An Ecological Assessment Process and Credits System for Highway Capacity Projects

Submitted August 1, 2010, Revised November 15, 2010

Word Count: 5,898

Gail L. Achterman (corresponding author)
Director, Institute for Natural Resources
Oregon State University
210 Strand Agriculture Hall
Corvallis, Oregon 97331-8598
541-740-3190
gail.achterman@oregonstate.edu

Lisa J. Gaines
Associate Director, Institute for Natural Resources
Oregon State University
210 Strand Agriculture Hall
Corvallis, Oregon 97331-8598
541-737-1976
lisa.gaines@oregonstate.edu

James S. Kagan
Portland Manager, Institute for Natural Resources
P.O. Box 751, Mail Stop INR
Portland State University
Portland, Oregon 97207
503-725-9955
jimmy.kagan@oregonstate.edu
ABSTRACT

This Strategic Highway Research Program Capacity Project (C06B) study developed a Cumulative Effects and Alternatives Assessment (CEAA) process for highway capacity projects within an integrated ecological and transportation planning framework, building tools to support the principles of *Eco-Logical: an Ecosystem Approach to Developing Infrastructure Projects*. Existing ecological assessment and ecosystem crediting tools were surveyed and assessed and a new template for cumulative effects and alternatives analysis was developed. The resulting process includes methods for enhancing data needed to reach early agreement with regulatory agencies under the Endangered Species Act and the Clean Water Act. Guidance for developing function-based ecosystem crediting tools to meet regulatory requirements and to promote environmental stewardship goals is also provided. The CEAA process was piloted in three states to compare results between the new method and traditional methods. Initial results and case studies show that integrated ecological and transportation planning can expedite capacity project delivery and improve environmental outcomes. The CEAA process and supporting tools, case studies and data sources will be integrated into the new *Transportation for Communities: Advancing Projects through Partnerships* (TCAPP) website.
The Strategic Highway Research Program (SHRP) Capacity research plan is developing approaches and tools to integrate environmental, economic and community requirements into analysis, planning and design of new highway projects. The Institute for Natural Resources, Nature Serve and Parametrix were funded in to develop an ecological assessment process for inclusion in the Transportation for Communities: Advancing Projects through Partnerships (TCAPP), website. The ecological assessment process is designed to address the scientific and technical obstacles to integrated conservation and transportation planning advocated by the Eco-Logical approach to infrastructure development (1). The process spans long range planning, corridor planning, environmental review and environmental permitting with the objective of accelerating project delivery while improving environmental stewardship.

NEED AND VISION

The Need

Traditionally environmental resource and permitting agencies have little involvement in the transportation planning process when alternatives are developed, waiting until a specific project solution is selected before becoming involved. As a result, planning decisions are often questioned, revisited, and modified in the National Environmental Policy Act (NEPA) process, delaying project delivery and adding cost. The Federal Highway Administration (FHWA) and the Council on Environmental Quality have worked together for many years to streamline NEPA and other environmental regulatory processes. They have developed and encouraged a goal-driven ecosystem approach to sustaining ecological functions, as reflected in the 1995 interagency Memorandum of Understanding to Foster the Ecosystem Approach (MOU).

Despite the recognized advantages of an integrated ecosystem approach, it has not been widely adopted by transportation or regulatory agencies. In 2002, the Surface Transportation Environmental Cooperative Research Program Advisory Board found that:

The current state of knowledge and the tools available for environmental assessment are inadequate to ensure informed and effective decisions on transportation and the environment (2).

Studies showed that data needed for considering environmental factors in transportation planning often were not available either to transportation planners or regulators. New decision support tools were needed to provide better environmental information to decision makers at the planning level in order to protect environmentally sensitive areas (3). Congress responded in the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) of 2005 in Sections 6001 and 6002 which emphasize early consideration of environmental issues in transportation planning and through the SHRP2 Capacity program and its charge to develop approaches and tools for systematically integrating environmental requirements into the analysis, planning and design of new highway capacity.

