



CHIEF OF ENGINEERS  
ENVIRONMENTAL ADVISORY BOARD  
WASHINGTON, D.C. 20314-1000 (CECW-P)

19 April 2016

Lieutenant General Thomas P. Bostick  
Commanding General and Chief of Engineers  
Headquarters, US Army Corps of Engineers  
4111 G Street NW  
Washington DC 20314-1000

RE: Report on Incorporating Ecosystem Services into Communication, Collaboration and Decision Making within the US Army Corps.

Dear LTG Bostick,

Ecosystem services is poised to be the next evolutionary step in resource management. With a Federal level White House-led initiative underway to incorporate ecosystem services into decision making, it is a great opportunity for the Corps to explore and adopt this approach where it can help improve communication and decision making across business lines and decision contexts.

In the attached report, the Environmental Advisory Board (EAB) provides: (1) an overview of the rationale, benefits and challenges of using ecosystem services; (2) a description of how their use may fit with federal agency and Corps decision making; and, (3) three recommendations for how the Corps might move forward to consider the use of ecosystem services for communication, collaboration, and decision making.

Given the opportunities that an ecosystem services approach can provide for improved stakeholder engagement and decision making, the EAB recommends that the Corps should move forward to integrate ecosystem services into these processes broadly across Corps operations, keeping in mind the very real, yet addressable challenges for implementation. To do this effectively the Corps needs additional internal expertise and strong interagency coordination. The EAB recommends that the Corps:

1. Use an internal Corps team to explore and develop decision appropriate methods for integrating ecosystem services into current decision making and policy processes across business lines and Corps activities. This team should look for opportunities to use integrated water resource management and a balanced and integrated approach across business lines as activities that address multiple business lines may better support ecosystem services and public welfare.
2. Build awareness of and capacity for using ecosystem services in Corps decision making across the Corps engaging all divisions.

3. Work in partnership with other federal agencies to coordinate the development and collection of necessary ecosystem services data and models and the computing infrastructure necessary to maintain, distribute, and update them over time.

By setting a baseline for application, increasing awareness, and actively collaborating with other federal agencies to develop data and process sharing efficiencies, USACE can benefit from implementing the use and consideration of ecosystem services to improve decisions and outcomes. To get the most out of the use of ecosystem services their use should be set within a balanced and watershed scale approach to decision making. This heightens the need for decisions to be balanced and integrated across the corps business lines and national accounts to allow consideration of multipurpose projects that can achieve multiple Corps objectives while also best providing ecosystem service benefits. The EAB looks forward to providing any assistance requested as the Corps moves to evaluate and implement incorporation of ecosystem services into its decision making processes.

Dr. Lydia Olander admirably led this effort with content contributions from Dr. Fred Sklar, Prof. Charles (Si) Simenstad, and Dr. Melinda Daniels. Dr. Fred Sklar, Prof Simenstad, Dr. Atkinson, Dr. Mary Barber, and Dr. Charles (Chuck) Somerville provided valuable comments.

Sincerely,



Dr. Rollin Hotchkiss, Chair  
Chief of Engineers Environmental Advisory  
Board

Final: February 12, 2016

Revised Draft by L. Olander (with EAB comments incorporated): February 2016

**Report on Incorporating Ecosystem Services into Communication, Collaboration and Decision Making within the US Army Corps of Engineers.**

by

Environmental Advisory Board (authored primarily by Dr. Lydia Olander with input from Dr. Fred Sklar, Prof. Charles (Si) Simenstad, and Dr. Melinda Daniels. Dr. Sklar, Prof. Simenstad, Dr. Sam Atkinson, Dr. Mary Barber, and Dr. Charles (Chuck) Somerville provided review comments)

U.S. Army Corps of Engineers

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**Executive Summary**

Ecosystem services are the benefits nature provides to people. Integrating ecosystem services into decisions is expected to improve the approaches used to communicate and quantify how changes in our natural resources affect well-being and public benefits, and as a result, improve decision making and outcomes. Recent policies and guidance at the federal level reflect a growing interest in using ecosystem service approaches in federal decision making. The October 2015 White House memorandum calling on Federal agencies to incorporate ecosystem services into Federal decision making requests a description of current agency practice and work plans to be submitted to the Council on Environmental Quality (CEQ) no later than March 30, 2016 and plans for implementation guidance to be developed in collaboration with the agencies by November 30<sup>th</sup>, 2016.

This report provides: (1) an overview of the benefits and challenges of using ecosystem services; (2) a description of how their use may fit with federal agency and Corps decision making; and, (3) three recommendations for how the Corps move forward to consider the use of ecosystem services for communication, collaboration, and decision making.

The incorporation of ecosystem services into agency process and decision making can have some important advantages. It can provide:

- improved communication with stakeholders and the public;
- more informed decision making by expanding the suite of impacts and benefits considered in a decision;
- improved evaluation of how nature based, nature enhanced, or non-natural solutions effect the production and provision of ecosystem services;
- motivation to more accurately characterize impacts and benefits realized at watershed and larger regional spatial scales and broader temporal scales; and
- an opportunity to identify and involve new partners.

However, the use of ecosystem services approaches also presents some challenges. They focus on human benefits which may dismay stakeholders focused on biodiversity, species, and ecosystem health; however, to the extent these factors are valued by people (e.g., protected by statute, the focus of conservation efforts, etc.) they can be incorporated as ecosystem services. These types of values (e.g., importance that ecosystems exist and are healthy) are difficult to quantify, can be scale dependent, and will require additional effort to include. There are also significant data and modeling gaps in both the ecological and social sciences that, at least in the short term, will make full and robust quantification and monetary valuation difficult to do for all services. Fortunately, full quantification and valuation are not required for all decisions and even simple steps to identify and quantify services can help provide additional information for stakeholders and decision makers. If valuation is not being used, other means to assess the scale of demand for a service, who the beneficiaries are, and how many there are, may also be quite helpful for decision makers.

Ecosystem services can fit into a wide range of typical Corps regulatory and decision processes across business lines such as restoration project prioritization and funding allocation, the development and tracking of performance metrics, operations and maintenance decisions, wetland and stream mitigation, and impact assessment under NEPA.<sup>1</sup> The use of ecosystem services to improve how ecological restoration is communicated to stakeholders and the office of Management and Budget, has been of particular interest to the Corps. For all of these civil works applications it is valuable for the Corps to acknowledge the implications of Corps actions or inactions (e.g., lack of maintenance or dredging) on all ecosystem services, while recognizing the Corps' need to focus their efforts on services that meet the federal interest of national significance (e.g., ecosystem health) rather than those that only address local interests (e.g.,

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<sup>1</sup> Lydia Olander, Robert J. Johnston, Heather Tallis, Jimmy Kagan, Lynn Maguire, Steve Polasky, Dean Urban, James Boyd, Lisa Wainger, and Margaret Palmer. 2015. "Best Practices for Integrating Ecosystem Services into Federal Decision Making." Durham: National Ecosystem Services Partnership, Duke University. doi:10.13016/M2CH07

recreation). The Corps should put further consideration into how regionally valuable services may be considered nationally significant.

