

APPENDICES

- A Cumulative Effects and Alternatives Analysis Process
- B Wetlands Workflow and Data Development
- C Lists and Sources for Plans and Data for Regional Ecological Frameworks
- D Pilot Project Reports
 - D.1. Solicitation for State Participation in the C06(B) Project
 - D.2. Approach to Testing C06B Technical Guidance
 - D.3. Colorado Pilot
 - D.4. Michigan Pilot
 - D.5. Oregon Pilot
 - D.6. Ecosystem Crediting Three State Study
- E Example Function-Natural Flow Regulation
- F Ecosystem-based Tool Database
- G Ecosystem Service Accounting Tools
- H Glossary

APPENDIX A: CUMULATIVE EFFECTS ASSESSMENT AND ALTERNATIVES ANALYSIS

APPENDIX B: WETLAND WORK FLOW AND DATA DEVELOPMENT

Workflow for Oregon Wetland Database Development September 2009

Specification Development

Develop a specification, keeping in mind how you anticipate the wetland geodata will be used. Will it be used mostly in an ecological, outreach, or jurisdictional context? Will a Cowardin classification suffice, or will other information, like hydrological alteration, hydrogeomorphic classification (HGM), wetland management, historic conditions, and vegetation communities be needed for detailed analysis or decision-making? Having a clear picture of the database usage will help determine what types of attributes are essential and what attributes may be useful, but can be populated at a later time.

If the geodata will be used in a jurisdictional or quasi-jurisdictional context, consult with the state wetland permitting agency. Have attributes clearly separating field-delineated wetlands versus wetlands determined from imagery or non-detailed field observation.

Determine if tracking historical loss or changes are an important potential use for the database. For Oregon, we established a non-overlapping wetland polygon paradigm, choosing to have our polygons represent current reality. This involves modifying or deleting obsolete polygons, or attributing them as 'developed'. Such a paradigm does not easily support change analysis.

Embed metadata with each polygon, in order to permit an assessment of their relative quality. Such information can include: who developed the polygon set; was it aerial-photo or field-based; field-delineated or field-observed; what year was it done; if aerial, what was month and year of the imagery, and scale was it done at?

Dataset Development

National Wetland Inventory (NWI) data should form the basis for a wetland geodatabase. Obtain a geodatabase directly from FWS that includes polylines. The NWI on-line distribution center does not distribute linear features (polylines). Older digitized quads often represented linear features with polylines, and while the FWS intention is to convert these features to polygons, many areas currently have polylines. If polylines are present, buffer them to 5.0 meters total width, and burn the layer on top of the polygon layer.

There are several known problems with the NWI database, including incomplete coverage and varying consistency with coverage, especially with stream networks. If there are major gaps in your statewide coverage, consider hydrography data sources as potential stopgap data: National Hydrography Dataset (NHD, <http://nhd.usgs.gov>) and NHDPlus cover most of the lower 48 states and include open water bodies and wetland-oriented features, albeit at 1:100K scales. Some states or regions may have smaller-scale hydrography datasets with attributes that can be cross-walked into a Cowardin classification. If large sections of NWI data are missing from your state, consider obtaining funding for their digitization from existing NWI paper maps, or if necessary, for their initial digitization. If digitizing, coordinate with USFWS for training and NWI development methodology.

Hydrography datasets can be spatially queried to check for potential wetlands that may not have been identified in the NWI dataset. A marsh, for example, may have been missed in the initial NWI development due to the limitation of the source imagery (not ideal time of year, or perhaps a drought year). In our experience, we evaluated each polygon individually; automation would have introduced too many false cases.

In areas with limited wetland information (for example, the NWI data are sparse or non-existent), hydric soil data from NRCS soil surveys can be helpful. With the use of the NRCS Soil Data Mart, mapunits with significant component of hydric soils can be extracted. NRCS surveys are typically done at scales much broader than wetland delineations (1:100000 versus 1:4800). Depending on the analysis needs, such coarseness may be sufficient as a wetland surrogate, or for mapping needs, the soils data can direct one's attention to areas for closer examination of unidentified extant wetlands. US Forest Service Soil Resource Inventory or Terrestrial Ecological Unit Inventory studies may be consulted for hydric soil areas in regions with no published NRCS soil surveys.

Similar to hydric soils information, flood zone data developed by Federal Emergency Management Agency (FEMA) or US Army Corps of Engineers may be useful identifying areas of potential wetlands, where no other wetland data exists. Flood zone data may be useful in helping determine historical wetland extent, or areas for potential wetland re-creation, as many river bottoms have been significantly altered from historic conditions.

Some states have mandates for natural resource inventories, conducted by local jurisdictions. Such inventories will likely have detailed wetland information that can replace NWI data. If used, develop an inventory boundary file to clearly designate where field-based inventories took place.

Develop contacts with wetland ecologists and GIS analysts in Federal and State land management agencies. Agencies may have their own field-based wetland mapping reports and data. Anticipate that many older reports will not be digitized. Agencies may identify areas with special ecological significance, such as the BLM's Area of Critical Environmental Concern, with wetlands comprising a significant portion or with wetlands being the primary purpose of designating the area.

Given the physical constraints of road and highway placement, state and local transportation departments are well aware of wetlands in and adjacent to rights-of-way. State Fish and Game (or equivalent) departments may have field-mapped wetland information, especially for waterfowl management.

Establish reference wetland sites within all ecoregions of your state. Such reference sites are typically minimally altered from pre-settlement conditions, and offer a functioning condition reference for wetland

restoration projects. Likewise, identify wetlands that have unique species assemblages, or that host wetland-obligate Threatened and Endangered species. Most state Natural Heritage offices have spatial databases that have information on wetland obligate or facultative state sensitive species.

Obtain land management spatial information for your state. Data from GAP analyses can form a baseline (e.g., <http://gapanalysis.nbii.gov/PADUS>), but there may be wetland-specific management goals not encompassed by such datasets. The Wetland Reserve Program, managed by National Resources Conservation Service, is an example of a land management designation specifically targeting wetland re-creation or restoration. Wetland mitigation banks are another example. Water rights permitting agencies can be consulted for permits to private parties for purposes of wetland re-creation or restoration. Land trusts or private conservation-oriented organizations in your state may have large wetlands under their ownership, or management via conservation easements. Jurisdictions may have zoning plans that identify areas protected from further development, or have identified special natural features or areas to eventually acquire.

Field-derived vegetation coverages may also be used to enhance the wetland geodata as a vegetation attribute, or perhaps identify new wetlands. A riparian vegetation study, for example, may outline areas containing ecoregion-specific wetland facultative or obligate species.

Dataset Maintenance

Anticipate spending time on ongoing maintenance of the geodata. Examples of changes include development of wetlands, wetland re-creation and restoration, and changes in estuary composition due to sea level changes or natural disturbances. NWI geodata derived from 1980s imagery may be obsolete over large areas. Wetland management changes can take place, as jurisdictions may decide to change protection designations, or NGOs/land trusts obtain property for permanent protection.

Using the Data

In Oregon's Willamette Valley, we identified priority sites within each fourth-level HUC unit, in order to encourage a focused agency and NGO effort for wetland restoration projects. We took advantage of a synthesis project by The Nature Conservancy in Oregon, wherein TNC reviewed numerous conservation-oriented actions plans and identified the best areas in the Willamette Valley to target for further conservation. Included in the TNC synthesis project was an initial version of wetland priority sites that was done without the benefit of a wetland geodatabase. Our objective was to determine if the near-final TNC version was adequate, or if it needed significant modification.

Our wetland geodata consisted of several dozen locally-based wetland inventories that replaced the NWI polygon coverage, along with more current information on species of concern and special wetland areas. For areas that had only NWI data, the Cowardin codes provided some information on wetland condition. Open water bodies and riparian areas were filtered out. We took advantage of historical reconstruction data, based on General Land Office records that suggested the pre-settlement extent of wetlands in the Willamette Valley. Our analysis combined FEMA flood zone data, current wetland density, wetlands of special concern (those that host unique communities or that host obligate Threatened and Endangered species), and recent and ongoing wetland restoration projects. The analysis identified several areas not

initially identified in the original dataset, and it also identified minor border adjustments to the original wetland priority site layer.

APPENDIX C: Lists and Sources for Plans and Data for Regional Ecological Frameworks

This list is not exhaustive but includes environmental related data and plans typically found in most regions, and includes data and plans most commonly used in conservation and/or land use planning. Identification of sources does not ensure plan availability in any particular area. Acquisition of some plans and/or data may require license agreements.

Federal Lands/Federally Managed Lands

- DoD Integrated Natural Resource Management Plans (INRMPs)
- DOI Bureau of Land Management
- DOI National Park Service
- DOI US Fish and Wildlife Service
- USDA Forest Service
- US Army Corps of Engineers (USACE) and NOAA have Special Area Management Plans (SAMPs)
- National Oceanic and Atmospheric Association (NOAA) and US Fish and Wildlife Service (FWS) recovery plans

Section 1.01 State/Regional agency plans

- Statewide Long Range Transportation Plans, any other state or regional transportation plan that includes proposed transportation projects (corridor analyses, regional transportation profiles, transportation improvement plans, etc.)
- State Wildlife Action Plans (SWAPs) <http://www.wildlifeactionplans.org/>, or other conservation/land use plans that are mapped and have “actionable” priorities. Some plans may have buy-in across the state and therefore offer a “pre-endorsed” plan.
- Wetland Conservation Plans
- State lands and reserve plans
- State game and trust species management plans, including wildlife crossings
- State natural heritage or state natural area plans (natureserve.org)
- State comprehensive outdoor recreation plan

- State 'open space' plan

Section 1.02 Local agency plans

- Local land use plans/Comprehensive Plans, Green Infrastructure Plans (The Conservation Fund), GreenPrint (The Trust for Public Land) plans, etc.
- Land Use/Land Cover
- Local watershed restoration plans completed by state water quality agencies or local watershed organizations. These can include municipal water supply watershed plans.

Section 1.03 NGO plans

- The Nature Conservancy's (TNC's) Eco-Regional Conservation Plans, covering all states in the US. These may be especially useful when SWAPs lack mapped, actionable priorities. (tnc.org)
- Other Potential Conservation Areas that are widely adopted/utilized.
- The Audubon Society's Important Bird Areas plans, joint venture waterfowl or waterbird plans, or other various single resource focused, scientifically-derived priority plans developed (Ducks Unlimited and Trout Unlimited).
- Local/regional land trust plans developed with systematic methods.

Data

- Protected area data (USGS PADUS, <http://www.protectedlands.net/padus/preview.php>, CBI, databasin.org)
- National Conservation Easement Database (<http://www.conservationaleasement.us/>)
- Natural Heritage Program Species Locations (natureserve.org)
- Predictive Species modeling data
- Ecological Systems or Natural Communities (<http://www.natureserve.org/explorer/classeco.htm>)
- National Hydrography Dataset (USGS)
- Soils (USGS), Hydric Soils data (NRCS)
- Wetland/Watershed - NWI, local watershed plans by state or local organizations or municipal water supply watershed plans, e.g., Wetlands of Special State Concern
- Impaired (303 d listed) streams (USEPA, state agencies)
- Impervious Surfaces (state or local govt.)

- Flood Plain (100year) FEMA
- Point sources (state govt.)

Other Useful National Data Portals

Highlights of tools aimed at watershed protection and additional information can be found at the following websites: http://www.placematters.org/index.php?option=com_wrapper&Itemid=85.
<http://www.epa.gov/waterspace/toolpage.html>

Ecosystem Based Management (EBM) tools are software or other highly documented methods that can help implement EBM by: 1) providing models of ecosystems or key ecosystem processes, 2) generating scenarios illustrating the consequences of different management decisions on natural resources and the economy, and 3) facilitating stakeholder involvement in a planning processes. The EBM Tools Network is an alliance of EBM tool developers, practitioners, and training providers. Get more information on tools and data that are available at: <http://www.ebmtools.org/>

Geo-Spatial One Stop. Inter/National geo-spatial data clearinghouse and computer network of data servers/portals. Available geographic data and metadata posted, shared, and coordinated with the National Spatial Data Infrastructure (NSDI) and Federal Geographic Data Committee (FGDC). Individual web links for each national, state, regional, and local data portal/server that is part of the overall inter/national data clearinghouse are accessible at: <http://registry.fgdc.gov/browse.php?order=title>. Search for various types of data and information across all data servers within the overall data clearinghouse at: <http://www.geodata.gov>

OpenGIS – Open Geospatial Consortium (OGC). An international industry consortium of **more than 300** companies, government agencies and universities participating in a consensus process to develop publicly available interface specifications. [OpenGIS® Specifications](#) support interoperable solutions. The specifications empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. Summaries available at: <http://www.opengeospatial.org/>

National States Geographic Information Council (NSGIC) is an organization committed to efficient and effective government through prudent adoption of geospatial information technologies. State summaries and contact person for each state available at: <http://www.nsgic.org/>

The National Biological Information Infrastructure (NBII) is a broad, collaborative program to provide increased access to data and information on the nation's biological resources. Also linked to the inter/national geo-spatial one stop described above. Learn more at: <http://www.nbio.gov/portal/server.pt>

APPENDIX D.1: Solicitation for State Participation in the C06B Project Pilots

Improving Highway Project Delivery and Environmental Results Testing a New Ecological Assessment Template

The Problem. Transportation and regulatory agencies are frustrated that time-consuming and expensive traditional permitting and mitigation processes too often fail to deliver either timely transportation solutions or effective high priority conservation results.

Research Project. The Transportation Research Board Strategic Highway Research Program is developing tools to integrate environmental, economic and community requirements into analysis, planning and design of new highway capacity projects. Our team is developing a scientifically-supported, outcome-based Ecological Assessment Template to facilitate efficient and effective transportation planning, regulatory decision-making and capacity development while maximizing opportunities for the long-term conservation and enhancement of ecosystem functions at multiple scales. Our research is aimed at delivering highway projects faster with superior environmental protection.

Research Team. The Institute for Natural Resources (INR) at Oregon State University, Nature Serve and four of its program partners (Oregon Natural Heritage Information Centre, Florida Natural Areas Inventory, Michigan Natural Features Inventory and Virginia Division of Natural Heritage), Parametrix, and CH2M Hill comprise the research team. Gail Achterman, the principal investigator, is the Director of INR and chairs the Oregon Transportation Commission. Marcy Schwartz, Senior Vice President of CH2MHill, has over 30 years of experience in transportation planning and will lead the pilot tests. Shara Howie of Nature Serve will organize the pilot tests, building on her experience facilitating FHWA conservation and transportation planning workshops.

Participating States. We plan to test the new Template in four states: Oregon, Florida, Michigan and Virginia.

Method. The new Template moves beyond existing static habitat maps and manual geographic information systems to applying systematic tools using more quantitative approaches. The Template will tie to regulatory assurances and ecosystem crediting systems to support transportation planning and project delivery more efficiently, objectively, and defensibly. We want to test it on recently completed long range highway plans, corridor plans or capacity projects. The Template will be revised in response to the lessons learned from these tests. In selecting pilots to test we seek diversity in organizational, policy and human contexts; diverse landscapes—urban, suburban and rural; and diverse ecosystems. This will allow us to better evaluate its applicability and relative effectiveness in other areas.