In 2006 a major step forward was taken when eight federal agencies and representatives of four states published Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects (1), building on the earlier MOU. Eco-Logical presents an eight-step integrated planning framework that incorporates the ecosystem approach to environmental mitigation agreements and adaptive management through performance measures. However, Eco-Logical does not provide the data systems, tools and decision support systems needed to implement the
principles. The SHRP2 Capacity program sought to remedy this problem by investigating the
interagency processes to develop a more detailed framework and business case for the ecosystem
approach *(Integration of Conservation, Highway Planning ad Environmental Permitting Using
an Outcome-Based Ecosystem Approach, Project C06A)* and scientifically robust ecological
assessment methods (C06B). The two research projects worked together to develop a shared
framework for integrating conservation and transportation planning.

Together we expanded on the *Eco-Logical* framework explaining step-by-step how the
delivery decision-making process, including the scientific assessment, regulatory assurances and
ecosystem crediting methods developed by our research. The resulting nine-step framework is
shown in Table 1. Our team developed a Cumulative Effects Assessment and Alternatives
(CEAA) process with supporting tools, case studies and data sources to provide the needed
technical and scientific methods needed to support the overall framework.

**TABLE 1. Framework for integrating conservation and transportation planning.**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Build and Strengthen Collaborative Partnerships and Shared Vision</td>
</tr>
<tr>
<td>2</td>
<td>Integrate Conservation, Natural Resource, Watershed and Wildlife Management Plans</td>
</tr>
<tr>
<td>3</td>
<td>Create and Agree on Regional Ecosystem Framework (REF)</td>
</tr>
<tr>
<td>4</td>
<td>Assess Transportation Effects on REF Resource Conservation Objectives</td>
</tr>
<tr>
<td>5</td>
<td>Establish and Prioritize Mitigation and Conservation Priorities and Rank Action Opportunities</td>
</tr>
<tr>
<td>6</td>
<td>Develop Crediting Strategy</td>
</tr>
<tr>
<td>7</td>
<td>Develop Programmatic Permits</td>
</tr>
<tr>
<td>8</td>
<td>Implement Agreements and Adaptive Management</td>
</tr>
<tr>
<td>9</td>
<td>Update REF as New Information Becomes Available</td>
</tr>
</tbody>
</table>

**The Vision**

The vision for our research was to develop a scientifically-supported, outcome-based
ecological assessment framework to facilitate efficient and effective transportation planning,
regulatory decision-making and capacity development while maximizing opportunities for the
long-term conservation and enhancement of ecosystem functions at multiple scales. The process
should:

- provide transportation agencies the toolkit to collaborate with resource agencies, local
governments, NGOs, and others to simultaneously meet conservation and transportation
goals/priorities during the decision-making process;
- provide the assurances that resource and regulatory agencies and transportation agencies
need to make earlier decisions and investments in the transportation planning and project
delivery process; and,
- integrate regulatory compliance within and across agencies.

Ideally, the overall framework and the CEAA should be customized and embraced by
transportation and resource agencies and result in sustained institutional change that encourages
transportation agencies to adopt environmental stewardship policies enhancing ecosystem and
hydrologic functions and maximizing the benefits of their investments.
Attributes and Benefits

We sought to develop an assessment process that focused on regional ecological priorities, used multi-resource ecosystem measurement and accounting systems, and achieved improved measurable environmental outcomes that would be:

1. Linked to the key decision points in TCAPP;
2. Scalable, flexible, regionalized, and compelling to agencies regardless of their experience with environmental management systems; and,
3. Designed to maximize the likelihood of beneficial environmental outcomes at all stages of transportation planning and project development.

