Exploring approaches to assessing natural capital's role in environmental decision making--Insights from stakeholder engaged watershed case studies in New England

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Plymouth State University
Chelsea Berg ‘15G, Jonathon Loos ‘15G, Madeleine Mineau, Rebecca Hanson
March 18, 2016
33 trillion dollars per year

Cited over 14,000 times

Ecosystem Services as the Currency of Social-Ecological Systems
Total Economic Value

Use value

Direct use
- Direct benefit from use of primary goods
  - For example: Provisioning services
    - Industrial inputs such as timber
    - Food, fodder and other forest products
    - Medicinal products
    - Fresh water
  - Cultural services
    - Recreation
    - Tourism
    - Education and science

Option
- Option for future use (direct or indirect) of goods and services
  - For example: Provisioning services
    - Fresh water
    - Medicinal products
  - Regulating services
    - Carbon storage
    - Air quality and water purification
    - Erosion control
    - Flood prevention

Indirect use
- Benefits from secondary goods and services (including non-consumptive use)
  - For example: Provisioning services
    - Fresh water
  - Regulating services
    - Carbon storage
  - Cultural services
    - Scenery and landscape
    - Recreation
    - Education and science

Non-use value

Bequest
- Value for future generations
  - For example: Cultural services
    - Scenery and landscape
    - Community identity and integrity
    - Spiritual value

Existence
- Value of existence without use or consumption
  - For example: Cultural services
    - Wildlife and biodiversity

Adapted from: The Economics of Ecosystems and Biodiversity, 2009, The Economics of Ecosystems and Biodiversity for National and International Policy Makers.
Great Bay in the News

Restoring health of Great Bay

Posted Mar. 13, 2016 at 3:15 AM

Upgrade approved for Portsmouth wastewater treatment plant

Residents speak out against $75 million project

UPDATED 12:25 PM EDT Mar 15, 2016

Seacoast Communities Move Toward Upgraded Wastewater Treatment

By JASON MOON • 15 HOURS AGO
• Values Nutrient Removal
  – Critical Issue for Great Bay Watershed

How it Works

Stakeholder Engagement

Scenarios

Biophysical Models

Economic Models

Maps
Tradeoff curves
Balance sheets

Dollar values
Maps
Tradeoff curves
Balance sheets

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Evaluating the Ecosystem Service of Nutrient Removal in a Coastal Watershed: A Case Study of NH's Great Bay

- TNC
- PREP
- GBNERR
- NHDES

Expert Stakeholder Input re: land use/conservation scenarios

Models
- FrAMES
- InVEST

Nitrogen Inputs to Great Bay
- Potential Avoided Costs

Value of N Removal?

C. Berg*, S. Rogers*, M. Mineau* 2015 Futures
C. Berg*#, M. Mineau* S. Rogers* Revisions Ecosystem Services
(*all equal contributors, # graduate student)
Working with Expert Stakeholders to Develop Realistic Scenarios

Please rank the following land cover types in order of most likely to increase (1) to least likely to increase (4).

- Urban
- Suburban
- Cultivated Crops
- Open Fields

The current land in conservation shown in Figure 8 represents 13.5% of the study area. In the next 10 years, how do you expect this total percentage to change? What is a realistic increase of the total percent area in conservation under this scenario? (ie: conservation areas will increase from 13.5% to _______% of the study area)
Figure 2. Spatial representation of the study area with the 18 POTWs represented with stars and the N removal costs in $/kg/yr adapted from Table 5 in Kessler (2010). Note the variation in cost from $15 to $9321 which created difficulty in determining marginal abatement costs.

<table>
<thead>
<tr>
<th>Discount Rate</th>
<th>1%</th>
<th>3%</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Marginal Value ($1538/kg)</td>
<td>46.4</td>
<td>43.1</td>
<td>40.1</td>
</tr>
<tr>
<td>Median Marginal Value ($396/kg)</td>
<td>11.9</td>
<td>11.1</td>
<td>10.3</td>
</tr>
<tr>
<td>Break-out by Subwatershed (see Table 4)</td>
<td>18.6</td>
<td>17.3</td>
<td>16.1</td>
</tr>
</tbody>
</table>
Findings

• In Great Bay Watershed, targeted conservation could offset some wastewater treatment facility upgrades but not the majority of them.

