THE CASCO BAY "MUD SUMMIT"

Local efforts to look at acidification, clams and nutrients

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Casco Bay Estuary Partnership

- One of 28 National Estuary Programs
- We build consensus, facilitate communications and attract funds for protection of the Bay
- Many partners
- Focused, collaborative
- Credible data and information
- Strategic direction

FOCB / CBEP 2012 Work on Acidification

- FOCB
  - Identified issue– 'Death by Dissolution'
  - Initiated informal studies in 2011
    - Working with local scientists
    - Staff and interns collected preliminary data on pH of tidal flats
  - Led efforts to collect data in 2012

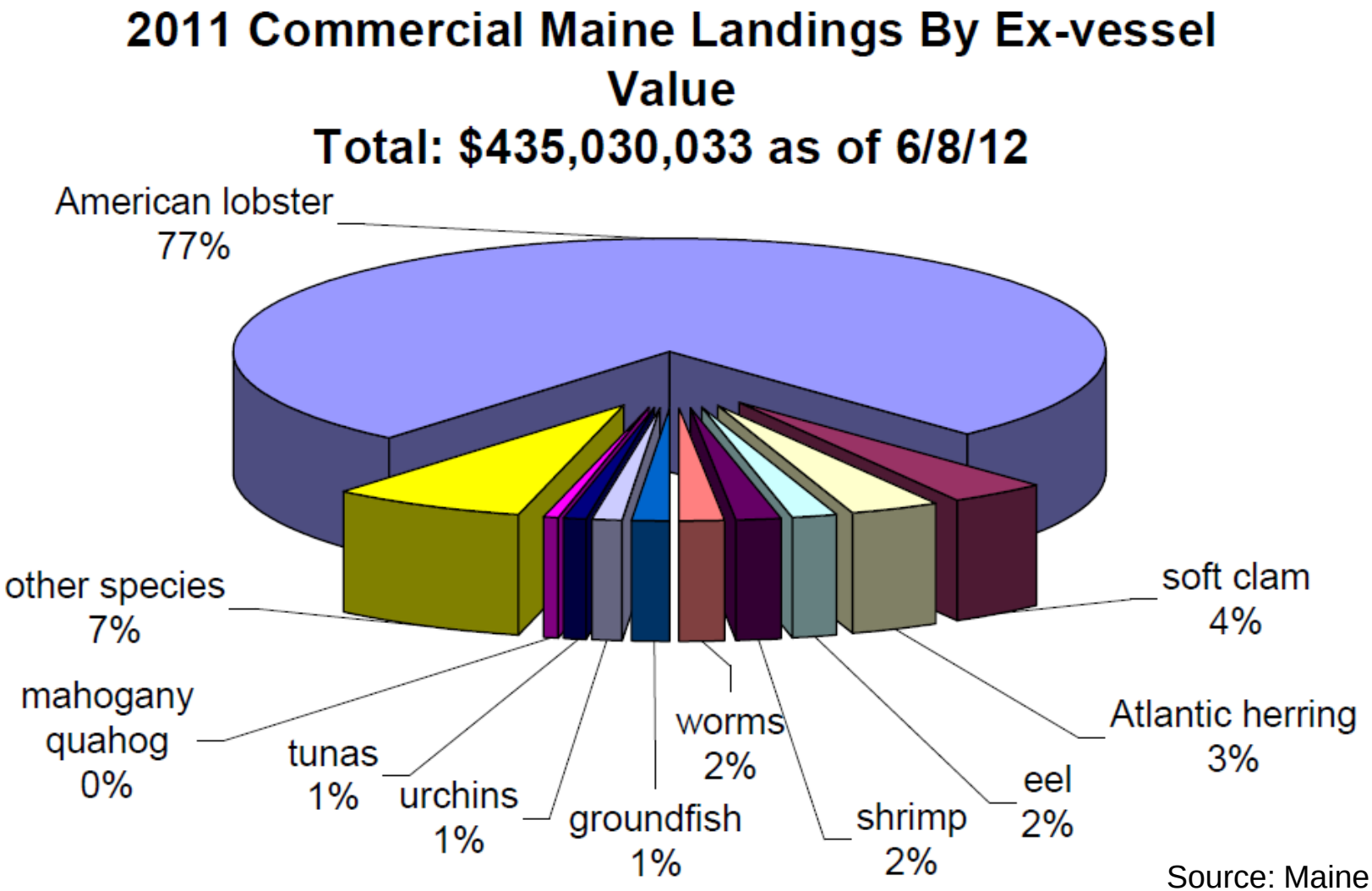
- CBEP
  - Consulted on study design
  - Provided partial funding for additional data – sediment chemistry
  - Funded related clam abundance surveys
  - Hosted "Mud Summit"