With this in mind, the Environmental Advisory Board recommends that the Corps should:

1. Use an internal team to explore and develop decision appropriate methods for integrating ecosystem services into current decision making and policy processes across business lines and Corps activities. This team should look for opportunities to incorporate integrated water resource management and a balanced and integrated approach across business lines as activities that address multiple business lines may better support ecosystem services and public welfare.
2. Build awareness of and capacity for using ecosystem services in Corps decision making across the Corps engaging all divisions.
3. Work in partnership with other federal agencies to coordinate development and collection of necessary ecosystem services data and models and the computing infrastructure necessary to maintain, distribute, and update them over time.

# Report

## Purpose

LTG Thomas P. Bostick, Chief of the US Army Corps of Engineers (the Chief) requested that the Environmental Advisory Board (EAB) explore the use of an ecosystem services approach by the US Army Corps of Engineers. In addition, the White House Executive Office of the President released a memorandum calling on Federal agencies to incorporate ecosystem services into Federal decision making. It requests a description of current agency practice and work plans to be submitted to the Council on Environmental Quality (CEQ) no later than March 30, 2016 and plans for implementation guidance to be developed in collaboration with the agencies by November 30<sup>th</sup>, 2016. **The purpose of this review by the EAB is to provide an overview of the benefits and challenges of using ecosystem services and how their use may fit with Federal agency and Corps decision making. Based on this review, the EAB recommends that the Corps pursue further incorporating ecosystem services into communication, collaboration, and decision making.**

## Background

“Our natural world provides critical contributions that support and protect our communities and economy. For instance, Louisiana’s coastal wetlands provide billions of dollars worth of flood protection and other benefits. Preserving and restoring forests in the Catskill Mountains enables New York City to access clean water at a cost several times less than the cost of building a new water-filtration plant. And current efforts to plant trees along Oregon’s salmon-rich rivers will improve local water quality – saving costs associated with installing expensive machinery to achieve the same purpose.

These are just a few examples of the many ways that nature creates benefits that contribute to our economic prosperity, protects the health and safety of vulnerable populations, and help build more resilient communities. But these “ecosystem services” are often overlooked. Integrating ecosystem services into planning and decision-making can lead to better outcomes, fewer unintended consequences, and more efficient use of taxpayer dollars and other resources.”

- Dickinson, Male and Zaidi, October 7, 2015<sup>2</sup>

Increasingly robust research, peer-reviewed scientific literature, and promising examples have led to high hopes for ecosystem services to improve Federal decision making.

## Definition

**Ecosystem services are the benefits nature provides to people.**<sup>3</sup> One common framework, the Millennium Ecosystem Assessment describes provisioning services such as timber and fish, regulating services such as water filtration and storage, cultural services such as recreation and existence of places and species, and supporting services such as photosynthesis and pollination.<sup>4</sup>

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<sup>2</sup> Tamara Dickinson, Timothy Male, Ali Zaidi, “Incorporating Natural Infrastructure and Ecosystem Services in Federal Decision-Making”, October 7, 2015, White House Blog. <https://www.whitehouse.gov/blog/2015/10/07/incorporating-natural-infrastructure-and-ecosystem-services-federal-decision-making>

<sup>3</sup> Much of the content in the background sections is adapted from the National Ecosystem Services Partnership. 2014. *Federal Resource Management and Ecosystem Services Guidebook*. Durham: National Ecosystem Services Partnership, Duke University, <https://nespguidebook.com>.

<sup>4</sup> Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.

The use of an ecosystem services approach requires a shift from thinking about ecological indicators such as acres of wetland as the primary unit of measure, toward thinking about how much water the wetlands can store for irrigation in the dry season, a benefit relevant indicator (BRI) (Box 1).<sup>5</sup> **The reason ecosystem services are being integrated into decision making is a desire to better capture and communicate how changes in natural resources affect well-being and public benefits, and to use this information to improve decision making and outcomes.** Our present metrics are vastly insufficient to capture the breadth of benefits that accrue to human societies and economies from natural ecosystems and ecosystem processes.

### *Historical Context*

The concept of nature's services was coined in the 1970s<sup>6</sup>. Recognition of the connection between healthy natural systems and social and economic welfare is not new and was, for example, cited at the birth of the U.S. conservation movement 100 years ago.<sup>7</sup> Natural resource management continues to evolve, most recently with the use of an ecosystem approach to resource management ("ecosystem based management")<sup>8</sup>. An ecosystem services approach is a next step in this progression that can build upon current practice.<sup>9</sup> The last two decades has seen an explosion of research and interest in incorporating analytically robust ecosystem services-based methods into management.

### *How Ecosystem Services Can Improve Communication, Collaboration, Decision Processes and Outcomes*

**The incorporation of ecosystem services into decision making can have some important advantages. Foremost is that it shows how ecological changes can affect people.** For example, instead of only including wetland acres restored or change in water storage volume, a focus on ecosystem services will suggest including information on how changes in wetland area and storage could affect late season water flows for irrigation users or even value from crop production (Figure 1). This will provide better insight into trade-offs.

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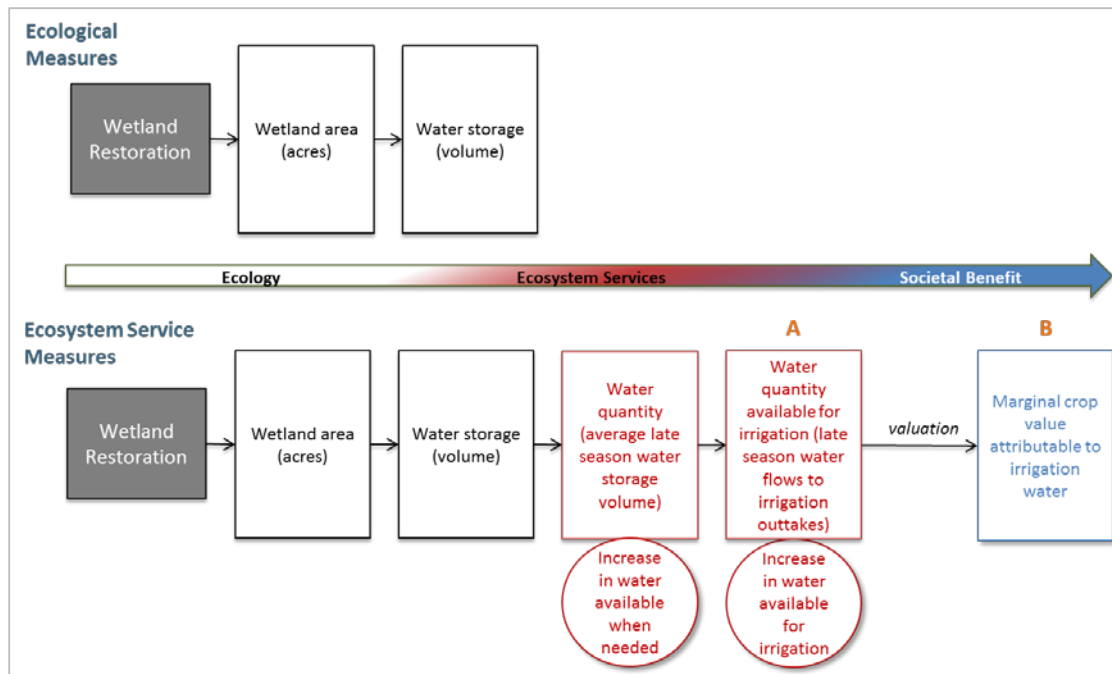
<sup>5</sup> Lydia Olander, Robert J. Johnston, Heather Tallis, Jimmy Kagan, Lynn Maguire, Steve Polasky, Dean Urban, James Boyd, Lisa Wainger, and Margaret Palmer. 2015. "Best Practices for Integrating Ecosystem Services into Federal Decision Making." Durham: National Ecosystem Services Partnership, Duke University. doi:10.13016/M2CH07

