

The Science of Ocean Acidification: A quick survey of biological impacts

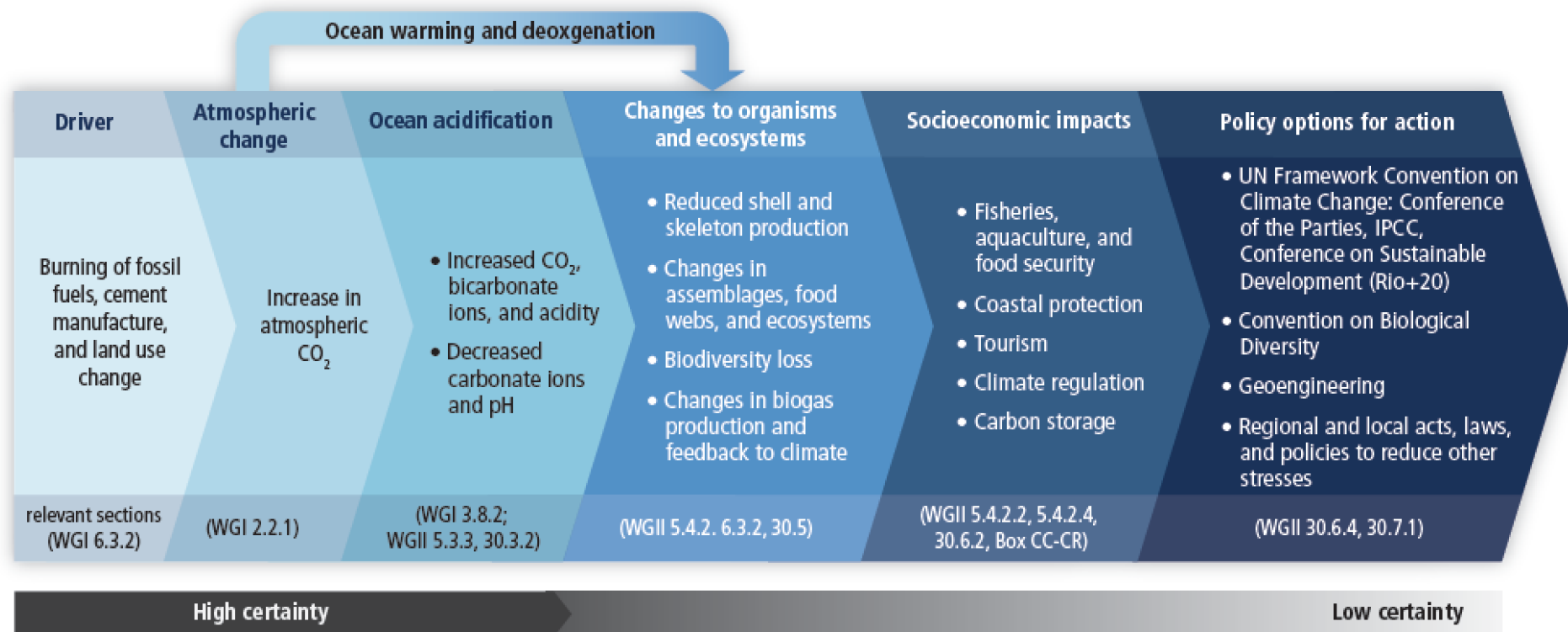
Terrie Klinger

Barer Professor of Sustainability Science

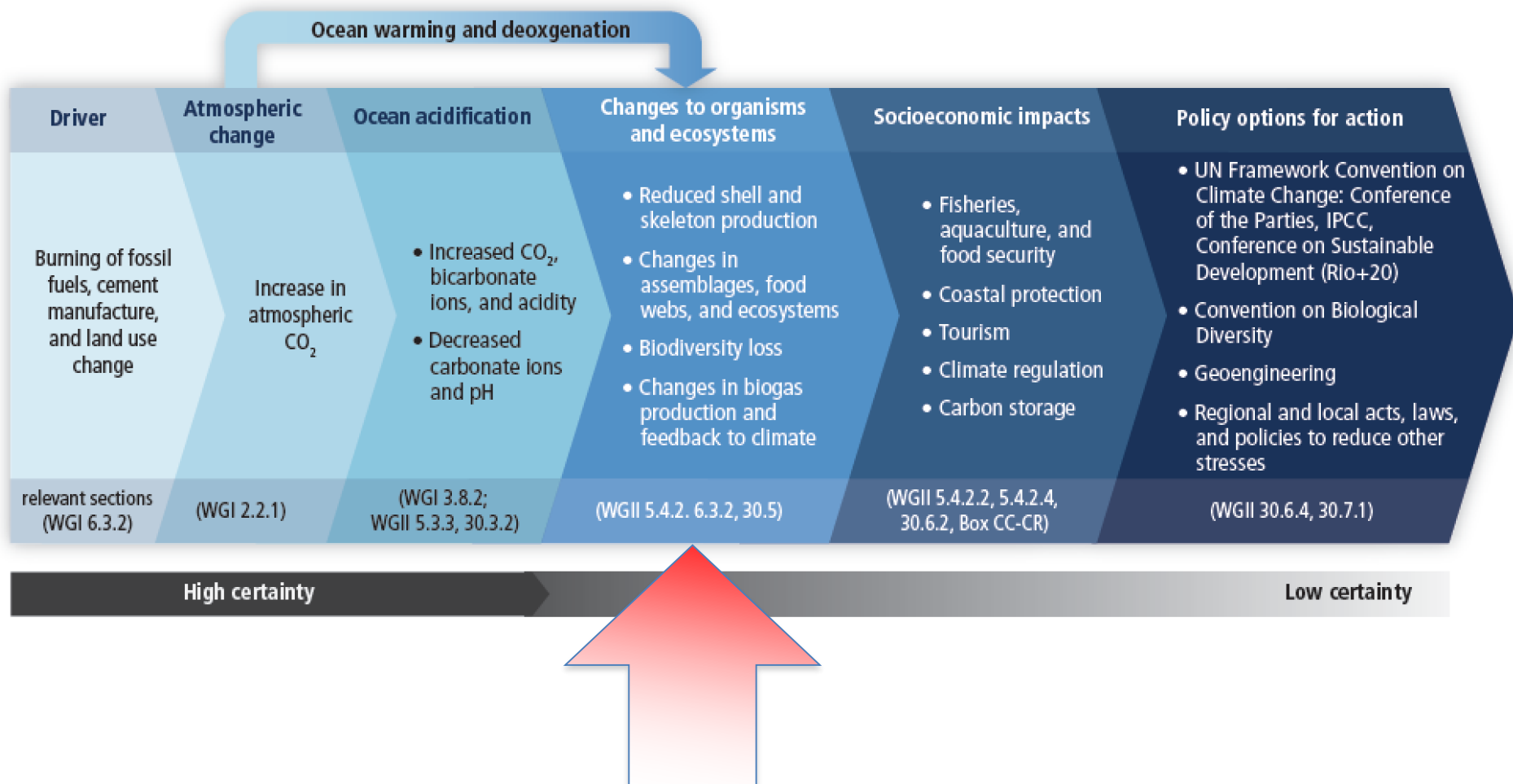
Director, School of Marine & Envir Affairs

