2021 Webinars:
Ecosystem Management and Restoration Research Program
Review of Research into Ecosystem Goods and Services in USACE Decision-making

Webinar Logistics:

- The webinar will begin at 1:00pm CDT.
- To access the audio select “Call Me” – this is the preferred option to reduce feedback.
- If you are unable to connect via the “Call Me” feature,
  - Dial: 1-844-800-2712
  - Access: 199 565 7227#
Webinar Instructions

- All lines are muted.

- Submit questions or comments in the Chat Box to “Everyone”.

- The webinar is being recorded and will be shared following the meeting.
Presenters

Dr. Charles Theiling is an Aquatic Research Ecologist interested in interdisciplinary applied science to integrate Corps missions for greater EGS output and cost saving.

Dr. Lisa Wainger is a research professor of environmental economics at the University of Maryland Center for Environmental Science. She has over 20 years of experience in evaluating the cost-effectiveness and social efficiency of environmental restoration and management options.

Ms. Elizabeth Murray is a research biologist with 30-years’ experience in wetland ecology, assessment, and restoration. She is interested in the role of ecosystems in providing social benefits, including protecting communities from the effects of climate change.
REVIEW OF RESEARCH INTO ECOSYSTEM GOODS AND SERVICES IN USACE DECISION-MAKING

EMRRP Webinar
Ms. Elizabeth Murray, Dr. Lisa Wainger, and Dr. Chuck Theiling
August 17, 2021
BACKGROUND

• Assessing and quantifying benefits generated from USACE water resources projects is a critical component of the USACE planning process.
• Most projects do not assess all levels of potential benefits (or harms), such as environmental, economic and social.
• A reoccurring question has been - what is the spectrum of benefits of USACE water resource projects, and can we quantify them?
• Ecosystem Goods and Services assessment provides methods to quantify benefits derived from ecosystems
Overview of Ecosystem Goods and Services Research

- Review of EGS Literature
- Review of EGS-related Policies & Authorities
- Retrospective Review of EGS Use at USACE

EGS Assessment Framework

- Framework Tests and Applications
- Other EGS Applications
- Exploration of non-monetized metrics for EGS outputs
Review of EGS Literature

- History and review of concepts and definitions
- Proposed working definition for the Corps to include managed ecosystems
- Proposed conceptual model or “causal chain” for how ecosystems provide services

1. Management Activity
   - A. Response Function

2. Ecological Outcomes
   - B. Ecoservice Production Function

3. Ecosystem Goods & Services
   - C. Benefit / Damage Function

4. Social Benefits
Proposed Working Ecosystem Goods & Services (EGS) Definition

*Ecosystem Goods and Services:* “Ecosystem goods and services are socially valued aspects or outputs of ecosystems that depend on self-regulating or managed ecosystem structures and processes.” (Murray et al. 2013)

- Includes EGS that are directly used or appreciated by people (i.e., use value), such as recreational fishing, and the existence values (i.e., non-use value), such as the preservation of scarce ecosystems.
- Supporting or intermediate EGS (as defined in the Millennium Ecosystem Assessment 2005) are referred to as ecological outcomes.
- Final EGS are benefits valued by people.
Review of EGS-related Corps Policies & Authorities

- No laws preventing use, but some policy changes may be needed to consider full array of benefits
- At the time, NOAA’s Damage Assessment, was only evidence of EGS being used in project-level decision making by other agencies or governments
- Some EGS are more aligned to other agencies’ missions, and identifying them highlights partnering opportunities
Retrospective Review of EGS Use at USACE

- Review of Five Projects:
  - Puget Sound Nearshore Ecosystem Restoration
  - Jamaica Bay Restoration Feasibility Study
  - Upper Mississippi River System
  - Louisiana Coastal Protection and Restoration Study
  - Central Everglades Planning Project
- EGS were often not well defined
- Indices lumped benefits that policy differentiates
- Intermediate biophysical metrics did not communicate benefits (demand was not illustrated)
- Including both intermediate and final indicators could lead to double-counting
- Communication with stakeholders about authorities and limitations of using EGS still critical
Evolving Policy

