2021 Webinars:

Ecosystem Management and Restoration Research Program

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

DISCOVER | DEVELOP | DELIVER

Review of Research into Ecosystem Goods and Services in USACE Decision-making

Webinar Logistics:

- The webinar will begin at 1:00pm CDT.
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Webinar Instructions

- All lines are muted.
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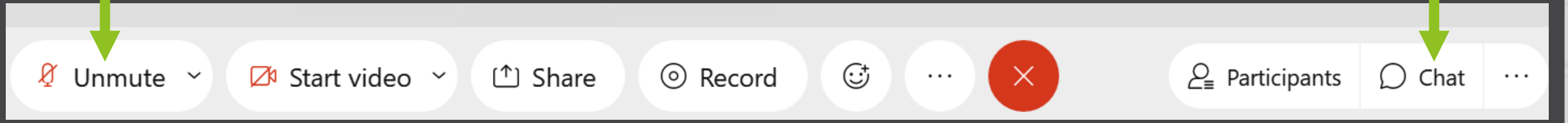


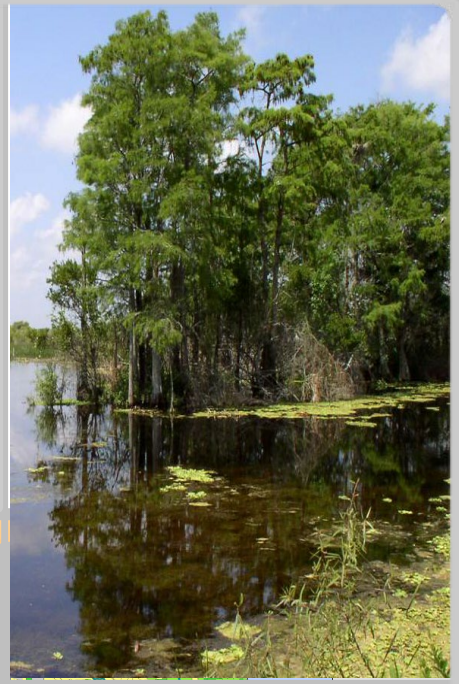
Presenters

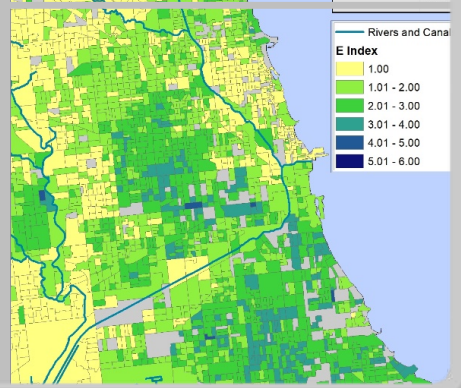
Dr. Charles Theiling is an Aquatic Research Ecologist interested in interdisciplinary applied science to integrate Corps missions for greater EGS output and cost saving.

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

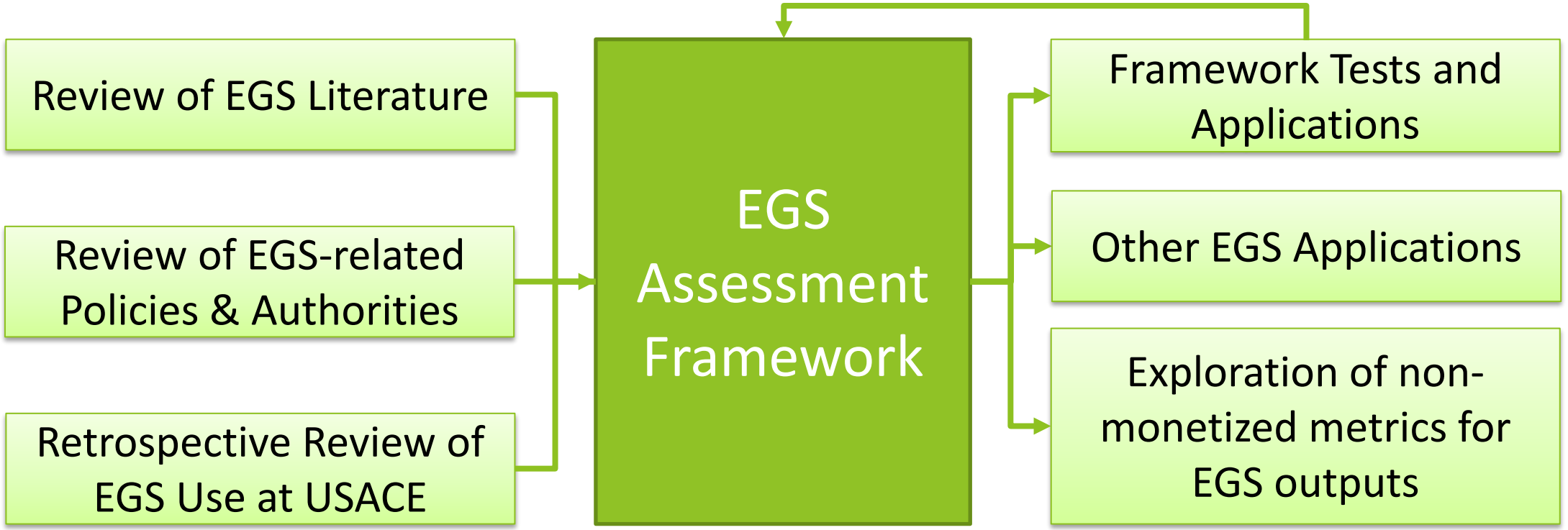
US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

BACKGROUND

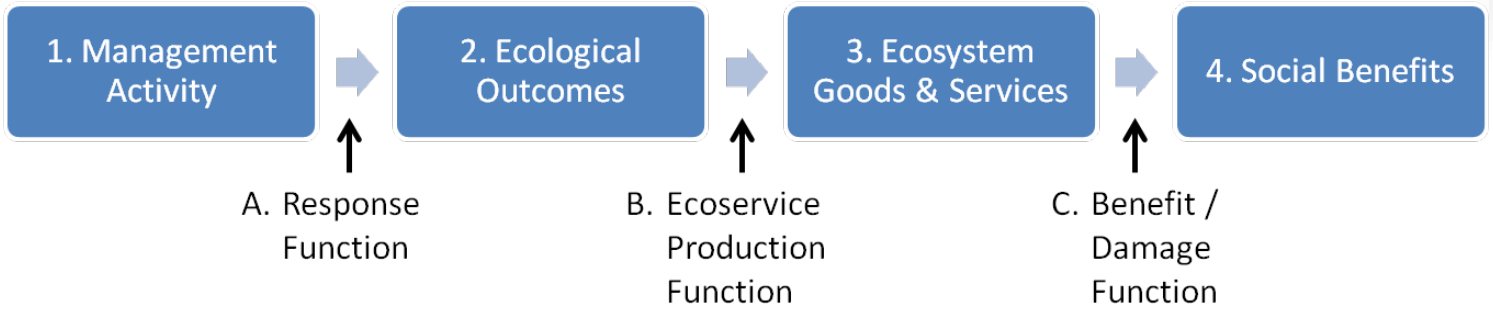
- Assessing and quantifying benefits generated from USACE water resources projects is a critical component of the USACE planning process.
- Most projects do not assess all levels of potential benefits (or harms), such as environmental, economic and social.
- A reoccurring question has been - what is 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

- 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



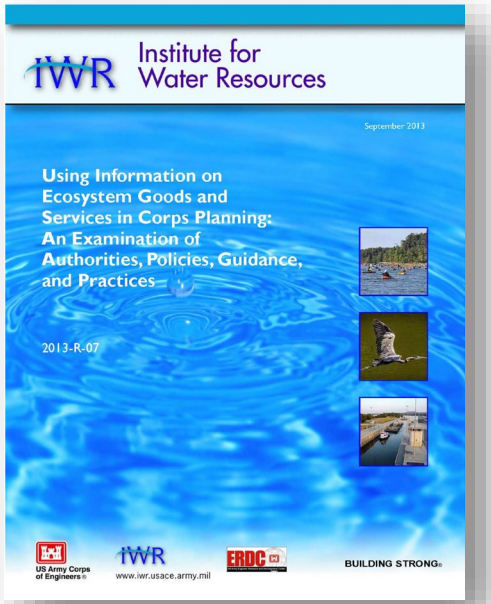
Proposed Working Ecosystem Goods & Services (EGS) Definition

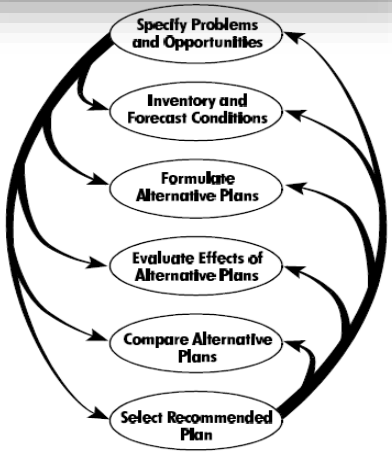
Ecosystem Goods and Services: "Ecosystem goods and services are socially valued aspects or outputs of ecosystems that depend on self-regulating or managed ecosystem structures and processes." (Murray et al. 2013)

