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SHRP2 C06A

GUIDE TO THE INTEGRATED ECOLOGICAL FRAMEWORK

Prepared for

C06A Technical Coordinating Committee of
The Strategic Highway Research Program 2

Transportation Research Board of
The National Academies

Prepared by

Marie Venner Consulting and URS Corporation
Lakewood, Colorado & Morrisville, North Carolina
with support from
NatureServe, Boulder, CO, Oregon State University and Parametrix, Portland, OR

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Author and Reviewer Acknowledgement

Marie Venner drafted this guide and the original Integrated Ecological Framework (IEF), based on process steps undertaken in previous efforts she facilitated. 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, so thanks to Bill Gilmore, head of the North Carolina Ecosystem Enhancement Program and chair of that panel are in order. The IEF was also developed to respond to barriers, interests, and suggestions identified by the 150 agencies and 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 reviewed. Dr. Patrick Crist, of the SHRP 6B team and Director of Conservation Planning and Ecosystem Management at NatureServe, was instrumental in significantly expanding many IEF substeps, so they comprised a robust ecological assessment process. The IEF would not be what it is, without him. Jimmy Kagan created the process for creating the wetland priority map and made contributions with regard to data.

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. Gail Achterman and Jimmy Kagan of the Oregon Institute for Natural Resources at Oregon State University, Shara Howie of NatureServe, and Kevin Halsey and Paul Manson of Parametrix (all of the SHRP 6B team) provided further review of the substeps, additions or recommended deletions in some cases, and developed and refined technical questions in 2010. Dr. Patrick Crist provided detailed guidance relating to 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, including the case examples and the template for programmatic ESA section 7 Biological Assessments and Biological Opinions included in the appendices. SEPI engineering based the watershed agreement on that for the North Carolina Ecosystem Enhancement Program. Kevin Halsey, attorney with Parametrix in Portland, Oregon, reviewed and added to the Section 7 Programmatic Template, which was also provided to USFWS national coordinators for review. Melissa Bauguess of URS provided an invaluable final edit of the guide.

The assistance and attention to the Framework provided by all is greatly appreciated, including an interagency team of 50, who assembled for an invitational symposium in Boulder, Colorado in September 2010. A summary version of this guide was distributed to these attendees and many at the TRB Summer Environmental meeting for review in June 2010. Comments were formally received, responded to, and incorporated in July 2010. Webinars presenting many of the examples and programmatic approaches described in Appendices E, F, and G were held on July 29-30, 2010 and are posted online at:

- www.trb.org/StrategicHighwayResearchProgram2SHRP2/Public/Pages/Toward_a_Common_Ecological_Framework--Part%201_459.aspx
- www.trb.org/StrategicHighwayResearchProgram2SHRP2/Public/Pages/Toward_a_Common_Ecological_Framework--Part%202_458.aspx.

Steve Andrle of the National Academies provided assistance and insight throughout and enabled this research effort, along with SHRP2 committees and the Expert Task Group. We thank them.

Guide to the Integrated Ecological Framework

Acronyms and Abbreviations

BA	Biological Assessment
BO	Biological Opinion
Caltrans	California Department of Transportation
CEAA	Cumulative Effects Assessment and Alternatives
Corps	US Army Corps of Engineers
CWA	Clean Water Act
DOT	Department of Transportation
EBM	Ecosystem-Based Management
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ETDM	Efficient Transportation Decision Making
FHWA	Federal Highways Administration
GAP	Gap Analysis Program
GARVEE	Grant Anticipation Revenue Vehicles
GIS	Geographic Information System
HUC	Hydrologic Unit Code
IEF	Integrated Ecological Framework
IUCN	International Union for Conservation of Nature
LRTP	Long Range Transportation Plan
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organizations
NEPA	National Environmental Policy Act
NGO	Non-governmental organization
NHD	National Hydrography Dataset
NHP	Natural Heritage Program
NOAA	National Oceanic and Atmospheric Association
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSDI	National Spatial Data Infrastructure
NWI	National Wetlands Inventory
PES	payment for ecosystem service
REF	Regional Ecosystem Framework
SAFETEA-LU	Safe Accountable Flexible Efficient transportation Equity Act: A Legacy for Users
SAMP	Special Area Management Plan
SHRP2	Strategic Highway Research Program 2
SIB	State Infrastructure Bank
SME	subject matter expert
SSURGO	Soil Survey Geographic Database
STIP	State Transportation Improvement Program
SWAP	State Wildlife Action Plan
TCAPP	Transportation for Communities – Advancing Projects through Partnerships
TE	Transportation Enhancement

TIP	Transportation Improvement Program
TMDL	Total Maximum Daily Load
USDA	US Department of Agricultural
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WBD	watershed boundary dataset

Abstract

This guide presents the Integrated Ecological Framework (IEF), a nine-step process describing how transportation, resource agencies, and non-governmental organizations (NGOs). The IEF was developed to effectively integrate conservation planning and transportation planning, and to lay 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 our existing laws and regulations.

Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects (*Eco-Logical*), drafted and signed by eight federal agencies in 2006, expressed a cross-agency ecosystem approach. The extended statement or "permission document" put forth a conceptual groundwork for integrating plans across agency boundaries. It endorsed ecosystem-based mitigation that addresses highest priority needs for the watershed, species, or ecological community, leveraging conservation and restoration investments for multiple resources.

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 Strategic Highway Research Program (SHRP) C06A 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 SHRP Transportation for Communities: Advancing Projects through Partnerships (TCAPP) website: transportationforcommunities.com.

Introduction

Environmental and transportation agencies are changing how they do business. Particularly relevant to the integration of conservation and transportation planning and regulatory permitting/consultation, the Environmental Protection Agency (EPA) and the US Army Corps of Engineers (Corps) are transitioning to integration of a watershed approach to 404 permitting. Also, the US Fish and Wildlife Service (USFWS) is integrating recovery planning in 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 as well as 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. Too often, environmental needs and priorities were not included in the long range (20-year) transportation planning (LRTP) and shorter range (4-6 year) cost-constrained programming and budgeting, often called the regional or State Transportation Improvement Program (TIP or STIP). Fortunately, advances in computing capacity, data, and modeling have enabled better, more informed, and scientifically sound environmental planning than ever before. Longer range environmental assessment and planning *can* occur, through analyses using geographic information systems (GIS), which can be integrated with transportation planning. This research takes advantage of integrated electronic data collection, management and GIS analysis methods to integrate transportation planning and conservation planning at multiple scales in order 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” — to ensure the survival of our culture and species, as well as many other species and habitats, wetlands and water quality, and indeed the well being and survival of our planet. These are not idle expectations or wishes; indeed, the goal is within view and we know that it is reasonable and feasible. Now, much transportation capacity development can be reasonably expected to enhance the environment, species viability, and watershed restoration. In 2006, this expectation was addressed by Congress in the Transportation Research Board (TRB) Strategic Highway Research Program 2 (SHRP2) 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 are still struggling with how to make this vision of planning level environmental decision making and integrated conservation-transportation planning to enhance the environment a reality; agency staff are still trying to find their footing, when departing from the well-worn paths in how to comply with the CWA and ESA. This guide steps into that gap and tries to show a way. The Integrated Ecological Framework herein 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 integrating that with the transportation decision-making process. This guidance is also provided online as part of the SHRP Transportation for Communities (TCAPP) web tool, along with documentation on commonly used methods, data and tools, and supporting case studies on the successful use of these methods, data and tools in integrated planning. Practitioners are provided with: 1) recommendations on the use of data, tools and methods, 2) a corresponding ‘roadmap’ that can improve and streamline decisions by introducing the appropriate environmental information earlier in the decision-making process, and 3) assistance for practitioners to adopt decision-making practices that integrate environmental considerations.

The urgency of 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 §404 of the CWA come to about $2.9 billion annually. 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. What is known, is that we can and must do much better, accomplish much more for the species and ecosystems we are trying to recover and the aquatic resources we are trying to restore. Climate disruption and the tight budgets faced by government at all levels makes the imperative that much greater. It is incumbent on us to steward both public tax dollars and natural resources to the greatest extent we can, to ensure that time and money are not wasted, and to ensure that what we are doing makes the desired difference toward the goals of species and ecosystem recovery and restoring and maintaining the integrity of the nation's waters.

Addressing Barriers

The Integrated Ecological Framework started with interviews and surveys of over 150 front-line practitioners at resource and transportation agencies in 2009, as the National Academies' SHRP research project C06A identified three major obstacles to doing 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 Research Program (NCHRP) Projects 8-38 and 25-25/32). A complete overview of the barriers, by agency, is available in the SHRP C06A Final Report, as well as interests, solutions, and incentives. Summary overviews of some of this information are also included in the agency business cases or rationales for an ecosystem approach and in the agency status and transition reports posted on shrpc06.com and also the aforementioned TCAPP website.

While some progress has been made in restoring and compensating for the loss of aquatic functions, to date, practitioners on all sides have been pressed to achieve performance metrics on timeliness, to the detriment of more difficult to achieve objectives like identifying the highest conservation and restoration needs in a watershed or ecoregion and integrating that information with transportation planning, to accomplish more for the environment and get a head start on CWA 404 and ESA Section 7 compliance. Satisfying the operative regulations and internal agency processes is also a dominant goal of front-line staff; however, as Gardner noted in 2009, much of the mitigation has not led to the creation, restoration, or conservation of *important* wetland habitats. The current system works well at avoiding and minimizing losses at the design level, post-Planning phase, when engineering and survey data are available. However larger scale opportunities to avoid and minimize impacts or preserve important areas have been lost by then, if agencies bypass analysis and decision making on avoidance and potential conservation investments at the broader scale planning level. Historically, these inefficiencies have stemmed from a lack of easily accessible data that regulators would consider sufficient for the proactive analysis and early commitments that could 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 sub-optimal mitigation outcomes result because resource agencies often feel they cannot effectively consult earlier, without knowing more about the resources in question.

However, as is the case 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, comprising a "pre-approved" set of mitigation sites.

There are two critical requirements for improved outcomes. The first is to provide the tools planners can use to identify potential impacts to regulated resources very early in the planning process – allowing them to avoid or minimize these impacts as much as possible. The second is to assure that any mitigation that must occur due to unavoidable impacts will provide effective, measurable, and high quality environmental outcomes for the impacted resources. Problems under Section 7 of the ESA result both from the lack of certainty about the probability and degree that a project may impact a listed species and the lack of certainty as to how to design meaningful mitigation measures. However, it *is* economically feasible to develop digital maps showing the probable distribution of all listed species (and other species of concern), radically improving conservation and project planning for regulators and transportation agencies.

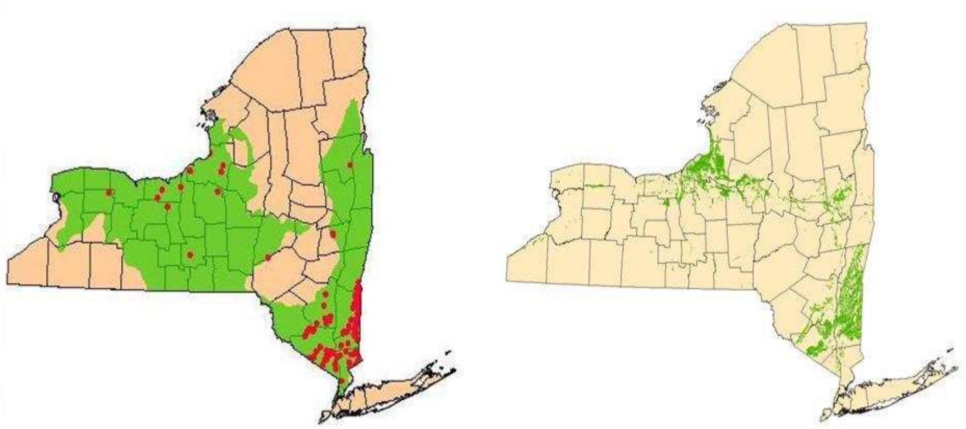
Inductive Species Distribution Models

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 where species are likely to occur.

To date, the ESA Section 7 consultation process has mostly relied on maps such as the one on the left below 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 habitat type and predicted distributions, based on highly sophisticated inductive models on the right. 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 counties and portions of the state, as on the left, without knowing where it was really most important to conserve habitat or invest in particular structures or management practices 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 the 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 produce lists of the top factors associated with the location of species and are thus useful in understanding and projecting the impact of climate change on species. Finally, these models can significantly reduce the size of areas requiring potential inventory for endangered species. The models can be used not only to define potentially occupied habitat, but most significantly, through probability analyses, areas which are <u>not</u> potential habitat for any listed species.

Figure 1. Comparison of Traditional and New Distribution Maps for the Bog Turtle



Maps showing traditional (left) and new (right) species distributions of the bog turtle in New York. Red dots indicate occurrences and the green on the left map are the ecological subsections in which they occur. (*Courtesy of NY Natural Heritage Program*.)

Figure 1 above 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.

The 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 them and understand their potential utility. In addition, the USFWS is developing a Section 7 decision support tool that focuses on analyzing impacts based on 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 while 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.

While only the Service 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), other agencies can participate in other steps in the integrated planning process, including integrating available maps and including critical habitat and recovery goals digitally in planning criteria for regional ecological frameworks.

One of the goals of the adjunct SHRP 6B project on data and tools was to assure that new models of wetlands and species mapping are acceptable for use and decision-making by regulatory agencies and thus provide regulatory certainty. The 6B team received indications from the Corps of the acceptability of their proposed approach to enhancing wetlands data, updating and combining all existing data on wetland locations and hydric soils into a readily available digital data set, essentially an updated National Wetlands Inventory (NWI). The 6A team set up meetings with the USFWS and FHWA on inductive species distribution models, leading to high level endorsement and expressed desire to see such models funded and incorporated into the agencies' on-line Biological Assessment tool and FWS's Information, Permitting and Consultation (IPaC) system, toward the end of improved planning for species conservation and more efficient decision-making. In the future, data might be exchanged through a Biodiversity Exchange Network (based on EPA's successful Water Quality Exchange Network) from which others might harvest constantly updated data.