- Four accounts
- Comprehensive Documentation Of Benefits (5 Jan 21)
- Tied to project outcomes
- Required effort scaled to project purpose
Overview of Ecosystem Goods and Services Research

Review of EGS Literature

Review of EGS-related Policies & Authorities

Retrospective Review of EGS Use at USACE

EGS Assessment Framework

Framework Tests and Applications

Other EGS Applications

Exploration of non-monetized metrics for EGS outputs
Entering into Framework Development we recognized:

- No other agency had a process we could just adopt
- Tools existed but were limited in scope and alignment with Corps policies and missions
- Clear EGS categories with emphasis on final services or proxies are needed for success
- Corps’ policies created some challenges for using EGS because of narrow project authorities and decision criteria
- THEREFORE, tried to develop something flexible that was tied to existing 6-step process but could be used in multiple ways depending on future Corps policy context
EGS Framework

- Refines EGS Categories
- Provides tables and decision trees to help teams organize, evaluate, and document all EGS effects, and screen for further analysis
- Allows for right-sizing assessments
- Uses Causal-Chain conceptual models to link biophysical changes to benefits
- Demonstrates Benefit Relevant Indicators of EGS for non-monetary assessment
- Offers examples of monetary valuation, but is not a calculator for generating monetary values
- Applicable to any Mission Area
Refined EGS Categories

- Uses consistent nomenclature and separates services that the Corps would likely need to differentiate in planning
- These categories get populated with more specific EGS that are appropriate to the project
- These are services potentially being supplied by an ecosystem, or a project that restores an ecosystem. They may not include all services being supplied by a USACE project under Comprehensive Benefits
### ‘Right Sizing’ the Analysis:

1. qualitative assessment only
2. quantitative assessment of only Selected Plan
3. quantitative assessment of all alternatives
Framework Analytic Core
Conceptual model for benefits estimation

1. Management Activity
   A. Response Function
      Quantify biophysical changes resulting from action

2. Ecological Outcome
   Biophysical Indicators

3. Ecosystem Goods & Services
   Benefit Relevant Indicators

4. Social Benefits (monetized)
   Monetary Values per Service

B. Ecoservice Production Function
   Assess human use, preferences, and concerns (e.g., scarcity)

C. Benefit / Damage Function
   Monetize benefits, if appropriate
Elements of Benefit Relevant Indicators (BRIs)

1. **Quality** is sufficient for users
   - Charismatic birds are present

2. **Complements** - Capital and labor available
   - Piers and boardwalks provide access

3. **Demand** - Users or beneficiaries present / possible
   - Potential birders living in driving distance

4. **Reliability** of the future stream of services
   - Surrounding landscape is protected from development

5. **Scarcity** and substitutability
   - Few alternative birding sites or other sites are congested
Screening of all EGS effects – 1. Causal Chain Models
Screening of all EGS effects – 2. Impact Evaluation

1. Is this project likely to substantially affect the quality or quantity of the biophysical inputs to the ecosystem good or service?
   - **No/Negligible Impact**
   - **Yes**

2. Is this positive or negative change likely to create substantial user/beneficiary impacts?
   - **No**
   - **Low Impact**

3. What is the availability of substitutes?
   - **None/Low**
   - **Medium/High**
   - **Medium Impact**

- **Biophysical**
  - Magnitude
  - Duration

- **Beneficiary**
  - Magnitude
  - Duration

- **Substitutes / Scarcity**
Goals of Scoping Process

- High impact service changes
- High magnitude ecological changes
- All services raised by stakeholders

