Aligning Stream Mitigation Policy with Science and Practices

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INTRODUCTION

The 2008 Compensatory Mitigation Rule (referred to in the paper as "the Rule") established equivalent standards for all mitigation required under the Clean Water Act's Section 404 regulatory program (33 C.F.R. § 325 (2007); 33 C.F.R. § 332 (2008); 40 C.F.R. § 230 (2006); 73 Fed. Reg. 19594 (Apr. 10, 2008)). In general, the Rule consolidated previous guidance documents and created standardized reporting criteria that help the U.S. Army Corps of Engineers (the Corps) evaluate compliance and success of all mitigation methods used to offset impacts to jurisdictional waters. For permittees, the goal of the Rule is to provide clear and standardized guidance, and over time, reduce the approval time of permit applications. In the long term, the Rule is expected to establish flexible mitigation options, promote the use of high resource value mitigation sites, and result in a positive overall benefit to watershed restoration efforts.

While the 2008 Rule certainly established much needed provisions, critics argue that the language is still relatively broad and leaves substantial discretion to district engineers, which causes inconsistency in application across the nation. While creating standardized mitigation guidelines for mitigation programs could help tie mitigation activities to functional improvements in the watershed, this can also be expensive and difficult to determine in a specific site given the complexity of an entire watershed. However, resources that guide planning, implementation, and monitoring of mitigation projects could help providers design projects to maximize watershed benefits based upon functional improvements.

The Nature Conservancy, in cooperation with the Environmental Law Institute, Stream Mechanics, and an advisory committee, worked on a series of white papers to support the development and refinement of science-based stream mitigation programs at the state and Corp district level. The Environmental Law Institute and Stream Mechanics developed white papers focused on the current stream mitigation policies at the Corps district and state levels, the current state of stream compensatory mitigation practice, and the current published research on the practice of stream restoration and mitigation.

This paper integrates these white papers while evaluating current mitigation policies related to the Rule and how those policies align with current mitigation practice and science. More specifically, this paper highlights some of the current gaps in Corps District and state SOPs and regulatory and scientific guidance for stream mitigation projects. These include: 1) mechanisms for integrating functional lift into the mitigation program; 2) shortfalls with the watershed approach 3) site selection 4) monitoring for adaptive management; 5) flexibility versus prescribed approaches; and 6) better integration of regulatory and ecological goals.

GAPS BETWEEN SCIENCE, PRACTICE, AND POLICY

1) Functional Lift

Functional lift is used to describe improvements in ecosystem function through compensatory mitigation actions such as restoration. Compensatory mitigation regulations state the amount of required compensatory mitigation be "sufficient to replace lost aquatic resource functions (33 § C.F.R. 332.3(f)(1))." The preamble to the Final Rule states that, "With this rule, we are encouraging the use of functional and condition assessments to determine the appropriate amount of compensatory mitigation needed to offset authorized impacts, instead of relying primarily on surrogate measures such as acres and linear feet. In the future, there will be more assessment methods available to quantify impacts and compensatory mitigation (FR Vol 73, 19633)." Currently, states and districts still rarely employ functional assessment methods for credit determination or for developing performance standards, primarily because few function-based tools are available (Practice Paper). However, tying functional assessment methodologies to credit determination, performance standards, and monitoring can help improve ecological success and achieve the goal of replacing lost aquatic resource functions.

Where appropriate functional or condition assessment methods are available and practicable, they should be used to determine how much compensatory mitigation is required (33 § C.F.R. 332.3(f)(1)) and how many credits are generated at a mitigation site. Functional assessments can also be linked to performance standards, monitoring, and adaptive management.

Although clear progress has been made, there are still many challenges to incorporating functional considerations into stream mitigation. Measuring functional uplift is a challenge; not only is it expensive, but land surrounding mitigation projects is managed by multiple public and private interests often outside one's control. Further, in the view of some, science tends to lag behind mitigation techniques, and it may not be possible to accurately evaluate certain functional improvements in the short term (Practice Paper). In addition, assessment methodologies and other tools are often not as function-based as regulators might hope. In fact, many of the assessment methodologies already employed in mitigation decision-making are more conditional rather than functional. Nevertheless, many districts are working to revise their approach to rely more on a function-based approach in the belief that incorporating more functional considerations would improve their methodology.

2) The Watershed Approach

One of the main focal points of the 2008 Rule is the establishment of a watershed approach for compensatory mitigation decisions (33 C.F.R. § 332.3(c)(1)). The watershed unit provides the basis for mitigation decisions because of the important physical, chemical and biological processes and changes that occur at this scale, providing a context for evaluating mitigation projects and developing comprehensive goals for projects across the watershed (ELI and TNC 2011). While the meaning of the word "watershed" can vary, it is important to think holistically about the project system when developing objectives. It is expected that the use of a watershed approach will result in ecologically successful compensatory mitigation that more effectively offsets the loss of aquatic resource functions and services, rather than mitigation occurring ad hoc throughout a service area, which was a primary complaint in reviews of mitigation success prior to implementation of the 2008 Rule (33 C.F.R. § 325 (2007); 33 C.F.R. § 332 (2008); 40 C.F.R. § 230 (2006)). If applied successfully, the watershed approach could also encourage connectivity between compensatory mitigation and already protected areas, ensuring the long-term sustainability of key functions.

Per the compensation mitigation regulations, in undertaking a watershed approach, the Corps will consider needs of the watershed as a whole and evaluate whether a proposed compensatory mitigation site would efficiently address those needs. Where there is an appropriate watershed plan available, the regulations state that the watershed approach should be based on that plan. When a watershed plan is not available, the Rule states that the watershed approach should be based on an analysis of information provided by the project sponsor or available from other sources ((33 § C.F.R. 332.3(c)(1)). Such information includes: current trends in habitat loss or conversion; cumulative impacts of past development activities, current development trends, the presence and needs of sensitive species; site conditions that favor or hinder the success of compensatory mitigation projects; and chronic environmental problems such as flooding or poor water quality (33 § C.F.R. 332.3(c)(3)(i)).

One often cited challenge with the implementation of the watershed approach is that many watersheds do not currently have a watershed plan (Guidelines and Practice Papers). Watershed plans help identify rapidly-developing or threatened areas throughout the watershed, as well as high land values, pristine parcels or landscapes surrounded by development in places where aquatic function will be threatened or lost without mitigation methods. Watershed plans often define specific desired outcomes, or specific, measurable goals for the watershed. However, watershed approaches can be characterized along a spectrum of categories from watershed informed decisions to watershed analyses with non-prescribed outcomes to watershed plans with prescribed outcomes (ELI & TNC, 2011). Even when a suitable watershed plan may not be available or there are not sufficient resources to develop a formal plan; there is a role and value of watershed analyses or watershed informed decision-making as important steps that can improve project outcomes at the site and watershed levels (see the Watershed Approach Handbook, (ELI & TNC, 2011). In other words, the lack of a watershed plan should not preclude the use of available data to identify and evaluate sites within a watershed context.

