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Useful Tool or Business as Usual?

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The University of Arizona.

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Highlights

- We assess the potential of using an ecosystem services approach as part of the U.S. National Environmental Policy Act (NEPA) environmental impact assessment process.

- We surveyed U.S. Forest Service staff who have worked on environmental impact analyses.

- Forest Service staff who are familiar with ecosystem services think that an ecosystem services approach may improve communication and decisions.

- Forest Service staff are influenced more by internal agency directives than general NEPA guidance documents.

- Perceived obstacles to greater use of ecosystem services include increased burdens on Forest Service staff and lack of clear methods for analyzing ecosystem services.

Abstract

Ecologists and economists have promoted the concept of ecosystem services as a tool for assessing and communicating to the public and decision makers the value of environmental trade-offs. We assess the potential of using an ecosystem services approach as part of environmental impact assessments under the U.S. National Environmental Policy Act (NEPA).

In 1999, the U.S. Environmental Protection Agency published a NEPA guidance document that suggested, but did not require, consideration of ecosystem services in environmental impact analyses. To assess the role of ecosystem services in NEPA analyses, we conducted an online survey of U.S. Forest Service professionals who had been involved in developing environmental impact assessments during a two-year period (January 2010 through December 2011). The goal of the survey was to determine (a) whether and how the ecosystem services concept is currently being used in Forest Service NEPA analyses, (b) how influential NEPA guidance documents are, and (c) whether respondents thought the ecosystem services concept could be useful in the NEPA process.

Forty-one percent of respondents were unfamiliar with ecosystem services. However, a majority of the remaining 59% who were familiar with the concept thought it could be helpful in NEPA analyses. The most commonly perceived advantage to using an ecosystem services approach was improved communication to the public and decision makers about environmental impacts.

Some respondents perceived that ecosystem services are already sufficiently considered in environmental impact assessments. The most commonly reported factors that might discourage additional use of the ecosystem services concept were lack of methods for incorporating ecosystem services and concern that more analysis of ecosystem services would increase the time and cost to complete the NEPA process.

Based on the survey results, we discuss some approaches for helping to incorporate the ecosystem services concept into the NEPA process.

Introduction

The concept of ecosystem services—the benefits humans receive from functioning ecosystems—takes into account the ways in which functioning ecosystems benefit society, weighing trade-offs in ecosystem management in terms of impacts on the environment and society. The goal of this approach is to help decision makers and stakeholders make more informed choices about ecosystem management (Ranganathan et al. 2008; Brauman et al. 2007; Ruhl et al. 2007; Millennium Ecosystem Assessment 2005; Daily et al. 1997). For example, a recent U.S. Forest Service report suggests that the ecosystem services framework provides a "more complete accounting of forest benefits" rather than narrowly focusing on output targets, such as the amount of timber sold (Smith et al. 2011, 2). Scholars of U.S. environmental policy have suggested that such an approach could improve federal and state environmental decision making (Scarlett and Boyd 2011; Smith et al. 2011; National Research Council 2004; Fischman 2001), and in particular environmental impact assessments under the National Environmental Policy Act (NEPA; Scarlett and Boyd 2011).

Under NEPA, federal agencies are required to evaluate and inform the public about potentially significant environmental impacts from about 50,000 proposed federal actions per year (Karkkainnen 2002; 42 U.S.C. § 4332(2)(C)(i)). Agencies must assess alternatives and allow for public participation and comment. The vast majority of proposed actions each year are disposed of either through a categorical exclusion determining that certain kinds of actions are not "major Federal actions significantly affecting the quality of the human environment" or through a preliminary environmental assessment (EA) and a finding of no significant impact (FONSI). Some environmental assessments include commitments to mitigation and monitoring to avoid triggering full NEPA process review. A much smaller number of proposed actions each year proceed to a full environment impact assessment (EIS).

Environmental policy scholars have suggested that the ecosystem services framework might be useful in meeting NEPA's goals of (a) informed assessment of the impacts of proposed actions and alternatives and (b) transparency. Fischman (2001) points out that NEPA itself encourages agencies to utilize an

interdisciplinary approach and to identify and develop methods to insure that environmental values are considered along with economic factors (NEPA, Section 102 (2)(B)). Scarlett and Boyd (2011) believe that the ecosystem services concept adds to the current practice of describing environmental impacts by helping decision makers evaluate trade-offs between current and future ecosystem services to be gained or lost. In addition, the ecosystem services framework could help communicate to the public how environmental impacts will affect them. The ecosystem services framework might do this by elucidating what impacts to ecosystem function and process were considered for particular proposed actions, how those ecosystem impacts were quantified, and how changes in ecosystem function and processes affect provision of services and, ultimately, human well-being.

Guidance Documents for the NEPA Process

The Council on Environmental Quality (CEQ) was created to oversee and monitor the National Enviornmental Policy Act. The CEQ writes guidance documents that fill in substantive details such as what to include in impact assessments, how long the documents should be, and how to file them. Under the authority of the Clean Water Act, the Environmental Protection Agency (EPA) also writes guidance documents, reviews all environmental impact statements (EISs), and can report to CEQ any EISs of unusual complexity or those that are lacking information (Fischman 2001). EPA and CEQ guidance documents are then adapted by federal agencies into internal agency-specific directives.

Three guidance documents in particular, *Considering Ecological Processes* (EPA 1999a), *Considering Cumulative Effects* (CEQ 1997a), and its related document, *Consideration of Cumulative Impacts* (EPA 1999b), provide direction for incorporating ecosystem service evaluation in NEPA analyses. *Considering Ecological Processes* indicates that ecosystems are important because they provide humans with valuable ecosystem services such as clean air and water, food, fiber, flood control, and other benefits. *Considering Cumulative Effects* and *Consideration of Cumulative Impacts* address environmental impacts that occur over a large landscapes and long time horizons, and might offer a way to incorporate ecosystem services as many ecosystem services occur over large spatial and temporal scales (Scarlett and Boyd 2011).

In 2012, the U.S. Forest Service approved a new Planning Rule that requires ecosystem services to be analyzed in new Forest Plans and related NEPA documents. The Planning Rule only applies to a fraction of the broad array of NEPA projects completed by the Forest Service, which include forest planning, vegetation management, wetland restoration, and energy projects. For all other Forest Service NEPA projects, and for all other agencies, ecosystems services could be considered under the general authority of NEPA. Guidance could come for any agency from the *Considering Ecological Processes* guidance document.

Despite the fact that the ecosystem services framework has been included in guidance documents since 1999, new ideas and policies do not always produce different outcomes. Management agencies are often constrained or disproportionately influenced by political institutions, institutional norms, laws, and interest groups such that statutes, actions, or decisions may only vaguely reflect the desires of the public or the individual bureaucrat (Mashaw 1997; Farber and Frickey 1991; Wright and Miller 2008). Although land management agencies have legal authority under the broad authority of NEPA to consider a wide range of factors that impact the environment, the barriers to change in agencies processes are more likely to come from the culture and habits of the agency itself.

This study examines to what extent ecosystem services are in fact being considered in the "high end" environmental impact statement process under NEPA given the difficulties of institutional change, the longstanding legal authority under NEPA to consider such factors, and the specific encouragment to consder ecosystem services since the 1997 and the two 1999 guidance documents.

