ERDC TN-EMRRP-EBA-18
December 2012

Evaluating Protocols to Quantify the Significance of Aquatic Ecosystems at Regional and National Scales: Proceedings of a Workshop, Cambridge, MA, 20-22 July 2011

by David J. Tazik

EXECUTIVE SUMMARY: The U.S Army Corps of Engineers (the Corps) needs a consistent, scientifically acceptable method to objectively classify and ascribe significance to aquatic ecosystems. This is necessary to maximize the environmental benefits of ecosystem restoration investments and ensure that the public interest is being served. This report summarizes the result of a workshop conducted to evaluate the Corps' current approach to assessing technical significance of proposed restoration projects and recommends improved protocols.

The purpose of the Corps' ecosystem restoration program is to restore significant ecosystem function, structure, and dynamic processes that have been degraded and to partially or fully reestablish the attributes of a natural, functioning, and self-regulating system. A key performance metric is the amount of nationally significant habitat restoration completed per dollar invested. Presently, significance is assessed based on institutional and public recognition and technical merit. Technical merit, which is the focus of this report, is evaluated based on seven criteria: habitat scarcity and status, connectivity, special status species, hydrologic character, geomorphic character, plan recognition, and self-sustainability.[1]

Workshop participants included technical experts from several government and nongovernmental agencies, academia, and the Corps. The workshop included a series of introductory presentations by several of the participants to review the Corps' protocols, evaluation criteria, policies and perspectives; provide a national view of the state of aquatic systems in the United States; and examine programs and policies of other agencies and NGOs. Several breakout sessions were conducted to review current protocols, suggest improvements, and identify potential data sources. Key issues identified by workshop participants are documented and evaluated in the report. Synthesis and analysis of presentations, breakout reports and subsequent discussion led to the following major findings:

1. The existing criteria are generally good in terms of ecological relevance but are not clearly tied to program goals and objectives; e.g., via application of an objectives hierarchy.

[1] Presently, national and regional significance are determined based on only four of these criteria: habitat scarcity and status, connectivity, special status species and plan recognition.

2. A more limited set of evidence-based keystone criteria would make significance evaluation more robust. Candidate criteria include habitat scarcity, biodiversity, and special status species, including an evaluation of risks and uncertainties.
3. Geographic and temporal scale, limiting factors, probability of success, and how well each is addressed need to be assessed in the project evaluation process, although possibly not as criteria against which to assess resource significance.
4. Socioeconomic considerations in the evaluation of significance can be accomplished by explicitly considering public and institutional recognition in addition to technical merit, and — perhaps — based on an assessment of ecosystem services delivered.
5. Further efforts to develop, modify and define significance criteria must clearly recognize the regional and geographic context in which significance is evaluated – e.g., to assess scarcity and vulnerability.
6. National standards and normalization techniques are needed to ensure consistency and comparability across regions and projects.

PRELIMINARY RECOMMENDATIONS:

1. To minimize bias, criteria selected should be amenable to quantification using the companion metrics selected and should meet the Measurable, Precise, Consistent, and Sensitive (MPCS) screening test; i.e., they are measurable, precise, consistent, and sensitive.
2. Develop and facilitate access to appropriate data, information and corporate databases to help Corps district personnel assess project resource significance.
3. Distinguish among criteria used to evaluate resource significance, those that might be used to prioritize projects, and limiting factors (i.e., biotic or abiotic factors that limit ecological function and structure).
    a. Significance should be based on a limited number of keystone criteria (e.g., habitat scarcity, special status species, and biodiversity), and include an explicit evaluation of risk and uncertainty.
    b. Prioritization criteria should be related to clear program objectives. Limiting factors should be used in a technical evaluation of those projects that meet the significance test.
    c. Public and institutional recognition are also factors in the significance determination and should be directly addressed in the budget EC.
4. Develop a national standard for significance determination that adjusts for regional and geographic variation in significance for specific habitat and ecosystem types.[1]
5. Apart from significance determination, develop project review criteria that address the following issues: spatio-temporal scope and scale; limiting factors; probability of success; and risk and uncertainty.

Recommendations 2, 3 and 5 seem most germane as follow-on R&D activities under this work effort.

[1] Temporal variation should also be considered. Determinations may need to be reevaluated periodically.

INTRODUCTION

Background: To maximize the return on the federal investment, the Corps focuses restoration activities on environmental resources of national and regional significance. Resource significance can be based on institutional, public, and technical recognition (Institute for Water Resources [IWR] 1994, 1995, 1996, 1997). *Institutional significance* derives from recognition of a resource in laws, adopted plans, and other policy statements of public agencies, tribes or private groups (e.g., Endangered Species Act). *Public significance* refers to recognition by a segment of the general public by virtue of, e.g., membership in organizations, financial contributions, volunteer labor, and correspondence that speak to the importance of a resource. *Technical significance* is founded on the technical merits of a resource. There are many scientific and technical criteria that could assist one in determining and describing technical significance; criteria such as scarcity, representativeness, distinctiveness, status and trends, connectivity, critical habitat, biodiversity etc. The focus of this research effort is on criteria relevant to technical significance.

Problem Statement: The Corps needs a consistent method to objectively classify and evaluate significance of aquatic ecosystems. The method must be scientifically defensible and acceptable to a range of federal agencies and non-governmental organizations (NGOs). A defensible approach will use criteria that can be objectively applied to compare the ecological significance and social benefits of likely outcomes. Creating such a system in collaboration with key partners and stakeholders would facilitate the Corps' budgeting process and help districts focus on those projects likely to yield the greatest environmental benefits.

Objective: Objectives of this research are to improve understanding and define a framework that can be used to evaluate national and regional significance of aquatic ecosystems based on professionally accepted methods that produce valid, verifiable results. The intent is to enable consistent evaluation for proposed restoration projects and studies, promote better documentation of the Corps' ecosystem restoration program benefits, and improve the budgeting process.

Approach: To meet these objectives, investigators will work with appropriate cooperating agencies and NGOs to identify criteria appropriate to an objective determination of national and regional significance for aquatic ecosystems in North America. One or more workshops will be conducted to (1) examine the scientific and technical criteria currently used by the Corps and others to assess technical significance of aquatic resources; (2) recommend additions and modifications to these criteria to improve the scientific foundation upon which ecosystem restoration priorities are set nationally; and (3) propose a framework within which to apply the recommended criteria. The approach must be scientifically based and broadly accepted by federal partners and the ecosystem restoration community of practice.

Scope: Following are the results of a workshop conducted during 20-22 July 2010 to kick off this work effort. A description of workshop goals, objectives and results are provided below.

WORKSHOP DESCRIPTION:

A workshop was held during 20-22 July 2010 in Cambridge, Massachusetts to help define a framework that can be used to objectively assess national and regional significance of aquatic resources as a basis upon which to effectively manage Corps ecosystem restoration program

investments. The framework is intended to support justification of national or regional significance of individual projects and prioritization of projects on a national level. Specific objectives are to:

1. Assess scientific validity and utility of technical criteria the Corps currently uses to assess national and regional significance;
2. Identify and recommend additions and modifications to these criteria that would improve the scientific foundation upon which ecosystem restoration priorities are set; as appropriate, propose a framework within which to apply the criteria identified; and
3. Recommend specific supporting data and information that can be readily used to justify national and regional significance of individual projects.

The workshop included a series of introductory presentations by several of the participants, to include a review of the Corps' criteria, policies and perspectives; a national view of the state of aquatic systems in the United States, and programs and policies of other agencies and NGOs. A series of breakout sessions was facilitated to then address each of the objectives described above. The full agenda is presented in Appendix A. Workshop participants are listed in Appendix B.

SUMMARY OF WORKSHOP PRESENTATIONS:

Project Justifications Regarding the Criteria and Process Used by the Army Corps of Engineers (USACE) — Leigh Skaggs, Headquarters, USACE

Key Points:

- The federal interest in any given ecosystem restoration project is based upon a determination of regional and national significance.
- Project benefits are typically measured in quantity and quality of habitat or habitat units restored.
- Significance is often ignored or inadequately addressed in restoration planning documents.
- Significance is based upon an evaluation of institutional, public and technical recognition.
- Significance criteria and their evaluation need to be objective and consistent through all phases of restoration.
- Corps-wide corporate data and information development and sharing would improve significance determinations and project outcomes.

It is critically important for the Corps to establish national and regional significance for all proposed ecosystem restoration projects in order to effectively communicate how projects serve the public interest. Because the benefits of restoration are not evaluated economically, establishing significance is the essential element by which to drive federal interest determinations – i.e., is the project in the federal interest? It also helps answer questions such as: How much restoration is enough, and how much investment can be justified? One common problem in many planning

documents, such as feasibility reports, is that significance is ignored or inadequately addressed, references often are not cited, and critical information is not summarized.

Restoration benefits are captured as National Ecosystem Restoration (NER) benefits and are planned in accordance with the Planning Guidance Notebook (USACE 2000) and the 1983 Principles and Guidelines (P&G).[1] Good policy dictates that the NER plan must reasonably maximize environmental benefits while passing tests of cost effectiveness and incremental cost analysis, demonstrating significance, and showing completeness, efficiency, effectiveness, and acceptability.[2] Environmental benefits are captured as project outputs, which typically have been accounted for as quantity and quality of habitat or habitat units. Ecosystem services represent another approach that is now emerging in the fields of ecology and economics to consider a broad range of environmental impacts and communicate changes in meaningful terms. The desire to incorporate ecosystem services is more explicitly addressed in on-going revisions to the P&G (CEQ 2009).[3]

Resource Significance is recognized along three dimensions – institutional, public and technical.

- *Institutional recognition* includes recognition in laws, plans or policy statements of public agencies, tribes and private groups.
- *Public recognition* represents grass roots support groups like Save the Bay, controversy over use of resources, when locals tax themselves to help pay for restoration, formal and informal national/regional/local expressions of value.
- *Technical recognition/merit* is based on scientific knowledge; e.g., the contribution of submerged aquatic vegetation (SAV) to blue crab nurseries, the role of vernal pools in amphibian life, avian migratory corridors, and critical habitats. Typical considerations include resource scarcity, biodiversity, status and trends over time, connectivity, limiting habitat, and representativeness.

More detailed discussion is provided in several IWR reports (IWR 1994, 1995, 1996, 1997). A review of past Corps reports resulted in the following observations:

- *Objective Criteria:* Virtually all of the Corps' restoration activity is in aquatic environments; virtually all of them are finite and unique in some way. Scarcity, connectivity, and biodiversity typically serve as justifiable criteria for judging significance in these systems. However, it is important to document the basis for saying an environmental element is rare and unique or will be served by enhanced connectivity.

[1] Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, March 1983; http://www.usace.army.mil/CECW/Documents/pgr/pg_1983.pdf

[2] *Completeness* is the extent to which alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. *Effectiveness* is the extent to which alternative plans contribute to achieving planning objectives. *Efficiency* is the extent to which an alternative plan is the most cost-effective means of achieving the objectives. *Acceptability* is the extent to which alternative plans are acceptable in terms of applicable laws, regulations and public policies. (USACE 2000)

[3] http://www.whitehouse.gov/administration/eop/ceq/initiatives/PandG

- *Consistent Presentation:* The significance justification used should be more consistent between the feasibility phase of analysis and in documentation submitted in the budgeting process.
- *Corporate Information Exchange:* Clearly, limited data constrain districts in their attempt to document national and regional significance. Presently, there isn't a standard data set or information source by which to compile and compare technical recognition data. It would be useful to have such data and information to share across the Corps and to share across organizations. The projects themselves also create datasets that are not compiled and shared; more Corps-wide corporate information exchange would be most helpful.
- *Retrospective Assessments:* Corps projects are often deemed a success due to engineering or construction aspects, but there have been few opportunities to monitor projects over the long term. It would be beneficial to close this loop on projects as a basis to help improve efficiency and effectiveness of similar projects in the future.[1]

USACE Performance Budgeting for Ecosystem Restoration — Ellen Cummings, Headquarters, USACE

Key Points:

- Typical performance measures include acres of habitat or river miles restored. There is a need to better capture meaningful outcomes such as the quality of habitat that results from the Corps' restoration program.
- There is no consensus on what constitutes nationally significant environmental resources.
- Seven criteria are used to assess the significance of environmental resources impacted by proposed restoration.
- Objective, broadly applicable measures are needed that reflect programmatic output and outcomes, don't add significantly to project cost, and are easy to understand and apply.