<sup>6</sup> Gomez-Baggethun, E., R. de Groot, P.L. Lomas, and C. Montes. 2009. "The history of ecosystem services in the economic theory and practice: From early notions to markets and payment schemes." *Ecological Economics* 69(6): 1209-18. doi:10.1016/j.ecolecon.2009.11.007

<sup>7</sup> Proceedings of a conference of governors in the White House, Washington, D.C., May 13-15, 1908. <https://archive.org/stream/proceedingsofcon00conf#page/n15/mode/2up>

<sup>8</sup> D. Scott Slocumbe. 1993. Implementing Ecosystem-Based Management. *BioScience* 43(9):612-622.

<sup>9</sup> Lynn Scarlett and James Boyd. 2015. Ecosystem services and resource management: Institutional issues, challenges, and opportunities for the public sector. *Ecological Economics*. 115:3-10.



Note: Black text indicates an ecological assessment and indicators; red text indicates extension to an ecosystem services assessment; and blue text indicates measures of social benefit and value. (Source: Olander and Kagan, presentation to DOT ecological webinar, October 2015)

**Figure 1. Moving beyond ecological measures to ecosystem services measures or benefit relevant indicators (BRIs) to assess how ecological changes are relevant to people.**

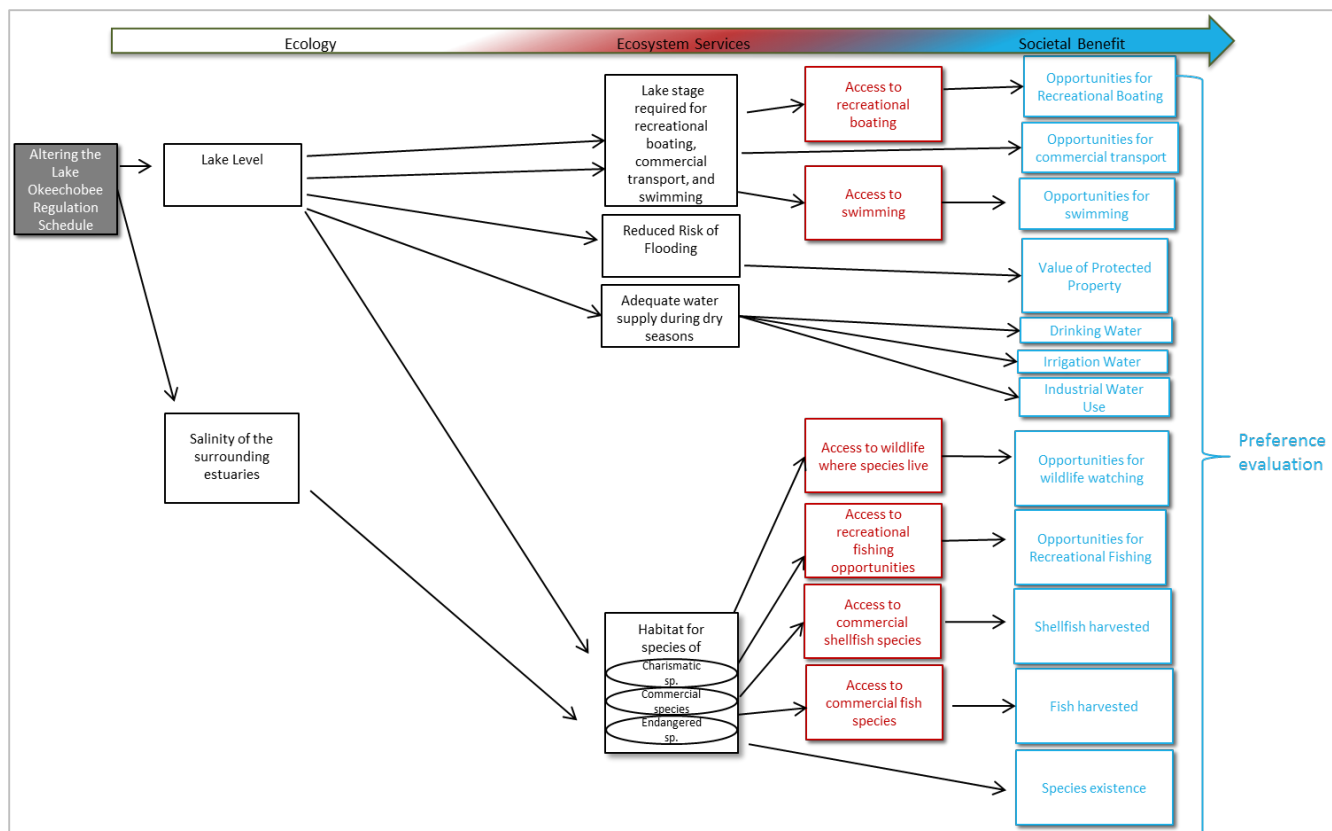
**A focus on measures of ecosystem services is also useful for communicating with stakeholders and the public.** While it is not always clear what the societal implications are of change in wetland area, a change in water storage or migratory bird populations will resonate with people and help them understand and weigh in more decisively on decisions that affect public welfare.

