



Ocean Acidification Research on Tatoosh Island

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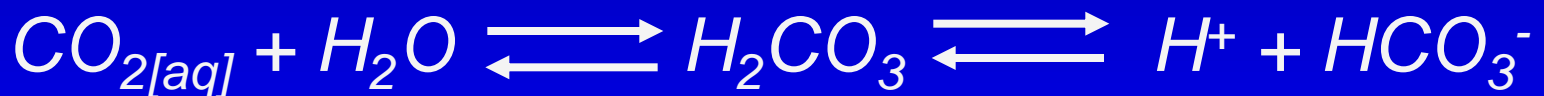
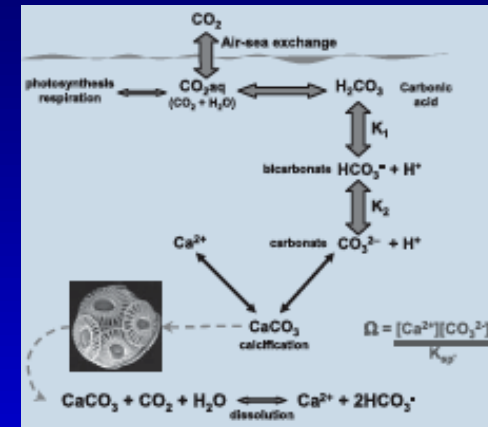
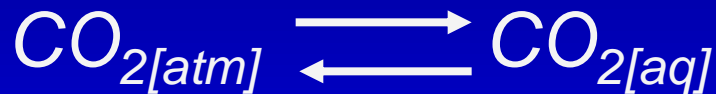
Who Are We?

- Dr. Cathy Pfister
 - Univ. of Chicago
- Started as students of Dr. Robert Paine (UW) in 1984 (TW), 1987 (CP)



Background

- Oceans play huge role in global carbon cycle
 - Sequestration via photosynthesis & sedimentation
 - CO_2 reaction with water



- Independent of temperature, increasing CO_2 may be reducing pH ($= -\log(\text{H}^+)$) of ocean
 - pH affects many biological processes including calcification of skeletons