The purpose of the Corps' ecosystem restoration program is to "…restore significant ecosystem structure, function and dynamic processes that have been degraded (USACE 1999a)." The Corps performs this mission through planning, design, and implementation of restoration actions; it generally does not acquire land for this purpose.[2] A performance-based budgeting system is used in conformance with requirements of the Government Performance Results Act of 1993,[3] the President's Management Agenda, and Office of Management and Budget (OMB) guidance. The Corps' strategic plan includes restoration goals and objectives, and looks at both outputs and outcomes (USACE 2004). Typical performance measures associated with ecosystem restoration include acres of habitat restoration completed, river miles of habitat restoration completed, and acres or river miles of nationally significant habitat restoration completed per dollar invested. Although useful, there is a need to better capture the quality of the habitat provided.

[1] This is a national problem that is not unique to the Corps alone (e.g., Bernhardt et al. 2005)
[2] As a general rule, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding 50 percent of total project costs are not likely to be given a high priority. (USACE 1999b)
[3] Public Law 103-62

There is no general consensus on what constitutes nationally significant environmental resources. Presently, the Corps currently uses seven criteria to aid in this assessment, including habitat scarcity, connectivity, special status species, hydrologic character, geomorphic condition, plan recognition, and self-sustainability (see further description in Appendix C). Overall, the Corps' venue is ecosystem rather than species-based, and these criteria are used to get at national and regional significance of affected resources within these ecosystems. Scoring is based upon trend information and relative quantities. Scarce and declining resources are considered especially significant. A few general observations follow:

- *Scarcity:* There is no required standard for determining habitat scarcity; there is no common gauge to quantify scarcity and to compare across diverse habitats, projects, locations, and geographic scales. Availability and accessibility of pertinent data is a typical challenge.
- *Connectivity:* Scoring is based on connecting important habitat pockets to facilitate species movement.
- *Special Status Species:* The primary question here is: is a significant contribution being made to key life cycle?
- *Hydrologic Character:* This criterion was specifically suggested by the Corps' Environmental Advisory Board (EAB) because Corps projects can actually impact it (EAB 2006). This addresses hydrologic characteristics that are needed to maintain the ecological functions or aquatic systems (time, duration, flow, etc.); it recognizes that many biological criteria are often affected by factors external to the project – e.g., surrounding land use and larger scale population dynamics.
- *Geomorphic Condition:* This was also specifically suggested by the EAB. It speaks to those structural and physical processes and conditions required for successful restoration.
- *Plan Recognition:* The fundamental question here is: To what extent is a contribution being made to a watershed or basin plan?
- *Self-Sustainability:* This is based on the average annual cost of operation and maintenance per acre or mile. A project is not sustainable if it is expensive to maintain.

Regarding any future modifications to this approach, measures will be needed that are objective and broadly applicable, that adequately reflect programmatic output and outcomes,[1] that don't add significantly to project cost, and that are easy to understand and apply.

National Perspective on Aquatic Ecosystems – David Strayer, Cary Institute of Ecosystem Studies

Key Points:

- Freshwater biological diversity has suffered tremendously on a global scale and will continue to suffer from pressures exerted by human societies.

[1] Outcomes are meaningfully improvements in desirable functions of the ecosystem such as denitrification or breeding success, as opposed to outputs such as acres of wetland that have not been evaluated for their functional quality.

- Intelligent management and protection of aquatic systems and catchments is needed to offset these impacts, but is often constrained by availability of basic information and knowledge of aquatic resources.
- Inadequate knowledge leads to potential bias and gaming in significance determinations; limits ability to learn from past actions and limits ability to forecast future conditions and how they might impact restoration actions.

Despite covering only 1% of the earth's surface, freshwater habitats harbor significant biological diversity. Many recent studies demonstrate that freshwater biodiversity is in poor shape. Human societies have had a tremendous impact on the aquatic ecosystems nationally and globally resulting in large numbers of imperiled species. Pressures include habitat loss, degradation and fragmentation, pollution, overharvest, introduction of non-native species, dams, and climate change. Unfortunately, otherwise relatively abundant populations may be in worse shape than might be apparent from population numbers; some long-lived species populations are aging without much recruitment. Pressures on aquatic systems will remain high or increase across the board. Action needs to be taken to prevent catastrophic losses in the future. There is a need for intelligent management and protection of freshwaters and their catchments. This requires good basic information and knowledge, which is surprisingly limited in many cases, even for endangered species and unevenly available across taxonomic groups as well. Unsurprisingly, vertebrates tend to be the best known.

What are the consequences of inadequate knowledge? There are at least three main issues. First, inadequate knowledge can clearly affect ranking criteria relevant to significance determinations. Information that is poor, of uncertain quality, uneven across resources, sites, criteria, and regions may lead to bias or gaming of rankings. It might be possible to incorporate the quality and uncertainty of information into the ranking process to address some of these concerns.

Second, inadequate knowledge also limits our ability to learn from our actions. Recent studies have shown that post-implementation monitoring is seldom done, or -- when done -- often done ineffectively. Studies that have been done find that biological success is seldom actually achieved as a result of restoration actions.[1]

Third, the future can't be predicted; uncertain changes in external forces may compromise restoration success. This may include natural disasters, climate, sea level rise, alien species, and changes in human activity, etc. Some changes are easier to predict than others. Clearly, this points to the need to use adaptable restoration designs.

In summary, freshwater resources are badly damaged, and restoration is a vital part of long-term management of aquatic resources. Effectiveness is inhibited by inadequate ecological knowledge and uncertainty surrounding future stressors. Robust, adaptable strategies are needed to address the knowledge gap in project planning and in subsequent operation and maintenance. Important sources of uncertainty need to be taken into account to the extent possible in assessing resource significance, planning restoration projects, and managing those projects after project implementation.

[1] Palmer et al. 2010 found that of 78 restoration projects, only 2 showed increases in invertebrate diversity sufficient to be deemed a biological success. Fish studies have exhibited a similar result.

USDA Natural Resources Conservation Service (NRCS) – Jerry Bernard, Headquarters, NRCS

Key Points:

- With few exceptions, the NRCS works with private landowners through state technical committees. Many are small-scale projects.
- Projects can be implemented fairly quickly when funds are available, but are often limited to individual fields and stream banks in contrast to watersheds and landscapes.
- An ideal tool would incorporate a landscape context, temporal and climate dynamics, uncertainty, and ecosystem service considerations.

NRCS works with a variety of landowners on restoration projects. They work through state technical committees to apply conservation to benefit natural resources, reduce erosion, etc. NRCS does a lot of small-scale projects with single landowners, including stream bank erosion control, animal waste storage, and treatment. Of particular note is the Mississippi River Basin initiative, which is intended to reduce nutrient loading to the river. NRCS doesn't usually conduct monitoring, yet is required to do so here at project and watershed levels.

A significant strength lies in NRCS's ability to work directly with private landowners to make decisions and implement projects quickly; landowners appreciate this. On the other hand, projects are generally focused on individual fields and stream banks, not watersheds or corridors. A landscape scale approach would be more beneficial. While NRCS possesses good engineering, biology, and geology expertise, putting them into a watershed context is a challenge. Some of this can be addressed by working with partners such as The Nature Conservancy (TNC).

A few thoughts and recommendations follow:

- An ideal tool would allow local decisions to be made while fitting in landscape and watersheds – i.e., work at field level but recognize the larger spatial context.
- Dynamics of time, seasons, climate change and other sources of uncertainty need to be addressed in the process.
- Consider incorporating ecosystem services in a ranking system. Other agencies, such as the U.S. Forest Service and Environmental Protection Agency (EPA) are moving in this direction.

Ducks Unlimited (DU) – Dawn Browne

Key Points:

- DU uses landscape priority areas to manage restoration investments based on a number of ecological criteria, recently including climate change, conservation revenue, and sustainability.
- Decision support models have been developed for the Prairie Pothole region and Mississippi Alluvial Valley.

- Important considerations that need to be further addressed in refining the prioritization of restoration investments include data development needs, model development and updates, relevant success metrics, project scale and externalities.

DU's International Conservation Plan uses landscape priority areas to manage restoration investments. Priorities are based on:

- Number and diversity of waterfowl species impacted
- Effects of ecological processes on waterfowl populations
- Degree of current or future threat to waterfowl habitat
- Existence of threatened and endangered species
- Ability to define and evaluate relevant issues
- Status of the relevant science
- Other special circumstances as appropriate

Traditionally, DU has also developed and used local risk models to help prioritize investments. More recently, DU has begun to consider climate change, potential for conservation revenue for landowners, and ability to achieve sustainability by restoring ecological processes. Based on these and other considerations (habitat fragmentation, threats to waterfowl populations and habitat, presence of rare and endangered species, partnerships, etc.) habitat priorities are ranked 1 through 5, with level 1 being most important. The Prairie Pothole region in North America is an example of a priority one area.

In the Prairie Pothole Region, DU originally looked at tracks where large numbers of ducks were breeding; the focus was on areas with high biological value and highest risk of conversion. The concern is that there are millions of acres under the Conservation Reserve Program that are set to expire in the near future in addition to the fact that there is more demand for commodities. A Grassland Loss Model was developed to predict areas most at risk of conversion to agriculture, based on soils, slope, seasonal wetlands, etc. Those areas at highest risk usually are, unsurprisingly, also most desirable for farming, and therefore, the most expensive for acquisition. Better economic data are needed to drive the model; they are working to add the cost of protection to the model.

A decision support model was also developed for forested wetlands in the Mississippi Alluvial Valley covering approximately 25M acres. The model is based on flora, soils, and hydrology, forest loss, soil moisture index, natural flood frequency, sinks/depressions, stream buffers, and flood probability. Weighting factors were considered, but scientific justification for it could not be developed; thus, all factors were weighted equally. DU has this model available on their website.

A few key observations and recommendations follow:

- Data Development: Significant investments are needed to develop required datasets to support prioritization efforts at the right levels of resolution and quality; they will require periodic updating.

- Model Updates: Models developed require a plan for evaluation and adaptation (lessons learned) as new information is developed.
- Success Metrics: Success of projects in terms of land use trends should be assessed over time. DU still can't fully assess their impact on the landscape – i.e., What has been produced for the funds invested?
- Scale and Externalities: Identifying the right data to track at the right scale is a challenge. DU basic benefit is waterfowl production and conservation. This can be driven more by agricultural policy than by DU actions.

The Nature Conservancy – Steve Haase

Key Points:

- TNC's mission to conserve global biodiversity is supported via development of Ecoregion Plans, which use the best available science to set priorities and plan conservation activities.
- Portfolio sites are determined for each TNC ecoregion based on their potential contribution to regional biological diversity.
- Focal Conservation Targets are identified, such as selected species, communities, or ecological systems that represent a full array of biodiversity in the project area.
- Key Ecological Attributes are identified that represent critical components of biological composition and structure, interactions and processes, environmental regimes, and landscape configurations that sustain target viability over space. They are evaluated based on a standard scoring system.
- Critical uncertainties and knowledge gaps are identified and addressed, and plans are updated as new information is developed.
- The recently developed Platform Site strategy is intended to demonstrate and/or evaluate specific biodiversity conservation initiatives.