Co-Director, Washington OA Center

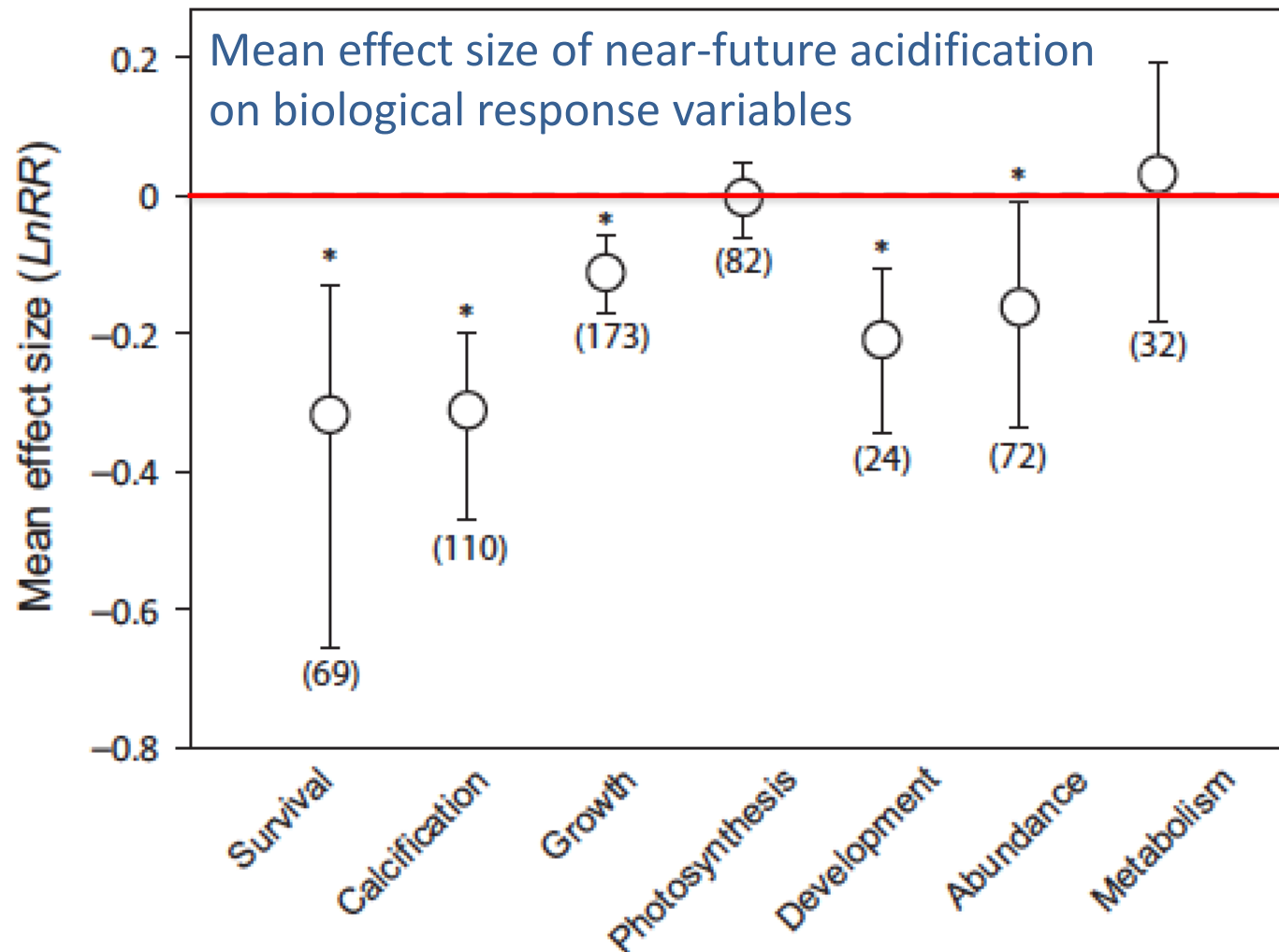
OA has chemical, biological, & socio-economic impacts



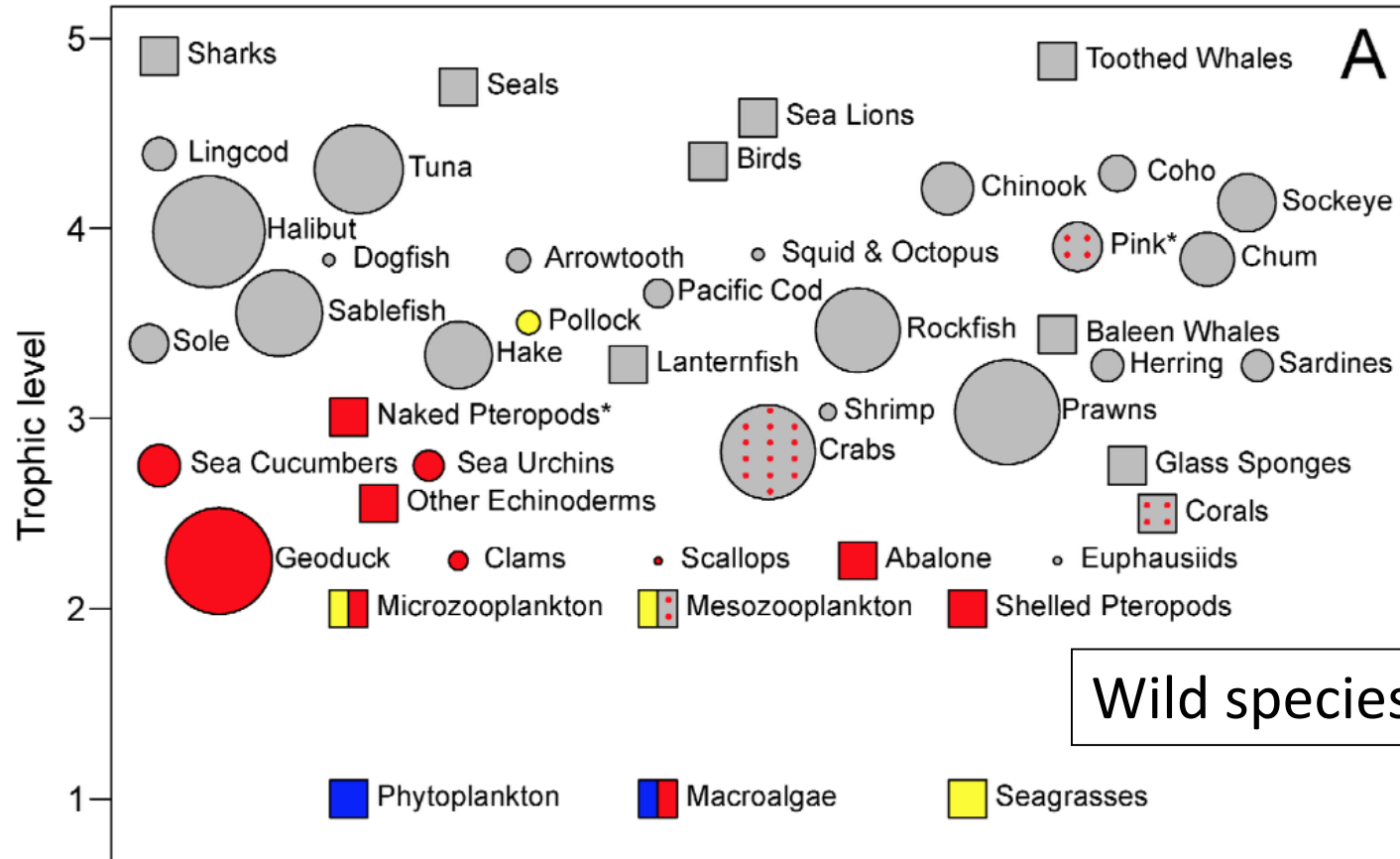
OA has chemical, biological, & socio-economic impacts