• Tools such as InVEST can be useful but require significant learning curves and careful engagement with expert stakeholders.
Partnering to Evaluate Priorities for the Squam Lakes Watershed

Shannon Rogers, Jonathon Loos, Chelsea Berg
Center for the Environment, Plymouth State University

Rebecca Hanson, Director of Conservation
Squam Lakes Association
<table>
<thead>
<tr>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
<th>Scenario D</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Management Regime</td>
<td>Chemical application</td>
<td>Hand Removal</td>
<td>Diver Assisted Suction Harvester</td>
</tr>
<tr>
<td>Effectiveness of Removal</td>
<td>None</td>
<td>Variable, over large areas.</td>
<td>Effective in small localized areas.</td>
</tr>
<tr>
<td>Removal Maintenance</td>
<td>None</td>
<td>Low – But requires two year consecutive treatment</td>
<td>High</td>
</tr>
<tr>
<td>Labor Investment</td>
<td>0</td>
<td>Days</td>
<td>Teams of 3-4, multiple weeks</td>
</tr>
<tr>
<td>Cost for SLA to Administer</td>
<td>0</td>
<td>$120/hour</td>
<td>Cost of Intern labor, training, and boating needs (~$1000/week)</td>
</tr>
<tr>
<td>Cost to Contract</td>
<td>0</td>
<td>$8000 for 2 spots</td>
<td>$6000/week</td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>Potential loss of native plants, altered habitat, recreation and aesthetic nuisance.</td>
<td>Uncertainty in effects associated with chemical use.</td>
<td>Localized, minor disturbance during pulling.</td>
</tr>
<tr>
<td>Your Rating</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your rating
<table>
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<th>Scenario C</th>
<th>Scenario D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Photo Credit: NH DES Exotic Species Program)</td>
<td>(Photo Credit: Wisconsin DNR)</td>
<td>(Photo Credit: SLA)</td>
<td>(Photo Credit: SLA)</td>
</tr>
<tr>
<td>Effectiveness of Removal</td>
<td>None</td>
<td>Variable, over large areas.</td>
<td>Effective in small localized areas.</td>
<td>Effective in small to medium localized areas.</td>
</tr>
<tr>
<td>Removal Maintenance</td>
<td>None</td>
<td>Low – But requires two year consecutive treatment</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Labor Investment</td>
<td>0</td>
<td>Days</td>
<td>Teams of 3-4, multiple weeks</td>
<td>Teams of 2-4; multiple weeks</td>
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</tr>
<tr>
<td>Cost to Contract</td>
<td>0</td>
<td>$8000 for 2 spots</td>
<td>$6000/week</td>
<td>$6000-$7200/week</td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>Potential loss of native plants, altered habitat, recreation and aesthetic nuisance.</td>
<td>Uncertainty in effects associated with chemical use.</td>
<td>Localized, minor disturbance during pulling.</td>
<td>Localized, heightened turbidity and equipment disturbance during harvesting.</td>
</tr>
<tr>
<td>Your Rating</td>
<td><strong>3.8</strong></td>
<td><strong>3.1</strong></td>
<td><strong>1.7</strong></td>
<td><strong>1.25</strong></td>
</tr>
</tbody>
</table>
Findings

• Membership supported the current priorities of the SLA and supported efforts to lead watershed planning

• Obtaining data for the proper comparison of alternatives is quite challenging but the process of doing so can inform future data collection processes
Understanding stakeholder preferences for flood adaptation alternatives with ecosystem service implications

Loos & Rogers. Revisions *Ecology & Society*
Review of literature, State hazard plans, regional flood history and relevant issues

1. STAKEHOLDER ENGAGEMENT
   - Identify stakeholder groups
   - Focus-group discussions
   - Gather local flood concerns and issues

