

Compensatory Mitigation Performance: The State of the Science

Evaluating the ecological and administrative performance of compensatory mitigation programs under §404 of the Clean Water Act is essential to ensuring that wetland functions are restored and protected. In this review of studies done in the last 15 years, trends show an overall decline in evaluations. The authors propose a process for stakeholders to develop a long-term approach to evaluating compensation performance.

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It has been nearly 15 years since the National Research Council (NRC) took a hard look at the effectiveness of compensatory mitigation in the Clean Water Act §404 program. A review of studies published since that time highlights the state of the science of compensation performance evaluation, indicating key trends and identifying critical knowledge gaps in our understanding of the factors that influence the effectiveness of compensatory mitigation. The authors also envision how a long-term approach to evaluating compensation performance might be designed and implemented at a state or regional scale.

BACKGROUND

Compensatory mitigation is defined as offsetting unavoidable impacts to wetlands, streams, and other aquatic resources via restoration, establishment, enhancement, and/or preservation. The U.S. Army Corps of Engineers (the Corps) and U.S. Environmental Protection Agency (EPA) have made it an important component of the Clean Water Act (CWA) §404 permitting program since the program's inception in the 1970s (LaRoe 1986). Permittees can satisfy compensatory mitigation requirements through a third party by purchasing credits from an approved mitigation bank or in-lieu fee program, or by completing a permittee-responsible mitigation project.

In 1999, EPA requested from the NRC a comprehensive examination of compensatory mitigation policy and science, following numerous state and federal studies published in the 1980s and 1990s (largely focused on permittee-responsible mitigation) that suggested that compensation projects often failed or were not even attempted. This NRC study, published in 2001, suggested that although losses of wetland acreage were theoretically being replaced via compensatory mitigation, a number of factors including poor site selection and planning, noncompliance with permit condi-

tions, and a lack of adequate performance standards were contributing to the failure of compensatory mitigation to effectively offset authorized wetland losses (NRC 2001). In 2005, the U.S. Government Accountability Office (GAO) evaluated the Corps' oversight of compensatory mitigation, finding that insufficient monitoring requirements and compliance checks were leading to inadequate administration of compensatory mitigation requirements (GAO 2005).

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To perform successfully, compensation programs must both ensure compliance with permit conditions and result in ecologically effective replacement of lost aquatic resource functions; Rebecca Kihlslinger (2008) defined these concepts as **administrative performance** and **ecological performance**, respectively. Numerous governmental and academic organizations have investigated the administrative and ecological performance of wetlands compensation programs, and recommendations from these studies have been used to refine policy and improve performance standards in the interest of creating effective and sustainable wetland compensation. Kihlslinger reviewed studies published between 1999 and 2007 to infer broad trends in the success of wetland compensation, finding issues continued to plague compensation programs: moni-

toring and long-term management requirements were often unmet by permittees, while inadequate performance standards led to poor compensation sites being deemed successful.

In 2008, the Corps and EPA jointly issued regulations revising and clarifying standards for compensatory mitigation projects and specifically implementing the recommendations of the NRC (2001). Among other clarifications, the 2008 Mitigation Rule:

- Established equivalent standards and criteria to be applied to all compensation projects—mitigation banks, in-lieu fee projects, as well as permittee-responsible mitigation;
- Emphasized a watershed approach for selecting appropriate compensation project locations, designs, and goals;
- Required assurance of long-term protection and management of compensation sites; and
- Established a preference for credits purchased from mitigation banks and in-lieu fee programs (over use of permittee-responsible compensation) to offset permitted impacts since they typically consolidate compensatory mitigation projects where ecologically appropriate, use a watershed approach to site selection and design, provide a greater level of financial planning and scientific expertise, reduce temporal losses of functions, and reduce uncertainty over project success.