We anticipate that a major benefit of the pilot tests will be input from regulatory and other agencies to help reshape decision making processes so that landscape scale conservation goals and information needs are addressed early, reducing future conflicts while still providing the information needed to meet project level regulatory requirements.

Your Obligation as a Pilot Site. The research team will conduct the necessary data integration and spatial analyses work. If you agree to participate, your obligations will be to:

1. Provide or help identify and secure data used in the original plan or project and additional data for the template not readily available to the research team
2. Participate in a review workshop in June 2010 to understand and respond to the results and utility of the pilot test.
3. Review and respond to our conclusions about the pilot test in our report.

Your Opportunity as a Participant. By participating in the pilot project, you will have the opportunity to gain the latest scientific information on wetlands, habitat and ecosystem credits in your state and see how this information and new analytical tools could be used to assist you in the future.

Schedule

Late October 2009/early November 2009

- 1 day workshop with transportation agencies and other stakeholders in each state
- Purpose: identify issues, review template, and select pilot project site for testing

Nov-Feb 2010

- Research Team gathers data and other necessary in-state information on the pilot project site to run tests with the assistance of local participants

March/April/May 2010

- Run the tests. This would be done remotely in collaboration with each state by the Research Team.

June 2010

- 1 Day workshop with the original October workshop participants to review the results of the demonstration and get feedback on the utility of the templates.

For more information contact: Shara Howie. Phone (703) 797-4811, (720) 565-0256, ext 4811 (CO Local). shara_howie@naturereserve.org

APPENDIX D.2: Approach to Testing C06B Technical Guidance

Overview

We plan to test our Ecological Assessment Framework with associated templates (hereinafter 'Framework') in three states: Colorado, Michigan and Oregon.

Our general approach is to conduct the pilots as described below but the analyses in each state will vary slightly based on the nature of the project, the data available in each state, and the tools used by the states for conservation and transportation planning. For example, in Colorado we are doing our analyses on an entire Metropolitan Planning Organization region that involves multiple projects which allows us to test our cumulative effects methodology in a large landscape context taking into account multiple potential impacts in an area. In Oregon, an Ecological project has funded the development of predictive species range maps for listed species, and an EPA project has resulted in the development of priority mitigation sites, so we will analyze how these data affect the decision outcomes. In Michigan we will be testing how using the Framework will impact the outcomes in an area where conservation priorities were not previously identified.

In all three states we will be comparing data and outcomes from the original projects with outcomes utilizing new and updated data, and the methods outlined in our Framework. In this comparison we will primarily be looking at:

1. Direct impacts identified based on original data and methods versus the data and methods identified in the Framework.
2. Mitigation effectiveness based on the sites selected in original project versus mitigation sites identified utilizing data and methods identified in the Framework, and predicted ecological outcomes at the different sites.
3. Cumulative impacts estimated from the original data and method versus the data and methods identified in the Framework, for at least the resources targeted in the selected pilot site.

General Approach to Testing the Framework

1. **Introduce Project to Natural Resource and Transportation Agencies.** Meet with DOTs, MPOs, and key state and federal agencies in the selected pilot states (CO, MI and OR) in order to introduce the project and get initial input on areas in the state that meet the pilot project selection criteria (Appendix A).
2. **Select Site for Pilot Test.**
 - a. Follow-up with each pilot state to get more information about data available for the areas proposed to conduct pilots.
 - b. Select an area in each state based on how well the area meets our pilot project selection criteria (see below), whether or not a sufficient amount of the spatial data from the original project is available digitally (in GIS, CAD or similar format).

Data Collection. Collect all data used in the original evaluation of the project selected, including the original infrastructure footprint, final project footprint, biological data or other conservation datasets, EIS or EA, ROD, other public concerns (noise, air quality, water quality, historic/cultural sites). The data available will vary among the pilot areas, according to the concerns and capacity of each project.

3. Run Pilot Test.

- a. Choose an Ecologically-based Geographic Boundary for the Analyses. An ecologically based area considers the full extent that a species or habitat could either be impacted, or considered for mitigation.
 - i. Identify the resources that intersect the project area
 - ii. For aquatic resources include the watershed that is expected to be inclusive of stream reaches, wetlands, and other water bodies that could contain the connected populations of species involved.
 - iii. Then nest the watershed within an ecoregional defined unit. The unit may be an aggregation of subdivisions of the EcoMAP or other similar accepted ecoregion based geographic map. The subdivisions to be included would, similar to the aquatic unit, incorporate the resources intersecting the project area and including the priority conservation areas from the REF that contain those same resources and could likely serve as mitigation receiving areas for impacted resources.
- b. Adopt or Develop Regional Ecological Framework. Follow the CEEA template methods for developing a regional ecological framework (REF) or accepting a previously developed plan of conservation priority areas. This includes:
 - i. Identifying ecological resources to be considered in analyses, and goals related to protection of those resources. Utilizing ecological data layers and conservation plans.
 - ii. Collecting, incorporating and/or developing current ecological data for area being evaluated. If possible including or developing predictive species distribution data and priority wetland data. When new data is used, evaluate its acceptance (via interviews or meetings) by the relevant regulatory agencies.
 - iii. Reviewing previous analysis or analyzing data or to determine the terrestrial and aquatic elements and areas that will be included in the analyses.
 - iv. Identifying and integrating land use and transportation planning information available spatially.
 - v. See Appendix B, the List and Sources for Existing Plans and Data to consider when building REF.
- c. Analyze the REF. The REF will proceed through workflow templates beginning with the REF source inputs detailed above. A Geographic Information System (GIS) decision support system (DSS) will provide the analytical functions to

produce the outputs used for the following step (c). The templates used for the pilot projects provide a relatively simple but highly robust and flexible approach to conducting regional cumulative impact assessment and the consequent development of alternatives and mitigations. The workflow is modeled on some of the core concepts of systematic conservation planning (Margules & Pressey, 2000) and the use of GIS tools that automate a great deal of the technical GIS work necessary to carry it out (Sarkar et al., 2006). An important component of the GIS decision support system approach to be used in the pilot projects are the application of suggested goal levels and indicators based on expert and/or stakeholder input.

The templates developed by the CO6B team depict the flow of information from source inputs to outputs utilized in decision making. It is important to emphasize that the workflow and supporting toolkit are decision *support* systems, not decision making systems so the results require review and judgment in terms of how they should affect decision making. The Colorado and Michigan pilots will use the NatureServe Vista DSS, a free extension of ArcGIS 9.3. The Oregon pilot will use ArcGIS 9.3 without NatureServe Vista.

A cumulative scenario analysis focuses on land uses (but can include management practices, natural disturbances, etc.). Land use change is then analyzed using multiple scenarios:

- i. *A current or baseline scenario* will describe current actual land use based on the best available data. The pilot projects will attempt to identify land use conditions at the time when the original project was started.
 - ii. *The original project scenario* will include the long-range transportation plan or corridor plans associated with the original project.
 - iii. *An alternative scenario* incorporating REF data and processed according to the proposed CO6B framework templates.
- d. Evaluate Results of Test with Original Project Outcomes. Compare the results of the analyses in Step 4b with the data and outcomes from the original project with a focus on direct and cumulative impacts and selection of mitigation sites.
- i. Direct Impact comparison – the CO6B project team will evaluate whether using the Framework in evaluating the project area identified differences in the number, aerial extent, or types of natural resources, and/or more accurately identified the severity of the impact within the project area(s) than the original project review under NEPA.
 - ii. Cumulative Impact comparison – this aspect of the analyses includes looking at the project within a regional landscape context and/or looking at the current and historic extent of habitats for potentially impacted species, and seeing how that compares to the results of the original project or planning in the area, such as more severe impacts or impacts to resources located in areas surrounding the project.
 - iii. Mitigation evaluation – this aspect of the analyses will illustrate whether the Framework approach uncovered:

1. more viable sites for mitigation (based on landscape context),
 2. sites with multiple conservation resource values, and/or
 3. sites that would provide greater contributions to other resources (i.e., water quality, priority non-regulated species, etc.)
- iv. **Savings in Time and/or Resources** – The CO6B team will try to show how using the Framework would result in a more streamlined decision making process. This analysis will likely require direct input from the natural resource and transportation agency staff each pilot state.
- e. **Analyze Permitting, Mitigation and Other Crediting Opportunities.** Step 4c will use compiled information from interviewees in DOT and with data collected in Steps 4a and 4b to evaluate the available crediting methodologies that may have supported the project better.
- i. **Analysis of Regulated Resource Crediting** – the project team will review the measurement challenges in the permitting stages to understand other mitigation actions in the region that generate mitigation demand both within the agency and among other permittees. A key component is understanding where measures are a barrier for consultation or permitting.
 - ii. **Analysis of Credit Markets** – Where available the team will review DOT and non-DOT based markets for credits, this include §404 or ESA banking.
 - iii. **Recommendation based on Future Needs** – the interviews with DOT staff will indicate upcoming regulated and non-regulated needs that crediting could potentially address. Tools and methods will be recommended to address these needs.
4. **Follow-up Meeting with Natural Resource and Transportation Agencies in Pilot States.** Set up webinar with our transportation and natural resource partners from each state to review and discuss results of analyses and comparison with original project outcomes.
5. **Finalize Templates.** Make adjustments to template based on input from federal and state agencies in pilot states.

References

- Margules, C.R. and R.L. Pressey. 2000. Systematic conservation planning. *Nature* 405:242–53
- Sarkar, S. R.L. Pressey, D.P. Faith, C.R.Margules, T. Fuller, D.M. Stoms, A. Moffett, K.A. Wilson, K.J. Williams, P.H. Williams, and S. Andelman. 2006. Biodiversity Conservation Planning Tools: Present Status and Challenges for the Future. *Annu. Rev. Environ. Resour.* 2006. 31:123–59

Pilot Project Criteria/Requirements

Scope and scale

- Capacity project with unavoidable ecological impacts – a measurable footprint change **(required criteria)**
- Project includes pre-project decision making process (i.e., corridor or other planning level process took place before project was selected) **(required criteria)**
- Project has been completed within the past 5 years **(highly desirable)**

Challenging ecological issues

- Multiple types of habitats – ideally including wetlands and/or streams in addition to other upland habitat types – habitats can be regulated or non-regulated
- Multiple types of species potentially affected by project
- Other key ecological and/or other water quality concerns
- In-kind, on-site mitigation was not ecologically preferable but was required by regulatory agencies

Background data

- Ecological data and ecological goals for region (e.g. Recovery Documents)
- Project design footprint information and mapping **(required information)**
- Baseline environmental documents (NEPA documents, Biological Assessments, mitigation plans and permits, BMPs) **(required information)**
- Site photographs pre-construction **(highly desirable information)**
- Orthorectified air photos of project area – ideally pre and post project **(highly desirable information)**
- Details of mitigation performed for project **(highly desirable information)**

Specific challenges experienced during design and permitting

- Concerns related to project delivery – certainty **(highly desirable information)**
- Agency and public concerns regarding assurances **(highly desirable information)**
- Budget and rough schedule for amount spent (time and money) on environmental analysis and compliance efforts **(highly desirable information)**

APPENDICES D.3 to D.5 COLORADO, MICHIGAN AND OREGON PILOT PROJECT REPORTS

See separate documents

APPENDIX D.6: Environmental Accounting Study

Incorporating Environmental Information in Project Delivery Oregon, Michigan, Colorado DOTs

The Task 4c team explained to DOT staff interviewees that the objective is to create guidelines for developing an adaptable process states can use to support local processes for incorporating environmental needs earlier in the project delivery process.

Oregon Department of Transportation

Based on preliminary discussion with ODOT staff, changes need to occur in the Statewide Transportation Improvement Program (STIP)¹. It is a more efficient time and step in the process for connecting environmental issues and the project delivery process. Environmental information is still not well accounted for in the STIP, which is more about transportation needs than environmental needs. For example, greater emphasis would be placed on engineering required to straighten a curve than on the project's overall environmental impacts. STIP criteria are being modified to incorporate more environmental values and linkage to NEPA; however, better inclusion of environmental values is still not happening in the planning process, which is at the political rather than the project level. Opportunities may arise from legislative requests such as in the Oregon Highway Plan. STIP also needs high level performance standards such as increasing the percentage of impervious areas treated. Regulators also need a role in the STIP process, particularly much earlier collaboration, and the STIP process also needs to include SWAP and OCS documents. STIP is also the level to evaluate programmatic or tradeoff decisions across resources; new regulatory concerns should first be evaluated at STIP level, to prevent surprises.

The following themes and issues emerged from the interview:

1. **Better environmental information is needed on the front end of the project delivery process.** ODOT is developing a GIS environmental management tool for regulatory teams. The tool, developed with best available data, is close to being usable although it is not yet complete. Additional data from other sources, coupled with greater coordination, would be very helpful.

Under the current process, ODOT pulls data from wherever it can find it and then goes out onto the proposed site to more fully assess environmental impacts and constraints. The general lack of data causes problems with project design, especially in ways that could better accommodate 'discoveries' when undertaking site analysis.

There is a need to coordinate CAD files/engineering priorities with GIS/environmental/mitigation divisions between data sets. Doing so will go a long way toward improving the project design process.

¹ See <http://www.oregon.gov/ODOT/HWY/STIP/>. Oregon's STIP is a four year transportation capital improvement program that identifies funding and scheduling of transportation projects and programs across multiple government entities.

2. **Coordination with, and changing expectations from, cooperating agencies is a continuing challenge.** Projects typically require cooperation among a range of state and federal agencies, which creates numerous blockages:
 - A. *One of the big challenges is mid-course or “11th-hour” changes in agencies’ requirements and expectations.* There needs to be a punctuated equilibrium approach, rather than a continual change approach. The best available science creates dynamic data sets; there should be some agreement among cooperating agencies that new standards will be applied to subsequent projects while allowing agreed-to performance standards for current projects to stand. Basic definitions can be lacking – expectation to treat 100% of stormwater on new facilities is an example. Does 100% mean all of the new surfaces or all of the existing and new surfaces? If 100% of existing and new, can they trade it to another facility?

Risk aversion is a big driver for regulatory agencies’ behaviors. They are consistently concerned about setting precedents with respect to agreed-upon standards and subsequently being perceived as not administering regulations as required. Although they have the legal power to require changes whenever they feel it is necessary, doing so while a project is underway creates significant delivery problems. Having clear, *durable* agreements among partners regarding mitigation requirements, priorities and tools to be used would provide a much needed level of certainty regarding project delivery obligations.
 - B. *Regulatory agencies distrust ODOT based on historic environmental performance that influences current perceptions.* There is a general perception that ODOT is not doing as much as it can for the environment. ODOT is actively improving its environmental practices; however, although it may do well on 50 projects, it’s the one in which ODOT doesn’t perform to expectations that the agencies remember and tend to regard as the measure of ODOT’s overall performance.
 - C. *Scope creep, based on a lack of explicit rules and responsibilities, creates problems.* ODOT works with at least two intergovernmental coordinating entities: the Collaborative Environmental and Transportation Agreement for Streamlining (CETAS) and the Bridge Delivery Program’s Programmatic Agreement Reporting and Integration Team (PARIT). When there isn’t enough other business to take care of, partner agencies have a tendency to “chew on the furniture” and become involved over and above what is called for. This stems from lack of specific rules and clear understanding among agencies regarding the limitations of their authorities. Agencies sometimes go looking for new issues to call their own. As an example, some agencies have inappropriately defined what needs to be done offsite as well as onsite with respect to wetlands mitigation. FHWA also sees collaboration or cooperation as DOT being too permissive with regulatory agencies. Remember FHWA portion of the equation. Regulatory agencies also have a tendency to try and reach back to impacts that predate regulation and address these.
 - D. *Issues “coming down the line.”* Always need to be planning ahead for such issues as Clean Drinking Water Act, greenhouse gas emissions, mobile air toxics, etc.
3. **ODOT is using a business case to change how it does business, but this approach is not well understood either externally or internally.** The business case can help ODOT be more proactive and consistent with respect to environmental needs. Regulatory partners do not seem to appreciate how business ‘works’ with entities such as ODOT. They are not alone, however, with respect to this lack of understanding the business aspect of project delivery: it is also an issue

with various departments within ODOT. Need to remember state level laws, Jobs and Transportation Act §18 is a good example. Has reporting and benchmarking requirements.