Introduction to the Integrated Ecological Framework (IEF)

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 "programs" of transportation projects chosen through established selection processes. The Integrated Ecological Framework outlined here 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, so avoidance and investment/mitigation decisions may 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, as well as identifying 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 impacted by transportation development?
- How will those resources be impacted cumulatively through the affected region?
- What areas could 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 Integrated Ecological Framework

The nine-step IEF process is designed to bring about efficient, integrated consultation on natural resource issues, both for unregulated resources and those regulated under the CWA and ESA, which provide the nexus for most DOT investment in the natural environment. The IEF brings together a variety of well-tested methods, data, and tools into a cohesive ecological assessment framework. 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 such early coordination and environmental analysis and associated decision-making by resource agencies, in the planning stages (i.e. for the transportation process, between 5-20 years and more, in advance of construction. For a complete overview of the transportation decision-making process, see www.transportationforcommunities.com.) These benefits include:

- Development of a single statewide and/or regional plan to protect water quality, quantity, biodiversity, etc. with mapped priority locations. Such a plan and map outline goals shared by multiple agencies and provide incentives for state DOTs to avoid, minimize, and 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.
- Agencies can work together to achieve important environmental goals, while creating a more efficient and predictable consultation and development process through early identification of needs and solutions.
- CWA authorities under Sections 401, 402, and 404 can be integrated and resources marshaled to address waters quality concerns, addressing issues highlighted in §305(b) reports and ultimately helping restore 303(d)-listed streams in the course of 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 changed development patterns is greatest. Regulatory approvals may be advanced for projects that provide clear ecological improvement and benefits over standard approaches.
- Conservation investments can occur and make a difference for species, ecosystems, and watershed restoration sooner rather than later.
- Potential CWA§404 compensatory mitigation sites can be identified on a watershed basis and according to watershed goals/needs and other ecological considerations, in compliance with the 2008 Mitigation Rule. This will provide for preservation, restoration, enhancement, and creation of aquatic resources based on §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 environmental investments that address multiple resource needs at once.
- Better site identification for mitigation banks and in-lieu fee projects that would 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.
- Funding can be planned and set aside for environmental solutions in a timely way, integrating with and/or leveraging the investment of other programs (e.g., existing parks, conservation areas, and refuges; USFWS Partners for Wildlife; CWA §319 Nonpoint Source Program; local conservation planning)

- With the best places for ecologically viable, multi-credit conservation banks identified, permit streamlining, insurance and other incentives for developers to purchase credits from these areas will become more possible.
- A crediting mechanism and simple, consistent, transparent approach to quantifying ecosystem services, separately and together, may be created allowing voluntary or regulated buyers to invest in ecosystem services associated with specific goals and resources.
- Existing government conservation incentive programs can be restructured to be more strategic and deliver measurable ecological outcomes, addressing and prioritizing unregulated resources as well.

Importantly for the public, transportation and regulatory agencies, and the resources of concern to all, this approach can create a path to compliance with environmental regulations that is more ecologically productive, easier, and more efficient than traditional approaches. This approach also has the benefit of being science-based and using state-of-the-art data, systems, and tools. Of particular importance, it seeks to ensure that all key conservation and restoration planning information and data is considered in the decision-making process on 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 the data, and reporting of results.

Findings from Pilot Testing the Integrated Ecological Framework

The Integrated Ecological Framework (IEF) process was pilot tested in three states: Colorado, Michigan, and Oregon. This testing, via the SHRP C06B project, 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 produced more accurate and comprehensive assessments of the impacts of transportation scenarios and was able to identify corridors with fewer direct and cumulative impacts.
- ***Modest Data Investments Vastly Improve Evaluation and Opportunity Consideration in Planning:*** The pilot projects found that a relatively modest investment in process changes and data development upfront would create 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 utilizes the best available suite of methods, data and tools.
- ***Savings of Time and Resources:*** Testing indicated that the framework approach would save 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 re-use 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 where 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 Framework is designed to be compatible with *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (*Eco-Logical*), signed by eight federal agencies in 2006. That concept and "permission document" encouraged Federal, State, tribal and local partners involved in infrastructure planning, design, review, and construction to use their regulatory processes and the flexibility therein to achieve greater environmental benefits. Specifically, *Eco-Logical* puts forth 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. EPA and the Corps of Engineers' watershed approach and USFWS and the US Geological Survey (USGS)'s Strategic Habitat Conservation approach and Landscape Conservation Cooperatives are complimentary.

The Integrated Ecological Framework presented in this guide provides more detail and "how to" information than some of these other complimentary frameworks. In some cases, the IEF involves further scientific analysis. Most of all, the IEF provides easily applicable and adaptable steps for front-line practitioners on how to conduct integrated conservation planning and enable earlier environmental decisions in planning, which will count later in 404 permitting or when ESA Section 7 Biological Assessments (BA) and Biological Opinions (BO) are finalized. **It helpings them 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. This is in turn achieved through proactive inclusion of resource considerations, watershed restoration, and species recovery needs and priority actions/opportunities early in the process.

Using the Integrated Ecological Framework

The steps presented in this guide provide a multi-agency 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 a Regional Ecosystem Framework (REF).

The essential components and steps are straightforward and can be summarized as:

A. Gather and integrate data on the areas and resources of conservation interest to represent a REF.

B. Gather information to represent current and future development scenarios for infrastructure, land use, and other disturbances.

C. Intersect the REF with the scenarios to quantify impacts in terms of what areas or resources would be impacted, how much would be impacted, 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.

D. Use this information to create better transportation alternatives, note where impacts may be unavoidable or where impacts should be avoided at all costs. Also use 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. Based on identified priorities, interagency agreement on these, and exploration of what the partners may accomplish together toward these ends, programmatic approaches can be developed that increase regulatory predictability during project development while furthering achievement of 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, in order to facilitate early conservation and restoration investments, in the form of advance mitigation. Suitability analyses identify optimal locations for the protection and restoration of natural resources, both aquatic and terrestrial.

IEF analyses draw on data layers all states have, addressing 303(d)-listed streams, wetlands and/or soils, endangered, threatened, and rare species. The IEF particularly seeks to use and meld the datasets 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:

- Unified map of transportation, land use, conservation, and restoration priorities.
- Maps of each potential transportation scenario (set of alternatives) that shows 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.
- Identification and evaluation of potential mitigation and enhancement areas within a region, providing and maintaining a dynamic reporting of regional 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 9 steps of the Integrated Ecological Framework and the purpose of each is summarized in the following table.

Steps of the Integrated Ecological Assessment Framework

Step	Purpose
Step 1: Build and Strengthen Collaborative Partnerships, Vision	**Build a vision of what is most needed for natural resources in the region** and commit to integrate and utilize transportation and environmental regulatory processes to address these greatest conservation and restoration needs and goals.
Step 2: Characterize Resource Status. Integrate Conservation, Natural Resource, Watershed, and Species Recovery and State Wildlife Action Plans	**Develop an overall conservation/restoration strategy that integrates conservation/restoration priorities, data, and plans**, with input from and adoption by all conservation and natural resource stakeholders identified in Step 1, addressing 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** (LRTP, STIP, and TIP) to create the 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 utilizing the REF developed in Step 3 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 goal of having analyses throughout the life of the project be in the same units.
Step 7: Develop Programmatic Consultation, Biological Opinion or Permit	**Develop Memoranda of Understanding (MOUs), agreements, programmatic 404 permits or ESA Section 7 consultations** for transportation projects in a way that documents the goals and priorities identified in Steps 5 & 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 the programmatic agreements, performance measures** and ecological metrics to improve project outcomes.
Step 9: Update Regional Integrated Plan/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 impact the practicality/utility of proceeding with previous priorities. Identify new priorities if warranted.

Accessing Associated Tools

The online version of the IEF includes references on the concepts and case studies that illustrate real-life applications, as well as useful technical tools and data sources to support its use and implementation. Over the course of the research project, 171 tools were evaluated via the Ecosystem-Based Management (EBM) Tools Network at www.ebmtools.org. The SHRP 6B team concluded that none of the existing tools were capable of conducting all the analyses necessary for regional ecological and cumulative effects assessment and thus developed additional filtering capacity on the EBM Tools website. Tools were excluded if sufficient information or documentation was not available, or if the tool was not field-tested, maintained, or considered useful for integrated conservation and transportation planning. Forty-two tools were defined and information about them was provided relative to steps in the integrated ecological framework. The tool linkages to the integrated ecological framework will be contained within the TCAPP website at www.transportationforcommunities.com.

Steps in the Integrated Ecological Framework

Step 1: Build & Strengthen Collaborative Partnerships, Develop a 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 with transportation planning. This can be initiated by the conservation community and professionals or 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 one's 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.
- Over the course of their initial interaction and coordination the team will also **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 tradeoffs that are likely to occur should be clear from the outset. Each agency will need to have internal conversations on what they really want and where they can offer more, or more flexibility, than they typically do.
- In the process, transportation and regulatory agencies will **identify opportunities and criteria for using 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 Corps-EPA mitigation rule and in implementing a watershed approach, achieve the following advantages identified by Corps Districts and EPA regions:
  - Address complex environmental relationships holistically.
  - Utilize ecologically based and naturally defined areas.
  - Promote stakeholder involvement in an interdisciplinary approach that also integrates solutions.
  - Increase regulatory and non-regulatory integration and compatibility across programs. Also integrate watershed data from multiple agencies and programs.
  - Produce better, less contentious permit applications since applicants know what is needed, where.
- The group's work will **build on conservation planning work already done** as part of the State Wildlife Action Plan, 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.
- Finally, the team will **develop a shared vision of what may be accomplished through joint action**.

Anticipated outcomes include:

- A shared vision of what agencies may accomplish together. Develop appreciation and understanding of each other's goals and interests and where 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 (multi-project, broad scope) consultation approaches to better address transportation and conservation planning needs.

Importantly, it is possible to start in different places and points in the process. The steps below may be taken in different orders than that presented here, as appropriate to local contexts or situations.

Implementation Substeps and Technical Considerations

An overview of Step 2 substeps and technical considerations follows:

Step 1: Build & Strengthen Collaborative Partnerships for Statewide or Regional Integrated Planning, along with a Vision to Address & Tangible Improve Priority Resources of Concern Across Agencies and Programs

Substeps:

1a. Identify preliminary planning region (e.g. watersheds, eco-regions, and/or political boundaries). Drivers may be environmental factors such as water quality needs or 303(d) listings, species' needs, watershed restoration needs, or rare wetlands.

1b. Identify counterparts and build relationships among agencies, including local government and conservation NGOs (stakeholders).

1c. Convene a team of stakeholders, 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 on potential new processes for increasing conservation, efficiency, and predictability.

1e. Initially explore funding and long-term management options to support conservation and restoration actions and long-term management.

Technical Considerations:

- <u>Integrated Approach</u> - 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.
- <u>Types of Resources</u> - What are the types of resources to include? Consider federal, state, local regulated and non-regulated resources (connectivity needs, migratory and declining species).
- <u>Boundaries</u> - 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).
- <u>Streamlining</u> - What are the repetitive and relatively standardized project activities conducted by the DOT that could be addressed through programmatic approaches?

1a. Identify preliminary planning region

In Step 1a, the originating team **develops preliminary ideas with regard to the assessment and planning region(s); i.e. they identify their focus area** or the general planning region within which they want to work. This may cover a whole state or large portion thereof (an ecoregion, large watershed, or series of watersheds). Analysis from larger areas or ranges may ultimately impact the goals set for various resources of concern, but the planning region provides bounds on where resource and development considerations will be analyzed for the assembled team.

The planning region is often identified based on 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 ecosystem thereof. The region may be inspired by a particular resource asset or ecological need and common goals or interests. For example, the Chesapeake Bay has driven a number of regional conservation and restoration strategies. In the central U.S., the decline of the shortgrass prairie and associated bird and keystone species prompted a multi-agency 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 303(d) listing of impaired waters and identification of causes of impairment and Total Maximum Daily Loads (TMDLs) for those constituents of concern could drive interagency attention to remediation needs and opportunities. Due to endorsement of a watershed approach by EPA, the Corps, and the National Research Council, watershed-based planning regions are ideal when regulatory needs are present. Hydrologic unit code (HUC) level may be discussed. See USGS and NRCS watershed boundary dataset – 8-digit, 10-digit, and 12-digit HUC, www.ncgc.nrcs.usda.gov/products/datasets/watershed.

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.
- 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 pertain to where certain stakeholders can contribute or where a champion can convene the larger group. Partnerships or conservation/restoration funding already in place (e.g., CWA 319 grants) are assets to work with in leveraging the investment, expanding the effectiveness of restored ecosystems, 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 1c it will be helpful to identify initial high-level resources of concern, known long-term trends, and overall priorities and concerns regarding resources in the planning region, based on experience of the forming team. State Wildlife Action Plans and existing conservation/restoration plans on a landscape, ecoregion, or watershed basis can also serve as a launching point and suggest natural boundaries for multi-agency 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.

Tips:

- 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.
- Helpful datasets for evaluation of wetlands include National Wetlands Inventory (NWI), National Hydrography Dataset, (NHD), NRCS' Soil Survey Geographic Database (SSURGO), local datasets,

historic data sets for the mid-1970s, historic aerials and maps, reports on losses such as Dahl's Status and Trends Report, and other local reports.

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

1b. Identify counterparts and build relationships among agencies, including local government and conservation NGOs (stakeholders).

Most states have multiple agencies and NGOs working to advance and protect their natural resources (watersheds, natural habitat, etc.). These stakeholders can provide plans and information to help identify conservation and restoration priorities.

Regulatory agencies oversee regulated resources which may be impacted by transportation projects and other development. Impacts to these natural resources need to be minimized to the maximum 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 will be the resource and regulatory agencies in the area and the transportation agencies (state DOT, FHWA, MPOs); however, it is valuable to include all who have an interest, from the local to the federal level. The public and other stakeholders should also be included or planning should occur for how the public and other stakeholders will be included later on. Consideration should be given to those in the region who have significant projects requiring mitigation, as they may become potential partners. Sometimes it is helpful to form committees. For example, a:

- Technical Advisory Committee may include experts from various programs identified to assist in developing the watershed approach or integrated ecological framework and encourage buy-in early in the process.
- Management Committee may include managers from the stakeholders and participating partners to oversee the Technical Advisory Committee and vision of the larger watershed or integrated ecological framework.
- Outreach/Training Committee – 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 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, it may be more appropriate for a resource agency, such as the State Wildlife Action Plan (SWAP) coordinator, to assume the lead role due to their previous work and focus on resources within the regional area of concern. Leadership and partner roles in conducting the cumulative effects alternatives assessment, especially creation and maintenance of the REF, generated considerable discussion at the C06 symposium in September 2010. Several participants suggested that larger MPOs would have the strongest motivation and coordination capability.

Tips:

- 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/NGO sector, 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.

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 multi-resource objectives.

The team will identify the most critical natural resource needs in the planning region to focus on during environmental analysis for transportation planning and conservation and mitigation investments. This will involve discussion of known long-term trends and overall priorities or concerns regarding aquatic or terrestrial resources in the planning region, based on the team members' experience. It is sometimes helpful to consult other current and historic datasets to reference the basis of the shared vision. Team members will likely be familiar with and may want to consult existing conservation and restoration plans, such as those described in Appendix C.

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, saving time and having efficient processes is another 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.

Appendix A provides guidance on building trust and cooperation using an interest-based approach. This appendix and the agency business cases at www.shrpc06.com and transportationforcommunities.com also provide information on compatibility of the approach outlined here with other agency missions and initiatives.

Tips:

- Concentrate on commonalities, some big ideas about how transportation mitigation investments may 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 motivation to try new approaches.

- As data are collected and compiled, the vision and priority resources will be expanded in Step 2b and in later decisions on priorities.
- Resource/regulatory agency participation, leadership, and buy-in are needed. This will require internal capacity building and training in methods and tools. Keys to success are to:
    - Use the best data you can obtain or collect, 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 your regulatory protection work, but understand that regulators must focus on their specific resource of interest.
- Suggestions for Lower Capacity Agencies: Ideally, transportation planning processes will build the necessary partnerships and funding needed to conduct the IEF process, ongoing updates, and adaptive management. If the transportation agency and partners in development of the Regional Ecosystem Framework lack capacity to implement the process, it is possible to use a significantly scaled back approach which can rely on subject matter expert (SME) involvement or be automated through 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 lose the opportunity to gather expert knowledge in a reusable database to apply to other plans/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 State Wildlife Action Plan and/or other spatial restoration and conservation priority maps for the resources of interest. Areas of potential conflict should be graphically identified. Subject matter experts can identify resources that might be impacted and make an expert judgment about the significance of the impact and options for mitigation. This approach is currently 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. The only technical requirement then for the transportation agency or local government would be to provide their LRTP for assessment. This alternative approach would accomplish the rudimentary need for comparing transportation and development plans to important resource locations, though it falls short of the recommended process in its ability to quantify cumulative effects and supporting a full cycle of LRTP option development, assessment, selection, mitigation, and implementation.

