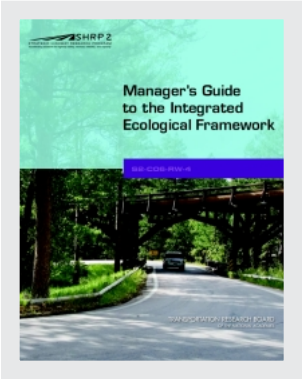

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Accelerating solutions for highway safety, renewal, reliability, and capacity

Manager's Guide to the Integrated Ecological Framework

S2-C06-RW-4

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

THE SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

Manager's Guide to the Integrated Ecological Framework

SHRP 2 Report S2-C06-RW-4

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TRANSPORTATION RESEARCH BOARD

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SUBJECT AREAS

Environment
Highways
Planning and Forecasting

THE SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer a new opportunity to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century.

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

SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

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FOREWORD

Stephen J. Andrle
SHRP 2 Deputy Director

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

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

strategies, ecosystem services, and partnership strategies, along with a summary of the available ecological tools that are most applicable to this type of work. The Volume 2 appendices document three pilot projects that tested the approach during the research.

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

CONTENTS

ACRONYMS AND ABBREVIATIONS

BISON	Biodiversity Information Serving Our Nation
BLM	Bureau of Land Management
CHAT	Crucial Habitat Assessment Tool
COG	Council of Governments
CWA	Clean Water Act
DA	Department of the Army
DOT	department of transportation
DVRPC	Delaware Valley Regional Planning Commission
EEP	Ecosystem Enhancement Program
EISPC	Eastern Interconnection States' Planning Council
EO	element occurrence
EPA	Environmental Protection Agency
EROS	Earth Resources Observation and Science (USGS)
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GAP	Gap Analysis Program
GIS	geographic information system

IEF	Integrated Ecological Framework
LCC	Landscape Conservation Cooperative
LCCP	Land Cover Characterization Program (USGS)
LWI	local watershed inventory
MOU	memorandum of understanding
MPO	metropolitan planning organization
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
PADUS	Protected Areas Database of the United States
REF	Regional Ecosystem Framework
REIDF	Regional Ecosystem and Infrastructure Development Framework
RGP	regional general permit
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAMP	special area management plan
SHC	strategic habitat conservation
SHRP 2	Second Strategic Highway Research Program
SLAMM	Sea Level Affecting Marshes Model
STIP	State Transportation Improvement Program
SWAP	state wildlife action plan
TCAPP	Transportation for Communities—Advancing Projects through Partnerships, former name of PlanWorks
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program
TRB	Transportation Research Board
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1 INTRODUCTION

BACKGROUND

There is compelling evidence that integrating regional-scale ecological needs early in transportation and infrastructure planning processes can achieve significant ecosystem, economic, and societal benefits. Many efforts are under way across the United States that promote and use these regional-scale ecological needs as part of a more integrated and collaborative approach to transportation and infrastructure planning and project development. These efforts are demonstrating that through early collaboration and proactive identification and response to resource needs, transportation and resource agencies—as well as local and regional governments—can more purposefully avoid and minimize impacts, restore watersheds, and recover species. Before these recent efforts were under way, many opportunities to avoid, minimize, and contribute to environmental priorities were missed. Regulatory decisions did not require interagency involvement; short-staffed agencies were hard pressed to find time to provide input on the planning level; and a majority of transportation plans moved forward without considering ecological needs.

Transportation agencies face significant costs to meet environmental mitigation requirements. Over $3.3 billion is spent annually on compensatory mitigation under the Clean Water Act (CWA) and the Endangered Species Act (ESA) (Environmental Law Institute 2007). Furthermore, environmental permitting can encompass 3% to 59% of road construction costs (Louis Berger & Associates, Inc. with BSC Group 1997). While these investments are considered costs to transportation projects, they represent one of the largest sources of funding for conservation action in the United States. The potential benefits from a more strategic application of these funds are therefore enormous, both for conservation and for streamlining and cost reduction for transportation improvements.

Realizing the high costs and lost opportunities, a team that represented nine federal agencies produced the publication *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (Brown 2006). The *Eco-Logical* approach recommends a collaborative, integrated, watershed or regional-scale approach to decision making during transportation and infrastructure planning, environmental review, and permitting that emphasizes using resources more effectively to enhance the environment, species viability, and watershed restoration.

The benefits of integrating regional-scale natural resource or conservation planning and highway planning are widely recognized; but as advances in computing capacity, data, and geographic information system (GIS) modeling have made it possible to facilitate better, more informed, and scientifically sound environmental planning, the need for practical and technical guidance on how to effectively implement these approaches became apparent. This guidance came through a research project funded by the Transportation Research Board's (TRB's) Second Strategic Highway Research Program (SHRP 2) and resulted in the Integrated Ecological Framework (IEF) (Institute for Natural Resources et al. 2012).

WHAT IS THE INTEGRATED ECOLOGICAL FRAMEWORK?

The Integrated Ecological Framework (IEF) is a peer-reviewed technical guide that provides a step-by-step process for implementing the *Eco-Logical* approach. It supports transportation planners and natural resource specialists, and uses a standardized, science-based approach to identify ecological priorities and integrate them into transportation and infrastructure decision making. The IEF draws on well-established and innovative approaches to conservation analyses. In addition, it is informed by efforts currently under way at federal and state natural resource and transportation agencies to address known organizational, process, and policy challenges related to accelerating project delivery while still achieving net environmental benefits. The success of the IEF depends on transportation and natural resource agencies working together to use not only cutting-edge science, tools, and current data, but also their respective expertise in transportation and conservation analyses and implementation.

The IEF is intended to primarily support mid- to long-range transportation and infrastructure planning rather than individual project assessment and design. However, by proactively addressing information needs at the regional scale, the IEF supports better project-level design, construction, and maintenance. IEF products lay the foundation for implementing a watershed approach to Sections 301, 303, 401, and—most often—404 of the Clean Water Act. The IEF also lays the foundation for a regional-scale approach to conservation and consultation under the Endangered Species Act, Section 7. Federal agencies have defined these approaches as Strategic Habitat Conservation, or landscape and watershed-based approaches. These ecosystem approaches aim to deliver the greatest benefits under existing laws and regulations supporting aquatic resource restoration, species and habitat recovery, and regional-scale resilience.

WHAT IS THIS GUIDE?

This guide was developed for managers and decision makers who want to understand what is entailed in conducting a transportation/infrastructure planning process with the appropriate stakeholders, information, and expertise to ensure the best transportation/infrastructure and conservation outcomes possible. It does not provide the level of technical detail provided in the SHRP 2 C06 report, but it does include some changes to the IEF steps and substeps based on feedback the C06 project team received. All significant changes to IEF steps and substeps are documented in Chapter 5.

This guide does the following:

- ✓ Moves the reader from *what* the IEF is to *how* to implement it, providing a high-level description of the IEF steps and technical methods used; and
- ✓ Discusses the practical considerations needed to accurately scope the work and assemble the technical and scientific teams and stakeholders.

Because transportation and infrastructure planning and delivery can take years, each step of the IEF is described as a discrete effort with prerequisites, inputs, and outputs. It is important to understand that the IEF is meant to be flexible rather than rigid and prescriptive in its implementation since the context and resources available vary by region and state. Not every step needs to be implemented, although some steps are dependent on outputs from other steps. The steps do not need to be conducted in the order presented, and there are several approaches to carrying out each step and substep. However, certain characteristics are essential to the successful implementation of the IEF. The following are the core aspects of the IEF that must be in place to achieve the goals described in *Eco-Logical*:

- ✓ Conducting analyses and making decisions within a regional context;
- ✓ Involving stakeholders in the planning region;
- ✓ Clearly identifying the important resources and their conservation requirements;
- ✓ Using a spatially explicit and quantitative assessment approach to planning; and
- ✓ Bringing in all these elements very early in the planning process.

WHO SHOULD USE THE GUIDE?

The guide was developed for managers and decision makers interested in obtaining a basic understanding of the IEF and/or considering implementing it in their agency or organization. Ideally, a partnership among the transportation agency, resource agency, and conservation nongovernmental organizations (NGOs) who are stakeholders in the planning region should jointly review this guide to initiate IEF implementation.

BEYOND THE GUIDE

A two-volume research report and a practitioner's guide about the IEF provide useful examples, sources, and tools to use for conducting each step and substep. They were published by the TRB SHRP 2 Capacity Research Program and can be found at the TRB website (http://www.trb.org/Main/Blurbs/169515.aspx, http://www.trb.org/Main/Blurbs/166938.aspx).

For an overview of how the IEF fits into the entire transportation planning process, go to the Transportation for Communities—Advancing Projects through Partnership (recently renamed PlanWorks) website (http://www.transportationforcommunities.com). If additional assistance is desired, a number of organizations can provide assistance, ranging from training to advising to conducting technical work. For more information, contact the Federal Highway Administration (FHWA) Office of Project Development and Environmental Review (environment.fhwa.dot.gov/strmlng/usctac.asp; 202-366-2065).

2 THE INTEGRATED ECOLOGICAL FRAMEWORK AT A GLANCE

The Integrated Ecological Framework (IEF) is a peer-reviewed, nine-step technical framework that supports transportation/infrastructure planners and resource specialists in the use of a standardized, science-based approach to identifying and integrating ecological priorities into transportation and infrastructure decision making. The IEF draws on both well-established and new approaches to conservation analyses, as well as on existing efforts being led by federal and state natural resource and transportation/infrastructure agencies to address known organizational, process, and policy challenges related to accelerating project delivery while still achieving net environmental benefits.

BENEFITS OF THE IEF

- *Supports more coordinated and consolidated administrative and decision-making processes* that result in significant time and resource efficiencies for transportation/infrastructure and natural resource agencies.
- *Creates a more efficient and predictable consultation and project development process* through early identification of needs and solutions.
- *Allows for a clearer understanding of regional-scale considerations and opportunities* including goals and priorities, and the potential for impact avoidance or minimization, restoration, and recovery.
- *Directs resources for mitigation* to regional-scale conservation priorities.
- *Provides transparent and measurable processes* that can be duplicated, contributing to better accountability and the ability to measure success.
- *Creates additional knowledge about priority conservation areas* thus driving incentives to develop programs and funding to conserve and restore those areas.

MAJOR IEF PRODUCTS

- *Regional maps of conservation and restoration priorities*;
- *Regional maps identifying affected resources* and the quantification of the direct and cumulative impacts for each transportation scenario being considered;
- *Identification and evaluation of potential mitigation and enhancement areas* within a state or region; and
- *A dynamic database of regional resources, goals, gaps, and achievements*.

The fundamental objective of the IEF is to help natural resource, transportation, and infrastructure practitioners integrate their vision, goals, and objectives so that, working together, they can implement transportation and infrastructure needs more efficiently and at a lower cost while not only minimizing impacts to the environment, but also contributing more effectively to existing environmental goals.

FREQUENTLY ASKED QUESTIONS

How is the IEF different from other conservation planning frameworks and/or what makes it unique?

Although the IEF draws on many existing processes and approaches to planning, it was specifically designed to frame issues and challenges that are unique to integrating conservation and transportation planning, and to provide scientifically based methods for addressing those issues.

What are the upfront costs to implementing the IEF?

Implementing the IEF may require more collaboration, information, and analyses upfront. However, using the IEF will very likely yield significant, long-term ecosystem and economic benefits and cost savings that could outweigh the additional, upfront costs necessary to establish this new regional-scale approach to achieving transportation and ecological goals (Cambridge Systematics 2011).

Can the IEF support other regional, ecosystem-based initiatives happening across the country?

Yes, and vice versa, especially by directing mitigation actions and resources to identified conservation priorities. The IEF should draw from a variety of federal, state, and NGO conservation plans and activities. (*See* Chapter 3, Leveraging Existing Resources.)

How do you implement different parts of the IEF at different stages of transportation/infrastructure work (in other words, does the IEF have "on ramps")? Can you start the IEF at any step? How can we take advantage of prior work?