Casco Bay

- About 200 Square Miles of Water
- More than 575 miles of shoreline
- 785 islands, islets and ledges
- A marine dominated coastal embayment
  - Tidal water exchange is (usually) much greater than river flow

Casco Bay Marine Resources

Maine Fisheries by Value



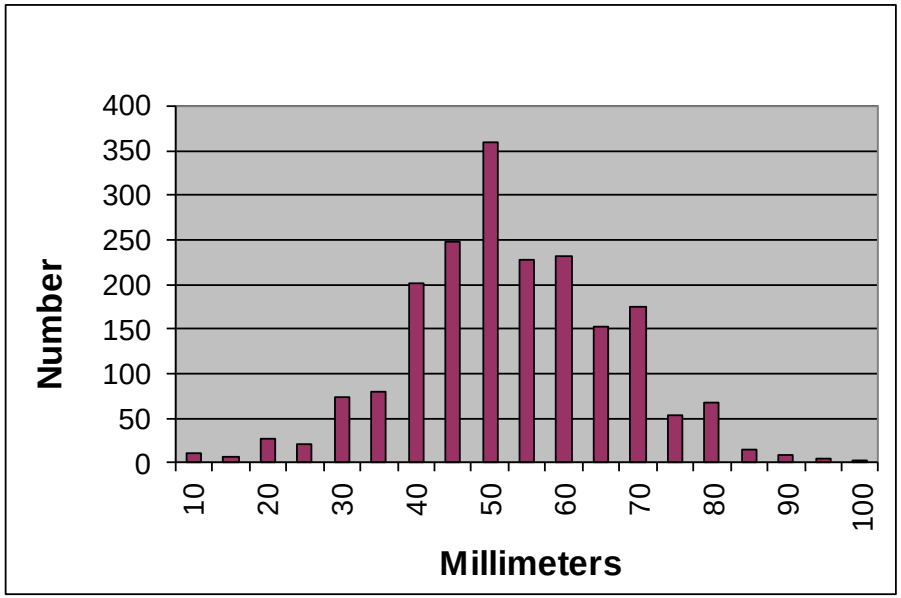
Source: Maine DMR 2013

Maine Shellfish Co-management

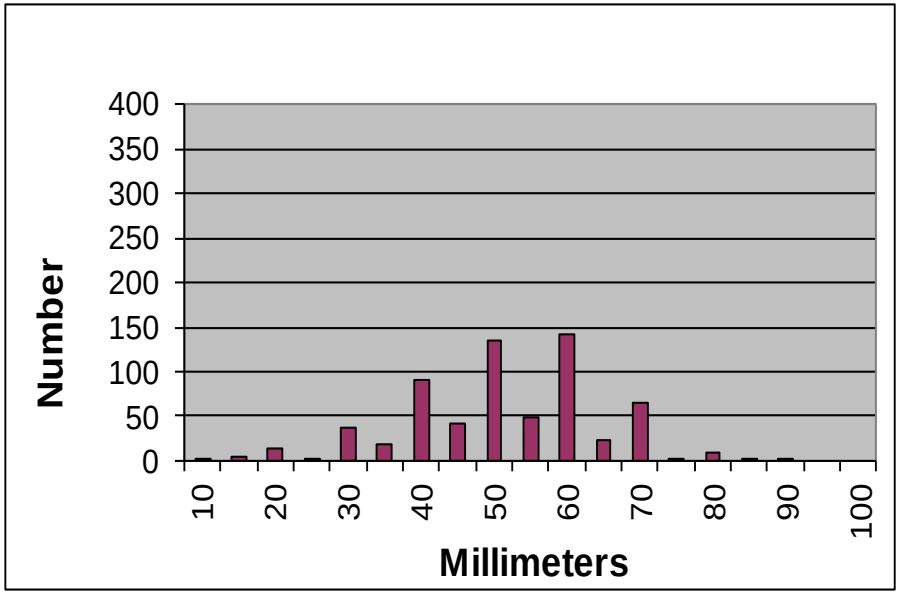
- Towns
  - Intertidal harvests only – Softshell clams
  - Shellfish Committees
    - Set number of licenses
    - Determine conservation measures
  - Harvesters required to contribute "conservation time"
    - Seeding of flats
    - Stock assessment
- State (DMR)
  - Professional biologists, make recommendations to Committees
  - Health closures
  - Subtidal harvests (quahogs)
- About 275 (Commercial) licenses in Casco Bay
  - Average cost ~ $241

