New Connections in Ecological Planning for Transportation:
Understanding and Addressing Barriers to Ecosystem Management and Strategic Conservation

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Abstract:

Traditional environmental and conservation planning in the transportation context is unique due to the linear nature of projects. The preferred sequencing of avoidance, minimization, and mitigation is more difficult to apply in these settings. Reflecting this, new laws and policies have encouraged comprehensive conservation planning that includes mitigation banking and advanced mitigation. These new efforts focus around outcome based approaches, yet despite their clear benefits obstacles remain to their implementation. Barriers include institutional challenges including well established patterns and routines to manage resources in a permit by permit approach, or in silos. This paper explores these challenges and the barriers to moving to a new ecological model for transportation planning. Incentives and disincentives must be managing to institutionalize a new cross-agency and multi-resource perspective that allows for planning to take an integrated approach to natural resources including ecosystem services and biodiversity. By implementing clear and repeatable accounting methods, trust and confidence can be developed to allow for a new outcome based planning methodology to emerge. Central to this new method is clear accountability with long-term performance monitoring and adaptive management practices to adjust to changes in the environment and in priorities. The authors draw on professional experience as transportation and environmental planners as well on recent research in the field of conservation planning.
A number of resources and key milestones have been passed over the past 15 years that raised hopes and possibilities for big changes in how the regulated and regulatory agencies conduct their permitting and consultation, but on a nationwide basis, the traditional process has shown remarkable strength and persistence. This paper explores the opportunities and challenges for breaking away from the traditional process and moving to new methods that support and encourage integrated conservation planning and actions. The authors draw on their experience in transportation and environmental planning as well as a review of recent policy and scientific analyses.

**WHAT IS ECO-LOGICAL OR A STRATEGIC HABITAT CONSERVATION APPROACH?**

Strategic habitat conservation and employment of the approach recommended in *Eco-Logical: an Ecosystem Approach to Developing Infrastructure Projects* (Eco-Logical) on a landscape, eco-regional or watershed level combines assessment of resources and impacts over broader areas and time periods with conservation or restoration of key areas for enhancing species viability or watershed function. Impact avoidance and minimization are the usual goals of mitigation, but due to the linear nature of transportation-related projects, most transportation improvements occur around existing transportation alignments, and there are limits to what can be achieved through impact avoidance and minimization. In recognition of this and the efficiencies that may result from off-site mitigation, the Federal Highway Administration (FHWA), the Transportation Equity Act for the 21st Century (TEA-21), the National Wetland Mitigation Action Plan (MAP), the Corps’ and EPA’s new rule on compensatory mitigation (40 CFR Part 230), and other recent federal wetland mitigation guidelines encourage and even prioritize banking or advance mitigation approaches. The US Fish and Wildlife Service (USFWS) encourages conservation banking – “a broader concept of off-setting adverse impacts or providing net benefits to the species as a whole, rather than individual members of that species” – that may target “preservation of existing habitat with long-term conservation value,” investment that may offset the loss of isolated and fragmented habitat that, in some cases, may have little long-term value to the species.2

FHWA, the US Environmental Protection Agency (USEPA), and the US Army Corps of Engineers (USACE) interpreted TEA-21’s streamlining provisions as calling for “advanced planning of mitigation efforts, allowing for greater flexibility and, in some circumstances, a broader range of options for compensatory mitigation, including mitigation banking… Early coordination and identification of potential mitigation needs can provide highway sponsors and resource managers with the opportunity to integrate mitigation for impacts to aquatic resources with other project and regional mitigation objectives.”3 SAFETEA-LU furthered this by incorporating new requirements for consultation with other existing resource plans in the planning phase of transportation decision making. The USEPA and USACE have provided for early solutions, with high level avoidance and minimization before proceeding to mitigation decision making, since at least 1990, when the agencies said “it may be appropriate to deviate from the sequence when USEPA and the USACE agree the proposed discharge is necessary to avoid environmental harm, or EPA and the Corps [USACE] agree that the proposed discharge (action as described) can reasonably be expected to result in environmental gain or insignificant environmental losses.”4 This is consistent with SAFETEA-LU and corresponding regulations specifying that the long-range transportation planning process is to include environmental priorities and functions and also includes a planning factor to “...protect and enhance environment, promote energy conservation and improve quality of life,” in order to “...promote consistency between transportation improvements and State and local planned growth and economic development patterns” [23 CFR 450.206 and 450.306].