- 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





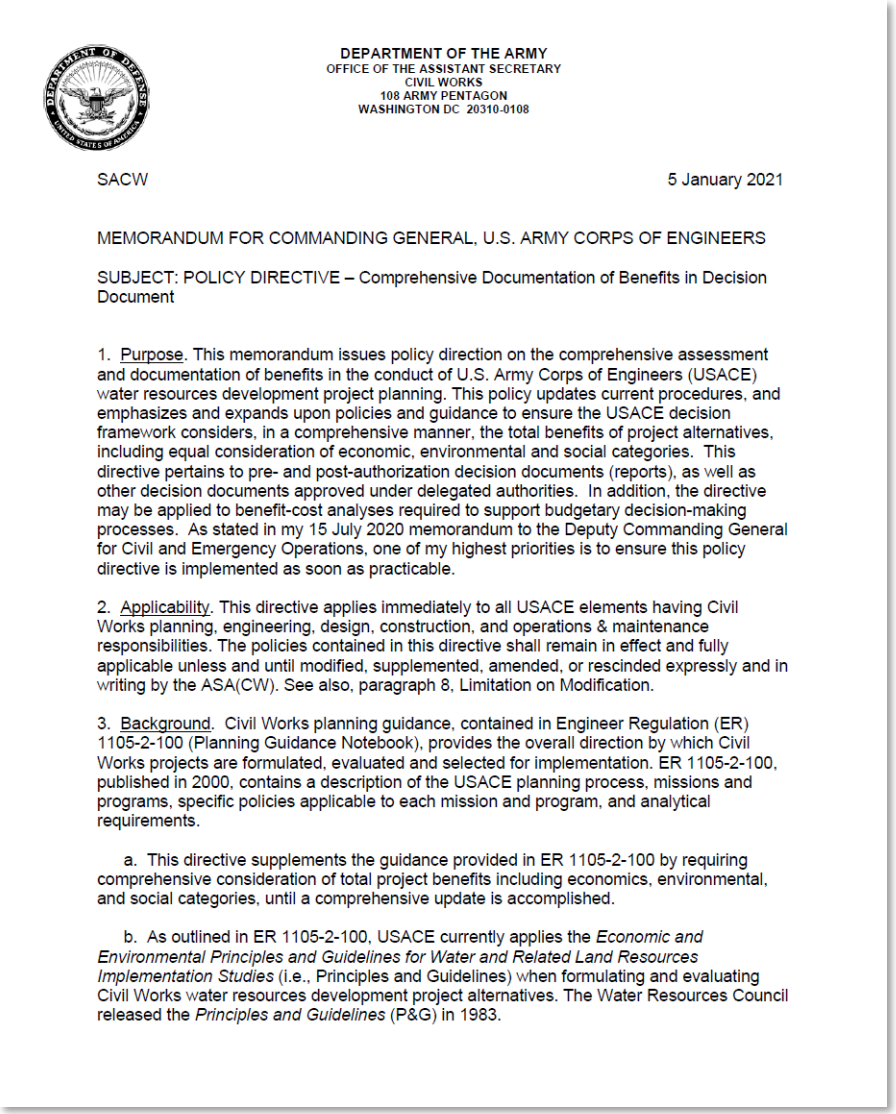
Corps Project Types	Ecosystem Goods and Services											
	Ecosystem Sustainability	Natural Hazard Mitigation	Recreation	Aesthetics	Water Supply and Regulation	Water Purification & Waste Treatment	Water Protection	Property, Infrastr., & Raw Materials	Food Provisioning	Cultural / Spiritual	Climate Regulation / Carbon Sequestration	Human Health
Navigation - Inland	FA	FA	PF	FA	PF	N/A	FA	FA	FA	N/A	N/A	
Navigation - Coastal	FA	FA	FA	FA	FA	N/A	FA	FA	FA	N/A	N/A	
Flood Risk Reduction	FA	PF	FA	FA	FA	FA	PF	FA	FA	N/A	N/A	
Coastal Storm Damage Reduction	FA	PF	FA	FA	FA	FA	PF	FA	FA	N/A	N/A	
Aquatic Ecosystem Restoration	PF	FA	PF	FA	FA	FA	FA	FA	FA	PF	FA	
Water Supply	FA	N/A	PF	FA	PF	FA	FA	N/A	FA	N/A	N/A	

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



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

SACW 5 January 2021

MEMORANDUM FOR COMMANDING GENERAL, U.S. ARMY CORPS OF ENGINEERS

SUBJECT: POLICY DIRECTIVE – Comprehensive Documentation of Benefits in Decision Document

1. Purpose. This memorandum issues policy direction on the comprehensive assessment and documentation of benefits in the conduct of U.S. Army Corps of Engineers (USACE) water resources development project planning. This policy updates current procedures, and emphasizes and expands upon policies and guidance to ensure the USACE decision framework considers, in a comprehensive manner, the total benefits of project alternatives, including equal consideration of economic, environmental and social categories. This directive pertains to pre- and post-authorization decision documents (reports), as well as other decision documents approved under delegated authorities. In addition, the directive may be applied to benefit-cost analyses required to support budgetary decision-making processes. As stated in my 15 July 2020 memorandum to the Deputy Commanding General for Civil and Emergency Operations, one of my highest priorities is to ensure this policy directive is implemented as soon as practicable.

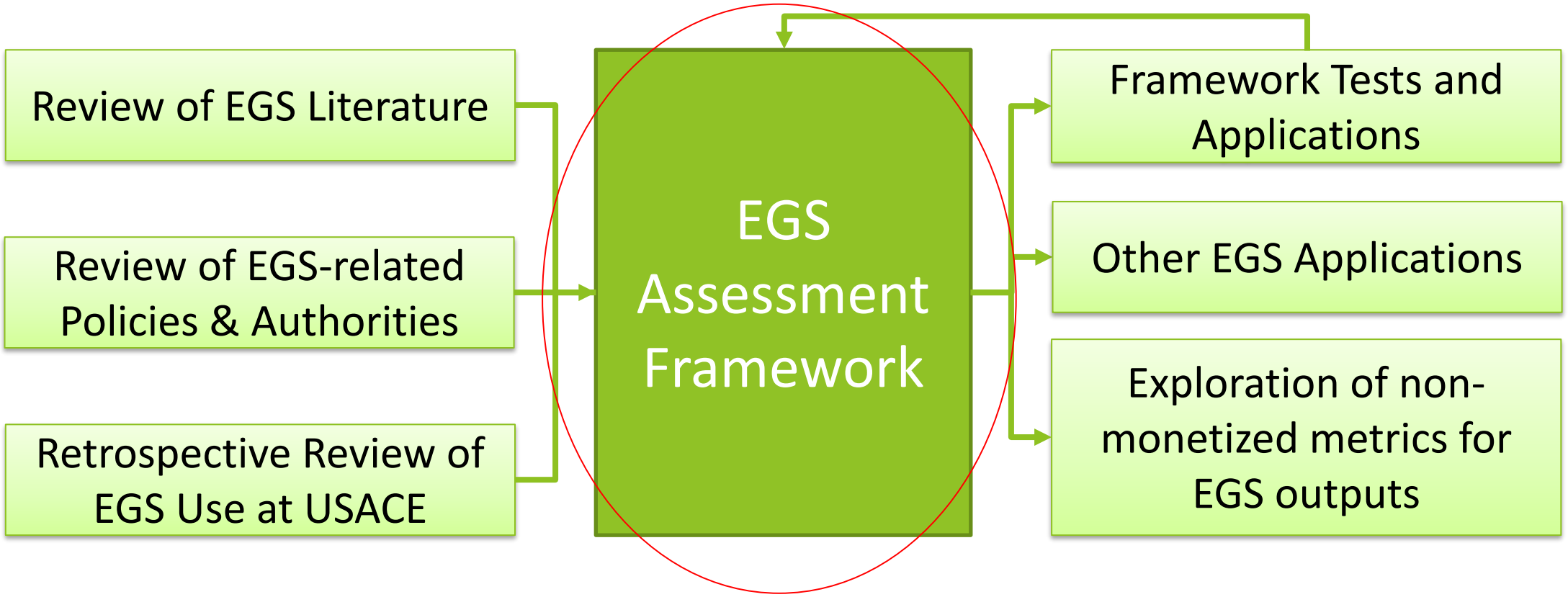
2. Applicability. This directive applies immediately to all USACE elements having Civil Works planning, engineering, design, construction, and operations & maintenance responsibilities. The policies contained in this directive shall remain in effect and fully applicable unless and until modified, supplemented, amended, or rescinded expressly and in writing by the ASA(CW). See also, paragraph 8, Limitation on Modification.

