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The EPA's NEPA Duties and Ecosystem Services

Robert L. Fischman*

I. INTRODUCTION ........................................ 497

II. SOURCES OF NEPA LAW ............................... 503
   A. NEPA and the Clean Air Act ..................... 503
      1. NEPA ........................................ 503
      2. Clean Air Act ................................ 508
   B. The CEQ Regulations ............................... 510
      1. Incomplete or Unavailable Information ...... 511
      2. Cumulative Impacts ............................ 512
   C. The CEQ Biodiversity Report ...................... 514

III. THE EPA's ENVIRONMENTAL REVIEW PROCESS .......... 516

IV. THE EPA ECOLOGICAL GUIDANCE FOR NEPA REVIEW 519
   A. Early Efforts ...................................... 521
   B. Habitat Evaluation ................................ 524
   C. Grazing on Federal Lands and Highway
      Development ....................................... 526
   D. Considering Ecological Processes in
      Environmental Impact Assessments .............. 529

V. CONCLUSION ........................................ 533

I. INTRODUCTION

For some time, conservationists have based utilitarian arguments for the protection of nature on the value of goods produced...

* Professor of Law, Indiana University School of Law—Bloomington. I would like to thank Jim Serfis of the EPA, who generously and patiently explained the intricacies of United States Environmental Protection Agency guidance and procedure. Any inaccuracies that remain in this article are the result of my own misunderstandings. Tamara Fraizer, Anne Miller, Jim Salzman, Matthew Sanders, and Jim Serfis offered helpful suggestions on earlier drafts. An EPA grant administered through American University as well as an Indiana University School of Law summer research grant supported this work. The views expressed in this article are entirely mine and not necessarily those of the EPA officials who offered comments. Jason Smith provided able research assistance. Finally, I owe special thanks to Jim Salzman for inviting and inspiring me to participate in the EPA-sponsored ecosystem services project.
by the Earth's diverse ecosystems. Food, forage, fiber, fuel, building materials, drugs, and industrial products are among the most frequently cited valuable outputs of natural systems. Indeed, for many years, the cancer-fighting drugs produced by the rosy periwinkle and the Pacific yew were veritable poster-children of the movement to protect biological diversity. However, more recently, ecologists have teamed up with economists to begin documenting and valuing the services produced by natural systems. This partnership is commonly called ecological economics.

Purification of air and water, pest control, flood abatement, pollination, climate regulation, and soil nutrient cycling are now among the most frequently cited services for which we depend on ecosystem functioning. The new poster-child of the movement to protect natural systems is New York City, which plans to spend $660 million to control development and restore ecosystems in the Catskills watersheds from which it derives much of its drinking water supply. In doing so, the City saved over $4 billion it would otherwise have had to spend on construction and operation of a water filtration facility.

While it is relatively easy to identify ecosystem functions, such as nutrient cycling, that provide important services, such as fertilizing crops, it is more difficult to quantify the value of those services. For instance, while the functional capacity of a wetland can be estimated by examining the density and composition of vegetation and animals, the value of its services will depend on its location. Two identically functioning wetlands, from the standpoint of flood con-
trol, will have different service values if one is located in a densely populated region and another is not.\(^6\) Quantification is crucial if ecosystem services are to be valued adequately (even at all) in a legal system that is rooted deeply in the utilitarian tradition. Well-publicized studies have estimated the worldwide, aggregate value of ecosystem services in the tens of trillions of dollars.\(^7\) As ecological economists refine their techniques to measure ecosystem services on scales more relevant to routine agency decision-making, valuation of ecosystem services will need to be integrated into environmental impact analysis.

The new valuation tools of ecological economics offer potentially powerful means of accounting for a wide range of nature's services. Whether measuring dollars through market substitutes or ecological indicators through comparisons among sites, service valuation responds to a utilitarian policy challenge: Judge human actions based on their consequences rather than on their "categorical attributes."\(^8\) The National Environmental Policy Act (NEPA)\(^9\) is the foundational environmental law that requires agencies to evaluate the consequences of a full range of alternative ways to pursue goals before acting. The utilitarian premise of NEPA is that better, and more comprehensive, prospective information will lead to better, and more sustainable, decisions. An environmental policy that is too reliant on the theory of comprehensive rationality, i.e., which depends on the ability of decision-makers to evaluate and anticipate a diverse array of considerations to optimize long-term objectives, will fail for reasons explored elsewhere.\(^10\) However, where we do call upon agencies to evaluate a comprehensive set of considerations, such as in NEPA, it is imperative to include the services provided by nature. If we fail to do so, then we treat land as a passive entity, doing nothing until transformed by devel-

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7. See Robert Costanza et al., The Value of the World's Ecosystem Services and Natural Capital, 387 NATURE 253 (1997); David Pimentel et al., Economic and Environmental Benefits of Biodiversity, 47 BIO SCIENCE 747 (1997).
opment, rather than a functioning, productive system vulnerable to damage.\(^1\)

Most of the United States Environmental Protection Agency's (EPA's) authorities limit the agency's purview to specific media or a relatively narrow range of ecosystem-disturbing activities. In contrast, the EPA's duty under the Clean Air Act to evaluate all federal environmental impact statements (EISs) filed under NEPA has a broad scope. This wide-ranging authority can help shape federal environmental policy.\(^2\)

As EPA guidance illustrates, several common projects entail significant impacts to ecosystem services and often involve major federal action triggering NEPA, such as: (1) community development, including planning and federal funding for highways; (2) renewable resource use and development on public lands, including logging and grazing; (3) energy production, including the development, extraction, generation, transmission, and use of petroleum, natural gas, and coal; (4) non-energy mineral resource development, processing, management, transport, and use; and (5) water projects and permits for wetland modification.\(^3\) The NEPA often requires that these and other activities be evaluated at a programmatic level, thereby allowing for a comprehensive analysis of regional or national impacts. Currently, techniques that value ecosystem services are more advanced and reliable in cumulating aggregate contributions than in conducting marginal analyses. Therefore, the regional or national EISs will be better able to accommodate emerging information on ecosystem services than project-specific EISs.\(^4\)

Whether programmatic or project-specific, the NEPA environ-

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12. I have explored the role that the EPA may play under this authority to promote conservation of biological diversity. See Robert L. Fischman, *Biological Diversity and Environmental Protection: Authorities to Reduce Risk, 22 ENVTL. L. 435 (1992).* Since the early 1990s, the EPA has made important progress through guidance documents in describing how environmental impact analysis should account for biological diversity. Maintenance of ecosystem services presents different, and in some respects, greater analytical challenges for NEPA analysis.


mental analysis is the purest expression of that strand of environmental law that seeks to expand cost-benefit balancing to include indirect and incidental effects. Valuation of ecosystem services is exactly the kind of assessment NEPA envisions, providing a means to inform the public and decision-makers about what we stand to gain or lose in several alternative scenarios.

The EPA does not have the power to compel agencies to make changes to their environmental analyses. However, its mandatory duty to evaluate critically the substantive merits and the environmental analysis of proposed federal actions can promote more careful consideration of the value of ecosystem services. Currently, EPA guidance and other documents that steer the environmental analysis establish footholds for including ecosystem services. These footholds are available for agency reviewers today, but should be expanded to advance more directly the state of knowledge of ecological economics. This article examines the footholds and offers recommendations for strengthening them. Recent developments in ecological economics and guidance encouraging new ways of approaching environmental impacts should be mutually reinforcing. Guidance should create a demand for information that will spur continual advances in measuring ecosystem services. And, new techniques for valuing ecosystem services should inform and improve environmental impact analysis.

There are several sources of authority that would support the EPA’s insistence that ecological services should be evaluated by action agencies—i.e., agencies that prepare NEPA documents—in the NEPA process. First, there are the statutes, including NEPA and the Clean Air Act. Second, the Council on Environmental Quality (CEQ) regulations bind all federal agencies and provide a uniform framework for environmental analysis. The CEQ regulations, strictly read, might be interpreted to mandate that agencies use the tools of ecological economics as the best scientific information about impacts and alternatives. Third, most action agencies have their own set of regulations to implement NEPA. Those regulations must be consistent with the CEQ regulations, but they are beyond the scope of this article because of their limited jurisdiction. Instead, this article will focus on the documents that the EPA employs to interpret the requirements of environmental analysis under the CEQ regulations. Rather than promulgating regulations, the EPA develops guidance documents that steer EPA review and inform action agencies what to expect in an EPA NEPA evaluation.
The EPA guidance directs most of the agency's attention to the issue of mitigation in EISs. Ecosystem services valuation will aid in the evaluation and monitoring of corrective actions for significant environmental impacts.

Though action agencies are not required to comply with EPA guidance, the EPA has leverage in shaping other agencies' environmental analyses. This leverage derives, in part, from the EPA's ability to jawbone and elevate disputes to the President's Council on Environmental Quality. Also, critical comments from the EPA in the administrative record may make an action more difficult to justify in a court exercising judicial review.