**OUTCOME BASED APPROACHES ARE STILL THE EXCEPTION TO THE RULE**

As demonstrated by legislation, the principles of outcome-based approaches enjoy increasingly wide acceptance, but in the practice of transportation planning and environmental consultation and permitting, applying such approaches is still the exception. The common practice of highway planning and environmental permitting is dominated by more traditional approaches and tools, even though many stakeholders—transportation agencies, environmental resource agencies, and the public—are often frustrated by the process and less than enthusiastic about the results.

In the traditional approach to incorporating environmental issues in transportation decision making, interdependent ecological elements are addressed in relative isolation, and overlapping regulatory processes that are implemented by different agencies are addressed relatively independently of each other. For example, stormwater is addressed in multiple regulatory processes and through different permits (MS4 implemented by multiple local jurisdictions, Clean Water Act (CWA) §401 implemented by states, and Endangered Species Act (ESA) §7
implemented by federal agencies). Each permit is typically negotiated one at a time, and the terms, conditions and mitigation are rarely determined within the context of broader ecosystem considerations or priorities. Resource agencies and others understand very well that this approach results in incremental degradation of the ecosystem but staff resource constraints, compartmentalization of responsibilities, and organizational pressures tend to keep us in the habit of using the project and permit review process at hand. At the same time, transportation agencies’ missions are often frustrated by the cost and time associated with this traditional approach, and the knowledge that it is also failing to deliver the best return on the public’s investment. Non-regulated upland areas, isolated wetlands, other unregulated natural areas, and areas outside the area of potential impact often receive little consideration in the decisions made for a given project, if they are considered at all.

**Figure 1: Protected Species PA/MOU Process**

Compounding the issue, environmental considerations typically have little currency in the initial phases of transportation planning, and only enter the transportation decision framework after system planning (long range planning) is complete. Even then, environmental considerations rarely reflect broader ecosystem issues or priorities and focus instead on finding a compromise between “competing” regulations and agency priorities. True integrated planning (transportation planning and resource conservation at minimum) is uncommon.

In addition, ecosystem impacts are typically undervalued. The current common practice, not unique to transportation planning, externalizes the economic aspects of ecosystem change. The concept of “ecosystem services,” and their economic value, is now more accepted and recognized, but most projects (including transportation) typically conduct economic analysis and environmental analysis without integrating the two, and without capturing externalities associated with environmental impacts and benefits. Because of this, the full costs and benefits of a project’s impacts are seldom understood or incorporated into decision-making.

Our regulations and how we administer them tend toward project-by-project, species-by-species evaluation, which in turn results in small-scale mitigation or none at all. As the Defenders of Wildlife observe in their award-
winning guide, *Second Nature*, “a species-by-species approach to conservation is costly, time-consuming and rarely successful.” Obviously the project-by-project approach has produced some successes, but the point is taken – addressed separately, each project design is tweaked to minimize impacts and achieve “no effect” or “not likely to adversely affect” determinations, but it may not minimize effects, and it will almost certainly fall short of achieving it’s potential to promote conservation on watershed, ecosystem, and ecoregional bases.

**UNDERSTANDING THE BARRIERS AND TURNING THE SHIP**

There are valid reasons why outcome-based approaches are not the rule. For starters, it is generally easier in the short-term, and individually less risky to follow standard procedures and routes, rather than navigate new waters. The known route may be less than optimal, but at least it’s known.

Barriers to greater planning level analysis, programmatic approaches, and integrated interagency decision-making include:

**Deficiency of information needed for successful adaptive management.** In the United States, over 12,000 species face extinction. At the same time, the U.S. is facing enormous transportation needs. For adaptive management (i.e., the ongoing feedback and refinement of decision making processes based on continually evolving understanding of cause and effect) a variety of information is needed, including: assessment of current resource conditions; ecological information on multiple scales; benchmarks of ecosystem conditions; quantification of uncertainty; assessment of risk; modeling; decision support; and transparent decision making, strategic planning, accountability and reporting.

**Lack of strategy for dealing with risk early.** Limited knowledge/ability at resource agencies on how to deal with uncertainty at early planning phases, assess the risks and benefits, and to make decisions based on those risks and benefits in the Endangered Species Act (ESA) Section 7 consultation and Clean Water Act (CWA) 404 permitting processes, among others. USFWS does have such a process though, for listing decisions (i.e., Structured Decision Making, used to identify the risks, knowns/unknowns, and take it through the decision making process).

