BANKING ON OFFSETS: A POLITICAL ECOLOGICAL AND ECO-GEOMORPHIC ANALYSIS OF SECTION 404 COMPENSATORY STREAM MITIGATION BANKING IN ILLINOIS AND MISSOURI

BY

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DISSERTATION

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ABSTRACT

No net loss goals play a major role in U.S. environmental policies. No net loss policies are championed as ways to simultaneously allow economic development and protect the environment. One such example is Section 404 of the U.S. Clean Water Act. Section 404 is administered by the U.S. Army Corps of Engineers ('the Corps') and the Environmental Protection Agency. Section 404 pertains to the dredging and filling of jurisdictional streams and wetlands nationally. Section 404 oversight is triggered when an applicant—such as a land or highway developer—proposes to fill or dredge a stream or wetland as a part of their development project. As a part of their project, the applicant must *mitigate* their overall impact by avoiding additional impacts, minimizing any impacts that occur, and compensating for their impacts by providing a commensurate amount of ecological function to a stream or wetland elsewhere. Since 2008, federal regulation prefers that compensatory mitigation for stream impacts is provided by a *stream mitigation bank*: a segment of stream or river that is enhanced, restored, or conserved to replace lost or damaged functions. Thus, rather than compensating sites on a project-by-project basis, federal guidelines prefer that compensation occurs prior to impacts on larger sites that can offset multiple impacts within the same watershed.

This dissertation examines the process through which the St. Louis Corps *commensurates* impacts and mitigation to streams in Illinois and Missouri. Commensuration, the comparison of different objects or qualities using a common metric, is fundamental to implementing no net loss policies. This is because the amount of compensation required to mitigate impacts is measured using district-defined measures of stream credits. A *stream credit* is an abstract unit of value that is supposed to represent the total function of a stream. Each Corps district is responsible for developing their own method and criteria for defining the criteria and value of stream credits.

These methods are called *stream mitigation methods*. Federal guidelines urge Corps districts design stream mitigation methods to assess stream impacts based on stream functions, rather than merely exchanging impacts and compensation using stream length or area (i.e. non-functional measures).

This dissertation contributes to three bodies of literature. First this dissertation contributes to practical studies of Section 404 compensatory mitigation by demonstrating significant hurdles to implementing in-kind compensatory stream mitigation banking nationwide. Second this dissertation contributes to the literature on stream and watershed management by demonstrating the applicability of the concept of stream naturalization to regulatory-based stream management. Third this dissertation contributes to the literature on the sociology of measurements and environmental compensation by testing theories of the constraints and drivers of measurement standardization. Using the framework of a sociology of translation, this dissertation shows that while methods are design with users in mind, the expectations of users is structured by a broader social context within which methods are created (i.e. the St. Louis Corps regulatory program).

The primary contribution of this dissertation is its explanation of how and why the St. Louis Corps implements no net loss goals by using non-functional metrics and non-functional commensuration systems. This dissertation shows the social factors that come into play to structure these outcomes. The result is that no net loss is achieved only numerically in Illinois and Missouri: while stream credits may balance, the actual functional conditions of streams remain uncompensated and unexamined. This dissertation is composed of four separate analyses. Each analysis provides additional insight into the logics and subsequent biophysical outcomes of Section 404 compensatory stream mitigation banking regulators and participants in Illinois and Missouri.

First, this dissertation explains the social dynamics involved in creating a standard method for assessing and evaluating stream function in Illinois and Missouri by Section 404 regulators and ecological experts. Previously unexplored, this contribution is achieved by analyzing the process by which the St. Louis Corps organizes and creates district-specific stream mitigation methods in Illinois and Missouri. The primary finding of this analysis is that the St. Louis Corps develops stream mitigation methods in Illinois and Missouri with the overall goal of ensuring that non-experts can use the methods rapidly. Thus, the Illinois and Missouri stream mitigation methods are not based on stream functions and therefore do not ensure no net loss of stream functions. Instead, the Illinois and Missouri stream mitigation methods are visual, activity, and physical-based assessments of impacts and mitigation.

Second, this dissertation follows a St. Louis Corps district regulator as he evaluates a Section 404 permit and assesses a proposed stream impact site using the Illinois stream mitigation method. Using participant observation, this analysis highlights the various comparisons that regulators make when commensurating stream impacts and potential stream mitigation. The primary finding of this section of the dissertation is that Corps regulators use individual discretion and personal preferences when assessing the value of stream impacts using the mitigation methods. This interpretive flexibility is rooted in the fact that the Illinois stream method is not prescriptive. Rather than requiring specific steps to assess the functional impact of a Section 404 activity, the method only requires visual assessment of physical channel conditions to discern the overall "impact" of a Section 404 project.

Third, this dissertation investigates how St. Louis regulators and mitigation bankers plan and design stream mitigation banking sites. In Illinois, along with elsewhere in the Midwestern U.S., stream mitigation banks provide stream credits through riparian corridor enhancement rather than in-channel stream work. Thus, stream credits are generated using work that is out-of-kind with impacts. Interviews with mitigation bankers and a St. Louis regulator reveal the underlying causes of this out-of-kind relationship. A primary finding of this analysis is that St. Louis regulators favor generating a larger pool of stream credits even if they are not generated using in-channel work. Without riparian work counting as stream credits, there would not be any stream credits available at mitigation banks in Illinois since stream mitigation bankers are hesitant to conduct in-channel work. St. Louis regulators allow out-of-kind stream credit work at mitigation banks because they are pressured by federal guidelines to encourage mitigation bankers to develop more mitigation banks. As a result, the preferences for mitigation bankers to essentially conduct wetland mitigation work and call it stream mitigation work becomes representative of how stream credits are generated at mitigation banks in Illinois and elsewhere in the Midwest.

Finally, this dissertation compares the geomorphic and water quality characteristics of impact sites and a mitigation banking site. Stream mitigation banks in Illinois exclusively generate stream credits through riparian corridor enhancement. Thus, mitigation banking sites are not in-kind with impact sites that include in-channel impacts. However, since riparian corridor work supposedly benefits in-channel habitat, there is interest in understanding whether or not riparian corridor banking sites generate non-compensatory mitigation benefits to the in-channel area. Using cross-sectional surveys, sediment analysis, watershed delineation, water quality measurements, and riparian corridor area comparisons, the fourth analysis in this dissertation compares four impact sites and their "off-setting" mitigation banking site stream. Findings from this analysis suggest that there are likely negligible non-compensatory mitigation benefits generated to the in-channel area from riparian corridor mitigation work based on the variables measured in this study.

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CHAPTER 1

INTRODUCTION

1.1 No Net Loss

No net loss goals play a major role in U.S. federal environmental policy. The basic premise of no net loss is simple: if someone damages an ecosystem, resulting in loss of function, they need to compensate for these damages by improving an ecosystem component to an equal or greater functional level than that lost (Lave et al. 2008). No net loss is championed as a way to protect the environment and enable economic development (Robertson 2004). However, no net loss rhetoric has not translated into substantive functional improvements of aquatic quality (Robertson 2000; NRC 2001). Despite this historical failure of no net loss policy, it remains an important component of many federal environmental programs.

Section 404 of the Clean Water Act ('the Act') is one such example (Doyle and Shields 2012). The primary goal of the Act is to maintain the "chemical, physical, and biological integrity of the nation's waters (Doyle and Bernhardt 2010). To this end, Section 404 regulates construction activities that result in degradation of streams and wetlands (Doyle and Shields 2012). Section 404 is regulated by the U.S. Army Corps of Engineers ('the Corps') and the Environmental Protection Agency ('the EPA'); the Corps issues permits, while the EPA can veto Corp permit decisions (Hough and Robertson 2009).

Section 404 regulations are triggered when a land developer proposes a project that will result in direct "unavoidable impacts" to a stream or wetland. Under Section 404, the applicant must *mitigate* its impacts (Hough and Robertson 2009). Mitigation includes first working to *avoid* impacts altogether, then to *minimize* any "unavoidable impacts," and last to *compensate* for the remaining “unavoidable impacts” (Hough and Robertson 2009). It is the compensation component of mitigation that entails no net loss.

Until 2008, the main focus of Section 404 was on wetlands and wetland mitigation. Some streams were mitigated in an *ad hoc* fashion as a “type” of wetland (Corps and EPA 2008). In the language of the Corps and EPA, streams are classified like some kinds of wetlands, as a “difficult to replace resource” (Corps and EPA 2008). Streams are difficult to replace because, among other reasons, they are organized in a hierarchical network (Corps and EPA 2008). Replacement of a stream therefore does not only entail creating a channel of similar length, but a channel of similar hydrology, sediment dynamics, and connectivity with the surrounding landscape (Corps and EPA 2008).

In response to the programmatic goal of no net loss and the fact that streams could be demolished and replaced with a wetland—the Corps and EPA issued the *Compensatory Mitigation for Losses of Aquatic Resources Rule* in 2008 (‘the 2008 Rule’). The goal of the 2008 Rule is to achieve no net loss goals for *both* streams and wetlands. The 2008 Rule offers regulatory guidance to Corps districts to better improve their compensatory mitigation requirements. Corps districts can choose to implement suggestions offered in the 2008 Rule “to the extent practicable.” This practicability is constrained by the Corps need to balance multiple priorities, including but not limited to, a) timely permit review, b) ensuring environmental protection, and c) their legal and administrative scope. Thus, the 2008 Rule is not a federal mandate or a single set of practices that all regulators will interpret identically (Corps and EPA 2008).

The 2008 Rule provides Corps districts with two kinds of recommendations to improve compensatory stream mitigation outcomes. First, the 2008 Rule urges Corps districts to create stream mitigation methods for the evaluation of impact and mitigation sites in the unit of stream credits. Each Corps district is responsible for issuing Section 404 permits and for establishing compensatory stream mitigation requirements and methods (Doyle et al. 2013). While Corps regulators have sole authority to issue Section 404 permits, they require input from other state and federal agencies. Not all agencies agree on the same definition or value of stream credits because commensuration, the comparison of different qualities using a common metric, differs across disciplinary and administrative lines (Espeland Stevens 1998).

Second, the 2008 Rule prioritizes compensatory mitigation that is off-site and in-kind. Off-site mitigation is mitigation that occurs elsewhere in the same watershed as the impacts (Corps and EPA 2008). The preferred method of off-site mitigation is via a mitigation bank: a parcel of land or segment of river that is created, enhanced, restored, or preserved to off-set the loss of wetland and/or stream functions elsewhere (Lave et al. 2008). In-kind compensation means that compensation must be of a similar function to the one lost; i.e. to replace a particular type of stream habitat with this same type of habitat. Corps regulators cannot require mitigation bankers to provide wetland or stream credits. Each banker must be incentivized to construct mitigation banks that provide credits necessary to meet no net loss goals.

An analytical framework for explaining the process through which Corps regulators a) develop district-specific stream mitigation guidelines, and b) work with mitigation bankers to encourage in-kind mitigation is *the sociology of translation* (Callon 1984). Translation refers to the creation and transfer of a standard measurement system and/or management protocol through a social network (Callon 1984). The extent to which the Corps achieves no net loss goals depends on this agency's capacity to steer the translational process of Section 404 stream mitigation banking to result in positive functional outcomes. This dissertation addresses these concerns by examining the engagement of the St. Louis Corps District (St. Louis) in Illinois and Missouri in the stream-mitigation process. St. Louis has been developing statewide stream mitigation methods in Illinois and Missouri since 2004. At the same time, St. Louis continues to encourage mitigation bankers to develop sites that generate stream credits through in-kind activities.

1.2 Research Objectives, Questions, and Dissertation Organization

The primary objective of this dissertation is to explain the translational process through which St. Louis *commensurates* streams for no net loss, and the biophysical outcome of this process. Commensuration is a general social process that entails comparing different qualities by a single metric (Espeland and Stevens 1998). Commensuration not only includes making comparisons, but also selecting or creating a suitable metric for making comparisons (Espeland and Stevens 1998). To achieve these goals, this dissertation focuses on a) how St. Louis orchestrates, with the involvement of other regulatory and non-regulatory agencies, the development and implementation of a standardized method to measure stream credits, b) how St. Louis encourages mitigation bankers to conduct stream mitigation work that meets compensatory mitigation requirements and policy goals, and c) whether or not mitigation banking site provide non-compensatory mitigation benefits, by comparing in-channel geomorphic and water quality conditions at impact sites and at a mitigation banking site. This dissertation argues that the resulting character of no net loss in Illinois and Missouri differs from the intended ideal of no net loss in a functional sense. This difference is caused by various mitigating factors that arise during the translational process.

This research asks three inter-related questions: (1) What practical, scientific, and political factors inform the creation of a standardized, state-specific stream mitigation method? (2) What is the translational process through which Section 404 actors determine what counts as an impact and what counts as sufficient mitigation to fulfill no net loss goals? And (3) Does the mitigation banking site (which consists solely of riparian tree plantings) provide non-compensatory mitigation benefits to the in-channel area?

This dissertation is organized around three steps taken by St. Louis to implement Section 404 no net loss goals: 1) develop a state-specific stream mitigation method in Illinois and Missouri; 2) use the method to assess impact activities and work closely with permittees to minimize overall impacts; and 3) work closely with mitigation bankers to encourage in-kind mitigation.

This first chapter has provided an explanation of the research problem, objectives, and questions. Chapter 2 reviews relevant literature, discusses the theoretical approach, and explains the methodologies employed to answer the three research questions. This dissertation frames the three steps taken by St. Louis to achieve no net loss as a question of translation. The issue at hand is how does a central authority, in this case St. Louis, encourage other actors to "buy in" to a standard method of defining, valuing, and assessing stream impacts and mitigation activities. Translation includes three steps (Callon 1984). First, a central authority must define a problem and define roles for those involved in solving the problem ("problematization"). Second, the central authority works to encourage actors to conform to these roles using both direct and indirect tactics ("interessment" and "enrollment"). Third, actors are mobilized to speak for the agreed-upon method or protocol ("mobilization").

Chapter 3, "Making the Illinois and Missouri Stream Mitigation Methods," answers question 1— *What practical, scientific, and political factors inform the creation of a standardized, state-specific stream mitigation method?* Chapter 3 examines steps 1 and 2 in the translational process. These steps, problematization and interessment/enrollment, include a) defining a problem, b) providing a solution, c) organizing a group of actors to solve this problem, d) specifying the roles that each actor will play, and e) reminding actors what is expected of them during negotiations and meetings. Chapter 3 examines this translational process by tracing the evolution of the Illinois and Missouri stream mitigation methods. Both the Illinois and Missouri methods were developed under St. Louis's guidance. St. Louis seeks buy-in to their approach to no net loss by incorporating feedback from participating agencies.

Chapter 4, "Mobilizing the Illinois Method and the 2008 Rule," begins to answer question 2 (*What is the translational process through which Section 404 actors determine what counts as an impact and what counts as sufficient mitigation to fulfill no net loss goals?*) by focusing on the definition of stream impacts. Chapter 4 uses a case study to examine these issues. The case study, the definition of stream impacts in southern Illinois, represents a typical situation that St. Louis regulators face. Using participant observation, chapter 4 presents data collected during a pre-application interview and an impact site assessment. The Illinois stream mitigation method is formal and not prescriptive; therefore, the definition of impacts and assessment of credits varies by method user.

Chapter 5, "Steering Compensatory Stream Mitigation Banking", finishes answering question 2 (*What is the translational process through which Section 404 actors determine what counts as an impact and what counts as sufficient mitigation to fulfill no net loss goals?*) by focusing on interactions between St. Louis regulators and Illinois mitigation bankers. Chapter 5 presents stream mitigation banking as a form of "stream naturalization." Stream naturalization, contrary to stream restoration, emphasizes that the meaning and value of stream management projects emerges out of place-based relationships between people and rivers. Stream management, rather than a purely technical affair, is fundamentally a social process. In this case, St. Louis and mitigation bankers consider the mitigation banks to be valuable because they convert farmland to historic plant communities. The primary goal of mitigation bankers in Illinois is thus to re-create historical plant communities, rather than off-set potential in-stream impacts. As a result, the criteria for no net loss of stream functions is based on this place-based comparison of stream value, rather than a universal system of measuring stream functions. This case demonstrates the utility of a naturalization perspective: rather than general rules being applied identically, they are crafted and valued differently in specific social settings.

Chapter 6, "Geomorphic and Water Quality Outcomes of Compensatory Stream Mitigation Banking in Illinois," answers question 3 (*Does the mitigation banking site provide non-compensatory mitigation benefits to the in-channel area?*). Chapter 6 uses geomorphic and water quality data collected at four impact sites and one mitigation banking site. The impact sites represent typical impact activities in southern Illinois: clearing riparian vegetation and construction of in-channel culverts. The mitigation banking site selected represents all mitigation banking sites that sell stream credits in Illinois: riparian corridor tree plantings. Chapter 6 finds that mitigation banking site stream in this case study likely does not currently provide non-compensatory mitigation benefits that would replace or off-set the damages caused at the impact sites.

Chapter 7 summarizes the main research findings. This study demonstrates that no net loss is constrained by the St. Louis Corps Districts priority to issue Section 404 permits without a significant delay. The priority to issue permits swiftly acts as a structural constraint on how St. Louis Corps regulators implement Section 404 guidelines in two ways. First, this priority acts as a structural constraint because it limits what Corps regulators consider practicable when evaluating stream functions for compensatory purposes. Second, this priority acts as a structural constraint because it encourages Corps regulators to approve compensatory mitigation plans even if they do not necessarily result in-kind compensation. As a result, this translational process results in biophysical outcomes that are far from ideal. Chapter 7 also presents the broader significance of this research, and concludes with future research directions.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND RESEARCH DESIGN

2.1 Introduction: Translating a Standard Method for Determining No Net Loss of Stream Function

The 2008 Rule provides guidelines for how individual Corps districts can implement Section 404 compensatory stream mitigation banking regulations (Bronner et al. 2013). These guidelines are supposed to serve two purposes: improve the environmental quality of mitigation and hasten the permit review process (Corps and EPA 2008). However, the Corps cannot implement these guidelines alone. Other federal and state agencies have regulatory authority, and planning agreements in place, related to the compensatory mitigation of streams and wetlands (Womble and Doyle 2012; Robertson and Wainwright 2013). This involvement of other agencies presents a problem for Corps districts working to establish standard ways of assessing no net loss of stream function. Regulatory agencies measure and value stream resources differently (Robertson and Wainwright 2013). Each agency has its own *classifying mindset*: a set of assumptions, methods, and data requirements that enable a particular application for a narrowly-constructed classification system (Tadaki et al. 2014). Corps districts must coordinate across these differences to establish a mutually-agreeable method that can become a standard.

Previous research suggests that the development of a useful standard must both a) overcome differences between agencies, and b) include unique differences between agencies (Star and Griesemer 1989; Timmermans and Berg 1997). The Corps requires cooperation from all agencies that provide oversight roles in the Section 404 process to establish new standards. If group members do not accept a single protocol or method, then it cannot become a standard (Timmermans and Berg 1997). At the same time, the lead Corps district requires the standard to incorporate the regulatory needs of other agencies (cf. Womble and Doyle 2012). The proposed method is not likely to be widely adopted if it does not cater to the specific working needs of all involved (Timmermans and Berg 1997). Proposing a new standard practice amongst a diverse social group thus requires simultaneously incorporating and overcoming differences between group members.

The 2008 Rule states the preference that *mitigation bankers* provide compensatory stream mitigation. A mitigation banker is a private actor who constructs mitigation sites to meet Section 404 compensatory mitigation needs (Robertson 2004). Corps regulators cannot force mitigation bankers to construct bank sites one way or another. Instead, Corps regulators rely on governance mechanisms—including economic incentives—to alter mitigation banker behavior. The entire process of establishing and implementing Section 404 no net loss stream function guidelines therefore requires coordination across multiple layers of government and that non-state actors construct off-setting mitigation sites. This process can be better understood as an example of *translation* (Callon 1984).

Translation is a conceptual model for analyzing the way that a central authority establishes the adoption and use of a standard protocol across social groups (Callon 1984; Star and Griesemer 1989). Callon (1984) first used the concept to explain how a central authority, three aquatic researchers, directed other actors to collect and analyze scientific data in a way to support their primary goals. This and similar research demonstrates that translation is a useful framework for analyzing the social practices necessary to coordinate inter-disciplinary technical work to achieve focused goals. Translation is a useful way to conceptualize Section 404 governance. The Corps must simultaneously coordinate and direct other agencies to develop a standard way (of their choosing) to commensurate streams.

Callon's (1984) original model of translation has four steps; this dissertation distills these into three. First, the group organizers must *problematize* the coordinated work that must occur. Problematization includes both a) defining the scope of the problem at hand and its appropriate solution, and b) establishing roles and duties for all members to fill to solve the defined problem. Second, group organizers must encourage group members to fulfill their defined roles and commit to their assigned scope. Callon (1984) described this as both *interessment* and *enrolment*. Third, translation requires actors to *mobilize* according to the duties and roles defined by the group leader.

The first step in translation is problematization. Problematization includes both a) defining a problem and providing a solution, and b) allocating roles for group members to fill to provide a solution. Contrary to conventional wisdom, problems are not always identified before solutions (Forsyth and Walker 2008). Instead, problems can be developed *after* a preferred solution has been identified (Forsyth and Walker 2008). In this light, problems are not merely 'identified' or 'uncovered,' but are instead *framed* based on particular values or beliefs (Forsyth and Walker 2008). Social scientists label this act *problem closure*: "the generation of one specific definition of a problem…[to] influence the generation of knowledge that reduces the attention given to alternative evaluations that may produce different knowledge" (Forsyth and Walker 2008, p. 12). The first step in problematization, defining the problem and providing a solution, therefore does not always occur in a "problem before solution" sequence. Instead, the two may be developed and framed concurrently, or in reverse order. The effectiveness of problematzation rests on whether or not participating actors accept the defined problem, solution, and their roles.

In Callon's (1984) model, actors are fully enrolled when they completely accept their assigned roles. Full enrollment, however, is not always simply achieved by asking actors to comply with their assigned roles (Callon 1984). Building on Callon (1984), Star and Griesemer (1989) find that developing *standard methods* improves the ability of a group leader to enroll group members. Standard methods structure the decisions that group members make when working towards a solution (Star and Griesemer 1989). In turn, group members are more likely to be "locked" into an established role. However, standards only become standards if they are useful across social groups (Star and Griesemer 1989; Timmermans and Berg 1997). Unless a standard complies with the *modus operandi* of various social groups, it will not likely be accepted and implemented as a standard (Timmermans and Berg 1997).

The final stage of translation is mobilization. Mobilization is the "litmus test" for whether or not a central authority has fully enrolled all actors (Callon 1984). The strength or weakness of mobilization hinges on whether or not actors are fully enrolled in their assigned roles. Actors can fail to conform to their prescribed roles or deviate from the defined problem and solution scope for different reasons. In the context of stream mitigation, for example, Corps regulators are not the only actors that will compare impacts and mitigation for the purpose of no net loss. Section 404 applicants may also conduct compensatory stream mitigation assessments. Therefore, the intent and goal of a standard method may not be clear to all users. Second, although standard protocols may be considered a standard, not all protocols may be implemented identically (Timmermans and Berg 1997). Method users may interpret and classify objects differently (Milner et al. 2013), disagree with parts or the entirety of the classification system being used (Espeland and Stevens 1998), or use standard methods "incorrectly" (Timmermans and Berg 1997). The translational process is not guaranteed to succeed, but can be streamlined with cooperation and input from all agencies involved.