Survey of Forest Service Personnel

We conducted an online survey of Forest Service professionals involved in environmental impact assessments under NEPA. We focused on the Forest Service for several reasons. First, the Forest Service currently produces more environmental impact statements than any other agency (EPA, unpublished data). Second, the Forest Service was sued 342 times for various reasons related to NEPA between 2001 and 2007. And third, in 2006, six thousand Forest Service environmental impact statements cost $365 million (Mortimer et al. 2011). Together, these indicate that NEPA is a time-consuming, costly process with a high risk of litigation for the agency. Finally, and most importantly, the Forest

Service is interested in and has begun using the ecosystem services framework in forest planning (Collins and Larry 2007; Smith et al. 2011). This provides an opportunity to ascertain to what extent an agency interested in ecosystem services is currently using ecosystem services in their high-end NEPA process.

The survey was designed to answer the following questions:

- Are agency staff familiar with the ecosystem services concept?
- To what extent is the ecosystem services concept currently being used in NEPA?
- How influential are the 1997 CEQ and 1999 EPA guidance documents?
- Do agency staff view the ecosystem services concept as useful in the NEPA process? And if so, how?

Based on initial scoping, we expected higher levels of familiarity among decision makers (i.e. forest supervisors) compared to interdisciplinary team members who actually produce the NEPA analyses. We expected that while ecosystem services may be currently considered in NEPA analyses, they might not be referred to as such. Finally we expected that CEQ and EPA guidance documents, particularly EPA's guidance, *Considering Ecological Processes*, may not be very influential in guiding the development of individual impact assessments.

Background: NEPA Process

NEPA sets up a process to inform the public about environmental impacts from all proposed federal, federally assisted, and federally licensed actions. When embarking on a new project that is expected to "significantly (affect) the quality of the human environment," agencies must complete different activities and documents. "Scoping" is used early in the process to "determin(e) the scope of issues to be addressed and (to identify) the significant issues related to a proposed action" (40 CFR 1501.7). Federal, state, and local agency staff, tribal members, and other interested parties may participate. After initial scoping, other public meetings may be held to discuss and gather comments about draft documents. Projects that "do not individually or cumulatively have a significant effect on the human environment" and without unusual circumstances are granted a "categorical exclusion" and require only brief documentation (40 CFR

1508.4). If the proposed environmental impact is unknown, an environmental assessment (EA) must be completed. Following an environmental assessment's determination of no significant impact, the responsible agency can file a "Finding of No Significant Impact" (FONSI). If the responsible agency expects significant impacts, the agency must complete an environmental impact statement (EIS). After compiling and reviewing public comments, the responsible agency decides whether or not to proceed to a Final EIS, which is followed by a Record of Decision (ROD) and possibly an appeal process, if applicable.

Numerous papers have been written critiquing the NEPA process (Karkkainen 2002, 2004; Gerrard and Herz 2003; Stein 2010; Stern and Predmore 2011; Predmore et al. 2011; Mortimer et al. 2011). NEPA has been criticized for requiring large amounts of predictive information prior to project approval with little or no ongoing monitoring or regulation (Karkkainen 2002, 2004) and—despite calls for transparency and easy access to information—for maintaining a decentralized, paper-based filing system instead of making documents available online (Gerrard and Herz 2003; Miller and Farber 2010). Although incorporating the ecosystem services approach will not solve these challenges, it might help advance NEPA's goals of using the most advanced interdisciplinary science and of communicating to the public about how environmental management decisions are made.

Methods

Survey design and focus group

We used a tailored design method (based on Dillman 2009) in an online survey. We included questions to elicit quantitative and qualitative information regarding familiarity with and opinions about ecosystem services and directives used by Forest Service NEPA practitioners across the county. We pre-tested the survey through scoping and a focus group (n = 8) consisting of Forest Service staff with varied and extensive experience working on NEPA projects. The aim of the focus group was to assess whether the survey questions were clearly worded. We modified the survey based on focus group feedback. For example, participants reported lack of clarity around the term "ecosystem services." Some participants reported looking online for a definition, while others expressed

different understandings about its meaning. The final survey included a definition of ecosystem services from the "More About Ecosystem Services" web page of the U.S. Department of Agriculture (the cabinet-level agency which houses the Forest Service).[1] The University of Arizona Institutional Review Board approved the survey and related materials in March 2012, and we distributed the questionnaire soon thereafter using DatStat Illume™ web-based survey software.[2]

Survey sample population and distribution

We selected our sample population using the Forest Service Planning, Appeals and Litigation System (PALS) database. Our sample population consisted of all the project managers, interdisciplinary team members, and decision makers (n = 1,230) who had worked on environmental assessments or environmental impact statements in a two-year period from January 2010 through Dec 2011.[3]

Participants were sent up to three invitation emails with links to the online survey over the course of three-and-a-half weeks in March–April 2012. The first email introduced the study. Non-respondents to that email were sent up to two reminders starting one week later. Each letter contained an individualized link to the survey. The survey was left open for 26 consecutive days (March 19–April 13, 2012). All survey responses were anonymous.

Out of 1,230 surveys initially sent out, 524 surveys were completed for a conservatively calculated response rate of 43%, which exceeds benchmarks for online surveys (Baruch and Holtom 2008). An additional 36 surveys were partially completed. Responses were received from all Forest Service regions across the United States. We suspect that the population eligible for the survey was actually smaller than 1,230 (and that the actual response rate is greater than 43%) because some people may have retired or left the agency.

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[1] See http://www.fs.fed.us/ecosystemservices/About_ES/index.shtml.

[2] See http://www.datstat.com/survey-research-software#illume.

[3] Interdisciplinary team members are staff (biologists, other specialists) responsible for writing NEPA documents. Decision makers are forest supervisors and district rangers, appeal reviewing officers, and appeal/litigation coordinators. A number of individuals were both interdisciplinary team members and decision makers during the study period.

Survey questions and analysis

Staff familiarity with ecosystem services

We asked closed-ended questions about practitioners' familiarity with the ecosystem services concept, and compared rates of familiarity between Forest Service positions (interdisciplinary team members, decision makers, and individuals who were in both positions during the study period).[4] Quantitative results were analyzed with the SPSS data-analyses software and qualitative responses were coded with QSR NVivo software to identify themes.[5]

To determine how respondents learned about ecosystem services we provided several response options, including internal training and colleagues, external sources such as U.S. Department of Agriculture's Office of Environmental Markets and the Millennium Ecosystem Assessment (2005), and in college or graduate school. We expected that:

a) internal Forest Service training would be the most influential and that some staffmight have learned about ecosystem services from the Office of Environmental Markets because of its focus on developing markets for ecosystem services and because the Forest Service and Office of Environmental Markets are both in the U.S. Department of Agriculture, and

b) Forest Service staff would know about the Millennium Ecosystem Assessment because it is widely considered a foundational report on ecosystem services.

Current consideration of ecosystem services

To account for the possibility that respondents might assess ecosystem services in the environmental impact analyses without calling them such, we asked participants how frequently they consider each of 28 factors widely considered

[4] We expected a bimodal distribution of respondents who were "unfamiliar" or "very familiar" with the ecosystem services concept, with higher levels of familiarity expected for decision makers.

