

Practitioner's Guide to the Integrated Ecological Framework

DETAILS

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Practitioner's Guide to the Integrated Ecological Framework

S2-C06-RW-3

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Practitioner's Guide to the Integrated Ecological Framework

SHRP 2 Report S2-C06-RW-3

Marie Venner Consulting and URS Corporation
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The need for SHRP 2 was identified in *TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*, published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

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Marie Venner drafted this guide as well as the original Integrated Ecological Framework (IEF). Work on NCHRP 25-25/10, Early Mitigation for Net Environmental Benefit: Meaningful Off-Setting Measures for Unavoidable Impacts, was also a precursor to this project, so thanks to Bill Gilmore, head of the North Carolina Ecosystem Enhancement, are in order. The IEF was also developed to respond to barriers, interests, and suggestions identified by the 150 agencies and nongovernmental organization (NGO) staff that participated in the C06A research process in 2009.

Shannon Cox of URS assisted with aligning steps to the original *Eco-Logical* steps, to facilitate integration with the SHRP C01 transportation decision-making framework, and Tom Denbow, also at URS, reviewed the alignment. Patrick Crist, Director of Conservation Planning and Ecosystem Management at NatureServe, was instrumental in significantly expanding many IEF substeps so they comprise a robust ecological assessment process. Jimmy Kagan developed the process for creating the wetland priority map and made data contributions.

Many federal, state, and regional agencies provided review of iterations of the framework in 2009 and 2010 and provided suggestions, which were incorporated. The SHRP Technical Coordinating Committee and Expert Task Group reviewed and approved the initial framework in 2009. Jimmy Kagan and the late Gail Achterman, also of the Oregon Institute for Natural Resources at Oregon State University, Shara Howie of NatureServe, and Kevin Halsey and Paul Manson of Parametrix provided further review of the substeps and additions or recommended deletions in some cases,

and developed and refined technical questions in 2010. Patrick Crist provided detailed guidance about the ecological assessment substeps, while Parametrix provided most of the substeps and detail in Step 6 on choosing metrics or a crediting scheme. Marie Venner drafted the remaining substep descriptions and guidance. SEPI engineering based the watershed agreement on that for the North Carolina Ecosystem Enhancement Program. Melissa Bauguess of URS provided an invaluable final edit of the guide.

Steve Andrie of the National Academies provided assistance and insight throughout and enabled this research effort, along with SHRP 2 committees and the Expert Task Group. We thank them.

FOREWORD

Stephen J. Andrie

SHRP 2 Deputy Director

The *Practitioner's Guide to the Integrated Ecological Framework* is intended to help transportation and environmental professionals apply ecological principles early in the planning and programming process of highway capacity improvements to inform later environmental reviews and permitting. Ecological principles consider cumulative landscape, water resources, and habitat impacts of planned infrastructure actions, as well as the localized impacts. The guide provides detailed, step-by-step instructions on how to use the Integrated Ecological Framework (IEF), a nine-step process for use in early stages of highway planning, when there are greater opportunities for avoiding or minimizing potential environmental impacts and for planning future mitigation strategies. Success requires some level of agreement among stakeholders about prioritizing resources for preservation or restoration. Such agreements rely on considering long-range environmental planning as a companion to long-range transportation planning so that there is a basis and methodology for prioritization. This guide provides a structured, collaborative way to approach these issues. It does not address environmental mitigation and permitting actions required by current law or regulation.

The research from SHRP 2's Capacity Project C06, Integration of Conservation, Highway Planning, and Environmental Permitting Using an Outcome-Based Ecosystem Approach, produced a two-volume report and this companion guide. Volume 1 of *An Ecological Approach to Integrating Conservation and Highway Planning* describes the role of federal and state agencies and other stakeholders in the early environmental scanning of additions to highway capacity and provides a framework for early involvement in the highway planning process. Early involvement, collaboration, and an ecological approach can lead to better transportation projects and more effective environmental protection. Volume 2 presents the Integrated Ecological Framework, provides technical background on cumulative effects assessment, ecological accounting strategies, ecosystems services, and partnership strategies, along with a summary

of the available ecological tools that are most applicable to this type of work. The Volume 2 appendices document three pilot projects that tested the approach during the research.

The *Practitioner's Guide to the Integrated Ecological Framework* provides step-by-step information to help practitioners use the IEF. A shorter manager's guide to the IEF is also available. The manager's guide presents the basics of the major steps, with some revisions based on four pilot tests of the IEF conducted by SHRP 2. Essential content from the C06 project is available on the Federal Highway Administration's PlanWorks website (Summer 2014). The site can be accessed by its former name, which is Transportation for Communities: Advancing Projects through Partnerships, or TCAPP (www.transportationforcommunities.com).

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INTRODUCTION

Environmental and transportation agencies are changing how they do business. Particularly relevant to the integration of conservation and transportation planning and regulatory permitting and consultation, the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) are transitioning to integration of a watershed approach to permitting under Section 404 of the Clean Water Act (CWA). Also, the U.S. Fish and Wildlife Service (USFWS) is integrating recovery planning in Endangered Species Act (ESA) Section 7 consultations. Transportation agencies at all levels are committed to earlier consultation and planning-level environmental analysis, to better avoid and minimize impacts and to uncover conservation investments that may be needed now, to help recover species and restore watersheds.

For many years, the quality of analysis that could be conducted on the planning level prevented earlier decision making. Environmental needs and priorities were not always included in long-range (20-year) transportation plans (LRTPs) or shorter-range (4- to 6-year) cost-constrained programming and budgeting, often called the transportation improvement plan (TIP) or state transportation improvement program (STIP). Advances in computing capacity, data, and modeling have enabled better, more informed, and scientifically sound environmental planning. Longer-range environmental assessment and planning can now occur, through analyses using geographic information systems (GIS), which can be integrated with transportation planning. Research can take advantage of integrated electronic data collection, management, and GIS analysis methods to integrate transportation planning and conservation planning at multiple scales, to accelerate project delivery and improve environmental outcomes.

Public expectations are changing, too. Environmental stewardship and infrastructure capacity development are no longer viewed as either/or but rather both/and. Much transportation capacity development can be expected to enhance the environment, species viability, and watershed restoration. In 2006, Congress addressed this

expectation in the Transportation Research Board's (TRB's) second Strategic Highway Research Program (SHRP 2) Capacity program and its charge to develop approaches and tools for systematically integrating environmental requirements into the analysis, planning, and design of new highway capacity.

Practitioners sometimes struggle with how to comply with the CWA and ESA and put into practice planning-level environmental decision making and integrated conservation-transportation planning. This guide tries to show a way: the Integrated Ecological Framework (IEF) provides natural resource and transportation practitioners with a step-by-step, peer-reviewed, and science-based process that guides development of conservation and restoration priorities and explains how to integrate those priorities in the transportation decision-making process. This guidance is also provided online as part of the PlanWorks (formerly known as Transportation for Communities—Advancing Projects through Partnerships, or TCAPP) web tool (available here until the PlanWorks website is ready: <http://www.transportationforcommunities.com>) (1). The website includes documentation on commonly used methods, data, and tools and supporting case studies on their successful use in integrated planning. Practitioners are provided with (1) recommendations on the use of data, tools, and methods; (2) a corresponding road map for improving and streamlining decisions by introducing the appropriate environmental information earlier in the decision-making process; and (3) assistance for practitioners who want to adopt decision-making practices that integrate environmental considerations.

The need for an integrated environmental framework that leverages resources across agencies and environmental program areas is clear. The Environmental Law Institute recently estimated that private and public expenditures for compensatory mitigation under Section 404 of the CWA come to about \$2.9 billion annually (2). In addition to serving as the primary source of funds to restore wetlands and watersheds across the nation, these funds represent more than three-quarters of all natural resources mitigation expenditures nationally. (The amount spent under the ESA or by transportation agencies in the Section 7 process is unknown.) The tight budgets faced by government at all levels underline the need to use tools like the IEF to steward both public tax dollars and natural resources.

The IEF started with interviews and surveys of over 150 frontline practitioners at resource and transportation agencies in 2009, as the National Academies' SHRP 2 research project C06 identified three major obstacles to integrated transportation planning. Participants agreed that the top barriers were (1) lack of data, information, and tools; (2) lack of resources, especially time and manpower; and (3) resistance to institutional/process change. Notably, previous research had also pointed to the lack of environmental data as a particular obstacle to achieving better environmental results from transportation decision making in transportation planning and project development (e.g., National Cooperative Highway Research Program (NCHRP) Projects 8-38 and 25-25/32). A complete overview of the barriers, by agency, is available in the SHRP 2 C06 final report, *An Ecological Approach to Integrating Conservation and Highway Planning*, as well as interests, solutions, and incentives.

Some progress has been made in restoring and compensating for the loss of aquatic functions. However, to date, practitioners on all sides have been pressed to achieve performance metrics on timeliness. Objectives that are more difficult to achieve have suffered—for example, identifying the highest conservation and restoration needs in a watershed or ecoregion and integrating that information with transportation planning, to get a head start on CWA Section 404 and ESA Section 7 compliance. Satisfying the operative regulations and internal agency processes is also a dominant goal of frontline staff; however, as Gardner noted in 2009, much of the mitigation has not led to the creation, restoration, or conservation of important wetland habitats (3). The current system works well at avoiding and minimizing losses at the design-level postplanning phase—when engineering and survey data are available. But if agencies bypass analysis and decision making on avoidance and potential conservation investments at the broader-scale planning level, then larger-scale opportunities to avoid and minimize impacts or to preserve important areas are lost. Historically, these inefficiencies have stemmed from a lack of easily accessible data that regulators would consider sufficient for proactive analysis and early commitments. Both are needed to maximize department of transportation (DOT) investments in conservation or restoration of significant areas, to help achieve watershed goals. Decision making in project development and permitting (during or after preliminary engineering design) and suboptimal mitigation outcomes result because resource agencies often feel they cannot effectively consult earlier, without knowing more about the resources in question. However, as with all issues related to planning and information, the lack of perfect data should not interfere with environmental consultation and decision making, especially while other decision making proceeds. A clear obstacle to better transportation and conservation outcomes is the lack of a reasonable and comprehensive set of conservation and restoration priority areas that make up a preapproved set of mitigation sites.

Two requirements are critical for improved outcomes. The first is to provide the tools planners can use to identify potential impacts to regulated resources early in the planning process, allowing them to avoid or minimize the impacts as much as possible. The second is to ensure that any mitigation which must occur (because of unavoidable impacts) will provide effective, measurable, and high-quality environmental outcomes for the affected resources. Problems under Section 7 of the ESA result from both the lack of certainty about the probability and degree that a project may affect a listed species and the lack of certainty about how to design meaningful mitigation measures. However, the development of digital maps showing the probable distribution of all listed species (and other species of concern) is economically feasible and can significantly improve conservation and project planning for regulators and transportation agencies. (For example, see box on page 4.)

Inductive Species Distribution Models

Most information on listed species locations currently exists in the form of observations, instead of habitat and predicted distributions. The occurrence of species is highly sensitive and, as a result, is not readily shared with transportation agencies or the public. However, these highly sensitive maps showing precise known locations of federally listed species can be transformed into public domain maps showing where these species are most likely to occur or where their habitat needs to be protected, through inductive modeling methods that learn rules about where species are likely to occur.

To date, the Endangered Species Act (ESA) Section 7 consultation process has mostly relied on maps, such as the one on the left, in the early stages of planning and project development. Agencies typically held off on decision making until surveys could occur, later in design and closer to construction. The map on the left shows possible species locations in the form of observation points, broadened out to counties or ecological subsections (rather than the habitat type and predicted distributions on the right, which are based on highly sophisticated inductive models). Making it even more difficult for state and local agencies to plan development, the red dot species occurrence information on the left was frequently not released for viewing by transportation agencies, local governments, or the public. Agencies were left with green areas covering large portions of the state, without knowing where conservation of habitat or investment in particular structures or management practices was most important to avoid impacts.

A handful of states have now developed inductive models to more scientifically project species distributions and create high-resolution maps. For example, using data from the Natural Heritage Network's Biotics species observations database and powerful new software for modeling species predictive distributions (e.g., DOMAIN, Random Forest, Maximum Entropy), predictive distribution maps of listed threatened and endangered species were developed which better represent where species might be. They also produced lists of the top factors associated with the location of species, which are useful in understanding and projecting the impact of climate change on species. Finally, these models can significantly reduce the size of areas requiring inventory for endangered species. The models can be used to define not only potentially occupied habitat but, most significantly, through probability analyses, areas which are not potential habitat for any listed species.

Figure 1.1 shows a detail of the bog turtle map, illustrating how the probability of presence can be identified and used to create maps for both Section 7 review and recovery planning. New York has completed such models for 250 species.

(continued)

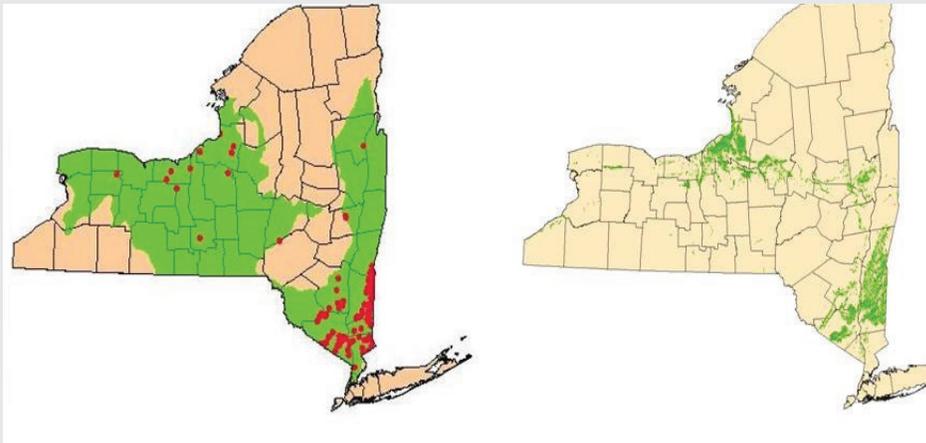


Figure 1.1. *Traditional (left) and new (right) maps showing distribution of the bog turtle in New York State. Red dots indicate occurrences, and the green on the left map indicates the ecological subsections in which the turtles occur. (Source: New York Natural Heritage Program.)*

The U.S. Fish and Wildlife Service (USFWS) has been using similar but simpler models to derive critical habitat for use in listing species under the ESA and developing recovery plans. As a result, regulators are familiar with the models and understand their potential utility. In addition, the USFWS is developing a Section 7 decision support tool that focuses on analyzing impacts by spatially mapping threats identified in listing and recovery documents and integrating the actions. The current tool used by the USFWS requires distribution information and would be significantly improved using inductive models. In proactive parts of the transportation planning framework, planners could use inductive models to locate and avoid probable distributions of endangered species. Areas where occupation was less likely could be preferred for transportation infrastructure development; important habitat areas could be avoided, from the earliest points, when planning is not far along and local governments are not yet counting on improvements in a location chosen without this sort of analysis.

Only the USFWS can decide the likelihood of occurrence thresholds to be used for each species (e.g., 50% likelihood for investment in avoidance and minimization measures, or perhaps 85%+ likelihood for investment for enhancing or extending effective conservation/protection of the best areas for species viability). But other agencies can participate in other steps in the integrated planning process, such as integrating available maps and including critical habitat and recovery goals digitally in planning criteria for regional ecological frameworks.

2

INTRODUCTION TO THE
INTEGRATED ECOLOGICAL
FRAMEWORK

Information on conservation and restoration priorities is a desirable input to the transportation planning process; metropolitan planning organizations (MPOs), state DOTs, and local governments are likely to use it if they have it. If information on conservation and restoration priorities is lacking, the required transportation planning process proceeds anyway, without the consideration of environmental factors and opportunities such information would enable. DOTs and MPOs must develop and approve 20-year plans and shorter-term budgets, the latter including transportation projects chosen through established selection processes. The Integrated Ecological Framework (IEF) aims to get the conservation and restoration planning done and accepted by regulatory agencies for use in decision making for CWA permitting and ESA interagency consultation. Thus, avoidance and investment/mitigation decisions can be identified early, and agency resources can be employed to achieve the greatest environmental benefit possible.

The IEF process addresses several long-recognized needs: (1) the need to proactively consider ecological values early in infrastructure and land use planning processes and preferably at a regional scale; (2) the need for spatially explicit and sufficiently precise cumulative effects assessment throughout a region to provide useful information to guide alternatives development and mitigation planning; (3) the need for a collaborative structure for technical information development and maintenance to serve multiple planning purposes dynamically over time; and (4) the desire to obtain better ecological outcomes from mitigation investments while meeting planning objectives.

Specifically, the IEF process guides an ecological assessment that (1) evaluates direct and cumulative effects on resources from any potential planning alternative or project, (2) assists in the identification or creation of alternatives, and (3) identifies the best mitigation and enhancement opportunities. The IEF supports a collaborative and scientifically rigorous process for avoiding and minimizing conflict and also identifies

mitigation and enhancement opportunities. In the process, it addresses several key questions in the transportation and conservation planning and project development process:

- What areas and resources will be directly affected by transportation development?
- How will those resources be affected cumulatively throughout the affected region?
- What areas can be used for mitigation? Which areas would maximize benefits for multiple resources? How would conservation or mitigation sites collectively work to achieve resource goals (species and/or ecosystem retention goals, watershed recovery)?
- How can anticipated, long-range, regional mitigation needs be aggregated for maximum ecological benefit?

BENEFITS OF THE FRAMEWORK

The nine-step IEF process is designed to bring about efficient, integrated consultation on natural resource issues and provides the nexus for most DOT investment in the natural environment. The IEF brings together a variety of well-tested methods, data, and tools in a cohesive ecological assessment framework for use in planning. The intent is to achieve better environmental outcomes for agencies' time and on-the-ground stewardship, enhancement, conservation, and mitigation investments. Many benefits are attainable through early coordination, environmental analysis, and associated decision making by resource agencies, in the planning stages. These benefits include the following:

- Development of a single statewide and/or regional plan to protect water quality, quantity, biodiversity, and the like with mapped priority locations. Such a plan and map outline goals shared by multiple agencies and provide incentives for state DOTs to avoid and minimize impacts and to invest in conservation. Local governments have additional knowledge and incentive to develop programs and funding to conserve and restore these priority areas.
- Much better avoidance and minimization of impacts on the state, regional, and local levels.
- Coordination among agencies working to achieve environmental goals, while creating a more efficient and predictable consultation and development process through early identification of needs and solutions.
- Integration of CWA authorities under Sections 401, 402, and 404 and marshaling of resources to address water quality concerns (e.g., addressing issues highlighted in Section 305(b) reports and ultimately helping restore Section 303(d)-listed streams in the course of Section 404 permitting).
- Better consideration of landscape-level insights, watershed goals and potential for restoration, and recovery needs and priorities results, when the possibility for effective action and new development patterns is greatest.

- More timely conservation investments that can make a difference for species, ecosystems, and watershed restoration.
- Identification of potential CWA Section 404 compensatory mitigation sites on a watershed basis and according to watershed goals/needs and other ecological considerations, in compliance with the 2008 compensatory mitigation rule (see box on page 70). The rule provides for preservation, restoration, enhancement, and creation of aquatic resources based on Section 404 mitigation requirements while enhancing environmental outcomes.
- Increased regulatory process and permitting efficiencies as well as the opportunity for reinforced and improved environmental outcomes, with investments that address multiple resource needs at once.
- Better site identification for mitigation banks and in-lieu fee projects to restore, create, enhance, and/or preserve aquatic resources in rapidly developing watersheds. Mitigation sites can be identified that are consistent with the site needs identified in state wildlife action plans, greenway and green infrastructure plans, species recovery plans, ecoregional conservation strategies, and city or regional open space plans.
- Timely planning and set-asides of funding for environmental solutions, integrating with and/or leveraging the investment of other programs.
- Improved likelihood of permit streamlining, insurance, and other incentives for developers to purchase credits from the best places for ecologically viable, multi-credit conservation banks—once those areas are identified.
- Creation of a crediting mechanism and simple, consistent, transparent approach to quantifying ecosystem services—separately and together—allowing voluntary or regulated buyers to invest in ecosystem services associated with specific goals and resources.
- Restructuring of existing government conservation incentive programs, making them more strategic and better able to deliver measurable ecological outcomes and address and prioritize unregulated resources.

For the public, for transportation and regulatory agencies, and for the resources of concern, this framework can create a path to compliance with environmental regulations that is more ecologically productive, easier, and more efficient than traditional approaches. This approach also benefits from being science-based and using state-of-the-art data, systems, and tools. It seeks to ensure that all important conservation and restoration planning information and data are considered in the process of deciding what actions, areas, and projects should be priorities for ecological investment, whether in the course of state DOT mitigation, investments by other agencies and levels of governments, or even the private sector. This process also facilitates broad-scale monitoring frameworks to track overall impacts and improvements in ecosystem services, management and synthesis of data, and reporting of results.

FINDINGS FROM PILOT TESTING THE FRAMEWORK

The IEF process was pilot tested in three states: Colorado, Michigan, and Oregon. This testing, reported in the SHRP 2 C06 Report Volume 2, uncovered the following benefits:

- *Better outcomes—lower impacts and mitigation sites with more ecological benefits.* Use of the framework process, including the recommended cumulative effects alternative assessment, leads to the selection of mitigation sites with more ecological benefits. Furthermore, the framework assessment process produces more accurate and comprehensive assessments of the impacts of transportation scenarios and can identify corridors with fewer direct and cumulative impacts.
- *Modest data investments, leading to vastly improved planning, evaluation, and opportunities.* The pilot projects found that a relatively modest investment in process changes and data development up front creates more accurate indications of potential impacts and mitigation opportunities early in the decision-making processes, vastly improving planning, corridor evaluation, and consideration of mitigation opportunities.
- *Enhanced scientific credibility.* Decisions have more credibility because the framework steps ensure the use of a more standardized, scientifically based, peer-reviewed process that uses the best available suite of methods, data, and tools.
- *Savings of time and resources.* Testing indicated that the framework approach saves time and resources by reducing impacts and, therefore, mitigation requirements. Species distribution models enable better targeting of needed field studies.
- *More targeted and productive conservation, enhancement, and mitigation investments.* The framework also supports more refined targeting of environmental conservation and mitigation investments, resulting in better environmental outcomes.
- *Standard data management practices.* DOTs are beginning to require consultants to submit data in standard ways for reuse by the agency as part of larger GIS systems. These additional data layers, which often include field surveys, can be used to generate better impact assessments and alternative analyses when available and thus increase agencies' ability to make decisions based on existing GIS data and previously conducted surveys.

COMPATIBILITY WITH *ECO-LOGICAL*, WATERSHED AND LANDSCAPE APPROACHES, AND STRATEGIC HABITAT CONSERVATION

The IEF is designed to be compatible with *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects (Eco-Logical)*, signed by eight federal agencies in 2006 (4). That concept and its “permission document” encouraged federal, state, tribal, and local partners involved in infrastructure planning, design, review, and construction to use the flexibility in their regulatory processes to achieve greater environmental benefits. Specifically, *Eco-Logical* lays the conceptual groundwork for

integrating plans across agency boundaries and endorses ecosystem-based mitigation. This broader ecosystem approach addresses highest-priority needs for watershed restoration, species viability and recovery, and sustainability of ecological communities—considering multiple resources in each mitigation investment decision. The EPA and Army Corps of Engineers watershed approach and the USFWS and U.S. Geological Survey (USGS) Strategic Habitat Conservation approach and Landscape Conservation Cooperatives are complementary.