A primary goal of the 2008 Mitigation Rule is ensuring that compensation projects provide effective and sustainable offsets for permitted impacts. In this article, we direct a meta-analytical eye to recent studies of compensation performance, with a specific focus on the temporal and geographic trends emerging from studies of compensation performance, the potential drivers of these trends, and the apparent gaps in our understanding of the factors that shape compensation performance. One of the key findings of this study is that there is a troubling lack of continuity and comparability in the literature on compensation performance. We devote the last portion of this article to envisioning how

a long-term approach to evaluating administrative and ecological compensation performance might be designed and implemented at a state or regional scale.

METHODS

Criteria for Selection

In this review, we were exclusively interested in studies that evaluated either administrative performance, ecological performance, or both. Nomenclature varies from study to study, so we developed four criteria for inclusion in this review:

- Studies must be a peer-reviewed research article or a government-issued report, and be quantitative in nature, with a defined geographic extent. This excludes editorial and opinion articles and limits the studies reviewed to those with sufficient scientific rigor.
- Studies must have been published since 2000. In addition to predating the major changes in compensation policy in the late 1990s and the emergence of rules for mitigation banks and in-lieu fee programs, all studies published prior to 2000 are assumed to have been taken into consideration in the 2001 NRC Report.
- Studies must specifically evaluate compensation performance, either administrative or ecological. Studies that investigate the ecological processes of restored or created wetlands via in-depth and/or manipulative experimentation do provide immediate regulatory value by increasing the depth and breadth of scientific knowledge available to guide performance standards and permitting decisions. They do not, however, specifically evaluate the performance of compensatory mitigation programs and thus are excluded for the purposes of this review.
- Studies must include multiple compensation sites—case studies are not considered to have the statistical rigor required to evaluate the performance of compensation programs.

Data Collection

The data that were collected from each study that met the above criteria are summarized in Table 1. Study areas were

Data Type	Data Collected
Temporal	Publication year, construction years of oldest and youngest sites (if available)
Source	Primary author and funding type (federal, state, or other/academic)
Geographic	Study area boundaries (as determined from study)
Aquatic Resource	Wetlands, streams, or other. Specific type of wetlands (if applicable)
Compensation Mechanisms	Mitigation bank, in-lieu fee, permittee-responsible (can be more than one)
Study Goals	Compliance rate (Y/N), area loss/gain (Y/N)
Study Methods	File review (Y/N and number of files), site visits (Y/N and number of sites)
Field Methods	Reference (i.e., non-mitigation) sites (Y/N and number of reference sites), vegetation, hydrology, soils, water quality, surrounding land use, wildlife/habitat

Table 1. Data collected from each compensation performance study, by data type.

typically defined by administrative boundaries such as state or county borders. A few studies were designed around watershed boundaries, and many were based on boundaries of environmental management areas such as water management districts or national estuary programs. When studies were designed around a specific wetland type within an administrative boundary, the boundaries were determined as the intersection of the known geographic distribution of that wetland type with the administrative boundary. To get a sense of how these studies were financed, funding source was determined as available from the information in the study acknowledgements. As stated previously, study goals were diverse and, as such, were difficult to classify into categories—we hence classified studies that measured compliance rates as “compliance”-type studies, and studies that measured a net gain or loss of wetland acreage as “area loss/gain”-type studies. “Compliance”-type studies generally spoke to aspects of administrative performance, while “area loss/gain”-type studies could speak to either administrative, ecological, or both types of performance, depending on the methods used. Studies could have both types of goals or neither type.

RESULTS AND DISCUSSION

Temporal Trends, Authors, and Funding

Forty studies investigating compensation performance were found to meet the criteria defined above; they are summarized by publication year and author type in Figure 1. Compensation project age data was not accessible for all studies, but of the 38 studies with project age data, only three included sites constructed in the years following the 2008 Mitigation Rule.

No studies made any sort of comparison between sites constructed before and after the 2008 Rule, highlighting a serious need to evaluate if and how the 2008 Mitigation Rule has affected the administrative and ecological performance of compensatory mitigation programs.

