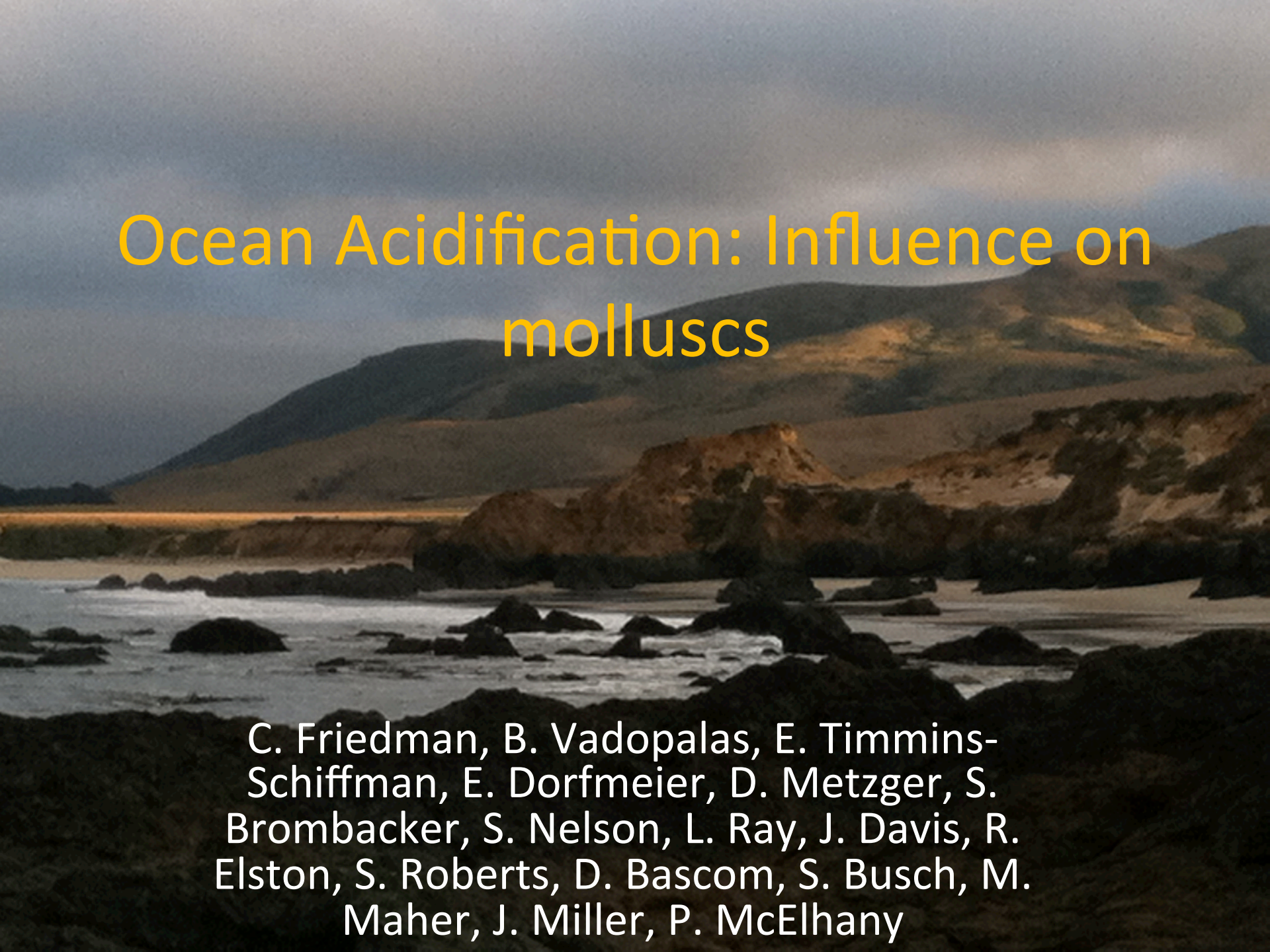
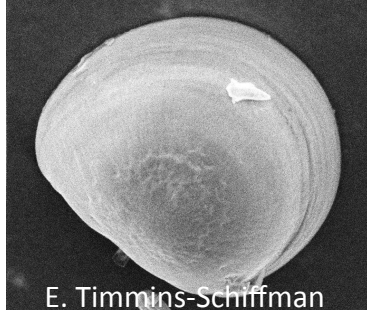