3. Background. Civil Works planning guidance, contained in Engineer Regulation (ER) 1105-2-100 (Planning Guidance Notebook), provides the overall direction by which Civil Works projects are formulated, evaluated and selected for implementation. ER 1105-2-100, published in 2000, contains a description of the USACE planning process, missions and programs, specific policies applicable to each mission and program, and analytical requirements.

a. This directive supplements the guidance provided in ER 1105-2-100 by requiring comprehensive consideration of total project benefits including economics, environmental, and social categories, until a comprehensive update is accomplished.

b. As outlined in ER 1105-2-100, USACE currently applies the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (i.e., Principles and Guidelines) when formulating and evaluating Civil Works water resources development project alternatives. The Water Resources Council released the *Principles and Guidelines* (P&G) in 1983.

Overview of Ecosystem Goods and Services Research

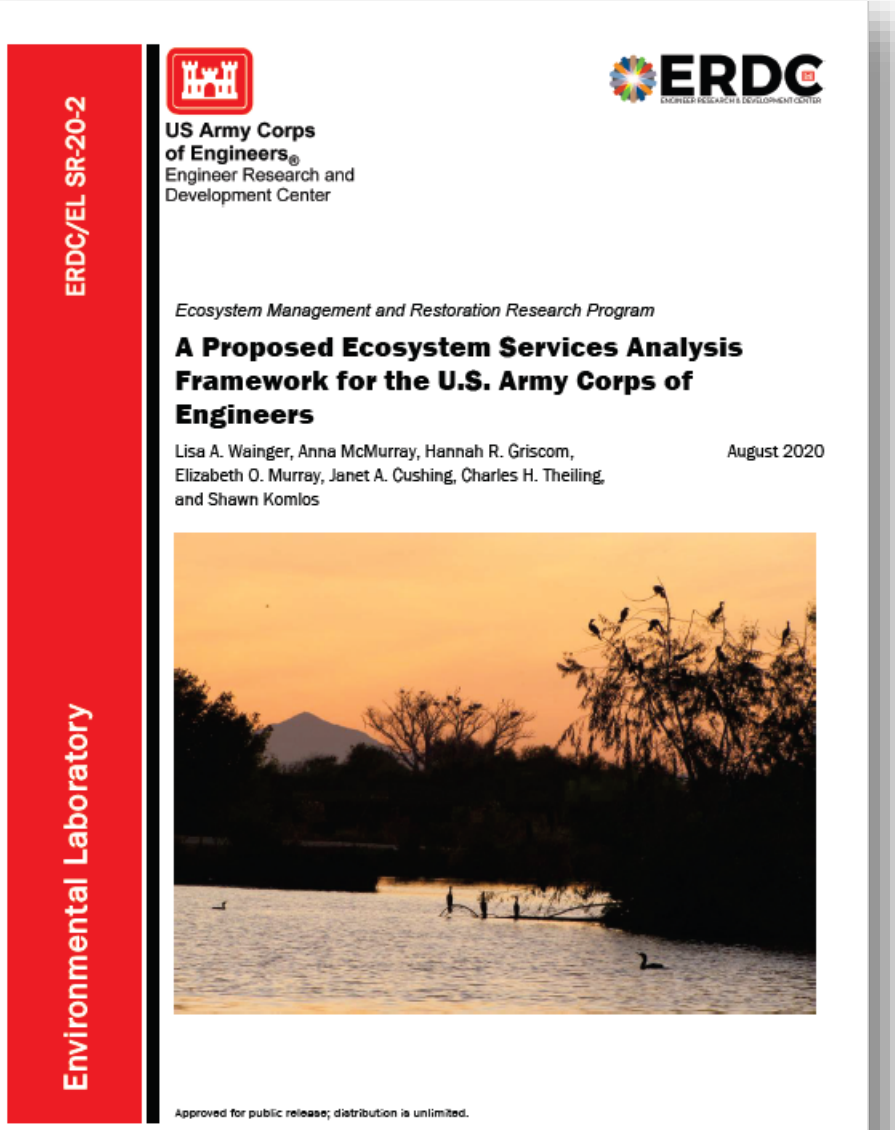


Entering into Framework Development we recognized:

- 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

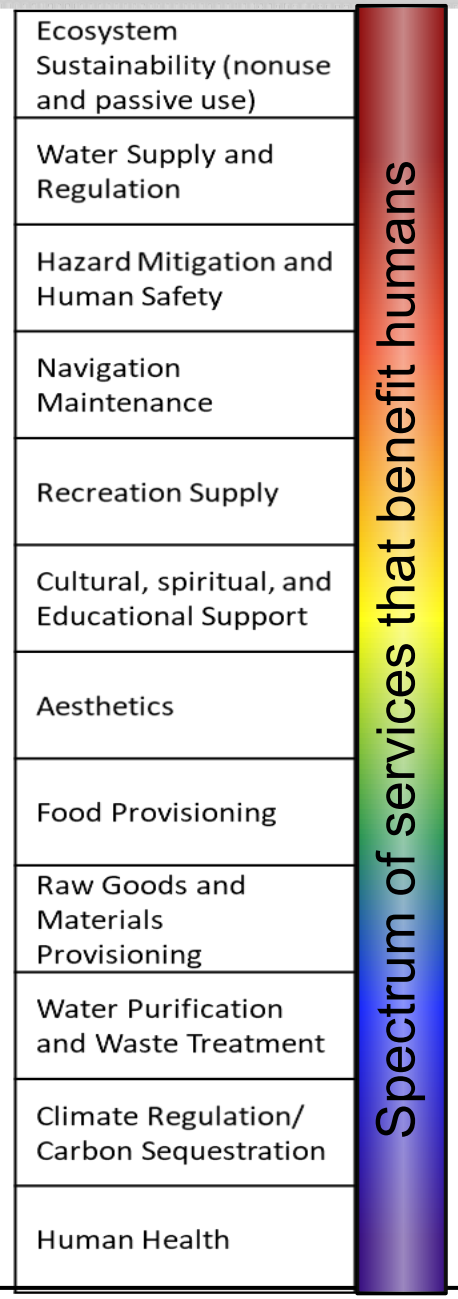
EGS Framework

- 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



USACE Six-Step Planning Process	1. Problems and Opportunities	2. Inventory and Forecast	3. Formulate Plans	4. Evaluate Plans	5. Compare Plans	6. Select Plan
EGS Analysis	1.1 Engage stakeholders and technical experts to identify problems, EGS opportunities, and management measures 1.2 Build EGS conceptual models linking potential management measures to EGS impacts 1.3 Rate and prioritize some EGS for further detailed analysis	2.1 Identify available data, methods and models 2.2 Choose analytic methods 2.3. Characterize existing conditions future with conditions	Inform plan formulation using EGS conceptual models and EGS prioritized by impact and relevance to project*	Analyze alternate plans by evaluating/ measuring changes in EGS*	Summarize differences between plans (describe and quantify EGS benefits and/or harms)*	Provide a summary of the EGS benefits and harms of the tentatively selected plan
Analysis Tools Provided by Framework	• EGS Definitions, Example Indicators, and Influencing Actions (Table 2) • Framework Conceptual Model (Figure 2) • Matrix of potentially affected EGS by ecosystem (Table 6) • Tables and figures to support the completion of Impact Evaluation and Decision Criteria Tables (Table 7-Table 13)	• EGS Dat Catalog* • EGS Con produced in Step 1.2	• EGS prioritized using Impact Evaluation and Decision Criteria Tables produced in Step 1.3	Criteria Tables produced in Step 1.3		
Planning Step Product	• EGS concerns identified by stakeholders (Figure 7) • EGS conceptual models (Figure 5) • EGS list - prioritized using Impact Evaluation and Decision Criteria Tables for plan formulation (Table 7 and Table 8).	Analysis methods and outputs identified Narrative of existing and future without project (FWOP) conditions with an emphasis on EGS 1	• Formulated plans	• Impact Evaluation and Decision Criteria Table per alternative OR • Summary Tables of EGS changes	• Summary Table of (monetized) benefits and harms or benefit/harm indicators (uncombined metrics) 3	• Summary Table of all EGS benefits and harms of tentatively selected plan 2

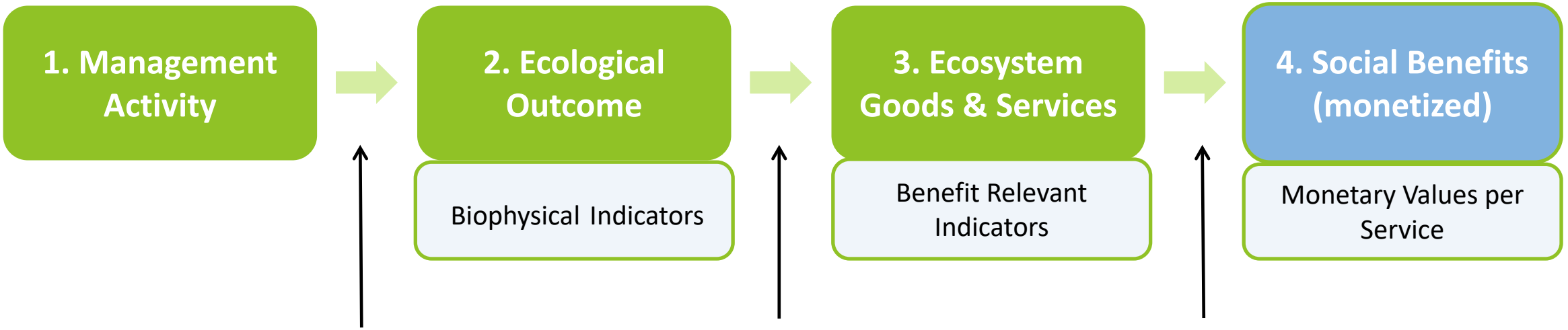
'Right Sizing' the Analysis:

1) qualitative assessment only
2) quantitative assessment of only Selected Plan
3) quantitative assessment of all alternatives

*Include these steps if the EGS framework is being used for plan formulation or selection; not needed if EGS are only being used to characterize the selected plan.