Softshell Clams at Lanes Island

2010



2012



Source: Marc-Nault, pers. com. 2013

Possible Factors

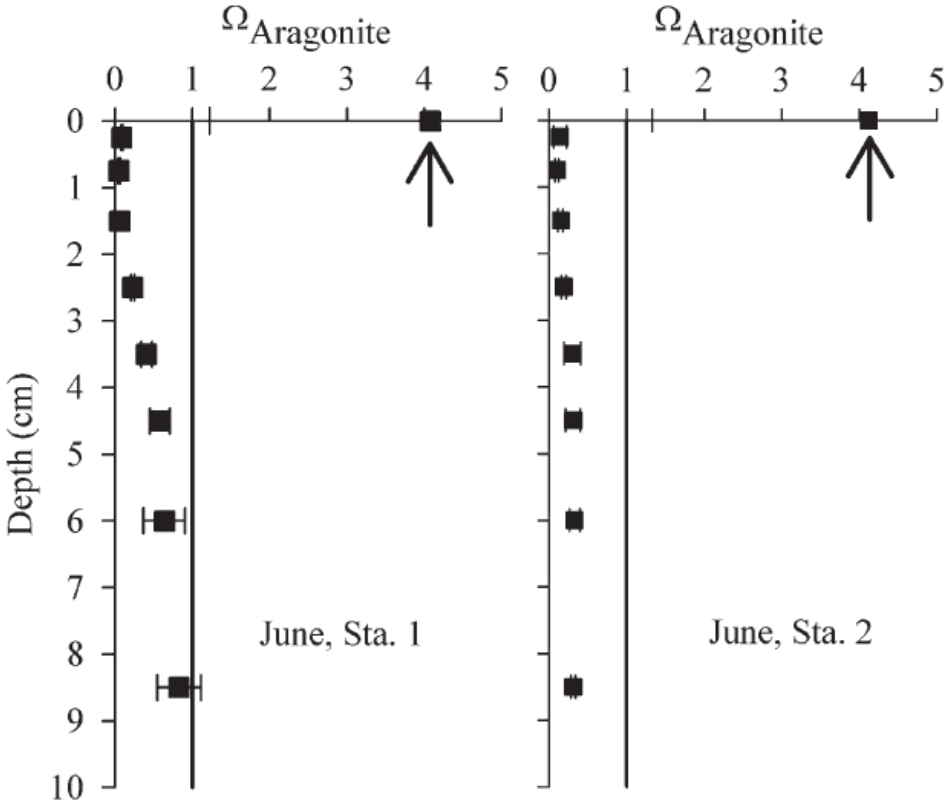
- Poor Recruitment
- Predation
- Over Harvest
- Disease
- “Bad Mud” (Ocean Acidification?)
- All of the above

Carbon Dioxide And Water

- More CO_2 in the atmosphere leads to more CO_2 in the oceans
- When CO_2 dissolves in water, the water gets more acidic
- Changes in ocean chemistry
  - Carbonate saturation state, or "CSS"
- Challenges for marine organisms with shells

