National Cooperative Highway Research Program (NCHRP) Project 25-25, Task 67

Optimizing Conservation and Improving Mitigation Cost/Benefit:
Task 1: Literature Review and Interviews

October 2010

Submitted to

NCHRP 25-25 (67) Project Panel
Standing Committee on the Environment
American Association of State Highway and Transportation Officials

Prepared by

Environmental Law Institute
Washington, DC

NatureServe
Boulder, CO

Institute for Natural Resources
Oregon State University

Resources for the Future
Washington, DC

Under Contract to:

Cambridge Systematics
Bethesda, MD

Table of Contents

c. Characterization of the progress being made to progressive approaches
d. Perceived and real obstacles to implementing the progressive approach
e. Key actions that would allow or support the transition to a progressive approach
f. Published reports or studies
g. Potential for the adoption of a progressive approach as a standard
h. Open ended responses
i. Attachments
    i. Attachment A: List of interviewees
    ii. Attachment B: Interview form

III. References

Introduction

Purpose of Literature Review

The purpose of this literature review is to: 1) document examples of progressive frameworks and methods that have been utilized around the country to streamline and improve environmental outcomes when selecting sites for compensatory mitigation, and 2) draw on this information to illustrate the potential for economic cost-savings induced by these progressive approaches. Although the process of mitigation requires the consideration of avoidance and minimization of impacts to natural resources before allowing compensation for authorized resource losses, our team primarily focused on documenting examples of progressive compensatory mitigation, that is, activities that compensate for an impact by replacing or providing "substitute" resources.

Our research team will provide a comprehensive view of the benefits and costs associated with these progressive approaches by discussing cost-savings in two distinct forms: 1) consolidation of mitigation projects, and 2) selection of compensatory resources of higher ecological quality. Consolidated mitigation can introduce economic efficiencies for transportation and resource agencies and resources with higher ecological quality can provide society with more extensive and therefore economically valuable ecosystem services. Ecosystem services are the societal benefits provided by natural, ecosystem functions (Costanza et al. 1997; Palmer 2009).

There is significant evidence in the literature pointing to the fact that traditional methods of compensatory mitigation are not achieving the federal policy of "no net loss"[1] of aquatic resource functions and acres set out in 1989 (Eliot 1985; Race 1985; Erwin 1990; Race and Fonseca 1996). In addition, a number of studies have criticized traditional methods of compensating for endangered and threatened species damages as improperly designed and ineffective (Beatley 1992; Clark et al. 2002; Schwartz 2009). As a result, compensatory mitigation is moving towards progressive approaches that go beyond "no net loss," to achieve greater environmental benefit, and promote ecosystem sustainability as envisioned and described in the *Eco-Logical* report and other publications (Brown 2006; Wilkinson et al. 2009). In addition to providing recommendations and guidance for agencies to explore implementation of progressive approaches, there is a need to demonstrate how these approaches will reduce costs for agencies involved in meeting compensatory mitigation requirements. Our research is aimed at making the case that if these progressive approaches streamline administrative processes and/or provide other "services" to society, there will be a greater incentive to explore these new ways of approaching compensatory mitigation.

[1] It is important to note that the concept of "no net loss" is generally not utilized in assessing the ecological success of ESA compensatory mitigation programs. While wetland and stream compensatory mitigation have the objective of replacing the entire "bundle" of aquatic resource functions lost to development, ESA habitat mitigation strives to offset impacts to a particular species. Therefore, preservation of habitat is an appropriate, and common, compensation method under the ESA (U.S. Fish and Wildlife Service 2003).

Background and Status of Traditional versus Progressive Approaches to Selecting Compensatory Mitigation Sites

Under §404 of the Clean Water Act (CWA), there are four methods that can be used to achieve compensatory mitigation – restoration, establishment (creation), enhancement or preservation (U.S. Department of Defense and U.S. Environmental Protection Agency 2008). The mechanisms that are typically used are permittee-responsible mitigation (on- or off-site), mitigation banks, and in-lieu fee mitigation (U.S. Department of Defense and U.S. Environmental Protection Agency 2008). In general, the literature suggests that using these methods in a regional, landscape and/or watershed context when selecting compensation sites is essential to ecological success (e.g., National Research Council 2001; Bedford 1995; Stein and Ambrose 2001).

Under the Endangered Species Act (ESA), there are several ways of accomplishing compensatory mitigation and all fall under a fee-based approach, including purchasing lands (on- or off-site), paying to ensure management of lands, buying conservation bank credits, and/or paying third parties to manage or purchase lands in the future. Traditionally, ESA recovery plans have managed individual species impacts on a local, project-by-project basis. Habitat Conservation Plans (HCPs) can often expand the scope to regional, science-based, multi-species plans which can promote more effective preservation of high-value habitat sites, such as those providing habitat connectivity, but these are often uneven and not comprehensive. (Wilkinson et al. 2009).

There are many challenges to achieving compensatory mitigation efficiently and effectively; especially ensuring that actions on-the-ground contribute to greater environmental benefits and ecological sustainability. The primary challenges are resource-based, process-based, and institutional, and include:

1) Current regulatory requirements and processes creating disincentives to achieving better compensatory results.
2) Current regulatory funding, requirements and processes restrict the time available to agency staff to implement additional processes that could support more progressive approaches.
3) Lack of clear and standard methods for evaluating and/or selecting areas that result in better restoration, establishment, enhancement or preservation outcomes.
4) Insufficient data and/or analyses needed to support the implementation of progressive evaluation or selection frameworks (Venner Consulting and URS Corporation 2009).

Of these obstacles, our literature review focuses on documenting on-the-ground efforts and studies being used to evaluate and select sites for compensatory mitigation. What methods are being used, and what are the results?

Since 1990, there have been many efforts to improve compensatory mitigation, including guidelines and training to support a watershed, habitat or ecosystem approach to evaluating and selecting mitigation sites, mitigation banking guidelines, and guidelines on consultation with natural resource agencies (Venner 2010b; Venner 2010c).

In our literature review of progressive approaches to compensatory mitigation, we found many tools, frameworks, and methods offering different approaches to improving the assessment, selection, and monitoring of mitigation sites. In addition, there are many published case studies that document on-the-ground implementation of these progressive approaches across the country. At least 14 states have documented their efforts to improve mitigation outcomes by utilizing a watershed, ecosystem and/or multi-benefit approach. These progressive approaches to compensatory mitigation can consider a variety of criteria in the assessment and selection of a site, including but not limited to: 1) high potential for restoration, 2) part of a larger unfragmented landscape, 3) on or in close proximity to protected or high priority conservation lands, 4) hydrologic and/or species dispersal connectivity, 5) high water quality, and 6) potential to contribute to imperiled species protection. More than a dozen species were the focus of progressive approaches to endangered species mitigation, and many of these efforts were also done in the context of ecosystem and/or multi-benefits approaches. Various publications state the need to combine wetland mitigation with endangered species mitigation since there is often an overlap between the two, and together conservation opportunities can be expanded (WWF, 1992).

Some efforts to implement progressive mitigation were more technically focused on the use of various modeling techniques, GIS-support analyses and/or decision support tools, whereas other efforts focused on the development of a common vision and partnership building in support of regional and state level programs for advanced mitigation, mitigation banking, etc. Others efforts had a combination of both collaborative partnership-building and the creation or use of methods and tools to support the goals agreed upon between the partners. Clearly, there is not a one size fits all approach to the assessment and selection of compensatory mitigation sites, and many of the published approaches to progressive compensatory mitigation have similarities. It would be beneficial to conduct a more in-depth study of the various technical approaches to the assessment and selection of mitigation sites in order to bring more understanding of and support in the use of the various approaches, and ensure more scientific rigor in the efforts to improve compensatory mitigation across the country.

But despite the fact that there has been guidance and exploration of more effective compensatory mitigation approaches, to date the greater than $3.3 billion spent annually on compensatory mitigation under the CWA and ESA (ELI 2007) may not be supporting critical conservation priorities, as well as not achieving "no net loss" of aquatic resources (Kihslinger 2008; Turner et al. 2001). And although there are many cases of regions or states exploring innovative methods of achieving more effective compensatory mitigation, by and large federal and state agency practitioners are still using more traditional methods or struggling to implement more progressive methods due to the challenges cited above. Below we document some of the more recent case studies that illustrate progressive approaches to selecting compensatory mitigation sites, and that had the goal of improving the effectiveness and efficiency of decision making about compensatory mitigation.

Case Studies of Progressive Compensatory Mitigation Approaches

Given that we are still achieving less than optimal results utilizing traditional in-kind, on-site compensatory mitigation methods, there is a push to make compensatory mitigation work more efficiently and effectively. What are the existing methods being tried on the ground to improve the selection of compensatory mitigation sites? How are they working?

Are the methods transferrable to other parts of the country? Below are some case studies to help answers these questions.

Case Studies for Aquatic Resources, including a Watershed Approach

Wetland mitigation selection frameworks tend to focus on methods of successfully selecting areas for wetland restoration, enhancement or creation, with the objective of achieving "no net loss" of these resource (Stein et al, 2000). Markets and regulations surrounding stream mitigation are beginning to mirror those of the well-established wetland mitigation industry (BenDor et al, 2009). In order to maintain overall watershed function, the regulatory agencies focus more on replacing the functions that are being lost by a wetland or stream at one site by creating, enhancing or restoring a wetland or stream with similar functions in the same area or watershed. Unfortunately many factors have contributed to making these compensatory activities minimally effective. These include ineffective restoration, design, creation, or maintenance, and the challenge of accurately assessing debits, credits, and the subsequent mitigation ratio necessary for full and successful resource replacement. The method of determining and applying compensation for an impact to an aquatic resource is guided by the U.S. Environmental Protection Agency (EPA) in coordination with the U.S. Army Corps of Engineers (COE) using a system of debits and credits. Although there have been many frameworks published on generating and applying debit and credit ratios (Stein et al, 2000), the assessment of debits (the amount and type of wetland lost), and the implementation of credits (amount and type of wetlands that will be used to compensate for a loss) is generally done using best professional judgment and are mostly scientifically indefensible and inconsistent. (Stein, et al, 2000).

Many of the progressive wetland and stream mitigation site selection methods (Kramer and Carpenedo, 2009, Strager et al, 2010) utilize a watershed approach, and include criteria that factors in the importance of the proximity of a site for compensatory mitigation to a conservation priority or otherwise protected area. Having a compensatory mitigation site located in close proximity to conservation or protected lands can contribute to increasing 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).

The watershed approach to compensatory wetland mitigation requires the Corps of Engineers to consider a number of factors when evaluating future mitigation. These factors include how compensation provides desired current and future aquatic resource functions; habitat requirements of important species, habitat loss trends, sources of impairment, development trends, storm water; the interaction of uplands with wetlands, the maintenance of terrestrial resources as they relate to aquatic resources; and finally the watershed approach should not focus exclusively on specific functions but rather on the suite of functions that are typically provided by potentially affected aquatic resources. (U.S. Department of Defense and U.S. Environmental Protection Agency 2008; Kramer and Carpendo 2008)

It is clear that many emerging approaches aimed at achieving better compensatory mitigation results are using a watershed and/or ecosystem approach. This landscape-scale approach supports the "allocation of compensatory funds derived from mitigation in a manner that supports lasting and large-scale ecological results" (Wilkinson and Bendick

2009). In order to effectively allocate compensatory mitigation funding, methodologies and tools are needed for project prioritization.

A study conducted by Kettlewell et al. (2008) revealed that a watershed approach to selecting wetland mitigation sites is essential. They found that the wetland mitigation sites that were being selected in the Cuyahoga River Watershed (Ohio) were contributing to a decrease in wetland diversity because wetlands that were being impacted were being replaced with more common open water wetlands. In addition, they found that most wetland mitigation sites were outside the watershed that was being impacted; therefore the compensation was not contributing to maintain the overall health of the watershed being impacted.

Strager et al. (2010) outlines a "three-tiered" mitigation site selection framework to guide the evaluation, prioritization and selection of potential mitigation banking sites. The researchers developed a 'ranking' system using criteria for wetlands and stream that allows the practitioner to score each according to their ability to be successfully restored, this system can be used to 'score' wetlands and streams separately and in a combined 'score' when they occur at the same site. Thus, 'this approach provided an efficient and effective means of selecting optimal wetland mitigation banking sites saving time, money, and allowing a defendable and documentable framework'. It also supported the practice of implementing mitigation for streams and wetlands that are connected, contributing to more cost effective and effective restoration. The following are some recent cast studies that illustrate efforts to use more quantitative and ecologically-based frameworks, like the ones described above, to select compensatory mitigation sites for aquatic resources.

One example of a progressive approach to wetlands mitigation is EPA Region 4's collaboration with the EPA Office of Water and Office of Research Development to develop a Watershed Index screening tool that will help identify, target, and prioritize watersheds for protection and restoration. This Watershed Index screening tool identifies watersheds that rank high for restoration opportunities (high degree of recoverability), watersheds that rank high for protection opportunities (high ecological value and/or high degrees of threats), watersheds that could serve as"replacements" for impacts because they share similar characteristics (ecological, physical, stressor, social context), and current condition of watersheds (probability of impairment, stressors, threats). The tool is intended to provide assistance in evaluating and selecting sites for compensatory mitigation, by supporting a more efficient way to target sites where compensatory mitigation could provide the most environmental benefit. Some methods and tools being utilized include the concept of ecological recovery potential documented by Norton et al. (2009), and metric identification guided by the EPA Causal Analysis/Diagnosis Decision Information System (CADDIS). Various modeling methods are being utilized as well, such as SPARROW (USGS) (Venner, 2010d).

The North Carolina Ecosystem Enhancement Program (EEP) was created in 2002 with the mission "to restore, enhance, preserve and protect the functions associated with wetlands, streams, and riparian areas, including but not limited to those necessary for the restoration, maintenance and protection of water quality and riparian habitats throughout North Carolina." The program is comprehensive and has been able to effectively implement a watershed approach to wetland mitigation. Impacts are offset by payment of in-lieu fees to the EEP, which develops basin wide wetland and riparian restoration plans for each river basin. These plans identify degraded wetlands in each Cataloging Unit (CU) and prioritizes potential compensation sites based on how well they can serve as restoration sites to enhance functions and values for the larger CU. EEP also conducted Local Watershed Plans in areas where the NC Department of Transportation (DOT) was projecting future impacts in order to better inform the selection of mitigation sites in those areas (Anderson 2005).

Maryland took on the development of a tool to help them "decide both what ecological activity is most beneficial to the watershed and where that activity ought to occur." That tool is called the Watershed Resource Registry (WRR) - a GIS mapping tool that integrates land cover, land use, soil types, wetlands, streams, forest hubs and corridors, endangered species, critical habitats, etc. in order to develop a watershed profile and identify the needs of a particular watershed. WRR assessments include maps of specific areas within a watershed that would provide the highest benefit to the health of the watershed if preserved or restored. The WRR was successfully tested in four watersheds in southwestern Maryland and has the potential to be used in other states by using the tool in combination with data from the area being evaluated (Bryson et al. 2010).