**Inadequate resources for addressing preservation and mitigation at the conceptual level.** As a project advances from the conceptual systems planning stage to the permitting phase, the opportunity for ecological or ecosystem-level preservation or mitigation diminishes. Pressing responsibilities of today make it difficult for agencies to seriously consider conceptual projects 20 years into the future. However, when a project reaches the environmental review and permitting decision point, some decisions and investments (in design, NEPA clearance, political acceptance) have already been made, making it too costly to step back and reconsider foregone opportunities.

**Limited penetration of new SAFETEA-LU expectations and requirements at many MPOs.** In most cases, dialogue is just beginning on resource concerns and discovery of resources available for integrated planning.

**Management.** State DOTs typically do not want to own and be responsible for the long-term maintenance of a wetland mitigation bank or a wildlife habitat conservation site. Nor do resource agencies or organizations want to manage “random acts of kindness” that do not contribute to a manageable network of sites focused on achieving key conservation objectives; i.e. coherent within a strategic conservation plan. For example, there is little incentive for resource agencies and organizations to incorporate or take on responsibilities for sites chosen for their ability to deliver a fast or large return to a mitigation banker. The parties need a framework for easy inclusion and transfer of sites in a pre-approved set, to ownership and management by an appropriate conservation agency or private entity. Likewise, efficient long-term assessment methods are necessary for adaptive management.

**Trust is an issue.** Resource agencies have to be able to trust the DOT to follow-through on commitments and the DOT has to be assured that significant investments in ecosystem preservation or advanced mitigation will satisfy future permitting requirements. The following issues stem from and result in a lack of trust among transportation and resource agencies:

**DOTs want to be sure resource agencies and local governments will protect large investments in mitigation.** For example, when the DOT constructs a wildlife crossing to maintain habitat connectivity, they want assurance that surrounding land owners, whether private or public, won’t develop the land and create a barrier to wildlife movement in a different location. DOTs need assurances that the resource investment, from transportation infrastructure funds, is going to be applicable and used once the project permitting/consultation and mitigation stage arrives.

**Lack of knowledge of and trust in innovative approaches and types of information used in decision making.** ESA Section 7 consultation and Section 404 permitting under the CWA have historically focused on
detailed project review and have involved on-site surveys where effects may occur. The USFWS, USEPA, and the USACE have become accustomed to having this level of detail for project reviews, such that sometimes little can be accomplished at planning level meetings without site level wetland delineations and on-site species surveys. Aerial photos have facilitated earlier discussions (during corridor or Tier 1 EIS studies) regarding wetland impacts and mitigation siting for CWA Section 404 permitting, but the true potential of remotely sensed or widely available continuous data for decision support has not been fully realized. There are a number of reasons that these systems have not been developed on a widespread basis. To date, USEPA, the USACE, NOAA Fisheries, and the USFWS have been hampered by stagnant or declining budgets, little or no programmatic guidance, and other drivers that dominate time allocation and decision making (e.g. lawsuits). Also, until recently, decision support tools have been cumbersome and recovery science has not been formatted for decision making.

**Tendency to focus on process and steps therein, while losing sight of larger conservation objectives.** In general, there is a lack of identification and reward of more creative, visionary staff who “build a better mousetrap” and use of such staff to communicate the change to others.

**Competition among agency missions.** There can be a competitive approach and feeling among agencies that one agency’s mission is being trumped by another’s, or a feeling that one agency’s needs and interests are minor or secondary.

**Lack of confidence that environmental commitments are implemented.** Distrust that commitments are implemented relates to the lack of rigorous environmental commitment tracking systems at most state DOTs. It also relates to construction contracting procedures which require selection of low bids that may not include the most qualified or diligent approach to implementing permit terms and conditions. This can be especially challenging with performance-based permits and approvals.

**Deficient natural and cultural resources data.** Resource/regulatory agencies desire more definitive species presence/survey data for making decisions. In particular, the absence or limitations of recovery plans and State Wildlife Conservation Plans is an issue.

**Fear of the implications of approving regional-scale mitigation.** Resource agencies may be hesitant to approve large, regional-scale mitigation for fear the DOT will assume a blanket clearance and not take the initiative to first avoid impacts on future projects.

