Effects of Reduced pH on Embryonic Pacific Herring Development: Implications for Ocean Acidification Impacts on Marine Fish

Fletcher Sewall
Ron Heintz
Mark Carls
Auke Bay Laboratories
Juneau, AK
fletcher.sewall@noaa.gov

Background

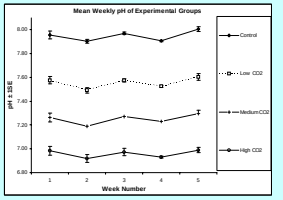
- **Ocean acidification due to carbon dioxide input is projected to increase at unprecedented rates given current trends in fossil fuel use**
- **Its effects may be especially pronounced in Alaskan coastal waters**
- **Direct physiological effects of acidification on marine fishes are largely unknown, but may decrease populations by reducing fitness at sensitive early life stages**
- **Reduced pH may require embryonic fish to allocate more energy to acid-base regulation, leaving less available for growth**
- **Pacific herring (*Clupea pallasii*) are ecologically important prey species for marine mammals, birds and groundfishes, and support commercial bait and sac roe fisheries and subsistence harvests**
- **Objective: determine the effects of lowered pH on survival and growth of Pacific herring embryos**

Methods

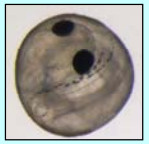
- **Pre-spawning herring captured by cast net near Juneau, Alaska in April 2009**
- **Eggs and milt mixed, fertilized eggs placed on slides**
- **Slides from 5 parental crosses placed in 1L flow-through containers**
- **Containers placed in seawater baths to maintain temperature**
- **Hatched larvae lengths taken by photo software, RNA/DNA by dye fluorometry, lipid levels by SPV reagent**

Dosing system:

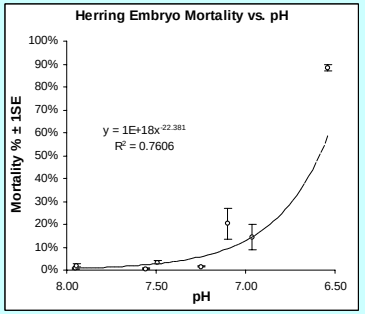
- **Seawater source pumped from 25m depth set the control pH at 7.94 - 7.95**
- **Filtered seawater acidified in a ~5m vertical PVC pipe with CO_2 bubbled through an air stone**
- **pH levels controlled by mixing acidified and untreated seawater**
- **Treatment levels approximate the surface ocean pH changes over the next 100-300 years.**



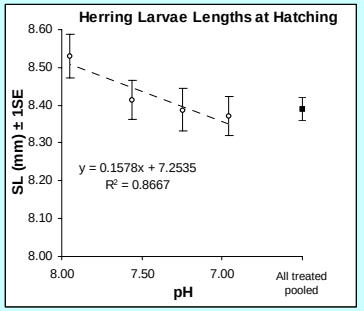
Summary of Findings



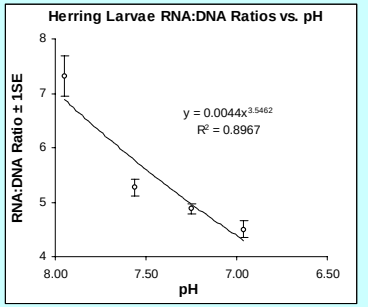
Key finding: **Reduced pH depressed the growth and protein synthesis rates of developing Pacific herring embryos and increased mortality at the lowest pH levels.**



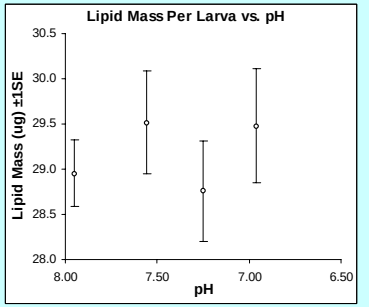
Mortality was dose dependent, ranging from 0.85% at pH 7.94 (control) to 88% at pH 6.54.



Length at hatch in all treatment groups combined (SL ± 1SE = 8.39 ± 0.03mm) was significantly smaller than in the control group (SL ± 1SE = 8.53 ± 0.06), suggesting a threshold effect.



RNA:DNA ratios at hatch decreased with pH levels, indicating reduced protein synthesis and growth rates.



Lipid energy stores per larva did not change in response to pH.

- These results suggest that any additional energy demands due to pH changes are met by shifting energy away from growth, while lipid energy stores are maintained.

Alaska Fisheries Science Center
NATIONAL MARINE FISHERIES SERVICE - NOAA FISHERIES

Acknowledgements: We thank Jack Christiansen, Tommy Abbas, JJ Vollenweider, Andrew Eller, Haley Poole, Carrie Talus, Lawrence Schaufler, Lawra Vanderhoof, Ashwin Sreenivasan, and Kevin Heffern for assistance with this project.