**Accessible through the Army Corps of Engineers Ecosystem Restoration Gateway (http://cw-environment.usace.army.mil/restoration.cfm).

Framework Analytic Core
Conceptual model for benefits estimation



A. Response Function
Quantify biophysical changes resulting from action

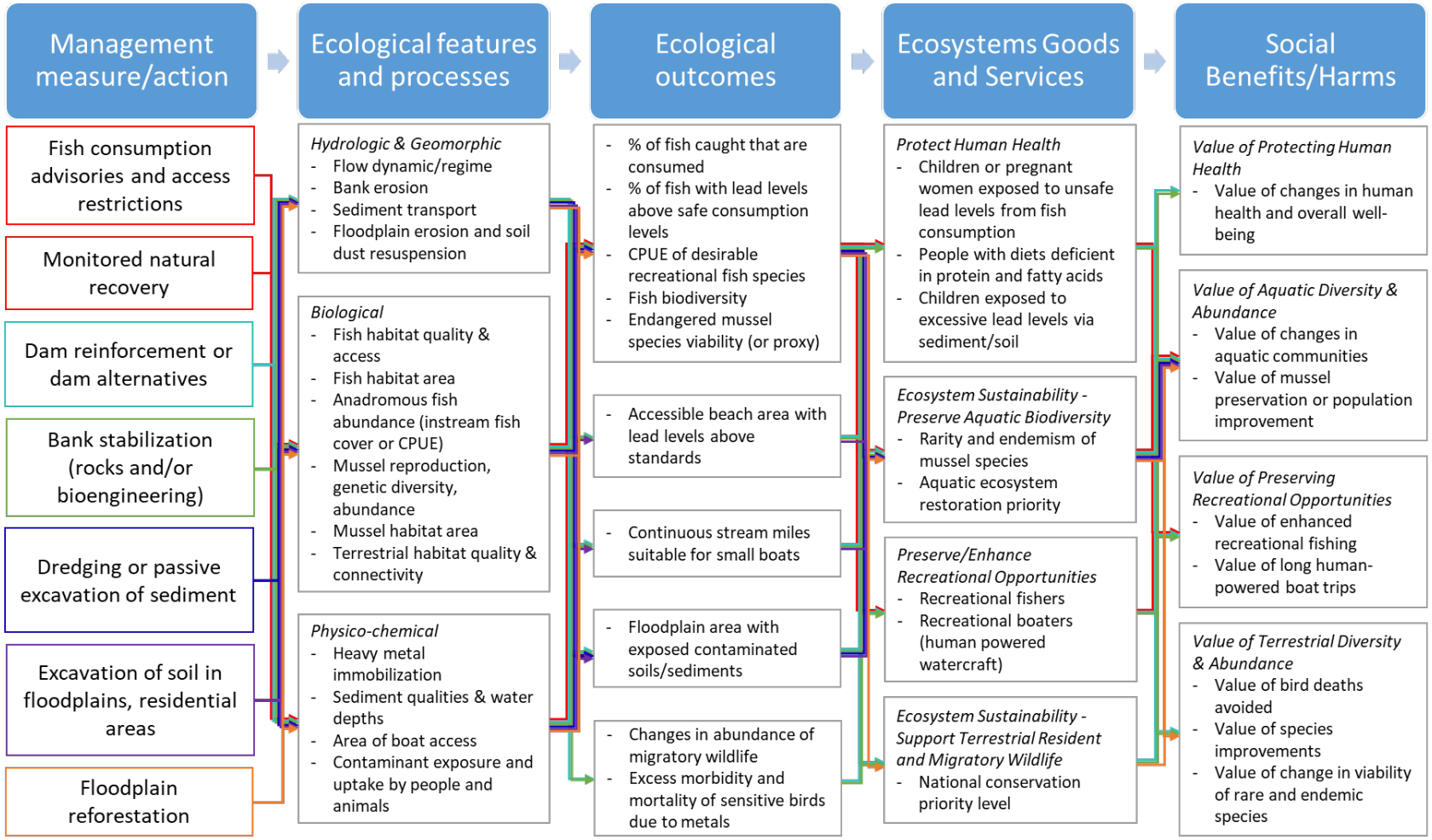
B. Ecoservice Production Function
Assess human use, preferences, and concerns (e.g., scarcity)

C. Benefit / Damage Function
Monetize benefits, if appropriate

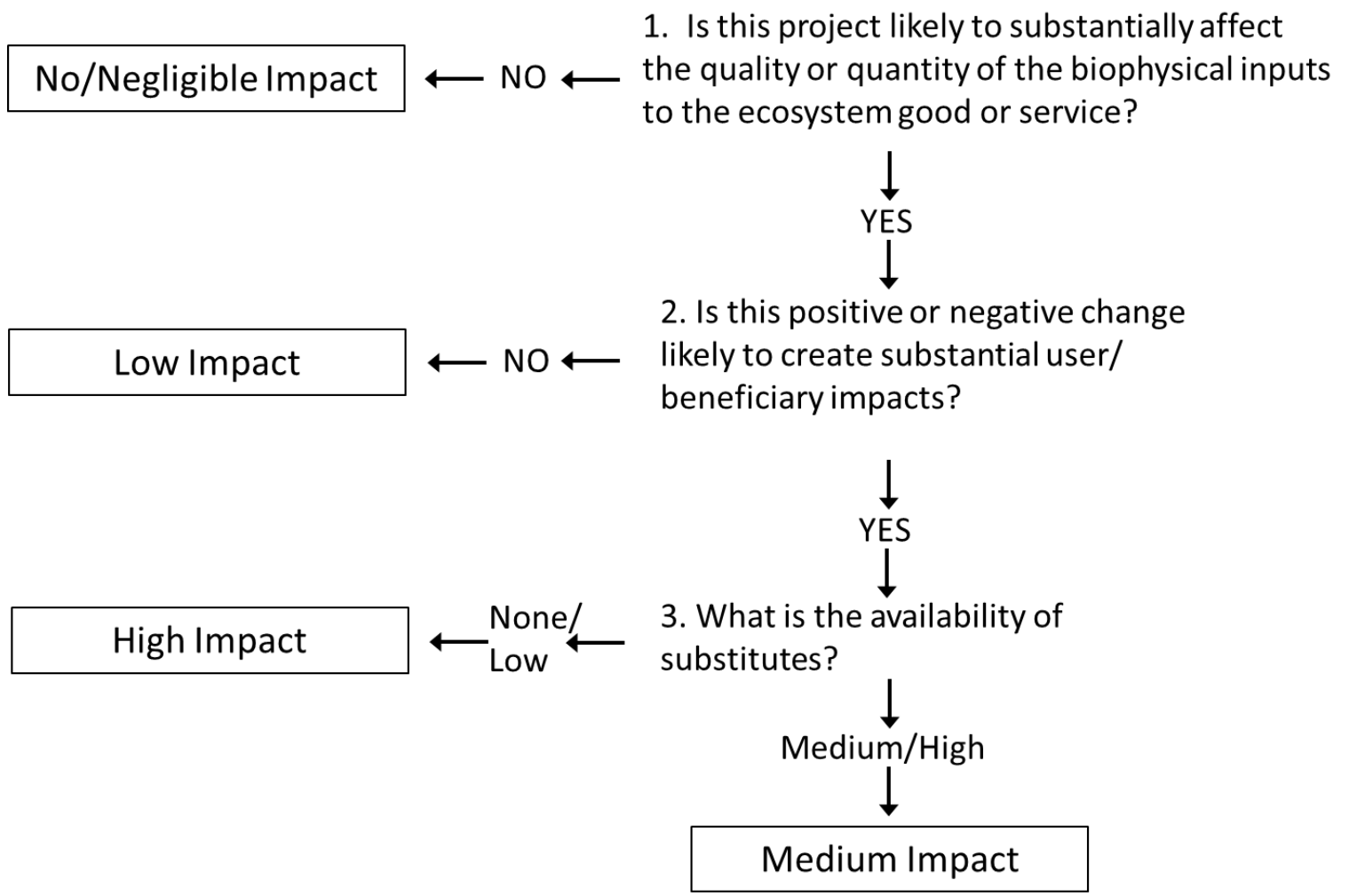
Elements of Benefit Relevant Indicators (BRIs)