The Integrated Ecological Framework presented in this guide provides more detail and how-to information than some of these other complementary frameworks. In some cases, the IEF involves further scientific analysis. Most important, the IEF provides frontline practitioners with easily applicable and adaptable steps on how to conduct integrated conservation planning and enable earlier environmental decisions in planning—both of which matter in CWA Section 404 permitting and when ESA Section 7 biological assessments (BAs) and biological opinions (BOs) are finalized. The IEF helps practitioners bring the right expertise, data, methods, and tools to the right stage of the transportation planning and project delivery decision-making process. The result is better environmental outcomes, achieved through reduced impacts, identification of high-quality mitigation and enhancement opportunities, and accelerated permitting. All this is achieved by proactively including resource considerations, watershed restoration, and species recovery needs and priority actions/opportunities early in the process.

USING THE FRAMEWORK

The steps presented in this guide provide a multiagency coordination and communication framework for implementing an ecosystem approach that addresses the impacts of development and initiates environmental decision making in long-range transportation planning. It provides more detail on how *Eco-Logical*, watershed, and Strategic Habitat Conservation approaches can be implemented. Using the latest geospatially explicit conservation planning methods, transportation agencies and resource agencies can develop a shared conservation and restoration vision for areas likely to be affected by new transportation projects. Their subsequent analysis is expressed in the Regional Ecosystem Framework (REF).

The essential components and steps of the REF are straightforward and can be summarized as follows:

1. Gather and integrate data on the areas and resources of conservation interest to represent a REF.
2. Gather information to represent current and future development scenarios for infrastructure, land use, and other disturbances.
3. Intersect the REF with the scenarios to quantify impacts in terms of what areas or resources would be affected, how much, where the impacts would occur, and what would cause the impacts. The REF can then be used to assess and guide transportation decision making at all stages of transportation planning and development

and allow impacts to be assessed and quantified early in the transportation planning and project delivery process.

4. Use this information to create better transportation alternatives, noting where impacts may be unavoidable or where impacts need to be avoided at all costs. Also use the information to create land use and transportation plans that avoid impacts and/or target mitigation to address ecological priorities and achieve better ecosystem outcomes.

Using the steps in the IEF, state DOTs, MPOs, and resource agencies work together during long-range planning to identify transportation program needs, potential environmental conflicts, and strategic conservation and restoration priorities in the state, ecoregion, or watershed. Suitability analyses identify optimal locations for the protection and restoration of natural resources, both aquatic and terrestrial. On the basis of identified priorities, interagency agreement, and exploration of what the partners can accomplish toward those ends, programmatic approaches can be developed that increase regulatory predictability during project development and help achieve regional conservation, restoration, and recovery goals. The framework is highly scalable to the time, resources, data, and expertise available and can be used at the regional, corridor, or project level. The approach provides for quantification of impacts to facilitate early conservation and restoration investments through the use of advance mitigation.

IEF analyses draw on data layers, which all states have, addressing Section 303(d)-listed streams; wetlands and/or soils; and endangered, threatened, and rare species. The IEF particularly seeks to use and meld the data set regulators use in making decisions in consultations and on permits. Bringing them together in one place fosters greater transparency, new efficiencies, and opportunities for collaboration, as well as improved resource planning and effectiveness in achieving desired environmental outcomes. Major outputs include the following:

- Unified map of transportation, land use, conservation, and restoration priorities;
- Maps of each potential transportation scenario (set of alternatives) that show an assessment of direct and cumulative effects at a landscape level with supporting data;
- Identification of affected resources and the quantification of the cumulative effects for each transportation scenario being considered; and
- Identification and evaluation of potential mitigation and enhancement areas within a region, providing and maintaining dynamic reporting of resource goal achievement or gaps.

Within the overall IEF and cumulative effects assessment process, two strategies are critical. First, transportation planners and project managers address regulatory requirements, ideally as early in the transportation planning and development process as possible. Second, environmental accounting strategies can be used to reach agreement with regulatory agencies on project impacts and mitigation requirements. The nine steps of the Integrated Ecological Framework and the purpose of each are summarized in Table 2.1.

TABLE 2.1. STEPS OF THE INTEGRATED ECOLOGICAL FRAMEWORK

Step	Purpose
Step 1: Build and strengthen collaborative partnerships, vision	Build support among a group of stakeholders to achieve a statewide or regional planning process that integrates conservation and transportation planning.
Step 2: Characterize resource status; integrate conservation, natural resource, watershed, and species recovery and state wildlife action plans	Develop an overall conservation strategy that integrates conservation priorities, data, and plans—with input from and adoption by all conservation and natural resource stakeholders identified in Step 1—that addresses all species, all habitats, and all relevant environmental issues.
Step 3: Create regional ecosystem framework (conservation strategy + transportation plan)	Integrate the conservation and restoration strategy (data and plans) prepared in Step 2 with transportation and land use data and plans (long-range transportation plans [LRTPs], state transportation improvement program [STIP], and transportation improvement plan [TIP]) to create a regional ecosystem framework (REF).
Step 4: Assess land use and transportation effects on resource conservation objectives identified in the REF	Identify preferred alternatives that meet both transportation and conservation goals by analyzing transportation and/or other land use scenarios in relation to resource conservation objectives and priorities using the REF and models of priority resources.
Step 5: Establish and prioritize ecological actions	Establish mitigation and conservation priorities and rank action opportunities using assessment results from Steps 3 and 4.
Step 6: Develop crediting strategy	Develop a consistent strategy and metrics to measure ecological impacts, restoration benefits, and long-term performance, with the goal of having the analyses be in the same language throughout the life of the project.
Step 7: Develop programmatic consultation, biological opinion, or permit	Develop memoranda of understanding (MOUs), agreements, programmatic Clean Water Act (CWA) Section 404 permits, or Endangered Species Act (ESA) Section 7 consultations for transportation projects in a way that documents the goals and priorities identified in Steps 5 and 6 and the parameters for achieving these goals.
Step 8: Implement agreements and adaptive management; deliver conservation and transportation projects	Design transportation projects in accordance with ecological objectives and goals identified in previous steps (i.e., keeping planning decisions linked to project decisions), incorporating as appropriate programmatic agreements, performance measures, and ecological metric tools to improve the project.
Step 9: Update regional ecosystem framework	Update the effects assessment to determine if resource goal achievement is still on track. If goal achievement gaps are found, reassess priorities for mitigation, conservation, and restoration in light of new disturbances that may affect the practicality and utility of proceeding with previous priorities. Identify new priorities if warranted.

Forty-two tools useful for transportation planning, information about them, and their linkages to the IEF are at the website for TCAPP (www.transportationforcommunities.com), soon to be known as PlanWorks.

3

STEPS IN THE INTEGRATED ECOLOGICAL FRAMEWORK

STEP 1: BUILD AND STRENGTHEN COLLABORATIVE PARTNERSHIPS AND VISION

Purpose and Anticipated Outcomes

The purpose of Step 1 is to build a team and vision for conservation planning in the state or region and set up the team to integrate that vision with transportation planning. This step can be initiated by the conservation community and professionals or by resource, planning, or transportation agency staff. The team and individual members will

- Build an understanding of what each agency can do to create incentives for more and better conservation. Initiators should start within their own agencies, building an understanding of the benefits of an ecosystem approach and gauging what their own agency (and other organizations) might be willing and able to do (or offer) to help achieve conservation and sustainability objectives. The degree of flexibility and creativity each party can offer will be proportionate to the benefits that can be achieved, for the environment and the community.
- Develop a mutual understanding of the key interests of each party that must be met to make the effort worthwhile. In general, the effort will need to deliver something more than the regular process. Thus the benefits and some of the trade-offs that are likely to occur should be clear from the outset. Each agency will need to have internal conversations on what it wants and how it can offer more, or more flexibility, than it typically does.
- Identify opportunities and criteria for transportation and regulatory agencies to use programmatic, landscape-level consultation and watershed-scale permitting approaches to better address transportation and conservation planning needs.

Thus, agencies will be able to implement the 2008 USACE-EPA mitigation rule (see box on page 70) and, in implementing a watershed approach, achieve the following advantages identified by USACE districts and EPA regions:

- Address complex environmental relationships holistically.
- Use ecologically based and naturally defined areas.
- Promote stakeholder involvement in an interdisciplinary approach that integrates solutions.
- Increase regulatory and nonregulatory integration and compatibility across programs, and integrate watershed data from multiple agencies and programs.
- Produce better, less-contentious permit applications since applicants know what is needed, where.
- Build on conservation planning work already done as part of the state wildlife action plan (SWAP), conservation priorities already identified in USFWS species recovery plans or larger landscape conservation approaches, and state and EPA priority areas for watershed restoration or protection.
- Develop a shared vision of what may be accomplished through joint action.

Anticipated outcomes include the following:

- A shared vision of what agencies can accomplish together. Team members will develop an appreciation and understanding of each other's goals and interests and the ways in which collaborative action may occur on conservation priorities/areas of conservation concern in a specified planning region (i.e., state, watershed, or other ecologically based region).
- Partnerships with initial understandings regarding roles, responsibilities, processes, and timelines, formalized in a memorandum of understanding.
- Identification of opportunities and criteria for using programmatic (multiproject, broad-scope) consultation approaches to better address transportation and conservation planning needs.

The process can begin in different places and at different points. And the steps may be taken in a different order than presented here, as appropriate to local contexts or situations.

Implementation Substeps and Technical Considerations

An overview of Step 1 substeps and technical considerations follows.

Step 1: Build and strengthen collaborative partnerships and vision

Implementation Substeps

- 1a. Identify preliminary planning region (e.g., watersheds, ecoregions, and/or political boundaries). Drivers may be environmental factors such as water quality needs or Section 303(d) listings, species' needs, watershed restoration needs, or rare wetlands.
- 1b. Identify counterparts and build relationships among agencies, including local government and conservation nongovernmental organizations (stakeholders).
- 1c. Convene a team of stakeholders, and share aspirations. Define and develop commonalities and a shared vision. Build an understanding of the benefits of a watershed/ecosystem recovery planning approach and develop a shared vision of regional goals for transportation, restoration, recovery, and conservation.
- 1d. Record ideas and vision. Develop memoranda of understanding (MOUs) on potential new processes for increasing conservation, efficiency, and predictability.
- 1e. Explore funding and long-term management options to support conservation and restoration actions.

Technical Considerations

- Integrated approach: Decide on a high-level approach to implement an integrated planning process that most effectively captures transportation effects on species and ecological functions at the landscape scale.
- Types of resources: Identify what types of resources to include. Consider federal, state, local regulated and nonregulated resources (connectivity needs, migratory and declining species).
- Boundaries: Considering ecological as well as political boundaries, select the area for evaluation of direct and cumulative impacts, restoration opportunities, and selection of mitigation sites (i.e., area evaluated for mitigation may be larger than area evaluated for direct impacts).
- Streamlining: Identify the repetitive and relatively standardized project activities conducted by the DOT that could be addressed through programmatic approaches.

Step 1a

Identify preliminary planning region. In Step 1a, the originating team develops preliminary ideas with regard to the assessment and planning regions; that is, the team identifies the focus area or general planning region within which to work. It may cover a whole state or large portion of it (e.g., an ecoregion, large watershed, or series of watersheds). Analysis from larger areas or ranges may ultimately affect the goals set

for various resources, but the planning region provides bounds on where resource and development considerations will be analyzed.

The planning region is often identified on the basis of driving factors, such as a region of jurisdiction, an ecoregion, a watershed, or the region of cumulative effects to the largest resource of concern or the relevant ecosystem. The region may be inspired by a particular resource asset or ecological need as well as common goals or interests. For example, the Chesapeake Bay has driven a number of regional conservation and restoration strategies. In the central United States, the decline of the shortgrass prairie and associated bird and keystone species prompted a multiagency partnership led by the transportation agency in Colorado. Potential, existing, or impending species listings in a region might drive attention for an integrated, programmatic approach. Likewise, a Section 303(d) listing of impaired waters and identification of causes of impairment and total maximum daily loads (TMDLs) for the constituents of concern could drive interagency attention to remediation needs and opportunities.

For ecosystem assessment, considerations in setting planning regions often include the following:

- The ability to recognize patterns for ecosystems and biodiversity related to their distribution, regional connectivity, and natural disturbance;
- Opportunities for off-site mitigation; and
- Technical limitations in terms of data precision and choice of tools.

The transportation agency may have initial suggestions on the planning region and then rely on input from resource agencies and organizations. Political boundaries are relevant, as they affect where certain stakeholders can contribute or where a champion can convene the larger group. Partnerships or conservation/restoration funding already in place are assets to work with in leveraging the investment, expanding the effectiveness of restored ecosystems, and improving the efficiency of long-term management. Such communities and watersheds are better positioned for joint action on restoration objectives.

In this step or in Step 1c, initial high-level resources of concern, known long-term trends, and overall priorities and concerns regarding resources in the planning region can be identified, based on the experience of the forming team. SWAPs and existing conservation/restoration plans on a landscape, ecoregion, or watershed basis can also serve as a launching point and suggest natural boundaries for multiagency efforts. For example, The Nature Conservancy has completed strategic conservation plans for community and species biodiversity in all ecoregions, completely covering the lower 48 states. Also, the Conservation Fund has completed some plans on a regional basis.

The following tips are useful in identifying the preliminary planning region:

- Select a planning region boundary and share it with partners to assist in identifying appropriate data and expertise.
- After a general planning region is selected, use a precise boundary to reduce inaccuracies and confusion when intersecting it with fine-scale data.

- Refer to existing data sets for evaluation of wetlands. Helpful data sets include National Wetlands Inventory (NWI), National Hydrography Dataset (NHD), National Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO), local data sets, historical data sets for the mid-1970s, historical aerials and maps, reports on losses such as Dahl's *Status and Trends Report*, and other local reports.

Step 1b

Identify counterparts and build relationships among agencies, including local government and conservation nongovernmental organizations (stakeholders). Most states have multiple agencies and nongovernmental organizations (NGOs) working to advance and protect their natural resources. Those stakeholders can provide plans and information to help identify conservation and restoration priorities.

Regulatory agencies oversee regulated resources that may be affected by transportation projects and other development. Impacts to these natural resources need to be minimized to the greatest extent practicable. At the same time, compensatory mitigation for impacts can generate investment in areas where resource agencies and advocates want to see conservation and restoration priorities addressed.

The basic partners in every case are the resource and regulatory agencies in the area and the transportation agencies (state DOTs, Federal Highway Administration, MPOs). However, all agencies with an interest, from the local to the federal level, can add value to the partnership. Including the public and other stakeholders (or planning how to include them later on) will be beneficial. Others in the region who have significant projects requiring mitigation may be potential partners as well. Forming committees can be helpful in this process. For example,

- *Technical advisory committee* may include experts from various programs identified. This committee could help develop the watershed approach or IEF and encourage buy-in early in the process.
- *Management committee* may include managers from the stakeholder organizations and participating partners. This committee could oversee the technical advisory committee and the vision of the larger watershed or IEF.
- *Outreach and training committee* may coordinate informational meetings and training sessions with interested organizations and local governments.

A central coordinator is critical to creating and maintaining a regional ecosystem framework. Because a REF by definition is a synthesis of the work of many contributors, many organizations should be involved in deciding how to create it. Nevertheless, strong central coordination is needed. The role of the coordinator is to identify the key sources of information and science needed to build and maintain the REF and

Partnerships focused on the greatest environmental needs of a species, watershed, or ecoregion can provide a high level of public benefit and help provide the justification for spending transportation funds. This only works when such investments can be linked with mitigation credit and substantial predictability for transportation projects.

to engage the responsible organizations in the REF partnership. MPOs or the state DOT may be willing to lead since the REF can be used in the transportation planning process. In other cases, an individual at a resource agency, such as the SWAP coordinator, may more appropriately assume the lead role given previous work and focus on resources within the regional area of concern.

The following tips are useful in identifying counterparts and building relationships among agencies:

- Use this outreach to initiate or expand relationships and lay the groundwork for cooperation.
- Build an understanding of state or regional conservation and sustainability objectives.
- In the private and NGO sectors, focus on organizations that conduct scientifically robust and systematic planning and prioritization of natural resources and conservation values, acceptable to regulators.
- Be clear about the potential benefits of coordination that partnerships with federal and state transportation agencies offer resource agencies and other conservation partners.

Step 1c

Convene a team of stakeholders and share aspirations. Define and develop commonalities and a shared vision. The team's shared vision speaks to the particular conservation action or good that the team aims to accomplish together, as well as the ways that future interagency processes (e.g., consultation, planning, permitting) might function to address larger ecosystems and better accomplish multiresource objectives.

In this step, the team discusses known long-term trends and overall priorities or concerns regarding aquatic or terrestrial resources in the planning region, based on the team members' experience. On the basis of those discussions, the team identifies the most critical natural resource needs in the planning region to focus on during environmental analysis for transportation planning and conservation and mitigation investments. Team members will likely be familiar with and may want to consult existing conservation and restoration plans as well as other current and historical data sets that reference the shared vision.

This step also involves building an understanding of the benefits of broader-scale approaches, often based on watershed, ecosystem, or recovery planning. As the initial *Eco-Logical* document noted (4), saving time and having efficient processes is a common need:

A shared advantage of integrated planning is the significant time savings made possible by establishing and prioritizing opportunities. If agencies know beforehand where the most ecologically important areas and resources are, they can work to see that projects avoid these areas as much as possible—saving time during planning, scoping, and environmental review. By understanding early on where the mitigation areas most beneficial for wildlife are located, required

mitigation can be more quickly implemented and permits and approvals may be streamlined. Finally, opportunities for ecosystem-level conservation and/or mitigation that are available now may no longer be available when a project is implemented. Increasing land costs or additional development may prohibit capitalizing on these opportunities at a later date. Act now to benefit from these opportunities.

The following tips are useful in convening a team of stakeholders and defining and developing a shared vision:

- Concentrate on commonalities, that is, some big ideas about how transportation mitigation investments can be focused to make a tangible contribution to the restoration, recovery, or conservation of resources of concern to multiple agencies and stakeholders. This vision and the associated benefits can drive participation and the motivation to try new approaches.
- Expand the vision and priority resources in Step 2b and in later decisions on priorities as data are collected and compiled.
- Develop the necessary resource/regulatory agency participation, leadership, and buy-in. This will require internal capacity building and training in methods and tools. Keys to success include the following:
 - Use the best data available early in the planning process.
 - Involve science-based NGOs to supplement/support resource agency capacity.
 - Stay in touch with regulators; contact them early and often, throughout planning and analysis and as decisions approach.
 - Take advantage of existing conservation planning work completed by federal agencies, state agencies, universities, and conservation organizations.
 - Link conservation planning with regulatory protection work, but understand that regulators must focus on their specific resource of interest.

Lower-capacity agencies may benefit from some additional suggestions. Ideally, transportation planning processes will build the partnerships and funding needed to conduct the IEF process, ongoing updates, and adaptive management. If the transportation agency and partners developing the REF lack the capacity to implement the process, a significantly scaled-back approach can be used; that approach relies on the involvement of subject matter experts (SMEs), or it can be automated through the statewide systems that are already developed or being developed in a growing number of states. Ultimately, though, such processes may require more staff time and produce less reliable or defensible results. SME approaches and one-time statewide scans also miss the opportunity to gather expert knowledge in a reusable database to apply to other plans and projects in the region.

In its most minimal form, the IEF process entails overlaying (graphically with hard copies or through a GIS) proposed LRTP alternatives with the SWAP and/or other spatial restoration and conservation-priority maps for the resources of interest. In that way, areas of potential conflict can be graphically pinpointed. SMEs can identify resources

that might be affected and make a judgment about the significance of the impact and options for mitigation. This approach is common in project assessments, and such functionality is supported through tools, such as Florida's online system for environmental evaluation in planning (Efficient Transportation Decision Making system, or ETDM). Local governments and lower-capacity transportation organizations would benefit from state or national systems providing all of the necessary resource layers and the capability to overlay maps. Then the only technical requirement for the transportation agency or local government would be to provide its LRTP for assessment. This alternative approach would accomplish the rudimentary need for comparing transportation and development plans with important resource locations; however, it falls short of the recommended process in its ability to quantify cumulative effects and support a full cycle of LRTP option development, assessment, selection, mitigation, and implementation.

Step 1d

Record ideas and vision. Develop memoranda of understanding (MOUs) on potential new processes for increasing conservation, efficiency, and predictability. Agreements on general approaches often are formalized in an MOU or memorandum of agreement (MOA). Examples of such agreements include the following:

- Interagency MOU among resource and transportation agencies in Colorado, regarding conservation needs and objectives and anticipated consultation approach for projects in the eastern third of the state and analysis of the 20-year plan. Colorado Shortgrass Prairie Initiative MOA—Colorado DOT; Colorado Department of Natural Resources, Division of Wildlife; The Nature Conservancy; Federal Highway Administration (FHWA); and USFWS (www.environment.fhwa.dot.gov/strmlng/comoa.asp) (5).
- TransNet Environmental Management Program MOA—San Diego Association of Governments, California Department of Fish and Game, California Department of Transportation (Caltrans), and USFWS (www.sandag.org/uploads/committeeid/committeeid_78_9098.pdf) (6). The charter of the Environmental Management Program working group is available at www.sandag.org/uploads/committeeid/committeeid_78_4687.pdf. Similarly, The Process and Criteria for Mitigation Acquisitions is available at http://www.sandag.org/uploads/committeeid/committeeid_78_8864.pdf.
- Federal interagency MOU to Foster the Ecosystem Approach, among 14 agencies, included as Appendix A in *Eco-Logical* and available at www.environment.fhwa.gov/ecological/eco_app_a.asp.

Interagency understandings require time to develop and record, to achieve their full benefit and to ensure that the understandings are not lost over time, especially as staff turnover occurs. Groups can lose years or their process altogether when understandings are not formalized.

Step 1e

Explore funding and long-term management options to support conservation and restoration actions. Federal laws and requirements provide the most common impetus for conservation and restoration investments by state DOTs. The Clean Water Act and Endangered Species Act have been particular drivers in off-site investments in conservation and restoration priorities; Appendix D of *Eco-Logical* contains a longer list of federal laws and requirements and can be viewed at www.environment.fhwa.dot.gov/ecological/eco_app_d.asp.

Traditionally, federal funding has financed a portion of project costs, with the rest covered by state and local governments. When a construction project occurs, environmental mitigation is included as part of the project and its financing. Environmental matters are not funded out of a separate funding category related to either mitigation or planning. State and local agencies find it difficult to address conservation needs or implement restoration investments earlier in the process.

Finding the necessary funds can give an integrated planning effort considerable momentum. Colorado and Washington State developed revolving funds to invest at the planning level and then be repaid by the projects after completion; however, a difficulty arises when an expensive and particularly long-range project depletes the fund by tying up its resources for many years, especially if the funding pool is not large. Better approaches have larger funding pools. San Diego passed a bond measure for transportation infrastructure and associated conservation and mitigation investments in the region. This supplemental funding helped the MPO and the California DOT (Caltrans) improve interagency understandings to advance the spending on priority conservation acquisitions identified by the team and local plans.

Partners and various funding sources can support integrated planning and development of a REF, as well as implementation of identified priority conservation and restoration actions. FHWA and traditional transportation funding support integrated planning and *Eco-Logical* approaches. (See the FHWA Funding for Mitigation box, page 22.) EPA, in addition to its wetland program development and water quality improvement projects, provides planning grants for green highways, streets, and sustainable low-impact development. USFWS has made funds available for multistate priority conservation/mitigation site identification through ESA Section 6.