**Considering ecosystem services can also expand the suite of impacts and benefits considered in a decision by thinking through the cascade of effects that lead to changes in public welfare.** This type of broad assessment may be most common as part of a NEPA evaluation or impact assessment. In some cases the Corps have done a good job of identifying a wide range of ecosystem services that will be impacted by water management even if not all services were fully quantified. Figure 2, shows a conceptual diagram that is based on the environmental impact studies done for Lake Okeechobee water level management and it shows a wide range of ecosystem services from recreation to shellfish production, to the existence of critical species and habitat.<sup>10</sup>

**This expanded view of possible services affected may also be an opportunity to identify collaborators** whether that be additional cost share partners or other Federal or state agencies. This may be particularly important if a critical service is outside the scope of a program authority and thus would not be fully assessed or addressed in Corps decision making.

<sup>10</sup> July 2005, Lake Okeechobee Regulation Schedule Study (LORSS) that led to a draft Supplemental Environmental Impact Statement (SEIS) dated August 2006





Note: This conceptual map of simplified causal chains shows possible outcomes from lake management. Black text indicates an ecological assessment and indicators; red text indicates extension to an ecosystem services assessment; and blue text indicates measures of social benefit and value. (source: student project - Baldino and Olander, 2015)

Figure 2. A conceptual diagram showing mapping of all services potentially affected altering management of Lake Okeechobee.

Considering the full suite of impacts and benefits and communicating them as ecosystem service measures that resonate with people seem likely to result in “better outcomes, fewer unintended consequences, and more efficient use of taxpayer dollars and other resources.”<sup>11</sup> However, robust examples of ecosystem services used in decision making are still relatively few and not fully assessed. A conversation is just beginning across the academic and natural resource management community about collecting and assessing such examples to explore when and how the use of ecosystem services in decision making results in these expected improvements in decision making and outcomes.<sup>12</sup>

<sup>11</sup> Office of Management and Budget, Council on Environmental Quality, and Office of Science and Technology Policy, “Incorporating Ecosystem Services into Federal Decision Making,” by Shaun Donovan, Christina Goldfuss, and John Holdren, M-16-01, Memorandum for Executive Departments and Agencies, October 7, 2015, <https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf>.

<sup>12</sup> For example, Joke Van Wensem, Peter Calow, Annik Dollacker, Lorraine Maltby, Lydia Olander, Magnus Tuvendal, and George Van Houtven. In review. Identifying and assessing the application of ecosystem services approaches in decision-making.

## Current Use

### *Federal Action on Ecosystem Services*

#### **Recent policies and guidance at the Federal level reflect a growing interest in ecosystem services and ecosystem service approaches to natural resource planning and management.**

The ecosystem services policy dialogue was sparked in part by the 1998 President's Council of Advisors on Science and Technology (PCAST) report, "Teaming with Life: Investing in Science to Understand and Use America's Living Capital."<sup>13</sup> A decade later, the 2008 Farm Bill<sup>14</sup> called for federal agencies to explore ecosystem services and their potential application in environmental markets, resulting in establishment of the U.S. Department of Agriculture (USDA) Office of Environmental Markets. Also in 2008 a new rule on wetland and stream mitigation issued by the US Army Corps of Engineers and Environmental Protection agency stated that "mitigation...should be located where it is most likely to successfully replace lost...services".<sup>15</sup> In 2010, appointees from federal agencies with natural resource jurisdictions met to explore markets and payments for ecosystem services. Also in 2010, the Obama Administration released a roadmap for restoring ecosystem resiliency and sustainability in the Louisiana and Mississippi coasts<sup>16</sup> which specifically points to the restoration of ecosystem services. Since then, several events have advanced federal agencies' consideration of ecosystem services approaches to natural resource planning and management.

- In 2011 the PCAST issued Sustaining Environmental Capital<sup>17</sup>: Protecting Society and the Economy, a report that asserts the critical importance of the environment for the economy and to societal wellbeing and that **emphasizes the need for agencies to develop consistent ecosystem services valuation techniques across federal agencies.**
- The U.S. Forest Service's 2012 Planning Rule<sup>18</sup> required that planning activities consider ecosystem services as part of an integrated resource management focus. The agency is moving quickly to phase in implementation of the rule.

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<sup>13</sup> Biodiversity and Ecosystems Panel, President's Committee of Advisors on Science and Technology, Teaming with Life: Investing in Science to Understand and Use America's Living Capital (Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology, 1998),

<http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-teamingwithlife.pdf>.

<sup>14</sup> "Food, Conservation and Energy Act of 2008" (PL 110-246, 18 June 2008), 122 United States Statutes at Large, pp. 1651-2312.

<sup>15</sup> J.B. Ruhl, J. Salzman, and I. Goodman "Implementing the New Ecosystem Services Mandate of the Section 404 Compensatory Mitigation Program: A Catalyst for Advancing Science and Policy." Stetson Law Review 38(2009):251-272.; [http://water.epa.gov/lawsregs/guidance/wetlands/upload/2008\\_04\\_10\\_wetlands\\_wetlands\\_mitigation\\_final\\_rule\\_4\\_10\\_08.pdf](http://water.epa.gov/lawsregs/guidance/wetlands/upload/2008_04_10_wetlands_wetlands_mitigation_final_rule_4_10_08.pdf)

<sup>16</sup> U.S. Council on Environmental Quality. Roadmap for Restoring Ecosystem Resiliency and Sustainability. By the Louisiana-Mississippi Gulf Coast Ecosystem Restoration Working Group. (Washington, D.C.: Executive Office of the President, 2010), <https://www.whitehouse.gov/administration/eop/ceq/initiatives/gulfcoast/roadmap>.

<sup>17</sup> President's Council of Advisors on Science and Technology, Report To The President: Sustaining Environmental Capital: Protecting Society and the Economy (Washington, D.C.: Executive Office of the President, President's Council of Advisors on Science and Technology, 2011),

[https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast\\_sustaining\\_environmental\\_capital\\_report.pdf](https://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_sustaining_environmental_capital_report.pdf).

<sup>18</sup> Forest Service, U.S. Department of Agriculture, "National Forest System Land Management Planning," Federal Register 77, no. 68 (April 9, 2012): 21162-21276, [http://www.fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5362536.pdf](http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5362536.pdf).

- In 2013, the White House Council on Environmental Quality released new principles and requirements for federal investments in water resources<sup>19</sup>. These principles and requirements include guidance on using an ecosystem services evaluation framework for water resources projects.
- In 2015, the Executive Offices of the President, the Office of Management and Budget, Council on Environmental Quality, and the Office of Science and Technology Policy, issued a **memorandum<sup>20</sup> directing Federal agencies to incorporate the value of nature or “green” infrastructure and ecosystem services into Federal planning and decision making.**

While the Corps has some restrictions on applying the new principles and requirements, the previous rules do not restrict them from moving forward to consider ecosystem services and the new White House memo provides additional support for these activities.

Many agencies, including the U.S. Army Corps of Engineers, have begun assessing and testing methods for identifying and valuing ecosystem services as they move toward applying them in decisions about natural resource management. Federal efforts designed to link social and ecological analysis predate the initiatives described above. Although not labeled ecosystem services analysis, natural resource damage assessments by NOAA and USFWS under the Ocean Pollution Act and the Comprehensive Environmental Response, Compensation, and Liability Act<sup>21</sup> require assessment of ecological damage and associated social costs arising from oil spills and improper hazardous waste disposal.