Ocean Acidification: Influence on molluscs

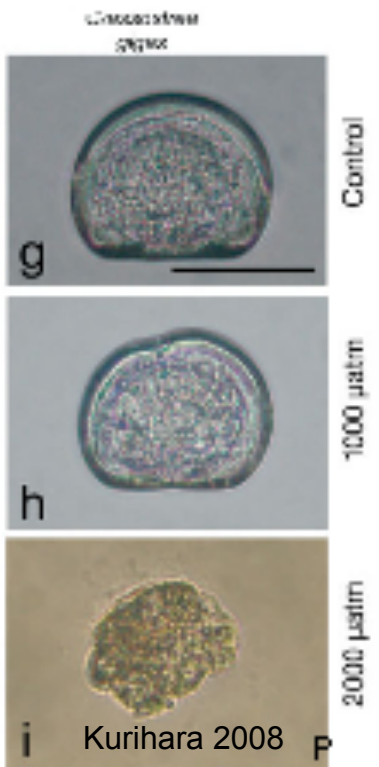
C. Friedman, B. Vadopalas, E. Timmins-Schiffman, E. Dorfmeier, D. Metzger, S. Brombacker, S. Nelson, L. Ray, J. Davis, R. Elston, S. Roberts, D. Bascom, S. Busch, M. Maher, J. Miller, P. McElhany

Background: Problems 1

- Larvae are often susceptible to low pH waters
  - Thin shells that are more prone to dissolving than those of older life stages
- Ocean acidification →losses of larval bivalves
  - Alarmingly low numbers of Pacific oyster *Crassostrea gigas* larvae have been observed in local estuaries in association with upwelling of low pH waters since 2005
    - Associated lack of oyster recruitment
- Regional hatcheries have suffered extreme losses of oyster larvae in association with low pH waters, altered carbon chemistry and, in some cases, disease outbreaks (vibriosis)


E. Timmins-Schiffman


E. Timmins-Schiffman



Kurihara 2008

Background: Problems 2

- In local hatcheries some species fare better than other species during periods of low pH and *Vibrio tubiashii* outbreaks
- e.g. Geoduck clam (*Panopea generosa*) seemed to thrive while oysters were dying
- We ask: *Who are the likely winners and losers?*



http://www.umces.edu/2002Session/oyster.html

Research Goals

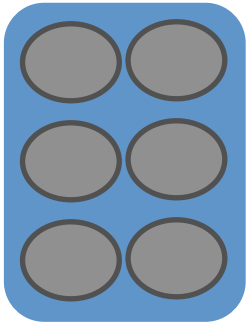
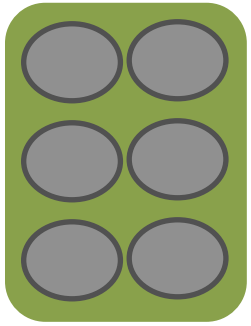
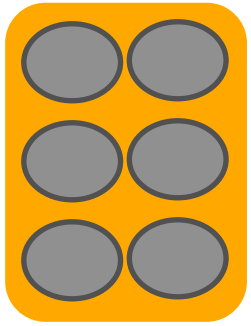
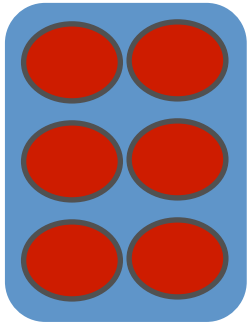
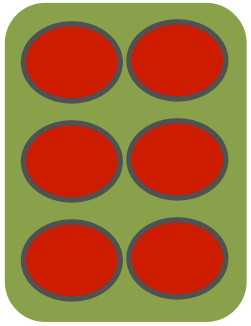
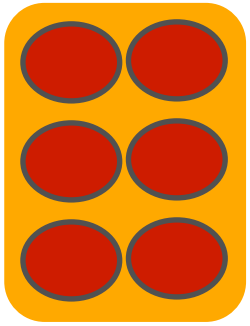
- Determine how elevated pCO_2 (ocean acidification) impacts survival and disease susceptibility of key wild and farmed molluscs
- Investigate how temperature influences vulnerability to these environmental stressors

Photo: Norbert Dankers

Ecosystem Response

- Lack or reduced of larval survival can have effects felt throughout the ecosystem:
  - No recruitment
  - Population declines
  - Lack of larvae means less food for its predators and can impact populations of predators
  - Potential for ecosystem wide response if affected species are keystone in that locale
- Others unaffected species may thrive
- Combined changes in who wins and loses can alter community dynamics

Experimental Design & Plans

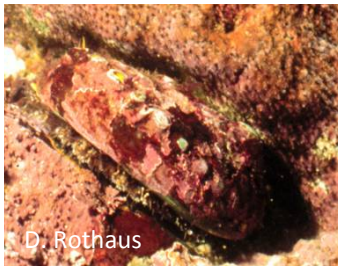
CO_2 level:	Current : ~390 ppm (control)	Yr 2100: 520 or 750 ppm	Yr 2100 and beyond AND current PNW: 1000 or 2000 ppm
No *Vibrio tubiashii*			
With Vt			

