Assessing human impacts on coastal ecosystems and services

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Marine Initiative of the Natural Capital Project
Human impacts ecosystem services

?
How do human activities influence delivery of services?

Marine InVEST: scenario assessment tool
Marine InVEST: scenario assessment tool

Human impacts $\rightarrow$ ecosystem structure $\rightarrow$ ecosystem services

Ecological production functions
Risk analysis approach

Human impacts ➔ ecosystem structure ➔ Response

Exposure
Risk analysis approach

Exposure

- Map of activities
- Map of ecosystems
- Intensity of activity (timing, current management)

Response

- % mortality, density
- Recovery: mortality rate, regeneration rate, connectivity, etc.
<table>
<thead>
<tr>
<th>Exposure</th>
<th>High (3)</th>
<th>Moderate (2)</th>
<th>Low (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areal overlap</td>
<td>&gt;50%</td>
<td>20-50%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Temporal overlap</td>
<td>Daily to weekly</td>
<td>Several times a year</td>
<td>Annually or less often</td>
</tr>
<tr>
<td>Effectiveness of management</td>
<td>Not effective</td>
<td>Somewhat effective</td>
<td>Very effective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response</th>
<th>High (3)</th>
<th>Moderate (2)</th>
<th>Low (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in area</td>
<td>&gt;50%</td>
<td>20-50%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Change in density</td>
<td>&gt;50%</td>
<td>20-50%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Frequency of natural disturbance</td>
<td>Annually or less often</td>
<td>Several times per year</td>
<td>Daily to weekly</td>
</tr>
<tr>
<td>Proximity to physiol. limits</td>
<td>Very close</td>
<td>Moderately close</td>
<td>far</td>
</tr>
<tr>
<td>Nat’l mortality</td>
<td>0-20%</td>
<td>20-50%</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>Recruitment pattern</td>
<td>Every 2+ years</td>
<td>Every 1-2 years</td>
<td>Annually or more often</td>
</tr>
<tr>
<td>Connectivity</td>
<td>low dispersal &lt; $10^1$ km</td>
<td>Moderate $10^1$ km - $10^2$ km</td>
<td>high dispersal &gt;$10^2$ km</td>
</tr>
<tr>
<td>Regeneration rate</td>
<td>&lt; decadal</td>
<td>Decadal</td>
<td>annual</td>
</tr>
</tbody>
</table>
Exposure

Areal Overlap/Proximity between Stressor and Habitat

Temporal Component of Stressor (Constant, seasonal, etc.)

Effectiveness of Current Management Strategy

Response

Resistance (change in area, change in density, proximity to physiological limits)

Recovery (natural mortality rate, regeneration rate, connectivity)

Impact = \( [(C - X_o)^2 + (L - Y_o)^2]^{0.5} \)
Risk analysis approach

Human impacts → ecosystem structure → ecosystem services

Exposure

Map of activities

Map of species

Intensity of activity (timing, current management)

Response

% mortality, density

Recovery: regeneration rate, connectivity, etc.

Production function

Impact = \[(C - X_0)^2 + (L - Y_0)^2\]^{0.5}
Vancouver Island, B.C.

More aquaculture

More nutrients

More tourism

More boating
Exposure  
Response  
Impact

\[ \text{Impact} = \sqrt{(X - X_0)^2 + (Y - Y_0)^2} \]
Human impacts

Exposure

ecosystem structure

Response
Human impacts → ecosystem structure → ecosystem services

Service model

Coastal protection

Carbon storage
As eelgrass density decreases, shoreline retreats.
As eelgrass density decreases, less carbon storage
How do management decisions influence delivery of services?
How do management decisions influence delivery of services?
Thank you!

Jeremy Davies, Greg Guannel, Anne Guerry, CK Kim, Mike Papenfus, Mary Ruckelshaus, Jodie Toft, Greg Verutes

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Human impacts \[\rightarrow\] ecosystem structure \[\rightarrow\] ecosystem services

\[\rightarrow\] ecosystem function
**Inputs**

- Map of activities
  - e.g., aquaculture, run-off, climate change
- Map of habitats
  - e.g., eelgrass, kelp
- Intensity of activity
  - e.g., timing, management
- Species response
  - Resistance and recovery

**Outputs**

- Map of impact
- Change in ecosystem structure
- Change in service production

*Stand-in ecosystem service models*