2. CRAFT DECISION SCENARIOS
   - Categorize flood vulnerabilities
   - Identify alternatives
   - Develop flood scenarios

3. BUILD MCDA FRAMEWORK
   - Define project criteria
   - Gather criteria performance information
   - Craft alternative matrices
   - Engage with experts

4. DESIGN WORKBOOK

5. STAKEHOLDER WORKSHOPS
   - Generate follow-up discussion
   - Obtain participant data

6. MAUT SCORING
   - Scale criteria performances
   - Apply utility function to each participant workbook
   - Obtain utility data
<table>
<thead>
<tr>
<th>Water Stabilization</th>
<th>BANK ARMORING</th>
<th>SOFT BANK STABILIZATION</th>
<th>CHANNEL REALIGNMENT</th>
<th>CHANNEL SLOWING FEATURES (rock vanes, log revetments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MITIGATION OUTCOME</td>
<td>Reduced erosion and risk of bank failure.</td>
<td>Reduced erosion and risk of bank failure.</td>
<td>Reduced erosion and risk of bank failure.</td>
<td>Reduced erosion and risk of bank failure. Reduced peak flow speeds.</td>
</tr>
<tr>
<td>COST ESTIMATE ($)</td>
<td>$15,000 per 250 ft.</td>
<td>$3,750 per 250 ft.</td>
<td>$31,000 per 250 ft.</td>
<td>$2,000–8,000 depending on width.</td>
</tr>
<tr>
<td>ENVIRONMENTAL IMPACT</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>EFFECTIVENESS</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>LIFETIME</td>
<td>10+ years</td>
<td>5+ years</td>
<td>10+ years</td>
<td>5+ years</td>
</tr>
<tr>
<td>AESTHETICS</td>
<td><img src="image1" alt="Bank Armoring" /></td>
<td><img src="image2" alt="Soft Bank Stabilization" /></td>
<td><img src="image3" alt="Channel Realignment" /></td>
<td><img src="image4" alt="Channel SLOWING FEATURES" /></td>
</tr>
<tr>
<td>PRIORITY RANKING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Findings

• Stakeholders and citizens in the Upper Valley prefer flood mitigation and adaptation options that are most effective and have low impacts on the environment. When those conditions are met, they may then choose ecosystem based options.

• Crafting decision scenarios can require information that is not always available.

• Stakeholders are not generally comfortable with making complex tradeoffs.
<table>
<thead>
<tr>
<th>Watershed</th>
<th>Stakeholder Engagement Tool</th>
<th>Level of Stakeholder Engagement</th>
<th>Notes on Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Bay</td>
<td>Expert stakeholder questionnaire to drive scenario generator and run ecosystem service model</td>
<td>Moderate</td>
<td>Diligent preparation required by researchers to develop sufficient questionnaire but less and/or more convenient time commitment for stakeholders than workshop</td>
</tr>
<tr>
<td>Upper Valley-CT River</td>
<td>Interactive group presentation and individual workbook influenced by and analyzed with multi-criteria decision analysis techniques. Expert stakeholders and interested citizens both engaged</td>
<td>High</td>
<td>Implementation can be challenging and time consuming for both researchers and stakeholders. Can be difficult to get stakeholders to the table for a 1-hour evening workshop but stakeholders are given ample time to express preferences</td>
</tr>
<tr>
<td>Squam Lakes</td>
<td>Survey administered at membership annual meeting. Facilitators available to help with questions/maps</td>
<td>Moderate</td>
<td>Piggybacking off an existing event can be beneficial if a specific stakeholder group is being targeted. Survey took about 20 mins but some questions were complex and may have benefited from a presentation first</td>
</tr>
</tbody>
</table>
Synthesis

• Through these place based, stakeholder engaged coastal and watershed resource case studies we’ve explored various ways of assessing natural capital

• Different systems may benefit from a nuanced approach to considering stakeholder perspectives and values around important ecosystem services

• This approach can be resource intensive and specific findings may not be transferrable but methods certainly can be
Acknowledgments

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• Stakeholders

• Colleagues at Dartmouth College