In Arkansas, an interesting combination of a GIS tool and an internet-based system brings scientific rigor to the selection of restorable wetlands in the state and makes this information available online in a format that non-GIS users can access. The GIS tool uses a combination of structural characteristics and landscape position criteria for wetlands, and uses these criteria to develop summations and categorizations of high priority wetlands for restoration. The Arkansas Wetland Information Management System is an online tool developed for non-GIS users to access information about these priority wetlands as well as impacted areas (i.e., areas that have been granted §404 permits). This system allows users to query impacted and priority wetlands at several ecologically based scales including a wetland planning area and ecoregion. The site will be maintained through partnerships between conservation agencies and the Center for Advanced Spatial Technologies at the University of Arkansas. The Arkansas Wetland Information Management System website 'will be one-stop shopping for program managers and local leaders who are involved in wetland conservation efforts' (Murray and Brazil, 2003).

In Georgia, a state rich in wetland diversity but also facing threats to these wetlands due to population growth, a potential wetland restoration areas (PWRA) prioritization model was developed. The purpose of this GIS model is 'to provide state, federal and non-governmental natural resource managers with a Georgia-specific GIS database of potential areas for wetland mitigation banks and conservation and restoration projects using a GIS model to prioritize wetland functions and values'. (Kramer and Carpendo, 2009) This model prioritizes wetland areas based upon ecosystem functions as well as threats to these functions. The approach developed a watershed model that included the following ecosystem functions and values: water quality and water quantity protection; flood control and flow regulation; biodiversity conservation; connectivity; ease of restoration; education; recreation; scenic value; and wildlife habitat. The model utilized data, methods and models that had already been developed in order to develop a scientifically rigorous process for selecting sites for compensatory mitigation that can be used at different scales and also inform other conservation planning efforts in the state.

Case Studies of an Ecosystem Approach

The ecosystem approach to compensatory mitigation is a similar concept to the watershed approach, but with less of a focus on wetlands. As documented in *Eco-Logical* (Brown

2006), an ecosystem approach is "a method for sustaining or restoring ecological systems and their functions and values." For similar reasons cited above related to the watershed approach, it is essential to look regionally at the status, location and threats to ecological systems in order to successfully mitigate in areas that will preserve the diversity of existing systems. Since one-third of endangered and threatened species occur in wetlands (WWF, 1992), often a combination of an ecosystem and watershed approach should be utilized for successful compensatory mitigation results

In Maryland, the Maryland State Highway Administration, The Conservation Fund, the Maryland Department of Natural Resources, and the U.S. Fish and Wildlife Service worked together to conduct an ecosystem scale evaluation of four Maryland watersheds potentially impacted by construction of a highway bypass. Based on feedback from stakeholders and previous assessment and prioritization methods, they 'modeled and validated a conservation network of high-quality wildlife and plant habitat (core areas), large contiguous natural areas (hubs), and linkages to facilitate wildlife movement and gene flow (corridors).' They then ranked 'elements' of this network at multiple scales, and identified high priority areas for conservation and restoration. (Weber and Allen, 2010)

The Wyoming Basins ecoregion was the target for a case study in the use of landscape planning and the selection of high priority mitigation sites (Kiesecker et al. 2009). In this study, the authors compared areas of oil and gas potential with conservation sites identified in an ecoregional conservation plan developed by The Nature Conservancy in collaboration with key state and federal agencies. By overlaying these two data layers, it was possible to identify potentially impacted natural resources and identify sites within the portfolio that could be used as offsets. Additionally, the conservation portfolio could be adjusted to focus high priority conservation and restoration in areas with low oil and gas potential as long as these areas could support the conservation goals of the impacted resources identified in the portfolio. This framework could also identify "irreplaceable targets" that cannot be "replaced" through any mitigation action and therefore the impact would have to be avoided or minimized.

In Colorado, there was a classic example of an ecosystem approach to selecting high priority sites that could be used for multi-species compensatory mitigation is the Shortgrass Prairie Initiative. The Colorado Natural Heritage Program in collaboration with The Nature Conservancy conducted an analysis that identified high priority sites for conservation, focusing not only on the habitat of species listed under ESA, but also on habitat for non-listed species with no identified protection in place and high levels of threats, especially from oil and gas exploration. This approach allowed agencies to target mitigation action in areas that are highly threatened and yet have little or no protection. This initiative led the FWS Colorado Division to recognize and accept the data as "best available" and the FWS therefore used it to develop their programmatic biological opinion (PBO) and Conservation Strategy for 36 species. (Neely et al. 2006; Venner 2010h)

In Oregon, the well known and regarded Oregon State Bridge Delivery Program brings a multi-resource, multi-benefit approach to compensatory mitigation by using programmatic permitting processes. First, baseline reports were developed that provided 'information about the environmental conditions at bridge sites along with preliminary indications of the environmental concerns, permits and approvals, and construction restrictions that may be in effect at those sites. These assessments were aimed at developing better impact avoidance, identifying enhancement opportunities early, identifying permit needs early, supporting development of programmatic permits and a statewide mitigation program, supporting NEPA compliance, efficiency, and more accurate cost estimates and schedules.' Second, Environmental Performance Standards (EPS) were developed that defined the 'acceptable level of effect that a project activity may have on the environment, rather than prescribing how the activity must be performed. The EPSs were a critical component of the jointly signed biological opinion. They require that contractors minimize unavoidable, short-term effects associated with a project and that restoration or mitigation actions be taken to offset unavoidable, long-term effects. It is also required that these actions not result in net long-term, adverse effects to listed species and their habitats'. And finally, a Comprehensive Mitigation and Conservation Strategy (CMCS), was developed that provided 'banking for all regulated resources affected by project delivery based on an ecoprovince priorities set of goals for each Oregon watershed rather than utilizing the traditional method of acre-for-acre, on-site mitigation. It also takes a non-traditional approach in that it mitigates for impacts to species, habitat and functions (e.g., wetlands, ESA recovery, habitat and abiotic functions such as water quality), utilizing a multi-resource mitigation debit and credit system.' . (Gaines and Lurie, 2007).

Case Studies of a Multi-resource/Multi-Benefit Approach

Although watershed and ecosystem approaches to compensatory mitigation address multiple resources and provide multiple benefits, the examples that follow focus on compensatory mitigation frameworks that include the development of multi-benefit Habitat Conservation Plans.

In southeastern Virginia, a combined benefits mitigation framework is being utilized. This effort included the development of a Multiple Benefits Conservation Plan (MBCP) Memorandum of Agreement signed by multiple stakeholders in the region. Some interesting features of this effort include the focus on "use of conservation corridors in the selection of a multiple benefits mitigation site," "use of a watershed-based approach to wetlands mitigation," development of data on the location of existing mitigation sites, the development of data to fill data gaps, and the goal of integrating information of priority mitigation sites into local plans. Selection of mitigation sites utilized a process of overlaying various data layers and using calculations to identify, by wetland and parcel, wetlands with high conservation priority including wetlands that are a priority for restoration. (Venner 2010f)

NiSource is an interstate natural gas company that decided to work directly with the FWS to comply with ESA in the 14 states where they worked in the hopes that a proactive approach to mitigation would reduce the administrative burden to them while achieving a goal of "net conservation benefit." NiSource worked with FWS to develop a Multi-Species Habitat Conservation Plan (MSHCP) under §10 rather than § 7 of ESA. This was the largest HCP ever initiated covering 14 states and addressing the offsets necessary to mitigate impacts to 43 species in cases when these species cannot be avoided. NiSource worked with The Conservation Fund to identify and evaluate mitigation sites utilizing data from NatureServe, FWS, state agencies, and other sources to identify and prioritize mitigation sites based on the species conservation goals identified in the HCP. The FWS decided on the ratio of mitigation requirements based on pipeline impacts. (Venner 2010e)

Case Studies of Advance Mitigation

Many efforts to achieve more effective compensatory mitigation are based on the idea that moving from a project-by-project approach to mitigation to an approach where natural resources are assessed at regional or state scales allows restoration or preservation of at-risk species and/or high priority habitat of impacts before they occur; this advance compensation can then be counted later as offsets for impacts. Although many of the approaches and case studies documented above include a component of advance mitigation, these case studies focus more on that aspect of the compensatory site selection process.

An example of providing compensation prior to impacts is the Regional Advance Mitigation Planning (RAMP) effort in California (Thorne et al 2009). This innovative effort estimated potential future impacts to resources by developing a "footprint" of future projects, using that to identify resources that may be impacted, and then developing a method for identifying sites that could offset these particular impacts in a way that contributes to regional and statewide conservation priorities. This framework was tested in a subregion of the Central Valley near Sacramento, California. Once a list of the species and habitat types that would potentially be impacted in the region was identified, the locations of these species and habitats were mapped across the region and overlaid with many other data layers including ownership, land cover, species habitat, minimum size of habitat, priority conservation areas, etc. to evaluate each parcel's contribution to restoring potentially impacted ecological components. MARXAN was used to evaluate each parcel and identify the ones with the most potential for high quality compensatory mitigation. Some of the resources that were identified for compensatory mitigation included vernal pool complexes, Giant Garter Snakes, and Burrowing Owls. Although this type of "systematic planning of ecological offsets" has been demonstrated in other publications (Kiesecker et al. 2009), this project illustrated an effective process that "integrated the mitigation needs of more than one infrastructure agency."

In addition, a similar statewide effort in California, the Statewide Advance Mitigation Initiative (SAMI), is building on RAMP's regional work. SAMI has garnered multi-stakeholder support for the development of HCPs and longer range integrated planning for species in those areas where HCPs are missing to inform the selection of compensatory mitigation sites across the state. (Venner 2010g)

Mitigation Cost-Savings Using a Progressive Approach

Progressive approaches to compensatory mitigation necessarily expand the spatial and temporal scope of decision-making to consider multiple options for developers to replace functions and services lost at aquatic resource or habitat impact sites (National Research Council 2001). Costs involved in undertaking compensatory mitigation, such as land acquisition and pricing, designing restoration plans, construction, terrain type, water rights, and opportunity costs of foregone development vary with space and time (Louis Berger & Associates, Inc. and BSC Group 1997; Drechsler and Watzold 2009). The ability of market-based environmental policy to choose least-cost restoration options is perhaps its chief advantage over alternative command-and-control mechanisms (Newell and Stavins 1999). Allowing, and indeed preferring, use of off-site compensation measures from mitigation banks or in-lieu fee programs generally increases alternatives available to permittees for compliance with the CWA or ESA, thickening the market for mitigation credits (U.S. Department of Defense and U.S. Environmental Protection Agency 2008; Newell and Stavins 1999). Thick environmental markets offer distinct advantages for credit permittees: increased participation typically induces increased cost heterogeneity among mitigation credit providers, allowing developers to identify least-cost restoration possibilities (Newell and Stavins 1999). Thick markets also may reduce mitigation costs by increasing competition among mitigation credit vendors, which diminishes possibilities for monopolistic or collusive behavior (Nash and Revesz 2001).

Cost heterogeneity in environmental markets has been studied empirically in the context of the sulfur dioxide (SO_2) emission markets established under the 1990 Clean Air Act (CAA) Amendments, widely regarded as one of the most cost-effective market-based environmental policies to date. Perhaps the prime reason for the success of the SO_2 market was the existence of substantial differences in marginal compliance costs across firms (Rezek and Blair 2005; Stavins 1998). The U.S. SO_2 emissions market, as compared to an annual, prescriptive emissions standard, generated an estimated cost-savings of $213,502,354 to $550,628,246 for regulated firms between 1995 and 1999 (Rezek and Blair 2005); additional research estimated the emissions trading program reduced compliance costs by between 30% and 50% compared to a prescribed emissions rate standard (Boyd et al. 2003). While not all of the cost-savings of the SO_2 market are attributable to the high cost heterogeneity between emitting firms,[2] there is adequate evidence to conclude that these differences in compliance costs across firms were a principal contributor to the program's efficiency (Rezek and Blair 2005). Other studies have investigated heterogeneous abatement costs as the foundation for reducing compliance costs in proposed markets for nutrient loadings and greenhouse gas emission reductions (Ramilan and Scrimgeour 2006; De Cara and Jayet 2000).

Biodiversity markets also share the potential to identify more cost-effective solutions to environmental degradation than command-and-control regulation, with overall compliance cost savings increasing as cost heterogeneity increases among market participants (Jack et al. 2008). While the effects of cost heterogeneity have not been analyzed strictly in the compensatory mitigation context to determine aggregate cost-savings, its implications are clearly evident. First, cost heterogeneity among mitigation providers is a reality, as credit prices vary significantly within existing conservation and aquatic resource mitigation markets, and across different biodiversity markets in the U.S. For example, wetland mitigation bank credits in the Norfolk district varied from $16,000-$20,000 in the Chowan Basin to $350,000 at estuarine banks (ELI 2007). Credit prices for conservation and aquatic resource compensation also show considerable nationwide variability; in FY03, banked wetland compensation credits were priced between $9,500/acre (Alaska) and $150,000/acre (Sacramento, San Francisco) (ELI 2007). While land value may be a leading source of differentiated mitigation costs, it is not the only one: A 1997 study in New England reported that wetland restoration and creation costs, excluding land acquisition, varied from $800/acre to $1,426,000/acre (Louis Berger & Associates, Inc. and BSC Group 1997). Second, this cost heterogeneity has had the effect of providing a competitive advantage to mitigation providers who can supply cheaper compensation credits. For example, mitigation banking under §404 of the CWA has facilitated a repeated trend of transferring aquatic resource ecosystem services from urban areas, which are high-value for development, to rural areas, where property values are less

[2] Dynamic cost-effectiveness; e.g. innovation of new technology under SO_2 trading, is also implicated as a major cost-saver (Newell and Stavins 1999; Chestnut and Mills 2005).

expensive, providing developers with lower-cost compensation credits. This urban-to-rural "migration" of wetlands is apparent in studies of mitigation banking in Florida, Oregon, North Carolina, and Illinois, and stream mitigation exhibits a similar geographic pattern in North Carolina (King and Herbert 1997; Salzman and Ruhl 2006; Brass 2009; BenDor et al. 2009; BenDor 2007). Under a flexible watershed or landscape approach to compensatory mitigation, one can reasonably expect expanded compensation possibilities to result in lower compliance costs for permittees.

Progressive approaches to compensatory mitigation generally encourage increased use of consolidated, off-site compensatory mitigation sources, such as mitigation banks, conservation banks, or in-lieu fee programs, presenting the opportunity to capture economies of scale and reduce compliance costs for permittees (U.S. Department of Defense and U.S. Environmental Protection Agency 2008; U.S. Fish and Wildlife Service 2003; Silverstein 1994). Indeed, federal policies and regulations governing use of conservation banks, wetland and stream mitigation banks, and in-lieu fee programs highlight economies of scale as a prominent advantage of third-party mitigation (U.S. Department of Defense and U.S. Environmental Protection Agency 2008; U.S. Fish and Wildlife Service 2003). Independent of any regulatory cost-savings induced by project consolidation, opportunities for achieving economies of scale in the physical development of compensatory mitigation projects are present in two stages: land acquisition and subsequent restoration or creation activities.

In utilizing a MARXAN algorithm to strategically identify promising compensation sites in two study areas in California, Thorne et al. observe a strong negative trend in parcel price per hectare as study site size increased (2009). Large-scale wetland and stream restoration projects may additionally capitalize on scale advantages by reducing the per-acre cost of aquatic resource restoration or creation; these projects can more effectively bundle restoration planning, design, construction, and operation costs (Silverstein 1994; Sapp 1995). Empirical evidence supports this claim; in 1994, King and Bohlen surveyed wetland restoration and compensation costs at 1,000 project sites, finding that on non-agricultural lands, an expansion of project size by 10% resulted in a 3.5% decrease in restoration cost per-acre, and in agricultural areas, a 10% increase in project size resulted in a 0.6% reduction in cost per-acre. Similarly, Templeton et al. (2008) reveal economies of scale for stream compensatory mitigation undertaken by the North Carolina Ecosystem Enhancement Program (EEP), noting that expenses for stream restoration or enhancement per linear foot decreased as project size increased. However, while economies of scale are commonly touted as a distinct advantage of consolidated, off-site compensatory mitigation options, the conclusion that large-scale wetlands achieve lower per-acre restoration costs is not universal. Turner and Boyer (1997) observe that river diversion-based wetland restoration in Mississippi displays diseconomies of scale, providing more cost-effective restoration at smaller project sites, although the applicability of the study to other settings has been challenged (Crooks and Ledoux 1999).

