Long-term Marine Research and the Grand Challenges in Ecology

Organizers:
Hugh Ducklow
Dan Reed
Chuck Hopkinson
Roll on, thou deep and dark blue Ocean -- roll!
Ten thousand fleets sweep over thee in vain;
Man marks the earth with ruin -- his control
Stops with the shore;

Byron, Childe Harold's Pilgrimage

The very deep did rot : O Christ !
That ever this should be !
Yea, slimy things did crawl with legs
Upon the slimy sea.

Coleridge, Rime of the Ancient Mariner

Mini-Symposium at the NSF
03 March, 2005
Long-term Marine Research
and the Grand Challenges in Ecology
The economic value of marine ecosystem goods and services

<table>
<thead>
<tr>
<th>Services ($/yr/ha)</th>
<th>Open Sea</th>
<th>Coastal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Reg</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Disturbance</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>Nutrient cycling</td>
<td>118</td>
<td>3677</td>
</tr>
<tr>
<td>Biol Control</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>Habitat/refugia</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Food production</td>
<td>15</td>
<td>93</td>
</tr>
<tr>
<td>Raw materials</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Recreation</td>
<td></td>
<td>82</td>
</tr>
<tr>
<td>Cultural</td>
<td>76</td>
<td>62</td>
</tr>
</tbody>
</table>

| Total ($/ha/yr)           | 252      | 4052    |
| Total (trillion $/yr)     | 8.4      | 12.6    |

Table after Costanza et al. Nature 387:253 (1997)

Total Marine value $21 trillion/year
Global GNP $18 trillion/year
Trash bag: 4000 meters

Courtesy: MBARI
Exxon Valdez oil spill
Marine Species Extinctions

- Steller’s sea cow
- Great Auk
- West Indian Monk Seal
- Ship sturgeon
- Sea Mink

Marine Species Extinctions
Species invasions

*Mnemiopsis* – Black Sea
Sea Ice: pollutant laden
Anthropogenic carbon dioxide accumulation in the North Atlantic ocean, 1997

Courtesy: D. Wallace, A Kortzinger, University of Kiel
Acidification of the global ocean

Probing into rising ocean acidity

The UK’s Royal Society has launched an investigation into the rising acidity of the world’s oceans due to pollution from the greenhouse gas carbon dioxide.

The change could have catastrophic consequences for marine life.

Oceans mop up carbon dioxide from the atmosphere, lowering the water’s pH value - an effect that may be exacerbated by burning of fossil fuels.

Scientists on the working group are due to publish an initial report into the phenomenon by early next year.

The investigation by the Royal Society, the UK national academy of science, will probe the potential impact of this rising ocean acidity on marine life - which at present is largely unknown.

“... The same pollution that we believe is heating the world’s oceans...is also altering their chemical balance.”

Professor John Raven
Eutrophication: Growing hypoxia

Area of Hypoxia

Shelfwide Mid-summer Cruises

1993
17,600 sq km
6,800 sq mi

1994
16,600 sq km
6,414 sq mi

1995
18,200 sq km
7,032 sq mi

(Rabalais, Turner & Wiseman)
Harmful algal blooms
High Seas - NW Atlantic

Devastation of fisheries

Catch (000 tonnes)

Year

- Cod -likes
- Scorpion -fishes
- Flatfishes
- Crustaceans
- Other fishes & inverts
- Sharks & rays
- Perch -likes
- Molluscs
- Tuna & billfishes
- Salmon, smelts, etc
- Herring -likes
- Anchovies
Tools:
The LTER Network

The Grand Challenges
Strategically-chosen marine coastal and oceanic LTER Sites can be a vital part of the global ocean and climate observing systems.
Growth and development of the US LTER Network

- 1980:
  - North Temperate Lakes
  - H.J. Andrews Forest
  - Coweeta
  - Konza Prairie
  - North Inlet Marsh
  - Niwot Ridge

- 1981:
  - Shortgrass Steppe
  - Okefenokee
  - Illinois Rivers
  - Cedar Creek
  - Jornada Basin

- 1987:
  - Arctic Tundra
  - Bonanza Creek
  - Hubbard Brook
  - Kellogg
  - Virginia Coast

- 1988:
  - Luquillo Forest
  - Sevilleta
  - Harvard Forest

- 1991:
  - Palmer Antarctica

- 1993:
  - Dry Valleys

- 1997:
  - Phoenix
  - Baltimore

- 1998:
  - Plum Island

- 2000:
  - Georgia Coastal
  - Florida Everglades
  - Santa Barbara

- 2004:
  - California Coastal
  - Moorea Coral Reef

- 8 Forests
- 8 Marine
- 10 Others
• 2001: NRC Report, **Grand Challenges in Environmental Sciences**
  “...written in response to a request from the National Science Foundation (NSF) that the National Research Council (NRC), drawing on expertise from across the environmental sciences, offer a judgment regarding the most important environmental research challenges of the next generation—the areas most likely to yield results of major scientific and practical importance if pursued vigorously now.”

• 2004: NRC list of grand challenges adapted to guide LTER Synthesis Initiative.
The LTER Grand Challenges for research at the Network level:

- Alterations in biodiversity
- Coupled human-natural ecosystems
- Climate change and climate variability
- Altered biogeochemical cycles

Integrating education through all 4 challenges and across the LTER Network

Today: how LTER is addressing these challenges in the marine biosphere
LTER Grand Challenges and Program Today:

Alterations in biodiversity
Presentation by Sally Holbrook and Dan Reed (UCSB; Moorea and SB Coastal)

Coupled human-natural ecosystems
Presentation by Wil Wollheim (UNH and Plum Island)

Education
Presentation: Ali Whitmer (UCSB, SB-Coastal and Moorea Coral Reef)

Climate change and climatic variability
Presentation: Mark Ohman (CA Current and Scripps)
Sharon Stammerjohn (Palmer and Lamont-Doherty)

Altered biogeochemical cycles
Presentation: Karen McGlathery (UVA and VA Coast Reserve)

Discussion & Conclusions:
Chuck Hopkinson (Ecosystems Center and Plum Island)