The ways in which federal funds can be spent has evolved. *Eco-Logical* noted that certain provisions allow DOTs, if they so choose, to use current federal transportation dollars to retrofit or improve environmental aspects of earlier projects (4). But transportation needs are such that DOTs rarely opt to do so; and state law and funds do not always offer the same flexibility as federal funds do.

According to *Eco-Logical*, “Often, Federal funding programs require a non-Federal matching share. A variety of mechanisms exist for fulfilling non-Federal cost-share responsibilities based on program requirements.” In-kind contributions generally count toward the nonfederal share, which must be quantified, tracked, and reported. *Eco-Logical* continues, “Matches and cost-sharing [may] include contributions toward preparation of plans, conducting studies, developing designs, planting material, construction, and operation and maintenance activities. For example, within

some programs, if a nonprofit, private, or local organization is willing to provide cash, materials, or land to a project, that contribution could serve as part of the required non-Federal match” (4). Conservation partnerships often leverage work that has already been initiated or completed by one of the partners.

FHWA Funding for Mitigation

FHWA's authority to fund mitigation for project impacts is outlined in FHWA's environmental regulations at 23 CFR Part 771.105(d). As summarized in *Eco-Logical* (4),

The provision reflects FHWA commitment to incorporate appropriate mitigation into transportation projects and provide funding to mitigate the impacts caused by FHWA-funded projects, provided it is a reasonable public expenditure. Reasonableness standards [are] addressed in 777.7(a), including: (1) the importance of the impacted natural habitats, (2) the extent of highway impacts as determined through an appropriate, interdisciplinary impact assessment, (3) actions necessary to comply with the CWA, ESA, and other relevant Federal statutes, and (4) input from the appropriate resource management agencies through interagency cooperation. Per enactment of 23 CFR Part 710.513, mitigation commitments in environmental documents become an integral and essential part of a transportation project decision and FHWA is responsible for ensuring their implementation.

Both the National Highway System and Surface Transportation Programs in [the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users] SAFETEA-LU allow states to fund mitigation of wetland and habitat impacts due to Federal-aid highway projects. These provisions allow expenditure of Federal-aid highway funds on efforts to conserve, restore, enhance, and create wetlands, and to establish habitat and wetland mitigation banks before, during, or after transportation projects are completed.

A March 2005 memorandum from FHWA Headquarters reiterates and “emphasizes that wetland and natural habitat mitigation measures, such as wetland and habitat banks or statewide and regional conservation measures, are eligible for Federal-aid participation when they are undertaken to create mitigation resources for future transportation projects.” The memo clarifies that “in the case of wetland or other mitigation banks, the State DOT and FHWA division office should *identify potential future wetlands and habitat mitigation needs for a reasonable time frame and establish a need for the mitigation credits*. The transportation planning process should guide the determination of future mitigation needs.” For specific details within this memo, visit: www.fhwa.dot.gov/environment/wetland/wethabmitmem.htm.

Also see Guidelines for Federal-aid Participation in the Establishment and Support of Wetland Mitigation Banks and this FHWA memorandum: Federal-aid Eligibility of Wetland and Natural Habitat Mitigation, www.fhwa.dot.gov/legsregs/directives/policy/memo55.htm.

According to *Eco-Logical*, state infrastructure banks (SIBs) and Grant Anticipation Revenue Vehicles (GARVEEs) “can be used only for projects that would be eligible for direct Federal-aid funding, but for which funding is not immediately available. State DOTs often have access to SIBs, which are a source of low-cost financing for eligible projects. The maximum loan term is 35 years, and the interest rate is set by the State. Loans from SIBs can make a large project affordable for a nonprofit or local community. . . . GARVEEs permit States to borrow against future Federal-aid funding. States pay debt payments with Federal aid. GARVEEs allow States to distribute the costs of expensive projects [, even conservation projects,] over many years” (4). See www.fhwa.dot.gov/innovativefinance.

Note that Caltrans is exploring how to fund advance mitigation on very large scales (regional and statewide), for habitat and wetlands, which would help other resources at the same time and present a model for others.

STEP 2: CHARACTERIZE RESOURCE STATUS

Purpose and Anticipated Outcomes

The purpose of Step 2 is to develop an overall conservation strategy that integrates restoration and conservation priorities, data, and plans. This step involves identifying and compiling information on resources as well as merging, overlaying, or combining that information with data on other resources.

The team discusses specific restoration and preservation goals for aquatic resources in the watershed, as well as connections between aquatic resources, their functions, and how they cumulatively support watershed-scale processes. Widely available data sets include land use/land cover data, national hydrologic data sets, department of natural resources (DNR)/NWI wetlands, Section 303(d)-listed streams, impervious surfaces, 100-year floodplains, and soils maps.

All conservation and natural resource stakeholders identified in Step 1 provide input to the compilation and analysis and ultimately adopt the characterization of resource status and the REF; both address all species, habitats, and relevant environmental issues. Anticipated outcomes for this step include the following:

- Group understanding of historical/long-term trends, priorities, and concerns related to aquatic and terrestrial resources, species, and habitats in the region;
- Compilation of existing data and plans into a refined map that identifies areas for conservation and restoration action;
- Descriptions of areas of significant ecological importance to protect watershed and ecosystem health, identifying the most suitable areas for restoration and preservation;
- Map of combined conservation/preservation and restoration areas used as the basis for a REF and cumulative effects analysis;
- Identification of gaps in data or plans that may need to be addressed separately, and identification of modeling or assumptions to be used to address those gaps; and
- Commitments and schedule for delivery of data and modeling to fill data gaps.

Implementation Substeps and Technical Considerations

An overview of Step 2 substeps and technical considerations follows.

Step 2: Characterize resource status; integrate conservation, natural resource, watershed, and species recovery and state wildlife action plans

Implementation Substeps

- 2a. Identify the spatial data needed to create understanding of current (baseline) conditions, and understand potential effects from future actions.
- 2b. Prioritize the specific list of ecological resources and issues that should be further addressed in the REF or other assessment and planning.
- 2c. Develop necessary agreements from agencies and NGOs to provide plans and data that agencies can use in their own decision-making processes. Agreements should allow data to be used to avoid, minimize, and advance mitigation, especially for CWA Section 404 and ESA Section 7.
- 2d. Identify data gaps and how they will be addressed in the combined conservation/restoration plan. Reach consensus on an efficient process for filling any remaining gaps.
- 2e. Produce geospatial overlays of data and plans outlined above, as well as supporting priorities, to guide the development of an overall conservation strategy for the planning region that identifies conservation priorities and opportunities, and evaluates stressors and opportunities for mitigation and restoration.
- 2f. Convene a team of stakeholders to review the geospatial overlay and associated goals and priorities, and identify actions to support them.
- 2g. Record methods, concurrence, and rationales based on stakeholder input (e.g., how the identified areas address the conservation/preservation or restoration needs and goals identified for the area).
- 2h. Distribute the combined map of conservation and restoration priorities to stakeholders for review and adoption.

Technical Considerations

- What are the quantitative retention goals for each resource to ensure viability or preservation of an agreed upon portion of the priority resources?
- What is the conservation status of identified priority species and habitats? How accurate is existing information on where priority species and habitats (including wetlands) occur or could occur? Are the viability needs of priority species and habitats (i.e., minimum habitat size required for particular species) well understood?
- What is the condition of the existing data (e.g., completeness, age, resolution)?
- What expertise and resources are needed to fill any identified data gaps?
- Are conservation priorities and actions represented accurately in the REF, including ones that are not spatially explicit?

- Do the different conservation plans developed in the planning region agree on the conservation priority areas and goals? How will any disagreement be resolved?
- What regulated resources are most common in the area and which are most likely to be affected or are most sensitive to disturbance?
- What ecosystem services of interest are most likely to be affected by transportation projects?
- Do mitigation banks, habitat conservation banks, or other markets exist for ecosystem services likely to be affected?
- What landscape-scale measurements exist, if any, for quantifying ecosystem services and impacts?
- What are the limiting factors associated with TMDLs and Section 303(d)-listed streams?

Step 2a

Identify the spatial data needed to create understanding of current (baseline) conditions, and understand potential effects from future actions. The spatial data needed depend on the resources to be evaluated; those in turn depend on the vision and priorities identified in Step 1 and also the best available or most easily developed data for existing resources of concern, including regulated resources. Thus, the data sets that regulators themselves would consult to address key aspects of their regulatory area and to make decisions on permits or BOs should be included in the data set.

According to a summary from a 2011 meeting of a regional economic area partnership,

Several efforts have identified data that is widely available and should generally be used, including State Wildlife Action Plans, species recovery plans, ecoregional conservation strategies, wetland and hydric soils data layers, Special Area Management Plans (where they exist), state impaired waters, as well as any existing state, federal, local, or NGO conservation or restoration priorities. . . . There is much data and many resources to use, in the absence of field level assessments, that characterizes decision-making in the planning phase; e.g., land use, impervious cover. For example, in the Baltimore District, Watershed Resources Registries developed ‘qualitative and quantitative descriptions of land cover, land use, soil types, wetlands, streams, forest hubs and corridors, endangered species, critical birding habitats and so on . . . [that] provide insight on the health of the watershed. (7, 8)

The lists of agencies in the following subsections are not exhaustive but include the sources of environmental-related data and plans found in most regions and those most commonly used in conservation and/or land use planning. Identification of sources does not ensure plan availability in any particular area. Acquisition of some plans and/or data may require license agreements.

The plans and plan documents should be reviewed to determine fit of scale, precision, purpose, source, and so on, and which resources are included. The team should make an initial determination as to which plans and/or resource maps to include in the REF and which resources each plan can represent. Each resource will typically be represented by only one plan, but important conservation areas that include multiple resources may represent an acceptable overlap. For example, a particular conservation priority plan might be deemed acceptable for representing bird conservation generally, but an individual bird species priority map might be added to the REF if it better represents that individual resource. Despite the overlap, both input maps would be useful for the REF.

Federal Agencies with Federally Managed Lands and Associated Plans

- Department of Defense, integrated natural resource management plans;
- Department of the Interior, Bureau of Land Management;
- Department of the Interior, National Park Service;
- Department of the Interior, USFWS;
- Department of Agriculture, U.S. Forest Service;
- National Oceanic and Atmospheric Administration (NOAA) and USFWS recovery plans; and
- U.S. Army Corps of Engineers and NOAA special area management plans (SAMPs).

State/Regional Agency Plans

- Statewide long-range transportation plans (LRTPs) and any other state or regional transportation plan that includes proposed transportation projects (e.g., corridor analyses, regional transportation profiles, transportation improvement plans);
- State wildlife action plans (SWAPs) (www.wildlifeactionplan.org) or other conservation/land use plans that are mapped and have actionable priorities (some may have buy-in across the state and therefore offer a pre-endorsed plan);
- Wetland Conservation Plans;
- State lands and reserve plans;
- State game and trust species management plans, including wildlife crossings;
- State natural heritage or state natural area plans (www.natureserve.org);
- State comprehensive outdoor recreation plans; and
- State open space plans.

Local Agency Plans

- Local land use plans such as Comprehensive Plans, Green Infrastructure Plans (The Conservation Fund), and GreenPrint (The Trust for Public Land) plans;

- Land use, land cover, and impervious cover (www.mrlc.gov/); and
- Local watershed restoration plans completed by state water quality agencies or local watershed organizations, including municipal water supply watershed plans.

NGO Conservation and Restoration Plans

- The Audubon Society's Important Bird Areas plans, joint venture waterfowl or water bird plans, or other single resource-focused, scientifically derived priority plans (e.g., Ducks Unlimited and Trout Unlimited);
- The Nature Conservancy's Eco-Regional Conservation Plans, covering all states in the United States, which may be especially useful when SWAPs lack mapped, actionable priorities (www.tnc.org);
- Other potential conservation areas that are widely adopted and used; and
- Local and regional land trust plans developed with systematic methods.

Other Data Sources

- Protected Areas Database (USGS PADUS, www.protectedlands.net/padus/preview.php) and Conservation Biology Institute's Data Basin (www.databasin.org);
- EPA's Reach Address Database, Section 303(d) Listings (<http://epamap32.epa.gov/radims/>), discharge of waste waters via permit compliance system, watershed boundary data;
- Data sets created by states, counties, and other local organizations (e.g., Maryland and Florida greenways/green infrastructure/green print initiatives that identify large, contiguous blocks of ecologically significant natural areas and link them with natural corridors to create an interconnected network of natural resource lands across the state);
- National Conservation Easement Database (www.conservationeasement.us/);
- Natural Heritage Program species locations (www.natureserve.org);
- Predictive species modeling data, including inductive species distribution models being developed by some state Natural Heritage Programs, located in universities or state resource agencies;
- Ecological Systems or Natural Communities (www.natureserve.org/explorer/classeco.htm);
- National Hydrography Dataset (USGS);
- Soils (USGS), Hydric Soils data (NRCS), and Existing NRCS Rapid Watershed Assessments (20- to 40-page characterization of watersheds based on geology, soils, land uses, and socioeconomic data available at www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/dma/rwa/);
- National Wetland Inventory, local watershed plans by state or local organizations or municipal water supply watershed plans (e.g., wetlands of special state concern);

- Impaired (Section 303(d)-listed) streams (EPA, state agencies);
- Impervious surfaces (state or local government);
- Federal Emergency Management Agency, 100-year floodplain; and
- Pollution point sources (state government).

Other Useful National Data Portals

The nonprofit Mid-America Regional Council (MARC), made up of city and county governments and MPOs, has compiled additional sources of useful data. According to MARC,

Highlights of tools aimed at watershed protection and additional information can be found at the following websites: http://www.placematters.org/index.php?option=com_wrapper&Itemid=85 and <http://www.epa.gov/waterspace/toolpage.html>.

Ecosystem Based Management (EBM) tools are software or other highly documented methods that can help implement EBM by: 1) providing models of ecosystems or key ecosystem processes, 2) generating scenarios illustrating the consequences of different management decisions on natural resources and the economy, and 3) facilitating stakeholder involvement in planning processes. The EBM Tools Network is an alliance of EBM tool developers, practitioners, and training providers.

More information is available at www.ebmtools.org. The list goes on:

Geo-Spatial One Stop. Inter/National geo-spatial data clearinghouse and computer network of data servers/portals. Available geographic data and metadata posted, shared, and coordinated with the National Spatial Data Infrastructure (NSDI) and Federal Geographic Data Committee (FGDC). Individual web links for each national, state, regional, and local data portal/server that is part of the overall inter/national data clearinghouse are accessible at: <http://registry.fgdc.gov/browse.php?order=title>. Search for various types of data and information across all data servers within the overall data clearinghouse at: www.geodata.gov.

OpenGIS – Open Geospatial Consortium (OGC). An international industry consortium of more than 300 companies, government agencies and universities participating in a consensus process to develop publicly available interface specifications. OpenGIS® Specifications support interoperable solutions. The specifications empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. Summaries available at: www.opengeospatial.org/.

National States Geographic Information Council (NSGIC) is an organization committed to efficient and effective government through prudent adoption of geospatial information technologies. State summaries and contact person for each state available at: www.nsgic.org/.

The National Biological Information Infrastructure (NBII) is a broad, collaborative program to provide increased access to data and information on the nation's biological resources. Also linked to the inter/national geo-spatial one stop described above. Learn more at: <http://www.nbii.gov/portal/server.pt>. (9)

Step 2b

Prioritize the specific list of ecological resources and issues that should be further addressed in the REF or other assessment and planning. In Step 2b, the team prioritizes the specific list of ecological resources and issues to be further addressed in the REF. A systematic approach is recommended to begin establishing a resource list:

1. Begin with federal and state legally protected resources, such as wetlands, impaired waters, and listed species.
2. Add resources that are determined to be at risk by the resource collaboration group/scientists.
3. Use ranking systems such as NatureServe's global rank of imperilment (G1–G3 status) and state Natural Heritage Program S-ranks (S1–S3). (See <http://www.natureserve.org/explorer/ranking.htm>.)
4. Apply the coarse/fine filter approach for biodiversity conservation planning, which seeks to conserve the full range of biodiversity.
5. Add so-called trust species—those in addition to the legally protected species which agencies are required to manage.
6. Add other resources of interest or value to stakeholders.

Next, it is highly useful to set quantitative retention or restoration goals for each resource and document the source(s) of information used. Goals are typically set in the systematic conservation planning process, with experts in those resources applying their judgment on historic-versus-current distribution and viability/sustainability requirements such as species population structure and natural disturbance regimes. For wetlands and watershed resources, the following should be established:

- Historic extent of aquatic resources;
- Current extent of aquatic resources;
- Cumulative impact analysis for aquatic resources;
- Compensatory mitigation analysis;
- Impervious surface analysis;
- Tributary buffer assessment; and
- Complete trends analysis.

Although estimates of actual historic distribution and loss may be required or desirable, this is difficult and expensive for most resources of concern. Some states have created historic vegetation distribution maps, and approaches exist for mapping historic wetland distribution. Individual plant and animal species historic distribution maps are rare and would have a high degree of uncertainty. Another approach is to apply NatureServe global ranks of imperilment. G-ranks incorporate expert judgment on historic loss and can be found at www.natureserve.org/explorer/. For nonlegally protected resources, goal-setting can be difficult and controversial, but it forms the basis for assessing the significance of impacts in later stages and facilitating mitigation and trade-off planning. Clearly characterizing the objectives for legally protected resources—including all goals identified in recovery plans, adopted watershed plans, and programmatic agreements—is a critical step.

The typical alternative to goal-setting is weighting the relative importance/priority of resources/features on some categorical scale (e.g., 1 to 5, low to high). Weighting resource importance is an initial step that can help inform the magnitude of potential impacts while quantitative goal-setting (which can often be a lengthier process) is being conducted. Also, weighting is often an easier value to extract from stakeholders than quantitative goals. However, the use of weights alone limits the usefulness of information generated from the impact assessment conducted later in the process; weights do not result in conclusions about resource viability impacts or the amount of mitigation that may be needed (other than for resources for which any impact must be mitigated). The weighting values provided by stakeholders can inform the expert judgment by gauging the amount of representation of a resource relative to science-based judgment about its viability or sustainability. For example, not much area may be needed to continue representing a particular resource in sustainable numbers in a planning area, but stakeholder values may suggest they'd like to see it widespread.

If using quantitative goals, the team can decide to use a single goal or a goal range. For legally protected resources, a single goal is likely needed (often 100% of what remains and improvement in other areas). Goals can also be set as a range, such as minimum and preferred levels (e.g., 50% and 75%, respectively), or high, medium, or low as an expression of risk of future loss (e.g., 10%, 30%, 50%, respectively). When setting resource goals, the team should document the source(s) of information used.

A database is useful for tracking the spatial and nonspatial information collected and generated through the application of this framework. Creating a database for resource information is critical to document and hold information on the following:

- Name (and taxonomy if applicable) of the data or plan;
- Reason for selection;
- Champion, meaning which partner(s) hold the resource in trust or otherwise advocate for it and can provide key information about it;
- Sources of spatial and expert information; and
- Retention goals and other key information necessary for effects assessment and the retention planning and mitigation described in Step 4a.

The process of populating this database can take some time. It can proceed in parallel with other tasks, but the sooner it is started the more likely the information will be in place when needed (in particular for Step 3 and later). Resource expertise is distributed among many institutions and individuals, and guidance exists for obtaining such information in useful and effective ways (e.g., workshops) (10). Often experts are located outside the planning region. Populating the database essentially involves engaging subject matter experts (SMEs) for each set of existing data and the resources in question and using their knowledge and judgment and that of other colleagues to develop the required attributes.

One of the ways to gather subject matter expertise is to host a workshop that allows experts the time to share their knowledge and gives the team the opportunity to record it; however, scheduling and funding travel for distant SMEs can be difficult. Increasingly, teams may find it possible to leverage other ongoing efforts (such as those under way in the Bureau of Land Management, Forest Service, Western Governors Association, The Conservation Fund, USFWS Landscape Conservation Cooperatives) or work in creative ways from afar. One approach to contacting other data owners is to send a data collection form via email. An example of an expert knowledge gathering process and forms is at www.natureserve.org/prodServices/vista/docs/expertInput-Guide.pdf (11).

Step 2c

Develop necessary agreements from agencies and NGOs to provide plans and data that agencies can use in their own decision-making processes. As referenced in the previous step, various partners hold their data resources in trust and otherwise advocate for it and can provide key information about it. As part of Step 2c, the team gains agreement from these organizations to share their data. Individual states, MPOs, and resource agencies typically arrange and negotiate such agreements, but they might also be formulated on larger, multistate or federal scales to save time and effort.

The agreement should indicate that the data will be used to help transportation and other developers avoid and minimize impacts and further site conservation and restoration projects according to the priorities discerned from the shared data.

Step 2d

Identify data gaps and how they will be addressed in the combined conservation/restoration plan. Reach consensus on an efficient process for filling any remaining gaps. After identifying the plans and data sets to be used in previous steps, team members (or engaged experts) need to determine the value of plans for target resources and gaps in resource coverage by plans. If gaps appear to exist, subject matter experts can conduct further investigation of resource coverage and decide how the team can address those.

Creators of the plans are the most knowledgeable about their plans and most able to inform the team about the extent to which their plans can suit the REF purpose and with what limitations. To the extent feasible, resource experts on and outside the team should be enrolled to review the plans to determine if they can adequately represent individual resources.

To understand how well existing plans represent specific resources, the team creates a matrix that cross-references resources to named plan products. If specific resource content is not documented in existing plans (e.g., locations identified only as habitat conservation areas), then team members can interview plan developers to determine resource content. If no further information can be obtained and the plan is to be included in the REF, then the following steps should be undertaken:

1. Identify and obtain existing resource distribution maps that the resource SMEs believe appropriately represent the resource.
2. Intersect plan priority/management areas with individual resource maps to determine resource content.
3. Identify those resources not covered or not adequately covered by any existing plan and decide how or whether they should be represented in the REF.
4. Document how well existing priority maps include each resource. Consider coding the relationship according to the strength of resource treatment in the plan (e.g., on a scale of 1 to 3 or low, medium, high) and document the strength of the treatment. Strength of treatment may refer to the quality of the data used (e.g., recorded observations or range maps versus accuracy assessed predictive distribution models) and the robustness of analyses (e.g., simple distribution area versus population dynamics).
5. Determine if enough information exists to include the resources in the process and if so whether they will be treated separately as individual element layers in the REF or integrated into an update of an existing plan product by the owner of that plan (e.g., add to a state action plan).
6. Document how each resource will be treated and by whom.
7. Fill gaps in conservation plans as feasible and otherwise note deficiencies and how those should be addressed during later phases of long-range planning and/or project planning.
8. Document priority areas and individual resource distribution maps with the amount of resource area and occurrences as well as confidence in resource presence in each occurrence. These data will be important for quantifying and evaluating impacts and mitigation needs and opportunities. Confidence information will also be useful for determining reopening clauses (see Step 7).
9. Document priority maps and/or specific priority areas for any of this information that could not be determined and plans for filling information gaps.
10. Identify any individual resources for which adequate distribution information was not available and plans for filling information gaps.

The regional ecosystem framework partnership needs to agree on the degree of scientific rigor acceptable for the REF applications. The team may reasonably conclude that the bar for planning may be lower than for project assessments (which require the full National Environmental Policy Act, or NEPA, process); in project assessment cases the number of considerations is lower, and more precise information can be

collected and rigorously analyzed. The objective of the REF is to provide a better and more precise assessment at the planning phase than has traditionally occurred, while not complicating such analysis with impracticable requirements. Education of partners and stakeholders in the use and value of SME judgment will be needed to achieve the objective of streamlining project delivery by moving considerations to the planning phase. The partnership should also agree on acceptable sources of scientific information and may want to develop a scientific research needs assessment and strategy for the mid to long term, to fill critical gaps.