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

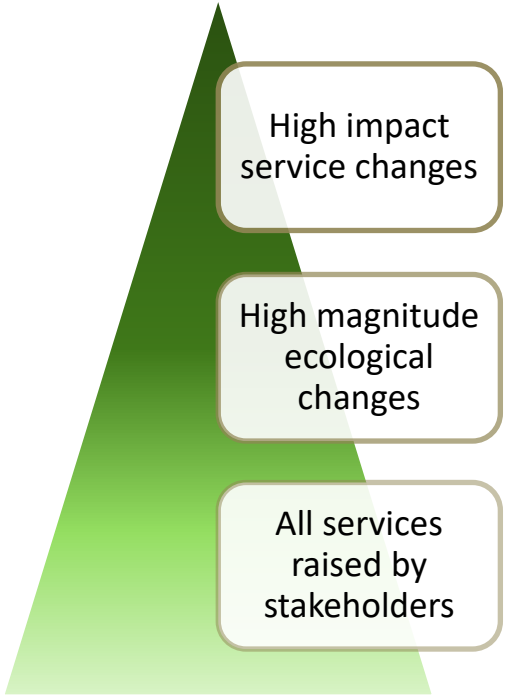


Biophysical
- Magnitude
- Duration

Beneficiary
- Magnitude
- Duration

Substitutes / Scarcity

Goals of Scoping Process



IMPACT TABLE

Impact Table Directions

1. Biophysical Changes: Rank the impact this project is likely to have on the biophysical processes driving this EGS, the duration of the impact, and whether it will be substantial.
2. Affected Beneficiaries: Rank the impact this project is likely to have on the beneficiaries of this EGS, the duration of the impact, and whether it will be substantial.
3. Does this EGS have low-cost or readily available substitutes? (If yes, decreases positive and negative impact).
4. Assign a cumulative rank using Figure 3.

Impact Key

+++/- - -	High Positive/Negative Change
++/- -	Medium Change
+/-	Low Change
o	No / Negligible Change
ii	Insufficient Information
n/a	Not applicable

Duration Key

*** Long-term * Temporary
** Short-term

EGS Categories	Biophysical Impacts[2] (see impact key)			Beneficiary Impacts[3] (see impact key)			Substitutes Available?[4] (yes, no)	Cumulative Impact Rank[5] (low, med, high)
	Magnitude	Duration	Is the impact substantial?	Magnitude	Duration	Is the impact substantial?		
Ecosystem Sustainability								
Terrestrial Ecosystem Diversity	++	***	Yes	++	***	Yes	No	High
Desert Perennial River Conservation	+	***	Yes	+	***	Yes	No	High
Population Viability of Warm Water Endemic Fishes	+	***	Maybe –> Yes	+	***	Maybe –>Yes	No	High
Population Viability of the Southwestern Willow Flycatcher	+	***	Maybe –> Yes	++	***	Yes	No	High
Natural Hazard Mitigation, Property & Infrastructure								
Property Protection from Flooding	- -	**	Maybe–>Yes	-	**	No	No	Low
Recreation								
Fishing	+	***	Maybe –>Yes	+++	***	Yes	Yes	Medium
Trail-based activities	++	***	Yes	+++	***	Yes	Yes	Medium
Aesthetics	++	***	Yes	+	***	Maybe –> No	No	Low

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)

DECISION CRITERIA TABLE

Directions

1. Transfer EGS and associated aggregate impact rating from the Impact Evaluation Table.
2. Rate your overall confidence of the aggregate impact rating (Table 12).
3. Is this EGS within project authorities?
4. Are there other important considerations regarding this EGS? (e.g., is it within a Corps mission area (Table 13), is it a NEPA concern, etc.)?
5. Combine aggregate impact rating with confidence rating (Table 14) and filter EGS by project authorities and other considerations, as appropriate, to select EGS for further analysis.

Ecosystem Goods and Services (EGS)[1]	Aggregate Impact Rating[1] (no/negligible, low, med, high)	Confidence Rating[2] (low, med, high)	Within the project authorities?[3] (yes, no)	Other considerations?[4] (E.g., Within a mission area? NEPA concern?) (yes, no)	Include in further analysis?[5] (yes, no)
Ecosystem Sustainability					
Non-use services from restoring a portion of a threatened riparian forest to meet quality threshold	High	Medium	Yes	-	Yes
Non-use services from restoring a portion of a threatened desert perennial river ecosystem to meet quality threshold	High	Medium	Yes	-	Yes
Non-use services from improving viability of the declining species Roundtail Chub	High	Medium	Yes	-	Yes
Non-use services from improving viability of the endangered Southwestern Willow Flycatcher	High	Medium	Yes	-	Yes
Natural Hazard Mitigation, Property & Infrastructure					
Property protection from flooding	High	Medium	No	Yes	Yes
Recreation					
General Recreation	Medium	Medium	No	Yes	Yes
Birdwatching	High	High	No	Yes	Yes
Aesthetics					
Visual enjoyment by riparian neighbors	Low	Medium	No	No	No

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

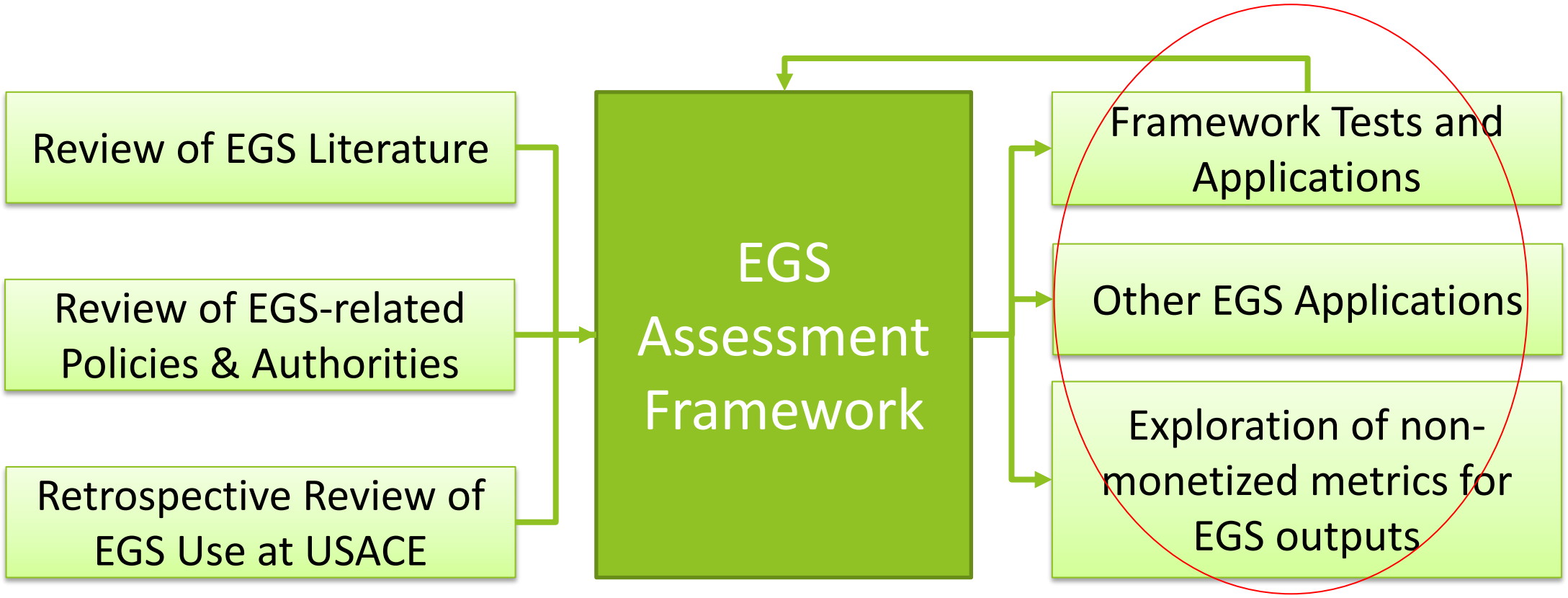
MCDA Results
EGS tradeoffs between project alternatives for Ayola, AZ case study

Key
- Large positive impact
- Moderate positive impact
- Small positive impact
- No change
- Small negative impact
- Moderate negative impact
- Large negative impact

