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ABSTRACT

Ecosystem services measurement and crediting tools are recognized as important to the transportation planning and project implementation process because they can aid the process of mitigating environmental impacts by reducing transaction costs, improving environmental outcomes, and shortening the time needed to implement projects. Because of this, they have been identified as a key step in the Eco-Logical framework integrating transportation and conservation planning, characterized by a SHRP2 Capacity Program Study as the Integrated Ecological Framework (IEF). Currently, there is not a straightforward methodology for creating a transportation-centric crediting program available throughout much of the US. However, successful programs in California, North Carolina, Oregon, and Washington have all developed approaches cooperatively with the regulatory agencies, state and non-governmental conservation programs, those actively involved in mitigation banking, and agencies or organizations funding restoration activities. An overview of crediting systems and valuation methods and their use at various scales in transportation planning are presented. Current projects and programs are evaluated to identify opportunities and obstacles transportation organizations may encounter when attempting to implement a crediting program.

INTRODUCTION

Developed as part of the Transportation Research Board (TRB) Strategic Highway Research Program (SHRP2), the “Integrated Ecological Framework” (IEF) is an ecological assessment process and framework to integrate conservation planning and transportation planning. The nine-step IEF (Figure 1) helps implement the Eco-Logical approach, developed by eight Federal agencies in 2006, which recommends a collaborative, integrated, watershed- or ecosystem-scale approach to decision-making during infrastructure planning, environmental review, and permitting. An IEF step that has been particularly difficult for Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) to implement is Step 6, developing a crediting strategy, which allows agencies to use rapidly emerging development of crediting information and tools.

Developing a crediting strategy for transportation requires knowing about “valuation”, ecosystem function, and different ways to measure and credit benefits and impacts of development and mitigation actions. We examine obstacles and opportunities for transportation agencies to create a meaningful crediting strategy.

VALUATION AND CREDITS

What is Valuation?

Valuation is a formal process for measuring the value of attributes or processes, where value may have fiscal or non-fiscal expressions. Many decisions related to transportation infrastructure are based on consideration of social preferences and values (e.g., congestion relief), regional economics, and project costs. Valuation is a useful method to apply to transportation decision-making for multiple needs because it can be used to draw equivalencies among dissimilar objects in a decision-space (e.g., driving time, wetland function, air quality). Equivalencies or equivalent values for these dissimilar objects may be on a unitless scale of preference or non-fiscal value, or on a fiscal scale, where cost is articulated for each object. California has developed an approach for valuing ecosystem attributes for use in transportation planning and system change (Lee et al., 2010). Valuation helps inform decisions related to regional planning networks (spatially connected elements) and temporally connected sequences of projects that are efficient relative to goals (e.g., have high total benefits). Valuation potentially also allows for comparisons among

project and route alternatives to maximize total benefits. In addition, valuation information facilitates the development of cost estimates and mitigation alternatives, including avoidance, minimization and compensation. Finally, valuation may inform corridor and regional plan development analyses that set a framework for project-level decision-making.

In the proposed process flow in California (Lee et al., 2010), transportation system impacts are first identified. These impacts are determined by comparing the “with project” and the “without project” impacts to environmental conditions in a region or corridor. Impacts are quantified and can then be translated into mitigation strategies using equivalent values. As described above, these values could be on a preference or fiscal scale, or some other value suitable for decision-making. Impact quantification requires data on potential risks, geographical and temporal extents of the impacts, and impact severity. It also requires showing a relationship between an impact and a quantifiable ecological outcome at an appropriate scale. It is critical that this relationship be clear as not all linkages between built system impacts, mitigation actions and ecological processes are straightforward (Bateman et al., 2002). For example, reduction in pollutant discharge to streams can be measured and permitted. But people and fish do not have measurable preferences for tons of pollutant, they have preferences for resulting water quality. Therefore, it is also important to express the physical parameter in a form that makes equivalent ecological values obvious.