The changes in EPA guidance for EIS review over the past dozen years track a larger shift in what we value in nature. The EPA has moved from a more simple, static, structural view of biodiversity as the centerpiece of ecological value to a more dynamic framework. The theme of valuing ecosystem functions, and ecosystem health or integrity to sustain those functions, dominates the recent guidance. The ecosystem functions approach focuses on flux through the natural world over time and reflects some of the current intellectual trends in ecology.\textsuperscript{15}

The most recent trend to consider ecosystem services, just emerging in the EPA guidance, applies utilitarian valuation techniques to ecosystem functions. Perhaps this development indicates a growing realization that we and our livelihoods are not removed from but rather entwined with nature. This holism promises a homecoming for NEPA's vision of people and nature existing in "productive harmony."\textsuperscript{16} On the other hand, perhaps the rise in ecosystem services valuation reflects the final, anthropocentric devaluation of any part of nature for which we cannot see tangible human benefits. Do the terms of the market now so dominate our discourse that we do not see the world in any other way?\textsuperscript{17}


\textsuperscript{16} 42 U.S.C. § 4331(a) (1994).

\textsuperscript{17} To be fair to Gretchen Daily and other prominent promoters of valuing ecosystem services, I have encountered no advocates who argue that ecological economics should displace other modes of decision-making. Instead, ecological economics offers a model for including ecosystem services in those situations where we are already reckoning the costs and benefits of alternative courses of action.
Part II of this article describes the statutory and regulatory foundation for the EPA's role in assisting and policing action agencies in their efforts to analyze environmental impacts. This foundation, laid by Congress and the CEQ, along with a key CEQ interpretive report, provides a solid basis for the EPA to promote the use of ecosystem services valuation tools. Part III of the article outlines the procedures the EPA has established to implement its EIS review responsibility. Part IV examines in detail the series of documents dealing with ecological impacts that the EPA has prepared to guide EPA reviewers in conducting their evaluation of EISs. These guidance documents provide the basis for the EPA to play a more active role in promoting the integration of valuation tools for ecosystem services into environmental impact analysis. The article concludes in Part V with a set of recommendations.

II. SOURCES OF NEPA LAW

This part reviews how two statutes establish the EPA's role in evaluating EISs. Through simple yet open-ended delegations, Congress designed a system of divided responsibility for environmental impact analysis. The CEQ then developed a comprehensive set of regulations that elaborated considerably on the sparse details of the statutes. Finally, a key CEQ report in 1993 charted a path for incorporating into EISs new information and concerns arising from developments in ecology and conservation biology.

A. NEPA and the Clean Air Act

The EPA derives its role in evaluating the environmental impact analyses prepared by federal agencies from two statutes, the National Environmental Policy Act (NEPA) and the 1970 Amendments to the Clean Air Act. This section briefly describes this statutory authority.

1. NEPA.

Widely considered to be the founding statute of the modern era of environmental law, NEPA declared Congress' policy on environmental conservation, established a procedure (often referred to as an "action-forcing mechanism") to ensure that agencies abide by the national environmental policy, and created the Council on Environmental Quality. In contrast to the subsequent statutory hallmarks of the modern era, NEPA is light on its feet. NEPA is brief, sets out very broad, general requirements, and is oriented
toward promoting better information about the relationship between humans and our environment. Due in large part to the statute's flexible, skeletal structure, Congress seldom has amended or revised NEPA, and then only in minor ways.

The substantive mandate. Section 101 of NEPA contains the substantive policy declaration of the Act. Although the EIS requirement of NEPA applies to a broad range of agency activities (major federal actions significantly affecting the quality of the human environment), the substantive mandate of NEPA has an even more expansive domain. It affirmatively calls upon agencies "to use all practicable means and measures" to achieve certain goals and also sets out six criteria with which to determine whether federal "plans, functions, programs and resources" meet the desired national environmental goals. The Supreme Court has been consistently clear in holding that courts will not enforce the substantive terms of this section against agencies. However, the substantive NEPA policy remains federal law, which agencies are bound to follow regardless of whether judicial review is available. Indeed, NEPA itself mandates that agencies interpret and administer their authorities "to the fullest extent possible" in accordance with the substantive policies.

James McElfish, an Environmental Law Institute Senior Attorney, has highlighted this language to argue that the substantive parts of NEPA "are not mere sentiments, but positive law, binding on . . . all federal agencies." Thus, the substantive provisions of NEPA are important both as direct mandates for the EPA and as goals that the EPA can aid other agencies in achieving.

The substantive mandate of NEPA has two parts. Both support the EPA's drive to apply ecosystem service valuation to environmental decision-making. First, the statute declares federal policy to "use all practicable means and measures, including financial and technical assistance, in a manner calculated . . . to create and maintain conditions under which man and nature can exist in productive harmony." This part of NEPA's substantive mandate is

19. Id. § 4331(b).
particularly relevant to EPA's role in promoting the development of the tools of ecological economics because the determination of whether a proposed action would disrupt, maintain, or create a condition of productive harmony may well turn on how well ecosystem services are maintained or replaced. The use of the term "productive" to modify "harmony" suggests a relationship where nature is contributing to social welfare. Quantifying this contribution would better inform agencies on how well they are meeting the substantive mandate of NEPA.

Second, the statute declares that "it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may" meet six stated goals.  

Better information about the marginal benefits of ecosystem services would help agencies accurately determine whether they have fulfilled these goals, especially their mandate to:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all Americans safe, healthful, productive, . . . surroundings;
3. attain the widest range of beneficial uses of the environment without degradation, risk to health, or other undesirable and unintended consequences; . . . and
4. enhance the quality of renewable resources . . . .

The first goal creates a fiduciary duty to future generations. Fulfilling such a duty requires us to understand what ecosystem services that we currently take for granted might be impaired in the future. In contrast to a common notion of the environment as an inert, static backdrop to human activities, the second goal characterizes the environment as something that actively produces value for humans. The ecological economic valuation tools provide measures for determining the productivity of the environment. The third goal speaks to cost-benefit balancing. Valuation of ecosystem services improves our ability to account for undesirable and unintended consequences of actions. An accurate accounting of the net costs and benefits of a proposal must include ecosystem services. Finally, the sixth goal requires an assessment of the quality of renewable resources. One component of that quality is the ability of a

24. Id. § 4331(b).
25. Id.
renewable resource actually to sustain a stream of services. Identifying and measuring those services is the chief challenge that the ecological economists are answering.

The procedural mandate. As I explore below, the EPA has a special mandate to bring these substantive criteria to bear on the EIS. Nonetheless, the practice of NEPA focuses largely on procedural concerns. Despite their holistic and farsighted qualities, the substantive mandates of NEPA are peripheral to current litigation and administration of NEPA. Agencies are concerned primarily with how to engage in an adequate environmental impact analysis, not whether a proposed course of action meets the substantive criteria of NEPA.

Although the environmental impact statement is the most celebrated procedural innovation of NEPA, it is not the only procedural requirement. Section 102 of NEPA describes eight distinct procedural requirements. Four stand out as particularly important. First, NEPA requires agencies to "utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences... in decisionmaking." The emerging tools of ecological economics appear tailor-made to fulfill this integrative mandate.

Second, and bolstering the first, NEPA requires that agencies "initiate and utilize ecological information in the planning and development of resource-oriented projects." The mandate to "initiate" information can support, as part of the NEPA process, further research into how ecosystems provide services. And, of course, agencies may be compelled to consider the consequences of their actions on ecological services when information suggests significant impacts. Longtime CEQ General Counsel, Dinah Bear, has noted that some early NEPA litigation implied that the adequacy of an EIS might depend, in part, on how well the agency explored this ecological information.

Third, agencies must "identify and develop methods and procedures... which will insure that presently unquantified environmental... values may be given appropriate consideration in

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26. Id. § 4332(2)(A).
27. Id. § 4332(2)(H).
decisionmaking along with economic . . . considerations." This mandate strongly endorses the valuation techniques that are currently at the cutting edge of the field. The measurement of ecosystem services is a developing method to better incorporate all relevant considerations in decision-making. Section 102(2)(B) of NEPA requires agencies to contribute to this development.

Fourth, of course, NEPA requires an environmental impact statement for "major Federal actions significantly affecting the quality of the human environment." The statute lists five issues that all such statements must address:

(i) the environmental impact of the proposed action,
(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
(iii) alternatives to the proposed action,
(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Although the valuation of ecosystem services could aid in the analysis of any of these five issues, it is the fourth issue, concerned with the long-term productivity of the environment, which has the strongest connection to the work of the ecological economists. It is the long-term productivity of soils, waters, and habitats that provide the services, such as pollution assimilation, that these researchers seek to quantify.

The EPA does prepare some statements under section 102 of NEPA, but this is not the focus of the agency's NEPA program. Although most of the EPA's activities do affect the quality of the human environment, Congress and the courts have exempted most EPA programs from the procedural requirements of NEPA.

