Eco-Logical Crediting and Ecosystem Services

Presenters:

Lydia Olander, Duke University, National Ecosystem Services Partnership & Nicholas Institute for Environmental Policy Solutions

Jimmy Kagan, Institute for Natural Resources, Portland State and Oregon State University

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(Learn more about Eco-Logical at the FHWA website)
Steps to Ensure Optimal Webinar Connection

This webinar broadcasts audio over the phone line and through the web room, which can strain some internet connections. To prevent audio skipping or webinar delay we recommend participants:

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The Eco-Logical On-Call Technical Assistance Tool is available for agencies to

- Request responsive, individualized guidance on Implementing Eco-Logical
- Submit ideas for webinars or other Eco-Logical Activities
Ecosystem Services in Federal Decision Making

**Lydia Olander**, Duke University, National Ecosystem Services Partnership & Nicholas Institute for Environmental Policy Solutions

**Jimmy Kagan**, Institute for Natural Resources, Portland State and Oregon State University

Ecological Webinar September 2015
What are Ecosystem Services?

**Millennium Ecosystem Assessment**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods or products produced by ecosystems</td>
<td>Natural processes regulated by ecosystems</td>
<td>Non-material benefits obtained from ecosystems</td>
</tr>
</tbody>
</table>

**Supporting**
Functions that maintain all other services

Source of slide: Businesses for Social Responsibility
Growing Use of Ecosystem Services

- BSR: Making Sense of New Approaches to Business Risk & Opportunity Assessment
- United Nations and World Bank Partnership
- The New York Times: Putting a Price Tag on Nature’s Defenses
- Wealth Accounting and the Valuation of Ecosystem Services
- Intergovernmental Platform on Biodiversity & Ecosystem Services
- The Nature Conservancy
- Stanford University
- Duke University
How are ES useful?

Communicating benefits ecosystems provide to people

Constructive engagement of stakeholders before decisions are made

Communicating and explicitly considering trade-offs that involve ecosystem services

More systemic comparison of alternatives (such as greener vs grayer infrastructure options)

Determining monetary values for important but often undervalued benefits

What about limitations to their usefulness?
Where could DOTs use ES?

State and regional transportation plans
- NEPA – avoiding and minimizing impacts to wetland, stream and other important resources and services
- Adds ES to steps 3 and 4 in Ecological Framework

Mitigation planning
- Developing the crediting strategy in step 6 of the Ecological Framework
- Partnering on advanced mitigation – maximizing benefits
NESP engages both public and private individuals and organizations to **enhance collaboration** within the ecosystem services community and to **strengthen coordination** of policy, market implementation, and research at the national level.

- Quarterly newsletter
- NESP Community of Practice
- Federal ES Community of Practice
- FRMES Online guidebook [nespguidebook.com](https://nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf)
- Best Practice Guidance [nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf](https://nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf)

[https://nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership](https://nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership)
Goals of our current efforts

Help to fill the gap between concept and practice

Educate newcomers & managers on the ground

Shared learning across agencies

Connect ecological and social methods for ES evaluation

Common framework that spans decision contexts, geography, and capacity

Bring together agency and academic experts to bring credibility while remaining practical
Why now?

1998
- PCAST report -
  Teaming with Life: Investing in Science to Understand and Use America’s Living Capital

2005
- Millennium Ecosystem Assessment

2008
- Farm Bill
- Establishment of USDA Office of Ecosystem Services and Markets
- Wetlands Compensatory Mitigation Rule

2010
- Inter-agency dialogue on payments and markets for ecosystem services

2011
- PCAST Report -
  Sustaining Environmental Capital: Protecting Society and the Economy

2012
- Forest Service Planning Rule
- International Platform on Biodiversity and Ecosystem Services

2013
- CEQ Principles and Requirements for Federal Investments in Water Resources

2015
- CEQ new guidance?
UNDERSTAND THE MOTIVATION for Ecosystem Services Approaches
History, definitions, benefits, limitations, FAQs