Although the IEF is presented as a set of nine steps arranged in a linear process, different agencies and regions will have different starting points and needs. The IEF is intended to be flexible with regard to starting point and emphasis; in reality it is a

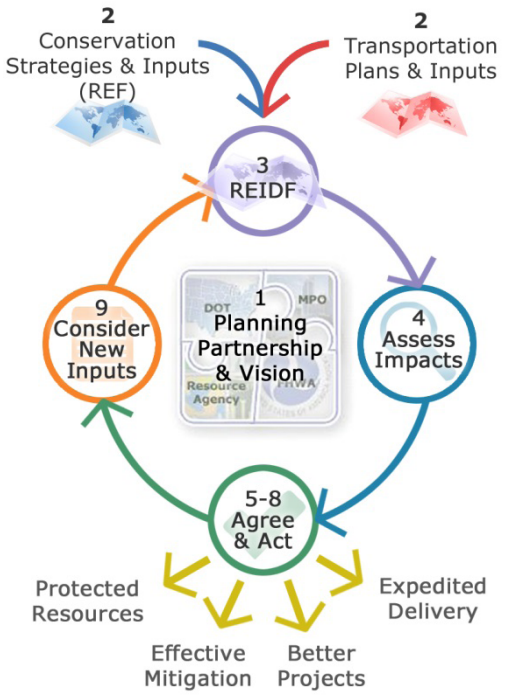

Figure 2.1. *Visual representation of IEF steps.*

cyclical process. (*See* Figure 2.1 and Chapter 3, On-Ramps.) Transportation and resource agencies often begin the IEF with a number of activities already under way, such as development of a long-range transportation plan or state wildlife action plan (SWAP). These activities are likely to contribute to accomplishing some steps of the IEF. Most of the IEF steps can be done independently, but some steps are prerequisites for the IEF to be successful. For example, Steps 1 and 2 are fundamental to the IEF and must be in place since they set the stage for all other IEF steps.

What is the core component of the IEF?

The Regional Ecosystem Framework (REF) is the core of the IEF. Essentially, the REF is a spatial database of the priority resources in a predefined area and preferably includes already-identified priority areas to avoid or to invest in mitigation (ecological improvement) or restoration actions. The REF represents natural resources as well as the values of partners and stakeholders; it may also include other concerns besides ecological resources, such as cultural resources and environmental justice (University of California, Davis Road Ecology Center 2013). The REIDF is the Regional Ecosystem and Infrastructure Development Framework.

How can the IEF help me in the long term?

The IEF is intended to be a continuous process, as is transportation/infrastructure planning overall. The key data sets and partnerships of the IEF, maintained over time, can continue to efficiently support assessment and planning into the future. Ongoing maintenance of these data and partnerships will greatly reduce the time and costs needed to keep the data updated and will contribute to improving the accuracy and quality of the results over time.

LAUNCHING THE IEF PROCESS

If you are getting ready to implement the IEF process, the steps in this section should be helpful. You may already have completed some of them; you will see that although the steps are presented sequentially, some aspects of them are concurrent and iterative.

Secure Partner Commitments

Because contributions of partners (expertise, funding, or in-kind) can greatly affect the budget and activities such as project extent, scope, and the need for coordination meetings, it is important to establish who the partners are and what they are contributing and expecting.

- *Identify the benefits of a multipartner project*. Overall and individual costs savings can accrue by distributing costs over multiple partners; access to a broader set of knowledge, data, and expertise may streamline many tasks and allow them to be conducted through in-kind contributions.

Scope the Project

A general scoping developed either internally or with partners is needed to determine the higher-level criteria for the project with an understanding of the approximate resources available. A detailed technical scoping of deliverables, budget, and schedule may be completed by appropriate internal and partner staff, or by a consultant using relevant portions of the SHRP 2 C06 documents.

- *Consider what is really needed*. What products are needed to make decisions; what level of precision is required of the data and results; how much time, funding, and staff capacity are available?
- *Define the geographic extent of the project*. There are no hard and fast rules for defining the planning region extent. It can include planning jurisdictions (e.g., a metropolitan planning organization, or MPO) or watersheds, or be organized by ecological resources and processes. However, the size of the planning region must be manageable relative to the desired precision of spatial products and the computing power needed to process information at the desired resolution. For example, a very large region may require sacrifices in spatial detail and limit the utility of outputs for some purposes.
- *Build in excellent documentation and data management*. Most projects intended for broad and long-term utility fail because they lacked adequate attention to (and

funding for) documenting all decisions, inputs, methods, and outputs and lacked the ongoing data management necessary to keep the inputs and outputs available and current. Investing in those aspects during the course of the project and thereafter will minimize the costs of accessing, updating, and applying the information in the future.

Obtain Funding and Specific In-Kind Commitments

Failure to reach the estimated funding needs may make it necessary to negotiate additional in-kind support or rescope the project within available resources.

The IEF…

- Is highly scalable.
- Can be time intensive and span a long time period coincident with transportation planning cycles.
- May be conducted over several years with intervening updates and iterations requiring varying levels of involvement by specific participants depending on what step is being implemented at any point in time.

Assemble the Teams

In this step, contracting (if needed) is completed and the team members are assembled into the desired **Project Team** structure (e.g., thematic work groups).

The **Partners Team** provides leadership and direction to the other teams to ensure that common and accepted objectives are met. Partners represent the agencies and organizations investing in the project.

The **Science Team** ensures that the REF represents best available scientific knowledge, makes recommendations about the natural resources that should be included in the REF, and populates the REF with information about the resources' conservation requirements and response to stressors that would appear in the transportation and land use scenarios. Because all knowledge cannot be integrated into the REF, the team should also be engaged to review and validate assessments and inform decisions. The team itself is composed of subject matter experts for the resources and may be drawn from state and federal agencies, universities, and NGOs among others.

The **Technical Team** manages and conducts the technical work of the IEF. A single project team member may have more than one of the necessary skill sets; for example, a staff member managing the project may also facilitate the partnership. IEF partners may have internal capacity to cover these skills, or they may need to look to an external contractor to fill some of the following Technical Team roles:

- *Project Manager* oversees all aspects of the project, ensuring that participants understand and perform their roles, securing bids, managing consultant contracts, coordinating all communication, and managing the budget and schedule.
- *Facilitator* leads and facilitates meetings of the partnership and stakeholders.
- *Science Lead* coordinates input of the Science Team consistent with direction of the project leadership.
- *GIS/Data Manager/Lead* oversees all spatial data management and GIS work. This position may be filled by the same individual as the one conducting geospatial analyses (*see* GIS Analyst).
- *GIS Analyst* acquires and processes data, conducts all geospatial analyses, develops interpretive products, presents results, and writes methods and documentation. For projects pursuing advanced modeling, a broader team of analysts/modelers will be required.

Initiate the Project

Initiation of the project will depend on what starting point (or on-ramp) is used, but it will most likely require a kickoff workshop of relevant partners. At this workshop, team members and partners are introduced; purpose, objectives, and scope are reviewed; initial information and findings are presented for discussion and initial decisions about next steps are made. Plenty of time should be allotted for this workshop as participants will likely have many questions requiring explanations, presentations, and discussion.

- *Research existing work and determine your starting point*. Carefully considering what work has already been accomplished on each IEF step will reduce duplication of effort—saving time, resources, and partner frustration. Existing work in the area should be researched to gain an understanding of the relevant data and analyses. This activity should be done early and should inform all IEF steps.

3 OVERVIEW OF THE IEF PROCESS

Using the IEF steps outlined in Table 3.1 and the subsequent sections of this chapter, state departments of transportation (DOTs), MPOs, and resource agencies can work together during transportation/infrastructure planning to identify transportation/infrastructure program needs, potential environmental conflicts, and strategic conservation and restoration priorities in the state, ecoregion, or watershed. Based on identified and agreed-on priorities, partners may choose to develop programmatic approaches that increase regulatory predictability during project development while further achieving regional conservation, restoration, and recovery goals.

BROADENING THE TYPES AND USE OF DATA

The IEF process requires that all states use data layers to address the regulated resources (such as Section 303(d)-listed streams, wetlands, and endangered or threatened species) which currently drive many transportation and infrastructure decisions at the project level. The IEF, however, seeks to integrate these more traditionally regulatory-oriented data sets used in permitting and consultations with nonregulated resources and data (such as important habitats, climate impacts, and other at-risk species). A broader set of data that is developed and used at a regional scale can

- ✓ Inform early stages of planning and foster improved resource planning and effectiveness,
- ✓ Achieve desired environmental outcomes,
- ✓ Help avoid additional species listings or expansion of Clean Water Act regulations, and
- ✓ Maintain better ecological integrity and build broader stakeholder support.

LEVERAGING EXISTING RESOURCES

Partners should draw on existing resources, such as the following:

- ✓ State wildlife action plans (SWAPs) nationwide, Crucial Habitat Assessment Tools (CHATs) in western states, other regional or state conservation strategies;
- ✓ Existing state, regional, or local watershed plans;
- ✓ State Natural Heritage Program conservation sites and priorities;
- ✓ Environmental organization conservation strategies, plans, and priorities;
- ✓ Bureau of Land Management (BLM) Rapid Ecoregional Assessments in western states; and
- ✓ The Eastern Interconnection States' Planning Council Energy Zone Mapping Tool (EISPC EZ Mapping Tool) in the eastern 39 states supporting energy planning for the Eastern Transmission Interconnection.

Also note that a national screening tool is under development to help implement the IEF by providing uniform access to integrated geospatial and ecological data portals and basic analytical functions. The tool is being built with TRB funding under the TRB SHRP 2 C40 contract (http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3336). The SHRP 2 C40 project also funded two pilots to test the tool in transportation planning and analysis.

STEPS OF THE IEF

A summary of each step of the IEF is noted in Table 3.1.

TABLE 3.1. SUMMARY OF EACH STEP OF THE IEF

Step	Purpose
Step 1: Build and strengthen collaborative partnerships and vision	Build support among relevant stakeholders to achieve a statewide or regional vision and planning process that integrates conservation and transportation/ infrastructure planning.
Step 2: Create a Regional Ecosystem Framework (REF)	Develop an overall environmental conservation strategy that integrates conservation priorities, data, and plans—with input from and adoption by all conservation and natural resource stakeholders identified in Step 1—that addresses the species, habitats, and relevant environmental issues and regulatory requirements agreed on by the stakeholders.

(continued)

TABLE 3.1. SUMMARY OF EACH STEP OF THE IEF (continued)

Step	Purpose
Step 3: Define transportation and infrastructure scenarios for assessment	Integrate existing, proposed, and forecasted development, transportation/infrastructure, and—optionally—other plans into one or more scenarios to assess cumulative effects on resources.
Step 4: Create a Regional Ecosystem and Infrastructure Development Framework (REIDF)	Integrate environmental conservation (REF) and transportation/infrastructure data and plans to support creation of a Regional Ecosystem and Infrastructure Development Framework (REIDF). Assess effects of transportation/infrastructure on natural resource objectives. Identify preferred scenarios that meet both transportation/infrastructure and conservation goals by using the REIDF and predictive models of priority resources to analyze transportation/infrastructure scenarios in relation to resource conservation objectives and priorities.
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 for all projects to promote progressive restoration and mitigation, and more accurate accounting of results.
Step 7: Develop programmatic consultation, biological opinion, or permit	Take advantage of identified regional conservation and restoration objectives to develop memoranda of understanding (MOUs), programmatic agreements (CWA Section 404 permits or ESA Section 7 consultations), or other CWA agreements for transportation/infrastructure projects in a way that documents the goals and priorities identified in Step 6 and the parameters for achieving these goals.
Step 8: Deliver conservation and transportation projects	Design transportation/infrastructure projects in accordance with ecological objectives and goals identified in previous steps (i.e., keep planning decisions linked to project decisions), incorporating as appropriate programmatic agreements, performance measures, and ecological metric tools to improve the project.
Step 9: Update the Regional Ecosystem Framework, scenarios, and regional assessment	Maintain a current REF that reflects the most recent distribution and knowledge of natural resources, conservation priorities, and mitigation opportunity areas that can support periodic updates to scenarios, and regional cumulative effects assessments.

The following sections summarize the nine major steps in the IEF process. Note that there have been some minor but important modifications to some of the steps presented here since the original TRB publication. Each step is presented as a discrete task to facilitate different starting points (or on-ramps).

Step 1: Build and Strengthen Collaborative Partnerships and Vision

Purpose

Build support among relevant stakeholders to achieve a statewide or regional vision and planning process that integrates conservation and transportation/infrastructure planning.