30. Id. § 4332(2)(C).
31. Id.
32. For research and development activities, facilities construction, wastewater treatment construction grants under the Clean Water Act, new source National Pollutant Discharge Elimination System permits, and certain miscellaneous projects funded through EPA appropriations, the agency is legally required to comply with NEPA. See 63 Fed. Reg. 29,019 (Oct. 29, 1998). The EPA implements the NEPA requirements through its regulations applying the CEQ rules at 40 C.F.R. Part 6, and voluntarily conducts environmental impact analysis under the NEPA rules for certain proposed actions described in its Policy and Procedures for Voluntary Preparation of NEPA Documents. See id.
33. Courts have found that many EPA activities that involve environmental review
Instead, EPA's primary role under NEPA is to assist other agencies (the action agencies) in their efforts to comply with NEPA, and to review the results of their efforts.

2. Clean Air Act.

Just a year after the passage of NEPA, Congress enacted section 309 of the Clean Air Act, requiring the EPA to review and comment on the environmental impacts of "any matter relating to duties and responsibilities granted" under federal statutes delegating authority to the EPA.\(^{34}\) This requirement extends the more general NEPA command that action agencies "consult with and obtain the comments of any Federal agency which has jurisdiction . . . or special expertise with respect to any environmental impact involved."\(^{36}\) The EPA role can be traced to the view that "mission-oriented agencies" should be subject to the oversight of a specialized environmental agency.\(^{36}\) Senator Muskie, the chief sponsor of section 309, interpreted the EPA's role even more broadly during the confirmation hearings for Administrator William Ruckelshaus. Muskie told Ruckelshaus that section 309 "makes you a self-starter, whenever you, unilaterally, see an environmental risk. You are given the responsibility to raise the red flag."\(^{37}\)

In addition, section 309 of the Clean Air Act requires that when the EPA determines that a proposed action of a federal agency "is unsatisfactory from the standpoint of public health or welfare or environmental quality, . . . the matter shall be referred to the
Council on Environmental Quality.\textsuperscript{38} The Council is an agency created by NEPA in the Executive Office of the President. In addition to preparing annual reports, the Council investigates and mediates environmental disputes between agencies. Where conflicts arise between agencies, Council rules establish a process for handling referrals from the EPA and from other federal agencies.\textsuperscript{39} The rules encourage agencies to make concerted efforts to resolve their NEPA disputes informally\textsuperscript{40} and limit the CEQ to resolving referrals only for those interagency disputes that rise to the level of national importance.\textsuperscript{41} The rules establish a timetable under which the EPA submits referrals, the action agency responds, and the CEQ takes action. The CEQ may initiate discussions, hold public meetings, require further negotiations between agencies, publish findings and recommendations, or submit a recommendation to the President.\textsuperscript{42}

Referrals under section 309 are rare.\textsuperscript{43} And, unlike the 102(2)(C) procedural requirements of NEPA, the section 309 review program has generated little litigation.\textsuperscript{44} Still, the EPA can and does alter action agency analysis and behavior. The few court opinions that do address section 309 accord great deference to the EPA determinations.\textsuperscript{45} \textit{Alaska v. Andrus},\textsuperscript{46} for instance, discusses the obligation of action agencies to respond to EPA concerns. In dictum, the court stated that an EPA determination that a proposed oil and gas lease program was environmentally unsatisfactory gives rise to a "heightened obligation" for the action agency to "explain clearly and in detail its reasons for proceeding."\textsuperscript{47} The court,

\begin{footnotes}
\item 38. 42 U.S.C. § 7609(a).
\item 40. \textit{See} id. § 1504.2.
\item 41. \textit{See} id. §§ 1504.3(c)(2)(iv), 1504.3(f)(4). An unreconciled disparity exists here because section 309 requires the EPA to refer to the CEQ all unsatisfactory matters regardless of whether the environmental issue is of national or more limited importance.
\item 42. \textit{See} id. § 1504.3(f).
\item 46. 580 F.2d 465 (D.C. Cir. 1978).
\item 47. \textit{Id.} at 475 n.44.
\end{footnotes}
while finding that a section 309 adverse determination created an additional burden for the action agency, did not precisely define the nature of the burden.\textsuperscript{48}

Although referrals are rare, the EPA has reviewed approximately 25,000 draft and final EISs under its section 309 program.\textsuperscript{49} Because such a wide range of proposed actions affecting ecosystem services funnel through section 309 review at the EPA, this program offers tremendous potential for leveraging changes in environmental impact analysis and spurring innovations in valuation tools.\textsuperscript{50} The section 309 review program in the EPA is the focus of this article.

B. \textit{The CEQ Regulations}

Because NEPA is written in such broad, sketchy terms, the CEQ regulations, which provide detailed instructions for fulfilling the NEPA procedural mandate, now dominate action agency practice and litigation. The CEQ regulations provide the authoritative framework for NEPA compliance because they are clearly organized and well written, and, more importantly, because NEPA itself offers so little specific instruction on how agencies are to comply with the statute. Though NEPA does not explicitly authorize the CEQ to promulgate regulations governing agency compliance with NEPA, courts generally find them binding.\textsuperscript{51} Action agencies themselves implement the CEQ framework through agency-specific regulations, guidelines, and handbooks.

The EPA guidance, analyzed in Part IV, does not focus on the enforcement of the CEQ regulations. Instead, it focuses on reviewing the EPA's own priorities, based on its section 309 authority.

\textsuperscript{48} \textit{Id.} In subsequent litigation over federal oil and gas leasing, the same court described the agency's failure to respond to EPA's section 309 concerns over cumulative impacts in finding that the EIS failed to comply adequately with the requirement of cumulative impact analysis. \textit{See} Natural Resources Defense Council v. Hodel, 865 F.2d 288, 298-300 (D.C. Cir. 1988).


\textsuperscript{50} \textit{See} William L. Andreen, \textit{In Pursuit of NEPA's Promise: The Role of Executive Oversight In the Implementation of Environmental Policy}, 64 \textit{IND. L.J.} 205, 231 (1989) (noting the EPA's central position as a checkpoint for assessing the impacts of other agencies' actions). Andreen also suggests reform of the CEQ regulations to further strengthen the EPA's role. \textit{Id.} at 258.

\textsuperscript{51} \textit{See}, e.g., Robertson v. Methow Valley Citizens Council, 490 U.S. 332 (1989) (deferring to CEQ's reinterpretation of NEPA in a rule modifying the original NEPA regulations); Andrus v. Sierra Club, 442 U.S. 347, 358 (1979) (giving "substantial deference" to the CEQ's interpretation of NEPA). \textit{See generally} MANDELKER, \textit{supra} note 44, at § 2.06[3].
Those priorities certainly fit within the structure of the CEQ regulations, which are more squarely in the mainstream of NEPA law. However, because the EPA does not stress the linkage to the CEQ regulations, it misses an important opportunity to strengthen and integrate important, cutting-edge issues, such as ecosystem services valuation.

This section discusses the two CEQ regulations that offer the strongest basis for promoting ecological economics. These are regulations that the EPA should revisit and incorporate into its guidance. Although the EPA should develop guidance that more directly stresses and describes compliance with the CEQ regulations, the EPA has not completely ignored the requirements of the CEQ regulations in evaluating EISs and recommending project and analysis modifications. The EPA has, for instance, played an important role in advancing the application of cumulative impact analysis in certain areas.52

1. **Incomplete or unavailable information.**

One of the most powerful aspects of environmental impact analysis under NEPA is that it "impose[s] on agencies an affirmative obligation to seek out information concerning the environmental consequences of proposed federal actions."53 This obligation is important to ecological economics in two ways. First, it requires agencies to apply information generated in ecological economic studies to analyses of impacts and alternatives. This practical application exposes the valuation methods to public debate and interdisciplinary evaluation, and helps refine the methods in response to decision-making needs. Second, the obligation to seek out new information can serve to generate the demand (and funds) for more work in the field.

Under the CEQ regulation, a basic duty of an action agency is to make clear when information is lacking in the evaluation of reasonably foreseeable significant adverse effects in an EIS.54 The CEQ regulation specifically addresses two situations involving incomplete or unavailable information. In the case where relevant information "is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant," the agency

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must include the information in the EIS.\textsuperscript{55}

Alternatively, in the case where "the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known," the agency is required to explain the significance of the missing information and include discussion of several issues in its EIS.\textsuperscript{56} These issues include a summary of existing credible scientific evidence and the "agency's evaluation of . . . impacts based upon theoretical approaches or research methods generally accepted in the scientific community."\textsuperscript{57} So, even if valuation techniques are unable to generate direct information about services, such as pollution assimilation, at a non-exorbitant cost, surrogates tied to the service by theory, such as microorganisms associated with the biodegradation of toxic materials, might become an essential element in environmental impact analysis.

Action agencies may have an additional incentive to use the most up-to-date valuation techniques in their EISs. The CEQ regulations require an agency to prepare a supplement to an EIS when it discovers significant new information bearing on the proposed action.\textsuperscript{58} Preparing a supplemental EIS is a resource- and time-intensive process that agencies generally prefer to avoid. Therefore, agencies should want to incorporate in an EIS any techniques on the verge of acceptance that are likely to generate significant new information. In practice, however, agencies often stick with more familiar analytical techniques that they have used before.

