Measuring The Ecosystem Value of National Natural Heritage Investments

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Context and History

- The U. S. Army Corps of Engineers has:
  - Economic development authority
  - Ecosystem restoration authority
- It must justify project investments
  - Monetary benefit-cost analysis for development
  - Non-monetary cost-effectiveness for restoration
- It must quantify ecosystem service benefits
  - Must monetize when possible
  - Must quantify non-monetary benefits
Context and History

- Needs nonmonetary metrics for different purposes
  - Reconnaissance evaluation
  - Ranking feasibility studies for budget allocation
  - Project planning and implementation ranking
- Different project metrics have proliferated
- Metric relationship to value is often unclear
  - Confuses cooperation and coordination
  - Impedes achievement of national goals
  - Probably results in inefficiency
- USACE seeks improved restoration metrics
  - A review was done to inform improvement
  - A new was metric developed for USACE consideration
Presentation Objectives

• Quick summary of background points
• Description of the new metric
• Summarize advantages & disadvantages
Value Classification (NRC 2005):

- **Total Value**
  - **Instrumental Value**
    - Resources & Services
    - Use Value
    - Nonuse Value
    - Option Value
    - Bequest Value (Heritage)
  - **Non-Instrumental Value**
    - Not resource concept
    - Linked to obligations
    - Recognized in law

- **Total Economic Value**
USACE Implications

• Economic development is for use value
• Ecosystem restoration is for nonuse value
• This is consistent with Corps policy
  – Forbids monetary measure of nonuse value
  – Promotes protection of heritage
  – Intrinsic value is recognized in legal constraints
• Conclusions
  – The ecosystem service is heritage maintainence
  – Metric should indicate heritage value added
ER Objective Achievement Indicators

• Must be “desired outputs”
• “more biologically desirable species”
• Restored via a more natural ecosystem state
  – That is self-regulating and sustainable
  – That has high native biodiversity
• Does not exclude other possibilities
Measure of Environmental Value

- In Government
  - Public value established in statutory goals
  - Goals indicate public desire for more or better

- In NonGovernment Organizations
  - Value established in organization mission
  - Goals indicate member desire for more or better

- Overall
  - Achievement measured by many indicators
  - Often includes use and nonuse values
  - Not much use for the USACE
Nonuse Value Focus

National natural heritage is indentified:

• In goals of certain Federal laws
  – The National Environmental Policy Act
  – The Endangered Species Act

• By implication, in conservancy missions

• By the USACE in environmental quality

• Rarity, distinctiveness, and threats are identified indicators of heritage value
Metric Development Assumptions

- Needs to indicate service benefit
- Benefit is indicated by objective achievement
- Needs to conform with authorities/policy
- Needs to be consistent with science & logic
- Needs to be stakeholder acceptable
- Needs to be practical
  - Uses widely available data sources
  - Practitioners capable of using it with training
  - Addresses needs broadly
The basic metric concept is a **Biodiversity Security Index** based on species security status:

$$\text{BSI} = \sum_{S=1}^{n} wG$$

- **G** = Security status of each indicator species (G1-GX)
- **w** = Policy determined weight
- **S** = Indicator species

*Could be used in reconnaissance and project feasibility study ranking*
NATURESERVE SECURITY STATUS

GX  PRESUMED EXTINCT
GH  POSSIBLY EXTINCT (WATCH)
G1  GREATLY IMPERILED
G2  IMPERILED
G3  INSECURE
G4  GENERALLY SECURE (WATCH)
G5  SECURE
An advanced metric that includes community distinctiveness and planning cost:

$$BSI = \sum_{S = 1\ldots n} \frac{(wD)(wG)}{C}$$

$G =$ security status of each indicator species (G1-GX)

$w =$ policy determined weights

$D =$ indicator species distinctiveness

$S =$ indicator species

$C =$ Cost

*Could be used for project feasibility study ranking*
TABLE 1. Example of basic calculations to determine BSI score.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>SECURITY STATUS</th>
<th>POLICY WEIGHT</th>
<th>DISTINCTIVENESS</th>
<th>POLICY WEIGHT</th>
<th>SPECIES SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECIES 1</td>
<td>G2</td>
<td>16</td>
<td>0.500</td>
<td>1</td>
<td>8.000</td>
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<tr>
<td>SPECIES 2</td>
<td>G1</td>
<td>48</td>
<td>0.210</td>
<td>1</td>
<td>10.080</td>
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<tr>
<td>SPECIES 3</td>
<td>G5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECIES 4</td>
<td>G3</td>
<td>4</td>
<td>0.020</td>
<td>1</td>
<td>0.080</td>
</tr>
<tr>
<td>SPECIES 5</td>
<td>G2</td>
<td>16</td>
<td>0.005</td>
<td>1</td>
<td>0.080</td>
</tr>
<tr>
<td>SPECIES 6</td>
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<tr>
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<td>1</td>
<td>0.009</td>
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<tr>
<td>SPECIES 8</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECIES 9</td>
<td>GH</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BSI SCORE</td>
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<td></td>
<td></td>
<td></td>
<td>18.689</td>
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</tbody>
</table>
TABLE 2. Policy weighting effects for different policies.

<table>
<thead>
<tr>
<th>STATUS</th>
<th>ANY NATIVE SPECIES</th>
<th>PROPORTION TO NEED</th>
<th>SECURE MOST IMPERILED</th>
<th>SECURE LESS IMPERILED</th>
</tr>
</thead>
<tbody>
<tr>
<td>GX</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GH</td>
<td>12</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>G1</td>
<td>12</td>
<td>48</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>G2</td>
<td>12</td>
<td>16</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>G3</td>
<td>12</td>
<td>4</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>G4</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>G5</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>72</td>
<td>69</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>
The most advanced metric for estimating increment of ecosystem security added:

$$BSI = \sum_{S = 1 \ldots n} H(wR)(wD)(wG)(A1-A0) / C$$

$A1$ = final number of viable population units for each species

$A0$ = initial number of viable population units for each species

$S$ = species

$C$ = project cost

$w$ = policy weight

$D$ = distinctiveness multiplier

$R$ = multiplier for risk of not succeeding

$h$ = indicator for habitat threat (0 or 1)

* Could use for project feasibility study and construction ranking
BSI Advantages/Disadvantages

• **Advantages**
  – Direct indicator of heritage service support value
  – Comparable across all projects in program
  – Not easily manipulated for unauthorized outputs
  – Metric is theoretically based in conservation science
  – Indicates desired output consistent with national goal
  – Outputs are native, “biologically desirable species”
  – Addresses risk factors

• **Disadvantages**
  – Data needs and costs are higher
  – Potential conflict with Corps cultural predisposition
  – New is “strange” and often judged “impractical”