Step 1: Outcomes

- An understanding of each stakeholder's goals, priorities, processes, and major areas of concern within a specified planning region.
- Documentation of significant issues that may affect agency goals and mitigation needs.
- A shared regional planning vision.
- Formal agreements on roles, responsibilities, processes, and timelines that establish or reinforce partnerships.
- Documented criteria and opportunities for using programmatic consultation approaches to better address transportation and conservation planning needs.
- Identification of initial funding options.

Implementation

- 1a. Identify the preliminary planning region (e.g., watersheds, ecoregions, political boundaries). The boundary may be influenced by environmental factors such as water quality needs or Section 303(d) listings, species' needs, watershed restoration needs, or rare wetlands.
- 1b. Identify counterparts and build relationships among agencies, including local government and conservation NGOs (stakeholders). This substep will be iterative with Substep 1a because the boundary will influence the choice of stakeholders and vice versa.
- 1c. Convene the partnership, share aspirations, define and develop commonalities. Build an understanding of the benefits of the IEF planning approach and develop a shared vision of regional goals for transportation, land use, restoration, recovery, and conservation.

- 1d. Record ideas and develop an MOU on potential new processes for increasing conservation, efficiency, and predictability through collaborative planning.
- 1e. Explore initial funding and long-term management options to support conservation and restoration actions. This substep could focus on a near-term, existing issue that must be resolved.

Step 2: Create a Regional Ecosystem Framework

Purpose

Develop an overall environmental conservation strategy that integrates conservation priorities, data, and plans—with input from and adoption by all conservation and natural resource stakeholders identified in Step 1—that addresses species, habitats, and relevant environmental issues and regulatory requirements agreed on by the stakeholders.

Step 2: Outcomes

- Compilation of existing available data and plans into a refined map that identifies locations of all resources of interest and areas for conservation and mitigation action.
- An understanding of historical/long-term trends, priorities, and concerns related to aquatic and terrestrial species and habitats in the region.
- Identification of any gaps in data that need to be addressed to achieve a complete and reliable product at the appropriate level of resolution and accuracy.
- An agreed-on set of conservation and mitigation goals.
- Commitments and schedule for delivery of data and actions to fill data gaps.

Implementation

- 2a. Identify the spatial data needed to create an understanding of current (baseline) conditions that are by-products of past actions and allow you to consider potential impacts from future actions.
- 2b. Prioritize the specific list of ecological resources and issues that should be addressed in the REF or other assessments and planning.
- 2c. Develop the necessary agreements from agencies and NGOs to provide plans and data that agencies can use in their own decision-making processes. Agreements should allow data to be used to avoid, minimize, and advance mitigation, especially for CWA Section 404 and ESA Section 7.
- 2d. Identify important 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, both in the short term for immediate applications and for longer-term improvements.

- 2e. Delineate priority areas for conservation and mitigation, if these do not already exist. These should include all of the identified resources and follow principles from systematic conservation planning and should include opportunities for off-site mitigation through restoring habitat.
- 2f. Convene a team of stakeholders to review the draft REF generated from the preceding steps. Identify any issues that need correction, and finalize the REF.
- 2g. Document the REF objectives, decisions, and methods based on stakeholder input and the technical and scientific methods used in Substeps 2a–2f. Document formats should be suitable for GIS metadata, formal reporting, and outreach to support use, updating, and external products.
- 2h. Distribute the combined map of conservation and restoration priorities (the REF) to stakeholders for adoption. Develop and provide a suitable method and online portal for accessing the products that respects any data security and use-limitation agreements.

Prerequisites to Conducting Step 2

Although some of Step 2 can be done before or at the same time as Step 1, it is important to identify a strong stakeholders group for a planning region and to have a vision and goals to

- Secure stakeholder buy-in on the REF and its appropriate applications;
- Identify the range of resource and other values that must be included in the REF; and
- Identify data sources and authoritative expertise for the components of the REF.

Step 3: Define Transportation and Infrastructure Scenarios for Assessment

Purpose

Integrate existing, proposed, and forecasted development, transportation, and—optionally—other plans into one or more scenarios to assess cumulative effects on resources.

Step 3: Outcomes

- Mapped scenarios that address current and future time frames and include all features and stressors that do or may affect natural resources.
- A shared understanding of the current and planned/proposed locations, quantities, and patterns of all development, uses, and resource stressors in the region.

Implementation

- 3a. Convene stakeholders and identify appropriate scenarios to represent. Formal scenario-based planning approaches can be very useful for envisioning, describing, and prioritizing scenarios for assessment. This step should include what time frames to represent (e.g., current, 15 years, 50 years), the scope of information included in the scenarios (i.e., transportation only or in combination with all relevant uses and stressors), and what future assumptions to incorporate and represent in alternate scenarios (e.g., low versus high growth, climate change, transportation funding).
- 3b. Obtain data to represent the land uses, activities, and other features for each scenario. Specific to transportation, include the long-range transportation plan, Transportation Improvement Program (TIP), or State Transportation Improvement Plan (STIP) and preferably the full set of land use and management plans from the major local, state, and federal regulatory, land management, and planning agencies in the region.
- 3c. Assemble the draft scenarios and review them with the stakeholders. Note and make corrections as needed.
- 3d. Provide the scenarios to the stakeholders.

Prerequisites to Conducting Step 3

There are none. However, it will be informative to know which natural resources (Steps 1 and 2) will be included in the REF to ensure the relevant stressors are integrated in the scenarios. Having a convened group of stakeholders to inform the implementation steps will also provide a more useful and accepted product.

Step 4: Create a Regional Ecosystem and Infrastructure Development Framework

Purpose

Integrate environmental conservation (REF) and transportation/infrastructure data and plans to support creation of a Regional Ecosystem and Infrastructure Development Framework (REIDF). Assess effects of transportation/infrastructure on natural resource objectives. Identify preferred scenarios that meet both transportation/infrastructure and conservation goals by using the REIDF and predictive models of priority resources to analyze transportation/infrastructure scenarios in relation to resource conservation objectives and priorities.

Step 4: Outcomes

- Regional-scale picture of potential and cumulative impacts on natural resources in the region based on transportation scenarios developed in Step 3.
- Agreement on preferences regarding avoidance, minimization, potential conservation, and restoration investments to support selection of the best transportation plan scenario.
- Identified and quantified mitigation needs.

Implementation

- 4a. Work collaboratively with stakeholders to weight the relative importance of resources as needed to help establish the significance of impacts and importance for mitigating actions.
- 4b. Establish individual resource conservation requirements (e.g., minimum viable habitat sizes, connectivity requirements) and their response to different types of transportation improvements and other stressors.
- 4c. Create the REIDF by combining the REF (from Step 2) with the scenarios from Step 3 to identify which priority areas or resources would be affected and the nature of the effect (e.g., negative, neutral, beneficial) and to quantify the effect, noting the level of precision of mapping inputs. A visual overlay of the scenarios with the REF can point to particular problem areas, while a quantitative assessment of cumulative effects facilitates better comparison among scenarios and quantifies mitigation needs. It can also identify potential performance measures.
- 4d. Compare scenarios, and select the one that optimizes transportation/infrastructure objectives and minimizes adverse environmental impacts (the least damaging scenario), or use the results to create a new scenario.
- 4e. Identify mitigation needs for impacts that are unavoidable; that may require minimization through project design, implementation, and/or 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 feasibility of mitigating out-of-kind (e.g., by helping secure a very high-priority conservation area supporting other resource objectives).

Prerequisites to Conducting Step 4

- The REF (Step 2) or some comprehensive spatial database of the location of high-priority resources that must be assessed; and
- Step 3 or spatially explicit transportation/infrastructure data intersected with natural resource data for the plan or project area to be assessed.

Step 5: Establish and Prioritize Ecological Actions

Purpose

Establish mitigation and conservation priorities and rank action opportunities using assessment results from Steps 3 and 4.

Step 5: Outcomes

Develop and agree on the following:

- A regional conservation, restoration, recovery, and mitigation strategy, with quantitative and qualitative valuation of mitigation sites.
- The preferred conservation/mitigation actions to achieve the priorities.
- Strategies and actions that consider regulatory requirements and programmatic implementation opportunities.
- Crediting opportunities (*see* Step 6).
- A lead agency or agencies for each strategy and method for achieving each strategy.

Implementation

- 5a. Using results from Step 4, identify areas in the REF planning region that can provide the quantities and quality of mitigation needed to address impacts from the cumulative 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) the anticipated contributions to cumulative effects, (b) the presence in priority conservation/restoration areas of the REF, (c) the ability to contribute to long-term ecological goals, (d) the likelihood of viability in the regional context, (e) cost, and (f) other criteria determined by the stakeholders.
- 5b. Select potential mitigation areas according to the ranking protocols described in Substep 5a. Create a new scenario (repeat Step 3), specifying the mitigation actions for selected sites, and reevaluate the mitigation scenario (repeat Step 4) to validate that the expected mitigation benefits can be achieved. The development of a comprehensive REF in collaboration with regulatory agencies should expedite this step since the priority mitigation areas would already be designated by these agencies, reducing the time it takes to select and move forward on mitigation efforts that are more likely to contribute to high-priority conservation needs.
- 5c. Field validate the presence and condition of target resources at the 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 and cost of conservation and restoration

opportunities with ranking score (as described in Substep 5a) and context of conservation actions of other federal, state, local, and NGO programs to determine overall benefit and effectiveness. Predictive species modeling can target areas for the field validation process.

- 5d. Develop/refine a regional conservation and mitigation plan and strategy to achieve ecoregional conservation and restoration goals, and advance infrastructure projects. This step should address the timing of actions related to when impacts are expected to occur and the urgency to secure mitigation sites before they are developed or used for other mitigation actions.
- 5e. Obtain stakeholder agreement on mitigation implementation actions.

Prerequisites to Conducting Step 5

Step 4 cumulative effects assessment and its prerequisites should be completed before beginning Step 5.

Step 6: Develop Crediting Strategy

Purpose

Develop a consistent strategy and metrics to measure ecological impacts, restoration benefits, and long-term performance for all projects to promote progressive restoration and mitigation, and more accurate accounting of results.

Step 6: Outcomes

- Improved and integrated mitigation sequence at a site level, setting the stage for compensation through outcome-based performance standards.
- Supported implementation tools such as advanced mitigation banks, programmatic permitting, and ESA Section 7 consultation.
- Supported use of off-site mitigation and out-of-kind mitigation as appropriate, since equivalency of value can be determined across locations and resources.
- Informed adaptive management and updates of the cumulative effects analyses.
- Measured gains and losses of ecological functions, and benefits and values associated with categories of transportation improvements or specific project-related impacts.
- Characterized project mitigation benefits related to currently unregulated services, such as carbon storage or late-season water provision.
- Was a means to track progress toward regional ecosystem goals and objectives.

Implementation

- 6a. Diagnose the measurement need. Define which ecosystem services need to be measured or which could be beneficial and straightforward to measure. Examine the regulated ecological services potentially affected by transportation/infrastructure projects in the watershed or REF area, as well as the services provided by nonregulated ecological resources identified in the REF.
- 6b. Identify ecosystem crediting protocols developed within the region and evaluate their applicability to resources identified as priority within the REF.
- 6c. Select or develop units and rules for crediting. If there are existing functional or conditional assessment protocols available, they can be useful for consistent measurement of ecological functions or services. They are also used in the establishment of mitigation or conservation banks, and can be used to define outcome-based performance standards. When these assessment protocols do not exist, protocols for the most similar landscapes and ecosystems may potentially be adapted. If assessment protocols are available, Substep 6d can be skipped.
- 6d. Test applicability of functional or conditional assessment methods for local conditions if new rules or methods for service measurement or crediting are developed (or adapted from other regions). This includes a review of the rules by the primary regulatory agencies along with other important stakeholders.
- 6e. Evaluate local market opportunities for ecosystem services. Currently, nonregulatory markets are limited; but carbon and other markets may be available soon, and this can provide opportunities for more effective mitigation banks.
- 6f. Negotiate regulatory assurances to grant credits and long-term agreements, after determining regulators have this capacity. If information in the IEF and the overall mitigation plan sufficiently demonstrates that the critical regulatory elements are properly addressed and are being used to drive regional and watershed priorities, then it is possible for DOTs and MPOs to integrate regulatory assurances into their crediting system.

Prerequisites to Conducting Step 6

- Regional mitigation strategies and other outcomes from Step 5 can significantly reduce the time and effort involved in Step 6.
- Many states include ecological function- and service-based biological inventory methodology in their regulatory framework (such as Rapid Wetland Assessment Protocols), which has been developed to measure ecological functions and services. When these types of methods are adopted by the regulatory agencies, it can provide a critical head start to implementing Step 6.