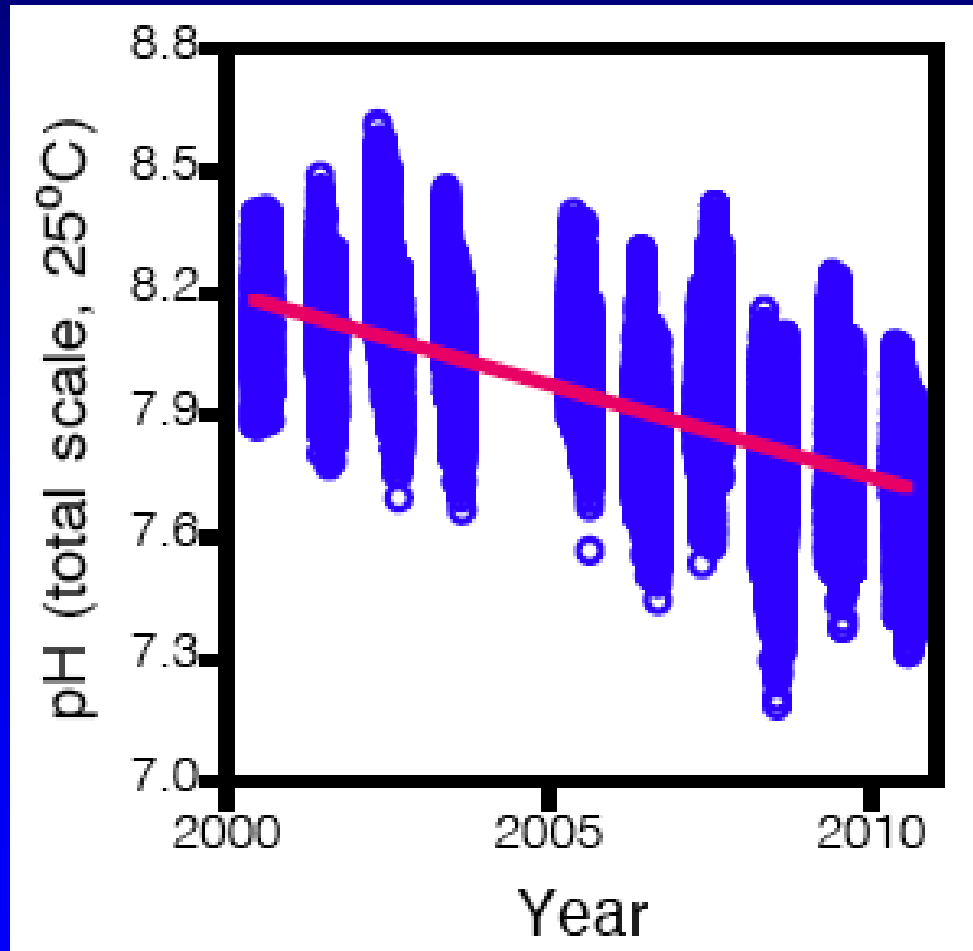
Tatoosh Data

- Long-term data from various sources
 - Shoreline abundances of species since 1993
 - Ocean water conditions logged since 2000
 - pH, Temp, O₂, Chl a, Salinity
 - Late Spring to Late Summer, 30 min intervals
 - Data from prior studies (Paine & students) 1967→
 - Collections of voucher specimens
 - Archeological data (Makah Museum)

