The Casco Bay “Mud Summit:” Local Efforts to Look at Acidification, Clams and Nutrients Powerpoint

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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
2011 Commercial Maine Landings By Ex-vessel Value
Total: $435,030,033 as of 6/8/12

American lobster 77%
other species 7%
Mahogany quahog 0%
tunas 1%
urchins 1%
groundfish 1%
worms 2%
shrimp 2%
eel 2%
soft clam 4%
Atlantic herring 3%

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

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>8.75</td>
</tr>
<tr>
<td>Median</td>
<td>7.54</td>
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<tr>
<td>Minimum</td>
<td>6.48</td>
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<tr>
<td>Mean</td>
<td>7.589</td>
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<tr>
<td>Standard Deviation</td>
<td>0.407</td>
</tr>
<tr>
<td>N</td>
<td>300</td>
</tr>
</tbody>
</table>
Sediment pH, Carbon and Nitrogen

![Graph showing the relationship between Sediment pH and Sediment Carbon %](image1)

![Graph showing the relationship between Sediment pH and Sediment Nitrogen %](image2)
“Productive” flats have higher average pH than “Unproductive” Flats

Difference = 0.23 +/- 0.101 (p<0.05)
**pH and Shellfish Abundance**

**ADULTS**

**ph, Adult Clams, and Informant Assessment of Productivity**

- **pH**
- **Adults**
- **Not Productive**
- **Productive**

**SPAT**

**pH, Clam Spat, and Informant Assessment of Productivity**

- **pH**
- **Spat**
- **Not Productive**
- **Productive**
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