Objective
Develop a new metric, the Biodiversity Security Index (BSI), to indicate benefits from securing natural biological heritage.

Rationale
Numerous organizations have missions and policies to restore and protect desired ecosystem resources. A common interest is the security of the Nation’s natural biological heritage—its native biodiversity.

Organizational coordination for effective national effort is complicated by a wide variety of benefits metrics and prioritization procedures. The U. S. Army Corps of Engineers (USACE) sponsored BSI development in its search for fewer, more widely applicable metrics.

The USACE requires a quantitative, nonmonetary indicator of benefit to inform stakeholders and decision makers during planning. Consistent with a natural heritage focus, USACE indicators of restoration success include more biologically desirable species, high native biodiversity, and ecosystem support.

Metrics Background
A common quantitative approach to indicating benefits is to calculate habitat units (HU) from the product of an indicator species habitat suitability index (HSI) and the number of acres to be restored. Indicator species “represent” the needs of less well known species.

The approach has limitations. Habitat is an indirect indicator of value. Use of an indicator species HSI for the desired species is even less direct. This results in more uncertain benefits indication than a direct indication of the desired species’ condition. Because species interact uniquely with habitats in different settings, many indicators are needed, which complicates planning. Benefits are not easily compared for priority rank in contributions to national benefit.

The Biodiversity Security Index
The BSI is a new indicator of benefit based directly on the value of restored population units of biologically distinct and scarce species. The value is determined by a public desire to sustain all species as indicated in law and opinion. The BSI is the sum of the products of population insecurity, distinctiveness and restoration risk indicators for all species (S) in a restored area: 

\[
BSI = \sum_{S=1}^{n} (h(wR)(wD)(wG)(A_i-A_0))
\]

\[
S = \text{indicator species}
\]

\[
wG = \text{policy weighted indicator of security status}
\]

\[
wD = \text{policy weighted indicator of distinctiveness}
\]

\[
wR = \text{policy weighted indicator of restoration success}
\]

\[
h = \text{indicator for habitat threat (0 or 1)}
\]

\[
A_0 = \text{initial number of viable population units}
\]

\[
A_1 = \text{final number of viable population units}
\]

The security status (G) of species is identified in the NatureServe Explorer database, which ranks species security from extinction. The weight w is set by policy.

Rationale
In the distinctiveness term, 

\[
D = 1/X
\]

where X is the # of species in the taxonomic family. Ultimately, genetic methods should prove useful. Policy determines the relative weight compared to the other terms.

The probability of population restoration success (R) is a composite term based on the suitability of conditions for restoration success, which ranges from 0 (intolerable risk) to 1.0 (no risk). Indicators of risk include:

- Incomplete connectivity
- Unreliable population sources for colonization
- Unreliable support materials and energy
- Invasive species
- Poor alignment of disturbance and project scales

The term h reflects authority or other organization limits. When permitted, h is 1 and is 0 otherwise. The USACE is limited to habitat improvement, for example.

Discussion
For most species, restoration should target establishment of the whole population to assure viability. For species without distinct populations, reproductive pairs may be viable units.

Table 1. A hypothetical community of nine species shows how the BSI is calculated. In this example, the weight (wt) for security status reflects the relative number of populations needed to secure a species and distinctiveness and success probability are given a weight equal to security status.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>G</th>
<th>G WT</th>
<th>D</th>
<th>D WT</th>
<th>R</th>
<th>R WT</th>
<th>H</th>
<th>SCORE</th>
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<td>SPS 1</td>
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<td>0.00</td>
</tr>
</tbody>
</table>

The BSI reduces economic bias and bias favoring “charismatic megafauna”. Each population has equal weight regardless of species size, appearance, or use.

Unlike HU and other benefits metrics, the BSI 1) indicates desired species directly, avoiding uncertain habitat relationships; 2) can be compared across projects for contribution to a national objective; and 3) includes the effects of risk on program effectiveness.

BSI data needs and costs may seem greater than other metrics largely because of risk assessment, which should be conducted with any metric use, but often is not. Despite deficiencies, the HU is well known and accepted, which predisposes its use against new metrics. The BSI will require more vetting, refinement, testing, and circulation before it is ready for general use in the USACE or elsewhere.

Future research will focus on development of a risk assessment protocol, guidance for integration into existing planning methods and models, and case study applications for project and program planning.

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