Measure:

- survival
- growth
- calcification
- development
- physiology (gene expression and stress response)

More pinto abalone survived at ambient conditions versus 750ppm CO_2 conditions 48 and 72 hr

Pinto abalone appear to be losers



Manila clam larval survival was not affected by CO_2 level

Sizes of Manila clam were the same at all CO_2 levels

Manila clams appear to be winners

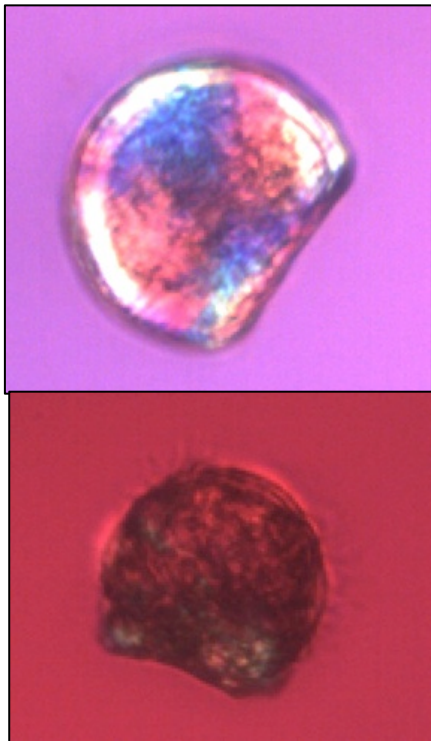
Geoduck appear to be winners too!

Graph courtesy of D. Bascom, S. Busch, P. McElhany et al.

Pacific oysters appear to be **losers**:

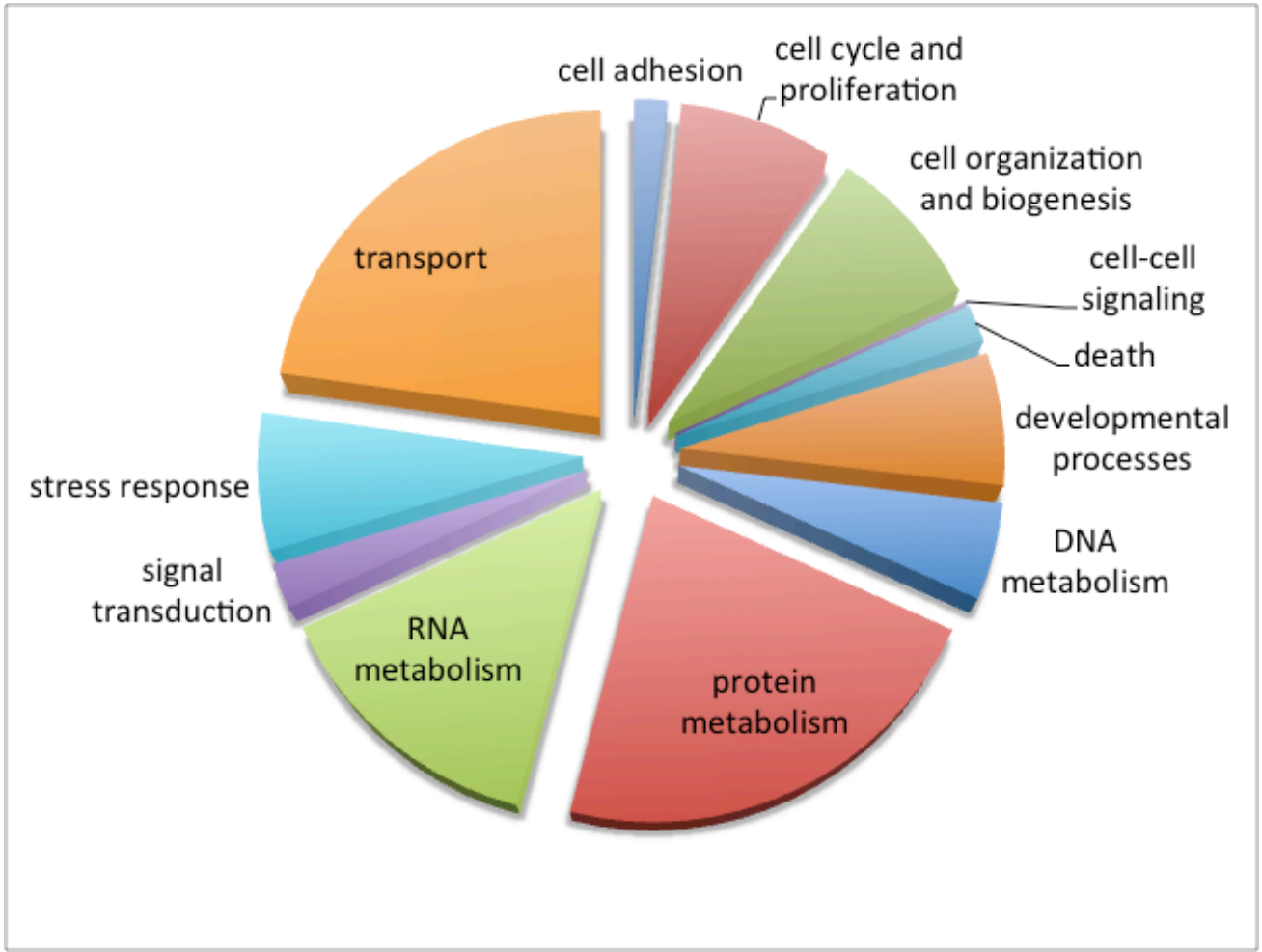
"Canary in coal mine"