The effectiveness of a Corps district to implement a standard method for Section 404 no net loss stream guidelines depends on how well it can steer the translational process of guideline development. Corps regulators face two problems when standardizing Section 404 no net loss stream guidelines: measurement of no net loss of stream function and governing the construction of compensatory mitigation banking sites (Robertson 2004). Both of these problems are simultaneously issues of measurement (i.e. commensuration) and governance (cf. Robertson 2004).

First, regulators must establish a standard method for assessing and evaluating stream functions. Unless a standard metric is established, there can be no way to determine whether or not no net loss goals are being achieved. This issue centers on the problem of commensuration: comparing different qualities using a single quantitative metric (Espeland and Stevens 1998). However, the acceptance of a single commensuration system requires effective governance in the form of coordinating actors so that commensuration can be implemented as designed (cf. Robertson 2004). Thus, regulators must govern one another and all Section 404 system actors to accept and use a standard commensuration system. Second, regulators must also encourage and steer mitigation bankers to develop stream mitigation banks that meet no net loss requirements. This issue is a question of governing mitigation bankers to conduct work that complies with the district-defined system of stream commensuration (Robertson 2004). Before examining these two problems in greater detail, it is first necessary to explain the entire Section 404 compensatory stream mitigation banking process.

2.2 Section 404 Compensatory Stream Mitigation Banking

The Corps and EPA regulate Section 404 of the U.S. Clean Water Act. The decision to issue or deny a Section 404 permit rests with the Corps. The EPA primarily plays an oversight role, but can veto Corps permit decisions. Less than 1 percent of all permits have ever been vetoed (Hough and Robertson 2009). The continental U.S. has 36 Corps districts (Doyle et al. 2013). All

Corps districts have the same basic requirements of Section 404 permits. First, land developers must apply for a Section 404 permit if they propose work that impacts a "water of the United States." All Section 404 permits also require a Section 401 water quality certification. State agencies issue Section 401 certificates. In most states, the Section 404 and Section 401 applicants are combined into a joint Section 404-401 application. Second, in the processes of reviewing the permit, the Corps must ensure that the applicant sufficiently *mitigates* their impacts. Mitigation entails: a) avoiding impacts, b) minimizing impacts, and c) compensating for unavoidable impacts (Hough and Robertson 2009).

The amount of compensation required to fulfill compensatory mitigation requirements is determined by comparing impacts with compensation using a standard metric. Historically, stream compensation has been calculated using length- and area-based metrics (Doyle and Shield 2012). Prior to the 2008 Rule, stream impacts were replaced with streams of a similar length or area to meet compensatory stream mitigation requirements. While it is easy to compare the length and area of impacts and compensation work, length and area do not represent how streams actually *function* (Doyle and Shield 2012; Doyle et al. 2013). Stream functions are controlled by complex interactions among channel morphology, sediment dynamics, and discharge variability (Doyle et al. 2005; Beechie et al. 2010; Hester and Gooseff 2010; Doyle and Shields 2012; Acuña et al. 2014). Any measure of stream function therefore needs to be based on these dynamics in some way.

The 2008 Rule aims to correct this failure by encouraging Corps districts to develop functional assessment protocols to assist in determining compensatory stream mitigation requirements. While in an ideal regulatory setting Corps regulators would measure individual functions and compare them between impact and mitigation sites, Section 404 regulators tend to instead assess the overall functionality of streams by creating metrics of *stream credits*. A stream credit is a unit that represents the total physical, chemical, and biological function of a stream (Lave et al. 2008). Each Corps district has the authority to determine its own measure for calculating stream credits (Corps and EPA 2008). This means that the assignment of value to stream credits, even if based on scientific evidence, is merely quantification of value-based judgments about the importance of certain stream functions relative to others.

Federal regulations state the preference that applicants purchase stream credits from a *mitigation bank* to meet compensation requirements. A mitigation bank is a segment of stream that has been enhanced, restored, recreated, or conserved by a private actor to provide offsetting stream credits (Lave et al. 2008). A Section 404 permit can be issued once an applicant has generated stream credits from an approved compensatory method, and has met necessary Section 401 water quality certification requirements.

2.3 Making a Credit-Based Stream Assessment Method

Within the context of the Section 404 process the Corps faces two primary translational issues in trying to achieve no net loss of stream function across all districts nationally: measurement and governance (cf. Robertson 2004). Establishing a system of measurement to assess no net loss of stream function increasingly takes shape under the guise of market-like principles. Section 404 is supposed to incentivize non-state actors to participate and provide compensation by allowing them to generate profit. The source of this profit is a standard commodity (stream credits) that non-state actors can generate through conservation activities (Robertson 2004; Lave et al. 2008).

Market-like ecological conservation hinges on establishing standard units or metrics that constitutes the "ecology" that is being "conserved" (Robertson 2004; 2012). This problem is not a simple one. Indeed, "nothing has vexed the [Section 404 mitigation practitioners] so much as the task of creating abstract and generalizable *measures* of the commodity that they sell" (Robertson 2004, p. 362, emphasis in original). From a social construction point of view, ecological value is not so much "discovered" as it is "created" out of the coordinated effort and practices of different social actors (Espeland and Stevens 1998; Robertson 2004; MacKenzie 2009; Robertson and Wainwright 2013).

Making new measurement systems is fundamentally a social endeavor (Robertson 2004; 2006; Espeland and Stevens 2008). Measurement systems reflect the priorities and values of their creators (O'Connell 1993; Robertson 2006; MacKenzie 2009). Furthermore, no measurement system is worth making unless it is worth *using* (O'Connell 1993). Measurement systems are thus designed with the skillset and capabilities of a certain user in mind (O'Connell 1993; Robertson 2006). The expectations of users constrain the usefulness of a stream credit measurement system. (Robertson 2006). Depending on user expectations, the kind of ecological information that is incorporated can vary.

There are inherent tradeoffs involved in making measurement systems that must simultaneously be legally-sound and capture ecological complexity (Robertson 2006). The primary concern of a measurement system designed for regulatory purposes is whether or not it is both legally defensible and procedurally consistent (Robertson 2006). These priorities do not match the needs of ecological scientists (Robertson 2006). To create such a system, ecological science must be selectively used (Robertson 2006). The capacity of regulatory-based measurement systems to account for ecological complexity is thus inherently limited (Robertson 2006). It is up to method creators, based on their expectations of the users, to determine what kind of ecological information is incorporated into ecological assessment methods (Robertson 2006).

The incorporation of ecological information into a new measurement system is filtered through the classifying mindset of its makers (cf. Tadaki et al. 2014). Classifying mindsets require different information and measurements when making decisions regarding commensuration and classification (Tadaki et al. 2014). For example, the Illinois EPA (IEPA) assesses the health of a stream by calculating the upstream watershed area of an impacted stream. If the watershed area of an impacted stream is greater than a defined areal limit (e.g. 5 $miles^2$), then the applicant requires in-depth chemical analysis. If the upstream watershed area of an impacted stream falls below that areal limit, then the applicant is not required to perform chemical analysis. By contrast, the Illinois Department of Natural Resources (IDNR) assesses the health of streams based on the economic value of fish that survive an impact. If a developer degrades a stream and fish die, the developer is required to pay a fee commensurate with the total economic value assigned to each fish species killed. Thus, environmental quality is viewed differently across agency lines.

The practical implication of this difference in stream assessment is that, depending on the agency and district, regulators will have different regulatory requirements for what is considered a commensurate exchange of the physical, chemical, and biological function of streams. The Corps must navigate and steer through extant differences in assessment among agencies to translate their method of assessing the physical, chemical, and biological function of streams.

2.4 Stream Mitigation Banking as Stream Naturalization

Although Corps regulators govern the compensatory mitigation process—both the permit application phase and the mitigation planning phase—the characteristics of Section 404 compensatory stream mitigation depend on district- and state-specific interactions between regulators, applicants, and mitigation bankers. Thus, mitigation practices that fulfill no net loss requirements vary from district to district (Bronner et al. 2013). A concept that captures the contingency of environmental management of streams to meet place-based environmental goals is *naturalization* (Rhoads et al. 1999). Developed in the context of community-based approaches to stream management, naturalization recognizes that conceptions of what is natural in specific management contexts emerges out of social negotiations amongst intervening actors in place (Rhoads et al. 1999). This perspective differs from stream restoration because naturalization does not imply that stream management will be targeted toward predisturbance, pristine conditions as a reference state for management as is commonly the case in restoration efforts. Instead, management targets for naturalizing a stream system are socially constructed and often place-specific. Naturalization acknowledges that stream management is fundamentally a social process that emerges from competing value systems among relevant stakeholders involved in the negotiations about management outcomes.

This dissertation intentionally avoids labeling the compensatory mitigation process a "restoration" practice. While the principles of ecological and stream restoration are relevant, labeling the process as "restorative" is problematic. As Emery et al. (2013) note, the term "restoration" is used so often that it is rarely used in its original meaning. Originally, "restoration" referred mainly to the "return of an ecosystem to a close approximation of its condition prior to disturbance" (NRC 1992). However, given that "a close approximation" and "disturbance" are a matter of debate and not objectively defined, "restoration" has always been a fluid concept (Rhoads et al. 1999; Stoddard et al. 2006). This fluidity is attributed to the fact that "the 'fuzziness' and interpretability of the concept of restoration…ensures that different people can apply it in different ways to justify or oppose what is ultimately the same physical environmental intervention" (Emery et al. 2013, p. 168). "Restoration" is therefore no more than a value-laden, place-specific *intervention* into a complex biophysical system (Hobbs et al. 2011); in other words, most practices that claim to be restoration are in fact examples of naturalization.

Naturalization provides an alternative framework to restoration for analyzing Section 404 compensatory stream mitigation governance. A naturalization perspective on Section 404 compensatory mitigation is important and relevant for two reasons. First, there is the issue that compensatory stream mitigation is not actually "restoration" at all. As discussed above, entering into the language of "restoration" is a messy, value-laden field that disguises its values behind the application of science and technology (cf. Rhoads et al. 1999; Emery et al. 2013). By using the language of naturalization, it is possible to better analyze the Section 404 compensatory mitigation process and its outcomes.

Second, and more importantly, is the fact that what constitutes a "stream" or "wetland" credit is determined in a district-specific setting due to regulatory flexibility. The 2008 Rule prioritizes that stream credits be assigned to activities that improve in-channel stream functions (Corps and EPA 2008). The list of examples to meet these criteria is vast when one considers that land and streams are connected. From a watershed-based approach, controlling land use is itself a potential positive way to improve in-channel stream functions (Doyle and Shields 2012). Therefore, in practice, Corps regulators seek input from local agencies and actors to formulate place-specific stream mitigation guidelines, at least on a state level. This process involves social interaction amongst the Corps and these agencies and actors to develop guidelines that define valuation for impacts and mitigation and that also determine how specific compensatory practices are weighted in relation to achieving the goal of no net loss. Moreover, at a more local level, the

Corps negotiates with applicants and mitigation bankers to establish what constitutes necessary and sufficient mitigation work to meet crediting requirements for mitigation. This interpretive flexibility is not merely "best professional judgement," but also involves individual sentiments and understandings of how regulations and law should and should not be implemented (Robertson 2010; Blomley 2008). For these reasons, stream mitigation "although dependent on science and engineering, is a process that is fundamentally social in nature" (Rhoads et al. 1999, p. 298).

This dissertation takes the position that Section 404 compensatory stream mitigation is a naturalization process. The standard system of measurement and value of no net loss emerges from the interpretation and application of the 2008 Rule. The system of measurement that emerges as the "standard" reflects the competing and shared values and classifying mindsets of participating regulators and non-state actors. The outcomes of the interpretation of the 2008 Rule reflects the translational process by which the Corps is able to reproduce and extend a standard system of meaning and value of stream resources. Although compensatory stream mitigation banking is based on market-like principles, federal regulators and mitigation bankers do not decide the characteristics of mitigation banking sites based on market signals. Instead, what constitutes "natural" or "mitigation" will depend on the actors present and most effective at steering or modifying the translational process of Section 404 compensatory stream mitigation.

2.5 Implementing No Net Loss Stream Guidelines in Illinois and Missouri

To examine the translational processes involved in the development and implementation of stream mitigation guidelines by the Corps, this study examines how the St. Louis Corps District's (St. Louis) has implemented the 2008 Rule in Illinois and Missouri. Although both states in more than one Corps district, St. Louis is coordinating the development of statewide Section 404 stream mitigation methods in Illinois and Missouri. The groups organized to develop these state-specific stream mitigation guidelines are called "stream assessment teams" (SAT). The Missouri SAT first convened in 2004 and has since developed two approved Missouri stream mitigation methods (2007, 2013[1]). Following success at establishing a statewide method in Missouri, St. Louis formed the Illinois SAT in 2008. The Illinois SAT has only developed one stream mitigation method to date (2010[2]), and despite the fact that it is available to the public, Corps regulators do not consider it to be an "approved" method. Illinois also has an unfinished draft stream mitigation method dated 2013 that is not currently being used. In both Illinois and Missouri, the methods currently used are temporary and interim. From St. Louis's perspective, these are "living documents" that will undergo future rounds of editing and modification. Nonetheless, the most recent documents issued for public guidance are used by St. Louis in Illinois and Missouri to evaluate Section 404 compensatory stream mitigation credit requirements.

The Missouri method is included in this analysis for two reasons. First, it is included because the Illinois method is based on the Missouri method. St. Louis generated the 2010 Illinois stream mitigation method by modifying the 2007 Missouri stream mitigation method to accommodate Illinois-specific needs. Therefore, to better explain and understand the translational process through which stream credits are defined in Illinois, it is necessary to examine the origins of the document upon which the Illinois method is based. Second, the Missouri deliberations are included to differentiate between local and general contingencies. By comparing between St. Louis's experiences in Illinois and Missouri it is possible to determine which aspects of the translational process are place-specific, and which transcend the local.

[1] The 2013 Missouri stream mitigation method can be accessed at: http://www.mvs.usace.army.mil/Portals/54/docs/regulatory/mitigation/Amended%20Missouri%20Stream%20Mitigation%20Method%20April%202013.pdf
[2] The 2010 Illinois stream mitigation method can be accessed at: http://www.mvm.usace.army.mil/Portals/51/docs/regulatory/publicnotices/Illinois/Illinois%20Method.pdf

St. Louis regulators also work closely with Section 404 applicants and mitigation bankers to govern the environmental quality of impacts and mitigation. This study examines several cases of mitigation to investigate translational processes. The case material presented, while limited to Illinois, represent the fundamental processes that occur in Missouri as well. The cases involve a St. Louis regulator who works both in Illinois and Missouri, and mitigation bankers in Illinois who conduct similar work as Missouri stream mitigation bankers.

2.6 Methods

2.6.1 Social Science Methods

For the social-science aspects of this dissertation, the extended case study approach is employed (cf. Robertson 2009). Here "extended" refers exploring "a single case at length and [linking] that case to…broader forces and trends" (Robertson 2009, p. 37). The extended case study approach strings together multiple steps in a single process (e.g. the compensatory mitigation banking process in this case). In doing so, the extended case study approach extends understanding of a system or process to a deeper level than analysis of one segment would alone (cf. Robertson 2009). The extended case study approach is useful for generating generalizable themes for understanding social interaction in spheres of social activity (Robertson 2009). In this case, the "sphere" of social activity is Section 404 compensatory stream mitigation banking in Illinois. The extended case study approach uses qualitative methods to investigate underlying social processes that shape decision making, power relations, and the reproduction of belief and value systems (Robertson 2009). The extended case study method therefore provides different data and through a different lens than conventional analyses of market interactions and economic processes (Robertson 2009). The extended case study enables an ability "to understand [mitigation] banking as it unfolds in particular places, through the actions of particular people" by taking seriously "the incompatibilities and muddling-through that takes place when economic, ecological and regulatory agendas must be aligned" (Robertson 2009, p. 36). In this light, the extended case study method is suitable for analyzing translational processes which rest on inter-personal and inter-disciplinary interactions.

The extended case study approach is based on ethnographic methods. Ethnographic methods provide insight into how individuals perceive and utilize shared systems of knowledge and value (Traweek 1988; Ho 2009). One of the most important ethnographic methods in this regard is *participant observation* (Traweek 1988; Ho 2009). Participant observation is a way of embedding oneself into a community (e.g. environmental regulators) that shares a "common sense" or sense of unity by participating in and observing community practices and activities (Traweek 1988). The observations made amount to a "'thick description' of settings, language, tone of voice, posture, gestures, clothing, distance, arrangement of moveable objects, and how all this changes from one interaction to another" (Traweek 1988, p. 9).

Participant observation extended beyond formal regulatory practices alone. Drawing from Ho (2009), this dissertation explicitly recognizes that participation and research occurs in different places and through different media. This perspective has been termed *polymorphous engagement* (Gusterson 1997; Ho 2009). A polymorphous engagement is a way of "interacting with informants across a number of dispersed sites, not just in local communities, and sometimes in virtual form; and it means collecting data eclectically from a disparate array of sources in many different ways [such as]…formal interviews…extensive reading of newspapers and official documents…careful attention to popular culture, as well as informal social events outside of the actual [regulatory] office or laboratory" (Ho 2009, p. 19). Hence, the ethnographic research in this dissertation involves a combination of open-ended interviewing with regulators and ecological practitioners, participation with regulators and practitioners in their mitigation projects, observation of regulators and practitioners, review of Section 404 policy documents at the state and federal level, review of district-specific Section 404 guidelines, reviews of Section 404 permit data, conversations with research participants in informal settings, and reading widely-circulated mitigation documents amongst regulators and practitioners.

The following sections detail the methodological design for answering questions 1 and 2 (chapters 3-5). The sections include: a) primary methodology, b) how I determined the sample of research participants and my rationale for selecting participants, c) the number of individuals interviewed and the agency that they represent, d) interview questions asked and the rationale for these questions, e) non-interview data sources (e.g. transcripts of prior meetings), including how those data were collected, and f) data synthesis.

Question 1: *What practical, scientific, and political factors inform the creation of a standardized, state-specific stream mitigation method?*

Primary Methodology: I used two primary data sources to answer question 1 (chapter 3): i) open-ended interviews with members involved in the creation of the Illinois and Missouri stream mitigation methods, and ii) transcripts and notes taken by group members during previous meetings.

a) Selection of Research Participants and Rationale: I selected research participants from the list of agencies and individuals representing the agencies involved in the development of the Illinois and Missouri methods. I gathered a list of group member contact information from the St. Louis Corps. I contacted all members of the Illinois team by phone or email for an interview. Many declined or did not respond. I also interviewed members of the Missouri team to investigate the origins of the Missouri method.

b) Number of Individuals Interviewed and their Home Agency: I interviewed eight members of the Illinois stream assessment. I interviewed the leader of the Illinois SAT, Will Jones[3] (St. Louis Corps), four times in-person and over the telephone. The remaining seven individuals interviewed are employed by the Illinois State Geological Survey (2 people), Illinois Department of Natural Resources (3 people), and Illinois Environmental Protection Agency (2 people). None of the remaining Illinois team members were willing to be interviewed as a part of this research. I interviewed seven members of the Missouri stream assessment; four of these seven were interviewed in pairs of two. These seven individuals work for the U.S. Fish and Wildlife Service (1 person), U.S. EPA Region 7 (1 person), St. Louis Corps (1 person), Missouri Department of Conservation (2 people), and the Missouri Department of Natural Resources (2 people). In addition to these two groups of people (Illinois and Missouri teams), I interviewed one Corps regulator from Charleston, South Carolina, by phone. This interview took place to provide background on the origin and use of the Charleston stream method. This interview was necessary to understand the origins of the Missouri method because the Missouri method is based on the Charleston method.

c) Interview Questions and Rationale: I asked group members in Illinois and Missouri fifteen questions (see table 2.1). In many cases, I did not ask all fifteen questions because the interviews were open-ended and respondents highlighted unexpected factors of importance. I selected these questions to gain a sense of the respondent's a) role in Section 404 regulation, b) opinion of the Section 404 stream mitigation process, c) background in stream sciences, d) opinion of how "open" discussions were, e) opinion of who/which agency had greatest and least influence,

[3] All research participants are given pseudonyms.

as well as f) how St. Louis organized the group and focused the group on a single goal. I recorded and transcribed some interviews. I took notes during unrecorded interviews.

1. Who do you work for and what is your job description?
2. What does your agency want to see happen with the [State name] stream method?
3. Do you have any training in the ecological or fluvial sciences?
4. How did you become involved in developing the [State name] method?
5. Who has the strongest influence when deciding what is incorporated into/discarded from the method?
6. Who has the weakest influence during this process?
7. What is your relationship with other members of this working group?
8. Do you offer contrasting opinions when in group discussions or do you refrain from making alternative claims? Why or why not?
9. In your opinion, what is necessary for a crediting method to adequately achieve no net loss goals for streams?
10. Are you familiar with the current draft of the [State name] method?
11. Can you explain how any individual components of the [State name] method were decided upon?
12. What information is missing from the current draft?
13. What is the strongest quality about the current draft?
14. Do you consider impact and mitigation sites to be commensurate because of this method?
15. In what ways does this method use "the best available information" and apply "scientific concepts to assist regulatory and resource agency staff in determining adverse impacts and appropriate mitigation credits"?

Table 2.1 Interview questions for answering research question 1.

d) Non-interview Data: Group members of the Illinois and Missouri teams provided me with transcripts and notes of prior meetings. These transcripts included: i) record of attendance, ii) primary issues of discussion, iii) meeting location, date, and time, iv) summary of assigned duties after meetings, v) notes taken during field site visits, and vi) correspondence between group members when discussing individual components of the Illinois and Missouri methods. I also compared the composition of successive drafts of the Illinois and Missouri method to identify the exact changes made to the methods over time.

e) Data Synthesis: I reviewed answers to interview questions and compared them against the primary research objectives. I also compared interview data, non-interview data, and changes to the methods against one another to triangulate and ensure consistency in sources.

Question 2: *What is the translational process through which Section 404 actors determine what counts as an impact and what counts as sufficient mitigation to fulfill no net loss goals?*

a) Primary Methodology: Question 2 is answered in two parts—Chapter 4 focuses on Section 404 impact assessment, and Chapter 5 focuses on coordinating compensatory stream mitigation banking. Question 2 is answered using a combination of open-ended interviewing, participant observation, and review of Section 404 permit data.

b) Selection of Research Participants and Rationale: The first part of question 2 (chapter 4), is answered using participant observation data during a one-day impact site evaluation. The site evaluation consisted of two parts: an in-office meeting with the applicant, and a field assessment of the proposed impact site. The field assessment included observation of how the St. Louis regulator used the Illinois method.

I interviewed the only two mitigation banking companies that sell stream credits in Illinois to answer the second part of question 2 (chapter 5). I selected these companies because they are the only two companies in the state that sell stream credits. St. Louis regulates both of these companies and their mitigation banks. The regulator that conducted the impact site assessment (chapter 4 above) is the same regulator in charge of reviewing sites constructed by these two stream mitigation banking companies. Therefore, I successfully identified and spoke with all companies selling stream credits in Illinois, and the primary Corps regulator that works with them to encourage no net loss stream mitigation.

c) Number of Individuals Interviewed: The primary data used in chapter 4 is participant observation data instead of interview data. I interviewed five people in chapter 5: Two individuals representing each mitigation company, and the same St. Louis Corps regulator that I interviewed in chapter 4. I conducted interviews in-person at mitigation sites, over the phone, and in-person when traveling during site selection and monitoring trips.

d) Interview Questions and Rationale: Chapter 4 used participant observation, and therefore did not use pre-formed interview questions. I followed up my observation by asking the assessor (a St. Louis regulator) specific questions based on notes taken during the observation process. My notes focused on where the regulator went in the impact site, what he said, his gestures, and how he came to deciding the overall impact value.