Furthermore, promoting use of consolidated, off-site compensation options may provide ecological economies of scale; for instance, larger parcels of endangered species habitat may provide increased protection from surrounding land uses, and as the size of a conservation bank grows, the marginal functional value of habitat may increase (Schwartz 1999; Murcia 1995; Drechsler and Watzold 2009). In addition, strategic siting of compensation as promoted under a progressive approach to aquatic resource or habitat replacement should identify particularly ecologically valuable land parcels, such as those that allow faunal community dispersal (U.S. Fish and Wildlife Service 2003); this may also increase the functional value of a compensation site on a per-acre basis, which could lead to lower credit prices.[3] Whether or not increased functional capacity of larger habitat sites translates to lower permittee costs depends on the level of incorporation of function into market currency and compensation requirements (Salzman and Ruhl 2000).

Holistic compensatory mitigation planning in advance of impacts implicates additional cost-savings in transportation-related mitigation because of early acquisition of land. Indeed, one of the principal benefits of an ecosystem approach championed in *Eco-logical: An ecosystem approach to developing infrastructure projects* is the ability to proactively "identify and capitalize on opportunities for meaningful mitigation and conservation – opportunities that may be quickly disappearing or becoming too expensive to realize as areas of ecological importance are developed" (Brown 2006). Increases in property values in some areas have historically outpaced inflation, thus early identification and purchase of ecologically valuable mitigation sites can reduce expenditures for transportation projects (Venner 2010a). Thorne et al. conclude that, due to economies of scale and the rising price of land over time, it may be cost-effective to purchase more land than current mitigation demand would dictate if large, ecologically suitable sites are identified. Transportation entities can then bank surplus credits for future use or for external sales (Thorne et al. 2009).

Clean Water Act

Many state departments of transportation (DOTs) confirm generating substantial cost-savings through capturing economies of scale for consolidated mitigation planning, increased flexibility in site-selection, and advance purchase of valuable mitigation parcels. Over the past decade, Michigan DOT (MDOT) has transitioned from a traditional, project-by-project approach to aquatic resource compensatory mitigation, which coupled timelines and funds for wetland mitigation with individual transportation projects, to a watershed approach that separated compensation and transportation project funding. Allowing holistic consideration of wetland mitigation has permitted MDOT to achieve economies of scale via off-site, consolidated wetland mitigation sites, reducing per-acre compensation costs from typically exceeding $100,000, and generally falling between $75,000 and $150,000, to a present-day average cost of $25,000-$30,000 per acre (Venner 2010a).

Washington State DOT (WSDOT) also credits significant mitigation cost-savings to economies of scale associated with adoption of a comprehensive watershed approach and additionally attributes cost-savings to increased flexibility in site-selection. In place of traditional project-by-project aquatic resource compensation projects, WSDOT established public mitigation banks, reducing mitigation costs by 30% to 80%. WSDOT approximates that mean prices for traditional compensatory mitigation cost around $1.2 million per acre, while banked credits generated by WSDOT cost between $80 and $833,333, with the upper value representing an extreme case. In addition, WSDOT expects credits from a new advance compensation program, Tarlott Slough, to sell for as low as $14,109 per acre (Venner 2010a).

North Carolina's EEP credits significant mitigation cost-savings due to more accurate projections of regional compensation demand. Prior to the EEP, the combination of the low

[3] This can also backfire, especially in thin markets; landowners who recognize the unique conservation value of their property may act strategically and increase mitigation costs (Shabman and Scodari 2004).

availability of adequate wetland and stream mitigation credits, along with assertive private mitigation bankers in some areas, caused the North Carolina DOT (NCDOT) to purchase compensation credits or sites whenever they became available; the end result was excessive expenditures on mitigation sites. Streamlining and integrating transportation planning with a watershed approach to mitigation allowed the EEP to rein in unnecessary mitigation spending and better target ecological restoration efforts (Venner 2010a). This is part of the reason why EEP has reduced wetland mitigation expenses as a percent of NCDOT project costs from 8% to less than 3%, representing an annual decrease of $32,500,000 to $65,000,000 (Anderson 2005).

Minnesota DOT (MnDOT) initiated development of a statewide mitigation banking program to offset transportation-related wetland impacts in the 1980s to transition from "postage stamp," project-by-project mitigation to holistic compensation (U.S. Federal Highway Administration 2010). MnDOT now works with the Minnesota Board of Soil and Water Resources (BSWR) to establish wetland compensation substantially before impacts. Though the MnDOT-BWSR partnership is already a cost-effective mechanism for reducing mitigation costs, the agencies expect the program to make future wetland offsets even more economical as they transition from primarily buying credits to sustaining compensation sites.

Since 2001, the Virginia DOT (VDOT) has established five wetland mitigation banks in different watersheds throughout the state to provide compensatory mitigation required for transportation-based wetland impacts. VDOT reports that their cost per acre of compensation is around $125,000; this number is estimated to be particularly cost-effective because VDOT can construct large, compensation wetlands in high-demand watersheds prior to impacts or can create wetland banks in areas that are of lower demand and thus cost less (U.S. Federal Highway Administration 2010).

Clean Water Act and Endangered Species Act

The New York State DOT's (NYSDOT) Environmental Initiative represents another early example of a proactive approach to incorporating avoidance, minimization, and compensatory mitigation into transportation planning. The Environmental Initiative addresses compensatory mitigation for all relevant environmental impacts, including those regulated under the CWA and the ESA; it also houses two sections, Environmental Benefits Projects and Environmental Betterment Programs, which focus on achieving and exceeding compliance with mitigation requirements. NYSDOT judges that the Environmental Initiative has accrued savings due to use of more cost-effective mitigation and lower punitive expenses for mitigation (Samanns 2002; McVoy et al. 1999).

To offset expected natural resource impacts from a planned Highway 301 bypass and increase the cost-effectiveness of compensatory mitigation projects, the Maryland State Highway Administration (SHA) requested that The Conservation Fund (TCF), the Maryland Department of Natural Resources (MDNR), and FWS analyze natural resource mitigation opportunities in four possibly affected watersheds. Though this study was formulated in a broader context of compensatory mitigation, it is particularly applicable to habitat and/or aquatic resource losses under the CWA or ESA. Weber and Allen's study (2010) primarily examined conservation, with additional mention of restoration, as sources of mitigation. To identify high-value compensation sites, TCF, MDNR, and FWS utilized a green infrastructure approach, which maps areas of core habitat, hub habitat surrounding core areas, and wildlife and plant dispersal corridors. TCF, MDNR and FWS developed a landscape ecological score for potential compensation sites based on a suite of environmental parameters; these parameters were compiled at six different spatial scales surrounding a mitigation site and they were weighted by their relative importance to determine the site's final landscape ecological score. These ecological scores were then integrated in the context of parcel boundaries to prioritize properties for preservation. Finally, the researchers performed field site visits at parcels over 8 ha in size to develop a field ecological score. Potential restoration sites were also analyzed in the context of the watersheds' green infrastructure based on a similar metric for restoration potential.

When prioritization data is available, mitigation sites are often chosen based on ranking methods that adopt the projects with the highest individual benefits, without considering the comparative costs of other, cheaper compensation options that, when aggregated, provide better overall ecological results. In order to select the most cost-effective, ecologically valuable suite of conservation parcels, the authors developed and utilized a benefit-cost optimization model that chooses mitigation sites based on a given budgetary constraint. In selecting conservation sites, the optimization tool analyzed a parcel's area of green infrastructure, average landscape ecological score, field ecological score, distance to previously protected lands, and land costs. The ecological metrics were then used to create an overall parcel conservation score, which was then compared with land costs to choose conservation sites under hypothetical budget scenarios of $15 million and $5 million. The model run with a $15 million limitation was compared with a rank-based prioritization method, with the benefit-cost optimizer resulting in 15% more green infrastructure area and a 7% higher net ecological score. Under the $5 million budget scenario, the optimizer resulted in a 14% higher overall ecological score as compared with a ranking method, although it did result in 28% less green infrastructure area due to the enhanced ecological value of the selected parcels. Unfortunately, Weber and Allen's empirical model results were limited to conservation prioritization and did not extend to restoration, though the framework is established for such analysis by comparing restoration potential with cost (Weber and Allen 2010).

Endangered Species Act

Transportation entities involved in ESA §7 consultation or similar regulatory programs also emphasize possibilities to lower mitigation costs by integrating future infrastructure project projections with progressive, landscape-scale endangered species recovery plans. Greater flexibility in fulfilling compensatory mitigation under a programmatic approach to ESA §7 allowed the Colorado DOT to save time and money while also enhancing the riparian habitat of Preble's meadow jumping mice, a federally listed threatened species. CDOT planned a number of road expansions which would impact approximately 100 acres of Preble's habitat and the traditional, ratio-based method of creating (2:1), restoring (3:1), or preserving (10:1 to 14:1) Preble's habitat as compensation would have been preventatively expensive or impossible given land values and availability in the surrounding area. Through a flexible, programmatic biological opinion (PBO), CDOT and the U.S. Fish and Wildlife Service (FWS) decided to move beyond strict, ratio-based mitigation requirements and consider alternative mitigation strategies. In addition to some restoration and preservation, CDOT provided more ecologically valuable compensatory mitigation by establishing habitat linkages between separated communities of Preble's; enhanced community linkage was promoted through installation of culverts under a highway and vegetative cover to allow passage across a dam (Wostl 2003). CDOT also installed six check dams, which raise water levels to an optimal level for the Preble's riparian habitat, establishing a 25-acre conservation bank for mitigation of future habitat impacts (U.S. Federal Highway Administration 2010). Collaboration between FWS and CDOT allowed road expansion to continue and sidestepped problems associated with land purchase and acquisition (Wostl 2003).

Related Compensatory Mitigation Programs

The San Diego Transnet, a countywide transportation administration initiative, maintains an Environmental Mitigation Program (EMP) to address requirements of the California Natural Community Conservation Planning (NCCP) Act, a state conservation statute enacted to prevent listing of potential endangered species (Poe et al. 2009). The San Diego Transnet projects that the EMP can save up to $200 million throughout the lifetime of its 40-year Regional Transportation Plan based on economies of scale in habitat preservation, flexibility in choosing cost-effective, ecologically sound compensation sites, and early acquisition of mitigation sites, which avoids more expensive purchases later due to rising land costs. Advance purchases are extremely useful for the EMP, as San Diego County mean land values have risen 286% since the mid-1980s; land values peaked at a 645% increase in 2005. Though the EMP has only operated for approximately 3 years, it has already preserved 1,040 acres of habitat, saving an estimated 32.3% of acquisition costs, amounting to $24 million dollars (Venner 2010a).

Transaction Cost-Savings Using a Progressive Approach

Late evaluations of the environmental impacts of road project development are the leading cause of expensive holdups in road construction (Transtech Management, Inc. 2003). Environmental permitting can encompass a large proportion of transportation project expenditures—ranging anywhere from 3% to 59% of mitigation or road construction costs—providing ample opportunity for reducing transaction costs (Louis Berger & Associates, Inc. and BSC Group 1997). For instance, the state of California is estimated to lose $75 million on an annual basis due to delays induced by the disjoint nature of project-by-project environmental planning and mitigation (Thorne et al. 2007). Progressive, landscape-scale approaches to compensatory mitigation for aquatic resource or endangered species impacts present an opportunity to streamline transportation planning, avoiding costly delays in project implementation and promoting efficient use of transportation and resource agency resources.

Eco-Logical advanced a general framework for better integrating transportation and resource agency objectives in the early stages of infrastructure planning and environmental permitting to harmonize agency interaction and accelerate project implementation. As with compensatory mitigation site acquisition, restoration, and maintenance, a holistic approach to transportation planning captures economies of scale for regulatory transaction costs. Programmatic or large-scale environmental review allows transportation and resource agencies to eliminate redundant investments, share data, and identify potential mitigation sites more effectively, which along with the use of consolidated, off-site compensation, can reduce field site visits and time spent approving and monitoring ecosystem restoration. Collaborative, ecosystem-scale approaches to mitigation also lower overall financial expenses by establishing regulatory assurances and thus reducing vulnerability to litigation or punitive damages, while also allowing transportation agencies to more accurately forecast expected project costs and their associated environmental compensation components. Regulatory assurances can also diminish potential conflicts in later permitting processes (Brown 2006).

Clean Water Act

Transportation programs pioneering a streamlined, ecosystem-based approach to infrastructure planning exhibit substantial transaction cost- and time-savings as compared to traditional, project-by-project compensatory mitigation. For example, the NC EEP, which bases its compensation activities on NCDOT's seven-year development projections, has significantly reduced delays for infrastructure projects. In 2001, the NCDOT reported that 55% of its transportation developments were delayed by wetland mitigation requirements; after ramping up streamlined transportation planning, the EEP reports that no NCDOT Transportation Improvement Projects associated with EEP are experiencing delays. As noted previously and partially due to increased efficiencies in transportation planning and environmental review, EEP has generated substantial savings for the NCDOT (Venner 2010a). Wetland mitigation costs dropped from 8% of total project costs prior to EEP to less than 3%, saving NCDOT between $32,500,000 and $65,000,000 (Anderson 2005).

Michigan Department of Transportation (MDOT) presents another prominent example of a streamlined, time-saving approach to watershed-scale aquatic resource mitigation planning. Michigan has a state-assumed §404 permitting program and through MDOT's streamlined approach to wetland mitigation, the Michigan Department of Natural Resources (MDNR) administers 66% of permits after 30 days, with permit evaluation infrequently lasting longer than 120 days. MDOT predicts that traditional §404 permitting with the U.S. Army Corps of Engineers (Corps) would considerably exceed current permit timelines. Also, as part of an effort to quicken regulatory approval of mitigation sites, MDOT initiated use of a geospatial site selection tool for strategic identification of ideal compensation areas. This wetland mitigation tool allowed MDOT to analyze watershed trends in aquatic resources and subsequently rank possible mitigation sites by restoration potential; projected restoration value was measured based on hydric soils, historic wetlands, and topographic wetness data. Under a project-by-project mitigation strategy, MDOT reported that staff commonly accompanied regulators on at least 4-5 site visits to determine the ecological suitability of potential restoration sites; now, MDOT's progressive approach to mitigation prevents consideration of less promising compensation sites and MDOT receives approval for around 95% of mitigation sites on their first site visit (Venner 2010a).

As previously mentioned, the Virginia Department of Transportation (VDOT) operates five large wetland mitigation banks around the state. VDOT's use of consolidated compensation sites is estimated to save a substantial amount of time—up to 25 percent—in receiving permit approval. Georgia's Department of Transportation (GDOT) utilizes an umbrella mitigation banking instrument to allow for more efficient administration of its 17 mitigation banks, as GDOT has at least one mitigation bank in each HUC-8 watershed in Georgia. Finally, the U.S. Federal Highway Administration's (FHWA's) Oregon Division has finalized two agreements, the Major Transportation Projects Agreement (MTPA) and the Collaborative Environmental and Transportation Agreement on Streamlining (CETAS), with 10 additional federal and state agencies. MTPA and CETAS are primarily designed to eliminate duplicate efforts between NEPA and §404 review (U.S. Federal Highway Administration 2010).