Most districts, however, lack guidelines for developing a watershed approach to stream compensation siting (Guidelines Paper) without a watershed plan, leaving much discretion to district engineers (Practice Paper). In general, many districts only require identification of challenges and opportunities within the watershed and a description of how projects will contribute to the conservation or restoration of priority watershed habitats and some districts, like New England, report not even using a watershed approach. It is still unclear how districts determine whether or not a project is contributing to watershed goals or how mitigation activities address the functions lost at the impact site in relation to the goals for the watershed. For example, the Mobile District refers to watersheds throughout their 2012 SOP, but does not refer to a watershed approach as the basis for developing projects and site selection for mitigation (Mobile District SOP 2012). The SOP does have a brief section on watershed assessment, primarily in relationship to surrounding land use. While surrounding land use is important to consider at the watershed scale, additional guidance on how to develop a watershed approach would benefit specific project prioritization within the watershed unit.

States like North Carolina have developed an extensive process for developing watershed restoration plans, prioritizing sub-basins and targeting local watersheds. The state developed their prioritization method in order to understand where restoration can be more effective or feasible, and which areas are particularly time sensitive and subject to degraded status without mitigation. This process clarifies data needs at both the sub-basin and local watershed level, and how the analysis contributes to larger watershed objectives (Division of Mitigation Services). The inconsistencies across the nation make it difficult to evaluate how stream mitigation projects are contributing to comprehensive watershed needs. The current lack of guidance continues to allow for a project-by-project analysis of mitigation sites that do not address the entire watershed and its needs. A large-scale approach is essential to identify critical watershed needs that could be addressed through a combination of preservation and restoration. In the absence of a watershed restoration plan, local guidance could encourage more integrated requirements at the watershed scale. Such guidance could include identification of stream mitigation benefits at a larger scale, such as: water quality, flood attenuation, habitat improvement, recreation, and return on economic investment. Encouraging the identification of these benefits across a larger scale can help achieve maximum functional improvement by prioritizing projects that mutually benefit each other and ultimately increase the overall benefit to watershed goals. Connecting project-scale functional lift to larger watershed functional improvements can better capture how individual project credits/debits contribute to watershed functional goals and requirements. For example, the benefit of removing a threat through preservation could be associated with functional improvement at the watershed scale that is not currently captured directly through the project site.

Watershed plans should clearly identify what impacts within the watershed need to be offset in order to provide functional lift for lost functions. Watershed plans ideally integrate science-based information across multiple spatial scales. Understanding that site-specific data is not independent from the larger influences of the watershed, watershed plans identify degraded resources and immediate or long-term needs to restore those resources. Utilizing a watershed approach with science-based inventories of historical and existing resources can help ensure that stream compensation projects are successful and sustainable. Moving towards a more functional rather than spatial watershed approach could also address the current ambiguity regarding the implementation of a watershed approach without watershed plans. In the absence of a watershed plan, identifying the relationship of watershed hydrology and localized stream hydraulics could clarify the linkages between compensation projects and the larger watershed functional goals. While there are clear performance measures and methods of measurement for localized stream hydraulics, there are inconsistencies with capturing the larger performance measures associated with watershed hydrology. In order to demonstrate an understanding of this relationship, projects should identify and attempt to address watershed stressors in order to improve overall stream function. This could incorporate land use analysis of the entire watershed that can help establish priorities in regard to stream function of individual projects. There are currently quantification tools in development that include catchment assessments to determine stressors that affect restoration potential, but are outside of the practitioner's control (Harman & Jones, 2016).

3) Site Selection

The watershed approach uses a landscape perspective to identify the types and locations of compensatory mitigation projects to benefit watersheds and offset impacts to aquatic resources. Appropriate site selection needs to clearly link the functional lift from project implementation to functional loss at the watershed scale. A key challenge in implementing the watershed approach is that many compensation sites are selected based on factors other than ecological considerations. In many cases, sites are selected opportunistically, based often on largely practical and economic considerations (Practice Paper). Many districts allow Hydrologic Unit Codes (HUC)s to influence site selection and rarely look beyond hydrology and topography. Even when practitioners attempt to use available watershed plans to identify "hotspots" and other areas where mitigation would be beneficial, sites that are ideal in terms of watershed needs may not be available to acquire or practical to restore (Practice Paper). In many cases it has been reported that mitigation policies are not detailed in addressing how the watershed approach should guide site selection (Practice and Guidelines Papers). Some SOPs consider site selection at a larger scale by focusing on ecoregion. The EPA defines ecoregions as "areas within which ecosystems (and the type, quality, and quantity of environmental resources) are generally similar" (EPA Western Ecology Division, Ecoregions. http://www.epa.gov/wed/pages/ecoregions.htm).

Considering ecoregions could lead to a more holistic approach to site selection and aligns well with the watershed approach.

To address these issues, districts could incentivize siting based on ecological criteria to encourage the broader use of the watershed approach to mitigation. For example, some districts incentivize mitigation projects that take into account broader watershed concerns by granting additional credits for projects in priority watersheds, or if a watershed approach is utilized (Kentucky Division of Water 2007, Kansas Stream Mitigation Guidance 2010, Wyoming Stream Mitigation Procedure 2013).

The purpose of understanding the watershed context of site selection is to develop function-based goals and objectives for the watershed and for the project site. Project goals and objectives should be clearly linked to the broader goals of the watershed, otherwise they are not clearly offsetting impacts within the watershed. Providing this linkage can benefit the goal of the compensatory mitigation to offset permitted impacts within the identified service area or watershed. When evaluating project-level goals and objectives, it should be clear that they are appropriate given the watershed characteristics and any limitations with the site given the surrounding land use. Understanding the restoration potential of a site is important at the programmatic level of compensatory mitigation in order to provide for a transparent process in regard to credit determination. The amount of potential credits should appropriately align with the project goals and the capacity of the site to improve the identified functions that offset those lost within the watershed. Utilizing a watershed approach can improve site selection by prioritizing across a larger scale, which could encourage a shift away from opportunistic site selection.

