Improving the Transfer of Ecological Estimates in Ecosystem Services Research & Policy

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Ecosystem services are the components of nature humans use and enjoy.
Ecosystem service assessments are often data, budget and time limited
Benefit transfer focuses on the issues and methods related to economic value transfer. There is no analogous method for the transfer of ecological estimates and models.
Question 1:
How can a benefit transfer approach be applied to ecological production estimates in ecosystem services research?
Context similarity is a key requirement of sound benefit transfers.
Question 2:
How to broadly define ecological contexts across services, ecosystems, and ecological processes?
Scales: A Structure for Ecological Contexts

Adapted from Suter, 1993
Contextual Reference Frames: Scale and Level of Organization

Grain: Community
Extent: Ecosystem
Grain: 1 m^2
Extent: 1 km^2
Grain: 1 hour
Extent: 3 months

Spatial Scale
Temporal Scale
Ecological Organization
Hypothesized Indicators of Transferability based on Contextual Similarity

Scale Consistency

Proximity

Drivers

Across space, time & ecological organization

Related to the process of interest
• 103 globally distributed BMPP rate estimates from Cahoon 1999

• Most estimates required temporal generalizations to be comparable

• 3 contextual variables for context assessment:
  • Climatic regime
  • Absolute latitude
  • Depth of observation

• What is the most reliable basis to transfer estimates?
One-way Analysis of Variance (ANOVA) models Climatic Regime, Absolute Latitude and Depth

<table>
<thead>
<tr>
<th>Variable for Model (1-way ANOVA)</th>
<th>Adj R²</th>
<th>RMSE</th>
<th>F-ratio</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic Regime</td>
<td>0.117</td>
<td>138.84</td>
<td>7.63</td>
<td>0.0008**</td>
</tr>
<tr>
<td>Absolute Latitude</td>
<td>0.153</td>
<td>136.02</td>
<td>4.00</td>
<td>0.013**</td>
</tr>
<tr>
<td>Depth</td>
<td>0.058</td>
<td>143.40</td>
<td>3.06</td>
<td>0.032*</td>
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Stronger evidence was observed across climatic regimes and absolute latitudes than depths.
Classification and Regression Tree (CART) model

Absolute Latitude ≥ 18.7°

≥56.55°
Mean=10.7

< 56.55°

< 55.53°

< 38.7°
Mean=114.1

≥ 38.7°
Mean=70.7

≥55.53°
Mean=162.3

Absolute Latitude < 18.7°

Depth ≥2.5 m

≥7.5 m
Mean=243.3

≥25 m
Mean=45.0

< 25 m
Mean=119.2

Depth < 2.5 m
Mean=553.8
Models perform better for “well-represented” temperate sites
More sophisticated method does not always perform better
Uncertainty and Error: Temporal Generalization Error

Hypothetical transformed estimate from average hourly rate to average annual rate

Original reported estimate: average annual rate
Conclusions

- Findings support the hypothesis that transfer errors are largest for reference frame inconsistencies or generalizations.
- Identification of broad contextual features permits the exploration of necessary assumptions and uncertainties.
- Comparison of approaches indicates that for some data simple methods may be just as effective as complex approaches.
- More case studies and assessment is needed to validate approach and indicator hierarchy.
Questions?
Next Steps

• Relative importance of reference frame components
• Investigation into model sensitivity
• More case studies!
## Steps for Conducting a Benefit Transfer

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<tbody>
<tr>
<td>1.</td>
<td>Describe the policy case</td>
</tr>
<tr>
<td>2.</td>
<td>Identify existing, relevant studies</td>
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<tr>
<td>3.</td>
<td>Review available studies for quality and applicability</td>
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<td></td>
<td>a. The basic commodities must be essentially the equivalent</td>
</tr>
<tr>
<td></td>
<td>b. The baseline and extent of change should be similar</td>
</tr>
<tr>
<td></td>
<td>c. The affected populations should be similar</td>
</tr>
<tr>
<td>4.</td>
<td>Transfer the benefit estimates</td>
</tr>
<tr>
<td>5.</td>
<td>Address uncertainty</td>
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Ecological Estimate Transfer Framework

**Step 1**
- **Define**
  - The policy site context and transfer needs
  - a. Select candidate estimates and identify context variables

**Step 2**
- **Screen**
  - Estimates based on conceptual validity

**Step 3**
- **Evaluate**
  - Operational validity: context similarity
    - a. Contextual locations: comparability and applicability
    - b. Qualitative context variable comparison
    - c. Quantitative context variable analysis

**Step 4**
- **Address**
  - Sources of error and uncertainty
How to fill knowledge gaps in ecosystem service models and assessments?