Though not explicitly addressing transportation impacts, the Savannah District of the Corps observes that its application of a watershed approach to aquatic resource compensatory mitigation has caused increased collaboration with permittees and garnered more public participation. Relationships cultivated under Savannah's regulatory application of the watershed approach advance early interaction between Corps regulators and permitees; often, these permittees will contact the Corps in the planning stages of development to receive consultation on proper avoidance and minimization of aquatic resource impacts. Advance consultation with the Corps lowers costs for permit applicants by reducing ecological impacts associated with a project, subsequent compensatory mitigation obligations, and streamlining environmental review (Bernstein and King 2009).

Clean Water Act and Endangered Species Act

Florida DOT (FDOT) pioneered the award-winning Efficient Transportation Decision Making (ETDM) program, which collaboratively works with Florida Water Management Districts (WMDs) to prioritize resource mitigation needs at the watershed or basin level. WMDs proactively acquire compensation sites and restore wetlands by watershed. ETDM accelerates environmental review for state environmental permits, CWA §404, and ESA mitigation, in addition to National Environmental Policy Act (NEPA) requirements. Early identification of potential impacts is promoted through the program's Environmental Screening Tool (EST), an online database that overlays transportation project and resource data from various sources, allowing planners to share data and foresee potential ecological impacts of infrastructure investments. Overall, the streamlined ETDM process has yielded financial benefits for FDOT by improving interagency coordination in early project phases, which reduces the number of project alternatives and possible mitigation scenarios being studied, avoiding conflict, introducing an enhanced dispute resolution system, better defining agency roles, and quickening project screening times. Over the lifetime of the ETDM program, these improvements have reduced FDOT's expenses by $15.2 million and accumulated an estimated time savings of 38 years, though these benefits also include reduced costs due to NEPA streamlining (Florida Department of Transportation 2009).

Montana became the first state to "adaptively apply" the *Eco-Logical* framework to compensatory mitigation for impacts to aquatic resources and endangered species habitat through implementation of the Integrated Transportation and Ecological Enhancements for Montana (ITEEM) project. The ITEEM process focused heavily on setting goals and a framework for a pilot study on the MT 83 highway corridor, leading to creation of an Interagency Review Team Working Group (IRTWG) to integrate the concerns of federal and state resource and transportation agencies. The ITEEM workgroup expects that early and improved collaboration between involved agencies and officials will introduce substantial efficiencies into the mitigation process. Cost- and time-savings are anticipated from having transportation and resource personnel address multiple projects concurrently, lowering the possibility of encountering significant obstacles to road expansion late in the project, and reducing regulatory time for permitting (Hardy et al. 2007).

Collaboration with environmental resource agencies and local community groups has allowed the New York State Department of Transportation's Environmental Initiative to reduce mitigation-related administrative permitting expenses and receive permit approvals on a faster timeline. The Environmental Initiative is also credited with lowering the overall time for implementation of transportation projects (Samanns 2002).

A number of attempts to adopt progressive, streamlined mitigation approaches profiled in *Environmental Mitigation in Transportation Planning: Case Studies in Meeting SAFETEA-LU Section 6001 Requirements* mention recognizing opportunities to expedite projects and save compensatory mitigation costs. SAFETEA-LU §6001 obliged metropolitan planning organizations (MPOs) and DOTs to integrate environmental mitigation and particular areas appropriate for conducting mitigation activities into their long range transportation plans (LRTPs). The Maricopa Association of Governments (MAG), Phoenix, Arizona's regional planning agency, reports that studies induced by SAFETEA-LU allowed for early recognition of environmental impacts associated with road corridors and that enhanced interagency relationships should lead to accelerated project approval in the future. MAG also attempted to remove redundant work from the mitigation planning process by better linking NEPA mitigation evaluations and mitigation for additional regulatory programs, such as those under the CWA or ESA. The Mid-Ohio Regional Planning Commission reported that consolidating resource agency requests across multiple MPOs could save staff time for these permitting agencies. Similarly, the North Carolina Piedmont MPOs decided to merge all resource agency inquiries and route them through one MPO to more efficiently use the time and funding of the MPOs and the permitting agencies. Montana's DOT (MDT) reports saving time and money through use of Quantm, a geospatial route optimization tool that evaluates thousands of different transportation routes and their environmental consequences to identify the most cost-effective route alignment that also avoids and minimizes ecological impacts (Poe et al. 2009).

Endangered Species Act

In one of the more inclusive programmatic consultation processes accomplished under ESA §7, the Oregon DOT (ODOT) consolidated over 400 bridges into a single biological assessment (BA) addressing the needs of 73 endangered, threatened, proposed, or selected sensitive species, along with their proposed or designated critical habitat. The programmatic, ecosystem-scale approach to ESA consultation drastically lowered permitting time and cost while concomitantly enforcing environmental and geomorphologic performance standards. The ODOT cites reducing redundant work across multiple permitting processes and decreased vulnerability to litigation as motivating factors for pursuing the broad BA. Not including time saved on the part of the state and federal resource and permitting agencies, ODOT estimates that the streamlined approach saved $54 million in expenditures and two years of work time over the life of the ten-year bridge project (Bonoff et al. 2005). In addition, ODOT approximates that every dollar spent under the programmatic consultation process exhibited a mean return on investment of $3.19, as compared to a traditional permitting approach, under which the mean return on investment for every dollar spent would be just $0.75 (Venner 2010a).

Wyoming Department of Transportation (WYDOT) worked with FHWA and FWS to establish a PBO for all infrastructure upgrades anticipated as part of the state's five-year Transportation Improvement Plan (STIP), assessing all impacts on federally listed endangered, threatened, proposed, and experimental non-essential species. The PBO resulted in two Incidental Take Permits for the Preble's meadow jumping mouse and the bald eagle. Previously, Wyoming experienced a high volume of individual §7 consultations and consolidation of the entire STIP into one PBO presented an efficient avenue to save agency time and resources (Venner 2010a; U.S. Federal Highway Administration 2006).

In addition to introducing flexibility into compensatory mitigation options, the CDOT Preble's meadow jumping mouse PBO proved valuable because of efficiencies in transaction costs. The PBO allowed both CDOT and FWS to avoid project-by-project §7 consultation and proceed with the permitting process faster than usual. Due to the PBO, CDOT now can more accurately forecast and allocate future project costs and CDOT's Preble's conservation bank will quicken transportation project implementation in at least two watersheds (Wostl 2003; U.S. Federal Highway Administration 2010).

Wisconsin Department of Transportation (WisDOT) is the only DOT participant in a statewide Habitat Conservation Plan (HCP), joining with 25 additional partners as part of a widespread HCP for the Karner blue butterfly, a federally listed endangered species. The Wisconsin Department of Natural Resources (WDNR) is the primary holder of the HCP, which also promotes the well-being of several state-listed and federally-listed species of concern. As long as WisDOT meets the terms of its HCP implementation agreement with WDNR and FWS, they are assured expedited ESA consultation; WisDOT simply submits a description of how transportation projects conform to the HCP and WDNR and FWS briefly review the prospective projects for HCP compliance.

Finally, FHWA also highlights additional PBO or programmatic biological assessment (PBA) agreements designed to expedite the ESA §7 consultation process between resource agencies and state DOTs. WSDOT, FHWA, and FWS have settled on a PBA covering impacts to all terrestrial species in the Olympic Region of Washington. Additionally, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) is implicated in ESA §7 consultation in Washington following the federal listing of salmanoids; NMFS and FWS are currently reviewing a statewide PBA addressing all aquatic species in Washington. In West Virginia, the state's Division of Highways (WVDOH), Division of Natural Resources (WVDNR), FHWA, and FWS are parties to a programmatic ESA §7 consultation agreement. WVDOH analyzes the ecological impact of minor transportation projects based on available geospatial and other data and if the project complies with preset standards, the need for additional ESA consultation is obviated. Oklahoma DOT (OKDOT), with approval of the FWS Tulsa office, is implementing a PBO to manage transportation-based impacts to the federally-listed, endangered American Burying Beetle through the year 2012. Under the PBO, OKDOT and FHWA will mitigate impacts through monetary contributions to an American Burying Beetle conservation fund, avoiding individual project delays and excess expenditures for the transportation agencies. FWS can also minimize the fragmented nature of project-by-project habitat compensation measures and pursue landscape-level approaches to bettering beetle survival. The Alabama DOT (ALDOT) has also moved beyond project-by-project compensatory mitigation for impacts to the federally-listed, threatened gopher tortoise, which was particularly vulnerable to prospective highway expansions and general development. With approval of FWS, ALDOT obtained over 600 acres of gopher tortoise habitat for use as a conservation bank (U.S. Federal Highway Administration 2010).

Environmental Cost-Savings: Including Ecosystem Services Valuation Under a Progressive Approach

In addition to promoting more efficient use of transportation and resource agency funding, holistic, landscape-scale approaches to infrastructure planning can enhance the functional capacity, and potentially the societal value, of compensatory natural resources (Brown 2006; National Research Council 2005). Currently, many of these ecosystem functions are economically undervalued; however they provide valuable services to nearby human populations (Engel et al. 2008). For instance, in addition to traditionally valued ecosystem services such as timber and fish production, wetlands are well-known for their ability to, among other things, filter excess pollutants and nutrients, reduce flood hazards, absorb storm surge, and provide unique recreational or scientific opportunities (Mitsch and Gosselink 2000; Zedler 2003). Biodiversity protection for endangered species supplies additional value for human populations (Loomis and White 1996). In order to fully evaluate the costs and benefits associated with programmatic, large-scale mitigation approaches, transportation and resource agencies should account for the costs (impacts) and benefits (mitigation) of the ecosystem services involved in landscape-scale transactions in natural resources. More ecologically effective avoidance, minimization, and compensation can preserve these tangible values provided by aquatic resources and endangered and threatened species, including additional economic benefits for ecosystem-scale analysis of transportation impacts.

Collaboration between permitting agencies and transportation planners before significant funds are expended on infrastructure project design and siting increases flexibility to accommodate alternative road routes, allowing proper avoidance and minimization of impacts to aquatic resource or endangered species habitat (White et al. 2007). Compensatory mitigation providers, whether internal or external, can also identify restoration sites of strategic importance to watershed or landscape health, allowing for better replacement of functions and services lost through authorized impacts to aquatic or endangered species resources (U.S. Department of Defense and U.S. Environmental Protection Agency 2008; U.S. Fish and Wildlife Service 2003). Compensatory mitigation under an ecosystem approach strives to address the most pressing landscape-scale needs; this may include providing compensation through non-regulated resources or through out-of-kind replacement (National Research Council 2001; U.S. Department of Defense and U.S. Environmental Protection Agency 2008). In addition to achieving enhanced ecosystem function, siting compensatory mitigation projects and considering proper avoidance and minimization at the proper spatial scale can ensure that these functions are serving human populations, and thus are more economically valuable to society (Mitsch and Gosselink 2000; King and Herbert 1997). Consolidated compensatory mitigation may also allow regulators to monitor ecological performance standards at compensation sites more regularly, which may improve compliance and provide better environmental results (Sapp 1995).

Measuring ecosystem functions, the spatial scales on which they operate, and their subsequent social value is a difficult and tenuous task (Kremen and Ostfield 2005). Ecosystem services are divisible into four broad categories: provisioning services, supporting services, regulating services, and cultural services (Millennium Ecosystem Assessment 2003). Each of these ecosystem service categories presents unique challenges for economic valuation (Kremen and Ostfield 2005). A number of case studies based on surrogate conversion factors for ecosystem service value have been conducted (e.g. Costanza et al. 1997; Sutton and Costanza 2002), yet a precise ecological understanding of the many natural benefits provided by an ecosystem, along with a widely applicable methodology for ecosystem service valuation, are lacking (Kremens and Ostfield 2005). However, a number of emerging tools are attempting to fill this void by allowing decision makers and corporate entities to identify the value of ecosystem services and the specific populations they serve in an effort to better target restoration or preservation (Waage et al. 2008).

Five leading ecosystem service valuation tools are available or currently in development which may be useful to practitioners in resource agencies or transportation planning. These tools may help prioritize natural resources, either through avoidance, minimization, or compensation, which will provide the most economic value to society. An introduction to each tool is provided below. Of these, ARIES, InVEST, and MIMES will likely be the most applicable tools for use in environmental regulation and transportation planning projects.

- ARIES (ARtificial Intelligence for Ecosystem Services): ARIES is a joint project of University of Vermont's Ecoinformatics Collaboratory, Conservation International, Earth Economics, and Wageningen University. Despite a complex model foundation, ARIES is a user-friendly, web-accessible tool. The ARIES model is a "decision-support infrastructure to assist decision makers and researchers by estimating and forecasting ecosystem services provision and their correspondent range of economic values in a specific area."
- ESR (Ecosystem Services Review): ESR, designed by the World Resources Institute (WRI), the Meridian Institute, and the World Business Council for Sustainable Development (WBCSD), is primarily targeted at corporate users and is the most experienced of these tools in the corporate environment. ESR is "a sequence of questions that helps managers develop strategies to manage risks and opportunities arising from a company's dependence on ecosystems" and supplies guidance on ecosystem service valuation.
- InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs): InVEST was developed by the Natural Capital Project, a collaborative effort between the Stanford University Woods Institute for the Environment, the Nature Conservancy, and the World Wildlife Fund. InVEST is "a decision-making aid to assess how distinct scenarios may lead to different ecosystem services and human-well-being related outcomes in particular geographic areas." InVEST developers are also progressing towards creating an ArcGIS extension version of the tool.
- MIMES (Multi-scale Integrated Models of Ecosystem Services): MIMES is a product of the University of Vermont's Gund Institute for Ecological Economics; it is "a multi-scale, integrated suite of models that assess the true value of ecosystem services, their linkages to human welfare, and how their function and value may change under various management scenarios." MIMES is open source and can provide valuation outputs of money, land area, or other metrics.
- NVI (Natural Value Initiative): The NVI is a project of Fauna and Flora International, the Fundação Getúlio Vargas Business School in Brazil, and the United Nations Environmental Programme Finance Initiative. NVI is principally focused on use in the corporate and financial sectors, providing "an evaluation benchmark methodology for assessing biodiversity and ecosystem services-related

risks and opportunities in the food, beverage and tobacco sectors" (Waage et al. 2008).

Use of these tools, or other methods, to integrate the economic value of non-market ecosystem services into mitigation approaches can provide a more complete picture of the overall costs and benefits of a prospective transportation project.

Barriers to Progressive Mitigation Approaches

Moving from traditional, project-by-project compensatory mitigation procedures to adoption of a holistic, landscape approach which incorporates natural resource concerns into early stages of transportation planning presents many challenges. Primarily, barriers to the implementation of these progressive mitigation strategies are encompassed in three broad categories: resource constraints, institutional constraints, and process-based constraints.

Resource Constraints

All transportation and resource agencies operate under budget constraints, and while progressive mitigation strategies present opportunities for long-term efficiencies and cost-savings, transitioning to more holistic approaches requires investment. Resource constraints may slow implementation of these innovative, streamlined programs, primarily due to the need for detailed data and funding constraints.

