The role of educators in solving coastal environmental problems: imparting knowledge, power and passion in students

Bill Dennison

Maryland Teachers Course
July 2005
Chesapeake Biological Laboratory
Outline

• Knowledge, power and passion are needed

• Ecological forecasts
  – Dissolved oxygen
  – Microcystis blooms
  – Bay grasses

• Global lessons in paradigm shifts
Coastal issues are of global concern

Global: Hydrology
   (Dams & sea level)
Polar : Climate change
Temperate: Eutrophication
Tropical: Coastal development
The global coastal management challenge

- Increasing population particularly coastal population
- Global climate change
- Lack of success in most coastal management programs
Knowledge

Individual knowledge needs to be transferred into community knowledge

Community knowledge
- Informs decision making
- Provides political support
- Empowers people

“All men by nature desire knowledge.”
Metaphysics, Aristotle (384-322 BC)
Knowledge of cholera location led to solution

- Cholera outbreak in London, 1854
- John Snow mapped cholera cases
- J. Snow linked cholera cases to pump locations
- Pump handle removed; cholera subsided
Power

Power = the ability of individuals to motivate change in human activities or behavior.

Power can be manifested:

- within government
- non-government organizations
- academia
- community groups

“Power consists in one's capacity to link his will with the purpose of others, to lead by reason and a gift of cooperation.”

Woodrow Wilson (1856-1924)
Aldo Leopold (1887-1948) 1949
"There are some who can live without wild things, and some who cannot. These essays are the delights and dilemmas of one who cannot."

Rachel Carson (1907-1964) 1962
“It was a spring without voices. On the mornings that had once throbbed with the dawn chorus of robins, catbirds, doves, jays, wrens, and scores of other bird voices there was now no sound; only silence lay over the fields and woods and marsh.”
Passion

Passion refers to the expression of caring about an environmental issue or ecosystem.

Environmental passion:

• Provides motivation
• Aids in learning
• Needs to have a public expression
• Needs to be focused

"Only passions, great passions, can elevate the soul to great things."
Denis Diderot (1713-1784)
Passionate individuals led effort to obtain justice in Love Canal, 1978

1980 Superfund created; Comprehensive Environmental Response, Compensation, and Liability Act
Combining knowledge, power & passion

- **Enthusiasm** counts

- **Quality time** is needed

- **Consistent effort** essential
Combining knowledge, power & passion lead to paradigm shifts

“Knowledge is power.” Sir Francis Bacon (1561-1626)
The relative importance of passion, knowledge and power vary during campaign.
Personal attributes needed to STUDY

- **S**cientific rigor
- **T**otal commitment
- **U**nderstanding complexity
- **D**eveloping methodologies
- **Y**earning for truth
Personal attributes needed to SOLVE

- **Shared vision**
- **Organized participation**
- **Leadership**
- **Varied communication**
- **Effective actions**
In order to both study and solve problems, the following attributes are needed:

Credibility, tenacity, creativity and virtue

“Wisdom is knowing what to do next; virtue is doing it.”

David Star Jordan
Shift towards problem solving

Observation Revolution

*Data gathering capabilities dramatically increasing*

Information Generation

*Capacity for data analysis increasing*

Knowledge Building

*Synthesis and visualization techniques not utilized enough*

Problem Solving

*Need integrated and applied approach*
**Pasteur’s Quadrant** = Research that both increases fundamental understanding & is useful

<table>
<thead>
<tr>
<th>Understanding driven research</th>
<th>Use driven research</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure basic research</strong></td>
<td><strong>Use-inspired basic research</strong></td>
</tr>
<tr>
<td><strong>Nils Bohr</strong></td>
<td><strong>Louis Pasteur</strong></td>
</tr>
<tr>
<td><strong>no</strong></td>
<td><strong>yes</strong></td>
</tr>
<tr>
<td><strong>Pure applied research</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Thomas Edison</strong></td>
<td></td>
</tr>
<tr>
<td><strong>X</strong></td>
<td><strong>yes</strong></td>
</tr>
</tbody>
</table>

An "Ecological Footprint" is a measure of the "load" imposed on the natural environment by a given population and represents the land area necessary to sustain current levels of resource consumption and waste discharge by the population. Human activities such as eating, traveling, heating homes, and purchasing consumer items all contribute to ecological footprints.