4) Monitoring

Monitoring is necessary to determine if a project is meeting performance standards. Programmatically, monitoring reports are meant to provide necessary data to evaluate credit release. Monitoring reports are used to determine the level of ecological success and programmatic compliance. They are generally not less than five years and can extend as long as necessary to determine if performance standards have been met. The content and level of detail should be commensurate with the project performance measures, goals, and objectives. Effective monitoring can provide an early indication of potential problems and provide the basis for corrective actions. Monitoring the effects of mitigation projects is essential to ensure that the perceived functional improvements of mitigation are observed in actuality. In addition, effective monitoring can provide opportunities for adaptive management, which ensures that mitigation projects are implemented based on current scientific knowledge of aquatic functions. The tension between stream restoration in practice and stream restoration policy is related to the inherent conflict between meeting ecological performance measures and obtaining credit release. Given the current state of stream restoration science, there is a lot of uncertainty regarding best practices, identifying potential challenges, and implementing remedial measures. Monitoring provides the best means to document the ecological progress of mitigation sites. There also seems to be a serious gap in the link between monitoring and performance standards. This disconnect hinders monitoring efforts from actually determining the environmental impacts of a project or being able to properly define the time scale in which these improvements should occur.

The 2008 Rule is relatively vague on monitoring stating that monitoring is necessary to determine if a project is meeting performance standards. The Rule does state monitoring should occur for at least five years and suggests that longer monitoring times *should* be considered for systems with slower development rates such as bogs and forested wetlands (33 C.F.R § 332.6 (a-b)). The Rule does little, however, to address concerns outlined in the Government Accountability Office (GAO) report in 2005 that found poor monitoring, if in existence at all. The report found that while 59 percent of the permit files analyzed contained requirements for monitoring, only 14 percent of those cases had monitoring reports that were received by the Corps (Goldman-Carter and Sibbing, 2009). Many district SOPs and guidelines require monitoring for at least five years, and may encourage up to ten years, and generally require both physical and biological monitoring (Guidelines and Practice Papers). Yet, many mitigation plans lack specific and measureable objectives that can be monitored to determine success (Science Paper).

Districts range in the level of detail provided in monitoring guidance based upon the mitigation activities. Table 1 identifies the most common types of monitoring listed for each level of restoration (stability, water quality, and biological) based upon the restoration potential of the project site.

Table 1. Monitoring for each level of restoration

Stability	Water Quality	Biological
• Channel slope • Valley slope • Cross-sections • In-stream structures • Reference photos • Erosion analysis • Plant survival analysis • Habitat assessment	• Water temperature • Turbidity • pH • Dissolved oxygen • Specific conductivity • Nitrogen and Phosphorous • Sediment loading	• Macroinvertebrate sampling • Invertebrate community index • Plant species diversity • Index of biotic integrity • Vegetative species monitoring (density and percent cover) • Invasive species

Some districts provide specific types of monitoring associated with different levels of restoration. For example, Kentucky includes detailed requirements for both physical and biological monitoring in their guidelines (Kentucky Division of Water, 2007). Plan requirements include: 1) an as-built survey that identifies the longitudinal thalweg profile, stream cross-sections, permanent concrete monuments and a plan view; 2) permanent picture stations of structures and bends that show riparian planting and erosion control measures; 3) riffle and channel pebble counts following the Wolman procedure; 4) bar sampling following the Rosgen procedure; 5) vegetative monitoring of species composition, dominant species, plant survival and invasive species presence; and 6) habitat assessments following the *Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers* (Barbour *et al.* 1999). Biological monitoring is based upon the Kentucky Department for Environmental Protection's *Methods for Assessing Biological Integrity of Surface Waters in Kentucky* that outlines physicochemical monitoring, sampling procedures for benthic algae as an indicator of biological integrity, and phytoplankton sampling procedures (Barbour *et al.* 1999). It then describes procedures for monitoring macroinvertebrates, including a specific section on freshwater mussel sampling. The section on fish community structure includes: sampling methods, how to incorporate the index of biotic integrity, and reporting fish data to demonstrate community structure. The Kentucky monitoring guidelines are more comprehensive than most districts and demonstrate how monitoring guidelines can relate the evaluation of projects to the restoration potential of a specific mitigation site.

One of the challenges associated with monitoring has to do with the inherent conflict between ecological performance and credit release. Ecological performance is tied to functional lift in order to achieve the goals and objectives of the project. The project-level goals and objectives are tied to the watershed goals and objectives in order to meet the purpose of compensatory mitigation to offset impacts to aquatic resources within the defined service area. However, as identified in the National Resource Council Report in 2001, we still have a long way to reach the goal of 'no net loss'. While there are successful examples of stream restoration, there are many challenges associated with effectively restoring degraded functional systems to their natural regimes. In order to meet the ecological goals of the Clean Water Act Section 404 Regulatory Program, stream restoration practitioners and regulators need to learn from past mistakes and identify ways to improve restoration in the future. Monitoring programs and reports ideally should not only serve the programmatic function of approving credit release, but also provide the necessary information to restore and maintain the chemical, physical and biological integrity of the nation's waters. One of the limitations of evaluating progress in this regard has to do with the programmatic focus of monitoring. Monitoring should ultimately be linked back to how well the project site functional lift is improving the functional loss within the watershed. Without this information, it is difficult to understand the challenges and limitations associated with site selection and restoration potential. Providing transparent documentation of implementation challenges and remedial action is a key element that has been missing in monitoring, in part, because of the focus on credit release.

One way to address this challenge might be to incentivize or provide credits where performance can be tied to the goals and objectives of the watershed. While it can be a challenge to provide a clear scientific linkage from the project scale to the watershed scale, it is necessary in order to evaluate if compensated impacts are offsetting for lost aquatic function. A more comprehensive attempt to evaluate project effectiveness not only at the project-scale, but at the watershed scale could improve our understanding of site selection and service area determination. Since performance is so integrally tied to the release of credits, mechanisms to address this gap should be developed. Monitoring report requirements should ensure there is sufficient information to determine that the site is meeting performance standards. Requirements should include:

- Progress in addressing watershed goals and impacts to aquatic resources
- Performance standards for project site to meet goals and objectives
- Documentation of functional lift to meet performance standards
    - Baseline, as-built and current data related to performance measures
    - Maps, plans, and as-built designs
    - Photographs documenting change
- Problems and remedial actions taken to address those problems
- Summary of site condition and any conclusions regarding ecological function

Providing accurate and transparent information in monitoring reports not only can help regulatory agencies better evaluate the effectiveness of specific projects in meeting their goals and objectives, but should also help evaluate the effectiveness of site location in regards to meeting the watershed goals and objectives. This is information and analysis is essential to meet the programmatic goals of the 404 Regulatory Program. In addition, clear monitoring documentation could help further the science of stream mitigation and ensure that practitioners are learning from mistakes and improving the ecological success of stream restoration projects.