<u>Data</u>

Watershed and landscape analyses of natural resource conditions, along with subsequent identification on ecologically favorable compensation sites, are heavily reliant upon accurate, high-resolution, and current data. GIS studies are particularly adept for large-scale evaluation of the status and trends of ecological data. Thus, data restrictions, particularly for geospatial data, can serve as a key barrier to implementation of watershed and landscape approaches to compensatory mitigation. Indeed, preliminary results from the SHRP C06 project attribute many regulatory conflicts and costly delays in project delivery to poor-quality or incomplete natural resource data. In the context of ESA §7, available data does not adequately depict how projects will impact listed species; for CWA §404 permitting, SHRP C06 recommends creation of a "wetlands mitigation catalog" with identified, previously approved wetland replacement sites in each watershed (Kagan 2010). The Capital District Transportation Committee (CDTC) of the Albany-Schenectady-Troy, NY area recorded the need for inclusion of specific, prioritized mitigation measures within LRTPs; the CDTC, along with the NC Piedmont MPOs, also had difficulty accessing relevant GIS data, often from decentralized sources. Similarly, the Mid-Ohio Regional Planning Commission listed insufficient geospatial data as a challenge in formulating mitigation planning (Poe et al. 2009).

A recent survey of a number of resource and transportation agencies performed as part of the SHRP C06A project also confirmed the lack of data as a principal difficulty. C06A surveyed the experience and perceptions of resource and transportation agency officials to identify common impediments to successfully managing infrastructure impacts and mitigation at an ecosystem level. Included in the survey were FWS, NMFS, the Corps, EPA, USFS, state resource agencies, FHWA, state DOTs, MPOs or similar regional transportation entities, city, county, and regional governments, and non-governmental organizations. Data concerns, specifically regarding geospatial data needs, were an acute barrier identified by all resource agencies, most transportation departments, and local governments.

Federal resource agency staff generally mentioned encountering similar data-driven problems in implementation of an ecosystem approach. FWS and NMFS survey respondents specifically identified the need for data prioritizing conservation objectives, the Corps noted that geospatial data is often of inadequate resolution or specificity for evaluation of the impacts of a particular project, and EPA noted the need for higher-quality datasets, particularly for the National Wetlands Inventory (NWI). Corps officials also specifically reported difficulties with integrating State Wildlife Action Plans, or other similar conservation plans, into broad watershed or ecosystem objectives. Other common impediments noted by the federal resource agencies were lack of thorough, ecosystem-scale data, particularly for some important species, lack of digitized data, out-of-date datasets, low interagency data sharing, partially due to regulatory constraints, and an inability to prioritize use of the many available GIS data layers. State resource agency personnel cited limited data on projects and the scope of their impacts, along with insufficient data depicting current ecosystem function and trends in resource use, as another obstacle to ecosystem planning.

Many FHWA staff did not identify low data availability as a priority concern in implementing ecosystem approaches to compensatory mitigation. However, some FHWA personnel noted encountering barriers in data sharing restrictions and incompatibility of distinct data sources. Survey results from state DOTs and MPOs revealed an entirely different situation; virtually all state and regional transportation agencies reported lack of adequate data as their main barrier to an effective ecosystem approach. State DOTs and MPOs both mentioned that more data prioritizing conservation objectives and opportunities is needed, with MPOs specifically stating that many local governments have not delimited specific preservation areas. State DOTs and MPOs also agreed that more specific data was needed. Furthermore, state DOTs reported a need for more digitized data while MPOs reported problems with obtaining current data, inadequate data sharing, incompatibility between different data sources, and lack of access to land use plans or urban development modeling tools.

Local city, county or regional governments shared concerns regarding data availability and accuracy, noting that ecosystem concerns integrated into local government plans can provide significant value for downstream users of data, such as MPOs or state agencies (Venner Consulting and URS Corporation 2009).

The Montana ITEEM process also anticipated mobilization and assimilation of technical tools, data, and geospatial data as an impediment to the progress of this *Eco-Logical* pilot project, though the group identified access to a substantial amount of data and data services. In reference to the Statewide Habitat Conservation Plan in place in Montana, the interagency workgroup noted that data of increased spatial specificity was needed to facilitate an appropriate understanding of ecosystem trends. ITEEM also reported that some useful data needed digitization (Hardy et al. 2007).

Funding

The need for significant funding is seen as a major deterrent for potential adoptees of landscape-level planning approaches. Transitioning resource agencies to new regulatory roles and transportation agencies to new planning procedures requires upfront capital for database investment, staff training, staff time, research, collaboration, and adaptive management, among other priorities (Venner Consulting and URS Corporation 2009). Fluharty and Lee (1988) postulate that successful adaptive management requires considerable initial expenditures (Halbert 1993). Louis Berger and Associates' 1997 report on wetland creation and restoration costs noted that use of off-site wetland mitigation may require substantially increased investments for site selection evaluations. One of the NC Piedmont MPOs shared this concern for up-front investment required by SAFETEA-LU, noting that "accounting for mitigation might add time and cost to developing estimates for the LRTP financial plan." The Mid-Ohio Regional Planning Commission also mentioned its undersized staff and inadequate time as a major barrier (Poe et al. 2009).

FWS, NMFS, the Corps, state resource agencies, FHWA, state DOTs, MPOs, and local governments all mentioned high initial investment as a barrier to conducting ecosystem-scale mitigation approaches. FHWA staff reported that upfront funding was hard to acquire due to uncertainty in the end results of streamlined transportation review. Resource and transportation agencies also commonly reported that the staff sizes or staff times required for collaborative landscape-scale objectives were simply not available; this concern was particularly acute for the Corps. EPA and USFS personnel also added that staff time restrictions may be particularly problematic for resource agencies, as they are also obliged to fulfill permitting duties to external parties. Other typical agency needs with limited funding include training sessions and interagency workgroups. Funding impediments particularly relevant to FHWA, DOTs, MPOs, and local governments include the lack of funding for a "full-time champion" or for environmental planners (Venner Consulting and URS Corporation 2009).

Montana's *Eco-Logical* pilot project also encountered funding and time restraints in the interagency workgroup process. Initially, the ITEEM group set out to establish a programmatic agreement that would be useful for managing common, similar transportation impacts. However, although the ITEEM group did follow the *Eco-Logical* guidelines, they eventually had to abandon ambitions of establishing a programmatic agreement because of its extensive time requirements (Hardy et al. 2007).

One of the principal concerns raised in implementation of North Carolina's EEP was the need for significant upfront capital to fund a holistic, advance planning program. Although NC DOT had historically been paying for wetland mitigation activities, they were never segregated into an individual budgetary item. In order to fund its first two operational years, EEP requested $200 million from the DOT Board. The DOT board acquiesced to paying for the program due to significant expected cost- and time-savings down the road (Anderson 2005).

Institutional Constraints

Institutional barriers to early consideration of transportation-related impacts and mitigation are another leading obstacle to moving beyond traditional, project-by-project mitigation approaches. Collaboration between resource and transportation agencies with conflicting missions poses significant challenges, as does internal resistance to progressive approaches. Political pressures may also rush or modify alternative mitigation strategies and resource agencies may encounter difficulties in formulating substantively valuable input at early project stages. Statutes, regulations, guidance, or other regulatory directives may also hamstring an agency's ability to proceed with an ecosystem approach.

Finally, agencies experiencing high staff turnover may find the transition from project-by-project mitigation more challenging (Venner Consulting and URS Corporation 2009).

Resistance

Internal resistance to implementing ecosystem approaches to compensatory mitigation is commonly identified as a significant impediment to progress. Regulators and transportation planners are often comfortable with project-by-project approaches and may feel that the process of moving to a different, novel permitting system is unnecessary or unwieldy. SHRP C06A's survey also regularly identified the lack of adequate incentives or the presence of disincentives to modify regulatory or planning practices as sources of this agency resistance.

Federal resource agencies provided several examples detailing why their staff were unwilling to adopt progressive mitigation standards. FWS reported that regulators were uneasy with use of non-traditional mitigation measures, hesitant to grant regulatory assurances prior to permitting or issuance of a BO, and hesitant to grant regulatory assurances without site-specific impact data. Corps survey respondents agreed that resistance to more programmatic permitting approaches was generated by unfamiliarity with using landscape planning data prior to receiving permit applications. EPA reported that "resource agency cultures are also not currently supportive of staff involvement in transportation systems planning activities" and that agencies were resistant to become involved in transportation review before planning reached the project level (Venner Consulting and URS Corporation 2009). In addition, the Corps noted that EPA staff were hesitant to utilize alternative metrics for ecosystem function in place of traditional, surrogate metrics such as acres or linear feet. FHWA surveys mentioned that, in general, resource agency headquarters personnel did not promote use of progressive mitigation approaches; another FHWA response noted that resource agency field staff were not making a concerted effort to implement ecosystem approach guidance. State resource agency staff in some regions were also noted as not seeing ecosystem-scale planning as particularly advantageous or necessary.

Transportation agencies also discerned staff reluctance to adopt progressive mitigation strategies as a key barrier to their implementation; nearly 90% of FHWA survey respondents mentioned institutional resistance as a problem. In multiple FHWA responses, the survey revealed that project leaders were promoting traditional mitigation methodology or that upper- and lower-level staff were in disagreement over mitigation approaches. The survey also identified another source of major institutional reluctance: many federal transportation planning staff believe that, at any cost, environmental investments are detrimental to highway efforts. DOTs also report that some staff resist landscape approaches because they believe that upfront, multi-agency environmental evaluations will impose significant delays on transportation project delivery. State DOT and MPO surveys mentioned certain staff as being particularly resistant to progressive approaches: some biologists are reluctant to shift from jobs involving field work to jobs primarily consisting of GIS-based, landscape analysis, and some engineers resist advance environmental planning because of a tendency to rely on technological fixes in later project phases. This highlights the obstacles that DOTs and MPOs face in "break[ing] the traditional roles of planners, engineers, and environmental staff" (Venner Consulting and URS Corporation 2009). Additionally, both resource and transportation agencies involved in the Montana ITEEM pilot project raised concerns over institutional approval, along with public approval, of a holistic approach to mitigation (Hardy et al. 2007).

The SHRP C06A survey additionally identified inadequate incentives, or in some cases disincentives, to transition to progressive mitigation approaches as a substantial barrier to improvement. Resource agencies noted that existing regulatory practice creates incentives for staff to become involved in transportation review primarily at the project level, after some planning has taken place, because of a focus on avoiding environmental impacts at that stage; this misses opportunities for resource agencies to push avoidance in early planning phases. Corps respondents also reported that there was no avenue for pre-application input in transportation project planning. FWS staff specifically mentioned that resource agencies were reluctant to accept increased risk associated with future project impacts. FHWA staff agreed, reporting that present regulatory arrangements are predictable and that transportation staff are comfortable with the regulatory process, providing little motivation to shift to new methods that are seen as risky. Similarly, transportation departments noted a lack of adequate assurance from regulatory agencies that agreements reached early in planning processes would be honored later. DOT responses provided further disincentives to conducting ecosystem-scale analysis, noting that there is often heavy internal and external pressure to finish transportation projects, and that these pressures may preclude investing time and funding in environmental planning at early project stages (Venner Consulting and URS Corporation 2009).

Conflicting Agency Missions and Lack of Collaboration

The SHRP C06A study reported that FWS, NMFS, FHWA, state DOTs, and MPOs see differences in agency missions as a significant impediment to implementation of a landscape approach to compensatory mitigation. Among resource agencies, FHWA reported that each agency seems focused on managing the resources they oversee, with less concern for ecosystem trends in other resources. Corps survey participants highlighted that their agency has a limited mission, focused principally on ensuring compensatory mitigation requirements are fulfilled, and that they are not a conservation agency. Corps staff also noted that their ability to evaluate smaller projects in the ecosystem context was limited. FHWA Divisions and DOTs were also implicated as seeing holistic mitigation planning as outside the scope of their mission and responsibility (Venner Consulting and URS Corporation 2009). Montana's pioneering ITEEM effort also anticipated challenges in implementing the *Eco-Logical* framework due to dissimilar agency missions and documented specific "interests of issue" that could instigate conflict between involved agencies (Hardy et al. 2007).

Resource and transportation agencies also reported inadequate collaboration, or an inability to collaborate, as a barrier to progressing beyond traditional mitigation. Some EPA staff specifically mentioned trouble working with the Corps, noting that in many cases their performance measures and budgeting processes were incompatible with advance planning. Corps personnel reported that a lack of information sharing with permittees was impeding progress and that agencies are reluctant to distribute datasets describing listed species positions or critical habitat. Corps, FWS, and state DOT staff shared the concern that assembling effective interagency workgroups was difficult. FHWA surveys also noted that disagreements between federal and state resource agencies were impeding progressive mitigation. Some state DOTs mentioned the need for enhanced inclusion of nonprofit entities in the transportation planning process. FHWA and state DOT responses also concurred that entrenched bureaucracy was stalling interagency collaboration (Venner Consulting and URS Corporation 2009). Multi-level, interagency collaboration was also hampered in some instances by an absence of "group chemistry"; in fact, the

Montana ITEEM process felt that group chemistry was one of its issues of "greatest concern" in applying the *Eco-Logical* framework (Hardy et al. 2007).

Legal and Regulatory Constraints

Obligations for permit processing or transportation planning, as imposed by law, regulation, or suggested in guidance, may limit an agency's ability to adopt watershed or landscape considerations into transportation projects. The Corps mentioned that the CWA 404(b)(1) guidelines, which set forward the avoid, minimize, and compensate sequencing requirements for mitigation, were inflexible and did not allow mitigation to be approved before analysis of project impacts. Moreover, FHWA staff concluded that regulators were not allowed enough flexibility to use ecoregions for mitigation compensation. Some FHWA divisions identified state statutes or regulations protecting wetlands as preventative to programmatic approaches. FHWA personnel also mentioned that there were no legal requirements imposing use of an ecosystem approach in LRTPs. State DOT personnel added that compensatory mitigation ratio requirements and reluctance to use preservation as compensation were impeding holistic resource management. FWS also mentioned that few resource agencies were taking advantage of the opportunity to file Fish and Wildlife Coordination Act (FWCA) reports under of ESA §7(a)(1) (Venner Consulting and URS Corporation 2009). Interestingly, Oregon's 400-bridge PBA encountered requirements to carry out conservation programs under ESA §7(a)(1) and reports that solving this conservation obligation was "considerably difficult," but was eventually resolved (Bonoff et al. 2005).

Substantive Value of Early Input

Resource agencies also mentioned encountering difficulties with providing input of substantive value at early transportation project planning stages. Resource agency personnel do not always know the proper time to consult with transportation planners on project planning, as input at very early stages of project planning may be of little value due to the generality of future projects and resource agency input. In contrast, some agencies may delay project implementation by submitting specific comments too late. Indeed, five of the agencies involved in Montana's ITEEM process reported challenges with submitting comments on transportation projects at the appropriate time. Timing also eventually caused the ITEEM project to shift highway corridors, from US93 to MT83, noting that "[p]rojects that have completed the NEPA process are too far along in the planning effort to allow for negotiating creative mitigation trade-offs" (Hardy et al. 2007). The Mid-Ohio Regional Planning Commission also had trouble obtaining project input from resource agencies in early stages of SAFETEA-LU consultation due to the absence of specific project information (Poe et al. 2009).