[5] For the comparison, we used a Kruskal-Wallis test and post-hoc comparisons (Dunn's [1964] procedure with Bonferroni correction). Statistical significance was accepted at $p < .0083$ for multiple comparisons.

as ecosystem services (Hassan et al. 2005) in their analyses.[6] Open-ended responses to "additional" ecosystem services were analyzed with NVivo.

Influence of guidance documents and other directives

We asked respondents to list up to five of the first sources of information they refer to for instructions when starting any core NEPA document (categorical exclusions, environmental assessments, or environmental impact statements). Open-ended responses were coded in NVivo. Participants were then asked to independently rate the level of influence of Forest Service directions and CEQ and EPA guidance documents when completing categorical exclusions, environmental assessments, or environmental impact statements—ranging from 1 (not influential at all) to 5 (very influential); with 6 (I don't know) and 7 (not applicable).[7]

Factors that encourage or discourage use of ecosystem services in NEPA

To determine if agency staff view the ecosystem services concept as useful in the NEPA process, we asked both open-ended and closed-ended questions, along with demographic questions. Respondents were asked to list any factors that might encourage or discourage consideration of ecosystem services, and whether or not they think the ecosystem services concept might be useful in framing NEPA analyses. We asked the participants who indicated that ecosystem services might be useful to explain in more detail how ecosystem services it might be useful. Similarly, we asked those who indicated that ecosystem services is not useful, to explain why not.

To test an additional hypothesis that persons who are more familiar with the ecosystem services concept are more likely to think it useful, we compared levels of familiarity with responses about usefulness.[8] These were accompanied by four

[6] We used exploratory factor analysis using principal component extraction with varimax rotation to assess the relationship between ecosystem services reported.

[7] To determine if any directives were more or less influential than the others, we used Wilcoxon signed-rank tests to compare the level of influence of internal (Forest Service) versus external directives (CEQ and EPA guidance), and the levels of influence of each directive for CEs and EA/EISs. We used Kruskal-Wallis tests to compare responses within internal directives (handbook, manual, memo, verbal instructions) and within external guidance documents: *Forest Health* (CEQ 2002), *Cumulative Impacts* (EPA 1999b), *Ecological Processes* (EPA 1999a), and *Environmental Justice* (EPA 1999c).

[8] We tested for significant differences using Wilcoxon signed-rank tests and post-hoc analyses.

closed-ended questions about whether ecosystem services would improve or worsen four aspects of the NEPA process: (1) the ability to communicate impacts to the public, (2) the time required to reach a decision, (3) the quality of the decision, and (4) the effectiveness in informing the decision maker. We asked respondents to consider how these four aspects would be affected at different stages of the NEPA process (scoping, findings of no significant impact, categorical exclusions, environmental assessments, environmental impact statements, other public meetings).[9]

Results

Familiarity and analysis of ecosystem services

Forty-one percent of respondents were "totally unfamiliar" with ecosystem services. Forty-two percent were "somewhat familiar," and almost 18% reported being "very familiar." There was a statistically significant difference between levels of familiarity between interdisciplinary team members and decision makers (p = .006) (Figure 1). Decision makers were more likely than interdisciplinary team members to be somewhat or very familiar with ecosystem services. People who are familiar with ecosystem services were more likely to think ecosystem services can be useful in NEPA (Figure 2).

Among respondents familiar with ecosystem services, the most frequently reported resources for learning about ecosystem services include other colleagues, agency or project memos, scholarly articles, and websites (Table 1). Respondents cited agency trainings less frequently, and only 1% of respondents had learned about ecosystem services from the Millennium Ecosystem Assessment or the USDA Office of Environmental Markets.

We used factor analysis to determine to what extent ecosystem services are already being considered in the NEPA process (whether or not they are referred to as such by the practitioner). We identified five factors that describe 56% of the

[9] We used Kruskal-Wallis tests to determine significant differences of the Likert ratings (1 = improve, 3 = worsen) between the four aspects.

statistical variance in the responses (Table 2). The factors show that some groups of ecosystem services are considered at similar rates by individuals and seem likely to occur in related kinds of projects. We called these factors "erosion and water quality," "water and recreation," "regulating services," "cultural services," and "agriculture and drought." Wildlife is correlated at similar levels with both erosion and water quality (Factor 1) and cultural services (Factor 4). We interpret this as wildlife habitat being considered about equally in projects that also impact erosion control, water quality, cultural importance, and tourism.

Open-ended responses describing "any additional ecosystem services … analyzed in NEPA" show a variety of ecosystem services, ecological processes, or environmental impacts (Figure 3). Some of the responses fit into the four Millennium Ecosystem Assessment categories (provisioning, regulating, supporting, and cultural services). However, the majority of responses (over 200 items) fell into the category "other," with 19 subcategories that are either not considered ecosystem services (based on Hassan et al. 2005; Millennium Ecosystem Assessment 2005) or for which the respondents' intended meanings are difficult to interpret. For example, items like "special uses," transportation, and tribal interests seem to relate more to human needs, rather than to ecosystem services, and fisheries, hunting, and watersheds could fit into multiple Millennium Ecosystem Assessment categories, depending on what exactly was being analyzed.

Guidance and other sources of direction

We expected that persons would predominately rely on internal Forest Service direction (handbook, manual, memos, and verbal instructions) and less on EPA and CEQ guidance. Independent mean scores confirm that among internal directives, the Forest Service Handbook (Forest Service 2011) is the most influential, and among external directives, EPA's *Considering Ecological Processes* (EPA 1999a) and *Environmental Justice* (EPA 1999c) guidance documents were less influential than *Forest Health* (CEQ 2002) and *Cummulative* Impacts (EPA 1999b)[10] (Figure 4A and 4B).

[10] *Cumulative Impacts* (EPA 1999) was used to include also *Cumulative Effects* (CEQ 1997a), because of their related content.

We also asked participants to indicate the first five sources of direction or information they turn to when they start a NEPA document (categorical exclusions, environmental assessments, environmental impact statements; Figure 5). These open-ended responses show that respondents most frequently rely on internal sources of information. The most frequently selected items are: the Forest Service Handbook (Forest Service 2011), co-workers, forest plans and other land and resource management plans, the Forest Service manual and recent NEPA documents. Other less common responses include data, law and regulations, CEQ, personal experience, templates, and court cases.

Aspects of the ecosystem services approach that could be useful in NEPA

Improved communication with the public and decision makers were the main ways in which respondents thought using ecosystem services could be beneficial to the NEPA process. A majority of respondents thought that considering ecosystem services would improve the effectiveness in informing decision makers, as well as the quality of the decision (Figure 8). However, opinions about the effect of ecosystem services on the ability to describe impacts to the public were divided such that the mean score indicates only slight improvement. Most respondents thought that inclusion of ecosystem services in NEPA analyses would lengthen the NEPA process.

Factors that encourage or discourage the use of ecosystem services in NEPA

The top three factors that respondents believe currently encourage or are needed to encourage consideration of ecosystem services in NEPA are: a legal requirement to do so, relevance and efficiency, and benefits that might result from using an ecosystem services approach. First, respondents wrote that a requirement—stemming from the public, court cases, Forest Service directives, or other laws—would be needed to impell consideration of ecosystem services in NEPA. It is unclear from our results whether these respondents were aware that NEPA itself does not limit the kinds of information that should be considered, or that the guidance document, *Considering Ecological Processes,* encourages agency personnel to consider ecosystem services.