TNC's mission is to conserve Earth's biodiversity and the waters and lands that it needs to survive. They manage lands and also turn land over to other agencies or sell the land with conservation easements. TNC has moved beyond simple acquisition to work on larger-scale projects in which they cooperate with a variety of partners. Planning conservation activities and setting conservation priorities are done within ecoregions. Ecoregion plans use the best available science; establish reasonably significant targets and strategies to abate threats; and include monitoring plans to assess outcomes.

TNC's approach relies on designation of *Portfolio Sites.* These are critical sites that if conserved will provide a significant degree of biodiversity in the ecoregion. Within these areas, focal conservation targets and key ecological attributes are identified.

Focal Conservation Targets generally include a limited suite of species, communities, or ecological systems that represent a full array of biodiversity in a project area. This might include, for example, bottomland hardwood matrix, Neotropical migrant birds, floodplain fish, natural flow regime, and other important composition, structure and processes on a landscape scale.

Key Ecological Attributes define what a species or group of species need to thrive. These include critical components of biological composition and structure, interactions and processes, environmental regimes, and landscape configurations that sustain target viability over space. Attributes are assessed using indicators that are measurable, precise, consistent, and sensitive (MPCS) relative to a change in a threat or progress toward an objective.

Plans are revised as new information becomes available. Key uncertainties and knowledge gaps are identified and prioritized for further action. The assumption is that successful conservation and protection of priority areas will secure native biodiversity within the targeted region. Elements of the process:

- The viability of important populations and the integrity of key systems and processes are evaluated to assess the status or health of a focal conservation target.
- Attributes and indicators are rated through a standard scoring system to determine where conservation initiatives are needed; this determines the basis for proposed restoration strategies and is used for long-term monitoring.

A new concept is being developed called the Platform Site strategy to demonstrate and/or evaluate specific biodiversity conservation initiatives. Mollisey Farms in the Upper Ouachita National Wildlife Refuge in northeast Louisiana is an example.

Great Lakes Restoration Initiative (GLRI) and Supporting Project Implementation, National Wildlife Federation – Michael Murray

Key Points:

- The Healing Our Waters – Great Lakes Coalition (HOW) Technical Advisory Committee was tasked to identify priority geographic areas to maximize benefits of work to be supported by the HOW Coalition, consistent with broader efforts of the federally funded Great Lakes Restoration Initiative (GLRI), via an expert opinion process involving a workshop and survey instrument.
- A conceptual ecological model was developed to help categorize areas for restoration or protection.
- The process was organized around the four major stressors/program areas of the GLRI– Areas of Concern/Toxic Chemicals, Invasive Species, Nearshore Health/Nonpoint Source Pollution, Habitat and Wildlife Impairments.
- Geographic area priorities were identified based on four broad criteria: severity of the problem, likelihood of timely improvement, risk of new degradation, and likelihood of risk reduction – these criteria were considered for each of the four program areas listed above.
- Expert opinion is a reasonable approach but has its limitations; e.g., there were several significant differences in expert opinion between workshop and survey results for two program areas.

The Healing Our Waters – Great Lakes Coalition (HOW) is active in promoting restoration and protection of aquatic resources in the Great Lakes region. The HOW Technical Advisory Committee was tasked to identify priority areas in support of the Great Lakes Restoration Initiative, a major program funding through EPA. The intent was to identify broad geographic areas where projects funded by the HOW Coalition (which could, in turn, support efforts for groups to pursue funding through the formal GLRI) could be focused to increase benefits.

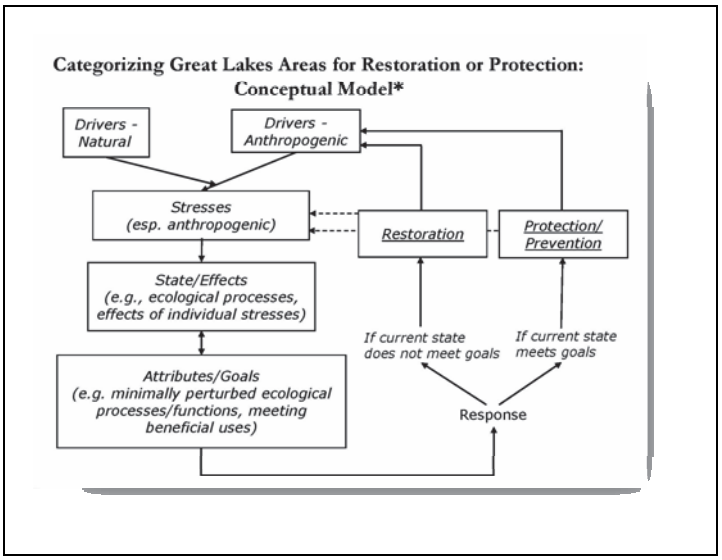

Figure 1. Conceptual ecological model to categorize areas for restoration or protection.

The group formulated a conceptual ecological model to categorize areas for restoration or protection. The model includes natural and anthropogenic drivers, stressors, state and effects, attributes and associated goals, and restoration and protection/ prevention. Figure 1 presents a simplified version; it would vary by site.

A workshop was conducted with 18 researchers to provide expert opinion around four key major stressors program areas – Areas of Concern/Toxic Chemicals, Invasive Species, Nearshore Health/Nonpoint Source Pollution, Habitat and Wildlife Impairments. These features have evolved over time in the Great Lakes area. Specific criteria used for landscape level prioritization included:

- Severity of the problem
- Likelihood of timely improvement
- Risk of new degradation
- Likelihood of risk reduction

A survey of 83 Great Lakes researchers was carried out resulting in 38 responses; 12 of the 15 workshop participants responded to the survey as well. The survey was used to rate areas on a 1 to 10 scale in terms of severity of the problem, likelihood of timely improvement, risk of new degradation, and likelihood of risk reduction for each of the four program areas listed above. The survey was focused on 10 geographic areas, though there were opportunities for respondents to recommend additional areas for attention.

There were significant differences in expert opinion between workshop and survey results. For example, the workshop yielded higher ratings in several areas — e.g., Toxic Chemical in Green Bay; Invasive Species in the Chicago area (the Asian carp issue was in the news); Nearshore Health in Western Lake Erie; Habitat Impairments in Eastern Lake/Ontario, among others. Other concerns:

- Expert opinion is a reasonable technique for large-scale priorities over broad areas. It does have limitations; it is less data driven than analytical approaches.
- Results are a mixed bag and sometimes confounded. Some areas are a priority across all major stresses. There are both similarities and differences between workshop and survey folks, potentially reflecting the different process. For example, survey respondents made choices independently, while in the workshop, a goal was consensus recommendations following open discussion. There were relatively small differences between geographic areas for a given stress category.
- Different default geographic areas (from the 10 available) in the survey might have led to different results.
- Economic, programmatic, and institutional factors were not considered.
- Some people skipped survey questions.
- It might have been useful to include more restoration practitioners.

National Council for Air and Stream Improvement – George Ice

Key Points:

- The Council provides research support to the timber industry concerning impacts of a variety of pollutants, land use and management practices, wildfire, and aquatic habitats.
- The fundamental question here is: How does a company decide to engage in a restoration action?
- Research includes evaluating fish response to flow velocities through various culvert designs; fish tagging to track passage; and efforts to prioritize road segments for modification.
- Restoration alternatives are evaluated based on cost, management options, potential effectiveness, literature references, limiting factors, timing, etc.
- Some companies have done watershed analysis to assess which restoration activities to pursue.

Formed in 1943, and supported by timberland owners like Weyerhauser, the Council is the oldest environmental research organization funded by a single industry in the U.S. Issues addressed include pulp and paper mill waste treatment and air pollution; sediment loads from past land clearing; effects of past splash dams and log drives; legacy road practices (side pass road construction, culverts not designed for fish passage, abandoned roads and railroads, etc.); wildfire and aquatic habitat influences.

The question here is: How does a company decide to engage in a restoration action such as modifying culverts for fish passage on private forest lands? For culverts, companies typically look at how much habitat is situated above the culvert, how valuable is the habitat, is it a species barrier, when and why is it a barrier, how critical is the timing of fish access to the upstream reach? Specific research efforts include evaluating fish response to flow velocities through various culvert

designs and fish tagging to track passage. There is an effort underway to prioritize road segments for modification. In some cases, 90% of sediment from forest operations comes from road system.

In evaluating restoration alternatives, they consider cost, management options, potential effectiveness, literature references, limiting factors, timing, etc. As an example, there are 28 different control or mitigation practices for roads.

The forest product industry looks at channel bed conditions, lack of large wood in stream, road network impact on sediment and turbidity, and fish passage access through culverts. How does the industry decide to do culverts versus roads, etc.? Some companies have done watershed analysis to answer this type of question.

Southern California Coastal Water Research Project – Eric Stein

Key Points:

- California has established a consistent approach to wetland monitoring that provides a flexible framework to meet overarching goals and priorities following EPA's level 1-2-3-paradigm.
- Level 1--Mapping includes inventory and landscape analysis for site selection and prioritization.
- Level 2--Rapid Assessment uses reference sites to anchor assessments for each major wetland type and subtype; it includes the California Rapid Assessment Method (CRAM), which is analogous to the Corps' Hydrogeomorphic Method (HGM).
- Level 3--Intensive Site Assessment is used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation.
- Multiple targets should be achieved to establish a fully functional system – i.e., buffer and landscape, biotic, hydrology, physical habitat. The biotic component alone is often not a good integrator.
- A program to prioritize restoration investments requires a consistent and standardized assessment method that provides ambient and reference data.

Nineteen state and federal agencies in California oversee wetlands. To ensure a consistent approach to wetland evaluations across the state, California has established a wetland monitoring plan that provides a flexible framework to meet overarching goals and priorities. This involves a regional approach that provides context for wetlands evaluation and management. Following EPA's level 1-2-3 paradigm, a consistent set of multiple tools is used to address different issues – i.e., site selection, design, restoration targets, performance, and adaptive management. The focus is on level 1 and 2 assessments as described below.

Level 1—Mapping: This includes inventory and landscape analysis for site selection and prioritization. It uses a modified National Wetlands Inventory protocol along with historical resources to recreate likely wetland and riparian areas – going back to 1750. Change analysis helps to inform restoration and look back at past restoration projects for lessons learned. By

identifying historic archetypes of different wetland types, we can assess impacts and determine where and how to restore wetlands and which wetland types to prioritize.

Level 2—Rapid Assessment: Currently, CRAM provides the main tool used to evaluate general wetland condition. CRAM provides diagnostic level evaluations and can be used to identify and prioritize subsequent intensive (Level 3) analysis. CRAM uses reference conditions to anchor assessments for each major wetland type and subtype. Ambient assessment of current conditions (using probabilistic surveys) provide context for site-specific evaluation of restoration performance. New federal mitigation guidelines call for the use of reference sites. Ambient monitoring programs are also used regionally to set targets for restoration. Rapid assessment provides a systematic way to identify high quality streams and streams that are at risk. Using probabilistic indicators, level 2 assessments provide information needed to understand the range of conditions in a given region.

Level 3—Intensive Site Assessment: Produces more detailed quantitative data on wetland conditions within an assessment area. It is used to refine rapid wetland assessment methods and diagnose the causes of wetland degradation. Level 3 assessments are typically accomplished using indices of biological integrity.

The California Rapid Assessment Method (CRAM) is a level 2 diagnostic tool used to rapidly assess overall wetland conditions. It is analogous to the Corps' Hydrogeomorphic (HGM) protocol, and provides a standard basis of comparison across the state. Key indicators include landscape context, hydrology, physical structure and biotic structure. It is used by the Corps regulatory office in California; the Corps planning community has not used it due to issues with model certification (USACE 2005, 2007). While it is possible to focus on a limited set of indicators, the assumption is that multiple targets should be achieved for a fully functional system — i.e., buffer and landscape, biotic, hydrology, physical habitat. Although the biotic component is often thought of as an integrator, that does not always hold true.