Resource agencies are grappling with the change in scope associated with streamlined transportation review; regulators are accustomed to evaluating site-specific data and impacts instead of managing a holistic, regional suite of functional trends and characteristics. Moving from the position of regulator to that of an environmental manager can be challenging (Venner Consulting and URS Corporation 2009). The Baltimore Regional Transportation Board (BRTB) and the Maryland State Highway Administration (MDSHA) also had trouble motivating all stakeholders to shift from a project-by-project mindset to evaluate holistic ecological impacts. Due to struggles with providing valuable, early input, some resource agencies have conceded that they do not see early planning as the correct stage to target their efforts. Finally, a lack of resource agency support has been documented in case studies of MPOs implementing the SAFETEA-LU §6001 requirements; for instance, in North Carolina, the Piedmont Area MPOs noted that they initially received no response from resource agencies when they solicited inquiries for early environmental review (Poe et al. 2009).

Political Pressure

Political considerations have also hindered adoption of a holistic, ecosystem-based approach to mitigation. SHRP survey respondents noted that political pressures to quicken transportation projects and accelerate regulatory approval processes could prevent use of progressive approaches. In addition, FWS and the Corps noted that political demand to contain compensatory mitigation within political boundaries, specifically at the state, county, or municipality level, could prevent use of a landscape approach to identify compensation sites of the highest functional quality. At a local level, city and county governments mentioned that politicians may be disposed to allow losses of natural resources in exchange for increased local tax revenue; they also reported that local zoning ordinances may not be consistent with environmental objectives (Venner Consulting and URS Corporation 2009).

Staff Turnover

Staff turnover, both at agencies and at regularly utilized consulting firms, was another obstacle to progressive mitigation approaches reported in the SHRP C06A survey. Staff turnover at regulatory or transportation agencies can delay projects and put previous regulatory assurances into question. In ESA §7 consultation, staff turnover within FWS and at state DOTs have been problematic; Corps respondents also mentioned staff turnover as an impediment to prioritizing mitigation needs (Venner Consulting and URS Corporation 2009). In addition, the MAG identified staff turnover at resource agencies as detrimental to mitigation consultation (Poe et al. 2009).

Process-based Constraints

After moving beyond resource and institutional restraints to implementation of a holistic approach to mitigation, transportation permittees and regulatory agencies are still faced with a number of pressing dilemmas regarding the actual structure and process used to achieve ecosystem-scale objectives. First, agencies have voiced concerns about the ambiguity of the ecosystem approach and the need for specific instruction on its implementation. Montana's ITEEM process encountered problems resolving "ambiguity" associated with applying the *Eco-Logical* guidelines, noting that converting the framework into discrete tasks for agency personnel was challenging (Hardy et al. 2007). The NC Piedmont MPOs also reported misunderstanding and disagreement among the resource agencies regarding the information necessary for incorporating mitigation into LRTPs (Poe et al. 2009).

Similarly, various staff at the Corps, EPA, FHWA, and state DOTs recalled problems either understanding what ecosystem planning entailed or lack of adequate knowledge to apply an ecosystem approach. Some Corps staff reported unfamiliarity with watershed planning. Furthermore, staff responses from state DOTs indicated a significant learning curve associated with applying a landscape approach; in particular, DOTs expressed unease with analyzing cumulative impacts over larger spatial scales and indicated that environmental consultants were unfamiliar with processing ecosystem-level data (Venner Consulting and URS Corporation 2009). Some resource agencies, along with the BRTB, indicated that unease with ecosystem approaches were due to a need for more examples of successful programmatic approaches (Venner Consulting and URS Corporation 2009; Poe et al. 2009).

Other impediments to ecosystem-scale approaches are more specific and structural in nature, dealing with the design of ecosystem-scale monitoring programs, designating the appropriate spatial scale for environmental evaluation, designing functionally consistent credit/debit systems, designating performance standards for compensation sites, conducting separate accounting for mitigation costs, and receiving credit for early compensation or compensation “above and beyond” requirements (Venner Consulting and URS Corporation 2009). The San Diego Transnet environmental mitigation program reported concerns with proactive mitigation being treated predictably in the future (Poe et al. 2009). Montana’s ITEEM pilot project projected encountering barriers in accounting for early, excess mitigation efforts and in defining the spatial scope of impacts to be evaluated; the *Eco-Logical* pilot also had trouble developing a “defendable” credit and debit system that satisfied all involved agencies (Hardy et al. 2007).

In addition, fundamental problems have been identified with large-scale, multi-species HCPs for endangered species. Multi-species HCPs are often ineffective when they manage species with little or no recorded presence in the plan area, and have also been charged with being less successful at achieving species recovery because of inadequate attention to the ecological requirements of individual species. HCPs may be particularly problematic when they are implemented over both federal and nonfederal lands, as occurrence and species needs data may not be quantified outside of federal domain (Suzuki and Olson 2007). HCPs requiring the coordination of multiple landowners may also be troublesome due to collective action problems (Raymond 2006).

Interview Summary

Introduction

Purpose & Goals of Interviews

The goals of the Task 1 interviews were to:

- Identify the range of emerging approaches to progressive compensatory mitigation being carried out or considered in both the §404 permitting program and the § 7 consultation process;
- Articulate the progress that is being made to transition to progressive compensatory mitigation strategies; and
- Summarize the perceived and real obstacles to implementing them at the field/district level.

The research team conducted targeted interviews with key Federal and state agencies, as well as relevant agencies and organizations, to identify the range of emerging approaches to mitigation being carried out or considered in both the §404 permitting program and the §7 consultation process.

This component of the research allowed us to summarize the progress that is being made to transition to these more progressive approaches to mitigation decision-making and to summarize the perceived and real obstacles to implementing these approaches at the field/district level.

Methodology

The project team contributed to assembling a list of key individuals to interview. The central priority for identifying interviewees was to find individuals with a national perspective on emerging approaches to mitigation under §404 of the Clean Water Act (CWA) and §7 of the federal Endangered Species Act (ESA). We intended to identify individuals from national/regional federal and state agencies and organizations that track innovative approaches to mitigation. The NCHRP Review Panel provided the research team with feedback on interviewees and specific questions that should be considered during the Task 1 interviews. The list of interviewees was reviewed by the NCHRP Review Panel. The final list is attached (see Attachment A).

The research team collectively developed a standardized form to guide the interviews (see Attachment B). Interviews were conducted by individual team members and synthesized below.

Once the interviews began, the team was able to eliminate nine individuals who we deemed to be unnecessary due to overlapping responses or agreement among team members that the individual would not have a value-added perspective (i.e., no longer working in the identified program area).

The current range of approaches to compensatory mitigation and examples

Interviewees were asked to characterize the range of approaches that are currently being taken to compensatory mitigation and indicate, in their opinion, where on the spectrum the approaches stood, from "traditional" to "innovative" approaches.

Clean Water Act

In the context of §404 of the Clean Water Act, the responses can be grouped by 1) the method used to identify compensatory mitigation projects and/or evaluate proposed compensatory mitigation projects; and 2) the mechanism for delivering the mitigation, i.e., the method of the offset. References for all of the examples listed below will be gathered during Task 2.

Method used to identify compensatory mitigation project sites/design projects included:

<u>Traditional:</u>

- The most traditional/least innovative approach is letting the permit applicant or mitigation provider suggest their preferences for sites on a project-by-project basis. This approach often relies on best professional judgment, which may be guided by a deep understanding of local needs. Ultimately, however, sites selected using this approach are generally chosen opportunistically to minimize cost, rather than maximize environmental outcomes. This approach was articulated by several interviewees.[4]

<u>In between traditional and innovative:</u>

- Single-priority analysis: When a permit applicant or mitigation provider identifies sites through the prism of one priority, i.e., threatened and/or endangered species on the property or the ability of a site to provide linkages to exiting protected lands.
- Mitigation guidelines: These are more qualitative approaches that are designed to guide mitigation providers to make better site selection decisions. These are often developed by Corps districts and states. They represent an effort on the part of regulators to be more proactive and convey to mitigation providers what types of projects they would like to see. They are not, however, tied to the landscape directly. Although more proactive than the traditional approaches, this mechanism does not necessitate the same level of effort and review as the watershed approach, nor does it directly include a consideration of past or cumulative resource losses or resource needs. Examples include:
    - Virginia's off-site mitigation location guidelines (design considerations, constraints, benefits) (U.S. Army Corps of Engineers, Norfolk District 2008).
    - Guam.
    - See also guidelines identified by the Environmental Law Institute in support of the Interagency Review Team Training.

[4] One interviewee suggested McKenney and Kiesecker 2010, an article summarizing this approach.

- Decision-making flowcharts/Hierarchical approaches: These approaches provide regulators with a framework for evaluating mitigation proposals by prompting questions that require the proposal to be evaluated with specific end criteria in mind. An example includes:
  - Framework developed in Washington State, “Selecting Wetland Mitigation Sites Using a Watershed Approach”(Hruby et al. 2009).

Innovative:

- The “Watershed Approach” to compensatory mitigation. This approach, articulated in the 2008 Compensatory Mitigation Rule (U.S. Department of Defense and U.S. Environmental Protection Agency 2008) and the 2001 National Research Council study on compensatory mitigation (National Research Council 2001), entails a more strategic, analytic approach to siting and design that relies on a robust analysis of a suite of data/information on the watershed in which the mitigation project is being proposed. Another interviewee described the approach as analyzing a watershed’s functional deficiencies and using compensatory mitigation as an opportunity to improve the overall condition of a watershed.
- This approach was articulated by every one of the interviewees with §404 expertise. Examples include:
  - The 4 watershed approach pilots sponsored by the U.S. Army Corps of Engineers/U.S. Environmental Protection Agency.
  - The 2 watershed approach pilots sponsored by the Environmental Law Institute/The Nature Conservancy.
  - Special Area Management Plans that look at the potential range of projects in a particular geographic area. These involve collaborative study efforts between the Corps and one or more local partners.
- State-sponsored in-lieu fee programs that have sought to identify compensatory mitigation opportunities on a watershed basis. Under the 2008 Compensatory Mitigation Rule, in-lieu fee programs are now required to undertake development of a “compensation planning framework,” which is essentially a watershed approach planning exercise. In-lieu fee programs that provide such an example include:
  - North Carolina Ecosystem Enhancement Program.
  - New Hampshire in-lieu fee program.
  - Oregon Department of State Lands.
  - Virginia Aquatic Resources Trust Fund (TNC).
  - Kentucky Department of Fish and Wildlife.
- Avoidance and minimization analysis: These efforts - generally spearheaded by – planning staff in state departments of transportation, MPOs, or state agencies – include an analysis of projected future anticipated impacts. Examples include:
  - North Carolina Ecosystem Enhancement Program.

- California Statewide Advance Mitigation Initiative (SAMI) and Regional Advance Mitigation Planning (RAMP).

The mechanism for delivering the compensatory mitigation:

Traditional:

- On-site, in-kind projects undertaken as close as possible to the impact site.

Innovative:

- Banks and in-lieu fee programs. Examples included:
    - Arkansas program in coordination with the state department of transportation and the U.S. Fish and Wildlife Service (FWS).
    - Michigan's banking program.
    - The San Diego Association of Governments (SANDAG) Environmental Mitigation Program, which provides mitigation banking in advance through a voter-approved sales tax. The money provides a strong incentive for partners to come to the table.[5]
- Approaches that allow for impacts to be mitigated out-of-kind, through preservation, upland activities, removal of upland stressors, or establishment of corridors. Although this approach does not support the national "no net loss" goal, it allows for the removal of watershed and aquatic resources stressors.

Endangered Species Act

In the context of §7 of the Endangered Species Act, the responses again can be grouped by 1) the method used to identify compensatory mitigation projects and/or evaluate proposed compensatory mitigation projects; and 2) the mechanism for delivering the mitigation. The interviewees identified the following approaches:

The mechanism for delivering the compensatory mitigation:

Traditional:

- Project-by-project approach.

Innovative

- Safe Harbor agreements.
- Candidate conservation agreements.
- Multi-jurisdictional collaboration, consultations, and partnerships (i.e., San Francisco).[6]

[5] See: http://www.sandag.org/index.asp?projectid=263&fuseaction=projects.detail

[6] Example HCPs to be provided by Therese Conant, NOAA National Marine Fisheries Service.

Method used to identify compensatory mitigation project sites/design projects included:

Traditional:

- Permit by permit consultations.

Innovative

- Programmatics: Application of §7(a)(1) to consultations for large programmatic government undertakings – very broad scale with very little detail. These are agreements on data, conservation measures, or mitigation that could be used to meet regulatory requirements en masse. This approach supports streamlining and reduces transaction times. Some examples are:
  - Oregon Bridges project.[7]
  - Bureau of Land Management solar program.
  - Bureau of Land Management and wind energy.
  - California and Southeast programmatics.
  - Indiana bat programmatic project. Approximately 12 states have signed onto the agreement.
  - Sacramento project (1995) that related to vernal pools and the fairy shrimp in 1995.[8]
- Conservation bank site selection that relies upon FWS regional plans and objectives, including State Wildlife Action Plans. These examples include banks that have been sited based on the historic range of species.
  - Case studies developed by Fox and Gardner for The Conservation Fund Conservation Banking course.[9]

Characterization of the progress being made to progressive approaches

All 10 of the interviewees responded to a request to characterize the progress that is being made to the progressive approaches they identified above. All 10 of the respondents felt that some progress was being made, but their level of optimism varied. Of the 10 respondents, half (5) indicated that although there is some progress being made, it is being made very slowly and limited. One respondent expressed skepticism about the strides being made with watershed planning. Another stated that initially, it appeared that a lot of progress was being made but that movement has slowed or even stalled. Two individuals stated that they are not seeing the transition uniformly across field staff, but rather that where innovation is happening it is largely due to individual initiative.

---

[7] See: http://www.fhwa.dot.gov/everydaycounts/projects/toolkit/programatic.cfm; http://environment.transportation.org/documents/programmatic_agreement_toolkit/main.html; and http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2813%29_FR.pdf.

[8] Additional reference needed from Mike Horton.

[9] See: http://www.conservationfund.org/conservation_bank_case_studies.

The remaining five respondents voiced more optimism toward the progression to a more innovative approach to compensatory mitigation. Some of the examples that were cited include field staff utilizing §7(a)(1) of ESA and local/state efforts to build the baseline data necessary to support ecosystem/watershed-scale analysis. Initiatives at the state level were cited by two respondents. Two respondents attributed this transition to the 2008 Compensatory Mitigation Rule.

Perceived and real obstacles to implementing the progressive approach

Interviewees were asked to characterize the perceived and real obstacles to implementing the progressive approach to compensatory mitigation at the field/district level.

The most frequent obstacle (6) identified was bureaucratic inertia, lack of leadership, or cultural resistance to adopting a new approach. One (1) respondent noted that there is currently no leadership at the top levels of government to guide this approach and no coordination among federal agencies. One (1) respondent stated that significant differences in how regulations are interpreted ("regulatory idiosyncrasies") – between agencies and within the same agencies – limit the transition to a more progress approach. One respondent (1) stated that there was willful resistance within specific agencies to allowing the flexibility that would support more progressive approaches.