1d. Record ideas and vision. Develop Memoranda of Understanding on potential new processes for increasing conservation, efficiency, and predictability.

Agreements on general approach often are formalized in a Memorandum of Understanding (MOU) or Agreement (MOA). Examples of such agreements include:

- 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 and Division of Wildlife, The Nature Conservancy, FHWA, USFWS) www.environment.fhwa.dot.gov/strmlng/comoa.asp.
- TransNet Environmental Management Program MOA (San Diego Assoc. of Governments, California Department of Fish and Game, Caltrans, USFWS) www.sandag.org/uploads/committeeid/committeeid_78_9098.pdf. The Charter of the Environmental Management Program working group is at www.sandag.org/uploads/committeeid/committeeid_78_4687.pdf. The Process and Criteria for Mitigation Acquisitions are also available at that website.
- Federal Interagency MOU to Foster the Ecosystem Approach, environment.fhwa.dot.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. But it is important to take this time; groups can lose years or their process altogether when understandings are not formalized.

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 and Endangered Species Acts have been particular drivers in off-site investments in conservation and restoration priorities, but a longer list of federal laws and requirements can be viewed at www.environment.fhwa.dot.gov/ecological/eco_app_d.asp. Appendix B provides guidance on marshaling funds for conservation and restoration.

Traditionally, federal funding with FHWA oversight has financed highways covering up to 80 percent of project costs coupled with cost-sharing mechanisms and partnerships. When a construction project occurs, environmental mitigation is included as part and parcel of the project and its financing. Environmental matters are not funded out of a separate funding category related to either mitigation or planning, which has received little federal support. For years, state and local agencies have been challenged in how to address conservation needs or implement restoration investments earlier.

Finding funds to allocate can give an integrated planning effort considerable momentum. Colorado and Washington State developed revolving funds for investment on a planning level and then repayment out of projects; 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. In San Diego, citizens passed a bond measure for transportation infrastructure and associated conservation and mitigation investments in the region. This funding and interagency interest in directing this investment to where it would produce the most good have helped the MPO and DOT get adequate regulatory assurances and interagency understandings to advance the spending on priority conservation acquisitions identified by the team and local plans. The USFWS Carlsbad Field Office's sample letter enabling the latter is included in Appendix D.

Partners and various funding opportunities can support integrated planning and development of a REF, and implementation of identified priority conservation and restoration actions. In addition to support for integrated planning and *Eco-Logical* approaches through FHWA and traditional transportation funding (see sidebar), EPA has grants for planning for green highways, streets, and more sustainable low impact development, in addition to wetland program development and water quality improvement projects. FWS has made funds available for multi-state priority conservation/mitigation site identification through Endangered Species Act Section 6.

Evolution has occurred in terms of how federal funds can be spent. *Eco-Logical* noted that "4R" provisions allow restoration of impacts due to past projects under current Federal-aid highway projects. DOTs can, if they so choose, utilize federal transportation dollars to retrofit or improve environmental aspects of earlier projects, but transportation needs are such that DOTs rarely opt for this and sometimes state law and funds do not offer the same flexibility as federal funds do.

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 non-Federal share, which must be quantified, tracked, and reported. 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. Conservation partnerships often leverage work that has already been initiated or completed by one of the partners.

The Transportation Enhancement (TE) program can also be used to fund conservation, as an enhancement of the natural environment. To be eligible for funding, a TE project must fit into one or more of 12 eligible categories and relate to surface transportation (see 23 U.S.C. 101(a)(35)). A project eligible for TE funding must meet Federal environmental, project administration, and right-of-way requirements. State DOT TE managers administer the program and establish eligibility specifics at the state level, often adding more specifications than FHWA guidance. DOTs are often reluctant to take "transportation funds" and allocate them to TE; however, mechanisms exist for the use of in-kind contributions to meet the non-Federal cost-share requirements. See www. fhwa.dot.gov/environment/te/guidance.htm.

State Infrastructure Banks (SIBs) and Grant Anticipation Revenue Vehicles (GARVEE) 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 (e.g. $100,000 over 30 years at 5 percent interest is equal to a mortgage payment). 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. See www.fhwa.dot.gov/innovativefinance.

Tips:

- Caltrans is exploring how to fund advance mitigation on very large scales (regional and statewide), for habitat and wetlands, helping other resources at the same time, presenting a model for others.

FHWA Funding for Mitigation Including Habitat or Wetland Banks and Statewide and Regional Conservation Measures

FHWA's authority to fund mitigation for project impacts is outlined in FHWA's environmental regulations at 23 CFR Part 771.105(d). The provision reflects FHWA's 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 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 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 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: fhwa.dot.gov/environment/wetland/wethabmitmem.htm.

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

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 involves identifying and compiling information on resources as well as merging, overlaying, or "mashing up" that information with data on other resources.

Specific restoration and preservation goals for aquatic resources in the watershed will be discussed, as will connections between aquatic resources, their functions, and how they cumulatively support watershed-scale processes. Widely available datasets include land use/land cover data, national hydrologic dataset, DNR/NWI wetlands, 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 ultimately the Regional Ecosystem Framework, which address all species, all habitats, and all relevant environmental issues. Thus, anticipated outcomes for this over-arching step include:

- Group understanding of historic/long-term trends, priorities, and concerns related to aquatic and terrestrial resources, species, and habitats in the region.
- Existing data and plans compiled into a refined map that identify 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 identifying modeling or assumptions to be used to address these gaps.
- Commitments and schedule for delivery of data. 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** that are a by-product of past actions 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 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/priorities, and identify actions to support them.**

2g. **Record methods, concurrence and rationales of this step 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**

Step 2: Characterize Resource Status. Integrate Conservation, Natural Resource, Watershed, and Species Recovery and State Wildlife Action Plans

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 accurately do we know where priority species and habitats (including wetlands) occur or could occur? Do we 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?
- Is there disagreement in the conservation priority areas and goals identified by different conservation plans developed in the planning region? How will this be resolved?
- What regulated resources are most common in the area, and are most likely to be impacted or are the 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 303(d)-listed streams?

2a. Identify the spatial data needed to create understanding of current (baseline) conditions and understand potential effects from future actions.

The spatial data needed will depend on the resources to be evaluated. This will 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 datasets that regulators themselves would consult to address key aspects of their regulatory area and to make decisions on permits or Biological Opinions should be included in the data set.

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. For greater detail and explanation of these types of plans, please see Appendix C. 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. 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."[1]

The list below is not exhaustive but includes environmental related data and plans found in most regions, and includes data and plans 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, etc., and which resources are included. The team should make an initial determination which plans and/or resource maps to include in the REF and which resources each plan can represent. Each resource should be represented primarily by only one plan, but important conservation areas that include multiple resources may represent an acceptable overlap. For example, a particular conservation priority plan may be deemed acceptable for representing bird conservation generally but an individual bird species priority map may be added to the REF that better represents that individual resource. Though there is some overlap, both input maps will be useful for the REF.

Federal Lands/Federally Managed Lands and Associated Plans

- Department of Defense, Integrated Natural Resource Management Plans
- Department of Interior, Bureau of Land Management
- Department of Interior, National Park Service
- Department of Interior, USFWS
- Department of Agriculture, Forest Service
- National Oceanic and Atmospheric Association (NOAA) and USFWS recovery plans
- US Army Corps of Engineers (Corps) 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 (corridor analyses, regional transportation profiles, transportation improvement plans, etc.)
- State Wildlife Action Plans (SWAPs) (www.wildlifeactionplans.org), or other conservation/land use plans that are mapped and have "actionable" priorities. Some plans 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 plan
- State 'open space' plans

Local Agency Plans

- Local land use plans/Comprehensive Plans, Green Infrastructure Plans (The Conservation Fund), GreenPrint (The Trust for Public Land) plans, etc.
- Land Use/Land Cover and impervious cover (www.mrlc.gov/)
- Local watershed restoration plans completed by state water quality agencies or local watershed organizations. These can include municipal water supply watershed plans.

NGO Conservation and Restoration Plans

- The Audubon Society's Important Bird Areas plans, joint venture waterfowl or waterbird plans, or other various single resource focused, scientifically-derived priority plans (Ducks Unlimited and Trout Unlimited)
- The Nature Conservancy's Eco-Regional Conservation Plans, covering all states in the US. These may be especially useful when SWAPs lack mapped, actionable priorities. (www.tnc.org)
- Other Potential Conservation Areas that are widely adopted/utilized
- Local/regional land trust plans developed with systematic methods

Other Data

- Protected area data (USGS PADUS, www.protectedlands.net/padus/preview.php, CBI, www.databasin.org)
- EPA's Reach Address Database, 303(d) Listings (http://epamap32.epa.gov/radims/), discharge of waste waters via permit compliance system, watershed boundary data
- Data sets created by the state, counties, and other local organizations. For example, Maryland and Florida have greenways/green infrastructure/green print initiatives that identify large, contiguous blocks of ecological 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), & Existing NRCS Rapid Watershed Assessments, 20-40 pp characterization of watersheds based on geology, soils, land uses, and socio-economic data www.nrcs.usda.gov/programs/rwa/rwa_statelinks.html
- Wetland/Watershed - NWI, local watershed plans by state or local organizations or municipal water supply watershed plans, e.g., Wetlands of Special State Concern
- Impaired (303(d)-listed) streams (EPA, state agencies)
- Impervious surfaces (state or local government)
- Floodplain (100-year) Federal Emergency Management Agency
- Pollution point sources (state government)

Other Useful National Data Portals

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 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.

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 and Federal Geographic Data Committee. 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 is 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 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 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

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 that should 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 at risk by the resource collaboration group/scientists.
3. Use ranking systems such as NatureServe's Global Rank of Imperilment (G1-3 status) and the State Natural Heritage Program S-ranks (S1-S3).
4. Apply the coarse/fine filter approach for biodiversity conservation planning (which seeks to conserve the full range of biodiversity).
5. Add "trust" species (those in addition to legally protected species which agencies are required to manage).
6. Add other resources of interest/value to stakeholders.

Next, it is highly useful to set quantitative retention or restoration goals for each resource (e.g., 90% of the distribution of habitat A or 100 occurrences of species B within the planning region) and document the source(s) of information used. Goals are typically set in the systematic conservation planning process using experts in those resources to apply their judgment relative to historic vs. current distribution and viability/sustainability requirements such as species population structure and natural disturbance regimes. For wetlands and watershed resources it is advisable to establish:

- 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
- Complete trends analysis

While it may be required or desirable to estimate actual historic distribution and loss, 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 high uncertainty. Another approach is to apply NatureServe global ranks of imperilment. These "G-ranks" already incorporate expert judgment on historic loss and can be found at (www.natureserve.org/explorer/). For non-legally protected resources, goal-setting can be difficult and controversial but forms the basis for assessing significance of impacts in later stages and facilitating mitigation and tradeoff planning. It is critical to clearly characterize the objectives for legally protected resources, including all goals identified in recovery plans, adopted watershed plans, and programmatic agreements.

The typical alternative to goal-setting is weighting the relative importance/priority of resources/features on some categorical scale (e.g., 1-5, low-to-high, etc.). Weighting resource importance can be used as an initial step to help inform the magnitude of potential impacts while quantitative goal-setting is being conducted (which can often times be a lengthier process) and 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 this process because weights do not result in conclusions about resource viability impacts or the amount of mitigation that may be needed other than for resources where any impact must be mitigated. Weighting values provided by stakeholders can inform the expert judgment process in terms of gauging the amount of representation of a resource relative to science-based judgment about viability or sustainability (e.g., it may not require much area 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). Appendix A contains further goal-setting guidance.

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

A database should be constructed to track the considerable amount of spatial and non-spatial information that will be collected and generated through application of this framework. Creating a database for resource information is critical to document/hold information on the:

- 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.
- Retention goals and other key information necessary for effects assessment and retention planning/mitigation described in Step 4a.

The process of populating this database can take some time and 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 Steps 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. use of workshops.[2] Often experts are located outside the planning region. Populating the database essentially involves having subject matter experts (SMEs) for each set of existing data and the resources in question, including 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 time for sharing and recording that knowledge; however, it can sometimes be hard to fund travel for distant subject matter experts or gain the necessary availability. It is increasingly possible to leverage other ongoing efforts, such as those currently underway in the Bureau of Land Management, Forest Service, Western Governors Association, the Conservation Fund, USFWS Landscape Conservation Cooperatives and others, 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/expertInputGuide.pdf.

2c. Develop necessary agreements from agencies and NGOs to provide plans and data that agencies 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. It is necessary to gain agreement from these organizations to share their data, as part of Step 2c. Individual states, MPOs, and resource agencies arrange and negotiate this, but such agreements might also be formulated on larger, multi-state or federal scales, to save time and effort.

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

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 datasets to be used in previous steps, the team needs (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 will address those.

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

To understand how well existing plans represent specific resources, create 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), 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 conduct the following steps:

1. Identify and obtain existing resource distribution maps that the resource subject matter experts 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 Regional Ecosystem Framework.
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 1-3 scale, 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 vs. accuracy assessed predictive distribution models) and the robustness of analyses (e.g., simple distribution area vs. population dynamics).
5. Determine if enough information exists to include the resources in the process and if so whether they will have separate treatment as individual element layers in the REF or be integrated into an update of an existing plan product by the owner of that plan (e.g., add to 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 re-opening 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. It may be reasonable to conclude that the bar for planning should be lower than for project assessment (full NEPA process) where the number of considerations is fewer and more precise information can be collected and rigorously analyzed. The objective is to provide a far better and more precise assessment at the planning phase than has traditionally occurred, while not hamstringing such analysis with impracticable requirements. Education of partners and stakeholders in the use and value of subject matter expert judgment will be needed to achieve the objectives of streamlining project delivery by moving considerations to the planning phase. Uncertainty in scientific knowledge should also contribute to agreements about triggers for additional analyses at the project phase. The partnership should also agree on acceptable sources of scientific information and should develop a scientific research needs assessment and strategy for the mid- to long-term, to fill critical gaps.

Data Availability and Quality

Lack of quality data is becoming less and less of an excuse to not do good resource assessment. While perfect data will never be achieved, more and better data are available every year. Thus, the quest for better and better data should not become the enemy of making use of good data that exists at resource agencies, 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.

The State Wildlife Action Plans should form a key component of the REF. While a few years back only 20 or so SWAPs had geo-spatial components, now over 30 do and others are in the works. Some may still be too coarse to support transportation planning, but as of this writing, 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/available geo-spatially in your state Action Plan, other plans may exist to fill this role wholly or partially in the interim, including work by large national or regional conservation NGOs and some natural heritage programs. Don't pass over multi-state conservation or restoration planning efforts, as the resolution may actually work for your purposes (see Region Ecological Assessment Protocol (EPA Region 4), the new Southeastern Ecological Framework (Region 6), species specific mitigation siting support tools as with the Desert Tortoise, the Watershed Restoration Registry in Maryland, or the 14-state NiSource conservation strategy developed by The Conservation Fund. See Appendices F and G.)