Effects occur across critical life processes



Effects occur across trophic levels



Red = likely negative Blue = likely positive Yellow = likely neutral
Gray = no data

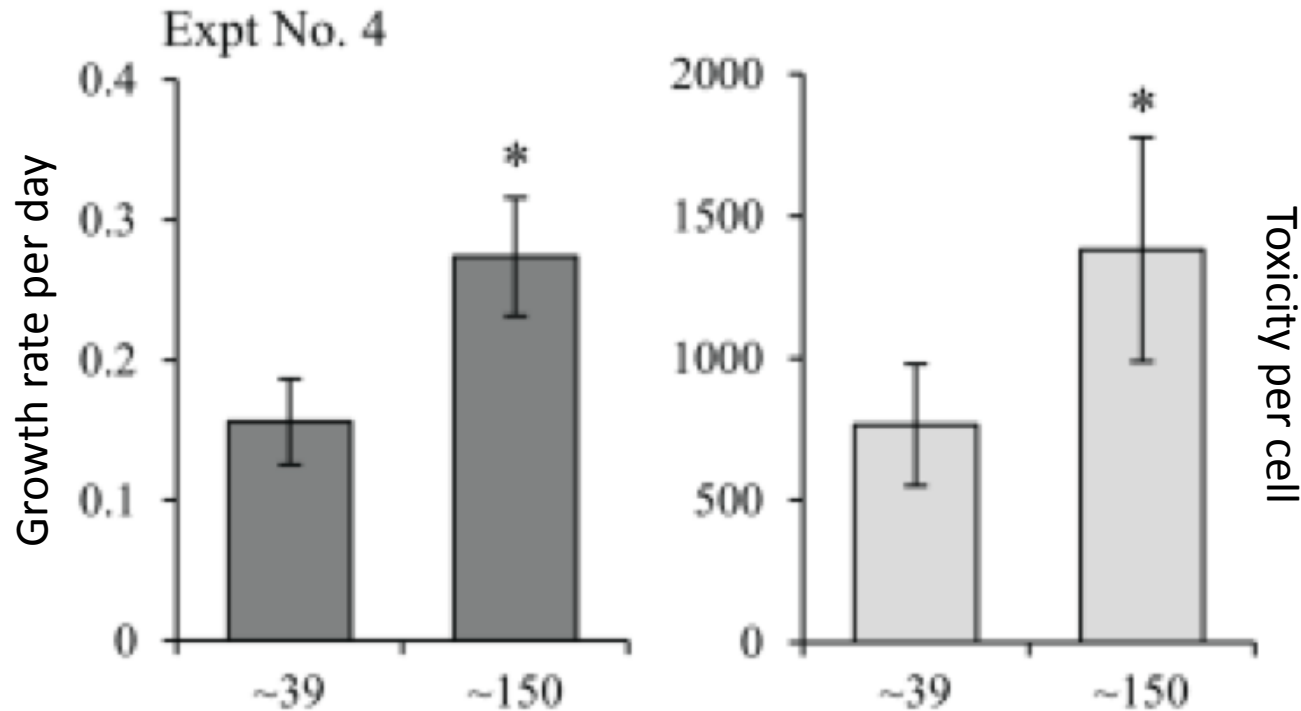
Circles: commercial species
Size of circle: estimated landed value
Solid color: likely effect
Stippled: potential effect

Harmful algae grow faster and are more toxic
under OA conditions



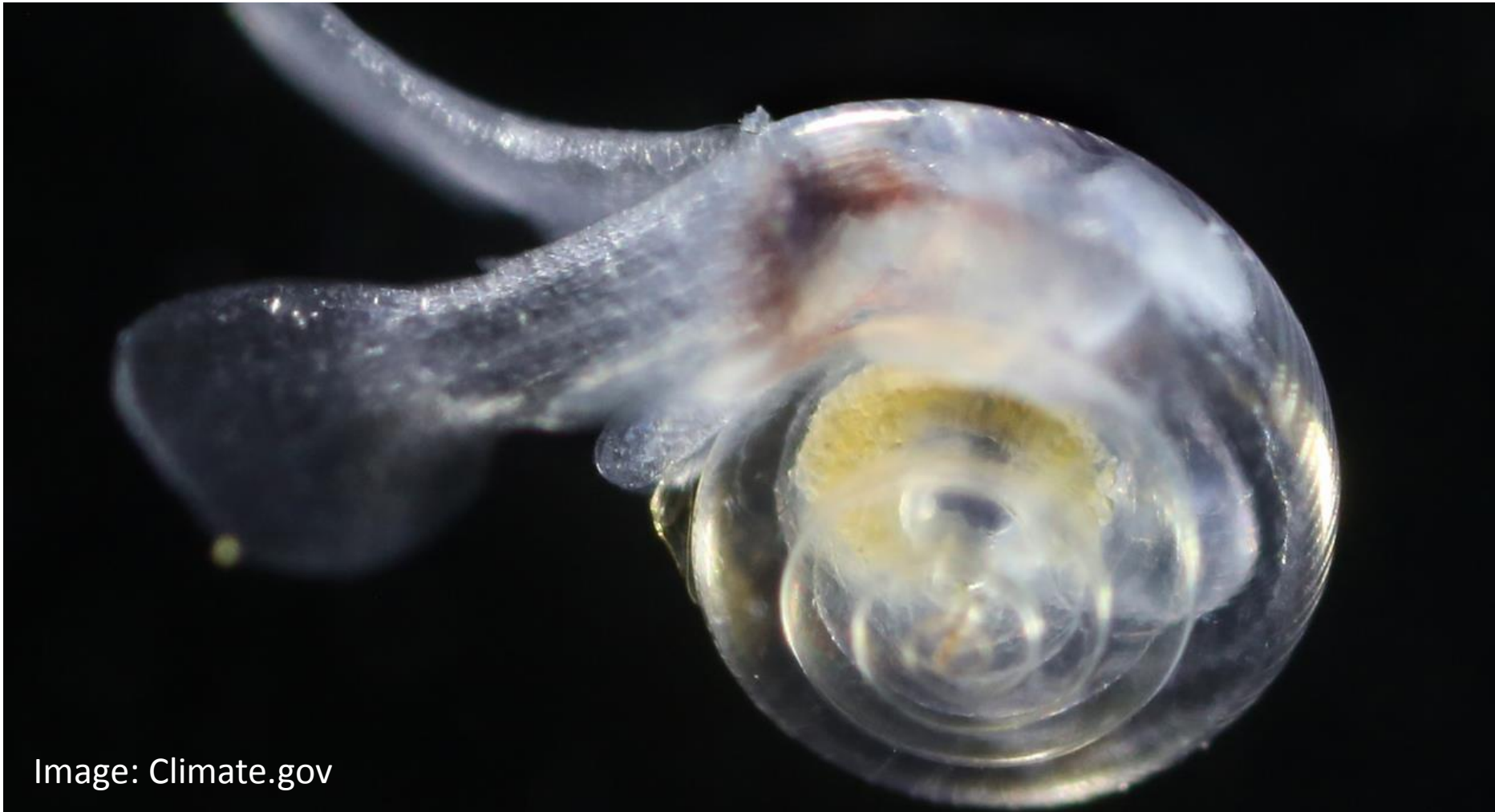
Image : D. Anderson, Woods Hole Center for Oceans and Human Health