- Global CO_2
- Local sources of CO_2

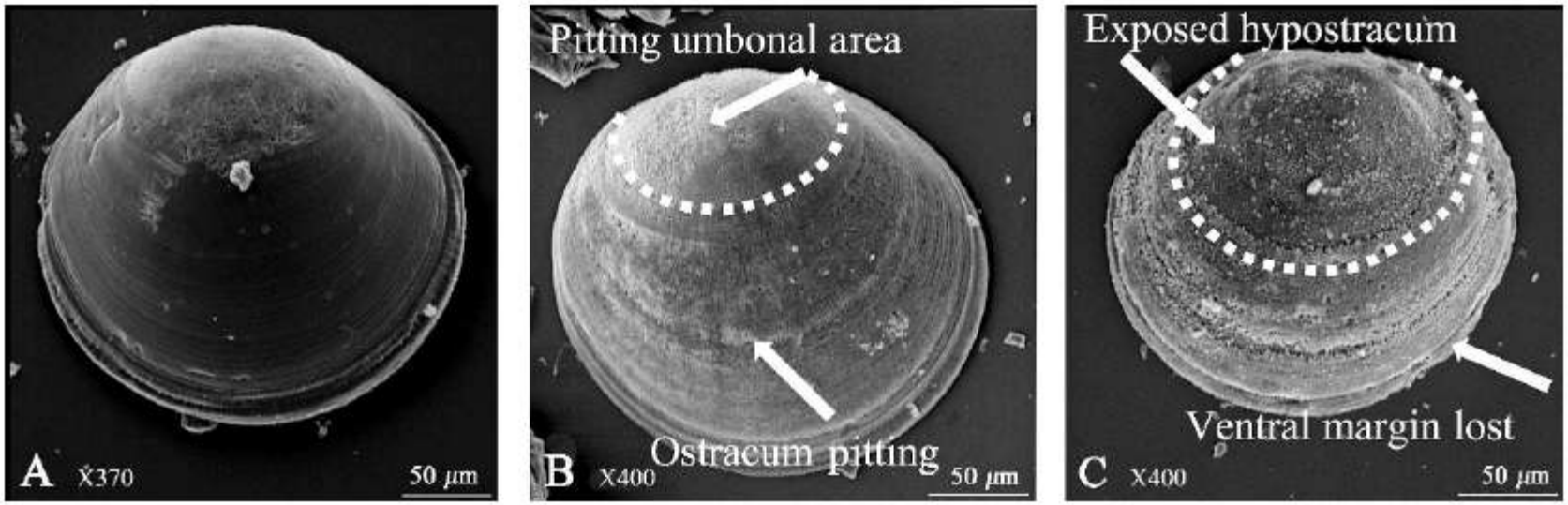
Sediments in Casco Bay



- Casco Bay Sediments offer a harsher microenvironment for calcifying organisms than does the overlying water
- At one Casco Bay tidal flat, median sediment CSS is around 0.75.

Green et al. 2009
Green et al. 2012

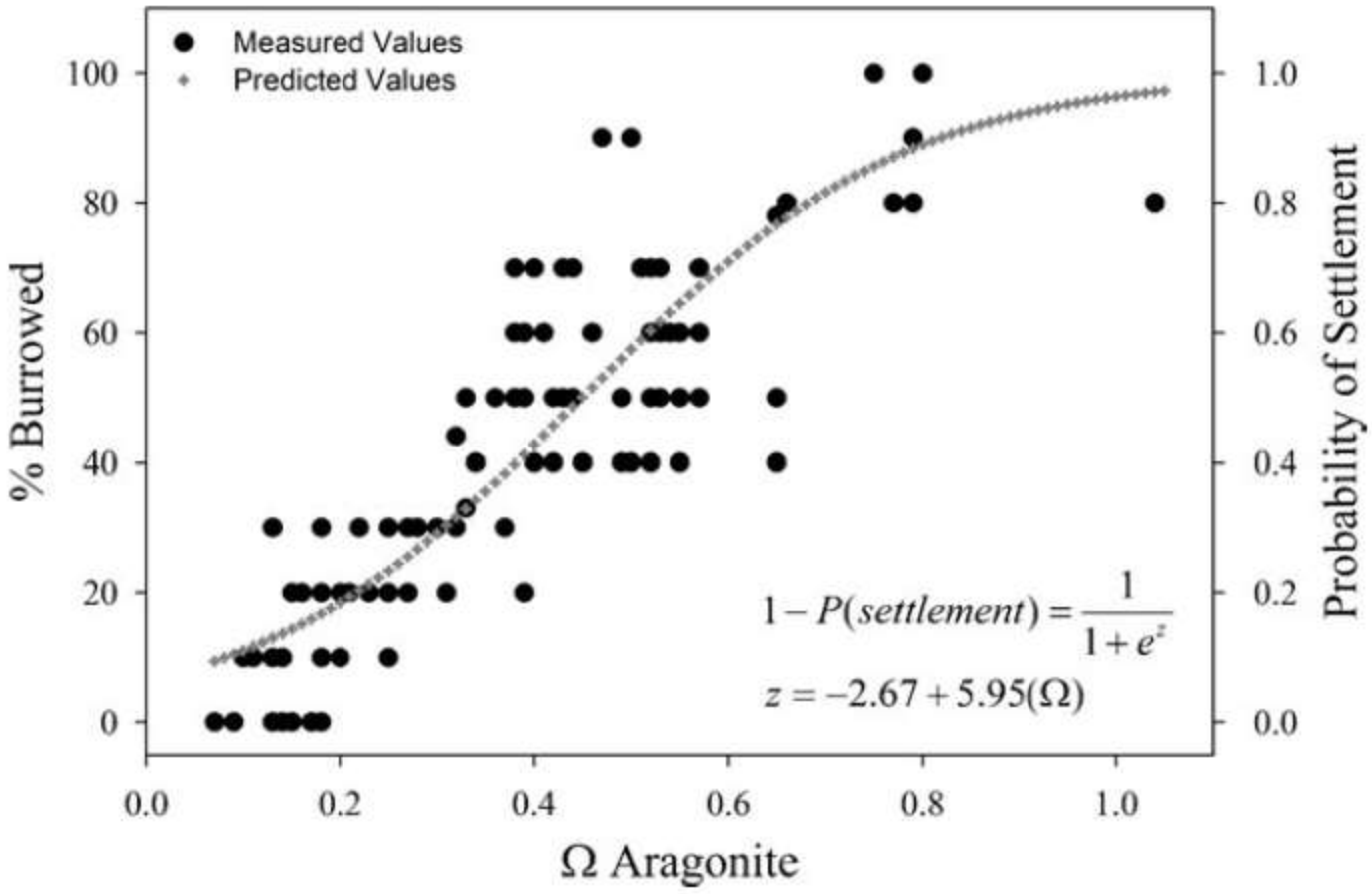
Negative Impacts of CO_2 on Mollusks In the Lab