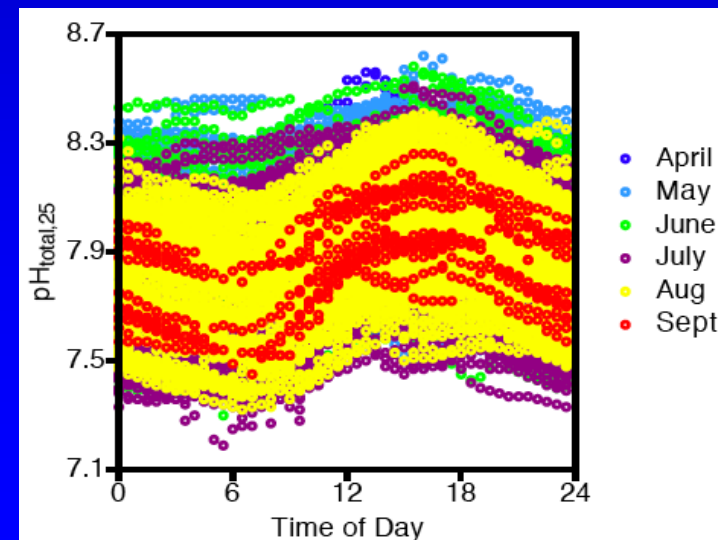


Ocean pH at Tatoosh is Declining

- 10 x faster than model predictions

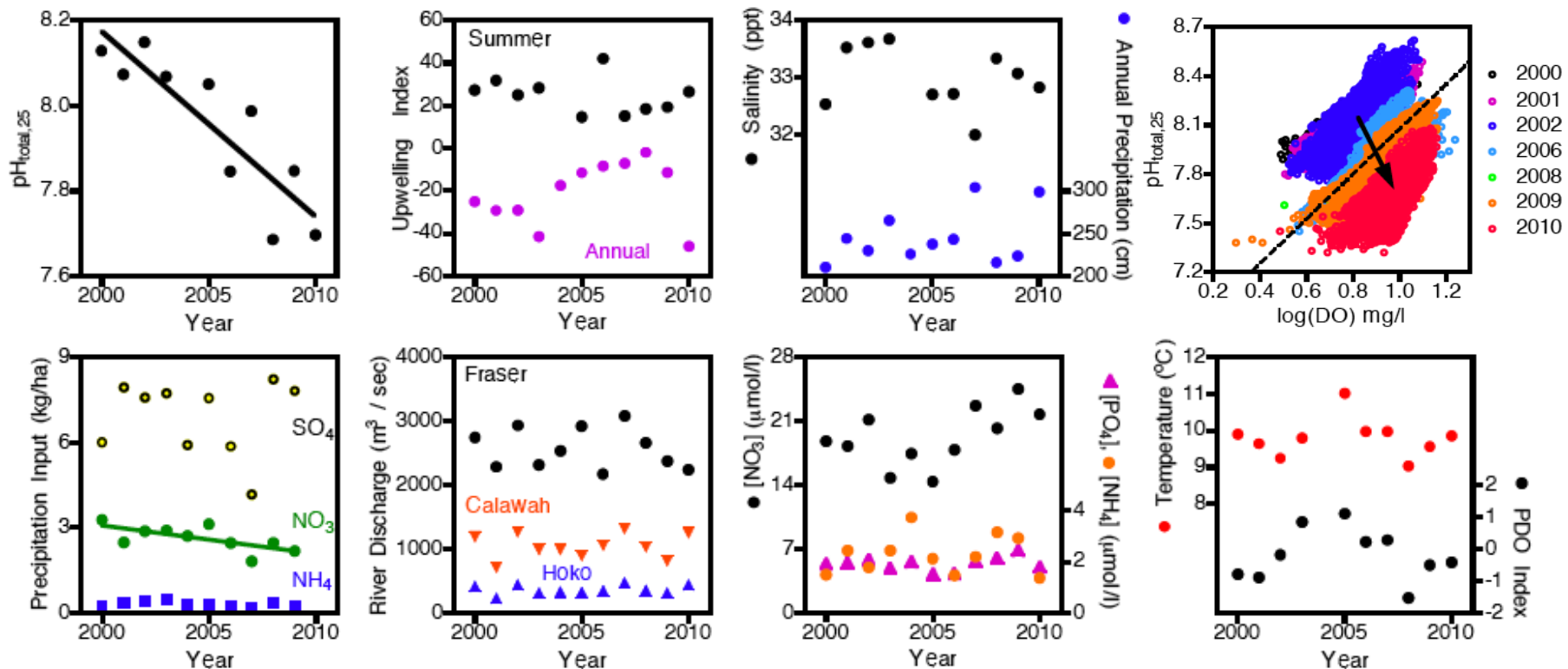


