National Ecosystem Services Partnership

Webinar

The Conceptual Model Series

Presented by:
Lydia Olander, Sara Mason, and Katie Warnell
Nicholas Institute for Environmental Policy Solutions, Duke University

September 28, 2018
JOIN US in our nation’s CAPITAL for an interdisciplinary forum to share experiences, methods, and tools for assessing and incorporating ecosystem services into public and private decisions.

ACES A Community on Ecosystem Services

December 3-7, 2018 | Washington, DC Area | www.conference.ifas.ufl.edu/aces
Dec 3: **Half day workshop** (registration required)
   *Methods for Incorporating Ecosystem Services into Decision Making*

Dec 3: **Pollinator Workshop**
   *Mapping pollination services in the southeast*

Dec 5: **Talk**
   *Building Ecosystem Service Conceptual Models for Federal Decision Making*

Dec 5: **Panel**
   *Getting to Why Ecosystem Services Matter*

Dec 5: **Town Hall**
   *Increasing Opportunities for Private Investment on Public Land*

Dec 5: **Session**
   *Law and Ecosystem Services*

Dec 5: **Talk**
   *Incorporating Ecosystem Services into Natural Capital Accounting*

Dec 6: **Talk**
   *Linking Restoration Impacts to Economic, Health, and Wellbeing Benefits for People in the Gulf of Mexico*
Presenters

**Lydia Olander** is the director of the Ecosystem Services Program at the Nicholas Institute for Environmental Policy Solutions at Duke University, and the head of the National Ecosystem Services Partnership (NESP)

**Sara Mason** and **Katie Warnell** are policy associates in the Ecosystem Services Program at the Nicholas Institute

**Frank Casey** is an agricultural and natural resources economist and serves as the Ecosystem Services Theme Lead for the Science and Decisions Center at the US Geological Survey. His responsibilities include incorporation of ecosystem services and their valuation (including market mechanisms) in adaptive management research and planning for resource conservation on both public and private lands.

**Pete Wiley** is an Economist with NOAA's Office for Coastal Management. Mr. Wiley has worked on a wide variety of issues including estimating market and non-market values in support of National Marine Sanctuary Regulations and research to better understand the link between the economy and environment in coastal areas. Recently, Mr. Wiley's work has concentrated on the role of ecosystem services in coastal management decision-making.

**Rebecca Moore** is an economist at the Bureau of Land Management. Rebecca’s expertise covers a range of environmental and natural resource economic topics, including ecosystem services valuation, conservation incentive programs, and spatial and dynamic decision making.
Evidence-Based Ecosystem Services Conceptual Models

Lydia Olander, Sara Mason, and Katie Warnell Nicholas Institute and NESP, Duke University

With support from Frank Casey USGS, Pete Wiley NOAA, Rebecca Moore BLM

NESP Webinar -- September 26, 2018

Duke Nicholas Institute
National Ecosystem Services Partnership
Cultural Attraction - appreciated by the public as well as local communities with a historical or cultural connection

Carbon sequestration contributes to climate stabilization for everyone

Trout production for recreational users and sustenance for local communities

Water supply for recreational users and downstream agriculture and communities

Water filtration to improve recreational experience and downstream well water

Flood prevention for recreational buildings and campsites

Health benefits of exercise for recreational users
What is an ESCM?

Intervention
Policy, management, or project

Biophysical changes
Changes in infrastructure or ecosystem structure and function
Measured by ecological indicators

Changes in human well-being
Outcomes for people; changes in benefits or harms that people receive; changes in ecosystem services
Measured by benefit-relevant indicators

Changes in social welfare
Changes in value realized or perceived by affected people
Measured by benefit assessment
Example: ESCMs for Green vs Gray shorelines
## Types of Conceptual Models

<table>
<thead>
<tr>
<th>Types of Models</th>
<th>Characteristics</th>
<th>What it takes to make them</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exploratory</strong></td>
<td>Preliminary, incomplete, unspecified</td>
<td>Quick initial sketch. Takes a few hours to a day, ideally with some input from experts, managers, and stakeholders or knowledge of the issues.</td>
</tr>
<tr>
<td><strong>General</strong></td>
<td>Complete, vetted, captures changes in generalized categories that represent a habitat or intervention type. (A parent model)</td>
<td>Few weeks to get sufficient expert input</td>
</tr>
<tr>
<td><strong>Specified</strong></td>
<td>Complete, vetted, captures specific outcomes (including species, recreational activities, etc…) that are specific to place and decision context (mostly likely to be used in decisions and to have quantifiable indicators associated)</td>
<td>Requires input from (or at a minimum knowledge of the priorities for a) wide range of stakeholders and beneficiaries as well as input from managers and experts.</td>
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</tbody>
</table>
Building evidence based ESCMs