Tiny (0.2mm) Hardshell Clams (*Mercenaria mercenaria*) grown in the lab at low CSS for 0,4, And 7 days.

Green et al. 2009

Behavioral Impacts

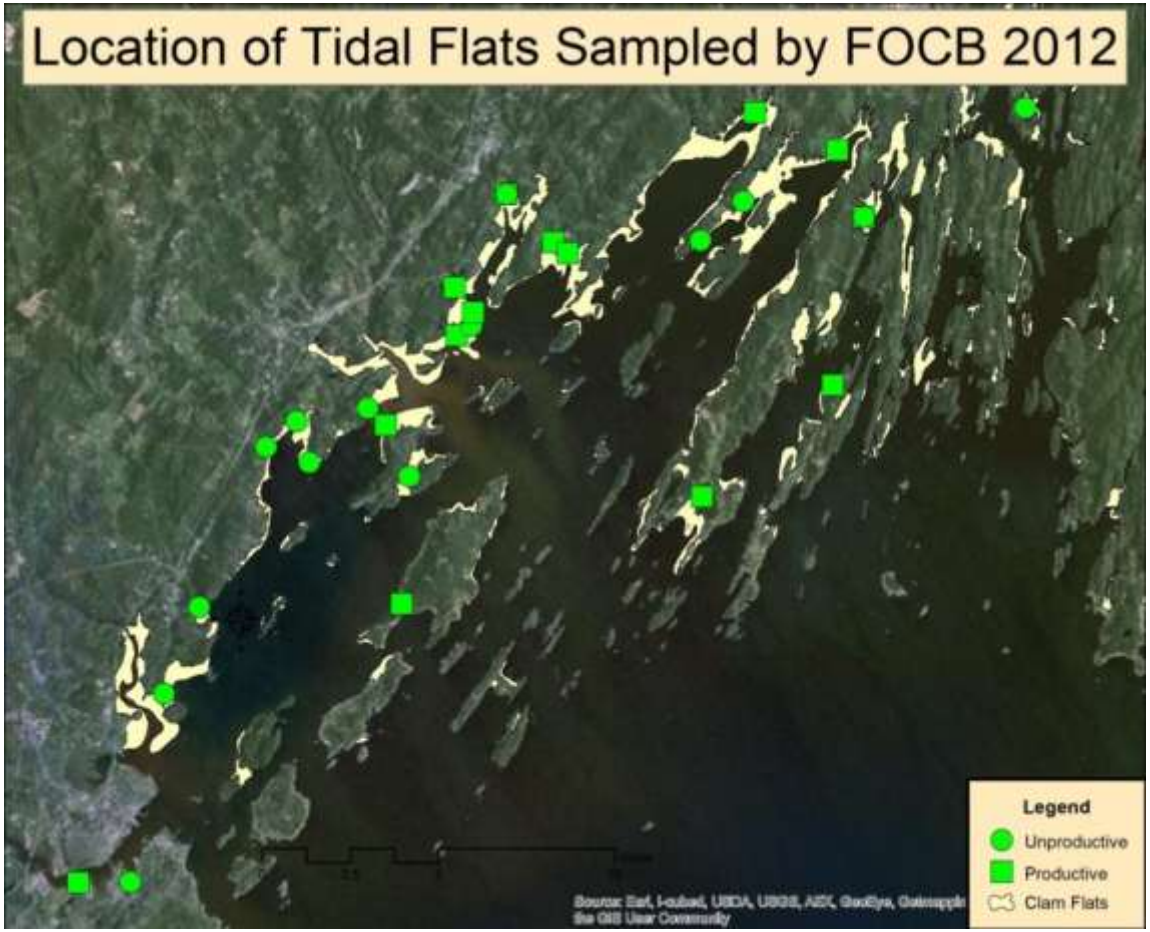


Settlement of *Mercenaria mercenaria* in the lab

Green et al. 2012

2012 Field Sample Sites

- Thirty (30) sites selected by contacting local informants in each town
- Identify "Productive" and "Unproductive" flats
  - i.e., sites that are no longer considered productive