- More variable than expected (biology, upwelling)



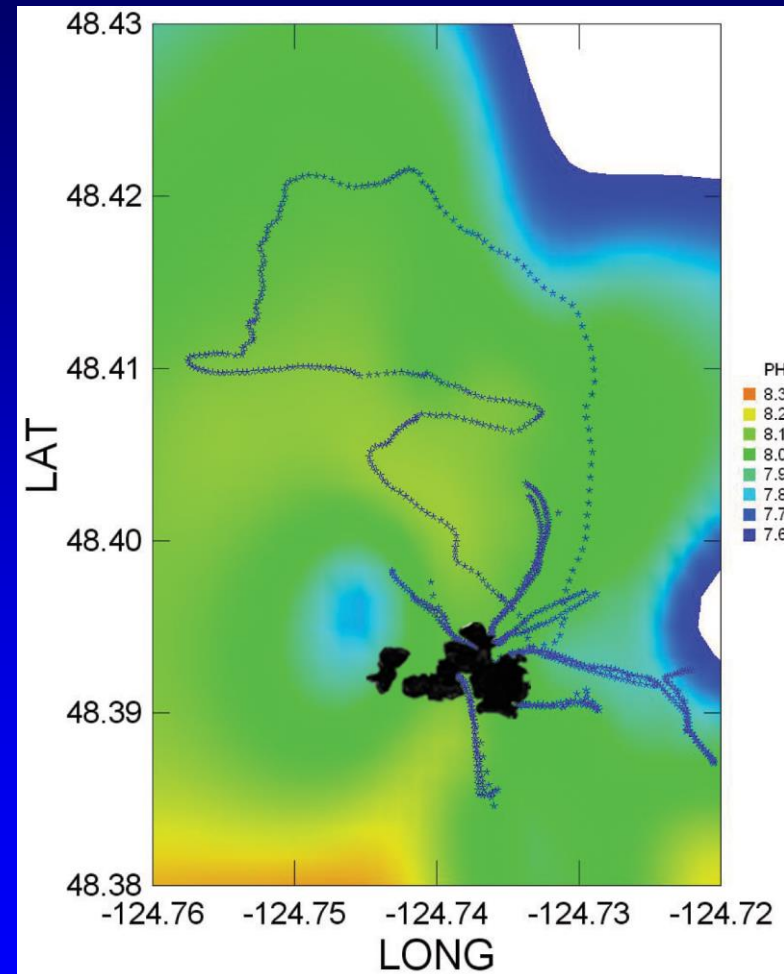
Causes of Rapid Decline?