Clear performance measures that link to functional lift can help clarify which measurements are important determinants for particular projects. Monitoring should reflect the performance standards that link to the specific and measureable objectives outlined in the project proposal. Ideally, the mitigation plan of each project identifies the goals and associated measurements for each function.

5) Flexibility Versus Prescribed Approaches or Specific Best Practices

While regulations establish many standards for the implementation of compensatory mitigation projects, the language leaves considerable flexibility and variation in how mitigation is actually carried out in practice (Practice Paper). Flexibility may be necessary in some areas due to the ecological differences across regions and to allow for innovation, but additional guidance could improve consistency and reliable outcomes (Practice Paper). When guidelines lack objective criteria, both practitioners and regulators may struggle because practitioners cannot understand what regulators expect, and regulators cannot review projects consistently. Standard criteria, templates, and performance measures could result in more consistent products. On the other hand, a lack of flexibility in some program components, performance standards for example, may cause providers to adapt projects to meet standard metrics rather than to restore functions appropriate for the site (Doyle and Shields, 2012).

Though stream compensation SOPs vary, many of them are alike in what they do and do not address. Many SOPs provide guidance on mitigation methods and debit/credit determination and most mention one or more allowable mitigation techniques (although a district may allow the use of a technique as a mitigation action even if the SOP does not explicitly identify that technique as a permissible action). Most state and Corps district stream compensation SOPs also discuss instruments needed to protect compensation sites in perpetuity by reiterating the language in the 2008 Rule. Some topics, however, consistently receive less attention than others. Some of the more complicated and important aspects of stream mitigation policy – the siting of projects, the watershed approach, and performance standards – are also the least well defined in policy and left up to review on a case by case basis, while the staff doing this case by case review are often not well trained in this area. Monitoring protocols and credit release schedules have also generally received little attention. This is true at both the district and state level, as the Association of State Wetland Managers found that the vast majority of states evaluated success on a case-by-case basis (ASWM, 2014). Similarly, as discussed above, most districts lack a comprehensive discussion of how to implement the watershed approach. Success should be evaluated both at the watershed and project level to ensure long-term transformation.

More guidance on these topics would improve consistency and aid both regulators and providers in designing sustainable mitigation projects. As discussed above, districts need more explicit guidance on effective methods of mitigation in a given context, and guidelines for application of the watershed approach in order to improve site selection and to adequately protect priority aquatic resources. Regional guidance could be tailored to local ecological conditions and resources. Standardizing certain mitigation guidelines, such as site selection, are necessary to tie performance standards to functional improvements.

6) Better Integration of Regulatory and Ecological Goals

The tension between stream restoration in practice and stream restoration policy is related to the inherent conflict between meeting ecological performance measures and obtaining credit release. Given the current state of stream restoration science, there is a lot of uncertainty regarding best practices, identifying potential challenges, and implementing remedial measures. Additionally, there is a high level of economic risk on the part of the practitioner, hence the various credit release schedules that attempt to compensate for upfront attainment of milestones and longer-term releases based on achievement of performance measures. Because of these challenges, it is incumbent on both practitioners and regulators to provide a transparent process for credit determination that best reflects the ability of projects to improve ecological functions. In order for projects to truly offset impacts to aquatic resources, the functional lift awarded credits should reflect the functional needs of the watershed. In order for credits to truly reflect lost functions they should not be awarded when the identified functions are not improved. Likewise, monitoring reports should accurately and honestly reflect upon ecological and functional performance, and how individual projects improve the aquatic function within the given watershed or service area.

POLICY RECOMMENDATIONS

In order to address the gaps discussed above and improve mitigation practices while accommodating both rapid infrastructure development and the aquatic conservation needs across the country, we need modern stream compensation guidance, procedures and practices. This section will highlight important criteria for an effective stream mitigation program with emphasis on what components are lacking clear guidance, and will include recommendations on how to move forward.

Criteria for an effective stream mitigation program

Over the past two decades the important functions and services streams perform in the landscape have been increasingly understood and recognized. At the same time, the field of stream restoration science has also continued to grow, and restoration practice has improved as new techniques were developed and tested. As stream mitigation continues to grow, lessons learned from stream restoration science and practice can improve guidance and ultimately outcomes on the ground. Based on our assessments of stream restoration policy, practice, and science, we have identified a number of key criteria that underpin a successful stream mitigation program. These criteria are listed below followed by detailed descriptions.

a) Program Components Should be Science-based
b) Project Success Should be Tied to Functional Improvement
c) Data Generated Should be Publically Available, Up to Date, and Used to Improve Mitigation Guidance

d) Mitigation Programs Should be Regularly Evaluated to Address Gaps and Shortcomings
e) Programs Should be Adaptive
f) Financial Assurances and Long-Term Management

a) Program Components Should be Science-based

An effective stream compensation program requires that all aspects of the program – most notably site selection, credit determination, performance standards, credit release schedules, adaptive management, and monitoring – be founded on ecological criteria and best available science. The flexibility allowed in the Rule, which may increase inconsistency, allows for new advances in science to be incorporated into decision-making. This flexibility also leaves a considerable amount of responsibility on districts and practitioners. As suggested in the Preamble to the Mitigation Rule, the lack of fully tested hypotheses and techniques should not preclude the use of best available science to ensure successful outcomes. An expanding body of literature on stream restoration science documents successful outcomes for stream restoration projects and provides the basis for advances in agency guidance (FR Vol 73, 19633). There are specific areas of the mitigation program where existing science could improve implementation over the short-term, including:

Site Selection and The Watershed Approach

Site selection, particularly using the watershed approach, is one area where existing science-based information can help ensure that stream compensation projects are successful and sustainable. For stream compensation projects, it is critical to holistically take into account watershed scale processes and the role and function of rivers and streams when selecting sites and designing projects. The condition of the watershed upstream from a specific project site can greatly influence the types of impairments that exist on site and the resulting restoration potential of a particular stream reach or segment. Areas both upstream and downstream from a project site are critical to the current and long-term condition of the site (Moerke and Lamberti 2003, Walsh *et al.* 2005, Roni *et al.* 2002). Thus, the ability of the site to achieve desired ecological and physical outcomes depends as much on position in the watershed and watershed context as do site conditions or quality of the restoration work itself.

As described above, SOPs across the country generally do not provide substantial guidance to providers on how to implement the watershed approach, and this has led to the continuation of ad hoc project site selection without coordination across the larger watershed. Districts, states, and other organizations should put substantial effort towards developing guidance on the watershed approach using available watershed plans or other suites of information (e.g., aquatic habitat conservation plans, etc.).