**Resistance to use of transportation funds for non-transportation projects.** DOTs do not want to be perceived as a “slush fund” for resource agencies to complete projects they cannot afford to do themselves.

**Limited awareness of the eco-regional conservation plans.** It is not widely known that eco-regional conservation plans are available for the lower 48 states, and the process, participation, and level of scientific information used in their development is not well understood.

**Limited awareness and use of predictive habitat modeling to identify species presence,** while realizing that in some cases habitat is not the determining factor in where the species occurs.

**Lack of availability and widespread acceptance of system(s) to engage the public and help explore long-term tradeoffs.** Technology (such as MetroQuest, I-PLACE3S) is available to help stakeholders understand the long-term implications of their choices across multiple areas, however, these systems and approaches are still too expensive for many regions. A number of tools have been developed to support a process of what has been called Ecosystem-Based Management (EBM); integrating biological, social and economic considerations into a comprehensive strategy to sustain and protect the diversity and productivity of natural resources, and helps stakeholders and decision makers visualize options, understand tradeoffs, set priorities, and make better decisions. EBM tools assist this process by:

- Selecting optimal areas for conservation or restoration,
- Predicting ecosystem response to human and natural disturbances,
- Visualizing the impact of development and resource-use scenarios on an ecosystem,
- Collecting local knowledge about a resource, and
- Facilitating stakeholder decisions on management alternatives.

Existing EBM software tools have different ranges of capabilities. In general they have fallen short of what regulators consider to be needed for decision making.

It can be time consuming for the DOT to get through the regulatory approval process on relatively small projects; the thought of going through the process on an ecosystem scale can be overwhelming. Further, getting approval from multiple Federal and state agencies for the protection of water quality, wetlands, threatened and endangered species, and wildlife habitat on a single site is an obstacle.
Resource agencies often do not come to the table in the long-range planning process with ecosystem protection strategies the DOT can integrate into the program. Alternatively, when the DOT only coordinates with the resource agencies at the final environmental review it can be too difficult to carve out the time or the funding for more strategic mitigation.

Without regulatory drivers, DOTs need incentives; they need to see a benefit to the agency in terms of cost or time savings, or political goodwill to go above and beyond the minimum required. In the last few years, notable progress in long-term planning for ecosystem protection has emerged with the State Wildlife Conservation Plans and the Nature Conservancy’s ecoregional plans in the lower 48 states. DOTs have noted that the process envisioned by SAFETEA-LU and integrated planning would be much more efficient and practical if each resource agency mapped out a state-wide long-term management plan for sensitive or ecologically important habitat that could be directly compared to the 20-year transportation plan. Collection of the data, producing the data in a common format, housing and maintaining such a large database would require a significant investment by all agencies. Most agencies do not have adequate revenue for a mega project like this but a collective national effort could address the issue.

UNDERSTANDING INCENTIVES AND DISINCENTIVES

Most participants have a complex mix of incentives and disincentives. While ecological incentives are critical to understand and communicate, it is also very important to understand and address the other risks/rewards that are not based on ecological concerns, including financial, institutional, schedule, political and personal. One of the more frequently discussed factors is leadership. Top management establishes the direction for the agency and their support and commitment of resources is needed to enable the agency to integrate ecosystem approaches with transportation improvements. In some cases this may require shifting funds and staff time, already in short supply, away from immediate transportation needs. Leadership endorsement of environmental stewardship is necessary to overcome ingrained resistance to change and attitudes of “this is the way we have always done it”.

Institutionalizing environmental stewardship, strategic conservation, and efficient decision making approaches requires a high-level vision that balances the agency’s mission to provide a safe and efficient transportation system with the mission of a variety of resource agencies that may have both complementary and conflicting objectives.