For aspects of the research presented in Chapter 5, I asked mitigation bankers twelve interview questions (see table 2.2).

1. How many mitigation banking sites (that sell stream credits) have you built before?
2. How are these sites different from one another, and how are they similar?
3. Why have you turned to mitigation banking? Do you have other sources of income?
4. Do you consider the way that credits are counted and measured when you build these sites?
5. In your mind, what constitutes successful mitigation?
6. What training do you have in ecological and/or fluvial sciences?
7. Where have you learned your mitigation methods/techniques?
8. Why did you choose to use this site as a mitigation banking site? What about other sites?
9. How do you decide/establish the goals for your mitigation banking sites?
10. Why have you chosen the mitigation methods I see here at this site?
11. Why haven't you extended mitigation practices to the in-stream channel?
12. How do you know that your mitigation bank is a success?

Table 2.2 Interview questions for answering the second part of research question 2.

e) Non-interview Data: Chapter 4 did not use any non-interview/observational data. Chapter 5 includes an overview of the characteristics of mitigation banks nationwide and in Illinois. Nationwide data is taken from the Institute for Water Resources October 2015 report titled "The Mitigation Rule Retrospective: A Review of the 2008 Regulations Governing Compensatory Mitigation for Losses of Aquatic Resources" (https://www.epa.gov/sites/production/files/2015-11/documents/mitrule_report_october_2015.pdf, Last accessed May 24, 2016). I collected Illinois compensatory mitigation banking data online at the Regulatory In Lieu Fee and Bank Information Tracking System (RIBITS) (https://ribits.usace.army.mil/ribits_apex/f?p=107:2, Last accessed May 24, 2016).

f) Data Synthesis: I reviewed participant observation data and interview questions in chapter 4 and 5 and compared against the primary research objectives.

2.6.2 Biophysical Science Methods

Chapter 6 answers question three: *Does the mitigation banking site (which consists solely of riparian tree plantings) provide non-compensatory mitigation benefits to the in-channel area?* The primary goal of the Act is to maintain the "physical, chemical, and biological integrity of the nation's waters" (Doyle and Shields 2012). Thus, question three compares the geomorphic and water quality characteristics of impact and compensation stream sites are compared. I analyze data by determining if impacted streams and a mitigation site have similar hydrology, geomorphic characteristics, and water quality. I selected these three parameters because these variables reflect the Corps's assumption of what is necessary to compensate stream resources.

Question three is addressed using primary and secondary biophysical data, including: a) channel dimension analysis, b) channel sediment-size distribution analysis, c) water quality analysis of impact and mitigation sites (temperature, pH, and conductivity), d) watershed size delineation comparison to estimate discharge and hydrologic characteristics, e) water level variation at mitigation bank, and f) Illinois EPA (IEPA) secondary water quality surveys. Data will be collected using space-for-time substitution. Space-for-time substitution is an alternative to "Before-After" impact assessment (Roni and Beechie 2012). Space-for-time substation is appropriate when Before-After assessment is not possible (Roni and Beechie 2012). Data was collected in three areas: upstream of the impact reach, through the impacted reach, and downstream of the impacted reach (see figure 2.1). Details of each measurement scheme are described in greater detail in chapter 6.

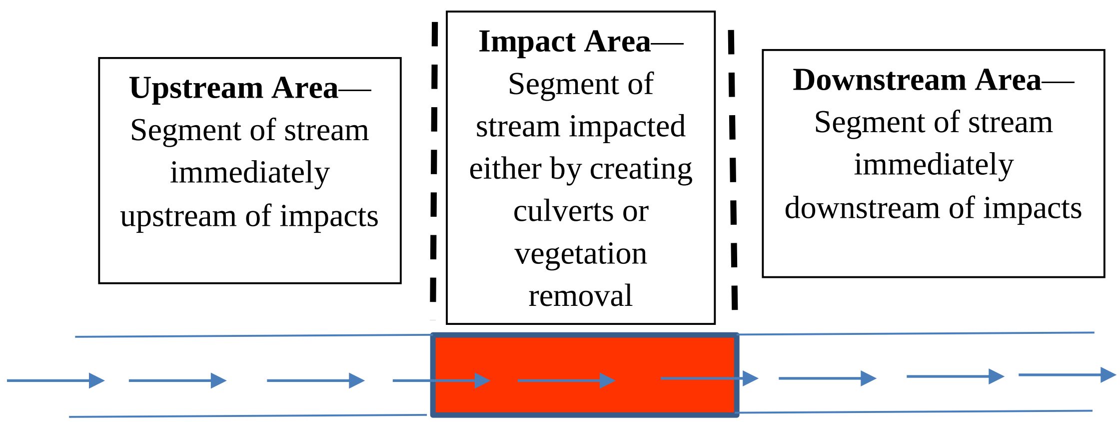

Figure 2.1 Schematic representing space-for-time substitution sampling strategy. Not to scale. Arrows indicate flow direction.

CHAPTER 3

MAKING THE ILLINOIS AND MISSOURI STREAM MITIGATION METHODS

3.1 Introduction

The 2008 Rule requires that each Corps district develop their own method for assessing stream credits. The stated purpose of this requirement is to better achieve the no net loss goal of the Clean Water Act. However, the 2008 Rule only gives recommendations for how districts should create stream mitigation methods. Each district is autonomous and can develop their own requirements for appropriating stream credits. There is no one set of federal requirements that all districts must comply with when measuring stream credits.

Illinois and Missouri both have multiple Corps districts. This situation presents problems for state agencies and statewide permittees. Rather than needing to comply with or review one set of standards, permittees and state regulators must adjust to the needs of each individual Corps district in the two states. As a result, identical development activities can be offset and mitigated in different ways depending on the Corps district in Illinois and Missouri.

The St. Louis Corps is working to create statewide stream methods in Illinois and Missouri to overcome these differences in crediting requirements. St. Louis cannot ignore other agencies when developing statewide methods. The Corps and EPA co-administer Section 404 with input from other state and federal agencies. Federal and state agencies, such as the U.S. Fish and Wildlife Service (US FWS) and US EPA also provide input into the Section 404 process as members of the Inter-Agency Review Teams (IRTs) (Womble and Doyle 2012). IRTs share the responsibility of reviewing Section 404 permits and providing the Corps with input when making their final permit decisions. St. Louis thus needs to convince participating agencies to embrace and adopt a standard classifying mindset in order to develop statewide stream mitigation methods in Illinois and Missouri.

This chapter examines how St. Louis works to solve this problem through the lens of *translation* (Callon 1984). St. Louis attempts to create statewide methods in Illinois and Missouri by using two strategies: *problematization* and *interessment/enrollment*. First, St. Louis defines the intended use and users of the statewide methods. In doing so, it focuses the task of the groups developing the stream methods (problematization). Second, St. Louis encourages other agencies to provide useful (as defined by St. Louis) input to encourage further acceptance of their defined scope. In particular, St. Louis wants to make sure the method accommodates state-specific regulatory requirements (interessment and enrollment).

This chapter makes two arguments. First, it argues that practical, scientific, and legal information included in the statewide methods are only included inasmuch as they do not conflict with an over-riding preference for the methods to be simple, rapid, and visual. Second, this chapter argues that the willingness of other agencies to buy into St. Louis's goal (*interessment/enrollment*) is limited when Corps district chiefs do not make collaboration a priority. In Missouri, where Corps District chiefs prioritized statewide method development, the Missouri method has had greater acceptance and has gone through more collaborative rounds of revision than the Illinois method. In Illinois, by contrast, Corps district chiefs only have weak interest in establishing a statewide method. Enrollment therefore can fail in a hierarchical administrative setting when top administrators do not formally approve or directly require the method.

3.2 Translational Mechanisms to Create Buy-In: Establishing State-Specific Standards for Stream Assessment

Standard methods and protocols are effective means of coordinating management and decision making across diverse social groups (Star and Griesemer 1989; Timmermans and Berg 1997; Espeland and Stevens 1998; Berg 1997; Espeland and Stevens 2008; MacKenzie 2009; Timmermans and Epstein 2010). A virtue of standardization is that it overcomes different sets of opinions to provide a predictable set of outcomes (Timmermans and Epstein 2010). If standardized methods amount to a highly-structured protocol, they can steer decision making in a procedurally consistent way (Berg 1997). Procedural consistency is important for environmental regulators because their authority to conduct environmental assessments are confined to a limited legal scope (cf. Robertson 2006).

Another virtue of standardization is that it can provide quantifiable information. When numbers are used to produce ranks, values, or percentages, they can be categorized easily for controlled decision making (Espeland and Stevens 2008). Used in these ways, numbers can coordinate how different qualities are *commensurated* (Espeland and Stevens 1998). Commensuration is useful for comparing otherwise different objects (Espeland and Stevens 1998). Depending on the complexity of the commensuration system, it can reduce the amount of information that is necessary to compare objects and simplify decision making (Espeland and Stevens 1998). For these reasons, commensuration in stream mitigation is convenient for achieving no net loss goals; it enables the comparison of impacts and compensatory mitigation using a metric of stream credits.

Because standard measurement systems are designed with intended users and uses in mind (O’Connell 1993; Timmermans and Berg 1997; Espeland and Stevens 1998) such systems vary in technological complexity (Espeland and Stevens 1998). The motivation behind creating a standard methodology is thus important (Espeland and Stevens 1998). Motivation shapes the accessibility of the method across social groups, and the applicability of the method across information types.

A standard method that is useful and accepted in one social setting is not necessarily useful and accepted in another (Timmermans and Berg 1997). In a regulatory setting, a legal or administrative requirement is often the motivation to create assessment methods. For these reasons, Timmermans and Berg (1997) describe standard assessment methods as *locally universal*. They are local in the sense that they only apply to a narrow geographic and/or social setting. They are universal because they are standard and useful to all members of a small group. Local universality captures the points that standardization "always rests on real-time work, and emerges from localized processes of negotiations and pre-existing institutional, infrastructural, and material relations" (Timmermans and Berg 1997, p. 275). "Material relations" here refers to the technical and practical working conditions (e.g. tools, time constraints, etc.) of group members. In the process of stream mitigation development and implementation, the St. Louis seeks to develop guidelines relevant for a specific geographic area, yet produce procedures that are standardized and useful. In this sense, St. Louis seeks local universality in establishing statewide methods to meet no net loss goals.

3.3 Problem Closure

The 2008 Rule provides guidance for St. Louis when they develop statewide stream methods in Illinois and Missouri. However, because the 2008 Rule is only guidance, St. Louis can decide what the constitution of the statewide methods should look like. In this section I discuss how St. Louis problematizes the creation of stream mitigation methods, including their format.

Before a solution to a problem can be found, one or all involved in the problem must agree on the nature of the problem itself. Often, "when one specific definition of a problem is used, this influences the generation of knowledge and reduces the attention given to alternative evaluations that may produce different knowledge" (Walker and Forsyth, 2008, p. 12). The closing off of some problems in preference of others is called *problem closure* (Forsyth and Walker 2008). Problem closure allows one group to direct others to find a "solution" that meets the interests and priorities of their choosing (Forsyth and Walker 2008). In developing guidelines for stream mitigation, the key for St. Louis is to ensure that their collaborating agencies focus on a problem defined by the Corps. In the process, other ways of framing the problem of compensatory stream mitigation, and other possible solutions, are marginalized.

The St. Louis Corps district approaches the development of statewide stream methods within the broader context of their duties and responsibilities. Environmental regulation is a relatively new duty for the Corps (Power 1977). Historically, the Corps has been responsible for maintaining river navigation and, since 1936, constructing levees and flood control structures (O'Neill 2006). The Corps did not assume environmental regulatory duties until 1976 (Hough and Robertson 2009). Corps districts can thus be described as "multiple-goal" agencies responsible for implementing multiple goals simultaneously (Biber 2009). The Corps's goals will often conflict with one another and therefore the agency will underperform on secondary goals relative to primary goals (Biber 2009). The potential conflict becomes apparent when noting that the Corps one the one hand is responsible for dredging waterways to keep them navigable—while on the other it is also responsible for reviewing dredge and fill permits on the grounds that these activities pose a threat to the physical, chemical and biological integrity of the nation's waters.

St. Louis, and all Corps districts, problematize Section 404 regulation with the intent "to balance environmental protection with sustainable development" (Corps 2006, p. 2). The Corps's form of sustainable development focuses on the socioeconomic benefits generated from permit activities (e.g. construction). For example, federal guidelines note that: "[a]ctivities authorized by [Corps] permits provide a wide variety of goods and services that are valued by society…" (Corps 2006, p. 47).

The Corps also aims to achieve environmental protection. The development of statewide mitigation methods is one way that the Corps works to achieve this goal. The 2008 Rule requires that Corps districts adopt functional stream assessment methods for determining physical, chemical, and biological impacts and compensations. There are no specific requirements for what these assessments should look like: "District engineers will determine the appropriate units for measure of…stream credits" (Corps and EPA 2008, p. 19633). St. Louis therefore decides what counts as "appropriate." In this case, an appropriate unit of measure for St. Louis is one that enables faster Section 404 permit review.

St. Louis's Problem: Issue Permits in a Timely Manner

No concern shapes the "practicability" of Section 404 compensatory stream mitigation as much as the amount of time it takes to issue a Section 404 stream permit (cf. Corps and EPA 2008). This is largely because, by law, Corps regulators are required to issue Section 404 permits in narrow timeframes (Corps and EPA 2008). In total, the word "timely" appears in the 2008 Rule no less than 30 times as a modifier for how guidelines provided in the 2008 Rule ought to be implemented (Corps and EPA 2008). Indeed, in addition to the potential ecological benefits, mitigation banking is the preferred method of compensatory mitigation because it streamlines the permit review process by requiring a single compensatory mitigation plan instead of one on a case-by-case basis (Corps and EPA 2008). There are three aspects of the permitting process that are problematic and limit timely Section 404 permit review for the St. Louis Corps. St. Louis collectively views these constraints as impediments to achieving Section 404 compensatory mitigation goals.

The first constraint deals with developing a consistent and predictable method for assessing stream credits for no net loss mitigation. An obstacle to timely permit review is the inability of permittees to know exactly what is expected of them when applying for a Section 404 permit. Prior to the 2008 Rule, regulators and applicants mainly determined mitigation requirements on a case-by-case basis. From St. Louis's perspective, a consistent and predictable crediting method will enable the public, regulators, and applicants to all know exactly what is expected of Section 404 permittees to meet mitigation requirements.

The second dimension of permitting that slows down permit reviews is the technical complexity of the assessment method. Corps regulators vary in environmental expertise, and few are environmental scientists in their own right. To this end, St. Louis wants to ensure that any regulator, and any Section 404 applicant (including non-experts), can simply and easily use the assessment method to streamline the permit process.

Finally, the third aspect of reviewing mitigation requirements that slows permitting is the time necessary to complete the credit assessment. Even if there is a method that is consistent, predictable, and accessible to non-experts, it must also be able to be completed in a short time frame. St. Louis is particularly interested in developing a method that can be used to assess stream credits in less than thirty minutes per application (Interview with ISGS scientist, 05/26/2015).

St. Louis's Solution: Develop a Rapid, Visual, Physically-based Stream Mitigation Method

St. Louis's solution to the problem of sluggish permit review is to develop a visual, physical, activity-based stream classification system that can readily be applied in Illinois and Missouri without the need for extensive technical training or expertise. This solution is supposed to help keep Section 404 permit reviews within The method cannot be too complex or require extensive data collection in the field because, "every regulator, resource agency commenter, farmer, consultant, private citizen, developer and so on throughout the entire state that may become subject to Clean Water Act 404 regulation will need [to be capable of using the approved method]" (St. Louis regulator, 03/02/2009).

Instead, St. Louis intends for the Illinois and Missouri mitigation methods to be completed using only desktop or secondary data sources. As Garrett Thompson of the Illinois State Geological Survey (ISGS) saw it, "It's meant to be done pretty quickly, pretty much office-based, [the St. Louis Corps] needed something [they] could do in half an hour. And [they] might have said that in specific" (Interview with ISGS researcher, 05/26/2015).

To "avoid reinventing the wheel" lead St. Louis agents collected existing Corps-approved stream methods from other Corps districts (Interview with St. Louis regulator, 07/15/2015). While St. Louis consulted other methods, they primarily used the 2002 Charleston Standard Operating procedures for stream mitigation as the basis for the 2007 Missouri method. The Charleston method is based on two fundamental assumptions that are much more uncertain than typically represented by Corps regulators: i) that similar permit activities always result in similar functional outcomes ("activity-based"), and ii) that enhancing physical diversity will always result in enhanced biological diversity and quality ("physically-based"). The methods are also designed to be *living documents*: given changes in federal or state rulemaking, application scenarios, agency policies and priorities, and on-the-ground experience, the methods should be adapted to these changes. Finally, St. Louis also intends the statewide methods to consolidate all Section 404 regulatory requirements into one document: "And the [St. Louis Corps], and other agencies as well as us, we'd like to see stream mitigation [the Illinois method] to be the fix for everything—a one stop shop—for stream assessment and stream mitigation. That's what it's designed to do—be a rapid assessment protocol" (Interview with Illinois EPA regulator, 05/13/15).

3.4 Group Formation and Role Allocation

The second step of problematization is to form a group and allocate roles (Callon 1984). Role allocation is important for translation because it establishes what is expected of group members when creating state-specific mitigation methods. St. Louis wants to encourage buy-in to the notion that Section 404 permits need to be issued rapidly, consistently, and using non-expert techniques. To do so, St. Louis relies on pre-existing agreements to establish agency roles. Embedded within these agreements are not only decision making protocols, but shared policies amongst agencies. St. Louis also uses these planning agreements to emphasize a shared permitting burden and therefore to encourage others to accept their approach to stream credit assessments. St. Louis's intent is to create a mutual sense that permits need to be issued rapidly, and that its solution is the best case scenario at present.

The most important joint planning agreements at the federal level are Memorandums of Agreement (MOAs). MOAs establish clearly demarcated decision making roles to settle disputes over authority in a jointly regulated context (Hough and Robertson 2009). The MOA of 1992 between the Department of the Army and the EPA is one example: "Purpose: Establish policies and procedures to implement Section 404 (q) of the Clean Water Act to "minimize, to the maximum extent practicable, duplication, needless paperwork and delays in the issuance of permits.’”” (Corps and EPA 1992, p. 1). The MOA goes on to describe the duties that the Corps and EPA play in permit decisions.

In addition to MOAs and joint-planning agreements, St. Louis narrowed participant input to the development of stream mitigation guidelines by inviting individuals to participate as “experts” on specific topics. For example, St. Louis invited many individual group members based on their previous experience in mitigation, wetland science, stream science, and a combination of these fields. The purpose of doing so was to “lock” participants into pre-defined roles to control the focus of conversations during method development.

Missouri Stream Assessment Team Formation

The membership and roles of the Missouri Stream Assessment Team evolved out of cooperation amongst all Corps districts in Missouri. Missouri has five Corps districts: St. Louis, Kansas City, Rock Island, Little Rock, and Memphis. The Chiefs of each district meet a few times a year to discuss issues related to standardizing Corps regulation in Missouri. A concern that emerged from these discussions was the need to develop a statewide stream mitigation method. The group in charge of creating this method, called the Stream Assessment Policy Development Team (or Stream Assessment Team for short), first convened in 2004. The group aimed to develop a statewide stream method for Missouri. To meet this goal, the group modified South Carolina’s method to suit regulatory requirements in Missouri. The second Missouri SAT reconvened in 2010 to improve the first version.

Corps district Chiefs determined the membership of the Missouri team. All members selected are involved in the IRT and/or are in the process of generating new joint planning agreements. As a representative to the Missouri DNR put it: "The use [and development] of the Missouri [stream mitigation] [m]ethod is central to the Joint Planning Agreement we are trying to develop with the Corps districts to facilitate faster turn-around on permits" (Missouri DNR agent, 10/31/2011). Team members include representatives from all state agencies in Missouri that review Section 404 permits and mitigation work: each Corps district in Missouri, US EPA Region 7, US Fish and Wildlife Service (USFWS), Natural Resources Conservation Service (NRCS), Missouri Department of Natural Resources (MDNR), and the Missouri Department of Conservation (MDC). The Missouri Department of Transportation (MoDOT), a non-regulatory member, was included because MoDOT conducts their own mitigation work and frequently requires Section 404 permits.

The two Missouri SAT's had different objectives and focuses when developing a statewide method. The 2007 Missouri method began as a modified version of the Charleston stream mitigation method. As Craig Gerson of the St. Louis Corps explains: "Little Rock said 'Hey in Arkansas we are putting a stream mitigation method together that we got from Charleston.' So, instead of recreating the wheel—[the problem then became]—how do we uniquely fit [the Charleston method] to the state of Missouri—in terms of stream types and project types" (Interview with St. Louis regulator, 07/15/2015). The formation of meetings therefore began as a set of questions: What about the Charleston method suits the regulatory context in Missouri, and what about this method does not apply? St. Louis therefore assigned group member roles according to the focus on stream types and project types. St. Louis encouraged the first Missouri SAT not to change the ratios/credit values of stream credits in the Charleston method. It justified its position on the grounds that: "the ratios were developed in trial and error, in Charleston, and so we didn't see why we should change them unless we had a significant justification to do so" (Interview with

MDNR regulator, 08/17/2015). By contrast, St. Louis encouraged the second SAT to consider changing credit values (Interview with MDNR regulator, 08/17/2015).

St. Louis organized the member roles on these two SATs under the overall presumption that the method would be developed in a trial-and-error fashion. Members of the 2004-2007 SAT needed to determine what parts of the Charleston method should be included or rejected. Team members reviewed the Charleston method to identify how it could fit into Missouri's regulatory setting. The second Missouri SAT convened in 2010 after three years of feedback from state and federal regulators, Section 404 applicants, mitigation bankers, and the general public. The primary question that the second Missouri SAT focused on was: How can numbers or wording in the 2010 Missouri method be changed to ensure that mitigation results in more in-kind mitigation and that the method is used consistently? Hence, in the second Missouri SAT, St. Louis asked members to provide input regarding mitigation types, examples of inconsistent method use, and ways to clarify the objectives of the method.

Illinois Stream Assessment Team Formation

While the motivations for creating the Illinois and Missouri SATs were similar, the Illinois SAT convened under different circumstances than Missouri. St. Louis convened the first Illinois SAT in 2008. Unlike Missouri, there is not a strong history of statewide coordination amongst the Corps districts in Illinois. Illinois is composed of four Corps districts: St. Louis, Rock Island, Louisville, and Chicago. St. Louis invited each of these districts to participate on the Illinois SAT, but participation by all Corps districts has been limited. The first Illinois SAT had a broader membership than the Missouri SAT; members included regulators, Section 404 applicants, and scientific experts. St. Louis included a broader membership in Illinois to not only provide regulatory input, but also technical input to improve the quality of stream compensation. The academic and professional scientists participated to provide input of “whether or not [the Illinois method] is scientifically sound” (Interview with ISGS researcher, 05/26/2015). Illinois DNR biologists also provided scientific input. St. Louis included participants to fill the role of determining the “practicability” of the mitigation guidelines; a method could only be accepted if it enabled faster permit turnarounds, and not at all if it caused frustration in the permit community (Personal communication with St. Louis regulator).

The original membership list on the Illinois SAT included regulators and scientists that work for: St. Louis, Rock Island, and Louisville Corps districts, federal EPA Region 5, U.S. Fish and Wildlife Service (US FWS), Illinois EPA (IEPA), Illinois DNR, Illinois Department of Transportation (IDOT), state and federal Offices of Surface Mining (OSM), the Illinois State Water Survey (ISWS), and the Illinois State Geological Survey (ISGS). During the second round (from 2010 onwards), the list expanded to additionally include an academic researcher at the University of Illinois. In total, at least thirty-five different people were involved in e-mail correspondence, in-person meetings, conference calls, or giving comments and guidance during draft editing since 2008.