A science-based watershed plan can provide a high degree of scientific rigor and an avenue for stakeholder input. Well-informed plans supported by strong data and broad consensus on desired outcomes can increase the confidence of agencies in making decisions and making them in a timely manner. By providing a vision for potential compensatory mitigation opportunities outside the context of individual permit decisions, a watershed plan for stream restoration and protection activities provides a forum and framework for scientific rigor outside of regulatory timelines—but the resultant plan can then be efficiently included in the decision-making process. The Etowah (Georgia), Stones (Tennessee), and Duck-Pensaukee (Wisconsin) watersheds are great examples of how to utilize available data in your region to inform a watershed approach. Looking at these pilot programs can help guide districts that do not have a watershed plan and need guidance on a watershed approach (ELI and TNC 2011).

Even without a watershed plan, numerous planning tools and methods have been developed that are useful for informing a watershed approach to stream compensation site selection and design. The Army Corps issued guidance on watershed planning and the preparation of watershed plans in 2010 (U.S. Army Corps of Engineers. (January 15, 2010). Watershed Plans. Circular No. EC 1105-2-411). The guidance includes four specific considerations to take into account when engaging in watershed planning: systems approach; public involvement, collaboration, and coordination; leveraging resources during implementation; and study area.

As described above, ELI and TNC's Watershed Approach Handbook (2011) provides an overall framework for the spectrum of watershed approaches, examples of specific types of watershed approaches, examples of types of analysis that may be useful for using a watershed approach, and a list of national data sources that might inform all of the above. The Handbook characterized the watershed approach along a spectrum of categories from watershed informed decisions to watershed analyses with non-prescribed outcomes to watershed plans with prescribed outcomes (ELI and TNC 2011). Where the watershed effort lies along this spectrum depends on how it addresses some key science-based steps common to watershed approaches. The five key elements include (ELI and TNC 2011):

1) Identification of watershed needs (e.g., specific ecological functions or ecosystem services) necessary for the improvement or sustainability of a watershed and for which a future desired condition has or can be identified. Watershed needs may include those identified by various regulatory and non-regulatory programs or in existing state, local, or regional plans.
2) Identification of desired outcomes (i.e., the specific and usually measurable results desired in the future).
3) Identification of potential project sites where streams can develop and persist into the future.
4) Assessment of the potential of sites to meet watershed needs through a science-based analysis that ranks the relative ability of a site to support desired ecosystem functions and services.
5) Prioritization of project sites based on their relative ability to sustain ecosystem functions and/or contribute to achieving desired watershed outcomes.

This science-based approach encourages an analysis of historic aquatic resource losses, development pressures and threats within the watershed, and the functional impacts associated with those losses. Ultimately, the analysis helps managers target priority areas based upon scarce or damaged functions in the watershed. The watershed approach allows decisions to be made in the context of a science-based analysis of watershed needs so that these projects can achieve broader conservation outcomes.

In the absence of watershed plans, it would be useful for districts to identify they type of criteria most useful for understanding the watershed context of mitigation sites. In other words, what criteria are most useful to understand the impacts of surrounding land use on the functional capacity of sites to meet hydraulic, geomorphic, physicochemical and biological functions? Districts could develop criteria such as:

- Percent natural vegetation in catchment (e.g. forested, grasslands, wetlands)
- Percent agriculture and urban land use in catchment
- Percent impervious surface
- Identify point source and non-point source discharges
- Percent of stream length with riparian zone
- Road density
- Ecological connectivity

These criteria were identified in a National Biological Assessment and Criteria Workshop in 2003 (Larsen, P). They were developed to help create a framework for understanding thresholds for reference condition, but could also be used to develop a better understanding of how much sites have deviated from a reference state, and what the potential is for sites to return to a reference state given the watershed characteristics. Developing specific watershed criteria can also help with monitoring and evaluation to determine whether or not a project is contributing to watershed goals, or how mitigation activities address the functions lost at the impact site in relation to the goals for the watershed.

Various suites of information and existing plans (i.e. GIS aquatic analysis, aquatic habitat conservation plans, etc.) can help direct a watershed approach. A list of some of the types of analyses is below. These various efforts yield a rich diversity of experiences, methods, and models on which to base a watershed approach to stream and wetland restoration and protection projects. Some examples of good sources of information for a watershed approach include:

- Existing plans, reports, or analyses (e.g., water quality standards and implementation plans, special area management plans, state wildlife action plans, ESA habitat conservation plans, flood management plans)
- Analysis of historical loss of aquatic resources in the watershed
- Analysis of current condition of aquatic resources in the watershed
- Analysis of trends and future threats within the watershed
- Stakeholder input
- Function and condition assessments
- Ecosystem service assessments
- Wildlife and habitat assessments
- Identify priority hydrologic units

It is important that districts clarify how a selected project will contribute to the goals and needs of the watershed based upon specific functional parameters and associated performance measures of the larger watershed.

Setting Function-Based Goals and Objectives

In order for project success or failure to be objectively evaluated, each stream compensation project should state clear and measurable goals and objectives that reflect the restoration potential of the site and the watershed context. A sizeable number of studies in the literature, about 30 percent, fail to refer to a project's objectives, and where they do they are often too broad to effectively evaluate whether the project successfully achieves the objectives (Science Paper). Further, few studies evaluate methodologies and metrics to determine whether objectives were actually achieved.

The Mitigation Rule requires mitigation plans to state project objectives and goals. The Rule requires the mitigation plan include, "A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest." Mitigation SOPs often reiterate these requirements. However, SOPs give little guidance on developing project objectives and generally do not require objectives to tie to mitigation activities, credit determination, or monitoring parameters (Policy Paper).

We recommend project proponents detail two levels of goals in their mitigation plans: programmatic and project or design goals. Programmatic goals state why the project is being completed from a regulatory or funding driver perspective. Example programmatic goals include: To provide mitigation credit or to satisfy a TMDL requirement. These goals do not relate to stream functions, but they are important in communicating the regulatory/permitting process that will be followed. For example, a mitigation project can be a lot more involved than a project funded by a landowner to stabilize an eroding streambank. Design or project goals are function-based, relate to the project reach, and must be developed after some form of project assessment has been completed. Design goals can be broad, but should state why the project is being completed and what functional problems will be addressed. Example design goals from Harman *et al.* (2012) are provided below.

1. Improve native brook trout habitat. This goal communicates that the purpose of the project is to improve habitat, e.g., riffles, pools, glides, cover, and maybe substrate composition, implying that habitat is degraded. This would be confirmed with the assessment. Note that this goal does not state that brook trout populations will be increased; just the habitat.
2. Increase the biomass of native brook trout. This goal does state that there will be more brook trout after restoration than before and implies that the watershed will support brook trout if the reach-scale problems are fixed.
3. Reduce sediment supply from eroding streambanks. This goal communicates that the functional problem is an excess of sediment entering the stream channel.

