Recent climate patterns are affecting seasonal water residence times and water temperatures in Puget Sound

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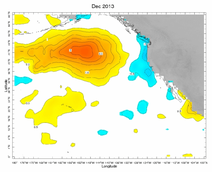
Introduction

Temperature structures affect species composition and lifecycles.

Hypothesis: Recent and predicted climate scenarios for Puget Sound cause warmer conditions year round.



At the end of 2014, water temperatures in Puget Sound increased in response to "The Blob", a region of high Sea Surface Temperature that formed toward the end of 2013 as reported by State Climatologist Nick Bond. We show warm temperatures along two transects in Puget Sound (Fig. 1). During summer drought, more solar heat was retained in Puget Sound due to a decreased exchange with the ocean (Fig. 2). In winter, warmer conditions caused premature snow melt and the freshening of Puget Sound via rivers. The seasonal shift in freshwater delivery may have impacted circulation patterns within Puget Sound and consequently, made Puget Sound warmer during the summer and winter of 2015.

Hood Canal and Whidbey Basin provide thermal-winter refuge for cold-sensitive species. The effect of recent climate shifts (giving rise to "The Blob") elevate Puget Sound water temperatures, especially in wintertime. These elevated temperatures might explain the increasing observations of southern species in Puget Sound such as northern anchovy and herring in Hood Canal.

Figure 1. Two intersecting transects combining hydrographic results from Ecology and King County hydrographic data sets.

Fraser River Outflow as Residence Time

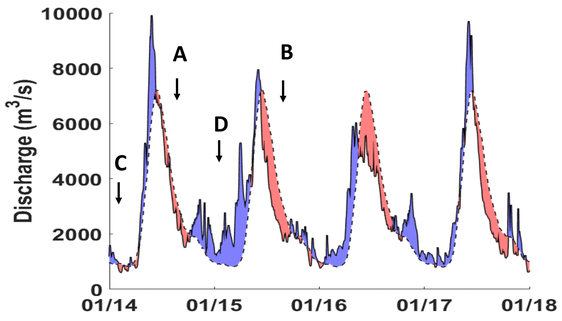


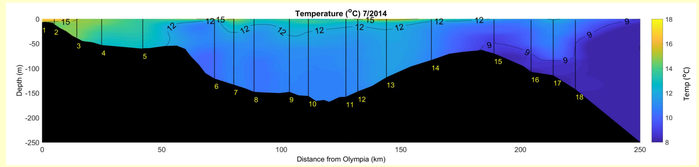
Figure 2. Fraser River discharge as a surrogate for residence time. Red indicates below normal transport (higher residence time), and blue indicates above normal transport (lower residence time). "A", "B", "C", and "D" refer to seasonal events in the center results panel.

Key Points

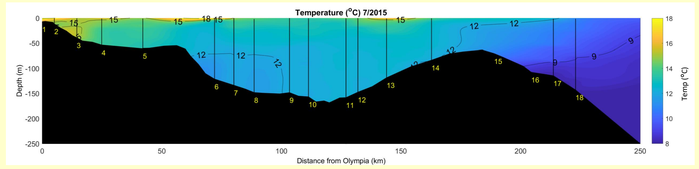
- Both summer and winter water temperatures were warmer in 2015 after the appearance of "The Blob" in 2014.
- Unexpectedly, thermal anomalies were more pronounced in the winter than in summer, particularly in Hood Canal and Whidbey Basin.
- Hood Canal and Whidbey Basin provide thermal-winter refuge for cold-sensitive species such as anchovy.

Blue Transect Results – South to North

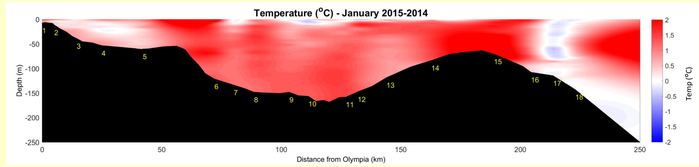
A) Summer (July) 2014 – normal Fraser flow, higher estuarine exchange flow with the ocean, and a lower residence time that led to lower Puget Sound temperatures.



B) Summer (July) 2015 – very dry with lower Fraser flow, lower estuarine exchange flow with the ocean, and a higher residence time leading to higher temperatures.

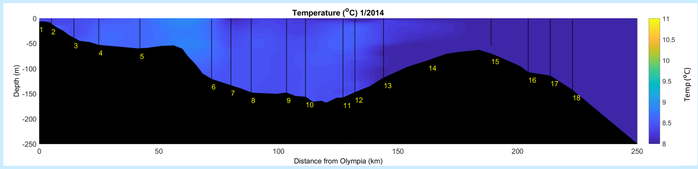


B-A) July 2015 minus July 2014 showing that thermal anomalies are mostly positive supporting the hypothesis.