EXPLORE AGENCY USE of Ecosystem Services
Agency decision contexts and examples

THE ASSESSMENT FRAMEWORK for Ecosystem Services
Methods for connecting ecological and social analyses
Assessment Framework

**SCOPING**
- Understanding socio-cultural context
- Engaging stakeholders
- Conceptual mapping
- Identifying services
  - Identifying alternatives

**ASSESSMENT/ANALYSIS**
- Causal chains
- Selecting services
- Quantifying BRIs
- Social evaluation
  - (Monetary or non-monetary)

**DECISION**
- Displaying results-alternative matrix or maps
- Weighting and aggregation

**REACTION**
- Monitoring BRIs
# Over 150 People Participated

## Project Leads
Lydia Olander, Dean Urban, Tim Profeta *(Duke University)*  
Lynn Scarlett *(The Nature Conservancy)*  
Jim Boyd *(Resources for the Future)*  
Sally Collins *(Consultant, Formerly USFS and USDA OEM)*

## Funders
**Gordon and Betty Moore Foundation**  
National Center for Ecological Analysis and Synthesis  
National Socio-Environmental Synthesis Center  
Duke University  
USDA Office of Environmental Markets  
Seed funding from several agencies

## Universities & Consultants
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Colorado State University  
Duke University  
University of Maryland  
Ohio University  
University of Wisconsin  
Vanderbilt University  
The New School  
Institute for Natural Resources  
Parametrix  
Spatial Informatics Group

## Agency Partners
U.S. Forest Service  
U.S. Bureau of Land Management  
U.S. Fish and Wildlife Service  
U.S. Geological Survey  
U.S. Department of the Interior  
U.S. Environmental Protection Agency  
National Oceanic and Atmospheric Administration  
U.S. Army Corps of Engineers

## Agency Observers
Council on Environmental Quality  
Office of Science and Technology Policy  
Office of Management and Budget  
USDA Office of Environmental Markets  
U.S. Department of State

## NGOs
Compass  
Defenders of Wildlife  
Conservation Science Partners  
NatureServe  
Resources for the Future  
The Nature Conservancy  
United Nations Environment Programme
Best Practices for Integrating Ecosystem Services into Federal Decision Making

Written by
Lydia Olander,
Rob Johnston,
Heather Tallis,
Jimmy Kagan,
Lynn Maguire,
Steve Polasky,
Dean Urban,
James Boyd,
Lisa Wainger,
Margaret Palmer

Guided by input and advice from
EPA, USGS, DOI, USACE, NOAA,
USDA, USFS, CEQ, OIRA, BLM,
How are the GB and BP being used?

Co-development of methods
- Informing Forest Service process
- Parallel development with USACE framework

Working with the agencies as advisors
- USACE, DOT, NOAA, EPA, USGS

Informing metrics/indicator development (BRIs)

Training
- ACES workshop
- TNC training

Keeping up with the Jones’s
- Finding out what other agencies are doing

Exploratory conversations -
- RESTORE council;
- USGS building ES resources;
Key ES concepts that everyone needs to understand
Key ES concepts

What distinguishes an ecosystem approach from an ecosystem *services* assessment

- Connection to people
An Ecosystem Services Approach
Action – Ecosystem - Benefit

**Action**
Policy, management, or project

**Ecosystem**
Measured by ecological indicators

**Ecosystem service supply**
Measured by benefit relevant indicators

**Societal benefit**
Measured by preference evaluation
Causal Chain

Ecological Measures

Wetland Restoration → Wetland area (acres) → Water storage (volume)

Ecosystem Service Measures

Wetland Restoration → Wetland area (acres) → Water storage (volume) → Water quantity (average late season water storage volume) → Water quantity available for irrigation (late season water flows to irrigation outtakes) → Increase in water available when needed → Increase in water available for irrigation → Water valuation → Marginal crop value attributable to irrigation water

Ecology → Ecosystem Services → Societal Benefit
What distinguishes an ecosystem assessment from an ecosystem services assessment?

- Connection to people

What are well-defined measures of ecosystem services?