The resulting framework and supporting CEAA process are designed to promote expedited transportation development; cross-agency understanding and incorporation of conservation goals and priorities early in the transportation decision-making process; reduced legal challenges and associated costs; and sustainable and systematic ecosystem restoration and mitigation outcomes. The research takes advantage of integrated electronic data collection, management and analysis methods using geographic information systems (GIS) to integrate transportation planning and conservation planning at multiple scales. This research is one more step toward integrated transportation and conservation planning, providing ready access to tools and methods practitioners can use.

APPROACH

Tool Survey and Utility Analysis

Scientists have developed many methods for assessing ecosystem function over various geographic scales and timeframes. The challenge is to identify the methods that are most useful at various stages of the transportation planning and project delivery process. This informs what resources and functions are important, how impacts to them can be avoided or minimized, and if impacts are unavoidable, how they can be mitigated most effectively. To identify methods appropriate for use at various key decision points in transportation planning and development, we developed and applied a tool survey protocol, building on the method used by the Ecosystem Based Management (EBM) Tools Network (4).

A tool evaluation database was developed consisting of decision support tools, ecological and conceptual modeling tools, transportation-sector specific tools that have broad applicability, and state-specific ecological and conservation data query tools. Some tools are best described as methods to organize information or integrate certain steps into a larger planning process. Each tool in the database was evaluated within the context of the overall Framework and the CEAA process. There is no ecological assessment “supertool” capable of conducting all analyses necessary for regional ecological and cumulative effects assessment; therefore, we developed a “toolkit” that combines multiple tools to support an information workflow through all levels of transportation planning and project delivery.

Regulatory Assurances and Data Quality

Transportation practitioners seek methods for identifying potential impacts to regulated resources as early as possible in the planning process so that impacts can be avoided or minimized. They also share the desire of regulatory agencies to assure that any mitigation required due to unavoidable impacts provides effective, measurable and high quality
environmental outcomes for the impacted resources. Through the planning and project
development process, transportation planners seek to address and resolve potential conflicts with
regulatory agencies about project impacts and mitigation requirements. For wetlands and
endangered species regulation, the literature and the work of the C06A team shows that
insufficient, incomplete or poor quality data is usually at the root of the problem.

For wetlands, to address regulators’ concerns we consulted with state and federal wetland
managers to determine what types of regulatory certainty can be provided in states without high
quality wetlands digital data. The status of wetlands information is quite variable across the
country so we diagrammed a workflow with data and tools that integrate the United States Fish
and Wildlife Service’s (USFWS’s) nationally available National Wetlands Inventory (NWI)
database with the process for refining and augmenting that information to assure the digital data
is complete enough for regulators to feel comfortable assuring that planned projects avoiding
identified areas will avoid all important wetlands. We also diagrammed the workflow to express
wetland ecological integrity and biodiversity value, which is critical for mitigation assurances.
Our workflow has two primary objectives: 1) it correctly characterizes the wetland values
impacted by transportation improvements and identifies opportunities to replicate those values
by protecting and enhancing wetlands throughout the analysis region; and 2) it identifies
locations where wetland mitigation sites correspond with overall conservation priority areas.

We developed methods to allow practitioners to move from regional scale analysis
needed for avoidance and minimization to the site specific level of information and analysis
needed for permitting decisions. The focus of these methods for endangered species is agreeing
with the regulatory agencies on acceptable data standards and developing new predictive
distribution maps for species and habitats.

Ecosystem Service Accounting

Over 200 accounting methods for and valuing ecosystem services were reviewed and
evaluated for their utility in transportation planning to develop a tools database for TCAPP. No
single method emerged as a readily available option for use in transportation planning and
project delivery given the wide variety of resource types and ecosystems. The project also
interviewed transportation and regulatory agencies and developed a step-by-step process for use
by any transportation agency seeking to use ecosystem valuation methods. This work is
summarized for each of the important ecosystem service types, as they relate to transportation
project impacts and will be included in TCAPP.