The following tips are useful in identifying gaps in the data and determining how to address them in the conservation/restoration plan:

- Create robust analyses understandable to decision makers and stakeholders. With the availability of more and better data and robust spatial analysis techniques and tools, analyses and products are becoming highly complex and more difficult to describe and explain. Greater simplicity can result from a hierarchical process that starts with the binary presentation of “problem/not a problem” which allows users to drill down through the information and add further detail as needed. For example, a cumulative effects assessment may indicate an incompatibility between a resource and a proposed action (a problem). Further investigation may reveal the resource is not legally protected, but the action would prevent achievement of the resource retention goal. Identification of the specific resource and the amount of area affected can then help identify possible mitigation options that interested REF partners can pursue.
- Integrate and maintain information from widespread sources. This point can pose a particular challenge for obtaining, integrating, and managing expert input on the resources. Experts are usually distributed among many organizations over wide geographic areas. Creation of a simple online location for entering their information may ease the burden on everyone involved in information collection and management. In addition, this approach makes the information reusable for multiple applications.
- Integrate dynamic processes and information. Dynamic data can include data that are updated frequently and/or that represent dynamic phenomena. Study and modeling of climate change are increasing and beginning to produce large amounts of dynamic data which may affect the REF (species/ecosystem change and migration) and assessment of additional important stressors on the resources. The REF partnership should explicitly consider what information should be included and how it should be used in updates to the REF and assessment.

Step 2e

Produce geospatial overlays of data and plans, as well as supporting priorities. The intent of this step is to create a robust spatial database. The point is not to create a presentation map, because visually representing all of the information on one map is not feasible. This database will be used to guide the development of an overall

Data Availability and Quality

More often than ever before, quality data are available and put to good use in resource assessment. Although data may never be perfect, more and better data are available every year. The quest for better and better data should not get in the way of making use of the good data that exist at resource agencies and NGOs or on the state level to better protect, restore, and conserve all resources of concern. The REF partnership focuses on making the best use of existing data, while discussing strategy and funding mechanisms to obtain better data. Landscape Conservation Cooperatives have taken on this mission as well and should be viewed as partners.

State Wildlife Action Plans (SWAPs) form a key component of the REF. A few years back only 20 or so SWAPs had geospatial components; now over 30 do and others are in the works. Some SWAPs may still be too coarse to support transportation planning, but at present, most states seem dedicated to increasing spatial components and resolution to support the usefulness and implementation of these plans.

If conservation and restoration areas are not mapped or available geospatially in a particular state action plan, other plans may exist to fill the role wholly or partially in the interim, including work by large national or regional conservation NGOs and some natural heritage programs. Multistate conservation or restoration planning efforts may also be useful for this purpose, as the resolution may be beneficial (see the Region Ecological Assessment Protocol for EPA Region 4). Also consider the new Southeastern Ecological Framework (EPA Region 6), species-specific mitigation siting support tools for the desert tortoise, the Watershed Restoration Registry in Maryland, and the 14-state NiSource conservation strategy developed by The Conservation Fund.

When no conservation priority area plans exist at the needed level of resolution, the partnership should decide if it is more efficient to scale down existing coarse-scale plans or create an interim product from existing data on individual resources of concern (e.g., wetlands, species, water quality needs). The SWAP and other partners' plans can provide important guidance on the resources to be considered, resource priorities, general areas of conservation importance, and perhaps even resource retention goals. To create a more resolved spatial-priorities map, one alternative is to use an existing high-resolution natural landcover/habitat map, such as those produced by the USGS Gap Analysis Program, to identify large intact natural habitat areas. That information can be augmented with other data, such as the natural heritage program occurrences of imperiled species and ecological communities and state resource agency maps of important game species habitat, to identify natural vegetation areas containing important resources.

Conservation priority areas often do not cover some important resources, and maps for such resources are often based on incomplete observation points. In the past, many SWAPs did not address plant species. Currently, many species distribution maps exist only as point observations (see Figure 1.1, maps of bog turtle distribution in New York State). The lack of complete geographic distribution maps for individual resources can be addressed using predictive distribution models. The USGS Gap Analysis Projects produced moderate-confidence models for most terrestrial and aquatic vertebrate species, and some developed models for other species. Other projects in states or regions may have produced other higher-confidence models for particular species. The REF partners may also be able to use contemporary tools and methods to create the necessary models, with much less effort than in the past.

conservation strategy for the planning region that identifies conservation priorities and opportunities and evaluates stressors and opportunities for mitigation and restoration.

The data in the database will provide the attributes needed to create visual presentations of particular themes of interest. Suggested attributes include (1) the source or owner of the input map, (2) the type and purpose of individual areas, (3) the resource content of individual areas, and (4) metadata for the methods used to map areas. When overlaying the various accepted plans (including individual resource maps), be sure to follow procedures for retaining all relevant attributes as available in those plans.

Areas within these plans need to be distinguished by their conservation status as either secured or unsecured for effective conservation (i.e., areas are or are not under some ownership/agreement to manage them in perpetuity for the resources to be sustained). Alternatively, all secured areas can be moved to a protected area database; then the remaining areas from this step are all unsecured priority areas that could be restored or conserved or could otherwise provide off-site mitigation. Secured areas also inform avoidance in planning. As priority areas are protected, their availability to offer mitigation is removed. It is especially useful to attribute areas that contain legally regulated resources.

Determining restoration and conservation objectives or priorities involves sequential consideration of objectives such as connectivity, sensitive species habitat, water quality functions, adjacency to open space, location within open space, and functional lift (quantitative) and watershed zones. The system for setting and rating priorities may highlight areas on the basis of attributes of content—such as legally protected, impaired, or especially rare/imperiled resources or the values integrated in weightings already described—and threat from conversion. It is critical that the REF partnership come to agreement on the creation of an acceptable rating system. A rigorous approach uses a key concept from systematic conservation planning called *irreplaceability* which informs how many options exist in the assessment/planning region to meet resource retention or restoration goals. For example, an area that contains a rare resource with a 100% retention goal (retention of existing distribution) would be 100% irreplaceable. Applying irreplaceability requires setting quantitative goals.

A function-based approach to determining watershed restoration objectives or priorities considers historical wetlands and the locations of priorities based on biodiversity, flood abatement, or water quality protection/filtration, and then combined restoration priority sites. Suitability analyses identify where in the watershed mitigation should occur. Locations where ecological actions would be most helpful are scored and ranked. Analyses identify highly affected areas, such as areas of high impervious surface where restoration is more risky. In affected urban and suburban areas, off-site mitigation in another contributing area or watershed may be more effective in protecting and restoring watershed health, as characterized at broader spatial scales.

Step 2f

Convene a team of stakeholders to review the geospatial overlay and associated goals and priorities, and identify actions to support them. The initial team of stakeholders, with the potential addition of further agency staff and SMEs, meets to review the

geospatial overlay and associated goals and priorities. The group may choose to discuss technical considerations such as the following:

- What are the quantitative retention goals for each resource to ensure preservation of an agreed on portion of the priority resources?
- What is the conservation status of identified priority species, habitats, and wetlands? How accurate is the team's knowledge of where priority species, habitats, or wetlands occur or could occur? Does the team understand the viability needs of priority species and habitats (i.e., minimum habitat size required for particular species)?
- What is the condition of the existing data (e.g., completeness, age, resolution)?
- What expertise and resources are needed to fill any identified data gaps?
- Are conservation priorities and actions represented accurately in the REF, including ones that are not spatially explicit?
- Do the different conservation, restoration, and recovery plans developed in the planning region disagree about the conservation and restoration priority areas and goals identified? How will the disagreement be resolved?
- What regulated resources are most common in the area, are most likely to be affected, or are the most sensitive to disturbance?
- What ecosystem services of interest are most likely to be affected by transportation projects?
- Are mitigation banks, habitat conservation banks, or other markets for ecosystem services likely to be affected?
- What landscape scale measurements exist, if any, for quantifying ecosystem services and impacts?
- What are the limiting factors associated with TMDLs and Section 303(d)-listed streams?

Using the assembled data and associated decision support tools, the team discusses potential conservation and restoration actions that could be undertaken by the DOT or other developers and which ones merit selection as highest-priority needs. This process must be recorded, as indicated in Step 2g. Ideally, priority areas for all of the following will be identified:

- Wetland preservation, enhancement, or restoration;
- Stream and riparian zone preservation, enhancement, or restoration;
- Upland preservation, enhancement, or restoration;
- Stormwater management opportunities; and
- Species-specific recovery.

These are not areas that will be used for mitigation, per se, for transportation projects or in certain development scenarios. Such preferences begin to be identified in Step 3c and then in Step 4.

Step 2g

Record methods, concurrence, and rationales based on stakeholder input. This step records how the priorities for addressing the conservation/preservation or restoration needs and goals identified for the area were chosen. The methods or rationale for selection of conservation and restoration goals and priorities must be documented for the work to be useful in other conservation, restoration, and transportation planning processes, and in associated consultation or permitting.

Step 2h

Distribute the combined map of conservation and restoration priorities to stakeholders for review and adoption. If the process is properly documented, the combined map of conservation and restoration priorities will be of great utility to many agencies. State DOTs, regional planning agencies, and local governments often lack this information; thus it has not always been included in development planning the way it could have. This information allows voluntary conservation and protection to occur.

Note throughout the process that the quest for better or more perfect data should not become the enemy of good data. (See the Data Availability and Quality box on page 34.) Opportunities for voluntary conservation or collaborative action on conservation and restoration priorities can otherwise be missed. And opportunity costs can result from retaining information or postponing sharing it.

STEP 3: CREATE A REGIONAL ECOSYSTEM FRAMEWORK**Purpose and Anticipated Outcomes**

The purpose of Step 3 is to integrate the conservation and restoration strategy (data and plans) prepared in Step 2 with transportation and land use data and plans (LRTP, STIP, and TIP) to create the REF. Anticipated outcomes include the following:

- Production of the REF, an integrated map of resource conservation and restoration priorities, LRTP, and other land use, infrastructure information, and socio-economic information;
- Review and verification of the REF and data sources used with all participating agencies and stakeholders; and
- Identification of areas in which planned transportation projects intersect with management and conservation priorities, including existing conservation areas.

At this level, the REF process can be used to link regional conservation and restoration priorities with what might be accomplished by transportation agencies and/or in conjunction with transportation investments. For example, in the USACE Baltimore District, watershed resource registries (WRRs) map “opportunity areas that would benefit most from the ecological actions suggested in the watershed profile. While the watershed profile is a descriptive tool, the targeting aspect of the WRR assesses areas in the watershed for their potential as an opportunity site. Areas might emerge as opportunities because of known ecological value, such as pristine stream corridors where permanent preservation is warranted, or problematic areas that require restoration or

[best management practices] to provide benefits to the watershed. . . . [The] targeting tool will show them what areas are optimal for fulfilling those needs” (7).

Implementation Substeps and Technical Considerations

A brief overview of the implementation substeps in creating the combined conservation strategy and transportation plan, a REF, may be seen as follows.

Step 3: Create a regional ecosystem framework (conservation strategy + transportation plan)

Implementation Substeps

- 3a. Overlay the geospatially mapped LRTP (or TIP or STIP) with conservation priorities and other land uses.
- 3b. Identify and show (1) areas and resources potentially affected by transportation projects and (2) potential opportunities for joint action on conservation or restoration priorities that could count for CWA Section 404 and ESA Section 7 regulatory requirements.
- 3c. Identify the high-level conservation goals and priorities, and opportunities for achieving them, relative to the transportation plan and other land uses and plans.
- 3d. Review and verify the REF with stakeholders.

Technical Considerations

- What areas will be directly affected by transportation development?
- How severe are the likely impacts in combination with other land uses and/or cumulative impacts?
- What and where are the affected natural resources?
- How many of these natural resources are statutorily regulated and how many are imperiled but not legally protected?
- What unprotected conservation priorities can be protected through project mitigation?
- What areas should be targeted for avoidance of impacts because of the presence of irreplaceable resources (i.e., endemic species or habitats)?
- What areas could be targeted for mitigation? Would those areas contribute to meeting REF objectives? What areas and measures could be used for mitigation to best benefit target resources (imperiled species, watershed/aquatic resource needs)?

Step 3a

Overlay the geospatially mapped LRTP (or TIP or STIP) with conservation priorities and other land uses. In this substep, the team seeks to understand how development plans are likely to affect resource conservation priorities. Existing transportation plans are one source of data, as are local development plans. Land use data is an important component of these plans, but existing development should be distinguished from

future development. Land use data should be segregated into actual current land use, allowable or planned land use (e.g., from local government comprehensive plans/zoning or public land management plans), predicted/forecast land use (e.g., from urban growth models), and proposed land use that falls outside of existing plans (e.g., a large planned unit development). Existing conservation lands should also be identified as a land use category, to assess the achievement of resource goals under current conditions.

Different development plans tend to use different names and identifiers for the various development types represented in those plans. Creation of a single classification of all of the development types acceptable to the partners is a useful step. Existing land use classifications can be assigned descriptors or cross referenced with this common classification; SMEs can then efficiently use the classification as they characterize or assign the response of resources of concern to current or anticipated land uses/disturbances in Step 4. The classification needs to be stratified enough for SMEs to distinguish differences in how resources respond to land uses but not so detailed that it unnecessarily increases the burden on the SMEs to attribute the responses. For example, on the one hand, local governments may have dozens of named land uses, but the vast majority are urban uses that have the same effect on resources. On the other hand, *agriculture* can mean many different types of practices that have very different resource implications. The use of a hierarchical classification can lump uses together to reduce the classification complexity when warranted. A good example is the classification of direct threats and conservation actions adopted by the International Union for Conservation of Nature (IUCN) and the Conservation Measures Partnership found at <http://www.conservationmeasures.org/initiatives/threats-actions-taxonomies> (12). IUCN standards have also been adopted by the USFWS for use in its Information, Permitting, and Consultation (IPaC) online assessment tool.

It is important that the classification be stratified enough for subject matter experts to distinguish differences in how resources respond to land uses. While many urban uses have roughly similar effects on natural resources, "agriculture" can mean many different types of practices that have very different resource implications. The use of a hierarchical classification can lump uses together to reduce the classification complexity when warranted.

Once a common classification is established, the spatial data can be brought in. The database should depict the distribution of regulated resources to ensure the analysis can identify impacts to individual regulated resources along with overall conservation objectives and trade-offs. These maps include species distribution maps for listed species showing areas where listed species are likely to occur and an updated NWI map for the area. Finally, the REF and the LRTP can be intersected to support Step 3b.

Step 3b

Identify and show (1) areas and resources potentially affected by transportation projects and (2) potential opportunities for joint action on conservation or restoration priorities that could count for CWA Section 404 and ESA Section 7 regulatory requirements. In this substep, output maps and quantitative reports are generated from the intersection in Step 3a to identify which priority areas and resources would be affected, the amount of area or resource distribution affected, and the location of the effects. Note that if Step 4 is not yet accomplished, this simple intersection assumes

conflict between all development and all resources/priority conservation areas. This assumption is reasonable at this stage to understand potential conflicts and needs. Step 4 will add information to create more precise results suitable for more detailed planning; however, applying a consistent format to the results is still important at this initial stage, to facilitate ready comparisons between alternative transportation scenarios. Note that to get a truly cumulative effects assessment, the LRTP needs to be combined with the existing land uses and other proposed/planned land uses, as described previously.

Next, the quantitative results from this substep are used to evaluate impacts. At this stage, the objective is to identify the resources and areas affected and the projects and uses causing the impacts. This evaluation can help the team identify opportunities for focused joint action to create better alternatives through avoidance or design mitigation, as well as early consideration of compensation opportunities if necessary.

Step 3c

Identify the high-level restoration and conservation goals and priorities, and opportunities for achieving them, relative to the transportation plan and other land uses and plans. The outputs of Step 3b allow the team to develop the list and map of affected resources and areas that will be the focus of further assessment and mitigation under the analyzed scenarios. From there the team can list and map the opportunity areas for mitigation and identify the key players that need to be engaged in the process to address those opportunities/priorities for ecological action.

A key consideration for ecosystem credits at this step is the ability to connect landscape-level measures to site-level measures. Landscape-level conservation or transportation decisions must translate to a project level through metrics that aggregate appropriately to track progress or support monitoring. The success of Steps 6f and 6g depend on this connection. Landscape goals are often too general to provide the basis for site-level decisions. Detailed landscape measures help remove ambiguity once the site level is being considered. For example, a conservation-level goal may identify the protection of habitat associated with a particular species life stage; but if this goal is left in general terms, it is impossible to implement at a site level.

Step 3d

Review and verify the REF with stakeholders. After the REF is developed, the team and any other relevant stakeholders need to be able to review and verify it. Questions and considerations may include the following:

- What areas will be directly affected by transportation development?
- How severe are the likely impacts in combination with other land uses and/or cumulative impacts?
- What and where are the affected natural resources?
- How many of these natural resources are statutorily regulated and how many are imperiled but not legally protected?

- What unprotected conservation priorities can be protected through project mitigation?
- What areas should be targeted for avoidance of impacts because of the presence of irreplaceable resources (i.e., endemic species or habitats)?
- What areas could be targeted for mitigation? Would those areas contribute to meeting REF objectives? What areas and measures could be used for mitigation to best benefit target resources (imperiled species, watershed/aquatic resource needs)?

STEP 4: ASSESS LAND USE AND TRANSPORTATION EFFECTS

Purpose and Anticipated Outcomes

The purpose of Step 4 is to identify preferred alternative conservation, restoration, and transportation investments that avoid and minimize impacts and help implement the highest conservation and restoration priorities in the region. The team assesses transportation effects, using the REF and identified conservation priorities. The team accomplishes this by analyzing transportation and/or other land use scenarios in relation to resource conservation objectives. This produces an initial sense of the amount and relative degree of impact of transportation plan scenarios.

The key outcome is an understanding of transportation effects and potential mitigation areas. More specific decisions and outcomes include the following:

- Development of program-level cumulative effects scenarios associated with transportation development and other future land uses;
- Identification and quantification of mitigation needs from anticipated transportation impacts; and
- Identification of agency preferences regarding avoidance, minimization, potential conservation, and restoration investments, to support selection of the best transportation plan alternatives (for transportation improvements as well as conservation and restoration investments).

Implementation Substeps and Technical Considerations

A summary of the implementation substeps and technical considerations is outlined as follows.

Step 4: Assess land use and transportation effects on resource conservation objectives identified in the REF

Implementation Substeps

- 4a. Work collaboratively with stakeholders to weight the relative importance of resource types (including consideration of resource retention or restoration goals) as needed to help establish the significance of impacts and importance for mitigating action.

- 4b. Establish individual resource conservation requirements (e.g., minimum viable habitat sizes and connectivity requirements) and respond to different types of transportation improvements and other stressors.
- 4c. Develop programmatic cumulative effects assessment scenarios that combine transportation plan scenarios with existing development and disturbances, other features and disturbances with an impact, and existing secured conservation areas. Include climate change threats to better understand which resources and areas may no longer be viable or which new resources may become conservation priorities in the planning region during the planning horizon.
- 4d. Intersect the REF with one or more cumulative effects assessment scenarios to identify which priority areas and/or resources would be affected, to identify the nature of the effect (e.g., negative, neutral, beneficial), and to quantify the effect, noting the level of precision based on the precision of the map inputs.
- 4e. Compare plan alternatives, and select the one that optimizes transportation objectives and minimizes adverse environmental impacts (the least environmentally damaging practicable alternative).
- 4f. Identify mitigation needs for impacts that are unavoidable, that may require minimization through project design/implementation/maintenance, and that may require off-site mitigation. For impacts for which in-kind mitigation does not appear practicable, review with appropriate resource agency partners the desirability of out-of-kind mitigation (e.g., by securing a very high-priority conservation area supporting other resource objectives).

Technical Considerations

- What areas have the highest degree of potential impacts? How important are those areas for resources of concern? What impacts should be avoided?
- What areas have opportunities for mitigation or restoration that best benefit target resources (imperiled species, watershed/aquatic resource needs)?
- What unprotected conservation priorities can be protected through project mitigation? Should impacts be mitigated on- or off-site? Does the area have mitigation banks or opportunities for bank development?
- What rules/methods will be used for weighing trade-offs among resource and transportation objectives?
- How does climate change influence the selection of mitigation sites? Which species are most vulnerable?
- For species in the planning area, what are their needs related to movement and habitat connectivity? What obstacles exist to habitat connectivity? How will species movement needs and possible transportation and land use impacts influence scenario evaluations?

Step 4a

Work collaboratively with stakeholders to weight the relative importance of resource types (including consideration of resource retention or restoration goals) as needed to help establish the significance of impacts and importance for mitigating action. A first step is to set individual resource and priority area importance weights. Weights in this sense do not replace quantitative goal-setting but instead inform a trade-off process when not all resource retention goals can be addressed in an iteration of the scenario assessment/mitigation process.

The team establishes how the weighting system will be used and how the weights will be set (e.g., SMEs, committees, stakeholder involvement). Next, the team establishes the weighting system and criteria (e.g., 1 to 5, highest to lowest), sets the weights, and documents the source of information and process used for setting the weights. To the extent weights can be decided in advance, they will ease decision making on priorities.

Some similar processes, such as the watershed resource registry in Maryland, identified preferred conditions and allocated a unitary weighting (value = 1) for every preferred condition (e.g., “forested”), acknowledging that some conditions are more valuable for some resources than others, to avoid having to come to consensus on weights. After assembling data sets but before selecting restoration sites, the Baltimore District interagency team identified opportunities that would benefit most of the ecological actions suggested in the watershed characterization/profile; then, for each ecological opportunity, the group outlined which physical factors enhanced an opportunity, which had to be present, and which could not be present. Factors included qualities that could be measured and mapped, such as whether the area drains to a Section 303(d)-listed stream, is currently forested, is within 200 ft of a wetland of special state concern, is in a stronghold watershed, is already protected, and so on. In this case, each attribute received a score (typically 0 or 1) and scores were tallied; thus, with the eight opportunity maps for different types of mitigation (e.g., wetland preservation, wetland restoration), the user can locate those areas in the watershed where ecologically beneficial actions would preferably occur, according to the interagency team.