Author and funding data suggest that state governments and federal funding are major drivers of studies on compensation performance. State governments seem to be the major generators of these studies, with state government employees

contributing to 24 studies. Federal employees contributed to an additional six studies, making a full 75% of studies with some contribution from governmental authors, but funding data suggest that federal funding, EPA funding in particular, also plays an important role in supporting studies of compensation performance. Two-thirds of all state government-authored studies on compensation performance were funded through EPA Wetland Program Development Grants (WPDG) (EPA 2015), suggesting that this funding mechanism represents an important stimulus for research and assessment.

Publication trends suggest federal reports may also have a stimulating effect on studies of compensation performance. Following NRC (2001), 18 studies of compensation performance were published in 2001–2004, with eight studies published in 2003, the most of any year since 2000. There appears to be a smaller spike in studies evaluating compensation performance following GAO (2005). Contrastingly, the frequency of compensation performance studies has remained low in years following the 2008 Mitigation Rule. Low frequency of government-authored studies is responsible for this trend, something attributable to a variety of factors including the 2008 financial downturn and subsequent reductions in state and federal budgets and workforce. In discussions with the Association of State Wetland Managers (ASWM), state staff noted that employee time constraints were a major limitation on the frequency of evaluations. Funding through EPA WPDG remains widely available to states wishing to evaluate their compensation programs, but eligible state universities may be an important means

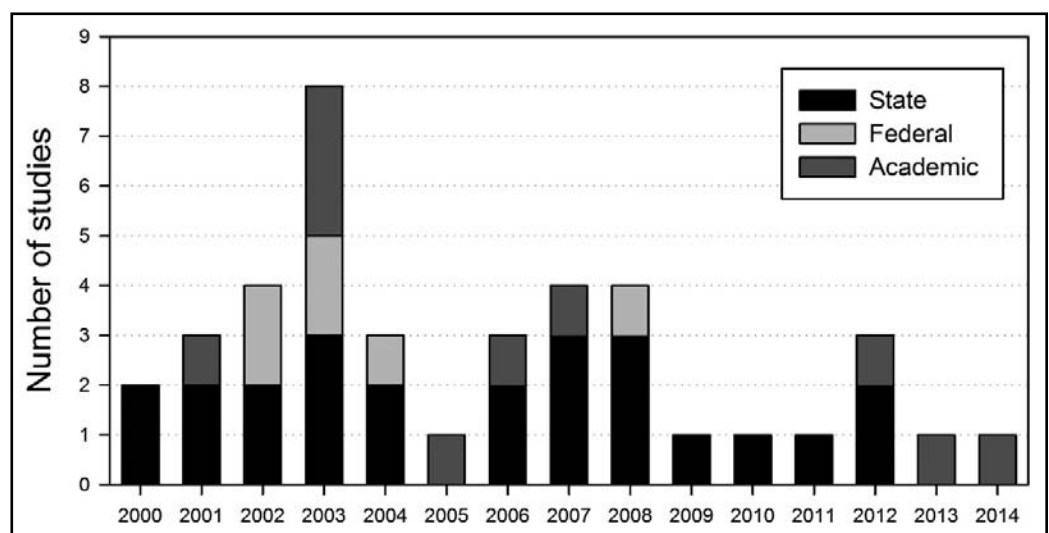


Figure 1. Studies evaluating compensation performance by year and author type (state government, federal government, or academic).