A program to prioritize restoration investments must have a standard set of assessment methods to provide ambient and reference data and incorporate a consistent approach to implementation as well as the institutional infrastructure to support such ongoing assessments.

Risk-Adjusted Social Benefit Metrics for Prioritizing Restoration Investments – Lisa Wainger, University of Maryland

Key Points:

- Public friendly restoration performance metrics are those that communicate social relevance (i.e., effects on drinking water taste, persistence of rare species, fishing opportunities).
- Benefits are produced when both ecological conditions (e.g., waterfowl abundance) and market conditions (e.g., demand for waterfowl hunting days) combine to produce improvements in welfare.

- What is achievable through restoration will depend on the state of the system – different levels of stress or alteration yield different opportunities to restore services (e.g., deer hunting versus bird watching).
- The probability of achieving project goals and producing benefits depends upon ecosystem service goals and performance risk of the restoration approach. Thus, performance risk can be managed by choosing goals that are appropriate given landscape constraints and using risk to weight expected outcomes.

The goal of this work with EPA, NPS and others has been to apply economic principles to the development of environmental benefit metrics that are used to prioritize restoration. The approach is to quantify ecosystem service changes by employing a combination of ecological production functions and economic production and benefit functions. The quality and quantity of ecological outcomes (e.g., changes in habitat quality) are evaluated as well as demand for those outcomes (e.g., potential recreational use). When economic benefits cannot be monetized, the system offers alternative metrics for communicating social value using public-friendly outcome metrics and non-monetary benefit indicators. Considerations:

- *Relevance* — Find those environmental metrics that a non-technical person would recognize and view as important by incorporating quality, quantity, and reliability of endpoints (e.g., % fish habitat regained, instead of changes in water quality parameters.)
- *Cost-Effectiveness* — Targeting restoration funds cost-effectively maximizes the public benefits of spending. A major consideration in achieving cost-effectiveness is: Can the restoration be expected to generate a significant improvement? Also: Is the improvement measured in terms of socially desirable outcomes and not just outputs (e.g., acres)?
- *Risk* — Riskier projects are usually seen as less desirable and may be removed from consideration. But a quantitative approach to measuring risk can demonstrate when potential benefits warrant taking the risk. Quantitative measures of risk are used to deflate expected benefits according to the level of risk so that high risk and low risk projects can be clearly compared.

Two types of conditions need to be measured to assess relative benefits produced: (1) Ecological Conditions--quantity, quality, reliability; and (2) Market Conditions--complementary inputs, scarcity /substitutability, and vulnerability. Market conditions determine whether the benefits suggested by ecological indicators are likely to be realized.

An example looked at a conceptual model of a benefit metric to evaluate a direct use service, waterfowl hunting (Figure 2). Supply was evaluated in terms of the quality of the hunting experience based on

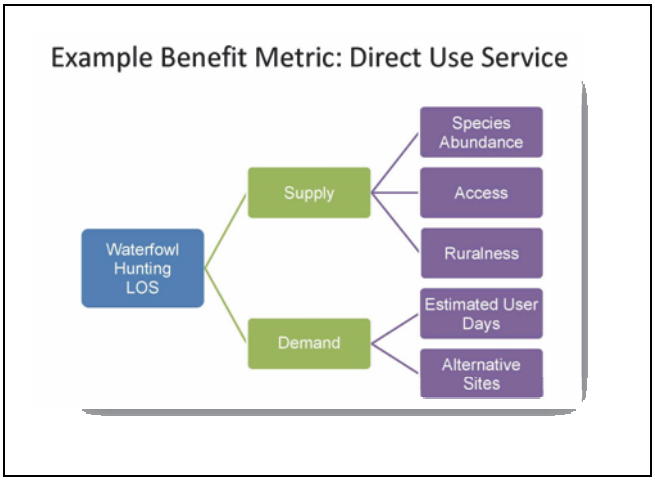

Figure 2. A conceptual model of a benefit metric to evaluate a direct use service, waterfowl hunting

hunter needs for access (e.g., availability of roads, trails, boat launches, etc.) and preferences (e.g., species abundance and ruralness). Demand at a given location is estimated based on population within driving distance, participation rates (user days) and availability of alternative sites. More demand and low availability of alternative sites makes the restoration of a site more beneficial, all else equal.

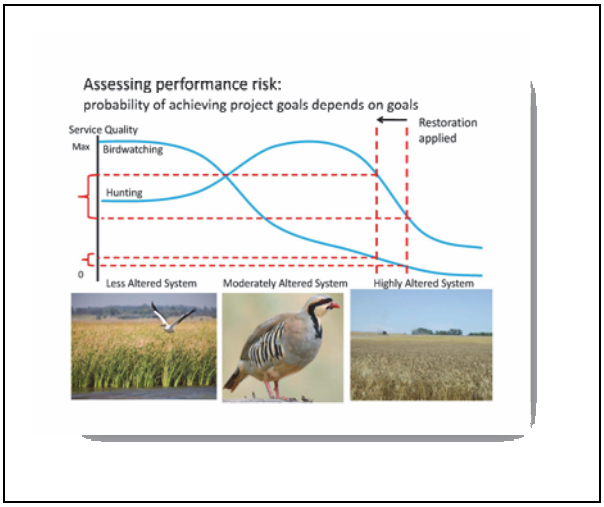

Figure 3. Effect of stress from habitat alteration on benefits derived from bird watching and waterfowl hunting.

One key finding is that restoration performance outcomes depend a great deal on the level of stress in the system. A highly altered system will have different ability to produce services compared to a less altered or moderately altered system. Therefore, restoration targeting should consider the reversibility of the impact and whether improvements will generate meaningful outcomes. For example, a modest decrease in nutrient loads, in a place where they are already extremely high, is not likely to generate meaningful outcomes for aquatic ecosystem services. However, the same level of reduction in a less altered system may generate meaningful improvements (Figure 3).

Performance risk – is the probability of achieving project goals and depends on which goals are set and which restoration approaches are used. Landscape constraints can limit success if they are not addressed in project design.

Performance risk can be managed by (1) setting restoration goals that reflect landscape constraints, and (2) considering reliability of specific restoration approaches. Many restoration projects have the goal of restoring natural dynamics, but this can be impossible in watersheds subject to multiple stressors. Restoration can still be effective at improving selected functions in multi-stressor environments, but some goals, such as fish habitat, will require restoration of multiple natural dynamics. This may be more achievable in systems with fewer stressors, such as when flow dynamics can be restored through dam removal.

National Oceanographic and Atmospheric Agency (NOAA) – Terill Hollweg

Key Points:

- NOAA has been criticized for trying to execute too diverse a portfolio of coastal restoration types; strategic planning and prioritization is needed to focus the program.
- In response, NOAA has established a clear set of goals and objectives to help drive the program and focuses primarily on these four areas: fish passage, hydrologic reconnections, shellfish restoration, and coral restoration.

- For each focus area, NOAA establishes clear, measurable performance metrics within a national prioritization framework, and uses regional expertise to weight criteria for prioritization; rolling this up at a national level is still a challenge.
- Restoration proposals are evaluated based on several standard criteria; funding targets vary regionally and programmatically depending on resources of interest.
- Tier 1, a minimum monitoring effort, is required on all projects. In depth, Tier 2 monitoring is required at some sites.

The NOAA Restoration Center has a diverse restoration portfolio addressing coastal restoration and management. Started in 1991, the Center has implemented 2000 projects with a variety of partners. Historically, projects were chosen largely on an opportunistic basis with acres-restored used as the basic performance measure. Recently, OMB criticized NOAA for trying to execute too diverse a portfolio of restoration types and recommended a more focused approach based on strategic planning and prioritization.[1] NOAA's current approach includes the following:[2]

Goals & Objectives for Prioritization: Establish a clear set of goals and objectives help to derive clear, outcome-based measures that can be used as a basis for restoration prioritization. Develop a map that highlights project areas with "buy in" from local scientists. Focus on priority areas for habitat restoration.

Pre-Prioritization Approach: Primary restoration focus areas include fish passage, hydrologic reconnections, shellfish restoration, and coral restoration. Individual strategies are developed for each that identify short-, mid- and long-range outcomes. This includes:

- Programmatic Performance Measures: Establishes clear, measurable performance metrics; e.g., by 2016 reduce fish passage barriers to priority species by 15% in three priority areas.
- A National Prioritization Framework: Includes criteria such as biological value (T&E, critical habitat, unfragmented, etc), opportunities (partnerships, ongoing projects, recovery plans), and threats (impervious land cover, poor water quality, population growth, climate change).
- Regional Scale Refinement: Uses regional expertise to weight criteria for prioritization. This includes giving a region-specific prioritization framework to a set of experts.
- National Scale: It is not yet clear how to role this up on a national level. There is a desire to be fair and objective at a national level.

After prioritization, NOAA publishes a request for proposals. Evaluation criteria used to evaluate proposals include feasibility, leveraging, self-sustainability, likelihood of success, applicant capability, additional ecosystem services, among others. Funding targets vary regionally and

[1] OMB has been critical of the Corps' ecosystem restoration program as well. Specifically, "Individual projects receive extensive review but the program as a whole has not been subject to regular independent evaluation. Such evaluation may contribute to identification of enhanced methods for performing comparative analysis of projects with dissimilar ecological outputs, refinement of the definition of nationally significant, and improved or alternative performance metrics." (see more at http://www.whitehouse.gov/omb/expectmore/summary/10004363.2006.html)

[2] The USACE Environmental Advisory Board has endorsed this general approach (EAB 2006)

programmatically. For example, NOAA puts more money for endangered species into the Northwest and more into coastal restoration in the Southeast. For community-based programs, NOAA emphasizes leveraged partnerships. Project implementation is emphasized in priority areas.

NOAA requires partners to monitor projects to evaluate success and understand the effectiveness of different restoration techniques. Tier 1, a minimum monitoring effort, is required on all projects. In depth, Tier 2 monitoring, is required at some sites.

Some of the key issues and challenges that NOAA faces include:

- Focusing on techniques versus species
- Balancing national and regional priorities
- Quantitative versus qualitative assessment of priorities
- Scale of assessment; e.g., HUC-4 versus HUC-8[1]
- Relative benefits in addressing highly versus less degraded sites
- Demonstrating impact versus supporting partnerships

Summary of Workshop Presentations

Key Points:

- The intent of the workshop was to evaluate the Corps' current approach to assessing technical significance of proposed restoration projects and recommend improved protocols.
- Limited ecological knowledge and uncertainty constrain the long-term effectiveness of ecosystem restoration measures.
- The Corps' restoration program is diverse and broad in scope, and it focuses on nationally and regionally significant resources.
- The several ecological criteria used to judge significance are not always well documented and are often limited by availability of and access to supporting data and information.
- Significance criteria need to be objective, broadly applicable, relevant to desired outputs and outcomes, easy to understand and apply, and economical.
- Several important issues were addressed: (1) organizing around a restoration portfolio; (2) consideration of scale and watershed and landscape context; (3) standardization of assessment methods; and (4) considerations of risk and uncertainty.

The Corps needs a consistent, scientifically acceptable method to objectively classify and ascribe technical significance to aquatic ecosystems. This is needed to maximize the environmental benefits of ecosystem restoration investments and ensure that the federal interest is being served.

[1] The United States is divided and subdivided into successively smaller hydrologic units which are classified into four levels: regions, subregions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system – HUC-2 regions, HUC-4 sub-regions, and HUC-8 cataloguing units. See http://water.usgs.gov/GIS/huc.html

This report summarizes the results of a workshop conducted to evaluate the Corps' current approach for assessing the technical significance of proposed restoration projects; the workshop also resulted in recommendations for improved Corps protocols.

Within the United States, aquatic ecosystems are badly damaged and restoration is a vital part of long-term management of aquatic resources. At present, long-term restoration effectiveness is inhibited — at least in part — by inadequate ecological knowledge and uncertainty surrounding future stressors. Important sources of uncertainty need to be taken into account to the extent possible in assessing resource significance, planning restoration projects, and managing those projects after project implementation.

