

September 2013

**Using Information on
Ecosystem Goods and
Services in Corps Planning:
An Examination of
Authorities, Policies, Guidance,
and Practices**

2013-R-07



Using Information on Ecosystem Goods and Services in Corps Planning: An Examination on Authorities, Policies, Guidance, and Practices

2013-R-07

September 2013

By

Denise Reed
Water Institute of the Gulf

Lynn Martin
U.S. Army Corps of Engineers
Institute for Water Resources

and

Janet A. Cushing
U.S. Army Corps of Engineers
Institute for Water Resources

Preface

This report is part of a research and development (R&D) work unit titled: *Incorporating Ecosystem Goods and Services in Corps Planning and Environmental Benefits Evaluation*. The purposes of the work unit are to investigate the potential for using ecosystem goods and services in U.S. Army Corps of Engineers (Corps, USACE) planning, investigating the current state of the field, relevant tools, and policies, and ultimately develop a practical framework that could allow Corps Districts to analyze ecosystem goods and services in planning and alternatives evaluation for Corps projects, thereby strengthening agency decision-making as it relates to assessing the benefits humans derive from functioning ecosystems as well as considering potential losses of various ecosystem goods and services. The work unit has been divided into several tasks listed below, and this report is a product of the second task.

- **Principles & Best Practices:** A Technical Note and longer Technical Report will explore the prevalent definitions, classifications, history and conceptual models relating to ecosystem goods and services, and will propose working definitions and conceptual models that are appropriate for Corps use, along with implications for the Corps planning process.
- **Policy Review & Analysis:** This report will review and analyze USACE authority, policy and guidance relative to supporting or impeding the integration of information on ecosystem goods and services, as well as review other agencies' policies and practices relative to using an ecosystem service-based approach in their programs.
- **Review of Data & Analytical Tools:** A database will be created to catalogue data sources, analytical tools & models with the potential to support EGS considerations in Corps planning. A synthesis report will describe strengths and weaknesses and offer example applications.
- **Case Study Retrospective:** A report will describe previous and current Corps efforts at addressing ecosystem goods and services in the planning process, summarize successes and lessons learned so that such knowledge may be incorporated into the proposed framework.
- **Analytical Framework and Guidelines:** Ultimately, the research described above will inform the development of a framework and suggested guidelines that could be used by Corps Districts to analyze ecosystem goods and services in the planning process.

The Co-Principal Investigators of this work unit are Elizabeth Murray (CE-ERDC-EL) and Janet Cushing (CE-IWR).

This report was jointly funded by the Institute for Water's Maass-White Scholar Program and the Ecosystem Management and Restoration Research Program of the Engineering Research and Development Center.

Views, opinions, and/ or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other official documentation.

Acknowledgements

This document was reviewed and subsequently improved by comments from Lillian Almodovar (USACE, Institute for Water Resources [IWR]), Rob Brooker (James Hutton Institute), Bruce Carlson (USACE, Planning & Policy Division), Dick Cole (USACE, IWR), Susan Durden (USACE, IWR), Olivia Ferriter (Department of Interior [DOI]), Chris Hartley (U.S. Department of Agriculture, Office of the Chief Economist), Elsa Haubold (Florida Fish and Wildlife Conservation Commission [FWC]), Bill Hubbard (USACE New England District), David Johnson (FWC), Shawn Komlos (USACE, IWR), Henry Langlois (USACE, IWR), David Moser (USACE, IWR), Michael Papenfus (U.S. Environmental Protection Agency [EPA]), Malka Pattison (DOI), Bruce Peacock (DOI, National Park Service), Robert Pietrowsky (USACE, IWR), Mark Plummer (National Oceanic & Atmospheric Administration [NOAA], National Marine Fisheries Service), Erin Rooks (USACE, IWR), Kathryn Saterson (EPA), Paul Scodari (USACE, IWR), Carl Shapiro (DOI, U.S. Geological Survey), Rennie Sherman (USACE, Planning & Policy Division), Benjamin Simon (DOI), Chuck Theiling (USACE Rock Island District), Lisa Wainger (University of Maryland, Center for Environmental Science), Peter Wiley (NOAA, Coastal Services Center), and Rob Winthrop (DOI, Bureau of Land Management). We also thank Katie Noland (IWR) and Brook Angel (IWR) for editorial revisions.

TABLE OF CONTENTS

Preface	ii
Acknowledgements.....	iv
Executive Summary.....	viii
Introduction	1
Part I. Civil Works Authorities, Policy, and Guidance Influencing the Use of EGS Information in Corps Planning.....	4
A. Authorities and Policies Relative to Considering EGS Information in Planning.....	5
Watershed Planning and Studies	7
National Environmental Policy Act (NEPA)	7
Planning Principles	8
Environmental Operating Principles	9
System Analysis.....	9
B. Topics for Special Consideration in Using EGS Information in Corps Planning.....	10
Water Quality.....	10
Recreation.....	10
Cultural.....	10
Spiritual	11
Aesthetics.....	11
Subsistence and Commercial Fishing.....	12
Navigation	12
Water Supply.....	12
C. Procedural and Analytical Considerations	13
Project Purposes	13
Multiple Purpose Studies	13
Benefit-Cost Analysis, Cost Effectiveness Analysis, Incremental Cost Analysis.....	14
Risk Analysis	15
Incidental Benefits and Other Direct Benefits	15
Separable Element	15
Tradeoff Analysis.....	15
Cost Sharing	16
Cost Allocation	16
Planning Modernization.....	16

D. Evaluation Framework for Aquatic Ecosystem Restoration (AER) Projects.....	17
National Ecosystem Restoration Benefits (NER).....	20
Combined NED/NER Plans	21
E. Opportunities for EGS in Corps Planning.	21
A. Corps Natural Resources Management Program	22
Part II. Use of Ecosystem Goods and Services by Others	24
A. Environmental Protection Agency (EPA).....	24
EPA Summary.....	26
B. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)....	26
NOAA Fisheries.....	27
Ocean and Coastal Resource Management.....	27
Damage Assessment, Remediation, and Restoration Program	28
NOAA Summary	29
C. U.S. Department of Agriculture (USDA).....	30
Natural Resources Conservation Service (NRCS)	31
Forest Service (FS).....	31
USDA Summary:.....	32
D. Department of the Interior	32
Fish and Wildlife Service (FWS).....	34
National Park Service (NPS)	36
Bureau of Land Management (BLM).....	36
DOI Summary	39
E. Department of Defense (DOD).....	39
DOD Summary.....	41
F. States	41
Colorado.....	41
Florida	42
Oregon	43
States Summary	46
G. Other National Governments.....	46
United Kingdom	46
Australia	48
UK and Australia Summary	50
H. Summary of the Use of EGS by Others.....	50

Part III. Discussion	55
Part IV. Conclusions	63
Appendix A - NEPA Summary.....	64
Appendix B - Federal Interest, Federal Objective, Corps Objective/Interest/Roles.....	66
Bibliography	69

LIST OF FIGURES

Figure 1. Simplified framework for consideration of EGS supplied by natural features and the benefits they provide.....	3
Figure 2. Surface lands managed by the Department	33

LIST OF TABLES

Table 1. Historic water resources legislation and planning guidance related to ecosystem functions and services.....	5
Table 2. Extract from BLM H-1601-1 Appendix D Table D-2, "Topics for Socio-Economic Analysis"	38
Table 3. Comparison of federal agency definitions of "ecosystem services" and context for using ecosystem services in their mission areas.....	51
Table 4. Examples of the different uses of EGS related concepts by other agencies and governments.	53
Table 5. Illustration of how proceeding through the six-step planning process can begin with the consideration of a wide array of EGS that are gradually narrowed throughout the analysis.....	56
Table 6. The potential use of ecosystem services in full accounting for project effects for USACE project types. Note: water supply is an ongoing operational aspect of many Corps projects with other purposes. PF stands for possible use in plan formulation, FA indicates the project may be used to provide full accounting of project effects, and N/A stands for 'not appropriate.'	58
Table 7. Illustration of potential partnering roles for other federal agencies and local entities toward provision of ecosystem services associated with USACE projects.....	60
Table 8. Outline summary of existing and potential use of incorporating EGS in the decision making policy arenas examined in this review.	61
Table 9. Summary of the findings of this review study relative to the issues posed.	62

Executive Summary

This review examined existing authorities, policy and guidance that can influence use of ecosystem goods and services (EGS) information in Corps planning, and the ways in which other agencies and governmental bodies use EGS in their policies and programs related to ecosystem restoration or natural system management. An EGS approach is defined broadly as using information on EGS in decision-making. By necessity this report considers current agency policy and practice, which may not necessarily reflect recently adopted policies and approaches or those under development.

Within the Corps, how the use of EGS information fits within the ongoing transformation of the Civil Works program and the associated modernization of the planning process is yet to be identified, but it is clear that implementation would need to be time-efficient and provide value-added. The accounting of EGS could be valuable in fostering collaboration in pursuing integrated water resources management and problem solving as it can help shape a multi-faceted view of needs, benefits and other effects, and clarify how the Corps' mission intersects with those of other agencies. This paper, while not geared toward Corps District-level planners, might be useful in providing information about current Corps' policy regarding the consideration of various ecosystem services, and show how different agencies and local sponsors might be interested in particular services.

Within a project planning context, an explicit consideration of EGS can clarify which EGS the Corps project will address, and those that remain to be considered by others. This may allow for recognition of collaborative opportunities as potential EGS problems and effects are identified that are within the purview of other agencies. Accounting for EGS allows the Corps to be more explicit regarding the broad array of effects associated with Corps projects. This approach would not require that the Corps consider a complete array of EGS in every project; planning teams will need to identify which EGS are relevant to their project and how they will be used, e.g., in formulation or in reporting of effects. This will influence the level of analysis and detail needed, and the approaches to obtaining or developing it. Additionally, some laws may influence the EGS considered in a particular study, as well as the tradeoffs among the EGS considered.

While monetization of EGS remains an area of considerable research, it is not a necessary element for incorporating EGS in plan formulation and evaluation. Current Corps policy and guidance does not require NER outputs to be monetized, and implies that EGS benefits that can be monetized will be treated as national economic development (NED) benefits, rather than national ecosystem restoration (NER) benefits.

It may be useful to revisit USACE policy and planning guidance relative to NER and how to account for services that can be described in terms of dollars as benefits from aquatic ecosystem restoration (AER) projects. Using valid information about such benefits from projects could enhance communication of the value of AER investments. Current policy and guidance emphasizes ecosystem value and productivity in expressing the benefits of AER projects.

Reconsideration of policy and guidance on AER objectives and NER outputs may be necessary to clarify how non-monetized EGS effects and benefits should be used in planning projects.

As an interim approach, it may be useful to consider how descriptions of ecological conditions can be used as proxies for EGS. This may help transition from the current emphasis on outputs relative to significant species and habitat, toward consideration of service outputs, and values of these outputs, to guide investment through the Civil Works program.

The potential advantages of incorporating EGS into decision-making include providing a broader, more accurate view of project effects, more directly illustrating the societal value of ecosystem restoration actions, and ensuring consideration of a wide array of project benefits and adverse effects in planning and management. A number of federal agencies are actively conducting research and/or conducting studies to quantify the value of the ecosystem good and services provided by the resources for which they are responsible, and the relevance of their programs to supporting these EGS.

In general, federal conservation and ecosystem management policies and guidance developed within the last few years acknowledge EGS explicitly; however, there is limited experience with implementation except that progress is being made in the development of 'markets'. Many policies are already in place that enable consideration of EGS information in planning or specific land management decisions. EGS may also be a useful approach for the Corps in mitigation planning and stewardship decision-making. Given the wide interest in the topic of EGS the Corps has the opportunity to leverage resources and expertise by including exploration of EGS approaches in partnering agreements with other agencies.

In summary, the use of EGS information in program or agency scale decision-making deserves further consideration and could enable strategic system- or national-scale consideration of water resource objectives, including ecosystem restoration. This conclusion provides a context for other research endeavors that seek to provide a framework for the use of EGS with Corps planning. In addition, the exploration of case studies within the Corps of how EGS have or have not been considered thus far can provide insights into what, if any adjustments, need to be made in Corps practice to build on the growing interest in and acceptance of EGS in other agencies.

Using Information on Ecosystem Goods and Services in Corps Planning: An Examination of Authorities, Policies, Guidance and Practices

Introduction

From the origins of modern ecosystem service analysis in the late 1970s, there has been growing interest in assessing the benefits that humans derive from more naturally functioning ecosystems (Gomez-Baggethuna, et al. 2009). There is a growing recognition of the importance to society that ecological goods and services provide for health, social, cultural, and economic needs, and perception that such services, or the potential for them, are being lost to a point beyond system resilience. However, efforts to consistently, completely and reliably quantify ecosystem functions and the values of related goods and services during water resources planning studies have realized limited success. USACE may have missed opportunities to display the full benefits provided by environmental restoration activities and/or failed to illuminate important trade-offs related to any particular decision.

Ecological goods might include clean air and fresh water.

Ecological services might include purification of air and water, maintenance of biodiversity, decomposition of wastes, soil and vegetation generation and renewal, pollination of crops and natural vegetation, groundwater recharge through wetlands, seed dispersal, greenhouse gas mitigation, and aesthetically pleasing landscapes.

Existing reports have explored the history, definitions, conceptual models, classification schemes, and operational approaches of ecosystem services as an initial step in development of a framework for incorporating ecosystems services in Corps planning (Tazik, et al. 2013). The information provided here is intended to inform USACE water resources planners as they attempt to include information about ecosystem goods and services (EGS) in studies, project formulation and evaluation. It also was developed to inform the other tasks in this research and development (R&D) work unit, including, development of the framework and guidelines, assessment of conceptual models, interagency collaboration strategies, and profiles for the case studies examinations. Conversely, the work under the other tasks will inform the development of recommendations regarding authorities, policy and guidance. Discussion of the concept of EGS and the role it can play in decision making is ongoing within the Corps and other agencies. The review and analyses presented here is current as of summer 2012 and as

other work unit products are completed, and other research and policy initiatives come to fruition, the analysis may require revision.

The Corps' planning process has evolved from a rich history of changing national priorities, policies and practices, and it will continue to evolve. The consideration of many types of information about effects of alternatives has been integral to water resources planning for decades (if not centuries). All significant effects of a plan are to be accounted for in the planning process. The consideration of environmental effects pre-dates the Corps' current aquatic ecosystem restoration (AER) mission. The deliberation on ecosystem services is growing in the literature, and in national and international discussions regarding natural resources management and stewardship, environmental protection, regulation and other applications. Many agencies have included ecosystem services terminology in their strategic plans or program discussion documents. However, whether EGS is being used by agencies to guide environmental decision-making is unclear.

The evolution of the EGS concept and different perspectives of categories of ecosystem goods and services have been discussed elsewhere (Tazik, et al. 2013). In this report, the roles of the Corps and others are considered relative to the list of ecosystem services relevant to water resources management shown in the box¹. It is important to note that consideration of EGS (Figure 1) does not require that benefits be reflected in economic terms. Also, the discussion in this report regarding the use of EGS in Corps decision making is not meant to convey that changes in EGS should be the sole rationale for project-related recommendations. Rather, the intent is to demonstrate where EGS can be used meaningfully as components of Corps analyses.

List of ecosystem services considered in this report:

- Ecosystem sustainability
- Natural hazard mitigation, property & infrastructure protection, human safety
- Recreation
- Navigation conveyance
- Aesthetics
- Water supply & regulation
- Water purification & waste treatment
- Raw goods & materials provisioning
- Food provisioning
- Cultural, spiritual, and educational support
- Climate regulation, carbon sequestration
- Human health

Part I of this paper discusses the Corps authority, policy and guidance influencing the potential use of EGS information in Civil Works project planning, and whether changes, clarification or other action may be necessary to advance this use of EGS information in project planning. Part II of this paper discusses the use of EGS concepts by other federal agencies, selected states and other countries in carrying out their programs, and assesses these ideas and approaches relative to potential USACE application. Part III draws together conclusions from the examination of the Corps and others, including some consideration of the use of EGS

¹ Definitions of these ecosystem services are provided in the 'Analytical Framework and Guidelines' currently under development.



Figure 1. Simplified framework for consideration of EGS supplied by natural features and the benefits they provide.

information to aid in portfolio applications and conveying the value to the nation from investments through the Civil Works program.

This paper, while not specifically geared toward Corps District planners, might be useful in providing information about current Corps' policy regarding the consideration of various ecosystem services, and show how different agencies and local sponsors might be interested in particular services.

Part I. Civil Works Authorities, Policy, and Guidance Influencing the Use of EGS Information in Corps Planning

An “EGS approach” is defined broadly as using information on EGS in decision-making. Below is the definition of ecosystem goods and services used in this paper.²

Ecosystem services are socially valued aspects or outputs of ecosystems that depend on self-regulating or managed ecosystem structures and processes.

Should the Corps formulate for the restoration of EGS? Is the Corps authorized to do so? Can the Corps consider EGS in its AER planning, and planning for other purposes? Are positive and negative effects of EGS considered to some degree already as part of planning? How is this similar or different from current practices used in localized or regional scale planning, and in cost share studies carried out in collaboration with non-federal sponsors, other agencies and stakeholders? Is there a need to change or clarify USACE authority, policy and guidance in order to include EGS in planning? How can information about EGS benefits provided by Corps AER or other water resource projects be useful in justifying and prioritizing these projects at the programmatic or portfolio level? How can EGS information be used to contribute to the value to the nation story of the Civil Works Program? Can information about potential changes to EGS help identify partners in undertaking recommended actions? Some of the questions above cannot be answered until the results of the ongoing research emerge and are assessed.

There are different ways to lump and split the concepts of EGS (Tazik, et al. 2013). Those that are most intuitively tied to the Corps’ water resources missions may be most readily useable in plan formulation and evaluation, or in project justification. Others may make a better case in telling the story of the value to the nation from federal investments made through the Civil Works projects, particularly AER. As with the other goods and services considered in water resources planning, EGS do not vary independently of one another, which can create different challenges in using this information, both at the project and portfolio levels.

While the terms ecosystem services or ecosystem goods and services are becoming more widely used, the nation and the Corps have implicitly recognized the importance of benefits arising from the ecological functions of healthy ecosystems for several decades. The existing use of information on EGS effects (positive and negative) for investment decisions may be most prevalent for the services that can be monetized, but other services have been recognized in planning and may be quantified, but not given dollar values, or they may be treated qualitatively.

² This is a 'working definition' proposed by companion research documents which provide discussion of alternative and evolving definitions of ecosystem goods and services from the literature. This definition is proposed for use in Corps planning, and may evolve over the course of the work unit.

The scope and approach to formulating, evaluating, justifying and prioritizing Corps Civil Works projects are influenced by many factors. These should be taken into account when discussing whether it is possible to formulate for EGS, or how to integrate information about EGS into studies and plans. Should changes to some of these factors be desirable, some are more readily changed than others. Among the factors that influence the scope and approach to studies and plans are authorities (including appropriations), national and agency policy, implementation guidance, analytical tools, as well as non-federal sponsor interests, priorities and constraints. The Administration’s budgetary priorities (issued annually), also influence the selection of Corps studies and projects recommended for inclusion in the budget for planning, design, construction and operation in any given year.

The following material identifies support for considering EGS, and factors within current authority, policy and guidance that can influence the treatment of this information.

A. Authorities and Policies Relative to Considering EGS Information in Planning

While not explicitly using the term “ecosystem goods and services”, Civil Works authorities and policies appear to support or allow consideration of such information in planning water resources projects.

Numerous authorities and directives related to Corps waters resources planning authorize the display and consideration of a broad range of effects of the proposed action (positive and negative). While not comprehensive, Table 1 illustrates an implied recognition of ecosystem functions and services in historic water resources legislation.

Table 1. Historic water resources legislation and planning guidance related to ecosystem functions and services.

