Ocean Acidification related to marine water quality in Washington state

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The Washington Ocean Acidification Center offers the following information, based on evidence presented in the peer-reviewed scientific literature, to clarify consideration of ocean acidification in Washington's marine and estuarine waters in the context of marine water quality.

1. Waters with an aragonite saturation value (Ω_{ar}) of 1 or less are "corrosive" by definition[1]. Aragonite saturation values of 1 or lower have been repeatedly observed in the marine waters of Washington and Oregon, in both the coastal ocean[2] and in the estuarine waters of Puget Sound[3]. An Ω_{ar} of 1 corresponds to a pH of ~7.75 at the values of temperature and salinity typical of Washington and Oregon marine waters.
2. Hatchery and laboratory studies have shown that oyster larvae experience conditions detrimental to their development and growth at Ω_{ar} of ~1.7[4], corresponding to a pH of ~8.03, demonstrating that negative biological effects occur at a threshold that is allowable under state water quality criteria for pH issued in accordance with EPA guidelines. Those criteria require that pH must be within the range of 7.0 to 8.5, and that within this range the human-caused variation must be less than 0.2 pH units or 0.5 pH units, depending on water use category. At present there is no water quality standard for Ω_{ar}.
3. Corrosive conditions and those that negatively affect development and growth of oyster larvae are influenced by both natural and anthropogenic factors. The anthropogenic increase in CO_2 in the atmosphere has caused a global average decline in surface ocean pH of 0.1[5]. This equates to decrease in aragonite saturation (Ω_{ar}) of 0.5[6]. This global signal, a reduction of 0.5 Ω_{ar}, is additive to the natural state, as explained at the Washington OA Center. The reduction in aragonite saturation level attributable to human-produced CO_2 emissions means that the threshold of importance to larval oysters — 1.7 Ω_{ar} — is crossed more frequently now than it was during the pre-industrial era. For example, Harris et al. [7] note this now occurs 33% of the time, compared with 11% of the time in the pre-industrial era. Low aragonite saturation levels occur in nature and in shellfish hatcheries that draw in local surface seawater.
4. Other biological and physical mechanisms (e.g., respiration, mixing, upwelling) can substantially affect the pH and aragonite saturation values at a given location and time, causing local variation in conditions, especially in inland waters (see Washington OA Center for more detail). As noted in the Washington State Blue Ribbon Panel Report and its Scientific Summary, we need to continue to increase our knowledge of the extent to which global anthropogenic factors and local human inputs affect inland waters (for example, by building on the findings of Feely et al., 2010, which addressed global anthropogenic factors, respiration, and upwelling in Hood Canal).
5. A group of planktonic calcifying organisms known as pteropods are sensitive to aragonite saturation levels. Dissolution of their shells has been observed at levels of pH and aragonite saturation that now occur in the waters of Washington and Oregon[8]. The observed negative effects on these native organisms in their natural environment would be significantly less if the anthropogenic signal (that is, a decrease in Ω_{ar} of 0.5) was absent.

The Washington OA Center is working to support EPA at the national level to determine if there is a better indicator of ocean acidification than the current water quality standards that exist for pH but not for aragonite saturation, for example. The Center is collaborating with numerous regional partners to monitor and assess current conditions and organismal effects, and to forecast conditions in Washington waters.

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