#### *The Challenges in Using Ecosystem Services*

**An ecosystem services approach is human-oriented by design in that it seeks to relate ecosystem features to the wellbeing of people.** While this can greatly enhance communication with stakeholders, and better reflect effects on public welfare, there is a risk. This orientation can lead to the impression - and if not well applied, the outcome - that utilitarian benefits such as water consumption, timber harvests, energy extraction, recreational resources, and commercial fisheries are the focus. **Ecosystem services are also meant to capture less tangible, more intrinsic, and equally important benefits such as species’ existence, wilderness, beauty, and the value to future generations of their preservation.** Because these matter to human wellbeing, they matter in decisions that consider ecosystem services. **However, the difficulty in quantifying and valuing these less tangible benefits has often resulted in only peripheral consideration, if any.** Use of benefit relevant indicators (see Box 1) and non-monetary multi-criteria analysis approaches in lieu of monetary valuation can help incorporate these less tangible

<sup>19</sup> White House, "Principles and Requirements for Federal Investments in Water Resources," March 2013, [https://www.whitehouse.gov/sites/default/files/final\\_principles\\_and\\_requirements\\_march\\_2013.pdf](https://www.whitehouse.gov/sites/default/files/final_principles_and_requirements_march_2013.pdf).

<sup>20</sup> Office of Management and Budget, Council on Environmental Quality, and Office of Science and Technology Policy, "Incorporating Ecosystem Services into Federal Decision Making," by Shaun Donovan, Christina Goldfuss, and John Holdren, M-16-01, Memorandum for Executive Departments and Agencies, October 7, 2015, <https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf>.

<sup>21</sup> U.S. EPA (U.S. Environmental Protection Agency). "CERCLA Overview." Last modified December 11. <http://pubweb.epa.gov/superfund/policy/cercla.htm>

benefits into decisions where they are important. It is important to keep in mind the likely inconsistencies in precision in quantifying different services and to take this into consideration.

**Box 1. What are Benefit Relevant Indicators?**

Benefit relevant indicators (BRIs) are measurable indicators that capture the connection between the ecosystem and its effect on people. These go beyond ecological indicators to clearly indicate or quantify the connection to people. Ideally they also provide some indication of demand or need. BRIs are what gets valued but are not measures of value that come from monetary valuation or preference ranking methods (like multi-criteria decision analysis). In figure 1, the circled indicators are examples of BRIs.

**Narrative descriptions of expected changes in a wide range of services are often used, but these are insufficient for formal analysis. Formal analyses require quantitative approaches that take into account appropriate spatial and temporal scales of ecosystem service flows and benefits which can be limited by significant data and modeling gaps.** Monitoring data currently collected for regulatory or more purely ecological purposes often does not match the data needed to conduct ecosystem services analysis. What is needed are data and models that link management actions to specific ecological and biological changes, often called ecological production function models, which are not yet available for many management activities in the ecosystems and geographies needed. Fortunately more of these models are becoming available and the Environmental Protection Agency is developing a database for collating and organizing these models in a way that may be quite useful moving forward.<sup>22</sup>

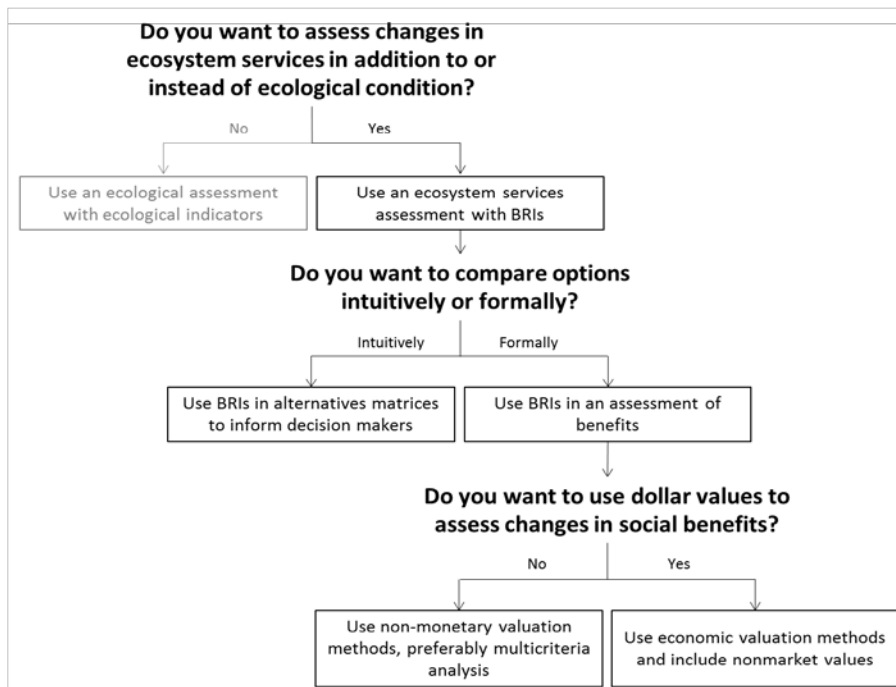
The social data and models needed to assess beneficiaries and values is even more limited. Despite hundreds of economic valuation and other social benefit studies, large gaps remain in our knowledge of social benefits. In some cases, like for water quality, meta-analysis based economic value models are being developed that allow better assessments and transfer of values.<sup>23</sup> In most cases “transferability” to other sites may be limited or impossible when resource and social conditions at these other sites are quite different than those at the project site. National level surveys (e.g., census or recreational survey) do not yet collect information that would help assess larger scale public values and use of services. Focused attention and resources will be needed to fill these gaps to allow widespread use of economic valuation for the assessment of ecosystem services. Non-monetary multi-criteria analysis methods<sup>24</sup> (structured ranking procedures) provide an alternative to economic valuation that might meet similar needs for many decisions and may be better for some (those with significant cultural or spiritual values), however, they are not designed to be transferable.

<sup>22</sup> EPA Ecological Production Function Library [http://cfpub.epa.gov/si/si\\_public\\_record\\_report.cfm?dirEntryId=241148](http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=241148)

<sup>23</sup> Johnston, R.J., J. Rolfe, R.S. Rosenberger and R. Brouwer, eds. 2015. *Benefit Transfer of Environmental and Resource Values: A Guide for Researchers and Practitioners*. Dordrecht, the Netherlands: Springer; Johnston, R.J., E.Y. Besedin, R. Iovanna, C.J. Miller, R.F. Wardwell, and M.H. Ranson. 2005. Systematic Variation in Willingness to Pay for Aquatic Resource Improvements and Implications for Benefit Transfer: A Meta-Analysis. *Canadian Journal of Agricultural Economics*. 53(2-3):221-248.

