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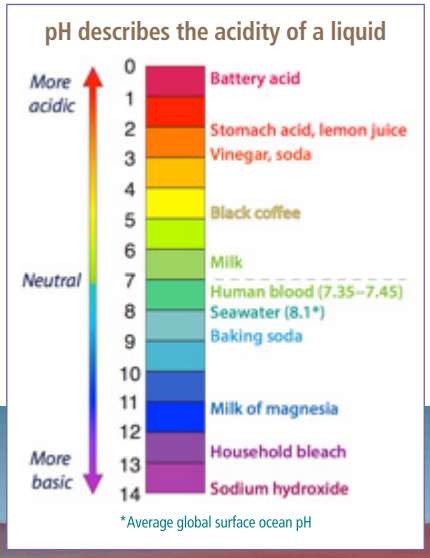
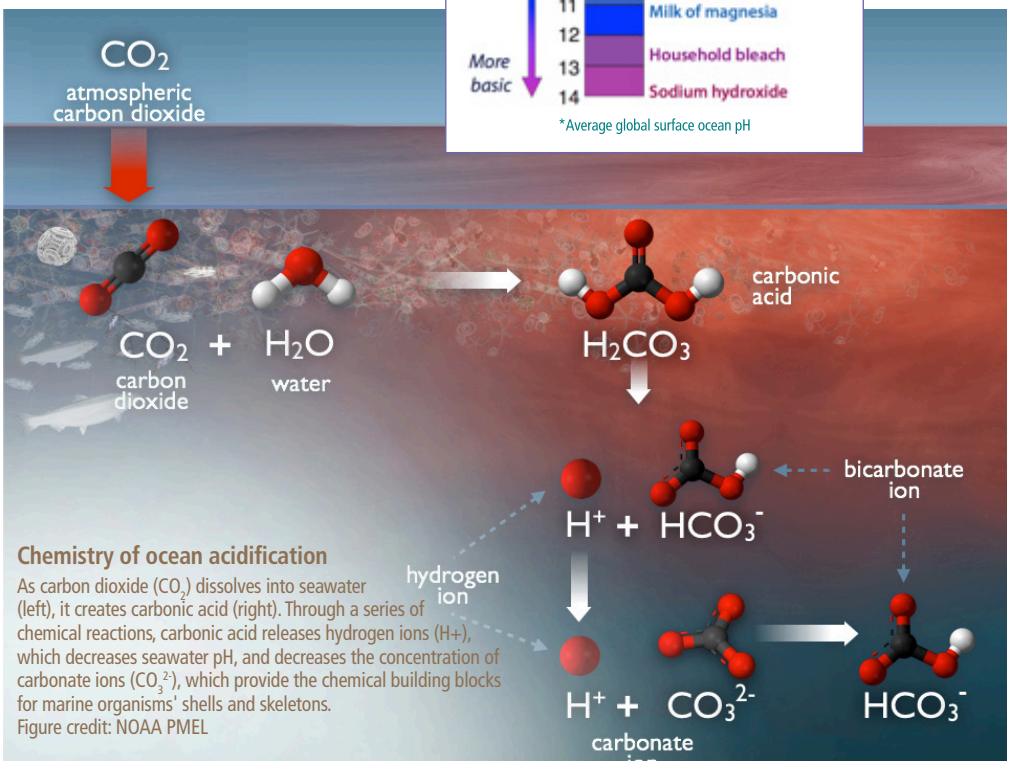
Ocean Acidification in Washington State

What is Ocean Acidification?

Ocean Acidification (or 'OA') is a long-term decrease in seawater pH that is primarily caused by the ocean's uptake of carbon dioxide (CO_2) from the atmosphere. CO_2 generated by humans' use of fossil fuels and deforestation has been accumulating in the atmosphere since the industrial revolution. About one quarter of this CO_2 is absorbed by the oceans, where it reacts with water to form carbonic acid. As a result, the average pH of seawater at the ocean surface has already dropped by ~0.1 units, a 30% increase in acidity. If atmospheric CO_2 levels continue to climb at the present rate, ocean acidity will double by the end of this century.