Step 7: Develop Programmatic Consultation, Biological Opinion, or Permit

Purpose

Take advantage of identified regional conservation and restoration objectives to develop MOUs, programmatic agreements (e.g., CWA Section 404 permits or ESA Section 7 consultations), or other CWA agreements for transportation/infrastructure projects in a way that documents the goals and priorities identified in Step 6 and the parameters for achieving these goals.

Step 7: Outcomes

- Agreement on resource management roles and methods.
- Outcome-based performance standards incorporated within programmatic agreements.
- Programmatic ESA Section 7 consultation, special area management plan (SAMP) for wetlands, regional general permit (RGP), or agreements that enable agencies to proceed with conservation or restoration action in line with CWA Section 404 and ESA program objectives/requirements and with maximum assurance that investments count and will be sufficient.

Implementation

- 7a. Identify actions to programmatically benefit regulated resources, and ensure agreements related to avoidance and minimization of impacts to regulated resources are documented.
- 7b. Plan for long-term management and 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/infrastructure projects that will be practical for long-term adaptive management, and include these in any ESA Section 7 biological assessment or biological opinion. While the Clean Water Act (particularly related to Sections 303 and 404) has not historically included performance measures, they have been successfully used in some programmatic agreements and should be evaluated.
- 7d. Choose a monitoring strategy for mitigation sites, based on Substeps 7a, 7b, and 7c, ideally using the same metrics as those used for impact assessment, site selection, and credit development.

- 7e. Develop programmatic ESA Section 7 consultation, special area management plan (SAMP), Section 404 regional general permits (RGPs), or other programmatic agreements to 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.
- 7f. Set up periodic follow-up meetings with stakeholders to identify what is working well, what could be improved.

Prerequisites to Conducting Step 7

Development of a REF, at least for resources under federal regulation, is a prerequisite to Step 7.

Step 8: Deliver Conservation and Transportation Projects

Purpose

Design transportation/infrastructure projects in accordance with ecological objectives and goals identified in previous steps (i.e., keeping planning decisions linked to project decisions), incorporating as appropriate programmatic agreements, performance measures and ecological metric tools to improve the project.

Step 8: Outcomes

- Continuity from early planning processes into project implementation phase.
- Tools and approaches incorporated into a monitoring and adaptive management strategy.
- Accurate recordkeeping and tracking of all commitments by transportation agency in project delivery.

Implementation

- 8a. Design/implement methods to complete transportation/infrastructure project(s) consistent with the mitigation scenario, 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, to ensure full credit for conservation action.
- 8d. Minimize unavoidable impacts to resources in the final design of transportation/infrastructure projects, using conservation and transportation/infrastructure

design experts, and tracking via performance measures (e.g., acres of habitat or wetlands).

- 8e. Use adaptive management to ensure maximum long-term benefit of conservation investment and compliance with requirements and intent of performance metrics.

Prerequisites to Conducting Step 8

Although some aspects of Step 8 are currently conducted outside of the regulatory compliance process, using the information and objectives of the IEF would ensure better transportation and conservation results and would therefore require performing Steps 2–7 of the IEF.

Step 9: Update the Regional Ecosystem Framework, Scenarios, and Regional Assessment

Purpose

Maintain a current REF that reflects the most recent distribution and knowledge of natural resources, conservation priorities, and mitigation opportunity areas that can support periodic updates to scenarios, and regional cumulative effects assessments.

Step 9: Outcomes

- A current REF consistent with best available data and expert knowledge.

Implementation

- 9a. Integrate any new or revised conservation plans into the REF, and as appropriate, update spatial information on individual natural resources.
- 9b. Update the conservation area/resource requirements, responses, and indicators in response to new research and data and the results of management actions and performance measures (e.g., assess regional goals, update to minimum required area for species and/or habitat, review weighting values of resources in REF, and evaluate responses to stressors).
- 9c. Update the implementation and performance status of mitigation areas (conservation/restoration investments that have occurred) in the REF to evaluate whether those areas are contributing to REF goals and priorities. This will identify whether a mitigation area should be recategorized as an established conservation area for specific resources or if it is still available for future mitigation action.

- 9d. Update the scenarios and the regional cumulative effects analysis with new infrastructure or ecological developments and/or disturbances, proposals, and trends (e.g., ecosystem-altering wildfire, new policies, plans, proposals, and trends, such as new sea-level-rise inundation models).
- 9e. Conduct regular review of progress, including effectiveness at meeting goals and objectives, current take totals, and likelihood of exceeding programmatic take allowance.

Prerequisites to Conducting Step 9

- An existing REF (Step 2); and
- New information on resource distribution (update to Step 2), expert knowledge about resource conservation requirements and response to stressors (update to Step 4).

ON-RAMPS: APPLYING THE IEF TO CURRENT TRANSPORTATION ACTIVITIES

For transportation/infrastructure activities that are already in process, there are numerous points of entry into the IEF process:

- *Prioritizing projects for the TIP*. When evaluating projects in the Transportation Improvement Program, the impacts and the overall benefits that may be achieved can be considered to understand and prioritize which projects offer the most benefits and fewest impacts, environmentally. This on-ramp would act as Step 3 of the IEF; conducting Steps 2 and 4 (even if in a rudimentary way) would provide the assessment necessary to contribute to the TIP prioritization process.
- *Corridor plans*. When a corridor is considered for a transportation route, everything that could be affected inside and along the right-of-way is analyzed. Examination of the larger context, using the REF, allows visualization of the entire range of species and resources and the potential impacts to them across the region or state, and reveals where agencies can act jointly to contribute to existing conservation and restoration priorities. Thus a corridor analysis could be an on-ramp to Step 4, assuming that a REF (Step 2) or partial REF is already in place.
- *Transportation project review*. Like TIP prioritization, this on-ramp provides a scenario, in the form of a project to assess. Therefore, IEF Steps 2 and 4 would provide the information for project review. If necessary, these steps could be limited in scope to the area around the project (versus regionwide) for time efficiency.
- *Mitigating a project under way*. Project mitigation requires an understanding of what impacts are expected or documented and what opportunities exist for mitigation. This requires IEF Step 2 in some form. If impacts are already documented, Step 4 may not be necessary (to quantify impacts)—although understanding the ramifications of those impacts in a regional context and against regional

conservation goals would help prioritize and direct mitigation actions to ensure these funds are spent to achieve the greatest benefit. The focus of Step 2 is identifying areas of mitigation investment that can be linked to project impacts and are recognized high priorities that are contributing to larger conservation goals. For example, if project impacts are primarily on wetlands, Step 2 could focus on identifying areas of the same wetland or a more significant area (preferably within the project watershed) where mitigation would result in the conservation or restoration of a large, intact, high-quality wetland community.

4 PRACTICAL CONSIDERATIONS

ECOSYSTEM-BASED MITIGATION APPROACHES

The IEF promotes the use of mitigation approaches that are more successful in supporting environmental needs, and in the long term reduces impacts and—potentially—the number of environmental permits needed. The following are just a few reasons why using a broader-scale, ecosystem-based approach to selecting mitigation sites can improve the site selection process and reduce expenses.

- Compensatory mitigation sites located in close proximity to conservation or protected lands can contribute to a created, enhanced, or restored wetland's success in compensating for losses by increasing its connectivity, size, and overall contributions to wetland functions in that watershed (Kramer and Carpenedo 2009).
- Compensatory mitigation approaches that use information about biophysical systems and consider multiple resources to evaluate the site are most likely to yield the highest number of ecologically valuable outputs (Cambridge Systematics 2011).
- Using consolidated, off-site compensation options, supported by a regional-scale approach to mitigation, may provide ecological economies of scale like the increased protection afforded to species by larger, unfragmented habitat patches (Murcia 1995; Schwartz 1999; Drechsler and Watzold 2009).

ECOSYSTEM SERVICES

Although the societal value of ecosystem production functions is rarely taken into account in the selection and design of compensatory mitigation projects (Ruhl and Gregg 2001; Cambridge Systematics 2011), they provide valuable ecosystem services to people close to the conservation areas (Engel et al. 2008). Wetlands are well known for their

ability to filter excess pollutants and nutrients, reduce flood hazards, absorb storm surge, and provide unique recreational or scientific opportunities (Mitsch and Gosselink 2000; Zedler 2003). Economic valuation studies have found that wetlands also can generate aesthetic benefits (Mahan et al. 2000), contributing to an increase in property values (Doss and Taff 1996; Greenspace Alliance and DVRPC 2011); thus wetlands in close proximity to larger housing communities have increased economic value.

SAVINGS IN ADMINISTRATIVE AND TRANSACTION TIME

The IEF process supports more coordinated, efficient decision making among transportation and regulatory resource agencies, as well as consolidation of regulatory permitting and consultation processes. In addition to integrated processes, collaborative, ecosystem-based approaches to compensatory mitigation encourage increased use of consolidated, off-site, compensatory mitigation sources, such as mitigation banks, conservation banks, or in-lieu fee mitigation programs, presenting opportunities to capture economies of scale and reduce compliance costs for regulatory permittees (U.S. Environmental Protection Agency 2008; U.S. Fish and Wildlife Service 2003).

LEVERAGING RESOURCES AND REDUCING LITIGATION

Programmatic mitigation uses processes that support a collaborative, regional-scale approach to mitigation. These collaborative, holistic, regional-scale approaches allow transportation and resource agencies to eliminate redundant investments, share data, and identify potential mitigation sites more effectively. This, along with the use of consolidated, off-site compensation, can reduce field site visits and time spent approving and monitoring mitigation sites. Collaborative, regional-scale approaches to mitigation also lower overall financial expenses by establishing regulatory assurances. Those assurances reduce vulnerability to litigation or punitive damages, while also allowing transportation agencies to more accurately forecast expected project costs and their associated environmental compensation components (Brown 2006; Cambridge Systematics 2011).

Many transportation programs have adopted a streamlined, regional-scale approach to infrastructure planning and experienced substantial transaction cost savings and time savings compared with traditional, project-by-project compensatory mitigation. In 2001, for example, the North Carolina Department of Transportation reported that 55% of its transportation developments were delayed by wetland mitigation requirements; after the department ramped up streamlined transportation planning and mitigation through its Ecosystem Enhancement Program (EEP), there were no delays in transportation improvement projects associated with EEP (Venner Consulting and URS Corporation 2013). The regional-scale approach to the compensatory mitigation process can generate significant ecological conservation, economic, and societal benefits. The IEF process also increases the effectiveness of existing planning and environmental assessment processes and may reduce the need for later on-site work through avoided impacts.

OTHER CONSIDERATIONS

Drawing on experience from pilot IEF (or similar) projects, guidance on the time, cost, staffing expertise, and information needed to conduct core parts of the IEF are summarized here, along with key suggestions for effectively and efficiently conducting the IEF. Experience has shown that initially an increased investment is needed to create a multiagency collaborative partnership and a robust REF, but these investments will make decision making more efficient and outcomes more effective, likely saving costs in the longer term. The IEF process can be readily adapted to fit the needs and resources available to a particular region, but several factors that will affect the time, effort, and cost to conduct the IEF need to be considered:

- Time frame within which results are needed to inform a planning effort with a set deadline;
- Resources required for the desired level of effort and currently available resources, including DOT/MPO funds, partner funds, and in-kind contributions to initiate the work;
- Existing staff capacity and expertise and availability of resources to supplement with outside expertise if needed;
- Geographic scope and complexity of the project;
- Availability of existing relevant analyses, data, and other information and important information gaps that need to be filled;
- Available hardware and software (although with the increasing availability of basic GIS capability within many agencies, this is a less-frequent limitation); and
- Number of partners and the relative benefits of their participation and contributions (a larger number of partners increases the complexity of coordinating the partnership and making decisions).

TIME FRAME

As with many broad collaborative and data-driven projects, implementing the IEF can be time intensive and require an extended commitment of time. For example, the development of the REF, scenarios, and initial cumulative effects assessment (IEF Steps 2–4) often takes between 12 and 18 months. This time frame does not take into account the partnership-building phase (Step 1) and assumes that there is a core, dedicated team and that staff and other experts can provide timely inputs and review so the technical work can progress without delays.