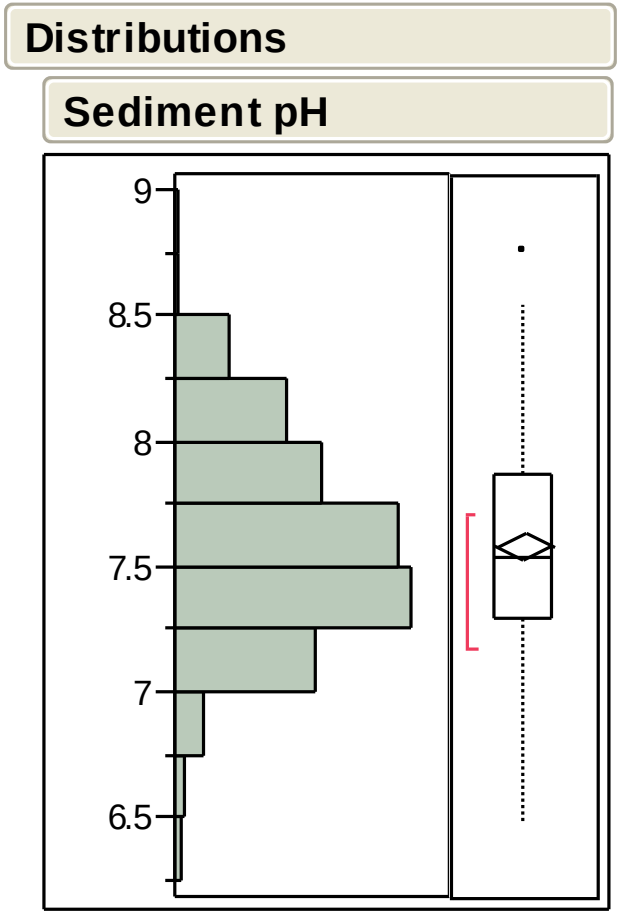


Casco Bay Clam Flat Monitoring Parameters 2012

- Water pH and Temperature
- Sediment pH
- Sediment ORP
- Sediment % Carbon
- Sediment % Nitrogen
- Sediment Surface Area

- Clam population assessments
- Limited data on Carbonate Saturation State (CSS)

Distribution of Sediment pH



Parameter	Value
Maximum	8.75
Median	7.54
Minimum	6.48
Mean	7.589
Standard Deviation	0.407
N	300