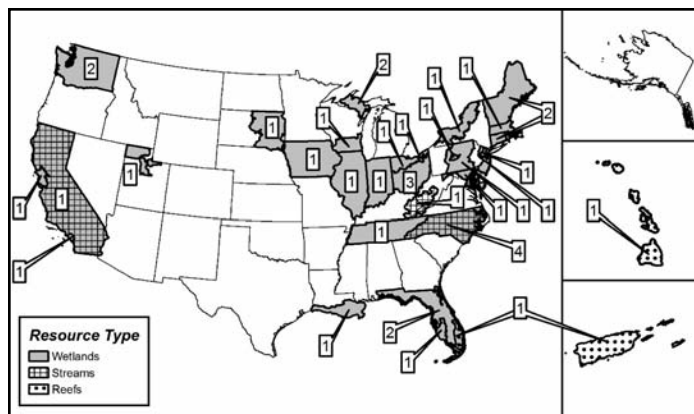


Figure 2. Studies evaluating compensation performance by study area and aquatic resource type (wetlands, streams, and/or reefs).

of supplementing state agency staff with support (universities that are agencies of a state government, i.e., chartered as part of a state government, are eligible to apply for Regional WPDG).

Geographic Trends and Resource Types

Study area and resource type data are summarized in Figure 2. Studies are heavily concentrated in the eastern part of the United States. Florida, North Carolina, and Ohio—states with very active wetlands programs—accounted for over 25% of all studies. There are several states with less active wetlands programs that have not evaluated compensation performance, but certain geographic regions appear highly underrepresented, especially areas in the Upper Midwest and Southeast that have exhibited high rates of compensation since the 2001 NRC Report.

Studies are primarily focused on wetlands—35 of 40 investigated wetlands of any type. Most are broadly focused on wetlands, but a few focused on wetland types thought to be particularly sensitive and difficult to compensate for, such as coastal and mangrove wetlands, vernal pools, and prairie potholes. Wetlands remain a dominant resource for which compensation is required, so it is appropriate that wetland compensation is well-studied.

There has been a large increase in the number of stream mitigation banks and stream-related in-lieu fee projects approved over the last 15 years (RIBITS 2015). Since the 2008 Mitigation Rule, there was an increased interest in evaluating stream compensation performance. Still, only six of 40 studies examined stream-compensation performance, four of which were conducted in the same state (North Carolina). The 2008 Mitigation Rule makes specific note of the necessity of in-kind compensation for streams and their functions—it is essential to evaluate the ecological perfor-

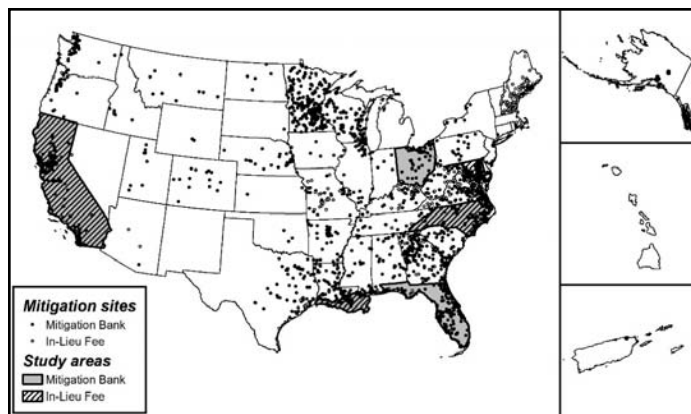


Figure 3. Mitigation bank and in-lieu fee program sites, and studies evaluating mitigation bank and in-lieu fee program performance by study area.

mance of stream-compensation sites with the level of rigor applied to wetland sites. As stream compensation becomes prevalent in the Southeast, Ozarks, and Northwest, evaluations of stream compensation performance should keep pace to ensure that compensation projects effectively and sustainably fulfill their intended purposes.