- Benefit Relevant Indicators (BRIs)
Benefit-relevant indicators (BRIs) are measurable indicators that capture the connection between the ecosystem and its affect on people.

Ecological indicators are not BRIs unless there is a connection to people

BRIs are not monetary values or preference rankings of the societal benefits.
Causal Chain

Ecological Measures

Wetland Restoration → Wetland area (acres) → Water storage (volume)

Ecosystem Service Measures

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Ecology → Ecosystem Services → Societal Benefit

A → B

Marginal crop value attributable to irrigation water
Key ES concepts

What distinguishes an ecosystem assessment from an ecosystem services assessment?
- Connection to people

What are well-defined measures of ecosystem services?
- Benefit Relevant Indicators (BRIs)

What are the different ways to quantify ES and what can they do (and not do) for you?
- When are BRIs alone sufficient, versus preference evaluation/societal benefits (monetary / non-monetary valuation).
Overview of ES assessment process

Do you want to assess changes in ecosystem services in addition to or instead of ecological condition?

- No: Use an ecological assessment
- Yes: Use an ecosystem services assessment with BRIs

Do you want to compare options intuitively or formally?

- Intuitively: Use BRIs in alternatives matrices to inform decision makers
- Formally: Use BRIs with preference information for valuation

Do you want to use dollar values to assess changes in social benefits?

- No: Use non-monetary valuation methods, preferably multi-criteria analysis
- Yes: Use economic valuation methods and include non-market values
### Alternatives Matrix for Considering Ecosystem Services in Intuitive Decision Making

<table>
<thead>
<tr>
<th>Ecosystem Service Benefit Relevant Indicator</th>
<th>BRI 1</th>
<th>BRI 2</th>
<th>BRI 3</th>
<th>BRI 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation density in areas upstream of flood prone area with people or property of interest</td>
<td></td>
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<tr>
<td>Aquifer volume accessible by households</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Amount of fish landed commercially</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acres of wetland habitat supporting recreationally important bird or fish species</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Evaluating trade-offs with BRIs
Preference Evaluation

BRIs measure *what is valued*, but do not measure *values*. When is preference evaluation required?

An evaluation of preferences (monetary or non-monetary valuation) is needed if:

1. service provision varies substantially across different stakeholder populations, i.e., there are tradeoffs across groups; or

2. changes in services in response to management or policy vary in direction (or magnitude) across services, i.e., there are tradeoffs across services.

Two main approaches

1. Monetary valuation
2. Non-monetary multi-criteria analytical methods
1. Extend assessments beyond purely ecological measures that are not explicitly tied to people’s values to measures of ecosystem services that are directly relevant to people.
   ◦ ES values or preferences – OR – Benefit Relevant Indicators

2. Assess these services using well-defined measures that go beyond narrative description and are appropriate to the analyses, even when data, time, or resources are limited.
   ◦ Narrative descriptions or ambiguously-defined categories do not meet best practice

3. Include all important services, even those that are difficult to quantify.
   ◦ For consideration if not assessment
Best Practices

Capture of ES Benefit

- None
- Partial
- Sufficient
- Complete

Time and Resources

- Narrative ES
- Quantitative Ecological
- BRI
- Quantitative Preference

BEST PRACTICE

MINIMUM
Conceptual map or diagram

Ecology

- Wetland
  - acres
  - functions

- Water quality
  - nutrients
  - sediment

- Forest structure
  - Edge Habitat
  - Fragmentation
  - Connectivity

- Outdoor access
  - Distance
to area
  - size

- Air quality
  - impacts from
  - Particulates
  - fumes

Ecosystem Services

- Water storage (volume)
  - Water quantity (average late season water storage volume)
  - Water holding capacity in storms
  - Water for drinking and swimming

- Habitat for species
  - Fish sp.
  - Charismatic sp.
  - Game sp.
  - Endangered sp.

- Populations of species of interest to people
  - Fish sp.
  - Charismatic sp.
  - Game species
  - Endangered sp.