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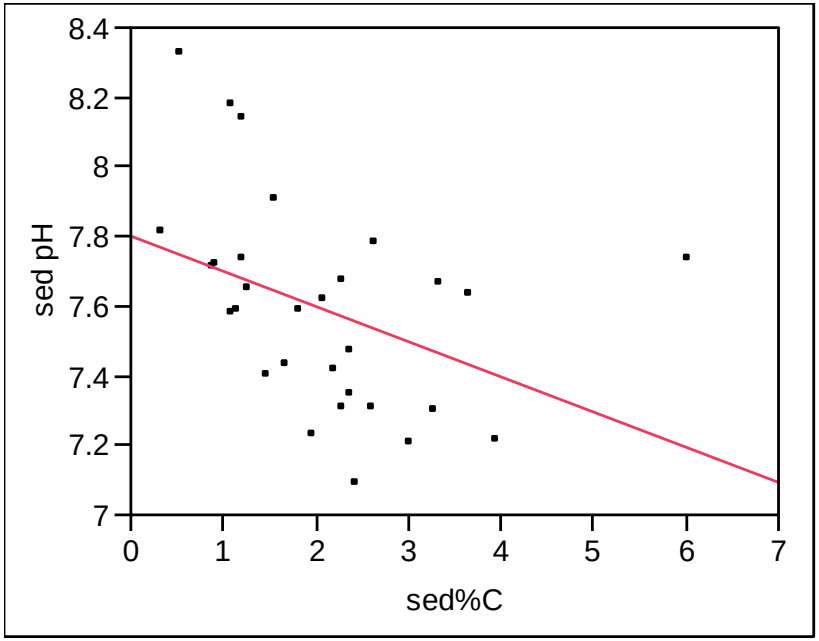
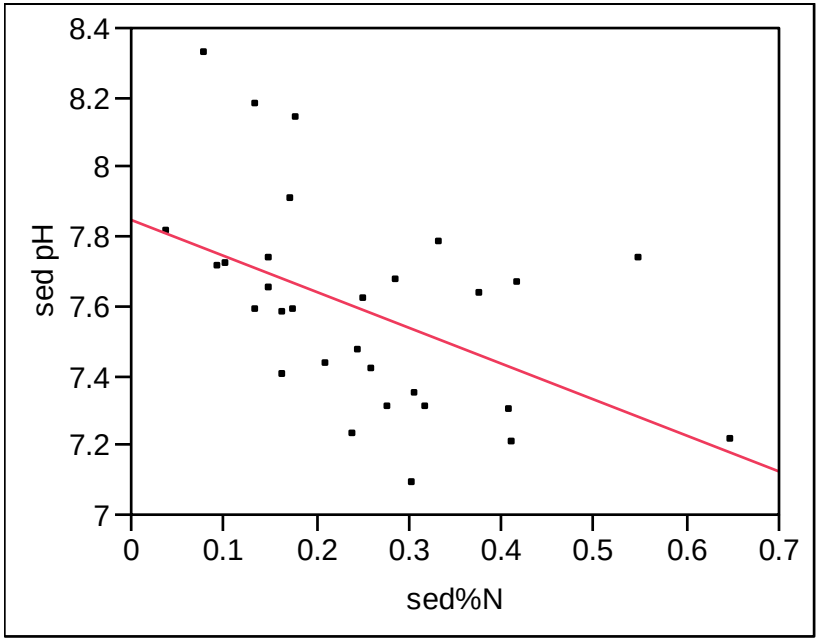
Sediment pH, Carbon and Nitrogen





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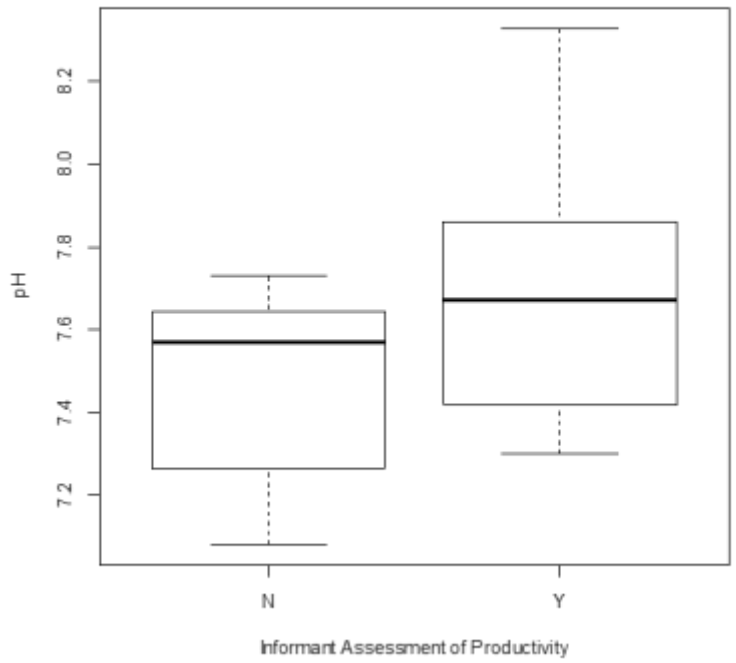
pH and Informant Assessment of Productivity



- "Productive" flats have higher average pH than "Unproductive" Flats
- Difference =

  0.23 +/- 0.101

  ($p<0.05$)