4. **Collaboratively developing appropriate decision processes or tools will greatly enhance outcomes.** Potential areas of focus include:
 - A. **A tool that could identify regional priorities.** There appears to be a good sense of regional priorities; however, the current process of determining those priorities is ad hoc. For instance, ODOT has done a good job of assessing priorities with respect to vernal pools, but it would be useful to be able to apply a consistent process to other resources. Need to be plugged in at the STIP level.
 - B. **A tool that could evaluate tradeoffs.** For example, agencies are often uncertain regarding what needs to be done offsite versus onsite regarding wetlands mitigation. Actions are often defined by best available technology or by what is feasible, which is insufficient to meet environmental goals. As the future of natural resources is active management rather than taking a hands-off approach, understanding tradeoffs is important to project decision making. Tradeoffs cannot be made strictly at the project level, they must be strategized and occur at a higher level.
 - C. **Partner agency agreement on the developed tools.** If the agencies don't clearly acknowledge and accept the tools, ODOT will wind up back at square one with respect to having to go through approval on a project-by-project basis.
5. **Project follow-up is constrained in multiple ways.** Until we have clearer direction on responsibility and value of tracking ecosystem service provision, post-project activities will remain outside ODOT's purview.
 - A. **There is no federal nexus for maintenance activities.** This creates conditions for ODOT that the maintenance and operation shop practices are different than construction. Spraying and chemicals not allowed in construction are not regulated in maintenance cases. Use of herbicides in riparian areas is another example; in this case the 4(d) rule does not apply. Thus ODOT faces uncertainty over how to design or proceed with maintenance projects.
 - B. **Monitoring is controversial in terms of investment and outcome.** The agency uses habitat as a surrogate for environmental quality. ODOT has been pushed by agencies to invest in more monitoring, but ODOT has pushed back on the demand since, if species do not reappear where they should, there is little ODOT can do about the situation.

Since monitoring information is currently seen to be of limited use for ODOT's purposes, they see little point in making the investment. Agencies often require monitoring in ways that don't make sense to ODOT. In these instances, having correct monitoring demonstrated and having the partner agencies provide guidance—what the agency needs to know, how to go about providing it, and providing feedback to improve monitoring—would increase efficiency.

What guidance has been provided has been too ad hoc or appears to be a one-size-fits-all approach. It would improve efficiency to be able to use a single methodology that all agencies could agree to.

Tracking annual mitigation/compliance costs is not precise. Such costs are not separated out as a part of doing business. As a result, those costs have low accuracy. It

was not clear from the interviews whether or not this is a significant issue for either ODOT or cooperating agencies.

- C. **Since ODOT is a small 'frequent filler' it doesn't make sense to invest in a mitigation bank, but it complicates design and delivery.** Because the agency is a 'frequent filler,' it has to respond to constant demands and requirements from regulatory agencies. The best solution for the agency would be to have an east side Cascades/west side Cascades bank to do advanced mitigation, but that's unlikely. A conservation registry might be one way to better meet ODOT's needs.
 - D. **Terrestrial species aren't typically considered.** Although ODOT is trying to do a better job of incorporating their requirements, there is no regulatory hook to include them in project design; and it is regulation that forces such inclusion. In the absence of regulations, if the state has a governor who doesn't support inclusion of terrestrial species, it won't happen.
6. **Links to local land use planning are weak.** When asked about how land use planning factors into design considerations, the response was that issues are mostly political, which can lead to directions that indicate little understanding or consideration of environmental impacts. An explicit example was an interchange design that did not maximize design opportunities on adjacent property according to the developer/stakeholder. The issue was elevated politically beyond ODOT's staff control or oversight, and directions were given to redesign the interchange. The redesign wound up creating greater environmental impacts. ODOT has created a process to get local land use entities to become more engaged in project design for intersections and interchanges, but that process does not currently incorporate environmental considerations.

Pursuant to the Jobs and Transportation Act §18, ODOT is charged with developing rules that account for using environmental performance measures in project design. It is also responsible for developing measures for four project objectives: saving money, saving time, protecting the environment and reducing the State's dependence on foreign oil. The interviews indicated that having measurement tools would help ODOT meet these obligations.

Michigan Department of Transportation

The nature of MDOT's business has changed significantly in the last ~5 years. Their major capacity projects are at border crossings with Canada, which involves some major natural resources, such as the Detroit River between Detroit and Windsor. Have had a moratorium on developing new capacity projects for financial reasons.

MDOT has been successful at avoiding impacts, so haven't had as many projects recently as they used to, when they had hundreds of acres of impacts on floodplains and wetlands, habitat. Two of their recent border projects were in urban areas, so involved impacts on fewer natural resources, and they did not have to deal with permits for natural resource management.

Quality of agency relations on natural resource management:

Coordination with cooperating agencies: Very smooth process – we have had very little conflict over past 5-6 years with resource agencies, v partner-oriented organization, have been working with other agencies from a program standpoint. Every year have a natural resource agency

meeting, very successful at attracting resource agency staff and driving mutual learning. Everything not rosy, but definitely improving.

Relationship-building with resource agencies: Focused on having communication building events with agencies, builds trust and fairness: what is it that you're looking for out of this project? Our DOT has been very sensitive to conflict resolution, collaboration throughout the process, trying to get right input at right time, to avoid having to rework or quit. Ran into T&E issue some years ago, with a "stinkin' butterfly" that they DO have to take these issues seriously. Provided a wake-up call.

Use of different staff teams for banking and mitigation issues: We were very into banking until this year, but the financial crisis stopped us. Six banking projects are up and running or in the works. We're really spoiled with the wetland banks right now, can use them for any wetland impact we have. Very streamlined, very unlike the former 2-year process – now assign the credits, get the approval and you're good to go.

Use of business case to change how agency operates:

Costs have gone from \$200k/acre to \$30k/acre. Previously had to buy and overly design parcels to get a wetland on one. Used to do a great deal of earth moving, but construction and acquisition costs are both down. Have been working hard to institute tracking now, with the result that we can now produce reporting on results.

Department has had *a fair amount of failure* – felt we needed to have a more process-based analysis of failures. How were we going to track results? Essential to start figuring out how our overall progress is going.

Money helps. I've developed partnerships with other agencies where I've funded GIS projects, and that's part of relationship building.

We're working with public money, we owe it to the public to figure out how to *spend money smartly* and get best results you can. If we're going to have experiments, let's have real ones, and let's prioritize them, through dialogue.

Collaborative development of appropriate decision processes/tools:

New approach is explicit: 'While we are going through this process you're going to be with us, rather than bringing you in at the end, where you express your conflict.'

Have *one-stop shopping* for most natural resource concerns, one place to work with state permit laws and most of federal laws. We pay for these people out of our budget, so they are highly motivated to work with us.

Improving relations with federal agencies:

New things coming down the line: worry more about *regulatory changes* than about new resources to watch. Don't have a lot of listed T&E. Economy means having massive shifts of population out of the state, may have more habitat than ever. Don't have a lot of requests for on-stream mitigation, but are hoping lessons out of wetland from standpoint of process and business practice, will be useful.

Interactions with USACE on Sn 10 having increasing success through time: at first we couldn't even get them on the phone, but that is changing. Also the Corps now has an annual meeting in March to look at hot current issues, which helps generate very rapid follow up.

Assumption agreement with EPA says it will have review and account (?) authority, to review 404 assumptions. We have run into some problems when not directly in contact with NEPA staff, but that's an *internal relations* issue. *Verbalizing these problems helps.*

Improving relations with engineering staff:

One project on Grand River involving large bridge crossing illustrates the change: 10 years ago we would talk to engineers about *spanning the floodplain* and they would laugh. This doesn't happen anymore, this time no question that they would span the floodplain.

What brought the engineers along? Having internal staff working on *changing attitudes* all the time helps educate. Also has to do with turnover of staff – you have hiring periods in government where things are good and you bring on a lot of people. Those people were retiring 5-8 years ago, which changed the whole organization. *Younger people* came in who are much more accepting of environmental laws, so a lot of the improvement had to do with society and educational changes. We just don't have the fights we used to have.

404 merger process and concurrence point were really helpful in developing this approach. Having a *stepwise process* has really helped, and we've applied it to a lot of different areas here. We're really into negotiation.

Emerging and local contextual issues:

Tourism is #2 industry, water resources are essential to tourism. From a transportation standpoint, stream and fish resources will become more of an issue here. We have matured to a level of confidence on handling wetland mitigation, and don't want to have to repeat those for stream mitigation. Need to lean on the partnerships we've built eg with fisheries people because they generate tremendous benefits to both regulatory and transportation depts., for a results-oriented approach.

Stream work is mostly upgrading facilities, correcting scour, building bigger bridges, culvert sizing, best practices for fish passage, sometimes stream relocation.

Not having a watershed-based approach to streams is a problem. We need to ask, what is the overall plan? This is a system, not just my little piece that will bring the fish back.

Continue to have conflict on airports. Usually on cheap land, usually wet, have a runway that needs extension, run into problems. Don't have the stepwise process, so often find them in the position of saying hell no we won't do that mitigation.

Need to share experience with mitigation. One problem we've had with wetland mitigation sites has been performance measures that are highly unrealistic for sites, no scientific background. Regulators are often on a fishing expedition. I would offer to do a research project, with money to track what happens, to work cooperatively and get past hard-edged requirements.

Colorado Department of Transportation

CDOT's process is that as projects come off the STIP to regions, regional environmental staff review and decide if statewide program help is needed. The staff is tasked to ensure CDOT is meeting federal and state wildlife laws, ensure statewide consistency, identify ways to streamline or find mitigation and

banking/programmatic projects helpful, try to coordinate across region. It also manages §7 consultation and state and federal wildlife processes.

Programmatic tools in place:

1. *Shortgrass prairie, 58,000 acres* acquired in natural state:
 - Deeded to TNC to manage, to cover up to 20 years of maintenance activities along highways (primarily used for plowing, signs, intersection improvements, rest stops).
 - Debits are recorded in acres and CDOT keeps a running tab of disturbed acres; must track both temporary and permanent impacts, and can reuse temporary acres if they hit the limit. Impacts are only measured through design. Consultation is now done with just a letter.
 - The department will reconsult with USFWS when this acreage is used up or when 20 years elapses.
 - Everything east of the Shortgrass line is considered shortgrass habitat and can be mitigated by the program.
2. *South Platte Water Related Activities Program (SPWRAP)*, adjusting depletions to Platte River. State put money into fund to buy water rights and restore habitat for species mostly in Nebraska, similar program for Colorado River across the divide in the western portion of the state.
3. If project comes in, look at all species on list provided by FWS, check impacts, likewise Forest Service list, and state-listed species. Have a *liaison at USFWS* just for section 7 issues, always available for consultation. Amenable and works well.
4. *Banking* is a growing option – support by regulators and DOT. Habitat data are primarily from university and Natural Heritage Program.

Emerging issues and concerns:

- i. *Canada lynx* is most difficult species to deal with – looking at barrier effects and migration patterns, how much effect on crossing the roads? To date, have tried to get region to mitigate by reducing barrier effect, taking out cement for guard rail, or guard rail for cable rail, work closely w Div of Wildlife, look for places to put gaps in barriers. Wavering due to lack of hard numbers on effects. If population of Lynx continues to grow conflicts will arise – especially along I-70.
- ii. *Cuttthroat trout*. Need to clean runoff.
- iii. *Conflicting regulatory drivers*: Loveland Pass example with stormwater detention and treatment facilities that are needed but these facilities block Lynx passage.
- iv. *Mitigation costs are not tracked*: The shortgrass prairie initiative was paid for in full at purchase and costs are not accounted for in projects when credits are used. Other species like SW Willow Flycatcher are avoided through scheduling entirely.
- v. *Coordination efforts*: Multiple working groups on resource issues can make coordination challenging.

- vi. *Prairie Dog*: Several species – the Black Tail is the primary concern in the east – local opposition to moving the animals, but a potential for listing in the longer term. Primarily euthanizing animals now.
- vii. Preble's meadow jumping mouse will affect growth in Denver/Colorado Springs area.
- viii. *Migratory birds*: need better options – exclusion practices are hard and timing is an issue.

Most species of concern are in remote areas where transportation projects are not needed: sagebrush grouse, mountain plover, boreal toad. Boreal toad is a particular challenge, affected by salting, sediments and stormwater and no real way to avoid when it is an issue.

APPENDIX E: Example Function – Natural Flow Regulation

1) Concept Description

1. Channel dimensions and discharge (i.e. stream flow) define the potential forces acting on sediments.
2. Those forces determine the initiation of bed and bank sediments.
3. Bed and bank mobility determine channel form.
4. When sediment contributions equal sediment exports, the channel is said to be in a state of dynamic equilibrium.
5. When contributions and exports are unequal, the channel will likely experience physical change, and is said to be in a state of dynamic disequilibrium.
6. Alterations to established significant flows and/or to sediment availability may affect channel form. Alterations may be from natural or manmade actions.
7. Factors such as sediment sorting, bank vegetation, imbrication, grade control features (such as bedrock, weirs, dams, etc.) all affect sediment mobility.

2) Overview of Function

Stream discharge characteristics affect sediment movement within a channel, which in turn affects the stream's physical form. The physical state, that is the dimensions, shape, and forms of a channel, includes spatial and temporal patterns that together may be said to express whether the channel is in a state of equilibrium or disequilibrium. A stream that undergoes physical changes but is able to maintain form and geometry within a consistent range over time is said to be in equilibrium. Another way of describing channel equilibrium is when sediment imported to a stream equals the sediment exported by that channel. A channel in the process of changing its fundamental physical state, or shifting its base condition, may be said to be out of equilibrium or in a state of disequilibrium.

Base condition changes may be in response to a variety of causes. One example is an increase or a decrease in the intensity and duration of peak flow events on average.

An addition to the intensity of peak flows may cause excessive erosion, leading to excessive channel down cutting lateral movement, over widening, or any combination of the three. Such an increase in peak flow intensity may occur in drainage areas where impervious surfaces and uncontrolled runoff increase, for example.

Conversely, a dampening of naturally occurring peak flows may lead to coarsening and armoring of a streambed. This process generally involves a reduction of bank erosion, potentially necessary to introduce fine sediments, coupled with loss of those fine sediments in the streambed to erosive forces, and the concentration of sediments too large for the stream to move. Dams and other flood control structures may precipitate such a response in a stream.