St. Louis organized the Illinois SAT with the intent of mimicking the trial-and-error process used in Missouri. This goal has not been met for a variety of reasons. First, even though the 2010 method is publicly available, it is not used regularly in all districts. Second, when the method is used, there is little feedback given to improve standardization to the Illinois context. For these reasons, St. Louis has been more successful at coordinating method development in Missouri than Illinois.

3.5 Development Timeframe of the Illinois and Missouri Methods

The Missouri and Illinois SATs faced different issues in trying to complete statewide methods in a timely manner. The Missouri Board of Directors of Corps districts formed the Missouri SAT in 2004. The Missouri SAT met regularly between 2004 and 2007. The first draft of the Missouri method would have been completed sooner, but Corps regulators had to assist in recovery after Hurricane Katrina in 2005. The first Missouri method was in place and used across Missouri from 2007 until 2010. Based on comments from regulators, applicants, and citizens, the Missouri SAT re-convened in 2010 to improve the method. The second Missouri SAT met eight times between 2010 and April 2013. This group took three years to complete the method because of a couple six-month hiatuses by the lead Corps participants who were required to assume other work duties. The Board of Directors approved the second Missouri method in April 2013.

St. Louis formed the Illinois SAT in 2008 out of an interest to duplicate the success in Missouri. The first Illinois SAT met semi-regularly in person and over phone between December 2008 and April 2010. The first Illinois SAT also met at a field site to test an initial draft of the Illinois method in Shelbyville, Illinois on January 28th, 2009 (ISGS Researcher, 05/26/2015). The first draft Illinois method has been the only method publicly available. The second Illinois SAT has met much less frequently than the first SAT: "Truthfully it's been pretty infrequent. It's been one or two meetings a year and most of these have been teleconference... I know it's been going on two years since we had the last one... It hasn't been the most active effort" (Interview with IDNR regulator, 07/07/2015).

When asked why so little progress has been made since 2010 on improving or modifying the Illinois method, even though the Illinois SAT is still loosely in existence, the St. Louis regulator leading the Illinois SAT (Will Jones) pointed to two factors. First, Jones doesn't see the benefit of working hard on coordinating the group and planning meetings if the method is not going to be used widely and consistently. Initially, only St. Louis and Rock Island used the Illinois method, however not exclusively. Rock Island also used the Missouri method. Louisville and Chicago, by contrast, based stream mitigation primarily on length and acreage-based crediting.

Second, Jones considers that he "probably let too many people in the group." This second point suggests that there was not a consistent voice organizing the Illinois SAT to establish a standard, statewide method. Compared to Missouri, St. Louis developed the 2010 Illinois method with input and comments from 11 agencies (including 5 non-regulatory agencies), while the 2013 Missouri method was developed with input and comments from only 7 agencies (including 1 non-regulatory agency). Furthermore, compared to Missouri, the members of the Illinois SAT included many individuals that do not work in regulatory positions. Therefore, the suggestions that they made were often from a non-regulatory perspective and thus not always consistent with the regulatory scope that St. Louis sought to maintain when developing the Illinois method. Figure 3.1 summarizes the timeline of notable developments during the creation of the Illinois and Missouri methods since 2004.

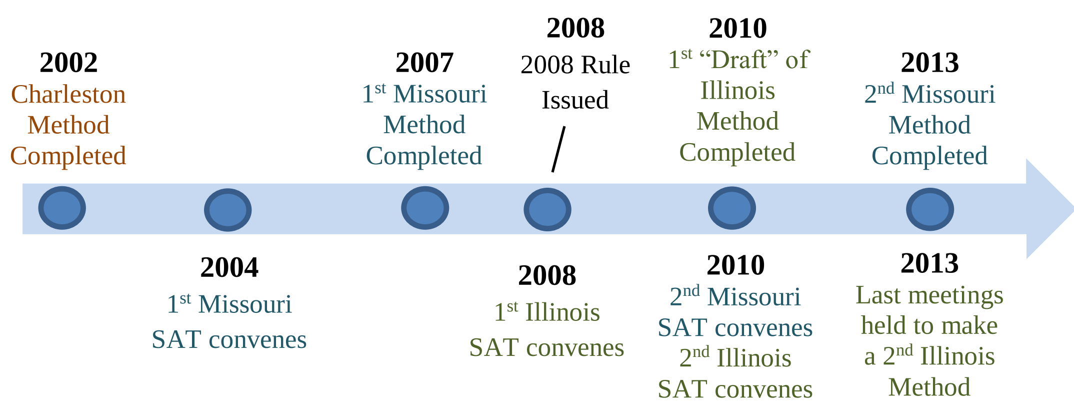

Figure 3.1 Timeline of the development of the Illinois and Missouri methods.

3.6 Missouri Method Development Process

The Missouri SAT created the Missouri stream mitigation method in two phases. In phase one, St. Louis focused the SAT on ensuring that the method referenced and was consistent with relevant state laws, regulations, and guidelines. For this reason, the changes made to the initial drafts consisted mainly of additions and removals. The SAT added references to state statutes, rules, and guidelines. The SAT also removed any reference to South Carolina, including special-case mitigation in coastal zones. The SAT added Missouri state resource lists to index vulnerable, protected, or other priority state waters. State resource lists—such as Missouri DNR and Missouri DC priority water lists, water quality surveys, and aquatic life surveys—make up the bulk of the biological and chemical components of no net loss analysis. Because the Missouri stream mitigation method would be a new guidance, and because it was being created by all regulatory agencies involved in the 404 process, members largely felt included. Compared to prior approaches to stream mitigation, Missouri SAT members considered this new method to be a great idea: "In the past you do not know what's going on. [The Missouri method] is repeatable, it's consistent, it gives some good recommendations, it gives more credit for certain areas than others so it tries to focus mitigation; it's there, it's out in the open, and everyone can see it. You can more easily communicate to permittees—everyone is held to the same requirements" (Interview with EPA Region 7 regulator, 07/09/2015). All Missouri SAT members interviewed shared similar sentiments, even if they disagreed with specific details.

The second Missouri SAT reviewed the Missouri method for both its usefulness and to determine whether or not the credit values "worked" for Missouri. These discussions, more so than the first round of discussions, focused on how well the Missouri method equates impacted and mitigated streams. While all agencies bought into the need for a standard and consistent method, they did not easily agree on what was appropriate to meet no net loss requirements. To demonstrate these tensions, this section elaborates on four decisions made during the development of the second Missouri method: i) adding User Notes, ii) modifying the cumulative impact factor, iii) changing the credit value of riparian corridor tree plantings and in-channel habitat restoration, and iv) ensuring buy-in by all Corps districts. These four are not an exhaustive list of cases that display how the SAT created the method; nor do these decisions wholly represent all members of all agencies. They demonstrate the primary data, decision-making protocols, and opinions that emerged during method creation.

User Notes

St. Louis, and other SAT members, were concerned that the Missouri method was not being applied *as designed* between 2007 and 2010. In many instances when state and Corps regulators reviewed application data, they could not figure out how an applicant came up with their total credit value required for mitigation. At the same time, some applicants repeatedly consulted with state and federal regulators to understand how they are supposed to use the method. To ensure more consistent and efficient use, the Missouri SAT added user notes. User notes amount to directions for appropriate use of the method. For example, the SAT added one user note to the 2007 Missouri method to ensure appropriate assessment of impact activities: "***User Note:*** *Armoring of the stream bed and banks with riprap or installing a retaining wall along both channel banks should be assessed as a "Morphological change"* (2013 Missouri method, p. 9, bold and italics in original).

Cumulative Impact Factor

While the Missouri method is intended to assess stream functions, the *length* of a stream impact remains a primary component. An assumption of the Missouri method is that the overall damage caused by impact activities partially depends on the length of stream impacted. To account for this issue, the method includes a cumulative impact factor. In the 2007 Missouri method, the cumulative impact factor is included as a linear impact factor. This means that the longer the project, the greater the "cost" of credits assigned to the project. In the method, this happens by requiring project length to be multiplied by the linear impact factor. This "cumulative impact factor" is then added to all other impact values to account for scale of impacts on streams. In the 2007 Missouri method this factor is broken into five classifications: impacts less than 100 feet have a cumulative impact factor of 0, impacts between 100 and 200 feet long have an impact factor of 0.05, impacts between 201 and 500 feet have an impact factor of 0.1, impacts between 501 and 1,000 feet have an impact factor of 0.2, and impacts greater than 1,000 feet are credited with a factor of 0.1 for every 500 feet (Figure 3.2).

Linear Impact	<100' 0	100'-200' 0.05	201-500' 0.1	501-1000' 0.2	>1000 linear feet (LF) 0.1 reach 500 LF of impact (example: scaling factor for 5,280 LF of impacts = 1.1)

Figure 3.2 Linear impact factor multipliers in the 2007 Missouri stream mitigation method.

This factor was problematic for Missouri regulators during the 2007-2010 trial period. In particular, the Office of Surface Mining and large mining projects voiced concerns that the cumulative impact factor alone made projects cost prohibitive. Members of the Missouri DNR and Corps districts were willing to change the value of the cumulative impact factor because they did not feel that the categories were not grounded in scientific evidence. In response, the Missouri SAT adopted a single multiplier to account for cumulative impacts. Not all agencies agreed with the basis for a single multiplier. Like the original linear impact factor, some US EPA, US FWS, and Missouri DC members pointed out that the multiplier value is still arbitrary. To defend the value selected for their single multiplier, members of the Missouri DNR and Corps relied on three pieces of evidence that together worked to cast their decision as rational.

First, the Missouri DNR views this value as one that reflects science. In their opinion, beyond some length, stream impacts stop causing *more* damage. This idea is based on hypothetical comparisons: what is really the difference to stream function if a stream impact is 4,500 or 4,900 feet long? From the perspective of the Missouri DNR, in both cases, damage is significant but there is not *that* much more damage beyond some distance (Interview with Missouri DNR, 08/17/2015). This assumption is based on the idea that stream impacts are non-linear; i.e. the "value" of impacts do not increase at a consistent rate with length of impacts. Beyond some distance, the "damage" does not accrue as rapidly as over shorter distances (Interview with Missouri DNR, 08/17/2016). The Missouri DNR did not provide a direct citation for this justification, but urged others to take their word for it.

Second, St. Louis and the Missouri DNR justified this single multiplier value because it struck a "balance" across project types and stream types. The Missouri SAT compared the credit results for multiple hypothetical stream projects in Missouri. The SAT selected the exact value of 0.0002 for the cumulative impact factor to ensure that typical impact and mitigation activities *all* resulted in a net gain of stream credits. In doing so, the Missouri SAT could claim that their method results in no net loss of stream credits statewide.

Third, the financial impacts of this new multiplier are limited; costs decline only modestly for large-scale projects. In a hypothetical case of filling a stream for one mile, the 2007 method requires 29,040 stream credits, while the 2013 method requires 28,807.68 credits for the same impacts. The similarity in costs, paired with the two explanations provided, largely alleviated the Corps and Missouri DNR of claims that they were too flexible and responsive to applicants.

In-Channel and Riparian Corridor Credit Worksheets

Compensatory stream mitigation can occur through one of two groups of activities: i) in-channel work, or ii) riparian corridor work. In Missouri, compensation requirements are usually met using a combination of these two activities, irrespective of the impact activity. Members of the Missouri SAT do not all agree that in-channel impacts should be allowed to be off-set by riparian corridor work. The spectrum extends between those who believe all mitigation needs to be in-kind (e.g. some US FWS workers), to those who think that mitigation should, at least, just improve the environmental quality of streams (e.g. some Corps regulators). For those in the latter group, while no net loss and in kind mitigation are a goal, they are required by law to *issue* permits; not to review them and deny them if they are not providing in-kind mitigation.

On the whole, the Missouri SAT agrees that mitigation should be *more* in-kind. To encourage in-kind work, the Missouri SAT de-valued riparian corridor plantings relative to in-channel activities. For example, in the 2007 method, if an applicant restored (51-100% planting) a 100-foot-wide buffer on one side of a stream, they would generate 1.6 credits. The same riparian work generates only 0.7 credits in the 2013 method. Likewise, in the 2007 method, an applicant would earn 2.0 credits for "good" in-channel work. "Good" in-channel work generates 2.4 credits in the 2013 method. Anecdotal evidence suggests that this change in numbers is beginning to work, and compensatory stream mitigation is beginning to include more in-channel work in Missouri (Interview with Missouri DC, 08/17/2015).

Resistance to Adopting the Method

Despite the coordination across all five Corps districts in Missouri, not all five were on board for adopting a statewide stream method. The Little Rock district especially resisted method development early in the process. They resisted because adopting a Missouri-specific method would require their regulators to issue two sets of stream mitigation guidelines: one that applies only to the Missouri portion of their district, and another that applies to the rest of their district outside of Missouri. However, this dispute did not last. Eventually the other Corps districts pressured Little Rock enough that they committed to the joint planning agreement.

3.7 Illinois Method Development Process

St. Louis directed the Illinois SAT to develop the Illinois method by focusing on the same questions as Missouri: what about the method needs to be changed to meet Illinois-specific regulatory requirements, and what about the method needs to be changed so that the credit values "work" in Illinois? St. Louis was more effective at achieving these goals during the first Illinois SAT than the second Illinois SAT for a variety of reasons.

The first Illinois SAT, like the first Missouri SAT, offered a first step towards providing a solution to a problem that many regulators agreed existed. Prior to the Illinois method, regulators conducted stream mitigation in an ad hoc fashion district-by-district. Districts used different metrics (length or acreage-based) for calculating compensatory stream offset requirements. The Illinois method, by contrast, offered a single way to calculate stream credits statewide. Charles North of the Illinois DNR put it this way: "Prior to this everything was pretty much case- by- case, seat of the pants, professional judgment...This is something that was documented. To me it was fair to the regulated community because they could see it and know up front what was required of them. And on the other hand the regulating community—the Corps—had something that would hopefully stand up in court because some of these are appealed and taken to the legal arena and all that" (Interview, 07/07/2015). All Illinois regulators interviewed shared the sentiment captured in this quote—including the Illinois EPA, other Illinois DNR regulators, and St. Louis regulators.

The first Illinois SAT developed a draft Illinois method in just over 15 months. The goal, as was the case in Missouri, was for each Corps district in Illinois adopt the method for a 6-month trial period. The trial period was supposed to be followed up with future meetings and rounds of development of the Illinois method. However, the second draft of the Illinois method remains unfinished. Despite the overall consensus by state regulators that a standard method is needed, there are disagreements over what a "useful" method for assessing no net loss of streams should look like. To illustrate these tensions, this section discusses two aspects of St. Louis's steering of the Illinois SAT: i) disagreement over what is necessary to make the method *applicable* and ii) how St. Louis steered discussion from the scientific aspects and back to the application aspects of the method.

Making a Method that is Applicable in Illinois

The Illinois SAT completed the first draft of the Illinois method under the assumption that it would work for all districts and regulators in Illinois. However, six years later, it is still not fully adopted or implemented statewide. Even when it is adopted and implemented, not all regulatory agencies completely agree that it is sufficient at assessing no net loss of streams according to their requirements. This sentiment is especially true of the Illinois EPA. Illinois EPA regulators participated in making the Illinois method since the beginning. Still, not all Illinois EPA regulators are comfortable with the Illinois method.

Federal law requires that Section 404 permits also undergo Section 401 water quality review. In Illinois, the Illinois EPA administers Section 401. The Illinois EPA's primary authority derives from Illinois Administration Code 302.105—"Antidegradation." By rule, the EPA (and Illinois EPA) regulate water body *use* not *function*. Therefore, IL Admin. Code 302.105 provides legal authority for the Illinois EPA to evaluate water quality certification within the scope of whether or not a proposed activity (e.g. utility line construction) will result in degraded *uses*. Uses include "existing uses" (e.g. a recreational stream), "outstanding resource waters," and "high quality waters." Antidegradation assessments require assessment of the potential pollutant load increases of specifically identified water bodies. The Illinois EPA sees a statewide Section 404 stream mitigation method as advantageous only if it can be enforced by the Illinois EPA.

As it stands, some Illinois EPA regulators see the current Illinois method draft as lacking in a chemical assessment that meets their antidegradation requirements. To fill this gap, some Illinois EPA participants on the Illinois SAT "provided language for the method…to put in some caveat that requires applicants to do watershed size delineation and incorporate chemical monitoring or chemical sampling as well" (Interview, 05/13/2015). Since the 2010 draft does not include these requirements at a level that conforms with Illinois EPA standards, it still remains an unaddressed concern. The Illinois EPA is concerned about this lack of a chemical-information requirement because, ultimately, the burden falls on the applicant to provide this information at a later date: "If the [Illinois method] doesn't include the chemical data up front the applicant is going to have to back pedal" (Interview, 05/13/2015). Thus, the Illinois EPA argues that unless the method addresses Illinois EPA regulatory requirements to begin with, the application process will slow down.

St. Louis was hesitant to require *any* data collection and monitoring. To require data collection would delay the permit process further and limit the potential pool of method users. At the same time, however, to not include some required form of chemical analysis will also lead to permit delays. St. Louis regulators expressed frustration with the Illinois EPA requirements because it is their duty (by law) to issue Section 404 permits in a timely manner. However, as long as Illinois EPA requirements are not included as required steps during method completion, the Illinois method will not be completely useful for Section 404 permitting in Illinois.

Keeping the Method State-Specific and Limiting Scientific Requirements

St. Louis organized the Illinois SAT with the express purpose of not only crafting the method to meet state regulatory requirements, but also to ensure that the method is scientifically defensible. In practice, however, St. Louis repeatedly dismissed scientific principles suggested by state regulators and stream scientists. Scientific suggestions were rejected on the ground that they were too complex and would limit who could actually use the Illinois method. Scientists making these suggestions shared a concern that the Illinois method lacks the methods and means to assess no net loss of stream *function*. In the end, the method could still become standardized despite disagreement from state scientists because most (excepting some in the IDNR) are not regulators and therefore do not have say over Section 404 permit reviews and issuance.

Illinois DNR, Illinois SGS, Illinois SWS, and University of Illinois scientists all questioned the scientific basis of the stream classifications in the method in at least two ways. First, the scientists questioned the validity of the definitions used to classify stream types. Second, and equally important, these scientists also questioned the *method* by which stream function was "assessed" with the Illinois method. As the method is designed, an applicant needs to determine

“Stream Type” and “Existing Condition”, among other classifications, to determine the net damage that occurs due to impacts. Stream Type is broken into three categories: Ephemeral/Intermittent, Intermittent Streams with Seasonal Pools, and Perennial. The purpose of this three-tier classification is to efficiently prioritize streams according to biotic habitat functions (Interview with IDNR regulator, 07/07/2015). This classification is rooted in hydrology: how often and in what amount is the channel filled with water? The basic assumption is that without water year-round it is unlikely that the stream channel provides continuous biotic habitat (Interview with IDNR regulator, 07/07/ 2015).

The Illinois method does not require any specific information to assess Stream Type. The primary methodology is *visual*, and not even necessarily repeated visual assessments. Hence, all an applicant needs to do is walk up to a stream and look at it and decide: is there water in this stream? Are there seasonal pools in this stream? Does it have water normally year-round? Scientists who provided input to development of the guidelines felt that the definitions were ambiguous and that the visual approach to determining stream type was insufficient When some asked to change the definitions, St. Louis ultimately refused on the grounds that the definitions of Stream Type are a matter of federal rules and regulations.

Scientists were also disgruntled by the visual assessments used to determine Existing Condition. The Existing Condition factor is extremely important because it is the only way that the method assesses the baseline condition of a stream prior to improvement or impacts. Like Stream Types, Existing Condition is assessed along purely visual lines and does not require data collection. For example, to determine if a stream is “Fully Functional,” the applicant needs to show that the stream “has not been channelized, leveed, impounded, or artificially constricted” (ISMM 2010, p. 5). Physical channel form and the presence/absence of human modifications (e.g. is there a culvert nearby?) are used as proxy information in assessing physical, chemical and biological stream functions.

To provide a more rigorous scientific basis for classification and assessment, scientists suggested alternative methods. Most recognized that large scale, long term monitoring was not realistic within the scope of assessment. However, as a middle ground, scientists suggested semi-rapid assessment methods that could begin assessing stream functionality in a "more" scientific way. Three suggested additions made during the creation of the first draft of the Illinois method included: adding a Qualitative Habitat Evaluation Index (QHEI) (Ohio 2006), a Channel Stability Index (CSI), and a Stream Power/Erodibility index of some kind.

St. Louis refused to accept these and similar methods as requirements for stream assessments on the grounds that:

> "… the Corps issues 7,000 to 8,000 permits a year in Illinois. This may also lead to more arguments and challenges between the regulated community and the Corps on making qualifications of what a CSI score of 10 or a QHEI score of 45 actually is. I doubt if many regulators or resource agencies have the appropriate knowledge base to use CSI or QHEI in this fashion. With permitting timeframes mandated by law, 120 days for individual permits and 45 days for nationwide permits, that's going make for a tough task to implement effectively. I think if we put it out to the public as is, industry will highly scrutinize the other methods and process looking for irregularities that may cause problems down the road." (St. Louis regulator, 03/02/2009)

St. Louis limited the technical complexity of the Illinois method. St. Louis allows non-experts to conduct stream assessments because they do not require complex data collection and processing to assess stream functions. By doing so, the Corps feels the Illinois method is accessible to a broad segment of the regulatory community.

In the end, the standardization of the Illinois method can occur or fail irrespective of the opinion of state scientists. This is because many of the scientists involved in the Illinois SAT were not regulators. These professionals had no actual involvement in the Section 404 process. Instead, these scientists were invited as outsiders to provide information to make the Illinois method more scientifically sound. Therefore, even if non-regulatory scientists continue to protest the legitimacy of the Illinois method, the Corps and other regulatory agencies can ignore their protest because non-regulatory scientists do not have a say over the issuance of Section 404 permits.

3.8 Conclusion

The St. Louis Corps district steered the development of the Illinois and Missouri methods on the basis that all Section 404 permit community members should be able to readily use the methods. St. Louis approached the creation of statewide stream methods within the context of their prioritization of work duties. The Corps are multiple-goal agencies, and environmental protection is not their primary goal or duty. St. Louis developed the Illinois and Missouri methods with these working needs in mind by ensuring that the methods created shorten the time necessary for Section 404 permit review. In turn, the current Illinois and Missouri methods are not based on scientific assessment methods and do not ensure no net loss of stream functions.

The Illinois and Missouri methods are designed to be rapid assessment methods that do not require data collection. Since the methods are also supposed to meet no net loss requirements, St. Louis modified the value of stream credits within the methods to maintain an overall balance of stream credits across impact and mitigation projects. No numbers were changed that resulted in a net loss of stream credits across hypothetical project types. In the end, St. Louis achieved its goal of making a rapid, visual, physical and activity-based assessment method that anyone could use. However, the methods are not fully standard in both Illinois and Missouri, and therefore St. Louis has not yet achieved the goal of creating statewide methods in both states.

The Missouri SAT and regulatory community bought in to St. Louis's goals from the beginning—even with some dissent from a couple Corps districts. Leaders of the SAT stymied this dissent on the grounds that all Corps districts in Missouri, as well as the Missouri DNR, needed to commit to a joint planning agreement intended to streamline Section 404 permit reviews. The suggestions put forward by the Missouri DNR largely fell within this agreed scope and therefore they were influential in developing the statewide Missouri method.