Ecosystem Goods and Services	Alternative A Add log structures. Construct trails over 5-mile section.	Alternative B Modify dam to incorporate environmental flows. Construct trails over 5-mile section.	Alternative C Modify dam to incorporate environmental flows. Construct two irrigation channels. Plant native riparian vegetation. Construct trails over 5-mile section.	Alternative D Modify dam to incorporate environmental flows. Construct two irrigation channels. Plant native riparian vegetation. Construct meanders over 10-mile section. Construct trails over 5-mile section.	Alternative E Modify dam to incorporate environmental flows. Construct two irrigation channels. Plant native riparian vegetation. Construct meanders over 10-mile section. Add log structures. Construct trails over 5-mile section.
Riparian ecosystem* sustainability	0	10	14	14	14
Aquatic ecosystem sustainability*	0	8	8	19	19
Roundtail Chub Viability*	0	4	4	9	9
Southwestern Willow Flycatcher viability*	0	0	8	10	10
Flood damage mitigation	0	0	3	10	10
General recreation	0	0	5	5	5
Recreational birding	0	0	5	5	5
Aggregate Score	**0**	**22**	**47**	**72**	**72**

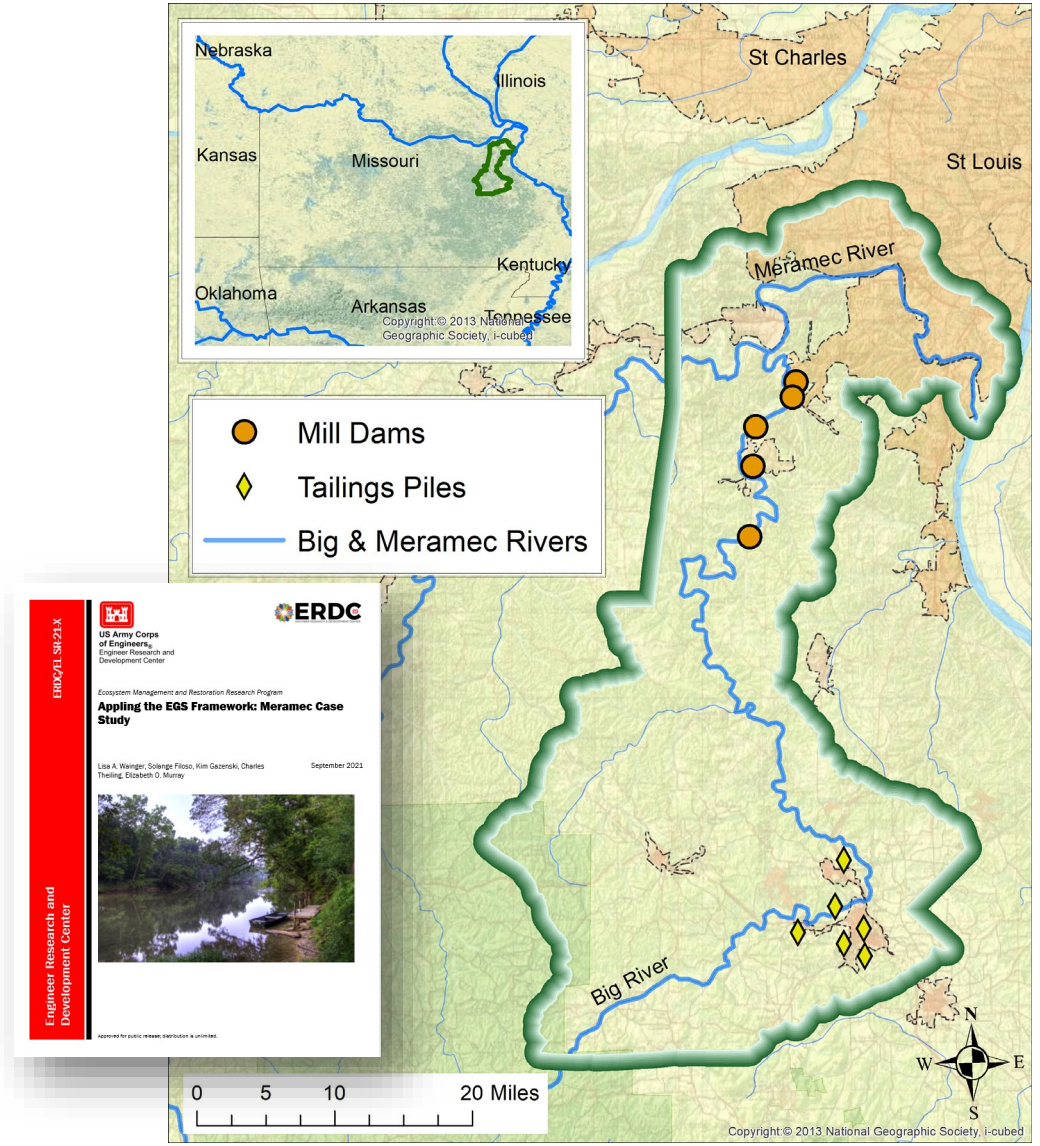
* Included in planning objectives

Overview of Ecosystem Goods and Services Research



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

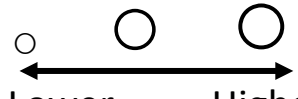
	Human Health			Ecosystem Sustainability		Recreation	
	Protect from contaminants in fish	Promote healthy diets (protein and fatty acids)	Protect from contaminants in sediment/soil	Preserve aquatic biodiversity	Support resident & migratory wildlife	Preserve/ enhance fishing	Preserve/ enhance human powered boating
Fish consumption advisories	●	○	—	●	—	○	—
Access restrictions	—	○	●	—	●	○	○
Monitored natural recovery	●	●	○	○	—	●	●
Dam reinforcements	●	—	●	○	—	●	○
Bank stabilization with rocks	●	○	●	○	○	○	○
Sediment dredging	●	●	—	●	●	●	●
Soil excavation	—	—	●		●	●	●

Fully Compatible

Lower Higher

Influence

Not Compatible



Lower Higher

Influence

No or Negligible Effect

—

Meramec River Case Study

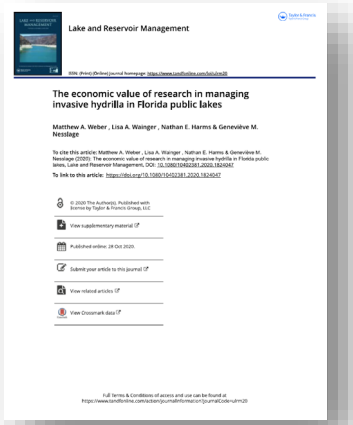
- Does scientific knowledge constrain the use of EGS in project planning?
  - Biophysical elements well captured with available data and information
  - Benefits unevenly captured
    - Would need different analyses to improve outcome metrics (e.g., changes in fishing catch, population effects, rarity)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


Lake and Reservoir Management

The economic value of research in managing invasive hydrilla in Florida public lakes

Matthew A. Weber , Lisa A. Wainger , Nathan E. Harms & Geneviève M. Nesslage

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.


Evidence-based economic analysis demonstrates that ecosystem service benefits of water hyacinth management greatly exceed research and control costs