<table>
<thead>
<tr>
<th>EGS Categories</th>
<th>Biophysical Impacts&lt;sup&gt;1&lt;/sup&gt; (see Impact key)</th>
<th>Beneficiary Impacts&lt;sup&gt;2&lt;/sup&gt; (see Impact key)</th>
<th>Substitutes Available?&lt;sup&gt;3&lt;/sup&gt; (yes, no)</th>
<th>Cumulative Impact Rank&lt;sup&gt;4&lt;/sup&gt; (low, med, high)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnitude Duration Is the impact substantial?</td>
<td>Magnitude Duration Is the impact substantial?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ecosystem Sustainability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terrestrial Ecosystem Diversity</td>
<td>+++ *** Yes</td>
<td>+++ *** Yes</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td>Desert Perennial River Conservation</td>
<td>+ *** Yes</td>
<td>+ *** Yes</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td>Population Viability of Warm Water Endemic Fishes</td>
<td>+ *** Maybe -&gt; Yes</td>
<td>+ *** Maybe -&gt; Yes</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td>Population Viability of the Southwestern Willow Flycatcher</td>
<td>+ *** Maybe -&gt; Yes</td>
<td>++ *** Yes</td>
<td>No</td>
<td>High</td>
</tr>
<tr>
<td><strong>Natural Hazard Mitigation, Property &amp; Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property Protection from Flooding</td>
<td>- ** Maybe -&gt; Yes</td>
<td>- ** No</td>
<td>No</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td>+ *** Maybe -&gt; Yes</td>
<td>++ *** Yes</td>
<td>Yes</td>
<td>Yes Medium</td>
</tr>
<tr>
<td>Trail-based activities</td>
<td>++ *** Yes</td>
<td>+++ *** Yes</td>
<td>Yes</td>
<td>Yes Medium</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>++ *** Yes</td>
<td>+ *** Maybe -&gt; No</td>
<td>No</td>
<td>Low</td>
</tr>
</tbody>
</table>
**Decision Table**

- Review high-impact service changes for USACE Authorities and other considerations
- Can inform whether to carry EGS forward or how detailed the analysis should be (right sizing methods)

<table>
<thead>
<tr>
<th>Ecosystem Sustainability</th>
<th>Aggregate Impact Rating</th>
<th>Confidence Rating</th>
<th>Within the project authorities?</th>
<th>Other considerations?</th>
<th>Include in further analyst?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-use services from restoring a portion of a threatened riparian forest to meet quality threshold</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Non-use services from restoring a portion of a threatened desert perennial river ecosystem to meet quality threshold</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Non-use services from improving viability of the declining species Roundtail Chub</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Non-use services from improving viability of the endangered Southwestern Willow Flycatcher</td>
<td>High</td>
<td>Medium</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Natural Hazard Mitigation, Property &amp; Infrastructure</th>
<th>Property protection from flooding</th>
<th>High</th>
<th>Medium</th>
<th>No</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreation</td>
<td>General Recreation</td>
<td>Medium</td>
<td>Medium</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Birdwatching</td>
<td>High</td>
<td>High</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Visual enjoyment by riparian neighbors</td>
<td>Low</td>
<td>Medium</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

US Army Corps of Engineers • Engineer Research and Development Center
If EGS used to Compare Plans...

- Multi Criteria Decision Analysis (MCDA) used to weight and combine services
- CE/ICA can be used to select plan

**MCDA Results**
EGS tradeoffs between project alternatives for Ayola, AZ case study

<table>
<thead>
<tr>
<th>Key</th>
<th>Large positive impact</th>
<th>Moderate positive impact</th>
<th>Small positive impact</th>
<th>No change</th>
<th>Small negative impact</th>
<th>Moderate negative impact</th>
<th>Large negative impact</th>
</tr>
</thead>
</table>

**Ecosystem Goods and Services**

<table>
<thead>
<tr>
<th>Riparian ecosystem* sustainability</th>
<th>Aquatic ecosystem sustainability*</th>
<th>Roundtail Chub Viability*</th>
<th>Southwestern Willow Flycatcher viability*</th>
<th>Flood damage mitigation</th>
<th>General recreation</th>
<th>Recreational birding</th>
<th>Aggregate Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>22</td>
<td>47</td>
</tr>
</tbody>
</table>

\* included in planning objectives
Overview of Ecosystem Goods and Services Research

Review of EGS Literature
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EGS