2. \textit{Cumulative impacts.}

All EISs must analyze cumulative impacts,\textsuperscript{59} which represent the most distant horizon of reasonably foreseeable effects. Cumulative impact analysis has always been a great challenge for EIS preparation. Ecosystem services can broaden the scope of cumulative analysis by defining the reasonably foreseeable horizon, and can contribute to making predictions about the type and extent of the impacts.

The CEQ regulations define "cumulative impact" as the impact

\begin{itemize}
  \item \textsuperscript{55} \textit{Id.} § 1502.22(a).
  \item \textsuperscript{56} \textit{Id.} § 1502.22(b).
  \item \textsuperscript{57} \textit{Id.} § 1502.22(b).
  \item \textsuperscript{58} \textit{See id.} § 1502.9(c)(1)(ii).
  \item \textsuperscript{59} \textit{See id.} § 1508.25.
\end{itemize}
on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over some period of time. Indeed, "the most ecologically devastating environmental effects may result not from the direct effects of a particular proposal, but from the combination of existing stresses and . . . multiple actions over time." Ecosystem services valuation may highlight cumulative impacts, which often quietly but steadily mount, escaping our notice. The regulations define effects to include ecological impacts relating to "the components, structures, and functioning of affected ecosystems."

The key concept limiting the EIS analysis of cumulative impacts is "reasonably foreseeable." To the extent that better valuation of ecosystem services extends the reasonably foreseeable horizon, the use of ecological economic techniques may be crucial in defining the scope of the EIS. This horizon may be defined on both temporal and spatial scales. As a former CEQ Senior Policy Analyst noted: "Many times there is a mismatch between the scales at which environmental impacts occur and the scales in which decisions are made, which is a significant obstacle to cumulative impact analysis." Virtually all environmental impact analyses struggle to assess adequately cumulative effects with minimal information on the environmental baseline. This assessment must describe the changes that have already occurred in an area, and predict the reach of future effects. Ecosystem services valuation has the potential to provide a framework for data-gathering and analysis where little currently exists.

The establishment of an environmental baseline combines both the CEQ requirements to obtain information and address cumulative impacts. Once the study area is defined, the agency should collect baseline environmental data, determine gaps in the data, and
design methods for collecting missing data. It must ensure that the analysts have access to data that will allow them to assess "past, present, and reasonably foreseeable" effects. The analyst may need habitat inventories, water quality surveys, and studies of social and economic patterns in a community. In some cases the collection of data may require sampling over four seasons or longer periods to ensure an understanding of the existing community social interactions, socioeconomic state, environmental conditions, or ecosystem processes. Historical data can sometimes be used to supplement the baseline database.

Ecosystem services valuation would help generate some of these baseline data, particularly for ecosystem processes, such as nutrient cycling or water purification. In a programmatic EIS, which will be less site-specific than a project-level EIS, the current state of ecological economics, which is stronger in aggregating values over large areas than in marginal analysis for individual plots, may be even more helpful in establishing a baseline of service valuations from which to project likely future cumulative effects.

Identifying what information is needed to examine effects remote in space or time can be accomplished through scoping. The CEQ regulations define scoping as the "early and open process for determining" the range of issues to be addressed in the NEPA process. Early identification of the issues allows agencies to acquire appropriate models for assessing cumulative effects and determine what information will be needed to use those models. As a hub for guidance on EIS development, the EPA may play an important facilitating role in identifying key cumulative effects and suggesting appropriate environmental analyses. The valuation of ecosystem services may help in detecting effects and providing these analyses.

C. The CEQ Biodiversity Report

In the early 1990s, the CEQ responded to growing concerns about conservation of biological diversity as a key environmental issue. The CEQ conducted a series of hearings and produced an

66. See 40 C.F.R. § 1508.7 (1999).
67. See Clark, supra note 62, at 660 (quoting 40 C.F.R. § 1508.7).
69. 40 C.F.R. § 1501.7.
70. See CEQ on Cumulative Effects, supra note 68 at 10.
71. The rise of biodiversity as a domestic environmental issue can be traced through
advisory report on biodiversity to identify how the NEPA process could incorporate new information and concerns. Although the report's recommendations are not binding on agencies, they are particularly applicable to the EPA's activities. The CEQ report identified ecosystem integrity and structure as important components of biodiversity. Concerns about adverse effects on ecosystem integrity spurred the current EPA program aimed at broadening NEPA to better account for ecological impacts.

The 1993 CEQ report on integrating biodiversity considerations into NEPA analysis established a framework for thinking about valuing nature. This framework, which predates the recent developments in ecological economics, is important because it established the approach EPA has taken in subsequent years in developing guidance for section 309 review. Employing an "ecosystem approach," the CEQ biodiversity report focuses on biogeography, the study of where the components of biological diversity occur. Nonetheless, the report describes the goal of biological diversity conservation as consisting of maintenance of "natural ecosystem processes," as well as organisms. The report stresses that biodiversity occurs simultaneously at different geographic scales. It suggests that agencies devote attention to biodiversity conservation in scoping, impacts analysis (especially for cumulative effects), mitigation, and monitoring. These four aspects of NEPA analysis became the focus of the EPA guidance, discussed below.

The CEQ biodiversity report contains specific recommendations in its discussion of issues as well as general recommendations in its conclusions. One specific recommendation with relevance to ecological economics is the adoption of indicators that can be monitored. Monitoring provides a means to determine whether ultimate goals are coming closer to fruition or retreating from view. The general goals of the report reinforce the importance of the

key reports, including COUNCIL ON ENVTL QUALITY, ENVIRONMENTAL QUALITY: TWENTY-FIRST ANNUAL REPORT 136-40 (1991); U.S. ENVTL PROT. AGENCY, THREATS TO BIOLOGICAL DIVERSITY IN THE UNITED STATES (1990); BIODIVERSITY, supra note 1 (comprising proceedings of a key 1986 conference sponsored by the National Academy of Science and the Smithsonian Institution); OFFICE OF TECH. ASSESS., U.S. CONGRESS, TECHNOLOGIES TO MAINTAIN BIOLOGICAL DIVERSITY (1987).

72. COUNCIL ON ENVTL QUALITY, INCORPORATING BIODIVERSITY CONSIDERATIONS INTO ENVIRONMENTAL IMPACT ANALYSIS UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT 1-25 (1993) [hereinafter CEQ ON BIODIVERSITY].

73. Id. at 8.

74. See id. at 20-21.

75. Id. at 21.
EPA in spearheading innovations in environmental impact analysis. The report recommends that, to improve consideration of biodiversity in NEPA analysis, agencies follow six steps:

1. Acknowledge the conservation of biodiversity as national policy and incorporate its consideration in the NEPA process.
2. Encourage and seek out opportunities to participate in efforts to develop regional ecosystem plans.
3. Actively seek relevant information from sources both within and outside government agencies.
4. Encourage and participate in efforts to improve communication, cooperation, and collaboration between and among governmental and non-governmental entities.
5. Improve the availability of information on the status and distribution of biodiversity, and on techniques for managing and restoring it.
6. Expand the information base on which biodiversity analyses and management decisions are based.  

The EPA, in its role as central evaluator of EISs, is in an excellent position to act on these recommendations in a manner that employs the latest developments of ecological economics. The CEQ recommendations support the creation of an EPA program that seeks to establish criteria for good environmental practices, sponsor new research, disseminate new information and tools of environmental impact analysis, and coordinate efforts across agency jurisdictions. Such actions would greatly facilitate the effective use of ecosystem valuation in the EIS process.

III. THE EPA'S ENVIRONMENTAL REVIEW PROCESS

The EPA implements its section 309 and other NEPA review responsibilities through the Environmental Review Process. The Office of Federal Activities (OFA) within EPA's Office of Enforcement and Compliance Assurance (formerly the Office of External Affairs) serves as the clearinghouse for section 309 review. Although regional EPA officials conduct almost all of the actual reviews, the OFA establishes the uniform Review Process and issues guidance to aid regional reviewers. This OFA guidance is the principal source of EPA's interpretation of its substantive (as opposed to procedural) review standards. Before examining the guidance

76. Id. at 23-24.
documents relevant to valuation of ecosystem services, it is worth outlining the EPA procedure for conducting an environmental review.

The EPA review and consultation with action agencies begins during the scoping process, an early and open effort to determine the range of issues that an EIS will address.\textsuperscript{78} Although action agencies will sometimes specifically solicit EPA views on issues and alternatives to be considered in an EIS, the EPA may self-initiate scoping contributions. The EPA's procedures establish four factors for determining the level of EPA participation in the scoping process: EPA statutory responsibility, severity of potential impacts, agency priorities, and available resources.\textsuperscript{79}

The EPA should consider adding its expertise as a factor in determining how much it should get involved in scoping. Because scoping is crucial in establishing the contours of the environmental analysis in an EIS, the EPA should participate so that it can suggest useful applications of ecological economics. Through its experience with biological criteria for water quality standards, wetland functions valuation for mitigation banking, and pollution assimilation in contaminated soils, the EPA should be able to contribute to scoping.\textsuperscript{80} In support of the expertise basis for the EPA's participation are two of the five topics that the OFA procedures cite as key information to provide to scoping agencies: specific information related to the area of interest, and "specific assessment techniques and methodologies that EPA program offices use or have approved for use."\textsuperscript{81}

The EPA's principal section 309 activity is review of draft EISs. In contrast to the CEQ's focus on process, the EPA is "primarily concerned with identifying and recommending corrective action for . . . significant environmental impacts."\textsuperscript{82} This substantive focus establishes an important and unusual bridge between NEPA's section 102 procedure goals and section 101 policy goals. The substantive focus also sets the agenda for the OFA guidance, which stresses mitigation. In addition to its comments on avoiding or minimizing

\textsuperscript{78} 40 C.F.R. § 1501.7 (1999).