By contrast, St. Louis organized the Illinois SAT without coordination across all Corps districts in Illinois. St. Louis encouraged other Corps districts to participate, but in the end only Rock Island and Louisville provided input during the development process. Chicago was largely absent. Even without this coordination, all regulatory members of the Illinois SAT agreed with the overall need to standardize stream mitigation in Illinois. State agencies, including the Illinois DNR, DOT, and EPA were all active and provided input throughout the development of the Illinois method. The Illinois SAT also maintained membership by state and academic scientists that had no regulatory responsibilities.

This study has demonstrated the applicability of Callon's (1984) *sociology of translation* model to the implementation of federal guidelines at state and district levels. St. Louis's inability to establish a widely-accepted stream mitigation method in Illinois can be explained by Callon's (1984) model of translation. First, St. Louis established a narrow problem scope (the need to issue Section 404 permits faster) and provided a solution (a statewide rapid, visual stream assessment method). Second, St. Louis organized the Stream Assessment Teams according to pre-existing planning agreements. Their intent was to generate consent and agreement among SAT members ("interess" and "enroll") with their proposed solution. Translation also helps to explain St. Louis's failure to encourage all Corps districts in Illinois accept the method. According to Timmermans and Berg (1997), standardization is best achieved when the standard method reflects the working priorities and needs of all parties. In Illinois, not all Corps districts wholly participated in the process because they saw an additional standard to be a burden on their working needs. In addition, the Illinois EPA has not fully embraced the Illinois stream mitigation method because it lacks sufficient chemical data analysis. Thus, the draft Illinois method does not wholly match regulatory priorities of regulators across Illinois. In effect, the Illinois stream method has not become standard to the extent that the Missouri method has in Missouri.

CHAPTER 4

MOBILIZING THE ILLINOIS METHOD AND THE 2008 RULE

4.1 Introduction

Corps regulators are charged with the duty of issuing Section 404 permits in a timely manner while limiting the overall environmental damage caused by the permitted activity. The primary mechanism through which Corps regulators exercise control over the environmental impacts of a proposed project is the *mitigation sequence*. Mitigation includes three requirements: avoidance, minimization, and compensation (Hough and Robertson 2009). Once an applicant has demonstrated an effort to avoid and minimize impacts, and the impact remains significant, applicants are required to compensate for their impacts (Hough and Robertson 2009). While compensation has only been required for 10 percent of permits nationally between 2010 and 2014 (IWR 2015), it remains the most interrogated aspect of the mitigation sequence (Bronner et al. 2013; except, see Clare et al. 2011).

The focus on compensation is not unjustified. Compensation is the only way Corps regulators can require applicants to "make up" for permitted impacts. While authors suggest that Corps regulators are given too much flexibility when determining compensation, these reports are primarily hypothetical and are not based on empirical evidence (e.g., Murphy et al. 2008; Bronner et al. 2013). It is necessary to trace the decisions made by Corps regulators to better understand the extent to which individual discretion shapes compensatory requirements, and also how the permit review process acts as a check to individual discretion.

The conditions in which Corps regulators assess stream impacts and decide Section 404 permits is largely responsive to the type and location of Section 404 impacts. The process begins when an applicant proposes a project by submitting a permit application. From there, Corps regulators must suggest environmentally positive alternatives, determine if compensation is necessary, and calculate the required amount of compensation. In this way, Corps regulators are significantly constrained at achieving significant environmental protection by the project type and location on a case-by-case basis. Rather than having a strong say over when and where impacts occur, Corps regulators must make the best of the proposed project by a developer. Corps regulators do so using regulatory guidelines.

Corps regulators increasingly determine compensatory stream requirements using standard assessment methods created at the district level. These methods are designed to meet the simultaneous needs of Corps regulators: work towards environmental protection and issuing permits in a timely manner. The highest environmental protection goal is no net loss of stream function. However, Corps regulators also rely on policies and guidelines outlined in the 2008 Rule when establishing compensatory mitigation requirements for proposed impacts. The outcomes of Section 404 mitigation thus depend on a) the type and location of stream impacts, b) the demands made by Corps regulators of Section 404 applicants, and c) the responsiveness of applicants to the Corps's demands.

This chapter argues that Corps regulators steer the permit review and impact credit assessment process with the overall goal of streamlining the permit review process. Corps regulators rely on information that applicants generate during the application process to assist in determining the overall environmental degradation that will result from projected impacts. Section 404 stream credit assessments amount more to an exercise in subjective environmental assessment than objective functional assessment. This argument is made using the extended case study approach to examine how a Corps regulator a) negotiates and coaches an applicant through a

Section 404 application, and b) conducts stream credit assessments for compensatory mitigation purposes using the Illinois stream mitigation method. Section 2 introduces the primary factors involved in mobilizing the 2008 Rule and the Illinois stream mitigation method. Section 3 discusses details of the Section 404 permit which serves as the case study for this chapter. Section 4 demonstrates how Corps regulators steer Section 404 permit applications to streamline the entire permit review process. Section 5 demonstrates that using the Illinois method is a subjective process that is not uniform across users. Section 6 concludes this chapter by summarizing the main findings.

4.2 Mobilizing a Standard Method of Stream Value: Not by the Protocol Alone

The final phase of translation in Callon's (1984) model is *mobilization*. Mobilization entails actors actually "doing" their assigned roles. The fundamental question that pertains to mobilization is "are the spokesmen representative?" (Callon 1984, p. 12). Mobilization is the "litmus test" for the degree to which a central authority effectively encourages socially diverse groups to implement tasks in similar ways. This chapter focuses on two moments of mobilization: a) when Corps regulators rely on the 2008 Rule and other guidance during Section 404 permit application review, and b) when regulators or permittees use the Illinois stream mitigation method to define the stream credit value of impacts.

Mobilization of the 2008 Rule during permit review

The 2008 Rule is designed to be implemented flexibly on a case-by-case basis (Bronner et al. 2013). The individual policies and guidelines presented in the 2008 Rule are meant to be ideal targets. Not every goal or guideline in the 2008 Rule is required for each instance of Section 404 compensatory stream mitigation permitting. Mitigation plans and impact assessments can be implemented in different ways at the district level (Bronner et al. 2013).

Section 404 regulators are supposed to balance two over-arching priorities when reviewing permits. First, all permits are required to be reviewed and issued in a timely manner (Corps and EPA 2008). Corps regulators are under pressure by federal rules and district regulatory Chiefs to simplify and streamline the regulatory process that land developers face whenever possible. Second, the environmental impacts of permits must also be considered. Permits can only be issued if the development plan demonstrates overall limited environmental impact (Corps and EPA 2008). Thus, Corps regulators are simultaneously pulled in two directions: they must issue permits rapidly, but they must be certain that the permitted activity does not result in significant and lasting environmental degradation.

Mobilization of the Illinois stream mitigation method during permit review

The Illinois stream mitigation method is designed to be useful for both regulators and applicants. Most users of the Illinois stream mitigation method have limited experience in stream sciences; mitigation bankers and regulators themselves may only have training in related environmental fields. Therefore, since most users have limited training, the method is designed to be accessible to non-experts.

The Illinois stream mitigation method is intended to provide general guidance, rather than be a detailed manual on mitigation practices. Therefore, rather than mobilization being determined by correct use of specific mitigation methods, the commensuration of stream functions depends on the context of mitigation, the expertise and resources of the individual user, as well as the preferences of Corps regulators. Thus, outcomes resulting from application of the stream mitigation method are both intentionally and unintentionally open-ended. open-ended.

Aspects of credit assessment are intentionally open-ended because of "practicable" concerns with applying the 2008 Rule across a range of permitting scenarios nationally (Corps and EPA 2008). The Illinois and Missouri stream mitigation methods are a form of "guidance." Guidance documents are "guidelines written to give broad advise [*sic*] on procedure instead of precise requirements and standards" (Black's Law online dictionary[4], emphasis in original). As guidance documents, the Illinois and Missouri stream mitigation methods do not give specific requirements for how classifications and definitions are supposed to be assessed or determined. Instead, these mitigation methods are applied on a case-by-case basis. The hypothetical strength of this flexibility is that, given a unique and complicated ecological circumstance, the mitigation method can still be used to calculate the value of a stream in the metric of stream credits.

At the same time, the Illinois and Missouri stream mitigation methods also leave commensuration and classification *unintentionally* open-ended. The unintended open-endedness derives from misconceptions about the capacity of assessment protocols to result in a consistent and transparent judgement of value. Protocols tend to reinforce the perception that, irrespective of the user, a "single answer" will always be found when the protocol is used correctly (Berg 1997). Furthermore, the functionality of assessment protocols is founded on the assumption that it is possible for individuals to consistently arrive at the same conclusion (i.e. akin to the scientific method). Hence, protocols are often characterized as "cook books": simply add the variables

[4] Accessed at http://thelawdictionary.org/. Last accessed May 31, 2016.

together in the correct order and the assessor will consistently conclude the same value of the stream in question (Berg 1997; Hilderbrand et al. 2005; Lave 2009).

However, contrary to these assumptions, the use of stream assessment protocols cannot be circumscribed as a purely objective task. Even expert stream scientists fail to agree on the type—let alone quality—of stream systems using visual assessment methods (Milner et al. 2013). A source of disagreement among individuals is their own disciplinary training (Milner et al. 2013; Tadaki et al. 2014). Beyond disciplinary backgrounds, some see value as inherent in objects, while others see value as relative and therefore always decided in comparison to other objects (Robertson and Wainwright 2013). An implication of someone holding an "inherent value" perspective is that assigning a comparable value using the metric of stream credits is often resisted and seen as problematic (Espeland and Stevens 1998; Robertson and Wainwright 2013). Individuals may also disagree with the rankings included in an assessment protocol (Espeland and Stevens 1998). For example, to some stream bank erosion is a "desirable" attribute while to others it is an "undesirable" attribute of river quality (Florsheim et al. 2008). It is for these reasons that rules, guidelines, and instructions cannot fully determine the application of assessment protocols. Instead, within the framework of the Illinois stream mitigation method, individual preferences, values, and resources are used to assess the overall quality of a stream site.

4.3 Impact Site Description and Jurisdiction Determination

The Section 404 permit review process begins when an applicant submits a joint Section 404 and 401 application form. The joint form contains 13 pieces of information, including, among other details, the name and address of the applicant, the name and address of their engineering firm that will be conducting the mitigation work, a five sentence project description, the location of the proposed activity, the date the proposed activity is to begin, and the estimated time of construction. On April 30, 2015 an applicant submitted a Joint Application Form for Section 404 and Section 401 (water quality) review with the following project description:

> "This project will feature the repairs to an existing berm along the southern edge of [the applicant's property] in [town name in southern, Illinois]. The proposed plan will include the construction of a clay buttress on the southern slope of the berm near a secondary pond. According to development plans, clay fill will be placed south of the berm to form the buttress. As a result of the proposed project, approximately 1,395 [Linear Feet] of a perennial tributary and approximately 80 LF of an ephemeral tributary will be impacted as a result of the filling activities. The perennial tributary will be rerouted immediately south of the proposed buttress." (Joint Application Form, p. 1)

This joint application also included a "Wetland and Waterbody Delineation." The delineation includes background and context for the permit application, a description of the site location, a soil and topographic survey, photographs taken throughout the site during a reconnaissance visit, a summary of the overall conditions of affected waterbodies, development plans, and potential changes in site conditions.

In this case, an engineering firm completed the stream and wetland delineation in two phases: a preliminary office-based survey and a field site reconnaissance survey to verify the office-based survey. Preliminary surveys amount to reviewing maps and asking: are there any mapped streams or wetlands in the project area? The contracted engineer used United States Geological Survey (USGS) topographic maps to conduct preliminary stream delineation. If the engineer saw a "blue line" representing a stream on their project site, they considered this sufficient evidence to conclude that their site contained an intermittent or perennial stream. Preliminary wetland delineation was conducted by the engineer using the National Wetlands Inventory (NWI) mapping service. In this case the engineer did not find any mapped NWI wetlands within the project boundaries.

On April 16, 2015 the engineering firm conducted the field reconnaissance survey to verify preliminary stream and wetland delineation data. The primary methodology used by the engineers for field wetland delineation was the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region* (Version 2.0). Wetland delineation contains three primary classification requirements: vegetation, soils, and hydrology. These classifications are assessed at multiple points within the site. First, the delineator assesses the percent cover of trees, sapling/shrubs, herbaceous plants, and woody vines that are wetland-type species. Hydrology can be stressful for many plant species, while other species require particular hydrologic regimes to grow. Therefore, the absence or presence of certain plant types as well as their abundance and distribution across a landscape are clues to the overall hydrology of the site. Second, the delineator cores into soil at least 16 inches deep to visually assess the character of soil. Hydric, or wetland soil, indicators include "stratified layers," "Iron-Manganese Masses," and "gleying," among others. These visual indicators are proxies for the reaction of water with minerals present within the soil column. In the absence of persistent wetting, these reactions will not occur. Third, the delineator assesses site hydrology. Indicators of surface water include evidence of a high water table in the soil, surface water ponding, water-stained leaves, aquatic plants, aquatic animals, crayfish burrows, landscape position (i.e. steep slope, in a basin, etc.), and sediment deposits. Based on these three visual classifications, the engineer determined that the impact site of the proposed project was not a wetland. As a result, the applicant only had to compensate for the stream impacts.

The delineation report also describes the type and quality of streams within the project boundaries. Stream delineation can be based on a variety of methods. While some permit applications include topographic surveys, estimates of stream discharge, and characterization of stream bank stability, most simply classify the stream using visual evidence at the time of a site visit. In this case, the stream delineation is typically based on measurements of channel width, stream type characterization, and an inventory of riparian vegetation.

This berm repair project delineation report describes two streams—tributaries A and B. Tributary A "is a perennial tributary which bisects the survey area and drains in a westerly direction" (Report, p. 2). The engineer estimates that 1,630 LF (Linear Feet) of Tributary A passes through the project boundary. The engineer also measured the width of the tributary at the Ordinary High Water Mark (OHWM) as "approximately 8 to 10 feet" (Report, p. 2). Variation in stream bank height is also considered. Bank heights range from three to five feet at each end of the project reach to only one to two feet high in the central portion of the survey area. The report noted understory riparian vegetation including Bush honeysuckle, Japanese honeysuckle, and Autumn olive elder. Trees include Box elder, Eastern cottonwood, Northern red oak, and Wild black cherry.

Tributary B is described as an "ephemeral tributary" that "enters the site from a culvert under the rail line to the south" (Report, p. 3). Tributary B is approximately 1 to 2 feet wide a OHWM and has banks 0.5 to 1.5 feet high. Tributary B has a riparian corridor approximately 50 feet wide, with vegetation including Northern red oak, Wild black cherry, Bush honeysuckle, and Multiflora rose.

The delineation report also includes an undeveloped mitigation plan. While not final, elements of the "development plan" inform how regulators proceed with determining overall mitigation needs. The purpose of including mitigation in a Section 404 permit review is to minimize the overall environmental impact of a proposed project (Hough and Robertson 2009).

As such, applicants must demonstrate that they have implemented the “least environmentally damaging practicable alternative” available to them (Hough and Robertson 2009).

Applicants are required to demonstrate least environmental damage through the mitigation sequence (Hough and Robertson 2009). The mitigation sequence for Section 404 permitting includes 1) demonstration that practicable avoidance was considered, then 2) demonstration that practicable minimization of impacts was effectively planned and implemented, and 3) if impacts remain, sufficient compensation of these impacts as measured by stream credits (Hough and Robertson 2009). Mitigation is a sequence: only after avoidance has been demonstrated can an applicant then move on to minimization and finally compensation. A major purpose of the wetland and stream delineation report described above is for the applicant to demonstrate that they have considered mitigation needs sufficiently.

For example, in this report, avoidance and minimization requirements are described. The report explains that: “Appropriate erosion control measures will be taken during construction to reduce the potential of unintentional sedimentation and sediment runoff in adjacent regulated waters. Due to the location of the tributary adjacent to the failing berm, impacts to the tributary cannot be avoided. Furthermore, due to the amount of impacts resulting from the proposed berm construction activities, [the engineering firm] anticipates that the project may require compensatory mitigation” (Report, p. 3). The report concludes in saying that: “The intent of this report is to provide the [U.S. Army Corps of Engineers] and [Illinois EPA] with the information they typically require during their review” (Report, p. 4).

If Corps regulators judge the delineation report to be of sufficient quality, it can be the primary source from which they determine mitigation (avoidance, minimization, and compensation) requirements for permit compliance. However, it is more common that Corps regulators use the initial stream and wetland delineation report to determine whether or not the applicant requires compensatory mitigation. Applicants fully address minimization requirements once a formal mitigation plan is developed alongside the completed impact project plans. Once the Corps receives and reviews the joint application form and delineation report they set up a meeting with the applicant and engineering firm to conduct their own site assessment. In this case, the proposed project was unavoidable, and therefore avoidance of impacts altogether was out of the question from the start.

Corps regulators meet with applicants to clearly explain regulatory requirements. During these meetings, called pre-application meetings, Corps regulators conduct a test run of the Illinois stream mitigation method while visually assessing the proposed impact site in the field. To streamline the process further, regulators conduct a "desktop run" prior to meeting the applicant. In a desktop run, Corps regulators calculate an estimated number of stream credits necessary for compensatory mitigation. To do so, they use both the delineation report provided by the applicant as well as other resources (e.g. Google Earth ™, soil maps, the NWI, and any other resources they wish). By doing this, Corps regulators arrive at pre-application meetings prepared to discuss specific mitigation planning options.

Corps regulators use the pre-application meeting as an opportunity to demarcate the specific steps and requirements necessary for permit review. They walk the applicant through potential mitigation methods (e.g. channel reconstruction, riparian tree plantings, etc.) that will generate sufficient credits to meet compensation requirements. The purpose of this conversation is to prepare the applicant for the need for compensation. Once an applicant and regulator are on the same page and understand the possible options for implementing a Section 404 permit, the process can proceed smoothly. Prior to the pre-application meeting on June 25, 2015, Will Jones had already reviewed the applicants' Section 404/401 joint application form and the stream and wetland delineation report. From this information, Jones had already come up with a potential number of stream credits that the applicant would be required to obtain/purchased to compensate for their unavoidable impact: "about 6,800 credits—6,872" (Interview with St. Louis regulator, 06/25/2015).

Two different components of the pre-application meeting are important in the compensatory mitigation process: an office meeting and a site field assessment. During the office meeting the St. Louis regulator (Will Jones) explains the mitigation process, sequence, and options to the applicant. The site field assessment is often the only time that a Corps regulator will visit a site prior to approving a mitigation plan and Section 404 permit.

4.4 Office Meeting with Applicants: A Section 404 Permit Discussion

On June 25, 2015 Will Jones made his first visit to the applicant's project location to conduct a pre-application office meeting. The cast of characters in the office meeting included the applicants (Gil and Sam), their contracted engineering firm (represented by Terry and Brent), the St. Louis regulator (Will Jones), and myself. The main purpose of the office meeting was to resolve the mitigation issue by explaining the mitigation process: what does it mean, what does it entail, and how can compensation occur in this case.

Will Jones first informed the applicant of the different kinds of compensatory mitigation, and why they must use Permittee-Responsible Mitigation (PRM). There are three kinds of compensatory mitigation: mitigation banking, In-Lieu Fee (ILF), and Permittee-Responsible

Mitigation (PRM). Jones explained to the applicant that mitigation banking was not an option for them in this case because: “there’s not enough stream credits available [at a bank in your watershed].” The second option on the table then would be to pay a fee into an ILF. An ILF is a third-party managed fund that uses compensatory mitigation fees to fund mitigation work throughout nearby watersheds. However, the applicant could not offset their impacts by paying into an ILF because there are no approved ILF programs in Illinois. Therefore, the third and only option for the applicant is PRM; they need to conduct compensatory mitigation on their own.

The applicant was not sure what PRM entailed, and so Jones and the applicants’ engineer began to discuss specific project options. Compensatory stream mitigation comes in two forms: in-channel work (e.g. enhancing fish habitat) and riparian corridor work (e.g. planting trees). Depending on where a project is located, in-channel or riparian work may not be an option. The engineer was cognizant of this issue and offered in-channel work: “Could we get more credit if we put in riffles and runs and such? If I’m correct we can’t plant trees there [at the impact site] because of the railroad…so we’ll want to do in-channel work.” Jones emphasized other requirements in response to the engineer’s idea: the site must be deed protected, the Corps prefers that it is handed over to a third party, and it must be monitored using photographs for five years.

Jones encouraged the applicant and engineers to consider the existing stream quality when selecting a candidate compensation stream. He did so because the existing quality of a stream affects the credit generation (and cost) of the compensation project. First, the 2008 Rule prioritizes that compensatory mitigation work occurs on streams of low quality. Applicants can generate more “ecological uplift” and better achieve no net loss goals if they improve a low-quality stream. Therefore, Jones advised against mitigating the stream immediately upstream of the impact project. Because the suggested stream is already of decent quality, the "net benefit" of compensation will be less than if the same work were implemented on a stream of poorer quality. Second, Jones also encouraged the applicants to select a site that is highly valued in the Illinois mitigation method to make the mitigation work more cost-effective: "You're going to get more credit if you go to a perennial stream…if you go to an intermittent or ephemeral stream then you'll have to do more work [to achieve the same credit value]."

Jones also urged the applicant to consider potential permit delays: "It will back you up with the IEPA—the 401. The project is technically not authorized until the 401 water quality is also ensured. So I issue the 404 and then you need to get the 401." To limit this delay, Jones explained his preferred *modus operandi* of permit review and issuance: "I don't like putting a permit out for public comment without the mitigation plan. If you have that you'll significantly reduce comments. With the mitigation plan I'd like to see the site plan. I see this with coal mines and big impacts. If you don't have these details, it's a lot of back and forth between the agencies and if you wait will after it's a lot of back and forth. It makes life easier on all of us—'cause we can work on this here within a small group closed to comments. Ultimately I decide the permit but we have to respond to comments."

Five generalizations can be made about Jones' ability to steer permitting and mitigation planning from this meeting. First, not all applicants are well versed in Section 404 mitigation rules. As a result, Section 404 regulators become spokespersons for Section 404, the 2008 Rule, and the mitigation method. Jones described these guidelines by listing different mitigation options available to the applicant and suggesting those he prefers if given a choice. Jones also interpreted the 2008 Rule by noting the different site protection requirements, the preferences for site take-over by a third party, and five-year monitoring requirements.

Second, it behooves the Section 404 regulator to clearly explain all of the requirements so that everyone fully understands what is expected. Unless an applicant understands their mitigation requirements and options, the mitigation process can be significantly prolonged. Jones clearly demonstrated the necessary components of a complete mitigation plan. Jones also explained why mitigation banking, although prioritized, was not an option in this case.

Third, Jones steered this meeting in a way to more efficiently review Section 404 permits. The primary goal for the Section 404 regulators is to issue the review in a timely manner. This meeting was conducted to develop positive working relationships. Rather than approaching his duty as “police,” Jones saw it necessary to “mediate” the issuance of this Section 404 permit through regulatory needs with the applicant’s help.

Fourth, the value of different mitigation options depended on both the Illinois stream mitigation method and broader Section 404 policies. While the Illinois stream mitigation method provide more credits for perennial than for intermittent or ephemeral streams, it does not value mitigation types differently (e.g. PRM versus banking). Jones explained to the applicant why mitigation banking is preferred, but why PRM was their only option. Furthermore, the Illinois stream mitigation method does not assign differential weighting to mitigation based on distance from an impact site. It only accounts for whether or not mitigation is in the same watershed. The decision to place mitigation nearer or further from impacts are made on a case-by-case basis by individual Corps regulators and Section 404 applicants. Fifth, Jones steered the timing and order of permit planning and mitigation planning. In this case, he stated a preference to issue a public notice only after the *entire* permit is complete. This approach is not a policy for all Corps regulators.