When no conservation priority area plans exist at the needed level of resolution, the partnership should decide if it will be more efficient to downscale 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 still 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, an 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 and augment them 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.

It is understood that conservation priority areas often do not cover some important resources, and maps for such resources are often based on incomplete observation points. Many SWAPs did not address plant species. And currently, many species distribution maps only exist as point observations (see maps of the 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 program/partners may also be able to use contemporary tools and methods to create the necessary models, with much less effort than in the past.

Tips:

- **Creating 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" and then allows users to drill down through the information to further detail as needed. For example, a result from a cumulative effects assessment may indicate an incompatibility between a resource and a proposed action (there is a problem). Further investigation may reveal the resource is not legally protected, but the action would prevent achieving of the resource retention goal. Identification of the specific resource and the amount of area impacted can then help identify possible mitigation options that could be pursued with interested REF partners.
- **Integrating and maintaining information from distributed sources**: This can be a particular challenge for obtaining, integrating, and managing expert input on the resources. Such experts are usually distributed among many organizations and over wide geographic areas. Creation of a simple online location where their information can be input can ease the burden on everyone for information collection and management. Using this approach makes their information reusable for multiple applications.
- **Integrating dynamic processes and information**: Dynamic data can include data that are updated frequently and/or that represents dynamic phenomena. Study and modeling of climate change is increasing and beginning to produce large amounts of such data which can affect the Regional Ecosystem Framework (species/ecosystem change and migration) and assessment of additional important stressors on the resources. The REF partnership should explicitly address what information should be included and how it should be used in updates to the REF and assessment.

2e. Produce geospatial overlays of data and plans outlined above, 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 it will be infeasible to visually represent all of the information on one map. This database will be used 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.

The data in the database will provide the attributes needed to create such visual presentations of particular themes of interest. Suggested attributes include: 1) source/owner of the input map, 2) type/purpose of individual areas, 3) resource content of individual areas, and 4) metadata for 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 and remaining areas from this step are all unsecured priority areas that should 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 often functional lift (quantitative) and watershed zones. The prioritization and rating system may highlight areas based on attributes of content such as legally protected, impaired, or especially rare/imperiled resources or those values integrated in weightings described earlier, and threat from conversion. The REF partnership should 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 the setting of 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. Areas that might present eco-opportunities (locations where ecological actions would be most helpful) are scored and ranked. Analyses identify highly impacted areas, such as areas of high impervious surface where restoration is more risky. In impacted 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. Avoidance and minimization are important.

2f. Convene a team of stakeholders to review the geospatial overlay and associated goals/priorities, and identify actions to support them.

The initial team of stakeholders, with the potential addition of further agency staff and subject matter experts, meets next to review the geospatial overlay and associated goals/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 upon portion of the priority resources?
- What is the conservation status of identified priority species, habitats, and wetlands? How accurately do we know where priority species, habitats, or wetlands occur or could occur? Do we 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 Regional Ecosystem Framework, including ones that are not spatially explicit?
- Is there disagreement in the conservation and restoration priority areas and goals identified by different conservation, restoration, and recovery plans developed in the planning region? How will this be resolved?
- What regulated resources are most common in the area, are most likely to be impacted, 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 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 merit choosing as highest priority needs. This process must be recorded, as indicated in Step 2g, below. 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
- 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.

2g. Record methods, concurrence and rationales based on stakeholder input.

This step records how the priorities to address 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.

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 and hence it has not always been included in development planning the way it should or could have. Having this information means that a great deal of voluntary conservation and protection can begin to occur.

It should be remembered throughout the process that the quest for better or more perfect data should not become the enemy of the "good." (See sidebar discussion on data quality on page 35). Opportunities for voluntary conservation or collaborative action on conservation and restoration priorities can be missed otherwise. There are definite opportunity costs to retaining information or postponing sharing it.

Step 3: Create the 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:

- Producing the REF, an integrated map of resource conservation and restoration priorities, transportation long range plans and other land use, infrastructure information, and socio-economic information);
- Reviewing and verifying REF and data sources used with all participating agencies and stakeholders; and
- Identifying areas in which planned transportation projects intersect with management/ conservation priorities, including existing conservation areas.

At this level, the Regional Ecosystem Framework 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 Corps of Engineers Baltimore District, Watershed Resources Registries "map opportunity areas that would benefit most from the ecological actions suggested in the watershed profile. While the watershed profile is more of a descriptive tool, the targeting aspect of the WRR will assess 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 wanted, or problematic areas that require restoration or [best management practices] to provide benefits to the watershed….[the] targeting tool [that] will show them what areas are optimal for fulfilling those needs."[3]

Implementation Substeps and Technical Considerations

A brief overview of the implementation substeps in creating the combined conservation strategy and transportation plan, a Regional Ecosystem Framework, may be seen in the table below.

Step 3: Create Regional Ecosystem Framework (Conservation Strategy + Transportation Plan)
Implementation Substeps:
3a. Overlay the geospatially mapped Long Range Transportation Plan (or TIP/STIP) with conservation priorities and other land uses.
3b. Identify and show 1) areas and resources potentially impacted by transportation projects and 2) potential opportunities for joint action on conservation or restoration priorities that could count for 404 and 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/plans.
3d. Review and verify REF with stakeholders.
Technical Considerations:
▪ What areas will be directly impacted 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 areas could be targeted for mitigation? Would these areas contribute to meeting REF objectives?
- What areas should we target to avoid impacts due to the presence of irreplaceable resources (i.e., endemic species or habitats)?

3a. Overlay the geospatially mapped LRTP (or TIP/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 an input, 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.

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.

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 and/or crosswalked into this common classification, which subject matter experts can then efficiently use as they characterize or assign the response of resources of concern, to current or anticipated land uses/disturbances in Step 4. It is important that the classification be stratified enough for subject matter experts 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, local governments may have dozens of different named land uses but the vast majority of those will be 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 www.iucn.org/about/work/programmes/species/red_list/resources/technical_documents/new_classification_schemes. IUCN standards have also been adopted by the FWS for use in their Information, Permitting, and Consultation (IPaC) online assessment tool.

Once a common classification is established, the spatial data can be brought in. The database can depict the distribution of regulated resources to assure the analysis can identify impacts to individual regulated resources along with overall conservation objectives and tradeoffs. In particular, these would 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.

3b. Identify and show 1) areas and resources potentially impacted by transportation projects and 2) potential opportunities for joint action on conservation or restoration priorities that could count for 404 and Section 7 regulatory requirements.

In this substep, output maps and quantitative reports are generated from the intersection in 3a above to identify which priority areas/resources would be impacted, the amount of area/resource distribution impacted, and the location of impacts. Note that if Step 4 is not yet accomplished, this simple intersection assumes conflict between all development and all resources/priority conservation areas. This is a reasonable assumption at this stage to understand potential conflicts and needs. Step 4 will add information for more precise results suitable for more detailed planning; however, it is still important at this initial stage to apply a consistent format to these results, to facilitate ready comparison between alternative transportation scenarios. Note that to get a truly cumulative effects assessment it is important to combine the LRTP with the existing land uses and other proposed/planned land uses, as described previously.

The quantitative results from this substep are then used to evaluate impacts. At this state, the objective is to identify the resources/areas being impacted and the projects/uses causing the impacts. This can lead to identification of opportunities for focused joint action on creating better alternatives through avoidance or design mitigation and early scoping of compensation opportunities should they be necessary.

3c. Identify the high-level restoration/conservation goals and priorities, and opportunities for achieving them, relative to the transportation plan and other land uses/plans.

The outputs of Substep 3b allow one 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 in order to address those opportunities/priorities for ecological action.

A key consideration for ecosystem credits at this step is the ability for landscape-level measures to connect to site-level ones. 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 can often be too general to provide the basis for site-level decisions. Detailed landscape measures help to 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 is left in general terms, it is impossible to implement at a site level.

3d. Review and verify REF with stakeholders.

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

- What areas will be directly impacted 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, due to the presence of irreplaceable resources (i.e., endemic species or habitats)?
- What areas could be targeted for mitigation? Would these areas contribute to meeting REF objectives? What areas and measures could be used for mitigation, in order 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 to implement the highest conservation and restoration priorities in the region. The team assesses transportation effects, using the Regional Ecosystem Framework 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:

- 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.
- 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 in the table that follows.

Step 4: Assess land use & 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) where needed to help establish the significance of impacts and importance for mitigating action.

4b. Identify/rate how priority conservation areas and individual resources respond to different land uses and types of transportation improvements.

4c. Develop programmatic cumulative effects assessment scenarios that combine transportation plan scenarios with existing development and disturbances, other impacting features and disturbances, and existing secured conservation areas. Include climate change threats to better understand what resources/areas may no longer be viable or what 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 and that may require minimization through project design/implementation/maintenance, and that may require off-site mitigation. For impacts that do not appear practicable to mitigate in-kind, review with appropriate resource agency partners the desirability of mitigating out-of-kind (e.g., by helping secure a very high priority conservation area supporting other resource objectives).

4g. Establish the preferred transportation plan, and quantify mitigation needs including the amount and quality of area by resource type for which impacts could not be avoided and require further mitigation attention**.**

Technical Considerations:

- What areas have the highest degree of potential impacts? How important are these 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? Are there mitigation banks in the area or are there opportunities for bank development?
- What rules/methods will be used for weighing tradeoffs 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?

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

A first step is to set individual resource/priority area importance weights. Weights in this sense do not replace quantitative goal-setting but instead inform a tradeoff process when not all resource retention goals can be addressed in an iteration of the scenario assessment/mitigation process.

The partnership should establish how the weighting system will be used and how the weights will be set (e.g., SMEs, committees, stakeholder involvement, etc.). Next, establish the weighting system and criteria (e.g., 1-5 highest to lowest, etc.) and set the weights and document source of information and process used for setting the weights. To the extent weights can be decided, they will ease decision-making on priorities.

Some similar processes, such as the Watershed Restoration Registry in Maryland (see profile in Appendix E) 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, and then for each ecological opportunity, the group outlined which physical factors *enhanced* an opportunity, which *must be* present, and which *could not be* present. Factors included measurable and mappable qualities, such as whether the area drains to a 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, so that with the eight opportunity maps for different types of mitigation (e.g., wetland preservation, wetland restoration, etc.) the user can locate those areas in the watershed where ecologically beneficial actions would preferably occur, according to the interagency team.

4b. Establish individual resource conservation requirements such as their response to different land uses and types of transportation improvements (and other stressors), minimum viable occurrence sizes, connectivity requirements, etc.

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 obtained to specify other recommended and optional parameters and input to the resource database such as:

1. **The minimum required area for a patch or occurrence** of the area/resource (recommended).
2. **Ecological condition thresholds**. Ecological condition is a function of the criteria used to assess the quality of the resource compared to viable reference conditions and usually takes into account (besides the minimum required area above) the presence of pollutants, exotic species, age class and vegetation structure, off-site effects, etc. (optional)
3. **Responses of REF priority areas and individual resources (if used) to various transportation plan components** or improvements (and any other plans or disturbances to cumulatively assess). This component 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., that 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 and it would likely add considerable complexity. However, if such assessment is desired it could be conducted as part of this step.

4. **Landscape ecological parameters or characteristics such as patch interior area, edge-interior ratios, connectivity**, **desirable stream buffers, etc.** Use parameters that are meaningful for the resource and practical and workable using available data and tools. (optional)
5. **Viable species population size and characteristics, when these can be reasonably established**. Assessment of these characteristics can be difficult and expensive and are more likely gathered during field assessment, but recording them during the expert knowledge gathering phase will be most efficient. Because this information is expensive and difficult to determine, it is most often addressed for legally-protected species where high certainty of cumulative effects is required. (optional)

This information provides assessment that is much more precise by taking into account some important considerations such as:

1. **Not every resource responds negatively to every land use/development activity**. Some species will have a neutral response and a few could 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** is not only very important to suitability for species but also important from a policy perspective for suitability to receive compensatory mitigation.

4c. Develop programmatic cumulative effects assessment scenarios that combine transportation plan scenarios with existing development and disturbances, other impacting features and disturbances, and existing secured conservation areas. Include climate change threats to better understand what resources/areas may no longer be viable or what 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 will be defined and evaluated. 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:

1. Current baseline of actual land use and management.
2. A "policy" baseline of allowable land use/management not yet realized. This is also known as a "build out" map for urbanization based on current local government plans and zoning.
3. A trend scenario that predicts likely urbanization (based on demand, suitability, and market conditions).

4. Climate change is another trend and future habitat stressor that could be mapped, affecting not only temperatures but also water availability and storm strength and frequency in some areas.
5. Alternative futures scenarios. There are often several of these which represent alternatives to preferred future scenarios which may be based on models, proposals, civic engagement, etc. Examples in regional transportation planning might include traditional long range plans assuming automotive travel vs. corridor development approach vs. an urban centers/transit-oriented development scenario.

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

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 —this is especially useful for land uses and management that are not easily distinguished through remote sensing such as working landscape uses/management.
    c. Infrastructure.
    d. Protected conservation areas.
    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. Note that in cases where multiple uses are allowed in an area it may be appropriate to attribute the most intensive allowable use under the precautionary principle.
    b. Urban growth model output for the transportation planning horizon. These are often developed by local and regional governments and other entities. They are not just population projections 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.
    c. Pest and disease spread. For example, pine bark beetle infestation in the Rocky Mountain region poses a significant cumulative threat to ecosystems and individual resources.
3. Alternative future scenario:
    a. Proposed transportation plans and projects (and their alternatives).
    b. Proposed land use and management plans (and their alternatives).

Resource partners may additionally collaborate on inclusion of predicted climate change threats to better understand what resources may not be viable or what 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 such as temperature, precipitation, soil moisture, etc.

Data can then be integrated into a single map containing the different scenario components. Instances may occur where one map input trumps others that overlap with it. For example, many counties will zone public lands in case land is swapped that puts that land into private hands (thus it will be appropriately "pre-zoned"). 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 should trump others.

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 will first determine the location and amount of each area/resource in each land use type in a scenario by intersecting the spatial data.

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

For assessing impacts on priority areas from the REF, it is most useful to have quantities of individual resources found within those areas to determine the type and amount of impact, though without precise resource location information the results have considerable uncertainty if a portion of the priority area is impacted versus all of it being impacted. When such information is not available, it may be necessary to work with the owner of the plan that area came from 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 what scenario areas (land use, infrastructure, management, etc.) are responsible for the impacts.

4e. Compare plan alternatives, and select the one that optimizes transportation objectives AND minimizes adverse environmental impacts (the least environmentally damaging practicable alternative, assuring regulated resources are sufficiently addressed).

Having generated spatial and quantitative results in Substep 4d, one 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 will compare equally acceptable transportation scenarios and readily identify the one with the least impact. In cases that are more common there will be tradeoffs 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., via 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/land use plan adjustments can be conducted, leading to identification of a preferred scenario in terms of meeting transportation and land use objectives and least impact on resource goals. The map and quantitative outputs of the assessment will prove highly valuable for guiding these adjustments by identifying locations, resources, and development activities that are in conflict. The database of resource responses to the classification of development activities will also be highly useful for determining compatible uses at priority conservation and restoration sites.