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Meramec River Case Study

- Dual-purpose project addressing aquatic ecosystem restoration (USACE) and public health (USEPA)
- Lead contamination remediation plan for Big River (tributary to the Meramec River) focused only on reducing bedload migration of lead tailings down-river and mitigating fine sediment in floodplain soils.
- Rivers also support endangered mussels, and stream restoration could improve population viability.
- Goal compatibility issues were illustrated in EGS assessment
## Goal Compatibility - Meramec Case Study

<table>
<thead>
<tr>
<th></th>
<th>Human Health</th>
<th>Ecosystem Sustainability</th>
<th>Recreation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protect from contaminants in fish</td>
<td>Protect from contaminants in sediment/soil</td>
<td>Preserve/ enhance human powered boating</td>
</tr>
<tr>
<td>Fish consumption advisories</td>
<td>● ● ○ —</td>
<td>● —</td>
<td>○ —</td>
</tr>
<tr>
<td>Access restrictions</td>
<td>— ○ ● —</td>
<td>— ● —</td>
<td>○ ○ ○ —</td>
</tr>
<tr>
<td>Monitored natural recovery</td>
<td>● ● ○ ○ —</td>
<td>○ ○ —</td>
<td>● ● ● —</td>
</tr>
<tr>
<td>Dam reinforcements</td>
<td>● — ● —</td>
<td>○ ○ —</td>
<td>● — ○ —</td>
</tr>
<tr>
<td>Bank stabilization with rocks</td>
<td>● ○ ● ○ —</td>
<td>○ ○ ○ —</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>Sediment dredging</td>
<td>● — ● —</td>
<td>● ● —</td>
<td>● ● ● —</td>
</tr>
<tr>
<td>Soil excavation</td>
<td>— — ● —</td>
<td>— ● ● —</td>
<td>● ● ● —</td>
</tr>
</tbody>
</table>

- **Fully Compatible**: ● ● ● —
- **Lower Influence**: ○ — ○ ○
- **Higher Influence**: ○ ● ● ○
- **Not Compatible**: ○ ○ ○ ○
- **No or Negligible Effect**: — — — —
Meramec River Case Study

- Does scientific knowledge constrain the use of EGS in project planning?
  - Biophysical elements well captured with available data and information
  - Benefits unevenly captured
    - Would need different analyses to improve outcome metrics (e.g., changes in fishing catch, population effects, rarity)

- Does EGS planning require more effort than current planning?
  - Minimal additional effort needed during the scoping/screening step
  - Amount of extra effort in later steps depends on desired accuracy

- Does applying the framework diminish project primary purposes to provide species habitat?
  - Effects are fully controllable through analysis design

- Would decisions change as a result of the EGS framework implementation?
  - Difficult to say.
  - Potential to clarify rationale for choices early in the process to lower risk of stakeholder dissatisfaction that causes delays late in the process
High benefit cost ratios for USACE + partner management investments

Hydrilla EGS analysis
Research investments (1999–2009)
- Benefit-cost ratio of about 3.8:1
- Costs of $7 million ($2017)
- Benefits of $19.5 million ($2017)
- Benefits to anglers, lake users over the 11-year analysis period
- Data limitations prevented adding other expected EGS (flood control, endangered species protections)

Water Hyacinth EGS analysis
Biological and herbicide research programs (1975–2013)
- Benefit-cost ratio of about 34:1
- Costs of $124 million ($2013)
- Benefits of $4.2 billion ($2013)
- Benefits to anglers, waterfowl hunters, boating-dependent businesses, and water treatment facilities over the 38-year analysis period.

Aquatic invasive plant backup behind Lock #4 on the Red River July 2015.
Photo courtesy of Allie Cozad
Hurricane Sandy Test Case: Simplified EGS Analysis

Can a rapid assessment work to show benefits of storm damage mitigation efforts?