Second, respondents thought that NEPA analyses would need to be limited to project-relevant ecosystem services to avoid making NEPA documents more

cumbersome. Third, respondents noted that benefits such as improved communication and improved quality of analysis would further encourage use of an ecosystem services approach. Other factors that would support the use of ecosystem services in NEPA include training, improved methods and data, public support for ecosystem services, and proof that the ecosystem services approach is effective.

When asked the converse, "Are there any factors that discourage (or might discourage) the use of ecosystem services?" the most frequent response (n = 164) is that the ecosystem services concept is unclear and unfamiliar to USFS staff and the public, and methods and data are lacking (Figure 7). The second most common response was that ecosystem services is simply a new buzzword for something the Forest Service already does. The third response was that an ecosystem services approach would make already cumbersome documents longer and more confusing without improving the decision, and that any analysis should be limited to project-relevant, easily measured services. One response exemplifies this notion:

> "I think many of my colleagues would like to consider ecosystem services in NEPA so long as it did not create even longer and more convoluted analyses with even more opportunity for blunders that become appeal points and then litigation. Forest Service NEPA has become like Elvis in his later years—bloated, with fancy outfit, but basically not very functional."

A smaller number of respondents wrote that analysis of ecosystem services would not make any difference because decisions are predetermined by the decision maker, Congress, other external factors like politics. Respondents also expressed concern that NEPA projects are generally on too small a scale to warrant analysis of ecosystem services that occur on a landscape scale. A less frequent but repeated theme in several open-ended questions was the risk of litigation:

> "The driving force of our NEPA review and work is lawsuits. We spend the majority of our time trying to ensure our documents are able to withstand a lawsuit by a special interest group. … We

> spend … enormous energy and resources … to ensure we (can) withstand a judge's decision."

Respondents expressed concern that lack of proven methods with regard to ecosystem services could make NEPA documents more vulnerable to appeals or litigation.

Discussion

Our goals in this study were to assess the extent to which ecosystem services are used—and could be used—as part of environmental decision making through the NEPA processes. NEPA was enacted to "declare a national policy for the environment." The language in Section 102 of NEPA (42 U.S.C. 4332) envisioned the ecosystem services concept well before the idea entered into popular use:

> "The Congress authorizes and directs that … all agencies of the Federal Government shall—
>
> (A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment;
>
> (B) identify and develop methods and procedures … which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations."

The underlying vision of NEPA is of decision making informed by science, public participation, and analysis. NEPA is often referred to as a purely "procedural" statute, but the animating purpose and language of NEPA embraces an idea of democratic legitimacy in government decisions through transparency, science, discourse (what is now often referred to in political science literature as "participatory governance"), reason, and explanation.

In this light, proponents of the ecosystem services approach hope that it will allow for greater transparency and better assessment of choices and tradeoffs in environmental decision making. Further, they believe that shifting from describing impacts on the ways eocsystems function to describing impacts to ecosystem services could help decision makers and the public to appreciate current and future gains and losses in ecosystem functions. Our study shows that Forest Service respondents think the ecosystem services approach could be useful in improving communication with the public and decision makers. However, the use of any tool requires knowledge and understanding about that tool.

Our survey of Forest Service professionals showed uneven levels of familiarity among respondents. We found that a majority of respondents is somewhat to very familiar with ecosystem services, with greater levels of familiarity among higher-level decision makers and lower levels of familiarity among interdisciplinary team members. Though not intuitive, this suggests that the ecosystem services approach to forest management outlined in Forest Service reports has been noted and internalized by supervisors, but not yet trickled down to interdisciplinary team members. This is significant because these team members are charged with the actual development of environmental impact statements, and because there are many more interdisciplinary team members than decision makers. Also, based on the number of people unfamiliar with "ecosystem services" and the diverse write-in responses for additional ecosystem services considered, we surmise that people have different understandings of the term "ecosystem services" and how to describe and quantify them.

Although not a primary focus of our survey, it is important to note that the term "ecosystem services" is also unfamiliar to the public. An informal survey commissioned by The Nature Conservancy found that the public supports the idea of ecosystem services but found the term unappealing (Metz and Weigel 2010). Our survey had similar results, with some respondents expressing concern about possible public opposition to the new and "jargon-y" idea of ecosystem services. An additional consideration is that many respondents indicated that the Forest Service already considers ecosystem services without using the term "ecosystem services." Respondents repeatedly commented that evaluating "ecosystem services" is a new term for something they already do, and our factor analysis results corroborate these comments. Factor analysis showed clusters of

correlated ecosystem services that are analyzed in similar types of projects. This indicates that ecosystem services are analyzed in groups that occur consistent with how ecologists think of ecological process and ecosystem services (Defries and Pagiola 2005; Hassan 2005; Millennium Ecosystem Assessment 2005).

Ecosystem services have been incorporated thus far under the general and expansive authority of NEPA. In addition the existing guidance documents provide just that—guidance—to encourage consideration of ecosystem services in NEPA analyses. Agencies can use this existing legal authority to incorporate new science into outdated processes (Ruhl 2010; Fischman 2001). However, based on our results, agencies are constrained by lack of clear metrics, fear of litigation, the workload involved with implementing a new procedure, and lack of a clear mandate. Agency staff were unaware of, or hardly influenced by *Considering Ecological Proceesses,* the guidance document that defines ecosystem services (EPA 1999a). EPA and CEQ guidance documents were more influential than we expected but still far less influential than internal Forest Service directives, especially the agency's handbook. In fact, respondents commented that a requirement, coming from public requests, court cases, Forest Service direction, or other laws, would be needed to encourage more analysis of ecosystem services. This is an important insight into how agency personnel applying NEPA, who are overwhelmingly not lawyers, view law and their own duties. They appear much more likely to respond to mandates or instructions about mandates than to general positive authority (such as NEPA) or even abstract "guidance" that interprets or builds on the more general authority. The internal agency manuals appear to be viewed more as instructions (perhaps mandates of employment) and NEPA documents from prior assessments as models (and perhaps as presumptively legitimate or defensible).

Like all questionnaires, ours had limitations. We asked respondents to indicate how often they evaluated ecosystem services, but we did not define nor ask respondents what it means to "consider" ecosystem services. We did not ask if they estimated economic values or at what scale they considered impacts. Scarlett and Boyd (2011) argue that current analysis is limited to description of ecological processes and functions, and that only in very limited cases are economic values or links to human well-being analyzed. We suggest text (content) analysis of recent NEPA documents as an area of future research to further assess the extent of ecosystem services in NEPA documents.

Nonetheless, a majority of Forest Service staff surveyed thought an ecosystem services approach could be useful in NEPA analyses, and respondents who were familiar with the concept of ecosystem services at the outset of the survey were more likely to think it might be helpful. We found that a majority of respondents think an ecosystem services approach can be useful in NEPA analyses, citing an improved ability to inform the public and decision makers as a possible outcome of its use. Some challenges may stymie efforts to further incorporate ecosystem services in NEPA analyses by the Forest Service and other agencies, in particular, lack of clear metrics and a mandate. Below we recommend a few steps that might improve incorporation of the ecosystem services approach in NEPA analyses.