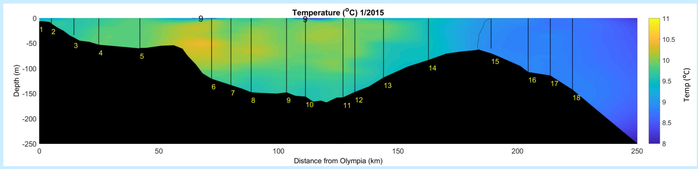


Summer

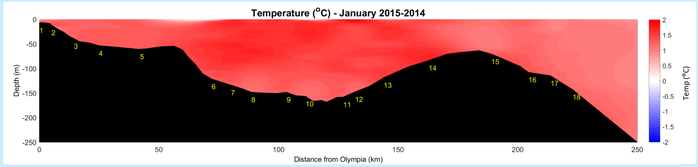
C) Winter (January) 2014 – normal Fraser flow with high snow pack. Estuarine flow was lower and residence time was higher, leading to lower temperatures in Puget Sound.



D) Winter (January) 2015 – higher Fraser flow, higher estuarine exchange flow, and lower residence time resulting in warmer Puget Sound water temperatures.



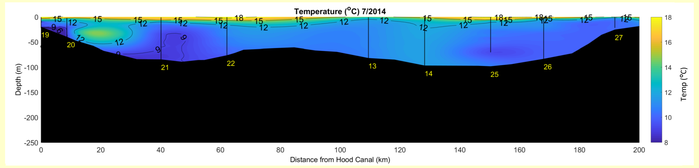
D-C) January 2015 minus January 2014, again showing positive thermal anomalies in support of the hypothesis.



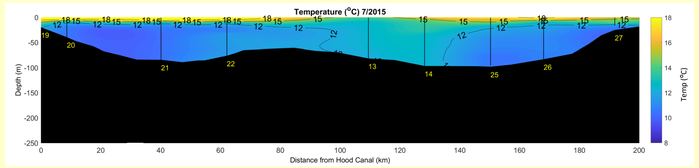
Winter

Red Transect Results – West to East

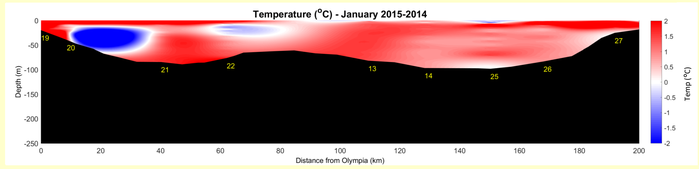
A) July 2014 – Hood Canal to Whidbey Basin transect.



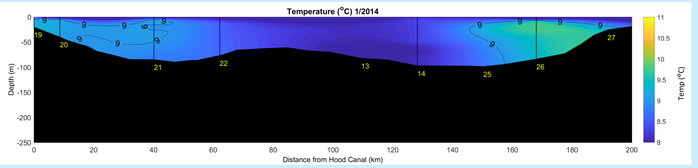
B) July 2015 – Hood Canal to Whidbey Basin transect.



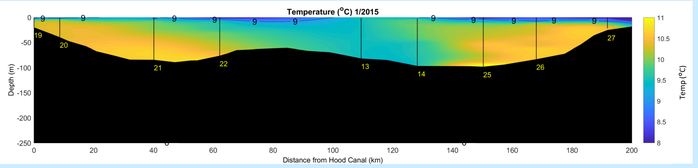
B-A) July 2015 minus July 2014 in Hood Canal to Whidbey Basin transect.



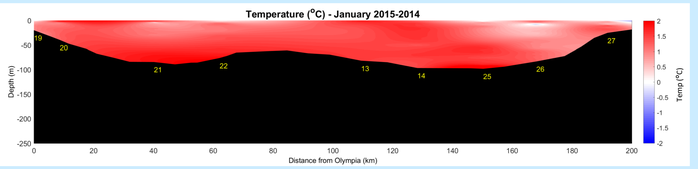
C) January 2014 – Hood Canal to Whidbey Basin transect.



D) January 2015 – Hood Canal to Whidbey Basin transect.



D-C) January 2015 minus January 2014 in Hood Canal to Whidbey Basin transect.



Washington State Department of Ecology, Environmental Assessment Program, Publication 18-03-023.