1) Start with an exploratory or general model
2) Specify the model for your context
3) Clarify model assumptions
4) Build an evidence library
5) Assess the evidence
6) Map the strength of evidence

Add-ons:
• Developing common indicators
• Building a predictive model
1. Four questions can help start the model building process

1. How does an intervention affect biophysical and ecological conditions?

2. How do changes in these conditions lead to changes in the delivery of ecosystem services to people who are using them, affected by them or appreciating them?

3. How do the changes in delivery of services affect the benefits or costs to individuals or groups?

Intervention
Policy, management, or project

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Changes in value realized or perceived by affected people
Measured by benefit assessment

How does an intervention directly affect people?
2. Specifying the models

Table 5. Illustrative questions to elicit specified outcomes and endpoints for a conceptual model for salt marsh restoration in San Francisco Bay

<table>
<thead>
<tr>
<th>Ecosystem service/social outcome</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health impacts (water quality)</td>
<td>Health impacts could include illness from exposure to contaminated water by swimming or drinking. Are these impacts important or relevant in San Francisco? Which contaminants introduce the greatest health risks? Are SF populations more vulnerable to certain contaminant risks because of other prevalent health conditions?</td>
</tr>
<tr>
<td>Health impacts (dietary)</td>
<td>Health impacts could include nutritional changes based on changing fish/shellfish populations and availability. Which groups of people rely on fish/shellfish from SF Bay? What portion of their protein or micronutrient needs are met by local fish/shellfish? Do SF residents depending on wild local fish/shellfish have access to dietary alternatives with similar nutritional qualities?</td>
</tr>
<tr>
<td>Existence</td>
<td>Existence value represents the value that people place on the existence of elements of the ecosystem—for example, the marsh itself or specific species that use the marsh as habitat. Often endangered, threatened, or charismatic species have high existence value. Which population’s existence values do people care about capturing (local SF bay residents, U.S. residents, global residents)? Which species are most valued by the focal population? Which marsh characteristics are most valued?</td>
</tr>
</tbody>
</table>
3. Articulating assumptions

Figure 5. Example of articulating model assumptions

Algae blooms deplete DO in water. Bacterial respiration during decay of the bloom causes DO levels to drop. Amount of DO reduction will depend on the length and size of the bloom.

Marine wildlife requires DO to survive, low DO can cause physiological stress or death. Low DO can also alter ecological communities. A commonly cited critical threshold for DO is 2.0 mg O2/L, though this threshold can differ depending on the wildlife taxa.
4. Evidence Library

- Description of the relationship
- Summary of the evidence
- Confidence in the assumption given available evidence
- List of other factors that may result in variation (location, timing, external drivers, and so on)
- List of sources

<table>
<thead>
<tr>
<th>Evidence element</th>
<th>Example from solar energy development conceptual model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link ID</td>
<td>10a: Solar energy development &gt;&gt; Water use</td>
</tr>
<tr>
<td>Description of relationship</td>
<td>Photovoltaic solar plants consume 11–226 gallons of water per MWh of electricity produced. This consumption includes water used to manufacture photovoltaic panels and for dust suppression during construction.</td>
</tr>
<tr>
<td>Summary of evidence</td>
<td>One meta-analysis harmonized lifecycle water consumption estimates for photovoltaic power plants and found the water consumption values listed above. It included 23 estimates of upstream (raw materials, manufacturing, construction, and transportation) and downstream (decommissioning) water consumption for crystalline silicon panels and 9 estimates of water consumption during operation.</td>
</tr>
<tr>
<td>Strength of evidence</td>
<td>Fair: The meta-analysis of water consumption by solar energy facilities was constrained by the number of studies available, and the included water consumption estimates ranged over an order of magnitude. This analysis did not account for site-specific factors including climate that may influence water consumption.</td>
</tr>
<tr>
<td>Other factors</td>
<td>The amount of water required for manufacturing photovoltaic panels varies by specific panel technology; for example, cadmium telluride panels require less water to produce than crystalline silicon panels.</td>
</tr>
</tbody>
</table>
# 5. Evidence Assessment Matrix