The majority of respondents noted that the resource limitations of the federal agencies were a significant obstacle. Two respondents (2) noted general resource limitations. Four interviewees (4) noted financial limitations. For example, one noted that state departments of transportation no longer have the same level of funding that they had in the past. The respondent stated that the result is that these agencies no longer have a strong interest in and incentive for undertaking these collaborative efforts. One (1) respondent stated a general lack of technical capacity and four (4) respondents noted that limitations in staff time were a significant obstacle. For example, the time it takes to coordinate between players and gather data is a limitation. In addition, another interviewee noted that regulators are more reactive in nature than pro-active; they view their job as processing permits and they have little opportunity or encouragement to be pro-active. One (1) respondent noted that data limitations were significant. The interviewee stated that there are many analytical constraints, including a lack of appropriate data, difficulties in obtaining available data, challenges in how to analyze data, and lack of sharing between permit applicants to help guide better avoidance, minimization and compensation planning. Finally, one (1) interviewee noted that a lack of training opportunities is an obstacle.

Two (2) respondents indicated that the absence of analytical frameworks or examples on how to carry out a progressive approach, or the technical difficulty of doing so, was a significant obstacle. One interviewee noted that at a strategic, national level not much is being done to develop transferrable methodologies.

Several additional comments are worth noting. One interviewee stated that the perception that wetlands mitigation has not been entirely successful undermines momentum for creativity. Another respondent stated that there is fear among the agencies that the watershed approach will be viewed by the public as a mechanism that allows too much flexibility and that it will lead to the regulatory agencies losing sight of the program's key goal of aquatic resource replacement.

Two interviewees offered specific examples of how the §404 programs policies inhibit more progressive approaches. One noted that the §404 program's no net loss goal inhibits creative, watershed-based ecological projects. Another stated that the 2008 Compensatory Mitigation Rule restricts flexibility because of the preference for banking; this preference leads to less out-of-kind mitigation.

Key actions that would allow or support the transition to a progressive approach

Interviewees were asked which key actions would allow or support the transition to a more progressive approach to compensatory mitigation. Six (6) of the respondents stated that case studies, pilots, general research, and syntheses of existing efforts would support the transition. For example, one respondent stated that additional watershed approach pilot efforts should be undertaken by qualified agencies and organizations. The respondent added that having enough pilots to allow for a synthesis of the different efforts would advance the transition. Three of these respondents also noted that documentation of the state of the practice would support this transition. Finally, one interview stated that "people need a vision of what 'it' is."

Four (4) interviewees suggested that the key to advancing a more progressive approach was leadership, policy development, and/or political will. One respondent stated that the regulatory agencies need to push transportation agencies to undertake advanced planning. Another suggested that the Federal Highway Administration and U.S. Environmental Protection Agency make it clear to the leadership of the U.S. Fish and Wildlife Service that taking these alternative approaches is a priority. One interviewee suggested that it would help to have a clear, agency-level statement of commitment for taking a regional/watershed approach. In addition, another respondent suggested that guidance on *how* to carry out the approach would also be needed. Finally, one interviewee stated that, in the §7 context, the FWS would need to hold regions accountable for taking the approach. Headquarters would need to not only require it, but would also need to check to determine how staff achieved the objective.

Three (3) interviewees suggested that training and/or outreach activities on how to carry out an ecosystem-based approach and the importance of doing so would help advance the adoption of such an approach. One respondent specifically noted that the lessons learned from the pilot projects should be disseminated.

Two (2) respondents stated that development of a step-by-step framework for carrying out an ecosystem-/watershed-based approach would help advance its adoption. One interviewee noted that we need to move from the broad policy guidance to a framework. At each step, the question needs to be framed and then the "how to" needs to be laid out. The "how to" can be the use of tools. For example, if one of the steps is "take ecosystem functions into account," how specifically that step should be carried out needs to be described.

The remaining four (4) comments were only noted by one interviewee each. One respondent suggested that the development and maintenance of centralized, national data layers would support more holistic analysis. Another stated that the development of decision support tools, risk-analysis tools, and enhanced GIS capacity in the regions would help advance the adoption of more progressive approaches. One respondent noted that, in the §7 context, better integration of and coordination between recovery and consultation staff would be a big improvement. Finally, one interviewee suggested that enhanced Congressional oversight and reauthorization of the Endangered Species Act, clarifying some of the ambiguities of the Act, would be a positive advancement.

Published reports or studies

Interviewees were asked if there were aware of any published reports/studies that characterize these traditional and progressive approaches. They were also asked if they were aware of any studies or information that documents the ecological and economic costs and benefits of each (i.e., information on transaction cost- and time-savings, streamlining, and mitigation cost-savings).

The majority of respondents stated that they were unaware of any published reports or studies such as those above. Below is a list of the resources provided by interviewees. Research team members will continue to follow-up with interviewees to assemble the information below.

- There may be a Keystone report that could be useful.
- Some documentation of how bank siting relates to regional conservation efforts was collected for The Conservation Fund conservation banking course. (Received.)
- Some data may be available in the draft or final Environmental Assessment for the 2008 Compensatory Mitigation Rule. See:
    - http://water.epa.gov/lawsregs/guidance/wetlands/upload/2006_03_21_wetlands_pdf_DraftEAandRA.pdf
    - http://www.saw.usace.army.mil/WETLANDS/Mitigation/2008-Updates/comp_mitig_analysis.pdf
- FHWA just finished doing a national survey to load all of the known programmatics into a database. Of the approximately 290 programmatics identified, 132 are "Eco-logical." AASHTO consultants did interviews to determine if there were any statistics on the benefits of these "Eco-logical" programmatics, including time-savings, cost–savings, and accelerated project delivery.
- Jae Chung, U.S. Army Corps of Engineers, would probably know about this area of literature.
- Dave Fowler, Milwaukee Metropolitan Sewage District, might have some documentation on how much money they saved from non-structural approaches to flooding.

Potential for the adoption of a progressive approach as a standard

The research team asked the interviewees what potential they see for the adoption of a progressive approach as a standard for use in compensatory mitigation. Generally, the respondents were guardedly optimistic and saw great potential. One respondent stated that although there is a lot of support for this right now and the time is right, the likelihood of declining funding was worrisome, particularly without funding and leadership from the top.

Two (2) interviewees noted that the current focus on ecosystem service markets holds a lot of promise in promoting the progressive approach. One suggested that coupling it to on-going Council on Environmental Quality (CEQ)/Office of Management and Budget (OMB) efforts[10] could be effective, as could a statement from FWS to the effect that the agency is looking for opportunities to protect species and ecosystems in any corrective action they take.

Open ended responses

The research team concluded the interviews by asking the interviewees if they had anything else they would like to add.

Two (2) respondents noted that the barriers to integrating watershed needs by deploying a range of Clean Water Act programs (i.e., §404, §401, TMDLs, non-point pollution programs) and integrating CWA with ESA tools was a significant obstacle to achieving watershed improvements.

One respondent noted that while programmatics are critical, it is essential that they not be characterized in ways that "bypass" current regulatory requirements or laws. Another commenter noted that there is *not* the need for this approach to be implemented in a completely standard way across the country; there needs to be clear requirements outlined for alternative approaches, and a set of tools which would work, but the approach might have to look differently in different parts of the country.

[10] http://www.whitehouse.gov/administration/eop/ceq/initiatives/gulfcoast/roadmap
http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG

Attachment A: List of interviewees

NCHRP Project 25-25, Task #67
Task Name: Optimizing Conservation and Improving Mitigation Cost/Benefit
Task 1: Draft Interviewees
Interview Goal: Identify emerging approaches to mitigation under §404 CWA and §7 ESA

✓	**= Completed interview**
✘	**= Unable to reach**
--	**= Determined not to be necessary due to overlapping responses or agreement that individual will not have a value-added perspective.**

---

§404 CWA

--Bob Brumbaugh
Senior Policy Analyst
Institute for Water Resources
U.S. Army Corps of Engineers

✓Jeanne Christie
Executive Director
Association of State Wetland Managers

✓Palmer Hough
Environmental Scientist
Wetlands Division
U.S. Environmental Protection Agency

✓Steve Martin
Environmental Planner
Institute for Water Resources
U.S. Army Corps of Engineers

✓David Olson
Directorate of Civil Works Operations and Regulatory Community of Practice
U.S. Army Corps of Engineers

Leonard Shabman
Resident Scholar
Resources for the Future

§7 ESA

--Michael J. Bean
Counselor, Assistant Secretary for Fish, Wildlife and Parks
Department of Interior

✓Jessica Fox
Research Scientist
Electric Power Research Institute

--Gary Fraser
Assistant Director for Endangered Species
U.S. Fish and Wildlife Service

✓John Fay
National Section 7 Coordinator
Division of Consultation, Habitat Conservation Plans, Recovery & State Grants
Branch of Consultation and Habitat Conservation Planning
U.S. Fish and Wildlife Service

✓Michael Horton
National IPaC Program Coordinator
Division of Consultation, Habitat Conservation Plans, Recovery & State Grants

U.S. Fish and Wildlife Service

✓Therese Conant
Acting Chief, Endangered Species Division
Office of Protected Resources
NOAA, National Marine Fisheries Service

Transportation

✓Shari Schaftlein
Program/Policy Development Team Leader
Office of Project Development and Environmental Review
Federal Highway Administration

Other

--Laura Gabanski
Healthy Watersheds Program Lead
Office of Wetlands, Oceans & Watersheds
U.S. Environmental Protection Agency

--John Goodin
Chief, Watershed Branch
Assessment and Watershed Protection Division
U.S. Environmental Protection Agency

--Mark Humpert
Teaming With Wildlife Director
Association of Fish and Wildlife Agencies

✓Bruce McKenney/Joe Kiesecker
Development by Design
The Nature Conservancy

--John Thomas
Office of Policy, Economics, and Innovation
U.S. Environmental Protection Agency

--Lee Garrigan
Environmental Council of the States

--Bruce Stein
National Wildlife Federation

Attachment B: Interview Form

NCHRP Project 25-25, Task #67
Optimizing Conservation and Improving Mitigation Cost/Benefit

Task 1: Interviews

Goals of Task 1 Interviews

- Identify the range of emerging approaches to progressive compensatory mitigation being carried out or considered in both the Section 404 permitting program and the Section 7 consultation process.
- Articulate the progress that is being made to transition to progressive compensatory mitigation strategies.
- Summarize the perceived and real obstacles to implementing them at the field/district level.

Interviewer:

Interviewee contact information:

Notes on contact attempts:

Date interview completed:

Promised follow-up:

---

1. **How would you characterize the range of approaches that are currently being taken to compensatory mitigation? What is "traditional" and what is "innovative"?**

2. **What are some examples of traditional and innovative approaches?**

3. **How would you characterize the progress that is being made to transition to progressive compensatory mitigation strategies?**

4. **How would you characterize the perceived and real obstacles to implementing them at the field/district level?**

5. **What are the key actions that would allow or support this transition?**

6. **Are you aware of any published reports/studies that characterize these traditional and progressive approaches? In particular, are you aware of any studies or information that documents the ecological and economic costs and benefits of each? Or information on transaction cost- and time-savings (streamlining) and mitigation cost-savings?**

7. **What potential do you see for the adoption of a progressive approach as a standard for use in compensatory mitigation?**

8. **Is there anything else you would like to add?**

References

Anderson, M. 2005. *Enhancing wetlands and watersheds using wetland banking, land trusts, and preservation within transportation mitigation: An analysis of the North Carolina Ecosystem Enhancement Program*. Trust for Public Lands, 44 pp.

Beatley T. 1992. Balancing urban-development and endangered species—the Coachella Valley habitat conservation plan. *Environmental Management*. 16(1):7–19.

Bedford, B.L. 1995. The Need to Define Hydrologic Equivalence at the Landscape Scale for Freshwater Wetland Mitigation. *Ecological Applications* 6(1): 57-68.

BenDor, T., J. Sholtes, and M.W. Doyle. 2009. Landscape characteristics of a stream and wetland mitigation banking program. *Ecological Applications* 19(8): 2078–2092.

BenDor, T., N. Brozović, and V.G. Pallathucheril. 2007. Assessing the Socioeconomic Impacts of Wetland Mitigation in the Chicago Region. *Journal of the American Planning Association* 73(3): 263-282.

Berish, C. USEPA Region 4. 2010. *July 2010 Watershed Integrity Index Tool*. Paper presented at the Transportation Research Board Symposium on Integration of Conservation, Highway Planning and Environmental Permitting, September 14-16, Boulder, CO.

Bernstein, C.L. and J.K. King. 2009. Using a Watershed Approach to Manage Resources Within Jurisdiction of the US Army Corps of Engineers, Savannah District Regulatory Program. In "Proceedings of the 2009 Georgia Water Resources Conference." Athens, GA: University of Georgia.

Bonoff, M.B., Z.O. Toledo, W.A. Ryan and R.G. Carson. 2005. *Oregon Department of Transportation's OTIA III State Bridge Delivery Program: 400 bridges one biological opinion*. In C.L. Irwin, P. Garrett, and K.P. McDermott (Eds.), "Proceedings of the 2005 International Conference on Ecology and Transportation" pp. 231-242. Raleigh, NC: Center for Transportation and the Environment, North Carolina State University.

Boyd, J., D. Burtraw, A. Krupnick, V. McConnell, R.G. Newell, K. Palmer, J.N. Sanchiro, and M. Walls. 2003. *Trading Cases: Five Examples of the Use of Markets in Environmental and Resource Management*. In W.E. Oates (Ed.), "The RFF Reader in Environmental and Resource Policy," pp. 56-65. Washington, DC: Resources for the Future.

Brass, T.W. 2009. Who is Affected by Wetland Mitigation Banking? A Social and Geographic Evaluation of Wetland Mitigation Banking in Benton, Lane, Linn and Polk Counties, Oregon. M.C.R.P. Thesis. University of Oregon, Department of Planning, Public Policy, and Management.

Brown, J.W. 2006. *Eco-logical: An ecosystem approach to developing infrastructure projects*. Cambridge, MA: U.S. Department of Transportation.

Bryson, E., R. Spagnolo, M. Hoffmann, and W. Seib. 2010. Achieving Ecosystem Health Using a Watershed Approach: The Watershed Resources Registry Pilot Project in Southwestern Maryland. *National Wetlands Newsletter* 32(3): 8-11, 27.

Chestnut, L.G. and L.M. Mills. 2005. A fresh look at the benefits and costs of US acid rain program. *Journal of Environmental Management* 77(3): 252-266.

Clark, J.A., Hoekstra J.M., Boersma P.D., Kareiva P. 2002. Improving U.S. Endangered Species Act recovery plans: Key findings and recommendations of the SCB recovery plan project. *Conservation Biology* 16:1510-19.

Costanza, R., R. d'Arge, R. deGroot, S. Farberk, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton and Marjan van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.

Crooks, S., and L. Ledoux. 1999. Mitigation Banking as a Tool for Strategic Coastal Zone Management: A UK Perspective. Working Paper GEC 99-02. Centre for Social and Economic Research on the Global Environment, University of East Anglia and University College London.

De Cara, S. and P.A. Jayet. 2000. Emissions of greenhouse gases from agriculture: the heterogeneity of abatement costs in France. *European Review of Agricultural Economics* 27(3): 281-303.

Donlan, M., M. Sperduto, and C. Herbert. 2003. Compensatory mitigation for injury to a threatened or endangered species: scaling piping plover restoration. *Marine Ecology Progress Series* 264: 213-219.

Drechsler, M. and F. Watzold. 2009. Applying tradable permits to biodiversity conservation: Effects of space-dependent conservation benefits and cost heterogeneity on habitat allocation. *Ecological Economics* 68(4): 1083-1092.

Eliot, W. 1985. Implementing Mitigation Policies in San Francisco Bay: A Critique. Oakland, CA: California State Coastal Conservancy.