ABSTRACT

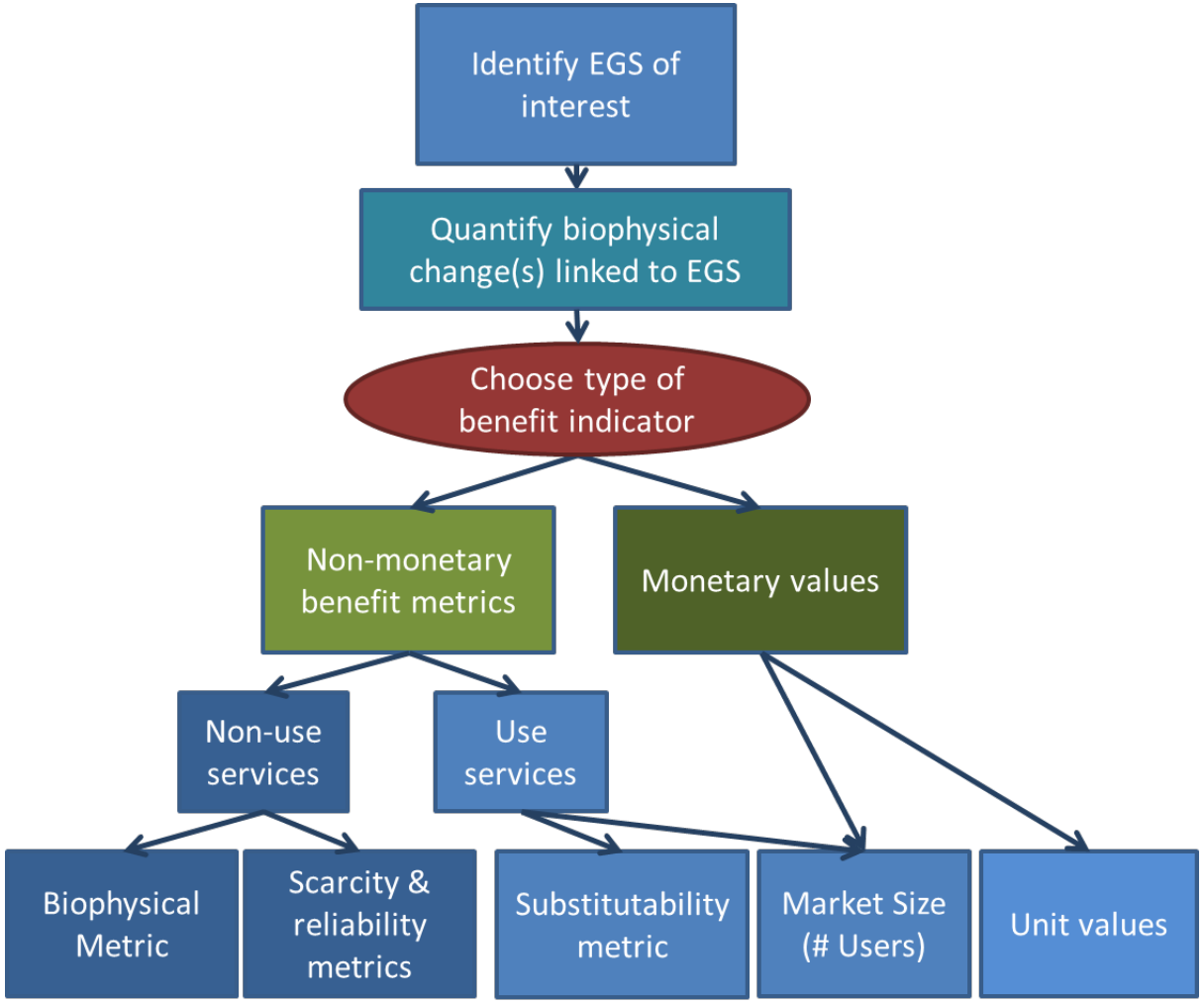

Aquatic invasive plant backup behind Lock #4 on the Red River July 2015.

Photo courtesy of Allie Cozad

Hurricane Sandy Test Case: Simplified EGS Analysis

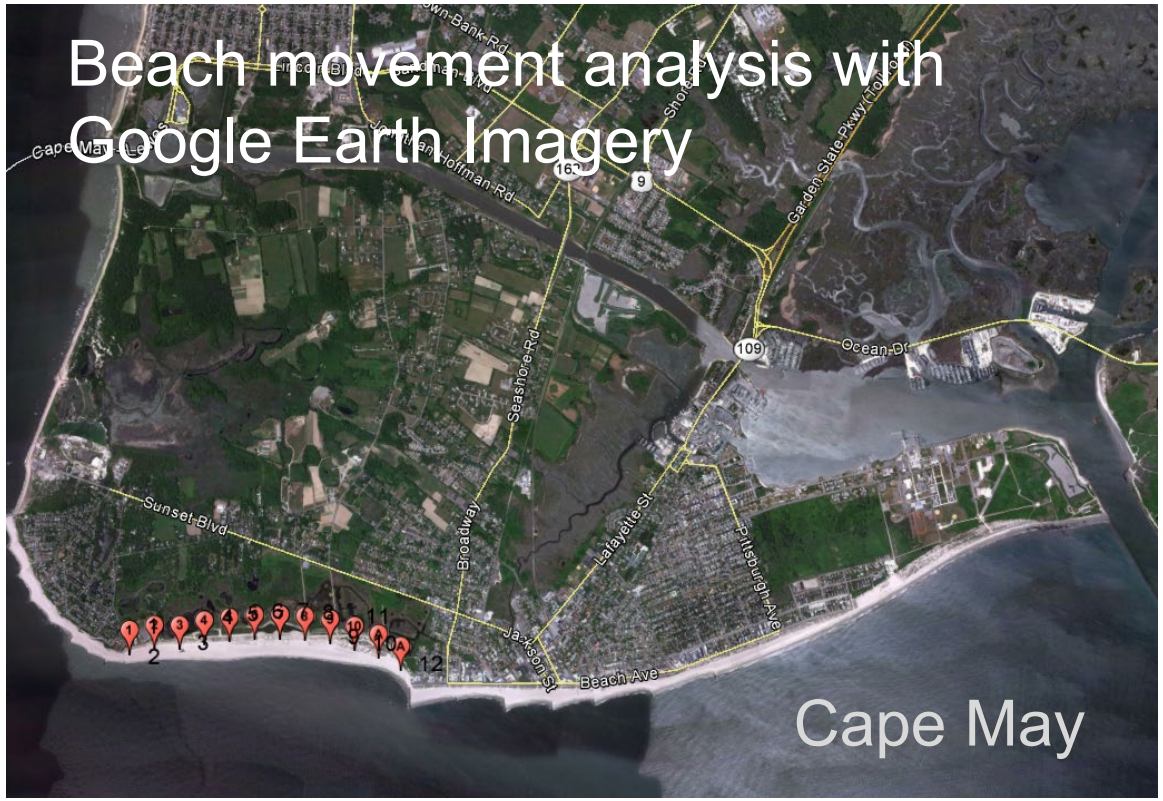
Can a rapid assessment work to show benefits of storm damage mitigation efforts?

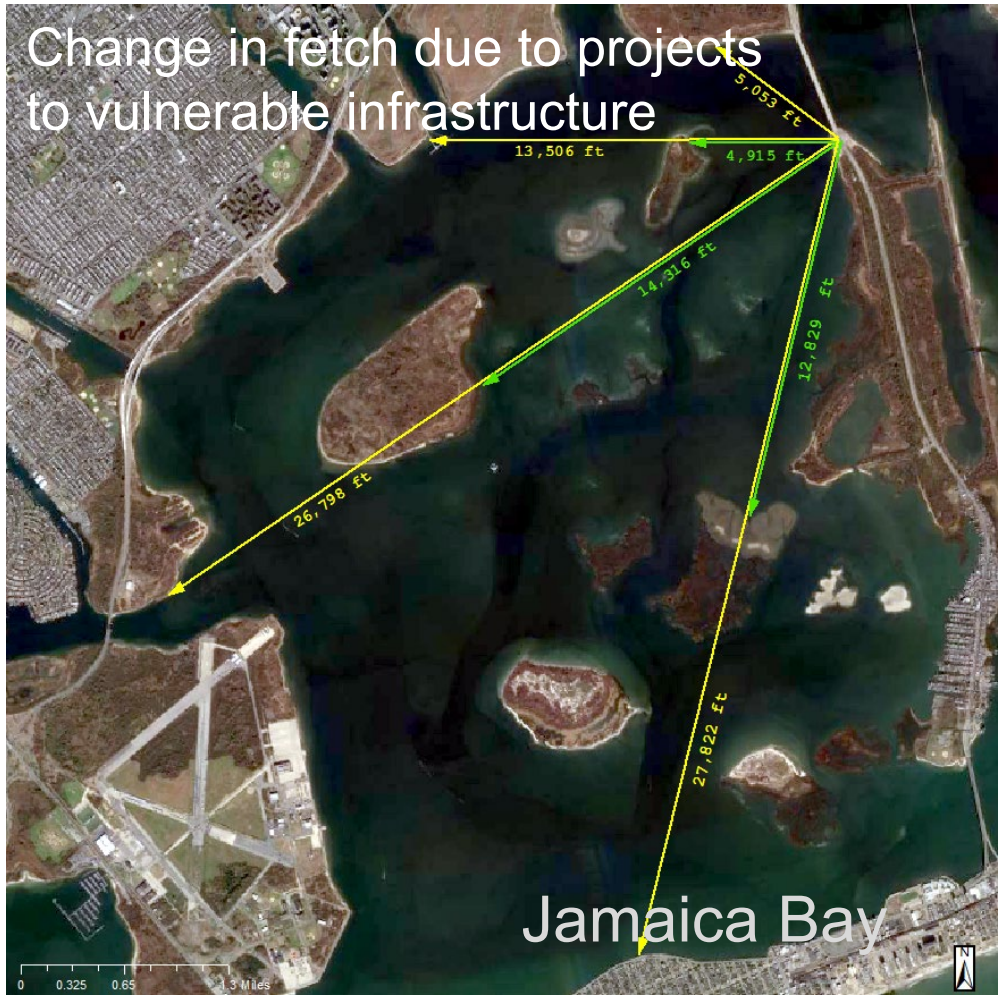
- Used existing data
- Developed evidence-based indicators instead of complex models
- Used economic benefit transfer as a simple aggregation of many benefits
- Species and ecosystem benefits measured as reductions in scarcity