- CO₂ largely predicts our pH measurements
- Annual change correlates with CO_{2,atm}
- No annual trends in other other conditions



Effect Restricted to Tatoosh?

- Off-island surveys find no “bullseye” around island
- Low pH seen in NOAA survey (2007)
- WA Dept. Ecology data shows rapid declines in Strait
- Data from Netherlands shows similar declines



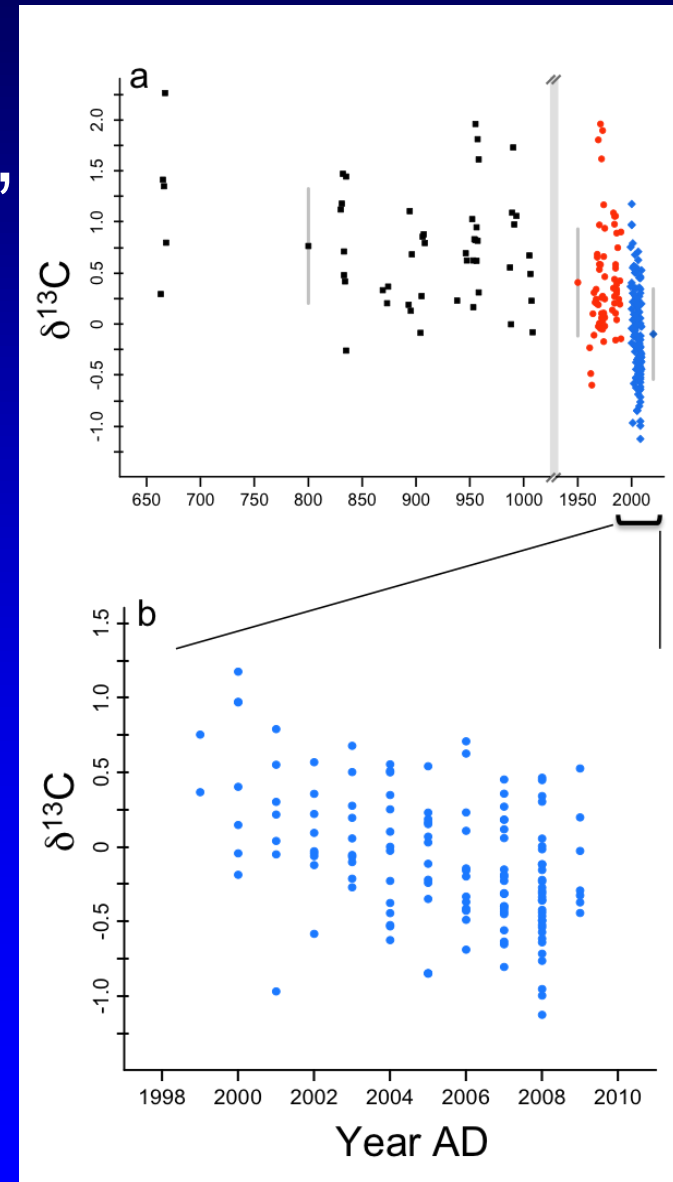
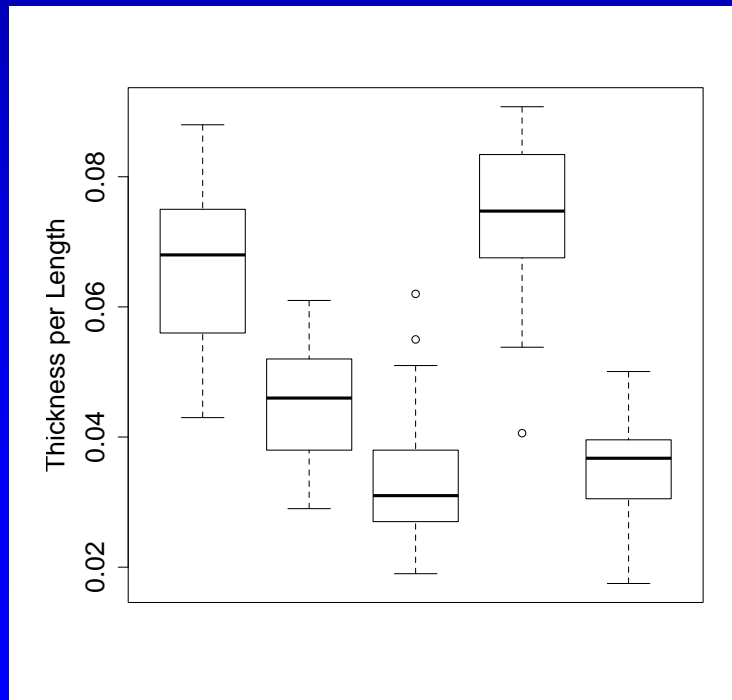
Is the Decline Unusual?