Harmful algae grow faster and are more toxic under OA conditions



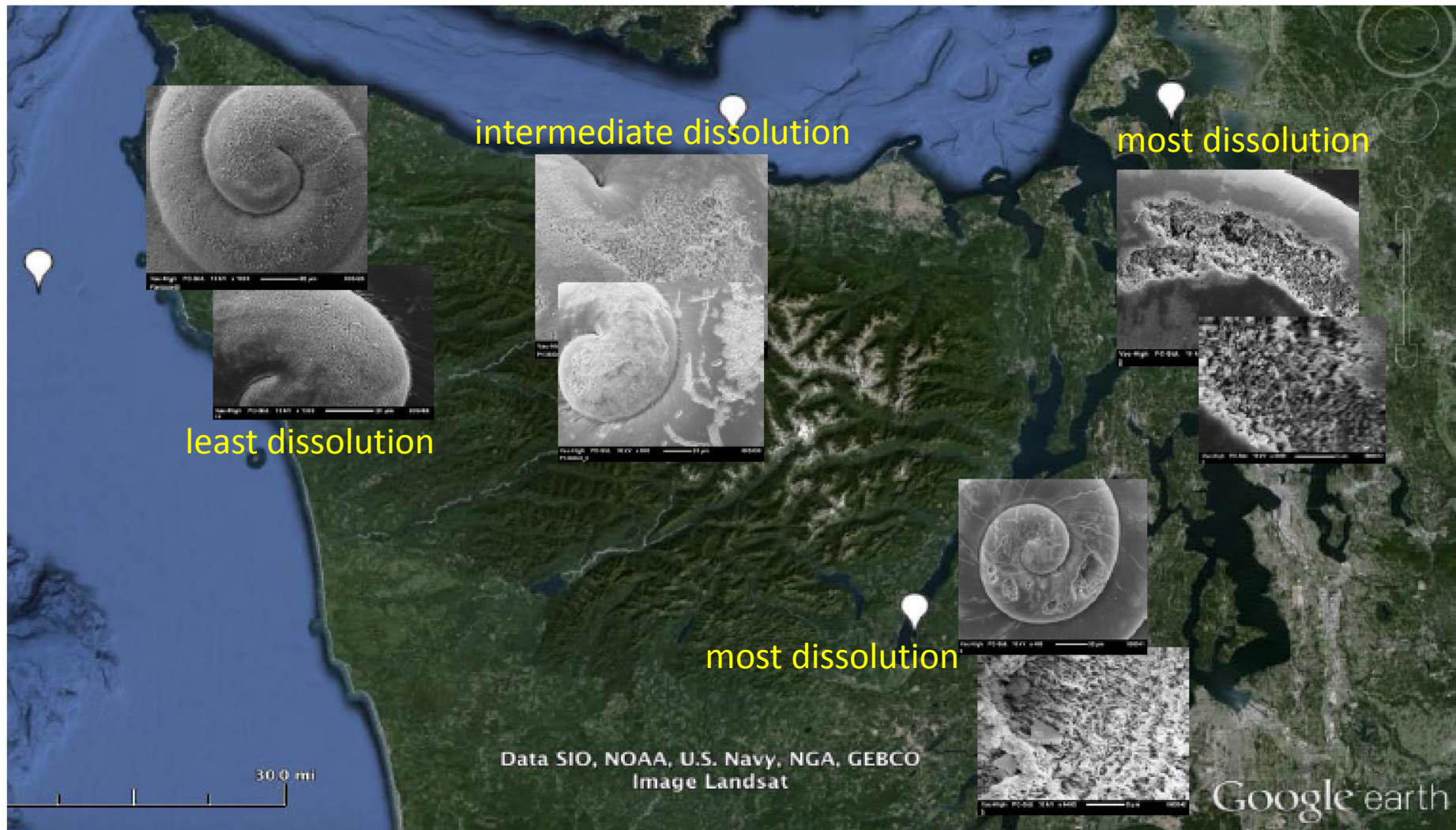
Growth rate (left panel) and toxicity (right panel) of the dinoflagellate *Alexandrium fundyense* under low and high pCO₂ conditions

Planktonic shells dissolve under OA conditions
Calcification rates decline
Behavioral changes are induced



Strong correlation between intensity of OA and shell dissolution in Washington waters

Hood Canal > Whidbey Basin > Strait of Juan de Fuca > Outer Coast



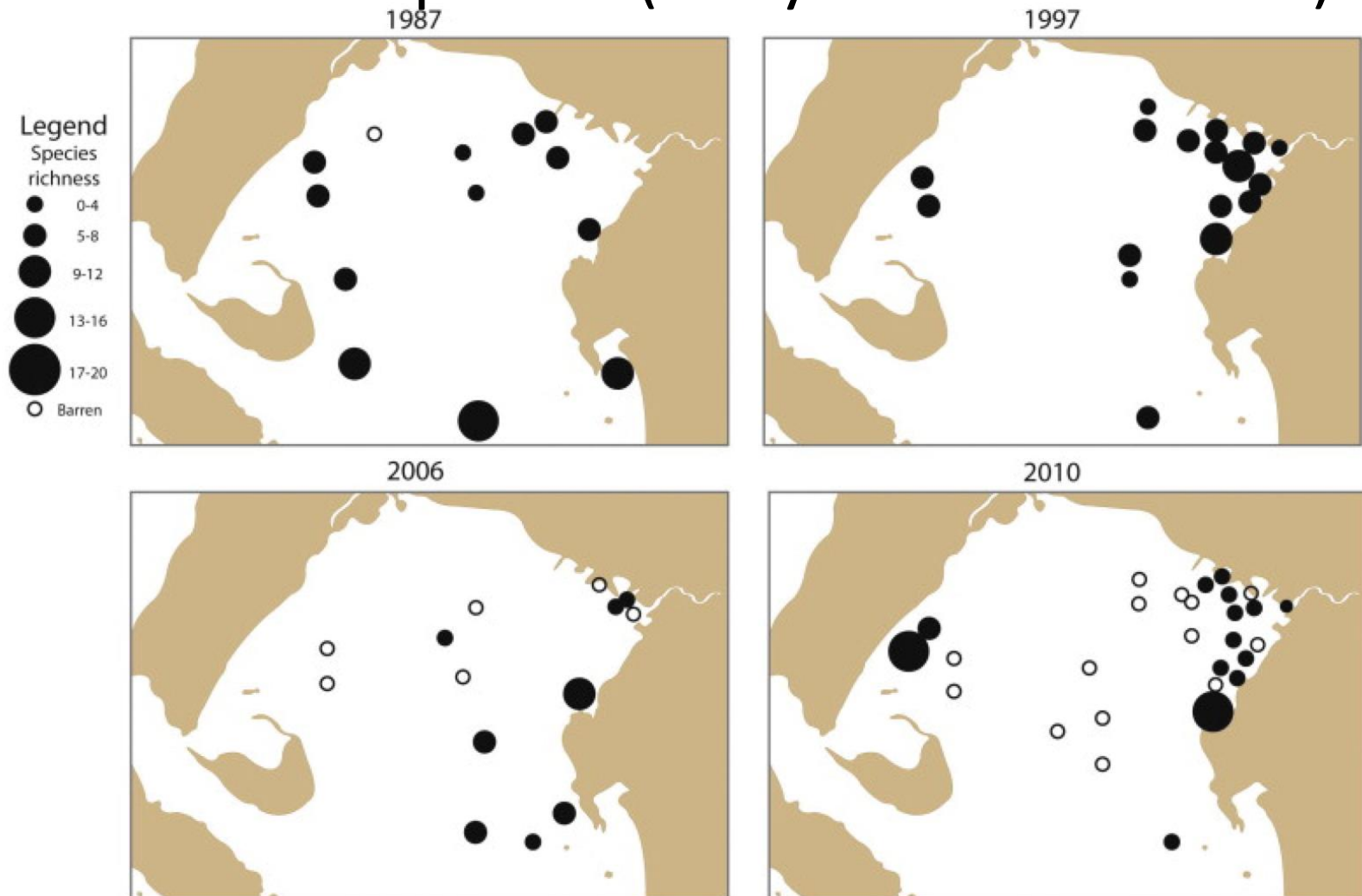
Calcified foraminifera are disappearing from sites in Puget Sound