<p>1950’s - Proposed Practices for Economic Analysis of River Basin Projects</p>	<p>Treatment of Tangible and Intangible Effects (italicized text are direct quotes)</p> <ul style="list-style-type: none"> - <i>These intangible effects need to be described with care and should not be overlooked or minimized, merely because they are not susceptible of dollar evaluation. Intangible costs may involve such effects as the possible loss of a scenic or historic site in connection with a proposed dam. On the other hand, intangible benefits may in some cases embrace effects such as strengthening of national security and regional economies through the encouragement of a more widely dispersed industry and the provision of opportunities for new homes, new investment, and new employment opportunities; and the provision of new avenues for the enjoyment of recreation and wildlife.</i> - <i>Recommendations. All project effects, both tangible and intangible, should be fully considered in making project recommendations. Project effects should be evaluated in monetary terms to the maximum extent practicable. If market prices are not available, estimated, derived, or agreed upon values may be appropriate in some cases. In other cases,</i>
--	---

	<i>intangible effects will need to be considered on a qualitative basis. If the recommended degree of project development is influenced in either direction by specific intangible effects, the value assigned to such effects should be clearly indicated. It is suggested that the agencies concerned develop procedures for the treatment of intangibles including assignment of acceptable project expenditure values for effects that are measurable in physical units for which no market value exists.</i>
1960's	
1962 - Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources	(Also known as Senate Document 97) -Prepared by the President's Water Resources Council, it called for three objectives to be fully considered: development of national and regional economies; preservation of the nation's natural bounty; and well-being of people.
1965 Water Resources Planning Act	Established the Water Resources Council which developed the federal multi-objective, multipurpose planning procedures under the WRC's Principles and Standards (P&S) for Water Resources Planning which included benefit-cost analysis for water quantity planning.
1969 National Environmental Policy Act	Required the consideration of all reasonable alternatives and of direct, indirect and cumulative effects of each alternative on significant resources; required the integration of mitigation in alternatives; and required the documentation of environmental considerations.
1970's	
1970 River and Harbors and Flood Control Act	Section 209 states that the objectives of enhancing regional economic development, the quality of the total environment, including its protection and improvement, the well-being of the people of the United States, be considered along with national economic development objectives, in the evaluation of benefits and costs of federally financed water resources projects, giving due consideration to most feasible alternative means if accomplishing.
1980's	
1986 Water Resources Development Act	<p>Section 904 – "Matters to be Addressed in Planning" authorizes including national economic development, the quality of the total environment, the well-being of the people of the United States, the prevention of loss of life, and the preservation of cultural and historical values in the formulation and evaluation of water resources projects. It also authorizes display of both the quantifiable and unquantifiable benefits and costs.</p> <p>Section 729 – "Study of Water Resources Needs of River Basins and Regions" authorized the study of such needs in consultation with federal, state and local agencies.</p>

Watershed Planning and Studies

Authorities such as WRDA 1986, Section 729, “Study of Water Resources Needs of River Basins and Regions,” and its amendments enable the Corps to undertake watershed studies and watershed planning. Watershed studies are planning initiatives that are multi-purpose and multi-objective in scope, and accommodate flexibility and collaboration in the planning process for examining needs and opportunities, and developing recommendations. Possible areas of investigation are specified in guidance as examples, but not limited to these – flood risk reduction, ecosystem restoration, navigation, water supply, and recreation.

Because watershed studies require consideration of water resources development and management in the context of multiple purposes rather than single purposes, facilitating a search for comprehensive and integrated solutions, these studies may be well suited for, and benefit from information on EGS.³ Watershed studies may also be more suited in scale for considering some services, and trade-offs among them. They may also facilitate opportunities for public and private groups to identify and achieve common goals, as well as leverage resources and programs to implement projects and actions in addressing EGS.

National Environmental Policy Act (NEPA)

As a foundational environmental law that requires agencies to evaluate the consequences of a full range of alternative ways to pursue goals before acting, NEPA seems particularly supportive of considering EGS information in water resources planning. NEPA requires the consideration of all direct, indirect and cumulative effects of each alternative on significant resources. The consideration of, if not the valuation or quantification of EGS, could contribute to informing the public and decision makers about potential gains and losses in EGS from alternative plans and scenarios. NEPA also includes provisions for considering activities at the programmatic level, allowing for analysis of regional or national effects. Information about EGS could inform these analyses.

National Environmental Policy Act declares it a national policy to “*encourage productive and enjoyable harmony between man and the environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation*” (42 U.S.C. 4321.)

Appendix A summarizes the provisions of NEPA which may be useful in considering the development and use of information about effects of Corps actions on EGS.

³ Corps policy requires use of a watershed perspective in both planning for a project feasibility study or a more comprehensive watershed study. (U.S. Army Corps of Engineers 2000) para. 2-6.

Planning Principles

The planning principles used to guide Civil Works water resources project planning evolved from these and other laws, and can accommodate consideration of EGS information.

Examination of goods and services is integral to Corps evaluation procedures, so to the extent that it is possible draw analogies to the use of this concept and associated procedures, the more readily relevant EGS information may be integrated into Corps planning. The term “ecosystem services” is mentioned once in Corps planning guidance, relative to AER project planning:

The conceptual basis for evaluating nonmonetized NER benefits is society’s value toward the increase in ecosystem services (U.S. Army Corps of Engineers 2000).

Corps planning for water resources projects is based on the Water Resources Planning Act of 1965 (specifically 42 USC §1962d-17), as well as the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) which, among other things, reaffirmed the use of four accounts to facilitate evaluation and display of effects of alternative plans. These accounts include the following:

- National economic development (NED)
- Environmental quality (EQ)
- Regional economic development (RED)
- Other social effects (OSE)

The NED account shows effects on the national economy. The EQ account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms. The OSE account shows urban and community impacts and effects on life, health and safety. The RED account shows the regional incidence of NED effects, income transfers, and employment effects.

NED account displays changes in the economic value of the national output of goods and services.

EQ account displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans.

RED account displays changes in the distribution of regional economic activity (e.g., income and employment).

OSE account displays plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts, e.g., community impacts, health and safety, displacement, and energy conservation (U.S. Army Corps of Engineers 2000), para E-3.

In addition to requiring presentation of information on the NED effects of alternative plans, the P&G states that “[o]ther information that is required by law or that will have a material bearing on the decision-making process should be included in the other accounts, or in some other appropriate format used to organize information on effects.” Depending upon the circumstances, information about EGS may be characterized within one of the four accounts (NED, EQ, RED, OSE), or may be otherwise formatted or organized to make it useful in the various stages of planning and decision-making. The requirement to recommend an NED plan is decision criteria, not a planning principle. Furthermore, the requirement to recommend the NED plan is not absolute. The P&G states the following:

“The alternative plan with the greatest net economic benefit consistent with protecting the [nation's] environment (the NED plan) is to be selected unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reason for selecting another plan, based upon other [federal], [state], local, and international concerns.”

Environmental Operating Principles

The U.S. Army Corps of Engineers’ (USACE) Environmental Operating Principles (EOP) were developed to ensure Corps missions include totally integrated, sound environmental practices. These principles provide corporate direction to ensure the workforce recognized the Corps’ role in, and responsibility for, sustainable use, stewardship and restoration of natural resources across the nation⁴. The EOP were introduced in 2002, and in 2012, the Corps re-energized the principles to better reflect the current mission and challenge. The Environmental Operating Principles relate to the human environment and apply to all aspects of business and operations. The EOP’s focus on environmental stewardship is expected to lead to more efficient and effective solutions, and will enable the Corps to further leverage resources through collaboration. This is seen as essential for successful, integrated water resources management, restoration of the environment and sustainable and energy efficient approaches to all USACE mission areas.

The 2012 Environmental Operating Principles

1. Foster a culture of sustainability throughout the organization.
2. Proactively consider environmental consequences of all USACE activities, and act accordingly.
3. Create mutually supporting economic and environmental solutions.
4. Continue to meet corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

System Analysis

System analysis is among the principles of analysis that are fundamental to the planning process. Under this principle, all Corps study initiatives are to consider broad system aspects of problems and solutions. In some instances these system considerations will be addressed throughout the planning process, such as in watershed or navigation systems studies. In other

⁴ While the EOP do not define sustainability in the Corps context, the supporting documentation does note that a culture of sustainability entails the “concept of stewardship, wise management and responsible use of natural resources.”

instances, such as with more limited project-oriented studies, systems considerations are to be included in a reasonable and cost-effective manner as part of the initial phase of the planning process.

B. Topics for Special Consideration in Using EGS Information in Corps Planning

This section presents information on several subjects that can influence how EGS information is used in Corps planning. Authorities and policy related to these topics may define how related EGS are considered in Corps studies. Other ongoing research within the work unit may identify potential changes and supporting rationale for changing policy or guidance to better integrate information about related EGS.

Water Quality

Water quality-related EGS may be some of the more easily understood outcomes, and they also may be closely aligned with the missions of other federal, state and local agencies.

Water quality conditions and effects are considered in planning any water resources project. However, the Corps is not generally authorized to undertake projects or features that would result in treating or otherwise abating pollution problems caused by other parties where those parties have, or are likely to have a legal responsibility for remediation or other compliance responsibility are not recommended for implementation under AER.

Recreation

Similar to water quality, recreation-related EGS may be among those that resonate readily with sponsors, stakeholders and the general public. Recreation features of Civil Works projects must be justified and are to be appropriately cost-shared. In planning for AER projects, recreational features are limited to those compatible with the ecosystem outputs for which the project is designed, and they should not increase the federal cost of the ecosystem restoration project by more than 10 percent without prior approval of the Assistant Secretary of the Army (ASA) Civil Works (CW). Although known primarily for the opportunities managed at its lake projects, the Corps also participates in the planning, design and construction of recreation facilities at a wide variety of other types of water resource projects. Such facilities might include hiking and biking trails associated with a stream channel or levee primarily designed for flood damage reduction. There is no general authority for Corps participation in a single purpose recreation project.

Cultural

While “cultural services” is used in some categorizations of EGS to represent an array of valued ecosystem outcomes such as recreation and aesthetics (Millenium Ecosystem Assessment Board 2005)⁵, Corps planning guidance does not address cultural ecosystem services

Topics discussed in this section include:

- Water Quality
- Recreation
- Cultural
- Spiritual
- Aesthetic
- Subsistence and Commercial Fishing
- Navigation
- Water Supply

⁵ Reid (2005) includes cultural diversity, spiritual and religious values, recreation and eco-tourism, aesthetic values, knowledge systems and educational values as 'Cultural Services.'

specifically. “Cultural resources” are considered in that Corps planning considers the impacts of projects and activities to these resources. The related ecosystem service is often characterized as “cultural heritage.” Heritage value may include consideration of both historic culture and implications for future generations. The former addresses contemporary society’s value on the past and the latter considers the value of resources or opportunities for future generations. Each may be described in terms of economic value, or intangible values to individuals, communities and society as a whole.

Corps guidance addresses cultural resources studies as scientific investigations conducted for the purposes of discovering cultural resources; confirming their location, extent, and character; evaluating their significance; determining potential project; and informing alternative preservation and/or mitigation plans. Studies often consider future social conditions to be expected with and without the plan throughout the period of analysis. The situation existing before the initiation of planning provides a basis for evaluating significant social effects relative to alternative plans. Significance of resources and outcomes can also be described in terms of public recognition, which may include the role of the resource in a community’s public customs and traditions (U.S. Army Corps of Engineers 2000), para E-37. It may be appropriate to display cultural ecosystem goods and services in the other social effects (OSE) account. This account can include effects on relevant social factors described and presented in terms that best characterize the planning perceptions and social setting of the affected area in the situation without the plan.

Spiritual

In some EGS characterizations, spiritual EGS are a component of cultural services (Millenium Ecosystem Assessment Board 2005). In addition, ongoing work with tribes often includes integrating consideration of effects on spiritual services, and studies with other partners and stakeholders may have integrated consideration of spiritual values. Spiritual values may be closely related to cultural values, but perhaps not always. It may be useful to talk with the USACE tribal coordinators as well as cultural resources specialists and social scientists regarding this category of services and integrating information about these effects into water resources planning.

Similar to cultural services above, it may be appropriate to display spiritual ecosystem goods and services in the OSE account. This account can include effects on relevant social factors described and presented in terms that best characterize the planning perceptions and social setting of the affected area in the situation without the plan.

Aesthetics

In some EGS characterizations aesthetics is a component of cultural services (Millenium Ecosystem Assessment Board 2005). Current planning guidance requires consideration of visual resources and impacts to cultural services in plan formulation, design and engineering. It allows aesthetic project features to help blend the project harmoniously into the setting, without aiming to beautify the surrounding area. Aesthetic measures are to be designed so that they are fully compatible with the project purpose and do not compromise the safety, integrity or

function of the project (U.S. Army Corps of Engineers 2000). Most discussions of aesthetic ecosystem services refer to the aesthetic value of the natural environment that is enjoyed, and contributes to human well-being (Tazik, et al. 2013). Because the environmental quality (EQ) account displays non-monetary effects on ecological, cultural, and aesthetic resources, it may be appropriate to include aesthetic ecosystem goods and services in the EQ account.

Subsistence and Commercial Fishing

Analytical procedures are available for effects attributable to subsistence and commercial fishing. Subsistence fishing is conducted primarily for personal or family consumption, by individuals whose incomes are normally at or below the minimum subsistence level established by the Department of Commerce. Commercial fishing benefits accruing to the commercial fishing sector may be described when the plan is projected to change fish catch or result in cost savings to existing harvests (U.S. Army Corps of Engineers 2000)⁶. For cost allocation purposes, subsistence fishing is considered commercial fishing. Commercial fishing benefits generally are attributable to cost savings for the existing catch because most fisheries are managed and not all can support increased catch.

Navigation

For navigation conveyance, it is recognized that some channels are naturally deep, thus providing the opportunity to transport goods. As ecosystem services are derived from naturally functioning ecosystems, dredging a channel to remove naturally occurring shoals would not necessarily qualify as providing an ecosystem service. However, actions to reduce excessive sediment input into a river could result in ecosystem services, including ecosystem sustainability and navigation; such services could be captured in terms of cost-savings in navigation operations costs over the life of the project. The application of sedimentation affecting navigation is also proposed by Keeler et al. (2012) in their depiction of the relationship between water quality change, which includes sediment, and multiple ecosystem goods and services (Keeler, et al. 2012).

Water Supply

Some EGS characterizations include water supply as provisioning of fresh water, regulating water flow or other availability. The Corps has a water supply business line which is more narrowly defined and important to understand in using related EGS in Corps planning. The Corps roles in water supply have evolved through a variety of laws, and the current federal interest recognizes that states and non-federal entities have the primary responsibility in the development and management of their water supplies.

The **Flood Control Act of 1944** and the **Water Supply Act of 1958**, as amended and other pieces of legislation, define the federal interest in water supply. The current policy was defined by Congress in Section 932 of the WRDA of 1986.

Legislation and Corps policy assigns financial responsibilities to supply users, acknowledging the significant but declining federal interest through Civil Works Program investment in the long

⁶ Details in para E-11.

range management of water supplies. However, the Corps may participate in developing water supply in connection with water resource improvements for construction, operation, maintenance, and modification of federal navigation, flood damage reduction, or multiple purpose projects when certain conditions of non-federal participation are met. Some authorities provide for use of Corps reservoirs for surplus water, for municipal and industrial (M&I) water supply and for agricultural water supply. Nationally, there is about 9.8 million acre-feet of M&I water supply storage space in 134 Corps multiple-purpose projects, located in 25 states. The Corps is also authorized to provide emergency water, and to assist states and local interest in their water supply planning process.

Consideration of in-stream flow needs is part of the development of guidance for Corps water control projects. These efforts are not managed as part of the Corps water supply mission. The Corps water control management policy includes consideration of water quality and other environmental needs and opportunities in managing and operating these projects.

C. Procedural and Analytical Considerations

The Corps' guidance on a number of topics can influence how information about EGS is used in specific projects. It may be useful to revisit some of this guidance and the related policies as the research and analysis advances.

Project Purposes

The term project purpose identifies the type of output(s) intended from the project. The previous section discusses some of the purposes or outcomes that require special consideration in examining related EGS in Corps planning. Often project purposes have a number of associated implications, such as a cost sharing formulas, a general notion of the type of outputs, and a legislative and institutional history. The policies concerning individual project purposes change over time with legislation and other national priorities. Depending on the authority, and circumstance, there may be different opportunities and flexibilities for integrating additional project purposes in a study, and for considering information on related EGS.

Topics included in this section include:

- Project Purposes
- Benefit- Cost Analysis Cost-Effectiveness Analysis, Incremental Cost Analysis
- Incidental Benefits and Other Direct Benefits
- Separable Element
- Tradeoff Analysis
- Cost Allocation and Cost Sharing

Multiple Purpose Studies

Multiple purpose studies can examine more than one type of water resources problem or opportunity and recommend projects with more than one purpose. Corps mission areas can be combined to address multiple objectives within the localized study area. For example, many existing reservoir projects also supply water (for municipal, industrial or agricultural uses), or provide hydropower. Additionally, there may be opportunities to address some combination of purposes which also could include ecosystem restoration and/or recreation. Oftentimes there will be competing water resource uses; therefore environmental, social, and economic

considerations need to be evaluated. The evaluation process for these projects should demonstrate the trade-offs for providing various combinations and levels of economic, social, and environmental outputs. Improved information about EGS can help inform this evaluation and communicate the tradeoffs. Multiple purpose studies may result in the recommendation of a single project or set of projects that satisfy the range of water resources purposes identified.

Benefit-Cost Analysis, Cost Effectiveness Analysis, Incremental Cost Analysis

It will be useful if the tools and methods developed to support the use of EGS information in Corps planning contribute to understanding and communicating the effects of the project, considering and weighing alternatives, and helping to justify recommended projects as sound investments. While it is not necessary to monetize all costs and benefits, quantitative information about changes to EGS is needed for analysis.

Benefit-cost analysis is both a concept and a technique for assessing proposed investments. In principle, all pertinent costs and effects (beneficial and detrimental) of an action are systematically tallied. The results can then be tested against investment criteria, such as benefits greater than costs and maximum net benefits, which is the criterion used for identification of the NED Plan in accordance with the federal objective.

Benefit-cost analysis is used to determine if an investment or decision is sound relative to the costs not exceeding the benefits, and to provide a basis for comparing projects. It involves comparing the total expected cost of each option against the total expected benefits to see whether the benefits outweigh the costs, and by how much.

When there is no monetary measure of benefits but project outcomes can be described and quantified in some dimension consistently across plans, cost effectiveness analysis can be used in assessing efficiency. Cost effectiveness analysis seeks to answer the question: given an objective, what is the least-costly way of attaining the objective? The ability to identify the least costly among several alternatives that have the same outcome is very useful. Cost effectiveness can also aid choice among projects that differ in their outcomes.

Optimization of net benefits defines a plan that returns the greatest excess of benefits over costs; it is not possible to improve upon a plan producing maximum net benefits (total benefits less total costs). The benefits can be monetary or nonmonetary.

Incremental analysis is a process used in plan formulation to help identify plans that deserve further consideration. It consists of examining alternative plans or project features to determine their incremental costs and incremental outputs. Incremental cost analysis examines the subset of cost effective plans sequentially by increasing scale and increment of output to ascertain which plans are most efficient in the production of environmental outputs. When the incremental costs exceed the incremental benefits, no further increments are assessed. Incremental cost analysis helps decision makers to weigh whether the additional output provided by each successive output level is worth its additional cost (Carlson and Paresh 1993).

Risk Analysis

Risk analysis is defined as an approach to evaluation and decision making that explicitly, and to the extent practical, analytically incorporates considerations of uncertainties and associated risks. Risk analysis is composed of assessment, management and communication, and is used to compare plans in terms of the likelihood and variability of their physical performance, economic and/or ecological success and residual risks. The total effect of risk and uncertainty on the project's design and viability can be examined, and conscious decisions made reflecting an explicit trade-off between risk and costs relative to both positive and negative effects on EGS and other project effects. For ecosystem restoration projects in particular, adaptive management is employed to help manage the risk of not attaining the expected benefits.

Incidental Benefits and Other Direct Benefits

The current guidance on other direct benefits may provide useful insights into the treatment of increases in EGS that may not be primary project purposes, particularly for the benefits that can be monetized. The other direct benefits in the NED benefit evaluation are the incidental direct effects of a project that increase economic efficiency and are not otherwise accounted for in the evaluation of the plan or project. They are incidental to the purposes for which the water resources plan is being formulated. They include incidental increases in output of goods and services and incidental reductions in production costs. For example, a project planned only for flood damage reduction and hydropower purposes might reduce downstream water treatment costs; this reduction in costs would be shown as another direct benefit in the NED account (U.S. Army Corps of Engineers 2000).

The other direct benefits in the NED benefit evaluation are the incidental direct effects of a project that increase economic efficiency and are not otherwise accounted for in the evaluation of the plan or project.

Separable Element

Discussion of EGS in Civil Works planning should consider whether the service outputs require or are attributable to separable elements of the project. Separable elements of a project are those that can be implemented as a separate action, and have separately assigned benefits and costs. Separable elements so considered are similar to the planning concept of "last added increments", with the added idea of separation or detachment of the increment from the whole. This concept may be useful in considering how to address EGS outputs through discrete actions carried out in conjunction with other project measures.

Tradeoff Analysis

Trade-off analysis is used by the Corps to identify the potential gains and losses associated with producing a greater or lesser amount of a given output or outputs, or for producing one output to the exclusion of another. Several analytical approaches can be used to explore trade-offs including Multi Criteria Decision Analysis (MCDA)⁷. The results of trade-off analysis are used in

⁷For more on MCDA see:

Keeney, Ralph, and Howard Raiffa (1993), *Decisions with Multiple Objectives: Preference and Value Tradeoffs*, New York: Cambridge Univ. Press.

the formulation, evaluation, comparison and selection of the recommended plan. It will be important for the information on EGS to be in a form useful for evaluating alternatives, comparing plans, and considering tradeoffs. It will also be useful if EGS information can be examined at the portfolio level to aid in establishing program priorities.