- Modern shells during span of measurements
 - Mussels have “growth rings”
 - Carbon isotope chemistry over time
 - $\delta^{13}\text{C}$ declines as pH declines
- Historical data from shells
 - Investigator collections (1970's, 1980's)
 - Makah middens (650-1000)



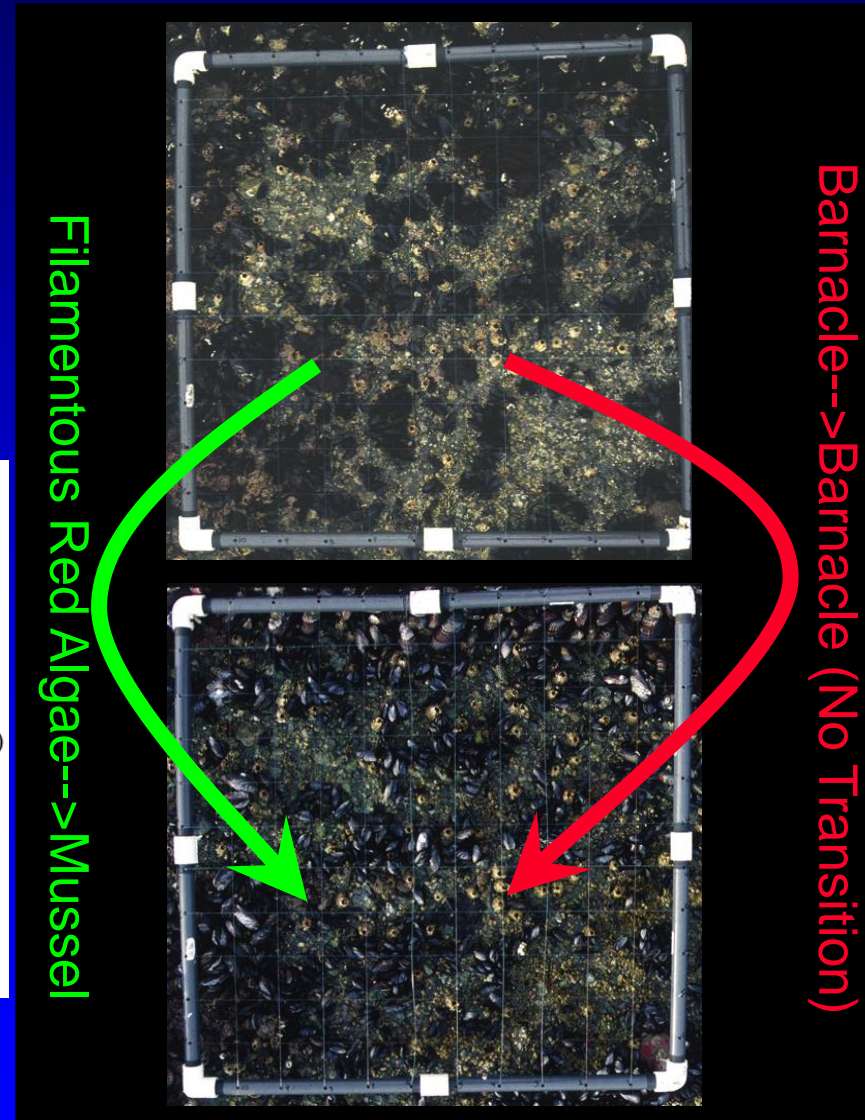
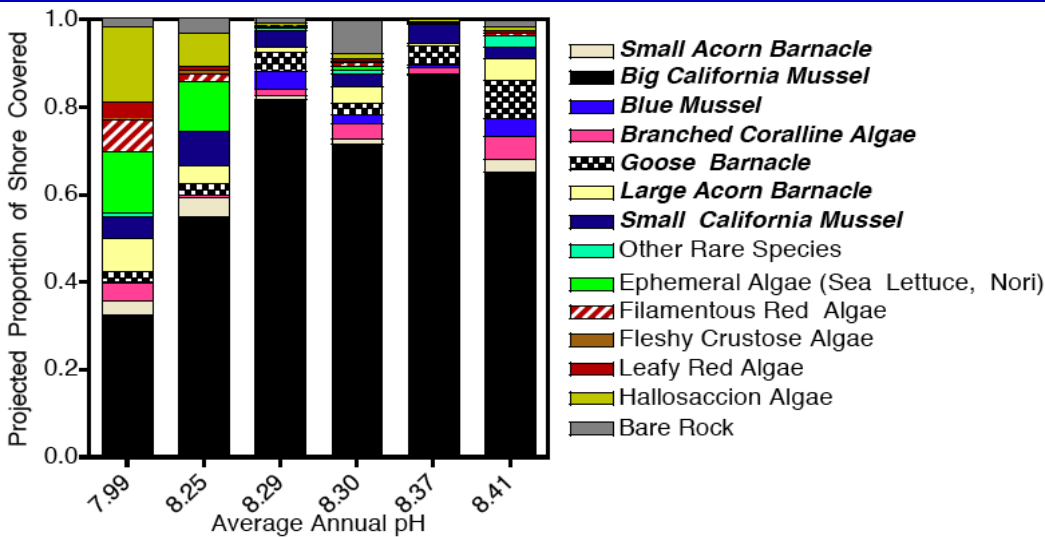
Decline is Historically Unprecedented

- Carbon isotopes decline rapidly with recent pH decline, not in historical shells
- Shells half as thick now as in the past



Are There Ecological Effects?

- Shell thickness
- Patterns of species replacements



What Next?

- Extend data series to better refine relationships
- Repeat Paine experiments under low pH conditions
- Targeted lab experiments varying pH
- Expand measurements to try to pin down causes of decline
- Further midden sampling to fill in 1000-1850 gap