Some of the incentives include:

- Improving predictability for project-level environmental permitting and reducing the risk of delay in delivering transportation projects.
- Facilitating integrated land use-transportation-environmental planning, including conservation across taxonomic groups and planning/managing for sufficient representation, resilience, and redundancy.
- Supporting data-driven decision making and accountability.
- Making decisions that stick, sooner rather than later, using widely available or derived data layers.
- Helping recover listed species (support identification of biological processes critical to achieving self-sustaining populations) and preventing new species from being listed.
- Balancing actions protecting suites of species and considering landscape context.
- Supporting state efforts to efficiently address resource needs in multiple areas, from multiple mandates.
- Increasing opportunities for agencies to attract and keep motivated and high performing employees.
- Reducing the overall costs of implementing transportation projects.
- Achieving better environmental outcomes, focused on ecosystem priorities, including mitigation and conservation with higher rates of long-term success.
- Optimizing biological efficiency and resource investments, achieving mitigation and conservation that is less expensive to maintain and where achievement of ecological objectives is more practical and likely.
- Improving relationships between transportation and resource agencies.
- Increasing opportunities for agencies to “make a difference” by leveraging their contributions with that of others.
- Enabling resource agencies to utilize their full range of skills, reducing, over the long term, the demand on resource agency staff time (after initial commitment to develop ecological approach, programmatic permits, etc.) with regard to the more perfunctory and less creative tasks.
- Improving internal tracking of projects at DOTs and resource agencies
- Producing cost and time savings and helping biologists target field studies
- Creating a platform for more innovation through mutual success.
• Improving our ability to respond more effectively and efficiently to climate change, by raising the analysis and decision-making up to a scale (landscape, regional, state) that is more conducive and appropriate to the climate change discussion. This is a more appropriate scale for addressing the potential effects of climate change on resources, as well as for developing climate change related mitigation.

It’s also important to understand disincentives, which may include:
• Requiring staff commitment to develop new approaches and tools as well as identifying in-agency leaders to demonstrate the applicability, wisdom, benefit, and application of these approaches.
• Opportunity costs of dedicating funding to develop new approach and tools. An agency with a transportation mandate may believe that management of environmental resources is the responsibility of the resource agencies. The agency will do what is required by law but absent regulatory drivers may not be willing to devote dwindling resources to areas perceived to be outside of their direct responsibility.
• Uncertainty regarding “how to do it,” that is, how acceptable it is within agency and local culture, regulatory interpretations, and legal sufficiency.
• Risk that a new approach will fail, reflecting on individuals as well as their agencies and organizations.
• Risk that it will require more resources and/or staff time to integrate environmental issues at the systems planning stage.
• Risk that early environmental considerations will influence systems planning in ways that make implementing the transportation mission more difficult.
• Risk that programmatic permits and ecosystem service market approaches could cut short or diminish incentives for impact avoidance.
• Risk that “cooperation with the opposition” undermines some traditional mobilization and fundraising approaches.
• Risk that new approaches erode the career value of individuals with a stake in the traditional approaches. At the same time, agencies are losing senior staff with broader perspectives and experience to retirement.
• Staff concern that different approaches undercut the important role they have played and continue to play in project evaluation, permitting, and interagency consultation ensuring compliance with federal environmental law.
• Local opposition when off-site mitigation or conservation occurs in a different “jurisdiction” than where the impacts occur, including concerns about the impact on local tax roles of land proposed for or placed in conservation status.

Some disincentives and risks are often more perceived than real; however, that differentiation may matter little as the concerns must be addressed either way. What appear to be “perceived” risks to some parties are very rational and real risks from the perspective of those who carry the risk. It is important to recognize that while there is broad acceptance of the principles of an ecological, outcome-based approach, many agencies and individuals have reasonable and rational motivations to not embark on or implement such approaches.

GIS and commitment tracking systems are enabling DOTs to do more documentation and quantification of how they are avoiding and minimizing, throughout the transportation planning, development, design, and construction process. Texas DOT has gone through a process of demonstrating avoidance and minimization on the planning level and NEPA Tier I for the I-69 corridor, to preserve the sequencing process and consider compensatory mitigation opportunities as well. For both ESA and CWA concerns, illustrating how and where avoidance and minimization occur in the process can allay concerns. Developing and applying best management practices (BMPs), or standards to be achieved on a programmatic basis, helps achieve avoidance and minimization. Sequencing problems have been reduced in Florida, now that Florida DOT (FDOT) is doing system-wide early analysis; FDOT is doing avoidance, minimization, and conservation throughout the process, estimating impacts and avoiding and minimizing where conflicts are identified, and then fine-tuning and avoiding and minimizing even more in the final design.6