3) Approach

It may be possible to gauge whether a stream is in a state of, or is approaching a state of equilibrium by comparing existing sediment characteristics to channel geometry along a reach. For this function, we assume that a stream in equilibrium is able to transport the observed mean sediment size found in that channel during bankfull flows.

Measurements of channel width, average maximum channel depth, and longitudinal slope may allow one to estimate the potential flows, and thus the forces able to act upon channel sediments. Measurements of sediment size classes within a stream reach allow for an estimate of the force, or critical shear stress necessary to move sediments downstream. By comparing the two, one may be able to judge the susceptibility for, and frequency of sediment movement. By extension, one may also be able to predict how changes to stream flow characteristics may affect channel form and stability.

Definition – what is channel equilibrium?

One way to describe 'channel equilibrium' is a state where forces acting upon a stream channel are balanced by sustainable reactions of that channel. Water and sediment entering the stream channel are balanced by flow discharge and redistribution of sediments. Luna Leopold describes the processes involved in the following way:

Initiation of motion involves mass, force, friction and stress. Gravity and friction are the two primary forces in play as water flows through a channel. Gravity acts upon water to move it down slope. Friction exerted on the water by the bed and banks of the channel works to slow the movement of the water. When the force of gravity is equal and opposite to the force of friction the water flows through the channel at a constant velocity. When the force of gravity is greater than the force of friction the water accelerates (Leopold, 1953).

'Equilibrium' does not necessarily equate to an unchanged channel; streams are dynamic and prone to change to some degree. A typical channel in a state of equilibrium may be expected to migrate laterally, causing banks to erode in some areas while simultaneously building new banks in others. The timeframe over which one considers physical changes is important to define in the context of equilibrium (Knighton, 1998). For this exercise, the timeframe considered is generational, or approximately 50 to 100 year periods.

"Channel-forming flow is a higher discharge that is dominant in driving the stream processes (erosion, sediment transport, and deposition) that shape the channel and its physical habitat. As such, the channel-forming discharge is a keystone variable in stream restoration design. The finding that intermediate flows with relatively short return periods, rather than rare, large floods, have the greatest influence on the physical form of the channel has long been one of the most influential paradigms in fluvial geomorphology (Doyle et al., 2005; Wolman and Miller, 1960). The channel-forming discharge is commonly represented by one of three flows: the effective discharge (Q_{eff}), the bankfull discharge (Q_{bf}), or the 2-year flow (Q_2) (Wolman, 1960; Doyle, 2005). The effective discharge is that flow which over a period of years transports the most sediment, and which consequently does the most work in forming the channel (Figure 6). While researchers initially suggested that the effective discharge should be represented by a single flow, recent studies suggest envisaging an "effective range of discharges" that consist of a range of flows of moderate frequency (typically between the 2 -and 5-year events), which together transport the great majority (usually about 70%) of the sediment load. (Biedenharn, 2000)

Rules

This approach is intended for streams with coarse sediments, such as pebbles, gravels, cobbles, and boulders. This approach is not suited to bedrock streams or stream with primarily fine matrices such as clays, silts, and sands.

Function Triggers and Modifiers

- Densely vegetated banks - decreased chance for bank mobility
- Banks cleared of vegetation - increased chance for bank mobility
- Grade controls - affect sediment movement and flow hydraulics
- Sediment

Vegetation stabilizes sediments by binding the soils and reducing surface erosion. Vegetation also stabilizes slopes, consequently reducing mass wasting events that may contribute sediments to a system.

Land use practices such as timber production and farming alter vegetative cover. Urbanization may also affect riparian vegetation and groundcover.

Attribute Consideration

Attributes to be measured/applied:

- Substrate composition
- Water depth
- Slope (gradient)
- Wetted width
- Velocity
- Maximum channel width
- Average maximum depth

Explanation

Maximum channel width, average maximum channel depth, and slope allow for the calculation of the theoretical channel forming, or peak discharge (Wolman, 1960). Wetted width, water depth, velocity, and slope measurements allow a direct measurement of immediate discharge. The direct discharge measurement is included in order to check calculations of the theoretical peak discharge.

Substrate composition estimates are necessary to characterize shear stresses necessary to initiate movement.

APPENDIX F: ECOSYSTEM BASED TOOL DATABASE

ID	tool name	Description
1	N-SPECT: Nonpoint Source Pollution and Erosion Comparison Tool	N-SPECT helps coastal managers and local officials predict potential water quality impacts to rivers and streams from nonpoint source pollution and erosion.
2	Ecosystem Management Decision Support (EMDS)	EMDS integrates the logic engine of NetWeaver to perform landscape evaluations, and the decision modeling engine of Criterium DecisionPlus for evaluating management priorities.
3	BASINS- Better Assessment Science Integrating point & Nonpoint Sources	BASINS is a customized ArcView GIS application designed to be used by regional, state, and local agencies to perform watershed- and water-quality-based studies and as a system for supporting the development of total maximum daily loads (TMDLs).
4	Information System of Plans (ISoP)	In most development situations, the existence of multiple plans and many distinct government agencies and interest groups is normal. The many plans that affect overlapping geographic areas are created by different stakeholders and are inconsistent in at least some respects. we can develop tools to treat these plans as an information system of plans (ISoP) and use them to advantage. The ability to access and compare multiple plans yields more information pertinent to making a decision than can be found in any one plan, which of necessity suppresses disagreement and multiple perspectives. The result is an ISoP that is a persistent, interactive and continually changing set of information that puts plans to work rather than on a shelf.
5	LEAM (Land use Evolution & impact Assessment Model)	LEAM is a computer-based tool that simulates change across space and time. Planners, policymakers, interest groups and laypersons use LEAM to visualize and test the impact of policy decisions. The LEAM system is designed to enhance our understanding of the connections between urban, environmental, social and economic systems.
6	C-Plan Conservation Planning System	C-Plan is designed around the concept of a decision-support system. Together with a geographic information system (GIS) it: maps the options for achieving an explicit conservation goal in a region, allows users to decide which sites (areas of land or water) should be placed under some form of conservation management, accepts and displays these decisions, and then lays out the new pattern of options that result.
7	Conservation Assessment and Prioritization System (CAPS)	CAPS is a computer software program designed to assess the ecological integrity and biodiversity value of every location based on natural community-specific models, in order to help prioritize lands for conservation action based on their assessed ecological value.

8	FRAGSTATS	FRAGSTATS is a spatial pattern analysis program for categorical maps.
9	Habitat Priority Planner	HPP is a spatial decision support tool designed to assist users in prioritizing important areas in the landscape or seascape for conservation or restoration action. What makes this tool unique is the ease with which the scenarios can be displayed and changed, making this a helpful companion when working with a group.
10	Impervious Surface Analysis Tool	NOAA Coastal Services Center has developed the Impervious Surface Analysis Tool (ISAT) to help managers and planners make a determination about the impact of impervious surface coverage on local water quality.
11	CommunityViz	CommunityViz® is a GIS software extension that is designed to help people visualize, analyze, and communicate about important planning decisions. Widely adopted by land-use planners, it supports informed, collaborative decision-making by illustrating and analyzing alternative planning scenarios.
12	TransCAD	TransCAD is a GIS system designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. TransCAD combines GIS and transportation modeling capabilities in a single integrated platform.
13	NEPAssist	NEPAssist is a GIS application that automates and web-enables the collection and coordination of information inherent in the environmental review process mandated by the National Environmental Policy Act (NEPA).
14	INDEX Planning Support Software	INDEX is an integrated suite of interactive GIS planning support tools for assessing community conditions, designing future scenarios in real-time, measuring scenarios with performance indicators, ranking scenarios by goal achievement, and monitoring implementation of adopted plans.
15	ARIES-Artificial Intelligence for Ecosystem Services	AGWA is designed to provide qualitative estimates of runoff and erosion relative to landscape change.
16	HEP USGS Habitat Evaluation Procedures	ARIES is a web-based technology offered to users worldwide to assist rapid ecosystem service assessment and valuation (ESAV). Its purpose is to make environmental decisions easier and more effective. ARIES helps discover, understand, and quantify environmental assets and what factors influence their values, in a geographical area and according to needs and priorities set by its users.
17	InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs	InVEST is a software tool that can model and map the delivery, distribution, and economic value of life-support systems (ecosystem services).

18	LCM- The Land Change Modeler	The LCM is an optional software extension for ArcGIS as well as another GIS platform, IDRISI Taiga also produced by Clark Labs. The LCM is a useful tool for analyzing and predicting land cover change and assessing the implications of that change for biodiversity.
19	CoastRanger	CoastRanger MS has been designed to explain the consequences that different management approaches have on coastal processes, natural environments and flood and coastal erosion risk. The software highlights the range of interests that need to be balanced on the coast and demonstrates the difficult decisions that have to be made in some areas.
20	LTM- Land Transformation Model	The LTM model uses landscape ecology principles, patterns of interactions to simulate land use change process, to forecast land use change.
21	RESTORE	RESTORE integrates models of watershed function and economic characterizations of restoration options with stakeholder-determined constraints and priorities to provide a tool for stakeholders to identify feasible restoration strategies and evaluate the ecological and economic effectiveness of these strategies at addressing watershed-level function.
22	WARMF- Watershed Analysis Risk Management Framework	WARMF is a physically based watershed modeling framework and decision support system for watershed management. It is suitable for applications including watershed stewardship, land use planning, climate change impact, mercury transport, and TMDLs.
23	Watershed Treatment Model	The WTM assesses uncontrolled pollutant loads from two broad categories of pollutant sources: primary sources and secondary sources. Primary sources are related to the urban stormwater runoff loads from major land uses (i.e. commercial, residential, agricultural). Secondary sources (i.e. sanitary sewer overflows, septic system failure, and channel erosion) are pollutant sources dispersed through the watershed whose magnitude cannot easily be estimated from available land use information.
24	PAT- Protected Area Tools for ArcGIS 9.2	One of the technical challenges within the process of evaluating and filling protected area gaps is the development and use of GIS-based user-friendly tools that support the protected area gap process. The development of a Protected Area Gap Decision Support System (DSS) was conceived as part of an ongoing process to help fill the technical void that exists.
25	Virginia Natural LandScape Assessment (VaNLA)	The Virginia Natural Landscape Assessment (VaNLA), a component of the Virginia Conservation Lands Needs Assessment (VCLNA), is a landscape-scale GIS analysis for identifying, prioritizing, and linking natural habitats in Virginia.

26	Virginia Natural Land Network (NLN)	A component of the VaNLA, the NLN identifies large, unfragmented cores, patches of natural land with at least 100 acres of interior cover. Cores provide habitat for a wide range of species, from interior-dependent forest species to habitat generalists, as well as for species that utilize marsh and maritime habitats.
27	CEDAR and CEDAR GIS	CEDAR allows users to enter and retrieve project data from a single source. The focus of the application is to facilitate environmental staff duties, with special attention given to meeting the needs of district staff who handle the majority of the project clearance activities. CEDAR provides the ability to assess potential environmental resource conflicts through the internal comprehensive GIS, where users can digitize project areas, and then spatially analyze those areas in order to identify potential resource conflicts.
28	NHDE	Natural Heritage Data Explorer is a website application that provides an interactive map service that allows the user to display a variety of data layers, including county boundaries, roads, streams, watershed boundaries, conservation lands, and topographic and aerial photography for the entire state.
29	LCDE	The Land Conservation Data Explorer is a public portal which allows users to view and query existing Natural Heritage land conservation information including Green Infrastructure GIS models/layers, Conservation Lands, NWI data and various reference layers including roads, jurisdictional boundaries and hydrology.
30	Wetland Restoration Catalog	This catalog identifies potential wetland restoration sites, based on their historic wetland characteristics and their inclusion in, or adjacency to, Natural Heritage Conservation Sites.
31	One N.C. Naturally Conservation Planning Tool	The One NC Naturally Conservation Planning Tool was envisioned to streamline the process of identifying and prioritizing the areas in North Carolina's landscape that are essential for conservation.
32	Virginia Coastal Geographic	ArcServer-based website that provides a gateway to Virginia's coastal resource data and maps, focusing on geospatial data and information related to coastal laws and policies; facts on coastal resource values; and direct links to collaborating agencies responsible for current data.
33	Miradi	The Miradi software tool helps conservation practitioners implement the Open Standards for the Practice of Conservation. Miradi provides an easy-to-use, interview-style interface that walks a project team through each step of the process of designing, managing and monitoring their project according to the best practice standards established and tested by the world's major conservation organizations.

34	NatureServe Vista	Natureserve is a software extension tool for conducting conservation planning and integrating conservation with other assessment and planning activities such as land use, transportation, energy, and natural resources management.
35	Marxan	MARXAN is a software designed to aid systematic reserve design on conservation planning. With the use of stochastic optimization routines (Simulated Annealing) it generates spatial reserve systems that achieve particular biodiversity representation goals with reasonable optimality.
36	QuantM	QuantM is comprehensive route optimization software designed for transportation planners.
37	Circuitscape	Circuitscape is software program which borrows algorithms from electronic circuit theory to predict patterns of movement, gene flow, and genetic differentiation among plant and animal populations in heterogeneous landscapes.
38	Florida ETDM	The Efficient Transportation Decision Making (ETDM) process was the response to the congressional passage of the Transportation Equity Act for the 21 st Century. The ETDM process redefined how the State of Florida accomplishes transportation planning and project development. The overall intent of the ETDM process is to improve transportation decision-making in a way that protects the human and the natural environments.
39	Colorado Planning & Environmental Linkages Tool	The PEL tool was designed for transportation planners to facilitate an improved approach to transportation decision-making that considers environmental, community and economic goals across the targeted corridor.
40	Texas Ecological Assessment Protocol (TEAP)	The Texas Ecological Assessment Protocol (TEAP) is a planning and screening-level assessment tool that uses existing data available from the statewide GIS grid to identify ecologically important resources throughout Texas. The results of the TEAP can be used in project planning (i.e. scoping, alternatives analysis), to determine appropriate areas to conduct detailed field investigations, and in mitigation discussions to avoid ecologically important areas, minimize impacts to those areas, and compensate for unavoidable impacts.
41	Florida EST	The Environmental Screening Tool (EST) provides a vital foundation to the transportation/conservation process, supporting agency participation and community involvement throughout the project life cycle. The EST is an Internet-accessible application that provides tools to input and update information about transportation projects, perform standardized analyses, gather and report comments about potential project effects, and provide information to the public.

42	Google Earth/Google Maps	Google Earth is a free desktop product for that displays aerial imagery and other GIS data on a desktop computer. Google Earth provides high-resolution imagery for most if not all urban areas in US. Increasingly, users are able to add their own data (such as KML or KMZ files) to Google Earth interface.
----	--------------------------	---

APPENDIX G: ECOSYSTEM SERVICE ACCOUNTING TOOLS

APPLIED RIVER MORPHOLOGY METHOD

Rosgen 1996

Provides a detailed explanation of the Rosgen stream classification system (Rosgen 1994) and “how it might be used to incorporate the observed processes of river mechanics into restoration designs.” (Rosgen 1996). Presents probable channel evolution scenarios based on existing channel and valley features to suggest potential future stream conditions. Based on field data but may have GIS component. Descriptive and quantitative output.

Intended use: Nationwide rivers and streams

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

ARTIFICIAL INTELLIGENCE FOR ECOSYSTEM SERVICES (ARIES)

University of Vermont

A federally funded information science tool developed for web distribution that provides users a guided and intelligent way to assemble data, values and issues.