4.5 Applying the Illinois Stream Mitigation Method to a Proposed Impact Site

The 2010 Illinois stream mitigation method is not prescriptive. Instead of requiring a specific sequence of data to be collected and analyzed in a consistent way, the type and amount of data collected is determined by the user. In total, the Illinois method includes six impact factors that, when aggregated, are intended to represent the total functional damage due to an impact activity. Each regulator uses their best-professional judgment to determine the value of each of the six adverse impact factors. These six are: i) Stream Type impacted, ii) Priority Water impacted, iii) Existing Condition, iv) Impact Duration, v) Activity, and vi) Cumulative Impact (a linear impact factor).

Determination of Stream Type Impacted: The determination of Stream Type is a highly subjective decision. Stream Type is divided into three classifications in the 2010 Illinois stream mitigation method: a) Ephemeral/Intermittent (0.1 stream credits per impact reach), b) Intermittent with Seasonal Pools (0.4 credits), and c) Perennial (0.8 credits). These classifications are defined according to hydrological pattern. The primary question that Illinois method users must ask themselves when determining this classification is: What is the predominant hydrologic pattern of this water body?

Perennial streams flow year round and are groundwater fed (in a normal hydrological year). Visually, this means that in the absence of a drought or human modification upstream, water will be in perennial streams irrespective of the time of year. Intermittent Streams with Seasonal Pools, by contrast, are only connected to groundwater in pools, and therefore may not have complete flow in a normal hydrological year. The key visual signal is that water is present, although only in "standing pools." Water flow in Ephemeral/Intermittent streams, by contrast, only results from precipitation events. Therefore, Ephemeral/Intermittent streams are typically dry for most of the year. They usually only convey water immediately after or during a precipitation event. The implication of a visual, hydrological classification is that, depending on the time of year, the Corps regulator/applicant can come up with different conclusions about the type of stream under investigation.

This classification problem was abundantly clear during a site visit to a potential stream impact site with St. Louis Corps District regulator Will Jones. During this visit Jones, the applicant, and the engineering firm, collectively "assessed" the existing condition of the stream. Jones relied on the applicant and engineering firm to determine the potential boundaries of the proposed impact. In the field, Jones was less certain of his initial desktop calculations and classifications using the Illinois method. He initially considered the stream to be "Intermittent" based on the fact that the waterbody has a relatively small watershed area. Walking the length of the stream with the engineering firm, Jones relied predominantly on four pieces of evidence to determine the Stream Type: i) the amount of water in the stream given recent precipitation events, ii) the engineers report that during a "dry period" the stream still had flowing water, iii) identification of aquatic species, and iv) evidence of "high" flow events, such as bent vegetation or debris encapsulating vegetation. At the time of the visit on June 25, 2015, the stream had multiple pools with fish and other aquatic species. Jones also looked at evidence of high flows. Feeling comfortable that he had identified a well-defined "ordinary high water mark," he then began to question his initial "Intermittent" classification.

Jones was willing to change his classification of Stream Type from Intermittent to Perennial based on two pieces of evidence: on his visual inspection and the engineers' remarks that during a "relatively dry" month of April the stream was flowing. In his own words out loud while walking the stream, Jones stated: "I would have a hard time not calling it perennial…but this is similar to what [the engineer] saw here in April…but when was the last rainfall?...if this site had water in April—and it hadn't rained--where is the water coming from?"

After leaving the site, one of the applicants informed me that there is a "natural groundwater spring" upstream of the impact reach. After the site visit, I told Jones what the applicant told me. Jones was even more convinced that this stream is a perennial water body after hearing this anecdotal evidence. As defined in the Illinois method, if a stream has a year-round supply of water, it should be assessed as a Perennial Stream. Hence, Jones saw this information as evidence that the stream is a Perennial Stream (as defined in the Illinois method). The definition of Stream Type can thus be a subjective decision. How Corps regulators make this decision depends on what questions and evidence the regulator requests, the time of year and condition of the site during the assessment, and what evidence is put forward by others involved in permitting the activity.

Determination of Priority Water Impacted: It is much more straightforward to determine the Priority Water than Stream Type in the Illinois stream mitigation method. Priority Water is classified into Primary (0.8 credits per reach), Secondary (0.4), and Tertiary (0.1); ranked from more to less biologically significant. These classifications are based on pre-existing data collected to assess ecological condition, water quality, and habitat. These data are synthesized into stream rating systems and state resource listings. For example, if a waterbody is listed on the Illinois EPA

Section 303 (d) Impaired Water List for “indigenous aquatic life use” it is considered a Secondary Water (0.4 stream credits per reach). By contrast, Primary waters are those that are ranked as “Biologically Significant Streams” (IDNR), “Significant Mussel Beds” (IDNR), or other state and national biological rating lists. Tertiary waters “include all other freshwater systems not ranked as primary or secondary” (ISMM 2010, p. 5).

Determination of Existing Condition of an Impacted Waterway: Other than Stream Type, Existing Condition is perhaps the most subjectively interpreted adverse impact category. Existing Condition is divided into three classifications: “Fully Functional” (1.2 credits), “Moderately Functional” (0.6 credits) and “Functionally Impaired” (0.2 credits). The purpose of the Existing Condition classification is to identify streams that may presently provide important ecological functions.

The classification of Existing Condition included in the Illinois method originates from the Missouri method. The developers of the Missouri method designed the classification with the intent to quickly determine the existing condition of a given stream. The method recommends that the user should provisionally assume that the stream is Moderately Functional. A stream should only be classified as Fully Functional or Functionally Impaired if the method user has substantive evidence (e.g. actual monitoring data or obvious signs of degradation) for either of those classifications.

In practice, however, users of the Existing Condition classification often deviate from this intent. A partial explanation for this deviation is that the method designers did not make their intent explicit enough in the early versions of the mitigation methods. They only clarified how assess Existing Condition in later versions (approved 2013 Missouri method; draft and in-development

2013 Illinois method). They did so by adding "User Notes" that prescribe how to interpret the Existing Condition of a stream. In the case of the permit application in southern Illinois Jones is using the 2010 Illinois stream mitigation method. Therefore, he did not follow the intended use of the guidelines to start with the assumption that a stream is Moderately Functional.

The Existing Condition factor is an example of the way in which the Illinois (and Missouri) stream mitigation methods are rooted in physically-based assumptions of aquatic integrity and overall ecological function. This factor is rooted in the assumption that streams without direct indication of human modification (e.g. not channelized) are more functional than streams with direct human modifications. For example, a stream is "Fully Functional" if:

> "it has all of the following characteristics: Has not been channelized, levied, impounded, or artificially constricted. Is not listed on the Illinois Section 303 (d) Impaired Waters List. Has no stream impact (see Activities for a list of impacts) within 0.5 mile upstream or downstream of the proposed stream impact or mitigation site. And has one of the following characteristics: Scores A or B for either Diversity or Integrity (Illinois Biological Stream Rating System). Has riparian buffer of deep-rooted native vegetation that is greater than 50 feet wide on both sides of the stream." (ISMM 2010, pp. 5-6)

Nowhere in this classification description can the user cite *actual observed biological variation or species*. Instead, Existing Condition is extrapolated from visually-observable physical channel conditions. Additionally, the Existing Condition is rooted in perceptions of historical channel change and condition. Corps regulators/credit assessors must therefore confidently identify whether or not the current stream condition exhibits historical evidence of human modification. Implicit in this assessment is the notion that an actively eroding and depositing stream are evidence of the stream "improperly functioning."

In this case, prior to the site visit, Jones had considered this stream to possibly be "moderately" or "poorly" [functionally impaired] functioning. Jones based these possibilities on two pieces of evidence: a) that he saw no direct evidence of channelization (i.e. the stream has likely not directly been modified), and b) that human impacts occur nearby that can affect the stream reach. This stream sits in a narrow valley between a railroad embankment on one side and a coal ash fill on the other. Jones considered that even though the channel itself has not been directly modified in recent history, the construction of embankments and slopes on the sides of the channel likely alter the local hydrology and runoff in a way that introduces "external" instability into the stream system.

As Jones walked the stream he constantly compared the classification requirements for existing condition categories. The stream channel itself was not manipulated (Fully Functional), but rock and concrete were present in the channel that came from some upstream source of human modification (Moderately Functional or even Functionally Impaired). This latter piece of evidence led him to conclude the stream could be functioning poorly. Because he identified physical features that indicated human impacts, he was less sure of the quality of the stream. At the same time however, this waterbody was not listed as "Impaired" on any Illinois EPA Section 303 (d) database and had visual evidence of biological functionality (e.g. identification of multiple fish species). Thus, Jones also thought that it may be a Fully Functional waterbody. In the end, while simultaneously re-adjusting his assessment of Stream Type, Jones indicated that: "If I did change anything I may change it to poorly functioning [functionally impaired]…but to be honest it's got pools and riffles and it's probably functioning…I need to read the [Illinois method] again."

Determination of Impact Duration, Activity, and Cumulative Impact of Activity: Impact Duration, Impact Activity, and Cumulative Impact are relatively straightforward determinations in the Illinois method. Impact Duration is simply the period of time over which impact activities occur. Temporary impacts (0.05) occur in less than 180 days, Short term impacts (0.1) remain evident after 180 days and will not exist after two years, and Permanent impacts (0.3) persist longer than two years.

The Impact Activity is the activity that the applicant is proposing. Often times the Impact Activity is clear because in the case of General Permits, each permit is classified according to the activity type. The Illinois and Missouri methods include nine Impact Activities: Clearing vegetation (0.05), Utility crossing/bridge footing (0.15), Below grade culvert (0.3), Armor (0.5), Detention (0.75), Morphological disturbance (1.5), Impoundment (2.0), Pipe (2.2), and Fill (2.5). While these are supposed to be straightforward categories, not all method users find these classifications easy to apply. Experience by the Corps regulators indicates that many method users incorrectly assign activities in the first round of method use. Hence, the Missouri team added user notes to clarify the appropriate designation of activities (according to the Missouri team). Cumulative impact is the product of the total linear footage of stream impact per reach (as measured through the channel center line) and a cumulative impact factor of 0.0003.

In total, these individual activities amount to a cumulative "Adverse Impact" value to the proposed Section 404 impact. The value of each adverse impact depends on the individual conducting the survey, the stream conditions at the time of the survey, and whether or not the assessor requests further information. Mobilization of the Illinois stream mitigation method, based on current Section 404 regulations, is thus an open-ended practice. Unless the Illinois mitigation method is changed to *require specific data* to be collected and interpreted, exactly how "Stream Type" and "Existing Condition" are determined will continue to vary by user.

4.6 Conclusion

This chapter has examined two aspects of mobilization of the 2008 Rule: Section 404 permit pre-application review and impact site compensatory stream credit assessment. Together, these two aspects represent important steps in implementation of the 2008 Rule during the process of Section 404 permit review. Mobilization of the 2008 Rule is inherently responsive and reactive both to permit situations and mitigation options in a watershed. Therefore, it is challenging to implement ideal conditions espoused by the 2008 Rule. Corps regulators thus require some degree of flexibility when issuing Section 404 permits.

Applicants and regulators help to define Section 404 stream impacts. Applicants define the scope of impacts when they submit a Joint Application Form for Section 404/Section 401 review and delineation report. The delineation report can vary in its complexity. The delineation report provides regulators with the basic information necessary to determine Section 404 permit types and mitigation requirements. Regulators use this report to develop their own understanding of the impacts and mitigation requirements.

Regulators take applicant input seriously because their job is to *issue* permits in a timely manner. The pressure to issue permits in a timely manner shapes the way that regulators mediate the Section 404 permit review process. Section 404 regulators benefit from being instructive in pre-application meetings. Pre-application meetings provide opportunities for Corps regulators to directly translate Section 404 policies to applicants.

Corps regulators streamline Section 404 permit review in different ways. In this case, Jones emphasized front-loading all of the necessary information to anticipate future requirements and questions. Other regulators may have different strategies for balancing the simultaneous needs of timely permit review and determination of the environmental implications of permit activities.

The stream mitigation method acts as a framing device rather than a credit-assigning device. It is intended to provide general guidance about mitigation, rather than detailed information on specific mitigation practices, to meet regulatory requirements. The application and use of the Illinois stream mitigation method is open-ended and varies both across its different users and application settings. Method users can call upon a variety of data sources when applying the method to interpret the overall ecological implication of Section 404 stream impacts. If the Illinois method actually assessed stream function, it would be prescriptive and require specific data to assess the functionality of a stream. Therefore, Corps regulators have a substantial flexibility in assessing stream functions, and use this flexibility to respond to pressure to issue permits in a timely manner.

Mobilization of the 2008 Rule and the Illinois stream mitigation method are therefore imperfect moments of translation (in terms of working towards no net loss goals) due largely to the fact that the 2008 Rule is guidance that prioritizes the balancing of two conflicting priorities: timely permit review and environmental protection. In practice, regulators can claim "successful" implementation and translation of the 2008 Rule by either issuing permits in a timely manner or requiring such strict avoidance and minimization requirements that an application is withdrawn altogether. "Successful translation" of the 2008 Rule therefore cannot be judged by looking at the issuance of permits or credit assessments alone. The planning and implementation of mitigation work, as well as the ecological trade-offs of compensation stream projects, must also be examined to comprehensively assess whether or not the 2008 Rule has been translated effectively.

CHAPTER 5

STEERING COMPENSATORY STREAM MITIGATION BANKING

5.1 Introduction

Federal guidelines state a preference that Section 404 compensatory stream mitigation services be provided by a *mitigation banker* (Corps and EPA 2008). A mitigation banker is a private entrepreneur who speculatively purchases a reach of a stream with degraded functions and improves it to sell stream credits to those who need to compensate for impacts ion stream elsewhere in a watershed (Womble and Doyle 2012). Mitigation banks generated 41 percent of the credits used to offset Section 404 permits between 2010 and 2014 (IWR 2015).

The Federal government views mitigation banks as providing higher quality mitigation than PRM (Permittee-Responsibility mitigation) or ILF (In-Lieu-Fee mitigation). Nonetheless, there are ecological drawbacks to mitigation banking. Research in North Carolina indicates that stream mitigation banks are often constructed in headwaters even though impacts typically occur in downstream portions of watersheds (BenDor et al. 2009). Because of such differences, stream mitigation banks often provide different ecological functions than those degraded by impacts (Doyle and Shields 2012).

Corps regulators cannot choose where mitigation bankers develop bank sites. Mitigation bankers develop sites in areas with a prospect of future land development (Womble and Doyle 2012) where developers are likely to require Section 404 permits and will be assessed for impacts by Corps regulators. Mitigation bankers are therefore generally hesitant to develop mitigation banks in rural watersheds that lack development (Womble and Doyle 2012).

Nor can Corps regulators choose the type of compensation work that bankers provide. This limitation has significant implications for attaining goals of no net loss of stream function via Section 404 mitigation. There are two primary types of mitigation work that count towards stream credits: in-channel work (e.g. bank stabilization, re-meandering, habitat enhancement) and riparian corridor work (e.g. recreating floodplain forests). In the Midwestern U.S., most stream mitigation banks rely on riparian corridors as their main source of stream credits.

This chapter examines how St. Louis regulators and mitigation bankers interact to develop stream mitigation banks in Illinois (cf. Robertson 2009). No mitigation banks in Illinois are solely stream mitigation banks; all have been developed primarily as wetland mitigation banks that also sell stream credits generated by riparian tree plantings. St. Louis regulators struggle to incentivize mitigation bankers to create in-channel stream mitigation banks for a variety of reasons.

This chapter argues that because St. Louis Corps regulators are under pressure to generate stream credits of any kind from a mitigation bank, they are willing to accept stream credits that are not generated using in-channel work. Corps regulators across the country are under pressure to issue permits in a timely manner and encourage the development of mitigation banks to provide compensatory mitigation. At the same time, Corps regulators are under pressure to ensure that compensatory mitigation is in-kind with impacts. In southern Illinois, mitigation bankers are reluctant to develop stream mitigation banks using in-channel mitigation work. Rather than force mitigation bankers to generate stream credits using in-channel work, St. Louis regulators advise the planning of riparian corridor enhancement as a way to improve stream conditions. St. Louis regulators emphasize that because the banks replaced farmland with historic plant communities, they enhance environmental conditions and therefore are worthwhile. Instead of taking pride in mitigation banks for their capacity to compensate for impacts, mitigation bankers and St. Louis regulators value mitigation banks for their capacity to replace historical conditions along stream corridors. The characteristics of mitigation banks thus results from a combination of regulatory requirements, economic decisions made by mitigation bankers, the relationship between bankers and Corps St. Louis regulators, and the ecological priorities and values held by bankers and St. Louis regulators. These findings show that the commensuration of compensation activities is contingent upon the requirements set by St. Louis regulators and the preferences of individual bankers on a district-by-district basis.

This chapter presents the governance of stream mitigation banking as an example of *stream naturalization* to make the argument that St. Louis regulators overlook in-kind requirements when approving stream credits generated at mitigation banks (Rhoads et al. 1999). Stream naturalization emphasizes the process through which actors come together and establish notions of "natural" and "restored" when working to achieve stream and watershed management goals. The rest of this chapter is organized as follows. Section 2 further explores stream mitigation banking as stream naturalization. Section 3 outlines the components to mitigation banks. Section 4 presents an overview of national and local (Illinois) trends in mitigation banking since 2008 and since 1995, respectively. Section 5 discusses the St. Louis Corps's regulatory goals and the primary ways that they seek to affect banker behavior for the purpose of generating in-kind banks. Section 6 draws on participant observation and interviews to characterize the two mitigation companies that sell stream credits in Illinois. Section 7 explains how these individuals, alongside Corps regulators, plan, select, monitor, and manage mitigation sites that generate stream credits in Illinois. Finally, section 8, concludes by summarizing the primary findings of the chapter.

5.2 Mitigation Banking as Stream Naturalization

Section 404 regulators prefer mitigation banking over other methods of ecological compensation for at least two reasons. First, regulations prefer mitigation banking because banks cannot sell credits until performance standards are met (Corps and EPA 2008). Second, banking is preferred because only one compensation review is necessary for multiple Section 404 permits (Corps and EPA 2008). Federal regulators cannot require a mitigation banker to develop a site. Instead, regulators must work closely with bankers that are interested in developing new sites. The responsive character of this relationship means that federal regulators continuously face the problem of figuring out new ways of steering how mitigation bankers design and implement mitigation goals.

The majority of studies on wetland and stream mitigation banking emphasize the use of economic incentives to influence mitigation banker behavior (BenDor et al. 2007; BenDor and Brozović 2007; Robertson and Hayden 2008; BenDor 2009; Doyle and Yates 2010). This work exemplifies a *rational economic actor* approach. The rational economic actor approach assumes that economic incentives to maximize profits primarily motivates mitigation bankers (cf. Doyle and Yates 2010). Furthermore, this approach posits that it is possible to completely model banker behavior by isolating individual incentives (cf. Robertson 2009).

While valuable, this work over-simplifies the decision making and preferences of mitigation bankers (Robertson 2009; Doyle et al. 2015). The ecological characteristic and location of stream mitigation banks are determined by a host of factors (Robertson 2009; Doyle et al. 2015), including aesthetic, economic, and ecological concerns for producing a high quality mitigation site (Robertson 2009; Doyle et al. 2015). These concerns evolve out of both individual and inter-personal preferences. Hence, instead of viewing mitigation bankers as isolated economicallymotivated actors, it is important to view their behavior as a product of a social and regulatory contexts (cf. Robertson 2009; Doyle et al. 2015). The broader literature on stream management and ecological compensation provides a larger social perspective on mitigation banking.

An emerging consensus from the literature on stream management and ecological compensation is that "stream restoration" is a catch-all term that represents a wide variety of biophysical interventions and stream management options (Emery et al. 2013). "Stream restoration" does not have a clear definition; it is defined on a case-by-case bases (Wheaton et al. 2006). The stream characteristics required to meet compensation and restoration needs derive from place-based negotiations and decision making (Cowell 1997; Rhoads et al. 1999). Nonetheless, the widely-held belief that interventions "restore" a stream to some prior, or more properly-functioning (i.e. "natural") condition is a commonality among many projects (Rhoads et al. 1999; Eden et al. 2000; Eden 2002). Implied in many stream interventions is the idea that the intervention activity results in "more natural" stream conditions. "More natural" is typically interpreted with respect to a human impact or modification (e.g. a bridge). Therefore, in practice, stream "restoration" predominantly signals a *sense of putting a stream back into a natural state*, rather than necessarily a return to a particular historical point or condition (Rhoads et al. 1999; Eden 2002; Emery et al. 2013).

Based on this observation, Rhoads et al. (1999) framed stream management to achieve environmental goals as *stream naturalization*. Stream naturalization signals a *process* through which "natural" conditions are perceived, defined, and implemented in management practices amongst a heterogeneous or geographically-specific group of actors. Rather than using the condition of what a stream was like prior to being disturbed by humans as a target, or reference state, for management (i.e. "restoration"), naturalization holds that conceptions of what is natural with regard to streams emerge out of social negotiations and interpersonal interactions within the context of individual stream projects (Emery et al. 2013). Furthermore, conceptions of natural will vary from place to place and even time to time as interested individuals engage in negotiations and interaction to define an environmental vision for management (Eden 2002; Emery et al. 2013).

Stream mitigation can be readily analyzed and explained from a stream *naturalization* perspective. The extant literature on Section 404 mitigation emphasizes the *flexibility* through which mitigation decisions are made (Robertson 2006; Murphy et al. 2008; Clare et al. 2011; Doyle 2012; Womble and Doyle 2012; Bronner et al. 2013; Doyle et al. 2013). Although federal regulations face a barrage of critiques for being too *ad hoc* (Murphy et al. 2008; Clare et al. 2011; Doyle and Shields 2012; Bronner et al. 2013), Section 404 compensatory stream mitigation is designed to be flexible within a framework of laws, rules, regulations, and guidelines. Thus, similar to the point that outcomes of management often result from a cacophony of voices and intervention practices, mitigation emerges out of unique practices in place. In this light, it is necessary to understand the values and priorities of all those who participate in stream and watershed management to explain the spatial and ecological pattern of stream mitigation banking projects (Rhoads et al. 1999; Eden et al. 2000; Robertson 2009; Emery et al. 2013; Doyle et al. 2015).

5.3 Mitigation Bank Components

Mitigation banks—either wetland and/or stream—are all composed of the same four elements (Robertson 2004). First there is the mitigation banking site itself – a parcel of land or segment of river that has been enhanced to generate wetland and/or stream credits. In Illinois, sites cannot be selected for mitigation unless they have degraded riparian corridors (e.g. dead or dying vegetation, non-native vegetation) and/or were wetlands that were converted to farmland prior to wetland protection laws (i.e. prior-converted wetland).

Second banks have a defined geographic service area - in Illinois, a Corps-defined watershed - within which credits can be sold (Womble and Doyle 2012). The service area is essentially the market range for a mitigation bank. If a mitigation bank is allowed to sell credits beyond the service area, credits are usually only sold at partial value. Because regulators prioritize banking over other mitigation types, permittees are often allowed to offset their impacts by purchasing credits from a bank in a different watershed than that in which impacts occurred.

Third, mitigation banks include the mitigation banking instrument. The banking instrument is the legally-binding document that includes all details regarding site planning, monitoring, financial assurances, third-party responsibilities, credit release schedules, credit performance standards, and mitigation bank sponsor details. The mitigation banking instrument is developed from the original mitigation banking plan that bank sponsors submit to the Corps.