Step 4b

Establish individual resource conservation requirements (e.g., minimum viable habitat sizes and connectivity requirements) and respond to different types of transportation improvements and other stressors. This step adds further detail to the quantitative retention and restoration goals established earlier, further fleshing out the overall cumulative effects assessment. Expert knowledge is solicited to obtain other recommended and optional parameters and input to the resource database such as the following:

1. *Minimum required area.* This parameter is specific to a patch or occurrence of the area or resource. (Recommended)
2. *Ecological condition thresholds.* Ecological condition is a function of the criteria used to assess the quality of the resource compared with viable reference conditions. In addition to the minimum required area, it usually takes into account the presence of pollutants; exotic species; age class and vegetation structure; off-site

effects; and so on. (Optional)

3. *Responses of REF priority areas and individual resources.* This step considers responses to various transportation plan components or improvements (as well as other plans or disturbances). It recognizes that not all resources respond equally to different land use and infrastructure types. Responses can be put on a numerical or categorical scale such as negative, neutral, or beneficial. (Recommended) *Note: The process recommended in this guide does not explicitly call for calculating multiplicative effects of disturbances (i.e., the sum level of disturbance to a resource from multiple resources is greater than the sum of their individual disturbances) as there is little science to support quantitative assessment of this effect; in addition, it would likely add considerable complexity. However, if such assessment is desired it can be conducted as part of this step.*
4. *Landscape ecological parameters or characteristics.* This step identifies parameters—such as patch interior area, edge-interior ratios, connectivity, and desirable stream buffers—that are meaningful for the resource and practical and workable using available data and tools. (Optional)
5. *Viable species population size and characteristics.* Assessment of these characteristics can be difficult and expensive, and the information is more often gathered during field assessment. But when the data can be reasonably established, recording them during the expert knowledge gathering phase is most efficient. Because of the expense and difficulty, this step is most often done for legally protected species for which high certainty of cumulative effects is required. (Optional)

The resulting assessments are much more precise because they take into account some important considerations such as the following:

1. *Not every resource responds negatively to every land use/development activity.* Some species have a neutral response and a few may benefit, though intensive development negatively affects most resources.
2. *Size and configuration matter.* The area of a habitat patch, its shape, context, and connectivity to other habitats are very important in determining its suitability and viability for many species.
3. *Condition of habitats matters.* The condition of a habitat is not only very important to its suitability for species but is also important from a policy perspective for suitability to receive compensatory mitigation.

Step 4c

Develop programmatic cumulative effects assessment scenarios that combine transportation plan scenarios with existing development and disturbances, other features and disturbances with an impact, and existing secured conservation areas. Include climate change threats to better understand which resources and areas may no longer be viable or which new resources may become conservation priorities in the planning region during the planning horizon. First, the partnership should decide what transportation and other development scenarios to define and evaluate. This substep builds

on those in Step 3 by conducting a more complete mapping of stressors in the scenarios (existing land use, management, and infrastructure combined with planned future land use and other infrastructure, and climate change effects). Typically, the scenarios to be evaluated include the following:

1. Current baseline of actual land use and management;
2. Policy baseline of allowable land use and management not yet realized (also known as a *build out* map for urbanization based on current local government plans and zoning);
3. Trend scenario that predicts likely urbanization (based on demand, suitability, and market conditions);
4. Climate change affecting not only temperatures but also water availability and storm strength and frequency in some areas; and
5. Alternative futures scenarios based on models, proposals, civic engagement, and so on (e.g., in regional transportation planning, traditional long-range plans assuming automotive travel versus a corridor development approach versus an urban centers/transit-oriented development scenario).

Once the desired scenarios are described, the team conducts an inventory of data sources that can represent the scenario content (uses, infrastructure, management practices, disturbances) for evaluation:

1. Current scenario
 - a. Actual land use mapped with aerial photography and/or satellite imagery;
 - b. Actual land use or management records that specify existing or ongoing activities, which is especially useful for land uses and management that are not easily distinguished through remote sensing such as working landscape uses and management;
 - c. Infrastructure;
 - d. Protected conservation areas; and
 - e. Known hazard areas that can threaten both development and resources.
2. Policy and trend scenario
 - a. Land use or management based on existing plans such as zoning or public land management plans (when multiple uses are allowed in an area, attributing the most intensive allowable use may be appropriate under the precautionary principle);
 - b. Urban growth model output for the transportation planning horizon, often developed by local and regional governments and other entities, which not only project population but often predict types of urban uses for areas expected to be developed (projections stated as housing unit or human population density can be converted to land use types); and

- c. Pest and disease spread (e.g., pine bark beetle infestation in the Rocky Mountain region) which pose a significant cumulative threat to ecosystems and individual resources.
3. Alternative future scenario
 - a. Proposed transportation plans and projects and their alternatives; and
 - b. Proposed land use and management plans and their alternatives.

Resource partners may also want to collaborate on inclusion of predicted climate change threats to better understand which resources may not be viable or which new resources may become conservation priorities in the planning region during the planning horizon. Direct threats modeled from climate change, such as sea-level-rise maps, can be incorporated in trend scenarios. In more sophisticated climate change analyses, other indirect resource threats can be modeled, such as species range shifts and regional condition impacts on resources (e.g., temperature, precipitation, soil moisture).

Data can then be integrated into a single map containing the different scenario components. Instances may occur in which one map input trumps others that overlap with it. For example, many counties zone public lands in case land is swapped, putting that land into private hands (thus it will be appropriately rezoned). However, public land management is of particular interest in the evaluation, not the theoretical private land zoned use, so rules must be used for combining the data to recognize when multiple uses actually co-occur and when one use should trump others.

Step 4d

Intersect the REF with one or more cumulative effects assessment scenarios to identify which priority areas and/or resources would be affected, to identify the nature of the effect (e.g., negative, neutral, beneficial), and to quantify the effect, noting the level of precision based on the precision of the map inputs. Once the scenarios are constructed in the GIS database per Substep 4c, the spatial analyses can be conducted. The intersection of the REF and scenarios determines the location and amount of each area/resource in each land use type in a scenario by intersecting the spatial data.

Next the process compares the responses of the areas/resources (e.g., negative, neutral, beneficial) to the land use types. Area/resource distributions with acceptable responses (e.g., neutral or beneficial) are compared with other spatial requirements (e.g., minimum viable patch/occurrence size). Areas meeting response and viability requirements are considered “retained” under the scenario. Remaining acceptable areas are then summed and compared with regional retention goals to determine if a scenario can meet area/resource retention goals.

For assessing impacts on priority areas in the REF, the quantities of individual resources found within those areas are needed to determine the type and amount of impact. Without precise resource location information, the results have considerable uncertainty—particularly if only a portion of the priority area is affected. When such information is not available, the team may need to work with the owner of the relevant plan to determine the nature of the impacts.

For all areas/resources, a report should be generated that quantifies the current distribution and the expected future distribution, to quantify impacts. Maps of locations of expected area/resource loss can identify where impacts would occur and which scenario areas (e.g., land use, infrastructure, management) are responsible for the impacts.

Step 4e

Compare plan alternatives, and select the one that optimizes transportation objectives and minimizes adverse environmental impacts (the least environmentally damaging practicable alternative, ensuring regulated resources are sufficiently addressed). Having generated spatial and quantitative results in Step 4d, the team can readily compare the ecosystem performance of the transportation development and conservation plan (REF) alternatives. Performance is based on meeting area/resource retention and restoration goals.

The likely rare and easiest case compares equally acceptable transportation scenarios and readily identifies the one with the least impact. More commonly, cases involve trade-offs between transportation scenarios and resource impacts. An initial evaluation will likely reveal opportunities to further minimize impacts by creating new transportation plan alternatives (e.g., hybrids of plan alternatives) or mitigating conflicts in a preferred plan through avoidance on a site-by-site basis.

If opportunities for plan improvements are identified, then iterations of transportation and land use plan adjustments can be conducted; the team can then identify a preferred scenario for meeting transportation and land use objectives with the least impact on resource goals. The map and quantitative outputs of the assessment guide these adjustments by identifying locations, resources, and development activities that are in conflict. The database of resource responses to the classification of development activities is also useful for determining compatible uses at priority conservation and restoration sites.

Step 4f

Identify mitigation needs for impacts that are unavoidable, that may require minimization through project design/implementation/maintenance, and that may require off-site mitigation. For impacts for which in-kind mitigation does not appear practicable, review with appropriate resource agency partners the desirability of out-of-kind mitigation (e.g., by securing a very high-priority conservation area supporting other resource objectives). The outputs from Step 4d provide the quantitative information required to understand what resources are affected and the quantity of the impact (e.g., acres or populations affected). Combined with policy information (such as mitigation multipliers required), participants/users can then describe the mitigation strategy for each resource that will meet the retention goals. This step does not identify the specifics for implementation but describes whether the mitigation will be met through minimization or restoration (e.g., through project design stipulations) or through off-site and/or out-of-kind mitigation when those options exist.

On-site or in-kind mitigation may not be practicable for all impacts, and not all on-site options are ecologically viable. In those cases, the team should review with appropriate resource partners the desirability and permissibility of mitigating off-site

or out-of-kind (e.g., by helping secure a very high-priority conservation area supporting other resource objectives of equal or higher priority). For legally protected resources (streams and wetlands or endangered and threatened species) out-of-kind mitigation may not be permissible; but for other resources, off-site mitigation should be explored to determine whether the REF includes priority conservation sites that support higher conservation values. (See Step 6 for more information about value trade-offs.)

Recent wetland mitigation guidance recommends that mitigation be done in areas where ecological processes can be restored unless maintaining the affected functions on the impact site is an ecological necessity (4, 13). In considering locating mitigation in larger watersheds, the key principles are generally to (a) locate mitigation projects in a way that helps sustain existing, minimally impacted aquatic systems and (b) select types of projects that complement the aquatic landscape profile of an area. Mitigation should be located where it will help protect or restore the health and condition of aquatic resources within a watershed or other appropriate area within a broad ecological landscape.

Note that Step 4f supports implementation of Steps 6a, 6e, and 6f—ascertaining measurement needs and negotiating credits—and may require partially completing those steps in advance. Step 6a includes a diagnosis of environmental, regulatory, and stakeholder issues and ways to create linkages between these various values to assess trade-offs. The market assessment and implementation decision in Steps 6e and 6f define a set of possible options for resolving environmental measurement problems and for finding more effective conservation and mitigation. These two steps connect in Step 4 through the analysis of alternatives and minimization decisions.

STEP 5: ESTABLISH AND PRIORITIZE ECOLOGICAL ACTIONS

Purpose and Anticipated Outcomes

The purpose of Step 5 is to establish mitigation and conservation priorities and rank preferred opportunities for ecological action, using assessment results from Steps 3 and 4.

Anticipated outcomes include developing and agreeing on the following:

- A regional mitigation (conservation, recovery, restoration) strategy and conservation and restoration priorities with quantitative and qualitative valuation of mitigation sites (the strategy and priorities should be iterative; and stakeholders should identify a process that supports updates as necessary);
- The preferred conservation/mitigation actions to achieve the priorities;
- Strategies and actions that consider regulatory requirements and programmatic implementation opportunities (e.g., seeking regulatory buy-in for mitigation solutions and/or establishing a mechanism by which resource agencies can convey their acceptance/approval of investments in vetted conservation or restoration priority areas); and
- Crediting opportunities (see Step 6 for details).

In this step, the partners will also identify a lead agency or agencies for each strategy and the method for achieving each strategy.

Implementation Substeps and Technical Considerations

An overview of the implementation substeps and technical considerations follows.

Step 5: Establish and prioritize ecological actions

Implementation Substeps

- 5a. Identify areas in the REF planning region that can provide the quantities and quality of mitigation needed to address the effects assessment and develop protocols for ranking mitigation opportunities. Ranking should be based on the site's ability to meet mitigation targets, along with (a) anticipated contributions to cumulative effects, (b) the presence in priority conservation/restoration areas of the REF, (c) the ability to contribute to long-term ecological goals, (d) the likelihood of viability in the landscape context, (e) cost, and (f) other criteria determined by the stakeholders.
- 5b. Select potential mitigation areas according to the ranking protocols in Step 5a.
- 5c. To increase confidence in the mitigation component of the plan, field-validate the presence and condition of target resources for attention at mitigation sites, and reassess the ability of sites to provide necessary mitigation. Revise the mitigation assessment as needed to identify a validated set of locations to provide mitigation. Compare the feasibility and cost of conservation and restoration opportunities with ranking score and context of conservation actions of other federal, state, local, and NGO programs to determine overall benefit and effectiveness. Predictive species modeling can target the field-validation process.
- 5d. Develop and refine a regional conservation and mitigation strategy (set of preferred actions) to achieve ecoregional conservation and restoration goals and advance infrastructure projects.
- 5e. Decide on and create a map of areas to conserve, manage, protect, or restore; include documentation of the resources and the quantities to be retained/restored in each area, and the agency and mechanisms for conducting the mitigation.
- 5f. Obtain agreement on ecological actions from stakeholders.

Technical Considerations

- What areas within REF priority areas meet the mitigation criteria?
- If required mitigation cannot be found within a REF priority area, what other mitigation opportunities exist that will further the regional restoration plans goals and objectives agreed on?
- What other conservation actions are occurring in the area?
- Who owns or manages the identified priority areas?
- What site-level measures are needed to verify progress at mitigation sites?
- What are the protocols for ranking mitigation opportunities?

- What is the most effective way to direct and conduct field validation of identified mitigation areas? How can field data be captured and provided to natural resource data maintainers/providers so that it can be used in future assessments?

Step 5a

Identify areas in the REF planning region that can provide the quantities and quality of mitigation needed to address the effects assessment and develop protocols for ranking mitigation opportunities. As prospective conservation/restoration/mitigation areas are identified, the team ranks them on the basis of the site's ability to meet mitigation targets, along with (a) anticipated contributions to cumulative effects, (b) the presence in priority conservation/restoration areas of the REF, (c) the ability to contribute to long-term ecological goals, (d) the likelihood of viability in the landscape context, (e) cost, (f) other stakeholder criteria.

For mitigation of impacts to individual resources, the team needs to have either high-confidence distribution maps of the individual resources or quantities of resources in potential off-site locations (receiving areas). Quantities will need to be verified before agreements are put in place, but the initial information can be used for planning purposes.

For mitigation of priority areas from the REF, having quantities of individual resources found within those areas is most useful for determining mitigation needs. When such resources are not available, the owner of the source map for the area should be consulted to help determine appropriate in-kind or out-of-kind mitigation. Securing approval and funding for such mitigation, however, will likely require additional investigation and verification of the resources that would be affected and the value of the proposed mitigation (see Step 5c). For out-of-kind mitigation, Step 6 must be addressed to determine equivalency of values that can be provided by areas or resources other than those directly affected.

Step 5b

Select potential mitigation areas according to the ranking protocols in Step 5a. When searching for mitigation areas, the team can conduct spatial queries against REF attributes to identify those areas meeting mitigation criteria and occurring in REF priority areas. When required mitigation cannot be found within a REF priority area, the team can identify and investigate other areas. Failure to find any in-kind mitigation opportunities may trigger discussions on out-of-kind mitigation opportunities.

For wetlands, endangered species, and other regulated resources, the team identifies, adopts, or develops programmatic approaches to mitigation, permitting, or ESA Section 7 consultation. This is especially important if sufficient development is likely to occur in the state or region with consequent impacts or opportunities for restoration or conservation of the target resources. These approaches may enable or draw on conservation or mitigation banking in the area. Steps for developing a catalog of preferred wetlands mitigation sites are identified in this box: Proposed Process for Creating the Priority Wetlands Map.

Step 5c

To increase confidence in the mitigation component of the plan, field-validate the presence and condition of target resources for attention at mitigation sites, and reassess the ability of sites to provide necessary mitigation. Revise the mitigation assessment as needed to identify a validated set of locations to provide mitigation. This step involves not only field validation but also comparison of the feasibility and cost of conservation and restoration opportunities—taking into consideration the ranking score and the conservation actions of other federal, state, local, and NGO programs—to determine overall benefit and effectiveness. Predictive species modeling can help target the field validation process for species of concern, when such models are available.

The integration of field validation information into the REF is critical. This information may include adjustments to resource distributions or priority area configurations and resource (e.g., species, water, wetland) viability or condition. By instituting an agreed on, standardized approach to integrating any field work done by or on behalf of the REF partners (and others) into the REF database, the precision and utility of the database will gradually improve.

The state Natural Heritage Program (www.natureserve.org) has the job of conducting surveys for rare and imperiled species and communities as well as integrating others' survey work (if it meets heritage standards). Thus it can serve as a critical partner for both contributing and maintaining such data. Data security/privacy issues may preclude integrating the most spatially precise data directly into the REF database, so data use agreements must be established.

Step 5d

Develop and refine a regional conservation and mitigation strategy to achieve ecoregional conservation and restoration goals and advance infrastructure projects. The outcome of the previous substeps is development of the conservation/mitigation component of the REF that identifies, in a particular analytical cycle, the priority areas to conserve or restore to meet partner objectives. Ideally, this substep details the preferred conservation and restoration actions for the previously identified conservation and restoration priority areas, which are further described in Step 5e. This includes documenting which resources and what quantities are to be retained or restored in each mitigation area and identifying the implementation agency and mechanism for conducting the conservation investment or mitigation. This information should be incorporated in or used to update the REF—the mitigation catalog and mitigation actions should be updated with information on restoration activities, lost opportunities, and areas conserved.

Note that this step will specify many of the necessary parameters for an ecosystem credit. Step 6b connects to this step to inform decision makers on the various measurement systems available to meet the goals and outcomes of this step. The subsequent steps in the crediting process (Step 6) provide the tools for implementing these priorities. Similar to the goal-setting concerns in Step 3, the definition of resources and priorities in this substep must provide a sufficient level of detail to be useful at the implementation steps. Priorities must consider the spatial, functional, habitat, and population issues defined in Step 6b.

Proposed Process for Creating the Priority Wetlands Map

Jimmy Kagan, Oregon State University

A comprehensive digital map of wetlands is needed. The goal is to ensure that all wetlands greater than 5 acres in size are represented. If possible, comprehensive maps of wetland soils and historical wetlands should be used as they can greatly improve the quality of the map. The NatureServe national ecological systems map includes the current distribution of wetlands, linked to National Wetlands Inventory (NWI), NatureServe, and National Vegetation classifications. Biophysical settings maps from the interagency LANDFIRE effort depict historical wetland distributions. Both of these maps are at 30 megapixel resolutions (approximately 1:100,000 scale). These may be compared and combined with NWI, wetland soils maps, and terrain models, and/or augmented with additional image interpretation.

Important benefits accrue from developing wetland maps that are linked to these standard ecological classification schemes. For example, NatureServe ecological classification units are categorized by conservation status. Using knowledge of relative rarity, trends in extent, and remaining habitat quality, each wetland type is categorized on a scale from “critically imperiled” to “secure.” These conservation status measures feed directly into prioritizing sites for wetland conservation. Additionally, most wetland types in the NatureServe ecological systems classification—typically, 10 to 20 types per state—have been reviewed and attributed as habitat for at-risk and focal species; that information is then accessible to users for project scoring and selection.

In Oregon’s Willamette Valley, the state Institute for Natural Resources/Natural Heritage Program started with a good wetlands soil and historical wetlands map and existing NWI data. The institute obtained Environmental Protection Agency (EPA) funds to enhance the NWI wetlands coverage with data from local wetland inventories, wetlands mapped by the Oregon DOT, and existing wetland restoration sites and mitigation banks. At a minimum, all available wetlands data (national, state, regional, county, and local site information) need to be integrated in this way. In addition, states must ensure that all the digital NWI data for significant wetlands is brought up to date using the most recent imagery and aerial photography that exists for each state. Virginia, for example, incorporated additional spatial data to ensure that farmed and partially developed wetlands were included.

Synthesize Spatially Explicit Representations of Conservation and Restoration Priority Sites

The synthesis includes any conservation opportunity areas developed in the context of state wildlife action plans (SWAPs), conservation portfolios created in the context of ecoregional plans, or watershed plans. The more comprehensive and detailed the regional ecosystem conservation and restoration framework—and the more widely accepted it is—the more useful it will be. In every state, the SWAP is an adopted and recognized framework that can be used as a starting point. Many already incorporate the ecoregional conservation strategies developed by The Nature Conservancy with the involvement of university staff, other nongovernmental organizations, and agencies with natural resource scientists.

(continued)

If conservation or watershed plans and identifications of conservation and restoration priorities already exist, the intent is to integrate them, rather than redo them. For a single ecoregion in Oregon, five comprehensive biodiversity or conservation strategies had been developed independently. For this process, The Nature Conservancy synthesized these strategies to create a combined coverage/map of priority areas. The synthesis was adopted for use by all parties, although that is not a critical step. Obtaining recognition by the USACE, EPA, the state, and other agencies that the final conservation and restoration priority map is the best “currently available” representation of conservation priorities, however, is essential.

This synthesis portfolio map, or REF, is the input to the next step. If a state has developed a watershed approach to define wetland restoration and mitigation priorities, this approach and the catalog developed should be used, and the remaining steps can be skipped.

Extract Existing and Historical Wetlands from the Synthesis Portfolio

To do this right, a fairly comprehensive digital map of wetlands needs to be available for the state. Access to such a map—for either wetland soils or historical wetlands (or both, if possible)—can greatly improve the quality of the map.

Modify the Extracted Wetlands Coverage into a Set of Priority Wetland Polygons

This step is a straightforward GIS exercise in which new, wetland portfolio sites are created. The use of high-resolution digital imagery to refine the boundaries is important for large or poorly mapped areas. The goal is not to develop a conservation plan for a site but to refine the boundaries of the areas, so they make sense to wetland regulators as well as those working on conservation and watershed restoration.

The wetland mitigation priority areas need to make sense. In some Project C06B test areas, the team was forced to eliminate portions of some areas because of criteria associated with wetland conservation (e.g., proximity to transportation infrastructure). For instance, an airport was included in The Nature Conservancy synthesis portfolio because of the presence of some rare plants on wetland soils. These sites showed up on the first draft of the priority map, in an area with a number of high-priority sites. Wetlands regulators had them removed because they did not want to promote wetland mitigation so close to an airport. If these sites had been critically important, or the only priority wetland in the watershed, the team might have discussed leaving them in. This task is not very time consuming, but it is important.

An alternative method, especially useful in areas with extensive wetlands, is to analyze all wetlands, determine their conservation significance, and rank them accordingly. The highest ranked areas become the wetland priority areas. This method is a bit more expensive but is useful in areas in which an overall synthesis of conservation priorities cannot be developed.

Ensure that Every Watershed Has at Least One Priority Wetland Conservation Site

This step involves working with regulators to determine if mitigation occurring in the same 8-digit Hydrologic Unit Code (HUC) can be considered in-place (assuming the types present are similar enough to be considered in-kind). If

(continued)

desired, a 10-digit HUC can be used; these are smaller and provide regulators more assurance that mitigation is in-kind and in-place. In almost every major basin in the country, one or more watersheds contain no synthesis, portfolio, catalog, or other priority areas. In those watersheds, catalog sites need to be identified from the original assessments that had wetland components or by looking for concentrations of natural wetlands. The Project C06B team made sure that each area had at least one potential site.

Nationwide, conditions vary considerably across 8-digit HUCs. In those for which no potential mitigation sites have been identified, local plans, known locations of at-risk biodiversity, NatureServe conservation status of wetlands (i.e., imperiled to secure), and the documented quality and condition of wetlands (using the NatureServe Landscape Condition map and other sources) can be used to identify priority sites for review by local regulators and practitioners.

Create Priorities for the Wetlands Catalog

Developing priorities can make decision making easier for transportation planners. A simple method is to rank the set of priority wetlands within each 8-digit HUC. The basic concept is that any restoration, mitigation, or conservation within a priority wetland area is good enough; and if being included in a priority area is a criterion for increased wetlands function (as it hopefully will be), then no difference in function crediting between any priority wetland should result, regardless of ranking. State DOTs may want to demonstrate that all decisions they made were based on regulators' or priority criteria, not their own, which is why ranking the priority wetlands within each watershed can be useful. Specific criteria for ranking the catalog are not recommended here.

Vet the Priority Map with Regulators and Wetland Program Staff

First, the priority map should be vetted with conservation partners, if they are available in the area. Then the team should set up a meeting with regulators, making sure to include the USACE, EPA, National Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), state agencies that regulate wetlands, the state DOT, the state fish and wildlife agency, and other state agencies as appropriate.