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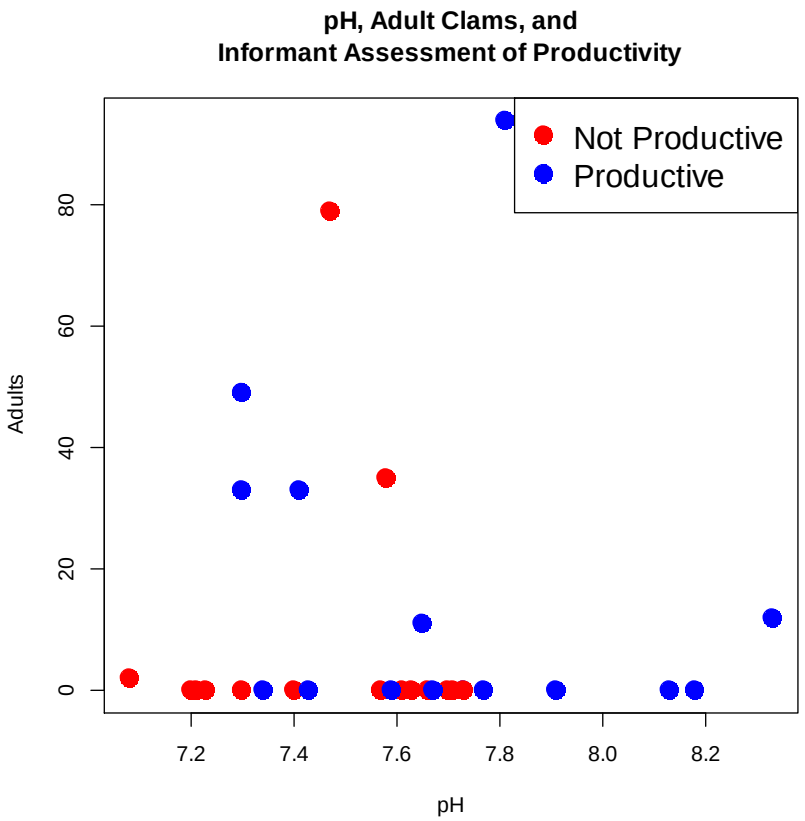
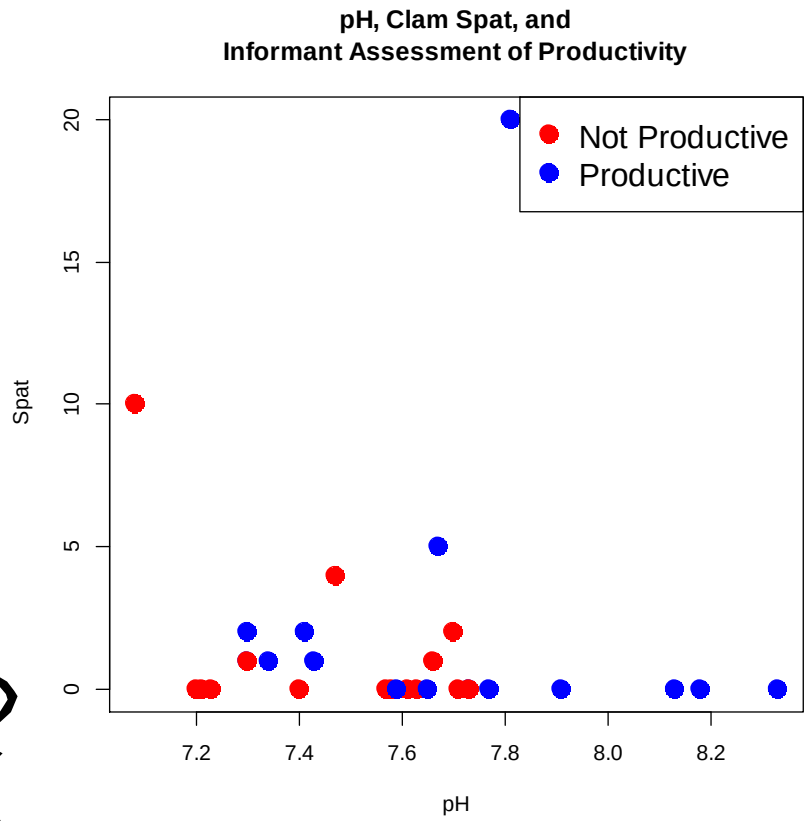
pH and Shellfish Abundance

ADULTS



SPAT



2012 Results

- Accurate and repeatable sediment pH measurements
- Some clam flats have very low sediment pH values
- Clam flats qualitatively categorized as “productive” had higher mean pH values than “not productive” flats
- But that pattern disappeared when compared to OBSERVED clam abundance
- Sediment with low pH values has relatively high %C and %N

Mud Summit

- Originally imagined as a small working meeting
- Invited CBEP STAC
- Word got around, ended up with more than 30 people

- Review science
- Present results of 2012 field studies
- Seek advice on next steps
- Articulate local research priorities
- Assist FOCB in planning 2013 field studies

"Mud Summit" Results

- Need to distinguish between two groups of questions:
  - Mechanisms of acidification
  - Effects on shellfish
- Specific research suggestions
  - Need to understand spatial and temporal variability of both pH /CSS and shellfish
  - Need to document relationship between pH – easy and inexpensive to measure – and carbonate saturation
- Recommendations for FOCB study 2013
  - Sample fewer sites, focus on spatial patterns
  - Transects across intertidal zone
  - Sample repeatedly
  - Collect more explanatory information