Pilot Projects

The CEAA process was tested on actual transportation projects in Colorado, Michigan
and Oregon. We met with state DOT officials and regulatory agencies in each state to select
appropriate projects. While the general approach was standardized, the analyses in each state
varied slightly based on the nature of the project, the data available and the tools used by the
states for conservation and transportation planning. For example, in Colorado the pilot was done
on an entire Metropolitan Planning Organization region that involves multiple projects. This
allowed us to test our cumulative effects methodology in a large landscape context taking into
account multiple potential impacts in an area. In Oregon, an FHWA Eco-Logical project funded
the development of predictive species range maps for listed species, and an EPA project has
developed priority mitigation sites, so we analyzed how these data affect the decision outcomes
for a new highway corridor in a rural, forested area. In Michigan, we tested how using the
Framework will impact the outcomes in an agricultural landscape where conservation priorities were not previously identified near a medium-size community.

In all three states we compared data and outcomes from the original projects with outcomes utilizing new and updated data, and the methods outlined in our Framework. In this comparison we looked at: 1) direct impacts identified based on original data and methods versus the data and methods identified in the Framework; 2) mitigation effectiveness based on the sites selected in the original project versus mitigation sites identified utilizing data and methods identified in the Framework, and predicted ecological outcomes at the different sites; and 3) cumulative impacts estimated from the original data and method versus the data and methods identified in the Framework, for at least the resources targeted in the selected pilot site.

Additional testing of the process will be done through the SHRP2 C21 Project, Pilot Test the C06A&B Approaches to Environmental Protection.

**TCAPP Integration**

The results of our research will be incorporated into the TCAPPs website as a “practical application.” Practical applications show how to apply collaboration to a subset of decision points in order to meet specific challenges, in this case integration of transportation and conservation planning. The basic process is now online at [http://transportationforcommunities.com](http://transportationforcommunities.com). Full integration of our research results will be completed by March 2011. The practical application will describe the CEAA process, regulatory assurances methods and ecosystem service crediting approaches. In addition, each step in the integrated transportation and conservation assessment framework will be linked to key decision points in the TCAPP Decision Guide. The TCAPP site interface provides tabs for each decision point allowing users to see decision making questions, technical questions, data sources, case studies, tools to support ecological assessment and accounting approaches, references, links to practitioners and technical support.

**THE ECOLOGICAL ASSESSMENT PROCESS**

**Cumulative Effects Assessment and Alternatives**

The Cumulative Effects Assessment and Alternatives (CEAA) template supports transportation and natural resource practitioners in the integration of transportation and conservation decision making. The CEAA template guides practitioners—helping them bring the right expertise, data, methods, and tools to the proper stage of the transportation planning and project delivery decision making process. The result is reduced impacts – bringing accelerated permitting and less re-dos, as well as identification of high quality mitigation and enhancement opportunities – bringing better environmental results.

Specifically, the CEAA template guides the transportation or natural resource practitioner in conducting an ecological assessment that evaluates direct and cumulative effects on resources on any potential planning alternative or project evaluation, but also identifies the best mitigation and enhancement opportunities. The CEAA template supports a collaborative and scientifically rigorous process for avoiding and minimizing conflict, as well as identifying mitigation and enhancement opportunities.

The CEAA methodology can be used at the regional, corridor, or project level. Undertaking a CEAA at the regional level includes working collaboratively with resource agencies and other stakeholders to agree on a set of targets and goals for the area of interest.
described in *Eco-Logical*, this process was defined as the development of a Regional Ecosystem Framework (REF). The REF can then be used to develop and assess transportation alternatives, including direct and cumulative effects at all stages of transportation planning and development. CEAA can work at multiple scales from an entire state transportation network to individual projects. The activities and rights-of-way where transportation improvements will occur are generally known for 6-10 years. Regional scale ecological data can now be matched and impacts can be assessed and quantified early in the transportation planning and project delivery process.