Each project should include a list of objectives for each goal. Objectives are more tangible than goals and explain how the goals will be achieved. It is preferable for the objectives to be quantifiable. If using goal number 1 above, example objectives might include the following. (Notice that these objectives do not state that channel dimension, pattern, or profile will be changed. In reality, the geometry will change, however, the reason is explained in functional terms.)

1. Reduce bank heights from an average of 4 feet to 2 feet. This objective shows that floodplain connectivity will be improved. The activity would likely include grading.
2. Increase the number of pools per 100 feet from 1 to 5. This objective shows that bed form diversity will be improved and would likely include the installation of wood, rock, or meandering to create and maintain the pools.
3. Reduce average bank erosion rates from more than 1 foot/year to less than 0.1 feet/year. This objective shows that sediment supply will be reduced.

Each project should also include a description of the restoration potential to accompany the goals and objectives. This can help ensure that credit determination adequately reflects the actual restoration potential given the watershed characteristics. It is important to provide a realistic view from the outset of what credits have to potential to be released, provided that the site is effective at improving the identified functions. Restoration potential is the highest level of restoration achievable given the health of the upstream watershed, condition of the project reach, and site constraints (Harman *et al.* 2012). In order to achieve goal number 1 (habitat), the restoration potential is less than goal number 2 (biomass). Goal number 1 could have a restoration potential limited to restoring hydraulic and geomorphology functions because the watershed or site constraints will not support biological improvements to a reference condition. For example, the watershed is moderately developed or has point source discharges that are impacting the biology. A restoration project could provide channel stability, reduce sediment supply, improve floodplain connectivity and more; however, the biology will not be significantly improved. Goal number 2 states that more fish will inhabit the reach after restoration, so the restoration potential extends through the biological functional category. This example might include a highly degraded stream reach downstream from a state or national forest.

Performance Standards

Performance standards provide a mechanism to understand if projects are meeting the identified goals and objectives. They are observable and measurable physical, chemical and/or biological attributes that are programmatically linked to a credit release schedule and ecologically linked to stream function. The Mitigation Rule states that performance standards must be based on attributes that are objective and verifiable and must also be based on the best available science that can be measured or assessed in a practicable manner. It also states that performance standards may be based on variables or measures of functional capacity described in functional assessment methodologies, measurements of hydrology or other aquatic resource characteristics, and/or comparisons to reference aquatic resources of similar type and landscape position (33§ C.F.R. 332.5(b)).

Stream mitigation SOPs generally include few specific examples or requirements for performance standards. In general, performance standards are considered case-by-case and depend on the project at hand. For example, Virginia's stream criteria are "a standard set of Criteria to choose from" and intended to be project-specific (USACE, Appendix M). The Mobile SOP observes that "[t]here are too many variables that must be addressed for a one-size fits all approach to stream channel restoration" and states that biological and chemical performance standards in particular may vary depending on the nature of the project, so long as they are "practicable, repeatable, and appropriate for implementation in the Regulatory Program" (p. 37). Savannah likewise states that the Interagency Review Team will determine which metrics are appropriate on a case-by-case basis.

However, various science-based and measurable performance standards are beginning to be developed for various project characteristics or types of aquatic resources across the country. These new methodologies are designed to clarify expectations and provide mitigation providers with clear guidance on what is expected of a mitigation project. These methodologies are typically more objective and more quantifiable, and focus more on the outcomes of the actions rather than the actions themselves. Examples include:

- The U.S. Army Corps of Engineers St. Paul District has developed performance standards for target hydrology (the hydrology necessary to achieve the objectives of a compensation site). The target hydrology performance standards were developed for specific plant communities based on monitoring well data, field observations, scientific literature and other sources. The performance standards for specific wetland plant communities included specifying minimums and maximums for depth, duration and frequency of inundation and/or a water table during the growing season and in the context of antecedent precipitation. Standards are regionalized to account for different plant communities, climatic conditions, etc. Monitoring wells/dataloggers are used to confirm whether performance standards are met (Eggers 2015).

- The U.S. Army Corps of Engineers Mobile District has developed performance standards for pine savannah. The objective was to develop ecological based wetland mitigation success criteria for Pine Savannah Wetlands that are objective, measurable, and based on the best available science. The district used current HGM manuals as best available science (RIBITS). The performance standard included 20 indicator species with pictures for easier identification.

Development of national criteria for developing performance standards that better assess functional lift can clarify how those standards capture the benefit of utilizing different mitigation approaches and techniques. The Science Paper provides parameters by which functional lift can be assessed in relation to the various restoration approaches and techniques (see list in Policy Paper) and how the approaches and techniques improve important functional characteristics. These functional parameters include five categories based upon the stream functions pyramid identified by Harman et al. (2012) which is composed of hydrology, hydraulics, geomorphology, physiochemical, and biology. The Science Paper establishes a mechanism for developing performance measures that can help quantify functional lift or loss related to each of the categories. The creation of standardized performance measures would benefit practitioners by providing clarity on how to demonstrate functional improvements and how credits and debits are determined in relation to stream mitigation. General SOPs could identify these standard measures and local districts could adapt them to meet unique local circumstances that might alter the importance of each category for determining functional lift. Likewise, these functions should be weighted based upon watershed needs and goals.

Credit Determination

The science of functional assessment continues to develop and methodologies that can link changes in function at the compensation site to credit determination are also under development (Guidelines Paper). Functional and condition assessment methodologies are currently applied in several districts (Practice Paper) and new methodologies are under development (ASWM 2014).

The incorporation of functional assessment methodologies in credit determination could help establish standardized mechanisms to consistently assess and credit functional lift associated with various mitigation approaches and techniques. Guidelines at the district level could require a clear link between mitigation approaches and/or techniques with identified function-based parameters, including floodplain connectivity, lateral stability, riparian vegetation, and bed form diversity, which are the major drivers of functional lift. There are numerous assessment methods throughout the country that capture some or all of these parameters (Harman *et. al* 2012, Starr *et al.* 2015). This could help apply credits to activities (such as creation of riffle-pools, bank stabilization, floodplain excavation, and tree planting) that yield quantitative changes to function-based parameters, and reduce reliance on the previous categories of dimension, pattern and profile, as these categories do not adequately capture how activities contribute to functional improvement. This level of guidance would maintain flexibility at the watershed and project level.

