Collaborative learning and ecological research: Undergraduate projects on the restoration of Foundry Cove

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Bio 371 - Restoration of Aquatic Ecosystems

- A course focused on field and laboratory investigations to evaluate ecologically-based restorations
- Focus on Foundry Cove Superfund site restoration on the Hudson River
- Use of collaborative learning techniques
- Emphasis on research goals rather than teaching of concepts or laboratory methods
- Supported by the Department of Ecology and Evolution and the Center of Science and Mathematics Education, Stony Brook University
- More information: Please contact levinton@life.bio.sunysb.edu
Pollution History

• Long history of industrial use (West Point Foundry from 1817 to 1911)

• Major pollution was caused by Nickel-Cadmium battery plant, between 1953 and 1979

• 179 MT of wastes were dumped into the river and cove (51 MT solid waste directly into cove) Klerks 1987
Pollution History

- Sediment in Foundry Cove was amazingly rich in Cadmium (500-250,000 ppm)
- Owing to the extreme levels of pollution, FC was declared a Superfund site in the mid 1980’s
Clean-up and Restoration

1992-1994: The marsh was excavated and the top 30-cm of sediment of the open cove was dredged.

1994-1995: The marsh was replanted and the cove refilled.

Marsh excavation
Dredging
Replanting (1994)
Restored (1996)
Biological effects of pollution

- High concentrations in sediments and orgs.
- Evolution of resistance leads to uptake of Cd
- Increase in potential for trophic transfer of Cd
- Creation of toxic environment and toxic resource species (e.g., blue crabs)
Cadmium Resistant Worms

Foundry Cove worms evolved resistance to cadmium following the 1995 cleanup.

**Graph:**
- Foundry Cove worms and control area.
- Loss of resistance following the 1995 cleanup.

**Legend:**
- South Cove
- Foundry Cove

**Statistics:**
- p ~ 0.0002
- p ~ 0.36

**Year:**
- 1994 to 2002
General Goals

• Introduce students to ecological work
• Focus on Foundry Cove restoration
• Use of collaborative learning techniques:
  – Students work independently and in groups towards common goal
  – “Sink or swim together”
  – They are accountable to each other
  – Interactions between students promote interest in the subject, critical thinking and creativity
• “Real-time” ecological research motivates students much more than “canned” lab activities

More information on the philosophy behind collaborative learning: http://www.gdrc.org/kmgmt/c-learn/
Specific Goals

1. Determine magnitude of current Cadmium Export from Foundry Cove (and compare with past levels)
2. Compare levels of Cadmium resistance between organisms from Foundry Cove and a control (un-impacted) cove
3. Compare benthic community structure between Foundry Cove and a control (un-impacted) cove
4. Compare results with previous published results and results from a similar class in the 1990s
Autonomy and Independence

**Pros**
- Students develop skills as-needed
- Students teach each other
- Increased motivation
- Creative problem solving
- Leaders emerge and develop
- Pride in a job well done
- Inertia

**Cons**
- Students may become overwhelmed
- Tendency to become stuck on problems
- Over-independence/over-dependence
- Distraction vortices
- Temptation to follow the paths of least resistance
- Inertia
Goal #1:
Measure Cadmium Export

- Measured cross sectional area of cove entrance
- Measured current speed over entire tidal cycle
- Calculated volume of water leaving the cove each day
- Collected water samples over entire tidal cycle
Goal #1: Measure Cadmium Export

- Filtered particles from water onto glass fiber filters
- Acid-extracted Metals from particles
- Measured Cd level with AAS at SoMAS

Andrew Collecting water
Chris and Sarah prepare to measure current speed
Goal #2: Measure Cadmium Resistance

- Collected Gallons of surface mud from Foundry Cove and South Cove (control)
- Built cultures of Limnodrilus in laboratory

J. Matt and Lauren filling buckets of mud at Foundry Cove
Goal #2: Measure Cadmium Resistance

- Isolated *L. hoffmeisteri*
- When enough were collected (N=96 per treatment), placed worms into watch glasses
- Cadmium added to experimental group
- Mortality measured over the next 24 hrs.

Students from multiple teams counting out worms for toxicity assay.
Goal #3: Comparing Benthic Communities

In the laboratory, students removed and identified ALL benthic invertebrates to lowest possible taxonomic level.