COST

As with time frame, a large number of variables affect the cost of the IEF. For IEF Steps 2–4, an estimate of $150,000–$200,000 (2012 dollars) is not unreasonable. This amount will cover only the direct costs for technical and ecological services. Direct

costs can be greatly reduced through in-kind contributions of science and technical services by partners. Costs should be shared among the multiple partners that will benefit from this work.

KEY INFORMATION INPUTS

Information needed to conduct an IEF includes spatial and nonspatial data from a large variety of sources depending on the nature and location of the region. The SHRP 2 C06 report *An Ecological Approach to Integrating Conservation and Highway Planning, Volume 2* (http://www.trb.org/Main/Blurbs/166938.aspx) provides much more detail on specific data and sources for each step; and Table 3.1 provides a general summary of the types of data needed and ideas for information gathering—highlighting when these efforts may be challenging and require thoughtful budgeting.

5 UPDATES TO THE IEF

The original TRB Guide to the Integrated Ecological Framework (hereinafter referred to as "original IEF Guide") is a very detailed technical guide to the IEF. This *Manager's Guide to the Integrated Ecological Framework*, or *IEF Manager's Guide*, is a more concise summary of the IEF. Its purpose is to help management-level decision makers understand how the IEF might benefit their region or state and to explain what they need to consider if they want to begin its implementation.

As mentioned in the What Is this Guide? section in Chapter 1, the C06 project team received feedback on the IEF after one of the report volumes was published in 2012 (http://www.trb.org/Main/Blurbs/166938.aspx). A majority of the feedback received was from the project teams associated with SHRP 2 C21, which tested the IEF in four geographic areas: California, Colorado, Oregon, and West Virginia. Changes resulting from the feedback, and the reason for each change, are documented in the following sections. In some cases changes were made simply to clarify the language; in other cases substantive technical changes were made to address the feedback received.

SUMMARY OF SUBSTANTIVE IEF UPDATES

The most significant changes to the IEF from the original IEF Guide are the changes to Steps 2–4. In the original IEF Guide, Step 2 is the integration of environmental and natural resource plans and data guided by experts in the various fields of natural resources and environmental conservation; in Step 3 a Regional Ecosystem Framework (REF) is created by overlaying the results of Step 2 with transportation plans and data; and in Step 4 the results of Step 3 (REF) are analyzed collaboratively by transportation and natural resource experts and other stakeholders identified in Step 1.

In this *IEF Manager's Guide*, the REF is redefined as the product resulting from the process completed in the original Step 2; Step 3 becomes the process of integrating transportation data, plans, and expertise; and Step 4 becomes the integration and analyses of the conservation and transportation strategies. These steps result in a product that is newly titled Regional Ecological and Infrastructure Development Framework (REIDF).

Appendix A provides a detailed comparison of each step showing changes from the original version of the IEF Guide. The summary provided in Table 5.1 focuses on data that are available nationally; especially recommended are data in a standardized format so that they are comparable across jurisdictional boundaries and thereby supportive of regional-scale planning.

TABLE 5.1. KEY NATIONAL INFORMATION INPUTS, SOURCES, AND COMMENTS

Information Type	Typical Sources	Comments
Species	State wildlife division databases, NatureServe and state natural heritage program nationally standardized species location data or element occurrence (EO) data, NatureServe's national animal distribution maps, Critical Habitat Designations (U.S. Fish and Wildlife Service), U.S. Geological Survey's (USGS's) Biodiversity Information Serving Our Nation (BISON) species observations, USGS's Gap Analysis Program (GAP) animal distribution maps	These sources include known and predicted species locations. The use of species distribution modeling software is recommended to generate maps of the probable locations for listed and endangered species, other key species, and areas that may be priorities for restoration and recovery. National broad-scale maps may be available for many other species of conservation concern.
Habitats and ecosystems data	National Wetlands Inventory (NWI), local watershed inventories (LWIs), or plans by state or local organizations, for example, Wetlands of Special State Concern, Impaired (303d-listed) streams; USGS GAP, Landscape Conservation Cooperatives (LCCs), EPA EnviroAtlas, NatureServe nationally standardized ecosystem and vegetation community data	Many existing wetland maps are incomplete and/or inaccurate; regional or state efforts to improve these maps are under way in some states, but all need to be done across the country. GAP vegetation data and land-cover data are generally available nationally, but downscaling the data to ecological systems maps and more localized habitat maps may be needed or desirable in many locations.
Resource conservation requirements	Expert knowledge is the primary source; some useful information can be found in scientific literature or technical reports.	It is a substantial effort for biologists from natural heritage programs, other agencies, and universities to establish thresholds, goals, indicators, etc., for resources. Plenty of time should be planned for this activity since this information is critical to accurate planning and performance measures.

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TABLE 5.1. KEY NATIONAL INFORMATION INPUTS, SOURCES, AND COMMENTS (continued)

Information Type	Typical Sources	Comments
Current physical stressors, land use, infrastructure data	DOTs, MPOs, Council of Governments (COGs), local government planning offices, National Resources Conservation Service (NRCS), National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analyses Program, Department of Defense, U.S. Energy Information Administration, Federal Energy Regulatory Commission (FERC), and other infrastructure data sources	This information is typically readily available but must be assembled from multiple sources if a previous project has not yet done that.
Natural resource management plans	Local government planning offices, and state and federal land management agencies	These plans generally represent potential near-term future (e.g., next 10–25 years) priorities and goals. These plans should be integrated and/or coordinated with each other. Coordination with other NGOs and universities involved in the development of protected-area data and conservation priority-area data can ensure you have the most accurate and complete set of data.
Current protected and managed lands	U.S. Protected Area Database (PADUS); National Conservation Easement Database; federal, state, and local agencies; NGOs/land trusts that hold protected lands; mitigation banks	Currently, protected-area data are not being tracked in a comprehensive and standard way across the country, but the situation is getting better. These data are critical to understanding the level of protection currently afforded to species and habitats. Thus, more accurate, current, and complete data on protected areas gathered locally can significantly improve the analysis.
Conservation priority areas	State wildlife action plans, state natural heritage programs, conservation NGOs (e.g., The Nature Conservancy, Ducks Unlimited, Audubon), local conservation NGOs and land trusts	Data for this theme must be carefully scrutinized to determine the match to the resources of interest and appropriate scale to be meaningful for analyses. Statewide and ecoregional prioritization efforts tend to generate very coarse maps that may not be useful for IEF purposes.
Climate change stressors data	USGS Regional Climate Science Centers, universities, Climate Wizard, Sea Level Affecting Marshes Model (SLAMM) outputs, NOAA Sea Level Rise Viewer	The IEF does not formally address climate change, but this is becoming a common requirement in many planning activities. Downscaled climate change data and secondary effects models (e.g., soil moisture changes) are highly dynamic but are increasingly being developed more consistently and at finer scales. For coastal areas, the U.S. Fish and Wildlife Service (USFWS) has invested in generating SLAMM analyses for many areas.

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TABLE 5.1. KEY NATIONAL INFORMATION INPUTS, SOURCES, AND COMMENTS (continued)

Information Type	Typical Sources	Comments
Other stressors (e.g., invasive species, wildfire)	Landfire program, BLM Rapid Ecoregional Assessments in the West, U.S. Forest Service, USGS, NatureServe, natural heritage programs, universities	The IEF does not require this information, but having this information will provide more accurate cumulative effects assessment for many resources. Often development is a much less important stressor than these types. This information is highly variable in its availability nationally. Effort should be expended to research its availability locally and consider modeling efforts to generate it. If modeling is needed, the effort required may be substantial, especially in combination with climate change forecasts.

GLOSSARY

Baseline conditions: The physical, chemical, biological, social, economic, and cultural setting in which the proposed project is to be located. Baseline conditions indicate where local impacts (both positive and negative) might be expected to occur (Shepard 2005).

Best available data: Under the Endangered Species Act, the use of best available data is required. The way best available data are determined is subjective and typically done on a case-by-case basis by experts in agencies and organizations. It should involve an evaluation of the currency, completeness, and quality of data needed. Typically the best available data must be acquired from more than one source to achieve the highest level of currency, completeness, and quality.

Biological inventory: A process of cataloging plants, animals, and/or habitats occurring in an area.

Biophysical systems: Any biological process which is studied on a system level.

Clean Water Act (CWA) Section 404: The Federal Water Pollution Control Act, known as the Clean Water Act, is a comprehensive statute aimed at restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. Authority for the implementation and enforcement of Section 404 of the Clean Water Act rests with the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA) for the discharge of dredged or fill material within U.S. waters (33 USC § 1251 et seq.).

Compensatory mitigation: The restoration (reestablishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purpose of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved (33 CFR § 332.2).

Compliance costs: Expenditure of time or money in conforming with government requirements such as legislation or regulation.

Connectivity (requirements): Connections between habitat patches that support species viability through a variety of mechanisms such as seasonal migration, seed dispersal, obtaining of food or water in different habitats.

Conservation analyses: The complete set of activities involved in creating the Regional Ecological Framework, cumulative effects assessment, and conservation and mitigation planning.

Conservation and mitigation receiving priority areas: Areas identified through advance conservation planning that are important to achieving regional conservation objectives, are currently unprotected and or requiring restoration, and therefore would be priorities for receiving off-site mitigation funds or actions.

Conservation area: An area of land that is either being managed, or has a designated protection status, to ensure that natural resources, cultural heritage, or biological processes are being preserved. A conservation area may be a nature preserve, a park, a conservation easement, or other area.

Conservation banking: *See* mitigation (or conservation) bank.

Conservation measures: Actions taken or planned to achieve mitigation or conservation objectives.

Conservation planning: Identification of a set of conservation objectives for an area, typically with a goal to identify the set of sites that maximizes representation of distinct species and communities while minimizing the area to be protected (modified from Kareiva and Marvier 2011).

Conservation requirements: The quantitative and qualitative parameters of what is needed to conserve or maintain a species, ecological system, or other biological resource within a geography of interest. An example of a conservation requirement is the minimum size of a resource occurrence that is needed for the occurrence to persist.

Consultation: The transportation conformity rule requires that agencies—including EPA, U.S. DOT, state DOTs, state and local air quality agencies, and MPOs—collaboratively develop effective interagency consultation procedures (40 CFR §§ 93.105 and 93.112). The interagency consultation process must include the following three components as well as conformity criteria and procedures:

1. General factors and specific processes for interagency consultation;
2. Conflict resolution procedures; and
3. Public consultation procedures developed in accordance with the Metropolitan Planning regulations (23 CFR § 450, 49 CFR § 613).

Corridor (analysis): Used to determine an *optimal corridor* between two points. For environmental purposes the corridor is often a narrow strip of land connecting

two larger habitats, and the analysis is done to help conservationists recognize the optimal path between two areas of habitat.

Crediting: Providing credit for mitigation or restoration actions, usually involves specifying quantities of individual resources (e.g., acres) tied to quantity of impacts needed for projects.

Critical habitat designation: The Endangered Species Act (ESA) requires the federal government to designate critical habitat for any species it lists under the ESA. *Critical habitat* is defined as, "Specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological resources essential to conservation, and those resources may require special management considerations or protection; and Specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation" (http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm).

Cumulative effects assessment: A process used to determine cumulative impact. According to 40 CFR § 1508.7, *cumulative impact* is the effect on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Cumulative impact: The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

Current take: The amount of a resource affected by current (existing and approved) projects.

Data gaps: Documented gaps in data or information based on a systematic review of data needs and data availability.

Data security and use-limitation agreements: Legal or interagency agreements used to protect species and ecological data from being collected, misused, or misinterpreted.

Data sources: Agencies, organizations, or individuals that collect, maintain, and/or manage data. Authoritative data sources are those recognized to have the best data.

Development: A general term for anthropogenic structures and activities that includes urbanization, industrialization, transportation, mineral extraction, water development, or other human activities that occupy or fragment habitats or that develop renewable or nonrenewable resources.

Distribution maps: Spatial maps that show the distribution of a species or habitat. Maps can be created using a variety of mapping methods including modeling

techniques that use species observations and other data, and the use of inductive and/or deductive modeling.

Downscaling: The process of transferring information from a coarser resolution to a finer resolution (e.g., from 15 km pixels to 4 km pixels), commonly done to convert global climate model outputs to regional climate change data. Conversely, *upscaling* is the process of transferring information from a finer resolution to a coarser resolution.

Ecological: Characterized by the interdependence of living organisms in an environment.