Bill Rees

Wackernagel, M & Rees, W, 1996, Our Ecological Footprint; Reducing Human Impact on the Earth, New Society Publishers: Canada
Ecosystem Services are the processes by which the environment produces resources that we often take for granted.

Bob Costanza

Records reaching back hundreds of years indicate that historical overfishing was the primary driver of the collapse of most coastal ecosystems worldwide. Current baselines for fisheries management and conservation badly underestimate the affect of traditional fishing on functioning marine ecosystems and the size of pristine populations. However, we can use historical perspective to design new and scientifically rigorous strategies for the sustainable development of the oceans.

Jeremy Jackson

Jackson et al., Historical Overfishing and the Recent Collapse of Coastal Ecosystems, Science 2001 293: 629-637
Fishing down the food web concept

Landings in global fisheries are steadily shifting from large, long-lived piscivorous (fish-eating) fish at the top of the marine food chain toward short-lived, low trophic level invertebrates and planktivorous (plankton-eating) fish.

Collapse: How societies choose to fail or succeed *Jared Diamond*, 2005

- **Pattern of collapse** (population growth, intensified agriculture, expanded farming, unsustainable practices causing environmental degradation)
- **Consequences of collapse** (food shortages, starvation, wars, destabilized governments)
- **Result of collapse** (population decrease due to starvation, war, disease, societal complexity lost--political, economic, cultural)
- **Factors influencing susceptibility to collapse**: environmental damage, climate change, hostile neighbors, trade partners, societal response
- **Most serious problems**: natural resource degradation (habitat destruction, loss of wild foods, biodiversity loss, soil erosion), ‘ceilings’ on natural resources (energy, freshwater, photosynthetic capacity), harmful things (toxic chemicals, alien species, atmospheric gases), population (numbers, consumption).
Is the Chesapeake Bay restoration a 'splendid failure'?

Extremely well studied
Intensively managed
Heightened awareness
Well funded

BUT
Continuing to degrade
Monitoring, management & research needs to be coordinated and focused
The Chesapeake Bay Program needs...

A communication strategy that:

- Provides easy access to the information being sought
- Provides a constant flow of products
- Occurs in a timeframe that is appropriate to the messages being conveyed
- Provides storylines and links information
- Underpinned by a range of robust and defendable data synthesis and analysis methods
- Provides information in maps, conceptual diagrams and other easy to interpret approaches
### Annual Communication Cycle

#### 2005
- **May**: E-newsletter
  - Health: SAV
  - Restoration: SAV
  - Stressors: Sediment
  - Major communication product: Summer Forecast

#### 2006
- **Jan**: E-newsletter
  - Health: Blue Crab
  - Restoration: Blue Crab
  - Stressors: TBD
  - Major communication product: Summer Highlights
    1. **June**: Annual assessment
    2. **July**: Annual assessment
    3. **Aug**: Annual Forecast

### Integrated Assessment

**Ecological Forecast**

**Water Quality 2005**

**Integration**

**Application**

**Network**
What is an ecological forecast?

• Analogous to a weather forecast - predict conditions in the future

• Predict the effects of biological, chemical, physical, and human-induced changes on ecosystems

• Do not guarantee what is to come - they offer scientifically sound estimations of what is likely to occur
Why make an ecological forecast?

• Provide context for understanding summer conditions
• Provide guidance for Chesapeake restoration efforts
• Establish a proactive communication and education program
• Aid management activities
Summer 2005 Forecast

- Dissolved oxygen
- Potomac River harmful algal blooms
- Submerged Aquatic Vegetation
Dissolved oxygen forecast

- Mean summer anoxic volume:
  - 1.7 cubic kilometers;
  - 3.3% of the Bay’s mainstem

- Range:
  - 1.1 to 2.4 cubic kilometers; or
  - 2.1 to 4.7% of the Bay’s mainstem
Potomac River harmful algal bloom forecast

- Bloom onset:
  - Late spring (June)
- Bloom duration:
  - Approx. 2.5 months
- Bloom extent:
  - >10 miles (length)
2005 Aquatic grass forecast

Community type

- **Low salinity** (12 species)
- **Medium salinity** (6 species)
- **High salinity** (2 species)