\textsuperscript{79} OFA Policy and Procedures, supra note 77, at ch. 3(3)(B)(3).


\textsuperscript{81} OFA Policy and Procedures, supra note 77, at ch. 3(3)(C)(2), (3).

\textsuperscript{82} Id. at ch. 4(1).
environmental damage, the OFA procedures also charge EPA with addressing potential environmental statutory violations, the range of alternatives (which may require suggesting a new alternative where significant impacts cannot be adequately mitigated through the action agency’s proposed alternatives), and the purpose and need for the proposed action.83

When commenting on the purpose and need for the proposed action, the OFA manual states that reviewers may “comment on the economic justification of the project, and the relationship between the lead agency’s economic analysis and any unquantified environmental impacts, values, and amenities. The comments may also address the technical validity and adequacy of the supporting data for the EIS’s economic analyses.”84 Although the EPA typically does not criticize a project solely on economic grounds, the ecosystem service valuation tools provide a basis for the EPA to act more frequently under this provision. Environmental impact analyses that fail to account properly for impacts to services may be inadequate from the EPA’s perspective not because the cost-benefit balance is unfavorable, but because it is incomplete.

In addition to providing narrative comments, the EPA evaluates draft EISs on two scales.85 One scale rates by severity the actual environmental impacts expected in the preferred alternative. The other scale rates the adequacy of the draft EIS itself. Poor ratings in either category trigger follow-up consultations with the agency. The follow-up procedures establish more formal and elaborate consultations for the poorer scores. An unfavorable rating is a signal to the action agency (and potential plaintiffs seeking judicial review) that there may be serious problems with its proposal or draft EIS. The scoring of the severity of impacts illustrates the EPA’s experience with measuring environmental effects on a non-monetary basis. The agency need not measure ecosystem services in dollars by using market substitution measures. Alternatives in a draft EIS may compare a service’s value through the use of surrogates.

The EPA continues to monitor the NEPA process through the publication of a final EIS. Only those EISs that had significant issues raised by the EPA at the draft stage receive detailed reviews of

83. Id. at ch. 4(3)(B)-(E).
84. Id. at ch. 4(3)(E).
85. Id. at ch. 4(4).
the final versions. A final EIS that is unresponsive to significant concerns (including inadequate information) raised by the EPA in its draft EIS review may be a candidate for referral to the CEQ.

In contrast to the CEQ policy, which does not address post-EIS implementation of the project, the EPA’s policy is to conduct selective, follow-up activities to ensure that action agencies fully implement mitigation measures, such as permit conditions and operating plan stipulations. Agencies are bound by NEPA to implement mitigation measures for projects where the mitigation was the basis for a finding of no significant impact to avert the need to prepare an EIS. However, the Supreme Court has found that NEPA itself does not bind agencies to implement mitigation measures discussed in an EIS. This commitment by the EPA, therefore, establishes the only oversight to ensure that action agencies abide by the mitigation plans discussed in EISs. Unfortunately, this selective follow-up to monitor mitigation seldom occurs due to scarce agency resources. Better monitoring of the outcome of mitigation is critical to adaptive management of the project at hand and successful adoption of mitigation in future projects. For these reasons, and because few agencies evaluate the success (or failure) of mitigation predictions, follow-up activities should receive the highest priority for resources within the section 309 program.

IV. THE EPA ECOLOGICAL GUIDANCE FOR NEPA REVIEW

To aid regional reviewers, the OFA prepares guidance documents that explain recent trends in impact analysis and suggest constructive ways in which a reviewer may improve EISs. The following sections evaluate, in chronological order, all of the guidance documents prepared by the OFA since 1990 that deal with ecological impacts.

Ecological impacts, or ecological risk, had long been neglected by the EPA. In 1990, the EPA’s Science Advisory Board recommended that the Agency re-prioritize its programs to “attach as

86. Id. at ch. 6(1).
87. See discussion supra Part II.A.2.
88. See OFA POLICY AND PROCEDURES, supra note 77, at ch. 7(1).
89. These situations where mitigation is part of the binding decision are often referred to as “mitigated FONSI.”
90. See Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 353 (1989). Nonetheless, the CEQ regulations state that “[m]itigation and other conditions established in the [EIS] . . . and committed as part of the decision shall be implemented.” 40 C.F.R. § 1505.3 (1999).
much importance to reducing ecological risk as it does to reducing human health risk." The EPA accepted this challenge, which built on an earlier EPA report. The following guidance documents are an outgrowth of the EPA's efforts to fulfill the mandate to exhibit more leadership on issues of ecosystem functioning and impairment. The documents are intended to help EPA reviewers in the regional offices conduct evaluations that reflect the rapidly expanding ecological literature.

For the most part, the guidance documents simply recognize and describe ecosystem functioning. A services approach values nature not just based on what is produced but also on whether there are humans in the area who use what is produced. However, recognizing the importance of processes in ecosystem functioning is an important foundation to understanding and assessing the services provided by nature. One always needs to begin with ecosystem functions before valuing services. So, to the extent that the early guidance documents overlook the services approach, they do not necessarily lead reviewers astray. They simply stop short of taking reviewers through the final step in the analysis of valuing what services the ecosystems generate while functioning.

The guidance documents reflect a trend that follows developments in the field of ecological economics. Throughout the 1990s, the OFA guidance has steadily increased its emphasis on evaluating impacts on functions that produce the most critical or easily measured services. From 1990 through 1993, the OFA guidance provided little background on services. The early documents do not go far beyond ecosystem structure and function. Even where the guidance does raise issues of service valuation, such as in describing the compensation element of mitigation, it fails to include techniques for comparing values. By 1994, the guidance increases its emphasis on the quantification of what mitigation should be considered adequate for a proposed action. The most recent guidance document gives greater stress to ecological functions that provide key services, such as beach replenishment, flood control, nutrient cycling, and purification services. By 1999, quantification of func-

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tions and services is an important part of EPA guidance. All this reflects a clear trend in the EPA guidance toward greater use of ecological economics and the ecosystem services approach.

A. Early Efforts

Early efforts by the OFA to provide regional EIS reviewers with a framework for better evaluation of ecological concerns resulted in two guidance documents: *Status and Trends of Terrestrial Environments: The Role of Federal Activities*, published in 1990; and *Checklist for NEPA Reviewers—Non-Coal Mine Sites*, published in 1991. Though these documents never progressed beyond draft status, OFA officials regard the guidance as complete and operative.

The Non-Coal Mine Sites guidance is principally a primer for non-specialists on the extraction, beneficiation, and processing operations associated with mining. The bulk of the guidance is dedicated to defining terms, describing operations, and explaining typical pollution problems. Throughout the guidance, the EPA highlights adverse impacts to "community structure and function," including changes in biodiversity. However, the guidance does not discuss ways to assess the services lost as a result of such adverse impacts.

In addition to a description of the adverse environmental impacts of mining, the guidance suggests general mitigation measures for different types of operations in one section and lists questions that EPA reviewers should ask in another. Neither of these sections focuses on the issue of ecosystem services. The only biological service the guidance cites is biological treatment for cyanide solutions remaining from leaching operations. Incorporating ecological economics into this guidance would highlight the biological treatment services performed by the affected environment.

The Non-Coal Mine Sites guidance calls for consideration of

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95. U.S. ENVTL. PROT. AGENCY, CHECKLIST FOR NEPA REVIEWERS—NON-COAL MINE SITES (DRAFT) (1991) [hereinafter EPA ON NON-COAL MINE SITES].

96. See E-mail from Jim Serfis, Environmental Protection Specialist, U.S. EPA to author (Nov. 30, 2000) (on file with author).

97. See, e.g., EPA ON NON-COAL MINE SITES, supra note 95, at 8, 25.

98. Id. at 26.

99. See Herman et al., supra note 80, at 485-88.
"post-mining land use" for most operations as part of the evaluation of mitigation.\textsuperscript{100} A comparison of pre- and post-mining land use\textsuperscript{101} based, in part, on the ecosystem services provided, could change the results of analyses that view undeveloped land as non-producing and unused. In this way, the ecological economic approach would require greater mitigation efforts to compensate for a wider range of services lost to mining.