The CEAA methods are woven into a structure of building partnerships, developing the REF, and interfacing with the Long Range Plans. Within this template, it is possible to begin at any transportation decision point and use the CEAA to help identify and incorporate the necessary questions, data, and analysis supporting better environmental and transportation decision making. The major elements of the regional CEAA are:

1. A unified map of transportation, land use, conservation, and restoration priorities;
2. Maps of each potential transportation scenario that shows an assessment of direct and cumulative effects at a landscape level with supporting data;
3. Identification of affected resources and the quantified nature of the effect for each transportation scenario being considered; and
4. Identification of potential mitigation and enhancement areas within a region and the likelihood of success.

Regulatory Assurances

Addressing regulators’ needs is an essential part of the decision making process for all transportation projects. While obtaining complete regulatory assurances may be impossible, this part of the project provides guidance on the information, tools and processes which can lead to faster decisions with improved environmental outcomes. The focus of this section is on regulations coming from the Clean Water Act (CWA) and the Endangered Species Act (ESA).

Our approach focused on identifying the aspects of current decision-making that provided the greatest concern for regulators at the national, regional, state and local levels; and then developing a set of potential tools or information to address these concerns. We believe that particularly for wetlands and endangered species, regulatory conflicts and delays largely result from transportation planners and regulators having insufficient, incomplete or poor quality data.

For all planning potentially impacting regulated resources, there are two critical objectives, both of which may be able to be addressed by the same information. The first is to provide the ability for transportation planners to be able to identify potential impacts to regulated resources very early in the planning process; that they can avoid or minimize impacts as much as is possible. The second is to assure that any mitigation that will occur due to unavoidable impacts will provide effective, measurable and quality environmental outcomes for the impacted resources.

The keys to success are to: 1) use the best data you can obtain or collect, early in the planning process; 2) stay in touch with regulators, contact them early and often, throughout planning and implementation; 3) take advantage of existing conservation planning work, completed by federal agencies, state agencies, universities and conservation organizations, such as state wildlife conservation plans; and 4) link conservation planning with regulatory protection work, but understand that regulators must focus on their specific resource of interest. Addressing
these issues through improved information and priority setting will not overcome the problem of turnover in agency personnel, but it will minimize misunderstandings and promote shared priorities.

The Clean Water Act (CWA) and its protections for wetlands (Section 404), runoff (319), water quality (303), and certifications under the Act (Section 401) provide the most significant regulatory challenges to efficient and environmentally effective project planning. This is often because the CWA is administered differently in different jurisdictions, usually with multiple agencies regulating different parts of the law. While all parts of the CWA are relevant to transportation planners, wetlands avoidance and minimization and wetlands mitigation usually provide the most significant problems, and are addressed here in the greatest detail. Some information is provided related to non-point runoff and to water quality as well.

Research indicates that: 1) access to comprehensive wetlands data early in the planning process is essential for avoidance and minimization; 2) data and plans should be vetted with regulators, and authoritative information should be used, if possible, as a web service, to assure it is consistently updated; 3) pre-approved mitigation sites (or banks or a mitigation catalog) for all CWA resources can both increase the speed of project approvals and improve conservation outcomes; 4) pre-approved mitigation sites should be based on a REF to assure the best conservation outcomes; and 5) functional measures can provide incentives for focused mitigation locations (5).

Most of the uncertainty that endangered species regulators have is caused by lack of information on the probable distribution and habitat of these species. While good information exists on known populations, the fear of losing an unknown but potentially important site for a species is a major barrier to many permits. Data on probable or potential distribution is also important to adequately assess impacts and plan for protection and recovery.

Natural Heritage Programs and NatureServe are the primary purveyors of endangered species information in the states because they collect and manage data from federal, state, and local agencies and private entities. This information is then used in federal, state and local conservation planning. Most of existing information on listed species locations currently exists in the form of observations, which represent information that is highly sensitive and as a result not readily shared with transportation agencies or the public. We evaluated new, inductive modeling methods of transforming these highly sensitive maps showing precise known locations of federally listed species into slightly more generalized, public domain maps showing places where these species are likely to occur or where their habitat needs to be protected.

