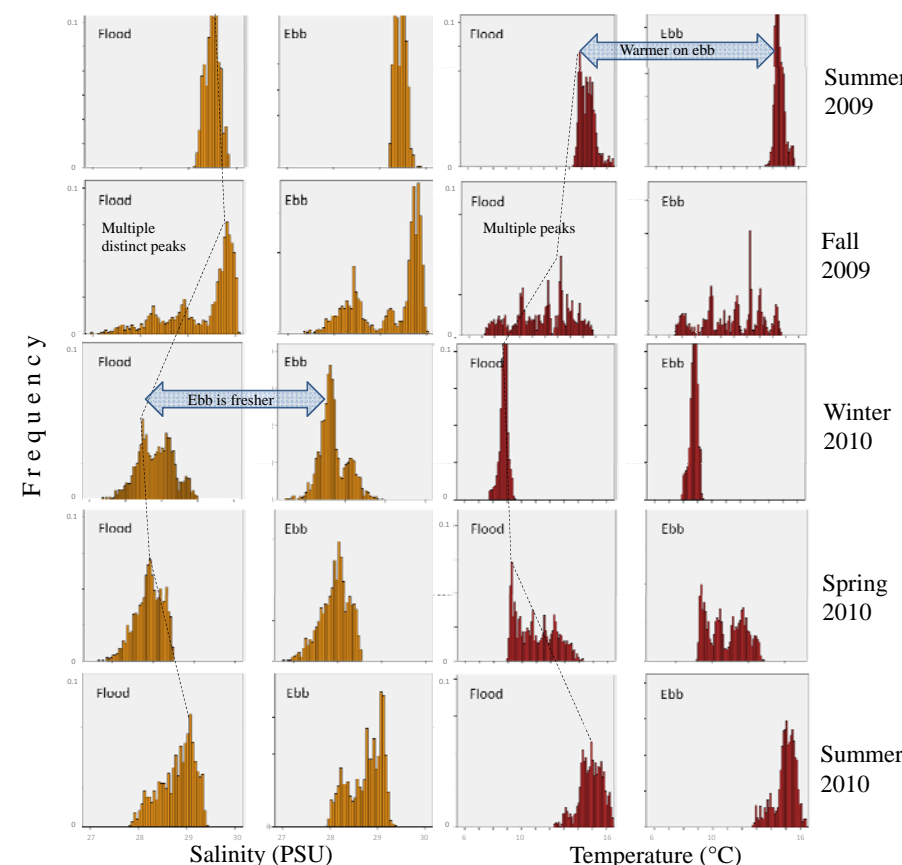


Figure 2. Salinity and temperature frequency distribution plots characterizing water masses as ebbs and floods pass the station. Dotted lines show shifts between seasons.

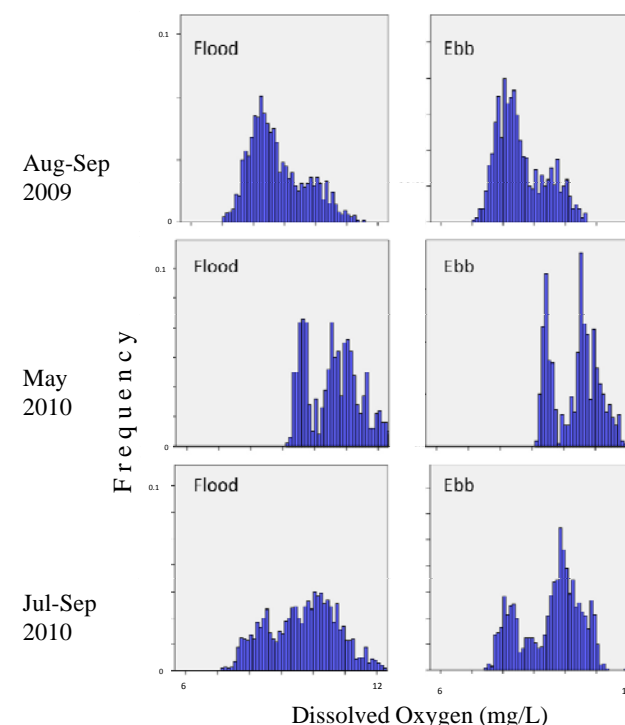


Figure 3. Dissolved oxygen (mg/L) frequency distribution plots characterizing water masses as ebbs and floods pass the station.