Factors which have helped in carving out successful approaches have included vision, leadership, and “big picture” thinking that attempts to achieve larger goals and objectives, along with ability to engage, evaluate, and make tradeoffs around uncertainty. Very pressing, compelling reasons for change and new levels of cooperation help. In Florida, agency leaders coalesced around “we’ll break our process if you break yours.” In North Carolina, the current and prospective transportation program was grinding to a halt over Section 404 permitting issues. Colorado faced potential listings for species widespread across the most populated and under-populated eastern third of the state, in a habitat that faced severe declines, while property prices were shooting up 15-50 percent annually;
Meanwhile, the consultation process was generating little for these species. Oregon faced the need to address bridge replacements statewide, amidst wetland and water quality concerns and multiple listed species. The existing situation in most places can be described in such a way that the urgency is apparent. Most needed was a willingness to act and experiment, since these new approaches were even more marginal at the time they were taken than they are now. Now climate change threats offer a new sense of urgency, along with potentially changing the emerging playing field for DOTs and resource agencies.

**SYSTEMS FOR ACCOUNTABILITY AND ADAPTIVE MANAGEMENT**

Many of the barriers profiled focus on trust in restoration actions. A critical final component of a successful conservation planning effort is the development of confidence-building tools and institutions that assure participants and observers that the conservation actions will be implemented effectively and meet the conservation goals over a long period of time. Systems for accountability and adaptive management are as key as the up-front tools of strategic conservation planning, data and analytical tools, integrating conservation frameworks, and effective ways to engage uncertainty and tradeoffs in order to move forward and make decisions, and leverage what all the partners can bring and gain from working together. Education, leadership, outreach, and changes to business processes will be needed to take strategic conservation approaches to the next level, and particularly to begin to incorporate more wide-scale and interdisciplinary resource threats such as climate change. In an implementation context, these tools are part of a long-term management plan for the conservation program.

The greatest challenge to managing these programs over time is the strong aversion to accepting risk over long time horizons. The risk stems from the failure of conservation programs, including failed wetland sites, spreading non-native invasive species, management errors, and climate change. This is a fair concern, and one that challenges both those that conserve resources as compensatory actions and those that oversee the conservation of resources. Our systems and policies have always found managing for the deep future a great challenge. However, we must address these to truly provide accountability and it requires adaptive management to adjust to the changes we must anticipate but are unable to predict accurately.

Successful management of long-term conservation plans and actions require building measurements to accurately evaluate progress towards goals and build trust, open reporting and data sharing arrangements, and effective management of long-term financial and legal risk. These key elements have many opportunities for further development, but they have not fully matured in any present system or program.

Once commitments have been made to a conservation strategy, monitoring of the program is required to assure that when losses of ecological values occur they only occur after proper sequencing and that they are then properly mitigated. On large linear projects, this requires a landscape level assessment that provides performance based metrics. The primary challenge here is consistent and continual data collection necessary to assess landscape level change. Where impacts are known and delineated such as in wetlands, condition assessments have been greatly needed for regulatory consultations for years. This information has typically not been widely available until on-site wetland delineation occurs. Likewise, condition information is rarely available for at-risk, or already threatened or endangered, species and ecosystems without on-site surveys. Once permitting and/or biological assessment and opinion approaches are developed and mitigation is finalized, agencies and partners often still lack adequate and efficient ways to measure the effectiveness of their actions.

Strategies for addressing this data issue include both field based methods and remotely sensed techniques. The former relying on visits by trained staff with consistent evaluation protocols and the latter based on repeated remote sensing data collection such as with aerial photography, LiDAR (Light Distance and Ranging), or other imaging options. Biodiversity scorecards can provide objective and readily accessible information for more informed decision making, as well as a means of tracking progress, challenges, and success. It provides an intuitive, repeatable, and easy to understand approach for evaluating viability and condition for species and communities, such as wetlands. It identifies measurable attributes which quantify and provide statistical assessment of viability, condition and effective conservation. Alternatively, some field based programs rely on functional assessments that identify natural services that support both species and human communities, thereby giving agencies a clear measurement for impacts and benefits from land management decisions. Field based programs are limited by the ability of agencies or organizations to get crews into the field, and by the standardization of data collection while there. Remotely sensed options are GIS based using data that can then be interpreted through computer aided systems. These systems can quickly process new data, allowing annual or even more frequent analyses of change over time. However, these systems are also limited by the type of data that can be collected, which is limited in detail and scale.
Systems for monitoring ecological health in regions can include analysis of at-risk species and ecological communities. Effective conservation occurs where biodiversity is expected to persist as a result of conservation actions, given current conditions. It is a measure of biodiversity status (condition, size, landscape context), future threat status (severity, scope), and protection/land management status (intend, tenure, potential for effective management/implementation) and this can be illustrated on a scorecard for each state and by ecoregion. A species or type of community may be considered effectively conserved when a sufficient number or distribution of a conservation target are under effective conservation; e.g. all three categories of effective conservation can be evaluated as good or very good.