Recommendations for Implementation

NEPA is one of the most important environmental laws in the United States and has been emulated around the world (Karkkainnen 2002; CEQ 1997b). NEPA also has many challenges and is a controversial statute; as of early 2013 there were more than 60 bills before Congress to amend NEPA. The inclusion of ecosystem services cannot solve issues like the lack of a centralized electronic NEPA library or the requirements for large amounts of predictive information prior to the start of a project (Miller and Farber 2010; Gerrard and Herz 2003; Karkkainnen 2002). However, an ecosystem services approach may be able to improve public communication and the quality of land management decisions. Nonetheless, management agencies respond to input from a variety of stakeholders—Congress, local land owners, recreationists, business, and interest groups—and may be disproportionately influenced by the most vocal of those stakeholders (Mashaw 1997; Farber and Frickey 1991).

The Forest Service, for example, may want to change its environmental impact analysis process—and indeed it has started a new process under the new Planning Rule—but it will need vetted scientific methods and good communication with stakeholders to defend a new process. Such changes may require additional time and money, which survey respondents say are in short supply.

Agencies or administrators who believe that ecosystem services could add value to NEPA analyses might consider clarifying their working definition of ecosystem services and conveying that information, especially through agency manuals and to staff responsible for writing reports. Efforts to structure ecosystem services analyses should use more consistent language and concepts when discussing ecosystem services and its value to the public. Based on levels of familiarity and sources of information reported in survey responses, colleagues were more frequently reported as a first source of information than the Forest Service memos or training. If the Forest Service (and other agencies) wants to increase the use of ecosystem services, it should focus on training NEPA coordinators, interdisciplinary team leaders and key team members. Finally, public outreach should avoid jargon and could use phrases that people find more appealing, such as "nature's value" and "nature's benefits" (Metz and Weigel 2010).

We suggest that including ecosystem services in the public participation process could also be useful during scoping and in subsequent public meetings to discuss draft analyses. This could be modeled on a public participation process for ecosystem management planning in Puget Sound (Granek et al. 2010). The participatory process educated the public about the ecosystem services concept, helped identify the most important ecosystem services to consider, and narrowed the scope of analysis (Granek et al. 2010).

Better tools for quantification and valuation would require additional interdisciplinary research. The ecosystem services framework entails considering impacts to the immediate area subject to proposed actions as well as for a broader spatial and temporal scale, which may require more data and predictive modeling into the future (Daily et al. 2009). Economic valuation can also be difficult, but methods are being developed by a variety of actors, including the USDA Office of Environmental Markets and The Willamette Partnership (2012). The Forest Service might benefit from producing case studies and manuals that outline methods and help practitioners identify important ecosystem services.

Despite the skeptical and modest use of the existing CEQ (1997a) and EPA (1999a, 1999b) guidance documents by Forest Service employees revealed in our study, CEQ and EPA might consider restating the guidance in those documents in shorter and clearer terms, using the current language of ecosystem services.

Our study suggests than an even more influential document to revise with better guidelines on how to incorporate ecosystem services would be the Forest Service Handbook (Forest Service 2011). While very preliminary, our study suggests the importance of focusing on the most immediate sources of executive office culture—agency leaders, staff, and department-specific handbooks. Several guides outline how to use the ecosystem services framework in environmental decision making, and these could help in improving ecosystem services guidance within agencies (Hanson et al. 2012; Landsberg 2011; Ranganathan et al. 2008; MA 2005; NRC 2004).

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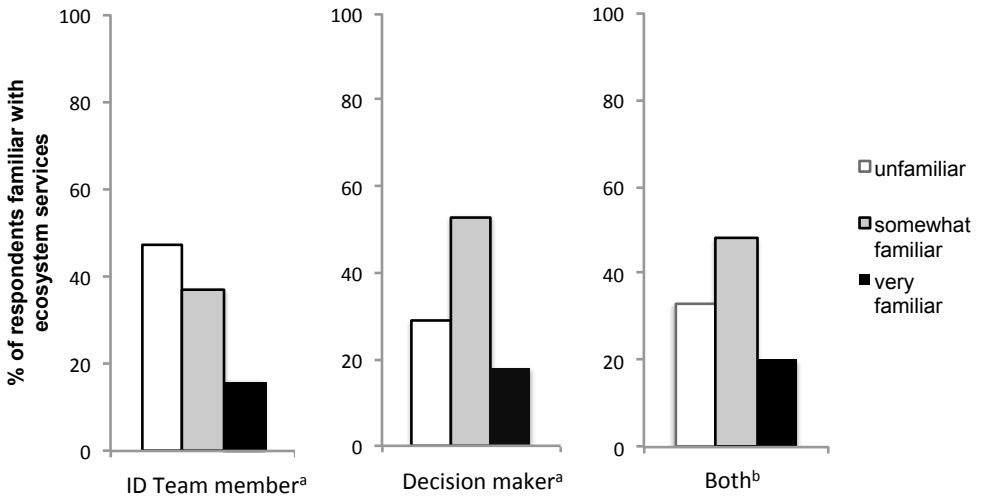
Figures & Tables

Figure 1. Survey responses comparing levels of familiarity with ecosystem services within U.S. Forest Service positions

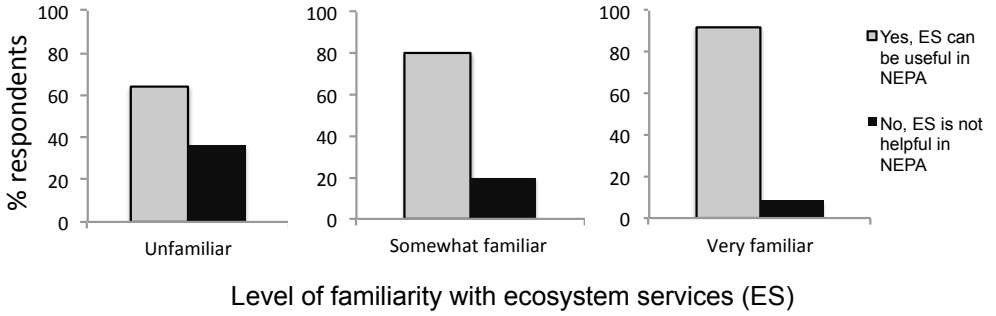


[a] There is a significant difference in interdisciplinary (ID) team members' and decision makers' levels of familiarity with ecosystem services (Kruskal-Wallis with Dunn's (1964) procedure, Bonferroni correction, p = .006).

[b] "Both" refers to respondents who were both interdisciplinary (ID) team members and decision-makers during the study period.