- Access to wildlife where species live
  - Fish sp.
  - Charismatic sp.
  - Game species
  - Endangered sp.

- Access to game species
  - (etc.)

Societal Benefit

- Marginal crop value attributable to irrigation water
- Reduced flood insurance rates. Reduced damage from floods
- Reduced drinking water costs
- Property value
- Opportunities for wildlife watching
- Deer or fish harvested
- Species existence

Preference evaluation

Simplified version
Doesn’t include all the steps

Water quantity available for irrigation (late season water flows to irrigation outakes)
Reduction in flooding
Number of downstream homes with reduced risk of flooding.
We recommend that:

Ecosystem services be brought into a decision processes using causal chains and conceptual mapping to inform the way options are considered.

All important services be considered (even if not fully evaluated) in an assessment.

The use of BRIs go beyond narrative description with well-defined measurement scales that are compatible with valuation and decision analysis methods, and that this be the minimum standard for ecosystem services assessment.

Using monetary or non-monetary valuation methods are the best practice and should be used where possible.
Examples of how ES can be incorporated into transportation decision making

1. Impact Assessment under NEPA
2. Programmatic Mitigation for Impacts to Wetlands and Streams
3. Environmental Performance Measures
4. Restoration Funding Allocation
5. Corridor Alternative Analysis
6. Culvert Replacement Prioritization
Impact Assessment under NEPA

US Highway 20 re-alignment EIS
Even though very few wetlands were impacted, the proposed typical mitigation from the EIS (see below) caused significant problems for the wetland regulators.

A priority mitigation area (see left) provided opportunities for long-term restoration, salmon habitat, and downstream flood protection, and was quickly approved.
Wetland Mitigation Priorities

Virginia Wetlands Mitigation and Restoration Catalog

- Virginia Natural Heritage Program developed, using the state wetlands map and available data, a prioritized catalog of wetlands suitable for mitigation, restoration, and conservation, using ecosystem services analysis. These mirror wetland “functions”, and assist in mitigation approvals.

http://www.dcr.virginia.gov/natural_heritage/wetlandscat.shtml
Maryland Department of Transportation
- Maryland State Highway Administration develops Environmental Objectives and Performance Measures to assist in developing MDOT’s Annual Attainment Report on Transportation System Performance
- Maryland’s Watershed Resources Registry provides information across agencies on many ecosystem services.

Oregon Department of Transportation
- The OTIA Bridge Project – used environmental performance measures as the basis for a programmatic agreement for over a billion dollars of bridge maintenance and repairs.
- ODOT is developing performance measures at the request of the Oregon Legislature, for environmental stewardship and project delivery.
Maryland’s Environmental Stewardship Performance Measures and the Maryland Watershed Resources Registry

**Objective:**

- Coordinate land use and transportation planning to better promote Smart Growth
- Preserve and enhance Maryland’s natural, community and historic resources
- Support initiatives that further our commitments to environmental quality

Maryland’s transportation agencies organize internal operation through environmental and energy management systems and prioritize investments to promote good stewardship of Maryland’s environment while keeping our people and our economy moving. Approaches include using recycled materials in construction, actively managing stormwater from transportation facilities, and offering incentives for truck fleet owners to replace older, more polluting vehicles.

<table>
<thead>
<tr>
<th>Monitoring Agency</th>
<th>Performance Measure</th>
<th>Page</th>
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<tbody>
<tr>
<td>MDOT</td>
<td>Transportation-related emissions by region</td>
<td>38</td>
</tr>
<tr>
<td>MDOT</td>
<td>Transportation-related greenhouse gas emissions</td>
<td>39</td>
</tr>
<tr>
<td>MDOT &amp; MTA</td>
<td>Transportation Emission Reduction Measures (TERM)</td>
<td>42</td>
</tr>
<tr>
<td>MPA</td>
<td>Acres of wetlands or wildlife habitat created, restored, or improved since 2000</td>
<td>37</td>
</tr>
<tr>
<td>MVA</td>
<td>Compliance rate and number of vehicles tested for Vehicle Emissions Inspection Program (VEIP) versus customer wait time</td>
<td>38</td>
</tr>
<tr>
<td>SHA</td>
<td>Acres of wetlands restored and miles of streams restored</td>
<td>37</td>
</tr>
<tr>
<td>SHA</td>
<td>Total fuel usage of the light fleet</td>
<td>40</td>
</tr>
<tr>
<td>SHA &amp; MTA</td>
<td>Travel Demand Management</td>
<td>40-41</td>
</tr>
</tbody>
</table>
Restoration Funding Allocation
Scenarios