4f. Identify mitigation needs for impacts that are unavoidable and that may require minimization through project design/implementation/maintenance, and that may require off-site mitigation. For impacts that do not appear practicable to mitigate in-kind, review with appropriate resource agency partners the desirability of mitigating out-of-kind, e.g., by securing a very high priority conservation area.

The outputs from Substep 4d will provide the quantitative information required to understand what resources are impacted and the quantity of the impact (e.g., acres or populations impacted). 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 if 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 where options exist.

For impacts that do not appear practical to mitigate on-site/in-kind or when on-site options are not ecologically viable, review with appropriate resource partners the desirability and permissibility for mitigating off-site/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 and endangered/threatened species) it may not be permissible to mitigate out-of-kind but for other resources, off-site mitigation should be explored to determine if there are priority conservation sites in the REF that support higher conservation values (see Step 6 for more information about value trade-offs). As previously mentioned, recent wetland mitigation guidance recommends that mitigation be done in areas where ecological processes can be restored, unless it is ecologically necessary to maintain the affected functions on the impact site.[4, 5] In considering locating mitigation in larger watersheds, the key principles are to (a) generally, 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 to protect or restore the health and condition of aquatic resources within a watershed or other appropriate area within a broad ecological landscape.

NOTE: This will support implementation of Substeps 6a, 6e, and 6f on ascertaining measurement needs and negotiating credits, and may require partially completing these in advance. Substep 6a includes a diagnosis of the environmental, regulatory and stakeholder issues and creating linkages between these various values to assess tradeoffs. The market assessment and implementation decision in Substeps 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, Restoration and Conservation Sites

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:

- **A regional mitigation (conservation, recovery, restoration) strategy, conservation and restoration priorities with quantitative and qualitative valuation of mitigation sites**. The strategy and priorities should be iterative, and it is important for the stakeholders to 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, including 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.
- **Crediting opportunities** (see Step 6 for details).

In this step, the partners will also identify lead agency or agencies for each strategy and 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) 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 described above.
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 feasibility/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/effectiveness. Predictive species modeling can target field validation process.
5d. Develop/refine a regional conservation and mitigation strategy (set of preferred actions) to achieve eco-regional conservation/restoration goals and advance infrastructure projects.
5e. Decide on and create a map of areas to conserve, manage, protect, or restore, including documentation of the resources and their quantities to be retained/restored in each area, and the agency and mechanisms for

Step 5: Establish and Prioritize Ecological Actions
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 agreed upon regional restoration plans goals and objectives? ▪ 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 is can be used in future assessments?

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, 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) ability to contribute to long-term ecological goals; d) the likelihood of viability in the landscape context; e) cost; and f) other stakeholder criteria.

For mitigation of impacts to individual resources, it will be necessary 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 prior to putting agreements in place but the initial information can be used for planning purposes.

For mitigation of priority areas from the REF, it is most useful to have quantities of individual resources found within those areas, to determine mitigation needs. When unavailable, 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, may likely require additional investigation and verification of the resources that would be impacted and the value of the proposed mitigation (see Substep 5c below). For out-of-kind mitigation, Step 6 must be addressed to determine equivalency of values that can be provided by other areas or resources than those directly impacted.

5b. Select potential mitigation areas according to the ranking protocols described above.

When searching for mitigation areas, spatial queries can be conducted 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, then other areas can be identified and investigated. Failure to find any in-kind mitigation opportunities may then trigger discussions for out-of-kind mitigation opportunities.

For wetlands, endangered species, and other regulated resources, identify, adopt or develop programmatic approaches to mitigation, permitting, or Section 7 consultation, especially if sufficient development is likely to occur in the state or region, with consequent impacts or opportunities for restoration or conservation of these target resources. These may enable or draw upon conservation or mitigation banking in the area. Steps for developing a catalog of preferred wetlands mitigation sites are identified below.

Proposed Process for Creating the Priority Wetlands Map

by Jimmy Kagan, Oregon State University

Mapping current and historic wetlands

A comprehensive digital map of wetlands needs to be available. The goal is to ensure that all wetlands greater than five acres in size are represented. If possible, having comprehensive maps of wetland soils and historical wetlands 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, NatureServe, and National Vegetation classifications. Biophysical settings maps from the inter-agency LANDFIRE effort depict historical wetland distributions. Both of these maps are at 30m pixel resolutions (approx. 1:100K scale). These may be compared and combined with NWI, wetland soils maps, terrain models, and/or augmented with additional image interpretation.

There are important benefits to developing wetland maps that are linked to these several 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 type is categorized along 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, 10-20 types per state - have been reviewed and attributed as habitat for at-risk and focal species, so this information becomes 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 EPA funds to enhance the NWI wetlands cover 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) needs to be integrated*. In addition, states must assure 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 incorporated additional spatial data to assure that farmed and partially developed wetlands were included (Appendix E).

Develop a synthesis of spatially explicit representations of conservation and restoration priority sites.

A synthesis would include any conservation opportunity areas developed in the context of 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. Fortunately, 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 NGOs, and agencies with natural resource scientists.

The first step involved in the proposed process is to identify existing watershed and conservation plans for a state. In a few cases, a state may have only one such conservation framework (since The Nature Conservancy has completed conservation strategies for the entire United States), or two (since nearly two thirds have mapped conservation priorities or opportunity areas in their SWAPs). Corps and EPA staff should become familiar with these and a state project coordinator may want to facilitate and formalize their endorsement and additions to have an approved/adopted working framework that can be improved and modified from there. If there are conservation or watershed plans and identifications of conservation and restoration priorities, then the process is to integrate these plans, 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 this is not a critical step.

In any case, obtaining recognition by the Corps, EPA, the state and other agencies that the final conservation and restoration priority map is the best “currently available” representation of conservation priorities 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 historic 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 a fairly comprehensive map of either wetland soils or historical wetlands (or if possible, both), can greatly improve the quality of the map.

Modify the extracted wetlands coverage into a set of priority wetland polygons.

This 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 an important step for large or poorly mapped areas. The goal of this is not to develop a conservation plan for a site. It is just refining the boundaries of the areas, so that they make sense to wetland regulators as well as to those working on conservation and watershed restoration.

It is important to make sure that wetland mitigation priority areas make sense. In some of 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 showed up on the first draft of the priority map, in an area with a number of high priority sites. Wetlands regulators had them remove this area because they did not want to promote wetland mitigation so close to an airport. If it had been a critically important site, or the only priority wetland in the watershed, the team might have discussed leaving it in. This is not very time consuming, but an important task.

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

Assure that at least one priority wetland conservation site exists in every watershed.

Work with regulators to determine if mitigation occurring in the same 8-digit HUC can be considered in-place (assuming the types present are similar enough to be considered in-kind). Where desired, a 10-digit HUC can be used, since these are smaller and provide regulators more assurances of mitigation being in-kind and in-place. In almost every major basin in the country, one or more watersheds will contain no synthesis, portfolio, catalog, or other priority areas. In these watersheds, catalog sites need to be identified using any of the original assessments that had wetland components or by looking for concentrations of natural wetlands. The C06B team made sure that there was at least one potential site in each of these areas.

Across the nation, conditions will vary considerably across 8-digit HUCs. In those where 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, and a simple method is to prioritize or 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 criteria for increased wetlands function (as it hopefully will be), there should be no difference in function crediting between any priority wetland, regardless of its rank. It may help a DOT to demonstrate that all decisions they made were based on regulators' or priority criteria, not theirs, which is why ranking the priority wetlands within each watershed can be useful. Specific criteria for ranking the catalog are not recommended here, although clearly the overall significance to conservation in the REF for each site should be considered.

Vet the priority map with regulators and wetland program staff

The priority map must be vetted with regulators and wetland program staff. A good first step is to vet the priority map with conservation partners, if they are available in the area. Then leads should set up a meeting with regulators, making sure to include the Army Corps of Engineers, EPA, NRCS, USFWS, any state agencies that regulate wetlands, the state DOT, state fish and wildlife agency, and other state agencies as appropriate.

Promote the Wetlands Priority products and facilitate its use by federal, state, and local planners

Once the wetland priority maps and resources have been developed, it is imperative to identify further steps that are needed nationally and in respective states, Corps Districts, and EPA or USFWS regions and field offices to facilitate its use in decision-making for 404 permitting, and as appropriate in ESA Section 7 consultations and in other regulatory matters. Clearly, the best methods for doing this will be different in each state and jurisdiction.

It is essential that the information be made available to the public as soon as it has been vetted, since otherwise wetland bankers who do not have access to the data will have a persuasive argument for protection of non-priority areas. This should be made available as soon as possible to local governments and all who develop and/or approve development applications on the local level, as considerable avoidance is anticipated, on a voluntary or pre-regulatory level.

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 will involve not only field validation but also comparison of the feasibility/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/effectiveness. Predictive species modeling can help target the field validation process for species of concern, when such models are available.

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

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) and thus 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.

5d. Develop/refine a regional conservation and mitigation strategy to achieve eco-regional conservation/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 step will detail the preferred conservation and restoration actions for the previously identified conservation and restoration priority areas, which are further described in Step 5e. This should include documentation of which resources and their quantities are to be retained or restored in each mitigation area, and the implementation agency and mechanism for conducting the conservation investment or mitigation. This information should be incorporated in or used to update the REF; assure the mitigation catalog and mitigation actions are updated based on restoration activities, lost opportunities, and areas conserved.

Ecosystem Crediting Aspects: 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) will provide the tools for implementing these priorities. Similar to earlier goal setting concerns in Step 3, the definition of resources and priorities must provide a level of detail to be used at the implementation steps. Priorities must consider the spatial, functional, habitat and population issues defined in Step 6b.

5e. Decide on and create a map of areas to conserve, manage, protect, or restore, including documentation of the resources and their quantities to be retained/restored in each area, and the agency and mechanisms for conducting the mitigation.

In this step, the REF database will be used to inform stakeholder decisions and create a map of areas to conserve, manage, protect, or restore. This will entail documenting the resources and the quantities that need to be conserved or restored in each priority area. This step will also provide further detail 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.

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 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 having the analyses throughout the life of the project be in the same units and language, 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. This can include a historic review of agency permitting obligations and costs, or reviewing 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 questions are what existing measurement systems are in use, such as ones associated with ESA recovery efforts, pollutant measures for TMDL management, and wetland measures. Early coordination with other planning efforts identifies both opportunities and challenges that need to be resolved early.

Outcomes of Step 6 will include:

- Improving and integrating 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 providing the basis for outcome-based performance standards, which sets the stage for Compensation – which is defined by the same metric calculating the debit/credit totals associated with the project impacts and mitigation outcomes, respectively.
- Accelerating implementation and improving mitigation results.
- Supporting implementation tools such as advance mitigation, banks, programmatic permitting, and ESA Section 7 consultation.
- Supporting use of off-site mitigation and out-of-kind mitigation where appropriate, since equivalency of value can be determined across locations and resources.
- Informing adaptive management and updates of the cumulative effects analyses.
- Balancing gains and losses of ecological functions, benefits and values associated with categories of transportation improvements or specific project related impacts.
- Providing the means of tracking progress towards regional ecosystem goals and objectives (assumes 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, non-regulated 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. Program implementation.

Technical Considerations:

- How will debits/credits be calculated? Is credit stacking allowed?
- What is the permissible service area for a bank, 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?

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 first and primary factors. The second component is the evaluation of regulatory requirements and non-regulatory expectations for the agency in managing the environment. The final component is to examine 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 their environmental impacts in both the regulated and non-regulated arenas. A discussion of these factors follows.

Examining the Ecological Setting

A key challenge in any environmental planning effort is to understand the scope of what may be impacted. Impacts range across types, scales, and time based on a variety of factors, and 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 each lend themselves to different measurement needs. Highly diverse ecosystems with complex biophysical processes require more detailed measurement systems. Simpler or more homogenous ecosystems can 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 with a need to either mimic the tension in the natural system or develop a series of tools to weigh tradeoffs in implementation that may favor one resource. An example of this can be found when habitat enhancements for an anadromous species may occur at the expense of a native warm water fish species. In this case, a policy decision is made to favor one over the other in a system that may have increasing pressures for both.

Resources to examine can be roughly categorized 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 to force an issue into consideration in the planning process.[6]

Regulated Resources and Frameworks: Working through resource agencies, 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 will identify aquatic resources to consider in measurement, along with other datasets such as local or national wetland inventories.

Non-regulated Resources: In addition to species or resources with specific protections, resources or habitats may exist that require consideration for community or regional interests. These resources may include species of local or state concern that are not afforded protections, but which 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: Ecosystem services must be selected for inclusion in a measurement system. 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.[7] The system divides services into four categories:

- Provisioning services: These services and goods 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, which provide the underpinning for all other services. These include biodiversity, nutrient cycling, and other key ecological processes.

Examining the Regulatory and Social Setting

The regulatory and social conditions can be evaluated through both a historical review of DOT experiences and a forward looking one that evaluates new potential regulations or social expectations from projects.

As a start permitting documents from projects over the previous five years should be examined, or internal and external agency staff overseeing such may be able to speak to the metrics used therein. This also creates a baseline level of impacts that provide important planning information, which helps understand the trends in resource impacts. Ideally, it includes estimates of costs for implementing compliance actions, to help understand implications and tradeoffs. This baseline must be understood in the context of the STIP priorities over the past planning period and compared to current priorities. Statewide planning and project delivery often come in cycles of periods of greater and lesser construction intensity and focus of transportation investment in different areas, which can help forecast regulatory needs and appropriate metrics. In other areas, indicators may be just emerging (e.g., new potential 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.[8] 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.[9] These same programs have provided better transportation cost efficiencies as well as more controlled and specified costs in project delivery.[10] Traditionally, such opportunities focus on examining existing banking or mitigation programs the DOT can take part in.[11] As mitigation banking has evolved, more innovative solutions are also emerging from other biodiversity-based drivers based on state or local laws.[12] However, 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.[13] 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-based system can be a smart extension to support local land use compliance requirements in private developments as well.

Non-mitigation based opportunities can include examining the green space, open space or other public lands needs of neighboring jurisdictions including state or county parks, or local parks districts. These approaches can align with regional open space or green infrastructure programs including "Greenprint" or green infrastructure programs.[14] While these programs may not legally be available for compensatory mitigation under federal law, they may provide an opportunity to comply with state, local, or non-regulatory expectations for projects, especially urban capacity projects, and the metrics used therein are relevant.

6b. Evaluate ecosystem and landscape needs and context to identify measurement options.

The initial step of diagnosing the needs for a measurement system identified 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 provides a definition for where off-site actions might 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. If a REF is being developed for an area, this is the proper starting point to identifying the appropriate boundary. However, additional refinement may be needed to assess the measurement options available if multiple resources are being combined. In addition to the ecological boundaries, it is important to be aware of traditional regulatory or political boundaries such as ones created by federal or state law and local conservation regulations or land use requirements. It may be necessary to identify multiple boundaries initially, and once crediting is decided upon, 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 also include fish return counts, water quality measurements, and biological integrity indices.