The Terrestrial Environments guidance is much broader in its scope than the Non-Coal Mine Sites document. The Terrestrial Environments guidance reviews the status of terrestrial environments, describes the practices that cause habitat loss in those environments, links the practices to federal programs, and categorizes problems by EPA region. As with all the EPA guidance for NEPA reviewers, the principal aim of the Terrestrial Environments report is to promote good mitigation practices.\textsuperscript{102} The secondary objective of the report is to educate reviewers so that they may better grasp the current scientific sources for evaluating impacts.\textsuperscript{103} The bulk of the report is a compendium of information on the status of ecosystem types. Little of the report addresses analytic questions about assessing values or impacts. Nonetheless, the report does recognize that the section 309 review process is the only mechanism available to EPA to address many important ecological risks.\textsuperscript{104} The guidance thus served as an early basis for beginning to recognize and respond to threats to ecosystem services.

Although the Terrestrial Environments guidance describes different scales at which natural systems may be characterized, the report focuses on vegetation-based ecosystem types. The guidance lists fifteen of these ecosystem types, including northern mixed forest, eastern deciduous forest, tall-grass prairie, Rocky Mountain forest, and tundra.\textsuperscript{105} In contrast, smaller scale habitats that occur in many ecosystem types, such as wetlands, caves, and cliffs, are not discussed in the report. This makes the Terrestrial Environments guidance most useful for programmatic EISs evaluating impacts that are felt across large areas (landscapes). Examples would include proposed agency grazing or oil/gas leasing programs. Another, more specific, example would be the Forest Service’s recent

\textsuperscript{100} EPA on Non-Coal Mine Sites, supra note 95, at 31, 39.
\textsuperscript{101} Id. at 40, 44.
\textsuperscript{102} EPA on Terrestrial Environments, supra note 94, at 2.
\textsuperscript{103} Id.
\textsuperscript{104} Id. at 69.
\textsuperscript{105} Id. at 5-8.
Sierra Framework for managing 11.5 million acres of Sierra Nevada forest resources.\footnote{106}{See Jane Braxton Little, \textit{A New Plan Frames the Sierra Nevada}, \textit{High Country News}, Feb. 12, 2001, at 6.}

The strongest connection between the concerns of the Terrestrial Environments guidance and the valuation of ecosystem services is an element common to all habitats, ecosystem function.\footnote{107}{See EPA \textit{ON TERRESTRIAL ENVIRONMENTS}, \textit{supra} note 94, at 8. The other values are species and ecosystem structure.} Although the report does not define ecosystem function, it does list energy flow, nutrient cycling, and resilience as examples of functions.\footnote{108}{Id. at 8.} The valuation of nature's services may be an important measure of how well ecosystems are functioning and how well mitigation measures will perform. The guidance identifies ecosystem function as an ecological value in the section reviewing ecosystem types, and then cites ecosystem function as an important component in describing the impacts of eight common practices covered by EISs, including conversion of land for transportation purposes, grazing practices, and water management.

The most detail the guidance offers of services is a narrative description of functions that falls short of making good use of current science to measure the extent of the functions. For instance, the ecological impacts of grazing practices are described in general terms as lowered nitrogen availability in soils, destabilization of streambanks, and retardation of nutrient filtration.\footnote{109}{Id. at 58.} The guidance describes functions of forests threatened by timbering practices as the regulation of waterflows, stabilization of soils, and maintenance of water purity.\footnote{110}{Id. at 55.} In the case of timbering practices, the guidance provides the only quantification of ecosystem functions in the report by citing studies that examined erosion and sedimentation rates in Oregon and northern California logging sites. Other functions mentioned in the report are not quantified and the report lacks an explanation of how those functional losses may be translated into service costs.

Though these early guidance documents lack instructions for practical application of valuation of ecosystem services, they do establish a good foundation for better evaluation. Maintaining ecosystem functions is a prerequisite to providing services. Placed in their historical context, these documents represented an impor-
tant step away from a static view of biodiversity and toward a more dynamic analysis of functions and services.

B. Habitat Evaluation

After a two-year break, the OFA released a key document, known as the Habitat Evaluation guidance.\textsuperscript{111} This guidance incorporated ecological concerns into the evaluation of NEPA documents and established a method of evaluation on which the EPA would come to rely in subsequent, more specific applications. The document provides assistance to EPA reviewers on evaluating ecological risks in effects considered in EISs. The guidance focuses on habitat loss and degradation, with particular emphasis on mitigation. The mitigation theme established in this and other early ecological guidance is reprised in all of the following guidance documents. Although the method in Habitat Evaluation is general and qualitative, it was a major step forward from the early guidance toward valuation of ecosystem services.

The Habitat Evaluation guidance aids reviewers in their section 309 analysis in two ways: first, it helps them to make informed comments in a regional context rather than in a more general way; second, it suggests specific mitigation measures that reviewers may propose to the action agency. Although the ecosystem services concept is not central to the guidance, which stresses mitigation to preserve ecological \textit{integrity},\textsuperscript{112} the guidance nonetheless calls for consideration (if not quantification) of a number of services. And, of course, ecological integrity is the basis for long-term sustainability of ecosystem services.

The Habitat Evaluation guidance is organized by "habitat regions," which are geographic areas that provide the context for determining the value of particular habitat affected by a proposal. The guidance divides the nation into eight of these habitat regions.\textsuperscript{113} These regions are similar to, but somewhat more general than, the fifteen ecosystem types into which the Terrestrial Environments guidance divides the nation.\textsuperscript{114} For each habitat region, the document defines habitats of concern (such as old-growth and

\begin{itemize}
  \item \textsuperscript{111} EPA on Habitat Evaluation, \textit{supra} note 13.
  \item \textsuperscript{112} See id. at 5.
  \item \textsuperscript{113} Northern lakes and forests; Southeastern forests and cropland; Midwestern cropland; Great plains and prairies; Western forests; Western deserts and grasslands; Alaska; and Hawai‘i and island territories. Id. at 1.
  \item \textsuperscript{114} EPA on Terrestrial Environments, \textit{supra} note 94, at 5-8.
\end{itemize}
mature forests), which are "those sensitive environments whose degradation or loss results in significant diminution of ecosystem integrity or ecological values." For each habitat region, the document also describes habitat values and trends, common activities affecting habitats, and mitigation measures, and provides summary guidelines for reviewers.

Like the earlier Terrestrial Environments guidance, the Habitat Evaluation guidance does not distinguish between (or sufficiently describe the connection between) the terms habitat and ecosystem. Despite this problem, the Habitat Evaluation guidance does cite the values and services provided by habitats in explaining why degradation or loss of habitat should be avoided or mitigated. The guidance specifically acknowledges that some ecosystem services have economic benefits. For example, under the category of "purification of resources," the guidance includes sediment and toxicant retention, nutrient removal and transformation, and pollutant detoxification as factors that should be considered in evaluating the effects of a proposed action. These factors are also services for which EISs should address mitigation. Other categories include market-valued services such as erosion control, sediment trapping, flood flow alteration, and fisheries. All of these habitat or ecosystem services are well suited to evaluation with the new techniques of ecological economics. Still, the loose definitions in the document, including the failure to distinguish between the concepts of ecosystem services, functions, and values, muddle what might otherwise be a clear directive to evaluate the real value of service losses.

The Habitat Evaluation guidance defines mitigation as including four measures (preservation, management practices, restoration, and compensation). Unfortunately, the regional chapters concentrate almost exclusively on only one of them (management practices). However, another component of mitigation is compensation. The guidance defines compensation to include both purchase of lands of comparable habitat size and quality as well as provision of financial restitution. Particularly in the context of

115. EPA ON HABITAT EVALUATION, supra note 13, at 2.
116. Id. at 5.
117. Id. at 7.
118. See id. at 5, 7.
119. Id. at 19. In clarifying mitigation, the Habitat Evaluation guidance cites a 1981 Fish and Wildlife Service framework that outlines means and measures for compensating impacts to wildlife. Id. at 20 (quoting 46 Fed. Reg. 7,660 (1981)).
the guidance's focus on ecosystems, the compensation component of mitigation should require review of information about ecosystem services. Though the guidance does not elaborate on compensation, the increasing availability of ecological economic information should make thorough compensation analysis more realistic now.

If the EPA were to revise its Habitat Evaluation guidance to provide more detailed suggestions regarding compensation—if EPA were to demand specific estimates of financial restitution, for instance—it might spur greater research into ecosystem services. Restitution in dollars would require determining the value of the services lost as a result of habitat degradation. In the case where the services have market substitutes, restitution could enable the beneficiaries of ecosystem services to continue to receive the services despite the habitat modification. NEPA, of course, does not require that this financial transaction take place. But the EPA is correct in its interpretation in the Habitat Evaluation guidance that NEPA requires agencies to estimate, when they can, the loss of services. The EPA can play a pivotal role in encouraging better accounting for these services in EISs.

C. Grazing on Federal Lands and Highway Development

In 1994, following the publication of the Habitat Evaluation guidance, the EPA turned to specific federal activities that raise difficult issues for ecological impact analysis: grazing on federal lands¹²⁰ and highway development.¹²¹ These two guidance documents, one on each issue, extend the Habitat Evaluation analysis by focusing on commonly encountered impacts from two types of federal actions. As with the prior guidance, these two documents focus on ecosystem functions. Though functions support the provision of services, they do not quantify the benefits in a way easily compared to other impacts or alternative actions. The documents do, though, strengthen the foundation for applying the tools of ecological economics to better describe the effects of actions on and mitigation for ecological services. The two guidance documents, especially the one on highway development, make important progress in highlighting some areas where services can and should be identified.