Fourth the mitigation bank includes, and is established in coordination with, the mitigation banking review team (MBRT). The MBRT is synonymous with the Inter-Agency Review Team (IRT), which reviews all Section 404 permits. Mitigation banks cannot sell credits (i.e. credits are not "released") until banks meet performance standards over a five-year monitoring period; however, there are exceptions to this rule, and credits can be released incrementally as portions of performance standards are met). Although ecological scientists are the primary individuals responsible for reviewing bank performance in Chicago (Robertson 2004), regulators without extensive scientific expertise review wetland and stream mitigation banks throughout the St. Louis Corps district. In fact, bank owner-operators implement the bulk of bank monitoring in the St. Louis Corps district. Owner-operators have varying expertise in wetland sciences. The IRT/MBRT most readily becomes involved in the St. Louis district to either a) perform independent site assessments during site establishment, or more often to b) review and approve monitoring documents developed by the bank owner-operators for annual reviews over the five-year monitoring period.

5.4 National and Local Mitigation Banking Trends

National-level Trends

Overall, the 2008 Rule is intended to "improve the planning, implementation, and management of wetland and stream compensatory mitigation projects by emphasizing a watershed approach in selecting compensatory mitigation project locations, requiring measurable and enforceable ecological performance standards with regular monitoring, and specifying the components of a complete compensatory mitigation plan" (IWR 2015, p. 13). The 2008 Rule thus modifies four moments of the mitigation process: 1) how Section 404 regulators review Section 404 permits, 2) how mitigation projects are designed and planned, 3) how impacts and mitigation are compared to determine compensatory mitigation requirements, and 4) enhanced emphasis on "in-kind" mitigation that is ecologically beneficial.

The Institute for Water Resources (IWR) conducted a "retrospective review" of all U.S. Corps districts to assess the extent to which the primary goals of the 2008 Rule are being met. Published in October 2015, the IWR's report titled *The Mitigation Rule Retrospective: A Review of the 2008 Regulations Governing Compensatory Mitigation for Losses of Aquatic Resources* (henceforth "the 2008 Review") reviews temporal changes in the types of 404 permits issued, permit review duration, the types of mitigation work implemented, and the relative proportion of mitigation across mitigation types (i.e. PRM, ILF, and banking). The 2008 Review concludes that, at the national level, "substantial progress has been made in implementation of the 2008 Mitigation Rule. Numerous Corps districts have developed regional guidelines to effectively implement the

2008 Mitigation Rule. Advances in Corps Regulatory Program data collection and tracking have been made through investments in ORM2 and RIBITS [two national regulatory permitting databases], and increased data sharing with the public using RIBITS" (IWR 2015, p. 11).

The Corps issued an average of 56,400 "written authorizations" per year between 2010 and 2014. A "written authorization" is roughly synonymous with a Section 404 permit. Out of these 56,400 authorizations, "approximately 10%...required compensatory mitigation to offset permitted impacts to aquatic resources" (IWR 2015, p. 11). Of the authorizations that required compensatory mitigation (i.e. about 5,640 per year, or about 28,200 in total during that five-year period), "41% used mitigation bank credits, 11% used in-lieu fee credits, 37% did on-site permittee-responsible mitigation, and 11% conducted off-site permittee-responsible mitigation" (IWR 2015, p. 11). The 2008 Review makes the point that because only 10% of all permitted impacts required compensatory mitigation, the Corps must be successfully implementing the mitigation sequence (i.e. requiring avoidance and minimization in the first place). However, it ignores the failure to achieve other primary goals of the 2008 Rule.

Despite increasing use of mitigation banks as a means of compensatory mitigation, which is consistent with the goal of the 2008 Rule to realize more "off-site" mitigation, the "in-kind" goal is still far from being achieved. Through 2014, there were less than 400 banks approved to sell credits providing stream credits nationally, and this number fell from over 40 banks being approved in 2013 to less than 20 in 2014 (IWR 2015, p. 63). By contrast, through 2014, there were nearly 1,300 cumulative approvals of banks selling wetland credits, also with a decline between 2013 and 2014 from over 90 to 58 (IWR 2015, p. 63). Hence, while mitigation banks are becoming more common, the vast majority of mitigation banks only sell wetland credits.

The 2008 Rule Review's accolade also ignores the variability of mitigation practices that count as stream credit work. In some Corps districts, enhancement of riparian corridors can generate stream credits. Thus, while impacts may take place within a stream channel, mitigation may largely focus on riparian corridors. The number of stream credits sold at mitigation banks that are created via in-channel work (either the removal of man-made structures, the stabilization of eroding banks, and/or the creation of habitat structures) is only a portion of the total number of stream credits sold at mitigation banks.

The 2008 Rule Review does not raise this point and provides no sense of how many stream credits are generated using in-channel compensation work nationally. However, in the Midwest, only 25 % of the stream credits sold in Missouri have been from in-channel work (mainly in the form of dam/flow structure removals) and 0 % of the stream credits in Illinois have been from in-channel work (RIBITS 2016). Thus, while "off-site" goals are increasingly being achieved, "in-kind" goals are significantly lagged in parts of the country. This distinction can be explored further by examining how the 2008 Rule is implemented in Illinois.

Mitigation Banking in Illinois

Since federal mitigation banking guidelines were first established in 1995, wetland mitigation banks were developed near areas of intensive development. This pattern holds true in Illinois. Looking at figure 5.1, two trends stand out. First, mitigation banks are concentrated in portions of Illinois within the Chicago and St. Louis Corps district. These locations correspond to areas of intensive urban development. Second, the rest of the state has only a few mitigation banks, and these banks are mainly developed by the Illinois Department of Transportation (IDOT). In many states, the DOT (or equivalent) and other transportation-related agencies/companies require the most Section 404 credits. Transportation-related (including railway) compensations accounted for at least 28 percent of mitigation bank purchases in Illinois since mitigation banks were first created after 1995 (RIBITS 2016). A second reason for this "empty" portion of Illinois is that agricultural land uses dominate large portions of Illinois. Apart from certain cases of completely new channel construction (i.e. channelization), maintenance and upkeep of agricultural ditches for agricultural purposes is exempt from Section 404 of the Act (Corps and EPA 2008). Therefore, while there are certainly ongoing impacts to streams throughout Illinois, regulation of these impacts does not fall within the scope of Section 404.

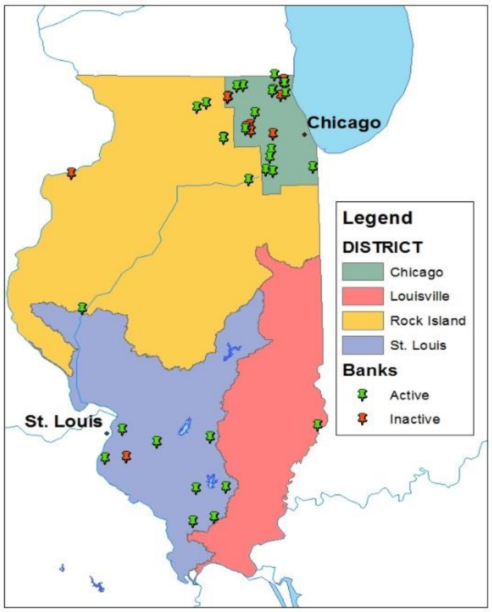

Figure 5.1 Map of mitigation banks and Corps districts in Illinois (Source: RIBITS).

None of the 42 active mitigation banks in Illinois exclusively sell stream credits (see table 5.1). Only three mitigation banks currently sell stream credits in Illinois. None of these stream credits is generated from in-channel work. There are wetland mitigation banks in the Chicago district with in-channel work, however this work is sold as wetland credits. Since streams were classified as a "kind" of wetland prior to 2008 at the federal level, these wetland credits likely could have been used to directly offset in-channel impacts. Thus far, impacts of nine permitted projects in Illinois have been compensated for by the purchase of stream credits from mitigation banks. These credits were generated from riparian corridor plantings and removal of invasive/undesirable plants (two of which were sold at an inactive wetland and stream mitigation bank).

Illinois					
District	**No. of active banks**	**No. of individual impacts**	**Offset by wetland credits**	**Offset by stream credits**	**In-channel work?**
Chicago	29	478	478	0	Not applicable.
St. Louis	6	77	70	7	No, riparian corridor only.
Rock Island	6	115	115	0	Not applicable.
Louisville	1	2	2	0	Not applicable.
Total	42	672	665	7	

Table 5.1 Breakdown of active mitigation banks by Corps district in Illinois. (Source: RIBITS)

Mitigation banks in Illinois are predominantly wetland mitigation banks that *additionally* sell stream credits. Of the 54 Illinois mitigation banks that are either active *or inactive* (i.e. those that are no longer active and not included in table 5.1), none exclusively sells stream credits. Thus, mitigation banks selling stream credits are predominantly wetland banks by a different name. How did these mitigation banks get approved to sell stream credits? Why are there no mitigation banks that sell stream credits generated from in-channel work in Illinois? Answering these questions requires more in-depth focus on the decision making processes involved in the mobilization phase of the translation of Section 404 (and the 2008 Rule) policies and priorities in a district-specific setting.

5.5 St. Louis Mitigation Banking Goals and Strategies

In a perfect world, every Section 404 applicant would be able to compensate for stream impacts by purchasing in-kind stream credits from mitigation banks. Contrary to this ideal scenario, in many cases stream impacts regulated by the St. Louis District are not compensated for using stream credits. The reason is that rarely are enough stream credits available in the district. Even when such credits are available, they are often not in-kind.

St. Louis regulators seek to alleviate this problem using different governance strategies. Economic incentives are the preferred strategy to influence mitigation banker behavior. The primary economic incentive is the commodity of stream credits: if bankers produce stream credits of sufficient quality, they can sell these credits for profit. St. Louis regulators assign credit values to different bank activities based on the Illinois stream mitigation method to incentivize bankers to create banks. For example, in the 2010 Illinois method, bankers can earn 10,725 stream credits for planting a 200-foot wide buffer on each side of a stream for 1,500 linear feet. At an average of $25-35 per stream credit (based on estimates in Missouri), mitigation bankers can sell credits for at least $268,125. The credit value of 10,725 is not solely due to planting a riparian buffer. Credit value is also assigned to preferred administrative components and environmental protection assurances. Bankers earn credit for the quality of their monitoring and whether or not the site is protected with a deed or a conservation easement.

In some ways, this incentive has been successful. The number of mitigation banks selling stream credits has been rising in the St. Louis Corp District portion of Illinois since 2008. However, these incentives are not meeting in-kind goals. In an effort to change banker behavior further, St. Louis regulators drafted a new Illinois method that would decrease the current value of riparian corridor work and increase the value of in-channel work. This draft method is not approved for use yet and is therefore unavailable as an incentive option.

In the absence of higher value in-channel stream credits, St. Louis regulators develop interpersonal relationships to encourage bankers to adopt in-kind mitigation. St. Louis does this by suggesting in-channel work when mitigation bankers approach them to propose new sites. In one instance a mitigation banker indicated that they wanted to fill St. Louis's need for in-channel work by developing a new site. This site, which would have reconnected an abandoned meander channel to a main channel, would be the first mitigation bank to generate in-channel stream credits in Illinois. However, the landowner ended up refusing to sell the property to the mitigation banker.

St. Louis also seeks to develop non-banking programs to meet the need for in-channel stream credits. During 2014 and 2015 St. Louis worked closely with a non-profit in southern Illinois to create the first In-Lieu Fee (ILF) program in Illinois. An ILF program is a conservation program funded by Section 404 permit fees. Rather than meeting compensation requirements by purchasing bank credits, ILF enables applicants to pay into the ILF program. The ILF program is uses Section 404 applicant compensation fees to target stream improvement in priority watersheds. This particular non-profit ILF was attractive to St. Louis because they coordinated large-scale stream and wetland restoration projects in the past. However, like the potential in-channel mitigation bank, this ILF program also did not get approved. In 2015 the head of the non-profit organization retired, thus stalling the development of an ILF proposal.

For St. Louis, the only mitigation options are currently either PRM or out-of-kind mitigation banking. St. Louis prefers mitigation banking over PRM. This preference is rooted in the desire to ensure that mitigation work is of the highest ecological quality possible. PRM projects do not require the same initial planning details as mitigation banks (Corps and EPA 2008). As the St. Louis regulator who handles stream mitigation permits in Illinois put it: whenever possible, it is better to approve work that can be trusted, will last a long time, and will meet intended ecological goals (Personal communication, St. Louis regulator). The worst case scenario would be to approve a stream project that then fails shortly after Section 404 impacts occur. Instead of necessarily providing in-kind work, the St. Louis Corps at least wants mitigation to be environmentally beneficial. Therefore, the St. Louis regulator steers compensatory stream mitigation banking with the intent of improving aquatic conditions and habitat in the St. Louis portion of Illinois. To do this, the St. Louis regulator works closely with mitigation bankers to establish goals of the bank and plans that, while not providing in-kind work, are at least environmentally beneficial.

5.6 Stream Mitigation Banking Companies in Illinois

Only three mitigation banks currently sell stream credits in Illinois; all three are in the St. Louis Corps district portion of Illinois. Two mitigation banking companies own and manage all three banks. Both companies are composed of two people. Thus, the social world of stream mitigation banking in Illinois is small and close-knit.

Individuals create mitigation banks for a variety of reasons. In addition to the profit motive, they are interested in environmental protection and management. In each case, mitigation bankers are involved in bank development because of a pre-existing interest in ecological management, wildlife habitat, hunting, or environmental quality. Mitigation bankers believe that their management work is beneficial because it returns sites to a "more natural" state. However, bankers have individual preferences and priorities in terms of what constitutes "more natural." Individual naturalizing visions shape how mitigation bankers develop and implement mitigation banking plans.

Hillcrest Banking Company Banking Strategy

HBC is composed of a sponsor (Kevin Lewis) and soil scientist/designer (Vince Lawton). Together, Lewis and Lawton manage one wetland and stream mitigation bank in Illinois—Hillcrest Stream and Wetland Mitigation Bank (henceforth Hillcrest). Lewis had experience in mitigation banking in the St. Louis region of Illinois and Missouri prior to creating Hillcrest. The selection of this particular site, however, was partly fortuitous: "In this case there were a couple of Doctors who owned property and leased it to a farmer…my father and uncle" (Interview, 06/11/2015). Interested to know if the site could potentially serve as a mitigation banking site, Lewis contacted his father and verified that the property was a prior converted wetland. "Prior converted" is an important land classification in Corps wetland mitigation. "Prior converted" land is an area that was once a wetland, but was converted to farmland prior to federal regulations that now prohibit wetland conversion. If land put into mitigation is "priori converted," the banker can generate more credits because they will be "creating/restoring" a wetland rather than "preserving/conserving" an existing wetland. After confirming that the Hillcrest site was "prior converted," Lewis contacted the Corps. The Corps came to the Hillcrest property, took soil cores, and confirmed that the property was a prior converted wetland and could potentially serve as a wetland restoration mitigation site. Owning the property but having no ecological expertise, Lewis contacted Vince Lawton.

Vince Lawton is a soil scientist and contractor with a B.S. degree in agronomy with a soil science concentration. Lawton has over 15 years of experience in the environmental management field. In addition to soil identification and classification, Lawton is well versed in plant identification, survival, mortality, and management. During a visit to the Hillcrest site, Lawton explained his personal banking preferences: “I like the volunteer plants; I’m more concerned with water quality and flood control than a plan for deer [habitat]” (Interview, 08/18/2015).

The ecological values of mitigation bankers, such as Lawton’s stated preferences, shape their opinions and judgement regarding necessary and acceptable adaptive management strategies. Because Lawton values general ecological functions and benefits, he is concerned about establishing a “naturally functioning wetland”. Lawton emphasized that he is not interested in constantly managing the water levels and plant composition. For example, because Hillcrest creek crosses the Hillcrest site from an adjacent forested bluff, Hillcrest receives floodwaters containing plant seeds originating offsite. In Lawton’s opinion, if the stream is maintaining a wetland, and if this stream also “recruits” seeds from the uplands, then the Hillcrest site is performing natural functions and should be valued for those benefits.

Mitigation banking site performance standards and credit classifications are often based on plant condition, at least for wetland credits. As the predominant cover changes (e.g. from woody to herbaceous, or vice-versa), the “type” of wetland approved for crediting also changes. As a result, Lawton must work closely with Will Jones of the St. Louis Corps to develop an adaptive management plan. An adaptive management plan is an agreement between the mitigation banker and regulators for how to implement management new management needs that are not already explicitly outlined in the original mitigation banking instrument/plan. In this case, as the adaptation plan is implemented, it is possible that Lawton’s credit classification will change.

The amount of enthusiasm that practitioners have for projects that they consider valuable and worthwhile is most obvious when they talk about their involvement in mitigation work: “We’ve got so many neat projects and [willing] landowners in [a Corps district in Missouri],” Lawton said with a wide smile (Interview, 08/18/2015). This enthusiasm is often tempered by frustration with the expectations or perceived shortcomings of individual Corps districts. In this case, the perceived shortcoming is that one Corps district in Missouri has yet to review and approve bank plans dated as far back as 2008 and 2011. Despite the possibility of many "neat" projects (e.g. in-channel and riparian projects), Lawton added, "I don't know if I want to do it" (Interview, 08/18/2015). Continuing while gesturing to the Hillcrest site from the roadside, "I enjoy construction and the work but this red tape here is driving me mad" (Interview, 08/18/2015). This anecdote reflects BenDor and Riggsbee's (2011) finding that it is often regulatory (in)activity that holds up and limits a potentially beneficial project from getting implemented.

HBC did not originally set out to generate stream credits. Hillcrest is designed to be a wetland mitigation bank. The stream credits were generated by planting a riparian buffer around Hillcrest creek. Lewis indicated that it was actually the Corps who suggested that HBC consider generating stream credits as well (based on a perceived need in Hillcrest's service area). Because Hillcrest creek crosses Hillcrest site, there was a potential opportunity to plant a riparian corridor to generate much-needed stream credits in Hillcrest's geographic service area. Lewis explained: "The Corps prefers at least one mile of a stream and a stream that has been farmed up to the bank, and that the sponsor owns both sides of the stream. In this case we put in a 300-foot buffer on about 17 to 1800 linear feet—this was enough to satisfy the Corps, and since it was also going to be a wetland bank, [they approved the shorter-than-preferred stream length]" (Interview, 06/11/2015). Intermixed with trees are warm season grasses, which cost HBC approximately $1,000 per acre. At the Hillcrest site, HBC planted aquatic plants, including wild millet (*Panicum miliaceum*) and mare's tail (*Hippuris vulgarus*), among many others.

HBC is doubtful that they will implement in-channel work in the future. In Lawton's opinion, there are not enough candidate streams for potential mitigation banking sites in Illinois. Lawton emphasized that in the St. Louis district region of Illinois, the primary cause of stream degradation is incision into loess (i.e. fine-grained material). Lawton is skeptical that in-channel work will be feasible because he considers correcting stream incision in loess to be prone to failure. In the meantime, Lawton emphasized his opinion that the combination of wetland and riparian corridor work will provide in-stream water quality benefits.

Stream Saver Company Banking Strategy

Like HBC, SSC is organized in terms of a division of labor. While Robert Douglas has experience with plants, compared to his partner Tom Grant, he considers himself more concerned with the administrative aspects of mitigation banking. Grant is the soil expert of the two. Douglas put it this way:

> "I mean yeah, there's a technical side and an administrative side to it. You have to understand the regulations; you know the components of a mitigation plan. So you gotta have a certain amount of diversity [of knowledge] to put all that in. It takes different disciplines you know with the mitigation plan. You not only have the mitigation work, but you also have endowments, you have surveys. You just have different disciplines of work. Sometimes you have to look at archeological information, you have to have a wetland background, you have to have financial assurances for different things. You use a lot of different skill sets." (Interview, 05/28/2015)

Douglas entered mitigation banking from his prior experience as a project manager in the Corps. He has a personal interest in wildlife habitat and restoration. He is also an avid duck and deer hunter. Douglas describes his diversion into mitigation banking saying that: "There was a program out there [i.e. Section 404 mitigation banking], and I was looking for other challenges. And I had an interest in restoration. You know, I didn't know if it was gonna be financially feasible and kind of took a chance. And for lack of something better I found a little bit of a niche…Historically I had other sources of income…I think I'm getting to the point now that it is specifically based on wetlands…Probably 13 out of the last 15 years have been wetlands and other supplements. Probably only in the last year or two has it been majority wetlands" (Interview, 05/28/2015).

Douglas and Grant collaborated to establish two mitigation banks that sell both stream and wetland credits, and are planning to develop more banks in the future. Both of SSC's stream and wetland mitigation banks are in the St. Louis district portion of Illinois. Both of these banks also generate stream credits using riparian corridor planting methods. At both sites SSC's primary *modus operandi* is the same. First, Douglas identifies a banking need and scopes out potential sites using land records, soil maps, and aerial photography. Once Douglas obtains permission to scope out the potential feasibility of banking on a property, he contacts Grant and they visit a site.

Douglas' planting types differ from HBC's. There are three kinds of trees generated at plant nurseries for transplantation: bare root, root-production method (RPM) (or "container"), and ball and burlap (Buckstrup and Bassuk 2009; see figure 5.2). Douglas plants RPM-generated trees, while HBC plants primarily bare root trees. Lawton is "not 100 percent sold on RPM" (Interview, 08/18/2015). One difference between RPM and bare root is the cost per tree. RPM can cost $8-10 for a 3-gallon container size root mass, while bare root trees cost on the order of $0.50-1.00 for individual tree saplings (Dey et al. 2006).

Bare root and RPM have different planting costs as well. Hand planting costs $0.50 per bare root tree, and about $4.00 per RPM tree (http://agebb.missouri.edu/commag/shelterbelt/cso-mdc700.pdf), Assuming that plantings at both sites have a 20 foot by 20-foot spacing, the density would be 109 trees per acre. Scaling up to HBC's Hillcrest site (a riparian corridor of approximately 540,000 square feet, or 12.4 acres), this spacing equates to 1,351 trees. If all trees are bare root and hand planted, an estimate of the total planting costs for Hillcrest's riparian corridor is $2,027. By contrast, SSC's Oak Park site has a riparian corridor area of 470,000 square feet, or 10.8 acres. This size equates to 1,177 trees. Assuming also that SSC uses hand planting, but instead purchases 3-gallon RPM, the total planting costs for Oak Park are approximately $14,124.

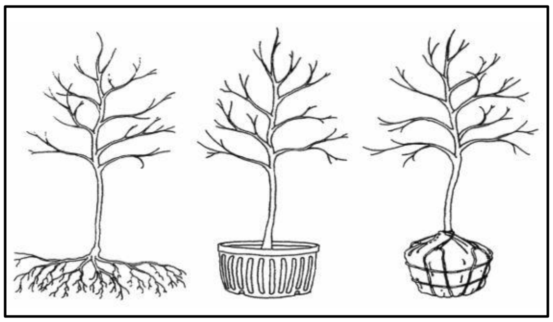

Figure 5.2 Bare root, RPM, and ball-and-burlap planting methods (Buckstrup and Bassuk 2009, p. 2).

Another important difference between bare root and RPM plants is the structure of the roots. Bare root saplings have broader root structures than RPM trees (Buckstrup and Bassuk 2009). Tree enthusiasts consider this structure to reflect "natural" root growth patterns and therefore desirable (Buckstrup and Bassuk 2009). RPM root saplings have condensed root wads with soil (Buckstrup and Bassuk 2009). Advocates for RPM cite the survivability, diameter at breast height, height attainment rate, and rate of nut/seed production as beneficial qualities (Dey et al. 2006). Advocates for bare root planting cite a more "natural" root structure which therefore encourages planters to not "plant too deep" and the low cost as the benefits of bare root planting (Buckstrup and Bassuk 2009).