Ecological function and service (also called ecosystem service production function): A description of the relationship between quality-adjusted ecological endpoints and the provision of ecosystem goods and services. This term differs from ecological production function because it includes both the biophysical functions and the nonecological assessments that are needed to demonstrate a service. Ecological function and service evaluate four things: (1) how ecological endpoints combine with complementary (nonecological) inputs to generate goods and services; (2) whether the quality of ecological endpoints is sufficient to generate the service; (3) whether required complementary goods and services (trails, roads, homes) are available; and (4) whether demand exists for the service by location. For example, a quantitative or qualitative description of how a population of watchable birds (the ecological endpoint), when combined with complementary inputs such as transportation infrastructure and demand by birders, produces the ecosystem service of recreational bird watching, is an ecosystem service production function. *See also* ecological production function (Wainger and Mazzotta 2009; input from J. Boyd).

Ecological integrity: The ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion.

Ecological systems: Recurring groups of biological communities found in similar physical environments and influenced by similar dynamic ecological processes, such as fire or flooding. They are intended to provide a classification unit that is readily mappable, often from remote imagery, and readily identifiable by conservation and resource managers in the field.

Ecologically valuable outputs: Quantifiable ecosystem services considered valuable to society.

Ecology: The scientific study of the relationship between organisms and their environment.

Economic valuation studies: Studies of the economic value of resources based on the services they provide to society.

Economies of scale: Reduction in cost per unit resulting from increased production, realized through operational efficiencies. Economies of scale can be accomplished because as production increases, the cost of producing each additional unit falls.

Ecoregion: A geographic area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions.

Ecosystem: The interactions of communities of native fish, wildlife, and plants with the abiotic or physical environment.

Ecosystem-based approach/mitigation: A holistic approach to environmental decision making that takes into account the full array of interactions of the ecosystems and species, as well as anthropogenic activities and influences, present in the area of interest, rather than just the resources in isolation from each other.

Ecosystem crediting protocols: Protocols that standardize the operations and management of ecosystem credit creation.

Ecosystem production: The goods and services produced by an ecosystem of value to society.

Ecosystem (or ecological) services: Benefits or services that the natural environment provides to society. These benefits or services include ecologically based outputs such as timber and fish production, filtering excess pollutants, providing a range of nutrients from oxygen to soil and plant-based nutrients, reducing flood hazards, absorbing storm surge, and providing unique recreational, scientific, or spiritual opportunities. There are four primary categories of ecosystem services:

- *Provisioning services* are the products obtained from ecosystems, such as food, genetic resources, fiber, and energy.
- *Regulating services* are the benefits obtained from the regulation of ecosystem processes, such as regulation of climate, water, and some human diseases.
- *Cultural services* are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience.
- *Supporting services* are ecosystem services that are necessary for the production of all other ecosystem services. Examples include biomass production, production of atmospheric oxygen, nutrient cycling, water cycling, and provisioning of habitat.

(Millennium Ecosystem Assessment 2005–2006)

Element occurrence: A term used by natural heritage programs to generally delineate the location and extent of a species population or ecological community stand and represent the area of the biological resource that is of conservation or management interest. Element occurrences are documented by voucher specimens (as appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

Enhancement areas: Areas that are restored, under mitigation or other projects, to create or support habitat that has been identified in the IEF as critical to sustain rare and imperiled species and ecosystems.

Environmental conservation strategy: The combination of mapped locations and actions to achieve the conservation objectives for resources.

Environmental permitting: Federal and state laws require authorization before taking actions that affect regulated environmental resources. This may include completing consultations or receiving a permit through a regulatory review process with various federal and state agencies.

Environmental planning: *See* conservation planning.

ESA Section 7: Under Section 7(a)(1), of the Endangered Species Act (ESA), federal agencies are directed to implement programs that support the conservation of threatened and endangered species. In Section 7(a)(2), the act requires a consultation on federal actions with the secretary of the interior or commerce, as appropriate. Federally funded programs at the state and local level, including transportation projects, require a consultation process under Section 7 of the ESA, which includes a biological assessment. These Section 7 consultations are designed to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed species or destroy or adversely modify critical habitat.

Field validate: To confirm the validity of the current status of an ecological resource through an on-site visit. Data for a specific species, site, or habitat are never 100% complete and current since species and habitats are dynamic and constantly changing, especially in response to human-related impacts. The IEF often relies on various ecological resource data sets, and these data sets are useful when doing regional assessments and planning. But once decisions are made to implement a transportation infrastructure, or mitigation project, there is often a need to do an on-site visit to validate the current status of an ecological resource that may be affected. This field validation process can sometimes result in a revision to an assessment and/or planning decision or action.

Geographic information system (GIS): A computer system designed to collect, manage, manipulate, analyze, and display spatially referenced data and associated attributes.

GIS metadata: A text file describing how a spatial database was created. Metadata files document how the data were created and their content, quality, condition, and other characteristics. Metadata's purpose is to ensure that a user knows the source and quality of the data to help in evaluating of its usefulness and appropriateness for analyses. The Federal Geographic Data Committee (FGDC) sets content standards for metadata.

GIS modeling: The action of generating new information in a geographic information system using existing input data (e.g., modeling the probable distribution of a species habitat based on information about land cover, soil types, slope, presence of water).

Habitat: An ecological or environmental area inhabited by a particular species of animal, plant, or other type of organism; the natural environment in which an

organism lives or the physical environment that surrounds (influences and is used by) a species population (Franklin Institute 2011). (Retrieved from the Franklin Institute website on June 29, 2011.)

Impact avoidance: To avoid a direct, indirect, and/or cumulative impact to the environment.

Impact minimization: To minimize a direct, indirect, and/or cumulative impact to the environment.

In-kind: Similar in structure or function. To replace *in-kind* means to replace a lost environmental resource with a resource of similar structural and functional type to the affected resource (33 CFR § 332.2).

In-lieu fee mitigation program: A program involving the restoration, establishment, enhancement, and/or preservation of aquatic resources through funds paid to a governmental or nonprofit natural resources management entity to satisfy compensatory mitigation requirements for DA permits. Similar to a mitigation bank, an in-lieu fee program sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the in-lieu program sponsor. However, the rules governing the operation and use of in-lieu fee programs are somewhat different from the rules governing operation and use of mitigation banks. The operation and use of an in-lieu fee program are governed by an in-lieu fee program instrument (33 CFR § 332.2).

Indicators: Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g., land health) that is too difficult, inconvenient, or expensive to measure.

Infrastructure: The basic facilities needed for the functioning of a community or society, such as transportation and communications systems, utilities, and public institutions, including buildings, roads, utilities, equipment, and other structures. In a refuge vulnerability assessment and alternatives or RVAA, infrastructure can be considered both as a resource to preserve as well as a stressor on ecological and cultural resources.

Integrated Ecological Framework, or IEF: The IEF is a technical guide that supports transportation planners' and natural resource specialists' use of a standardized, science-based approach to the identification of ecological priorities and the integration of those into transportation and infrastructure decision making—as outlined in *Eco-Logical*.

Integrated planning: The process by which multiple agencies and partners combine planning efforts to understand the ways in which their work intersects and how best to leverage resources to achieve shared goals and priorities.

Known species location: An accurately mapped location of a species whose location and (sometimes) condition has been verified in the field by a qualified field biologist. For example, element occurrences (EOs) collected by NatureServe member programs or natural heritage programs use a standard methodology for data

collection, mapping, and assessment. An EO is defined as an area of land and/or water in which an element (such as a species or ecological unit) is or was present as demonstrated by verifiable sources of evidence.

Land cover data: The (bio)physical material or cover on the surface of the earth. There are two primary methods for capturing information or data on land cover: field survey and analysis of remotely sensed imagery. Often surveys of land cover define similarly named categories of land cover (e.g., forests) in different ways. In the United States, the USGS National Center for Earth Resources Observation and Science (EROS) is the primary developer of land cover data as part of the USGS Land Cover Characterization Program (LCCP).

Land use and management planning: These are terms used for a branch of public policy that encompasses various disciplines seeking to order and regulate land use and planning to prevent land use conflicts. Governments use land use planning to manage the development of land within their jurisdictions. By doing so, the governmental unit can plan for the needs of the community while safeguarding natural resources. To this end, it is the systematic assessment of land and water potential, alternatives for land use, and economic and social conditions in order to select and adopt best land-use options (Young 1993).

Long-range transportation plan: A document resulting from regional or statewide collaboration and consensus on a region or state's transportation system, and serving as the defining vision for the region's or state's transportation systems and services. In metropolitan areas, the plan indicates all of the transportation improvements scheduled for funding over the next 20 years (http://www.fhwa.dot.gov/planning/glossary/glossary_listing.cfm?sort=definition&TitleStart=L).

Minimum viable habitat size: Usually estimated as the habitat size necessary to ensure the survival of the species and habitat into the future. The minimum viable habitat size is determined using analyses involving species and habitat experts, data, and sometimes modeling.

Mitigation: The Council on Environmental Quality regulations define *mitigation* as follows:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
- Compensating for the impact by replacing or providing substitute resources or environments (http://environment.fhwa.dot.gov/projdev/tdmmitig2.asp).

Mitigation (or conservation) bank: A site, or suite of sites, where resources (e.g., wetlands, streams, riparian areas) are restored, established, enhanced, and/or preserved for the purpose of providing compensatory mitigation for impacts authorized by DA permits. In general, a mitigation bank sells compensatory mitigation credits to permittees whose obligation to provide compensatory mitigation is then transferred to the mitigation bank sponsor. The operation and use of a mitigation bank are governed by a mitigation banking instrument (33 CFR § 332.2).

Model/modeling: Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and change through time. Models incorporate hypotheses about resource structures and functions, and they generate predictions about the effects of management actions.

Natural heritage program: An agency or organization, usually based within a state or provincial natural resource agency, whose mission is to collect, document, and analyze data on the location and condition of biological and other natural resources (such as geologic or aquatic resources) of the jurisdiction. These programs typically have particular responsibility for documenting at-risk species and threatened ecosystems, and as members of NatureServe, all use consistent standards for collecting and managing the data, allowing information from different programs to be shared and combined regionally, nationally, and internationally. Together the NatureServe network collects and analyzes data about the plants, animals, and ecological communities of the Western Hemisphere. There are 82 member organizations, known as natural heritage programs or conservation data centers, and they operate throughout the United States, Canada, Latin America, and the Caribbean. *See* www.natureserve.org/visitLocal/index.jsp for additional information.

Natural resource planning: *See* conservation planning.

Natural resources: Natural resources can be defined in many ways, but in the context of this report natural resources refer to resources that naturally occur in the environment such as land, water, air, soil, plants, animals, and so forth.

Off-site compensation: Implementation of mitigation at a location not on or immediately adjacent to the site of impacts, but within the same watershed.

On-ramp: A starting point for using the IEF. There are several places at which a practitioner can begin to use the steps and substeps, thus the term *on-ramp* describes a starting point for using the IEF.

Out-of-kind mitigation: A mitigation project that replaces lost resources with resources that are not similar (e.g., restoring a different type of wetland than the one that was affected). The mitigation project may or may not be in close proximity to the site of impact.

Performance measures: Measures that address two IEF components: (1) measures for projects that describe the planned and acceptable impacts to resources and project guidelines to minimize impacts; and (2) measures for mitigation actions, which can

include resources types, resource area, and other measures of resource viability that must be achieved for successful mitigation.

Predicted species locations: *See* predictive species modeling (or predictive models of priority resources).

Predictive species modeling (or predictive models of priority resources): An innovative GIS-based method used to produce maps that predict where elements (i.e., species, ecological community type) are likely to occur and likely not to occur.

Preferred alternative: The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) environmental review process for transportation projects contains a set of requirements that includes the analysis of (route) alternatives and the identification and design of the preferred alternative (route). The goal of the IEF is to provide guidance and analyses that will help transportation and natural resource agencies work together to select, from a comprehensive list of all alternatives, the preferred alternative which will minimize the environmental impacts while still meeting transportation goals.

Programmatic ESA Section 7 consultation: *See* programmatic implementation and agreements.

Programmatic implementation and agreements: A formal, legally binding agreement between a state DOT and other federal and state regulatory agencies, which establishes a process for consultation and project review usually based on a set of agreed on actions. The main objectives of taking a programmatic approach to consultation are to address the effects on listed species resulting from the implementation of a suite of actions as a whole and to provide a strategy, or process, for ESA compliance on the individual activities.