The Corps' ecosystem restoration program is concentrated on aquatic environments; virtually all of which are finite and unique in some way. The Corps' program is exceptional in that it covers a wide range of ecosystems, habitats, project types and scales of endeavor that typically require significant modification of hydrologic and geomorphic conditions and processes. Many of these hydrologic and geomorphic conditions and processes have been highly altered by human activities. The Corps has instituted a process to focus its program on nationally and regionally significant environmental resources to ensure that the federal interest is properly served and substantial value is provided to the nation.

Scarcity, connectivity, and biodiversity typically have served as good criteria in judging significance in aquatic systems addressed by the Corps. However, documentation is frequently lacking to fully justify significance assessments. For example, what is the basis for saying something is rare and unique? This is, in part, the result of limited availability, access to, or quality of data and information required to make significance determinations.[1] There is a need to (1) develop and facilitate access to the needed data and information; (2) share these across the Corps and with other agencies; and (3) exchange data and information from the projects themselves as a basis to learn and adapt over time.

Modifications to the Corps current approach must (1) rely on measures that are objective and broadly applicable; (2) adequately reflect programmatic output and outcome; (3) not add significantly to project costs; and (4) be relatively easy to understand and apply. A number of additional issues need to be considered as well:

- ***Restoration Portfolio:*** What is the most appropriate basis for organizing and prioritizing the agency's restoration portfolio? For example,
  - NOAA has organized around four major restoration targets — fish passage, hydrologic reconnections, shellfish restoration, and coral restoration — and is developing strategies and quantitative performance measures for each.
  - TNC has organized around Portfolio Sites as identified within Ecoregion Plans. TNC's strategies address specific biological diversity targets and key ecological attributes that contribute to sustaining regional biodiversity.

[1] It's also possible the Corps can't fully rely on related determinations that could be applied; e.g., several habitat types might be considered significant (in a threshold sense) by virtue of their designation as Special Aquatic Sites (33 CFR PART 332--Compensatory Mitigation For Losses Of Aquatic Resources; http://www.usace.army.mil/CECW/Documents/cecwo/reg/materials/33cfr332.pdf

  - DU is similar in identifying landscape priority areas and evaluating risks and opportunities to enhance waterfowl populations and habitat.
  - NRCS works, with some exception, through state technical committees to respond to individual land owner needs.
  - GLRI is organized around major ecological stressors/issues within the Great Lakes region: Areas of Concern/Toxic Chemicals, Invasive Species, Nearshore Health/ Nonpoint Source Pollution, Habitat and Wildlife Protection and Restoration.

- ***Scale and Context:***
  - Individual projects should be evaluated in the context of watershed and larger landscapes.
  - A regional perspective has merit as illustrated by TNC and NOAA. A hierarchical approach permits emphases to vary depending upon the major ecological challenges and opportunities within any given region. However, aligning regional and national priorities remains a challenge.
  - Factors outside of the restoration footprint may have a large, sometimes larger, impact on restoration outcomes than proposed restoration actions. Such externalities may include changing land use policies, land development, climate, distant population impacts, arrival of alien species, etc.
  - The social context is also important. How should we balance evaluation of potential ecological outcomes (lift) with the need or desire to develop and maintain supporting partnerships? And what of conflicting interests among potential partners and stakeholders?

- ***Tools and Methods:***
  - A program to prioritize restoration investments must have a standard set of assessment methods to provide comparable data within and across project types, habitats, etc.
  - Significant investments will need to be made in data development and management to develop and routinely update the datasets required to support national and regional restoration planning and prioritization.
  - What are the appropriate success metrics? A description needs to be provided for what has been produced with the funds invested. What is the value to the nation?
  - Incorporating ecosystem service concepts must be considered in the ranking system.

- ***Risk and Uncertainty:***
  - Dynamics of time, seasons, climate and land use change and other sources of risk and uncertainty need to be explicitly addressed in the process.
  - Risks to environmental resources subject to restoration and information uncertainty with respect to significance criteria should be considered.
  - Dependency of benefits on the type and level of degradation is a related issue.

- Together, these have a direct and important bearing on setting realistic restoration goals, assessing the probability of successful outcomes, and formulating appropriate monitoring and adaptive management plans.

Summary of Breakout Sessions: Eleven general issues were identified during the breakout sessions. These are presented in Table 1 along with suggested solutions. In short:

Table 1. General Issues and Suggested Solutions Identified by the Breakout Groups.

General Issues	Suggested Solutions
Strategic Planning: Program goals and objectives are not clearly articulated in the budget EC, making it difficult to justify the criteria used in determining Significance. Clear articulation and organization of goals and objectives would help significantly in establishing rational criteria that can serve to set national priorities.	Establish National priorities to drive the program. Define criteria more clearly as they relate to national goals and objectives; better define what the agency is trying to achieve. Metrics should be tiered in a hierarchical fashion to goals, objectives and criteria selected; create a goals and objectives hierarchy (a structured decision tree). Consider weighting criteria according to national priorities; some objectives and related metrics/criteria may be more important than others. NOAA's Pre-Prioritization and Strategy is one example of this approach.
Subjectivity: The process is too subjective with many opportunities for gaming. Some projects could have the same score but not actually be equal overall. Scoring needs to be more evidence based.	Rankings need to be supported by objective data, citations, and other quality information. Develop a database to support ranking information, and refine the model and scoring to limit potential for gaming. Consider third party review to minimize bias; don't increase administrative burden.
Comparability: Different types of projects are not easily compared; e.g., how to compare wetland restoration versus fish passage versus salt marsh restoration. It is also difficult to directly compare projects across regions; e.g., key issues in the arid Southwest are far different than issues in the Pacific Northwest. Need more uniformity in habitat-type descriptions.	Develop an approach to normalize rankings across regions. Develop national standards for project type descriptions; limit comparisons to similar project types; e.g., dam removal to dam removal.
Risk and Uncertainty: The current approach does not address probability of success, risk and uncertainty; probable future conditions and vulnerabilities need more explicit consideration. There is a clear need to distinguish "sure thing" projects from more" iffy" ones. projects. How projects address risk and uncertainty is also important. (Note: risk (in the sense of threats) to habitats and species is addressed below under specific, relevant criteria.)	Add a category/criterion to represent "likelihood of success" to account for risks and uncertainties and how they will be addressed. One could rank projects in terms of high, medium and low risk. Alternatively, overall project risk could be evaluated based on risk of not achieving individual project objectives. Develop a protocol to address offsite impacts and related externalities; i.e., invasive species, climate change, potential land use change, potential for natural catastrophes, other restoration activities in the region, etc. Caution: Be sure not to kill innovation in the process; it may be necessary to tolerate more risk where much can be learned in the process of applying new and innovative restoration actions. Long-term monitoring needs to factor in somewhere; how is risk and uncertainty to be addressed?
Geographic Scale: Geographic extent and scale needs to be considered. Presently, no distinction is made between small and large-scale projects; a 10-ha project is treated the same as a 100-ha project.	Add a criterion for scope of project improvement – i.e., the geographic extent and quality of the impact, not just the project area. (Note: Project size is not considered a criterion for determining Significance per se. However, it is addressed elsewhere in the Budget EC.)
Temporal Scale: Consider temporal response -- How long will it take to achieve the desired outcome?	No specific solution was suggested. (Note: Temporal response may not have a direct bearing on Significance *per se* and might be better addressed elsewhere in the Budget EC.)

Cumulative Effects: Consider the combined, cumulative effects of other projects in the area.	No specific solution was suggested. (See Plan Recognition below.)
Socialeconomic Considerations: Consider project visibility, local community interest and support, potential economic stimulus; also timing and windows of opportunity.	No specific solutions were suggested. (Note: Institutional and Public Recognition are separate and important components in determination of national and regional significance. They don't appear to be addressed in the budget EC; should they be?)
National & Regional Significance: Why is there a need for this as an additional factor at the end? Why is the formula limited to only four criteria? All are considered to contribute to significance. Need a way to better establish regional vs. national significance. Regional significance needs to be placed in the right context. Certain wetlands may be rather significant in one region but not others; each region will have its own set of significant and valued environmental resources. A better definition for both concepts is needed.	Drop it or come up with a better formula. As is, any of the individual criteria used can be a deal breaker. The problem is that not all are going to be limiting factors; while even one factor could be rather significant. For example, habitat could be quite scarce, but Special Status Species and Plan Recognition might not score all that high. See more on a limiting factor approach below.
Criteria: While the individual criteria used may be perfectly acceptable, any given project will have its own set of factors that limit ecological structure and function. A pre-determined weighting method that lumps all the criteria together can miss important restoration opportunities. A project might be scored low due to a single criterion that doesn't really apply.	(1) The criteria should be kept but with modifications in most instances. (2) Consider using a "limiting factors assessment" in lieu of a pre-determined weighting method. Rank projects on the basis of their ability to address limiting factors. (3) Consider adding a criterion related to innovation – give points to projects that innovate with respect to methods, partnering, location, habitat, etc. (will need to balance success risk with innovation). (4) Think about "keystone criteria" which could boil down to habitat scarcity/fragmentation, biodiversity, and special status species.
Data and Information: Credibility of ratings and rankings is limited by availability of and access to quality data and information. Data quantity and quality is uneven across taxa, resources, regions, and the criteria themselves. Expert opinion is not the same as data and fact.	Look for ways to more effectively tap into existing information, regional expertise, and data basis. Don't spend a lot of time justifying what is already known to be important; getting the documentation behind it is the critical thing.

- The Corps should more clearly define program goals and objectives as a basis for determining significance.
- Subjectivity needs to be reduced by making assigned scores more evidence based.
- A better protocol is needed to make significance assessment more consistent and comparable across project types and regions.
- The Corps should consider adding several criteria, including: risk and uncertainty, geographic and temporal scale, cumulative effects, and socioeconomics.
- It is not clear why the criteria are rolled up into a significance score when each can be viewed as important in its own right. Is it needed? If it is, find a better way to obtain it and consider the regional context more effectively.
- Workshop participants thought that the existing criteria are appropriate but require some modification.
- A limiting factors analysis might also be appropriate in evaluating projects, and innovation could be considered as well.
- More work needs to be done to develop and make available data and information that can be used to support project evaluation and ranking.

