Why Clean Air Matters: Linking Air Pollution to Ecosystem Services

Tamara Blett and Mike Bell
NADP-CLAD, 2016 Spring Meeting
Madison, WI
We (CLAD) have a problem....

Most people don’t CARE about critical loads (un-relatable)

Need to link pollution-caused change in a biological indicator to a final ecosystem service that is valued by humans

CLAD can increase effectiveness via better AQ stories
“Ecosystem Services”....
Also known as “Nature’s Benefits”

Components of nature, directly enjoyed, consumed, or used to yield human wellbeing
Objectives:

- Support the EPA NOx/SOx secondary standards
- Communicate Air Quality impacts on Federal Lands
- Provide Forum for invited experts to reconcile various ES approaches (FEGS, NESCS, MEA)
- Develop tool for linking ecosystem stressors to people (via ecological production functions)
Workshop Details

- Initiated by CLAD
- Funded by $15K NSF Grant (via the International Nitrogen Initiative)
- Implemented by NPS (ARD); EPA; FS-Air
- 28 Ecologist, Air Quality, and Economist subject matter experts
4 categories of indicators for air pollution effects on sensitive natural resources

<table>
<thead>
<tr>
<th></th>
<th>Acidification (eastern US)</th>
<th>Eutrophication (western US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquatic</td>
<td><img src="image" alt="Aquatic Indicator" /></td>
<td><img src="image" alt="Eutrophication Indicator" /></td>
</tr>
<tr>
<td>Terrestrial</td>
<td><img src="image" alt="Terrestrial Indicator" /></td>
<td><img src="image" alt="Terrestrial Indicator" /></td>
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</table>
CL Bioindicators

- CLAD and others have Critical Loads for the following Bioindicators:
  - Aquatic biota (macroinvertebrates and fish)
  - Diatoms
  - Lichens
  - Herbaceous plants
  - Invasive grasses
  - Forests (trees)
What was known:

CL → Biological Indicators

Ecosystem Services → Final Ecosystem Goods and Services Classification System

Biological Indicators → Δ Ecosystems
Air Quality and Ecosystem Services Workshop Report
Santa Monica Mountains National Recreation Area, Thousand Oaks, CA – February 24-26, 2015

Natural Resource Report NPS/NRSS/ARD/NRR—2016/1107

“When the plants you haven’t heard of go...
the animals you like will start fading, too.”
—Elizabeth Farnsworth
AQES Workshop

AQES Workshop Report

Mike Bell (NPS): AQES Overview

Claire O’Dea (FS): Aquatic Acidification

Charles Rhodes (EPA) Aquatic Eutrophication

Irina Irvine (NPS) Terrestrial Acidification

Chris Clark (EPA) Terrestrial Eutrophication

5 Journal Articles (Ecosphere Special Issue)

Adaption of “STEPS” framework by others

TNC Forest Health Workshop

UK Metals Paper

AQES – Proposed Session at ES Conference 2016
STEPS Framework – 3 Modules

- Stressor
- Ecological Production Function
- Final Ecosystem Goods and Services CS
Stressor Module

- Can be used for any stressor that impacts environmental conditions (e.g.; Acid deposition)
- The stressor causes a change in environmental conditions that impacts ecosystem function.
- Identifies the biological indicator (first obvious species to change with altered ecosystem.)
the cascading ecosystem effects due to the change in the biological indicator

The EPF can have zero to n steps

Final component of EPF is the Ecological Endpoint which is used, appreciated, or valued by humans
FEGS Classification System

- Counts only direct interactions (uses) between a beneficiary and the ecosystem
- Identifies human beneficiaries and use, thus linking to human well-being
- Facilitates direct communication and collaboration between natural and social scientists
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- **Identifies human beneficiaries and use, thus linking to human well-being**
- **Facilitates direct communication and collaboration between natural and social scientists**

**Final vs Intermediate FEGS**

It’s necessary to identify the final change in the ecosystem that human’s use. By linking Beneficiaries to “upstream” components, you risk counting the effect of that component more than once which limits future valuation.
## Describing Final Ecosystem Goods and Services

<table>
<thead>
<tr>
<th>e.g.</th>
<th>What is the last thing in the environment directly used?</th>
<th>Who directly uses the FEGS?* Beneficiary Sub-Category</th>
<th>From what environmental origin is the FEGS derived? Environmental Sub-Class</th>
<th>How might we measure the FEGS? Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water</td>
<td>Swimmers</td>
<td>Rivers and Streams, Lakes and Ponds</td>
<td>Water quality (i.e., healthful, clean water)</td>
</tr>
<tr>
<td>2</td>
<td>Aquatic Biota</td>
<td>Hikers/Viewers</td>
<td>Rivers and Streams, Wetlands, Lakes and Ponds</td>
<td>Population of fish, aquatic insects, macroinvertebrates, mammals, etc. AND water clarity</td>
</tr>
<tr>
<td>3</td>
<td>Brook Trout</td>
<td>Anglers, Subsisters</td>
<td>Rivers and Streams, Lakes and Ponds</td>
<td>Population of Brook Trout within recreational size-class limits</td>
</tr>
<tr>
<td>4</td>
<td>Presence of the Environment</td>
<td>Resource-Dependent Business Owners, Residential Property Owners</td>
<td>Forests, Grasslands, Scrublands/Shrublands</td>
<td>Environmental stability (fire frequency and intensity may be an important component of stability)</td>
</tr>
<tr>
<td>5</td>
<td>Grass</td>
<td>Livestock Grazers (i.e., Ranchers)</td>
<td>Grasslands, Scrublands/Shrublands</td>
<td>Nutritional value, percent non-native species, presence of toxic species</td>
</tr>
<tr>
<td>6</td>
<td>Autumn Foliage</td>
<td>Hikers/Viewers, Ornamental Extractors, Artists</td>
<td>Forests</td>
<td>Enhanced color spectra, percent deciduous trees</td>
</tr>
</tbody>
</table>
## Results from the workshop

<table>
<thead>
<tr>
<th></th>
<th>Change in Biological Indicators</th>
<th>Ecological Endpoints</th>
<th>Beneficiary Groups</th>
<th>EPF</th>
<th>Chains</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aquatic Acidification</strong></td>
<td>9</td>
<td>10</td>
<td>15</td>
<td>21</td>
<td>208</td>
</tr>
<tr>
<td><strong>Aquatic Eutrophication</strong></td>
<td>7</td>
<td>11</td>
<td>18</td>
<td>13</td>
<td>123</td>
</tr>
<tr>
<td><strong>Terrestrial Acidification</strong></td>
<td>8</td>
<td>11</td>
<td>10</td>
<td>62</td>
<td>160</td>
</tr>
<tr>
<td><strong>Terrestrial Eutrophication</strong></td>
<td>21</td>
<td>54</td>
<td>16</td>
<td>72</td>
<td>582</td>
</tr>
</tbody>
</table>
How a rain of fertilizer caused a reign of fire

www.californiachaparral.org
How acidification struck out baseball, silenced rock and roll, and cancelled Christmas.
Questions?