¹²⁰ U.S. ENVTL. PROT. AGENCY, GRAZING ON FEDERAL LANDS (1994) [hereinafter EPA ON GRAZING].
¹²¹ U.S. ENVTL. PROT. AGENCY, ECOLOGICAL IMPACTS FROM HIGHWAY DEVELOPMENT (1994) [hereinafter EPA ON HIGHWAY DEVELOPMENT].
and roughly estimated, even though they do not provide a comprehensive method for the analysis.

The Grazing guidance focuses on ecological effects of livestock grazing, especially impacts on water and soil. Mitigation plays a relatively minor role in the document. However, several significant environmental impacts are described by the guidance, including effects on stream water quality, drainage, soil stability, and water availability. All of these impacts affect important ecosystem services that may be quantified to more precisely evaluate a grazing proposal.\textsuperscript{122}

The sections of the Grazing document dealing with indirect impacts on terrestrial and aquatic ecosystems make the greatest contribution to developing methods of valuing of ecosystem services.\textsuperscript{123} Both sections cite studies that describe the functional ecosystem losses resulting from the decline in vegetative diversity that often accompanies grazing. For example, the section on terrestrial ecosystems notes reductions in the nutritional value of forage from grazing. The aquatic ecosystems section is more specific, and discusses a number of services that may be impaired, including energy flow, moderation of stream temperature, flood control, and sediment trapping.\textsuperscript{124} The guidance does not discuss the utility of quantifying those services, and valuation would certainly improve our understanding of the magnitude of the impact. The services discussed in this guidance are the subject of current ecological economic investigation.

The Highway guidance also takes an ecological approach to describing impacts, but includes relatively more discussion of mitigation than the Grazing guidance. The Highway guidance also explicitly connects consideration of ecological impacts to existing action agency regulations and guidance.\textsuperscript{125} The guidance is thus able to use Federal Highway Administration material to support an evaluation within a regional context and a number of substantive goals, such as: preservation of sensitive ecosystem and species, maintenance of natural habitat structure and ecosystem processes, minimization of habitat fragmentation, and restoration.\textsuperscript{126} This connection strengthens EPA's leverage in the section 309 process.

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{122} See EPA on Grazing, supra note 120, at 6, 12.
\item \textsuperscript{123} See id. at 25-29.
\item \textsuperscript{124} Id. at 27-29.
\item \textsuperscript{125} See EPA on Highway Development, supra note 121, at 5.
\item \textsuperscript{126} Id. at 5-6.
\end{itemize}
\end{footnotesize}
by illustrating to the action agency how to better meet its own mandates.

In describing serious impacts of highway development, the EPA guidance considers the disruption of natural processes. This helps provide a basis for evaluation of the services based upon these processes. For instance, in discussing riparian ecosystem processes, the guidance describes the relationship between erosion, runoff, sedimentation, and floods in a way that suggests the supply of flood control. Similarly, and more directly, the guidance recognizes that hydrological degradation harms nutrient and energy cycles, and cites the importance of these impacts in rural areas. In differentiating the value of a function (such as nutrient cycling) based on its location (rural), the guidance moves toward an ecosystem services approach. A services approach values nature not just based on what is produced but also on whether there are humans in the area who use what is produced. The guidance also distinguishes impacts on wildlands based on the setting.

In order to evaluate the ecological impacts of highway development, the guidance recommends determining the appropriate scale of analysis and establishing concrete ecosystem goals. The guidance stresses the importance of identifying quantifiable endpoints for each goal. This guidance's advocacy of quantification provides an important link to valuation of ecosystem services. The guidance would evaluate EISs based on a two-step approach of, first, characterizing ecological values and functions, and then quantifying impacts. Quantifying endpoints of an activity—such as the resulting status of hydrology, or consequent changes in nutrient and energy cycling—is one of the steps involved in assessing the value of ecosystem services.

In addition to quantifying impacts, ecological services valuation would also help meet the Highway guidance's recommendation to use compensation as a form of mitigation. Three of the specific mitigation measures listed in the guidance are: (1) "[c]ompensate for unavoidable loss of habitat through in-kind restoration or miti-

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127. See id. at 14-15.
128. Id. at 15.
129. Id. at 18.
130. Id. at 19.
131. See id. at 22-23
132. Id. at 28.
133. Id. at 24-25.
gation banking programs”; (2) “[c]ompensate for unavoidable direct loss of habitat by increasing the carrying capacity . . . and providing access to water supplies”; and (3) “[c]ompensate for unavoidable loss of sensitive habitats . . . [by] preserving areas of similar or greater value.” Each of these measures requires some form of valuation of ecosystem functions or services and should be informed by the emerging ecological economic tools. The guidance specifically recommends ecological restoration as a tool for mitigation in certain circumstances. Here as well, valuation of ecosystem services can help to “specify the restoration objectives” and to monitor the performance of the restoration.

The Grazing and Highway guidance documents develop and present a strong quantitative and conceptual basis for valuing ecosystem services. For example, in explaining the value of biodiversity, the Highway guidance asserts that access to genetic resources “contributes about $1 billion annually to U.S. agriculture through development of improved crops.” Future guidance may rely on the estimates of the monetary value of ecosystem services to support the importance of considering the impacts on services of agency proposals.

D. Considering Ecological Processes in Environmental Impact Assessments

After a hiatus of five years, the OFA released its most recent ecological guidance, Considering Ecological Processes in Environmental Impact Assessments, in 1999. This “Ecological Processes” guidance builds on the Terrestrial Environments and the Habitat Evaluation guidance reports in providing a framework for NEPA reviewers that more closely follows current theories of conservation biology. Indeed, the guidance cites conservation biology materials to justify its focus on ecological processes as “fund-
Building explicitly on the 1993 CEQ Biodiversity and EPA Habitat Evaluation reports, the Ecological Processes guidance emphasizes ecological functions and services much more than any of the other guidance documents discussed in this article. The Ecological Processes guidance shows great potential for the OFA to continue to incorporate new developments in conservation biology, either through the existing Ecological Processes framework or through guidance issued periodically to update valuation methods.

In its introduction, the Ecological Processes guidance directly connects concerns about nature's services to its framework:

[C]lean air and clean water depend not only on the control of hazardous discharges, but on the maintenance of ecosystem services that assimilate wastes . . . . Ecosystems provide not only valuable products and essential services, but also opportunities for recreation and aesthetic enjoyment. Examples of ecosystem services include purifying air and water, providing flood control, building fertile soils, and producing food, fiber, and other natural resources for human consumption. Healthy forests, for example, provide wood products, sequester man-made gases that cause global warming, and control erosion that degrades water quality and fisheries, and support wildlife and rare species.

In contrast to previous guidance organized around particular practices that threaten the environment or particular ecosystem types, the Ecological Processes guidance organizes its analysis around ten processes “that effectively capture ecosystem functioning and should be evaluated for adverse effects.” The guidance discusses methods to mitigate adverse impacts on each process, but focuses mostly on describing the ecological processes and the effects they suffer from than it does on mitigation. The ten processes evaluated by Ecological Processes are: (1) habitats critical to ecological processes, (2) pattern and connectivity of habitat patches, (3) natural disturbance regime, (4) structural complexity, (5) hydrologic patterns, (6) nutrient cycling, (7) purification services, (8) biotic interactions, (9) population dynamics, and (10) genetic diversity.

143. CEQ on Biodiversity, supra note 72.
144. EPA on Habitat Evaluation, supra note 13.
146. Id. at 4.
147. Id.
Of these ten processes, hydrologic patterns, nutrient cycling, and purification services have the most direct connection to market substitutes that can be used to estimate their service value. Hydrologic patterns, for instance, are credited in the guidance with maintaining coastal beaches, a project for which there exists valuation data from sand nourishment efforts. The guidance goes so far as to assert that "all effective shoreline engineering procedures create erosion" by interrupting the replenishment of sediment to beaches. If so, a very large number of EISs would benefit from the valuation analysis of ecological economics to quantify the impairment of beach replenishment services. Similarly, the guidance describes a wide range of watershed modification activities that, by impairing hydrologic patterns, create costs through increased flood frequency, increased flood magnitude, bank erosion, and decreased baseflow during dry periods. Because the market provides and values services that seek to substitute for these reductions in ecosystem functions, ecological economics could improve environmental analyses and might better satisfy the concerns of the EPA guidance.

Nutrient cycling and purification services are the two ecological processes with the greatest connection to the existing work on valuing nature's services. In the chapters describing these processes, the guidance cites essays from Nature's Services, the path-breaking collection of studies valuing ecosystem services. These citations help indicate what information the EPA should demand from EISs and from recent developments in ecological economics.