<table>
<thead>
<tr>
<th>Confidence level</th>
<th>Types of evidence</th>
<th>Consistency of results</th>
<th>Methods</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Multiple</td>
<td>Direction and magnitude of effects are consistent across sources, types of evidence, and contexts</td>
<td>Well documented and accepted</td>
<td>High</td>
</tr>
<tr>
<td>Moderate</td>
<td>Several</td>
<td>Some consistency</td>
<td>Some documentation, not fully accepted</td>
<td>Some</td>
</tr>
<tr>
<td>Fair</td>
<td>A few</td>
<td>Limited consistency</td>
<td>Limited documentation, emerging methods</td>
<td>Limited</td>
</tr>
<tr>
<td>Low</td>
<td>Limited, extrapolations</td>
<td>Inconsistent</td>
<td>Poor documentation or untested</td>
<td>Limited to none</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

*Source: Adapted from Bridge Collaborative strength of evidence template.*
External factors

Salt marsh restoration → Salt marsh habitat area → Flooding

Sea level rise
6. Strength of Evidence Map

**GREEN** – high

**YELLOW** - Fair

**PURPLE** – Low or None

-----> Short-term

-----→ Long-term
## Indicators

<table>
<thead>
<tr>
<th>Ecosystem services or social benefit</th>
<th>Indicator (benefit-relevant or monetary)</th>
</tr>
</thead>
</table>
| Health impacts                      | Numbers of households exposed to water-borne disease  
                                      | Number of hospitalizations resulting from forest fire smoke each year |
| Commercial fishing                  | Increase in commercial fishing revenues ($)  
                                      | Avoided number of days of shellfish bed closures (acre/day) |
| Recreation                          | Numbers of anglers visiting  
                                      | Distance people are willing to travel to recreate ($) |
| Existence                           | Willingness to pay for the existence of certain species or habitat ($)  
                                      | Number of books, art, or literature tied to a specific species or place |
| Flooding                            | Likelihood of flooding each year (likelihood/number of properties)  
                                      | Days of disruption due the closure of critical services |
| Education/research                  | Number of people participating in educational events  
                                      | Use of related science by other people |
## Time and Expertise Required

<table>
<thead>
<tr>
<th>Task</th>
<th>Time</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory Model</td>
<td>1 hour to 1 day</td>
<td>Familiarity with ES and conceptual models</td>
</tr>
<tr>
<td>Refined Model (general or specified)</td>
<td>1 to 2 weeks for articulation of assumptions and expert review</td>
<td>Same as above</td>
</tr>
<tr>
<td>Identifying socio-economic indicators/metrics</td>
<td>Part of <strong>initial 1 hr – 1 day</strong> session</td>
<td></td>
</tr>
<tr>
<td>Assessing indicator/metric feasibility</td>
<td>0.5-6 months full time</td>
<td>Familiarity with socio-economic measures and local monitoring</td>
</tr>
<tr>
<td>Initial evidence library and evidence assessment</td>
<td>6 weeks full time for new one 3 weeks or fewer for adapting</td>
<td>Experience with literature review and gathering expert input, understanding of ecosystems, and ecosystem services</td>
</tr>
</tbody>
</table>
How ESCMs can help with implementation

• Get stakeholders and experts on the same page.
• Provide an intuitive entry point for those new to considering ecosystem services
• Capture priorities and link them to interventions in a transparent and systematic way.
• Make sure there are no critical outcomes/impacts that are missing from consideration.
• Provide an evidence-based qualitative assessment of ecosystem services implications of interventions.
• Provide a common foundation of best available science to reduce time and expertise needed for use and to reduce duplication of effort.
• Identify critical information gaps that generate significant uncertainty for decision makers, and pinpoint crucial research/monitoring needs.
• Identify a subset of socio-economic metrics that best capture important ecosystem service outcomes.
• Provide consistency in services assessed, evidence considered, and metrics selected.
• Provide a consistent and credible foundation for qualitative assessments, quantitative assessments, or monetary or non-monetary valuation where such methods are desired.
Using ESCMs to support implementation: Reference Model and Library