Larvae were smaller and fewer larvae were fully calcified in the highest pCO_2 (lowest pH) treatment



Manila Clams: Is the biology of the clams altered even though they seem to survive well at all CO_2 levels tests?

Analysis of gene expression says YES!



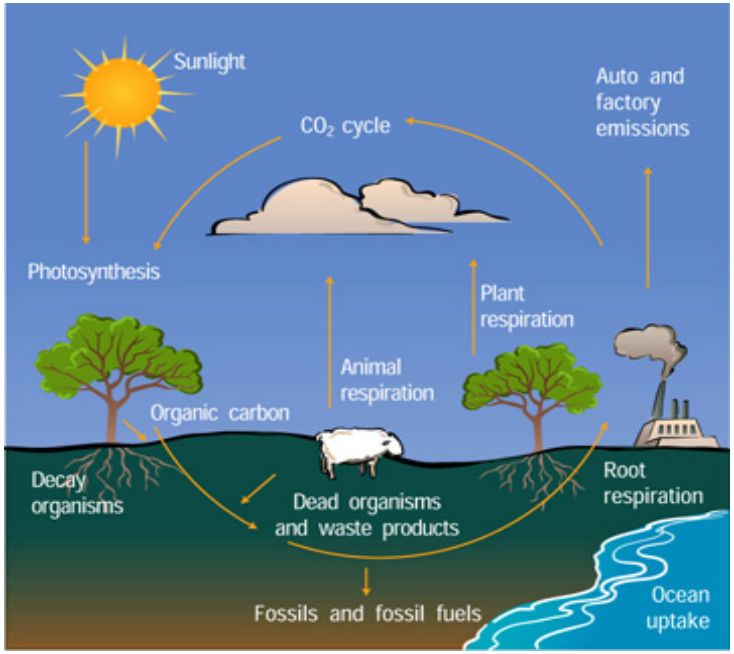
Tools developed

- Determine winners (Geoduck and Manila clams) and losers (Pinto abalone and Pacific oysters) for industry to adapt to changing conditions
- Better enable managers to make policy decisions
- Not all losers may be losers:
  - May be differential performance among families
  - **We aim to identify more resistant Pacific oyster families (lines)**
- Molecular analyses may enable us to:
  - Understand mechanisms of resistance or susceptibility to OA
  - Identify which animals are likely winners

Way To Move Forward

- Education, education, education
- Ask yourselves: What can you do?
- What are we doing besides research, turning off lights and riding our bikes to work?

Teaching climate change, ocean acidification and the carbon cycle: OASIC:GK-12 Sea Grant project



Hands-on Science: Educational Outreach, Ocean acidification and Oysters

Samantha Brombacker, Siri Nelson

Brent Vadopalas, Carolyn Friedman

Washington Sea Grant Project # NA10OAR4170057

OACIS | OCEAN & COASTAL INTERDISCIPLINARY SCIENCE

GK–12 program bringing marine science into classrooms in Seattle and the San Juan Islands

University of Washington: OACIS GK-12

- Ocean and Coastal Interdisciplinary Science
- Pairs Biology, SAFS and Oceanography graduate students with High School Teachers in Seattle and San Juan Islands
- Reached over 800 students during the 2010-11 school year
- Biology, Marine Science, Environmental Science and Chemistry classrooms all participated

Ocean Acidification Kits: To evaluate the influence of OA on oyster seed survival, weight and color

- Students measure:
  - Temperature
  - pH
  - Gray scale value
  - Buoyant weight
  - Mortality

Conclusions

- Ocean acidification's impacts on larvae vary among species
- Some are winners and some are losers
- We are investigating differential affects on larvae and adult stages and developing tools to aid the shellfish industry and resource managers
- Education is an important tool to effect behavior change in our communities
  - High School OA curriculum developed

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