Photo: Burke Museum

Species richness among forams has declined in Bellingham Bay

Link to OA suspected (not yet demonstrated)



Pink salmon show dose-dependent reductions in critical life-history and behavioral traits

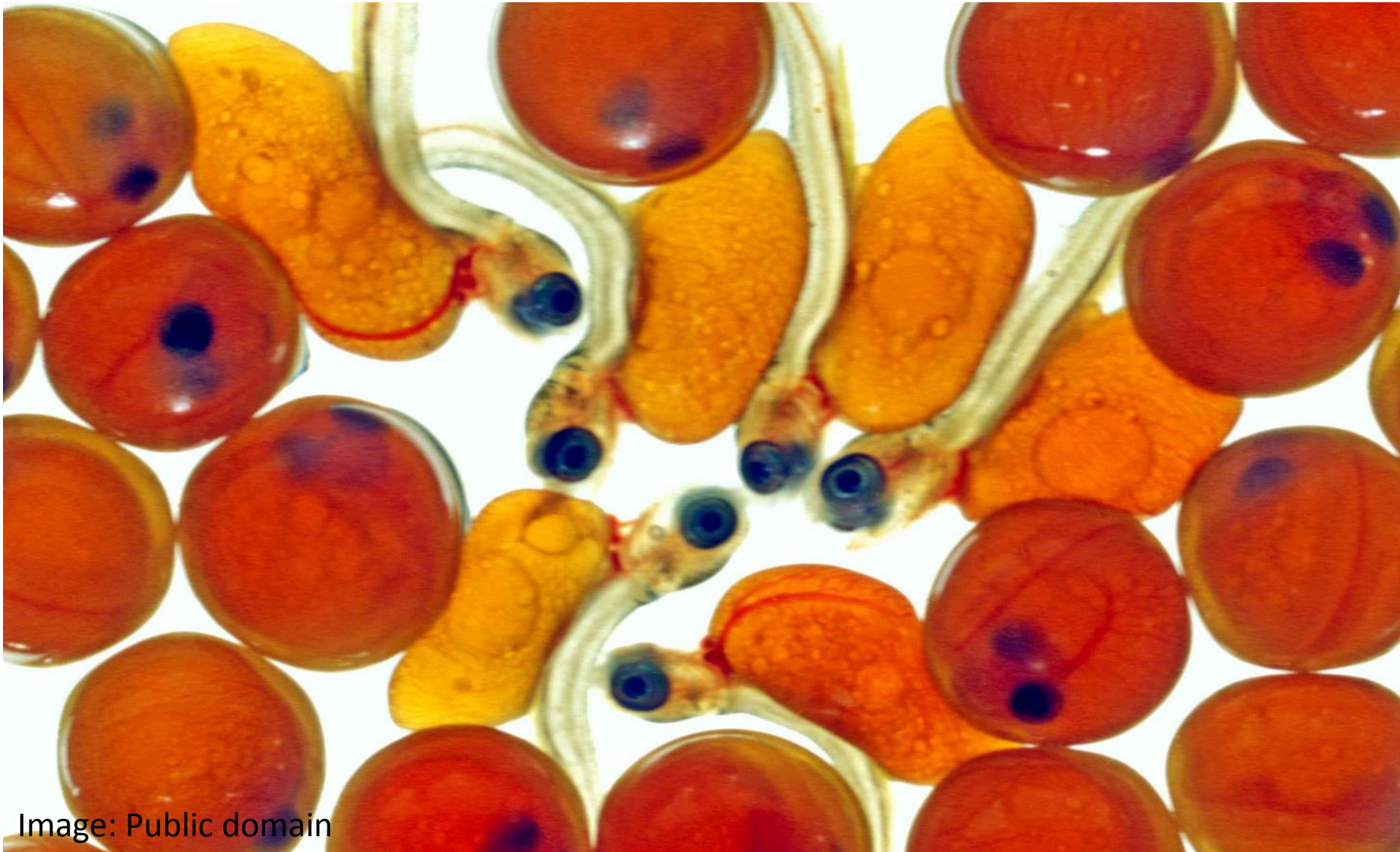
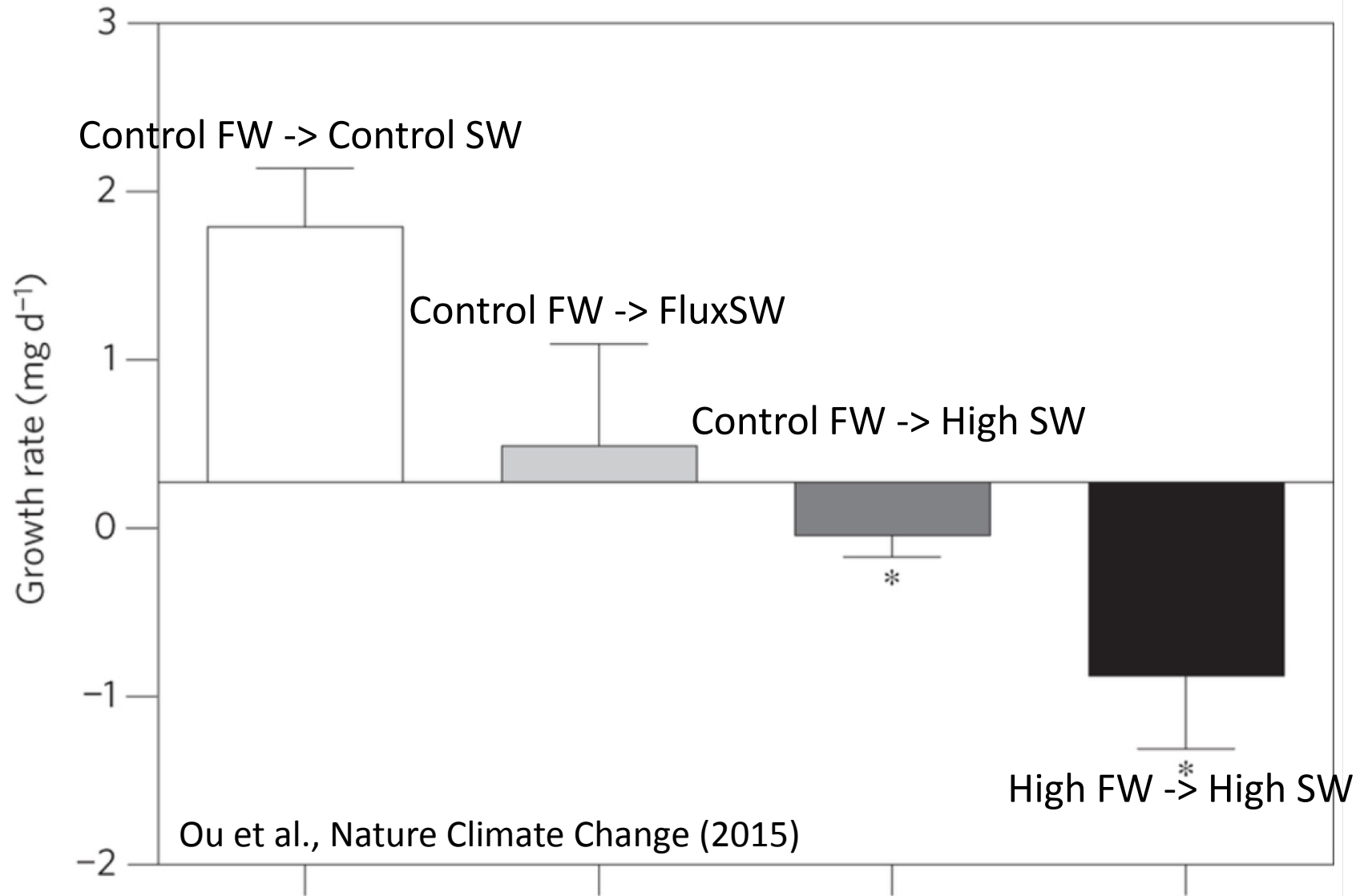