- Used existing data
- Developed evidence-based indicators instead of complex models
- Used economic benefit transfer as a simple aggregation of many benefits
- Species and ecosystem benefits measured as reductions in scarcity
Low cost EGS Analysis
Used GIS, satellite imagery, existing databases

Beach movement analysis with Google Earth Imagery

Change in fetch due to projects to vulnerable infrastructure

Cape May

Jamaica Bay
### Example Results for Cape May
**Rare Habitat quantified + Monetized values from benefit transfer**

<table>
<thead>
<tr>
<th>Ecosystem Service</th>
<th>Biophysical Change due to Project</th>
<th>Per-Unit Value</th>
<th>Market Size</th>
<th>Benefit Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Protection</td>
<td>Was not measurable from available data.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Infrastructure</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property Value Enhancement</td>
<td>Beach width added as of 2011 = 5.3 m (17.4’’)</td>
<td>0.3% of home value change</td>
<td>Value of property within ½ mile of beach = $675,446,000</td>
<td>$176,291,000 property value enhancement due to project</td>
</tr>
<tr>
<td>Recreational beach use</td>
<td>Beach width added as of 2011 = 5.3 m (17.4’’)</td>
<td>Change in consumer surplus = $1.98 / user day</td>
<td>300,000 user days annually</td>
<td>$594,100 annual benefit due to project in 2011</td>
</tr>
<tr>
<td>Recreational bird watching</td>
<td></td>
<td>Change in consumer surplus due to increased marsh area = $5.25</td>
<td>45,000 annual user days (GIS analysis) or 100,000 annual visits (USACE estimate)</td>
<td>$236,000 - $525,000 annual consumer surplus increase</td>
</tr>
<tr>
<td>Ecosystem diversity</td>
<td>0.54 ha (1.33 acres) of the rare ecosystem Atlantic Coastal Plain Southern Dune and Maritime Grassland were buffered / enhanced by project</td>
<td></td>
<td></td>
<td>0.54 ha (1.33 acres) of rare ecosystem buffered represents 0.31% of ecosystem present in ecoregion</td>
</tr>
<tr>
<td>Terrestrial species diversity</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation priority for ecosystems and species</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessing relative wetland flood risk reduction benefits using COPE: An exploration of Capacity, Opportunity, Payoff & Equity

- BRI for flood risk reduction due to wetland restoration in fluvial systems
- Synthesizes evidence for factors described in literature into single index comprising 4 parts
- Capacity and Opportunity reflect biophysical aspects of the restored wetland and watershed that affect flood risk mitigation
- Payoff and Equity address beneficiaries of flood risk reduction.
Conclusions

- The EGS Framework improves benefit communication to facilitate coordination with partners, stakeholders, and regulators
  - Ecological outcome measures and benefits incorporate whether changes are substantial, given existing levels of system stress
  - Benefit metrics bring in economic principles of value, such as scarcity and substitutability, even when outcomes are not being measured in monetary units
  - Uses analysis of benefits to assess and manage tradeoffs during formulation

- Case studies suggest that economic valuation results can be compelling (e.g., high benefit:cost ratios)

- EGS Framework provides a method to improve representation of nonuse / passive use values but is limited by lack of a nationally consistent set of restoration priorities and site qualities that affect success
EGS R&D Products


EGS Assessments & Applications of Framework


Thank you!

Elizabeth Murray (Elizabeth.O.Murray@usace.army.mil)
Dr. Lisa Wainger (Wainger@umces.edu)
Dr. Chuck Theiling (Charles.H.Theiling@usace.army.mil)
Questions & Answers

Please post any questions to the “CHAT”.

Join Us Thursday!

August 19th – 1:00 PM CDT

Topic: Brief Overview and Guide to Developing Monitoring and Adaptive Management Plans

Speakers: Dr. Brook Herman, Ms. Darixa Hernandez-Abrams, Mr. Michael Porter, Mr. Brian Zettle, and Mr. Andrew Loschiavo

Missed past webinars?

June 15th

Topic: Model to Assess Species and Habitat Migration Due to Climate Change

Speakers: Dr. Jacob Jung & Ms. Christina Saltus

June 29th

Topic: Monitoring Ecological Restoration with Imagery Tools

Speaker: Dr. Kristofer Lasko