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Vignette 12: The Blob

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12 THE BLOB: WHAT WERE ITS IMPACTS ON THE SALISH SEA?

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A marine heat wave (MHW) of unprecedented severity, areal extent and duration occurred in the Northeast Pacific Ocean during 2014-2016. This event, known as the "Blob", had a wide variety of far-ranging effects on physical, chemical, and biological ocean properties; here we focus on the Salish Sea. The Salish Sea is connected to the open ocean, of course, and so it stands to reason that the Blob must have influenced our local waters. However, it is not necessarily obvious how, and to what extent. Because the Blob was such a massive perturbation, it represents an attractively large signal for inquiry. Conceivably it represents a dress rehearsal for typical conditions in future decades due to global climate change. With those ideas in mind, the purpose of this piece is to briefly review what happened and the lessons learned.

The near surface waters of the Northeast Pacific began warming substantially, relative to seasonal norms, in the winter of 2013-2014. This warming, which actually entailed less seasonal cooling than usual, can be attributed to a persistent ridge of higher than normal pressure that set up shop over the Gulf of Alaska. The ridge disrupted the usual parade of storms that cross the Northeast Pacific that time of year, with lower wind speeds as a result. The consequence was less heat drawn out of the upper ocean (one cools off a bowl of soup by blowing on it) and suppressed mixing of colder water from below, and ultimately surface temperatures that were as much as 2-3°C on the warm side by early spring 2014 over a large area offshore of the Pacific Northwest. Once formed, this mass of warm water was maintained by an overall reduction in low cloud coverage, and hence enhanced solar heating, in the warm seasons of 2014 through 2016. It was also reinforced by a weather pattern in the winter of 2014-2015 that featured anomalous winds from the south, of sub-tropical origin, and a shift in the overall pattern to include positive sea surface temperature (SST) anomalies along the coast of western North America (Figure 1). For the most part, the Blob ended in late fall of 2016, in association with an active storm track that brought a preponderance of cool winds out of the northwest. On the other hand, a lingering hangover from the Blob was still noticeable through 2019 at depths roughly between 100 to 300 meters, particularly in the Gulf of Alaska.

The Blob both directly and indirectly impacted the Salish Sea. The Salish Sea's primary exchange with the open ocean is at the west entrance of the Strait of Juan de Fuca; ocean conditions at that location both impact the properties of the inland waters and modulate their ventilation (i.e., residence times). The Northeast Pacific also indirectly influences the Salish Sea through its effects on the weather. Because the prevailing winds usually include an onshore-directed component, sea surface temperature anomalies off the coast of the Pacific Northwest tend to be reflected in air temperature anomalies of the same sense. The record high temperatures in Washington State during the winter of 2014-2015 can be attributed in part due to the Blob.

With that lead-in, let us now consider what happened in the Salish Sea. Much of the following information is cribbed from the "Puget Sound Marine Waters" annual overviews produced by the National Oceanic and Atmospheric Administration's (NOAA) Northwest Fisheries Science Center for the Puget Sound Ecosystem Monitoring Program's Marine Waters Workgroup, and interested readers are encouraged to check out those overviews.

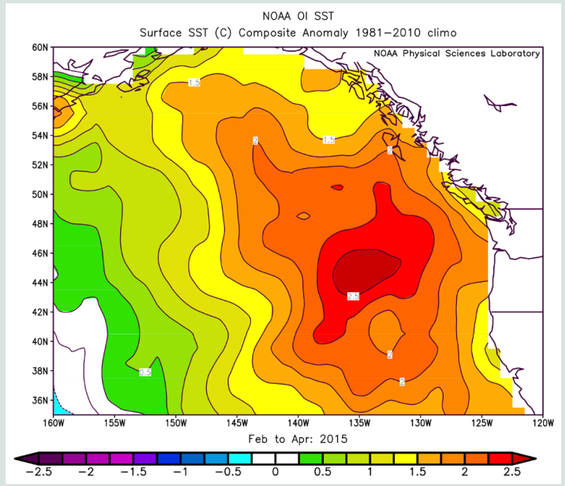
The Blob really began rearing its ugly head in fall 2014 when the seasonal transition in the coastal winds from upwelling to downwelling shoved the extremely warm water lurking offshore right up to the coast. The warm water entering the Strait of Juan de Fuca at that time meant that the density differences driving the estuarine circulation were weakened. An important consequence of the lack of flushing was abnormally low oxygen concentrations in some locations, especially in lower Hood Canal. The relatively warm and sunny weather during fall 2014 was accompanied by a prominent phytoplankton bloom.

The heyday of the Blob was during 2015. The aforementioned warm winter of 2014-2015 resulted in the most paltry snowpack for the Pacific Northwest in the historical record. Because the precipitation was much more in the form of rain rather than snow, there was greater freshwater runoff than usual in early 2015, leading to low salinities in the upper part of the water column, and very low streamflows in summer 2015, resulting in high salinities. The latter had the positive effect of promoting vertical mixing, and hence helped in some locations to keep oxygen concentrations at depth from cratering. That being said, the open ocean conditions associated with the Blob imply that there were relatively long residence times for the waters of the Salish Sea with a host of incompletely known consequences. This was a year that will long be remembered for harmful algal blooms of Pseudo-nitzschia spp. along the west coast of North America, but the Salish Sea also got in the act with an amazingly early bloom of *Alexandrium* spp. in Hood Canal in April and numerous examples of Vibrio-contaminated oysters. Impacts on higher trophic levels also became apparent, including herring, seabirds (e.g., rhinoceros auklets) and some species of marine mammals.

The year of 2016 was less extreme as the Blob wound down, but the Salish Sea definitely remained on the warm side. This year also featured a continuation of the recent trend for warmer spring weather and rapid snowmelt, with the result being earlier freshening of the near-surface waters of the Salish Sea. Herring populations and some seabird and marine mammal species continued to struggle.

The post-blob period of 2017-2019 represents a mixed bag. The return of more normal conditions—whatever that means during a time of inexorable trends in physical and chemical ocean properties—was accompanied by recovery in some populations and continued declines in others. A telling example here is the plight of the southern resident orcas, who apparently spent relatively little time in the summer of 2019 in their usual haunts in the Salish Sea, perhaps because of the Blob's longer-lasting impacts on Chinook salmon runs.

In terms of takeaways, perhaps the Blob can serve as a wake-up call. The climate community appreciated the overall warming that was occurring, but still was stunned by the magnitude of this recent event. The marine ecosystem response was complex, especially at higher trophic levels, and it is proving to be no cinch to tease out the interplay between all the potential factors. Better understanding of the Salish Sea's response to the climate forcing through improved monitoring and further research is necessary. We know that the Salish Sea will experience future events, and that they are liable to be even more extreme and with profound effects, given the background warming and changing ocean chemistry.



Sea surface temperature (SST) anomaly distribution (°C) for February-April 2015 from NOAA's Optimal Interpolation Sea Surface Temperature dataset. Source: NOAA/ESRL Physical Sciences Laboratory from their website at http://psl.noaa.gov/.