Compensation Mechanism and Method

Figure 3 shows the nine studies that evaluated the performance of mitigation banks and/or in-lieu fee sites; the other 31 studies exclusively focused on permittee-responsible mitigation, often purposely excluding mitigation bank and in-lieu fee program sites. All but one of the nine studies evaluating mitigation bank or in-lieu fee site performance were conducted by state governments (California, Florida, Louisiana, Maryland, North Carolina, and Ohio), and all but two were funded via WPDG. Only one state (North Carolina) evaluated stream compensation performed by mitigation banks and an in-lieu fee program. The 2008 Mitigation Rule made mitigation banks the preferred compensation mechanism in the §404 program. Of the three compensation mechanisms, only mitigation banks require that the mitigation site be secured, the restoration plan approved, and necessary financial assurances provided before the site can be used for any compensation purposes, and all credit releases are tied to demonstrated achievement of project milestones or ecological performance standards. This makes mitigation banks the least risky form of compensation, at least in terms of administrative performance. However, for all compensation mechanisms, including banks, it is important to periodically investigate whether the performance standards used are resulting in the desired long-term ecological outcomes. Since the 2008 Mitigation Rule,

increased attention has been directed towards mitigation banks and their performance standards, but the long-term outcomes of each mitigation mechanism can be difficult to interpret when they are investigated in isolation rather than compared to each other.

Studies primarily focused on aquatic resource restoration and establishment projects—34 and 33 studies, respectively—and frequently excluded enhancement and preservation sites from consideration. Fifteen studies examined enhancement projects, and 12 examined preservation projects. Restoration and establishment projects are the most common forms of compensation, and are often prioritized because they generally result in replacement of both aquatic resource area and function. Nevertheless, it is important to investigate the ecological and administrative effectiveness of enhancement and preservation projects.

Study Goals

Studies measuring permittee compliance rates, of which there were 17, became much less common following the 2008 Mitigation Rule. Only three studies have measured compliance rates since 2008 (25% of total studies since 2008), compared to 14 studies measuring compliance from 2000-2008 (50% of total studies 2000-2008). Compliance remains of interest to all agencies involved in compensatory mitigation and needs to remain a focus of investigation, but interest has shifted to also include ecological performance as the challenges associated with stream and wetland restoration are further elucidated and focus on ecological function becomes more prevalent in both science and policy.

Comparing the areas (or linear lengths in the case of stream compensation) of impacted and compensated wetlands within a specified geographic area is a common approach to evaluating whether a mitigation program is resulting in a net loss or gain of aquatic resource area and is used in 18 different studies (e.g., Robb 2001; Porej 2003; Kettlewell et al. 2008; and Hill et al. 2012). There is a significant amount of overlap between the studies measuring compliance rates and those comparing impacted and compensated areas (11 studies), but they appear to be well-dispersed over the years since 2000. The “area loss/gain” approach to evaluating compensatory mitigation reflects the priorities of state wetland programs during this time period—to inventory all mitigation sites and

evaluate compliance rates. These studies utilize similar ways of measuring performance (% compliant, net gain/loss), which allows for temporal and geographic trends to be drawn, such as in NRC (2001) and Kihlsinger (2008).

However, as the authors above pointed out, merely comparing the areas of impacted and compensated aquatic resources may provide misleading information on whether the functions of these ecosystems are being adequately compensated for.

We found 16 studies that neither measured compliance rates nor compared impacted and compensated areas. These were

often highly detailed field studies, with 20 or fewer sites, interested in assessing specific biological functions (Penrose 2006; VanDeWalle et al. 2008), examining ecological processes over long time horizons (Spieles 2005; Shafer & Roberts 2008), or developing assessment tools (Hatfield et al. 2004; Wilcox 2009). These studies reflect an increased emphasis on the ecological performance of compensatory mitigation rather than administrative performance, but the disparate methods and approaches used by these studies make it difficult to infer geographic or temporal trends in ecological performance.

One aspect of compensation performance evaluation rarely included in the studies reviewed was the evaluation of trends in performance over time. Few states have conducted more than one study (Figure 2), and those evaluations that have been performed tend to lack the methodological similarity to allow comparison. Two exceptions are the states of North Carolina and Ohio; although their numerous studies have utilized varying methods, they have been able to draw some limited conclusions about changes in administrative and ecological performance over time. The Great Lakes Evaluation of Compensation Sites study in Ohio (PGE & MBI 2012) found a 200% increase in the proportion of mitigation bank sites meeting vegetative performance standards compared to a study seven years previous (Mack & Micacchion 2006), concurrent with a roughly 30% decrease in success rate of permittee-responsible mitigation sites.