Chemistry of ocean acidification
As carbon dioxide (CO_2) dissolves into seawater (left), it creates carbonic acid (right). Through a series of chemical reactions, carbonic acid releases hydrogen ions (H^+), which decreases seawater pH, and decreases the concentration of carbonate ions (CO_3^{2-}), which provide the chemical building blocks for marine organisms' shells and skeletons.
Figure credit: NOAA PMEL

OA in Washington State

Our region is experiencing ocean acidification sooner and more severely than expected, due to a combination of human and natural causes. In the spring and summer, acidification along our coast is compounded by upwelling, which mixes deep, naturally low-pH seawater into the already acidified surface layer. In Puget Sound, nutrients generated by human activities (mostly nitrogen and phosphorus from sewage, fertilizers and manure) fuel processes that add even more CO_2 to this 'doubly-acidified' seawater. The combination can be deadly to vulnerable organisms. pH levels as low as 7.4 have been recorded in Hood Canal, an important shellfish-growing region. State and federal agencies, scientists, tribes, shellfish growers and NGOs are working together to address OA in our region.

What does OA mean for marine life?

As seawater becomes more acidic, *calcifiers* — marine organisms such as oysters, pteropods and corals — have to work harder to obtain the dissolved minerals they need to build their calcium carbonate shells and skeletons. This extra effort leaves them with less energy to spend on other important activities like growth and reproduction. Juveniles seem to be

over

especially vulnerable to acidification; shellfish hatcheries now monitor seawater chemistry carefully to avoid exposing their larvae to corrosive conditions that can kill them overnight. Even animals that don't have shells are feeling the effects of acidification. High levels of dissolved CO_2 cause a range of sensory, behavioral, and metabolic effects in fish and invertebrates.

What OA is not….

- Ocean acidification does *not* mean the oceans are becoming *acidic* (i.e. pH less than 7). The term "acidification" refers to a shift in pH towards the acidic end of the scale; similar to the way an increase in temperature from -20°C to 0°C (-4°F to 32°F) would be described as "warming," even though it's still cold.
- Seemingly small changes in pH are *not* insignificant. The pH scale, like the Richter scale, is logarithmic; that means pH 7 is *10 times* as acidic as pH 8. Because most animals and plants have a narrow pH "comfort zone," even a small increase in acidity can be very stressful.
- OA is *not* a future threat; it's already happening, and is having serious impacts on Washington State's marine resources and the people who depend upon them.
- OA is *not* just an "oyster problem." Oysters have been called "canaries in the coal mine" because it was oyster hatchery die-offs that first drew attention to the issue in the mid-2000's, but many other species have since shown signs of vulnerability as well. Unless we do something soon, the marine food web may change in dramatic and unpredictable ways as more and more species struggle to cope with changing seawater chemistry.

Learn more

Visit Washington Sea Grant's Ocean Acidification webpage for more information *wsg.washington.edu/our-northwest/ocean-acidification/*.

What can be done?

- In 2012, Washington Governor Christine Gregoire appointed a Blue Ribbon Panel on Ocean Acidification to assess the problem and recommend solutions. The state continues to work on ways to reduce CO_2 emissions, fund OA monitoring and research programs, and help the shellfish industry adapt to changing seawater chemistry.
- If protecting the Washington's marine environment and economy from the effects of OA is important to you, let your local and federal decisionmakers know! Ask them to support programs that will help us understand and address OA and its causes.
- Although OA is a global problem that will require global solutions, there *are* things you can do to mitigate OA locally. Reducing your carbon footprint, keeping nutrients out of the marine environment, and getting engaged in marine conservation will help make Washington's marine waters more resilient to OA. Check out Washington Sea Grant's OA Action Page for tips *wsg.washington.edu/our-northwest/ocean-acidification/what-can-you-do-about-oa/*.

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