When impacts are measurable, the next step is to find equivalent values for the impacts. Different methods are available to value ecosystem attributes. Litman (2009) provides an extensive literature review on the equivalent fiscal costs of environmental impacts from the transportation sector including air pollution, greenhouse gas emissions, noise, land use, water pollution and waste disposal. However, not all impacts can be evaluated by using economic valuation methods or given fiscal cost-equivalents. A review by Delucchi and McCubbin (2010) shows that only congestion delays, accidents, air pollution, climate change and noise impacts have good cost estimates in road transportation.

Three valuation methods available to value ecosystem attributes are revealed and stated preference methods, contingent analysis, and benefit transfers. The two main types of valuation for environmental attributes are the revealed preference methods and the stated preference methods. Revealed preference approaches depend on a connection between the environmental attribute of interest (e.g., noise) and a market good (e.g., housing). The method uses data revealed by behavior related to actual decisions (for instance, changes in prices of housing). The major problem of this method is that it is based on existing conditions and so the potential to evaluate alternatives is limited.

In contrast, stated preference techniques are based on hypothetical situations and surveys that determine people’s willingness to pay for a situation. Stated preference methods can be used for environmental systems, like a wetland, where there are both use and non-use values. The contingent valuation method is a type of stated preference method usually used to estimate the

value of an environmental change scenario. The method uses a survey which begins with a statement describing the change in environmental attributes. Then it asks individuals to reveal how much they are willing to pay for the change. For example, we could ask people how much they are willing to pay to restore wetlands surrounding a highway needing widening.

Benefit transfer allows users to transfer estimates of non-market values from existing studies to new locations or different but related services. An example of this approach is when highway construction results in destruction or modification of habitat of wildlife with social or economic value, such as deer or elk winter range. Compensatory mitigation payments accompanying this project would be based on the equivalent cost of each animal multiplied by the number of animals lost. This method is often used because it saves time and resources. Usually, benefit transfer is best suited for tasks where the need for accuracy is low. It is generally considered a “second best” valuation method because benefit transfers involve reusing existing data and does not provide error bounds for the value in the new application. For example, it has been found that using benefit transfer methods, the cost/ha of wetlands providing a single ecosystem service could vary by two orders of magnitude (Woodward et al., 2001).

When using the valuation approach in transportation, the last step is to incorporate the values of the affected environmental attributes and a qualitative analysis of those non-measurable impacts into the overall transportation plan, project or corridor analysis. Because there are potential evaluation-scale effects on the process (project, corridor, and region), it may be desirable to develop different flows of valuation outputs into a decision process for each scale. Both natural (e.g., watershed, ecosystem) and jurisdictional (e.g., district, county) scales can be used to frame the flow of the valuation process and to determine appropriate scales of analysis. The background and information needed for either of these approaches should be contained in the first 5 steps of the IEF.

What are Credits?

In order to plan for infrastructure development in complex social-ecological systems, many think it is necessary to create devices, like ecosystem credits, that draw equivalencies among non-like values. Credits use units of measure that are native to part of the system, such as land area; that can be derived from financial calculations, such as money; or that are normalized on a preference scale of some kind, usually from least to most preferred. An example of a credit is a hectare of habitat, or dollar equivalents of that habitat. Credits are often proposed in planning and mitigating infrastructure development as a way to get ecologically-meaningful mitigation accomplished.

Using a crediting approach to mitigation requires both methods and protocols to quantify units of environmental benefit (credits) or impact (debits), as well as a crediting framework in

which regulatory agencies and stakeholders agree to a common set of standards and operating procedures that govern how credits and debits can be used to meet mitigation requirements. By doing this, planners can align mitigation objectives and have greater efficiency and proficiency in identifying mitigation and restoration opportunities that address multiple ecosystem services. Accurately measured project impacts and mitigation site benefits can be more readily converted into credits. Standards and procedures, agreed to a priori, can both expedite regulatory approval and allow for improved mitigation outcomes.