The second form are model-based measures that rely on data to estimate species or ecosystem response. Often these measures rely on similar concepts to condition-based ones, or try to replicate a condition-based measure with models. Some models can very reliably do so, through 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 measures 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, and are used when rare or unique resources need measures, but that are not easily measured with one species. Model-based measurements can combine elements of a function-based measure and a condition-based measure, where 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 needed for the full suite of mitigation decisions: avoidance, minimization, and compensation. These concerns need to guide the selection or development of a measure. In the following sections, the various existing measures used in environmental management settings are presented. This is followed by a summary of challenges and a guide for developing custom measurements.

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 where they are a common tool for management, such as under the Clean Water Act (CWA) 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 may potentially create erosion and sediment inputs that place the waterbody over limits for turbidity in a municipal water system.

Two primary forms of condition-based measures are indices of environmental quality or integrity and observation-based systems:

Index-Based. Indices for environmental measures are based on identifying a set of field-based measures that can 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.[15] These methods reflect an understanding that biological organisms better capture the health of a system than strictly chemical and physical measures. This places a focus on a selection of 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 the comparison to 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. Data 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.[16]

Observation-Based. 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 where 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 of this include water quality monitoring in systems where the contributors to turbidity are easily understood and any observed increase of the expected levels 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 are introduced as a part of the SHRP2 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 to support 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 to compare against.

Model-Based Measures

Model-based systems rely on an agreed upon 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 sample-based data, models focus on the elements of the ecosystem that can be affected by human action.

Examples of this 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.[17, 18] Likewise, the Spatial Decision Support for Desert Tortoise Recovery incorporates a threats assessment model and provides a tool for recovery action prioritization and evaluation. Emerging carbon protocols for climate change accounting are agreed upon models that represent the carbon benefits or detriments of specific actions.[19] Models are best applied in complex environments where complete baseline data is not easily available, across the desired range, and where individual actions or impacts need to be understood in a context of many human actions, where 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 also used but are more complex, relying often on multiple sub-functions to assemble to 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 then evaluated based on scoring protocols built on existing literature, models, or peer review processes. These attributes then combine to provide a measure of performance for that function. The final unit of measure is then a combined multi-function level of performance by area. This provides a functional areal measure that can be compared to 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.[20] 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 that we manage resources for.[21, 22] Environmental economists have recommended making a shift towards function-based measures as 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.[23]

Several implementation benefits are available 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.

Importantly, 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 and can then be scored and credits or debits estimated. Scenarios in this context can include alternative vegetation management programs, stream restoration, 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 for functional measurement systems is that they provide a basis for ecosystem service measurements.[24, 25] Adding the opportunity to also provide a field-based measurement provides the best approach to an empirical measurement for ecosystem services. Currently, function-based approaches are developed regionally, with different but similar methods used based on the local scientists. Developing standards may be difficult, but could improve the adoption of these methods.

Summary of Challenges

These three forms of measure can be understood based on the type and nature of data required and the temporal frame these measures work within. 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 processes existing data and does not rely on field-based datasets necessarily. 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 based on proposed actions or change in the environment. Condition-based systems rely on historic 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 proposed impacts and proposed restoration actions need some certainty in measurement before they are implemented. Because a common application of credits are in the terms and conditions of permits, these credits must be easily defined based on 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 such as in restoring water quality. These measurement systems are suited for comprehensive management for 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 condition-based measure may include random sampling for macroinvertebrates. Ideally longitudinal data collection has occurred to provide the baseline and level of variation. Following construction of a project, the monitoring can continue and document a change. In practice, this is problematic though. The baseline and variation analysis present the main barriers to implementation, which does not rule out the use of condition-based systems: they can provide information in design about resources that are considered vulnerable and therefore required to avoid. However, the need to compare actual impacted conditions to a reference site makes these measures best applied after construction of a project and 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 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 tiered off of the REF, conservation plan, or recovery documents to provide priorities. For more complex environmental settings or where forecasting impacts are more critical due to the sensitivity of resources, models and functional measures excel. Finally, if multiple resources need to be tracked, forecasted, and credited, then functional measures excel.

The SHRP2 C06B project identified a number of tools at the landscape and planning level that address the need for integrated resource management with transportation development. The TCAPP website contains this database of international measurement and assessment tools, which were evaluated on their applicability in generating credits for environmental mitigation decisions and actions. The tools are categorized by their basis of measurement: function, population or habitat type. The tools were also categorized based on their existing use or lack of use in regulatory systems, and the ability for 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 connection needed between planning-level analysis and site-level analysis. To fully implement the planning tools developed in C06B, a functional measurement system is necessary to reconcile multiple resources at a site level.

One of the key challenges in site measures for multiple resources is *stacking* of various credit types. Because many of the crediting programs will need to connect back to both regulatory and non-regulatory processes it is necessary to document that no single credit is satisfying multiple regulations. In other words, credits must be shown not to "double-dip" or be able to 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.

It is important to note that this challenge is not an environmental one. Stacking is the natural course of events in the environment, as multiple resources can benefit from a single feature. For example, a riparian forest provides shading to cool adjacent waters, carbon sequestration through growth, and song bird habitat. These resources evolved synergistically and certain characteristics often reinforce and benefit others. Our regulatory system requires that mitigation benefits only be counted for the debit they are assigned to, though. Technically, this is accomplished with functions, but we note this distinction here, to remember that while the environmental benefits of stacking are clearly beneficial, 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 C06B. 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 Substep 6f.

6c. Select or develop units and rules for crediting

This step provides the basis for developing a custom measurement system based on functions for multi-resource crediting. If an appropriate existing measurement system was identified in the previous step, then this step may not be necessary. The following sections 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 of Ecosystem Services.*

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

Identify Resource and Ecosystem Services

The first question to ask is what services or resources are of concern. An important starting point is to review the highway- or agency-specific concerns and then identify services from there. For example, stormwater treatment may be identified as 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, etc.

Similarly, a regulatory agency or other stakeholder may identify a resource concern such as listed species or species of concern. These are biodiversity services. Functions are then identified that support these specific biotic concerns. For example, concern over aquatic species will then require 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 are identified to support them, overlap of functions will occur. Using the example of the water quality and aquatic species above, both will rely on functions performed by stream-side vegetation that shade waterbodies or reduce sediment and pollutant transport into waterbodies. This overlap is a critical feature of the multi-resource functional measurement system. It allows for the multiple resources to have a relationship that can inform site and design choices.

Develop 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 are collected that indicate the level of functional performance. Functions must be developed understanding this structure. Functions can be divided into the abiotic and biotic ones – or 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 abiotic functional performance score and the biotic functional performance score 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.

To develop a biotic or abiotic function, a conceptual diagram is the first step. This aids in all aspects of the development of the function, but most importantly in terms of the application of the measurement system. The conceptual diagram considers pre-existing 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 based on 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, the list of field-based data needed is developed for the function. In addition to identifying these attributes, their role in contributing to the performance of the function is evaluated. For all functions, there is a 100% level where the natural system is performing the function at its highest possible level. It is helpful to consider this in evaluating the type and amount of attributes needed. Similarly, at 0% function, it is useful to think of what attributes that, if missing, would limit the function fully. It is important to remember that at this level, other functions may be affected. For example, a function that is highly dependent on canopy cover will not co-exist with a function that is dependent on exposed ground or grasslands.

As attributes are identified, their relative contribution to the function will start to emerge, but the next step is to score all attributes for the function. For example, in a function that is evaluating a map unit's ability to infiltrate stormwater, the amount of pervious surface needs to be scored. In this case, it may be a logarithmic curve that indicates 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 increasing rapid impact to 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 assure that the data collection protocols remain constant. This is frequently a challenge where different measurement standards are combined across disciplines. The compilation of the attributes will provide the basis for the creation of a functional measurement datasheet 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 with just a few additional attributes needing to be programmed into the system.

Temporal factors are the final consideration for functional measure development. *In order 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 this. 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 based on agreed-upon rules. Depending on the selection of functions to combine, there are often policy considerations that inform the relative importance of functions. For example, stormwater management functions may be prioritized over other functions in a transportation context. In these situations, formal weighting factors must be applied to capture these priorities. While other services may still be important, they must be combined at a lower level with the higher priority stormwater management functions.

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 of the process is to generate one or more design alternative scenarios. For each of these design alternatives, a set of map units and data for each is generated based on the information in the design plan. This should reflect conditions on the site at some pre-determined future date. In general, a 20-year post implementation time period is used. Using this set of map units and data, a future conditions functional performance score is generated for each alternative considered. 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.

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. These PES systems are negotiated contracts with landowners to maintain a certain level of environmental performance to maintain or enhance ecosystem services.[26] Criticisms of these systems come from a concern that there is no clear way to track the performance; however, this is a technical measurement problem and does not undermine the potential power of PES systems.[27]

Developing ecosystem metrics and tracking project impacts using those measures can make it easier to access any operating regional ecosystem markets. Substep 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 these 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, there is greater budget certainty since the cost per credit is generally a known quantity, whereas mitigation design and construction is 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 five to ten years or more.
- **Transfer of Liability.** Many ecosystem markets include a transfer of liability for mitigation success. Wetland mitigation banks pursuant to §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 is focused on providing and maintaining transportation systems. This 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. In this circumstance, it is not uncommon to have the mitigation lumped into the same contract as the road or bridge construction. This can lead to situations where the grading and earth work 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 our highway infrastructure.
- **Improved Ecosystem Outcomes.** Ecosystem markets provide the opportunity to focus larger more meaningful restoration projects towards addressing regional ecosystem priorities. In making this shift, the on-site "postage stamp" mitigation that has frequently occurred on DOT projects is eliminated. These small mitigation sites were often developed to satisfy the preference for on-site, in-kind mitigation, but are inefficient, and too often not ecologically viable or useful. DOT biologists are focused on achieving ecological beneficial outcomes, but the process and preferences sometimes interfere.

  Mitigation bankers on the other hand, have an incentive to focus on ecologically desirable outcomes, in addition to maximizing their return on investment, since regulators are less likely to approve use of the bank if it is unlikely to provide adequate ecological benefits. They have an incentive to make the site successful, since credit release is incumbent upon reaching certain, pre-established 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. Other times bankers have transferred sites to local governments, which, especially in rural areas, tend to have less staff capacity for active long-term management.

6f. Negotiate credits and regulatory assurances

Credits have been most often allocated on a (ratio of a) per acre basis for wetlands. The "*Federal Guidance for the Establishment, Use and Operation of Mitigation Banks*," first provided guidance on the procedures used to establish credits and debits at bank sites, which were to "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… 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."[28] Districts determine, on a case-by-case basis, whether to use a functional assessment or acreage surrogates for determining mitigation and for describing authorized impacts, using the same approach to determine losses (debits) and gains (credits) in terms of amounts, types, and location(s) for describing both impacts and compensatory mitigation.[29]

For the USACE, additional flexibility came into play with Regulatory Guidance Letter (RGL) 02-2, which stated that riparian areas and, under limited circumstances, upland areas (see Federal Mitigation Banking Guidance and Nationwide Permit General Condition 19) may receive credit within a compensatory mitigation project to the degree that the protection and management of such areas enhance aquatic functions and increase the overall ecological functioning of the mitigation site, or of other aquatic resources within the watershed. This RGL was superseded by the 2008 Mitigation Rule. The establishment of buffers in riparian and upland areas may be credited as mitigation if the USACE District determines that this is best for the aquatic environment on a watershed basis. In making this determination, USACE Districts consider whether the wetlands, streams or other aquatic resources being buffered: 1) perform important physical, chemical, or biological functions, the protection and maintenance of which are important to the region where those aquatic resources are located; and 2) are under demonstrable threat of loss or substantial degradation from human activities that might not otherwise be avoided. Further, the rule offers some

2008 Compensatory Mitigation Rule Supports an Ecosystem Approach and Consideration of Continued Function Over Time, in a Changing Landscape

§332.3 (c) (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) adds the considerations: **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** flexibility in allowing the DE to approve out of kind mitigation that is designed to meet specific needs identified in approved watershed management plans.

Importantly, the 2008 Mitigation rule provided for other considerations, including viability in changing landscapes, and *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.*[30]

Increasingly habitat acres are being used to account for species impacts as well. Crediting on a habitat basis facilitates attention to ecosystem processes and functioning that benefits both target resources and other non-regulated resources. In providing a biological opinion on listed species, USFWS must justify the case that habitat may serve as an indicator for the species (e.g., the presence of suitable habitat, the proximity of the action area to known species' locations, the history of the species occurring in similar habitats under similar circumstances, etc.). USFWS may then explain the relative value to the conservation of the species of the habitat within the action area, as opposed to the individuals utilizing that habitat, in assessing the species likelihood of survival and recovery of the species in the wild and actions that may diminish or enhance the chances for species recovery. [31]

In general, USFWS lists the following factors for potential consideration in determining credit values: habitat quality, habitat quantity, species covered, conservation benefits (including contribution to regional conservation efforts), property location and configuration, and available or prospective resource values.[32] The credit system must match the system for bank debits (e.g. both in acres or both in breeding pairs). Mitigation ratios may be designed for the particular impact and impact assessment method, based on qualitative factors such as the scale of impact or quality of habitat, but quality of habitat need not always be assessed. The Natomas Basin Habitat Conservation Plan and the legal decision on it, *NWF v. Babbitt*, are significant for programmatic approaches and the crediting strategy they employ. The Habitat Conservation Plan covers the 53,000-acre basin in and near Sacramento and permitted up to 17,000 acres of land use (much of it low quality) with a mitigation fee to effectively conserve better quality lands at risk of development. The mitigation fee funds the Natomas Basin Conservancy to buy a half-acre of habitat for every acre developed in specified areas, without requiring assessment of quality of land impacted. In defending the plan and crediting strategy, USFWS called it an "innovative and biologically sound approach to species and habitat conservation at a regional, ecosystem level."[33] The court found that the 0.5:1 mitigation to impact ratio was reasonable, though weakened in this case by failure to identify specific reserve parcels in advance; however, DOT advance mitigation approaches avoid this problem. Importantly, the judge viewed the "uniform treatment" of essentially "treating all Basin lands as fungible, as equally valuable habitat" as a "strength" in that "mitigation fees are to be collected on all acreage and are used to set aside 0.5 acres of habitat land for each 1.0 acres of gross development that occurs." [34] The court upheld the "assuming presence approach" and confirmed that the plan "overprotects by assuming that any acre lost to development is potential habitat." [35] Likewise, mowed or otherwise degraded or impacted habitat in existing DOT right-of-way has been considered impacted by nearby vehicles and "unmanaged" for natural resource values (Nevada DOT-Clark County Multi-Species Habitat Conservation Plan) and estimates of impacts and mitigation have occurred (Colorado DOT Shortgrass Prairie Initiative) without assessing quality of the habitat. See overviews provided in Appendix F.

The primary, most common method of accounting continues to be acres of wetland or habitat type and linear feet of stream impacts, the latter within species' range. Though functional assessment approaches continue to be developed and to evolve, with increasing hopes that new data and modeling will increase practicality and use, accounting in acres remains an important method of ensuring that a baseline level of environmental mitigation occurs. Additional goals, requirements, or evaluation criteria are often layered on top as needed.