Promote the Wetlands Priority Products and Facilitate Their Use by Federal, State, and Local Planners

Once the wetland priority maps and resources have been developed, any further steps needed to facilitate their use in decision making for Section 404 permitting and, as appropriate, ESA Section 7 consultations and other regulatory matters must be identified. This step involves consideration of the nation as a whole as well as the respective states, USACE districts, and EPA or USFWS regions and field offices. The best methods will be different in each state and jurisdiction.

The information should be made available to the public as soon as it has been vetted (otherwise, for example, wetland bankers who do not have access to the data will have an argument for protection of nonpriority areas). In particular, the information should be made available as soon as possible to local governments and all those who develop and/or approve development applications on the local level, as considerable avoidance is anticipated, on a voluntary or preregulatory level.

Step 5e

Decide on and create a map of areas to conserve, manage, protect, or restore; include documentation of the resources and the quantities to be retained/restored in each area, and the agency and mechanisms for conducting the mitigation. In this step, the REF database is used to inform stakeholder decisions and create a map of areas to conserve, manage, protect, or restore. This step entails documenting the resources and the quantities that need to be conserved or restored in each priority area. It also provides further detail on the preferred conservation and restoration actions for the previously identified conservation and restoration priority areas (e.g., the agency and mechanisms for conducting the mitigation).

Step 5f

Obtain agreement on ecological actions from stakeholders. In Step 5f the decisions of the stakeholder agencies are formalized, and agreements may be recorded in MOUs or regulatory documents. Also see Step 7, to which this step is a lead-in.

STEP 6: DEVELOP CREDITING STRATEGY**Purpose and Anticipated Outcomes**

The purpose of Step 6 is to develop a consistent strategy and metrics to measure ecological impacts, restoration benefits, and long-term performance—with the goal of using the same units and language throughout the life of the project, to the maximum extent possible.

The ecosystem service accounting methodology follows a seven-step subprocess to the IEF, in which the DOT and REF team verify the need for a crediting system, identify existing options, and—if needed—select a method for developing a custom crediting system. These measurements may be used to provide the basis for credits or debits in a compensatory mitigation context, or to evaluate design alternatives that best avoid or minimize impacts.

The first step in employing ecosystem crediting is to analyze the need and roles of crediting. This may include a scan of regulatory, conservation, and market needs. The regulatory scan starts with a review of the permitting and compliance requirements in the study area. It can include a historical review of agency permitting obligations and costs or a review of the agency records for permitting. Conservation scans require examining other regulation-based and voluntary conservation efforts that may identify species, habitats, or systems that require attention. Market scans include reviewing the regional mitigation need and banking if used.

Ecosystem crediting decision making begins with agreements on objectives for crediting and the basic rules for their use in transportation planning. The key question is, What existing measurement systems are in use? They may include those associated with ESA recovery efforts, pollutant measures for TMDL management, and wetland measures. Early coordination with other planning efforts can help resolve any opportunities and challenges that are identified.

Anticipated outcomes of Step 6 include the following:

- Improvement and integration of the mitigation sequence at a site level through *avoidance*, using a metric that provides a systematized and structured scenario analysis that leads into *minimization*, which is aided by the same metric and provides the basis for outcome-based performance standards, which sets the stage for *compensation*, which is defined by the same metric and calculates the debit and credit totals associated with the project impacts and mitigation outcomes, respectively;
- Accelerated implementation and improved mitigation results;
- Implementation tools such as advance mitigation, banks, programmatic permitting, and ESA Section 7 consultation;
- Off-site and out-of-kind mitigation where appropriate, since equivalency of value can be determined across locations and resources;
- Better informed adaptive management and updates of the cumulative effects analyses;
- Balanced gains and losses of ecological functions, benefits, and values associated with categories of transportation improvements or specific project-related impacts; and
- The means to track progress toward regional ecosystem goals and objectives (assuming site-level ecological metrics are correlated to the landscape-level tools used to define the REF).

Implementation Substeps and Technical Considerations

A summary of the substeps follows.

Step 6: Develop crediting strategy

Implementation Substeps

- 6a. Diagnose the measurement need. Examine the ecological setting (including regulated resources and frameworks, nonregulated resources, and ecosystem services); examine the regulatory and social setting; and identify additional opportunities.
- 6b. Evaluate ecosystem and landscape needs and context to identify measurement options.
- 6c. Select or develop units and rules for crediting (e.g., rules for field measurement of ecological functions, approved mitigation/conservation banking, outcome-based performance standards using credit system).
- 6d. Test applicability of units and rules in local conditions.
- 6e. Evaluate local market opportunities for ecosystem services.
- 6f. Negotiate regulatory assurance for credit.
- 6g. Implement the program.

Technical Considerations

- How will debits and credits be calculated? Is credit stacking allowed?
- What is the permissible service area for a bank or off-site mitigation?
- Who may participate in the crediting system?
- How will credits be registered and tracked?
- How long will regulatory decisions on a given project be binding?
- How will values be calculated across locations and resources?
- What long-term monitoring is needed?

Step 6a

Diagnose the measurement need. Diagnosing resource measurement needs for the purposes of transportation development, regulatory permitting, and environmental stewardship requires examining the resources, constraints, and opportunities that affect the choice of a methodology. The natural environment and resources in the area—either in the entire jurisdiction or within the areas of anticipated highway improvements—are the primary factors. The second component is the evaluation of regulatory requirements and nonregulatory expectations for the agency in managing the environment. The final component is an examination of the opportunities for meeting the environmental management needs through existing markets, conservation initiatives, or other innovative solutions. Through this diagnosis, an agency can assess the ecological, social, and economic needs for tracking environmental impacts in both the regulated and nonregulated arenas. A discussion of these factors follows.

Examining the Ecological Setting

A key challenge in any environmental planning effort is understanding the scope of what may be affected. Impacts range across types, scales, and time depending on a variety of factors; they occur in a context of other impacts from existing and new actions, as well as other recovery or conservation actions and priorities in a region. Choosing the correct strategy for measuring the environment entails understanding this ecological setting.

Different resource types and habitats lend themselves to different measurement needs. Highly diverse ecosystems with complex biophysical processes require more detailed measurement systems. Simpler or more homogenous ecosystems allow for more basic measurement systems. The interaction of ecosystem functions also informs the measurement system selection. In ecosystems with competing processes, the analysis is complicated; it needs to either mimic the tension in the natural system or develop a series of tools to weigh trade-offs in implementation that may favor one resource. An example is habitat enhancements for an anadromous species made at the expense of a native warm water fish species. In that case, the policy decision favored one species over the other in a system that presumably has increasing pressures for both.

Resources to examine can be roughly divided into three categories based on the resource connection to the DOT business model. Recognizing that not all DOTs have the same levels of authority or support for addressing some resources, these categories

can be different from state to state. However, they are based primarily on the existence of drivers that force an issue into consideration in the planning process (14).

Regulated resources and frameworks. Resource agencies can help the team identify species and habitats covered by the ESA or state or local protections. Data may include species distribution data such as probabilistic data or recorded occurrence data. Water quality regulations identify aquatic resources to consider in measurement, along with other data sets such as local or national wetland inventories.

Nonregulated resources. In addition to species or resources with specific protections, other resources or habitats may exist that require consideration for community or regional interests. These resources may include species of local or state concern which are not afforded protections but are recognized by the public or NGOs as important. Examples are recreational, fishing and hunting, or subsistence resources. Native foods or resources may also need to be included.

Ecosystem services. The ecosystem services approach provides a framework for measurement. Depending on the classification system used, ecosystem services can be divided into many categories, often too numerous for implementation in a transportation context. The Millennium Ecosystem Assessment provides a broad set of definitions for ecosystem services that can help identify ecosystem services to include in analysis (15). The system divides services into four categories:

- *Provisioning services* are the services and goods that are most directly consumed by society. They include the production of fuels, foods, fiber, and other tangible goods that may already have an established market or economic definition.
- *Regulating services* include the natural systems that moderate floods; maintain healthy fire, disease, or pest regimes; or provide protection for catastrophic events naturally.
- *Cultural services* are the social, spiritual, and recreational services from the landscape.
- *Supporting services* provide the underpinning for all other services. They include biodiversity, nutrient cycling, and other key ecological processes.

Examining the Regulatory and Social Setting

Regulatory and social conditions can be evaluated through both a historical review of DOT experiences and a forward look at potential new regulations or social expectations from projects.

An examination of permitting documents from projects over the previous 5 years is a useful start. In addition, the internal and external agency staff who supervised the permitting may be able to speak to the metrics that were used. This evaluation also creates a baseline level of impacts that provide important planning information, which helps in understanding the trends in resource impacts. Ideally, it includes estimates of costs for implementing compliance actions, to highlight implications and trade-offs. This baseline must be understood in the context of the STIP priorities over the past planning period and compared with current priorities. Statewide planning and project delivery often come in cycles, with periods of greater and lesser construction intensity

and focus of transportation investment in different areas. An awareness of these cycles can help the team forecast regulatory needs and appropriate metrics. In other areas, indicators may be just emerging (e.g., potential new regulation, such as expansion of listings under the ESA, the growing applicability of the Safe Drinking Water Act, and the role of climate change regulation in transportation planning).

The social setting captures the concerns, usually outside the formal regulatory system, that the public expects the DOT to address. Such concerns may be found in recent environmental documents or a review of stakeholder communications, in a more passive approach to assessing public concern (16). Often the public has not had the opportunity to fully study environmental issues, so clear and consistent preferences are not established.

Identifying Additional Opportunities

Ongoing compliance efforts or conservation programs can also provide opportunities for off-site mitigation actions that may improve environmental performance and function in important ways (17). These same programs have provided better transportation cost efficiencies as well as more controlled and specified costs in project delivery (18). Traditionally, such opportunities focus on examining existing banking or mitigation programs the DOT can take part in (2). As mitigation banking evolves, more innovative solutions are emerging from other biodiversity-based drivers based on state or local laws (19). In addition, new policy research has called for opening up innovative DOT-sponsored environmental mitigation and conservation programs to private entities to increase private environmental compliance and to support DOT environmental programs (20). BenDor and Doyle examined the North Carolina Ecosystem Enhancement Program and identified the difference in compliance efforts by public versus private permittees. They suggest that the public system can be a smart extension to support local land use compliance requirements in private developments as well (21).

Nonmitigation-based opportunities can include examining the green space, open space, or other public lands needs of neighboring jurisdictions such as state or county parks, or local parks districts. These approaches can align with regional open space or green infrastructure programs (e.g., Greenprint) (21). While these programs may not legally be available for compensatory mitigation under federal law, they provide an opportunity to comply with state, local, or nonregulatory expectations for projects, especially urban capacity projects; and the metrics used are relevant.

Step 6b

Evaluate ecosystem and landscape needs and context to identify measurement options. The initial step of diagnosing the needs for a measurement system (Step 6a) identifies the important boundaries for managing the resources. The subsequent step is to evaluate the necessary scale and units for management and to identify linkages to landscape tools such as the REF or other selected tools.

The starting point for evaluating the need for an environmental measure is to define the service area boundary that the measure will be used within and the relevant resources present. A service area is defined by the spatial limits that include resources with ecological connections and also specifies where off-site actions may be

undertaken. For aquatic resources, service areas are almost always hydrologic. For faunal species, the service area may be a particular range, habitat, or ecoregion. Air resources, especially carbon, can have large service areas.

When a REF is being developed for an area, this is the proper starting point for identifying the appropriate boundary. If multiple resources are being combined, additional refinement may be needed to assess the measurement options available. In addition to the ecological boundaries, an awareness of traditional regulatory or political boundaries (such as ones created by federal or state law and local conservation regulations or land use requirements) is important. Multiple boundaries may need to be identified initially; once crediting is decided on, the boundaries can be reevaluated for integrity.

Crediting Definitions and Considerations

Environmental measures can be divided into three forms. First are condition-based measurements. Measurements in this category focus on quantifying changes in the status of the regulated resource. For instance, population surveys provide an indicator of species viability and potential impacts for species of concern. Condition-based measurements also include pollutant loads, which are normally defined by quantifying specific amounts of criteria pollutants added or removed from the system (e.g., pounds of nitrogen or percent increase in turbidity). Condition-based examples include fish return counts, water quality measurements, and biological integrity indices.

The second form is model-based measures that rely on data to estimate species or ecosystem response. Often these measures rely on concepts similar to condition-based ones, or they try to replicate a condition-based measure with models. Some models can very reliably do so, by learning rules and relating observations to predictions, through hundreds of thousands of model runs. The latter are sometimes known as inductive methods.

The third form of environmental measurement is function-based. These measures focus on habitats, structures, and processes as the basis for measuring the environment. Function-based systems are not species-specific; they are used when rare or unique resources need measures that are not easily measured with one species. Model-based measurements can combine elements of a function-based measure and a condition-based measure, in which case the model relies on habitat or field data to estimate habitat use and densities.

To truly get at a measurement for use in transportation projects, the results of planning-level models or data need to tie the natural impacts back to specific actions at a site. This is necessary for the full suite of mitigation decisions: avoidance, minimization, and compensation. These concerns need to guide the selection or development of a measure. The various existing measures used in environmental management settings are described in the following paragraphs. Then a summary of challenges and a guide for developing custom measurements are presented.

Condition-based measures. Condition-based measures are structured to collect data on the physical, chemical, and biological attributes of a system. These measures can be as simple as a plant and animal survey to measure occurrence of a species. More

complex measures provide the basis for long-term monitoring and management of a region.

Condition-based measures can be applicable in certain cases for transportation projects, though they present important challenges that must be considered before agreeing to use them in permitting or in restoration. For transportation projects in remote and undeveloped areas with no other anthropocentric inputs to affect environmental quality, condition measures may be able to evaluate an action's level of impact. They may also be important in regulatory settings in which they are a common tool for management, such as under the Clean Water Act or Safe Drinking Water Act. An example of such a use is a river crossing with potential impact on surface drinking water sources. Disturbances to surrounding upland areas might create erosion and sediment inputs that place the body of water over limits for turbidity in a municipal water system.

Two primary forms of condition-based measures are index-based systems (indices of environmental quality or integrity) and observation-based systems. Index-based systems identify a set of field-based measures that provide a comprehensive index for health. The use of indices expanded with the passage of the CWA, which requires a comprehensive measure for a water body's health. Early implementation of the CWA was supported with the development of indices of biotic integrity (22). These methods reflect an understanding that biological organisms better capture the health of a system than strictly chemical and physical measures. Thus they focus on species that are understood to serve as indicators of the health of a system, such as macroinvertebrates or fish species. These measures provide a relative measure of health based on a comparison with conditions at reference sites and other randomly selected sites that are considered comparable for analysis. This process develops measures of deviation and allows for long-term monitoring. Data collected in this process are based on sampling surveys and can include species abundance, diversity, size classes, species composition, observations of health, and other biological measures. Data can be in absolute terms such as abundance or in qualitative terms such as health (23).

Observation-based measures are less commonly used in accounting applications because of challenges in attributing causation to the observed data. A reasonable use is for relatively closed systems in which the DOT actions are clearly the only source of undesired impacts. Observation-based systems also apply in situations with species or resources that are relatively static, such as plants. Observed measures may also be a component of monitoring sites after restoration or disturbance. Permit conditions can also be based on observed data. Examples include water quality monitoring when the contributors to turbidity are easily understood and any observed increase can be assigned to the construction activities in the watershed. This method has been used in limited cases and depends heavily on well-understood watershed processes that the permittee and regulator both agree on and trust.

Probability-based distribution mapping tools have been introduced as a part of the SHRP 2 program as a replacement for traditional inventories of observed points. These probability-based tools are best suited for project planning, since they may be applied at that level without site observations. Thus they are very useful in avoidance

and minimization measures and in supporting the identification of sites for compensation. In general, observed data are not recommended for use unless a trusted and continuous base of data is available to provide reference conditions for comparison.

Model-based measures. Model-based systems rely on an agreed on set of rules and conditions that are expected to result in an environmental outcome. Model-based systems are similar to condition-based measurement systems but are usually employed for planning purposes. Unlike condition-based systems that focus on sampling data, models focus on the elements of the ecosystem that can be affected by human action.

Examples are found in biological and chemical applications. Salmonid modeling, such as with the Ecosystem Diagnosis Tool, identifies the restoration actions or ecosystem components that contribute to species health (24, 25). Likewise, the Spatial Decision Support for Desert Tortoise Recovery incorporates a threats-assessment model and provides a tool for prioritizing and evaluating recovery actions. Emerging carbon protocols for climate change accounting are agreed on models that represent the carbon benefits or detriments of specific actions (26). Models are best applied in complex environments for which complete baseline data are not easily available across the desired range and for which individual actions or impacts need to be understood in a context of many human actions, when effects may be difficult to attribute.

Function-based measures. Function-based systems combine elements of condition-based systems and model-based systems. A function-based measurement identifies attributes that capture the habitat structures, elements, and other biophysical features. A function can be both abiotic and biotic. Abiotic measures tend to be more common as they are relatively static and easily observed. Biotic measures are more complex, relying often on multiple subfunctions to assemble a properly functioning measure.

Functional measures are often performed with field-based observation and investigation. Attributes are empirical, observed data that include such measures as percent cover of vegetation, substrate types, slopes, species mixes, and so on. The attributes are evaluated on the basis of scoring protocols built on existing literature, models, or peer review processes. The attributes are then combined to provide a measure of performance for that function. The final unit of measure is then a combined, multifunction level of performance by area. This provides a functional area measure that can be compared with other sites. While reference sites are not necessary for functional measures, they can be used to test outcomes and calibrate scoring of credits. In this manner, they are based on site-level evaluations with values based on best-available science.

This approach provides a common unit of measurement for biological, chemical, and physical processes that can readily be linked to economic decision making (27). Functions also provide a robust common unit for analyzing multiple resources or ecosystem services because functions provide a bridge between the biophysical and the final outcomes for which we manage resources (28, 29). Environmental economists have recommended making a shift toward function-based measures because they also allow for analysis of the services before clear pricing or valuation is developed. The

structures and functions of a natural system must be understood before any value system can be placed on top of it (30).

Several implementation benefits accrue with the use of function-based systems. First, because the natural environment and ecosystem services are measured through constituent functions, multiple resources can be captured in a single measure. Second, the empirical basis of observed attributes of functions allows for easier inclusion of functional measures in contracts or permit terms and conditions. They are objective and enforceable elements that can be requested of an agency or contractor.

Alternatives analysis and scenario-based planning can also be implemented with function-based measures. The future scenarios specify the assumed attributes to be found on a site, the attributes can be scored, and credits or debits can be estimated. Scenarios in this context can include alternative vegetation management programs, stream restoration, and forest management, as well as impact scenarios based on highway development. The alternatives can then each be evaluated based on the number and type of credits generated or diminished by the proposed actions.

Another benefit of functional measurement systems is that they provide a basis for ecosystem service measurements (30, 31). Adding the opportunity to provide a field-based measurement is the best approach to an empirical measurement for ecosystem services. Currently, function-based approaches are developed regionally, with different but similar methods used, depending on the local scientists. Developing standards may be difficult but could improve the adoption of these methods.

Summary of Challenges

The three forms of measure can be understood according to the type and nature of data required and the temporal frame within which they work. Data included in these systems can be primary or secondary. In general, condition- and function-based systems focus on primary data collected specifically for the measure, though secondary data can be used. Modeled data process existing data and do not necessarily rely on field-based data sets. The temporal frame is the usability of the measurement system to *track* changes versus the ability to *forecast* change. Functional and model systems are able to forecast change on the basis of proposed actions or change in the environment. Condition-based systems rely on historical data and are challenged when they attempt to forecast future changes in condition. This temporal frame is critical in a regulatory or crediting scenario as some certainty in measurement of proposed impacts and proposed restoration actions is needed before they are implemented. Because a common application of credits is in the terms and conditions of permits, the credits must be easily defined on the basis of proposed restoration actions that may be written into a construction contract or similar agreement.

Condition- and model-based systems center on species and their responses to impacts on the environment. These measurements are most commonly used in monitoring species health and for responding to impaired landscapes (e.g., restoring water quality). These measurement systems are suited for comprehensive management of a given resource. The challenge they present for impact and conservation actions is they do not provide a methodology to attribute the benefits or impacts of a given action. For

example, a protocol for a condition-based measure may include random sampling for macroinvertebrates. Ideally, longitudinal data collection will have occurred to provide the baseline and level of variation. Following construction of a project, the monitoring can continue and document a change. In practice, though, this is problematic. The baseline and variation analysis present the main barriers to implementation. Condition-based systems can provide information in design about resources that are considered vulnerable and have to be avoided. However, the need to compare actual affected conditions with a reference site means these measures are best applied *after* construction of a project and are less applicable for estimating credits in the planning stages. The measures do not lend themselves to reliable forecasting of change because of the level of assumptions required. Condition-based systems can also provide support for long-term monitoring after construction of a highway project or a restoration project.

Selecting the Right Measure

Recognizing that each region, agency, and regulatory setting requires a unique response, these general classes of measurement are presented to help practitioners decide on the best system to use. In areas with lower levels of biodiversity, or with only one or two resources of concern, condition-based measures can assist transportation project delivery. In this context, the condition-based measure is derived from the REF, conservation plan, or recovery documents to provide priorities. For more complex environmental settings or when forecasting impacts is more critical because of the sensitivity of resources, models and functional measures excel. Finally, if multiple resources need to be tracked, forecasted, and credited, then functional measures excel.

Volume 2 of the SHRP 2 C06 Report, *An Ecological Approach to Integrating Conservation and Highway Planning*, identifies a number of tools at the landscape and planning level that address the need for integrated resource management with transportation development. The PlanWorks, formerly known as Transportation for Communities—Advancing Projects through Partnerships (TCAPP), website contains this database of international measurement and assessment tools, which were evaluated to assess their applicability in generating credits for environmental mitigation decisions and actions. The tools are categorized according to their basis of measurement: function, population, or habitat type. They are also categorized according to their existing use or lack of use in regulatory systems, as well as the ability of the credit to capture multiple functions, credit types, or resources. Credit systems with field versus GIS-based analysis are also identified, along with a breakdown of access and cost issues associated with the tools.

These integrated programs provide guidance in planning at the project level. The crediting system documented here addresses the need for a connection between planning-level analysis and site-level analysis. To fully implement the planning tools developed in Volume 2 of the C06 Report, a functional measurement system is necessary to reconcile multiple resources at the site level.

One of the key challenges in site measurements for multiple resources is the *stacking* of various credit types. Because many of the crediting programs need to connect back to both regulatory and nonregulatory processes, documentation is needed to

clarify that no single credit is satisfying multiple regulations. In other words, credits must be shown not to “double-dip” or count twice for a liability. One strength of functional measures is that credits are created with constituent functions that can be assigned to specific regulations or goals and mathematically isolated to prevent double-dipping.

Note that this challenge is not an environmental one. Stacking occurs naturally in the environment, as multiple resources can benefit from a single feature. For example, a riparian forest provides shade to cool adjacent waters, carbon sequestration through growth, and song bird habitat. These resources evolved synergistically, and certain characteristics often reinforce and benefit others. The regulatory system, however, requires that mitigation benefits be counted only for the debit they are assigned to. Technically, this is accomplished with functions, but the distinction is relevant here; although the environmental benefits of stacking are clear, they are seen as undesirable in the regulatory system. The technical details of stacking are discussed in the next step.

The following step introduces the method for adopting or developing a functional measure to integrate into the *Eco-Logical* approach and the larger planning tools included in Volume 2 of the C06B Report. The step provides a process for a DOT to develop, negotiate, and adopt a crediting system that can include ecosystem services and regulated resources while at the same time managing multiple stacked credit types. Stacking and double-dipping are discussed further under negotiating credits in Step 6f.