Ecosystem Services: A Possible Crediting System

The ability to measure and value services provided by the environment holds great promise for society's ability to assure these services are maintained over time. Ecosystem services are commonly defined as benefits people obtain from ecosystems – often characterized into different types of services, including provisioning, regulating, supporting and cultural. Ecosystem service values, costs and benefits may be an efficient way to consider both impacts and improvements to the environment, and as such can represent a new way for transportation agencies and regulatory agencies to address unavoidable losses and associated mitigation. That being said, not all ecosystem processes and attributes can be reflected by an obvious ecosystem service. This is largely because although we may recognize and value certain aspects of an ecosystem, there may be functions and patterns in nature that provide no obvious or discernible benefit to people, but still have inherent value. An example of this would be non-pest insects that do not directly benefit people through pollination or other services, but provide an important food source to birds, amphibians, or other animals.

Ecosystem services measurement and crediting tools can assist the transportation planning and implementation process by improving the process of mitigating environmental impacts through reducing transaction costs, improving environmental outcomes, and potentially shortening the time needed to implement projects. They also hold the promise of providing critical information to transportation agencies for developing environmental performance measures.

Ecosystem service credits are essentially units of environmental benefit. In theory, credits are created through the conservation or high-quality restoration of naturally functioning ecosystems. They represent the quantification of things ranging from provision of clean water for community drinking supplies, to pollination of agricultural crops, to sequestering carbon to help mitigate climate change. Of these, carbon, water quantity and availability for drinking and irrigation, endangered species and water quality are the closest to having established crediting systems or methodologies available for DOTs and MPOs. Tools for water quality crediting, particularly for nitrogen, phosphorus and temperature, are well along in development. However,

addressing erosion and stormwater crediting still needs extensive work, and has been identified as a priority for transportation research.

Market opportunities include existing conservation/mitigation banking systems or payment for ecosystem service (PES). PES programs are negotiated contracts with landowners to maintain a certain level of environmental performance to maintain or enhance ecosystem services. PES programs provide various benefits to DOTs, such as reduced uncertainty associated with a project and its environmental analysis, transfer of liability to another party responsible for providing and maintaining the service, and adherence to mission alignment because agencies that build roads may have a difficult time with maintaining ecosystem function. Although PES systems have great potential power for ecosystem preservation, some criticisms have been made of them (Redford and Adams 2009), including the risk that economic arguments about services valued by humans will overwrite and outweigh noneconomic justifications for conservation, and the concern that there is no clear way to track the performance of the system.

Crediting Systems and Mitigation

A crediting system should address site design and selection, and should include a robust analysis of the suite of data on the watershed or landscape in which the compensatory mitigation project is being proposed. As mentioned previously, much of the background work to create the system is developed in earlier steps of the IEF; but when related to mitigation, either through a mitigation or conservation bank, in-lieu fee program or another compensatory mitigation mechanism, planners should try to characterize a watershed or ecosystem's functions. There is often some confusion between functions and ecosystem service values, and in general the differences do not impact transportation planners very much. However, when dealing with wetlands and streams, the regulatory community has chosen to require that both the functions and values be maintained or replaced (Stokstad 2008). Therefore, in siting and designing compensatory mitigation projects, it is necessary to assure the site will improve the overall condition of a hydrologic or ecological unit, and will provide at least the important functions to be credited.

Many states have or are in the process of developing mitigation programs and programmatic agreements to address wetlands; a few states have been developing similar programs for endangered species. It is also possible to create crediting tools for transportation by working with regulators to develop methods to measure, map and value services such as stormwater improvement or water quality (eg. TMDL or 303d) nutrient abatement. Trading can lead to programmatic agreements and pre-approved mitigation areas with established credits for multiple credit types. A set of standard methodologies are needed to enable transportation agencies and MPOs to measure the ecosystem services and functions being lost from project impacts or gained from rehabilitation. Crediting systems, as implemented by transportation

agencies for a single service, often focus on regulatory requirements based on areas impacted, so actual fiscal valuations may not be required.