These new data are called predictive species distribution maps. The work to date has focused on three primary areas: 1) working with regulators to determine how to assure the data would achieve the project goals; 2) defining methodology, steps and costs for developing the data across the country; and 3) addressing issues related to standards, linking the data to the framework, data security, and data distribution and maintenance. The difference between the two approaches is illustrated by Figure 1.
Using the data from the Natural Heritage Network’s Biotics species observations database and new software for modeling species predictive distributions (DOMAIN, Random Forest, Maximum Entropy), predictive distribution maps of listed threatened and endangered species were developed which better represent where species might be, and which can significantly reduce the size of areas requiring potential inventory for endangered species. The models can be used not only to define potentially occupied habitat, but more significantly, through probability analyses, areas that are not potential habitat for any listed species. The project has identified a series of detailed methodology questions related to data development, and a list of answers from researchers at institutions that have developed these models.

**Ecosystem Services Accounting**

Transportation planning and permitting decisions require a clear measurement of impacts to understand available choices, but agreement on measurements to assess impacts and mitigation options can be difficult to reach. Additionally, as decisions are made in resource-specific processes, each natural or ecological resource is managed separately.

The goal of our research and the resulting website is to help integrate the existing regulatory concerns and measures, with emerging requirements and stakeholder concerns. The website presents a suite of function-based crediting systems, with some tools detailed for use. We also offer general guidance for transportation agencies to develop their own systems. Function-based crediting tools are measurements based on understanding the natural processes and benefits provided by natural and modified environments. This methodology is reflected in many of our current regulatory structures and in conservation planning.

Ecosystem accounting tools generally deal with project-specific measurement issues such as mitigation quantities. However, tools within this class can provide a wide variety of benefits beyond merely calculating mitigation debits/credits. The tools presented go beyond regulatory compliance and into broader stewardship and sustainability through ecosystem service measurement. Examples of their additional benefits include: 1) measuring on the ground implementation of regional planning decisions for transportation projects; 2) tracking project effects on achievement of regional goals; 3) implementing the regulatory, policy and economic decisions through agreed upon measurement systems; and 4) providing the basis for permitting...
conditions (including improved outcome-based performance standards), compliance tracking, and evaluation of impacts and opportunities within projects.

Our communities rely on ecosystem services of many kinds to be economically prosperous, healthy and safe. Measuring ecosystem services is increasingly seen as an important aspect of sustainability planning and an important tool in public engagement to communicate how and why we manage the natural environment the way we do. The website and the final project report will provide transportation and regulatory agencies with the tools and options to:

1. Identify and build agreement on resources, functions and data needed for decision-making.
2. Assess and diagnose measurement needs and selection from possible existing tools to meet these needs for project planning, design and delivery.
3. Develop custom credit tools built around measurement of functions and natural processes; and
4. Identify innovative implementation options including advance mitigation, banking, or environmental market-based solutions.

PILOT PROJECT RESULTS

Overall, in the three pilot projects, we found that transportation agency staff accurately understood and accounted for direct impacts to natural resources. Using the CEAA process our pilot assessments achieved very similar results to the original project assessment. But it is important to note that the CEAA testing process did not include any field studies, so very similar potential impacts were found at a much lower cost, and likely with much less time. Limitations of data accuracy and resolution will not eliminate the need for on-the-ground evaluation of a project site, but the CEAA process could target field studies and thereby reduce overall assessment costs.