The Ecological Processes guidance advises EIS reviewers on quantitative description of nutrient cycling. Quantitative measurement of ecological processes is difficult but scientists do have the ability to track nutrient cycles through radioactive tracers and chemical analyses of soils, waters, sediments, and plants. Quantitative descriptions of nutrient cycling provide an excellent basis for comparing functions across the various alternatives presented in an EIS. Although the quantitative measures are not service valuations,

148. Id. at 40.
149. Id. at 42.
150. Id. at 41-42.
151. See, e.g., id. at 51 (citing Gretchen C. Daily et al., Ecosystem Services Supplied by Soil, in Nature's Services, supra note 3), 58 (citing Charles H. Peterson & Jane Lubchenco, Marine Ecosystem Services, in Nature's Services, supra note 3), 59 (citing Katherine C. Ewel, Water Quality Improvement by Wetlands, in Nature's Services, supra note 3).
152. See EPA ON ECOLOGICAL PROCESSES, supra note 139, at 48-49.
they at least offer a basis for making those valuations if there are adequate substitutes priced by the market. However, the report's discussion of nutrient cycling does offer a caveat for the ecological economic valuation of fertilization based on synthetic substitutes. The report notes that introduction of synthetic fertilizers create "many deleterious effects on the environment."\textsuperscript{153} Even where market substitutes offer the same level of services, such as availability of biologic nitrogen, as ecosystem processes do, there may be environmental costs to providing those services by means outside of normal ecological functioning. Ecological economic valuation must account for those costs of a substitute where they are absent from the production of the services through normal ecological processes.

Adverse impacts to nutrient cycling may involve addition of nutrients to ecosystems, as when fertilizers are applied, or the subtraction of nutrients, as when soil is washed away. Depending on the impact, artificial wetlands may offer mitigation. Wetlands can assimilate nutrient overloads and abate erosion by slowing flood flows. Mitigating impacts on nutrient cycling, therefore, may bring to the section 309 evaluation all of the valuation issues associated with wetlands creation and restoration.\textsuperscript{154} The guidance also discusses wetlands for mitigating adverse effects on purification services.\textsuperscript{155}

Many of the issues associated with nutrient cycling also apply to purification services because assimilation of contaminants may be a function of both. A nutrient in one setting may be a contaminant in need of assimilation (purification) in another setting where elevated nutrient loads exist. The Ecological Processes guidance advises EIS reviewers on purification services, offering the most direct link between an ecological process and a service valued by ecological economists. Indeed, "purification services" is the only process category described by the guidance as a "service." The close connection between the purification services chapter of the guidance and ecological economics is manifest in the section on how purification services should be described. This section contains a number of quantitative measures useful in comparative analysis. One measure comes directly from an essay describing the ecosystem ser-

\textsuperscript{153.} \textit{Id.} at 49.\textsuperscript{154.} See \textit{id.} at 52; \textit{see also} Ruhl & Gregg, \textit{supra} note 80 (2001); Salzman et al., \textit{supra} note 4 (2001).\textsuperscript{155.} See EPA ON ECOLOGICAL PROCESSES, \textit{supra} note 139, at 59.
vices of marine ecosystems: "The marginal value of using aquatic ecosystems to scrub nutrients from sewage wastewater can be estimated by using standard engineering formulae to calculate the costs of construction and operation" of wastewater treatment facilities.156 The EIS reviewers could benefit from more references to quantitative measures developed by scientists working on ecosystem services valuation.

In describing mitigation for purification services, the guidance promotes comprehensive watershed and pollution prevention approaches.157 The guidance suggests that the level of mitigation may be determined by "[t]he emerging field of ecological risk assessment."158 The task of better integrating the tools of ecological risk assessment into ecological economics, and vice versa should be a high priority for OFA and researchers interested in improving environmental impact assessment.

The fact that only three of the ten ecological processes identified by the OFA as critical in EIS review are easily susceptible to the ecological economic analysis reveals the limitations of the valuation tools. Although valuing nature's services may provide important information to help decision-makers and the public compare the merits of different courses of action, that information does not capture all of the dimensions of ecological processes, such as population dynamics or natural disturbance. It may well be that without these non-market processes, ecosystems will not sustainably provide the market-valued services. An important challenge to the ecological economists is to include a wide range of these essential ecological processes in their value calculus, even where they do not directly supply market-valued services.

V. Conclusion

This study of the relationship between the EPA's NEPA duties and valuation of ecosystem services yields a number of recommendations. Many of the recommendations point in directions toward which the EPA has already begun to move. Certainly, the section 309 guidance at the heart of the EPA's NEPA program reflects a gradual, steady increase in sophistication and effectiveness in inte-

156. Id. at 57 (citing Charles H. Peterson & Jane Lubchenco, Marine Ecosystem Services, in Nature's Services, supra note 3, at 177).

157. See id. at 59.

grating ecological economic understandings of ecosystem services with the regulatory framework. The challenge ahead for the EPA is to improve quantification of ecosystem services for valuation and to ensure that agencies effectively implement mitigation.

Although the substantive mandate of NEPA sets goals that are difficult to measure without valuing ecosystem services, it is the procedural mandate of NEPA that offers the strongest support for using the new tools of ecological economics. The section 102(2)(B) mandate to "identify and develop methods and procedures... which will insure that presently unquantified environmental... values may be given appropriate consideration in decisionmaking along with economic... considerations" essentially requires agencies to support the methods and procedures of ecosystem service valuation.

The most important procedural mandate of NEPA is the section 102(2)(C) requirement to prepare an environmental impact statement for major federal actions significantly affecting the quality of the human environment. The statute requires each EIS to describe "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." To do so, agencies must assess the productivity of the environment. The valuation of ecosystem services is one powerful method of fulfilling this mandate.

Because the CEQ regulations provide the blueprint for agency preparation of EISs, the EPA guidance on EIS review should build on the CEQ regulations. Future guidance from the OFA should anchor more strongly to the CEQ regulatory requirements on incomplete or unavailable information, and cumulative impacts. The former supports the use of new techniques valuating ecosystem services in order to provide information that is otherwise unavailable and essential to reasoned decision-making. The latter promotes analyses that search out the most distant reasonably foreseeable effects of actions, which include impacts on the functioning of ecosystems.

The CEQ biodiversity report sets an agenda that the EPA has adopted somewhat in its EIS review guidance. However, the report suggests a more comprehensive agenda for the EPA: to establish criteria for good environmental practices, to sponsor new research,

to disseminate new information and tools of environmental impact analysis, and to coordinate efforts across agency jurisdictions.

Because the EPA's EIS review process creates a gateway for examining all proposed major federal actions with significant environmental effects, it can be an attractive vehicle for evaluating a myriad of concerns. However, the section 309 process is particularly well suited for the valuation of ecosystem services for at least three reasons: (1) section 101 of NEPA provides substantive goals that match the aim of the valuation; (2) valuation is in a state of development where a moderate increase in demand for information from the government would substantially advance the precision of the valuation techniques; and (3) valuation answers real, practical questions that are often raised but unanswered in EISs.

Also, the EPA's section 309 EIS review program is an excellent vehicle for promoting useful applications of ecological economics because it melds the procedural with the substantive. The review program is concerned with evaluating the action-forcing environmental impact analysis. However, unlike the CEQ regulations, the EPA guidance sets a substantive agenda for review of action agency proposals and EISs. Although the EPA's substantive focus on mitigation may divert its attention from other important substantive concerns, it does provide an opportunity for the EPA to develop special expertise in this area where action agencies and the CEQ are weak. And, the adequacy of mitigation does implicate the substantive goal of correcting for significant environmental impacts. The EPA can better strengthen mitigation through the use of ecosystem services valuation to measure the pre- and post-action services available in an impact area. Monitoring the status of promised mitigation after an agency makes its EIS final will be crucial to the success of the mitigation program.

Since 1990, guidance documents issued by the EPA Office of Federal Activities have advanced significantly the cause of including ecosystem functions and services in NEPA and project review. The guidance documents remain more focused on functions than on services. But, because a services valuation approach builds on knowledge of ecosystem functions, the EPA guidance continues to create information that would support future valuations. Many of the recommendations in the OFA guidance may be fulfilled through the use of new ecosystem valuation techniques. Examples include: evaluating the impacts of proposed actions on services, such as sediment/toxicant retention, nutrient removal, flood con-
control, soil productivity, and pollution detoxification; estimating restitution and compensation for habitat loss; distinguishing the value of ecological services based on their location; and evaluating effects using a two-step process of characterizing ecological functions and then quantifying the services they provide.

Still, new guidance from the OFA should specifically describe the situations where the tools of ecological economics are most valuable. New guidance should also detail a protocol for evaluating the adequacy of an ecosystem services valuation. Where appropriate, guidance should assist EPA reviewers and action agencies in quantifying ecosystem services as part of the effort to account more accurately for the effects of proposals. Where services cannot be quantified directly, the quantification of ecological processes, such as nutrient cycling, may provide a basis for estimating the service provided. While market substitutes for ecosystem services, such as fertilization, may offer a convenient metric for estimating value, future guidance must be careful to account for the negative impacts, such as eutrophication of waters, of those market substitutes.