Intended use: To help organizations or jurisdictions identify issues and opportunities for understanding ecosystem services. A decision support system.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

BASINWIDE VISUAL ESTIMATION TECHNIQUE (BVET)

Dolloff et al. 1993

A sampling design for estimating total fish abundance and total fish habitat area within a watershed. Based on field data but may have GIS component. Quantitative output.

Intended use: Small streams. Not limited to any single geographic region, but was developed and has been most utilized in the western U.S.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

BENEFICIAL USE RECONNAISSANCE PROGRAM (BURP) FIELD MANUAL FOR STREAMS

Idaho Department of Environmental Quality, BURP TAC 2004

Initiated to help determine the existing uses and beneficial use support status of Idaho’s water bodies. BURP monitoring emphasizes sampling, analysis, and assessment of biological assemblages and physical habitat structure of streams to ultimately support characterization of stream integrity and overall quality. This BURP Field Manual provides information needed for consistency and comparability of monitoring efforts among Idaho Department of Environmental Quality personnel as well as other entities interested in following these methods. A descriptive, ordinal scale with quantitative output.

Intended use: Idaho streams

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

BUSHBROKER

Victoria Department of Sustainability and Environment, Australia 2006

A trading scheme for registering and trading native vegetation offset credits. Native vegetation credits are listed on the *BushBroker* register and these can be bought by another party and subsequently used as an offset for the approved clearing of native vegetation.

Intended use: Auction-based tool for managing offset mitigation.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

BUSHTENDER PROGRAM

Victoria Department of Sustainability and Environment, Australia

This survey protocol develops habitat scores based on field site studies that can be conducted on large tracts of land. The resulting score has been used in trials for auction based conservation financing.

Intended use: Auction-based tools for restoration of native range and forest land.

Able to calculate multi-resource credit: Possible, currently creates a landscape level score for trading based on biodiversity.

Sensitivity: Coarse spatial scale, focused on a single ecosystem.

Capable of being integrated into multi-resource credit: Unknown

BUSINESS AND BIODIVERSITY OFFSET PROGRAM (BBOP)

Forest Trends

An international partnership between companies, governments and conservation experts to explore biodiversity offsets and develop the principles and methodologies required to support best practice in voluntary biodiversity offsets. BBOP has published a set of ten principles on biodiversity supported unanimously by the 40 member organizations of the BBOP Advisory Committee, together with supporting material in the form of interim guidance on the design and implementation of offsets.

Intended use: To develop best practice on biodiversity offsets for the BBOP partners.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

CALIFORNIA CARBON PROJECT PROTOCOLS

California Climate Action Reserve

There are a number of protocols developed for different credit actions. Most relevant is December 2008 forest protocol applicable nationally. Quantifies only carbon sequestration.

Intended use: Carbon credit calculator

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

CALIFORNIA RAPID ASSESSMENT METHOD (CRAM)

Southern California Coastal Water Research Project

A wetland functional assessment that looks at conditions and stressors. Allows for differing level of detail based on use. First step is classifying the wetland, then assigning scores for Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure.

Intended use: Wetland assessment

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

CASCO BAY WATERSHED WETLANDS CHARACTERIZATION METHOD

Hertz and Sartoris 2001

To provide a watershed-based wetlands characterization method using GIS. Listed uses include: to inform and support wetlands conservation and protection programs at the state, local, and national levels; as an aid in municipal and regional planning, including open space, habitat and water quality planning; and to provide information on wetlands and affiliated upland systems for use in compensatory mitigation situations. Nominal scale output units.

Intended use: Maine freshwater and marine wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

CITY GREEN

American Forests

An ArcGIS package of models that calculates ecosystem services and economic value for stormwater, carbon storage and sequestration, air pollution removal, and water quality. Does analysis on user-defined land cover layer.

Intended use: Analysis tool for decision makers.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

COMBINED HABITAT ASSESSMENT PROCEDURE/HABITAT EVALUATION PROCEDURES

Bonneville Power Administration/NW Habitat Institute

Used to quantify the impact of hydroelectric projects and benefits of mitigation in the Pacific Northwest. CHAP is an evolution that allows for crediting out-of-kind habitats. Based on species-habitat associations.

Intended use: Integrated ecosystem services accounting

Able to calculate multi-resource credit: Yes

Sensitivity: The system is sensitive to direct impacts from projects, but can only measure change based on presence/absence of habitat elements. Function-based accounting, but the functions are limited to those provided by species. Has more potential benefit as an assessment.

Capable of being integrated into multi-resource credit: Yes

CONNECTICUT METHOD

Ammann et al. 1986

To provide a method of wetland evaluation for use by public officials and others who have some familiarity with wetlands; to be used for wetland policy formation and analysis. Ordinal scale output.

Intended use: Connecticut inland wetlands and watercourses.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

DELAWARE RAPID ASSESSMENT

Jacobs 2005

To assess the current condition of the wetland site and identify stressors that are present that are lowering the condition of the site. Ordinal scale output.

Intended use: Non-tidal wetlands of Outer Coastal Plain regions of Maryland and Delaware.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

DESCRIPTIVE APPROACH (HIGHWAY METHODOLOGY)

USACE New England Regulatory Program 1999

To identify and display wetland functions and values acceptable for the Corps New England District Regulatory Program. This method can be used for any project where the characterization of wetland resources is necessary for Section 404 permit requirements.

Intended use: New England wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

DEVELOPING RAPID METHODS FOR ANALYZING UPLAND RIPARIAN FUNCTIONS AND VALUES

Hruby T., 2009

A rapid assessment method for non-wetland riparian habitat in Washington State. Indicators are used to identify the potential of a site to provide a function, the potential of the landscape to support the function, and the value the function provides to society.

Intended use: To implement upland riparian laws in Washington.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

DEVELOPMENT OF A FLORISTIC QUALITY ASSESSMENT METHODOLOGY FOR WISCONSIN

Wisconsin Department of Natural Resources, 2003

Developed to provide an intensive measure of wetland biological integrity based on the condition of the plant community.

Intended use: For use with the Wisconsin wetland monitoring program.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

EASTERN KENTUCKY STREAM ASSESSMENT PROTOCOL (EKY) USACE 2002

The eKY Protocol was developed to address the need for a headwater stream assessment procedure to assess potential impacts of projects proposed in the Eastern Kentucky Coalfield Region by applicants seeking authorization from the U.S. Army Corps of Engineers pursuant to Section 404 of the Clean Water Act. In addition, the assessment protocol also had to suggest requisite levels of compensatory mitigation efforts to offset the adverse impacts and identify applicable monitoring variables and success criteria to evaluate the success of mitigation efforts. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Eastern KY Coalfield physiographic region; 1st to 3rd order streams.

Able to calculate multi-resource credit: Yes

Sensitivity: At the stream reach (minimum 100m in length), plus a macroinvertebrate bioassessment index for headwater streams of the Eastern Coalfield Region.

Capable of being integrated into multi-resource credit: Unknown

ECOLOGICAL SITE INVENTORY Bureau of Land Management

A descriptive tool used by NRCS to describe the baseline ecological conditions as part of natural resources planning. There are not quantitative elements, so an extensive review was not conducted.

Intended use: Qualitative tool.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

ECOMETRIX Parametrix

An integrated function based ecosystem services accounting methodology that integrates resources and methodologies allowing for decision making analysis, crediting and trading, and environmental performance measurement monitoring.

Intended use: Integrated ecosystem services accounting

Able to calculate multi-resource credit: Yes

Sensitivity: The methodology is very sensitive to direct impacts from projects – both restoration and development related, but can be used at landscape-scale. Function based accounting based on ecosystem services identified by the Millennium Assessment. Can be tailored to meet geography, habitat, and policy requirements.

Capable of being integrated into multi-resource credit: Yes

ECOSYSTEM DIAGNOSIS AND TREATMENT MODEL Mobrand Biometrics, Inc. / ICF Jones and Stokes

Ecosystem Diagnosis and Treatment (EDT) is a system for rating the quality, quantity, and diversity of habitat along a stream, relative to the needs of a focal species such as coho or Chinook salmon.

Intended use: The methodology includes a conceptual framework for decision making and a set of modeling tools that organize environmental information and rate the habitat elements in regard to the

focal species. In effect, it describes how the fish would rate conditions in a stream based on our scientific understanding of their needs.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

ECOSYSTEM VALUATION METHODS

Virginia Department of Forestry

A package of models on a website that allows landowners to calculate potential ecosystem credits from their lands. Best available models are approved by agencies for use but are still early in development.

Intended use: Water quality

Able to calculate multi-resource credit: Not likely due to “still in development” nature of models

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

ENVIRONMENTAL MONITORING AND ASSESSMENT PROTOCOLS (EMAP)

Environmental Protection Agency

A series of assessment methods and guidance for monitoring ecological conditions and risks.

Intended use: Broad set of assessment tools for various resources.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

ENVISION

Oregon State University

Envision is a GIS-based tool (beta version) for developing alternative-futures analysis used to model the landscape impacts of various policy scenarios on land use change and accompanying biophysical impacts. Strongest applications are mapping the cumulative effects of multiple actions at multiple sites as it tracks impacts over time. Has the ability to plug in evaluative models (e.g., credit calculators).

Intended use: Created to conduct research about the nature and properties of coupled human and natural environmental systems in the context of climate change.

Able to calculate multi-resource credit: Unknown, but has connections to other credit calculators.

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

EPA OREGON STREAM METHODOLOGY

EPA

Identifies perennial and ephemeral streams in Oregon. Uses field indicators that identify evidence of flow.

Intended use: Water quality assessment

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: No

EPA REGION 10 IN-STREAM BIOLOGICAL MONITORING HANDBOOK

EPA/Hayslip 1993

To supplement the rapid bioassessment protocols (Plafkin et al. 1989; rev. Barbour et al. 1999) by illustrating how Region 10 States have adapted the RBPs for the northwestern U.S.; to define the minimum components necessary to conduct stream bioassessment; and to encourage consistency of sampling methods to facilitate data sharing. Ordinal scale, nominal scale, and quantitative output.

Intended use: Wadeable streams and rivers in Region 10 (WA, OR, and ID)

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

EVALUATION FOR PLANNED WETLANDS (EPW)

Bartoldus et al. 1994

To determine whether a planned wetland has been adequately designed to achieve defined wetland function goals. This method has also been used to assess conditions of existing wetlands. Ordinal scale output.

Intended use: US wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

FAIRFAX COUNTY STREAM PHYSICAL ASSESSMENT PROTOCOLS

Fairfax County Stormwater Management Branch 2001

Fairfax County developed a Stream Protection Strategy as part of on-going progress towards a watershed management program. The Strategy includes methods that build upon and incorporate extant bioassessment programs and will allow the Stormwater Management Branch to better anticipate, prevent, prioritize, and correct adverse impacts to the County's stream resources. The Strategy incorporates biological sampling (e.g. benthic macroinvertebrates and fish) and rapid physical habitat and geomorphology assessments. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Fairfax County small streams

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

FIELD MANUAL FOR OHIO'S HEADWATER HABITAT STREAMS

Davic 2002

The Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams is intended to promote standardized assessment of actual and expected biological conditions in primary headwater habitat (PHWH) streams in Ohio. The principal regulatory and/or administrative impetus for development of the protocols was pursuant to water quality standards (designated uses, water quality criteria, antidegradation) for the NPDES program. The methods outlined in the Manual are designed to statistically differentiate among three quality classes (designated uses) of PHWH streams in Ohio: Class III PHWH Stream (cool-cold water adapted native fauna); Class II PHWH Stream (warm water adapted native fauna); Class I PHWH Stream (ephemeral stream, normally dry channel). Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Ohio; however, this method can be applied to other areas that have cold-cool spring fed adapted biological communities of headwater salamander and benthic macroinvertebrate communities.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

FIRE REGIME CONDITION CLASS

FRCC 2005

To provide tools for fire, vegetation, and fuels assessment and management at both the landscape and stand levels. Methods are used to describe general landscape fire regime and vegetation-fuel characteristics. Descriptive, ordinal scale, and nominal scale output.

Intended use: Forests nationwide

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

FLORIDA WETLAND QUALITY INDEX

Lodge, T.E., H.O. Hillestad, S.W. Carney, and R.B. Darling., 1995

A method for determining compensatory mitigation requirements for impacted wetlands within the Everglades.

Intended use: To evaluate mitigation site compliance with regulatory requirements.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

FLORIDA WETLAND RAPID ASSESSMENT PROCEDURE

South Florida Water Management District, 1999

A rapid assessment procedure designed to assess mitigation projects with a habitat emphasis. It yields a single score that may be interpreted as condition.

Intended use: Assessing mitigation projects

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

FLORISTIC QUALITY ASSESSMENT INDEX (FQAI)

Swink and Wilhelm 1979

To provide an objective standard (Floristic quality assessment index) for describing the quality of plant communities. Used to make relative comparisons in environmental and natural resources management. Ordinal scale output.

Intended use: Any vegetation community. Initially for Chicago Illinois, but subsequently has been modified for use in a few additional states.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

FRESHWATER WETLAND MITIGATION QUALITY ASSESSMENT PROCEDURE

New Jersey Department of Environmental Quality, 2001

A wetland functional assessment that evaluates the relative probability that a constructed freshwater wetland will develop to approximate the functioning of natural wetlands over time.

Intended use: An informatory tool only.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

GRAVEL BED INSTREAM FLOWS

Schmidt and Potyondy 2004

To provide a methodology for estimating essential water flow regimes needed for the self maintenance of gravel-bed stream channels. Quantitative output.

Intended use: Intermountain west. Perennial, unregulated, snowmelt-dominated, gravel-bed streams with alluvial reaches. This method is unlikely to work in arid environments with ephemeral channels where hydrographs are flashy.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

GUIDANCE FOR RATING THE VALUES OF WETLANDS IN NORTH CAROLINA

North Carolina Department of Environmental and Natural Resources, 1995

A wetland functional assessment that assesses six wetland functions only for their effect on wetland values (societal benefit).

Intended use: Tool for making 401 Water Quality decisions on impacts and mitigation.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

GUIDEBOOK FOR HYDROGEOMORPHIC (HGM)-BASED ASSESSMENT OF OREGON WETLAND AND RIPARIAN SITES – WILLAMETTE VALLEY RIVERINE IMPOUNDING AND SLOPES/FLATS SUBCLASSES

Adamus and Field, 2001

An HGM reference-based assessment restricted to Willamette Valley ecoregion riverine impounding and slopes/flats wetlands. Addresses both functions and values for these subclasses.

Intended use: Wetland assessment

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

GUIDELINES FOR EVALUATING FISH HABITAT IN WISCONSIN

Simonson et al. 1993

To establish a standardized general protocol “that can be used when conducting any stream habitat survey, evaluation, monitoring program, appraisal, or special project.when precise, defensible methods are

needed to substantiate management objectives, priorities, or effectiveness [of management treatments]" (Simonson et al. 1994). Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Wisconsin and adjacent states. Permanent, wadeable streams.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

HABITAT ASSESSMENT MODEL

Wockner et al. 2005

To aid managers in discerning the relationships between wildlife populations (for elk and mule deer) and habitat sustainability. The model produces a range of population values with related management implications (e.g., grazing, burning) that can be used in the planning process. Developed to resolve fence and forage conflicts on private and public lands. Quantitative output.