Credits and Monetization

The use of monetary value provides a common scale for the valuation of impacts. Fiscal-equivalent values for some impacts (e.g., emissions) are already used by some DOTs for Cost Benefit Analysis (CBA) or, more precisely in life-cycle benefit/cost analysis. In California, such analysis is performed using a model called Cal-B/C (Systems Metrics Group 2009) to monetize impacts such as accidents or vehicles emissions. But other impacts, such as noise or water pollution could be monetized as well. Monetary valuation methodology also can create problems when addressing ecosystem attributes such as biodiversity, which can be very difficult to price (Boyd and Banzhaf 2010). Many wetland functions result in goods and services that are not traded in markets and therefore remain un-priced. It is then necessary to value these goods or services using a non-market valuation technique. Wetlands and transportation are a good example to describe the process of non-market valuation, because wetlands losses are regulated, and addressing wetlands often involves several state and federal agencies and projects related to transportation system planning, expansion, and maintenance.

The first step of putting a fiscal equivalent on wetland credits is to understand what characteristics of the wetland can be valued, so one must first summarize the functions, uses and values of wetlands. Wetland functions represent different ecological processes (e.g., photosynthesis), characteristics (e.g., water depth) and structure (e.g., fauna and flora). Wetlands provide both services (e.g., flood control) and goods (e.g., edible fish). It is at this stage that the connection is made between ecology and economy since many wetland uses can be monetized because links can be made between wetland uses and human activity. Yet monetizing wetland uses is not direct, is often inaccurate, and depends on what type of use is considered. In addition, decision making regarding wetlands does not have to rely upon monetization as the only way to include wetlands' value in decision making.

IMPLICATIONS FOR TRANSPORTATION PRACTICE

Estimating the values of the transportation project impacts on environmental attributes can be used as a guide to allocate resources to lessen the total environmental costs of projects, and as part of a benefit-cost analysis of optimal investment in transportation modes and infrastructure (Delucchi and McCubbin, 2010). The valuation of environmental attributes, and corresponding credits, may be used at several points during the transportation planning process: in the regional planning process, in the system planning process, in corridor planning, at the project development stage, and at the programming stage. Development of actual credits at these different planning stages is likely to require different tools or methods appropriate for the spatial-

temporal scale of analysis and level of detail needed. Valuation and credits for regional planning may require lower-resolution analysis of impacts and calculation of equivalent values, providing a general but coarse overview. Valuation for corridor or project planning may require higher-resolution analysis of impacts and corresponding credit-values in order to select among project alternatives. It is possible that regional valuation will provide cost-savings for the valuation process itself because of economies of scale. Once equivalent values are found within a region, they may be more legitimately applied among places within the region using the benefits transfer approach. Calculating the total environmental value or cost of transportation may be more feasible at the corridor or project scale because more detailed information is likely to be available at those scales.

Use of environmental valuation in the regional transportation planning (RTP) process

Regions are appropriate scales to analyze certain impacts from transportation systems (e.g., ecoregional biodiversity and air quality). MPO regions develop and adopt long-range RTPs that aggregate the transportation system development desires of member municipalities and counties. Through MPOs, valuation methods provide institutional frameworks for analysis, decision-making, and programming (Handy, 2010). They are also suitable scales of analysis for almost all surface transportation related impacts and benefits, and are also excellent scales for planning transportation systems as networks of interconnecting modes and infrastructures. At regional scales, valuation and crediting could consist of: 1) establishing the linkages between impacts and corresponding ecological outcomes; 2) establishing the credit-value system that allows for comparing among dis-similar objects and estimating total costs of credits; and 3) establishing agreements about rules used to guide the use of valuation and credits in eventual project delivery.

Use of environmental valuation in the corridor-system planning process

Transportation agencies conduct system planning and establish long-term corridor plans. The corridor scale implicitly includes the project scale and is a sub-unit of the regional and district scales. Planning for this scale provides an important means for reducing the harm from transportation impacts and an opportunity to remediate current harm and mitigate future harm. The corridor scale also provides an opportunity to organize more multi-disciplinary planning that looks at the whole range of changes in the transportation system, along with long-term operations and maintenance and the environment and human communities. At this scale, valuation and crediting could tier from the regional system and consist of: 1) comparing values among projects proposed along a single corridor; 2) comparing values among corridors in a regional network; 3) seeking agreement on corridor-specific value or credit tradeoffs among involved parties; and 4) programming long-term actions along and among corridors based on credit-values and corresponding costs.