Study Methods

File review is a common component of compensation studies, found in 38 of 40 studies reviewed. Nine studies relied purely on file review without any field assessment of mitigation sites. Mitigation plans and monitoring reports are

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an increasingly information-dense resource and can be obtained from the Corps district offices or through state §401 permitting agencies, or via online repositories for these documents such as the Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS) (USACE 2015). The information regarding compensation and impact areas included in mitigation plans and permits is well-suited to evaluating aquatic resource area loss or gain, and monitoring reports can often be used to assess compliance. Monitoring reports can also be a valuable resource for academic authors for whom more polished documentation of program performance may be elusive; Margaret Palmer and Kelly Hondula (2014) analyzed monitoring reports from stream mitigation projects in the coal fields of southern Appalachia, finding that water quality and biological condition at many of these sites were poor and showed no sign of improvement over the monitoring period.

Field visits were also a common component of studies of compensation performance, and took place in 31 of the studies reviewed. The number of mitigation sites analyzed was highly variable, ranging from four to 204, with a mean of 41 sites. Studies involving a large number of field sites often utilized rapid-assessment methods for single-site visits, while others opted for fewer sites in favor of more detailed assessments or longer monitoring periods. Field methods tended to focus on wetland indicators—vegetation (28 studies), hydrology (19), and soils (15). Thirteen studies evaluated fauna or wildlife habitat. Other possible contributors to compensation performance were not measured as often—surrounding land use was evaluated in 10 studies and water quality was only evaluated in five studies.

Only 10 studies measured the same variables at non-mitigation wetland sites, either in a paired study design or in a different wetlands assessment. Reference sites can be an important tool in assessing ecological performance (Brinson & Rheinhardt 1996; Moorhead 2013), but present their own challenges. Some think it is unrealistic to expect restored systems to perform exactly like pristine or unimpaired wetlands, but comparison to reference conditions can establish whether compensation sites are on a positive ecological trajectory. Different reference sites and/or baseline conditions make it difficult to compare results from different studies, whether they occur in different time periods or geographic areas.

STUDY HIGHLIGHTS

This study highlights a number of knowledge gaps and weaknesses in the current assessment and evaluation of compensation performance:

- Published compensation performance evaluations have decreased in frequency, particularly since the 2008 Mitigation Rule, likely due in part to the 2008 financial downturn and subsequent reductions in state and federal budgets and workforce.
- Some states have conducted several assessments of their compensation programs since 2000, while large geographic areas have seen no assessment whatsoever.
- Stream compensation has increased in volume over the past 15 years, but assessments of stream compensation performance have not kept pace.
- In states where compensation performance has already been evaluated, there is a need to evaluate how the provisions of the 2008 Mitigation Rule are affecting the ecological performance of all three compensation mechanisms, especially as the volume of compensation conducted by mitigation banks and in-lieu fee programs continues to increase.
- An increased emphasis on aquatic resource function has led to a shift away from studies focusing entirely on compliance and loss or gain of wetland area, but a lack of standardized methods makes comparing these studies across time and space difficult.

DEVELOPING A PROGRAMMATIC APPROACH TO COMPENSATION PERFORMANCE

We believe that many of the problems highlighted above stem from the lack of a long-term vision for compensation performance. As mentioned previously, aquatic resource compensation programs must be built on a strong scientific foundation, and should be supported through continuous investigation and application of the principles of restoration ecology. Resources such as ASWM's "Improving Wetland Restoration" webinar series (Stelk et al. in preparation) represent an important tool in disseminating scientific knowledge and provide a forum for regulators and scientists to discuss the challenges and lessons of administering ecologically successful compensation programs.