For cumulative impacts, the traditional approach looks at species impacts based on the existing condition of the landscape or habitats. Our pilots included information that indicated how the habitats looked historically in order to show how much of the habitats have been impacted over time. This approach provides a more complete picture of the cumulative effect that additional impacts would cause. Data that shows how the landscape looked historically is often not used because it is not readily available, but in most cases there are other sources of data available through state or federal agencies that can be used as a proxy for historic data (such as hydric soil data). The CEAA documents a recommended list of data sources including the types of data that can provide a true assessment of the cumulative impact of transportation infrastructure and associated land use on species and habitats over time. Our guidance also provides recommendations on other high priority datasets that are generally not available across the country but, if they were available, would streamline the assessment of landscapes for planning and project development (e.g. high quality data on wetlands and endangered species).

When our team looked at the assessment of cumulative impacts and the selection of mitigation options, especially when comparing our results to the results of traditional transportation planning efforts, our pilot tests found more significant differences utilizing the CEAA process. These differences were due mostly to the following factors:

1. Cumulative effects and mitigation options are evaluated within a larger, more ecologically-based area than is typically used;
2. Some of the original planning efforts in the pilot states included less comprehensive or no ecological information; and
3. Different and/or more comprehensive data (e.g., historical landscape, wetland priorities, or predictive species distribution maps) were utilized in the pilot project assessment of the project area using the CEAA process.

Another result of the pilot testing analyses was a more accurate and complete understanding of some of the issues related to the use of data to guide assessment of impacts to natural resources and evaluation of mitigation options. We found that development of key datasets could significantly improve the assessment of ecological resources. For example, the pilot tests illustrated how the accuracy and resolution of data influences what types of data are most useful for planning level decision making versus project level decisions. Therefore, the CEAA guidance includes a recommended list of data sources to support each step. The CEAA also recommends development of other high priority datasets that are generally not available across the country. If they were available, it would streamline the assessment of landscapes for planning and project development. For the datasets that may not be readily available across the country, the CEAA documents how they could be created. Thus, a result of the pilot testing analyses was a more accurate and complete understanding of some of the issues related to the use of data to help guide a more accurate assessment of impacts to natural resources and evaluation of mitigation options, and recommendations for the development of key datasets that could bring significant improvements to the assessment of ecological resources.

We also looked at the time and cost of planning and project development for the pilot test areas and documented how the CEAA could have streamlined transportation planning and project development decision making, possibly saving time and money. For example, the Michigan pilot illustrated how the evaluation of corridors using the CEAA process would result in a more accurate assessment of potential impacts, supporting the selection of corridors with the lowest mitigation costs. The CEAA process (which includes use of more comprehensive data and decision support tools) also allows better targeted field studies, reducing the number required.

The most significant differences found from each pilot test state comparing the outcomes of the original assessment versus the outcomes of the CEAA were as follows:

1. Pioneer Mountain-Eddyville Project (Oregon): CEAA assessment would likely have resulted in mitigation being done in larger priority wetland areas in the watershed that would have provided opportunities for restoration contributing to creation or enhancement of salmon habitat.

2. South I-25 Corridor (Colorado): CEAA assessment would likely have provided a more accurate assessment of cumulative impacts (affecting the ratio of mitigation requirements) because we did spatially explicit analyses of the impacts that included some data types not included in the original assessment. The CEAA pilot team also used a larger ecologically based area for the cumulative impacts assessment.

3. US-131 Corridor (Michigan): The CEAA assessment resulted in selection of a different alternative that had the least number of impacts. If it had been selected it would have reduced mitigation requirements. The results differed because the pilot team used more detailed ecological data than was used in the original corridor assessment including historic wetland data and data from a 2005 wetland functional assessment. The pilot team also used a decision support tool allowing a very precise and quantitative impact assessment by resource.
An unexpected finding of the pilot tests was that in all three states, the data used in the
original assessment of the project area was not readily available to the transportation agencies
nor was it available in a GIS format suitable for use with a decision support tool. Thus, even data
collected from costly field studies were not captured in a way that it could be used for future
assessments. The development of data management and archival standards to support
transportation planning and project related assessments would contribute to better application of
data collected for future decision making not only by transportation agencies, but by natural
resource agencies as well. For example, if field studies for a listed species are completed and that
information was provided to a database on the status of imperiled species in that state, that
information could contribute to range-wide assessments of those species by USFWS and other
natural resource practitioners for conservation planning purposes.