Use of environmental valuation at the project development stage

The project development stage requires comparing project alternatives in environmental analysis and permitting, benefits and values estimation, and cost estimates. Valuation of environmental attributes could be used at this stage to evaluate the potential environmental impacts associated with each project alternative from a change in value point of view, and to better estimate the mitigation credits needed (and corresponding costs) to offset environmental impacts. If considerations of environmental attributes were anticipated by valuation from previous planning phases, this process will be streamlined and projected estimates can be refined. At this scale, valuation and crediting could use information and agreements arrived at higher-order scales to: 1) describe exactly the value change associated with each project alternative; 2) describe the corresponding credit loss and gain from impacts and mitigation actions; and 3) gain agreement among all parties involved that a particular action, bank or mitigation package results in the greatest net value.

Use of environmental valuation at the programming stage

At the programming stage, state decision-making entities require transportation agencies to evaluate their RTP or the Interregional Transportation Improvement Program (ITIP). Some states use formal models that incorporate project benefits such as travel time savings, vehicle operating cost savings, safety benefits (e.g., cost savings from avoiding accidents) and emissions reductions and costs such as direct project costs, mitigation costs, and transit agency cost savings. For example, Caltrans uses the California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) to evaluate the return on investment/lifecycle. Currently, the Cal-B/C model, and similar DOT models, do not estimate values for most of the environmental impacts, and it is not required to do so under the principal environmental and transportation laws, including the National Environmental Quality Act (NEPA) and Endangered Species Act (ESA), that govern the required assessments. New directions in federal transportation law are intended to enhance the consideration of environmental issues and impacts within the transportation planning process. Incorporating the values of the environmental impacts early within transportation planning and analysis can better account for the benefits and costs that society may incur. By doing so, project programming decisions would be based partly on maximizing environmental benefits and accounting for environmental values that are lost and gained among various alternatives, an important advance in sustainable transportation planning. At this point, the conversation would be usefully informed by demonstrating how environmental values were considered within different orders of decision-making (e.g., corridor-scale) and what process was used to arrive at agreement on benefits and credits associated with different construction/mitigation packages.

EXAMPLES OF CREDITING STRATEGIES

California State Highway 37 Stewardship Study (SHRP-2 C21)

In its pilot test of the tools from the Integrated Ecological Framework (IEF), the University of California Davis Road Ecology Center developed a novel crediting strategy, employing both non-monetary and monetary valuation approaches. To be functional, an accounting or credit system would provide a way to both indicate relative or absolute effects or impact and to measure potential performance of credits, usually in the context of mitigation. Credits in this study were proposed as scores on a unit-less scale from 0 to 100, given to alternatives, for 5 themes: Transportation, Environment, Cost, Community and Reversibility. Each theme was accompanied by indicators of impact within each theme, which allowed the development of stewardship-oriented scenarios, as well as evaluation of the actual impacts that accompanied each scenario. The normalization of impacts to a 0 to 100 credit scale was both an end itself and also served as an intermediate step for subsequent conversion to fiscal equivalents for system attributes for which fiscal equivalents are known. Because these equivalents are usually approximate at best, the unit-less credit scale permitted valuation without the inexactness of monetizing benefits and dis-benefits (including costs) of various project choices. For the environmental theme for this corridor, the nearby tidal and freshwater wetlands provide both constraints and opportunities for stewardship planning. Because of the unique potential for wetland restoration in the highway 37 corridor, there may be few possibilities for mitigation bank strategies or payment for ecosystem services.