Intended use: CO terrestrial habitat.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

HABITAT EQUIVALENCY ANALYSIS (HEA)

NOAA

Developed to calculate the credits needed to identify impacts for Natural Resource Damage Assessments under a series of statutory authorities including CERCLA (Superfund) Assigns a habitat functional score to each habitat unit in a site and multiplies that by the area. Time to being fully functional is also accounted for using a standard discount rate. The assessments allow for out of kind and off site assessments, but it is used only in response to natural resource damages not in anticipation.

Intended use: Integrated ecosystem services accounting

Able to calculate multi-resource credit: Allows for measurement for mitigation but not necessarily credits per se.

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

HABITAT EVALUATION PROCEDURE (HEP)

USFWS 1980

Assess the quality and quantity of available habitat for selected wildlife species, by comparing the same area at different points in time, or different areas at one point in time. Ordinal scale output.

Intended use: All regions regularly inhabited by species for which HIS models are available.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

HAWAII STREAM BIOASSESSMENT

Kido 2002

To provide the tools and informational framework required to conduct meaningful water quality assessments aimed at restoring and/or maintaining the "biological integrity" of Hawaii's streams. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Hawaii streams

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

HEAT SOURCE MODEL

Oregon Department of Environmental Quality

Currently the Shade-a-Lator tool within the Heat Source model is being used to calculate temperature credits in the Willamette. Requires data from GIS and field collection.

Intended use: Water quality assessment

Able to calculate multi-resource credit: Yes

Sensitivity: Focuses on a single component of water quality.

Capable of being integrated into multi-resource credit: Unknown

HYDROGEOMORPHIC METHOD (HGM)

U.S. Army Corps of Engineers/EPA/FHWA

National methodology for wetland impacts and mitigation.

Intended use: Wetland assessment

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

IDAHO SMALL STREAM ASSESSMENT

Grafe 2002

To assess aquatic life use support for small streams using biological indicators, habitat data, and numeric water quality criteria. The document provides detailed technical information concerning the development and integration of the Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI) used in the aquatic life use support determination. Ordinal scale, nominal scale, and quantitative output.

Intended use: ID medium and large rivers in mountainous settings.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

INDEX OF BIOLOGICAL INTEGRITY (IBI) – BIRDS, FISH, INVERTEBRATES, AND PLANTS

Karr 1981

To assess biological integrity of a habitat utilizing one of the four (birds, fish, invertebrates, and plants) as indicators of relative condition of a selected habitat. Ordinal scale and quantitative.

Intended use: Nationwide in most habitat types.

Able to calculate multi-resource credit: Yes

Sensitivity: Sensitive for the four specific biotic groups (birds, fish, invertebrates, plants) in relation to habitat.

Capable of being integrated into multi-resource credit: Unknown

INDEX OF MARSH BIRD COMMUNITY INTEGRITY

DeLuca et al. 2004

To evaluate the biological integrity of marsh bird communities and assess estuarine wetland condition. Ordinal scale output.

Intended use: Chesapeake Bay (Maryland, Virginia, and Delaware) tidal wetlands.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

INSTREAM FLOW INCREMENTAL METHODOLOGY (IFIM)

Bovee 2004

IFIM is a tool to assess in-stream flow problems, ranging from simple diversions to complex storage and release schemes. It provides resources managers with a decision support system for determining the benefits or consequences of different water management alternatives. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: National

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

INTERIM GUIDELINES TO AVOID AND MINIMIZE WILDLIFE IMPACTS FROM WIND TURBINES – POTENTIAL IMPACT INDEX (PII)

USFWS 2003

PII is a protocol allows the user to evaluate potential development sites using checklists and rank them against a reference site. Objectives are to: (1) assist developers in deciding whether to proceed with development; (2) provide a procedure to determine pre-construction study needs to verify use of potential sites by wildlife; and (3) provide recommendations for monitoring potential sites postconstruction to identify, quantify, or verify actual impacts (or lack thereof).

Intended use: To assist the wind energy industry in avoiding or minimizing impacts to wildlife and their habitats.

Able to calculate multi-resource credit: The Physical Attributes, Species Occurrence and Status, and Ecological Attractiveness groupings in this protocol should serve as a model framework; the terrain features, species, and conditions used in these groupings will be dictated by local conditions and should be developed by wildlife biologists familiar with the region in which this protocol is being used.

Sensitivity: Acknowledges that each proposed development site is unique due to local differences in wildlife concentration and movement patterns, and requires detailed, individual evaluation.

Capable of being integrated into multi-resource credit: Unknown

INVEST

Natural Capital Project

A package of models in an ArcGIS extension that calculates ecosystem services based on land use/land cover and packaged assumptions about service provision by land cover type.

Intended use: Integrated ecosystem services accounting

Able to calculate multi-resource credit: Yes

Sensitivity: Scoring is based on landscape scale data inputs. Not sensitive to direct impacts caused by implementing projects.

Capable of being integrated into multi-resource credit: Unknown

KING COUNTY FUNCTIONAL EQUIVALENCY EVALUATION SYSTEM (KC-FEES)
King County Department of Natural Resources and Parks and Department of Development and Environmental Resources, 2008

Description: A methodology to provide a standardized procedure for assessing the functions provided by wetlands and aquatic areas, the amount those functions are reduced by impacts and the amount of mitigation required to offset the loss.

Intended use: Establishes a system for determining the amount of mitigation needed to offset adverse impacts to wetlands and aquatic areas. The system also is designed to award and deduct credits through the King County Mitigation Reserves Program.

Able to calculate multi-resource credit: Yes

Sensitivity: A standardized procedure at the site level for assessing wetland and aquatic function.

Capable of being integrated into multi-resource credit: Yes

LANDSERVER

Pinchot Institute for Conservation

LandServer is a tool for landowners, managers and governments to identify ecosystem service production opportunities on their lands. The tool is under development with a current pilot test running in the Chesapeake region. It is a secondary data GIS based tool that works to identify payment for ecosystem services options for landowners.

Intended use: Mid-Atlantic and then national.

Able to calculate multi-resource credit: Yes

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Via monetary equivalents.

MARYLAND GREEN INFRASTRUCTURE ASSESSMENT

Weber 2003

To help identify and prioritize those areas of greatest statewide ecological importance, as well as those at greatest risk of loss to development. Nominal scale output.

Intended use: Maryland

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MDT MONTANA WETLAND ASSESSMENT METHOD

Berglund 1999

To evaluate wetland function and values. Designed to address highway and other linear projects, but can be applied to other types of projects including mitigation. Nominal and ordinal scale output.

Intended use: Montana wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

METHODS FOR ASSESSING WETLAND FUNCTIONS. VOLUME I: RIVERINE AND DEPRESSIONAL WETLANDS IN THE LOWLANDS OF WESTERN WASHINGTON
Washington State Department of Ecology, 1999

An HGM reference-based assessment restricted to depressional and riverine class wetlands located in Washington's western lowlands.

Intended use: Wetland assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

METHODS FOR ASSESSING WETLAND FUNCTIONS. VOLUME II: DEPRESSIONAL WETLANDS IN THE COLUMBIA BASIN OF EASTERN WASHINGTON
Washington State Department of Ecology, 2000

An HGM reference-based assessment restricted to depressional class wetlands located in Washington's Columbia Basin.

Intended use: Wetland assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

METHODS FOR CHARACTERIZING STREAM HABITAT (NAWQA)
Fitzpatrick et al. 1998

To assess status and trends in water quality nationwide and to develop an understanding of the major factors influencing observed conditions and trends. Descriptive and quantitative output.

Intended use: Nationwide streams

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

METHODS FOR EVALUATING STREAM CONDITIONS
Platts et al. 1983

Platts et al. (1983) presents standard techniques for measuring aquatic, riparian, and biotic attributes and stresses the precision and accuracy of each measurement. In this way, the authors aim to provide the field practitioner with tools and information to build on and evaluate for assessing particular aquatic habitat and biological features. Platts et al. (1987) expands upon Platts et al. (1983) with a "comprehensive set of the latest methods for ... use in managing, evaluating, and monitoring riparian conditions...." Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Nationwide

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

METHODS FOR STREAM HABITAT SURVEYS AQUATIC INVENTORIES PROJECT
Oregon Department of Natural Resources

Developed to monitor habitat conditions for Oregon streams

Intended use: Streams and rivers.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

MICHIGAN VALLEY SEGMENT ECOLOGICAL CLASSIFICATION - INVENTORY

Seelbach et al. 1997

Identify and describe naturally occurring, ecologically distinct, spatial units in river. Uses include inventory, research (sampling designs based on stratification of river valley segment types), and basis for resource management. Descriptive output.

Intended use: Lower Michigan. Currently being revised for application for entire states of Michigan, Illinois, and Wisconsin.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MINNESOTA HABITAT AND WATER CHEMISTRY PROTOCOL

Minnesota Pollution Control Agency (MPCA) 2002

To support assessment of water quality and development of biological criteria for Minnesota streams. These procedures are also applicable for USEPA Environmental Monitoring and Assessment Program (EMAP) stations and sites suspected of being impacted by a source of pollution. Descriptive and ordinal scale output.

Intended use: MN wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MINNESOTA ROUTINE ASSESSMENT METHOD (MNRAM)

Minnesota Board of Water and Soil Resources

Wetland functional assessment. Starts with assessment of vegetation then asks 72 questions to develop functional indices.

Intended use: Wetland assessment

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MINNESOTA ROUTINE ASSESSMENT METHOD (MNRAM) (UPDATED VERSION)

Minnesota Board of Water and Soil Resources 2007

The original 1992 version of MnRAM was developed to provide a practical assessment tool that would help local authorities make sound wetland management decisions as they assumed responsibility for regulating wetland impacts. The current version represents a more refined procedure that provides numeric, rather than the original descriptive, ratings. It may be applied to existing wetlands or potential restoration sites. Descriptive and ordinal scale output.

Intended use: Northern Great Plains Prairie Pothole Region wetlands within watershed context including open water bodies and streams

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MONTANA STREAM MITIGATION PROCESS

U.S. Army Corps of Engineers – Omaha

Uses indicators of riparian functions to assign a broader range of trading ratios.

Intended use: Water quality assessment

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

MONTANA WETLAND RAPID ASSESSMENT METHOD

Montana Department of Environmental Quality, 2005

A wetland rapid assessment that looks at ecological integrity (condition) of a wetland.

Intended use: Field-based screening level assessment tool used to help identify and prioritize wetlands within a watershed or region for protection and restoration.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

MULTI-SCALE ASSESSMENT OF WATERSHED INTEGRITY (MAWI)

Smith 2003

To provide a baseline (current condition) assessment of riparian ecosystem integrity at the watershed scale. Once completed the assessment can be used to evaluate potential impacts of future development on riparian areas within a watershed or to help prioritize areas for riparian restoration. Ordinal scale output.

Intended use: Watersheds of California (i.e. watersheds that drain to the Pacific Ocean); Riparian ecosystems and streams, including adjacent upland areas.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

NEW HAMPSHIRE METHOD

Ammann and Stone 1991

To provide a method of wetland evaluation for use by public officials and others who have some familiarity with wetlands, but who are not necessarily wetland specialists. Used for planning, education, and wetland inventory. Ordinal scale output.

Intended use: NH Nontidal wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

NEW JERSEY WATERSHED METHOD

Zampella et al. 1994

GIS-based method for assessing watershed and wetland integrity and the potential impact to this integrity. Created to enable a comparative assessment of all watersheds and wetlands in NJ pinelands. Ordinal scale output.

Intended use: NJ Pinelands; could apply to other riverine wetland types

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

NORTH CAROLINA COASTAL REGION EVALUATION OF WETLAND SIGNIFICANCE (NC CREWS)

Sutter et al. 1999

Designed to predict the relative ecological significance and to assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands using a watershed-based model in GIS software. Nominal scale output.

Intended use: NC coastal region wetlands.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

NUMERICAL METHOD FOR EVALUATION OF MAINE PEATLANDS

Davis and Anderson 1999

A quantitative method of evaluation of the natural features of peatlands, providing the fundamental tool for establishing peatland protection priorities. Nominal and ordinal scale output.

Intended use: Maine peatlands

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

NUTRIENT TRADING TOOL (NTT) (POWERED BY THE APEX MODEL)

USDA – Natural Resource Conservation Service

Developed by NRCS to calculate Nitrogen credits. Has expanded to include phosphorous, and can also calculate sediments. It is powered by the APEX model, which is a run-off based model. No field-level data is required. Farmer can input crop types, fertilizer use, irrigation patterns, and BMPs. Future add-ons will include water quantity and carbon calculations.

Intended use: Water quality assessment

Able to calculate multi-resource credit: Yes

Sensitivity: Site-level sensitivity that incorporates condition and management practice.

Capable of being integrated into multi-resource credit: Yes

NUTRIENTNET (POWERED BY EPIC)

World Resources Institute

NutrientNet is a web-based platform customized for each watershed to support nutrient trading. It has a credit calculator, registry, and exchange function. Very similar to Nutrient Trading Tool, but maybe not as powerful.

Intended use: Water quality assessment

Able to calculate multi-resource credit: Yes

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

OHIO RAPID ASSESSMENT METHOD FOR WETLANDS, VERSION 5.0

Ohio EPA, Division of Surface Water, 2001

The Ohio Rapid Assessment Method is designed to aid in the determination of wetland categories as defined in Ohio's Wetland Antidegradation Rule. The use of the Ohio Rapid Assessment Method should not be considered as a substitute, and is not intended to be a substitute, for detailed studies of the functions and biology of a wetland.

Intended use: The method is designed to identify the appropriate level of regulatory protection a particular wetland should receive. It is not designed or intended to be used to determine a particular wetland's ecologic or human value.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

OREGON RAPID WETLANDS ASSESSMENT PROTOCOL (ORWAP)

Adamus (in development)

Being developed as a rapid functional assessment combining visual assessments and collection of spatial data. Considers both wetland functions and conditions.

Intended use: Wetland assessment for regulatory compliance

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes. Currently being integrated into the EcoMetrix method library.

OREGON VERNAL POOL METHOD

Adamus et al. 2007

To provide a technique that (1) assesses 4 major functions and 7 values of vernal pool wetlands, (2) is standardized and rapid (in the sense that the procedure can be completed in one day or less), (3) is well-documented with scientific literature, mainly from Oregon, and (4) can be used to prioritize vernal pool complexes and compare them before and after restoration or impact. Ordinal scale output.

Intended use: OR Individual vernal pools and vernal pool complexes in non-forested lowlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

PFANKUCH CHANNEL STABILITY

Pfankuch 1975

To provide information about the resistance of a channel to erosive forces acting upon its bed and banks and to suggest the capacity of streams to recover from changes in flow or increases in sediment. Nominal and ordinal scale output.

Intended use: U.S. Forest Service Northern Region

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

PHYSICAL HABITAT SIMULATION SYSTEM (PHABSIM)

U.S. Geological Survey

The purpose of (PHABSIM) is to simulate a relationship between streamflow and physical habitat for various life stages of a species of fish or a recreational activity. The basic objective of physical habitat simulation is to obtain a representation of the physical stream so that the stream may be linked, through biological considerations, to the social, political, and economic world.