<sup>24</sup> See Lynn Maguire and Dean Urban 2014. Benefit Assessment: Non-monetary methods. In NESPguidebook <https://nespguidebook.com/assessment-framework/multi-criterion-decision-analysis/> for a description and list of references which include R.T. Clemen 2001. *Making Hard Decisions*. 2<sup>nd</sup> Ed. Revised. Pacific Grove, CA; Duxbury Press; and note training courses for federal agencies at NCTC <http://nctc.fws.gov/courses/programs/decision-analysis/index.html>.

One of the underlying expectations is that decisions based on ecosystem services will avoid unintended consequences because they will consider implications for all affected ecosystem services. **Given the data and modeling gaps mentioned before, as well as the time, expertise and costs of applying some of these methods (e.g., economic valuation and multi-criteria analysis), it will likely be daunting to quantify all affected services. While agencies do need to consider effects on all services, they need to select only the most important services for quantification and have leeway to use less precise (but perhaps more conservative) methods as they work toward developing better ones in the coming years.**<sup>25</sup> Just identifying services that may be affected in a decision, and being transparent about how they are considered, is quite helpful. Furthermore, taking the next step of quantitatively estimating the ecological changes and describing how these are expected to effect the provision of services would be a significant improvement. The more complicated steps of (1) quantitatively estimating the change in ecosystem service (what is valued) or (2) accounting for how much such changes are valued (Figure 3), may only be used for critical decisions that need benefit cost assessments in the near term.<sup>26</sup> The Lake Okeechobee example in Figure 2 shows a number of societal benefits that are in conflict, where an increase in one will lead to a decrease in another illustrating where valuation approaches are helpful and may be needed.



Note: Intuitive comparisons require decision makers to use their knowledge of preferences implicitly, rather than to assess them explicitly.

**Figure 3. Alternatives for quantifying ecosystem services** (Source: Olander et al. 2015 [https://nicholasinstitute.duke.edu/sites/default/files/publications/es\\_best\\_practices\\_fullpdf\\_0.pdf](https://nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf))

<sup>25</sup> Recommendations on selecting services can be found at NESPguidebook link and citation and in Lydia Olander, Robert J. Johnston, Heather Tallis, Jimmy Kagan, Lynn Maguire, Steve Polasky, Dean Urban, James Boyd, Lisa Wainger, and Margaret Palmer. 2015. “Best Practices for Integrating Ecosystem Services into Federal Decision Making.” Durham: National Ecosystem Services Partnership, Duke University. doi:10.13016/M2CH07

<sup>26</sup> More on these methods can be found in Olander, et al. 2015. “Best Practices for Integrating Ecosystem Services into Federal Decision Making.” Ibid.

Another challenge associated with considering all services, is that **some services may be outside an agency’s jurisdiction or authority, suggesting an opportunity for calibration and need for transparency about what is effected but not included in the decision process.** For example, the Corps does not generally consider water quality as a primary objective of its projects, yet its actions can have significant water quality effects (both positive and negative) changing the provision of services. So, if the Corps identifies all potentially affected services, it can quantify those that are under its authority and invite an agency partner like EPA or state water management agency to focus on the others. This will help the Corps be thorough and inclusive in communications with its stakeholders and partners.

Some managers are concerned that using ecosystem services will entail significant effort but have only minimal effect on decisions and outcomes. **In a climate of constrained funding and limited ability to increase organizational capacity, an ecosystem services (or any) approach must clearly demonstrate its value.** Thus the Corps will need to evaluate and adapt its use of ecosystem services to when and where it provides the most value for decision making.

#### *USACE exploration of Ecosystem Services*

USACE first explored ecosystem services in the 1990s as a part of the Evaluation of Environmental Investments Research Program. The program resulted in over 20 reports on a variety of topics including ecosystem services, monetary and non-monetary valuation of environmental benefits and investments, resources scarcity and significance, and cost effectiveness-incremental cost-analysis.

**More recently a Corps work unit tasked with exploring the challenges and opportunities of integrating ecosystem services into the Corps’ operations, released a few reports and is developing a trial framework for incorporating analysis of ecosystem services into Corps decision processes.** In 2013, the Corps released two documents that represent initial efforts to tackle this goal. The first, “[Incorporating Ecosystem Goods and Services in Environmental Planning: A Literature Review of Definitions, Classification and Operational Approaches](#),” lays the foundation for meeting the goal by reviewing key concepts and best practices and outlining how they may be best applied to existing Corps processes.<sup>27</sup> The second report, “[Using Information on Ecosystem Goods and Services in Corps Planning: An Examination of Authorities, Policies, Guidance, and Practices](#),” reviews existing Corps policies, authorities, and guidance that may allow or impede incorporation of ecosystem services into planning processes.<sup>28</sup> According to this report, one impediment could be a project’s purpose or authority. For example, the purpose under the Corps authority to conduct aquatic restoration projects is to restore degraded ecosystems to more natural conditions. Under current guidance, these projects’

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<sup>27</sup> D. Reed, L. Martin, and J. Cushing, Using Information on Ecosystem Goods and Services in Corps Planning: An Examination of Authorities, Policies, Guidance, and Practices, 2013-R-07, U.S. Army Corps of Engineers, 2013

<sup>28</sup> Tazik, D., J. Cushing, E.O. Murray, and L. Wainger. 2013. *Incorporating Ecosystem Goods and Services in Environmental Planning: A Literature Review of Definitions, Classification and Operational Approaches*. ERDC/EL TR-13-17, U.S. Army Engineer Research and Development Center.

measurable outputs are related to species and habitat, potentially putting other ecosystem services, even significant ones, outside the scope of the projects' purpose.<sup>29</sup>

This Corps work group is also developing a framework for integrating ecosystem services assessments into planning efforts, and has prospective reports underway that examine available tools and models, present case studies of Corps projects that involve ecosystem services assessments, and discuss interagency coordination (personal communication and webinar presentation to NESP Federal Community of Practice by Janet Cushing, Elizabeth Murray, Lisa Wainger).

**Ecosystem services have also been considered in the USACE Environmental Research and Development Center (ERDC) recovery efforts, post hurricane Sandy, in the use of ecosystem goods and services quantification and quantitative metrics to assess green infrastructure for coastal resilience.**

#### *Opportunities for the Corps to use ecosystem services*

In general, the use of ecosystem services in decision making neither preempts an agency's existing mandates and decision-making discretion nor requires that a specific decision be reached. Rather, it provides additional information on how best to meet existing priorities (and acknowledge the more comprehensive suite of benefits at the same time), thereby supporting informed decision making. It does not replace current assessment practices but can be used to supplement them. For example, it can be used in benefit-cost analysis, cost-effectiveness analysis, and cumulative impacts analysis and should be applied in processes and methods that considers the long-term sustainability of resource and natural benefits under the uncertainties of climate change, urbanization, and other major drivers of change. Ecosystem services can also be used in monitoring and adaptive management. When a high degree of uncertainty accompanies a mandate or decision, then the monitoring of ecosystem services can provide critical adaptive management information and awareness about changes in demand for services as a project progresses. This is a topic to be explored in more detail when the EAB develops a report for the Chief on the Status of Adaptive Management.