The valuation and crediting approach developed in this study was based upon quantification of impacts within the effect-area of the highway in question. It was also based upon expert and public evaluations of how well a given project alternative met particular transportation and non-transportation needs. This is a non-monetized contingent valuation and one result from this approach is shown (Figure 2). In this case, five scenarios for the highway were considered together for their relative benefits and dis-benefits, using a unit-less scale from 0 to 100. In this case, the “expanded footprint” scenario (a rough doubling of the right-of-way onto wetlands) provided desired transportation benefits, but would require additional action to improve or mitigate environmental dis-benefits. In comparison, the “Napa-Sonoma Causeway” scenario (expanding the right-of-way, but on a causeway across the wetlands) provided similar transportation benefits, but may require little if any environmental credits or mitigation.

North Carolina Ecosystem Enhancement Program (EEP)

North Carolina has implemented an Ecosystem Enhancement Program (EEP) that is entirely funded by the NC Department of Transportation (NCDOT). The program, part of their Department of Environment and Natural Resources (DENR), works with watershed groups throughout the state to establish restoration and mitigation priorities, creating the equivalent of a statewide programmatic for Clean Water Act issues. This is possible because DENR also administers the state’s water quality program. While ESA issues are not an important part of the EEP, the NC Natural Heritage Program which manages the ESA location information for the state is also part of DENR and provides information to the EEP office to assure that state ESA

priorities are at least addressed in the restoration priorities. In 2001, NCDOT reported that 55 percent of its transportation developments were delayed by wetland mitigation requirements. After ramping up streamlined transportation planning and mitigation through EEP, there were no delays in Transportation Improvement Projects associated with EEP from 2003 through 2010 (Venner 2011). According to the DENR program accomplishment report from 2010, the EEP met over 97% of all mitigation requirements assumed since 1996, and more than 80% of all EEP's current stream mitigation credits and 95% of wetland credits were in a "post-construction" phase of maturity. A recent detailed study of the EEP determined that the program allows mitigation to occur at significant distances and in different locations from the impacts, potentially creating concerns related to losses in ecological and landscape function, and that these should be addressed in both mitigation policy and crediting program implementation (BenDor et al. 2009).

Oregon's Willamette Partnership

One of the most current and potentially useful work related to an overall crediting system for transportation is a set of overlapping projects undertaken by the Willamette Partnership. The work was initially focused on Oregon's Willamette Basin, but has expanded to cover much of the Pacific Northwest, and in water quality trading, the entire United States. The project is focused on expanding the protection and restoration of ecosystem services by utilizing planning products and decision support tools that model the economic value of natural processes under different development/conservation scenarios. To date, Willamette Partnership has developed one of the most advanced and comprehensive structures to integrate the economic values of ecosystem services into multiple regulatory programs requiring compensatory mitigation.

The Willamette Partnership is a 501(c)3 non-profit organization focused on developing markets based on detailed accounting procedures for multiple types of ecosystem service credits. It has worked to create science-based ecosystem service quantification methods in partnership with regulatory agencies and with agencies needing ecosystem credits. The process, called "Counting on the Environment", is a multi-stakeholder agreement to use a shared accounting system for quantifying impacts and benefits to ecosystems in a markets-based and/or mitigation banking system. The quantification methods and associated crediting protocols are designed to measure the functions and values associated with improvements and impacts to separate ecosystem services. Tools for measuring improvements and damages to wetland habitat, upland prairie habitat, sagebrush/sage-grouse habitat, salmon habitat, nitrogen and phosphorus loadings, thermal pollution offsets, and stream condition have been developed. Several site-based calculation methods have already been approved by state and federal regulators, including those for salmon, prairie, wetlands (tied to the Oregon Rapid Wetland Assessment Protocol, or ORWAP), and water temperature.

The Partnership's General Crediting Protocol – which provides the rules for using the ecosystem service accounting system – references priority areas for ecological improvements to

salmonid habitat, prairie habitat, wetland habitat, and water temperature impairments. The Partnership identifies priority rivers and streams for improved salmon habitat based on National Marine Fisheries Service (NMFS) data, priorities for investment in prairie habitat and thermal pollution mitigation based on Willamette Basin Synthesis Map, and priorities for wetland mitigation based on the wetland priorities identified in the Synthesis Map, in areas surrounded by high-function wetlands as determined by ORWAP, or in wetland complexes with the highest restoration/mitigation scores in the newly developed state wetlands coverage (Willamette Partnership 2009).