The **multi-criteria decision making approach (MCDA)** is a means to compare alternative decision outcomes without readily comparable or quantifiably costs and benefits, especially in terms of monetary value. Fundamentally, it is a tool to structure and analyze complex decisions. The relative utilities of (i.e. the satisfaction from) alternative outcomes are elucidated from stakeholder preferences using a structured methodology based on quantitative surveys.

Cost Sharing

The costs of Civil Works water resources studies and projects are shared between

federal and non-federal entities as defined in laws and administrative provisions. The WRDA of 1986, as amended, establishes cost sharing rules for all studies and projects conducted by the Corps. The amount of the non-federal share varies depending upon the project purpose and the general and specific laws that apply to each project. Non-federal sponsor interests could influence whether and how EGS is considered in any given study.

If a sponsor prefers a plan more costly than the NED plan, the NER Plan or the combined NED/NER Plan, and the increased scope of the plan is not sufficient to warrant full federal participation. The Assistant Secretary of the Army (ASA) for Civil Works may grant an exception as long as the sponsor pays the difference in cost between those plans and the locally preferred plan (LPP). The LPP, in this case, must have outputs similar in-kind, and equal to or greater than the outputs of the federal plan. It may also have other outputs.

Cost Allocation

The allocation of total project financial costs among the purposes served by a plan is also established in policy. Separable costs are assigned to their specific purposes, and joint costs are allocated among purposes for which the plan was formulated. EGS outputs will have to be described so that all project costs can be allocated appropriately.

Planning Modernization

One of the Civil Works transformation initiatives is Planning Modernization, which includes an effort to streamline the Civil Works planning process. To ensure an expedited, economical and focused study process, a 3x3x3 rule has been established, where studies are limited to three years for a cost of no more than \$3 million, with three levels of vertical team integration (District, Division and Headquarters), unless otherwise approved. There is concern that developing information on EGS may increase study time and costs. It will be useful to consider how using information on EGS is compatible with the new 3x3x3 rule. Integration of EGS

Lahdelma, Risto, Pekka Salminen, and Joonas Hokkanen (2000), "Using multicriteria methods in environmental planning and management," *Environmental Management*, Vol. 26, No. 6, pp. 595-605.

Linkov, I., F. K. Satterstrom, G. Kiker, C. Batchelor, T. Brides, E. Ferguson, (2006), From comparative risk assessment to multi-criteria decision analysis and adaptive management: Recent developments and application, *Environment International*, 32, 1072-1093.

information in project formulation and evaluation could be especially helpful if its use reduces costs or brings other partners to help cost-share in the implementation. Similarly, the identification of tools that can ease the access to and use of EGS data and information might contribute to broader consideration of effects on EGS in the transforming planning environment.

D. Evaluation Framework for Aquatic Ecosystem Restoration (AER) Projects

While the scope of this paper is Corps planning relative to any water resource purpose, because there are some differences in formulation and evaluation processes for AER projects, this section discusses policy and guidance topics that may be relevant to using EGS information in restoration planning. Depending upon the results of other research tasks, potential changes may be identified for consideration.

The planning process for single purpose AER projects is the same as for any other purpose; however, the evaluation process is different in that it focuses on quantitative and qualitative restoration outputs and monetary benefits are usually incidental. Instead of monetary benefit-cost analysis, cost effectiveness and incremental analysis is used, and the significance and scarcity of the outputs are critical in determining if the monetary and /or non-monetary benefits of the proposed project justify monetary and/or non-monetary costs (U.S. Army Corps of Engineers 2000).

The significance of restoration outputs is recognized in terms of institutional, public, and/or technical importance. This information, along with information from cost-effectiveness and incremental-cost analyses, as well as information about acceptability, completeness, and effectiveness helps determine whether the proposed investment is worth its cost, and whether a particular alternative should be recommended (U.S. Army Corps of Engineers 2000; Apogee Research, Inc. 1997). See Box for further elaboration on these concepts and their consideration.

Considerations in planning AER projects

Information about the following is used to help determine whether a proposed investment is worth the cost, and whether a particular alternative should be recommended:

- Cost effectiveness and incremental cost analyses
- Significance of ecosystem outputs
- Information about acceptability, completeness, and effectiveness

Significance is

This is typically communicated using qualitative information about restoration outputs in terms of institutional, public, and/or technical (scientific) recognition.

Institutional: – Importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include Federal federal or state laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal federal government or of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Public -: Some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, providing volunteer labor, and correspondence regarding the importance of the resource.

Technical - : The resource is recognized as significant based on its 'technical' merits, which are based on scientific knowledge or judgment of critical resource characteristics. Corps planners are to 'describe technical significance in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, critical habitat, and biodiversity.'

Completeness, Effectiveness, Efficiency and Acceptability

These – are four evaluation criteria specified in the P&G (Paragraph 1.6.2(c)) in the screening of alternative plans. Alternatives considered in any planning study, not just AER studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans. These concepts are discussed in more detail in ER 1105-2-100, para E-3, and E-38 (U.S. Army Corps of Engineers 2000).

Considerations in planning AER projects. Information about the following is used to help determine whether a proposed investment is worth the cost, and whether a particular alternative should be recommended:

- Cost effectiveness and incremental cost analyses
- Significance of ecosystem outputs
- Information about acceptability, completeness, and effectiveness

Significance is typically communicated using qualitative information about restoration outputs in terms of *institutional, public, and/or technical* (scientific) recognition.

Institutional – Importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include Federal or state laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal government or of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Public - Some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, providing volunteer labor, and correspondence regarding the importance of the resource.

Technical - The resource is recognized as significant based on its 'technical' merits, which are based on scientific knowledge or judgment of critical resource characteristics. Corps planners are to 'describe technical significance in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, critical habitat, and biodiversity.'

Completeness, Effectiveness, Efficiency and Acceptability– are four evaluation criteria specified in the P&G (Paragraph 1.6.2(c)) in the screening of alternative plans. Alternatives considered in any planning study, not just AER studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans. These concepts are discussed in more detail in ER 1105-2-100, para E-3, and E-38 (U.S. Army Corps of Engineers, 2000).

This evaluation framework seems both accommodating of information about EGS, as well as limiting. AER outputs are to be identified and quantified in appropriate units, and increase in ecosystem value and productivity is preferred.⁸ Examples provided in current guidance include

⁸Ecosystem restoration outputs must be clearly identified and quantified in appropriate units. Although it is possible to evaluate various physical, chemical, and/or biological parameters that can be modified by management measures which would result in an increase in ecosystem quantity and quality in the project area, the use of units that measure an increase in 'ecosystem' value and productivity are preferred. Some examples of possible metrics which may be used include habitat units, acres of increased spawning habitat for anadromous fish, stream miles restored to provide fish habitat, increases in number of breeding birds, increases in target species and diversity indices. Alternate measures of ecosystem value and productivity may be used upon approval by CECW-P. Monetary gains (e.g., incidental recreation or flood damage reduction) and losses (e.g., flood damage reduction or hydropower) associated with the project shall also be identified.' (U.S. Army Corps of Engineers 2000, pg 3-25).

habitat units, acres or stream miles of restored habitat, increases in numbers of targeted birds, or species and diversity indices.

The current guidance also states that “alternate measures of ecosystem value and productivity may be used upon approval by CECW-P. Monetary gains (e.g., incidental recreation or flood damage reduction) and losses (e.g., flood damage reduction or hydropower) associated with the project shall also be identified.” (U.S. Army Corps of Engineers 2000).

AER studies seek to identify means to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. The emphasis is on aquatic ecosystems. Some EGS may be viewed as significant, but beyond the scope of the AER program because they are a departure from this emphasis. Alternatively, if articulating the relationship of the EGS resulting from the restoration action helps to communicate the value of the project, this should be further developed as it will be useful in project justification and potentially program defense. Questions remain as to whether habitats and changes to habitat conditions will be used as a proxy for EGS, or whether and when quantified EGS will be recommended and used. Because current guidance emphasizes outputs relative to significant species and habitat, moving toward greater use of EGS in AER planning may require further conceptual reconciliation among ecosystem structure and functions, and service outputs and values of these outputs and appropriate investment through the Civil Works program.

National Ecosystem Restoration Benefits (NER)

Contributing to National Ecosystem Restoration (NER) is identified in Corps guidance as the objective for Corps ecosystem restoration planning. Contributions to NER outputs are expressed in non-monetary units, and increase in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is usually based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured in the planning area and in the rest of the nation. Often habitat structure and function serve as a proxy for a host of beneficial outcomes that may be described but not quantified.

Single purpose ecosystem restoration plans are formulated and evaluated in terms of their net contributions to increases in ecosystem value (NER outputs) expressed in non-monetary units. Current policy and guidance would have EGS benefits that can be credibly monetized treated as NED or Regional Economic Development (RED) benefits rather than NER benefits, which could reduce the assessment of ecosystem restoration benefits as NER outputs. Multipurpose plans can include contributions to NER and NED outputs. For these, a plan that trades off NED and NER benefits to maximize the sum of net contributions to NED and NER is usually recommended. See Combined NED/NER Plans below.

Combined NED/NER Plans

When a project has both NED benefits and NER effects, the recommended plan is called a combined NED/NER plan. According to ER 1105-2-100, these plans attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two federal objectives. Recommendations for multipurpose projects can be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.” (U.S. Army Corps of Engineers 2000). There have been few instances of successful development and justification of these plans.

E. Opportunities for EGS in Corps Planning.

This analysis has shown that the information about EGS can be considered in Civil Works studies and this information could be useful in communicating project effects. No laws would need to be changed to do this. The approach may be particularly valuable in watershed studies where a broad array of effects can be considered, and EGS information may help illuminate and justify how and where the Corps and others could collaborate to achieve desired outcomes relative to EGS.

However, the procedural policy and guidance may need to be revisited once additional research results become available. Examples of potential challenges include the following:

- Treatment of services that are measured in dollars when planning for AER purposes – for service outputs that can be monetized, would this detract from the more traditional non-monetary environmental resource-based outputs because they would be considered NED benefits?
- Which ecosystem service will encompass the concept of National Ecosystem Restoration (NER) benefits currently founded in an ecological resources focus? Does it make sense to redefine NER?
- Approaches to combined NED/ NER plans – while current policy and guidance accommodates this, there continue to be challenges in practice. It is possible that the use of EGS can be used to rethink approaches to combined plans.

Quantifying multiple EGS in a way that they can be combined and reflected by a single value (either monetary or non-monetary) may provide a metric that appropriately reflects the multiple outcomes of a measure, but it can mask the contributions of recreational or aesthetic benefits, which are part of EGS, but not part of the NER objective and outputs. There is also the need to consider risk and uncertainty regarding project benefits, which may become difficult if multiple outcomes are combined. Some of the current challenges are attributable to uncertainties in the system response(s) to proposed restoration measures.

Some issues may arise in cost allocation, as discussed above, concerning incidental benefits and separable elements. Project outputs that are not considered NER outputs or that are not in the other priority categories for investment (flood damage reduction or navigation) should

probably be separately identified, e.g., recreation, one of the most widely recognized ecosystem services. Current practices may require modification for EGS to be used in a holistic way, i.e., representing the net effect on an array of services to represent project outcomes. One potential solution to this is to identify the effects of a project on an array of ecosystem services, but only use a subset of them in formulation, while using others to account for the multiple effects of the projects beyond those for which it is specifically formulated.

Consideration of EGS during planning may facilitate communicating a fuller array of effects provided by Corps activities and projects. Incorporating this into a planning study could require assessment of many more factors than are currently considered. Given concerns about protracted planning timelines and increased costs, it may be impractical for some studies, those for Continuing Authority Program (CAP) projects in particular, to fund the development and synthesis of information needed to adequately characterize demand for and effects on EGS. Use of EGS will require the identification and/or development of tools and assessment approaches, scaled for different study circumstances. These tools and assessment approaches could include sets of conceptual models, enabling Corps planners to readily identify which EGS might be positively or negatively impacted by a project or measure.

In addition to its use in planning, consideration of EGS may provide additional value to the Corps in program development, including prioritizing projects for funding and reporting on the contributions of the program as a whole, e.g., value to the nation. It may also help the Corps and other agencies to align efforts to deliver goods and services important to the region and nation. The multi-year life span of Corps projects in the federal budget process results in projects being subject to changing Administration priorities over time.

The more types of outcomes reported or accounted for, although not necessarily formulated for, in project documentation may help a project compete across an array of priorities for ecosystem restoration. It may also allow for greater collaboration with other agencies through identification of common interests. Further consideration of EGS may provide a way of refining the current consideration of resource significance in project justification and within the Corps AER program budget development. Research is still needed to determine whether EGS can inform national priorities and investment given the regional, species- and habitat-based differences in the current distribution of services and their impacts on human well-being.

A. Corps Natural Resources Management Program

The Corps has its own land management policy (ER 1130-2-540) for Corps administered project lands and water (U.S. Army Corps of Engineers 1996). Specifically the following:

“It is Corps policy to apply principles of good environmental stewardship to the natural and cultural resources occurring on Corps administered and/or managed lands and waters. For the Corps the term 'steward' shall mean manager of those public resources. Environmental stewardship shall include both passive and proactive management to sustain healthy ecosystems and biodiversity, and conserve natural resources, such that Corps lands and waters are left in a condition equal to or better than their condition when acquired, and such that

those natural and cultural resources are available to serve the needs of present and future generations.”

In addition, ER 1130-2-540 provides policy regarding the administration and management of natural resource activities at Civil Works water resource projects. This indicates that the Corps “conserves natural resources and provides public recreation opportunities that contribute to the quality of American life.” Ecosystem management is considered to be a proactive, goal-driven approach to sustaining ecosystems and their values. The focus of the Corps Natural Resource Management appears to be primarily recreation⁹.

⁹ <http://corpslakes.usace.army.mil/nrm.cfm>

Part II. Use of Ecosystem Goods and Services by Others

Many federal and state agencies are engaged in aquatic ecosystem restoration and disburse public funds in pursuit of ecosystem restoration goals. Agencies are also engaged in other actions related to ecosystem protection, conservation and natural resource stewardship. Some are responsible for management of public lands and associated natural resources. These activities are undertaken within the context of various statutes, policies and internal guidance documents. The focus of the discussion presented here is whether there are any lessons learned from the ways other agencies use ecosystem services in their various policies and management decisions, including ecosystem restoration, land stewardship and management, and environmental regulation, which may be useful to the Corps in the consideration of how to incorporate EGS into Corps planning.

This review of agency activities focused on federal agencies where ecosystem restoration, stewardship or management is a central agency mission, and/or where pursuit of methods to consider ecosystem services by agencies with broader missions has been helped by a more complete accounting of effects. While agencies use an array of criteria in their decision-making, the focus here is on their use of EGS, and EGS-related concepts such as environmental value and benefits accruing to people as a result of agency actions in the environment. Scarlett and Boyd (2011) describe existing federal policies that permit or promote ecosystem services analysis, management, investments, and markets. Their analysis recognizes that there are opportunities for more explicit use of an ecosystem services approach, and that federal agencies have considerable capacity to manage or even increase natural wealth. In addition, Ingraham and Foster (2008) and Gleason et al. (2008) describe the value of federal programs or outcomes with regard to the ecosystem services that were produced. Several agencies have ongoing research on EGS geared toward refining such estimates and developing tools to enable valuation to play a more central role in decision making.

A. Environmental Protection Agency (EPA)

The EPA has primary responsibility for enforcing many of the major environmental statutes and regulations of the United States including the Clean Water Act and Clean Air Act. This review focuses on guidance issued by EPA relative to their regulatory role, as well as some of their research responsibilities that consider ecosystem services.

EPA's Ecological Research Program Research Multi-Year Plan (2008-2014) states that several statutory and regulatory mandates for EPA support the shift to an ecosystem services focus, including, but not limited to:

- **Executive Order (EO) 12866.** EO 12866 requires an examination of the environmental costs and benefits of EPA's regulatory actions.

- **Clean Water Act (CWA).** The CWA has several provisions that give EPA authority to conduct research on, and regulate impacts to, ecosystem services provided by aquatic systems.
- **Clean Air Act.** Nox and Sox secondary standards directly evaluate impacts on ecosystem services.
- **Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).** The regulations that guide the assessment of natural resource damages under CERCLA provide for compensation resulting from injury to natural resources and the loss of services those resources provide.

While these statutes pre-date the current use of the term “ecosystem services,” they support the concept of protecting ecosystem services by protecting ecosystem structures and processes for their benefits to humans (EPA 2010).

EPA is clearly investing time and resources toward integrating ecosystem services into their decision making processes, including their Wetlands Compensatory Mitigation Program and Nox/Sox Secondary Standards Review (Cox et al., 2013). Many key EPA guidance documents, e.g., Guidelines for Ecological Risk Assessment (GERA) (U.S. Environmental Protection Agency 1998), date before ecosystem services became widely used terminology, but the concept of ecological value is often used in EPA guidance. Understanding how this term is used by EPA in decision making has many parallels to how ecosystem services are currently considered. For example, GERA notes that one of the key questions for risk managers to answer is “what are the ecological values (e.g., entities and ecosystem characteristics) of concern?” Similarly, a key part of risk assessment is interpreting management goals in terms of specific objectives and identifying “ecological values that can be measured or estimated in the ecosystem of concern.” Further, the guidelines recognize that definition of ecological values to be protected provides the best foundation for assessing risk. Management goals are considered the “desired characteristics of ecological values that the public wants to protect.”

Despite the obvious linkages to ecosystem services in the risk assessment guidelines, no explicit consideration of ecosystem services could be identified in recent guidance on water criterion for methylmercury (U.S. Environmental Protection Agency 2010) or contaminated sediment remediation (U.S. Environmental Protection Agency 2005). Similarly, the 2011 EPA Strategic Sustainability Performance Plan (U.S. Environmental Protection Agency 2011) does not address ecosystem services as an operational framework or as a context for decision making. Like other agencies EPA does have policy on water quality trading (U.S. Environmental Protection Agency 2003), which lays out objectives for water quality trading that EPA would support. One of these recognizes that water quality trading can be a way of combining ecological services to achieve multiple environmental and economic benefits, such as wetland restoration to improve water quality and wildlife habitat.

Despite the limited direct incorporation of ecosystem services into current decision making in EPA, they have active research into how ecosystem services can be used. This work has been directly advised by the EPA Science Advisory Board (SAB). In 2009, the EPA SAB produced a

report “Valuing the Protection of Ecological Systems and Services” (U.S. Environmental Protection Agency 2009), which identifies that valuation of ecosystems and services is most useful when done in the context of specific decisions affecting the environment. The report was prepared by the SAB Committee on Valuing the Protection of Ecological Systems and Services. It identifies several policy contexts where ecological valuation could be important to EPA including the following:

- 1) To better value the ecological effects of EPA actions in national rule making (the Committee finds such an approach to be consistent with OMB Circular A-4).
- 2) To set priorities, especially at the regional level, for actions such as wetland restoration, or to identify critical ecosystems or ecological resources for attention.
- 3) In site specific decision, e.g., remediation, where ecological valuation could improve decisions at cleanup sites.

The EPA Ecosystem Services Research Program (ESRP) is now part of the Sustainable and Healthy community Research Program and is undertaking ES research in a variety of areas. Many products are described at <http://www.epa.gov/research/ecoscience/eco-services.htm>, including a recently produced the report “Quantifying Coral Reef Ecosystem Services” (U.S. Environmental Protection Agency 2012). One of their ongoing initiatives is to effectively measure and communicate the type, quality, and magnitude of services that humans receive from ecosystems so that ecosystem value can be considered in decision-making. One major product is the EnviroAtlas. The Atlas “will allow the user to interact with a web-based, easy-to-use, mapping application to view and analyze multiple ecosystem services for the contiguous United States.”¹⁰

EPA Summary

- EPA Office of Research and Development is developing a broad array of studies and tools related to ecosystem services. The concept of 'ecological value' is commonly used in EPA guidance including guidance for ecological risk assessment.
- EPA Science Advisory Board has been a strong advocate for increased research on ecosystem services, and EPA has extensive ongoing research on ecosystem services in the Office of Research and Development.

B. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)

Several of NOAA’s programmatic documents utilize the ecosystem service approach. The 2010 Next Generation Strategic Plan includes long-term goals for healthy oceans and resilient coastal communities and economies, and the term ecosystem services is used to describe the outcomes expected for several of the objectives. The science and technology enterprise also includes the development of tools for valuation of ecosystem services. The 2011 NOAA Business Operation Manual, which is intended to describe how they do business, refers to the balance of competing uses for ecosystem services as a measure of the quality of the agency’s

¹⁰ <http://www.epa.gov/research/enviroatlas/>

management and regulation responsibilities. However, the ecosystem service approach has more specific application within several specific NOAA offices and programs.