We believe that compensation programs should take this long-term approach to evaluating and improving their ecological and administrative performance as well. This could be addressed using a programmatic approach, which would be customizable to state needs, sustainable over very long time horizons, and allow for interpretation of national trends. Key steps of such an approach include:

- Adopt an appropriate study design.
- Organize compensatory mitigation project files in a geospatial database.
- Conduct baseline evaluation and subsequent evaluations using the study design at regular intervals (e.g., every five to 10 years).

Adopt an Appropriate Study Design

Developing an appropriate study design that is tailored to address individual state needs while also allowing for compar-

ison with findings from other states and continued improvement of national policy is a challenging yet crucial step. The Environmental Law Institute (ELI) convened a panel of wetland scientists to develop a study design to assess and compare the ecological outcomes of the three compensatory mitigation mechanisms using an approach that enables ongoing and replicable assessments (ELI 2013). While this effort was focused on development of a national study design and focused exclusively on wetland compensation projects, it has a number of important implications for states developing a study design to address wetland, stream, and other aquatic resource compensation projects.

The national study design (ELI 2013) recognizes that relevant ecological data on impact sites may not be available, so evaluations of losses at impact sites and gains at mitigation sites may not always be possible. It also recognizes that relevant baseline ecological data is often not available for compensation sites. These considerations affected the approach to the study design and lead study design authors to frame a methodology that addressed the following questions:

- How does the ecological condition of compensation sites compare to the least-disturbed reference condition?
- How does the condition of compensation sites compare to the ambient condition of a population of non-compensation wetlands or other aquatic resources (ambient condition represents wetlands, or other aquatic resources, across the full range of human disturbance, i.e., from most-disturbed to least-disturbed)?
- Does the condition of compensation sites differ as a function of the three compensation mechanisms (mitigation banks, in-lieu fee programs, permittee-responsible mitigation)?
- Does the condition of compensation sites differ as a function of the four compensation methods (restoration, establishment, enhancement, preservation)?

These questions do not address administrative performance, and states would thus need to supplement any study design with additional questions to evaluate regulatory compliance; however, the data collection entailed in addressing the four questions above would easily facilitate answering a number of questions relevant to administrative performance.

The national study design (ELI 2013) leverages a number of key facets that are common to both the National Wetland Condition Assessment (NWCA) and the National Rivers and Streams Assessment (NRSA) (EPA 2015) and could be useful to states developing a compensation study design; these include:

- **Generalized Random Tessellation Stratified (GRTS) Survey Design:** Both the NWCA and the NRSA identify sample points using the GRTS survey design for an aerial resource

developed by EPA's Environmental Monitoring and Assessment Program (Stevens & Olsen 1999; 2004). GRTS provides a geospatially balanced (based on the location of existing sites) probability sample of a target population. This method has been widely employed in surveys of aquatic sites. The power of this survey design is that it can be used to produce an unbiased estimate of the performance (with known probability and error rates) of an aquatic resource over large geographic areas, despite the relatively small number of samples collected. In the context of a compensation evaluation, this sampling design allows results to be reported as estimates of the proportion by area by a compensation mechanism that meets desired ecological outcomes with a known level of confidence. For example, results could identify what proportion of compensation at mitigation banks or permittee-responsible mitigation was in the category of good, fair, or poor. GRTS requires a large sample size though, and may not be appropriate for study areas with few compensation sites.

- **Field Operations Manual:** Once sites have been identified for sampling, field operations manuals from the NWCA and the NRSA, which include protocols for evaluating wetland and stream condition, respectively, could be utilized. For example, the NWCA manual includes protocols to evaluate vegetation, soils, and hydrologic stressors at sample sites. States may have more robust, regionally tailored wetland or stream sampling and assessment protocols that should be used to supplement or replace the NWCA/NRSA protocols.
- **Reference Network:** A network of reference sites that represent the full range of human disturbance, i.e., from most-disturbed to least-disturbed, is a valuable tool to help support analysis of the results of a compensation study. To date, the NWCA has sampled approximately 1,000 wetland sites and the NRSA has sampled over 3,000 river and stream sites that span a wide range of aquatic resource condition. NWCA and NRSA ambient assessments can provide context to interpret findings of compensation assessments, providing a basis of comparison across regions and states.