Willamette Partnership is currently working with Oregon DOT and Oregon Department of Fish and Wildlife to develop the quantification tools and protocols in order to pilot a mitigation banking approach to meeting fish passage requirements for ODOT projects. Results from the pilot will be available for review in June 2014, and should allow ODOT to create a crediting system for any maintenance or construction impacting a culvert, of which there are more than one hundred thousand in Oregon.

Washington's Thurston County

Most relevant to transportation agencies creating a general crediting framework is a project recently developed by the Willamette Partnership with Thurston County, Washington and their MPO (Thurston Regional Planning Council and MPO). The project was built on the prairie calculator, a site-specific valuation methodology designed for native prairies and their species in Oregon's Willamette Valley. The purpose is to develop a credit system with an interim permitting strategy and Habitat Conservation Plan to address the conservation of three federally proposed species, the Taylor's checkerspot butterfly (*Euphydryas editha taylori*) to be listed as endangered and both the streaked horned lark (*Eremophila alpestris strigata*) and Mazama pocket gopher (*Thomomys mazama*) as threatened. The methodology includes tools to quantify potential prairie impacts and associated benefits from proposed mitigation. Methodology protocols and templates help make development and conservation decisions predictable and transparent. It is being built from the Species and Habitat Assets and Risk Prioritization (SHARP) framework developed by ENVIRON, and perfected for use in the Puget Sound. SHARP is a geospatial model that characterizes habitat suitability based on factors such as vegetation, structural and management-based impacts, and species presence. The Willamette Partnership's accounting protocols are added to track, verify, and report on credits and debits resulting from actions on South Puget Sound prairie ecosystems. This project demonstrates both the practicality of modifying a set of protocols developed elsewhere to develop a crediting system, and the need for some additional resources to be available to address local political and ecological issues.

REGULATORY CONSTRAINTS AND INSTITUTIONAL BARRIERS TO IMPLEMENTING CREDITING SYSTEMS

Local Government Issues with State, Regional and National Crediting Systems

Large-scale crediting strategies or conservation frameworks sometimes identify mitigation banks and restoration priorities that occur outside local jurisdictions – meaning local governments sometimes see these efforts as reducing their opportunities to conserve open space, wetlands and the amenities associated with these lands. As a result, local opposition, especially in communities where local jurisdictions have significant regulatory authority, can become a barrier to implementation of crediting. There have not been many studies examining this, but recent work in Oregon, in the city of Gresham and in the water management district for the Tualatin watershed demonstrated that a major obstacle to scaling down prioritization from the statewide level to local levels is lack of equivalent datasets. This is an issue because many of the characteristics needed to identify mitigation priorities that may be available at the local level, such as species distributions linked to stream reaches, are not available for entire watersheds. Several means to solve the data issue are recommended, including coordinating regional data collection efforts with local efforts, and creating incentives to get local jurisdictions to provide updates, on attributes such as wetland boundaries, to state agencies and groups working on developing regional priorities.

Aside from barriers related to the scale and availability of information, there can be real issues when areas best suited for restoration and mitigation are located within a watershed but outside the jurisdiction where mitigated losses are occurring. An ecosystem services framework may be well-suited for addressing these issues, because increased property values due to adjacent open space or recreational opportunities could eventually be included in the analysis that identifies priority mitigation sites. However, regulatory agencies are likely to focus initially on the ecological replacement and restoration needs.

Regulatory Constraints

Most of the regulatory constraints related to developing or implementing a crediting protocol result from traditional regulatory barriers. Examples include insisting mitigation occurs on or immediately adjacent to the project location, or general distrust that transportation planners might be searching for alternatives to best restore or protect the resource. Most if not all the regulatory agencies are interested in moving to functional approaches that allows for more effective and efficient mitigation projects. However, many regulators are so overwhelmed with current permit processing tasks that they find it impossible to find or make the time to understand and implement a new approach, even if it were faster and more efficient. In this case, sharing already implemented projects from elsewhere in the agency may overcome this barrier.