NOAA Fisheries

There is a substantial emphasis on moving toward ecosystem approaches to fishery management in NOAA, much of which is a result of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. However, specific reference to ecosystem services is limited. The concept is implicit in integrated ecosystem assessments (Levin, et al. 2008) and the emphasis on increased use of market-based management tools, including catch shares, may entail assessment of ecosystem goods and services. NOAA's report to Congress on the state of science to support an ecosystem approach to fishery management (National Oceanic and Atmospheric Administration, National Marine Fisheries Service 2009) refers to the need for additional data to allow assessment of ecosystem goods and services, but does not, for example, call for the development of specific approaches to their assessment.¹¹ The Office of Habitat Conservation also references ecosystem services as a general approach, but it is unclear whether and how ecosystem services are used in specific decisions. The exception is the assessment of increased base development on Guam and its effect on coral reefs using Habitat Equivalency Analysis (see NRDA below) that is seen by NOAA as an ecosystem services concept.¹²

Ocean and Coastal Resource Management

NOAA's Office of Ocean and Coastal Resource Management administers a number of programs, several of which potentially link to ecosystem services. It works with states on a voluntary basis to meet the goals of the Coastal Zone Management Act (CZMA) of 1972. The CZMA section 303 states that it is a matter of national policy "to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development."

The Act pre-dates the recent emergence of ecosystem services as a concept for ecosystem management, and thus references to ecosystem services are implicit. Many of the activities of the CZM program are consistent with the consideration of ecosystem services. For example, the 2007-2012 CZM strategic plan recognizes ecosystem services in its goal to "protect, restore, and enhance coastal ecosystems," but the objectives for this goal are cast in terms of habitat rather than ecosystem services.

Also under this office is the Coral Reef Conservation Program. This program has articulated a set of strategic coral reef management priorities developed in consensus by the coral reef managers in seven U.S. coral reef jurisdictions. The goals and objectives of the overall program (National Oceanic and Atmospheric Administration 2009) identify ecosystem services as important attributes of coral reef ecosystems, and note that the services are at risk from

¹¹ Such an approach may be of interest to the Corps as it would combine NED- and NER-type outputs.

¹² <http://www.habitat.noaa.gov/about/habitat/ecosystemservices.html#>

climate change. However, ecosystem services are not a key concept in the actual management priority documents. Many include an ecosystem approach to management, as opposed to single species, but do not specifically reference ecosystem services as component of decision making.

The CZMA also established the National Estuarine Research Reserve System (NERRS). The NERRS protects more than 1.3 million coastal and estuarine acres in 28 reserves located in 22 states and Puerto Rico for purposes of long-term research, environmental monitoring, education, and stewardship. Although there is no explicit language in the CZMA regarding ecosystem services and the NERRS, the NERRS system protects coastal habitats that are important for ecosystem service provision. The research conducted within the NERRS can provide the information needed to prioritize protection, restoration, and enhancement, and inform management decisions based on ecosystem services.

The NERRS also sponsors the “NERRS Science Collaborative,” which includes several projects related to the provision of ecosystem services. An example of these is a coastal blue carbon project funded by NOAA’s NERRS Science Collaborative, which is examining the relationship between salt marshes, climate change, and nitrogen pollution in the Waquoit Bay NERR. The goals of this project are to generate science and tools that coastal decision makers can use to manage nitrogen pollution, design effective wetland protection and restoration projects, and create policy frameworks and economic incentives to reduce greenhouse gases.

Damage Assessment, Remediation, and Restoration Program

NOAA’s Damage Assessment, Remediation, and Restoration Program (DARRP) was created in 1992 after the Exxon Valdez oil spill in 1989. The program guides assessment and restoration of natural resources injured by releases of oil and hazardous substances, as well as by physical impacts, such as vessel groundings in National Marine Sanctuaries. At waste sites or after an oil spill, the Assessment and Restoration Division conducts a Natural Resource Damage Assessment (NRDA). The NRDA process determines the extent of harm to natural resources and their uses and the appropriate type and amount of environmental restoration required to compensate the American public for those impacts.

Habitat equivalency analysis (HEA) is a methodology used by NOAA to determine compensation for such resource injuries. The principal concept underlying the method is that the public can be compensated for past losses of habitat resources through habitat replacement projects providing additional resources of the same type. The process of scaling a project involves adjusting the size of a restoration action to ensure that the present discounted value of project gains equals the present discounted value of interim losses. There are two major scaling approaches: the valuation approach and the simplified service-to-service approach, which applies under certain conditions.

Habitat Equivalency Analysis (HEA)¹³ is an example of the service-to-service approach to scaling. The implicit assumption of HEA is that the public is willing to accept a one-to-one trade-off between a unit of lost habitat services and a unit of restoration project services (i.e. the public equally values a unit of services at the injury site and the restoration site). HEA does not necessarily assume a one-to-one trade-off in resources, but instead in the services the resources provide, and thus HEA is consistent with an ecosystem services, as opposed to a habitat-based, approach to restoration. If the assumption of a one-to-one trade-off between the resources at the injury site and the compensatory restoration site is invalid, the valuation approach to scaling can be used.

Value-to-value¹⁴ scaling entails equating the monetary value of natural resource services lost from an injury with the monetary value of restoration project(s) that would compensate for those lost services. In other words, the value of the services provided by the restoration project should equal the value of the interim losses. Alternatively, the value-to-cost approach only requires estimation of the value of the interim losses of natural resource services. That value, or dollar amount, is then spent on appropriate compensatory restoration projects.

A recent example of the application of these approaches is in the February 2012 Final DARP/EA for the Cosco Busan oil spill in San Francisco Bay (Cosco Busan Oil Spill Trustees 2012). For the quantification of injuries to wildlife and habitat, the Trustees relied on a service-to-service restoration-based approach. Resource Equivalency Analysis (similar to HEA) was used for this analysis. However, to compensate for the loss of recreational use resulting from the incident, the Trustees gathered data regarding visitor use of impacted sites and associated activities. To value those lost uses, the Trustees used a Travel Cost Model for general beach use, and are employing the Benefits Transfer Method for boating and fishing. Restoration actions are then selected using a value-to-cost approach, with the cost of the restoration actions being scaled to the monetary value of lost and diminished human uses.

NOAA Summary

- Ecosystem services are frequently used as a general descriptor of the breadth and import of ecosystem attributes NOAA programs address.
- Historically, few NOAA programs used ecosystem services analysis to directly inform decision-making; however, a move to ecosystem-based management is changing this.
- Damage assessment and restoration plans do use service-based analyses and valuation techniques, which are similar in some ways to ecosystem service assessment methodologies.

¹³ NOAA., Habitat Equivalency Analysis: An Overview (1995, rev. 2000, 2006), *available at* <http://www.darrp.noaa.gov/library/pdf/heaoverv.pdf>

¹⁴ <http://www.darrp.noaa.gov/economics/tools.html>

C. U.S. Department of Agriculture (USDA)

USDA has several initiatives that consider EGS or related issues. For example, the National Institute for Food and Agriculture has provided substantial funding for research and tool development, and the Agricultural Research Service and the Economic Research Service provide supporting research. In addition, the USDA Climate Change Program Office is conducting work on greenhouse gases. USDA appears to consider environmental services and ecosystem services as equivalent terms¹⁵. It also uses the term watershed services that include water purification, ground water and surface flow regulation, erosion control, and stream bank stabilization. The mission of USDA includes leadership on agricultural issues, and management of natural resources on public and private lands. In addition to the specific initiatives outlined here, USDA has supported a variety of research that could underpin specific assessments of ecosystem services relative to agriculture and forestry.

While not specifically focused on EGS, the Farm Services Agency's Conservation Reserve Program¹⁶ (CRP) provides financial incentives for farmers to establish land cover that provides environmentally beneficial outcomes such as reduced sediment runoff. The Farm Service Agency also reports on environmental benefits and has a Voluntary Carbon Data Initiative that will allow landowners to estimate carbon sequestered in the Conservation Reserve Program.

A more specific USDA approach to ecosystem services in relation to agriculture is captured in the following quote from the USDA Forest Service fact sheet on Valuing Ecosystem Services: “Private investments in conservation can financially compensate landowners for protecting and enhancing ecosystem services, particularly in places where these services are degraded or scarce.” (U.S. Department of Agriculture Forest Service 2007). Furthering this approach might be supported by the development of markets or market-like mechanisms for the trading of credits for valuable aspects of the environment. USDA researchers have examined the pros and cons of using markets to increase private investment in environmental stewardship (Ribaud, et al. 2008).

Section 2709 of the Food Conservation and Energy Act of 2008 (Farm Bill) authorizes the Secretary of Agriculture to “establish technical guidelines that outline science-based methods to measure the environmental services benefits from conservation and land management activities in order to facilitate the participation of farmers, ranchers, and forest landowners in emerging environmental services markets” with a priority to establish procedures to enable farmers, ranchers and forest landowners to participate in carbon markets. The legislation calls for “a procedure to measure environmental services benefits” and a “protocol to report environmental services benefits.” This led to the establishment of the Office of Ecosystem Services and Markets in December 2008 with funding to be provided by the Natural Resources Conservation Service, Forest Service, Farm Service Agency, and Rural Development. In February 2010 this office was renamed the Office of Environmental Markets (OEM) and charged with

¹⁵ see <http://www.fs.fed.us/ecosystemservices/OEM/index.shtml>

¹⁶ see <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp>

supporting the development of emerging markets for carbon, water quality, wetlands and biodiversity.

Natural Resources Conservation Service (NRCS)

In August 2011, the NRCS released their Natural Resources Credit Trading Reference (Kling and Secchi 2011). NRCS identifies environmental credit trading (ECT) as a range of market-like transactions where an entity undertakes an activity that provides environmental benefits in exchange for payment from another. They note that this does not require the engagement of the public entity and can occur between private parties. However, “it can only be effective in improving the environment if there is some firm requirement for environmental improvement (a cap or a standard)” (Kling and Secchi, 2011). Thus they view ECT as complementary to, rather than as a substitute for other policy mechanisms, such as regulation.

The report also notes that to be effectively applied in agriculture, credit trading programs will have to overcome the difficulty of measuring and monitoring the environmental good being produced, and the contribution of a specific market participant to the provision of the environmental good. Proxies for the actual environmental good can be used; in agriculture, the application of conservation practices is often used as a proxy for measured reductions in soil erosion and nutrients. Using practice-based proxies creates the additional challenge of accounting for the variation in the effectiveness of the same practice in delivering the desired environmental outcomes over space and time.

Notwithstanding these and other challenges, environmental markets were identified in the 2010 Strategy for Protecting and Restoring the Chesapeake Bay Watershed (Strategy) as an emerging tool for facilitating the implementation of conservation measures by providing financial incentives. The Chesapeake Bay Environmental Markets Team is chartered by the Strategy to facilitate collaboration among federal agencies in development of the infrastructure needed for enabling environmental markets to function effectively in the Chesapeake Bay Watershed. The team is supported by USDA Office of Environmental Markets.

In January 2012 NRCS announced the availability of up to \$10 million in Conservation Innovation Grants to enhance the effectiveness of water quality trading, with up to \$5 million focused on water quality credit trading in the Chesapeake Bay watershed. The Office of Environmental Markets is also partnering with NRCS, the World Resources Institute (WRI), and Chesapeake Bay tributary states on the development of NutrientNet, a multi-state on-line nutrient trading platform. WRI is working on this through a Conservation Innovation Grant awarded in 2010, and the on-line calculation tool is already in use by the Pennsylvania Nutrient Credit Trading Program.¹⁷

Forest Service (FS)

The mission of the FS is “to sustain the health, diversity, and productivity of the Nation’s forests” on both private and public lands.¹⁸ FS has identified ten things the agency could do “in

¹⁷ <http://pa.nutrientnet.org/>

¹⁸ <http://www.fs.fed.us/aboutus/mission.shtml>

the spirit of ecosystem services” (Collins and Larry 2007). Many of these describe increasing awareness and research. Two of these are concerned with the development of markets. In 2006, FS estimated that more than 44 million acres of private forests in the lower 48 states were at risk of development in the next 25 years. FS is interested in the potential of markets to trade ecosystem services as a way of mobilizing investments to protect and restore such forests.¹⁹ In 2007, FS entered into a memorandum of understanding (MOU) with the National Forest Foundation (NFF), which called for cooperation on reforestation projects and for NFF to estimate the amount of carbon sequestered by reforestation projects, if any, using commonly accepted carbon accounting procedures including 3rd party verification. However, the MOU specifically states that any carbon credits generated are not to be traded.

Another of the items calls for an approach to forest planning and management that sustains the flow of ecosystem services. In 2012, new rules for National Forest System Land Management Planning were released. The new rule was developed, to some extent, in response to court dismissal of the 2008 rule. According to FS, a “new planning rule is needed to ensure that plans will be responsive to the challenges of climate change; the need for forest restoration and conservation, watershed protection, and wildlife conservation; and the sustainable use of NFS lands to support vibrant communities” (U.S. Department of Agriculture Forest Service 2012). The new rule requires “the consideration and integration of the management of physical, biological, social, and cultural resources, given a unit’s distinctive roles and contributions of ecosystem services and multiple uses to the local area, region, and Nation.” Given that the new rule has only recently been released, specific methodologies to support its consideration of ecosystem services have not yet been identified.

USDA Summary:

- Several USDA agencies are engaged in ecosystem service initiatives.
- The USDA has an Office of Environmental Markets charged with catalyzing the development of markets for ecosystem services.
- Funds are currently being directed toward the development of environmental markets, especially in Chesapeake Bay watershed.
- Consideration of ecosystem services is required in new rules for the development of forest management plan but no specific methodologies are yet available.

D. Department of the Interior

The Department of the Interior (DOI) is charged with “protecting the [nation's] resources and ensuring equity in their use” (U.S. Department of Interior 2013). It is “the steward of 20 percent of the [nation’s] lands including national parks, national wildlife refuges, and the public lands” (U.S. Department of Interior 2011). DOI formally adopted a Climate Change Adaptation Policy that establishes the need to “maintain key ecosystem services.”²⁰ It also has responsibilities for the Outer Continental Shelf (OCS); policies and guidance for EGS and OCS activities have not

¹⁹ <http://www.fs.fed.us/news/2006/speeches/06/ecosystem-services.shtml>

²⁰ <http://elips.doi.gov/elips/DocView.aspx?id=3740&searchid=bdf2920d-b35e-4186-8059-2e5e3053315b&dbid=0>

been considered in this review. In addition, the agency is responsible for migratory wildlife conservation. The extent of the surface land managed by DOI is shown in Figure 2. This review has not considered EGS in policies for tribal reservation lands.

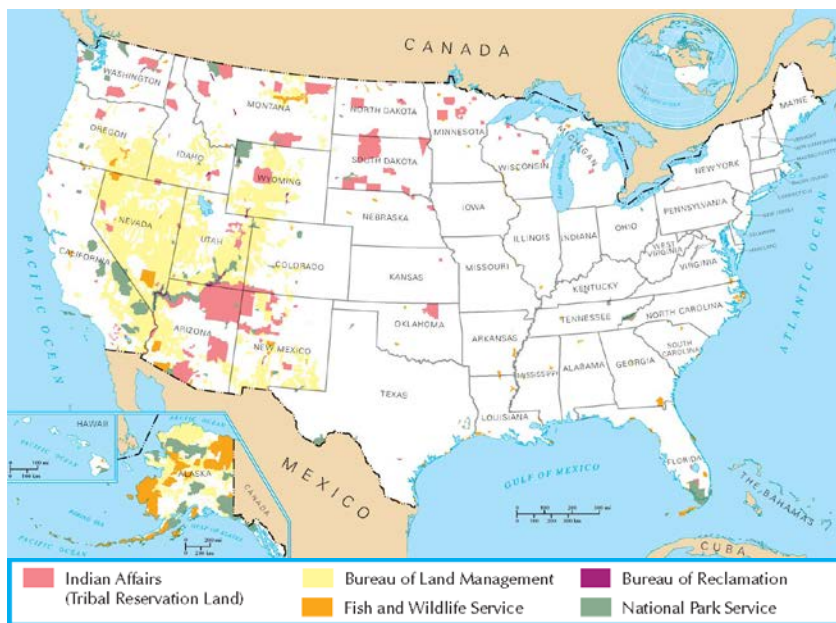


Figure 2. Surface lands managed by the Department

Because of the different missions of its bureaus and offices, there is common interest regarding ecosystem issues. According to the DOI Strategic Plan, “managing and protecting the biological and physical components that support ecosystem services and processes is a priority of the Department, especially as it relates to the impacts of climate change”. The Fish and Wildlife Service (FWS), National Park Service (NPS), Bureau of

Land Management (BLM), and the Bureau of Reclamation (Reclamation), are incorporating ecosystem services into resource evaluation and management, and conducting a number of studies for broader applications.

The mission of the USGS is to serve the nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. As the nation's largest water, earth, and biological science and civilian mapping agency, the USGS collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The USGS conducts large-scale, multi-disciplinary investigations and provides impartial scientific information to resource managers, planners, and other decision makers.

As a scientific organization without regulatory responsibilities, the USGS conducts research on ecosystem services, their monetary and non-monetary values, and their application in planning and decision making. In this capacity, USGS partners with other federal organizations including other DOI bureaus, USDA, EPA, and USACE. One such interagency effort is implementing the 2011 recommendations of the President's Council of Advisors on Science and Technology (PCAST) that “[federal] agencies with responsibilities relating to ecosystems and their services (e.g., EPA, NOAA, DOI, USDA) should be tasked with improving their capabilities to develop valuations for the ecosystem services affected by their decision-making and factoring the

results into analyses that inform their major planning and management decisions" (President's Council of Advisors on Science and Technology 2011).

The following review has focused on policies and guidance for three of the large land management and natural resources components of DOI.

Fish and Wildlife Service (FWS)

The mission of the FWS is "working with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people" (U.S. Fish and Wildlife Service n.d.). Their strategic plan further commits the agency to an ecosystem approach, which is described as requiring working with partners.

While the FWS does not have a formal EGS program, the agency incorporates EGS into resource management and conservation in many ways. Examples of FWS programs that use market-based tools for conserving trust resources include Partners for Fish and Wildlife payment incentive programs and the use of conservation banking in ESA consultation (U.S. Fish and Wildlife Service 2013). Since 2005, FWS has been working with a partnership of federal, state, tribal, and local governments and non-governmental organizations (NGOs) to develop a strategic approach to prioritize coastal ecosystem restoration and protection investments based on ecosystem services (Washington Department of Fish and Wildlife 2012).

Opportunities exist for incorporating voluntary market mechanisms (for example eco-certification, carbon sequestration markets and payments for watershed services); traditional payment incentive programs (such as NRCS Farm Bill programs); and mitigation programs (like offsets from Natural Resource Damage Assessments) with existing FWS conservation tools (such as Safe Harbor Agreements and Candidate Conservation Agreements). The FWS is encouraging pilot projects to test these tools as well as other habitat credit trading programs and is involved with partners, including USACE, in several EGS market-based programs (e.g. Willamette Partnership's Counting on the Environment) (Willamette Partnership n.d.).

The FWS also manages the National Wildlife Refuge System, which includes more than 150 million acres, 556 national wildlife refuges and other units of the Refuge System, plus 38 wetland management districts. One of the goals of the refuge system is to "provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation)" (U.S. Fish and Wildlife Service 2006).

The policies and guidance which are used in this management are part of the FWS Service Manual (U.S. Fish and Wildlife Service 2013). The statutes governing the refuge system identify the conservation of wildlife as the highest priority for management and "wildlife comes first" is an essential tenet of refuge management. In developing Comprehensive Conservation Management Plans for each refuge, FWS uses a "systematic decision-making process" and seeks to "maintain, and where appropriate, restore the ecological integrity of each refuge" (U.S. Fish and Wildlife Service 2000). Refuge management economic activities are also identified to

include farming, grazing, haying, and timber harvesting, in recognition of refuges' production of additional goods and services of value. Such economic activities are subject to compatibility determinations if a commodity is generated that is either sold for income or revenue or traded for goods and services (U.S. Fish and Wildlife Service 2002).

A 2012 report, "Amenity Values of Proximity to National Wildlife Refuges," details the results of a national-scale analysis of the effect National Wildlife Refuges have on nearby homeowners' property values (Taylor, Xiangping and Hamilton 2012). FWS also factors EGS into calculating the economic benefits of national wildlife visitation to local communities (Caudill and Henderson 2005). The FWS also has stewardship of lands with wilderness designation.

Wilderness areas are defined by the Wilderness Act as (emphasis added):

A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped [federal] land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historic value (U.S. Fish and Wildlife Service 2008).

Due to the lack of human intervention in wilderness areas, the values described are provided by the natural environment and could be described as ecosystem services if biotic elements contribute to the value. In the development of management plans for wilderness areas, alternative approaches are evaluated. The Manual specifically identifies the following:

We consider the full range of wilderness values and character when evaluating the alternatives. These values include the undeveloped and untrammelled natural condition of wilderness, cultural resources, outstanding opportunities for solitude, the potential for the public to have a primitive and unconfined type of recreational experience, and other components of wilderness character.

No indication is provided of how the alternatives should be compared (e.g., quantitatively or qualitatively). However, this evaluation is part of a Minimum Requirement Analysis and the Manual goes on to describe how MRA analyses are conducted in conjunction with NEPA compliance suggesting that the level of analysis and approaches may be similar.