Image: Public domain

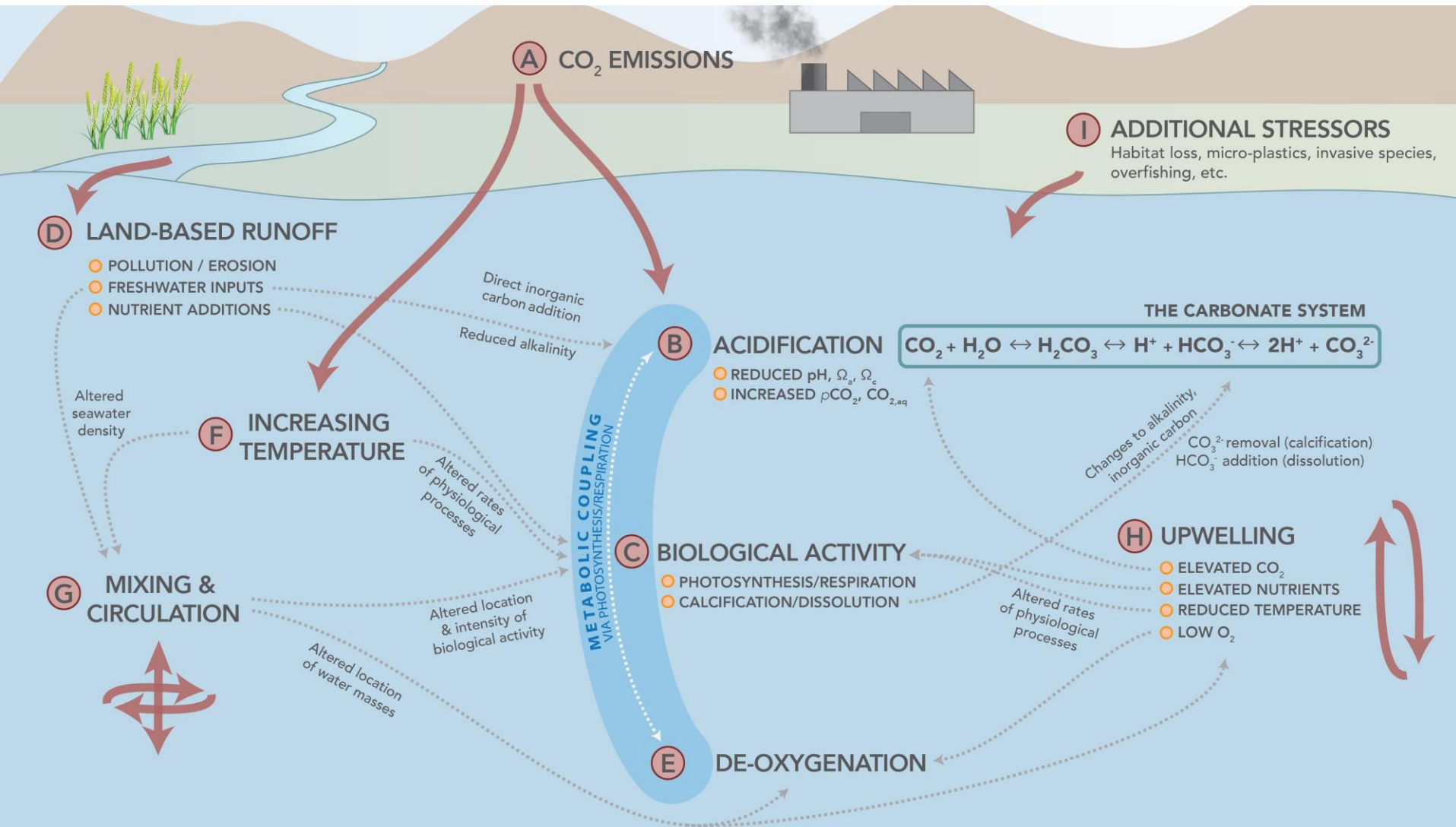
Pink salmon fry respond negatively to high CO₂