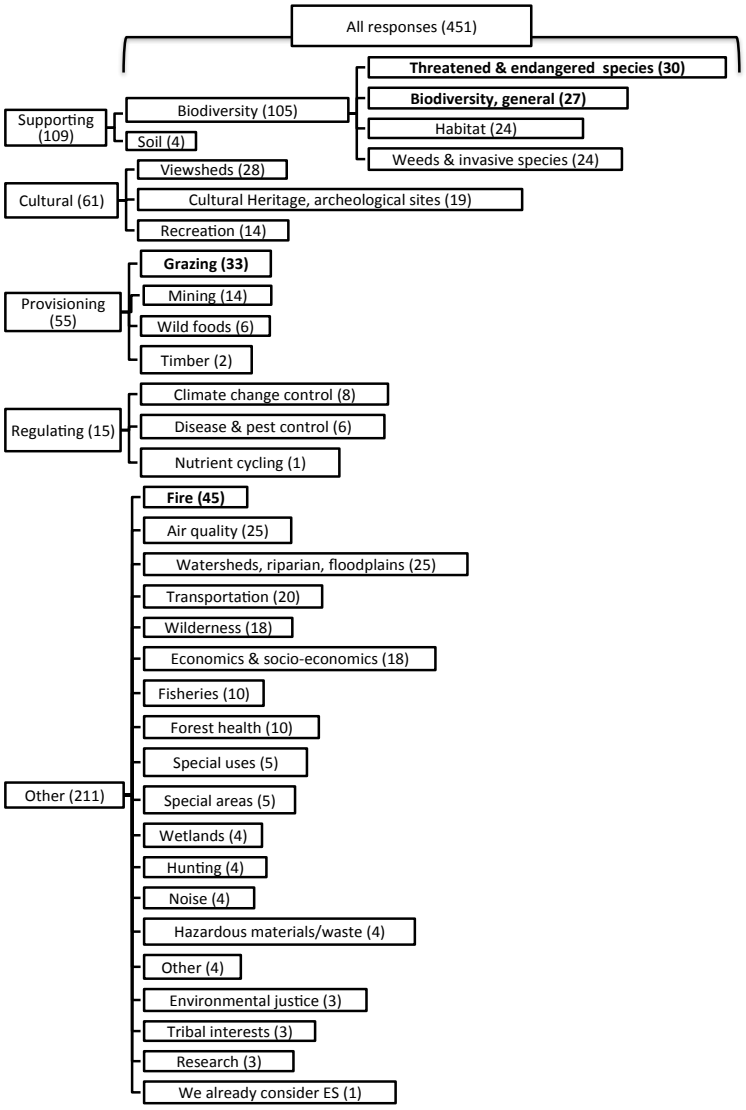
Decision makers are more familiar with ecosystem services than interdisciplinary (ID) team members. Respondents self-identified their position in the Forest Service (ID team members, decision makers, or both during the study period) and rated their familiarity with ecosystem services on a likert scale (1 = not familiar, 3 = very familiar).

Figure 2. Survey results regarding level of familiarity with ecosystem services (ES) and usefulness of ecosystem services in National Environmental Policy Act (NEPA) impact analyses



As familiarity with ecosystem services increases, people are more likely to think ecosystem services can be useful in NEPA. Respondents rated their familiarity with ecosystem services on a Likert scale (1 = not familiar, 3 = very familiar) and indicated their opinion about whether or not ecosystem services can be useful in the NEPA process.

Figure 3. Survey results showing open-ended responses identifying "other" ecosystem services that were not included in a list provided in the survey but are analyzed in NEPA documents.



Responses were clustered into ecosystem service categories (Hassan et al. 2005). Response frequency is indicated in parentheses. **Bold** formatting indicates most frequently reported comments. The most frequently reported additional ecosystem services reported were *fire*, followed by *grazing*, *threatened and endangered species*, and *biodiversity* (in general). Open-ended comments (n = 166) were sorted into a total of 451 responses, which were grouped with similar items. About half of the responses fit into Millennium Ecosystem Assessment categories (provisioning, supporting, regulating, cultural;Hassan et al. 2005; MA 2005). The remaining responses are either not considered ecosystem services (according to Hassan et al. 2005) or the respondents' intended meanings are difficult to interpret.

Figure 4A: Survey results regarding levels of influence of internal U.S. Forest Service (USFS) directives when completing Categorical Exclusions (CEs), Environmental Assessments (EAs), and Environmental Impact Statements (EISs). Among internal directives, the Forest Service Handbook is the most influential.

Figure 4B. Survey results regarding level of influence of external (CEQ and EPA) directives when completing Categorical Exclusions (CEs), Environmental Assessments (EAs), and Environmental Impact Statements (EISs). Among external directives, *Considering Ecological Processes* is the least influential.