Valuing ecosystem services, participating in environmental market development, refining current payment for incentives programs, and improving existing offset programs are examples

of how the FWS and its partners can improve the effectiveness of fish and wildlife conservation at multiple scales.

National Park Service (NPS)

The National Park Service (NPS) “preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations” (National Park Service 2006). The “protective” aspect of their management approach is captured in NPS management policies in one of the NPS principles that seeks to “prevent impairment of park resources and values.” The Manual also notes that the fundamental purpose of parks includes “providing for the enjoyment of park resources and values by the people of the United States,” recognizing that human benefit is essential.

Further, “the enjoyment that is contemplated by the statute is broad; it is the enjoyment of all the people of the United States and includes enjoyment both by people who visit parks and by those who appreciate them from afar. It also includes deriving benefit (including scientific knowledge) and inspiration from parks, as well as other forms of enjoyment and inspiration,” which is consistent with the concept of non-use value that is discussed by many economists²¹ and some of the cultural services described in the Millennium Assessment (Millennium Ecosystem Assessment Board 2005). However, according to the Manual, when there is a conflict between conserving resources and values and providing for the enjoyment of the, conservation is predominant.

How this guidance is interpreted on the ground and which procedures are used to guide park management requires examination of Implementation Plans for individual parks, which is beyond the scope of this assessment. However, the NPS has incorporated EGS into its evaluations of the total economic value of water-related recreational activities along the Colorado River, visibility of airsheds in parks affected by non-point pollution, and natural sounds. The NPS has also incorporated EGS into its planning activities, such as with air quality impacts of Snowmobile use in Yellowstone National Park (Ray 2012). The NPS has documented and estimated on an annual basis the regional economic impacts of visitation on local economies as ecosystem services. The NPS has based its natural resource damage assessments under the Park System Resource Protection Act, Oil Pollution Act, and Comprehensive Environmental Response, Compensation and Liability Act on EGS through economic valuation and restoration planning. Additionally, the NPS has established its Inventory and Monitoring Program to identify and quantify to the extent possible EGS in national parks.²²

Bureau of Land Management (BLM)

The BLM manages more than 245 million acres of public land, known as the National System of Public Lands, primarily located in 12 Western states, including Alaska. The BLM has a multiple-use mission is to “sustain the health and productivity of the public lands for the use and enjoyment of present and future generations.”²³ The Bureau manages such activities as

²¹ For example, the existence benefits described by Boyd and Banzhaf (2007)

²² <http://science.nature.nps.gov/im/units/NETN/Reports/reports.cfm>

²³ http://www.blm.gov/wo/st/en/info/About_BLM.html

outdoor recreation, livestock grazing, mineral development, and energy production, and is charged with conserving natural, historical, cultural, and other resources on public lands. The BLM's mission is set forth in the Federal Land Policy and Management Act (FLPMA) of 1976. Land use planning, consistent with the principles of multiple use and sustained yield is guided by the Land Use Planning Handbook (Bureau of Land Management 2005).

In the FLPMA (Sec. 201), Congress declares that “public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values” (U.S. Department of Interior 2001). Multiple use is defined as “the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people (Sec. 103).”

Later sections require an inventory of “lands, their resources, and other values” and call for land use planning to consider “the relative scarcity of the values involved.” Methods for assessment or quantification of these values are not specified beyond the need to “use a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic, and other sciences” (Sec. 202(c)(2)). Additional information is provided where the FLPMA provides for exchanges of land. Sec. 206 states “that when considering public interest the Secretary concerned shall give full consideration to better [federal] land management and the needs of State and local people, including needs for lands for the economy, community expansion, recreation areas, food, fiber, minerals, and fish and wildlife,” and that all of these values are be considered in determining whether an exchange of land is beneficial.

The Land Use Planning Handbook explicitly references the case where there may be competing resource uses and values within the same area. In this case, the Handbook indicates that “BLM manage the public lands and their various resource values so that they are utilized in the combination that will best meet multiple uses and sustained yield mandates” (Bureau of Land Management 2005).²⁴ The Handbook provides guidance on the land-use planning process and its relationship to NEPA, and includes an Appendix with specific guidance on the use of socio-economic information in land use planning. Appendix D calls for the impact analysis in the Environmental Consequences section of the Environmental Impact Statement (EIS) to include an analysis of “the positive and negative economic effects of each alternative developed within the Resource Management Plan on those communities and groups.” Table 2 shows the specific reference to non-market valuation in the guidance.

²⁴ Sustained yield is defined in FLPMA as 'the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the public lands consistent with multiple use.'

Table 2. Extract from BLM H-1601-1 Appendix D Table D-2, “Topics for Socio-Economic Analysis”

Topic	Planning Relevance	Examples
Non-market values of resources and activities	Consider the significance of the non-market values associated with resources managed or impacts by BLM when formulating the management alternatives	Estimate the value of open space, improved riparian areas, improved wildlife habitat
Subsistence activities	Non-market production from BLM lands for local use	Amount and value of subsistence hunting by local residents

Some guidance is provided on the analysis to be used and includes the following:

Non-market value. The analysis of economic impacts for each plan alternative should consider not merely anticipated expenditures (market transactions), but where feasible, the anticipated consumer surplus generated by the proposed activity, as determined by estimates of willingness-to-pay (non-market values). To estimate non-market values for activities proposed under a plan alternative, it is often more practical to utilize benefit transfer methods than to undertake new research within the study area, by applying soundly derived non-market values established for comparable sites and activities (Appendix D, page 10).

BLM’s Natural Resource Damage Assessment and Restoration program has guidance describing the use of nonmarket valuation methods in calculating compensable damages, (Bureau of Land Management 2008) following Interior Department regulations.²⁵ In addition, BLM’s socioeconomic program is conducting several projects to improve the Bureau’s ability to incorporate the values of ecosystem goods and services, including nonmarket values, in its management decisions.

Nonmarket Values Guidance. Guidance on the use of nonmarket values in resource management plans and environmental impact statements is planned for release by May 2013. This is intended as interim guidance, to be revised in light of forthcoming field case studies (see next item).

Nonmarket Valuation Field Case Studies (BLM-USGS). The economic methods for estimating nonmarket values are complex, and BLM staff has very limited experience in their use. Project researchers will work with a number of BLM field offices to identify management issues that could benefit from estimates of nonmarket values, and will prepare estimates using function transfer techniques incorporated in a web-based estimation tool. The case studies will document challenges and successful approaches in using nonmarket values in resource decisions. The lessons will be documented in a guidebook for BLM staff.

²⁵ 43 CFR 11.83.

Ecosystem Services Guidance. BLM's socioeconomics program is participating in an interagency effort to develop guidelines for the use of ecosystem service metrics in federal resource decisions. This effort is organized by the National Ecosystem Services Partnership, based at the Nicholas Institute at Duke University.

Ecosystem Services Projects. BLM has partnered with USGS researchers to conduct two pilot projects intended to assess the technical feasibility and usefulness of incorporating EGS values into management decisions. The Phase 1 project, a comparative assessment of ecosystem services valuation tools in the San Pedro watershed in Arizona, has been completed (Bagstad, et al. 2012). The Phase 2 project involves modeling scenic and recreational values for the Moab Master Leasing Plan EIS, which involves tradeoffs among oil and gas production, potash mining, and recreation in the highly scenic Canyon Country District in Utah. BLM has also incorporated EGS in evaluating the efficiency and effectiveness of hazardous fuels treatment in California (Ganz, et al. 2007).

DOI Summary

- DOI bureaus and offices are using EGS in planning, resource management, and resource damage assessment and restoration. Additionally, DOI bureaus and offices are conducting EGS research.
- The concept of value pertaining to natural and cultural resources is common in guidance for managing national wildlife refuges, national parks, and public lands managed by BLM.
- The management and conservation of resources with the purpose of access to and/or appreciation by the American public is also common. In some agencies it is secondary, e.g., "wildlife comes first" in national wildlife refuges.
- FWS, NPS and BLM planning guidance all include references to concepts that are consistent with including EGS in management decisions. BLM land use plans require analysis of economic effects. Guidance on the use of non-market values is included in their handbook, although not required for all resource management plans.

E. Department of Defense (DOD)

The Department of Defense (DOD) has an important role in land stewardship. Through its Natural Resources Conservation Compliance Program (NR Program) the DOD provides policy, guidance, and oversight for management of natural resources on approximately 29 million acres of military land, air, and water resources owned or operated by DOD.²⁶ The goal of the NR Program is to support the military's combat readiness mission by ensuring continued access to realistic habitat conditions, while simultaneously working to ensure the long-term sustainability of DOD lands.

Policies for "the integrated management of natural resources including lands, air, waters, coastal, and near-shore areas managed and/or controlled by the Department of Defense" are

²⁶ <http://www.dodnaturalresources.net/>

provided in DOD Instruction NUMBER 4715.03 dated 18 March 2011 (Department of Defense 2011). This instruction, which explicitly does not apply to land under the control of USACE, states that it is DOD policy that the principal purpose of all DOD lands is to support mission related activities, and that natural resources conservation program activities “shall work ... to sustain the long-term ecological integrity of the resource base and the ecosystem services²⁷ they provide.” Further, “DOD shall demonstrate stewardship of natural resources in its trust by protecting and enhancing those resources for mission support, biodiversity conservation, and maintenance of ecosystem services.”

Integrated Natural Resource Management Plans (INRMPs) are to be prepared for all installations that include significant natural resources; the instruction calls for them to incorporate the principles of ecosystem-based management.²⁸ The instruction states the purpose for incorporating this approach is to foster long-term sustainability of ecosystem services and accommodate use of those ecosystem services in a sustainable manner.

Additionally, for areas that are appropriate for leasing for forestry or agriculture, INRMPs should place ecological sustainability objectives above revenue optimization goals. Little specificity on the interpretation of ecosystem services is provided. However, there is recognition of the market value of conservation. The Instruction states:

DOD Components shall not engage in Conservation Market-Based Credit sales, trade, exchange, or use other forms of offsets of DOD land, air, and water resources to outside interested parties. Use of markets for environmental and ecosystem services through voluntary market mechanisms, such as environmental credit trading and mitigation banking, is precluded as it is a form of encroachment on military lands (Department of Defense 2011).

Despite this emphasis on ecosystem services, the Natural Resources Conservation Metrics, which are used to “assess the overall health and trends of each installation’s natural resources program,” do not consider ecosystem services explicitly. They refer to ecological integrity, which is to be measured in terms of the extent and status of the native systems and habitats.

The DOD Legacy Resource Management Program²⁹ provides an opportunity for installations to receive funding to assist with natural resource conservation. The 2012 Request for Proposals

²⁷ Ecosystem services are defined as 'The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth'.

²⁸ Ecosystem-based management is defined as ' A goal-driven approach to managing natural and cultural resources that supports present and future mission requirements; preserves ecosystem integrity; is at a scale compatible with natural processes; is cognizant of nature’s timeframes; recognizes social and economic viability within functioning ecosystems; is adaptable to complex and changing requirements; and is realized through effective partnerships among private, local, State, tribal, and Federal interests. Ecosystem-based management is a process that considers the environment as a complex system functioning as a whole, not as a collection of parts, and recognizes that people and their social and economic needs are a part of the whole.'

²⁹ <https://www.dodlegacy.org/legacy/Intro/aoe.aspx>

specifically requests proposals to “demonstrate the importance of ecosystem services to military lands and waters.”

DOD Summary

- The Natural Resources Conservation Compliance Program makes ecosystem services a prominent part of the management of DOD lands.
- There is broad appreciation of the values associated with natural resources conservation, but few specifics on how they should be considered in INRMPS.

F. States

A review of all ecosystem services-related activities by states is beyond the scope of this review. However, to sample the ways in which ecosystem services are being used by state agencies to further environmental goals, three states with different types of environments and ecosystem related problems were considered. The review for each is not exhaustive, but is illustrative of on the ground thinking about ecosystem services in water resources related decision making.

Colorado

Colorado encompasses extensive areas of National Forest and National Grassland, which are managed by the U.S. Forest Service as described above. In addition, a variety of entities have discussed the importance of ecosystem goods and services derived from sustainable management of rangelands (Maczko and Hiding (eds.) 2008). Of particular note, however, is that the emergence of an ecosystem services marketplace offers an opportunity for revenue generation by both private and state land owners. To this end, the Colorado State Board of Land Commissioners (State Land Board [SLB]) specifically identifies ecosystem services markets in its Strategic Plan, updated in 2013, as a potential new revenue-generating strategy available to the SLB (Colorado State Board of Land Commissioners 2013). The plan states the following:

Strategic Objective #2.1: Develop a comprehensive management plan to promote stewardship of natural values on Stewardship Trust lands.

- Complete realignment of Stewardship Trust parcels based on natural values, attributes and capacity to support a range of potentially compensable ecosystem services.

Strategic Objective #2.3: Develop creative and diverse ways to produce income from conservation and conservation services.

- Establish pilot projects to test prospects for adding value to trust lands through marketing compensable ecosystem services.
- Generate \$10 million in conservation revenue, including non-simultaneous exchanges, conservation easements and lease revenue, from all trust lands.
- Begin an inventory of species and potential compensable ecosystem services on all state trust lands in both established markets (wetlands) and emerging markets (wildlife habitat, streams, forests).

- Monitor developments in future markets (carbon sequestration, soils, grasslands).
- Manage ecosystem service leases and/or projects and monitor development of emerging and new ecosystem service opportunities.

The confidence of the SLB that the demand side of the markets will be realized is based on consideration of three sources of demand: (1) project impacts that require compensatory mitigation under federal or state laws; (2) project impacts that may provide pre-compliance mitigation for species that are of concern, but are not yet listed; and (3) downstream water users who may desire up-stream watershed protection (Sonoran Institute; Solano Partners, Inc.; Parametrix 2012). Within this context, the expectation of continued highway and transportation developments as well as facilities associated with oil and gas exploitation and renewable energy generation supports the concept of a continuing need for mitigation.

In addition, this interest seems to be motivated by a recent example of payment for watershed services involving the U.S. Forest Service and Denver Water. On August 28, 2010, these agencies announced an agreement to proactively improve the health and resiliency of forests and watersheds in areas critical for providing water to the City and County of Denver.³⁰ Each agency will contribute \$16.5 million for a total of \$33 million to manage forests toward reducing wildfire risk, restoring areas recovering from past wildfires, and minimizing erosion. From the Denver Water perspective, these watershed improvements can help minimize sedimentation impacts on reservoirs and other water infrastructure by reducing soil erosion and the risk of wildfires.

Florida

Florida is the first state that has passed legislation to address ecosystem services. The 2008 Florida Legislature enacted new requirements for the annual report of the Land Management Uniform Accounting Council effective July 1, 2008. The new law requires managing agencies to report on the ecosystem services that their lands provide. Section 259.037(3)(b)5, F.S., states that each reporting agency shall do the following:

...include a report of the estimated calculable financial benefits to the public for the ecosystem services provided by conservation lands, based on the best readily available information or science that provides a standard measurement methodology to be consistently applied by the land managing agencies. Such information may include but not be limited to, the value of natural lands for protecting the quality and quantity of drinking water through natural water filtration and recharge, contributions to protecting and improving air quality, benefits to agriculture through increased soil productivity and reservation of biodiversity, and savings to property and lives through flood control.

³⁰ <http://www.denverwater.org/supplyplanning/watersupply/partnershipUSFS/>

However, as of the 2011 Annual Report of the Land Management Uniform Accounting Council, such a calculation has not been possible. The annual report notes that “it is possible that, as an interim solution to meeting the statutory requirements, the next 12 months will lead to the ability to provide broad estimates of ecosystem services for the total acres of land in public ownership, but the science for measuring such services at the unit management level does not yet exist at a level that would be feasible for managing entities to implement. If such estimates become possible, they will appear in subsequent annual reports” (Land Management Uniform Accounting Council 2012).

Despite these difficulties being encountered by those required to make ecosystem service valuation calculations, there was a recent call by multiple entities for the South Florida Ecosystem restoration task force to use the valuation of ecosystem services in decision-making for Everglades restoration (Everglades Coalition 2010). In Florida, as in other states, there is great interest in the development of ecosystem markets to incentivize sound ecosystem management practice. Florida's Cooperative Conservation Blueprint calls for the establishment of “an ecosystem services markets incentive that monetizes the value of the environmental services provided by rural lands” (Florida Fish and Wildlife Conservation Commission 2010). The concept is that public and private utilities or agencies requiring an environmental service (for example, storing and purifying water to prevent flooding and meet water quality standards) would first look to private landowners to provide those services through conservation management practices and restoration activities.

There is a recent example of this payment for ecosystem services in the North Everglades. The South Florida Water Management District (SFWMD) developed its Northern Everglades-- Payment for Environmental Services (NE-PES) program as part of the agency's broader Dispersed Water Management program. In January 2011 it issued a solicitation for eligible cattle ranchers in the Northern Everglades to propose water management alternatives that would provide either acre feet of water retention or pounds of nutrients (phosphorus or nitrogen) removed over a ten-year contract. A total of 14 proposals were evaluated and eight were approved for funding. The selected ranchers will receive financial assistance in making the best use of existing infrastructure and/or developing new, simple infrastructure that will increase water and nutrient retention capabilities. All projects will be monitored under an agreement with the World Wildlife Fund to document that the contracts are meeting the water retention goals (South Florida Water Management District 2011).

Oregon

In 2009 the 75th Oregon Legislative Assembly enacted Senate Bill 513 which establishes the following:

Section 2. It is the policy of this state to support the maintenance, enhancement and restoration of ecosystem services throughout Oregon, focusing on the protection of land, water, air, soil and native flora and fauna.

Section 3(1). It is necessary to assist landowners in gaining access to additional sources of revenue such as emerging ecosystem services markets and to help landowners diversify their incomes.

Section 3(5). The conservation and restoration of ecosystem services will help avoid carbon emissions, help address impacts associated with climate change and help natural resources adapt to these impacts.

Section 3(6) Given appropriate oversight, ecosystem services markets can save money, lead to more efficient, innovative and effective restoration actions than pure regulatory approaches and facilitate improved integration of public and private investment.

Section 4(2). State agencies are encouraged to use ecosystem services markets as a means to meet mitigation needs, after carefully avoiding the most sensitive resources and minimizing adverse impacts where development occurs.

Additional goals of SB 513 also call for the Sustainability Board to convene a working group on ecosystem services markets. The report resulting from the working group's activities, published in 2010, offers 10 recommendations (See Box on page 45 of this document).³¹ Refinements of this statute were attempted in 2012 with SB 1511, which would have authorized state agencies to purchase or receive credits for ecosystem services, and would have additionally allowed such agencies and local governments to use these ecosystem service credits for compensatory mitigation and water quality credit trading.” Although considered by the Senate Committee on Environment & Natural Resources, SB 1511 was ultimately referred to the Senate Committee on Rules and ultimately was not passed by the Assembly.

The Oregon Board of Forestry, in its 2011 Forestry Management Plan, is similarly supportive of the development of markets for forest ecosystem services beyond timber production, but it also includes the status of forest ecosystem services as an indicator of success for the program as whole. The desired trend is for Oregon forest ecosystem services produced to be stable or increasing, and to be sustainable. The plan cites some existing success with carbon credits and encourages the development of markets to support private landowners to contribute to the sustainability of ecosystem services (Oregon Board of Forestry 2011).

³¹ <http://www.oregon.gov/OWEB/SB513.shtml>

Policy Proposal Recommendations by the Oregon Sustainability Board in Response to SB 513.

- #1: Ensure conservation and restoration goals are integrated across state agencies to focus state investments and priorities.
- #2: Continue to identify and address statutory and administrative impediments to state agencies' and local governments' use of ecosystem market approaches and tools.
- #3: Encourage public-private partnerships to develop standardized tools and processes for accounting and approving ecosystem credits and payments.
- #4: Provide authority and direction to State [state] agencies and encourage local governments to purchase credits and invest in ecological outcomes that are consistent with state conservation and restoration goals.
- #5: Allow state agencies and local governments to sell credits under limited circumstances.
- #6: Use an adaptive management framework to consistently and collaboratively evaluate ecosystem services approaches.
- #7: Encourage state and local governments to cost, compare, and consider natural infrastructure as an alternative to hard engineering for new development projects and mitigation.
- #8: Encourage state and local governments to make policy-level land use and development decisions that fully consider the services ecosystems provide at an ecologically appropriate scale.
- #9: Provide a testing ground and stimulate demand for payments for ecosystem services.
- #10: Continue the dialogue with interested and affected parties to further facilitate development of ecosystem services and market approaches.

