Measuring Economic Benefits of Restoration for Spatial Targeting and Ecosystem Service Trades

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The Geography of Social Welfare from Ecosystem Services

1. How do net benefits vary spatially?
   - Which ecosystem services are affected?
   - How much is each service user affected?
   - How many people gain or lose?
   - How do practice costs & effectiveness vary?

2. Are vulnerable populations treated equitably?

3. Are public and private interests balanced?
Linking Restoration Actions to Social Benefits

Human Action Restoration Effort

Ecosystem Services Quality-adjusted stocks & flows

Social Benefits Net change in well-being

Restoration-Response Functions

Economic Benefit Functions
Spatial Economic Decision Support (SEDS) Tool

Set Global settings using the "Sliders" as desired.
Select/Enter the remaining information as desired.
When done, click the "Next" button.
Major Goals of the SEDS Tool

1. Support selection of sites and treatment options to manage invasive species
2. Evaluate economic benefits of management options in terms of ecosystem service changes

Cooperative Agreement with National Park Service National Capital Region
Quantify Benefits of a Restoration Action

Benefits = Damage Costs Avoided

- Benefits Inventory
  - Annual value of service user-days

- % Susceptible to damage
  - % invadable

- % Loss (for a given weed density)
  - loss in quality, quantity or value

= Economic loss (Net benefit of treatment)
Benefits Inventory Step 1
Which “users” are affected and how sensitive are they to environmental change?

<table>
<thead>
<tr>
<th>Casual Visitors</th>
<th>Through Travelers &amp; Neighbors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetics of visitor experience</td>
<td>Safety &amp; convenience of travel</td>
</tr>
<tr>
<td>Boating Opportunities</td>
<td>Aesthetics from roads &amp; viewpoints</td>
</tr>
<tr>
<td>Walking, Hiking, Biking Opportunities</td>
<td>Property values</td>
</tr>
<tr>
<td>Safety of Outdoor Recreation</td>
<td>Buffer incompatible uses</td>
</tr>
<tr>
<td><strong>Avid Recreationists</strong></td>
<td>Reduce maintenance costs</td>
</tr>
<tr>
<td>Birdwatching</td>
<td></td>
</tr>
<tr>
<td>Native plant/wildflower viewing</td>
<td><strong>Businesses</strong></td>
</tr>
<tr>
<td>Insect watching (e.g., butterflies)</td>
<td>Agricultural production</td>
</tr>
<tr>
<td>Amphibian / reptile watching</td>
<td><strong>Other Non-Proximal</strong></td>
</tr>
<tr>
<td>Nature photography</td>
<td>Climate Regulation</td>
</tr>
<tr>
<td>Historic / cultural experiences</td>
<td>Native ecosystem preservation</td>
</tr>
<tr>
<td><strong>Students &amp; Researchers</strong></td>
<td>Charismatic species preservation</td>
</tr>
<tr>
<td>Educational and research opportunities</td>
<td>Maintain significant natural areas</td>
</tr>
<tr>
<td></td>
<td>Maintain historic structures and character</td>
</tr>
</tbody>
</table>
Benefits Inventory Step 2
Quantify quality and substitutability of service flows

1. Quality / Attractiveness
   • Do site features enhance the user experience?

2. Landscape Enhancements
   • Does adjacency or connectivity affect potential benefits?

3. Substitutability & Rarity
   • Are local substitutes available?
   • Is site irreplaceable?
Mapping Service Quality
Wildlife Viewing

Attractiveness
- Vegetation Diversity
- Miles of Stream Adjacent to Trail

Connectivity
- Connected to Green Infrastructure Corridor

Rarity
- # Rare Plants;
- Only park occurrence

Gower Distance Metric

Wildlife Viewing Quality Metric

0.44 - 0.53
0.54 - 0.60
0.61 - 0.67
0.68 - 0.77
0.78 - 1.00
## Benefits Inventory Step 3

**Map Spatial Demand Based on Accessibility & Popularity**

<table>
<thead>
<tr>
<th>Service</th>
<th># Visitors (2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail Use</td>
<td>247,500</td>
</tr>
<tr>
<td>Wildlife Viewing</td>
<td>146,250</td>
</tr>
<tr>
<td>Historical/Cultural</td>
<td>67,500</td>
</tr>
<tr>
<td>Road Use</td>
<td>10,500,000</td>
</tr>
</tbody>
</table>

Wildlife Viewers
Benefits Inventory Step 4
Value Ecosystem Services by Location using Spatial Benefit Transfer

$ Value (no weeds) = \text{Spatial Demand (user days)} \times \left( \frac{\text{Relative Quality Metric}}{\text{Mean consumer surplus per visit}} \right)$
Inventory Results: Location-specific benefit measures that capture ecological quality, desirability and rarity

Bar chart showing the benefits for different properties.

- Property
- Existence
- Wildlife Viewing
- Historic/Cultural
- Driving
- Trail Recreation

Benefits range from $0 to $25,000,000.
Damage Functions

Trail Recreation - Aesthetics and Safety
- Trees

Existence Value
- Shrubs

Trail Recreation - Aesthetics and Safety
- Woody vines

Existence Value
- Grasses / Forbs
Net Benefits of Restoration Step 1

Trail Recreation - Aesthetics and Safety

Trees

% Service

Net Benefits

Planning horizon

% Invasive cover

Baseline
Net Benefits Step 2 – Risk Adjustments
Treatment Risk = Probability that Species Will Reappear

T. Lookingbill & E. Minor 2010
Risk-Adjusted Benefits
Treatment Risk Is a Deflator on Benefits

Trail Recreation - Aesthetics and Safety
Trees

Risk-Adjusted Net Benefits
Planning horizon

New baseline
Costs vs. Risk-Adjusted Benefits
Allow Selection of Cost-Effective Restoration

- Costs
- Risk-adjusted Benefits

Less Cost-Effective
Best Buy sites
Novel Elements of Spatial Economic Decision Support Tool

1. **Spatial benefit transfer** used to value ecosystem services in ways that are sensitive to ecological qualities

2. **Damage functions** translate loss of ecological qualities into changes in well-being

3. **Treatment costs** are estimated from extensive databases and reflect site characteristics

4. **Risk-adjusted benefits** reflect spatial variability of practice effectiveness

5. Can be applied to targeting restoration and evaluating equivalency of trades/offset in terms of ecosystem service changes