Temperature

The southern shallow bays were heat sources for Puget Sound. During summer, warmer water exited (see Figure 2). During spring and fall, the signature became more diverse for both flooding and ebbing tides. During winter, temperatures remained uniform between flooding and ebbing tides.

Salinity

The salinity of the southern bays changes with the season and responds to precipitation and evaporation. In summer, salinity in southern inlets remained high, while in winter the inlets became fresher (see Figure 2). During fall, a more diverse salinity signature occurred consistent with divergent temperatures. During spring, flooding and ebbing waters featured similar salinity signatures.

Dissolved oxygen

Frequency diagrams for dissolved oxygen during spring and late summer are shown in Figure 3. During summer 2010, ebbing water featured a distinct oxygen signature reflecting the physical complexity of the water leaving the inlets. Algal blooms may have played a role in helping define this signature. We speculate that South Sound inlets served as a moderate dissolved oxygen sink during both spring and summer.

Changes in water masses leaving southern inlets during the spring-summer transition

Springtime featured a transition point for heat, salt, and freshwater in southern inlets. Squaxin Passage often saw two distinct water masses, a more “marine” and a more “estuarine” signal (Figure 4).

In spring 2010, the biggest difference between water masses was due to freshwater lowering salinity. Later in spring and early summer, salinity differences decreased and temperature effects were more distinct. This transition denotes an important transition point for the system. By mid-summer most of the difference in water masses were driven by temperature while salinity differences were small.

The gradual sloping between the two distinct water masses (marine estuarine) in temperature-salinity space corroborates a distinct warmer water signal next to a colder water mass. This colder water may be residual from the incoming tide.

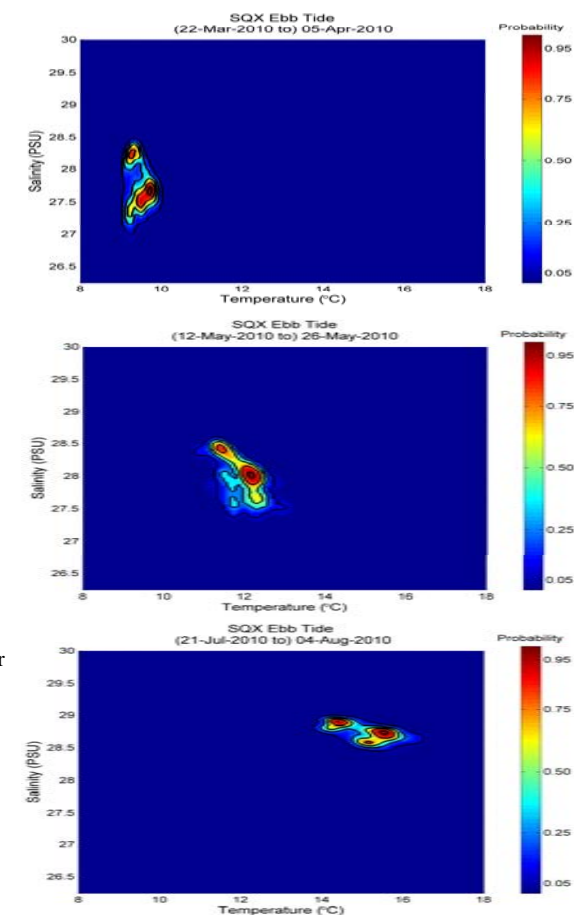


Figure 4. Statistical temperature-salinity plots illustrating water masses split into ebb and flood tides during spring and summer of 2010. Dark red areas indicate highest probability.

This poster is on the Department of Ecology web site at: www.ecy.wa.gov/biblio/1003063.html

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