Oregon also provides two examples of advancing the use of ecosystem management in water resources decision-making:

- In 2010, Oregon Department of Forestry (ODF) partnered with the Oregon Department of Fish and Wildlife and the Tualatin River Watershed Council to place large wood debris into a one-mile reach of upper Gales Creek in Washington County. Grant funds were used to place logs within the stream channel and floodplain as a part of planned thinning and timber sale activities on the ODF-managed land. Under Oregon law, public agencies are not authorized to deal in ecosystem service credits; however, the project was carried through the full ecosystem credit estimation, verification, and registration cycle without the credits being purchased. The stream improvement project costs for ODF were about \$90,000. Had the credits been openly traded as an ecosystem market security, the credits could have been purchased by the public for an estimated \$1.4 million (Weeks 2012).
- For the City of Damascus, a suburb of Portland, the local wastewater/surface water management service provider to the City is investigating the viability of an ecosystem services approach to providing surface water management services in terms of the potential to provide long-term cost savings to ratepayers and an overall watershed health benefit. The goal is to inform the development of an implementable and cost-

effective approach to providing stormwater management services. Preliminary results indicate that in many cases existing natural resources can support development if augmented with low impact development (LID) site design that emphasizes infiltration and on-site water quality treatment (Yap and Murdock 2011).

States Summary

This limited review of state-level activities in the area of ecosystem services identified several themes, including the following:

- Various U.S. states also have shown an increased interest in ecosystem services, including Hawaii and Washington along with the states discussed above (Thompson 2012). The interest lies in the development of markets to both incentivize actions that sustain ecosystem services, but also, and perhaps more importantly, to provide sources of revenue for rural landowners.
- Payment for ecosystem services and/or payment for watershed services have been recently implemented through partnership between willing landowners and state/local agencies.
- The demand for environmental mitigation is often a motivator for the development of processes and procedures in support of ecosystem service evaluation and trading.

G. Other National Governments

The discussion of ecosystem services is global in nature.³² To illustrate the ways in which ecosystem services are incorporated into ecosystem restoration and water resources decision making overseas, two countries were selected, the UK and Australia, and specific high-profile water/environmental issues examined.

United Kingdom

Within the UK, a step forward in consideration of ecosystem services was made in 2011 with the completion of the first national ecosystem assessment (U.K. National Ecosystem Assessment 2011). The assessment points to the importance of ecosystem services, but notes that they are “consistently undervalued in economic analyses and decision making”. The consequences of this include “a less efficient resource allocation, with negative consequences for social well-being”. A follow-on phase commenced in 2012 to make the assessment applicable to decision and policy making at a range of spatial scales across the UK to a wide range of stakeholders.³³

³² As exemplified by the attention of international groups like IUCN (http://www.iucn.org/about/union/commissions/cem/cem_work/cem_services/) and UNEP (<http://www.ipbes.net/>)

³³ <http://uknea.unep-wcmc.org/NEWFollowonPhase/Whatdoesthefollowonphaseinclude/tabid/129/Default.aspx>

The current EU Water Framework Directive (WFD), developed in 2000, was intended to guide Member States toward an integrated approach to managing water resources through 2027. The 2000 WFD provided for water-related ecosystem issues, but did not advocate accounting for ecosystem services for managing water resources. At the end of 2012, after reviewing the Directive's implementation, the European Commission will publish proposals to safeguard the EU's water resources to 2020.

In May 2012, the Agriculture, Fisheries and Environment subcommittee of the House of Lords Select Committee on the

European Union (EU) issued a report on the EU Freshwater Policy.³⁴ They noted that water scarcity was becoming a major issue in Europe and that efforts should be made to educate citizens about the value of water and the ecosystem services provided by freshwater bodies in their local catchment area. Several of those who testified and provided evidence to the Committee discussed the importance of valuation of ecosystem services.

UK Department of Environment, Food and Rural Affairs Interest in Payments for Ecosystem services

- These market approaches provide opportunities not only for recognizing the importance of these services but linking more directly those who benefit from ecosystem services to those who can deliver them and to do so in cost-effective ways.
- By linking up beneficiaries and providers, these approaches can strength the integration between the natural environment and economy and society.
- Of particular interest is in understanding the opportunities for new financing streams and considering the potential for private PES schemes to emerge. If more ecosystem services could be incorporated in the formal economy, opportunities for innovation and investment in their provision might increasingly become mainstreamed.
- By linking up beneficiaries and providers, PES also provide opportunities for engaging a broad spectrum of stakeholders which could deliver improved outcomes for the natural environment and its many beneficiaries at local, catchment, national, and, in the case of climate regulation and biodiversity, potentially international level.

Within the UK government, the responsibility for areas of policy development has been passed to the devolved administrations. In Scotland, approval of a new biodiversity strategy would occur at the cabinet level, thereby committing other policy sectors to work toward the strategy's goals. Activities of the Department of Environment, Food and Rural Affairs (Defra) are relevant only to England and approaches may differ between countries. Defra has recognized the utility of payments for ecosystem services and notes four reasons for government interest (see Box) (Department for Environment Food and Rural Affairs 2010). Further UK Defra research in this area highlights the potential advantages and disadvantages of these schemes (Dunn 2011).

One active example of Payments for Ecosystem services schemes is being implemented by South West Water and the West Country Rivers Trust where payments to landowners to

³⁴ <http://www.publications.parliament.uk/pa/ld201012/ldselect/ldcom/296/29602.htm>

improve water quality in a number of rivers have been implemented.³⁵ In the Fowey catchment in Cornwall, this work is being extended to include payments from a wider variety of beneficiaries including those brought in as multiple buyers. These might include the Fowey Harbour Commission (reduced dredging costs), angling groups (enhanced fish stocks) and the tourist industry (increased visitation).³⁶

Furthermore, in 2011 UK Defra published Biodiversity 2020, which lays out a comprehensive plan for biodiversity policy in England to meet its commitments under the Convention of Biological Diversity (CBD). Implementing Biodiversity 2020 will include the integration of ecosystem services into their responses to the Aichi Targets that are noted in the CBD (Department for Environment Food and Rural Affairs 2011).

Australia

Market-based schemes to support ecosystem sustainability have been in place, at least for specific issues and areas, for some years in Australia (Coggan and Whitten 2005). One of the longest running of these is Bush Tender, which began in 2001.³⁷ BushTender is an auction-based approach to protecting and improving the management of native vegetation on private land in Victoria. Landowners competitively bid for contracts to better protect and improve their native vegetation with successful bids being those that offer government the best value for money. Successful landowners receive periodic payments for their management actions under agreements signed with Victoria Department of Sustainability and Environment. The bid process means that the price for the action is set by those who know how much it will cost rather than the government as an external entity with less knowledge of the natural lands than the landowners.

At the national scale, the Water Act of 2007 specifically acknowledges the importance of ecosystem services (see Box) and makes protecting, restoring and providing for ecosystem services an objective. However, the extensive studies conducted for the development of the 2001 Murray-Darling Basin Plan (MDBA) do not explicitly consider ecosystem services. In the development of the Environmentally Sustainable Level of Take (ESLT), ecosystem services are considered synonymous with the productive base (Murray-Darling Authority 2011). The report goes on to note that “empirical evidence on environmental water quantities needed to support ecosystem services is relatively immature” and concludes that “in determining the surface water ESLT, MDBA considers that by providing environmental water for key ecosystem functions and key environmental assets, productive base water requirements will also be supported.” Thus the ESLT is determined not by support for ecosystem services, but by an amount of water deemed sufficient to provide for five different habitat types from “in-stream” to “mid and high level floodplains.” Further, the MDBA selects the flow rate that optimizes environmental, economic and social outcomes to achieve a healthy working Basin on the basis of a qualitative assessment of the tradeoffs among the three sectors.

³⁵ <http://www.wrt.org.uk/projects.html> described a number of initiatives between these two entities.

³⁶ <http://wrt.org.uk/wordpress/?p=132>

³⁷ <http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/rural-landscapes/bushtender>

The Water Act of 2007. Objects:

The objects of this Act are:

- (a) to enable the Commonwealth, in conjunction with the Basin States, to manage the Basin water resources in the national interest; and
- (b) to give effect to relevant international agreements (to the extent to which those agreements are relevant to the use and management of the Basin water resources) and, in particular, to provide for special measures, in accordance with those agreements, to address the threats to the Basin water resources; and
- (c) in giving effect to those agreements, to promote the use and management of the Basin water resources in a way that optimises economic, social and environmental outcomes; and
- (d) without limiting paragraph (b) or (c):
 - (i) to ensure the return to environmentally sustainable levels of extraction for water resources that are overallocated or overused; and
 - (ii) to protect, restore and provide for the ecological values and **ecosystem services** of the Murray-Darling Basin (taking into account, in particular, the impact that the taking of water has on the watercourses, lakes, wetlands, ground water and water-dependent ecosystems that are part of the Basin water resources and on associated biodiversity); and
 - (iii) subject to subparagraphs (i) and (ii)—to maximise the net economic returns to the Australian community from the use and management of the Basin water resources; and
- (e) to improve water security for all uses of Basin water resources; and
- (f) to ensure that the management of the Basin water resources takes into account the broader management of natural resources in the Murray-Darling Basin.

While the Murray-Darling represents Australia's highest profile water management challenge, the management of the Great Barrier Reef is a global scale ecosystem issue. The Great Barrier Reef Marine Park Act of 1975 guides park policy and management.³⁸ As might be expected from a 1970's statute, the Act does not consider ecosystem services, but does call for an ecosystem based approach to management. An assessment of the economic value of the park was undertaken in 2003 in response to a new zoning plan for the park; this report considers ecosystem services (Hand 2003). However, the interpretation appears to be rather narrow as cultural, spiritual and fishing benefits of the park, to name a few, are considered indirect environmental values rather than ecosystem services. Policies guide activities in the park including structures, dredging, moorings, sewerage disposal, etc. Most of these date from the early 2000's and do not consider ecosystem services. The structures policy was updated in 2010 but does not refer to maintaining or supporting ecosystem services (Great Barrier Reef Marine Park Authority 2010). Even the more recent Great Barrier Reef Annual Report of 2011-2012 does not explicitly mention ecosystem services (Great Barrier Reef Marine Park Authority 2012). It is possible, given the overwhelming acceptance of the value of this ecosystem and the strong policies limiting development within the park, that using ecosystem services evaluation to identify tradeoffs and/or reveal hidden values of actions does not necessarily provide value added to the management already in place.

³⁸ See <http://www.gbrmpa.gov.au/> for more information

UK and Australia Summary

While the review of ecosystem services applications in the countries was limited several common issues emerge, including the following:

- The importance of ecosystem services is acknowledged by government in statute, and in some practices.
- Market based approaches are considered advantageous in promoting ecosystem sustainability, and are in common use in some local areas and have apparently been successful. Techniques vary with locale.
- More work remains to be done on tools and techniques for ecosystem service assessment and valuation as even when statutes call for ecosystem services to be considered in decision-making, its actual use has been limited by available information and techniques.

H. Summary of the Use of EGS by Others

The use of ecosystem services concepts and terminology by others is fairly recent, and not yet solidly integrated into practice. Different terminologies are used (e.g., environmental services, ecosystem services or watershed services are used within USDA and by some states including Florida and Colorado). Table 3 provides a comparison across the federal agencies analyzed in this report regarding ecosystem goods and services within the context of their mission areas. The definition of ecosystem services is similar across agencies, due to the broad nature of the definition. The various mission areas differ across the agencies, and it is these authorized missions that affect how agencies approach the use of ecosystem services.

Table 3. Comparison of federal agency definitions of "ecosystem services" and context for using ecosystem services in their mission areas.

	USACE	EPA	NOAA	USDA	DOI	DOD
Ecosystem Service Definition	Ecosystem services are socially valued aspects or outputs of ecosystems that depend on self-regulating or managed ecosystem structures and processes.	Ecosystem services are the direct or indirect contributions that ecosystems make to human well-being	Ecosystem services are the contributions that a biological community and its habitat provide to our day-to-day lives. Defining ecosystem services is dependent on human values.	Regarding ecosystem services, the USDA Office of the Chief Economist refers to the natural assets that provide benefits to society. USDA Forest Service notes that ecosystem services are commonly defined as the benefits people obtain from ecosystems.	Generally understood to be the benefits of nature to individuals, communities, and economies.	The benefits obtained from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.
Mission Areas	Navigation, Flood risk management, Ecosystem restoration, Water supply, Environmental stewardship, Regulatory (Clean Water Act, Rivers & Harbors Act), Coastal storm damage reduction, Hydropower, Emergency response, Military support	Regulatory (laws pertaining to human health and environment via media (air, water, land etc), Grant administration, Science research (environmental, health and well-being)	Climate and ocean/coastal science research, Marine and coastal resources management, Regulatory, Fisheries management, Natural Resource Damage Assessment, Environmental satellite information management	Environmental markets; Farm Bill administration; Natural resources management on public/private lands, Forest management; Recreation; Rural community development; Wildland fire management; Nutrition programs; Agricultural and forest research	Fish and wildlife, natural resources, land, and cultural resources management, Regulatory (e.g., Endangered Species Act, etc.), Scientific research, Manage recreation, Mineral resources management	Land management to support DOD mission of providing military forces needed to deter war and to protect the security of the US

Context for Use of Ecosystem Goods and Services	Planning or watershed studies, assessing Value to the Nation, natural resources management; mitigation banks	Integrating predictive ecological modeling with economic valuation methods that support local, regional, and national decision-making for sustainability; using ES in guidance on how best to evaluate the economic effects of EPA regulatory decisions.	Damage assessment and restoration plans use service-based analyses and valuation techniques. NOAA is moving to ecosystem-based management for the resources under their purview, which incorporates the consideration of ecosystem services.	Payments for ecosystem services (Environmental markets) in regional settings (e.g., Chesapeake Bay), preparing Forest Management Plans, and developing a spatial dataset that can be incorporated into broad-scale planning, such as the State Forest Action Plans; identifying watersheds where a payment for watershed services (PWS) project may be an option for financing conservation and management on forest lands.	Incorporating ecosystem services into resource evaluation and management, planning, and resource damage assessment and restoration	Incorporating into Integrated Natural Resource Management Plans
Reference website	http://acwc.sdp.sirsi.net/client/search/asset/1028349 ; http://www.usace.army.mil/Portals/2/docs/civilworks/news/2011-15_cw%20stratplan.pdf	http://www.epa.gov/research/ecoscience/eco-services.htm ; http://www.epa.gov/v/ged/tbes/index.html	http://www.habitat.noaa.gov/about/habitat/ecosystemservices.html	http://www.usda.gov/oc/environmental_markets/services.htm ; http://www.fs.fed.us/ecosystemservices/OEM/index.shtml ; http://www.fs.fed.us/ecosystemservices/About_ES/index.shtml	http://www.doi.gov/ppa/upload/DOI-Econ-Report-6-21-2011.pdf	http://www.dodnaturalresources.net/files/DoDI_4715_03.pdf

There are several ongoing and proposed uses for the ecosystem services concept and related information. These might be classified as the following:

- System characterization
- Risk or impact analysis and compensatory mitigation
- Informing program direction
- Establishing program or regional priorities
- Assessing program performance and communicating program value
- Informing specific actions or projects
- R&D to improve capabilities to use information on ecosystem services

Examples of some of these applications are described in Table 4.

Table 4. Examples of the different uses of EGS related concepts by other agencies and governments.

System Characterization	<ul style="list-style-type: none"> • NOAA Fisheries uses integrated ecosystem assessments. • EPA identifies ecosystem services as important attributes of reef ecosystems, as a framework for considering stressors. • FWS, NPS and BLM management policies require consideration of and managing for a broad range of resource qualities, activities and human uses and values.
Risk Assessment	<ul style="list-style-type: none"> • EPA “Guidelines for Ecological Risk Assessment” recognize that definition of ecological values to be protected provides the best foundation for assessing risk.
Inform Program Direction	<ul style="list-style-type: none"> • EPA identifies potential use to better evaluate the costs of rule making. • NOAA 2011 Business Operation Manual, Office of Habitat Conservation (OHC) reference to considering ecosystem services in the management of coastal resources. • USDA FS 2012 rules for National Forest System Land Management Planning require consideration of contributions to ecosystem services and multiple uses to the local area, region and the nation. • DOI Strategic Plan includes “managing and protecting the biological and physical components that support ecosystem services and processes” under its mission area of providing scientific foundations for decisions making. • DOD Natural Resources Program guidance includes protecting, enhancing and sustaining ecosystem services as part of its natural resources management.
Informing Specific Actions - Compensatory Mitigation	<ul style="list-style-type: none"> • NOAA Damage Assessment, Remediation & Restoration Program Habitat Equivalency Analysis uses a service-to-service approach to scaling compensatory mitigation relative to impacted services. In these instances, monetary values of restored services are compared to monetary value of services lost.

Informing Specific Actions - Conservation Incentives	<ul style="list-style-type: none"> • USDA Conservation Reserve Program calls for conservation that protects and enhances services.
Informing Specific Actions - Environmental Markets	<ul style="list-style-type: none"> • USDA Office of Environmental Markets (formerly Office of Ecosystem Services and Markets). • USDA NRCS “Natural Resources Credit Trading Reference” developed to account for environmental benefits in exchange for payment; described as complimenting not replacing regulation. • USDA FS is exploring the potential of markets to trade ecosystem services as a way of mobilizing investments to protect and restore private forests (including carbon sequestration). • Chesapeake Bay strategy (implementation of EO 15308) identifies environmental markets as a tool to provide financial incentives to facilitate conservation, including water quality trading.
Research and Development	<ul style="list-style-type: none"> • NOAA Office of Science & Technology to develop tools for valuation of ES. • USDA assessments of ES relative to agriculture and forestry. • USGS studies regarding ES.

Other than for NOAA Damage Assessment, Remediation and Restoration, this review identified little observed use of EGS information in project level planning or decision making. Proxies have been used for environmental goods used in agriculture credit trading because of difficulty in measuring the environmental good produced. A similar approach may be useful to the Corps.

Part III. Discussion

This review has focused on existing authorities, policy and guidance that can influence use of EGS information in Corps planning, and the ways in which other agencies and governmental bodies use EGS in their policies and programs. By necessity it considers current agency policy and practice, which may not necessarily reflect recent changes or policies and approaches under development. Within the Corps, the ongoing transformation of the Civil Works program and the associated modernization of the planning process can influence approaches to using EGS information in the Civil Works program. There may be some concern that accounting for EGS requires increased analysis of project effects as the number of potential outputs increases. How the use of EGS information fits within the ongoing Corps planning process changes is yet to be identified, but it is clear that implementation will need to be time-efficient and provide value-added information.

Including EGS during plan formulation and evaluation could be especially valuable in fostering collaboration in integrated water resources management and problem solving as it can help shape a multi-faceted view of issues and effects, and clarify how the Corps mission intersects with those of other agencies. To illustrate this utility, the roles of the Corps and others are considered here relative to the list of ecosystem services presented earlier in the report:

- Ecosystem Sustainability
- Natural Hazard Mitigation
- Recreation
- Navigation Conveyance
- Aesthetics
- Water Supply and Regulation
- Water Purification and Waste Treatment
- Property, Infrastructure, and Raw Materials Protection
- Food Provisioning
- Cultural and Spiritual
- Climate Regulation / Carbon Sequestration
- Human Health and Safety

There is ongoing discussion on whether information on EGS can help in decisions on how to prioritize investment in water resources projects, particularly AER projects because their effects can be difficult to communicate. There is also interest in whether and how EGS information can be used to communicate the 'Value to the Nation' of the Civil Works program, particularly AER investments. In developing a framework for use of EGS by the Corps, consideration should be given to both the project-level and portfolio-level applications including budget justification and prioritization, and communication of program value.

These broader context issues make a case for Corps consideration of developing a framework to incorporate EGS into decision-making. The description in Part II of how such an approach is compatible with many aspects of existing authority, policy and guidance shows how it would mesh with current practice. One of the issues that frequently arises in discussing use of EGS information in Corps project planning is whether using EGS requires the monetization of outputs. Consideration of EGS (Figure 1) does not require that benefits be reflected in monetary

terms. Further, Corps planning guidance already provides for circumstances where projects include both monetized and non-monetized outputs. While monetization of EGS remains an area of considerable research, it is not a necessary element of accounting for EGS. Current policy and guidance does not require NER outputs to be monetized, and implies that EGS benefits that can be monetized will be treated as NED benefits, rather than NER benefits. Upon availability of the research results, it may be useful to revisit USACE policy and planning guidance relative to NER and accounting for services that can be described in terms of dollars as benefits from AER projects. Using valid information about such project effects could enhance communication of the value of Civil Works investments, including AER. These policy deliberations may also need to revisit the combining of NER and NED costs and benefits.

This review has affirmed that existing authorities, policy and guidance allows use of a range of information about project effects both in plan formulation (i.e., those outcomes essential to the success of the project) and in accounting for the broader effects of the project. Further, the different steps of the planning process allow for a gradual narrowing of the array of project effects, or EGS, being considered relative to Corps implementation. Table 5 illustrates how for any Corps project, the planning process can begin by considering a wide array of EGS as well as other project objectives as part of identifying needs and opportunities that may gradually be narrowed as the planning analysis proceeds.

Table 5. Illustration of how proceeding through the six-step planning process can begin with the consideration of a wide array of EGS that are gradually narrowed throughout the analysis.