Funding and Organizational Barriers

One of the biggest institutional challenges to both creating a regional ecosystem framework and developing a valuation and crediting system for ecosystem services is convening the transportation and resource agencies and deciding on who will lead, maintain, update, warehouse, track transactions and fund such an effort (Institute for Natural Resources et al. 2012). This is a problem that results from agency silos, and occurs at both the state and federal levels. In some instances, a regional or watershed conservation strategy with goals and objectives could be “owned” by the Army Corps of Engineers (ACE), Bureau of Land Management, Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service, U.S. Geological Survey, National Oceanic and Atmospheric Administration and other agencies. A positive example of this agency ownership occurred with the [Maryland Watershed Resource Registry](#), developed jointly by the EPA and ACE, with assistance from the USFWS through a number of large scale, multi-species programmatic agreements, and now adopted by most Maryland state agencies. However, current federal agency cooperation mostly involves communicating what each agency is doing; rarely, such as in the Landscape Conservation Cooperatives, having two agencies in the same department working together. In addition, mechanisms for integrating watershed or local scale priorities, methods, or plans into statewide or regional priorities, methods or plans also rarely exist, and almost never in state or federal government agencies.

CONCLUSIONS

It is not likely that any DOT or MPO will be able to find a simple tool or silver bullet allowing them to easily establish a crediting framework, in spite of the large numbers of organizations and companies that will suggest that they have or can easily build a tool to do this. Measuring either the environmental improvements as a result of restoration or mitigation, or the degradation occurring as a result of construction, maintenance or adjacent growth is never going to be simple. Over time, advances will be made to simplify measurement of ecosystem services or more advanced methods to model how restoration may impact stream hydrology and flooding will be developed. However, determining how to understand these environmental changes is less critical to establishing the crediting framework than is the maintenance of the partnership between the transportation and development community and the regulatory community.

States as politically different as North Carolina and Oregon have been able to establish statewide or regional crediting approaches and programs for environmental mitigation, which before the system was in place had created significant barriers to their capacity improvement and maintenance permitting. To succeed in building a crediting system with broad buy-in, MPOs and DOTs must avoid caring only about permit streamlining, and really focus on working with the conservation and regulatory community on establishing goals and methods to measure ecosystem impacts and values and to protect, restore and rehabilitate important areas. The use of environmental values in planning can demonstrate to the regulatory community that avoidance

and minimization are a critical part of all the operations of a MPO or DOT, and allow the crediting framework to create a focus on environmental improvement.

The simplest way for MPOs and DOTs to succeed is to take one of the existing systems that have been shown to work, and modify it to work locally. This could mean getting state or regional agreement as to what ecosystem values to consider in transportation planning, and what credit-values can be used to facilitate communication and agreement about mitigation. To do this, it is essential to address both the local geography, ecological and biological issues, as well as the political and institutional relationships. Again, if this is done in concert with the nine-step Ecological framework, MPOs and DOTs will have an agreed-upon regional ecosystem framework to build off of, and some meaningful conservation priorities which can motivate the conservation and regulatory community to embrace a crediting system that provides additional resources towards rehabilitation and conservation.

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- Step 1:** Build and strengthen collaborative partnerships and vision
- Step 2:** Create a spatially explicit, landscape-scale environmental plan or regional ecosystem framework (REF)
- Step 3:** Define transportation and infrastructure scenarios for assessment
- Step 4:** Create an ecosystem and infrastructure development framework (REIDF) to assess effects of transportation on natural resources objectives.
- Step 5:** Establish and prioritize ecological actions
- Step 6:** Develop crediting strategy
- Step 7:** Develop programmatic consultation, biological opinion or permits
- Step 8:** Implement agreements and adaptive management and deliver conservation and transportation projects

FIGURE 1. Integrated Ecological Framework (IEF) steps.



FIGURE 2. Stakeholder approximation of “credits” received by alternative highway scenarios (e.g., Expanded Footprint), in each area of value (e.g., Environment). A low credit score indicates a potentially mitigable inadequacy in that area for that scenario.