Oysters and Ocean Acidification in the Pacific Northwest

CHE Webinar September 18, 2014
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“Between 2005 and 2009, disastrous production failures at Pacific Northwest oyster hatcheries signaled a shift in ocean chemistry that has profound implications for Washington’s marine environment.”

Washington Blue Ribbon Panel on Ocean Acidification 2012
Ocean Acidification (OA) Chemistry 101

$\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$

$\text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^-$

$\text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}^+ + \text{CO}_3^{2-}$

$\text{CO}_2$ (carbon dioxide) + $\text{H}_2\text{O}$ (water) $\rightarrow$ $\text{CO}_2$ (carbonic acid) $\rightarrow$ $\text{H}^+$ (hydrogen ion), $\text{HCO}_3^-$ (bicarbonate ion), $\text{CO}_3^{2-}$ (carbonate ion), pH (saturation state $\Omega$)
How CO$_2$ in seawater affects marine life

**Changes in chemistry**
- CO$_2$(aq) $\uparrow$
- HCO$_3^-$ $\uparrow$
- CO$_3^{2-}$ $\downarrow$
- pH $\downarrow$

**Biological effects**

**Increase in photosynthesis**

**Decrease in calcification**

**Changes in physiology**

**Global**
- Temp $\uparrow$
- Oxygen $\downarrow$

**Regional**
- Overfishing
- Pollution
- Oil spills
Socioeconomic implications of ocean acidification

In Washington State alone:

- The shellfish aquaculture industry is worth $270 million per year and employs more than 3,200 people.
- Recreational shellfish harvesting contributes another $30 million per year to the state.
- The seafood industry generates 42,000 jobs and contributes $1.7 billion to gross state product.
- Shellfish are an important natural resource and of cultural importance to Washington’s tribal communities.
Oyster production declines with elevated CO$_2$

**Quality**

**Key outcomes:**

- Break-even point identified between net growth and mortality.
- Larvae have smaller shells with signs of dissolution at lower saturation states.
- Monitoring at hatcheries facilitates adaptation strategies.

*Photos: G. Waldbusser, E. Brunner*

*Barton et al. 2012*
Policy linkages from shellfish-science partnership

Performance

- **Washington State Blue Ribbon Panel on Ocean Acidification** – Outgrowth of partnership with shellfish growers (2011–2012)

- **West Coast OA & Hypoxia Science Panel** – California, Oregon, Washington, and British Columbia (2013–present)
Linkages to human health and food security

• **Food security** – Over 1 billion people derive all their dietary protein directly from the ocean.

• **Changing CO₂ and nutrient conditions**
  • Elevated CO₂ plus nutrient limitation can lead to increased toxin production in harmful algal bloom species.
  • Changes in carbon chemistry may also drive changes in phytoplankton community composition and thus food quality for higher trophic levels.