- North Carolina's Ecosystem Enhancement Program accounts for acres of freshwater and coastal wetlands and riverine and non-riverine wetlands. An MOA between the Corps, North Carolina DOT, and the state Department of Environment and Natural Resources acknowledges the goal of moving to a functional replacement system for mitigation, and provides a mechanism to transition 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 Corps is experimenting with new landscape-level functional assessment tools for SAMP development. The Corps' Waterways Experiment Station and the Cold Regions Research and Engineering Laboratory, as experts in aquatic resource delineation and wetland functional assessment, have developed a tool to conduct a high-precision, planning-level wetland delineation (i.e., the identification of aquatic resources) and a landscape-level functional assessment (i.e., the characterization of aquatic resources). The tool has been used to assess aquatic resources within large watersheds (over 200 square miles). Using the tool, the Corps has been able to assess hydrologic integrity, water quality integrity, and habitat integrity. Hydrologic integrity refers to the frequency, magnitude, and location of stream water flow and the interaction of the stream with the floodplains — all on the plan level. Water quality integrity refers to the processing of nutrients and sediments within streams. Habitat integrity refers to the quality and quantity of habitat necessary to support functioning riparian systems.
- Oregon DOT's functional assessment determines Habitat Value credits for wetlands and species based, in part, upon acreage. However, in addition to acreage, other values related to habitats, species, and functions are used to derive the Habitat Value number. Oregon DOT's functional assessment approach relies on Key Ecological Functions as a key component of successful ecosystem-based management. Using species and habitat data, historic and current functional profiles for each Ecoprovince were developed to assess how functions have changed over time. The Ecoprovince functional profile allows for a review of the functional roles played by all species thought to occur within the Ecoprovince. This understanding makes it possible to consider how species' functions contribute to performing ecological functions across a broader, Ecoprovince scale. This information is used to help determine if the focal species play functional roles not generally performed by other species, thus indicating the potential need for species and habitat protection. Changes (lower functioning or fewer redundancies in functions performed) from pre-development conditions were identified and tallied, based on habitat and species changes. Key Management Activities which affect such functioning were also identified, to determine how to best understand and address potential needs associated with habitat forming processes and assess issues relevant to species recovery. In light of this, each Ecoprovince has a list of land use and land management activities that have the potential to negatively effect species, habitats, and habitat forming processes. This assists in designing conservation areas/regional banks to help offset regional trends. Some of the land use and land management activities that have significantly impacted species, habitats, habitat forming processes, and the potential for species recovery include, but are not limited to: human development, agriculture, grazing, fire suppression, timber harvesting, coastal development, and fragmentation of land ownership.

  Oregon's DOT has adopted backstops that track impacts in an acreage-based or species-specific fashion. Using the backstops, they will be able to show that it meets all of the same requirements as any other entity regulated by the Corps. If, through the Program review and agency reporting process, it is determined that the Program is falling short of no net loss obligations, adjustments to the accounting system will be made and the department is committed to performing the mitigation necessary to achieve the ledger balance and ensure regulatory compliance.

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 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, assures that credits are used only as approved and allowed. This stacking function allows for the interactions of the natural elements to be more fully measured.

Incentives for investing in conservation and restoration actions that generate a wide variety of ecosystem benefits are currently missing in regulation-driven, acreage-based credit systems. Generally, once a site meets the minimum regulatory requirements for mitigation of a given resource, all potential additional benefits provided by the site are ignored or forgotten. But with a "stacking" credit system, the proper incentives for conservation can be introduced, as the benefits of an action to all resources become clear. Similarly, in an impact context, stacking allows the effects on resources to be better understood.

Stacking requires strict accounting to prevent the use of credits to offset impacts of multiple projects. In a regulatory context, this is critically important. Through the function-based nature of credits, individual functions are assigned to the credit type that must be audited. This ties the constituent components of the credit together, ensuring that credits are not used repeatedly in different transactions (double-dipping).

6g. Program implementation

There are a number of ways in which good metrics can inform transportation planning processes and be incorporated into project compliance documentation and regulatory processes. For instance, good metrics can provide a much better means of conducting NEPA alternative analysis. A good metric can also 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, it can be the basis for justifying off-site and/or out-of-kind mitigation. It is important that project delivery staff be aware of these opportunities.

There are a few basic thing DOTs can do to encourage these improvements. For instance, it is important to provide on-going training and support for staff to help them understand the potential opportunities for process improvements. An easy way to affect this type of support is to use a community of practice approach, so that relevant staff have a mechanism to share concepts and ideas and impart lessons learned about what worked and what did not work. Another useful step for program implementation is to develop a data sheet that standardizes the metric application. Ideally, the data sheet can become an integrated part of project data collection and can be used to make that process more efficient and effective.

Step 7: Develop Programmatic Permit, Biological Assessment or Opinion

Purpose and Anticipated Outcomes

In Step 7 the team ensures that associated documentation has occurred and regulatory connections have been made. As a result of this, the agencies will have formalized:

- Agreement on resource management roles and methods.
- Incorporation of outcome-based performance standards into programmatic agreements to improve project avoidance, minimization, as well as aiding effective monitoring and adaptive management actions.
- Programmatic ESA Section 7 consultation, Special Area Management Plan, Regional General Permit, or agreements enabling agencies to proceed with conservation action in line with CWA Section 404 and ESA program objectives/requirements and with maximum assurance that conservation or restoration investments count and will be sufficient, as transportation projects continue through the design and development process.

The SHRP2 C06A Phase 2 report documents the benefits and challenges in implementing programmatic agreements. Finally, this guide includes template programmatic approaches for 404 permitting and for development of programmatic Biological Assessments (BAs) and programmatic Biological Opinions (BOs). These are included as Appendices H and I.

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 are documented relating to CWA Section 404 permitting, avoidance and minimization, ESA Section 7 consultation, roles and responsibilities, land ownership and management, conservation measures, etc.
7b. Plan for long-term management/make arrangements with land management agencies/organizations (e.g. land trusts or 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 in 404 permit and/or Section 7 BA/BO.
7d. Choose a monitoring strategy for mitigation sites, based on practical measures above, ideally using the same metrics as those used for impact assessment, site selection, and credit development.
7e. Set up periodic meetings (at least annual) to identify what is working well and what could be improved.
Technical Considerations:
▪ Who will lead in development of needed agreements?
▪ Under what conditions would the agreement be revisited?

7a. Ensure agreements are documented relating to CWA Section 404 permitting, avoidance and minimization, ESA Section 7 consultation, roles and responsibilities, land ownership and management, conservation measures, etc.

In Substep 7a the team ensures that associated documentation has occurred and regulatory connections have been made. MOUs, MOAs, programmatic CWA 404 permits, SAMPs, Section 404 Regional General Permits, or ESA Section 7 consultations and associated Biological Assessments and Biological Opinions, or other programmatic agreements may be developed for transportation projects. Pertinent interagency agreements and understandings may begin to be made and recorded as early as Step 1. Ultimately, the regulatory vehicles or agreements that are developed will include most of the elements in this section (Step 7), and advance conservation action in line with CWA Section 404 and ESA program objectives/requirements and with maximum assurance that conservation/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 to develop initially as the details and terms are developed. Due to this, the usual application of programmatic agreements is in settings where a project, or series of projects will require 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 provide 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, the types of impacts or activities covered, and 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 assure the sum of the actions included is meeting the expectations of the signatories and participants.

Advantages for 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 the impacts are included in the agreement. Programmatic agreements allow for resource agency time to be more efficiently used and allow them to focus on monitoring or tracking of projects. These agreements can also cover multiple regulations or resources, and in the REF setting should in fact do this. This multi-resource programmatic approach can allow for more integrated permitting decisions to avoid conflicts between regulated resources, such as listed species and Section 404 requirements. This multi-resource approach may also rely on on-the-ground ecosystem credits as identified in Step 6. These multi-resource credits can allow for more comprehensive mitigation with conservation priorities included.

Challenges for a programmatic tend to rest on how complex the resources are, and the diversity of impacts included. Another important component of programmatic agreements is the level of trust and history of collaboration among all involved agencies. These agreements may require high-level support and an ongoing collaborative staff relationship. If these two components are not in place, programmatic agreements are difficult to create and maintain. This may also include stakeholder buy-in as well.

Conservation groups or other advocacy groups can play a key role in challenging these agreements, or in supporting their implementation. This makes the efforts of Step 1 important in involving all key players and getting to successful implementation. See Appendix A for more detailed guidance in this regard.

Even in cases where the diversity of resources, impacts or stakeholders makes programmatic agreements difficult or impossible, the data and values from the REF can provide a key path to individual permit decisions. The REF and ecological priorities allow for analysis of alternatives, permit performance standards, and other important decisions to be reached without having to perform the analysis for each permit. This savings alone can speed project delivery greatly and reduce costs from delays.

Templates for Programmatic Agreements and Programmatic BAs and BOs

Appendices H and I contains two templates for developing programmatic agreements, developed by the SHRP2 6A team. One template covers a watershed approach to planning for and permitting under the CWA and the other covers a programmatic consultation under ESA Section 7. The latter pertains to BAs submitted by the transportation agency and to the BO that the USFWS or NOAA provides in return. The provided templates combine basic elements of successful programmatic agreements that have been developed around the U.S., drawing from award-winning approaches. While most programmatic agreements have a certain amount of "legalese", the examples provided are written in plain English to convey the important points of each section. The sample language is provided as guidance to exemplify the nature and scope of each section of the agreement. These resources and several other models are also available www.shrpc06.com.

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, developed 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 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."

Identify How Individual Projects Will Be Reviewed and Fit Into the Whole, Ensuring Avoidance and Minimization

Identification of how individual projects will be reviewed and fit into the programmatic approach often represents a more difficult part of the negotiation, because it may present a departure from how individuals and agencies normally review projects. While staff may save significant time and see efficiency increases (for example, USFWS estimated a 100 percent increase in productivity, with only half the staff time needed to focus on former project tasks in Florida),[36] any change in their duties or scope of responsibility can raise concerns, which take time to address and resolve and then record in the form of interagency agreements. Such agreements try to create a streamlined approach for project-by-project review and greatly reduce (or virtually eliminate) the negotiation which otherwise occurs at that stage. However, remember that such agreements cannot be used to change statutory or regulatory requirements.

Under the CWA Section 404 program, individual permits require project review by the Corps. The Corps decides whether to issue an individual permit based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity. According to Corps regulations, permits should not be issued for activities which will create "significant" degradation of the waters of the U.S. or have "significantly adverse effects on wetlands values;" however, the CWA provides no clear definition of "significant."[37] 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. Corps regulations identify 21 factors which are 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, which prohibit a discharge of fill if there is a less environmentally damaging alternative that is still practicable, are often considered the driving force in the Corps permit process.[38] Practicability is determined based on 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 where the net impacts to waters of the U.S. are not significant.

On projects requiring an individual Section 404 permit, state DOTs continue to conduct project-by-project reviews, though in the case of the North Carolina DOT's process, for example, after avoidance and minimization, the decision to choose off-site mitigation is reduced to a "yes-no" decision; i.e., partial on-site mitigation does not occur. If the permitting agencies determine that on-site mitigation opportunities (in or adjacent to the right-of-way, in conjunction with construction activities) are both practicable and environmentally preferable to existing mitigation available through the North Carolina Ecosystem Enhancement Program, the permit will be conditioned to require such on-site mitigation. However, the permitting agencies have agreed not to delay the issuance of a permit or certification for a transportation project due to such on-site mitigation requirements.

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 is determined "may affect, but is not likely to adversely affect" a listed species or designated critical habitat must have a written concurrence from the USFWS, while any action that is determined to be "likely to adversely affect" a listed resources must have a complete biological opinion (including an incidental take statement, where appropriate) (*Conner v. Burford*, 848 F.2d 1441 (9th Cir. 1988), *Conner v. Burford*, 605 F.Supp. 107 (D.Mont.1985), *Silver v. Babbitt, Silver v. Thomas*). This is understood to be a "second tier" to the Biological Opinion, though such an opinion may be as brief as a page or two, confirming that the project fits within the scope of the original programmatic consultation.

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 that is retained continues to be negotiated separately for each programmatic or advance mitigation approach. For Section 404, the more timeworn paths of mitigation banks and in-lieu fee programs, and established individual permitting requirements, leave less in question. DOT biologists and natural resource program managers who work with the resource agencies on developing programmatic agreements and MOAs say that templates would greatly facilitate their work. Even in states where multiple agreements have been developed though, the agreements continue to evolve, and thus negotiation often continues. Legal review continues to be a challenge for such agreements, as solicitors seek maximum certainty for their own agency and collaborative, early environmental investments are still considered alternative approaches.

7b. Plan for long-term management

Step 7b involves checking and 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 non-governmental organizations (e.g. non-profit 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 that preserves the ecological functions of the subject property and as required by the permit, in the case of Section 404 of the CWA. 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 necessary endowment funds to sustain the budget, and yearly reporting requirements.

A watershed or ecosystem-based approach helps to 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. In the examples cited in this report, mitigation/conservation sites are owned by a wide array of entities—federal, state, county, and municipal government, private bankers, and non-governmental, non-profit conservation organizations.

The Center for Natural Lands Management has developed a tool that is widely used in western states to estimate the expense of management in perpetuity. Costs vary with the nature of the land, the type of protection (owned or under easement), and the purpose of conservation (endangered species, visitor services, education). The Center's Property Analysis Record database can be used to analyze the characteristics and needs of the property from which management requirements are derived, consider management tasks and their costs, as well as administrative overhead. The report can then be used as a justification for a certain level of long-term funding from endowments, special district fees, and other sources.

Even with adequate estimation of long-term management costs and high desirability of the parcel according to the resource agencies involved, tight budgets at the latter have made assumption of ownership and management responsibility difficult in some cases. Private entities can go bankrupt. Short-staffing or hiring freezes at resource agencies may prohibit further acquisitions, regardless of the amounts of funding available for site administration or management by contract. Even if the resource agency receives money, staff are sometimes concerned that the resources would not be there when they need it. Some states' situations are further complicated by state restrictions on transferring conservation easements to private entities or local government agencies.

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 agencys' or conservation organizations' acquisition plans and priority lists. For a variety of ecological reasons, connectivity improvements are receiving greater attention and emphasis over the past ten years. It is anticipated that sites adjacent to and/or providing connectivity between already protected conservation areas will 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; i.e., if a conservation area will be going in, it is valuable and advisable to coordinate with the local government to try to protect the long-term conservation values and take action to ensure that those values will not be inadvertently undermined by permitting of incompatible adjacent development. The Regional Ecosystem Framework and associated database facilitates such exchange of information.

7c. Design performance measures for transportation projects that will be practical for long-term adaptive management. Include in 404 permit and/or Section 7 BA/BO.

It is important that the long-term performance measures for adaptive management are practical for the implementing agency taking on these 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 § 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."[39] 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.[40] These systems also include commitments and responsibilities derived from Section 404 permits and ESA Section 7 consultations. Visual assessment, informal mapping, photographic records, and assessment of spread/prevention of invasive species are common assessment methods for both wetland and species/habitat mitigation/conservation sites.