Low cost EGS Analysis

Used GIS, satellite imagery, existing databases





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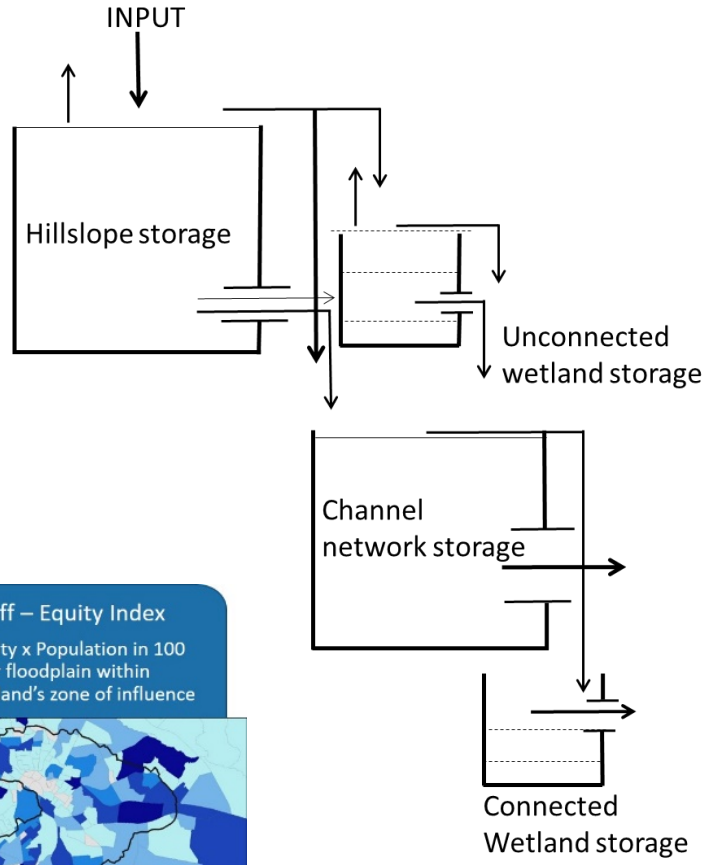
Example Results for Cape May

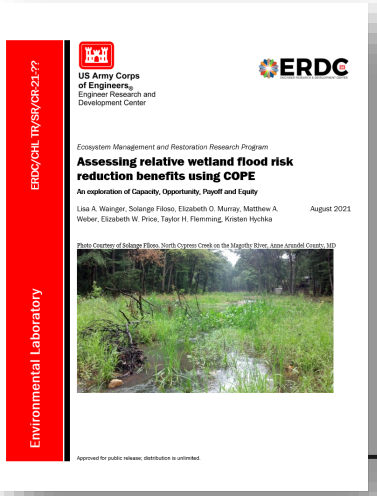
Rare Habitat quantified + Monetized values from benefit transfer

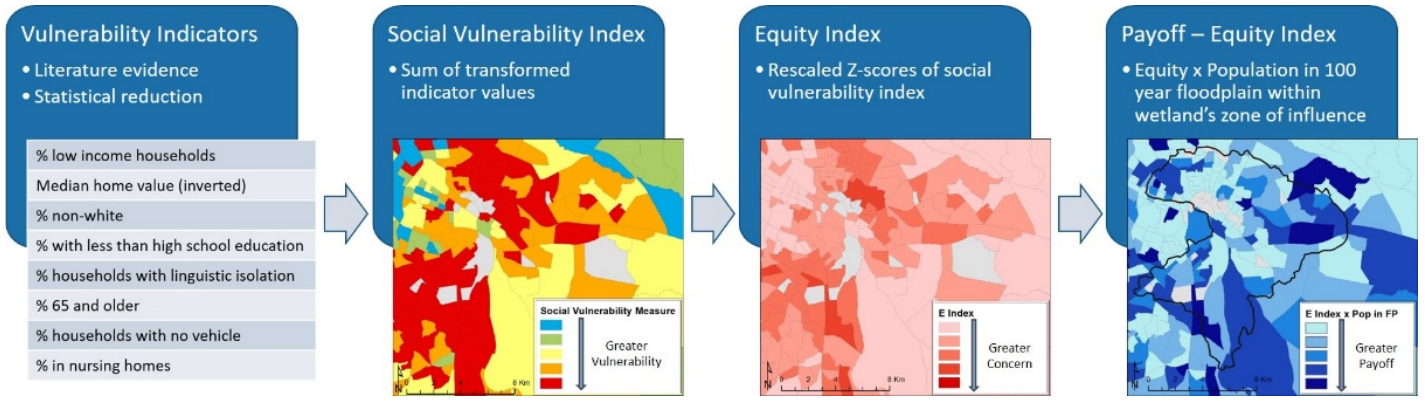
Ecosystem Service	Biophysical Change due to Project	Per-Unit Value	Market Size	Benefit Metric
Property Protection	Was not measurable from available data.			
Critical Infrastructure	n/a			
Property Value Enhancement	Beach width added as of 2011 = 5.3 m (17.4')	0.3% of home value change	Value of property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

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.







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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**

Referenced Reports and Publications:

EGS R&D Products

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EGS Assessments & Applications of Framework

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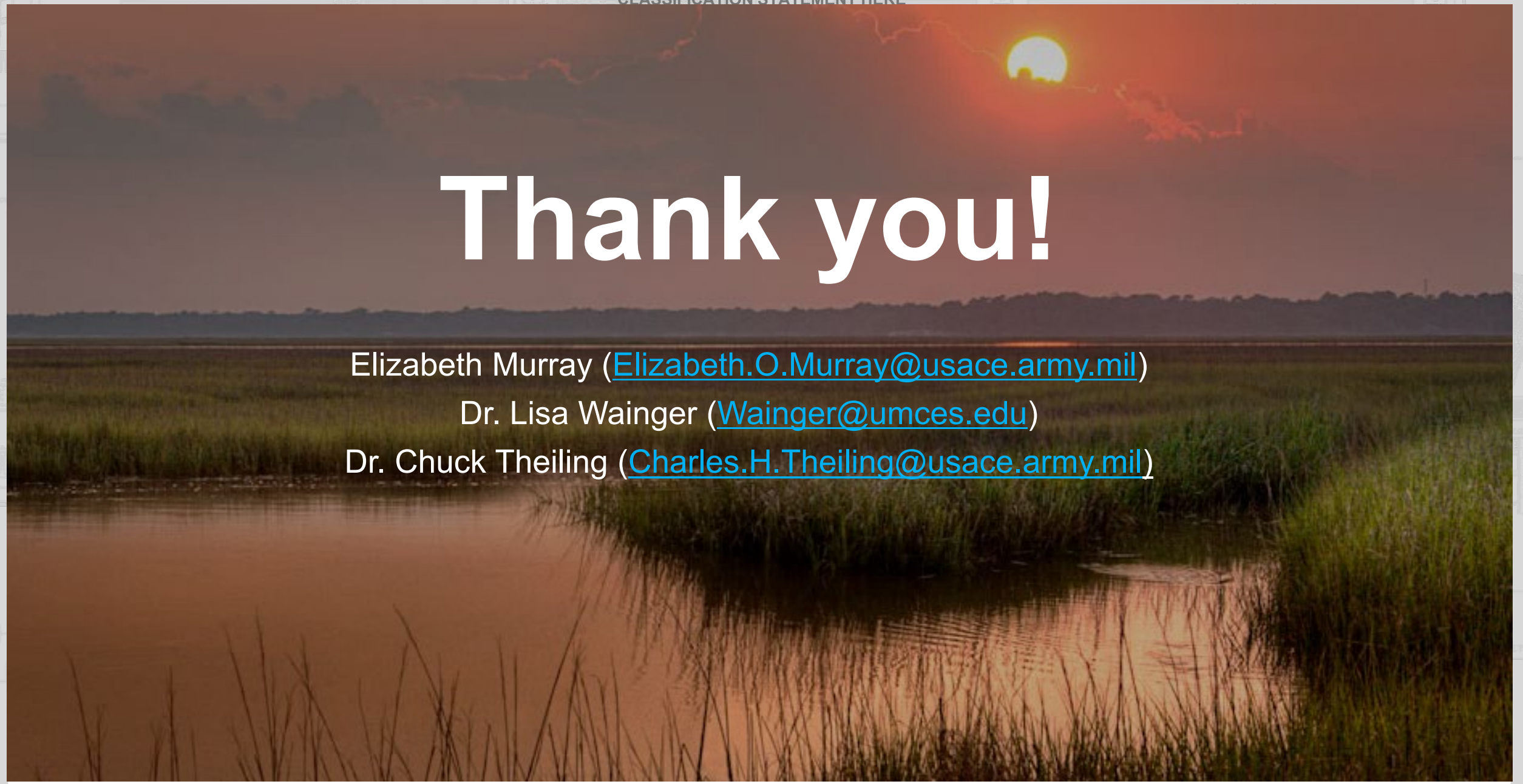

Thank you!

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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

POSTED: https://emrrp.el.erdc.dren.mil/webinars.html.