Absolute growth rates following transfer
to different SW pCO₂ treatments



OA co-occurs with other stressors

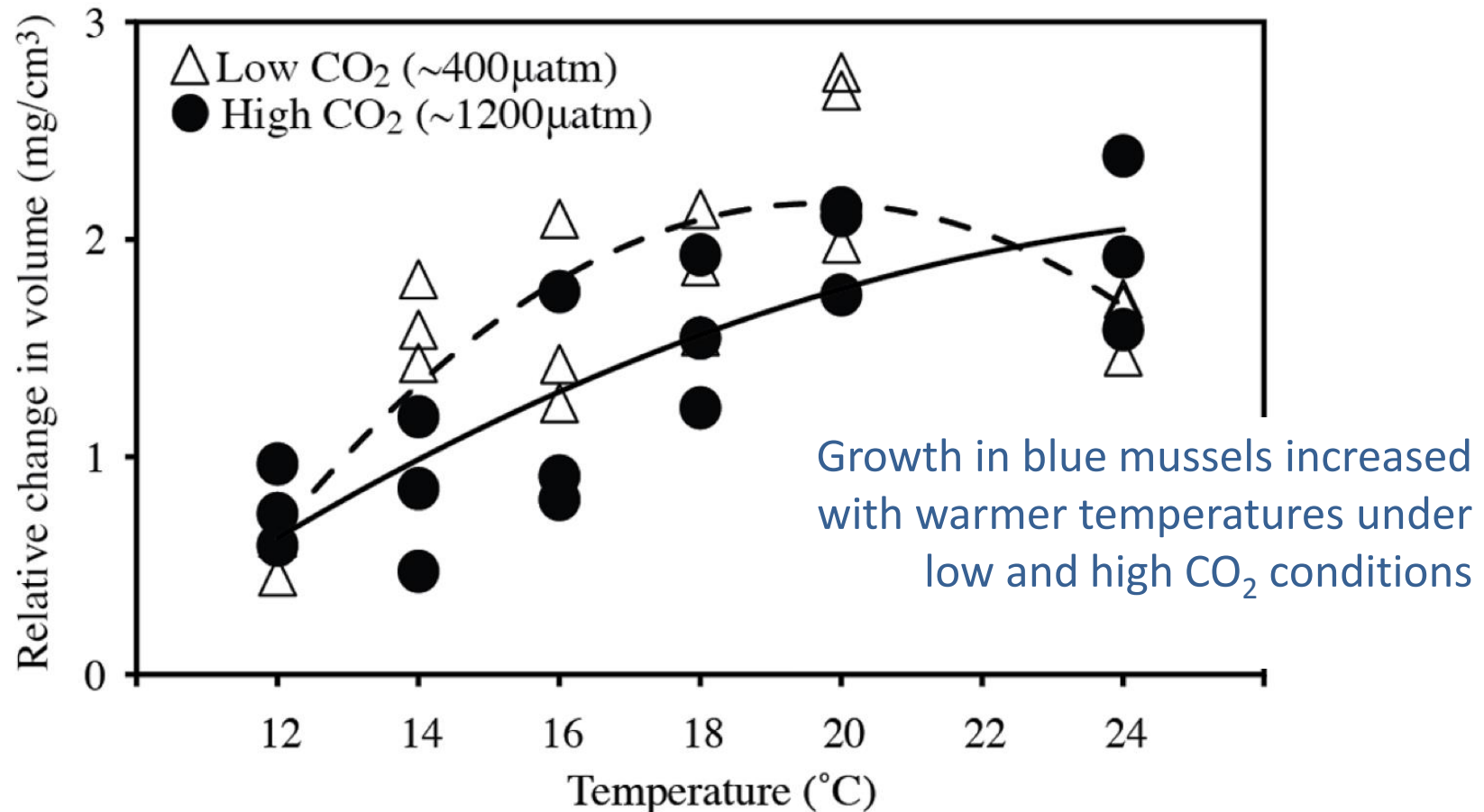
temperature, dissolved oxygen of particular concern



Warming temperatures can modulate response
to OA



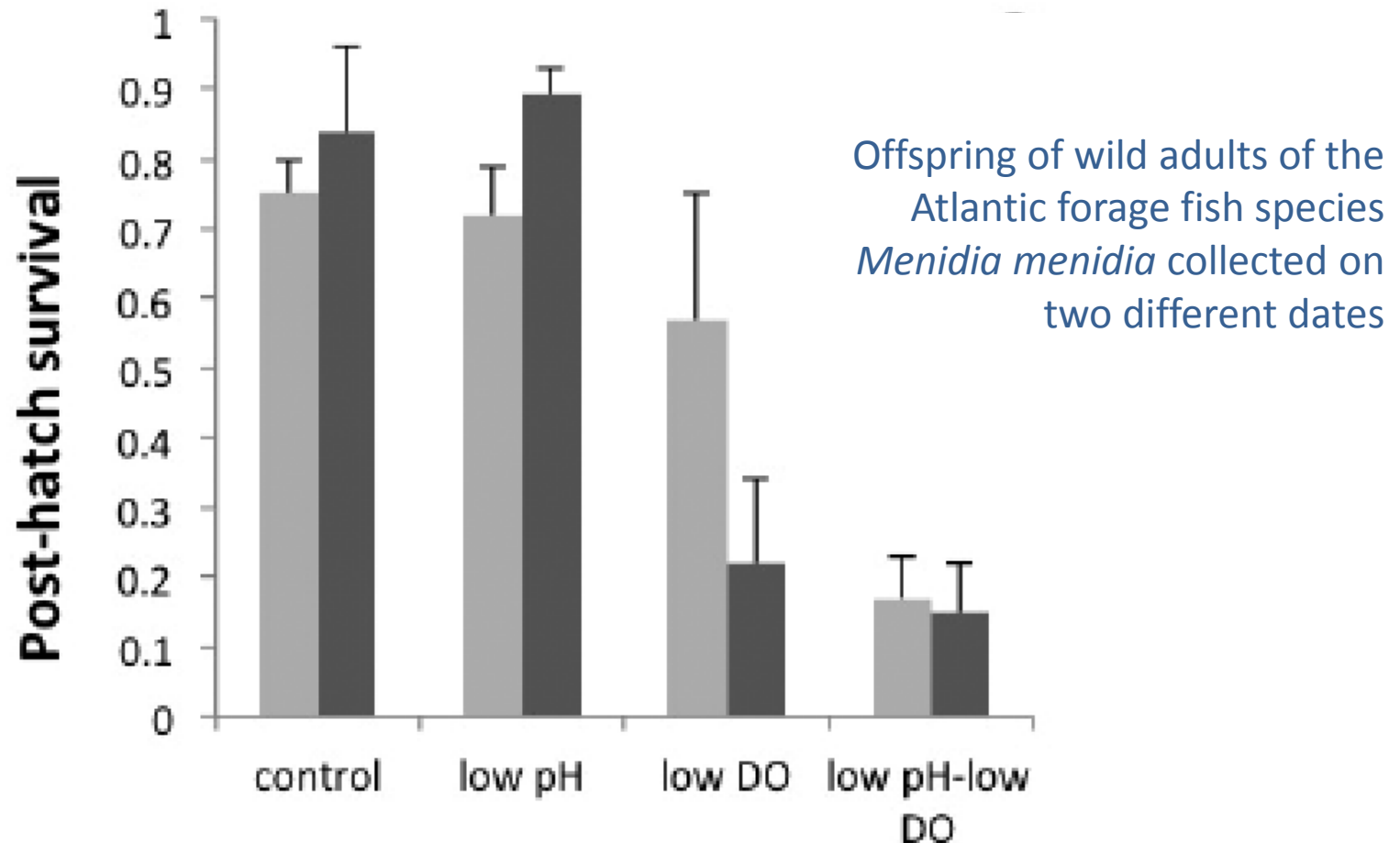
Warming temperatures can modulate response to OA