Protected lands (protected area): A geographical space designated, through legal or other means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Quantitative assessment: A process that measures the probability and consequences of risks and estimates their implications for project objectives.

Regional Ecological Framework or REF: As defined in *Eco-Logical*, an element of integrated planning that likely consists of an overlay of maps of [natural resource] agencies [and/or environmental organizations] individual plans, accompanied by descriptions of conservation goals in the defined region.

Regional Ecological and Infrastructure Development Framework (REIDF): The actionable plan needed to implement ecological and infrastructure projects that minimizes environmental impacts, increases opportunities for environmental restoration and conservation, and supports effective and efficient implementation of transportation plans. This actionable plan is created by overlaying the REF with transportation plans and scenarios, doing an assessment on the impact each has on the other, and making adjustments to achieve the best balance of environmental and transportation outcomes.

Regional general permit (RGP): One of three types of permits established under CWA Section 404 to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. Responsibility for administering and enforcing Section 404 is shared by the USACE and EPA. Under Section 404(e), general permits may be issued by USACE for categories of activities that are similar in nature and would have only minimal individual or cumulative adverse effects on aquatic resources. General permits can be issued on a nationwide (*nationwide permit*) or regional (*regional general permit*) basis. A general permit can also be issued on a programmatic basis (*programmatic general permit*) to avoid duplication of permits for state, local, or other federal agency programs.

Regional mitigation strategies: Strategies intended to define mitigation needs for a particular scenario that incorporate all significant, foreseeable stressors and their impacts on resources.

Regional-scale or context: Referring to assessment and planning conducted within an area characterized by multijurisdictional and/or ecological or watershed boundaries. No set size defines a region, but a region is larger than a local planning jurisdiction and may encompass an MPO boundary or larger.

Regulatory assurance: Acceptance from regulatory agencies of planned actions to mitigate identified impacts.

Resource conservation requirement: Define what resources need to remain viable, such as minimum patch/occurrence size, sensitivity/compatibility with stressors, minimum population size, and so forth.

Resource requirement: *See* resource conservation requirement.

Restoration: Reestablishment of wetland and/or other aquatic resource characteristics and function(s) at a site where they have ceased to exist, or exist in a substantially degraded state (http://www.wetlands.com/pro/fr21jul99pte.htm).

Restoration areas: Locations identified for conducting restoration activities for target resources.

Right-of-way: A parcel of land granted by deed or easement for construction and maintenance according to a designated use. This may include highways, streets, canals, ditches, and the areas adjacent to these structures.

Scenario-based planning: An approach for developing plausible descriptions and, optionally, maps of future conditions incorporating changes in stressors and new stressors.

Scenarios: Specific to the IEF, maps that incorporate land use (including conservation), infrastructure, and all other stressors for particular time frames identified for assessment.

Scientifically based methods: Methods that employ one or more of the following: (1) a systematic approach to observation or analyses, (2) use of best available data, (3) use of rigorous data analyses that are adequate to test the stated hypotheses, (4) measurements or observational methods that provide valid data across multiple

evaluators and observers and across multiple measurements and observations, and (5) acceptance by a peer-reviewed journal or approval by a panel of independent experts through a comparatively rigorous, objective, and scientific review.

Spatial data: Information about the location and shape of, and relationships among, geographic features, usually stored as coordinates and topology within a geographic information system.

Species and habitat recovery: The process required by the USFWS and National Marine Fisheries Service (NMFS) of creating an endangered species recovery plan outlining the goals, tasks required, likely costs, and estimated timeline to recover endangered species (i.e., increase their numbers and improve their management to the point that they can be removed from the endangered list).

Species location: *See* known species location.

Species observations: The documentation of evidence of the presence or absence of an element at a specified location. Observations document the location of the element and may include nonspatial information such as abundance, distribution, reproductive status or phenology, ecological associations, and environmental conditions.

Species of conservation concern: Any species that is "of concern" because it is vulnerable to extinction due to habitat destruction or other impact that has led to the decline of viable populations of this species or is vulnerable because it inherently has a very limited range of occurrence and therefore is more vulnerable to potential impacts. Such species may or may not have a legal protection status.

Species viability: Species are viable if they have the conditions to persist over time.

Stakeholder: An individual or group with an interest in the success of an organization in delivering intended results and maintaining the viability of the organization's products and services. Stakeholders influence programs, products, and services.

State wildlife action plan (SWAP): A proactive plan, known technically as a *comprehensive wildlife conservation strategy*, that assesses the health of a state's wildlife and habitats, identifies the problems they face, and outlines the actions needed to conserve them over the long term. Under the Wildlife Conservation and Restoration Program and the State Wildlife Grants Program, Congress charged each state and territory with developing a wildlife action plan (http://teaming.com/state-wildlife-action-plans-swaps).

Strategic habitat conservation (SHC): A science-based framework for making management decisions about where and how to deliver conservation efficiently to achieve specific biological outcomes. Strategic habitat conservation incorporates biological planning and conservation design, delivery, monitoring, and research in a framework that allows change (adaptive) and repetition (iterative) (http://training.fws.gov/BART/resources/SHC/SHC_fact_sheet.htm).

Streamline/streamlining: The process of several agencies working together to establish realistic time frames, adhere to those time frames, and effectively coordinate

time and resources to complete a transportation process as efficiently as possible. Section 1309 of the Transportation Equity Act for the 21st Century (TEA-21) mandated environmental streamlining, which it defined as the timely delivery of transportation projects while protecting and enhancing the environment. A key element of environmental streamlining is communication with and gathering of input from the public and stakeholders (http://www.transportationforcommunities.com/shrpc01/glossary).

Stressor: Any feature, action, or phenomenon capable of negatively affecting a resource. Factors causing such impacts may or may not have anthropogenic origins. Note that a stressor for one resource may not be a stressor for another one.

Systematic conservation planning: An approach to assessing and planning for conservation that is based on certain concepts, such as coarse and fine filters for selecting surrogates for biodiversity and establishing quantitative goals for representing biodiversity in a region (*see* Groves 2003).

Target resources: Resources that are the objective of particular actions in a plan or location (e.g., the resources requiring mitigation under a particular plan or for a particular location to receive mitigation action).

Transaction costs: The cost associated with the exchange of goods or services. Transaction costs cover a wide range, but in the context of transportation and natural resources planning and management, some of these costs include cost of communication and consultation, fees and costs associated with creating easements, costs associated with obtaining data and conducting analyses, biological inventories of species and habitats.

Transportation and natural resource practitioner: Staff from any local, regional, state, or other type of planning agency or organization.

Transportation Improvement Program (TIP): A document prepared by a metropolitan planning organization that lists projects to be funded with FHWA or Federal Transit Administration (FTA) funds for the next 1- to 3-year period (http://www.fhwa.dot.gov/planning/glossary/glossary_listing.cfm?sort=definition&TitleStart=L).

Transportation planner: Staff involved in transportation planning activities at state DOT, MPO, and local county or tribal planning agencies. Under the *Eco-Logical* guidance, the goal is to create a regional-scale approach to planning which involves local, regional, and state-level agencies and organizations working collaboratively.

Transportation planning: Transportation planning, in the United States, that includes public involvement and considers land use, development, safety, and security. The planning process includes an analysis and evaluation of the potential impact of transportation plans and projects and strives to address a wide range of societal needs and concerns. Planning is done at the local, rural, tribal, metropolitan, statewide, national, and international level.

Transportation project development (and delivery): The general process of seeing a transportation project from the beginning, when a need is identified from an

existing plan, to getting it programmed, to the end, when it is approved for implementation. The delivery of a transportation project is the process of implementing it once it is developed.

Unfragmented habitat patches: Areas of land that have no discontinuities or barriers. Fragmented habitat has discontinuities or disturbances in an organism's preferred environment. Fragmentation of habitats can cause the fragmentation of and impact to specific species populations. Species typically have a minimum habitat size that is required for survival, and in some cases this habitat needs to be unfragmented or have limited fragmentation for the species to persist over time.

Vegetation data: Data describing vegetation and plant communities' composition and distribution.

Vulnerability: A resource's susceptibility to stressors. By coupling the exposure of resources to stressors with the assessment of resource responses to stressors, the effect of stressors on the resources (i.e., their vulnerability) can be calculated.

Watershed: A land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ultimately the ocean (33 CFR § 332.2).

Watershed restoration: "The return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the functions of the ecosystem are recreated. … The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs" (NRC 1992).

Weighting values: Values typically expressed as numeric scores on a fixed scale to indicate the relative importance of individual resources within the REF. They can be used to calculate and depict the relative importance or value of locations based on the weights of the resources present.

Wetland function: A process or series of processes that take place within a wetland. These include the storage of water, transformation of nutrients, growth of living matter, and diversity of wetland plants; and they have value for the wetland itself, for surrounding ecosystems, and for people. Functions can be grouped broadly as habitat, hydrologic, or water quality, although these distinctions are somewhat arbitrary and simplistic. For example, the value of a wetland for recreation (hunting, fishing, bird watching) is a product of all the processes that work together to create and maintain the wetland (http://water.usgs.gov/nwsum/WSP2425/functions.html).

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A DETAILED UPDATES TO THE IEF

Documented below are all substantive changes that were made from the original IEF Guide. Any IEF steps or substeps that are not included did not have substantive changes. Minor edits made for clarity are not documented.

STEP 2

Title

- *Original title*. Characterize Resource Status, Integrate Conservation, Natural Resource, Watershed and Species Recovery and State Wildlife Action Plans
- *Updated title*. Create the Regional Ecosystem Framework

Summary of Changes

The most significant updates to the IEF start in Step 2 and include updates to Steps 3 and 4. These updates address confusion about the order of the IEF process and how each step is described. The original Step 2 was the creation of an ecological conservation strategy, which resulted from combining all conservation plans and data, and getting appropriate experts and specialists to agree on environmental conservation priorities and goals. In this updated *IEF Manager's Guide*, Step 2 is the same process of creating an environmental conservation strategy, but the resulting product has been recharacterized as the Regional Ecosystem Framework (REF). Initially, the REF was the product resulting from original Step 3, which included an overlay of the conservation strategy with the transportation plans and data. The C06 project team determined that it was useful to have a title for the environmental conservation–related product that resulted from the Step 2 process, and that the REF title more accurately described this ecologically focused product.

Changes to Substeps

Minor changes were made to Substeps 2e, 2f, and 2g.

Substep 2e

Original Substep 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.

Updated Substep 2e

Delineate priority areas for conservation and mitigation, if these do not already exist. These should include all of the identified resources and follow principles from systematic conservation planning and should include opportunities for off-site mitigation through restoring habitat.

Summary of Substep 2e Updates

Although the product of Substep 2e is the same—priority conservation and mitigation areas—this substep was updated to more accurately describe the necessary process of delineating these areas based on a systematic conservation planning process involving conservation expertise rather than just an "overlay" of data and plans.

Substep 2f

Original Substep 2f

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

Updated Substep 2f

Convene a team of stakeholders to review the draft REF generated from the preceding steps. Identify any issues that need correction, and finalize the REF. This step was refocused from reviewing an overlay and identifying actions to support identified priorities to reviewing the REF to identify any issues that need to be addressed for all the stakeholders to finalize it.

Summary of Substep 2f Updates

The original version included the identification of actions; but since the integration of information about potential impacts (Step 4) is critical to complete before appropriate actions are identified, this part of the step was modified. Thus, this step focuses on only reviewing and finalizing the REF with input from stakeholders.

Substep 2g

Original Substep 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).

Updated Substep 2g

Document the REF objectives, decisions, and methods based on stakeholder input and the technical and scientific methods used in Substeps 2a–2f. Document formats should be suitable for GIS metadata, formal reporting, and outreach to support use, updating, and external products.

Summary of Substep 2g Updates

Mostly the wording was clarified in this substep, but it is also more explicit in recommending how to document decisions.

STEP 3

Title

- *Original title*. Create Regional Ecosystem Framework (Conservation Strategy + Transportation Plan)
- *Updated title*. Define Transportation and Infrastructure Scenarios for Assessment

Summary of Changes

Originally, Step 3 was an overlay of the integrated conservation strategy and transportation plan; but the team received input indicating that this was confusing since a separate process needs to be led by transportation practitioners to integrate transportation and infrastructure plans and data to determine the transportation needs, goals, and priorities. This same concept applies to Step 2, since creating the REF is typically done separately by environmental, conservation, and natural resource stakeholders from various organizations and agencies. The infrastructure and environmental stakeholders typically begin to work together during the process of developing a regional vision (Step 1), and then again when the overlay and integration of the REF with the transportation and other infrastructure plans, information, and scenarios happens (updated Step 4). This does not mean that stakeholders involved in the transportation/infrastructure side and the stakeholders involved in the environmental side will not have any communication during Step 2 and Step 3, but the majority of the discussion will happen during Step 1 and then again in Step 4 during the development and review of the REIDF.