Ideally, a hybrid process of field collected data in higher impact or risk areas can compliment remotely sensed data in broader less threatened landscapes. By doing so it can account for the impact some strategies have had on biodiversity target occurrences and helps ensure accountability, so that conservation outcomes are measured and partnership/cooperation in and of itself are not the highest goal (“compromise to extinction”). The process will help provide indicators that can be quickly and efficiently applied in management and monitoring, offering practicality of measurement across large areas. Level 1 indicators may be remotely sensed. Level 2 consists of rapid field measurements (less than 15 minutes on site). Level 3 is intensive, quantitative assessment on the ground, which in this methodology should be focused on sites with higher risk or with special decision making information requirements. These detailed site visits also help calibrate Level 1 and Level 2 assessments. Examples of intensive site based evaluations include traditional wetland analyses and classifications, the Oregon DOT habitat value calculations and Parametrixx EcoMetrix assessments. The ODOT and EcoMetrix models both rely on defining the functions performed in the natural system and generating quantitative measures to allow for alternatives analysis, offsets, and monitoring. Key to these two methods is site based evaluations allowing assessments at the square meter level. The Colorado Biodiversity Scorecard is primarily remotely sensed, but based on site verification. Remotely sensed program examples include the NatureServe program from the Nature Conservancy, the Southwest Regional Gap Analysis Program, as well as traditional GIS suitability analyses based on available data. Many of these regional level tools can also be found in state Wildlife Action Planning efforts, or regional conservation planning efforts such as landscape level recovery plans developed by the USFWS or NMFS.

To be effective, indicators must be measurable, meaningful, efficient, useful and credible – with a foundation in science. This is also critical for building trust between transportation planners, regulatory agencies and non-governmental conservation organizations. This repeatable method to measure the success of conservation efforts and the health of the state’s biodiversity answers the primary question: How well are we doing at conserving the state’s rare species and primary ecological systems? Species and ecological systems are scored on their abundance, quality, threats, and land status, considering viability information, proportion of total acreage in patches of preferred size, percent of natural vegetation within a half mile of patches, landscape integrity, energy development potential, projected population growth and development, potential for future transportation development, and protection level.

While repeated data collection and analysis provides a tool for assuring promised conservation actions are followed through, it is also necessary for more than accountability. Agencies are managing in a period of high environmental uncertainty. Pressures on ecological health are complex and many, and responsibility for responding to them requires adaptive management systems. This is a feedback loop that allows conservation planners to track changes over time, and attribute them to causes which then return to the planning process to support future decisions. This may also include adjusting expectations for goals at particular sites. A sudden natural disaster may radically alter the performance of a site, managing this natural change is required. Opportunities and threats both feed into this analysis, as well as a study of exogenous impacts to ecological health for a given conservation program.

The species and ecological systems component of the scorecard provide assessments of the status, threats and conservation progress for key biodiversity elements. However, a complete scorecard will include additional modules: statewide threats (status and trends), aquatic and riparian status and threats, and protection and management status (see), and, likely climate change due to rising atmospheric levels of greenhouse gases. A statewide threats assessment determines the areas of highest and lowest fragmentation due to land use and transportation/energy corridors. The aquatic measures component assesses the state of aquatic flows, riparian habitats, and degree of protection of waters and watershed. The protection/management module assesses the degree to which lands and watersheds are under conservation management. These assessments and resulting scores will provide key information to understand conservation needs, progress, and context for decision making.

In the context of transportation planning and implementation, a complete scorecard can be used to support decisions on location of projects, local and regional context, and importantly, cumulative impacts at multiple scales.
in addition to the critical information on sensitive species and ecological systems—important considerations for regulatory agencies and environmental stakeholders.

**Figure 2: State of the State’s Natural Diversity**

The scorecard system will indicate progress in abating threats to natural systems and whether protection is occurring where threats have been identified. It will show whether the conservation status trends are improving or declining. Many state economies rely on maintaining our natural heritage in a healthy and functioning state. In addition to answering numerous conservation questions, this approach can also be used to assist with prioritizing future conservation efforts and beginning to explain to the public the likely impacts of climate change on species and ecological systems.