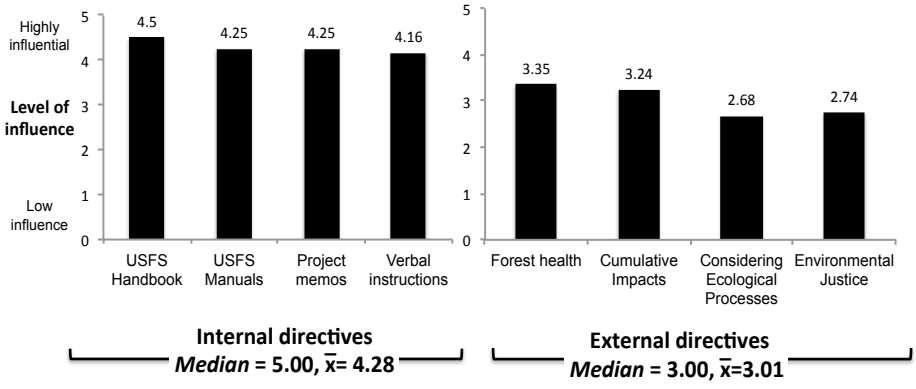
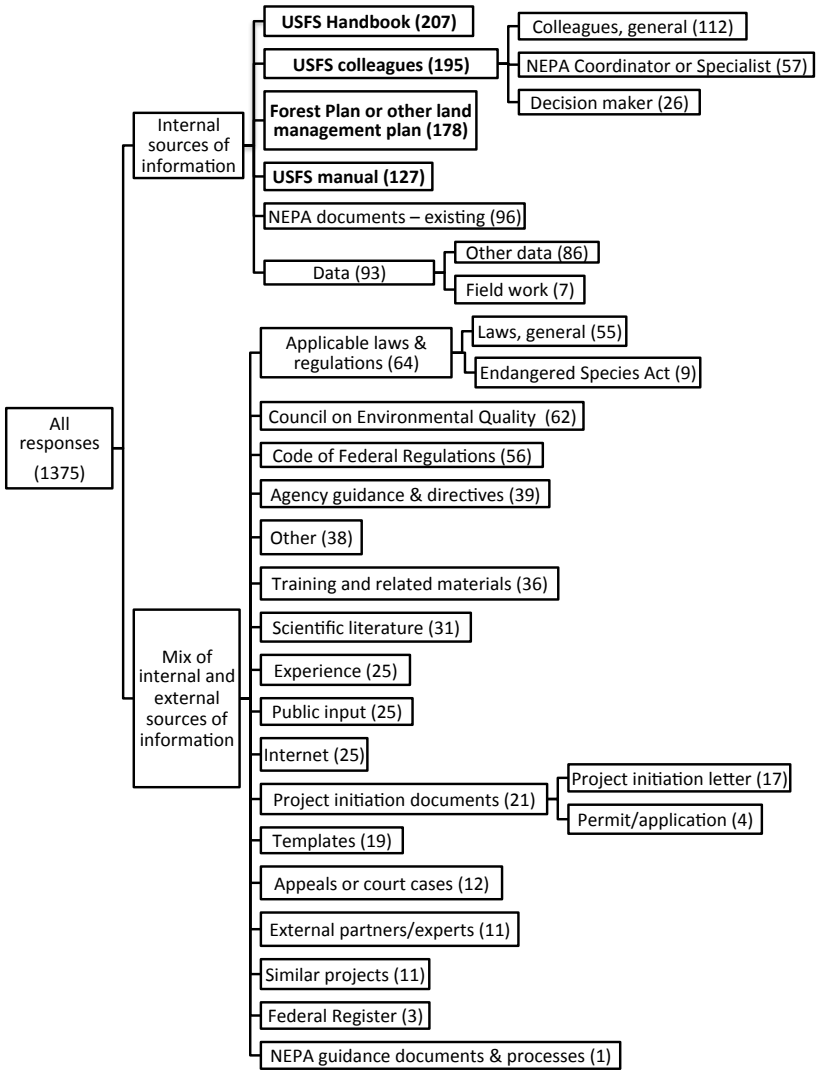
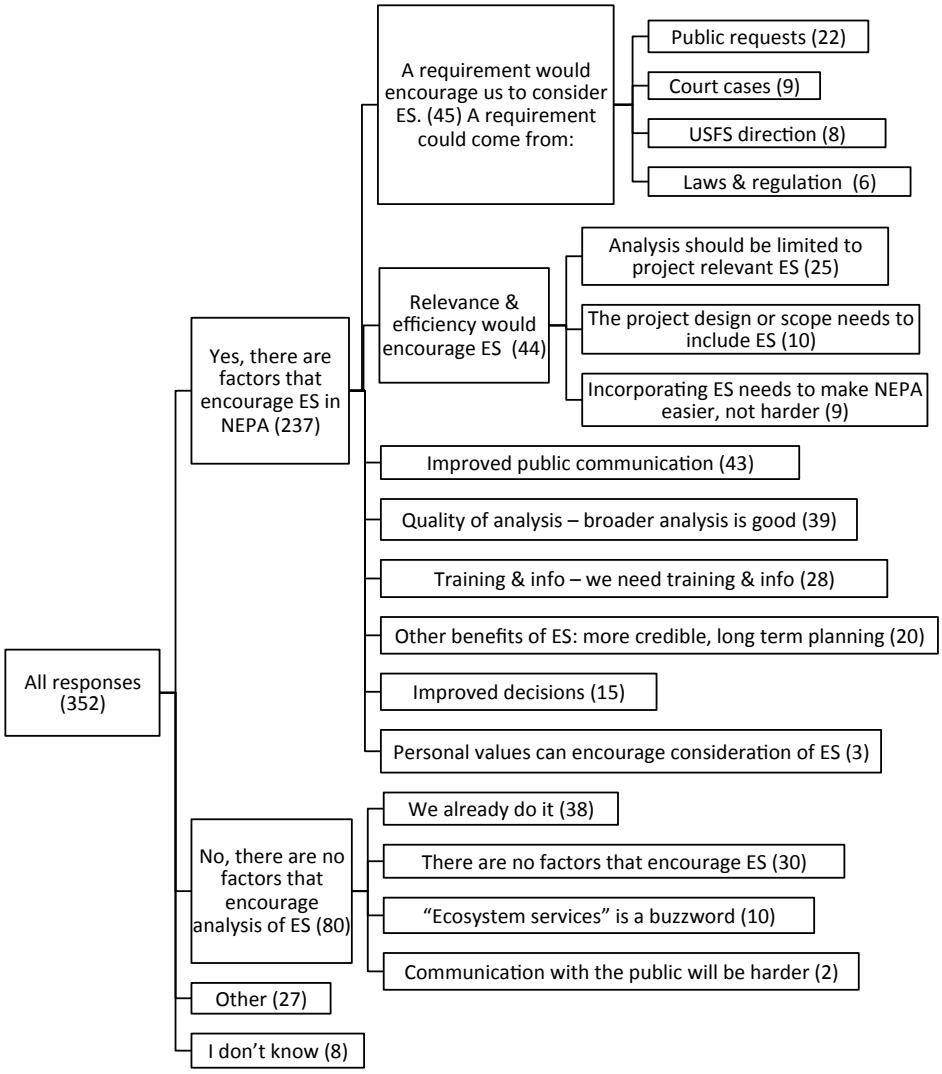


Figure 5. Survey results from open-ended question regarding the first sources of information respondents use when initiating a National Environmental Policy Act (NEPA) document. Responses are clustered by themes with response frequency indicated in parentheses.



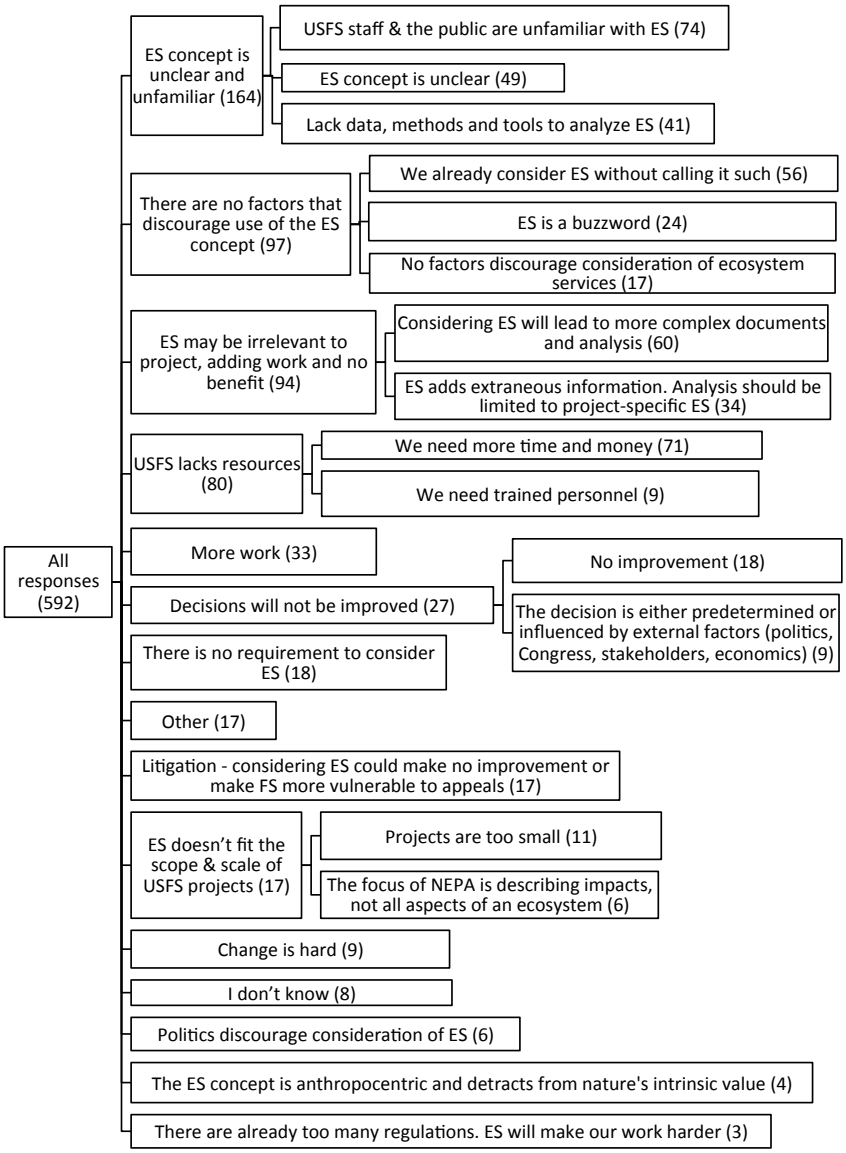
Bold formatting indicates most frequently reported comments.
Open-ended responses (n = 392) were sorted into 1375 items and grouped into categories with similar items. Internal Forest Service sources are the most frequently used sources of information when initiating a NEPA document (categorical exclusions, environmental assessments, or environmental impact statements). Internal Forest Service sources included Forest Service Handbook, co-workers, forest plans or other land and resource management plans, the Forest Service manual, and existing or recently complemented NEPA documents.