**For the Corps, ecosystem services can fit into a wide range of typical regulatory and decision processes like project prioritization and funding allocation, the development and tracking of performance metrics, operations and maintenance decisions, wetland and stream mitigation, and impact assessment under NEPA.<sup>30</sup>**

Ecosystem services are commonly used in assessing alternatives for a project or program to supplement information on the primary benefits and costs of a project, to account for the less often considered effects on ecosystems and the benefits they provide to people. Given that proposed Corps projects often consider multiple benefits and impacts, broadening the scope to additional ecosystem services that can be considered in a transparent and consistent manner, may

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<sup>29</sup> There is precedent of considering other local ecosystem services in projects when they are critical; for example water supply in the Everglades.

<sup>30</sup> Lydia Olander, Robert J. Johnston, Heather Tallis, Jimmy Kagan, Lynn Maguire, Steve Polasky, Dean Urban, James Boyd, Lisa Wainger, and Margaret Palmer. 2015. "Best Practices for Integrating Ecosystem Services into Federal Decision Making." Durham: National Ecosystem Services Partnership, Duke University. doi:10.13016/M2CH07

fit well into the ongoing progression for how the Corps makes decisions on new and aging infrastructure.

It may also be possible to incorporate ecosystem services into operation and management decisions. For example the Engineering with Nature program at ERDC is exploring beneficial uses of dredge material.<sup>31</sup> Incorporating benefits into O&M decisions may provide an opportunity for the Corps to move from a least cost disposal approach to one where both use and non-use benefits are balanced with costs, helping to achieve other objectives of the Corps (particularly those related to restoration or recreation) as well as those of its partners and stakeholders. The Engineering with Nature program is exploring linking ecosystem services metrics to operations and maintenance activities and into planning for natural and nature based options for new structures.<sup>32</sup>

Ecosystem Services can also fit into regulatory programs like the Clean Water Act 404b program to address impacts to wetlands and streams. The 2008 joint rule for compensatory mitigation issued by the Corps and the EPA stated that, “mitigation...should be located where it is most likely to successfully replace lost...services”.<sup>33</sup> Partner agencies like the Department of Transportation are developing complementary approaches that may help them reduce impacts and develop advanced mitigation in partnership with the Corps providing a better landscape scale replacement of lost services.<sup>34</sup>

Corps leadership has also expressed interest in using ecosystem services to better communicate and evaluate the benefits of restoration projects, which should be possible by talking about the range of benefits provided by the restoration beyond simply the habitat units restored (Box 2).

**Box 2. Expanding Restoration Benefits beyond Habitat Units**

While the Corps’ default approach of using Habitat Units to describe the benefits of ecosystem restoration projects does provide a quantitative method for evaluating benefits to specific endangered or threatened species, the habitat unit model has several shortcomings that may limit the Corps’ ability to demonstrate the full range of benefits. As a metric, Habitat Units provide a viable indicator of ecosystem structure and a limited assessment of ecosystem function, but they fail to provide any measure of dynamic ecosystem processes and do not capture many other recognized ecosystem services. For example, using the Habitat Unit approach, a floodplain restoration project may be represented by X acres of wetland habitat units critical to species Y and Z, but this approach does not adequately capture the additional functional ecosystem services provided in the form of flood storage, groundwater recharge, nutrient removal, base flow support, thermal regulation, or carbon and sediment sequestration. Using ecosystem services measures in addition to Habitat Units can help to capture fundamental and valued environmental processes that are called for in the Corp’s Environmental Operating Principles, such as achieving environmental sustainability and assessing cumulative impacts to the environment, are inadequately addressed.

<sup>31</sup> <http://el.ercdc.usace.army.mil/factsheets/budm.pdf>

<sup>32</sup> <http://el.ercdc.usace.army.mil/ewn/>

<sup>33</sup> J.B. Ruhl, J. Salzman, and I. Goodman “Implementing the New Ecosystem Services Mandate of the Section 404 Compensatory Mitigation Program: A Catalyst for Advancing Science and Policy.” *Stetson Law Review* 38(2009):251–272.

<sup>34</sup> Janice Brown. 2006. *Eco-logical: An Ecosystem Approach to Developing Infrastructure Projects*. U.S. Department of Transportation, Research and Innovation Technology Administration, Volpe National Transportation Systems Center.



Presently, projects funded by the Corps are required to have national significance and thus, many ecosystem services are considered to be outside the scope of this authority because they provide only local benefits (e.g., water quality). Yet, many ecosystem services could meet the national significance criteria if they have effects at the basin or regional scale. Incorporating ecosystem services requires considering the flows of services and benefits often leading to larger temporal and spatial scales of analysis. In this way ecosystem services assessment would fit well with the Corps' strategic planning effort to incorporate integrated water resource management.<sup>35</sup> A broad consideration of all ecosystem services affected by Corps decisions would provide more information relevant to both federal and local interests than is presently available.<sup>36</sup>

It will be impossible to quantify the potential effects of every Corps decision on all services. However, even a relatively descriptive but systematic assessment, such as those found in simple conceptual diagrams (e.g., Figure 2) can be very informative. This approach would help ensure that the possible effects of Corps decisions on the production of ecosystem services are recognized and communicated as needed. This general approach could be incorporated into processes like Environmental Impact Statements for NEPA. The next step will be to determine what needs to be quantified and valued and by whom.

The Corps will likely see consideration of ecosystem services changing their decisions more if they use a balanced and integrated approach to planning where multipurpose projects are considered as alternatives to those limited to a single business line. Multipurpose projects are more likely to support and enhance a range of ecosystem services benefits that support public welfare.

### **Recommended Actions**

The October 7, 2015 memorandum from the Executive Offices of the President on "[Incorporating Ecosystem Services into Federal Decision Making](#)" directs agencies to "develop policies to promote consideration of ecosystem-services assessments within existing agency planning and decision frameworks, where appropriate and practicable...". By March 30<sup>th</sup> agencies are expected to provide a review of current use, and a work plan for integrating ecosystem services.<sup>37</sup> With this in mind the Environmental Advisory Board provides the following recommendations.