- Urban growth (Steinitz et al. 2003)
- Mesquite management/ grassland restoration
- CAP water augmentation (Brookshire et al. 2010)
Results: ARIES & InVEST models

InVEST biodiversity, carbon, water yield results

ARIES carbon results, incl. uncertainty maps
Traffic flow – Napa and the other adjacent communities didn’t want any option that would reduce traffic. (so removing highway was not an option).

Normal analysis would evaluate traffic and regulated resources (here, wetlands and endangered species)
## Highway 37 Alternatives Analysis

1. Included polling adjacent communities to access their interest in transportation, and various natural resources and environmental benefits.
2. Determined that wetlands and habitats were as important as access. The survey did not ask why, but they did not want the environment benefits to go away.
3. Considered climate change vulnerability.

<table>
<thead>
<tr>
<th>REACH</th>
<th>ALTERNATIVE</th>
<th>Cost 1</th>
<th>Cost 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – Levee</td>
<td>$300</td>
<td>$1,100</td>
</tr>
<tr>
<td></td>
<td>2- Slab Bridge Causeway</td>
<td>$470</td>
<td>$1,600</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>$770</strong></td>
<td><strong>$2,700</strong></td>
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</table>
Millions of culverts need to be replaced across the country, far exceeding the resources available to DOTs and restoration groups.

Most prioritization focuses on a single issue (fish passage)

Culverts influence multiple services:
- clean water for drinking or swimming
- riparian conditions for wildlife
- aquatic conditions for at-risk mussels
- scenic quality of streams

A number of recent studies have developed tools and models to help evaluate multiple ecosystem services while developing priorities that key priorities, such as fish passage and road stability, are properly identified.
Online guidebook
nespguidebook.com

Best Practice Guidance
nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf

National Ecosystem Services Partnership (home)
nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership

To sign up for NESP email list and newsletter
e-mail to nesp@duke.edu

FHWA Ecological Step 6 Crediting Webinar:
http://orbic.pdx.edu/transfer/2014-10-16_Transportation_Crediting_Webinar.wmv

Transportation Crediting final reports (interim link while FHWA codes them to the Environmental Review Toolkit):
What about intrinsic value?

Concepts of value not linked to humans and not susceptible to measurement are not relevant to analyses of ecosystem services.

A broad range of values can be incorporated as ecosystem services, including many types of non-use values (e.g., existence, aesthetic, spiritual, educational) that include some, but perhaps not all, of the types of value that some authors describe as “intrinsic.”

Non-use values are captured by BRIs; purely “intrinsic” values are not.
## Examples of What Would and Would Not Qualify as a BRI

<table>
<thead>
<tr>
<th>Ecosystem Service</th>
<th>Not BRI</th>
<th>BRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existence or abundance of wolves</td>
<td>People donating to general conservation organizations*</td>
<td>Numbers of wolves x Number of people holding existence value for wolves</td>
</tr>
<tr>
<td>Ecological production of recreationally harvested fish</td>
<td>Fish abundance</td>
<td>Abundance of recreationally targeted fish, in areas used by recreational anglers</td>
</tr>
<tr>
<td>Flood regulation</td>
<td>Flood frequency</td>
<td>Number of vulnerable people (elderly, ESL) in areas with flood risk reduced by management action</td>
</tr>
<tr>
<td>Water quality regulation</td>
<td>Nitrogen concentration (proxy measure)</td>
<td>”swimmable days” x number of people with ready access to the swimming sites</td>
</tr>
</tbody>
</table>