Example: USFS forest management actions

<table>
<thead>
<tr>
<th>Goal</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire risk reduction (frequency, severity)</td>
<td>Thinning, prescribed burns, chemical treatment</td>
</tr>
<tr>
<td>Wildlife support</td>
<td>Habitat restoration, road removal, fire management</td>
</tr>
<tr>
<td>Timber production</td>
<td>Harvest, thinning, replanting</td>
</tr>
<tr>
<td>Drinking water provision</td>
<td>Fire suppression, riparian zone management, thinning to reduce evapotranspiration</td>
</tr>
<tr>
<td>Healthy forest system</td>
<td>Invasive species and pest management</td>
</tr>
<tr>
<td>Increase recreational opportunities</td>
<td>Improving access (paths, docks), viewsheds, or siting opportunities</td>
</tr>
</tbody>
</table>

Ecosystem Services Conceptual Model Application
Bureau of Land Management Solar Energy Development
Katie Warneff, Lydia Olander, and Soni Macon

Large Scale Solar Installation for BLM
BLM Solar Energy Program

Purpose:
• Facilitate utility-scale solar energy development on suitable BLM lands
• Minimize the ecological and social impacts of solar energy development

Solar Energy Zones:
• Areas of high solar energy potential where ecological and social impacts will be relatively low
• Project authorization is streamlined, but a site-specific environmental assessment is required
ESCM: Large-scale solar on BLM-managed land
NOAA and NERRS Salt Marsh Habitat Restoration
General Model

[Diagram showing ecological impacts and outcomes for Site A and Site B]

Map source: https://coast.noaa.gov/hemis/
General Model Adaptability
## New Applications of ESCMs

<table>
<thead>
<tr>
<th></th>
<th>Method</th>
<th>ES Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Mexico (RESTORE, NRDA)</td>
<td>Indicators</td>
<td>Oyster reef restoration</td>
</tr>
<tr>
<td>NOAA National Estuary Research Reserves</td>
<td>Indicators</td>
<td>Oyster reef restoration, Salt marsh restoration, Mangrove restoration</td>
</tr>
<tr>
<td>Department of Defense</td>
<td>Predictive Model</td>
<td>ES provided by military bases; ES provision of lands surrounding bases</td>
</tr>
<tr>
<td>US Forest Service</td>
<td>Predictive Model</td>
<td>How forest management activities affect ES provision</td>
</tr>
</tbody>
</table>
Discussion: How agencies think ESCMs could be helpful for implementation.

Pete Wiley (NOAA), Rebecca Moore (BLM), Frank Casey (USGS)
Questions?

**ESCM series** [https://nicholasinstitute.duke.edu/conceptual-model-series](https://nicholasinstitute.duke.edu/conceptual-model-series)

**Contact:** Lydia.oolander@duke.edu

[https://nespguidebook.com/](https://nespguidebook.com/)

*If you are interested in joining the NESP e-mail list, please e-mail* [nesp@duke.edu](mailto:nesp@duke.edu).*
National Ecosystem Services Partnership (NESP)

(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.

- NESP Community of Practice (email list)
- Quarterly newsletter
- Webinars
- FRMES Online guidebook
- Best Practice Guidance & Workshops
- Engaged Expert Network

https://nicholasinstitute.duke.edu/focal-areas/national-ecosystem-services-partnership
Water filtration to improve recreational experience and downstream well water

Cultural Attraction - appreciated by the public as well as local communities with a historical or cultural connection

Water supply for recreational users and downstream agriculture and communities

Carbon sequestration contributes to climate stabilization for everyone

Health benefits of exercise for recreational users

Flood prevention for recreational buildings and campsites

Trout production for recreational users and sustenance for local communities
Box 2. Principles for Collaboration

**Use evidence to inform decisions.**
By learning from evidence of what has and has not worked in the past, decision makers can make faster progress, cut costs, and avoid failures and backtracking.

**Act now and learn by doing.**
Acknowledge that progress can be made now even in the absence of complete understanding, evidence, or political or social alignment. Encourage flexibility and intentional learning along the way to improve actions and impact.

**Seek and respect other perspectives.**
Believe and act as if goals for one type of objective (e.g., economic) may be met more effectively, efficiently, or sustainably by embracing ideas, interventions, approaches, or concepts from other areas (e.g., conservation).

**Be intentional about inclusion.**
Use established tools for including and empowering under-represented groups.

**Strive to do no harm.**
Seek out and circumvent potential harmful outcomes, strive for positive outcomes that do not come at the expense of negative outcomes for other sectors (economic, health, environment), other groups, or future generations. When trade-offs occur, make efforts to minimize and mitigate negative outcomes.

**Share information.**
Share data, frameworks, and concepts quickly, openly, and transparently.

*Source: Adapted from the Bridge Collaborative (Tallis et al. 2017).*