Issues and possible solutions specific to each of the existing criteria identified by workshop participants are shown in Table 2. In summary:

Table 2. Issues Specific to Each Criterion and Suggested Solutions

Criteria Specific Issues	Suggested Solutions
Habitat Scarcity & Trends – This needs more stringent standards and better guidance for documentation; data availability and verification are critical issues. Regional factors also need to be considered. Habitats are scarce in a regional context; which ones are scarce and where varies regionally. The habitat concept is by definition species dependent; habitat is scarce as it relates to species associated with that habitat. So there may be some overlap and redundancy with Special Status Species. Need also to consider potential future trends due, e.g., to climate change. What is the continuing and future level of threat or risk to the resource?	Develop a more stringent, exacting method for determination. Make better use of existing data on habitat scarcity; develop a database based on past projects and available resources. Another approach is to identify, *a priori*, priority habitats within the Corps restoration portfolio. For example, this could be based on a national inventory of habitat types, their degree of loss and provision of ecosystem services; recognize that these may vary region to region. Other factors could include level of degradation, change from historical condition, degree of threat value of lost functions, etc. Factors to consider include: (1) physical loss; (2) loss of function; and (3) loss of ecosystem services.
Connectivity – The concept is good in theory but seldom applied appropriately in practice. As defined, it does not account for strengthening existing connectivity. Relation to regional connectivity is lacking. A more quantitative approach is needed to increase rigor. What exactly is provided by connectivity – e.g., physical versus functional connectivity? How can this be strengthened for riparian areas, etc?	No specific solutions were offered.
Special Status Species – This may be somewhat redundant with Habitat Scarcity and Trends. Species management is not a Corps mission, but the biological elements of ecosystems need to be addressed; e.g., biodiversity. Need also to consider the level of threat or risk to the resource.	Reevaluate the desirability for this criterion. Consider eliminating this and adding a biodiversity criterion to address the biological component; include current and future threats. (Note: The Corps does have an affirmative responsibility to conserve species on the federal list of threatened and endangered species (and by inference to conserve those at risk of being added to the list); so any substantive improvements to those ecosystems upon which they directly depend should be recognized in some manner. This can also be captured in Institutional Recognition.)
Hydrologic Character -- The process gives the highest scores to the most degraded sites; fewer points if the hydrology is more intact. Is restoring natural conditions really achievable or desirable? Projects may be constrained to the extent to which this can be restored. May want to restore some of the process without restoring the natural condition. Some exclusions may be appropriate like dam removal, levee removal.	Consider capacity for self-regulation as a criterion. Differentiate scoring for constrained settings. (Note: It may be appropriate to evaluate this in the context of a limiting factors assessment. It might help if this criterion was tied to a specific goal.)
Geomorphic Character – Landscape position, physical processes and morphology should be evaluated separately. As written, geomorphic character excludes certain activities. Scoring should be adjusted to reflect evidence of what is effective.	No specific solutions were offered. (Note: It may be appropriate to evaluate this in the context of a limiting factors assessment. It might help if this criterion was tied to a specific goal.)
Self-Sustainability – This may be too limiting. Needs to address risks and stressors. How do these stressors impact the feasibility of success? Revisit these values.	No specific solutions were offered.
Plans Recognition: Some regions are plan rich, some plan poor – need to consider these regional differences across all criteria. This should not be a deal killer.	Change from “plan recognition” to “regional coordination;” factor in cumulative benefits.

- Evaluation of Habitat Scarcity and Trends should be more evidence based and make better use of available data and information.
- Definition and evaluation of Connectivity may need to be refined.
- Special Status Species should be reevaluated and perhaps replaced by Biodiversity.
- Hydrologic and Geomorphic Character may be more suitable in a limiting factors analysis rather than used as scoring criteria.
- Self-Sustaining is too limiting and should include consideration of specific system stressors.
- Plan Recognition may be too inconsistent across regions. It misses coordination activities that aren't captured in formal plans.

The results of the third breakout session are presented in Appendix D. It is a simple listing of data sources identified by the workshop participants. This information is not treated further in this report.

DISCUSSION

Key Points:

- The concept of "Significance" is a key ingredient in the Corps' ecosystem restoration program. Significance is addressed in program goals and objectives, performance metrics, determination of Federal interest, and program budgeting.
- Workshop participants agree that the Corps' current significance criteria are subjective and not specifically tied to national goals and priorities.
- Geographic and temporal scale matter in the project prioritization but may not seem relevant in determinations of significance or of federal interest.
- Socioeconomic considerations are not addressed by current significance criteria; these considerations could be by including public and institutional significance and an evaluation of ecosystem service benefits.
- Limiting factors should be addressed, not in the context of significance or the budget, but as they relate to project planning and evaluation.
- Risk and uncertainty as they relate to the probability of project success and sustainability should be considered in budget prioritization.
- Current significance criteria are satisfactory with modifications. Although some may be more important than others, any weighting scheme would need to be clearly justified. Also, a threshold might be achieved based on one criterion alone in some cases.
- The regional and geographic context is quite important in determining significance as recognized by the workshop participants, the Corps' Environmental Advisory Board, and other federal agencies, such as NOAA.
- Data and information gaps need to be filled in order to support an evidence-based approach to significance evaluation; risk and uncertainty should be explicitly considered.

The purpose of the Civil Works ecosystem restoration program is to restore significant ecosystem function, structure, and dynamic processes that have been degraded (USACE 1999a). The intent is to partially or fully reestablish the attributes of a natural, functioning, and self-regulating system, with emphasis on wetlands, riparian and other floodplain and aquatic systems. The Corps concentrates its restoration efforts on those initiatives most closely tied to its missions and areas of expertise. Furthermore, ecosystem restoration and protection initiatives are to be conceived in the context of broader watershed or regional water resources management programs and objectives, which may involve contributive actions by other Federal and non-Federal agencies and stakeholders.

Civil Works Strategic Plan Goal 2 is the basis for program planning in ecosystem restoration (USACE 2004). The goal is to "Repair past environmental degradation and prevent future environmental losses." Under this goal, the specific objective is to "Restore degraded, significant ecosystems structure, function, and process to a more natural condition." More specifically, the intent is to "Invest in restoration projects or features that make a positive contribution to the Nation's environmental resources in a cost-effective manner." Three performance metrics are stated in the plan for ecosystem restoration:[1]

1. Acres of habitat restoration completed
2. River miles of habitat restoration completed
3. Acres/river miles of nationally significant habitat restoration completed per dollar invested

Clearly, the Corps' intent is to restore nationally significant aquatic habitats,[2] applying an ecosystem-based approach that addresses system structure, function and processes. Projects funded by the Corps must meet the test of being in the Federal interest and are not to be driven solely by local preferences and desires. To ensure this, the Corps has established a "National Significance" test. This workshop reviewed the Corps' current approach to significance determination. It provides an opportunity to review and revise existing criteria, formulas, and processes in order to enhance credibility, objectivity, efficiency and effectiveness.

In ecosystem restoration planning, the concept of significance of outputs plays an especially important role in the determination of Federal interest because of the challenge of dealing with non-monetary outputs (USACE 2000). However, significance does not directly assess the merits of the technical approach to the restoration activity *per se*. Focusing specifically on the Significance issue, what are the appropriate criteria and processes by which to screen projects?

Strategic Planning and Subjectivity. Workshop participants observed that the current significance criteria are subjective and need to be more meaningfully tied to national goals and

[1] Note: none of these include a quality component, which may be a shortcoming.

[2] Habitat is defined by the New Oxford Dictionary as (1) "the natural home or environment of an animal, plant, or other organism: *wild chimps in their natural habitat*" and (2) "a particular type of environment regarded as a home for organisms: *Long Point was internationally recognized for its unique Great Lakes coastal habitat."* While (1) does suggest a species or population-based approach that seems out of synch with ecosystem restoration *per se*; the broader concept in (2) implies a wider system more compatible with an ecosystem view. Here we assume the Corps intends for "habitat" to cover the full range of situations from small habitat development projects (e.g., a 10-acre salt marsh) to large-scale restorations inclusive of multiple habitat types (e.g., Everglades scale) ; in each case remaining cognizant of the importance of addressing structure, function and process, not just single species requirements.

priorities. They suggested development of a goals and objectives hierarchy as a basis for identifying objective significance criteria and performance measures. This is consistent with generally accepted processes for metrics development (see e.g., McKay et al. 2010). For example, it may be appropriate for the Corps to prioritize those projects that aim to restore the hydrologic character of selected aquatic ecosystems; hydrology and hydraulics are of particular expertise within the Corps and so are clearly legitimate areas of national emphasis. The same could be said for geomorphic character. The present criteria addressing these two areas may or may not be appropriate as stated depending upon their relationship to current or future goals and objectives statements. A goals and objectives hierarchy has the benefit of strategically linking screening criteria to national program goals and focusing on criteria for which good metrics can be discerned. Metrics selected should then be supported with appropriate databases to assist the district in making significance determinations.

An attempt is made in Table 3 to assess the alignment of current criteria with relevant goals and objectives of the Corps' ecosystem restoration program and related policies.

Table 3. Relationship of Current Significance Criteria to the Corps' Ecosystem Restoration Goals and Objectives and Related Policies.

Criteria	Relationship to Corps Goals and Objectives	Comment
Habitat Scarcity and Trend	The Corps clearly intends to focus on specific habitat types that exhibit exceptional regional or national scarcity. This is in keeping with the goal of restoring significant aquatic habitat.	Based on current objectives, this seems the most relevant criterion. Habitat fragmentation can also be captured here as it often goes hand in hand with habitat loss.
Connectivity	None stated.	As currently defined, there are multiple dimensions to it (Appendix B). It is clearly linked to habitat, so it would seem relevant along with scarcity and trend. However, there is some concern about misapplication of the concept. A more precise definition coupled to an explicitly stated goal would help.
Special Status Species	None explicitly stated; inferred in statutory requirements under the Endangered Species Act.	(1) Species management is not a Corp mission per se. However, as a Federal agency, the Corps does have an affirmative responsibility to conserve Federally listed threatened and endangered species and the ecosystems upon which they depend. As such, it would seem appropriate to state this as a program goal and include this as a criterion. (2) On the other hand, the Endangered Species Act does confer Institutional Recognition, so this could be covered there. (3) It may be appropriate to take a broader view based on consideration of biological diversity as a whole.
Hydrologic & Geomorphic Character	None explicitly stated; implied in policy.	(1) Given the Corps' particular expertise, these criteria appear quite reasonable, and were recommended by the EAB (2006). As stated in its ecosystem restoration policy, "The Corps will focus its restoration efforts on those initiatives most closely tied to Corps missions and areas of expertise." However, these criteria would be best served if they were clearly tied to relevant program goals and objectives. (2) Absent (1) above, these may more properly be addressed as limiting factors. Otherwise sound restoration projects should not be penalized by not addressing these issues if they are not in fact limiting factors within the scope of the project.

Plan Recognition	Not explicitly stated; implied in Corps policy.	(1) Corps policy states that "Ecosystem restoration and protection initiatives should be conceived in the context of broader watershed or regional water resources management programs and objectives, which may involve contributive actions by other Federal and non-Federal agencies and other stakeholders." (2) Plan recognition may be a bit limiting; there could be substantial regional and watershed scale coordination in progress without the benefit of a formal plan. A more explicit goal along with broader guidance may be warranted here.
Self- Sustainability	None stated.	This seems more of an issue related to technical soundness of the project itself, not a basis for determining National Significance. It should be part of a technical evaluation.

Geographic and Temporal Scale. Does size matter in determination of significance? While project size and potential benefits relative to estimated cost should be a consideration in selecting projects for funding, it is not clear that they bear directly on the Federal interest *per se*. Unless there is some basis for an objective that guides the Corps toward projects of a certain geographic scale, there would seem to be no rationale for biasing for or against the physical size or anticipated project trajectory. However, other benefit-cost considerations that factor in spatio-temporal scale may be appropriate. However, this falls in the realm of an environmental benefits assessment rather than significance determination.

Socioeconomic Considerations. Present significance criteria do not address this issue. However, significance determination in planning is based on three elements: institutional recognition, public recognition and technical merit. These were described earlier in this report and are addressed in considerable detail elsewhere (IWR 1994, 1995, 1996, 1997). The primary focus of this workshop was criteria for technical merit. Institutional and public recognition were not intended to be addressed in the workshop. Nonetheless, the budget EC does not appear to include the later, but rather focuses exclusively on elements of technical merit.[1] The use of an open and inclusive (i.e., 'democratic') process for establishing national significance is one way to consider social benefits because doing so reflects priorities of stakeholders who represent public concerns. Another way to address socio-centric considerations is to incorporate criteria related to ecosystem services, which reflect the value of functioning ecosystems to human well-being.

Significance versus Limiting Factors. As already discussed, significance relates to a Federal interest determination rather than technical adequacy of a given project. Consideration of limiting factors is critically important in planning sound ecosystem restoration projects. For example, an assessment should indeed be made as to whether a project/study has clearly identified and addressed those factors that limit ecosystem health and integrity – these could include hydrology, geomorphology, habitat fragmentation, etc. However, limiting factors *per se* do not directly bear upon a determination of significance; they do bear upon technical soundness of a proposed restoration effort.