Step 6c

Select or develop units and rules for crediting. This step provides the basis for developing a custom measurement system based on functions for multiresource crediting. If an appropriate existing measurement system was identified in Step 6b, then this step may not be necessary. The following paragraphs detail the considerations and issues that must be addressed for a robust measurement that is also balanced with the level of effort needed to implement it. An excellent introduction into regional-scale measurement requirements for ecosystem services can be found in Ruhl, Kraft, and Lant’s 2007 text, *The Law and Policy of Ecosystem Services* (32).

To develop a measurement system, practitioners must first consider the resources of concern and the size of the areas to be included. Much of this will have been identified in Step 6a, with the assessment of the various ecological, regulatory, and social contexts; however, in this substep the details of the resources are further developed.

Identifying Resource and Ecosystem Services

The first question to ask is what services or resources are of concern. To start, practitioners should review the highway- or agency-specific concerns and then identify services. For example, stormwater treatment may be a concern. From an ecosystem services perspective, the site-level need is for more natural water quality regulation. Water quality regulation as a service is provided by functions performed based on the existing vegetation, soil types, site topography, and so on.

Similarly, a regulatory agency or other stakeholder may identify a resource concern such as listed species or species of concern. These are biodiversity services. Practitioners then identify functions that support these specific biotic concerns. For example,

concern over aquatic species requires functions that support various life stages of the species, such as foraging and rearing, spawning, and connectivity for migration. These functions can then be defined through specific attributes such as pool or riffle types, substrate, and adjacent bank characteristics.

As the services or resources are compiled and the necessary functions to support them are identified, functions may overlap. Using the example of the water quality and aquatic species, both rely on functions performed by stream-side vegetation that shades water bodies or reduces sediment and pollutant transport into water bodies. This overlap is a critical feature of the multiresource functional measurement system. It allows the multiple resources to have a relationship that can inform site and design choices.

Developing Functions and Attributes to Measure Services

The basic spatial unit of a functional system is the map unit, a relatively homogenous and contiguous land cover type. Within these map units, attributes that indicate the level of functional performance are collected. To develop functions, practitioners must have an understanding of this structure. Functions can be divided into the abiotic and biotic categories, that is, functions that address biophysical processes versus species-specific processes. The measurements are based on attributes that can be easily collected by a field crew without extensive field instrumentation or long-term monitoring.

An overall functional performance score for the map unit is derived equally from the contributions of the abiotic and biotic functions. The respective biotic and abiotic functional performance scores are combined to provide a total biotic and a total abiotic functional performance score for the map unit. The two performance scores are then combined and multiplied by area and habitat type to obtain the overall measure of functional performance for the particular map unit. These scores are summed to provide the functional performance score for the entire site.

The first step in developing a biotic or abiotic function is creating a conceptual diagram. The diagram aids in all aspects of the development of the function but is most important to the application of the measurement system. In creating the conceptual diagram, practitioners consider preexisting conditions or current conditions to describe what the function requires at a site level. In general terms, this creates the logic of how and when to score a map unit for a particular function. The system itself turns functions on and off within the equations on the basis of the triggering conditions identified in the conceptual diagram.

With the functional diagram completed, the attributes and scoring must be generated. Through a survey of literature, available science, outreach to experts, and other tools, practitioners develop the list of field-based data needed for the function. In addition to identifying these attributes, practitioners evaluate their role in contributing to the performance of the function. All functions have a 100% level at which the natural system is performing the function at its highest possible level. This level is helpful to consider when evaluating the type and amount of attributes needed. Similarly, at 0% function, what attributes, if missing, would limit the function fully? Note that at the 0% level, other functions may be affected. For example, a function that is

highly dependent on canopy cover cannot co-exist with a function that is dependent on exposed ground or grasslands.

As attributes are identified, their relative contribution to the function starts to emerge; the next step is to score all attributes for the function. For example, in a function that evaluates a map unit's ability to infiltrate stormwater, the amount of pervious surface needs to be scored. In this case, a logarithmic curve may indicate slight loss of functional performance as the initial increments of impervious surface are added to the map unit. However, each additional increment of change to impervious surface will have an increasingly rapid effect on the functional score. The scoring curves are drawn for all attributes that contribute to the functional performance.

As the functions are developed, the attributes must be checked across all the functions to ensure that the data collection protocols remain constant. This is frequently a challenge when different measurement standards are combined across disciplines. The compilation of the attributes provides the basis for the creation of a functional measurement data sheet that combines all the data requirements for the system into a single instrument for field use. Another benefit of this functional approach is that, as new functions are identified, they can be built from existing attributes—or by programming just a few additional attributes into the system.

Temporal factors are the final consideration for functional measure development. To ease implementation, the goal should be for measures to work at any point in time. Water cycles, seasonal fluctuations, and other natural system dynamics can complicate attainment of this goal. For example, substrate observations for stream systems may be influenced by turbidity that limits visual assessment. These considerations need to be addressed as attribute data collection is defined in the field protocols. Other measurement methods may need to be developed or other assumptions may need to be in place to address the limitations.

As functions are developed, they are combined on the basis of agreed on rules. Depending on the selection of functions, policy considerations often inform the relative importance of functions. For example, stormwater management functions may be given priority over other functions in a transportation context. In those situations, formal weighting factors must be applied to capture the priorities. While other services may still be important, they must be combined at a lower level with the higher-priority stormwater management functions.

Step 6d

Test applicability of units and rules in local conditions. The application of a functional measure is recommended as a three-step process. Initially, the current pre-implementation (baseline) condition of the site is determined using data collected on site. The system generates a baseline functional performance score for the site. The second step is to generate one or more design alternative scenarios. For each alternative, a set of map units and data is generated on the basis of the information in the design plan. This should reflect conditions on the site at some predetermined future date. (In general, a 20-year postimplementation time period is used.) Using this set of map units and data, a future-conditions functional performance score is generated for each alternative. To determine the uplift or impact of a given design, the baseline-conditions

site score is subtracted from the future-conditions site score. If the resultant number is negative, a debit has been generated; if positive, the project results in uplift. The degree of impact or uplift is the number generated.

Step 6e

Evaluate local market opportunities for ecosystem services. Market opportunities can include existing wetland or conservation banking systems or more advanced payment for ecosystem service (PES) systems. PES systems are negotiated contracts with landowners who agree to maintain a certain level of environmental performance to maintain or enhance ecosystem services (33). Criticisms of these systems come from a concern that they lack a clear way to track performance; however, that is a technical measurement problem and does not undermine the potential power of PES systems (34).

Developing ecosystem metrics and tracking project impacts using those measures can ease access to any operating regional ecosystem markets. Step 6a includes consideration of the existence of ecosystem markets as part of the regulatory compliance considerations associated with selecting or developing an ecosystem metric. If those criteria have been properly considered, then the DOT's ecosystem measurement system should be well suited to ecosystem market use. Ecosystem markets can offer a number of advantages for DOTs, including the following:

- *Certainty.* Purchasing credits from a mitigation bank removes the schedule risk and uncertainty associated with getting approval of mitigation siting and design. Further, ecosystem markets provide greater budget certainty because the cost per credit is generally a known quantity—while mitigation design and construction are not (particularly for sites that have difficulty with plant establishment). Also, the costs of mitigation and the liability associated with those costs can extend out 5 to 10 years or more.
- *Transfer of liability.* Many ecosystem markets include a transfer of liability for mitigation success. Wetland mitigation banks pursuant to Section 404 of the Clean Water Act and conservation banks pursuant to the Endangered Species Act place the liability for restoration/conservation success on the banker. Note that this is not universally the case. Liability under the Clean Water Act's National Pollutant Discharge Elimination System permit program remains with the permittee, even when the permittee is meeting permit conditions through a market transaction.
- *Better alignment of missions.* Although many DOTs employ highly qualified and experienced biologists and ecologists, the mission of the DOT focuses on providing and maintaining transportation systems. That means the DOT project delivery focus is on the road, bridge, or other aspect of transportation infrastructure—not the wetland or native habitat being restored as part of the project's impact compensation. Thus, the mitigation is often lumped into the same contract as the road or bridge construction. This can lead to situations in which the grading and earthwork for the mitigation site is done by contractors with experience and expertise in road construction. Restoring or establishing a wetland and building a road require different skill sets. It is best when restoration professionals build and

oversee development of mitigation sites and road construction contractors build the highway infrastructure.

- *Improved ecosystem outcomes.* Ecosystem markets provide the opportunity to focus larger, more meaningful restoration projects on addressing regional ecosystem priorities, moving away from small, on-site mitigation, which is often ineffective. Small mitigation sites were often developed to provide on-site, in-kind mitigation, but they are often inefficient and not ecologically sustainable.

In contrast, mitigation bankers have an incentive to focus on ecologically desirable outcomes since regulators are not likely to approve use of the bank unless it provides adequate ecological benefits. The bankers have an incentive to make the site successful because credit release is incumbent on reaching certain, preestablished success criteria. Though credits are often released before the wetland is fully functioning, some benefits are in place or on the way before the impact occurs. Mitigation bankers are also supposed to provide for protection in perpetuity at the site. Often this has meant turning the site over to a third party (e.g., land trust or conservation organization), preferably with an endowment to pay for long-term site management.

2008 Compensatory Mitigation Rule for Losses of Aquatic Resources

Section 332.3 General compensatory mitigation requirements. (c) *Watershed approach to compensatory mitigation.* (2) *Considerations.* (iv) "A watershed approach to compensatory mitigation should include, to the extent practicable, inventories of historic and existing aquatic resources, including identification of degraded aquatic resources, and identification of immediate and long-term aquatic resource needs within watersheds that can be met through permittee-responsible mitigation projects, mitigation banks, or in-lieu fee programs. Planning efforts should identify and prioritize aquatic resource restoration, establishment, and enhancement activities, and preservation of existing aquatic resources that are important for maintaining or improving ecological functions of the watershed. The identification and prioritization of resource needs should be as specific as possible, to enhance the usefulness of the approach in determining compensatory mitigation requirements.

(2)(i) ". . . Such an approach considers how the types and locations of compensatory mitigation projects will provide the desired aquatic resource functions, and will continue to function over time in a changing landscape. It also considers the habitat requirements of important species, habitat loss or conversion trends, sources of watershed impairment, and current development trends, as well as the requirements of other regulatory and non-regulatory programs that affect the watershed, such as storm water management or habitat conservation programs" (13).

Step 6f

Negotiate regulatory assurance for credit. Credits for wetlands have most often been allocated on a per acre basis. The “Federal Guidance for the Establishment, Use and Operation of Mitigation Banks” (35) first provided guidance on the procedures for establishing credits and debits at bank sites: “Credits represent the accrual or attainment of aquatic functions at a bank; debits represent the loss of aquatic functions at an impact or project site. Credits are debited from a bank when they are used to offset aquatic resource impacts (e.g., for the purpose of satisfying Section 10/404 permit . . . requirements).

“. . . The range of functions to be assessed will depend upon the assessment methodology identified in the banking instrument. The same methodology should be used to assess both credits and debits. If an appropriate functional assessment methodology is impractical to employ, acreage may be used as a surrogate for measuring function. Regardless of the method employed, the number of credits should reflect the difference between site conditions under the with- and without-bank scenarios.”

Districts determine, on a case-by-case basis, whether to use a functional assessment or acreage surrogates to determine mitigation and describe authorized impacts. The same approach is used to determine losses (debits) and gains (credits) in terms of amounts, types, and location(s) for describing both impacts and compensatory mitigation (36). North Carolina and Oregon provide two examples:

- North Carolina’s Ecosystem Enhancement Program accounts for acres of freshwater and coastal wetlands and riverine and nonriverine wetlands. An MOA between the USACE, North Carolina DOT, and the state Department of Environment and Natural Resources acknowledges the goal of moving to a functional replacement system for mitigation; it also provides a mechanism for transitioning the MOA to functional replacement accounting if and when a scientifically acceptable method is developed by the three agencies. Although initially emphasized, the functional assessment approach is now on the slow track, as the partner agencies have agreed on the benefits of the simpler, acre-based approach.
- The Oregon DOT’s functional assessment determines habitat value credits for wetlands and species based, in part, on acreage. In addition to acreage, other values related to habitats, species, and functions are used to derive the habitat value number. The Oregon DOT’s functional assessment approach relies on key ecological functions as an important component of successful ecosystem-based management. Using species and habitat data, historical and current functional profiles for each “ecoprovince” were developed to assess how functions have changed over time. The ecoprovince functional profile allows users to review the functional roles played by all species thought to occur within the ecoprovince.

Stacking Credits and Double-Dipping

Ecosystem functions and services have interconnected relationships that can be complementary, conflicting, or magnified based on their interactions. The ability to measure multiple resources and services at once is a critical feature in functional measures, particularly when they are used to generate credits that will be bought or sold in a

mitigation or ecosystem marketplace context. By working at the most basic level of environmental measurements, functional measures provide a system that can “stack” or combine multiple credit types or resources and, at the same time, ensure that credits are used only as approved and allowed. This stacking function allows the interactions of the natural elements to be more fully measured.

Step 6g

Implement the program. Metrics can inform transportation planning processes and be incorporated into project compliance documentation and regulatory processes in a number of ways. A good metric can provide the basis for terms and conditions, conservation measures and performance standards, and ongoing monitoring. In addition, when combined with an appropriate landscape measurement system, a good metric can be the basis for justifying off-site and/or out-of-kind mitigation. Project delivery staff need to be aware of these opportunities.

Transportation agencies can do a few basic things to encourage these improvements. Ongoing training using a community of practice can be effective. Data sheets that standardize the application with metrics are useful for program implementation. Ideally, the data sheet can become an integral part of project data collection and can be used to make that process more efficient and effective.

STEP 7: DEVELOP PROGRAMMATIC CONSULTATION, BIOLOGICAL OPINION, OR PERMIT

Purpose and Anticipated Outcomes

In Step 7 the team ensures that associated documentation has occurred and regulatory connections have been made.

Implementation Substeps and Technical Considerations

An overview of implementation substeps and technical considerations follows.

Step 7: Develop programmatic consultation, biological opinion, or permit

Implementation Substeps

- 7a. Ensure agreements relating to CWA Section 404 permitting, avoidance and minimization, ESA Section 7 consultation, roles and responsibilities, land ownership and management, and conservation measures are documented.
- 7b. Plan for long-term management and make arrangements with land management agencies and organizations (e.g., land trusts, bankers) for permanent protection of conservation and restoration parcels. Notify and coordinate with local governments for supportive action.
- 7c. Design performance measures for transportation projects that will be practical for long-term adaptive management, and include them in CWA Section 404 permit and/or ESA Section 7 BA/BO.

- 7d. Choose a monitoring strategy for mitigation sites, based on practical measures, ideally using the same metrics as those used for impact assessment, site selection, and credit development.
- 7e. Set up periodic (at least annual) meetings to identify what is working well and what can be improved.

Technical Considerations

- Who will lead the development of needed agreements?
- Under what conditions would the agreement be revisited?

Step 7a

Ensure agreements relating to CWA Section 404 permitting, avoidance and minimization, ESA Section 7 consultation, roles and responsibilities, land ownership and management, and conservation measures are documented. In Step 7a the team ensures that associated documentation has occurred and regulatory connections have been made. Various programmatic agreements may be developed for transportation projects, including MOUs, MOAs, programmatic CWA Section 404 permits, SAMPs, Section 404 Regional General Permits, and ESA Section 7 consultations and associated biological assessments and biological opinions. The process of developing pertinent interagency agreements and understandings may begin as early as Step 1. Ultimately, the regulatory vehicles or agreements that are developed include most of the elements in this section (Step 7), with the goal of advancing conservation action in line with CWA Section 404 and ESA program objectives and requirements and with maximum assurance that conservation and restoration investments by DOTs will count.

The use of the integrated planning method described in this guide provides the ideal basis for development of programmatic agreements (agreements pertaining to multiple projects, across a program or broad region). Furthermore, programmatic agreements can include agreements for compliance under a number of regulations or statutes. Common programmatic agreements include biological opinions, Section 404 permits, and local permits. In general, programmatic agreements require more time and effort initially as the details and terms are developed. As a result, programmatic agreements are most often used when a project, or series of projects, requires numerous permits or consultations, with many involving similar types of actions, resources, or impacts. Agencies can gain efficiencies for the resources, the process, and staff time by looking at the larger picture.

The level of resource and transportation information developed in the REF and transportation plan documents provides a strong foundation for identifying programmatic implementation opportunities. Through an analysis of the common impact types, a set of programmatic permits can be developed to help speed project delivery. Programmatic agreements within the REF must describe the resources covered and the types of impacts or activities covered, and provide clear instructions on avoidance, minimization, and mitigation in program delivery. The programmatic agreements must also include tools to assist in monitoring and management of the project

to ensure the sum of the actions included is meeting the expectations of the signatories and participants.

The advantages of using programmatic agreements rest primarily on the streamlining allowed once the agreement is in place. A programmatic agreement can be as simple as a one- or two-page letter that outlines the information and certifies that the impacts are included in the agreement. Programmatic agreements allow resource agency time to be used more efficiently. These agreements can also cover multiple regulations or resources. The multiresource programmatic approach allows for more integrated permitting decisions to reduce conflicts between regulated resources.

Developing Interagency MOAs

Interagency understandings may be formalized in MOAs or MOUs when their scope exceeds that which would occur in a programmatic consultation or a banking instrument. For example, the Colorado DOT's Shortgrass Prairie Initiative MOA, described in Step 1, records the roles of the partners and the general approach the agencies agreed to take. Caltrans' Memorandum of Agreement for Early Mitigation Planning for Transportation Improvements in California outlines a long-range strategic planning process to improve early coordination and "obtain better results from funds spent for the compensation and enhancement of biological resources" (37).

Identifying How Individual Projects Will Be Reviewed and Fit into the Whole, Ensuring Avoidance and Minimization

Identifying how individual projects will be reviewed and fit into the programmatic approach is often a more difficult part of the negotiation, because it may depart from the way individuals and agencies normally review projects. While staff may save significant time and see efficiency increases, any change in their duties or scope of responsibility should be recorded in the interagency agreements. Such agreements try to create a streamlined approach for project-by-project review and greatly reduce the negotiation that otherwise occurs at that stage. However, such agreements cannot be used to change statutory or regulatory requirements.

Under the CWA Section 404 program, individual permits require project review by the U.S. Army Corps of Engineers. The USACE decides whether to issue an individual permit based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity. According to USACE regulations, permits should not be issued for activities which will create "significant" degradation of the waters of the United States or have "significantly adverse effects on wetlands values"; however, the CWA provides no clear definition of "significant" (38). The evaluation process for an individual permit is based on guidelines established under Section 404(b)(1) of the CWA and on the "public interest review" procedures. Public interest review involves a broad qualitative evaluation of a project's benefits and detriments. USACE regulations identify 21 factors relevant to permit review: conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food

and fiber production, mineral needs, consideration of property ownership, and the general needs and welfare of the people. The Section 404(b)(1) guidelines prohibit a discharge of fill if a less environmentally damaging alternative, that is still practicable, exists; these guidelines are often considered the driving force in the USACE permit process (39). Practicability is determined on the basis of technological, economic, social, and logistic considerations. If a proposed project has greater than significant impacts, attempts must be made to avoid and minimize impacts. Impacts which cannot be avoided must be mitigated to a level such that the net effect on U.S. waters is not significant.

For ESA Section 7, each action that may directly or indirectly affect listed species or designated critical habitat (in this case, either adoption of the plan or implementation of any specific project under that plan) must have the appropriate ESA effects analysis and associated documentation. In other words, any action that “may affect, but is not likely to adversely affect” a listed species or designated critical habitat must have a written concurrence from the USFWS; any action that is “likely to adversely affect” a listed resource must have a complete biological opinion (including an incidental take statement, if appropriate) [*Conner v. Burford*, 848 F.2d 1441 (9th Cir. 1988); *Conner v. Burford*, 605 F. Supp. 107 (D. Mont.1985); *Silver v. Babbitt*, 924 F. Supp. 976 (D. Ariz. 1995); *Silver v. Thomas*].

For ESA Section 7, site-specific BOs may be appended to a programmatic consultation to complete a Section 7 consultation. The degree of project-by-project review continues to be negotiated separately for each programmatic or advance mitigation approach.

Step 7b

Plan for long-term management. Step 7b involves ensuring that adequate plans for long-term management of conservation and restoration investments have been made. Such arrangements can be made with public land management agencies or in-lieu fee providers or with NGOs (e.g., nonprofit land trusts or for-profit mitigation or conservation bankers) for permanent protection of conservation and restoration parcels. In rare cases a for-profit mitigation banker may plan to hold onto a parcel for the long term.

In general, all sites used to satisfy compensatory mitigation requirements must remain within the public domain in perpetuity, either in fee simple title or subject to appropriate conservation easements. Sites must be managed in accordance with a long-term management plan to preserve the ecological functions of the subject property and, in the case of Section 404 of the CWA, to fulfill the requirements of the permit. Management needs of a mitigation/conservation site may include restoration or enhancement of habitats, monitoring of resources, maintenance of facilities, public uses, control of public access, start-up funding, budget needs and endowment funds to sustain the budget, and yearly reporting requirements.

A watershed or ecosystem-based approach helps address a major challenge in mitigation development and long-term management. Ensuring that sites are more environmentally valuable and important to federal and state resource agencies or conservation organizations for protection in perpetuity dramatically increases the chances

of finding an appropriate conservation owner. DOTs' investments in acquisition and initial restoration may mesh with other agency and organizations' long-term stewardship and land management missions.

An appropriate long-term ownership and management arrangement or option must exist, and ideally be secured, before property acquisition makes sense. In most parts of the country, this is not a problem if the property is part of an environmental agency's or conservation organizations' acquisition plans and priority lists. For a variety of ecological reasons, connectivity improvements have received greater attention and emphasis over the past 10 years. Sites adjacent to and/or providing a connection between already protected conservation areas are expected to remain practical and desirable sites for conservation management entities.

A piece that is often missing is notification and coordination with local governments for supportive action. That is, if a site will become a conservation area, coordination with the local government is valuable and advisable—to protect long-term conservation values and ensure that those values are not inadvertently undermined by permitting of incompatible adjacent development. The REF and associated database facilitates such an exchange of information.

Step 7c

Design performance measures for transportation projects that will be practical for long-term adaptive management, and include them in CWA Section 404 permit and/or ESA Section 7 BA/BO. Long-term performance measures for adaptive management need to be practical for the implementing agency taking on those responsibilities in perpetuity.

Mitigation that is included as a commitment in the environmental document becomes an integral and essential part of the transportation project and Record of Decision. The FHWA's responsibility regarding the implementation of mitigation measures identified as commitments in environmental documents is stipulated in 23 CFR Section 771.109(b): "It shall be the responsibility of the applicant, in cooperation with the Administration, to implement those mitigation measures stated as commitments in the environmental documents prepared pursuant to this regulation. The FHWA will assure that this is accomplished as a part of its program management responsibilities that include reviews of designs, plans, specifications, and estimates (PS&E), and construction inspections" (40). DOTs have developed a variety of tracking systems, from simple checklists and spreadsheets to more complex databases and systems for hand-off, from design to construction and maintenance (41). These systems also include commitments and responsibilities derived from CWA Section 404 permits and ESA Section 7 consultations. Visual assessment, informal mapping, photographic records, and assessment of the spread and prevention of invasive species are common assessment methods for both wetland and species/habitat mitigation/conservation sites.