Measuring success is a key element of any framework for overall conservation success and achievement of beneficial outcomes. Measures can establish baselines for ecosystem, biodiversity, or species health; identify and track the status of key threats to conservation; and measure the progress of actions toward conservation. Even in areas and ecoregions where relatively few studies and inventories have been conducted, there is an abundance of data and information that was unfathomable when key environmental protection acts were created in the late 1960s and 1970s, and even the early 1980s as regulations continued to be promulgated.[41] While the basis for making and refining conservation decisions may be better than ever before, the decision-making environment is also polarized with a desire for clarity beyond what may exist or be reasonably attained in many cases.

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?" and 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. In taking an ecosystem approach that can be rolled up to measure conservation status and progress at wider scales, ecoregional measures may rely on focal species and indicators of ecosystem health, such as degree of invasive species and management including natural processes such as grazing or fire.

Adaptive management is a method for examining alternative strategies for meeting biological goals and objectives, and 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 pre-determined evaluation criteria. The six principal components of adaptive management are problem assessment, design, implementation, monitoring, evaluation, and adjustment.

7d. Choose a monitoring strategy for mitigation sites, based on practical measures above, ideally using the same metrics as those used for impact assessment, site selection, and credit development.

The Corps and EPA's 2008 mitigation rule provides some guidance on monitoring for wetlands, as does a Regulatory Guidance Letter released later that year.[42] Regulatory Guidance Letter 08-03 (Oct. 10, 2008) addresses Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources, and supports the Program Analysis and Review Tool performance measures for mitigation site compliance and mitigation bank/in-lieu fee compliance.

Monitoring requirements are typically based on the performance standards for a particular compensatory mitigation project and consistent with the objectives for the project. Those may vary from one project to another; however, the Corps intends for standardized monitoring requirements to aid when reviewing compensatory mitigation sites, thereby allowing the Corps to effectively assess the status and success of compensatory mitigation projects.

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 are typically provided as special conditions of the 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 five years (see 33 CFR 332.6(b)). 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 3-10 year range), although 14 percent do not, and only 22 banks indicate that the length of the monitoring period is based on the final achievement of performance criteria.[43]

As state agencies with a high degree of public attention and accountability, 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. Per guidance developed by Washington State DOT and resource agency partners, 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 that goal (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 (68 FR 15100-15115, 3/18/03), "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." [46] 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 section 4(a)(1) analysis.[47]

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. [48]

- The nature and extent of threats being addressed by the conservation effort are described, and how the conservation effort reduces the threats is described.
- Explicit incremental objectives for the conservation effort and dates for achieving them are stated.
- The steps necessary to implement the conservation effort are identified in detail.
- Quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured, are identified.
- 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.
- 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 particular circumstances will also determine the amount of information necessary to satisfy these criteria.

Based on the above guidance on evaluation of formalized conservation efforts, USFWS and NOAA Fisheries list the following potential effectiveness measures/considerations: [49]

- 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.
- Estimated length of time that it will take for a formalized conservation effort to produce a positive effect on the species.

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.[50]

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 key in revealing something important about a trend or status in conservation. In some cases precision is less than desirable but the indicator remains useful. [51]

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 one reporting period to another period, 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:

- Evaluate compliance based on current levels of credit authorization.
- Determine if biological goals and objectives are being met.
- Provide feedback information for subsequent management changes and adaptations, including remedial actions if necessary.
- Substantiate and authorize additional credit that could be allowed from the bank, based on habitat restoration accomplishments or phase-in of additional bank lands.

Monitoring presence or absence of species on already conserved sites is sometimes conducted to provide for additional credits through documenting additional species' presence. 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/resource values that are protected/benefited over the long term.
- 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 the Ecoregional Assessment. Ecoregional Assessments may establish minimum goals based on estimates of the historical extent of key vegetation types and different scenarios and what (goals) 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 four ecoregional measure categories:

Status of Biodiversity – 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 to assess ecoregional biodiversity health include the numbers and composition of species and ecological systems that are rare, imperiled, listed, available for conservation, etc. It is important to know the degree to which adequate areas of the right sizes have been identified, protected, and actively managed. This provides an estimate of the degree to which conservation actions might contribute toward species recovery. Other potential indicators for measuring biodiversity health include:

- Number of known occurrences, acres, or miles for targets known vs. “needed” for viability or recovery.
- Ranking status for targets (e.g., natural heritage ranks – a trend downward in ranks suggests that species or natural communities are getting rarer and therefore is a bad sign of biodiversity health.
- Listing status for species targets in the ecoregion – more listed or candidate species over time also suggests that species are becoming more rare and therefore is a bad sign of 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 is a reflection of 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 excellent private and public conservation lands that have no legal protection, it is an important indicator of the progress that has been made to secure 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 that 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 insure 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 non-restorable state. Several different ways of assessing protected area status will be discussed as well as other ways of assessing status.

Protected and Managed Area Status **-** This measure employs the Gap Analysis Program (GAP) 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. IUCN has similar but more categories ranging from strict nature reserves to managed resource protected areas. Neither GAP nor IUCN adequately capture protected status for conservation easements and perhaps for other conservation lands.

Gap Status 1 includes areas having *permanent protection from conversion of natural land cover* and 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 having permanent protection from conversion of natural land cover and 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 having permanent protection 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; includes all areas not identified above 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 wherever there are data available. Measures may include:

- Number of acres of each ecological system that is affected by a given threat.
- Where the spatial data are available and of sufficient quality, the severity and scope of the threats will be assessed. 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 into decision making processes around mitigation and conservation measures. The Service considers the Desert Tortoise Decision Support Tool, profiled in Appendix F, to be their leading example of this, 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 ecoregions. The status of these habitat types, indicated by assessing the status in each ecoregion, can be rolled up to provide important information toward 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 that is underway to prioritize Total Maximum Daily Load 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 Clean Water Act section 106 granting process. In an effort to provide greater scientific support for Regional priorities and optimize where resources are spent EPA's OPM Geospatial Enterprise Operations Section and Water Protection Division are working in collaboration with EPA Office of Water and Office of Research Development to develop 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.

Toward this end, EPA has identified four primary goals that the screening tool is intended to help address:

1) ***Identify candidate restoration watersheds***
   - High degree of recoverability? High priority target for restoration
   - Low degree of recoverability? Long-term restoration goals
2) ***Identify candidate protection watersheds***
   - High ecological value/services? High priority target for protection
   - Threatened by current & potential future stressors (e.g., urban development)? High priority target for protection
3) ***Identify watersheds with similar characteristics***
   - Compare watersheds based on ecological, physical, stressor, and social context to identify additional target watersheds for protection/restoration
4) ***Improve information on current watershed condition***
   - Evaluate un-assessed areas, determine probability of impairment
   - Identify watersheds with similar ecological, stressor, and social context

As a proof of concept, EPA is currently focusing on the top three regional (and national) water quality impairments to demonstrate the utility of the watershed index screening tool to prioritize *restoration* activities: 1) nutrients (nitrogen and phosphorus), 2) pathogens, and 3) sediment/siltation. The Watershed Index screening tool will use a combination of landscape indicators to calculate an integrated pollutant-specific watershed index value to predict watershed integrity and recovery potential. The reporting unit is based on EPA Strategic Plan reporting scale of the USGS 12-digit HUC hydrologic unit; however, users can also work on larger watersheds.

The screening process is based on the concept of ecological recovery potential outlined by Norton et al (2009) and utilizes ecological, stressor, or social context indicators measured from a wide variety of readily available landscape datasets, impaired waters attributes reported by states to EPA, and monitoring data sources. Metric selection is specific to each assessment's location and purpose.

Ecological capacity, stressor exposure, and social context represent three gradients, or axes, along which watersheds are rated using the selected indicators. The user's objective is to choose indicators that collectively estimate the influence of each of the three classes on a watershed's overall recovery potential. Individual metric identification is guided by EPA Causal Analysis/Diagnosis Decision Information System (CADDIS) stressor conceptual models for nutrients, pathogens, and sediment/siltation. This ensures that indicator development is based on sound science and all relevant stressor causal pathways are included as a measure of recovery potential. Different subsets of the Region's selected indicators can be used for prioritizing restoration, prioritizing protection, and addressing gaps in condition information.

To date, EPA has identified nearly 200 potential landscape metrics for every 12-digit HUC in the entire lower 48 states, along with several "use case" scenarios for developing the user interface software. EPA ORD will evaluate the predictive ability of the indicators (and a narrower set of 15-20 top indicators) by comparing each indicator or suite of indicators to water quality monitoring data (primarily IBI scores based on fish or macroinvertebrate data) provided by the states to EPA, as well as to predictive models such as SPARROW (for nutrients). Watershed metrics are calculated at three scales: the 12-digit HUC, within a 100 m riparian buffer zone, and within a "hydrologically connected zone." Metrics currently being evaluated for their predictive ability are listed below.

- Percent land use/land cover classes
    - Percent undeveloped
    - Percent N-index (an index of the "naturalness" of an area)
    - Percent forest
    - Percent wetland
    - Percent agriculture
    - Percent urban
- Percent HUC12 in each of 10 NHDPlus stream order classes
- Percent impervious surface
- Number of road stream crossings (all streams and first order streams)
- Percent coverage by top three Level 3 ecoregions in each HUC12
- Empower Density (as a measure of human disturbance)
- Land use/land cover change (1992-2001, NLCD)
- Slope
- Percent Southeastern Ecological Framework (SEF) hubs and corridors (i.e., Region 4 map of green infrastructure)
- Percent core forest (i.e., contiguous areas of interior forest greater than 100m from edge)
- Social Indicators Protected areas database (USGS) by land owner (Doug's social index)
- Environmental Justice seat (Doug's social index)
- Population density
- Population change

EPA's national Office of Water is documenting the metrics and indices developed for this project. Region 4 is developing software for the user interface. The interface will assist Water Division staff in determining the relative potential for restorability for any 12-digit HUC in the lower 48 states. With a simple web-based user interface, users will be able to define a larger study area, or "area of interest," as well as a specific watershed(s) of interest. With the click of a button, statistics and ranks for all HUC12s in the study area can be calculated and given a relative ranking based on the user's specific watershed protection and/or pollutant-specific restoration priorities. Because problems with 1) nutrients, 2) sedimentation or 3) pathogens have different origins in urban vs. rural watersheds there will be 6 sets of conditions from which to choose. Users will also be able to generate detailed reports from the analysis including the individual indicator and index values, as well as watershed rankings within the specific study area. Watersheds identified through the screening process will then be subjected to a more detailed watershed assessment to further identify pollutant sources and target specific restoration and protection activities. In addition to targeting watersheds for restoration and protection activities, Region 4 anticipates the screening tool will be useful in addressing additional Office of Water statutory requirements and Strategic Plan goals, including:

1) Restoration
    a. Prioritize TMDL and restoration efforts
    b. Prioritize waters for delisting efforts
    c. Estimate recovery potential
    d. Evaluate landscape stresses and problem causes for large areas
    e. Assist stressor identification
    f. Relate human disturbance to in-stream effects
2) Protection/Conservation
    a. Identify candidate reference (i.e., least disturbed) areas
    b. Target conservation efforts to protect key ecosystem components critical to maintaining water quality
    c. Target areas for prevention efforts
    d. Target grant outreach/education and selection efforts to maximize environmental benefits and support state and local decision-makers
    e. Raise awareness of the consequences of local land decisions
3) Monitoring
    a. Identify suspected problem areas
    b. Identify candidate reference (i.e., least disturbed) areas
    c. Assist the calibration of biological and other condition measures
    d. Define and document human disturbance gradients for Tiered Aquatic Life Uses (TALU) and other purposes
    e. Target monitoring to confirm problems
    f. Extrapolate to waters lacking in-situ data

The Maryland Watershed Resources Registry, presented in Appendix E, also illustrates use of watershed level indicators and decision rules.

7e. Set up periodic meetings to identify what is working well and what could be improved.

The agencies involved should set up periodic meetings to identify what is working well and what could be improved in the overarching agreement(s) for the team. It is recommended that such meetings occur on an annual basis, though they could occur more often, if deemed necessary by the team.

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 help ensure continuity from the early planning processes into transportation project implementation.

Anticipated outcomes include:

- 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 standards and programmatic agreements as appropriate into permitting and consultation documents.
- Integration of programmatic cumulative effects analysis into project NEPA, §404 and §7 analysis.
- Incorporating tools and approaches into a monitoring and adaptive management strategy to ensure positive project outcomes.
- Accurate recordkeeping and tracking of all commitments by transportation agency in project delivery.
- Updating information from construction and operation into REF.
- Measuring performance success in project delivery.

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

Implementation Substeps and Technical Considerations

Implementation substeps and technical considerations are summarized below.

Step 8: Implement Agreements and Adaptive Management. Deliver Conservation and Transportation Projects
Implementation Substeps: **8a. Design/implement methods to complete transportation project(s) consistent with REF, conservation/restoration strategy, and agreements**. **8b. Identify how advance mitigation/conservation will be funded**, if this has not been done already. **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/methods can be used to track how projects contributed to and/or improved the REF priorities and goals?

Ecosystem Crediting Aspects: An important aspect of any crediting system is to include an adaptive management or policy feedback loop that allows for new discoveries to inform better crediting. IEF Step 6g works to capture these lessons and redefine credits or measurements in subsequent revisions. Credits should be monitored and measured against other measurement systems. Step 6g includes a discussion of how indices or other long-term monitoring measures can accompany a crediting system and provide a useful tracking mechanism for system performance.

This is an important step, and one that 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, it is important to set these changes in the context of previous decisions so as to not 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:

- Updating REF and cumulative effects analysis.
- Updating conservation and restoration priorities.

Implementation Substeps and Technical Considerations

A summary of implementation substeps and technical considerations follows.

Step 9: Update Regional Integrated Plan/Ecosystem Framework
Implementation Substeps: **9a. Integrate any revised conservation plans into the regional integrated plan/ecosystem framework and, where appropriate, individual resource spatial information**. **9b. Update the area/resource conservation requirements, responses, and indicators in collaboration with stakeholders** (e.g., assess regional goals, update to minimum required area for species and/or habitat, review confidence threshold for achieving goals, review 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 model). **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?

9a. Integrate any revised conservation plans into the regional integrated plan/ecosystem framework and, where 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.

9b. Update the area/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 REF. Responses to land use and infrastructure should be reaffirmed as well.

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 these areas 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.

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 model)

The framework implementation as described is explicitly designed to support adaptive planning and management. A key aspect of this process then is to re-analyze the cumulative effects whenever there is a significant change in potential stressors to the ecosystem. Each assessment iteration should entail the following:

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

<u>Ecosystem Crediting Aspects:</u> As changes occur in the REF or new information is included in the decision-making process, the crediting system will also need to adapt. This may be due to new resource concerns, emerging regulations, or public concern that is critical but not yet regulatory. Reevaluating Step 6a will be important to assuring the crediting system is current and in alignment with environmental, social, and regulatory concerns.

9e. Conduct regular review of progress.

The team will want to conduct regular reviews of progress. Such meetings are recommended annually. Key topics for review include:

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

Summary

This guide presents the Integrated Ecological Framework (IEF), a nine-step process describing how transportation, resource agencies, and non-governmental organizations (NGOs). The IEF was developed to effectively integrate conservation planning and transportation planning, and to lay 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 our 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 Strategic Highway Research Program (SHRP) C06A 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 SHRP Transportation for Communities: Advancing Projects through Partnerships (TCAPP) website: transportationforcommunities.com.

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