Intended use: Discharge and habitat assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

PROPER FUNCTIONING CONDITION

Bureau of Land Management

Uses the Ecological Site Inventory results to calculate conditions for riparian areas. There didn't appear to be quantitative, objective, or clear measures attached to this. It is more of a framework. No detail review was conducted.

Intended use: Riparian assessment tool:

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

QUALITATIVE HABITAT EVALUATION INDEX (QHEI)

Midwest Biodiversity Institute for Ohio Environmental Protection Agency

To provide a rapid, reproducible measure of stream habitat generally corresponding to the physical stream factors that affect fish communities and other aquatic life. Results in an index (scale 0 to 100), representing an evaluation of a stream's macrohabitat characteristics that are important to fish communities relative to streams within a given watershed or region.

Intended use: Habitat assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

RAPID ASSESSMENT METHOD FOR OREGON TIDAL FRINGE WETLANDS (RAM)

Adamus 2006

To provide a technique that (1) assesses 13 recognized wetland functions and values of tidal marshes, (2) is standardized and rapid (in the sense that the procedure can be completed in one day or less), (3) is well-documented with scientific literature, and (4) can be used to compare tidal wetlands before and after restoration or impact. Ordinal scale output.

Intended use: OR tidal wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

RAPID BIOASSESSMENT PROTOCOLS FOR USE IN STREAMS AND WADEABLE RIVERS: PERIPHYTON, BENTHIC MACROINVERTEBRATES, AND FISH. SECOND EDITION.

U. S. Environmental Protection Agency

Developed to provide “a practical technical reference for conducting cost-effective biological assessments of lotic systems.”

Intended use: Rapid assessments of streams and rivers.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

RAPID STREAM ASSESSMENT TECHNIQUE FIELD METHODS (RSAT)

Galli 1996

To provide a simple, rapid reconnaissance-level assessment of stream quality conditions on a watershed scale. Descriptive and ordinal scale output.

Intended use: MD Piedmont non-limestone Piedmont streams with a watershed of approximately 100-150 square miles

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

REMOTE FUNCTIONAL WETLAND ASSESSMENT MODEL (RFWAM)

Stallman et al. 2005

Assess wetlands in the project area in order to categorize them as suitable for conservation, enhancement, or restoration. Nominal and ordinal scale output.

Intended use: Alabama Gulf Shore depressional, riverine, and flat wetlands

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

REMOTELY SENSED INDICATORS FOR MONITORING CONDITION OF NATURAL HABITAT IN WATERSHEDS

Tiner 2004

To characterize and assess trends in the general ecological condition of watersheds using a set of remotely sensed indicators of “natural habitat integrity.” Ordinal scale output.

Intended use: Nationwide; all habitats within a watershed

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

RIPARIAN COMMUNITY TYPE CLASSIFICATION OF UTAH AND SOUTHEASTERN IDAHO - INVENTORY

Padgett et al. 1989

Provides a riparian community type classification system for use in the inventory of lands administered by the USDA Forest Service in Utah and southern Idaho. Descriptive output.

Intended use: Utah and SE Idaho riparian communities

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

ROUGE RIVER PROJECT RAPID ASSESSMENT METHOD

Tilton et al. 1997

Provide a regional evaluation of the condition of wetland (river and lake) resources in order to aid in development of a watershed management plan. Nominal scale output.

Intended use: Michigan Rouge River watershed

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

SAVANNAH'S STANDARD OPERATING PROCEDURE: MITIGATION

U.S. Corps of Engineers – Savannah

Uses indicators of wetland functions and stream functions to assign a broader range of trading ratios.

Intended use: Wetlands and surface water assessment

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

SOIL MANAGEMENT ASSESSMENT FRAMEWORK

Andrews et al. 2004

To enhance and extend current soil assessment efforts by presenting a framework for assessing the impact of soil management practices on soil function. Ordinal scale output.

Intended use: Agricultural lands; intended as a national framework, to be modified as necessary for more local use

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

SOUTH AUSTRALIAN BIODIVERSITY ASSESSMENT TOOL (SABAT)

Government of South Australia, Dept. of Water, Land and Biodiversity Conservation

The Biodiversity Significance Index factors three components in to its assessment of biodiversity values: Conservation Significance (CS), Landscape Context (LC), and Habitat Condition (HC). The value of SABAT: Standardized/Objective Indexing Framework, Vegetation Association Benchmarks, Compares Apples with Oranges –in Standardized ‘Fruit Units’, Provides for Regional/State/larger BSI, Makes Complex Evaluations Simple, Spatial Database – In-Field Operations, Provides ‘Condition’ Benchmark for Ongoing Monitoring, Allows Roll-up for Regional M&E Framework,
Intended use: Southern Australia: multiple habitat types

Able to calculate multi-resource credit: Yes

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

SOUTHERN CALIFORNIA RIPARIAN ECOSYSTEM ASSESSMENT (SCREAM)

Stein et al. 2004

To assess hydrology, sediment processes, habitat support, and biogeochemistry components of riparian habitat using a watershed-based model in GIS software. Ordinal scale output.

Intended use: Southern CA riparian areas

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

SPATIAL WETLAND ASSESSMENT FOR MANAGEMENT AND PLANNING (SWAMP)

Sutter 2001

To assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands using a watershed-based model in GIS software. Nominal scale output.

Intended use: Ashepoo-Combahee-Edisto River Basin, South Carolina tidal and riverine wetlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

STREAM AND RIPARIAN HABITATS RAPID ASSESSMENT PROTOCOL

Starr and McCandless 2001

Provides a comprehensive stream and riparian corridor assessment and inventory protocol for use by trained practitioners to rapidly identify, assess, and prioritize physical stream corridor conditions. Ordinal scale, nominal scale, and quantitative output.

Intended use: Chesapeake Bay stream and riparian habitats

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

STREAM ASSESSMENT IN THE VIRGINIA COASTAL ZONE: DEVELOPMENT OF A SIGNIFICANT NEW DATABASE AND INTERACTIVE ASSESSMENT APPLICATION

Virginia Commonwealth University, 2004

Development of a multivariate model of reference stream conditions for the Virginia Coastal Zone using biological, ecological, and geomorphological variables.

Intended use: Virginia Coastal zone stream assessment

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

STREAM CHANNEL REFERENCE SITES

Harrelson et al. 1994

Provides techniques from numerous published sources for collecting a minimum set of high quality data necessary to quantify the physical character of streams for monitoring, impact assessment, inventory, response to management actions, etc. Descriptive and quantitative output.

Intended use: Nationwide wadeable streams

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

STREAM CORRIDOR ASSESSMENT SURVEY PROTOCOLS (SCA)

Yetman 2001

To rapidly assess the general physical condition of a stream system and identify the location of a variety of common environmental problems within the stream's corridor. Not intended to be a detailed scientific survey, it provides a rapid method of examining an entire drainage network to target future monitoring, management or conservation efforts. One of the main goals is a prioritized list of problems to be corrected throughout an entire watershed. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: MD wadeable streams and rivers

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

STREAM IMPACT ASSESSMENT MANUAL FOR THE NORTHERN VIRGINIA STREAM BANK

Wetland Studies and Solutions, Inc. 2006

The purpose of the Manual is to describe a system whereby the user can rapidly assess the condition of a stream, in a repeatable manner, without specialized equipment or significant training.

Intended use: Intended for use by regulatory agencies and the regulated public utilizing Clean Water Act and Virginia Water Protection permits that utilize compensation in the Northern Virginia Stream Bank.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

SUBJECTIVE EVALUATION OF AQUATIC HABITATS

Kansas Dept. of Wildlife and Parks 2004

To provide a rapid holistic evaluation based on subjective assessments of physical, biological, and chemical parameters of the aquatic system. Descriptive, ordinal scale, and nominal scale output.

Intended use: KS Ephemeral, intermittent, or perennial streams and small impoundments or large lakes

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

TECHNIQUE FOR THE FUNCTIONAL ASSESSMENT OF NON-TIDAL WETLANDS IN THE COASTAL PLAIN OF VIRGINIA

Virginia Institute of Marine Science, 1991

A wetland functional assessment based on WET that assesses functions of non-tidal wetlands in the coastal plain of Virginia. Output is a rating system of high, medium, and low relative probability that a wetland has the opportunity to perform and/or be effective at performing a function.

Intended use: To evaluate the relationships among vegetation structure, function, and landscape position. Has been largely phased-out by HGM models.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

TEMPERATURE TRADING PLATFORM

Oregon State University

Tool that allows landowners to draw a reach for riparian shade and estimate the temperature credits created. The tool is powered by a derivative of the Heat Source model rather than the shade-a-lator. Wetted width and some data still needs to be collected in the field, but most runs on spatial GIS layers.

Intended use: Temperature credit calculator

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

UNIFORM MITIGATION ASSESSMENT METHOD (UMAM)

Florida Department of Environmental Protection

A functional assessment for wetlands and surface waters, but also applicable to several terrestrial habitat types. Quantifies gains and losses by developing a multiplier applied to area. Considers landscape support, water environment, and community structure. Also applies factors for time lag for recovery and risk of project failure.

Intended use: Wetland mitigation credit calculations.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

UNIFIED STREAM ASSESSMENT – URBAN SUBWATERSHED RESTORATION MANUAL NO 10

Center for Watershed Protection (Maryland), 2005

The Unified Stream Assessment is a rapid technique to locate and evaluate problems and restoration opportunities within an urban stream corridor in Maryland.

Intended use: Maryland subwatershed restoration planning

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: No

VARIABLES FOR ASSESSING REASONABLE MITIGATION IN NEW TRANSPORTATION (VARMINT)

Vermont Agency of Natural Resources 2004

To provide a framework to lessen and mitigate impacts to terrestrial environments. Nominal and ordinal scale output.

Intended use: Pennsylvania: Habitat not stated but implied that the framework is applicable to most habitats within a project area including, but not limited to shrubland, forest, prairie, wetlands, riparian areas, etc.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

VERMONT STREAM GEOMORPHIC ASSESSMENT PROTOCOL HANDBOOKS

Vermont Agency of Natural Resources, 2003

The Handbooks have a focus on those watershed processes and features critical to its riparian corridor management objectives.

Intended use: The purpose of the assessment protocols is to provide a phased method for gathering information that can be used for watershed planning and detailed characterization of riparian and instream habitat, stream-related erosion, and flood hazards. The information will be used for basin planning; river and riparian corridor protection, management, and restoration projects; aquatic and riparian habitat assessment; and hazard assessment to reduce property loss and damage from riverine erosion during floods.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

VISUAL STREAM ASSESSMENT PROTOCOL

Natural Resources Conservation Service (NRCS)

NRCS has a number of protocols used by field staff to identify baseline farm conditions and to design conservation plans. Most are visual assessments that provide general scores of conditions.

Intended use: Water quality assessment

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WADEABLE STREAM ASSESSMENT FIELD OPS

EPA 2004

Contains the field operations and bioassessment methods for evaluating the health and biological integrity of wadeable freshwater streams throughout the US. These methods can be used to determine stream condition assessment and/or to monitor the effects of impacts on aquatic organisms, particularly benthic macroinvertebrates. Descriptive, ordinal scale, nominal scale, and quantitative output.

Intended use: Nationwide; Wadeable streams (generally stream orders 1-3, or higher orders in arid to semi-arid regions of the U.S.). Intermittent or ephemeral streams can be sampled using the WSA Field Ops protocols, but only when water is present in the channel.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WASHINGTON AQUATIC HABITAT DESIGN GUIDELINES

Saldi-Caromile et al. 2004

To characterize the present (and/or historic) state of habitat and the processes that create and maintain it so that problems and appropriate restoration options and obstacles can be identified and prioritized. No output units?

Intended use: WA; Primarily aquatic habitat in streams, riparian areas, and standing water bodies

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WASHINGTON STATE WETLAND FUNCTION ASSESSMENT PROGRAM (WFAP)

Washington State Department of Ecology

The Wetlands Function Assessment Project was a statewide effort to develop relatively rapid, scientifically acceptable methods of assessing how well wetlands perform functions such as improving water quality, reducing floods, and providing wildlife habitat. The methods were developed for different wetland types in Washington State.

Intended use: Wetland assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

WASHINGTON STATE WETLAND RATING SYSTEM (WESTERN AND EASTERN VERSIONS)

Washington State Department of Ecology, 1993; 2002

Washington's wetland rating system evaluates functions and special characteristics weighted heavily on the opportunity of a wetland to perform a particular function. Also evaluates sensitivity to disturbance, rarity, and inability to replace.

Intended use: Wetland assessment.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

WATERSHED VULNERABILITY ANALYSIS

Zielinski 2002

To identify and classify subwatersheds that are vulnerable to changes in land use based on estimates of current and future impervious cover; and to identify subwatersheds that warrant restoration actions. Descriptive output.

Intended use: Streams within subwatersheds. The model was based on research in the Pacific Northwest and Mid-Atlantic regions. However, supporting data exists for the Northeast, Upper Midwest, and Southeast.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WATERSHED-BASED PRELIMINARY ASSESSMENT OF WETLAND FUNCTIONS (W-PAWF)

Tiner 2003

To provide a preliminary assessment of wetland functions based on enhanced National Wetlands Inventory digital data. The assessment uses a combination of wetland classifications, specifically the U.S. Fish & Wildlife Service's official system (Cowardin et al. 1979) and the classification system to enhance the NWI by adding LLWW descriptors for landscape position, landform, water flow path, and waterbody type (Tiner 2003a). Descriptive and nominal scale output.

Intended use: Wetlands and deepwater habitats of the United States, but the emphasis for functional assessment is on wetlands including shallow open waterbodies such as ponds. Developed for all regions of the United States; however, the correlations focus on the Northeastern U.S.

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WETLAND EVALUATION TECHNIQUE (WET)

Adamus et al. 1987

WET is an initial, rapid assessment of wetland functions, designed to assess the qualitative probability that a wetland function will occur. WET has been superseded by more rigorous reference-based, regionally specific methods recently developed.

Intended use: Wetland consultants.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

WETLAND VALUE ASSESSMENT METHODOLOGY (WVA)

Environmental Work Group 2002

Estimates wetland benefits of proposed wetland restoration projects submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The application in the plan formulation process is described in USGS (2006). Ordinal scale output.

Intended use: Louisiana coast marshlands

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WILDLIFE HABITAT APPRAISAL PROCEDURE (WHAP)

Frye 1995

To allow a qualitative holistic evaluation of wildlife habitat for particular tracts of land statewide (Texas) without imposing significant time requirements. WHAP is intended to be used for (a) evaluating impacts upon wildlife populations from development project alternatives, (b) establishing baseline conditions, (c) comparing tracts of land which are candidates for land acquisition or mitigation, and (d) evaluating general habitat quality and wildlife management potential for tracts of land over large geographical areas. Ordinal scale output.

Intended use: Texas; based on list of habitat classes; seems to represent all upland and wetland habitat in Texas (e.g., swamp, cultivated wetlands, water including ponds, and water treatment facilities, urban areas, dunes, beach).

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

WISCONSIN RAPID ASSESSMENT METHODOLOGY FOR EVALUATING WETLAND FUNCTIONAL VALUES

Wisconsin Department of Natural Resources, 1992

A wetland functional assessment to evaluate and provide a measure of wetland function.

Intended use: For use with making routine Section 404 permit applications decisions.