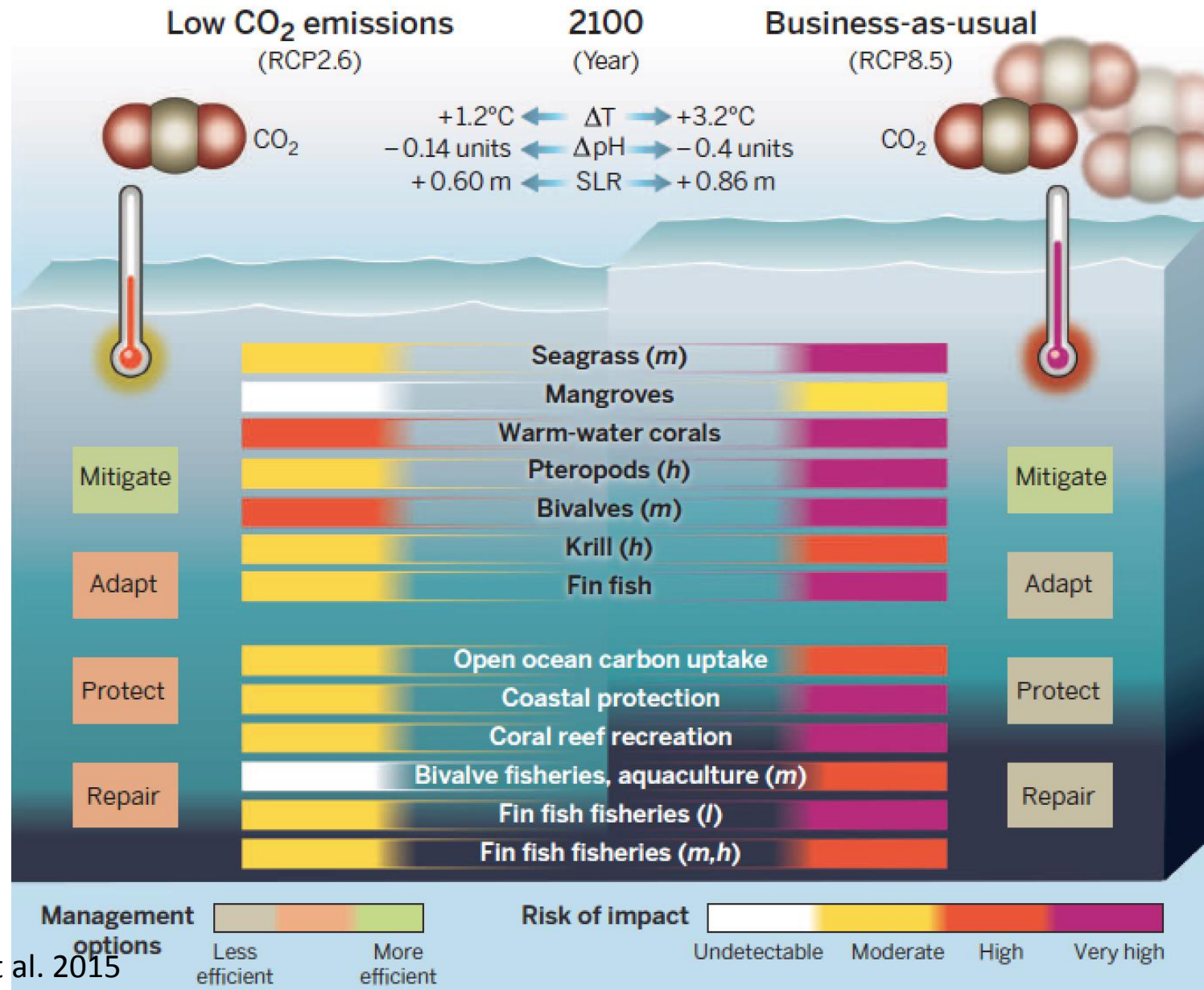
Co-occurring stressors can cause synergistic effects in forage fish



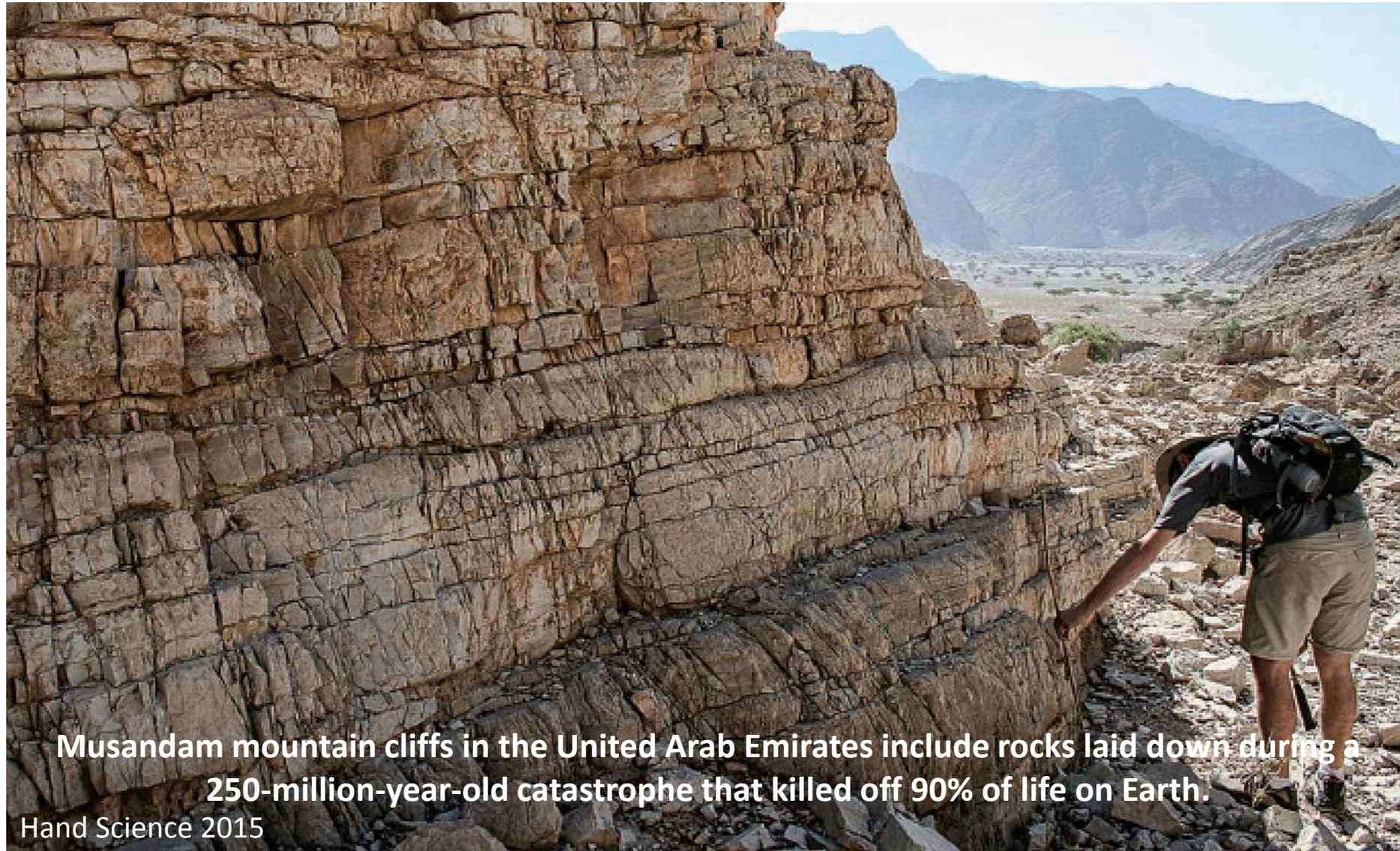
Effects of low pH most pronounced under conditions of low DO



Emissions scenarios describe alternative futures



“Signature of acidification found in Permian extinctions 250 million years ago” [E. Hand, Science 2015]



Musandam mountain cliffs in the United Arab Emirates include rocks laid down during a 250-million-year-old catastrophe that killed off 90% of life on Earth.

Hand Science 2015