	Planning Step	EGS	EGS	EGS	EGS	EGS	EGS	EGS	EGS	EGS	
		1	2	3	4	5	6	7	8	9	
	Problems & Opportunities	Corps coordinates w/ wide range of partner agencies/sponsors to consider an array of ecosystem services.									
	Inventory and Forecast	Corps/sponsor/partners focus on mission centric services.						Other entities identify options for other services.			
	Formulate Alternatives	Corps/partners develop plans based on select group of EGS.									
	Evaluate Alternatives	Each plan evaluated according to effects on EGS.									
	Compare Alternatives	Comparison recognizes that plans not equal in effects on EGS and tradeoffs exist.									
	Select Plan	Selected Plan may address fewer EGS.									

Taking this approach more explicitly both clarifies which EGS effects the Corps project will address and those which remain to be considered by others. This approach also allows for identification of collaborative opportunities as potential EGS problems and for effects that are within the purview of other agencies. Consideration of more than one EGS can lead to the challenge of combining potentially incommensurate output metrics, a problem which monetization might address, but this challenge often exists already within Corps project planning process if the full effects of the project are considered.

Assessing EGS could be useful in describing a more complete array of effects associated with Corps projects. Even if Corps mission or budgetary priorities constrains use of information on some EGS in plan formulation, effective planning and environmental compliance requires reporting, or accounting, of a wide array of project effects. Table 6 illustrates how some EGS are central to some Corps projects, while potential effects on other EGS could be accounted for, and others may be not appropriate for Corps investment. Both plan formulation and accounting for project effects under NEPA need to consider factors other than EGS; EGS should not be considered to describe all of the effects of interest. The consideration of EGS during planning does not require all EGS to be considered in every project; planning teams will need to identify which EGS are relevant to their study or project, and how they will be used, e.g. in formulation or in reporting of effects.

The use of information on EGS may also enhance the identification of effects on significant resources as required by NEPA, influencing both mitigation considerations, and the communication of project effects. In addition, some environmental laws may influence the EGS considered in a particular study, as well as the tradeoffs among the EGS considered. Depending upon the region and associated actions, requirements of the Endangered Species Act, the Marine Mammal Protection Act, or other laws may result in some alternatives favoring some EGS at the expense of others.

Information on EGS may be useful in planning multipurpose projects that produce combined NED/NER benefits. However, as noted earlier there may be a need to update guidance on the how this information on EGS benefits and costs is treated in evaluation.

Current policy and guidance emphasizes ecosystem value and productivity with habitat units, acres, stream miles of restored habitat, increases in numbers of targeted birds, or species' and diversity indices provided as examples of AER outputs (U.S. Army Corps of Engineers 2000). It is not yet clear whether such benefits would be characterized as part of an ecosystem sustainability service. Utilization of an EGS framework may require an evolution of this approach for planning aquatic ecosystem restoration projects (see Box). Ideas on this will evolve as more information becomes available from the use of EGS through pilots or demonstrations, and as case studies are developed. It may be useful to revisit the policy and guidance on AER outputs and NER outputs after results from the other research tasks in the EGS work unit are available. Further research into EGS may be needed to provide improved and more defensible metrics for AER outputs.

Table 6. The potential use of ecosystem services in full accounting for project effects for USACE project types. Note: water supply is an ongoing operational aspect of many Corps projects with other purposes. PF stands for possible use in plan formulation, FA indicates the project may be used to provide full accounting of project effects, and N/A stands for ‘not appropriate.’

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

The research conducted under the other tasks in the EGS work unit, including the analysis done as part of the case studies, can help inform whether the current procedural guidance can accommodate use of the EGS information identified in the framework. The design of the case study work should integrate these and other topics addressed in this paper. The Box below contains additional ideas for consideration in other tasks within the work unit.

Recommended near-term research needs to be addressed within current EGS R&D work unit or otherwise are listed below:

- Watershed studies: Consider one or more watershed studies as potential candidates in the case studies and other EGS research tasks because of the scale of analysis and breadth of players they may engage.
- Water quality: The research may help articulate appropriate Civil Works involvement in water quality improvement as part of AER. It should also consider how water quality-related EGS may help foster leveraging among agencies and stakeholders to contribute to these outcomes.
- Recreation: The research may help identify how recreation-related EGS may help advance leveraging among agencies and stakeholders to contribute to these objectives and outcomes.
- Aesthetic EGS: Other research tasks within the work unit might help define aesthetic EGS relative to Corps planning. Additionally the material on aesthetics in ER 1105-2-100, Appendix C, pg 6-39 refers to a “summary of standard Corps practice is contained in Appendix R ER 1105-2-100,” which is not in the current version of the guidance.
- Using EGS at a national level: Research is needed to determine whether EGS can inform national priorities and investment given the regional, species- and habitat-based differences in the current distribution of services and their impacts on human well-being.

The potential utility of an EGS approach, e.g., providing a broader, more accurate view of project effects, more directly illustrating the societal value of ecosystem restoration actions, and ensuring consideration of a wide array of project benefits and costs, has been recognized by a wide array of other federal and state agencies, and by governments outside the U.S. Many federal agencies are actively conducting research and/or conducting studies to help communicate the value of the ecosystem good and services provided by the resources for which they are responsible.

A number of federal agency policies developed within the last few years explicitly acknowledge ecosystem services. However, information on implementation experience is not yet available, except that progress is being made in the development of markets. At the local level there are a growing number of examples of payment for ecosystem or watershed services (e.g., Florida and Colorado examples described in Part II). Many agencies are interested in using EGS as a more central component of decision-making on ecosystem restoration and stewardship, but few comparative studies or assessments of the value-added provided are yet available.

Given this interest, there may be opportunities for collaboration and partnering to develop, test and apply approaches to EGS quantification and use in decision-making. Table 7 shows potential intersections of Corps interests in various water resources-related EGS and the interests of other federal agencies.

This report has focused on the Civil Works project planning and related decision making. However, there is potential for consideration of EGS information to also be useful in Corps stewardship programs, which manage the lands and waters associated with Corps projects. DOD natural resource conservation policies include sustaining integrity of the ecosystem services. Installation natural resource management plans are to incorporate the principles of ecosystem-based management. However, the policy precludes installations from engaging in market-based sales, trades, etc. as it is viewed as a form of encroachment on military lands. It may be useful to examine the implementation of these policies in the future for potential utility in managing the natural resources at Corps projects.

Table 7. Illustration of potential partnering roles for other federal agencies and local entities toward provision of ecosystem services associated with USACE projects.

	USACE Interest	EPA	NOAA	Forest Service	NRCS	FWS	NPS	BLM	BOR	FEMA	Local Sponsors
Ecosystem Sustainability	Formulation	X	X	X	X	X	X	X			X
Natural Hazard Mitigation	Formulation									X	X
Recreation	Formulation		X	X		X	X	X	X		X
Aesthetics	Accounting					X	X				X
Water Supply & Regulation	Formulation			X	X				X		X
Water Purification & Waste Treatment	Accounting	X			X						X
Property, Infrastructure, & Raw Materials Protection	Formulation			X				X		X	X
Food Provisioning	Formulation ³⁹		X		X	X		X			X
Cultural / Spiritual	Accounting			X	X	X	X				X
Human Health	Accounting	X	X								X

³⁹ Food provisioning can only be considered by Corps in limited circumstances. Subsistence fishing is conducted primarily for personal or family consumption, by individuals whose incomes are normally at or below the minimum subsistence level established by the Department of Commerce. For cost allocation purposes, subsistence fishing is considered commercial fishing. Commercial fishing benefits may be described when the plan is projected to change fish catch. Details in ER 1105-2-100.

Table 8 summarizes the existing and potential uses of EGS identified in this review. Many policies already exist that enable consideration of EGS information in planning or specific land management decisions. In addition, most of the examples identified in this review of the successful use of EGS-motivated actions and payments were for place-specific actions. However, potential application also exists at the program and portfolio levels. Thus far this is best illustrated by studies that identify the value of EGS for a particular program. The use of EGS information in program or agency scale decision-making deserves further consideration and could enable strategic system- or national-scale consideration of environmental objectives, including ecosystem restoration.

Table 8. Outline summary of existing and potential use of incorporating EGS in the decision making policy arenas examined in this review.

Existing Project- level/Place-based decisions	Potential Use in Program-level decisions
<p>Corps project planning studies:</p> <ul style="list-style-type: none"> - More fully capture benefits and other effects - Illuminate trade-offs - Monetization not necessary, but potentially useful - Tools must be available/readily applicable 	<p>Corps budget process:</p> <ul style="list-style-type: none"> - Refine Resource Significance criteria - Monetization not necessary but potentially useful
<p>Corps watershed planning studies:</p> <ul style="list-style-type: none"> - Provide opportunities for considering a broad array of needs and opportunities - Affords collaboration among agencies - Monetization not necessary but potentially useful 	<p>Federal budget process:</p> <ul style="list-style-type: none"> - Fit within changing priorities - Monetization not necessary but potentially useful
<p>Resource conservation and stewardship:</p> <ul style="list-style-type: none"> - Forest Service planning - Bureau of Land Management land use plans - Dept. Defense Integrated Natural Resource Management Plans 	<p>Value to the nation:</p> <ul style="list-style-type: none"> - Monetization beneficial
<p>Restoration federal decision making:</p> <ul style="list-style-type: none"> - NOAA natural resource damage assessment 	<p>Other federal actions:</p> <ul style="list-style-type: none"> - Rule-making cost-benefit analysis, e.g., EPA
<p>Other:</p> <ul style="list-style-type: none"> - Water quality trading to achieve environmental and economic benefit - Natural resources credit trading for farmers - Payments for ecosystems services - Payment for watershed services 	<p>Other:</p> <ul style="list-style-type: none"> - Strategic assessment of resource priorities.

In summary, Table 9 outlines the findings of this review relative to the questions posed in Part I.

Table 9. Summary of the findings of this review study relative to the issues posed.

Issue	Findings
Should the Corps formulate for the restoration of EGS?	This will require specificity of the services to ensure the EGS considered by any project are consistent with policy and guidance.
Is the Corps authorized to do so?	Use of some EGS information is consistent with project authority and current policy, but ability to formulate for EGS may vary with authority.
Can the Corps consider EGS in its AER planning, and planning for other purposes?	Use of some EGS information is consistent with current policy and guidance.
How is this similar or different from current practices used in localized or regional scale planning, and in cost share studies carried out in collaboration with non-federal sponsors, other agencies and stakeholders?	The use of some EGS information maps directly onto existing practice. Use of others may require a new approach and/or the development of additional planning tools, and collaboration with partners on implementation.
Is there a need to change or clarify USACE authority, policy and guidance in order to include EGS in planning?	The need varies with the particular service.
How can information about EGS benefits provided by Corps projects be useful in justifying and prioritizing these projects at the programmatic or portfolio levels?	EGS information could be useful in communicating project effects, and EGS may help demonstrate and justify how and where the Corps should collaborate with others to achieve certain types of outcomes.
How can EGS information be used to contribute to the 'Value to the Nation' story of the Civil Works Program?	In addition to supporting budget priorities, a more complete accounting for information on effects and outcomes in project documentation may help a project compete across an array of priorities for ecosystem restoration.

Part IV. Conclusions

This review has identified several key points to be considered in incorporating EGS considerations into Corps planning, including the following:

- Other than for NOAA Damage Assessment, Remediation and Restoration, this review identified little observed use of EGS information in project level planning or decision making at the federal level. EGS have been a key component of some environmental management decisions by state agencies, and governments outside the U.S. Several federal agencies are using EGS to inform program direction, establish priorities, characterize systems, determine impacts of specific actions and communicate the value of their programs. There are more formal EGS policies and guidance in other agencies compared to within the Corps.
- Developing a methodology or framework to analyze EGS could be useful for integrated water resource management and problem solving by providing a multi-faceted view of the effects of water resources decisions and linking the Corps missions with those of other agencies.
- The inclusion of EGS in plan formulation and evaluation has the potential to provide a broader, more accurate view of project effects; more directly illustrate the societal value of ecosystem restoration; and provide for more transparent consideration of the benefits and costs of proposed projects. Such potential has been identified but a number of other agencies and by governments outside the U.S.
- Use of some EGS is consistent with current Corps policy and guidance, although it may be limited for some specific project authorizations. EGS can be assessed both in planning and in the reporting of project effects; it does not require all EGS to be considered at every stage in every project.
- Monetization of EGS benefits, while not necessary a part of an EGS framework, would enhance communication regarding the value of Civil Works investments, including AER.
- Revisiting USACE policy and guidance relative to NER and accounting for benefits from AER projects that can be monetized could clarify how some EGS can best be characterized in the planning process.
- Ongoing EGS research within this work unit and by others within and outside the Corps will be helpful in the identification of both metrics to represent NER outputs and tools, which can be used to estimate EGS within the timeframes required by Corps planning modernization.
- As an interim approach, it may be useful to consider how descriptions of ecological conditions can be used as proxies for EGS. This may help transition from the current emphasis on outputs relative to significant species and habitat, toward consideration of service outputs, and values of these outputs, to guide investment through the Civil Works program.

Appendix A - NEPA Summary

The material below summarizes the provisions of NEPA which may be useful in considering the development and use of information about effects of Corps actions on EGS in planning for any type of water resources project.

The National Environmental Policy Act (NEPA) is the basic national charter for protection of the environment. The Act declares it a national policy to “encourage productive and enjoyable harmony between man and the environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the [nation]” (42 U.S.C. 4321). The profound impacts of man’s activities “on the interrelations of all components of the natural environment” are recognized (e.g., urbanization, population growth, industrial expansion, resource exploitation) (42 U.S.C. 4331). The Act specifically declares a “continuing policy of the Government, in cooperation with State and local governments, and other public and private organizations to use all practicable means and measures ... to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans” (42 U.S.C. 4331).

The Act also states that it is the continuing responsibility of the federal government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate federal plans, functions, programs, and resources to, among other things: assure safe, healthful, productive and esthetically and culturally pleasing surroundings for all Americans; attain the widest beneficial use of the environment without degradation, risk to health or safety; preserve important historic, cultural and natural aspects of our national heritage; achieve balance between population and resource use which will permit high standards of living and a wide sharing of life’s amenities; and, enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (42 U.S.C. 4331).

Agencies are required to “utilize a systematic, interdisciplinary approach which will ensure the integrated use of the natural and social sciences and the environmental design arts in planning and decision making...”⁴⁰ They are also to “insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations.”⁴¹

Section 102(2)(C) (42 U.S.C. 4332) requires that every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment, include a statement on the environmental impacts of the proposed action; any adverse environmental effects which cannot be avoided should the proposal be implemented;

⁴⁰ Section 102 (2) (A)

⁴¹ Section 102 (2) (B)

alternatives to the proposed action; the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and, any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. Agencies responsible for the action shall consult with and obtain comments from other agencies with jurisdiction by law or special expertise, with response to any environmental impact.

NEPA also establishes the Council on Environmental Quality (CEQ), in the Executive Office of the President. One of its primary functions in relation to water resources is the preparation of regulations concerning the development of environmental impact statements developed by the Corps and other agencies.

NEPA requires that a detailed statement accompany every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment.

For further information see ER 200-2-2, Procedures for Implementing NEPA; and ER 1105-2-100, Appendix C Environmental Compliance.

Appendix B - Federal Interest, Federal Objective, Corps Objective/Interest/Roles

These terms can be confusing, particularly outside of the Corps' Planning community and the community of stakeholders who have a long history of working with the Corps. The concepts set bounds on Corps participation in water resources projects, influence plan selection, and the effects resulting from the allocation of costs between the Corps and other entities. These concepts, combined with authorities can influence whether the Corps can formulate for EGS, and for which services it may be appropriate to describe effects from CW investments in AER projects.

Some EGS may be more aligned with other agencies' missions and programs. This is not to say that the Corps should avoid contributing to these EGS or describing contributions to them, particularly if the benefits are coincident with actions taken in support of priorities specified for the Corps. However, if achieving the EGS has additional costs, it may be necessary to leverage with other partners to accomplish such outputs. Some sponsors may have greater interest in the non-NED project outputs, or lifts in services that are not priorities for CW investment. In these cases the information on EGS may be useful to them in prioritization and gaining their stakeholder support.

Are issues or resources "[nationally] significant," and thus appropriate for federal investment generally, and through the Civil Works program specifically? How do these relate to interests and responsibilities of state, local, private interests? Addressing these questions may be most relevant in setting the objectives of a study and scoping it, as well as determining who pays for both the analysis and the implementation of the affecting actions.

Federal interest at a fundamental level provides rationale for why the federal government should be involved in a particular program or action, rather than state or local entities. The federal interest concept has a historical context, originating in the Constitution and developing from federal statutes and policy. In this sense, federal interest can fluctuate over time, based on the national challenges and needs of the American public. The direction of the fluctuation is most noticeably recognizable in actions resulting from political climate and public interest. As one of many federal agencies, USACE would seem to have responsibility for a subset of EGS in carrying out its missions – those most closely tied to the alteration of hydrologic conditions and substrate. Additionally, as discussed previously under NEPA above, information about EGS may be helpful in more fully describing the suite of significant effects from a proposed action(s) and the significance of these changes that result from activities of multiple agencies.

A federal objective is defined for water and related land resource project planning in the Principles of the P&G (see text box).

The Corps Planning Guidance defines federal interest in the context of Civil Works studies:

“Within the larger [federal] interest in water resource development, the Corps of Engineers is authorized to carry out projects in seven mission areas: navigation, flood damage reduction, ecosystem restoration, hurricane and storm damage reduction, water supply, hydroelectric power generation and recreation” (U.S. Army Corps of Engineers 2000).

The federal cost sharing specified in law (e.g. WRDAs), is the portion of an authorized study or projects funded through the Civil Works program. This is contrasted with non-federal interest, which is the share of a study or project paid by the non-federal sponsor. Some sponsors and stakeholders may have greater interest in non-NED project outputs. Displaying the effect of plan alternatives on these outputs may be helpful to them and for identifying potential areas of collaboration.

The outputs may be incidental direct effects of the project and thus no separate cost-sharing is required. However, if a separable feature is required for these outputs, the sponsor would bear the costs of this separable element.

Defining the federal interest in Corps studies or projects typically involves determining whether the study effort is likely to lead to project implementation through the Civil Works program. This determination is one of the objectives of the Reconnaissance Study Phase. Generally, studies are to be terminated if there is no clear federal interest in a project or if the project will not meet the current policies or budget priorities. Exceptions are watershed studies, which may or may not result in identifying further Corps studies or implementation projects. Additionally, if the non-federal sponsor wishes to continue the feasibility study, continuation will be considered on a case-by-case basis.

In cost sharing agreements, the Department of Army remains responsible for representing the federal interest by following federal policies and budgetary priorities. The Planning Guidance states:

“In ecosystem restoration planning, the concept of significance of outputs plays an especially important role because of the challenge of dealing with non-monetary outputs. The three sources of significance (scientific, institutional, and public), and documentation on the relative scarcity of the resources helps determine the significance of the resources to be restored.

ER 1105-2-100 (Principles)

2. Federal Objective

...to contribute to national economic development consistent with protecting the Nation’s environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

(a) Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

(b) Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed.

This information is used to help establish a [federal] interest in the project. The significance of expected restoration outputs is used in conjunction with information from cost effectiveness and incremental cost analyses to help determine whether an alternative should be recommended. Information on effectiveness, acceptability, efficiency and completeness of ecosystem restoration plans also contributes to this determination” (U.S. Army Corps of Engineers 2000).

Some say the trend is for the federal government to play more of a facilitation and support role, allowing the state and local communities the roles of greater responsibility, at least in flood risk management and navigation. More opportunities, within the federal construct, will be made available to state and local entities to implement actions that promote the principles of sustainable development (e.g. grant programs, market-based incentives). This shifting of responsibility, along with proposed budget reductions and federal government down-sizing may trend to limit the magnitude and level of federal involvement and participation in EGS across federal programs.

Bibliography

Apogee Research, Inc. *Resource significance protocol for environmental project planning*. IWR Report 97-R-4, Alexandria: Institute for Water Resources, U.S. Army Corps of Engineers, 1997.

Bagstad, Kenneth, Darius Semmens, Rob Winthrop, Delilah Jaworski, and Joel Larson. *Ecosystem services valuation to support decisionmaking on public lands—A case study of the San Pedro River Watershed, Arizona*. Reston: DOI USGS, 2012.

Boyd, James, and Spencer Banzhaf. *What are ecosystems? The need for standardized environmental accounting units*. *Environmental Economics*, 2007, 616-626.

Bureau of Land Management. *BLM Natural Resource Damage Assessment and Restoration Handbook*. Rel. 1-1712, Washington: DOI BLM, 2008.

Bureau of Land Management. *Land Use Planning Handbook*. H-1601-1, Supersedes Rel. 1-1667, DOI BLM, 2005.

—. *The Bureau of Land Management: Who are we and what do we do?* January 26, 12. http://www.blm.gov/wo/st/en/info/About_BLM.html (accessed June 3, 3012).