Able to calculate multi-resource credit: No

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Yes

WISCONSIN WETLAND ASSESSMENT METHODOLOGY (WIRAM)

Wisconsin Department of Natural Resources 2001

To provide a standardized process for the professional to evaluate the extent to which a specific wetland performs a given function. Descriptive output.

Intended use: WI wetlands

Able to calculate multi-resource credit: Unknown

Sensitivity: Unknown

Capable of being integrated into multi-resource credit: Unknown

Summary Overview

Method	Intended Use	Multi-Resource Credit	Integrate into Multi-Resource
Applied River Morphology Method	River classification	No	Unknown
Artificial Intelligence for Ecosystem Services (AIRES)	Decision support system	Unknown	Unknown
Basinwide Visual Estimation Technique (BVET)	Fish abundance and habitat estimation	No	Unknown
Beneficial Use Reconnaissance Program (BURP) Field Manual for Streams	Stream assessment	Unknown	Unknown
BushBroker	Native vegetation offset credit trading	No	Unknown
BushTender Program	Native vegetation credit trading	Possible	Unknown
Business and Biodiversity Offset Program (BBOP)	Development of offset BMPs	No	Unknown
California Carbon Project Protocols	Carbon credit calculator	Unknown	Unknown
California Rapid Assessment Method (CRAM)	Wetland assessment	No	Yes
Casco Bay Watershed Wetlands Characterization Method	Wetland assessment	No	Unknown
City Green	Integrated ecosystem services assessment	Unknown	Unknown
Combined Habitat Assessment Procedure (CHAP)	Integrated ecosystem services accounting	Yes	Yes
Connecticut Method	Wetland assessment	No	Unknown
Delaware Rapid Assessment	Wetland assessment	No	Unknown
Descriptive Approach (Highway Methodology)	Wetland assessment	No	Unknown
Developing Rapid Methods for Analyzing Upland Riparian Functions and Values	Riparian (upland) assessment	No	Yes
Development of a Floristic Quality Assessment Methodology for Wisconsin	Floristic quality assessment	No	Yes
Eastern Kentucky Stream Assessment Protocol (eKY)	Stream assessment	Yes	Unknown
Ecological Site Inventory	Qualitative tool	No	Unknown
EcoMetrix	Integrated ecosystem services accounting	Yes	Yes
Ecosystem Diagnosis and Treatment Model	Stream assessment	No	Yes
Ecosystem Valuation Methods	Integrated ecosystem services accounting	Unlikely	Unknown
Environmental Monitoring and Assessment Protocols (EMAP)	Assessment tools	Unknown	Unknown
Envision	Water quality assessment	Unknown	Unknown
EPA Oregon Stream Methodology	Water quality assessment	No	No
EPA Region 10 In-Stream Biological Monitoring Handbook	Stream assessment	Unknown	Unknown
Evaluation for Planned Wetlands (EPW)	Wetland assessment	No	Unknown
Fairfax County Stream Physical Assessment Protocols	Stream assessment	No	Unknown

Method	Intended Use	Multi-Resource Credit	Integrate into Multi-Resource
Field Manual for Ohio's Headwater Habitat Streams	Water quality assessment	No	Unknown
Fire Regime Condition Class	Vegetation assessment	No	Unknown
Florida Wetland Quality Index	Wetland assessment	No	Yes
Florida Wetland Rapid Assessment Procedure	Wetland assessment	No	Yes
Floristic Quality Assessment Index (FQAI)	Vegetation assessment	No	Unknown
Freshwater Wetland Mitigation Quality Assessment Procedure	Wetland assessment	No	Yes
Gravel Bed Instream Flows	Stream assessment	No	Unknown
Guidance for Rating the Values of Wetlands in North Carolina	Wetland assessment	No	Yes
Guidebook for Hydrogeomorphic (HGM)-based Assessment of Oregon Wetland and Riparian Sites – Willamette Valley Riverine Impounding and Slopes/Flats Subclasses	Wetland assessment	No	Yes
Guidelines for Evaluating Fish Habitat in Wisconsin	Stream habitat assessment	No	Unknown
Habitat Assessment Model	Terrestrial habitat assessment	No	Unknown
Habitat Equivalency Analysis (HEA)	Integrated ecosystem services accounting	No credits	Unknown
Habitat Evaluation Procedure (HEP)	Habitat assessment	No	Unknown
Hawaii Stream Bioassessment	Stream assessment	No	Unknown
Heat Source Model	Water quality assessment	Yes	Unknown
Hydrogeomorphic Method (HGM)	Wetland assessment	No	Yes
Idaho Small Stream Assessment	Stream assessment	No	Unknown
Index of Biological Integrity (IBI) – Birds, Fish, Invertebrates, and Plants	Habitat assessment	Yes	Unknown
Index of Marsh Bird Community Integrity	Habitat and wetland assessment	No	Unknown
Instream Flow Incremental Methodology (IFIM)	Stream assessment	No	Unknown
Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines – Potential Impact Index (PII)	Site evaluation	Yes	Unknown
InVEST	Integrated ecosystem services accounting	Yes	Unknown
King County Functional Equivalency Assessment System (KC-FEES)	Wetland and aquatic assessment and credit calculator	Yes	Yes
Maryland Green Infrastructure Assessment	Habitat assessment	No	Unknown
MDT Montana Wetland Assessment Method	Wetland assessment	No	Unknown
Methods for Assessing Wetland Functions. Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington	Wetland assessment	No	Yes

Method	Intended Use	Multi-Resource Credit	Integrate into Multi-Resource
Methods for Assessing Wetland Functions. Volume II: Depressional Wetlands in the Columbia Basin of Eastern Washington	Wetland assessment	No	Yes
Methods for Characterizing Stream Habitat (NAWQA)	Stream assessment	No	Unknown
Methods for Evaluating Stream Conditions	Stream assessment	No	Unknown
Methods for Stream Habitat Surveys, Aquatic Inventories Project, ODFW	Stream assessment	No	Yes
Michigan Valley Segment Ecological Classification – Inventory	Stream assessment	No	Unknown
Minnesota Habitat and Water Chemistry Protocol	Water quality assessment	No	Unknown
Minnesota Routine Assessment Method (MnRAM)	Wetland assessment	Unknown	Unknown
Montana Stream Mitigation Process	Water quality assessment	Unknown	Unknown
Montana Wetland Rapid Assessment Method	Wetland assessment	No	Yes
Multi-Scale Assessment of Watershed Integrity (MAWI)	Ecosystem integrity	No	Unknown
New Hampshire Method	Wetland assessment	No	Unknown
New Jersey Watershed Method	Wetland assessment	Unknown	Unknown
North Carolina Coastal Region Evaluation of Wetland Significance (NC CREWS)	Wetland assessment	Unknown	Unknown
Numerical Method for Evaluation of Maine Peatlands	Peatland assessment	Unknown	Unknown
Nutrient Trading Tool (NTT)	Water quality assessment	Yes	Yes
NutrientNet	Water quality assessment	Yes	Unknown
Ohio Rapid Assessment Method for Wetlands, Version 5.0	Wetland assessment	No	Yes
Oregon Rapid Wetlands Assessment Protocol (ORWAP)	Wetland assessment	No	Yes
Oregon Vernal Pool Method	Wetland assessment	No	Unknown
Pfankuch Channel Stability	Stream assessment	No	Unknown
Physical Habitat Simulation System (PHABSIM)	Discharge and habitat assessment	No	Yes
Proper Functioning Condition	Riparian assessment	No	Unknown
Qualitative Habitat Evaluation Index (QHEI)	Habitat assessment	No	Yes
Rapid Assessment Method for Oregon Tidal Fringe Wetlands (RAM)	Wetland assessment	No	Yes
Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.	Stream and river Assessment	No	Yes
Rapid Stream Assessment Technique Field Methods (RSAT)	Stream assessment	No	Unknown
Remote Functional Wetland Assessment Model (RFWAM)	Wetland assessment	Unknown	Unknown

Method	Intended Use	Multi-Resource Credit	Integrate into Multi-Resource
Remotely Sensed Indicators for Monitoring Condition of Natural Habitat in Watersheds	Habitat assessment	No	Unknown
Riparian Community Type Classification of Utah and Southeastern Idaho – Inventory	Riparian community classification	No	Unknown
Rouge River Project Rapid Assessment Method	Wetland assessment	No	Unknown
Savannah's Standard Operating Procedure – Mitigation	Wetlands and water assessment	Unknown	Unknown
Soil Management Assessment Framework	Soil assessment	No	Unknown
South Australian Biodiversity Assessment Tool (SABAT)	Habitat assessment	Yes	Unknown
Southern California Riparian Ecosystem Assessment (SCREAM)	Riparian habitat assessment	Unknown	Unknown
Spatial Wetland Assessment for Management and Planning (SWAMP)	Water quality, habitat, and hydrologic function assessment	No	Unknown
Stream and Riparian Habitats Rapid Assessment Protocol	Stream and riparian habitat assessment	No	Unknown
Stream Assessment in the Virginia Coastal Zone: Development of a Significant New Database and Interactive Assessment Application	Stream assessment	No	Yes
Stream Channel Reference Sites	Stream assessment	No	Unknown
Stream Corridor Assessment Survey Protocols (SCA)	Stream assessment	Unknown	Unknown
Stream Impact Assessment Manual for the Northern Virginia Stream Bank	Stream assessment	No	Yes
Subjective Evaluation of Aquatic Habitats	Aquatic habitat assessment	No	Unknown
Technique for the Functional Assessment of Non-Tidal Wetlands in the Coastal Plain of Virginia	Wetland assessment	No	Yes
Temperature Trading Platform	Temperature credit calculator	No	Unknown
Unified Stream Assessment – Urban Subwatershed Restoration Manual No. 10	Subwatershed restoration planning	Unknown	Unknown
Uniform Mitigation Assessment Method (UMAM)	Wetland and surface water assessment	No	No
Variables for Assessing Reasonable Mitigation in New Transportation (VARMINT)	Habitat assessment	No	Unknown
Vermont Stream Geomorphic Assessment Protocol Handbooks	Stream assessment	No	Yes
Visual Stream Assessment Protocol	Water quality assessment	Unknown	Unknown
Wadeable Stream Assessment Field Ops	Stream assessment	No	Unknown
Washington Aquatic Habitat Design Guidelines	Aquatic habitat assessment	No	Unknown
Washington State Methods for Assessing Wetland Functions (WFAP)	Wetland assessment	No	Yes
Washington State Wetland Rating System (Western and Eastern versions)	Wetland assessment	No	Yes

Method	Intended Use	Multi-Resource Credit	Integrate into Multi-Resource
Watershed Vulnerability Analysis	Stream assessment	No	Unknown
Watershed-Based Preliminary Assessment of Wetland Functions (W-PAWF)	Wetland assessment	Unknown	Unknown
Wetland Evaluation Technique (WET)	Wetland assessment	No	Yes
Wetland Value Assessment Methodology (WVA)	Wetland assessment	No	Unknown
Wildlife Habitat Appraisal Procedure (WHAP)	Upland and wetland habitat assessment	No	Unknown
Wisconsin Rapid Assessment Methodology for Evaluating Wetland Functional Values	Wetland assessment	No	Yes
Wisconsin Wetland Assessment Methodology (WIRAM)	Wetland assessment	Unknown	Unknown

APPENDIX H: GLOSSARY

Assign/crosswalk the land uses: matching equivalent land cover categories between two or more classification systems

Baseline map: A map depicting background reference information such as landforms, roads, landmarks, and political boundaries, onto which other thematic information is placed. A basemap is used for locational reference.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

Biological assessment: A document prepared for the Section 7 process to determine whether a proposed major construction activity under the authority of a Federal action agency is likely to adversely affect listed species, proposed species, or designated critical habitat.

Categorical scale (e.g., 1-5, low to high, etc.)

Coarse filter: the general conservation activities that conserve the common elements of the landscape matrix, as opposed to the "fine filter" conservation activities that are aimed at special cases such as rare elements (see Jenkins 1985)

Connectivity: The degree to which a landscape facilitates or impedes movement (Taylor et al. 1993). Linkages...at multiple spatial and temporal scales (Noss 1991).

Conservation: Preserving and renewing, when possible, human and natural resources. The use, protection, and improvement of natural resources according to principles that will ensure their highest economic or social benefits.

Eco-Logical: *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* is a guidance document developed in partnership between the Bureau of Land Management, Environmental Protection Agency, Federal Highway Administration, National Oceanic and Atmospheric Association, National Park Service, US Army Corps of Engineers, US Forest Service, and the US Fish and Wildlife Service to encourage Federal, State, tribal and local partners involved in infrastructure planning, design, review, and construction to use flexibility in regulatory processes. Specifically, *Eco-Logical* puts forth the conceptual groundwork for integrating plans across agency boundaries, and endorses ecosystem-based mitigation - an innovative method of mitigating infrastructure impacts that cannot be avoided.

Ecoregion: a large region, usually spanning several million hectares, characterized by having similar biota, climate, and physiography (topography, hydrology, etc.)

Ecosystem: a biological community (ranging in scale from a single cave to millions of hectares), its physical environment, and the processes through which matter and energy are transferred among the components

Ecosystem Approach: Protecting or restoring the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated.

Endangered: The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

Endangered Species Act of 1973, as amended: Federal legislation intended to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, and provide programs for the conservation of those species, thus preventing extinction of native plants and animals.

Endangered Species: Animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (man-caused) or other natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act.

Fine filter: see "coarse filter"

Gap analysis: a comparison of the distribution of elements of biodiversity with that of areas managed for their long-term viability to identify elements with inadequate representation

Geographic information systems (GIS): computer hardware and software for storing, retrieving, manipulating, and analyzing spatial data

Geospatial overlays: A spatial operation in which two or more maps or layers registered to a common coordinate system are superimposed, either digitally or on a transparent material, for the purpose of showing the relationships between features that occupy the same geographic space.

Habitat: the physical structure, vegetational composition, and physiognomy of an area, the characteristics of which determine its suitability for particular animal or plant species

Landscape: The traits, patterns, and structure of a specific geographic area, including its biological composition, its physical environment, and its anthropogenic or social patterns. An area where interacting ecosystems are grouped and repeated in similar form.

Mitigation: Measures taken to reduce adverse impacts on the environment. Natural habitat

Range - The geographic area a species is known or believed to occupy.

Restoration: Measures taken to return a site to pre-violation conditions.

Section 7: The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the Service, to insure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.

Spatial analysis: The process of examining the locations, attributes, and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge. Spatial analysis extracts or creates new information from spatial data.

Spatial queries: A statement or logical expression that selects geographic features based on location or spatial relationship. For example, a spatial query might find which points are contained within a polygon or set of polygons, find features within a specified distance of a feature, or find features that are adjacent to each other.

Special Area Management Plans (SAMPs): "plans which provide for increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas, including those areas likely to be affected by land subsidence, sea level rise, or fluctuating water levels of the Great Lakes, and improved predictability in governmental decision making."

(<http://coastalmanagement.noaa.gov/special.html>)

Stakeholder: Any organization, governmental entity, or individual that has a stake in or may be impacted by a given approach to environmental regulation, pollution prevention, energy conservation, etc.

Watershed: The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Wetlands: An area that is saturated by surface or ground water with vegetation adapted for life under those soil conditions, as swamps, bogs, fens, marshes, and estuaries.