Overall, the pilot projects demonstrated the practical value of utilizing the CEAA process
to streamline and improve decision making in transportation planning and project development.
We found that the CEAA could create more accurate ‘sign posts’ early on in any transportation
decision making process, alerting practitioners to potential impacts and mitigation opportunities.
Some key findings and conclusions from the testing of the CEAA process included:

- **Better Outcomes**: Most significant changes in outcomes from the original project or
  planning were in the areas of mitigation site selection, evaluation of multiple corridors,
  and/or development of transportation plans. The pilot test results lead to the selection of
  mitigation sites with more ecological benefits, and more accurate and comprehensive
  scenario assessments that identified corridors with the fewest direct and cumulative
  impacts.

- **Modest Investments in Data**: The usefulness of the CEAA for planning and project
  development depends on the accuracy and resolution of available data. A relatively
  modest investment in process changes and data development upfront would create more
  accurate ‘sign posts’ early in the decision making processes about potential impacts and
  mitigation opportunities, improving planning, corridor evaluation, and consideration of
  mitigation opportunities.

- **Scientific Credibility**: Decisions have more credibility because the CEAA process
  ensures the use of a more standardize, scientifically-based, peer-reviewed process that
  utilizes the best available suite of methods, data and tools.

- **Saving in Time and Resources**: The CEAA approach would likely save time and
  resources by reducing impacts and therefore mitigation requirements, as well as
  supporting more targeted field studies for assessment of alternatives.

- **Standard Data Management Practices**: Better data management practices would
  contribute to better application of data collected during transportation alternative
  assessments for future decision making by transportation agencies and natural resource
  agencies.
CONCLUSION

The new Integrated Transportation and Conservation Planning Framework with the
technical and scientific processes provided by the CEAA process should begin to provide
transportation and resource agencies with the support they need to avoid sensitive environmental
areas in the planning process and provide environmentally significant mitigation where impacts
cannot be avoided. The Framework takes advantage of new mapping methods and models to
facilitate integration of transportation and conservation plans at multiple scales, helping
transportation planners and regulatory agencies to develop shared understandings of their
respective needs and priorities. Based upon initial testing, the Framework and supporting tools
should help achieve the vision of accelerating transportation project delivery while improving
environmental stewardship.

ACKNOWLEDGMENTS

This research was supported by the Federal Highway Administration in cooperation with
the American Association of State Highway and Transportation Officials and was conducted in
the Strategic Highway Research Program, administered by the Transportation Research Board of
the National Academies. The authors are grateful for the support of Stephen J. Andrle, TRB
Senior Program Officer, Marie Venner, co-principal investigator on the SHRP2 Integration of
Conservation, Highway Planning and Environmental Permitting Using an Outcome-Based
Ecosystem Approach (C06A) project, and Janet D’Ignazio, principal investigator on the SHRP2,
A Framework for Collaborative Decision Making on Additions to Highway Capacity (C01)
project. We are also indebted to the work of Shara Howie, Patrick Crist, Kevin Halsey, Paul
Manson, and the other members of our team who contributed greatly to the research.

REFERENCES

1. Transportation for Communities: Advancing Projects through Partnerships,
   http://www.transportationforcommunities.com/shrpc01/.
2. Brown, Janice W. Eco-Logical: An Ecosystem Approach to Developing Infrastructure
3. Transportation Research Board Special Report 268. Surface Transportation Environmental
   transportation systems planning. NCHRP Report 541. National Cooperative Highway
5. Ecosystem-Based Management Tools Network. EBM Tools.