Carlson, Bruce D, and Gary D Palesh. *Bussey Lake: Demonstration study of incremental analysis in environmental planning*. IWR Report 93-R-16, Alexandria: US Army Corps of Engineers, Institute for Water Resources, 1993.

Caudill, James, and Erin Henderson. *Banking on Nature 2004: The economic benefits to local communities of National Wildlife Refuge visitation*. Washington: U.S Fish and Wildlife Service, 2005.

Coggan, Anthea, and Stuart M. Whitten. *Market Based Instruments (MBIs) in Australia: What are they, important issues to consider and some applications to date*. CSIRO Sustainable Ecosystems, 2005.

Collins, Sally. *The Forest Service's role in markets for ecosystem services*. Washington: USDA Forest Service, 2006.

Collins, Sally, and Elizabeth Larry. *Caring for our national assets: An ecosystem services perspective*. Portland: USDA Forest Service, 2007.

Colorado State Board of Land Commissioners. *Strategic Plan*. Strategic Plan, Colorado State Board of Land Commissioners, 2013.

Cornell University Law School. *43 CFR 11.83 - Damage determination phase—use value methodologies*. 2008. <http://www.law.cornell.edu/cfr/text/43/11.83> (accessed 2013).

Cosco Busan Oil Spill Trustees. "Cosco Busan Oil Spill: Final Damage Assessment and Restoration Plan/ Environmental Assessment." California Department of Fish and Game, California State

Lands Commission, National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service, National Park Service, Bureau of Land Management, 2012.

Cox, Llael M., Andrew L. Altmeter, and Kathryn A. Saterson. "Protecting our life support services: An inventory of U.S. federal research on ecosystem services." *Ecosystem Services*, 2013.

Denver Water. *From Forests to Faucets: U.S. Forest Service and Denver Water Watershed Management Partnership*. 2013.

<http://www.denverwater.org/supplyplanning/watersupply/partnershipUSFS/> (accessed June 3, 2013).

Department for Environment Food and Rural Affairs. *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*. London: Defra, 2011.

Department for Environment Food and Rural Affairs. *Payments for ecosystem services: A short introduction*. London: Defra, 2010.

Department of Defense. *Department of Defense Instruction*. DoDI 4715.03, Washington: DOD, 2011.

—. *DoD Natural Resources Conservation Compliance Program. Enabling the Mission, Defending the Resources*. <http://www.dodnaturalresources.net/> (accessed June 3, 2013).

—. *Legacy Resource Management Program*. 2013.

<https://www.dodlegacy.org/legacy/intro/aoe.aspx> (accessed June 3, 2013).

Department of Environmental and Primary Industries. *Conservation & Environment: BushTender*. May 20, 2013. <http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/rural-landscapes/bushtender> (accessed June 3, 2013).

Dunn, Helen. *Payments for Ecosystem Services*. Paper 4, Defra Evidence and Analysis Series, 2011.

Everglades Coalition. "Everglades Coalition Resolution advocating the Valuation of Ecosystem Services as decision-support for Comprehensive Everglades Restoration Plan (CERP) implementation." *Everglades Coalition*. 2010.

http://www.evergladescoalition.org/PDF/EvCO_Resolution_ValuingEcosystemServices.pdf (accessed 2013).

Florida Fish and Wildlife Conservation Commission. *Creating a cooperative conservation blueprint for Florida: Two years of progress and a framework for next steps*. Tallahassee: Florida Fish and Wildlife Conservation Commission, 2010.

Ganz, David J., S. David Saah, Matthew A. Wilson, and Austin Troy. "Efficacy of the California Bureau of Land Management Community Assistance and Hazardous Fuels Programs." *The Fire*

Environment—Innovations, Management, and Policy. Fort Collins: USDA Forest Service Conference Proceedings, RMRS-P-46CD, 2007. 585-606.

Gomez-Baggethuna, Erick, Rudolf de Groot, Pedro L. Lomas, and Carlos Montes. "The history of the ecosystem services in economic theory and practice: From early notions to markets and payment schemes." *Ecological Economics* 69, no. 6 (April 2009): 1209-1218.

Great Barrier Reef Marine Park Authority. *Great Barrier Reef Annual Report 2011-2012*. Annual Report, Townsville QLD: Great Barrier Reef Marine Park Authority, 2012.

—. "Structures Policy." *Great Barrier Reef Marine Park Authority*. 2010. http://www.gbrmpa.gov.au/__data/assets/pdf_file/0003/16968/Structures-Policy-reviewed-2010.pdf (accessed 2013).

Hand, Tony. *An economic and social evaluation of implementing the Representative Areas Program by rezoning the Great Barrier Reef Marine Park*. Great Barrier Reef Marine Park Authority, 2003.

Ingraham, Molly W., and Shonda Gilliland-Foster. "The value of ecosystem services provided by the U.S. National Wildlife Refuge System in the contiguous U.S." November 2008: 608-618.

Keeler, Bonnie L, et al. "Linking water quality and well-being for improved assessment and valuation of ecosystem services." *PNAS Proceedings of the National Academy of Sciences of the United States of America*, November 6, 2012: 18619-18624.

Keeney, R.L., and H. Raiffa. *Decisions with multiple objectives: Preferences and value tradeoffs*. IWR Report 97-R-4, Alexandria: U.S. Army Corps of Engineers, Institute for Water Resources, 1997.

Kling, C.L, and S. Secchi. *Natural Resources Credit Trading Reference*. Washington, DC: USAD National Resources Conservation Service, 2011.

Lahdelma, Risto, Pekka Samminen, and Joonas Hokkanen. "Using multicriteria methods in environmental planning and management." *Environmental Management* 26, no. 6 (December 2000): 595-605.

Land Management Uniform Accounting Council. *Land Management Uniform Accounting Council 2012 Annual Report*. Annual Report, Tallahassee: Florida Department of Environmental Protection, 2012.

Levin, Philip S., Micheal J. Fogarty, Gary C. Matlock, and Marjorie Ernst. *Integrated ecosystem assessments*. NMFS-NWFSC-92, Silver Spring: National Oceanic and Atmospheric Administration, 2008, 20.

Linkov, I.F, F.K Satterstorm, G. Kiker, C. Batchelor, T. Bridges, and E. Ferguson. "From comparative risk assessment to multi-criteria decision analysis and adaptive management:

Recent developments and application." *Environmental Risk Management*, December 2006: 1072-1093.

Maczko, Kristie, and Lorie Hiding (eds.). *Sustainable Rangeland Ecosystem Goods and Services*. Fort Collins: Sustainable Rangelands Roundtable, 2008.

Millenium Ecosystem Assessment Board. *Millenium Ecosystem Assessment- Ecosystems and human well-being: Current state and trends*. Edited by Robert Scholes, Neville Ash Rashid Hassan. Vol. 1. 3 vols. Washington: Island Press, 2005.

Morris, Lucy. *The Trust wins prestigious ecosystem service pilot project on the River Fowey*. Feburary 10, 2012. <http://wrt.org.uk/wordpress/?p=132> (accessed June 3, 2013).

Murray-Darling Authority. *The proposed "environmentally sustainable level of take" for surface water of the Murray–Darling Basin: Method and Outcomes*. Murray-Darling Authority, 2011, 30.

"National Environmental Policy Act of 1969." 1969.
<http://ceq.hss.doe.gov/Nepa/regs/nepa/nepaeqia.htm>.

National Oceanic and Atmospheric Administration. *Environmental Economics: Economic Tools Used by DARRP*. General Council of Natural Resources. Febuary 13, 2013.
<http://www.darrp.noaa.gov/economics/tools.html> (accessed May 30, 2013).

National Oceanic and Atmospheric Administration. *Habitat equivalency analysis: An overview*. Silver Spring: NOAA, 2006.

National Oceanic and Atmospheric Administration National Marine Fisheries Service. *Habitat Conservation- What's it Worth*. 2013. <http://www.habitat.noaa.gov/> (accessed May 29, 2013).

National Oceanic and Atmospheric Administration. *NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015*. Silver Springs, MD: NOAA, 2009.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *The State of Science to Support an Ecosystem Approach to Regional Fishery Management*. NOAA Tech. Memo, NMFS-F/SPO-96, 2, U.S. Dept. of Commerce, 2009, 24.

National Park Service. *Management Policies 2006*. Washington: National Park Service, 2006.
—. *Northeast Temperate Network, Reports and Publications*. 2013.
<http://science.nature.nps.gov/im/units/netn/reports/reportsPubs.cfm> (accessed June 3, 2012).

Norton, Brian G. *Installations and Watersheds: An examination of changes in water management on Army installations*. ER 1130-2-540, Atlanta: Army Environmental Policy Institute, 2000.

Nutrient Net. *Pennsylvanis Water Quality Trading*. 2006. <http://pa.nutrientnet.org/> (accessed May 30, 2013).

- Oregon Board of Forestry. "Draft 2011 Forestry Program for Oregon." *State of Oregon*. 2011. <http://www.oregon.gov/ODF/Pages/board/fpfo2011.aspx> (accessed 2013).
- Oregon Watershed Enhancement Board. *Senate Bill 513 Ecosystem Services Markets Working Group*. 2010. <http://www.oregon.gov/OWEB/Pages/SB513.aspx> (accessed June 3, 2013).
- President's Council of Advisors on Science and Technology. *Sustaining Environmental Capital: Protecting Society and the Environment*. Washington: Office of Science and Technology Policy, 2011.
- Ray, J.D. *Winter Air Quality in Yellowstone National Park 2009-2011*. Natural Resource Technical Report NPS/NRSS/ARD/NRTR—2012/551, National Park Service, Denver: DOI National Park Service, 2012.
- Ribaudo, Marc, LeRoy Hansen, Daniel Hellerstein, and Catherine Greene. *The use of markets to increase private investment in environmental stewardship*. ERR-64, Washington: USDA, 2008, 77.
- Robinson, Ridgley, William Hansen, Kenneth Orth, and Samuel Franco. "Evaluation of environmental investments procedures manual- Interim: Cost effectiveness and incremental cost analysis." IWR Report 95-R-1, Water Resources Support Center and Waterways Experiment Station, U.S. Army Corps of Engineers Institute for Water Resources, Alexandria, 1995.
- Ruhl, J.B., Steven E. Kraft, and Christopher L. Lant. *The Law and Policy of Ecosystem Services*. Washington: Island Press, 2007.
- Scarlett, Lynn, and James Boyd. *Ecosystem services: Qualification, policy applications, and current federal capabilities*. RFF-DP-11-13, Resources for the Future, 2011.
- Sonoran Institute; Solano Partners, Inc.; Parametrix. *Analysis of Ecosystem Services Potential on Colorado State Trust Lands*. Colorado State Land Board, 2012.
- South Florida Water Management District. "South Florida Water Managers Take Steps to Increase Water Storage. Dispersed water projects provide a cost-effective method of keeping water on the landscape." *South Florida Management District*. October 14, 2011. http://www.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/nr_2011_1014_dispersed_water_storage.pdf (accessed 2013).
- Taylor, Laura, Liu Xiangping, and Tomothy Hamilton. *Amenity values of proximity to National Wildlife Refuges*. G09AC00299, Northern Carolina State University Center for Environmental and Resource Economic Policy, 2012.
- Tazik, David J, Janet A Cushing, Elizabeth O Murray, and Lisa Wainger. *Incorporating ecosystem goods and services in environmental planning: A literature review of definitions, classification*

and operational approaches. ERDC/EL-TR-13-17. Vicksburg: Engineering Research and Development Center, 2013.

Thompson, Jr., Barton H. "Background and history: Ecosystem services." In *2011 Ecosystem Services Seminar Series: Measuring Nature's Balance Sheet*, edited by Coastal Quest and Gordon Betty Moore Foundation, 1-69. Palo Alto: Gordon and Betty Moore Foundation, 2012.

U.K. National Assessment Ecosystem. *Follow Phase One*. August 12, 2013. <http://uknea.unep-wcmc.org/NEWFollowonPhase/Whatdoesthefollowonphaseinclude/tabid/129/Default.aspx> (accessed June 3, 2013).

U.K. National Ecosystem Assessment. "U.K. National Ecosystem Assessment: Synthesis of the Key Findings." UNEP-WCMC Technical Report, Cambridge, 2011.

U.K. Parliamentary. "European Union Committee - Thirty-Third Report. An Indispensable Resource: EU Freshwater Policy." 2012.

U.S. Army Corps of Engineers. *Environmental stewardship operations and maintenance policies*. ER 1130-2-540, Washington: U.S. Army Corps of Engineers, 1996.

—. *Natural Resources Management Gateway...to the future*. May 2013. <http://corpslakes.usace.army.mil/> (accessed May 29, 2013).

U.S. Army Corps of Engineers. *Planning Guidance Notebook*. ER 1105-2-100, Washington: U.S. Army Corps of Engineers, 2000.

—. *U.S. Army Corps of Engineers Environmental Program*. <http://www.usace.army.mil/Missions/Environmental> (accessed May 28, 2013).

U.S. Department of Agriculture Farm Service Agency. *Conservation Programs: Conservation Reserve Program*. May 14, 2013. <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp> (accessed May 30, 2013).

U.S. Department of Agriculture Forest Service. *National Forest System Land Management Planning: Final Programmatic Environmental Impact Statement*. PEIS, Washington: USDA FS, 2012.

—. *USDA Office of Environmental Markets*. July 11, 2011. <http://www.fs.fed.us/ecosystemservices/OEM/> (accessed May 30, 2013).

U.S. Department of Agriculture Forest Service. *Valuing Ecosystem Services: Capturing the true value of nature's capital*. Washington: USDA FS, 2007.

U.S. Department of Interior. *Departmental manual: Climate change policy*. 523 DM 1, Washington: DOI, 2012.

U.S. Department of Interior. *Federal Land Policy and Management Act of 1976, as amended*. Public Law 94-579, Washington: DOI, 2001.

—. *FY 2013 Interior Budget in Brief*. 2013.

<http://www.doi.gov/budget/appropriations/2013/highlights/index.cfm> (accessed May 30, 2013).

U.S. Department of Interior. *Strategic Plan for Fiscal Years 2011-2016*. Washington, DC: DOI, 2011.

U.S. Environmental Protection Agency. *Contaminated sediment remediation guidance for hazardous waste sites*. EPA-540-R-05-012, Washington: EPA, 2005.

—. "Ecological Research Program Research Multi-Year Plan (2008-2014)." December 11, 2010. [http://semanticcommunity.info/EPA/EPA_GEOSS_Web_2.0_Pilot_Wiki/Ecological_Research_Program_Research_Multi-Year_Plan_\(2008-2014\)#Introduction_\(Complete\)](http://semanticcommunity.info/EPA/EPA_GEOSS_Web_2.0_Pilot_Wiki/Ecological_Research_Program_Research_Multi-Year_Plan_(2008-2014)#Introduction_(Complete)).

—. *Final Water Quality Trading Policy*. 2003.

<http://water.epa.gov/type/watersheds/trading/finalpolicy2003.cfm> (accessed 2013).

—. *Ground Water and Ecosystems Restoration Research*". August 14, 2012.

<http://www.epa.gov/ada/> (accessed 2013).

U.S. Environmental Protection Agency. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F, Washington: EPA, 1998.

U.S. Environmental Protection Agency Office of Research and Development. "Decision Support Framework (DSF) Team." EPA/600/R-09/104, 2009.

U.S. Environmental Protection Agency. *Quantifying Coral Reef Ecosystem Services*. EP/600/R-11/206, Research Triangle Park, NC 27711: EPA, 2012.

U.S. Environmental Protection Agency. *Strategic Sustainability Performance Plan: FY 2010-FY 2020*. Washington: EPA, 2011.

U.S. Environmental Protection Agency. *Valuing the protection of ecological systems and services*. EPA-SAB-09-012, Washington DC: EPA, 2009.

U.S. Environmental Protection Agency. *Water Quality Criteria: Notice of Availability of Water Quality Criterion for the Protection of Human Health: Methylmercury*. EPA 823-R-10-001, Washington: EPA, 2010.

U.S. Fish and Wildlife Service. "Comprehensive Conservation Planning Process." *FWM# 355 (Supersedes 602 FW3)*. 2000. <http://www.fws.gov/policy/602fw3.html> (accessed 2013).

- . *Endangered Species*. July 15, 2013. <http://www.fws.gov/endangered/landowners/conservation-banking.html> (accessed May 30, 2013).
- . "General Overview of Wilderness Stewardship Policy." *610 FW1*. November 7, 2008. <http://www.fws.gov/policy/610fw1.html> (accessed 2013).
- . "Habitat Management Plans." *06/19/02 FWM 400 Supersedes 620 FW 1 and Exhibit 1, 12/13/91, FWM 007; 620 FW 6, 10/12/92, FWM 038; and 6 RM 2, 3, 4, 5, and 9*. 2002. <http://www.fws.gov/policy/620fw1.pdf> (accessed 2013).
- . *Message from the Director and Deputy Director: Mission Statement*. <http://www.fws.gov/planning/Mission.html> (accessed 2013).
- . "National Wildlife Refuge System Mission and Goals and Refuge Purposes." *601 FW1*. 2006. <http://www.fws.gov/policy/601fw1.html> (accessed 2013).
- U.S. Fish and Wildlife Service. "Outline and Guidance for Developing Habitat Management Plans." Exhibit 1, 620 FW 1, 2012.
- . *Service Manual Chapters*. July 26, 2013. <http://www.fws.gov/policy/manuals/> (accessed 30 2013, May).
- U.S. House 110th Congress, 2nd Session. "Section 2702." In *H.R 6124, Food and Conservation and Energy Act of 2008*. Washington: Washington Government Printing Office, 2008.
- Washington Department of Fish and Wildlife. *The Puget Sound Nearshore Ecosystem Restoration Project*. June 13, 2012. <http://www.pugetsoundnearshore.org/> (accessed May 30, 2013).
- Weeks, Kevin. "Habitat project serves as dry run for ecosystem credits market." *Forests for Oregon, Magazine of the Oregon Department of Forestry*, Winter 2012: 1.
- Willamette Partnership. *Willamette Partnership: Counting on the Environment*. <http://willamettepartnership.org/ongoing-projects-and-activities/nrcs-conservation-innovations-grant-1> (accessed May 30, 2013).
- Yap, Anita, and Carol Murdock. "Is ecosystem services implementable by municipalities at the landscape level?" *Oregon Planner's Journal*, February 2011: 13-18.



Institute for Water Resources

The Institute for Water Resources (IWR) is a U.S. Army Corps of Engineers (USACE) Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA; Davis, CA; Denver, CO; and Pittsburg, PA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the USACE water resources planning and water management programs.

IWR strives to improve the performance of the USACE water resources program by examining water resources problems and offering practical solutions through a wide variety of technology transfer mechanisms. In addition to hosting and leading USACE participation in national forums, these include the production of white papers, reports, workshops, training courses, guidance and manuals of practice; the development of new planning, socio-economic, and risk-based decision-support methodologies, improved hydrologic engineering methods and software tools; and the management of national waterborne commerce statistics and other Civil Works information systems. IWR serves as the USACE expertise center for integrated water resource planning and management; hydrologic engineering; collaborative planning and environmental conflict resolution; and waterborne commerce data and marine transportation systems.

The Institute's Hydrologic Engineering Center (HEC), located in Davis, CA specializes in the development, documentation, training, and application of hydrologic engineering and hydrologic models. IWR's Navigation and Civil Works Decision Support Center (NDC) and its Waterborne Commerce Statistical Center (WCSC) in New Orleans, LA, is the Corps data collection organization for waterborne commerce, vessel characteristics, port facilities, dredging information, and information on navigation locks. IWR's Risk Management center is a center of expertise whose mission is to manage and assess risks for dams and levee systems across USACE, to support dam and levee safety activities throughout USACE, and to develop policies, methods, tools, and systems to enhance those activities.

Other enterprise centers at the Institute's NCR office include the International Center for Integrated Water Resources Management (ICIWaRM), under the auspices of UNESCO, which is a distributed, intergovernmental center established in partnership with various Universities and non-Government organizations; and the Conflict Resolution and Public Participation Center of Expertise, which includes a focus on both the processes associated with conflict resolution and the integration of public participation techniques with decision support and technical modeling. The Institute plays a prominent role within a number of the USACE technical Communities of Practice (CoP), including the Economics CoP. The Corps Chief Economist is resident at the Institute, along with a critical mass of economists, sociologists and geographers specializing in water and natural resource investment decision support analysis and multi-criteria tradeoff techniques.

The Director of IWR is Mr. Robert A. Pietrowsky, who can be contacted at 703-428-8015, or via e-mail at: robert.a.pietrowsky@usace.army.mil. Additional information on IWR can be found at: <http://www.iwr.usace.army.mil>. IWR's NCR mailing address is:

U.S. Army Engineer Institute for Water Resources
7701 Telegraph Road, 2nd Floor Casey Building
Alexandria, VA 22315-3868



US Army Corps
of Engineers®

IWR

www.iwr.usace.army.mil

2013-R-07