The national study design (ELI 2013) also identifies relevant information that should be reviewed from the files for each of the compensation projects selected for sampling. These include the compensation mechanism, compensation method, permit, mitigation plan, performance standards, and any monitoring reports. For mitigation banks, this would also include bank instruments and for in-lieu fee projects, it would include in-lieu fee program instruments and associated site-specific mitigation plans. Lastly, the national study design provides guidance on effective data analysis, compilation, and reporting to support answering the four study questions. Two pilot studies (PGE & MBI 2012 and Hill et al. 2013) were con-

ducted using the principles of the national study design in Ohio and North Carolina, respectively. These studies were able to investigate the relative performance of different compensation mechanisms and compare them across geographic regions, as well as draw some limited conclusions about temporal trends by comparing their results to pre-Mitigation Rule studies, suggesting that the study design represents a useful template that addresses some of the specific knowledge gaps highlighted above (Fennessy et al. in preparation).

Organize Compensatory Mitigation Project Files in a Geospatial Database

One of the major limitations on the number of compensation evaluations is the considerable resource expenditures associated with locating, compiling, sorting, and reviewing information and files regarding compensation projects in the study area. Organizing relevant information for each compensation project (see previous section) in a geospatial database dramatically reduces these expenditures for subsequent evaluations and is an important step in operationalizing a programmatic approach to compensation performance evaluation and could have the added benefit of providing a mechanism to link impact sites to their respective compensation sites. Not only is such a database an efficient way of managing compensation project information, it is necessary in order to utilize the GRTS survey design, which requires mapped polygons of each compensation site. Creating such a database should leverage existing data sources such as RIBITS, which currently includes information regarding over 1,400 approved mitigation bank sites and over 50 approved in-lieu fee programs (USACE 2015). Important considerations in developing the database include determining how many years of historical data will be included, how compensation project information going forward will be maintained, and whether any of the information in the database will be available to the public online.

Conduct Baseline Evaluation and Subsequent Evaluations Using the Study Design at Regular Intervals

Using the selected study design as described above, a sample can be drawn from the state's geospatial database of compensation sites. Using this sample, sites are selected and then file review, field evaluation, and data analysis are conducted for the selected sites. Based on the results of this baseline evaluation, adjustments and refinements can be made to the study design itself. In order to facili-

tate analysis of trends over time, additional evaluations should be conducted at regular intervals, e.g. every five to 10 years, using new samples drawn from the state's compensation site database. This kind of ongoing analysis provides important feedback on compensation performance that can be used to inform policy and regulatory changes, including improvements to compensatory mitigation project performance standards.

CONCLUSION

It is important to evaluate both administrative and ecological performance at compensation sites on a regular basis. Our review of evaluations of compensation performance published since 2000 finds that the frequency of these studies (particularly since issuance of the 2008 Mitigation Rule) is on the decline, large gaps exist in evaluation for certain geographic areas (e.g., Southeast, Midwest, Mountain West, Southwest, and Pacific Northwest) and resource types (most notably streams), and when evaluations are done, there is a lack of consistency among studies in how compensation performance is defined and assessed. We propose the development of a programmatic approach to compensation performance evaluation, which would be customizable to state needs, sustainable over very long time horizons, leverage preexisting national aquatic resource surveys, and allow for interpretation of temporal and geographic trends at larger scales than currently possible. EPA WPDG continue to be available to states wishing to better track and evaluate compensation, while partnering with academic institutions may help provide the logistical support needed to gather information and conduct field surveys. We look forward to working closely with states, the Corps, and other federal agencies to develop and refine a programmatic approach to compensation performance evaluation. ■

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