#### *1. Develop internal methods*

*Use an expert Corps team with experts from across business lines, to explore and develop decision appropriate methods for integrating ecosystem services into current decision making processes in all business lines and Corps activities.*

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<sup>35</sup> [http://www.usace.army.mil/Portals/2/docs/civilworks/news/2014-18\\_cw\\_stratplan.pdf](http://www.usace.army.mil/Portals/2/docs/civilworks/news/2014-18_cw_stratplan.pdf)

<sup>36</sup> If helpful, the corps could provide clear guidance to cost share partners that ecosystem services of only local significance would not be eligible for consideration at the national policy and planning levels.

<sup>37</sup> October 7, 2015. Memorandum for Executive Departments and Agencies  
<https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-01.pdf>

We recommend that the Corps further develop the use of benefit relevant indicators (Box 1) (ecosystem service indicators) across its business lines and decision processes. This would build upon current explorations and research in the Corps to:

- explore approaches for using ecosystem goods and services in all business lines;
- explore how ecosystem goods and services can be used in different decision contexts such as planning, operations and maintenance, stream and wetland mitigation, and prioritization; and
- where the approaches prove useful develop implementation frameworks, methods, and tools

We also recommend the Corps further consider how benefit relevant indicators (ecosystem service indicators)<sup>38</sup> can be used in other ways such as:

- for communicating additional benefits of ecological restoration projects;
- for assessing performance of projects and policies;
- in project funding prioritization measures; and
- in watershed informed budgeting.

There are a number of existing resources that may be useful including the National Ecosystem Services Partnership online guidebook<sup>39</sup> developed in partnership with many federal agencies and the Ecosystem Goods and Services Framework developed by Institute for Water Resources (IWR) and EDRC which is still undergoing internal review.<sup>40</sup>

We recommend the Corps begin pilot testing ecosystem services integration into active decision making processes. These examples can be used to test and refine application across decision contexts and to develop robust internal guidance and examples and templates for managers to follow. It might also lead to the identification of some common services and metrics for common decision types within the Corps that could be considered for performance metrics or prioritization measures. To address the coordination challenge head on, where possible, the Corps can use examples that have multiple agencies or partners involved to evaluate how these approaches can be coordinated and how benefits and values of different parties can best be considered in the Corps' decision processes. These pilots can also be used to determine when and where incorporating ecosystem services is a cost effective approach for improving decisions and where it is not proving as useful. This can inform future Corps guidance and policy on the use of ecosystem services.

## *2. Build awareness and capacity*

*Build awareness of and capacity for using ecosystem services in Corps decision making across all business lines and divisions.*

We recommend that the Corps:

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<sup>38</sup> Lydia Olander, et al. 2015. "Best Practices for Integrating Ecosystem Services into Federal Decision Making." Durham: National Ecosystem Services Partnership, Duke University. Ibid.

<sup>39</sup> National Ecosystem Services Partnership. 2014. *Federal Resource Management and Ecosystem Services Guidebook*. Durham: National Ecosystem Services Partnership, Duke University, <https://nespguidebook.com>.

<sup>40</sup> Lisa A. Wainger, Anna McMurray, Hannah R. Griscom, Elizabeth O. Murray, and Janet A. Cushing. In review. A proposed ecosystem services analysis framework for the US Army Corps of Engineers. ERDC

- Conduct an assessment of USACE internal and contractor technical capacity in economic valuation (including non-market valuation methods) and multi-criteria decision analysis and consider expanding capacity in both research and district personnel.
- Consider developing a temporary (e.g., 6 years then reevaluate need) internal ecosystem services leadership group that will have members spread across research institutions (IWR, ERDC) and districts to (1) provide support and coordination for implementation of the new approaches, and (2) address concerns and update the new methods being implemented across the Corps.
- Develop and provide training in ecosystem services for resource managers and leadership for a defined period of time to accelerate uptake of new approaches, shared learning, and consistency and quality in application. This could include the Command School for district commanders, the Corps' Senior Leaders meetings, and the Planning Core Curriculum and Planning associates Program. The structured decision-making courses at the National Conservation Training Center which teach basic multi-criteria decision analysis methods may be a useful resource.<sup>41</sup>

### 3. *Coordinate with other agencies*

*Work in partnership with other Federal and State agencies to coordinate development and collection of necessary ecosystem services data and models and the computing infrastructure necessary to maintain, distribute, and update them over time.*

The Corps can increase their engagement with an established interagency body coordinating development of data & tools. The Office of Science and Technology Policy coordinates the National Science & Technology Council's Subcommittee on Ecological Systems,<sup>42</sup> which has relevant working groups. The Corps has been involved with the Coastal Green Infrastructure & Ecosystem Services Task Force and Climate Resilience Toolkit effort, but may also want to engage with the Ecosystem Services Working Group which is supporting the development of data and tools including EnviroAtlas and EcoInforma. The Corps could contribute to a number of tasks that would help agencies develop the necessary data and modeling infrastructure to support the widespread use of ecosystem services approaches across agencies and improve coordination across agency partners. These activities could include:

- A process and effort to collect ecological production functions<sup>43</sup> that are commonly used within the USACE and may be useful for other agencies which may support the creation of generalized yet adaptable models/tools for key services where cost effective. The

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<sup>41</sup> <http://training.fws.gov/courses/programs/decision-analysis/structured-decision-making-overview.html>

<sup>42</sup> <https://www.whitehouse.gov/administration/eop/ostp/nstc>

<sup>43</sup> Ecological production functions are ecological models that capture the responsiveness of ecosystem services provision to changes in the environment. Each production function that connects an action to an ecosystem service response can be made up of multiple models (see figure 1 for an example).

production function library<sup>44</sup> under development by the Environmental Protection Agency may provide a useful starting place.

- Remove internal Corps barriers (ER 1105-2-100 Chapter 3 and Appendix E) for use of non-market valuation methods like contingent valuation methodologies as these are critical for assessing non-use values.
- Develop a survey template for non-market valuation (generalized version that can be adapted for specific uses) that can be approved by OMB allowing the Corps and other agencies to more easily get project specific surveys approved and build data for generalized models that will greatly improve benefit transfer and allow greater use of monetary valuation for non-market and non-use values where it is useful to the Corps.
- Develop lists of key services and metrics by which they could be assessed, creating templates for common agency activities. For example, wetland restoration may include the following categories of services - water storage, groundwater recharge, filtration of contaminants, processing and capture of excess nutrients, habitat for at risk species, etc..

To get the most out of the use of ecosystem services their use should be set within a balanced and watershed scale approach to decision making. This heightens the need for decisions to be balanced and integrated across the Corps business lines to allow consideration of multipurpose projects that can achieve multiple corps objectives while also best providing ecosystem service benefits.

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<sup>44</sup> R. J. Bruins, L. Wainger, S. Sifleet, and T. H. Dewitt. Development of US EPA's Ecological Production Function Library. Presented at EcoSummit 2012, Columbus, OH, September 30 - October 05, 2012.  
[http://cfpub.epa.gov/si/si\\_public\\_record\\_report.cfm?dirEntryId=241148](http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=241148)