Risk and Uncertainty. This theme was rather pervasive throughout the workshop. The issue certainly includes risks and uncertainties that bear on probable success of the project, and how best to integrate risk and uncertainty into programmatic evaluation.[2] It may also include

[1] Should the budget EC incorporate these?
[2] This includes risk that the restoration action will fail, that it won't be sustainable in the face of climate and land use changes.

uncertainty in determination of significance. For example, there may not be good information available about whether a population of one more important species is small or large, becoming more or less scarce, and whether it is well connected to other nearby populations; or whether existing hydrologic modification is a major or minor constraint.[1] Apart from significance determination, probability of success, and how well risk and uncertainty are technically addressed in a project proposal should all be considered alongside a limiting factors analysis.

Risk, as it relates to threats to environmental resources, is best captured with respect to issues such as habitat, biodiversity, and special status species – i.e., status, trends, current and future threats. These considerations would seem to serve as reasonable significance criteria in this context.

Significance Criteria and Thresholds. Significance can and has been defined along multiple dimensions (see Appendix B). Generally, the workshop participants thought that the existing criteria are satisfactory but in need of some modification. That is, they are reasonable and relevant in the context of ecosystem restoration and can still be improved upon. Also, some may be more important than others in making a significance determination.

Could a threshold of significance be achieved based on one factor alone? If the focal habitat is clearly scarce and declining, why would other criteria need to be considered absent other clearly stated national program goals and objectives? A related issue is weighting of criteria. There needs to be a clear rational basis for weighting which justifies why one criterion is more important than another. It is not clear whether this has been done.

Regional Context. The regional and geographic context of a project is important in making a significance determination. Factors limiting in one region are not necessarily limiting in another. Habitats important in the Southwest are far different from those in the Pacific Northwest. Riparian habitat, in general, is significant, but primarily in the context of the arid Southwest; it isn't "nationally significant" everywhere. Development of national standards for significance determination should take this into account.

The Corps Environmental Advisory Board earlier addressed this issue (EAB 2006). They recognized that the nature of Corps restoration authorities meant that there are no meaningful national targets or goals for Corps ecosystem restoration against which the program can be measured. They suggested a regional approach as one way to identify programmatic ecosystem restoration goals, citing the National Strategy for Estuary and Coastal Habitat Restoration (Restore America's Estuaries 2002) which proposes regional identification of restoration priorities based on:

1. Severity of need (scarcity of habitat and threat to species or habitat)
2. Ecological benefits provided by the habitat or species
3. Chances of successfully restoring the habitat or species
4. Public support for restoration of the habitat or species
5. Social and economic benefits provided by the habitat or species

[1] If uncertainty about significance is large, there may be a tendency to give up on a project, which may bias restoration portfolios to favor well-studied species and habitats over those poorly studied.

They noted that NOAA is also developing approaches for regional assessment of restoration priorities (as described above), and that such efforts may be limited by availability of supporting data and information. Also, while recognizing that the project-based approach used by the Corps limits its ability to strategically address regional goals even if such goals were articulated, a regional framework might allow a broader context for the assessment of Corps restoration outcomes.

Data and Information Gaps. The workshop participants recommended an evidence-based approach to evaluating the significance criteria in order to enhance objectivity and minimize gaming. While it is possible that adequate use is not made of available data and information, there are also likely limits due to availability and access to the needed data and information sources. Also, data quantity and quality are uneven across regions, taxa, resources and the criteria themselves. It would be most useful if an evaluation structure could be established that promoted objectivity with the minimum data and information necessary to ensure consistency and credibility.

CONCLUSIONS AND RECOMMENDATIONS:

The purpose of the Corps ecosystem restoration program is to restore significant ecosystem function, structure, and dynamic processes that have been degraded; and to partially or fully reestablish the attributes of a natural, functioning, and self-regulating system. A key performance metric is the amount of nationally significant habitat restoration completed per dollar invested. The Corps has devised a means to evaluate national significance using the seven criteria listed in Appendix B.

The objectives of this workshop were to (1) assess the technical criteria the Corps currently uses to assess national and regional significance; (2) identify and recommend additions and modifications to these criteria and a framework for their application; and (3) recommend specific supporting data and information that can be readily used to justify national and regional significance of individual projects. The first objective was largely accomplished. The second was partially accomplished – additions and modifications were addressed, a specific framework remains to be developed, if one is deemed appropriate. With regard to the third objective, a rather extensive list of possible data sources was identified. These are listed in Appendix D with little additional comment at this time. A more thorough evaluation will be conducted at a later time.

Major conclusions follow:

1. The existing criteria are generally good in terms of ecological relevance but are not clearly tied to program goals and objectives. Notwithstanding the Corps' congressionally influenced, project-driven program, more emphasis needs to be placed on defining appropriate program goals and objectives that can be tied in a hierarchical fashion to relevant criteria and performance metrics.
2. A more limited set of evidence-based keystone criteria would make significance determination more robust. Candidate criteria include habitat scarcity, biodiversity, and

special status species[1]. Other criteria could be used to further prioritize those projects deemed to meet the significance (i.e., the Federal interest) test.[2]

3. Geographic and temporal scale, limiting factors, probability of success, and how well each is addressed need to be assessed in the project evaluation process, although perhaps not as criteria upon which to assess regional and national significance.
4. Socioeconomic considerations in significance determination can be addressed by explicitly considering public and institutional recognition in addition to technical recognition in the budget EC, and — perhaps — based on an assessment of ecosystem services delivered.
5. Further efforts to develop, modify and define significance criteria must clearly recognize the regional and geographic context in which significance is evaluated.
6. National standards (inclusive of data and QA/QC standards) and normalization techniques are needed to ensure consistency and comparability across regions and projects.

Recommendations follow:

1. In order to minimize bias in the process, each criterion selected should have metrics that meet the screening test; i.e., they are measurable, precise, consistent, and sensitive. (This should include sample characterizations and descriptions.)
2. Construct or facilitate access to appropriate data, information and corporate databases (e.g., NatureServe among others) to help Districts objectively assess project significance within the appropriate geographic regions. Appendix D is a starting point.
3. Distinguish significance criteria from prioritization factors and limiting factors. Significance could be based on a limited number of keystone criteria (e.g., habitat scarcity, special status species, and biodiversity[3]), while other criteria could be used in subsequent prioritization of those projects that meet the significance test. Prioritization criteria should be related to clear program objectives. If the Corps has a specific goal related to hydrologic restoration, then this could and probably should factor in the project prioritization. If not, then it should not; in which case it would be viewed as a possible limiting factor to be addressed in project planning. In the latter instance, the project would be evaluated in terms of how well it addresses this factor (a probability of success issue).
4. Factor in Public and Institutional Recognition in the significance determination and directly address them in the budget EC.

[1] Productivity was later mentioned as a possible criterion; and connectivity may still be a useful factor to consider.
[2] We may have three fairly distinct types of criteria to consider in evaluating projects proposals – significance, prioritization, and limiting factors. *Significance criteria* are most appropriate to judge against the federal interest threshold (i.e., is there a sufficient level of regional or national priority evident); it does not, however, speak well to prioritization among projects, though it is a qualitative consideration. *Prioritization criteria* that are clearly tied to program goals and objectives form a better basis for ranking projects even though they may not relate to resource significance. Finally, clear identification of *limiting factors* is essential to any proposed restoration project; proposals should be tested against this and clearly demonstrate technical means to effectively address those limiting factors. Limiting factors in and of themselves do not speak well to resource significance or project prioritization.
[3] Possibly including productivity and connectivity as well

5. Develop a national standard for significance determination that adjusts for regional and geographic variation in significance for specific habitat and ecosystem types. (Case studies would be helpful here.)
6. Apart from significance determination, develop project review criteria that address the following issues: spatio-temporal scope and scale; limiting factors;[1] probability of success; and risk and uncertainty.

Recommendations 2, 3 and 5 seem most germane as follow-on R&D activities under this work effort.

ADDITIONAL INFORMATION

This technical note was developed under the Environmental Benefits Analysis (EBA) Research Program. The USACE Proponent for the EBA Program is Rennie Sherman and the Technical Director is Dr. Al Cofrancesco. Principle investigators for this work are Drs. Craig Fischenich and Dave Tazik. The workshop was facilitated by Julie Marcy, who also recorded notes throughout. Technical reviews by Jerry Bernard, Al Cofrancesco, Michael Murray, Larry Oliver, Leigh Skaggs, Eric Stein, David Strayer, Lisa Wainger, Julie Marcy, Craig Fischenich and Sarah Miller greatly improved prior drafts of this document.

POINTS OF CONTACT:

For additional information, contact the manager of the Environmental Benefits Analysis Research Program, Mr. Glenn Rhett (601)-634-3717; Glenn.G.Rhett@usace.army.mil). This technical note should be cited as follows:

> Tazik, D. J. 2011. *Workshop proceedings: Evaluating U.S. Army Corps of Engineer protocols to quantify aquatic ecosystem significance at regional and national scales*. EBA Technical Notes Collection. ERDC TN-EMRRP-EBA-18, Vicksburg, MS: U.S Army Engineer Research and Development Center.

REFERENCES

Bernhardt, E.S. et al. 2005. Synthesizing U.S. river restoration efforts. *Science* 308:637-638.

Council on Environmental Quality (CEQ). 2009. Proposed National Objectives, Principles & Standards for Water and Related Resources Implementation Studies, December 2009 (established pursuant to the Water Resources Planning Act of 1965 (Public Law 89-8)).

Environmental Advisory Board. 2006. Environmental benefits and performance measures: Defining national ecosystem restoration and how to measure its achievement: A discussion paper. U.S. Army Corps of Engineers (USACE*)* http://www.usace.army.mil/CECW/Documents/eab/ebpm_mar07.pdf

Institute for Water Resources (IWR). 1994. *Review and evaluation of programs for determining significance and prioritization of environmental resources.* IWR Report #94-R-7 http://www.iwr.usace.army.mil/docs/iwrreports/94r07.pdf

IWR. 1995. *Resource significance: A new perspective for environmental projectpPlanning* IWR Report #95-R-10 http://www.iwr.usace.army.mil/docs/iwrreports/95r10.pdf

[1] A limiting factors analysis may relate more properly to project review rather than budget review.

IWR. 1996. *Significance in environmental project planning: Resource document.* IWR Report 96-R-XX http://www.iwr.usace.army.mil/docs/iwrreports/96r07.pdf

IWR. 1997. *Resource significance protocol for environmental project planning.* IWR Report #97-R-4 http://www.iwr.usace.army.mil/docs/iwrreports/97r04.pdf

McKay, S. K., B. A. Pruitt, M. Harberg, A. P. Covich, M. A. Kenney, and J. C. Fischenich, 2010. *Metric development for environmental benefits analysis*. EBA Technical Notes Collection. EMRRP-EBA-04, Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Palmer, M.A., H.L. Menninger, and E. Bernhardt. 2010. River restoration, habitat heterogeneity, and biodiversity: A failure of theory or practice? *Freshwater Biology 55* (Supplement 1): 205-222.

Restore America's Estuaries. 2002. *A National Strategy to Restore Coastal and Estuarine Habitat. Restore America's Estuaries*. Washington DC. https://www.estuaries.org/a-national-strategy.html .