Currently, credit determination varies by district, but few stream mitigation SOPs provide detailed guidance on credit determination (Policy Paper). In many instances where no guidance is provided, credits are determined based upon a linear-foot basis rather than functional parameters (Policy Paper). Some SOPs provide credit tables that identify mitigation methods associated with different credit ratios based upon the mitigation method type (i.e. restoration, preservation, etc.). Relatively few SOPs attempt to link functional lift to the amount of credits generated, and where they do, they generally do not incorporate specific methods. Wyoming's SOP instructs applicants to use an assessment method to calculate anticipated benefit, but it does not specify a particular method, instead suggesting multiple potential assessment methods.

Other states, such as Pennsylvania, have developed specific protocols for function based aquatic compensation as recently as 2014. They identify four main function groups: hydraulic, biogeochemical, habitat, and recreation or resource support. They develop a table with associated functional parameters for each group that can help practitioners understand credit determination in relation to improvement in the functional parameters. This determination is based upon an evaluation of the project effect, with specific metrics that identify minimal or limited effect ranging from moderate to severe. These guidelines also have provisions for determining the appropriate category for aquatic resource value, ranging from minimal and support resources to special and significant resources that maintain valuable functions for the ecosystem. These categories allow for benefit adjustment if projects are within waters of exceptional value, such as those with threatened or endangered species. In this way, Pennsylvania allows for functional lift for projects that not only include restoration and stream manipulation, but also projects that maintain resource value and quality through preservation.

Developing credit determination methods that link mitigation activities to changes in function-based parameters to create credits is critical. To accomplish this linkage, it is recommended that IRT's move beyond attaching credits to changes in dimension, pattern, and profile. An ideal change would be linking the credits to changes in floodplain connectivity, bed form diversity, lateral stability, and riparian vegetation at a minimum. Additional parameters should be added based on landscape settings and restoration potential. For example, stream projects in regions with bottomland hardwood forests might require large woody debris; streams in alluvial valleys might require sinuosity; and urban projects might require runoff and nutrients associated with best management practices installed in conjunction with a stream restoration project.

Finally, specific performance measures are used to evaluate the identified aquatic functions of importance for the project site and watershed. Monitoring and evaluation should ensure that the identified objectives are met through the approaches and techniques of the project. If this is not the case, it might be necessary to adapt the approach and/or techniques to ensure that mitigation is implemented with the best available science. This component of the plan is of particular importance due to the limited success of restoration and enhancement to adequately mimic natural systems.

b) Project Success should be Tied to Functional Improvement

As discussed above, where appropriate functional or condition assessment methods are available and practicable, they can be used to determine how much compensatory mitigation is required (33 § C.F.R. 332.3(f)(1)) and how many credits are generated at a mitigation site. However, as discussed above, states and Districts still rarely employ functional assessment methods for credit determination, primarily because few have been developed and they are likely to vary by geographic region.

As stated in the Preamble to the final Rule, "With this rule, we are moving towards greater reliance on functional and condition assessments to quantify credits and debits, instead of surrogates such as acres and linear feet. We believe that more frequent use of such assessment methods will help improve the quality of aquatic resources in the United States." (FR Vol 73, 19601). Although stream functional assessment methodologies are still relatively rare, there are a number of assessment methodologies that have been developed that are currently being applied to stream mitigation decision-making across the country.

c) Data Generated Should be Publically Available, Up to Date, and Used to Improve Mitigation Guidance

Data availability is key to continuously evaluating and improving stream compensatory mitigation programs. The Regulatory In lieu fee and Baking Information Tracking System (RIBITS) was developed by the Corps with support from the Environmental Protection Agency, the U.S. Fish and Wildlife Service, the Federal Highway Administration, and NOAA National Marine Fisheries Service to provide better information on mitigation and conservation banking, and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers sites, associated documents, mitigation credit availability, and service areas. This information is a critical component of evaluating how and if projects are meeting performance standards and project objectives, as well as the broader objectives of the 404 Regulatory Program. If the purpose of mitigation sites is to ensure the maintenance of system function in a watershed, then the only way to assess that is to have data broadly available from all the relevant sites (both areas of impact and where preservation or restoration has occurred). Without that information, monitoring the symptoms of system function alone (water quality and flow regime, for example) can't make any direct links to the changing conditions of impacted areas in the watershed.

The Rule requires that mitigation plans include baseline information (e.g., historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site(s) or the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation on the site (33 § C.F.R. 332.4(c)(5)). This information along with data gathered in required site monitoring can not only ensure that projects are meeting performance standards and project objectives, but can also help agencies to determine if mitigation techniques and evaluation measures are sufficient to ensure projects are successful and mitigation programs are meeting no net loss of aquatic resource area and function.

d) Mitigation Programs Should be Regularly Evaluated to Address Gaps and Shortcomings

The implementation and reformation of stream compensation methods will be inadequate without proper and stringent evaluation. The Rule includes little guidance on program evaluation. In-lieu fee programs are required to include in the compensation-planning framework "A strategy for periodic evaluation and reporting on the progress of the program in achieving the goals and objectives in paragraph (c)(2)(v) of this section, including a process for revising the planning framework as necessary." (33 § C.R.F. 332.8(c)(2)(x)). The district engineer may audit the records pertaining to the program account. All books, accounts, reports, files, and other records relating to the in-lieu fee program account shall be available at reasonable times for inspection and audit by the district engineer. However, the Rule says little about evaluating or auditing other types of compensatory mitigation.

The execution of random audits of mitigation projects (including permittee responsible, bank, and ILF projects) and programs could encourage continual improvement within the mitigation community and allow the Corps to be more successful at evaluating whether the mitigation program is achieving national goals. Although mitigation banks and ILF program have generally faced more frequent oversight by the Corps, evaluation at the project level has been historically lacking (GAO, 2005). Ultimately, districts must do a better job at assessing whether or not projects are meeting ecological standards and resulting in any watershed level changes.

There has been no consistent approach, methodology or effort at the national scale to assess the performance of mitigation, nor have essential study elements been described for comparing the three mitigation mechanisms. ELI convened a panel of expert wetland scientists to develop a study design to assess the regulatory and ecological outcomes of the three compensatory mitigation mechanisms—mitigation banking, in-lieu fee mitigation, and permittee-responsible mitigation—in a manner that will enable comparisons of the three mechanisms nationwide. This methodology could provide the basis for continued evaluation of stream compensation projects (Fennesy *et al.*).

e) Programs Should be Adaptive

Corps districts generally recognize the importance of adaptive management for stream projects and incorporate it into compensation requirements, but they tend to do so in one of two different ways. First, several districts, including Galveston, Little Rock, Los Angeles, Mobile, Norfolk, and Wilmington, require some minimum adaptive management discussion in the mitigation plan. This may be brief and simple, recognizing that the problems that require adaptation often are unforeseeable, but adaptive management must be at least considered in the plan from the outset (Guidelines Paper). Adaptive management discussions tend to describe a process for forming an adaptive management plan if the need arose later (Practice Paper). Alternatively, a few districts — Fort Worth, New England, and Omaha — require adaptive management if and when a project encounters difficulty, rather than up front in the mitigation plan. The discrepancy is in whether or not adaptive management is addressed up front and there is no regional reason for why these approaches are different. Ultimately, future deliberations need to consider homogenizing approaches (where suitable) across districts so that the most efficient and scientifically informed practices are being utilized.