Figure 6. Survey results showing open-ended responses about factors that encourage consideration of ecosystem services in National Environmental Policy Act (NEPA). Responses are clustered by themes with response frequency indicated in parentheses.



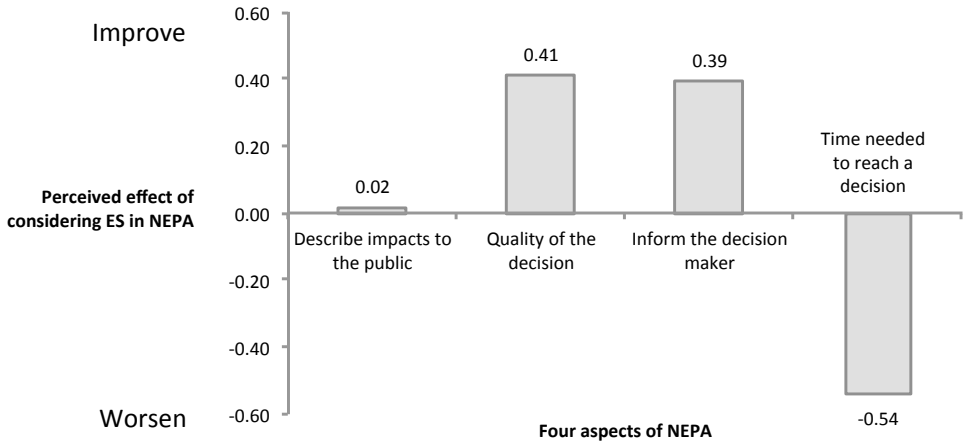
Open-ended responses (n = 278) were sorted into 352 items, which were grouped with similar items into themes. A majority of respondents thought that some factors exist which might encourage the use of ecosystem services in NEPA. The most frequently reported factors that might encourage or would be needed to encourage consideration of ecosystem services in NEPA include: a requirement, limited workloads, and perceived benefits that result from using ecosystem services (ex: improved communication). A minority of respondents (n = 80) thought there were no factors that encourage ecosystem services, largely because "ecosystem services" is just a new term for something they already do.

Figure 7. Survey results showing open-ended responses about factors that discourage consideration of ecosystem services in the National Environmental Policy Act (NEPA). Responses are clustered by themes with response frequency indicated in parentheses.



Open-ended responses (n = 327) were sorted into 592 items, which were grouped with similar items into themes. The most frequently reported factor that discourages consideration of ecosystem services is that ecosystem services concept is unfamiliar to Forest Service staff and the public and that the concept is vague and lacks methods and data. A smaller number of respondents thought that "ecosystem services" is just a new term for something they already do.

Figure 8. Survey results showing perceived effect of considering ecosystem services (ES) on four aspects of the National Environmental Policy Act (NEPA) process



Participants think considering ecosystem services in NEPA analyses would very slightly improve or make no difference in their ability to describe impacts to the public, improve the quality of decisions and the effectiveness of informing the decision maker, and worsen (take more time) the time needed to reach a decision. Respondents rated the effects using a likert rating: (+1) Improve, (0) No difference, and (-1) Worsen.

Table 1. Survey results indicating how U.S. Forest Service staff learn about ecosystem services (ES)

How people learn about ES	% of responses
Other colleagues	14.1
Agency or project memo(s)	12.8
Scholarly article(s)	11.8
Website(s)	11.4
On-the-job training	10.2
Agency training(s)	9.3
Interest groups: environmental or conservation groups	8.1
Attended conference(s)	7.2
College or university level class(es)	7.0
Supervisor(s)	3.4
Other (please specify)	2.3
Millennium Ecosystem Assessment	1.3
USDA Office of Environmental Markets	1.1
TOTAL	100%

Among respondents who were somewhat to very familiar with ecosystem services, the most frequent ways respondents learn about ecosystem services (ES) is from colleagues, agency or project memos, scholarly articles, or websites. Respondents were asked to select from a list all the ways they have learned about ES.

Table 2. Exploratory factor analysis of survey responses to assess correlations between ecosystem services analyzed by U.S. Forest Service staff in National Environmental Policy Act (NEPA) impact analyses

Ecosystem services evaluated[a]	*Components*				
	Factor 1 Erosion & water quality	Factor 2 Water & recreation	Factor 3 Regulating	Factor 4 Cultural	Factor 5 Drought & agriculture
erosion control	**.746**	.097	.084	.192	.122
sediment reduction	**.800**	.148	.103	.184	.007
soil production	**.628**	.144	.297	.121	.192
water quality improvement	**.722**	.139	.193	.091	.115
wildlife habitat	**0.49**[b]	-.036	.050	**0.48**[b]	-.062
sport fishing	.216	**.750**	.115	.152	-.060
fish for human consumption	.143	**.709**	.245	.088	-.094
aquatic sports	.036	**.658**	.132	.009	.103
preventing algal blooms	.032	**.559**	.289	-.017	.230
bird watching	-.002	**.551**	.178	.279	.194
flood control	.324	**.479**	-.047	.231	.277
water purification	.202	**.479**	.105	.185	.306
disease control	.086	.105	**.641**	.180	-.188
carbon sequestration	.205	.152	**.639**	.017	-.009
nutrient cycling	.416	.111	**.637**	.030	.134
photosynthesis	.069	.174	**.617**	.041	.410
pollination	-.055	.282	**.542**	.115	.449
micro-climate regulation	.122	.223	**.511**	.176	.357
seed distribution	.134	.151	**.463**	.138	.340
timber	.340	.148	**.452**	.188	-.339
wild foods	-.040	.306	.405	.370	.107
cultural importance	.299	.059	.155	**.645**	.080
spiritual importance	.131	.129	.101	**.630**	.265
tourism	.072	.434	.140	**.621**	-.037
recreation	.436	.141	.092	**.600**	-.092
agricultural crops	.083	.208	-.010	-.058	**.467**
drought regulation	.120	-.024	.158	.171	**.685**

[a] List of ecosystem services adapted from Hassan et al. 2005.

[b] Wildlife is about equally correlated with two factors.

Bold formatting in each column indicates correlated items (we accepted values > 0.45).

Factor analysis shows clusters of ecosystem services that Forest Service staff analyzed at similar frequencies. The clusters centered around themes, which we named as follows: (1) erosion and water quality, (2) water and recreation, (3) regulating services, (4) cultural services, and (5) agriculture and drought.