USACE. 1999a. *Civil Works ecosystem restoration policy*. Engineer Regulation 1165-2-50130. http://140.194.76.129/publications/eng-regs/er1165-2-501/entire.pdf

USACE. 1999b. *Ecosystem restoration--supporting policy*. Engineer Pamphlet 1165-2-502. http://140.194.76.129/publications/eng-pamphlets/ep1165-2-502/entire.pdf

USACE. 2000. *Planning guidance notebook.* Engineer Regulation 1105-2-100. http://140.194.76.129/publications/eng-regs/er1105-2-100/entire.pdf

USACE. 2004. Department of the Army Corps of Engineers Civil Works strategic plan fiscal year 2004 – fiscal year 2009. http://www.iwr.usace.army.mil/docs/cw_strat.pdf

USACE. 2005. *Planning - planning models improvement program: Model certification*. USACE Engineering Circular 1105-2-407. http://140.194.76.129/publications/eng-circulars/ec1105-2-407/entire.pdf

USACE . 2007. *Policy guidance on certification of ecosystem output models*. USACE Headquarters Memorandum. http://www.usace.army.mil/CECW/PlanningCOP/Documents/news/eco_models.pdf

USACE. 2010. *Corps of Engineers Civil Works direct program development guidance*. USACE Engineering Circular 11-2 199. http://140.194.76.129/publications/eng-circulars/ec11-2-199/entire.pdf

APPENDIX A: WORKSHOP AGENDA

Workshop: Quantifying Significance of Aquatic Ecosystems for Effective Ecosystem Restoration Program Planning

Location: Boston Marriott, Cambridge, MA
Dates: 20-22 July, 2010

Day 1

Introduction and Background

8:30-9:15 am	Welcome and Introductions	Dave Tazik & Julie Marcy
	Workshop Objectives & Participant Expectations	Dave & Julie

Setting National and Regional Priorities for Aquatic Ecosystem Restoration—Current Approaches and Perspectives

9:15-10:15	*Criteria and Process Used by the US Army Corps of Engineers* Project Justifications—Leigh Skaggs Performance Budgeting—Ellen Cummings
10:15-10:30 am	Break
10:30-11:00 am	*National Perspective on Aquatic Ecosystems*--David Strayer
11:00-11:30 am	*USDA Natural Resource Conservation Service*—Jerry Bernard
11:30-1:00 pm	Lunch
1:00-1:30 pm	*U.S. Fish and Wildlife Service*—Tamara McCandless
1:30-2:00 pm	*Ducks Unlimited*—Dawn Browne
2:00-2:15pm	Break
2:15-2:45pm	*The Nature Conservancy*—Steve Haase
2:45-3:15 pm	*Great Lakes Restoration Initiative*—Michael Murray
3:15-3:30 pm	Break
3:30-4:00 pm	*National Council for Air and Stream Improvement* – George Ice
4:00-4:30 pm	*Southern California Coastal Water Research Project*--Eric Stein
4:30-5:00 pm	Wrap up; Discuss plans for Day 2
~6:15 pm	Meet for dinner as desired

Day 2

8:00-8:15 am	Review results of Day 1; Review Plans for Day 2
8:15-8:45 am	*Risk Adjusted Social Benefit Metrics for Prioritizing Restoration Investments* – Lisa Wainger
8:45-9:30 am	*National Oceanographic and Atmospheric Agency*—Terill Hollweg
9:30-9:45 am	Break
9:45-11:00 am	***Breakout #1:*** Groups will independently assess existing Corps criteria and processes for justification and prioritization. *Issues to address include scientific validity, utility, potential for bias, benchmarks for numeric scoring, etc. Is there a need for minor modifications or major adjustments?*
11:00 am-Noon	***Breakout #1 Report:*** Groups report out on results of their deliberations
Noon-1:30 pm	Lunch
1:30-3:30 pm	***Breakout #2:*** Based on the results of Breakout #1, recommend specific modifications to current practice or suggest, if appropriate, an alternate framework and criteria for quantifying significance of aquatic ecosystems. *How would you do it differently, e.g., to minimize bias and to enhance validity, credibility and impact? (Questions might be adjusted based on the outcome of Breakout #1.)*
3:30-3:45 pm	Break
3:45-4:45 pm	***Breakout #2 Report:*** Groups report out on results of their deliberations
4:45-5:15 pm	Wrap up; Discuss plans for Day 3
6:15 pm	Meet for dinner as desired

Day 3

8:00-8:15 am	Review results of Day 2; discuss plans for Day 3
8:15-10:15 am	***Breakout #3:*** Groups will identify and recommend specific supporting data and information that can be readily used to objectively describe and quantify national and regional significance of aquatic ecosystems. *This may include a variety of databases, literature sources, points of contact, web sites, etc.; we may also identify the need to compile new sources of data and information.*
10:15-10:30 am	Break

10:30-11:30 am	***Breakout #3 Report:*** Groups report out on results of their deliberations
11:30-noon	Wrap up; next steps

APPENDIX B: WORKSHOP ATTENDEES

Jerry Bernard	USDA Natural Resource Conservation Service
Dawn Browne	Ducks Unlimited
Dick Cole	USACE Institute for Water Resources
Ellen Cummings	HQUSACE
Peter Dodgion	USACE, Huntington District
Kim Gavigan	USACE, Los Angeles District
Steve Haase	The Nature Conservancy
Terill Hollweg	National Oceanic and Atmospheric Administration
Len Houston	USACE, New York District
George Ice	National Council for Air and Stream Improvement
Julie Marcy	USACE Engineer R&D Center (Facilitator)
Sarah Miller	USACE Engineer R&D Center
Michael Murray	National Wildlife Federation
Larry Oliver	USACE, New England District
Glenn Rhett	USACE Engineer R&D Center
Rennie Sherman	HQ-USACE (via telecom)
Leigh Skaggs	HQ-USACE
Eric Stein	Southern California Coastal Water Research Project
David Strayer	Cary Institute of Ecosystem Studies
Dave Tazik	USACE Engineer R&D Center
Chuck Theiling	USACE, Rock Island District
Lisa Wainger	University of Maryland
Rebecca Weiss	USACE, Northwestern Division

APPENDIX C: SIGNIFICANCE CRITERIA[1]

Habitat Scarcity & Status: This addresses the scarcity of the type of habitat to be restored in the national and regional context. It is based on historical losses, trend information and relative abundance of the habitat. All special aquatic sites as defined in the 404(b)(1) guidelines are nationally important and relatively scarce. The intent is to identify specific habitat types with exceptional regional or national scarcity. It is not intended to address critical habitat of threatened or endangered species (addressed under **Special Status Species**) or habitats located in priority regions of landscapes (addressed under Plan Recognition).

Connectivity: This addresses the extent to which a project facilitates movement of native species by connecting important habitat pockets within the ecosystem, region, watershed or migration corridor; adds a critical component to an ecosystem; or contributes to increased biodiversity.

Special Status Species: The project must provide a significant contribution to some key life requisite within the potential range of a species to receive points in this category. The demonstrated presence or potential presence of a species of concern in the project area is not sufficient to justify a score above zero.

Hydrologic Character: This recognizes the importance of appropriate hydrology in maintaining the ecological functions of aquatic, wetland, and riparian systems. The hydrologic character refers to the timing, magnitude, duration, frequency, and rates of change of the flows, water levels, and surface/subsurface exchange processes. Projects that restore and sustain the natural hydrologic "signature" of a system are more likely to provide sustainable environmental services.

Geomorphic Character: This relates to the establishment of suitable structure and physical processes for successful restoration. The scale, form, and landscape position of the system, along with key processes such as erosion, sediment transport and deposition play a critical role in defining ecosystem health and resilience and must be considered in project development.

Plan Recognition: This recognizes Corp ecosystem restoration projects that contribute to watershed or basin plans as emphasized in the "Civil Works Strategic Plan." It ranks the importance of the plan that the Corps project supports. Recovery plans may not be used as a basis for a score.

Self-Sustaining: The ideal goal of most restoration is a self-sustaining ecosystem consisting of natural processes. The cost of the average annual O&M per acre will be used as an indicator of the level of human intervention needed to maintain the restoration outcome. The most recent cost estimates or the actual costs of O&M (if greater than the latest estimate) will be used in this calculation. (This applies to only the Project Engineering and Design and Construction phases, not Reconnaissance and Feasibility phases.)

1 Modified from USACE (2010)

APPENDIX D: POTENTIAL SOURCES OF DATA AND INFORMATION RELEVANT TO SIGNIFICANCE DETERMINATIONS

National Websites and Databases:

- NWI – wetlands coverage
- NBII – variety of environmental/ecological monitoring parameters. GAP Report
- Nature Serve – distribution, status, trend, species
- NERI – National Estuary Restoration Information. Collection of estuarine and coastal sites, project data.
- Museum databases – location of species/distribution, etc.
- NRRSS – Margaret Palmer's work
- National Stream… - sample of all restoration and success info
- NRCS Soils Maps
- NAS– Nonindigenous Aquatic Species, invasive species database (including on introductions, distribution), USGS
- USGS Water resources database on gauge data
- CCAP – land cover changes
- REEF Base database – non profit
- Corps national inventory of dams
- Roads and Rails - US Census Bureau data on transportation corridors
- Essential fish habitat map – similar with NOAA and USFWS, has maps

Regional Sites

- State and county GIS databases – landscape coverage
- SOPHIA – regional, integrated database for Everglades (example of regional effort)
- Great Lakes Commission database
- Surf Your Watershed - EPA Watershed database (plan recognition)

National Reports

- Pew and Heinz reports – environmental indicators, conditions
- EPA Coastal Conditions report – sediments, microinvertebrates, fish
- Recovery plans for endangered species – NOAA, USFWS
- Critical habitat reports – NOAA, USFWS
- National fish habitat action plan – also a database

- North American Waterfowl Management Plan - NAWMP
- EPA National Water Quality Inventory reports (including impaired waters)
- National Academy of Science reports

Regional Reports

- FWCAR – state & federal wildlife resources utilizations
- ESA Consultation BO – status and trends of T&E species and critical habitat
- State fish and wildlife reports
- State of the Lakes Ecosystem Conference reports –Great Lakes
- State and Soil Conservation Service maps (also county)
- Great Lakes Environmental Indicators project out of University of Duluth
- International Joint Commission reports – water issues for Boundary Waters of the U.S.

Agencies & Groups

- LCCs/RCSCs – landscape and regional science centers for collaborative data compilation and adaptive management related to climate change
- Regional fisheries councils
- Western States Water Council, WESTFAST
- Regional Collaborations
    - Puget Sound
    - Chesapeake Bay
    - CalFed
    - Great Lakes
- Journal articles – Web of Science and Google Scholar to search articles
- Great Lakes Fisheries Committee Reports

Habitat Scarcity

- Ecosystemrestoration.org – ecosystem services
- National land cover database
- CCAP (NOAA) – maps, coastal change
- National status & trends website, USGS
- Conservation portal
- National Fish & Wildlife Foundation – collects NGD ecosystem services trading
- Ecological site descriptions website, NRCS

- Heinz Center – synthesizes ecological data
- NEON – collection of regional eco observations, government and academic
- World Resources Institute – atlas of scarce resources

Geomorphology/Hydrology

- NEH 654 – technical supplement, NRCS, list stream assessment/inventory tools, 3A
- SAUCIER – geomorphic maps, only Mississippi
- Regional geomorphic curves (state and federal) online – USGS, Rosgen,
- WARSSS (EPA website)
- Levee databases
- NRCS, USDA soils database
- USGS seamless data server (one stop data), seamless.usgs.gov.

Plan Recognition

- EPA's surf your watershed website (*http://cfpub.epa.gov/surf/locate/index.cfm*)
- State DEP/EPA has watershed group lists
- NRCS maintains watershed group lists

Connectivity

- FEMA maps
- Public lands database (CBI)
- GUIDOS – national morphometric map identifies gaps in connectivity
- Wildlands National Corridor Assessment
- EPA's National Atlas (EPA, National Geographic)

Self-Sustaining

- NOAA/NCCOS – maintains climate change data/observations, Coastal Storms program
- IPCC – potential source for climate change, predictive coverage for US, downscaling analysis
- USGS national assessment of shoreline change
- General Land Office surveys - GLO. Google GLO to access. This might provide a good pre-settlement reference that is very helpful for designing new projects (captures change over time for large federal projects).

Ecosystem Services

- Millennium Ecosystem Assessment – lists services
- Forest Service – valuing ecosystem services website
- Ecosystem Services Program – US EPA

Special Status Species

- USGS GAP analysis models
- USFWS – Joint Ventures directory
- Institute for Bird Population (IBP) – MAPS and monitoring report