Locations where community types occur

20 years of aquatic grass cover

- Overall increase in area
- No overall change expected
- Small overall increase in area

2005 forecast
Hurricane Isabel; Sept. 2003
**Effects of Hurricane Isabel could have been predicted**

<table>
<thead>
<tr>
<th></th>
<th>1933 hurricane</th>
<th>Hurricane Isabel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min pressure (&quot; Hg)</td>
<td>28.3</td>
<td>28.3</td>
</tr>
<tr>
<td>Max sustained wind speed</td>
<td>98 mph</td>
<td>98 mph</td>
</tr>
<tr>
<td>Tidal surge in Potomac River (feet above MLLW)</td>
<td>11.1 '</td>
<td>11.3 '</td>
</tr>
</tbody>
</table>
Storm surges nearly identical; 1933 hurricane & Hurricane Isabel
Impacts magnified with relative sea level rise
Annual integrated assessment

• Goals
  – Conduct an annual assessment of key indicators
  – Develop an improved assessment capacity by improving timeliness and incorporating new indicators
  – Effectively communicate the assessments with spatially explicit maps and rigorous scientific assessments to the Chesapeake Bay community.

• Rationale
  – Provide context for understanding environmental conditions in Chesapeake Bay
  – Provide an explicit linkage between management objectives (e.g., Chesapeake 2000) and actual progress in Chesapeake restoration
  – Establish a proactive communication and education program
Indicator Framework: Three Functional Groups

- **Chesapeake Bay & watershed restoration**
  - Example: Miles of riparian forest buffer restored

- **Chesapeake Bay & watershed stressors**
  - Example: Nontidal sediment loads and river flow

- **Chesapeake Bay ecosystem health**
  - Example: Trends in restoration of underwater Bay grasses

Feedback (e.g., improved restoration efforts)
### Indicator reporting framework

#### Overarching Indices
- Restoration Progress Index
- Ecological Footprint Index
- Bay Ecosystem Health Index

#### Top level indices
- Land & loads
- Habitat
- Harvest
- Loads
- Land use
- Harvest

#### Reporting Indicators & Indices
- Chesapeake Bay & watershed restoration
  - Agricultural BMPs
  - Urban BMPs
  - WWTP upgrades
  - Air quality controls
  - Preserved lands
  - Fish passage
  - Oysters
  - Fisheries Management Plan

- Chesapeake Bay & watershed stressors
  - Nitrogen
  - Phosphorus
  - Sediment
  - Flow
  - impervious/pervious
  - Land uses

- Chesapeake Bay ecosystem health
  - Crab
  - Oyster
  - Fish
  - Dissolved Oxygen
  - Chl-a
  - Clarity
  - Chemical contaminants
  - SAV
  - Wetlands
  - Phytoplankton
  - Zooplankton
  - Benthic community
  - Forage fish

#### Diagnostic-detailed Indicators
- Remainder of indicators

### Key Points
- Facilitate interpretation of the reporting indicators/indices (diagnostic)
- Provide for geographically detail (detailed)
- Address topics of special interest not used in the generation of top level indices (special interest)
River prize winners (1999-2004)
Existing paradigm: "Environmental restoration will cost too much."

New paradigm: Investments in protection & restoration will never be cheaper & can stimulate local economies.

Case Study: Mersey Basin Campaign

- 25 yr. campaign
- 6 million people; world’s 1st industrial region
- Negative value land turned into 4 star hotel
- In 1985 3 raw sewage discharges; now swimmable water
Existing paradigm: “There are too many jurisdictions & stakeholders with divergent views”.

New paradigm: A participatory process can create a shared vision among a variety of stakeholders.

Case Study: Mekong River Commission

Cambodia, Lao PDR, Thailand, Vietnam

Large river system (8th in volume globally)

Major fisheries

High rice production

17 million people; 70 ethnic minorities
Existing paradigm: "Cultural differences preclude collaboration."

New paradigm: Sharing an environmental goal can bring people together.

Case study: Alexander River Restoration Administration

2nd largest river in Israel

Soft shell turtles

Palestinian & Israeli cooperation
Paradigm shifts occur when scientific discovery is effectively communicated to society.
Integration and Application Network

www.ian.umces.edu