Engel, S., S. Pagiola, and S. Wunder. 2008. Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economics* 65(4): 663-674.

Environmental Law Institute. 2007. *Mitigation of impacts to fish and wildlife habitat: Estimating costs and identifying opportunities*. Washington, DC: Environmental Law Institute.

Erwin, Kevin L. 1990. Wetland Evaluation for Restoration and Creation. In "Wetland Creation and Restoration: The Status of the Science," edited by J. A. Kusler and M. E. Kentula. Washington, DC: Island Press.

Florida Department of Transportation. 2009. *Florida's ETDM Process: Progress Report #4*. Webpage. <<https://etdmpub.fla-etat.org/est/servlet/blobViewer?blobID=9539&rand=0.28886017290076376&est=.pdf>>.

Fluharty, D. and K.N. Lee. 1988. Neither wilderness nor factory: learning from natural resource management. *Proceedings of the 1st Annual Meeting on Puget Sound Research* 1: 256-265.

Halbert, C.L. 1993. How adaptive is adaptive management? Implementing adaptive management in Washington State and British Columbia. *Reviews in Fisheries Science* 16:261-283.

Hardy, A.R., T. Burch and C. James. 2007. *Developing the "Integrated Transportation and Ecological Enhancements for Montana" (ITEEM) process: Applying the eco-logical approach. In*: C.L. Irwin, D. Nelson, and K.P. McDermott (eds.). "Proceedings of the 2007 International Conference on Ecology and Transportation". Raleigh, NC: Center for Transportation and the Environment, North Carolina State University.

Hruby, T., K. Harper, and S. Stanley. 2009. Selecting Wetland Mitigation Sites Using a Watershed Approach. Publication #09-06-032. Washington State Department of Ecology.

Jack, B.K., C. Kousky, and K.R.E. Sims. 2008. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. *Proceedings of the National Academy of Sciences* 105(28): 9465-9470.

Kiesecker, J.M., H. Copeland, A. Pocewicz, B. McKenney. 2009. Development by design: Blending landscape-level planning with mitigation hierarchy. *Frontiers In Ecology and the Environment* 8: 261-66.

Kihslinger, R.L. Success of Wetland Mitigation Projects. *National Wetlands Newsletter* 30(2): 14-16.

Kagan, J. 2010. *Addressing Regulatory Certainty in the Ecological Framework*. Paper presented at the Transportation Research Board Symposium on Integration of Conservation, Highway Planning and Environmental Permitting, September 14-16, Boulder, CO.

Kittel, G., P. Comer, D. Faber-Langendoen, Ian Varley and Jon Hak. In Prep. NatureServe's Wetland Mitigation Framework. Draft Report to EPA Region 10.

King, D. and C. Bohlen. 1994. Estimating the Costs of Restoration. *National Wetlands Newsletter* 16(3): 3-5, 8.

King, D.M. and L.W. Herbert. 1997. The fungibility of wetlands. *National Wetlands Newsletter* 19(5): 10-13.

Kremen, C. and R.S. Ostfeld. 2005. A call to ecologists: measuring, analyzing, and managing ecosystem services. *Frontiers in Ecology and the Environment* 3(10):540-548.

Loomis, J.B. and D.S. White. 1996. Economic benefits of rare and endangered species: summary and meta-analysis. *Ecological Economics* 18(3): 197-206.

Louis Berger & Associates, Inc. with The BSC Group. 1997. *Costs for Wetland Creation and Restoration Projects in the Glaciated Northeast*. Prepared for the U.S. Environmental Protection Agency, Region I, Boston, Mass.

McKenney, B. and J.M. Kiesecker. 2010. Policy Development for Biodiversity Offsets: A Review of Offset Frameworks. Environmental Management 45:165-176.

McVoy, G., M. Sengenberger, and E. Novak. 1999. The NYSDOT Environmental Initiative Guidelines and Procedures for a New Paradigm. New York State DOT Environmental Analysis Bureau, Albany, N.Y., 11p.

Millennium Ecosystem Assessment. 2003. *Ecosystems and Human Well-Being: A Framework For Assessment*. Washington, DC: Island Press.

Mitsch, W.J. and J.G. Gosselink. 2000. The value of wetlands: importance of scale and landscape setting. *Ecological Economics* 35(1): 25-33.

Murcia, C. 1995. Edge effects in fragmented forests: implications for conservation. *Trends in Ecology and Evolution* 10(2): 58-62.

Murray, E., and Brazil, K., 2003. For Arkansas: Protecting Begins with Multi-Agency Planning. *National Wetlands Newsletter 25*(3): 1, 23-25.

Nash, J.R., and R.L. Revesz. 2001. Markets and Geography: Designing Marketable Permit Schemes to Control Local and Regional Pollutants. *Ecology Law Quarterly* 28: 569-662.

National Research Council. 2001. "Compensating for wetland losses under the Clean Water Act". Washington, D.C.: The National Academy Press.

National Research Council. 2005. "Valuing ecosystem services: toward better environmental decision-making." Washington, D.C.: The National Academy Press.

Neely, B., S. Kettler, J. Horsman, C. Pague, R. Rondeau, R. Smith, L. Grunau, P. Comer, G. Belew, F. Pusateri, B. Rosenlund, D. Runner, K. Sochi, J. Sovell, D. Anderson, T. Jackson and M. Klavetter. 2006. Central Shortgrass Prairie Ecoregional Assessment and Partnership Initiative. Boulder, CO: The Nature Conservancy of Colorado and the Shortgrass Prairie Partnership.

Newell, R.G. and R.N. Stavins. 1999. Abatement-Cost Heterogeneity and Anticipated Savings from Market-Based Environmental Policies. Working Paper. Resources for the Future.

Palmer, M.A. and S. Filoso. 2009. Restoration of Ecosystem Services for Environmental Markets. Science 325: 575-576.

Poe, C., S.C. Edmiston, and A. Zlotoff. 2009. *Environmental Mitigation in Transportation Planning: Case Studies in Meeting SAFETEA-LU Section 6001 Requirements*. Prepared for the U.S. Federal Highway Administration, Office of Planning, Environment, and Realty.

Race, M.S. 1985. Critique of Present Wetlands Mitigation Policies in the United States Based on an Analysis of Past Restoration Projects in San Francisco Bay. Environmental Management 9(1): 71-82.

Race, M.S. and M. Fonseca. 1996. Fixing Compensatory Mitigation: What will it take? Ecological Applications, 6 (1): 94-101.

Ramilan, T. and F. Scrimgeour. 2006. *Abatement Cost Heterogeneity and Its Impact on Tradable Nitrogen Discharge Permits*. In "New Zealand Agricultural and Resource Economics Society Conference 25-27", New Zealand Agricultural and Resource Economics Society Conference, Nelson, New Zealand.

Raymond L. 2006. Cooperation without trust: Overcoming collective action barriers to endangered species protection. *Policy Studies Journal*. 34:37–57

Rezek, J. and B.F. Blair. 2005. Abatement Cost Heterogeneity in Phase I Electric Utilities. *Contemporary Economic Policy* 23(3): 324-340.

Roise, J.P., K.W. Gainey, and T.H. Shear. 2004. An approach to optimal wetland mitigation using mathematical programming and geographic information system based wetland function estimation. *Wetlands Ecology and Management* 12:321-331.

Salzman, J. and J.B. Ruhl. 2000. Currencies and the Commodification of Environmental Law. *Stanford Law Review* 53(3): 607-694.

Salzman, J. and J.B. Ruhl. 2006. The Effects of Wetland Mitigation Banking on People. *National Wetlands Newsletter* 28(2): 1, 9-14.

Samanns, E. 2002. Mitigation of Ecological Impacts: A Synthesis of Highway Practice. NCHRP Synthesis 302 Report. Washington, D.C.: Transportation Research Board.

Sapp, W.W. 1995. The Supply-Side and Demand-Side of Wetlands Mitigation Banking. *Oregon Law Review* 74(3): 951-994.

Schwartz, M.W. 1999. Choosing the appropriate scale of reserves for conservation. *Annual Review of Ecology and Systematics* 30:83-108.

Schwartz, M.W. 2009. The Performance of the Endangered Species Act. *Annual Review of Ecology, Evolution, and Systematics*. 39(1): 279-299.

Shabman, L. and P. Scodari. 2004. Past, Present, and Future of Wetlands Credit Sales. Discussion Paper 04-48. Resources for the Future.

Silverstein, J. 1994. Taking Wetlands to the Bank: The Role of Wetland Mitigation Banking in a Comprehensive Approach to Wetlands Protection. *Boston College Environmental Affairs Law Review* 22(1): 129-162.

Stavins, R.N. 1998. What Can We Learn from the Grand Policy Experiment? Lessons from SO2 Allowance Trading. *The Journal of Economic Perspectives* 12(3): 69-88.

Stein, E.D. and R.F. Ambrose. Landscape-Scale Analysis and Management of Cumulative Impacts to Riparian Ecosystems: Past, Present, and Future. *Journal of the American Water Resources Association* 37(6): 1597-1614.

Stein, E.D., F. Tabatabai and R.F. Ambrose. 2000. Wetland mitigation banking: A framework for crediting and debiting. *Environmental Management* 26(3): 233-250.

Strager, M.P., J.T. Anderson, J.D. Osbourne, and R. Fortney. 2010. A three-tiered framework to select, prioritize, and evaluate potential wetland and stream mitigation banking sites. Forthcoming, *Wetlands Ecology and Management*, available online June 29, 2010.

Sutton, P.C. and R. Costanza. Global estimates of market and non-market values derived from nighttime satellite imagery, land cover, and ecosystem service valuation. *Ecological Economics* 41(3): 509-527.

Suzuki, N. and D.H. Olson. 2007. Options for biodiversity conservation in managed forest landscapes of multiple ownerships in Oregon and Washington, USA. *Biodiversity Conservation* 16:3895-3917.

Templeton, S.R., C.F. Dumas, and W.T. Sessions. 2008. Estimation and Analysis of Expenses of Design-Bid-Build Projects for Stream Mitigation in North Carolina. Research Report RR 08-01. Clemson University Department of Applied Economics and Statistics.

Thorne, J.H., E.H. Girvetz, and M.C. McCoy. 2009. *A Multi-Scale and Context Sensitive State-Wide Environmental Mitigation Planning Tool for Transportation Projects in California*. University of California-Davis: John Muir Institute of the Environment. Webpage. <<http://escholarship.org/uc/item/9bh201bp#>>.

Thorne, J.H., P.R. Huber, E.H. Girvetz, J. Quinn, and M.C. McCoy. 2009. Integration of Regional Mitigation Assessment and Conservation Planning. *Ecology Letters* 14(1): 47-66.

Transtech Management, Inc. 2003. *Causes and Extent of Environmental Delays in Transportation Projects*. Prepared for the American Association of State Highway and Transportation Officials, Washington, DC.

Turner, R.E., A.M. Redmond, and J.B. Zedler. 2001. Count It By Acre or Function—Mitigation Adds Up to Net Loss of Wetlands. *National Wetlands Newsletter* 23(6): 5-6, 14-16.

Turner, R.E. and M.E. Boyer. 1997. Mississippi River diversions, coastal wetland restoration/creation and an economy of scale. *Ecological Engineering* 8(2):117-128.

U.S. Army Corps of Engineers, Norfolk District. 2008. *Virginia Off-Site Mitigation Location Guidelines*. Public Notice. <<http://www.deq.virginia.gov/export/sites/default/wetlands/pdf/VA_Offsite_Mit_Guidelines.pdf>>.

U.S. Department of Defense and U.S. Environmental Protection Agency. 2008. *Compensatory Mitigation for Losses of Aquatic Resources*. 33 CFR 325, 332; 40 CFR 230, Washington, D.C.: U.S. Army Corps of Engineers and U.S. Environmental Protection Agency.

U.S. Federal Highway Administration. 2006. *Wyoming Takes a Programmatic Approach to Biological Assessment*. Webpage. <<http://www.environment.fhwa.dot.gov/strmlng/newsletters/apr06nl.asp>>.

U.S. Federal Highway Administration. 2010. *State Practices Database*. Webpage. <<http://www.environment.fhwa.dot.gov/strmlng/es3stateprac.asp>>.

U.S. Fish and Wildlife Service. 2003. *Guidance for the Establishment, Use, and Operation of Conservation Banks*. Washington, D.C.: U.S. Fish and Wildlife Service.

Venner Consulting and URS Corporation. 2009. *C06A Phase I Interim Report APPENDIX A: Interests, Barriers, Incentives, And Solutions – By Agency*. Prepared for the Transportation Research Board of the National Academies.

Venner, M. 2010a. *The Case for an Ecosystem Approach to Transportation Decision Making: A More Effective and Efficient Environmental Review & Permitting Process*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010b. *A Watershed and Ecosystem Approach to Achieving More Efficient, Effective and Proactive Protection and Restoration through CWA Section 404 Permitting: A Case for the U.S. Environmental Protection Agency*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010c. *Why Implement an Ecosystem Approach? Integrating Recovery Planning in Section 7 Consultations for Infrastructure Projects and Putting the Right Conservation in the Right Place*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010d. *Watershed Integrity Index Tool*. Webpage <<http://shrpc06.com/>>.

Venner, M. 2010e. *NiSource Multi-Species Habitat Conservation Plan 14 State Advance mitigation for 43 Species, HCP and 50 yr ITP*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010f. *Southeastern Virginia Combined Benefits Mitigation Plan*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010g. *California Statewide Advance Mitigation Initiative (SAMI) and Regional Advance Mitigation Planning*. Webpage. <<http://shrpc06.com/>>.

Venner, M. 2010 h. *Programmatic ESA Sec. 7 Consultation and Advance Mitigation for Habitat Impacts of 20 Year Plan in Eastern Third of Colorado: The Shortgrass Prairie Initiative*. Webpage. <<http://shrpc06.com/>>.

Waage, S., E. Stewart and K. Armstrong. 2008. *Measuring corporate impact on ecosystems: A comprehensive review of new tools*. Synthesis Report. Business for Social Responsibility. Accessed from << http://www.bsr.org/reports/BSR_EMI_Tools_Application.pdf >>.

Weber, T.C., and W.L. Allen. 2010. Beyond on-site mitigation: An integrated, multi-scale approach to environmental mitigation and stewardship for transportation projects. *Landscape and Urban Planning* 96(4): 240-56.

White, P., J. Michalak and J. Lerner. 2007. L*inking conservation and transportation: Using the state wildlife action plans to protect wildlife from road impacts*. Washington, D.C.: Defenders of Wildlife.

Wilkinson, J.B., J.M. McElfish, Jr., R. Kihslinger, R. Bendick and B.A. McKenney. 2009. *The Next Generation of Mitigation: Linking Current and Future Mitigation Programs with State Wildlife Action Plans and Other State and Regional Plans*. White paper. Washington, D.C.: Environmental Law Institute and The Nature Conservancy.

World Wildlife Fund. Statewide Wetlands Strategies : A Guide to Protecting and Managing the Resource. Island Press, 1992.

Wostl, R. 2003. *A Programmatic Section 7 Consultation to Restore Habitat Connectivity and Achieve Recovery for a Federally Threatened Species: Preble's Meadow Jumping Mouse*. University of California-Davis: John Muir Institute of the Environment. Webpage. <<http://escholarship.org/uc/item/74h8g57x>>.

Zedler, J.B. 2003. Wetlands at your service: reducing impacts of agriculture at the watershed scale. *Frontiers in Ecology and the Environment* 1(2): 65-72.