In order for projects to be truly adaptive, the districts should require provisions in their Adaptive Management Plan for procedures that allow for the modification of performance standards. This is often necessary if mitigation projects are meeting mitigation goals, but in unanticipated ways. For example, the Detroit District includes the following provision: "Corrective actions may be required if a mitigation site is not fully successful. Describe procedures to allow for modifications of performance standards if the mitigation project has unanticipated changes or time limits cannot be met" (p. 24). While credit release is clearly contingent upon meeting performance measures, there is no guarantee that projects will succeed and that credits will be released. There is a great deal of uncertainty and risk associated with mitigation projects, and the 2001 NRC and 2005 GAO reports clarified the large gap in meeting the goal of compensatory mitigation. For this reason, it is critical not only for the regulatory agencies, but also for the practitioners to ensure the program will continue to improve and meet the goals of the Clean Water Act. Documentation of challenges through monitoring and implementation of remedial action through adaptive management is the best opportunity to improve the science of stream restoration.

f) Financial Assurances and Long-Term Management

Financial assurances and long-term management are two separate financial components of a mitigation plan, yet both are critical to ensure that projects are implemented and stewardship is maintained beyond the life of the project. Financial assurances not only help ensure that a project is completed, but also provide resources to correct or replace an unsuccessful project. They are an important mechanism to address elements of scientific or natural uncertainty and financial risk in regard to every mitigation project. Long-term management usually is initiated when all performance measures are met or credits released. Long-term management funds are expected to finance long-term management and monitoring of the mitigation property in perpetuity. These funds should help plan for contingencies and adaptive management. Interagency Review Teams can encourage or require buffering mechanisms that delay the spending of funds from these accounts to allow time for the funds to mature. Finally, it is essential to ensure that funds are legally restricted to the purposes and property for which they were created. It is important for clear communication of expectations for the type and amount of financial assurances and long-term management between project managers and regulatory review.

The goal of compensatory mitigation is to offset impacts to aquatic resources from permitted activities under the Clean Water Act 404 Regulatory Program. The purpose of each component of mitigation identified in this chapter is to better ensure that off-site mitigation projects are in fact restoring the necessary functions to offset permitted impacts. So, in conclusion, districts should consider the following as they continue in the future:

- Site selection should not occur in an ad hoc or opportunistic fashion. The identification of sites should be reflective of science-based reasoning about site potential given the watershed characteristics. Site selection also needs to be clearly linked to restoration potential and functional improvement.
- Districts, states, and other organizations should put substantial effort towards developing guidance on the watershed approach using available watershed plans or other suites of information (e.g., aquatic habitat conservation plans, etc.).
- In the absence of watershed plans, districts should provide criteria by which to evaluate site potential within the watershed context.
- In order for project success or failure to be objectively evaluated, each stream compensation project should state clear and measurable goals and objectives that reflect the restoration potential of the site and the watershed context.
- Project-level goals and objectives should be clearly linked to the watershed goals and objectives.
- We recommend project proponents detail two levels of goals in their mitigation plans: programmatic and project or design goals. The ecological goals should identify some linkage to the programmatic goals.
- Each project should include a list of objectives for each goal. Objectives are more tangible than goals and explain how the goals will be achieved. It is preferable for the objectives to be quantifiable.
- Each project should also include a description of the restoration potential to accompany the goals and objectives. This helps ensure that credit determination is appropriate given the watershed limitations and site potential.
- Districts, states, and other organizations should put substantial effort towards developing guidance on the watershed approach using available watershed plans or other suites of information (e.g., aquatic habitat conservation plans, etc.).
- It is important that districts clarify how a selected project will contribute to the goals and needs of the watershed based upon specific functional parameters and associated performance measures of the larger watershed.
- The creation of standardized performance measures would benefit practitioners by providing clarity on how to demonstrate functional improvements and how credits and debits are determined in relation to stream mitigation. General SOPs could identify these standard measures and local districts could adapt them to meet unique local circumstances that might alter the importance of each category for determining functional lift. Likewise, these functions should be weighted based upon watershed needs and goals.
- Developing credit determination methods that link mitigation activities to changes in function-based parameters to create credits is critical. To accomplish this linkage, it is

recommended that IRT's move beyond attaching credits to changes in dimension, pattern, and profile.

- Monitoring and evaluation should ensure that the identified performance measures are met through the approaches and techniques of the project. If this is not the case, it might be necessary to adapt the approach, techniques, and/or performance measures to ensure that mitigation is implemented with the best available science.
- Monitoring reports should identify challenges and remedial action taken to address those challenges. This is critical to improving stream restoration science and ecological performance.
- Monitoring reports should require information about how project-level improvements tie back into watershed plans and how expectations and limitations during the site selection phase may have changed throughout implementation.
- Monitoring reports should be required at regular intervals with a consistent process for documentation. This would go a long way to address issues of staff turnover, and allow for improved evaluation of program success.
- Programs should be adaptive and districts should include provisions for modifying performance standards when unanticipated changes occur.
- Mitigation data should be publically available and used to improve mitigation guidance while existing data should be made more accessible and easier to utilize.
- The execution of random audits of mitigation projects (including permittee responsible, bank, and ILF projects) and programs could encourage continual improvement within the mitigation community and allow the Corps to be more successful at evaluating whether the mitigation program is achieving national goals.

CONCLUSION

Although some of the gaps identified here will clearly require years of scientific data to address, many of the issues can be addressed within district SOPs or through Regulatory Guidance Letters (RGLs). As noted in the Practice Paper, many of the districts have yet to update their SOPs to bring guidance up to date with the 2008 Rule. If districts want to increase compensatory mitigation effectiveness, durability, transparency, and consistency the SOPs need to provide clarification on key items discussed in these recommendations. While some variation is expected between districts given the difference in aquatic resources across the nation, Corps and EPA headquarters should assist districts in developing standard language for the gaps highlighted in this paper so mitigation is applied more consistently across the nation.

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