To develop the indicators, each species and ecological system is first scored individually. From these basic scorecards, the overall status of biodiversity can be summarized by category. Summary tables, graphs and distribution maps are prepared for each species and ecological system and used to generate “roll-up” statistics. The approach takes core methodologies and packages it in a way that is useful and easy to understand for partners—especially important for laypeople such as legislators. It is also forging the way for improved partnerships among resource agencies, as methods are refined.

In addition to collecting these data for decision making support, the data also needs to be freely shared across partners to assure the best methods and sources are available. Just as silos for permitting can cause unintended consequences, closed data systems can develop myopic perspectives on resources. Through regional or national data sharing and maintenance, an integrated and more evolved dataset can emerge to support planning at all spatial scales. This also permits innovative expansions on data collection. A distributed, but networked data collection program can allow local government agencies to contribute and use data with regional or national agencies. This increases the rate of updating for data and improves accuracy if managed actively.

Finally, key to the accountability and adaptive management are programs that manage environmental and legal risk associated with conservation actions. As entrepreneurial banking has shown, one of the greatest incentives for mitigation credit buyers is the transfer of long-term responsibility for ecological health to the bankers. Of course
developers or transportation agencies may not want to be in the conservation business, it may not fit in their business process, so banking offers an appropriate option. However, this protection does not always extend to transportation or other agencies that choose to conserve or restore areas in advance of potential impacts. The liability and management can become a disincentive for doing the right thing. Long-term management programs would benefit from the wetland and conservation banking model by introducing third party actors to assure monitoring and maintenance occurs with endowed financial resources. In turn, legal liability could then follow these stewards who are also most motivated to see restoration or conservation succeed.

But even the best plans do not always work. A final layer of risk management that may prove to be important in the future development of conservation planning is a collective risk pooling tool on a regional basis. This pool might include all conservation or restoration actors and allow for small individual investments to support redundant mitigation based on historical failure rates. In essence this could be an insurance policy that pays out conserved or restored lands. The added benefit is that this program might allow for a modest increase in overall restoration, or allow for financing of important but marginal lands to support this risk pool. If a conservation action then failed, these lands could be used to satisfy permit or program obligations for a pool member.

CONCLUSION

The barriers to outcome-based, ecological approaches are real but not insurmountable. Tools and regulations, both existing and under development, can help address the technical, regulatory and management barriers. Even so, such approaches are still rare. Additional work is needed to develop the necessary data, refine tools and increase the awareness and knowledge of how to effectively and efficiently implement and manage these approaches.

Agencies must ask, answer, and implement the question: “What can we do together that would most benefit the resource?” The answer and actions that come from this question will allow for offsetting measures on a programmatic basis. With this, project schedules can be made more predictable and funds directed to on-the-ground ecosystem restoration and recovery. A win-win result with the potential to realize both public conservation objectives and more efficient delivery of transportation projects.

These approaches help the public and state and federal transportation and resource agencies:

- Address the greatest threats to imperiled species, habitats, cultural resources and watersheds.
- Improve the temporal and spatial aspects of mitigation and reduce uncertainty regarding effectiveness.
- Address climate change at a more effective and efficient scale.
- Save time and money, manage workload, and create predictable project schedules.

\footnote{Strategic habitat conservation here refers to the general practice of understanding the role of high value habitats and their stewardship in a regional and temporal context that allows for better decision making about conservation actions. The term is also used by a number of agencies as a term of art. Fore example, Florida DOT uses Strategic Habitat Conservation mapping to identify high value habitat on private land to better assist planning for wildlife crossings or impacts. (Cf. American Association of State Highway and Transportation Officials, Environmental Issue Construction and Maintenance Practices Compendium, 2004.) Also, the US Fish and Wildlife Service has a similarly named program for identifying and prioritizing land conservation and restoration actions as well as their long-term maintenance and monitoring. (Cf. US Fish and Wildlife Service, \url{http://www.fws.gov/Science/StrategicHabitatConservation.html})}


\footnote{FHWA, EPA, Corps - TEA-21 Mitigation Preference Guidance, 2003.}


6 Personal communication, Josh Boan, Florida DOT, June 27, 2005.


9 For more information visit: http://www.cnhp.colostate.edu/