Changes to Substeps

Summary of All Substep 3 Changes

All of the changes to the Step 3 substeps support the fundamental change to this step from the focus on the integration of transportation and environmental strategies to the integration of just the transportation-related data, plans, priorities, and goals, and the creation of transportation scenarios that can then be overlaid with the REF in Step 4 to determine impacts.

Substep 3a

Original Substep 3a

Overlay the geospatially mapped long-range transportation plan (or the TIP or STIP) with conservation priorities and other land uses.

Updated Substep 3a

Convene stakeholders and identify appropriate scenarios to represent. Formal scenario-based planning approaches can be very useful for envisioning, describing, and prioritizing scenarios for assessment. This step should include what time frames to represent (e.g., current, 15 years, 50 years), the scope of information included in the scenarios (i.e., transportation only or in combination with all relevant uses and stressors), and what future assumptions to incorporate and represent in alternate scenarios (e.g., low versus high growth, climate changes, transportation funding).

Substep 3b

Original Substep 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 Section 404 and Section 7 regulatory requirements.

Updated Substep 3b

Obtain data to represent the land uses, activities, and other features for each scenario. Specific to transportation, include the long-range transportation plan (or the TIP or STIP) and preferably the full set of land use and management plans from the major local, state, and federal regulatory, land management, and planning agencies in the region.

Substep 3c

Original Substep 3c

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

Updated Substep 3c

Assemble the draft scenarios and review with the stakeholders. Note and make corrections as needed.

Substep 3d

Original Substep 3d

Review and verify REF with stakeholders.

Updated Substep 3d

Provide the scenario to the stakeholders.

STEP 4

Title

- *Original title*. Assess Land Use and Transportation Effects on Resource Conservation Objectives Identified in the REF
- *Updated title*. Create a Regional Ecosystem and Infrastructure Development Framework (REIDF)

Summary of Changes

Although the focus and products of Step 4 remain the same—an assessment of the effects of land use and transportation effects on resource conservation objectives—the title and substeps were changed for clarity. Originally the product resulting from the analyses in Step 4 was called the Regional Ecosystem Framework, but the team felt that this title did not adequately characterize the fact that it included an analysis of the impacts of transportation and other infrastructure on environmental resources. So the title of the step was changed, and several changes were made to the substeps. In addition, some processes included in the substeps were combined, resulting in the elimination of the last two steps included in the original IEF Guide.

Changes to Substeps

Substep 4b

Original Substep 4b

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

Updated Substep 4b

Establish individual resource conservation requirements (e.g., minimum viable habitat sizes, connectivity requirements) and their response to different types of transportation improvements and other stressors.

Summary of Substep 4b Changes

Added process of establishing resource conservation requirements before rating their response to different stressors.

Substep 4c

Original Substep 4c

Develop programmatic cumulative effects assessment scenarios that combine transportation plan scenarios with existing development and disturbances, other impacting stressors, 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.

Updated Substep 4c

Create the REIDF by combining the REF (from Step 2) with the scenarios from Step 3 to identify which priority areas or resources would be affected and the nature of the effect (e.g., negative, neutral, beneficial) and to quantify the effect, noting the level of precision of mapping inputs. An initial visual overlay of the scenarios with the REF can point to particular problem areas, while a quantitative assessment of cumulative effects facilitates better comparison among scenarios and quantifies needs for mitigation. It can also identify potential performance measures.

Summary of Substep 4c Changes

No significant changes in the content of the step but reworded it to be clearer and added the suggestion of including a climate change threat assessment.

Substep 4d

Original Substep 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.

Updated Substep 4d

Compare scenarios and select the one that optimizes transportation/infrastructure objectives and minimizes adverse environmental impacts (the least damaging scenario), or use the results to create a new scenario.

Summary of Substep 4d Changes

Originally this step included intersecting the REF with the cumulative effects assessment scenarios, but those analyses are outlined in Substep 4c. Thus, this step focuses on the process of comparing the results of the various scenarios (created in Substep 4c) and selecting the one with the best overall conservation results and minimal impacts.

Substep 4e

Original Substep 4e

Compare plan scenarios and select the one that optimizes transportation objectives and minimizes adverse environmental impacts (the least environmentally damaging practicable scenario).

Updated Substep 4e

Identify mitigation needs for impacts that are unavoidable; that may require minimization through project design, implementation, and/or 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 feasibility of mitigating out-of-kind (e.g., by helping secure a very high-priority conservation area supporting other resource objectives).

Summary of Substep 4e Changes

The comparison and selection of scenarios is outlined in Substep 4d, so the focus of this step is on the process of identifying mitigation needs based on knowing what the impacts of the selected scenario will be.

Substep 4f

Original Substep 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).

Updated Substep 4f

Deleted.

Summary of Substep 4f Changes

All processes related to identifying mitigation needs were integrated into the updated Substep 4e, so the original Substep 4f was deleted.

Step 4g

Original Substep 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.

Updated Substep 4g

Deleted.

Summary of Substep 4g Changes

All processes related to identifying mitigation needs were integrated into the updated Substep 4e, so the original Substep 4g was deleted.

STEP 5

Title

- *Original title*. Establish and Prioritize Ecological Actions, Restoration and Conservation Sites
- *Updated title*. No change.

Summary of Changes

This step remained the same in terms of the title, processes, and products. One of the substeps was eliminated because it was redundant and more detail on mitigation-related processes was provided for Substeps 5b and 5d. All other changes were minor and not substantive but merely added clarity.

Changes to Substeps

Substep 5b

Original Substep 5b

Select potential mitigation areas according to the ranking protocols previously described.

Updated Substep 5b

Select potential mitigation areas according to the ranking protocols described in Substep 5a. Create a new scenario (repeat Step 3), specifying the mitigation actions for selected sites, and reevaluate the mitigation scenario (repeat Step 4) to validate that the expected mitigation benefits can be achieved. The development of a comprehensive REF in collaboration with regulatory agencies should expedite this step since the priority mitigation areas would already be designated by these agencies, reducing the time it takes to select and move forward on mitigation efforts that are more likely to contribute to high-priority conservation needs.

Summary of Substep 5b Changes

Added more detail about how to select potential mitigation areas and associated actions, as well as information on how to get regulatory assurances associated with these sites and actions.

Substep 5d

Original Substep 5d

Develop/refine a regional conservation and mitigation strategy (set of preferred actions) to achieve eco-regional conservation/restoration goals and advance infrastructure projects.

Updated Substep 5d

Develop/refine a regional conservation and mitigation plan and strategy to achieve ecoregional conservation and restoration goals, and advance infrastructure projects. This should address the timing of actions related to when impacts are expected to occur and the urgency to secure mitigation sites before they are developed or used for other mitigation actions.

Summary of Substep 5d Changes

Added sentence to emphasize the importance of addressing the timing of actions as they relate to impacts.

Substep 5e

Original Substep 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.

Updated Substep 5e

Obtain agreement on actions from stakeholders to implement the mitigation.

Summary of Substep 5e Changes

Substeps 5b, 5c, and 5d are all processes that support and include the creation of areas that can potentially contribute to mitigation goals, so the original Substep 5e was redundant. Thus the original Substep 5e was deleted, and Substep 5f became 5e.

Substep 5f

Original Substep 5f

Obtain agreement on ecological actions from stakeholders.

Summary of Substep 5f Changes

Deleted. Substep 5e in the original REF was deleted, so this step became Substep 5e. *See* the reason for deletion of the original Substep 5e.

STEP 6

Title

- *Original title*. Develop Crediting Strategy
- *Updated title*. No change.

Summary of Changes

The title, focus, and approach of this step remain the same as in the original IEF Guide, but a more detailed summary of each substep was provided, and one significant concept was added to Substep 6b.

Changes to Substeps

Substep 6b

Original Substep 6b

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

Updated Substep 6b

Identify ecosystem crediting protocols developed within the region, and evaluate their applicability to resources identified as priority within the REF.

Summary of Substep 6b Changes

Originally the step was worded to "evaluate ecosystem and landscape needs and context to identify measurement options." The updated version describes the use of platforms and protocols either already developed or adopted from another region.

STEP 7

Title

- *Original title*. Develop Programmatic Consultation, Biological Opinion, or Permit
- *Updated title*. No change.

Summary of Changes

A few minor editorial changes were made to Step 7 to add clarity, but one substantive change to Substep 7a led to the addition of a new substep (7e).

Changes to Substeps

Substep 7a

Original Substep 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.

Updated Substep 7a

Identify actions that could be taken to programmatically benefit regulated resources and 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.

Summary of Substep 7a Changes

The change keeps the focus on first identifying actions that support a programmatic approach to working on regulatory processes rather than on the development of agreements upfront. Once actions are identified in Substep 7a, then Substeps 7b, 7c, and 7d continue to focus on actions that support a programmatic approach.

Substep 7e

New Substep 7e

Develop programmatic ESA Section 7 consultation, special area management plan (SAMP), CWA Section 404 regional general permits (RGPs), or other programmatic agreements to advance conservation action in line with CWA Section 404 and ESA program objectives/requirements and with maximum assurance that conservation/restoration investments by DOTs count or will count.

Due to the addition of Substep 7e, the substep that was formerly 7e becomes 7f. Other than placement, there were no changes to this substep.

Summary of Addition of Substep 7f

The change in Substep 7a led to the need for a new substep (7e) that focuses on the development of programmatic agreements to codify the procedures and actions identified in Substeps 7a–7d. Formal programmatic agreements can easily include the type of technical approaches that are introduced in the IEF Steps 2–6, thereby institutionalizing a regional, multistakeholder, and multiresource approach to planning and project development.

STEP 8

Title

- *Original title*. Implement Agreements and Adaptive Management
- *Updated title*. Deliver Conservation and Transportation Projects

Summary of Changes

The change to the title better summarizes the focus of the substeps: to deliver or implement conservation and transportation projects based on the outcomes and information from all the previous steps and substeps. No substantive changes to any of the substeps were made.

STEP 9

Title

- *Original title*. Update the Regional Ecosystem Framework
- *Updated title*. Update Regional Ecosystem Framework, Scenarios, and Regional Assessment

Summary of Changes

The title was changed to emphasize that conservation data in the REF should be regularly updated. The best available transportation and other infrastructure data should also be available for conducting transportation scenario analysis. Substantive changes were made to two substeps.

Changes to Substeps

Substep 9b

Original Substep 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).

Updated Substep 9b

Update the conservation area/resource requirements, responses, and indicators in response to new research and data and the results of management actions and performance measures (e.g., assess regional goals, update to minimum required area for species and/or habitat, review weighting values of resources in REF, and evaluate responses to stressors).

Summary of Substep 9b Changes

This substep was changed to focus on environmental conservation updates only, and in addition the phrase "in collaboration with stakeholders" was taken out since this substep would likely not include all IEF stakeholders. Instead it would include stakeholders and others directly involved in developing conservation and natural resource data, goals, and plans.

Substep 9c

Original Substep 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.

Updated Substep 9c

Update the implementation and performance status of mitigation areas (conservation/restoration investments that have occurred) in the REF to evaluate whether those areas are contributing to REF goals and priorities. This will identify whether a mitigation area should be recategorized as an established conservation area for specific resources or if it is still available for future mitigation action.

Summary of Substep 9c Changes

Changes were made to clarify that the focus should be on mitigation areas. In addition, the changes emphasized that not only the implementation status of mitigation should be evaluated, but also whether established mitigation areas are meeting the conservation performance goals that were developed in the REF. Lastly, an addition was made to ensure that all mitigation areas are recategorized so, if further action is needed to meet REF goals, that would be documented for future assessments.

RELATED SHRP 2 RESEARCH

Integration of National-Level, Geospatial, Ecological Tools and Data (C40A)
Application of Geospatial, Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—California US-101 (C40B1)
Application of Geospatial, Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—East-West Gateway Council of Governments (C40B2)
Application of Geospatial, Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—Contra Costa County Transportation Authority (C40B3)
TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned (C41)