Creating meaningful and practical performance measures that will be useful in adaptive management is a key challenge for regulators and conservation practitioners. To refine and improve a manager's ability to monitor conservation progress, performance measurement data should help answer the question, Are we conserving what we say we are? The data should also provide a barometer of how well biodiversity is doing, the degree to which it is conserved, and the likelihood of success in

achieving conservation goals. An ecosystem approach can measure conservation status and progress at wider scales; the ecoregional measures used in that approach may rely on focal species and indicators of ecosystem health, such as degree of invasive species and management, including natural processes (e.g., grazing or fire).

Adaptive management is a method for examining alternative strategies for meeting biological goals and objectives, then adjusting future conservation management actions as necessary. The term refers to a systematic approach for evaluating and adjusting management practices based on monitoring of predetermined evaluation criteria. The six principal components of adaptive management are problem assessment, design, implementation, monitoring, evaluation, and adjustment.

Step 7d

Choose a monitoring strategy for mitigation sites, based on practical measures, ideally using the same metrics as those used for impact assessment, site selection, and credit development. The USACE and EPA's 2008 compensatory mitigation rule (13) (see box on page 70) provides guidance on monitoring for wetlands, as does a Regulatory Guidance Letter released later that year. Regulatory Guidance Letter No. 08-03, Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources, "supports the Program Analysis and Review Tool . . . performance measures for mitigation site compliance and mitigation bank/in-lieu fee compliance" (42). Monitoring requirements are typically based on the performance standards for a particular compensatory mitigation project consistent with the objectives for the project.

According to Regulatory Guidance Letter 08-03, "These standards ensure that the compensatory mitigation project is objectively evaluated to determine if it is developing into the desired resource type and providing the expected functions. The objectives, performance standards, and monitoring requirements for compensatory mitigation projects required to offset unavoidable impacts to waters of the United States must be provided as special conditions of the DA [Department of the Army] permit or specified in the approved final mitigation plan (see 33 CFR 332.3(k)(2)). Performance standards may be based on functional, conditional, or other suitable assessment methods and/or criteria and may be incorporated into the special conditions to determine if the site is achieving the desired functional capacity."

The mitigation rule requires a monitoring period of not less than 5 years (see 33 CFR 332.6(b)). Letter 08-03 continues:

The District determines how frequently monitoring reports are submitted, the monitoring period length, and report content. If a compensatory mitigation project has met its performance standards in less than five years, the monitoring period length can be reduced, if there are at least two consecutive monitoring reports that demonstrate that success. Permit conditions will support the specified monitoring requirement and include deadlines for monitoring report submittal. Longer monitoring timeframes are necessary for compensatory mitigation projects that take longer to develop (see 33 CFR 332.6(b)). For example, forested wetland restoration may take longer than five years to meet

performance standards. . . . Certain compensatory mitigation projects may require more frequent monitoring and reporting during the early stages of development to allow project managers to quickly address problems and/or concerns.

Monitoring methods vary greatly in terms of the level of detail and the frequency of monitoring. The purpose of monitoring is to determine if mitigation is achieving its performance standards or if intervention is required to address a particular problem. According to an Environmental Law Institute study, most wetland banking instruments include some reference to monitoring and maintenance provisions (usually in the 3- to 10-year range), although 14% do not, and only 22 banks indicate that the length of the monitoring period is based on the final achievement of performance criteria (43).

State DOTs develop detailed site-specific, or in some cases, agency-wide evaluation criteria for wetland restoration success. During the monitoring period, assessment of vegetation and assurance of self-maintaining hydrology are primary objectives. Increasingly, habitat restoration is a key consideration. The Washington State DOT and resource agency partners developed the following guidance: during the monitoring period, a project may be evaluated relative to the goals (wetland functions and values) the mitigation project is intended to achieve, specific elements of those goals (function or value), and performance objectives with corresponding success standards (an observable or measurable benchmark for a particular performance objective, against which the mitigation project can be compared) (44). If the standards are met, the related performance objectives are considered to have been successfully achieved. Monitoring methods appropriate to the performance objective must be designed and implemented, and then contingency measures provide avenues for corrective action.

USFWS and NOAA Fisheries have provided some guidance for assessing the value of formalized conservation efforts in species recovery. Though USFWS and NOAA Fisheries policy was initially developed for Evaluation of Conservation Efforts When Making Listing Decisions, “this policy may also guide the development of conservation efforts that sufficiently improve a species’ status so as to make listing the species as threatened or endangered unnecessary” (45). Proactive conservation efforts by state DOTs and resource agencies commonly share this goal of improving the viability of one or many species, whether through on-site best management practices or through wetland or upland habitat preservation, restoration, or altered management regimes.

Of the factors that USFWS and NOAA evaluate in determining a species to be threatened or endangered, DOTs may most affect (positively and negatively) “the present or threatened destruction, modification, or curtailment of its habitat or range” (45). In evaluating formalized conservation efforts, USFWS and NOAA look for elimination or adequate reduction of one or more threats to the species identified through the ESA Section 4(a)(1) analysis (46). In making an estimate of a species’ future condition and the likely impact or success of a formalized conservation effort, USFWS and NOAA assess the level of certainty that the effort will be implemented and the likely effectiveness in elimination or reduction of threats to the species. Advance mitigation ensures the former; adaptive management helps ensure the latter.

The following criteria may be used to determine a level of reasonable certainty that the conservation effort will be effective:

1. The nature and extent of threats being addressed by the conservation effort are described, and how the conservation effort reduces the threats is described.
2. Explicit incremental objectives for the conservation effort and dates for achieving them are stated.
3. The steps necessary to implement the conservation effort are identified in detail.
4. Quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured, are identified.
5. Provisions for monitoring and reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the conservation effort are provided.
6. Principles of adaptive management are incorporated.

“These criteria should not be considered comprehensive evaluation criteria. The certainty of implementation and effectiveness of a formalized conservation effort may also depend on species-specific, habitat-specific, location-specific, and effort-specific factors. . . . The specific circumstances will also determine the amount of information necessary to satisfy these criteria.” (45)

Based on this guidance on evaluation of formalized conservation efforts, USFWS and NOAA Fisheries list the following potential effectiveness measures/considerations:

- Level of participation (e.g., number of participating landowners or number of stream-miles fenced);
- Length of time of the commitment by landowners;
- Whether the program reduces the threats on the species; and
- Estimated length of time that it will take for a formalized conservation effort to produce a positive effect on the species (45).

The conservation effort may need to be modified to adequately address an increase in the severity of a threat or to address other new information on threats. USFWS’s conservation banking guidance states that, while conservation outcomes are ideal measures, they must be balanced, and in some cases indicated, by management actions over which sponsors have more control (47).

An indicator is a unit of information measured over time that documents changes in a specific condition. Indicators are often used for communicating measures, as indicators may provide a way to summarize, present, or manage complex information in a clear manner and assess where future action is most critical. The best indicators are measurable, precise, consistent, and sensitive. Sometimes the indicator and the measurement are equal. At other times, an indicator can be an indirect measurement or a compilation of several measures that are believed to be central to revealing something

important about a trend or status in conservation. In some cases precision is less than desirable but the indicator remains useful (47).

Biological goals provide a framework for developing a monitoring program that measures progress toward meeting those goals. Goals or standards should be structured to compare the results from two reporting periods or to compare different areas within the conservation bank. Monitoring provisions to measure and assess habitat protection, restoration, or creation activities should be included in the conservation banking agreement.

According to USFWS's conservation banking guidance, monitoring provisions should include components to

1. Evaluate compliance based on current levels of credit authorization;
2. Determine if biological goals and objectives are being met;
3. Provide feedback information for subsequent management changes and adaptations, including remedial actions if necessary; and
4. Substantiate and authorize additional credit, based on habitat restoration accomplishments or phase-in of additional bank lands (47).

The presence or absence of species on already conserved sites is sometimes monitored to allow for additional credits if the presence of additional species' is documented. Annual reporting and baseline tracking for banks focuses primarily on ecosystem intactness, invasive species, changes in (surrounding) land use, and ongoing (revised) recommendations for site management. Photo points, aerial photos, and general observations on wildlife diversity, activity, and general trends may complete the picture. Success may be measured in

- Acres of habitat perpetually protected;
- Number of species or resource values that are protected or benefited over the long term; and
- Ecological processes enhanced or undisrupted.

Beginning to Track Conservation on an Ecoregional Level

Local, state, national, and international conservation organizations are exploring the use of ecoregional measures to

- Track progress toward meeting the goals identified in ecoregional assessments. Ecoregional assessments may establish minimum goals based on estimates of the historical extent of key vegetation types and different scenarios and what may be adequate to support populations or occurrences of most species that depend on those types for the foreseeable future. Indicators of this measure include the degree to which each conservation target has an adequate area or number of locations to achieve the degree of success estimated to be viable under different scenarios.
- Identify major threats within an ecoregion, establish baseline conditions, and develop a method of tracking changes over time.

- Identify and support the most vulnerable and threatened conservation areas within the ecoregion.
- Monitor, measure, and communicate conservation status.

Measurements often occur in five ecoregional measure categories:

Biodiversity status—Progress toward meeting ecoregional goals, and biodiversity health measures. Ecoregional goals are established as a means of estimating the numbers or areas needed to resist extinction and degradation factors. The goals are surrogates for viability of conservation targets over the long term. Therefore, progress toward ecoregional goals is an indicator of viability or integrity. Other potential indicators for assessing ecoregional biodiversity health include the numbers and composition of species and ecological systems that are rare, imperiled, listed, available for conservation, and so on. The degree to which adequate areas of the right sizes have been identified, protected, and actively managed is important. That information provides an estimate of the degree to which conservation actions might contribute toward species recovery. Other potential indicators for measuring biodiversity health include the following:

- Number of known occurrences, acres, or miles for targets known versus number needed for viability or recovery;
- Ranking status for targets (e.g., natural heritage ranks—a downward trend suggests that species or natural communities are getting rarer, which is a bad sign for biodiversity health); and
- Listing status for species targets in the ecoregion (more listed or candidate species over time also suggests that species are becoming more rare, which is again a bad sign for biodiversity health).

Conservation status—Protected and managed area status and management effectiveness. This measure assesses the degree to which land of conservation interest (or need) is legally protected and managed. This reflects the degree of land that can be guaranteed to remain as a contribution to conservation should all other lands be removed. While this measure does not incorporate many private and public conservation lands that have no legal protection, it is an important indicator of progress toward securing the conservation of certain species and ecological systems. The data used are important for understanding the level of protection (and conversely threats) to mitigation/conservation areas. Measuring the degree to which lands are protected from specific threats (e.g., development, oil and gas exploration) provides strong indices of conservation progress. Within this category are also lands that are protected from specific threats and managed to some degree for biological values. For example, some multiple-use federal lands are managed for production of recreational or livestock grazing values in ways that do not ensure complete and/or highest-quality ecological systems; nonetheless, they have many ecological values that contribute to the greater picture of conservation success *and* are for the most part free from the threat of total conversion to a nonrestorable state. Several different ways of assessing protected area status are discussed in subsequent sections, as well as other ways of assessing status.

Protected and managed area status. This measure employs the Gap Analysis Program (GAP), a classification system to describe the status of protected lands in the ecoregion. GAP uses four status categories to identify the relative degree of protection and intended management for biodiversity, where 1 represents the highest, most permanent level of protection, and 4 represents the lowest. The International Union for Conservation of Nature (IUCN) has similar but more categories, ranging from strict nature reserves to managed resource protected areas. Neither GAP nor IUCN adequately captures protected status for conservation easements and perhaps other conservation lands.

GAP Status 1 includes areas permanently protected from conversion of natural land cover, with a mandated management plan in operation to maintain a natural state within which disturbance events are allowed to proceed without interference or are mimicked through management. GAP Status 2 includes areas permanently protected from conversion of natural land cover, with a management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance. GAP Status 3 covers areas permanently protected from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining). Areas with GAP Status 4 have no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types; this category includes all areas not identified in categories 1–3.

Management effectiveness indicates the intended management of protected and managed areas and the degree to which the managers can fulfill their goals, including the enabling conditions for effective conservation.

Threat status. Threats assessments at ecoregional scales provide important early warning measures for changes in biodiversity status. The spectrum of threat measures, the status, distribution, and trend of the threats identified in the ecoregional assessments may be assessed anywhere data are available. Measures may include the following:

- Number of acres of each ecological system that is affected by a given threat.
- When spatial data are available and of sufficient quality, the severity and scope of the threats. (Threats may include altered hydrology, oil and gas development, altered fire regimes, fragmentation, invasive species, climate change, and land use change.)

The USFWS has been developing guidance and internal processes for assessing threats and incorporating that information into decision-making processes around mitigation and conservation measures. The USFWS considers the Desert Tortoise Decision Support Tool to be their leading example, in practice.

Intactness—land cover status. Ecoregions are important base units for measuring conservation priorities and goals as well as for measuring conservation status. Each ecoregion is dominated by a major vegetation type that is comparable to those found in other similar ecoregions. The status of these habitat types, indicated by assessing the status in each ecoregion, can be combined to contribute to a global conservation assessment. Land use change is a prominent factor that alters the integrity of natural diversity throughout the world. The extent, distribution, and pattern of land uses are primary drivers in conservation planning and implementation. The pattern of land use and land cover is the basis for understanding fragmentation, current and long-term potential connectivity, and likelihood of species and ecosystem viability.

Impervious surface is often used as a landscape-level indicator in watersheds. EPA has a watershed indexing project under way to prioritize total maximum daily load (TMDL) development, actions to address impairment, and potentially siting of stream and wetland mitigation. A critical yet often overlooked aspect of restoration is the maintenance and protection of least-disturbed watersheds for flood storage capacity and as a source of high-quality water for dilution and maintenance of ecological flows, refugia, and groundwater recharge. Currently, regional priorities are often established through regional-state negotiations during the CWA Section 106 granting process. In an effort to provide greater scientific support for regional priorities and optimize where resources are spent, EPA is developing a spatially explicit, multimedia Watershed Index screening tool and simple web-based user interface to identify, target, and prioritize watersheds for protection and restoration management activities.

Step 7e

Set up periodic (at least annual) meetings to identify what is working well and what can be improved. The agencies involved should set up periodic meetings to identify what is working well and what can be improved in the team's overarching agreement(s). Such meetings should occur on an annual basis, though they may occur more often if the team deems necessary.

STEP 8: IMPLEMENT AGREEMENTS AND ADAPTIVE MANAGEMENT

Purpose and Anticipated Outcomes

Step 8 involves implementing the previous agreements, updating the REF, and designing transportation projects in accordance with ecological objectives and goals identified in previous steps (i.e., keeping planning decisions linked to project decisions), appropriate programmatic agreements, performance measures, and ecological metrics. This will ensure continuity from the early planning processes into transportation project implementation.

Anticipated outcomes include the following:

- Use of regional ecological goals and objectives in project planning and decision making;
- Use of REF maps to guide project avoidance and mitigation decisions;

- Incorporation of performance measures and programmatic agreements, as appropriate, into permitting and consultation documents;
- Integration of programmatic cumulative effects analysis into environmental documents;
- Incorporation of tools and approaches into a monitoring and adaptive management strategy to ensure positive project outcomes;
- Accurate record keeping and tracking of all commitments by transportation agency in project delivery;
- Information updated from construction and operation into REF; and
- Measurements of performance success in project delivery.

Step 8 interaction with the REF (described in other step guidance on the cumulative effects analysis) is primarily iterative with other substeps already described, such as updating the resource status and condition. A summary of the substeps follows. No additional guidance was developed as the step and substeps are suitably described.

Implementation Substeps and Technical Considerations

An overview of the implementation substeps and technical considerations follows.

Step 8: Implement agreements and adaptive management; deliver conservation and transportation projects

Implementation Substeps

- 8a. Design and implement methods to complete transportation project(s) consistent with the REF, conservation/restoration strategy, and agreements.
- 8b. Identify how advance mitigation/conservation will be funded, if not already done.
- 8c. As needed, develop additional project-specific, outcome-based performance standards related to impact avoidance and minimization.
- 8d. Design transportation projects, and integrate performance measures to minimize impacts to resources.
- 8e. Use adaptive management to ensure compliance with requirements and intent of performance measures.
 - i. Develop and track ecoregional biodiversity, indicators of viability, and integrity.
 - ii. Develop and track conservation status, protected and managed area status, and management effectiveness.
 - iii. Identify remedial actions and needed plan adjustments.
 - iv. Adjust the planning process and management processes and/or management of individual conservation areas.
 - v. Incorporate outputs into future cumulative effects analyses for the region.

Technical Considerations

- What tools are available that could help document goals and priorities identified in the REF that need to be considered in project delivery?
- What tools and methods can be used to track how projects contributed to and/or improved the REF priorities and goals?

An important aspect of any crediting system is inclusion of an adaptive management or policy feedback loop that allows for new discoveries to inform better crediting. Credits should be monitored and measured against other measurement systems.

Capturing lessons learned is an important step as it may change standards from one version of the crediting to the next. This is an acceptable change if justified by new science or policy priorities. However, changes should be set in the context of previous decisions so as not to create new barriers for crediting in future projects. Adaptive management relies less on the idea of precedents and more on the notion of new discoveries and decisions; the process cannot become overly tied to past decisions if new information is available.

The remaining implementation substeps in Step 8 are self-explanatory.

STEP 9: UPDATE THE REGIONAL ECOSYSTEM FRAMEWORK**Purpose and Anticipated Outcomes**

The purpose of Step 9 is to ensure that the REF and integrated plan become a living database. The effects assessment should be updated to determine if resource goal achievement is on track. If goal achievement gaps are found, priorities for mitigation, conservation, and restoration should be reassessed in light of new disturbances that may impact the practicality/utility of proceeding with previous priorities. New priorities should be identified if warranted.

Anticipated outcomes of this step include the following:

- Updated REF and cumulative effects analysis; and
- Updated conservation and restoration priorities.

Implementation Substeps and Technical Considerations

A summary of implementation substeps and technical considerations follows.

Step 9: Update the Regional Ecosystem Framework**Implementation Substeps**

- 9a. Integrate any revised conservation plans into the regional ecosystem framework and, as appropriate, individual resource spatial information.
- 9b. Update the area and resource conservation requirements, responses, and indicators in collaboration with stakeholders (e.g., assess regional goals, update the minimum required area for species and/or habitat, review the confidence threshold for

achieving goals, review the weighting values of resources in REF, evaluate responses to land use and infrastructure).

- 9c. Update the implementation status of areas in the REF to review those areas that are contributing to REF goals and priorities, and determine if additional conservation/protection action is required.
- 9d. Update the cumulative effects analysis with new developments, new disturbances, proposals, and trends (e.g., ecosystem-altering wildfire, new policies, plans, proposals, and trends such as new sea-level-rise inundation models).
- 9e. Conduct regular review of progress, including effectiveness at meeting goals and objectives, current take totals, and likelihood of exceeding programmatic take allowance.

Technical Considerations

- Has the status of species or habitats changed? How does this affect REF goals?
- Do areas on the landscape critical to meeting goals identified in REF need additional protection or restoration action?
- How often should the REF be revised to incorporate new conservation data or plans?
- How often should the cumulative effects analysis be updated?
- Are indicators used to track conservation progress capturing the correct trends?
- Are transportation project delivery indicators improving (e.g., streamlined decision making and/or better conservation outcomes)?
- How can modifications be moved forward to alter mitigation and restoration priorities previously identified but not yet implemented?

Step 9a

Integrate any revised conservation plans into the regional ecosystem framework and, as appropriate, individual resource spatial information. Any further conservation or restoration plans that are developed in the region should be included in the REF, as should new research and information on species, or further data developed by Landscape Conservation Cooperatives.

Step 9b

Update the area and resource conservation requirements, responses, and indicators in collaboration with stakeholders. The regional goals and conservation and restoration requirements will evolve with time and likely with climate change. Thus regional goals should be assessed and updated to incorporate the minimum required area for species and/or habitat or restoration. Confidence thresholds for achieving goals should be reviewed, along with the weighting values of resources in the REF. Responses to land use and infrastructure should be reaffirmed as well.

Step 9c

Update the implementation status of areas in the REF to review those areas that are contributing to REF goals and priorities, and determine if additional conservation/protection action is required. As conservation and restoration actions occur, the implementation status of these areas should be reviewed to ensure they are contributing to REF goals and priorities as anticipated and to determine if additional conservation, restoration, or protective action is required in these or other areas.

Step 9d

Update the cumulative effects analysis with new developments, new disturbances, proposals and trends (e.g., ecosystem-altering wildfire, new policies, plans, proposals, and trends such as new sea-level-rise inundation models). The framework implementation as described is explicitly designed to support adaptive planning and management. A key aspect of this process is to reanalyze the cumulative effects whenever a significant change occurs in potential stressors to the ecosystem. Each assessment iteration should entail the following:

- Update the effects assessment to determine if resource goal achievement is still on track.
- If goal achievement gaps are indicated, reassess priorities for mitigation in light of new disturbances that may affect the practicality/utility of proceeding with previous priorities.
- Identify new priorities if warranted.

Ecosystem crediting aspects. As changes occur in the REF or new information is included in the decision-making process, the crediting system also needs to adapt. Examples include new resource concerns, emerging regulations, or public concern that is critical but not yet regulatory. Reevaluating Step 6a will be important to ensuring the crediting system is current and aligned with environmental, social, and regulatory concerns.

Step 9e

Conduct regular review of progress. Annual reviews of progress are recommended. Key topics for review include the following:

- Effectiveness at meeting goals and objectives;
- Current take totals; and
- Likelihood of exceeding programmatic take allowance.

SUMMARY

This guide presents the Integrated Ecological Framework (IEF), a nine-step process describing how transportation and resource agencies and nongovernmental organizations (NGOs) can work together to protect resources across agencies and environmental programs. The IEF was developed to effectively integrate conservation

planning and transportation planning. Further, it lays the foundation for implementation of a watershed approach to Clean Water Act (CWA) Section 404 permitting and an ecosystem-based approach to conservation and consultation under the Endangered Species Act (ESA) Section 7. Federal agencies have defined these, alternately, as *Eco-Logical*, Strategic Habitat Conservation, or watershed-based approaches—all ecosystem approaches geared toward delivering the greatest benefits for aquatic resource restoration and species and habitat recovery, and greater landscape-level resilience, out of existing laws and regulations.

With these proactive approaches, coordination between transportation and resource agencies early in the transportation decision-making process can generate the following benefits:

- Transportation agencies can gain early insight and input regarding potential environmental conflicts or conservation opportunities.
- Resource agencies have more flexibility and resources to meet conservation objectives.
- Funding can be planned and set aside for environmental solutions.
- Transportation agencies can get buy-in on transportation and conservation solutions early on and avoid conflicts later in the decision-making process.
- Programmatic approaches to meeting local and regional conservation priorities can be established and addressed, while meeting regulatory requirements.

This guide is a final product of the second Strategic Highway Research Program (SHRP 2) C06 research effort. It outlines a way to address the conservation and restoration needs and objectives of multiple entities in an integrated fashion. This guide is integrated into the PlanWorks, formerly known as Transportation for Communities: Advancing Projects through Partnerships (TCAPP), website: www.transportationforcommunities.com.



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RELATED SHRP 2 RESEARCH

Integration of National-Level Geospatial Ecological Tools and Data (C40A)

Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—California US-101 (C40B1)

Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—East-West Gateway Council of Governments (C40B2)

Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—Contra Costa County Transportation Authority (C40B3)

TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned (C41)

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