Integrated Ecosystem Assessments: a tool for bridging science and ecosystem management

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**NCCOS**
National Centers for Coastal Ocean Science
...science serving coastal communities
NOAA’s VISION
An informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions

Approach: Regional ecosystem management
the starting point...

Integrated ecosystem Assessments

“A synthesis & quantitative analysis of information on relevant physical, chemical, ecological and human processes in relation to specified ecosystem management objectives”
Integrated Ecosystem Assessments

Characteristics

• geographically specified

• Incorporates multiple indicators of the physical environment, human factors affecting ecosystems, & the abundance and production of ecosystem goods & services

• Establishes target levels & thresholds for important ecosystem components

• Evaluates the impacts of management options & risks of not attaining target ecosystem states.

Source: Murawski & Menashes, NOAA Ecosystem Goal Team, March ‘07
Integrated Ecosystem Assessment

While more has been written on the topic, NOAA has found that we don’t yet have an working model for how to conduct an IEA…
Ecosystems are in worldwide decline. Aren’t they?
The Millennium Assessment (MA):

A UN initiated report - assessed the consequences of ecosystem change for human well-being. Focus on ecosystem services

State of major ecosystem classes
18 MA-approved sub-global assessments
15 with an associated status.

Experts and Review Process
– Prepared by 1360 experts from 95 countries
– 80-person independent board of review editors
– Review comments from 850 experts and governments

Source: www.millenniumassessment.org
Two important Findings...

- Over the past 50 years, humans have changed ecosystems more rapidly and extensively ...  
  - population doubled - 3 to 6 billion people; economy 6x!

- The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many [other] ecosystem services
  
  - food production increased 2 ½ times
  - water use doubled
  - installed hydropower capacity doubled
### Trade-offs

Effective ecosystem management would optimize the trade-off scenario & ensure sustainability.

### Status of Provisioning Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td></td>
</tr>
<tr>
<td>crops</td>
<td>⇑</td>
</tr>
<tr>
<td>livestock</td>
<td>⇑</td>
</tr>
<tr>
<td>capture fisheries</td>
<td>⇑</td>
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<tr>
<td>aquaculture</td>
<td>⇑</td>
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<tr>
<td>wild foods</td>
<td>⇑</td>
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<tr>
<td>Fiber</td>
<td></td>
</tr>
<tr>
<td>timber</td>
<td>+/-</td>
</tr>
<tr>
<td>cotton, silk</td>
<td>+/-</td>
</tr>
<tr>
<td>wood fuel</td>
<td>⇑</td>
</tr>
<tr>
<td>Genetic resources</td>
<td>⇑</td>
</tr>
<tr>
<td>Biochemicals, medicines</td>
<td>⇑</td>
</tr>
<tr>
<td>Fresh water</td>
<td>⇑</td>
</tr>
</tbody>
</table>

Source: [www.millenniumassessment.org](http://www.millenniumassessment.org)
MA take-home messages

• We are not effectively managing ecosystems.
  – we generally manage individual uses of ecosystems
  – often without explicit goals, even for individual uses

• Societal demands are not checked by limits imposed by ecosystem sustainability thresholds

• Society’s decisions on one ecosystem issue, largely uninformed of inherent tradeoffs
  • Agriculture/Aquaculture vs. ‘wild’ fisheries
  • today’s benefits can compromise an ecosystem’s ability to provide future services
How does this knowledge help us in framing our approach to EM?

• Effective management ecosystem requires specific goals an ecosystem

• A portfolio of ecological goals / ecosystem services, is not enough unless it …
  – Treats the ecosystem as a functional unit
  – Accounts for tradeoffs that result from finite limits of the ecosystem to services while sustaining form and function
  – Is based upon some form of social consensus that provides for a prioritization of ecosystems uses/services/conditions
An IEA seeks to the answer to:
is ecosystem ‘x’ healthy?

The Steps

1. Define/describe the ecosystem & its boundaries

2. Identify ecosystem goals/uses as determined by social consensus

3. Define ecosystem status and historic trends relative to ecosystem goals

4. Define causes and consequences of the current status
   • identify trade-offs and antagonistic service demands

5. Use projection models to contrast costs, benefits, and outcomes given different policy scenarios
   • A ‘business as usual scenario’ versus optimization options 1, 2, …
1. Define the ecosystem in question

Clearly establish geographical boundaries

- Watershed delineations are useful here
  - Pay attention to, but do not blindingly use ecologically meaningless jurisdictional boundaries
  - Attempt to encompass important processes, populations, and habitats
  - Unique or important anthropological, social, or socio-economic structures (fisheries based communities, etc.)

- No ecosystem is self contained
  - Acknowledge ‘open’ boundaries & exchanges
2a. Identify social consensus goals:

Examples for Ecosystem ‘X’ …

- **Sustainable fisheries** that support the economy, social constructs, and recreational opportunities of coastal communities.

- **Areas that can be safely used for recreational activities**, including uses such as: powerboating, sailboating, waterskiing, jet skiing, snorkeling, beach going, fishing, clamming, & crabbing.

- **Adequate energy infrastructure** to support the current and future home, industrial, transportation, & recreational activities.
2b. What to do when society’s comprehensive set of goals for an ecosystem is unavailable?

Federal Legislation – clearly a viable form of social consensus

• Clean Water Act: *(shorthand goals)*
  – Fishable & swimmable

• Endangered Species Act: *(shorthand goals)*
  – no species should go extinct
3. Status and trends: evaluate...

Fishable
  – Safe & desirable to fish
    • Healthy, abundant, & diversity of gamefish?

Swimmable
  – Safe & desirable to beaches
    • Beach closures, fish kills, clear waters?

Are any species endangered?
4. Define causes & consequences of the current status & Visualize trade-offs!

Endangered Species
- sea turtles

Swimmable
- safe & desirable

Fishable
- Recreational fishing
- Traditional pound nets
- Industrial (trawlers)

Land use
- Pathogen abundance
- Eutrophication
- Hypoxia
- Poor gamefish health
- Gamefish abundance
- Forage fish abundance (filter feeders)

Between goals
- Beach closures
- From ‘other’ uses: Need comprehensive goals for the ecosystem

Within a goal
- Within a goal

From ‘other’ uses:
- Need comprehensive goals for the ecosystem
5. Model costs, benefits, & outcomes under different policy scenarios

Scenarios
- Reforestation
  - 52% forested
  - “Business as usual”
  - 38% Developed

Model Trade-offs!

Ecological models
- stressor ⇒ habitat ⇒ living resources
- temperature
- oxygen

Outcomes
- Reforested watershed
- “Business as usual”

habitat “squeeze”
IEA version 1.0 for Ecosystem ‘X’

- will be limited & imperfect
- *will* demonstrate tradeoffs inherent with effective ecosystem management
- is a starting point for more holistic & informed decisions when managing ecosystem ‘X’
- will provide ‘leverage & momentum’ in initiating a process for deriving a set of comprehensive ecosystem goals through social consensus
Ecosystem management requires:

- goals for managed ecosystems that are set by social consensus
- Models relating stressors to goals and trade-offs between goals
- cost-benefit optimization of trade-offs to guide effective decision making
Thank You