Douglas and Grant's preference for RPM trees reflects a combination of personal relationships with the RPM company and their ecological goals for mitigation banking. Personally, Douglas and Grant have a positive working relationship with the nursery company that produces RPM trees. Both Douglas and Grant strongly believe in the work of RPM-founder Wayne Lovelace. Beyond their personal working relationship, Douglas and Grant consider that RPM trees meet their shared ecological values.

Douglas and Grant's primary goal when designing and constructing a new mitigation bank is to un-do historical damages (e.g. from farming), provide wetland habitat and plant diversity, and do so at high quality. The RPM fits their values because RPM plantings are marketed as a more efficient way of improving air-soil-water interactions in the topsoil, as being able to reach mature height faster than other planting methods, and as attaining thicker tree stem diameters at breast height faster than other planting methods (http://www.fknursery.com/). By using RPM trees, Douglas and Grant thus adopt mitigation practices and produce site outcomes that reflect the environmental qualities they value.

Similar to HBC, stream credits were originally an "added bonus" for SSC. From Douglas' perspective, if he is generating roosting habitat for migratory water fowl, storage of floodplain water to dampen flood waves, carbon storage in the form of wetland soil, and removing agricultural land from production, then he should get credit for all of these benefits.

Like Lawton, Douglas also cited stream incision as a major cause of stream degradation in southern Illinois. In Douglas's opinion, in-channel mitigation is a question of identifying and investing in a degraded stream that needs to be modified to alleviate erosion or incision. Douglas cited the risk of project failure as reasons for not pursuing in-channel work. In the meantime, riparian corridor credits provide Douglas with an opportunity to generate additional benefits specific to the stream channel. For Douglas, witnessing increased terrestrial and aquatic animal diversity as a result of his work is testament that his mitigation sites are ecologically beneficial and may also improve in-channel quality.

5.7 Stream Mitigation Banking Site Planning

There are different reasons why mitigation bankers establish bank sites, but they always work within the framework laid down by regulators. Vince Lawton of HBC preferred to "let the site be", but this perspective conflicted with the Corps's priority to sustain a given mitigation classification. Instead of "letting the site be," Lawton must adopt "hands on" adaptive management. In the end, the two agreed on an adaptive management plan that initially required mowing volunteer plants and raising the water level (by increasing berm height) to inundate and flood out woody plants in a small portion of the site to maintain the 'emergent' classification. The give-and-take between regulators and mitigation bankers occurs throughout the entire process of bank development.

Primary Stream Mitigation Planning Strategy: Successional Ecology, Climax Plant Communities, and Diversity

HBC and SSC both adhere to the notion that plant communities change over time through a "successional" model (see figure 5.3). This model is also implicit in the Section 404 mitigation credit classification system. Ecological succession is partly characterized by plant communities that, over time, change from one dominant unit/type to another. These units, also called "stages," are differentiated by their predominant plant types. If left undisturbed (i.e. to fire, water, human removal, etc.), the successional model predicts that early, or "emergent" stages will progress into more permanent, “climax” stages. Barbour explains that according to Clementian succession “the floristic composition within any community is homogenous throughout its range…because the component species are tightly interdependent upon each other. Moreover, if an association is disturbed by fire, logging, grazing, cultivation, or flood, it recovers its original species composition and appearance over time (once the disturbance ceases) in a process called succession” (Barbour 1995, p. 235).

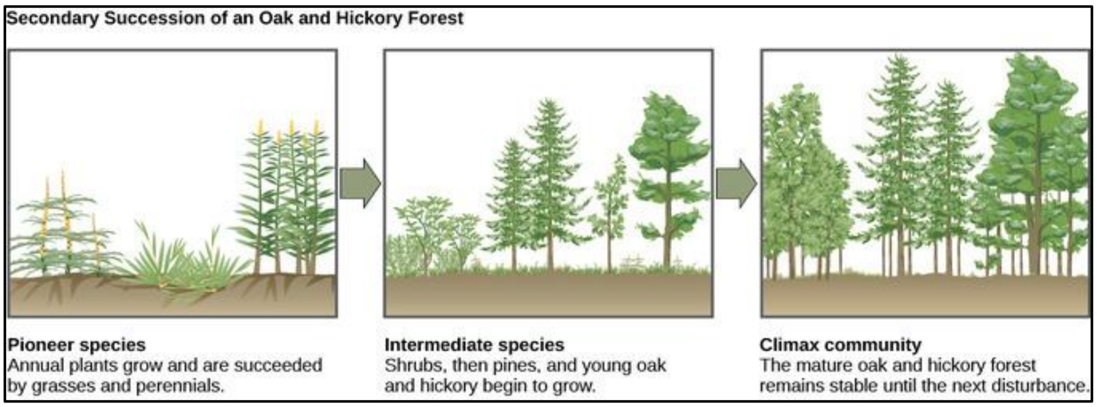

Figure 5.3 Plant succession model. Source: https://www.boundless.com/biology/textbooks/boundless-biology-textbook/population-and-community-ecology-45/community-ecology-254/ecological-succession-939-12198/. Last accessed June 12, 2016.

Ecological succession is evident in Section 404 stream and wetland mitigation guidelines. In particular, it is embodied by the plants selected during the planning stages of compensatory mitigation banking. According to successional theories, each region has a unique climate characteristic which in turn shapes unique “zones” of ecological types. Each zone has its own “climax” or “old growth” community. In Section 404 mitigation, mitigation bankers select species (e.g. especially oaks) that represent the historical “climax” community prior to European colonization and land disturbance activities. Therefore, in planting oaks based on the historical record, Section 404 regulators and mitigation bankers make the assumption that what once thrived in the mid-Mississippi valley region will continue to thrive if “jumpstarted” to the later stages of plant succession. Within this approach, because of a social preference and assumption that native plants are more ecological valuable, non-native species (i.e. species that are not found in the pre-disturbance record) are devalued and sought to be eliminated from all mitigation banking sites, irrespective of the ecological functions that they may provide.

A related ecological concept that is fundamental to both credit performance standards and mitigation banker prioritization is ecological diversity. Corps regulators and mitigation bankers tout ecological diversity for a variety of reasons, including their assumptions that it results in: increased system (i.e. site) survival with stress, increased functional diversity, and an increased array of benefits provided. Plant survival and diversity are also the primary metrics for credit performance in the St. Louis Corps district. Plant survival is simply a question of whether or not planted trees survive successive seasons. Diversity, by contrast, is often measured by counting individual species in randomly stratified sampling plots. In some cases, mitigation assessors use the Floristic Quality Index (FQI) of randomly stratified sampling plots to evaluate mitigation outcomes (Robertson and Hayden 2008). The only difference between counting and listing individual species and measuring FQI is that in FQI each species is given a specific “score.” The “score” assigned to the FQI ranking is based on the assumption that “native” plants (and a naturally functioning vegetation unit) are more valuable than non-native plants (DeKeyser et al. 2003).

Diversity is also important in Illinois for the “kinds” of wetland credits. Douglas put it this way: “When I look at a site, I’m trying to give it some type of a diversity. So that’s by looking at emergent and looking at a forested. A wetland credit…[is] broken out by ‘emergent’ and ‘forested.’ In Illinois it’s, they say hey, I’m going to restore 40 acres. There’s going to be 30 acres of ‘forested’ and 10 acres of ‘emergent.’ So you have to sell based on those wetland categories” (Interview, 05/28/2015). In Missouri, by contrast, “It’s not broken out by ‘emergent’ and ‘forested.’ They look at the site and they say ‘Hey we’re going to work 240 acres, and that will generate, for the lack of [a specific measurement], 40 [wetland] credits” (Interview, 05/28/2015). Therefore, diversity impacts mitigation bankers at two levels: within (i.e. the assemblage of plants selected) and between (i.e. either emergent herbaceous plants or forested woody plants) wetland types.

Existing policies in Illinois are likely to change in the near future. Douglas indicated that in Illinois, soon any “kind” of wetland can be sold generically as a “wetland credit.” He predicts that this change will mean that he will not focus as much on forested wetlands. Instead, he will design more emergent sites and may begin planting shrub-sedge wetlands. To Douglas, shrub-sedge represent an intermediate “stage” in the successional model—between emergent and forested wetlands. Douglas notes that the challenge in implementing a new planting type is designing sites with the appropriate hydrologic variability for each wetland type.

Plantings for both HBC and SSC are thus similar because they both seek to recreate historical plant communities (predominantly bottomland hardwood forests and emergent wetlands) in the greater Mississippi valley region. Furthermore, they both seek to do so by providing sufficient diversity within a particular wetland classification (emergent or forested). A typical riparian corridor hardwood planting list at a HBC or SSC site may include: Serviceberry (*Amelanchier*), hackberry (*Celtis occidentalis*), eastern redbud (*Cercis canadensis*), roughleaf dogwood (*Cornus drummondii*), grey dogwood (*Cornus racemosa*), green ash (*Fraxinus pennsylvanica*), walnut (*Juglans*), swamp chestnut oak (*Quercus michauxii*), swamp white oak (*Quercus bicolor*), shingle oak (*Quercus imbricaria*), burr oak (*Quercus macrocarpa*), slippery elm (*Ulmus rubra*), pin oak (*Quercus palustris*), pecan (*Carya illinoinensis*), and white oak (*Quercus alba*), among others.

Mitigation bankers and Corps regulators verbally cite many benefits of riparian corridors for in-channel conditions. Riparian trees modify in-channel temperature by providing shade. Certain species (oaks more so than maples) provide habitat. When planted beside existing forests and wetlands, these sites also provide habitat for water fowl including migratory species. Over time, riparian forests serve as a large woody debris source for in-channel habitat. Finally, riparian corridors also provide stream stabilization and therefore limit bank erosion. These benefits can potentially overlap the functional damages caused by in-channel work (e.g. bank stabilization using tree plantings). However, on the whole, the potential benefits attributed to riparian corridor replacement only partially overlap the potential impacts caused by in-channel activities. Thus, riparian corridor work remains a valued compensatory mitigation strategy even though it does not necessarily provide benefit that is in-kind with in-channel impacts.

5.8 Conclusion

This chapter has examined the final moment of mobilization of the 2008 Rule: design and implementation of compensatory stream mitigation banks. All stream credits in Illinois are generated using riparian corridor tree plantings. There are no current plans for compensatory stream mitigation banks to generate credits using in-channel work in Illinois. The main argument of this chapter has been that St. Louis regulators accept stream credits generated using riparian corridor work to accommodate a need for increasing the pool of stream credits available in the Illinois-portion of the St. Louis district.

From the perspective of mitigation bankers, streams in Illinois that would most benefit from in-channel work are those that are incised. However, from their perspectives, correcting incision is both risky and costly. Instead, mitigation bankers strongly believe that the enhancement of riparian corridors will provide benefits to in-channel conditions. Corps regulators work closely with mitigation bankers to suggest and promote mitigation banking activities that are at least potentially ecologically beneficial. Corps regulators review mitigation banking plans and monitoring reports to ensure that banks are designed and implemented with the goals of the 2008 Rule in mind. Because Corps regulators recognize a need for stream credits to compensate for stream impacts, they accept the work mitigation bankers provide as a form of work that benefits the stream channel even though it does not necessarily address the need for achieving no net loss of stream function.

Mitigation bankers develop mitigation banks for different reasons. Each mitigation banking company has a unique ecological perspective. These perspectives in turn shape how mitigation bankers design banks, implement management plans, and relate to the expectations of St. Louis regulators. St. Louis regulators therefore are always responsive to the priorities of individual mitigation bankers when reviewing mitigation documents and site assessments. Thus, rather than a single set of practices, what constitutes “compensatory stream mitigation” always emerges out of place-based deliberations amongst regulators and bankers. What constitutes work that counts as stream credits depends on the individual ecological priorities of mitigation bankers and Corps regulators. Practical needs to provide stream credits of any kind overshadow the need to provide stream credits that are based on whether or not mitigation improves in-channel functions.

In this way, compensatory stream mitigation banking can be viewed through the lens of stream naturalization. Rather than set in stone or tied to a single meaning, the definition of benefits that derive from mitigation work is contextually defined. Although scientific principles are cited and referenced to justify mitigation work, Corps regulators and mitigation bankers selectively frame scientific principles (e.g. riparian corridor connectivity vis-à-vis their economic, regulatory, and environmental values and priorities. At the same time, mitigation bankers and Corps regulators cite returning farmland to a "more natural state" as justification for counting riparian corridor work using stream credits. The precise functional benefits that these activities provide to the stream channel remain unexamined because both Corps regulators and mitigation bankers assume "more natural" looking riparian corridors to mean "naturally functioning" riparian corridors. Hence, rather than proven, the functional benefit of riparian planting to in-channel work is assumed within the broader classifications of "improved" riparian corridors.

This chapter also shows that Illinois stream mitigation bankers primarily construct and design mitigation banks from the perspective of ecological succession. This ecological ethos is also reflected in the St. Louis's crediting system. Rather than necessarily providing particular functions, mitigation bankers are given credits for generating types of wetland habitat. Mitigation bankers and St. Louis regulators therefore share in a goal of replacing agricultural land uses with historical wetland vegetation types. No net loss is thus not always the primary factor that Corps regulators consider when approving compensatory mitigation banking sites.

Mitigation bankers in Illinois are motivated by some St. Louis crediting incentives but not others. Mitigation bankers in Illinois are not currently motivated by increased credit value assigned to in-channel mitigation work. However, mitigation bankers are motivated by wetland classification requirements and riparian buffer area crediting. If St. Louis regulators require mitigation bankers to modify site conditions to maintain one classification or another they are responsive to those demands. However, economic incentives are not the only factor driving mitigation banker behavior and banking strategies. Mitigation bankers believe strongly in doing "good" work. Mitigation work that is considered "good" is anything that mitigation bankers can frame as potentially improving stream or wetland functions. Bankers take pride in replacing agricultural land uses with historical wetland vegetation types. Thus, like the St. Louis Corps regulators, mitigation bankers are not motived by no net loss goals when constructing mitigation banking sites.

Finally, the mobilization of the 2008 Rule is therefore not wholly determined by St. Louis regulators. While mitigation bankers do respond to St. Louis requirements, St. Louis regulators depend on the willingness of mitigation bankers to develop sites in the first place. Currently only parts of the 2008 Rule are being implemented by compensatory stream mitigation banking in Illinois. In-kind goals are not being met and can only be met when mitigation bankers decide to design and implement banks that include in-channel activities. Until mitigation bankers invest in in-channel mitigation credits, compensatory stream mitigation banking in Illinois will remain off-site but not in-kind. Like the definition of stream credits in the Illinois and Missouri methods, the definition of "sufficient" stream mitigation is also not guided by direct measurements of stream functions.

CHAPTER 6

GEOMORPHIC AND WATER QUALITY OUTCOMES OF COMPENSATORY STREAM MITIGATION BANKING IN ILLINOIS

6.1 Introduction

Compensatory stream mitigation banking under Section 404 of the Clean Water Act is supposed to replace aquatic functions damaged by permitted activities. The primary goal of the Clean Water Act in this regard is *no net loss* of stream function nationally. The 2008 Rule establishes new guidelines to improve Corps districts' abilities to achieve this goal. Being guidelines, each Corps district interprets and implement these goals differently. As Chapters 3-5 demonstrate, St. Louis has implemented these guidelines by developing a system to measure no net loss of stream impacts. However, as designed, their system of no net loss does not measure or necessarily replace stream functions.

First, The Illinois and Missouri SAT did not develop measurements for determining no net loss of stream function using functional stream measurements. Instead, no net loss measurements are primarily activity-based systems. These credit systems assume that individual activities always result in similar functional damages or benefits—irrespective of the stream condition. For example, "clearing vegetation" always costs 0.1 stream credits.

Second, compensatory stream mitigation bankers in the St. Louis Corps district do not construct mitigation sites that provide in-channel improvement. Impact activities—such as filling and re-routing streams, and putting culverts in stream channels—are being replaced with mitigation activities in the form of riparian tree plantings. These out-of-kind replacements are allowed because the Corps deems them commensurate using measures of stream credits.

Despite this exchange of “apples” for “oranges”, there is the potential that compensatory mitigation banking sites provide benefits outside of the scope of compensatory mitigation stream crediting. Currently, mitigation banks in Illinois generate stream credits based on the extent to which mitigation bankers improve the plant composition of riparian corridors. The conditions and characteristics of the stream channel itself at mitigation banking sites lie outside the scope of compensatory stream mitigation in Illinois. Thus, what this regulatory environment means for resulting in-stream conditions is an open and unanswered question.

Corps regulators and mitigation bankers both benefit from understanding the in-channel benefits derived from compensatory stream mitigation banking. Corps regulators and mitigation bankers frame riparian corridor tree plantings as a kind of “stream” mitigation. Both Corps regulators and mitigation bankers defend riparian corridor work as a kind of stream improvement using ideas borrowed from ecological connectivity theory. Riparian corridors improve in-stream conditions, they argue, because riparian corridors provide habitat for aquatic organisms, improve nutrient cycling for aquatic plants, and limit stream temperature by providing shade. Thus, from the perspective of Corps regulators, riparian corridor work is “stream mitigation” because it may potentially improve in-channel habitat quality.

However, since compensatory stream mitigation banks are designed with wetland compensation in mind, site for these banks are selected with the intent of meeting wetland performance standards. Likewise, because impacts occur wherever permitted Section 404 land development occurs, a correlation between the stream types impacted and the stream types replaced is not to be expected. Nonetheless, compensatory stream mitigation banking sites focusing on riparian improvements may have in-stream conditions that provide non-mitigation benefits. Contrary to compensatory mitigation benefits, non-compensatory mitigation benefits would be a benefit that is derived from environmental conditions not included or accounted for in the compensatory mitigation approval.

The goal of this chapter is to examine the extent to which the mitigation banking site provides benefits beyond those assessed and evaluated as compensatory mitigation crediting criteria (i.e. non-compensatory mitigation benefits). To evaluate these concerns, this chapter compares in-channel geomorphic and water quality characteristics of four impact sites with those at a single compensatory stream mitigation banking site. This chapter argues that there is currently not likely noticeable non-compensatory mitigation benefits provided by the mitigation banking site stream in the form of geomorphic variability and water quality. Section 2 discusses the permit background of the case selected for this chapter. Section 3 describes the methodological steps taken in the analysis. Section 4 presents the major findings of the comparison between impact sites and a compensation site. Section 5 discusses these findings in the context of Section 404 compensatory stream mitigation metrics and off-sets. Section 6 concludes the chapter by summarizing its main findings.

6.2 Details of the Impacts and Stream Mitigation Bank

The development impact that triggered the need for Section 404 permitting in this case study was the construction of an approximately thirty-mile long transmission line in southern Illinois. The two primary impacts that resulted from constructing the transmission line are 1) clearing of riparian corridor vegetation, and 2) installation of in-channel culverts for access roads. The compensatory mitigation bank used to compensate for these impacts through the purchase of credits focuses mainly on enhancement (10-50% planting) and creation (51-100% planting) of floodplain forest. Impact activities occurred in and around August 2009. The Corps approved the release of credits from riparian work at the mitigation banking site (i.e. sale) by October 2008. Thus, the impacts consist both of in-channel and riparian corridor components, whereas compensation work consists only of riparian corridor enhancement and creation.

In total, the permitted Section 404 activity (transmission line construction) that was compensated by the purchase of credits from the mitigation banking site impacted 48 ephemeral, intermittent, and perennial streams and rivers, as well as ephemeral water features. Of these 48, 13 stream impacts required mitigation in the form of compensation. None of these 13 is classified as perennial by the permit documentation. Nor were any of these impacts classified as permanent, despite the fact that the culverts remain in three stream channels.

This analysis focuses on four of these streams. The four streams and mitigation bank are representative of the types of impacts and range of stream types affected by this permitted activity (Figure 6.1-6.5). Furthermore, the stream types and impacts included in this study also reflect permitted activities that have been compensated by the purchases of credits in a similar stream mitigation bank elsewhere in Illinois. This chapter is therefore generalizable to the rest of the compensatory stream mitigation banking program in Illinois. The impacted streams surveyed in this study were largely relatively narrow, headwater channels that varied in sediment composition. These five impacted streams had an average upstream watershed area of 3.47 km^2, but the upstream areas of the streams range over three orders of magnitude (from 0.13 to 14.24 km^2). The mitigation banking site has an upstream drainage area of 450.66 km^2 (see table 6.1).

Site	Impact/Compensation Activity	Drainage Area (km²)
Impact 1	Vegetation clearance	14.245
Impact 2	Vegetation clearance	0.129
Impact 3	Vegetation clearance and culvert for access road	0.733
Impact 4	Vegetation clearance and culvert for access road	1.158
Mitigation bank	Riparian corridor planting	450.66

Table 6.1 Impact sites and mitigation banking site activities and drainage areas.

The impact sites and mitigation banking site have differences in climate, geology, soils, and surrounding land use (Table 6.2). The impact sites occur in two different eco-regions: the Karstic Northern Ozarkian River Bluffs eco-region (impact site 1) and the Southern Illinoian Till Plain eco-region (impact sites 2-4). The Karstic Northern eco-region receives 101.6-114.3 centimeters of rain on average annually. The average annual January low temperature is -6.1°C and the average annual July high temperature is 32.8°C (Woods et al. 2000). While similar, the Southern Illinoian region has a larger precipitation range (99.06-114.3 centimeters), with slightly warmer winters (-8.3°C average annual January low) and slightly cooler summers (31.1°C average annual July high) than the Karstic Northern region. The mitigation banking site is also in the Southern Illinoian region, and hence has similar temperature and precipitation ranges as impact sites 2-4.

The impact sites occur on steeper slopes than the mitigation bank, but all sites have similar soil textures according to the Web Soil Survey. Only one impact site (#1) sits in a low valley. All others are in steep headwater locations. All impact sites except #1 are less than 1 km streamwise from the headwater tip of their respective stream channel. The mitigation banking site sits on a flat till plain and is surrounded by wetland soil, oak-hickory forest, and farmland (Figure 6.5). It also is located much lower in a much larger watershed than the impact sites. Thus, the impact sites and the mitigation bank site have different slopes and drainage areas, but similar surrounding land uses and soil textures.

Site	Eco-Region	Bedrock?	Soil	Slope	Land Use
Impact Site 1	Karstic Northern Ozarkian River Bluffs	Mixed alluvial-bedrock stream. Mississippian limestone, sandstone, and siltstone	Alfisols, inceptisols, entisols and mollisols (Sonsac flaggy silt loam, Tice silty clay loam, Wakeland silt loam)	18-35% North/West; 0-5% East/South	Oak-Hickory forest (N/W); Corn and Soy (E/S)
Impact Site 2	Karstic Northern Ozarkian River Bluffs eco-region and boundary of the So. Illinoian Till Plain eco-region	None at surface.	Alfisols on both sides of the stream (Ruma-Ursa silt loams)	18-35% both sides of stream.	Oak and hickory cleared for the impact. Upstream is an actively farmed wheat field.
Impact Site 3	Southern Illinoian Till Plain eco-region	None at surface.	Entisol on both sides of the stream (Wakeland silt loam)	5-18% both sides of stream.	Oak-Hickory mixed forest upstream. Surrounded by corn and soy.
Impact Site 4	Southern Illinoian Till Plain eco-region	None at surface.	Entisol (Wakeland silt loam) and Alfisols (Bunkum, Marine, and Homen silt loam soils)	5-18% both sides of stream.	Cow pasture immediately bounds the stream. Corn and soy on both sides of the pasture.
Mitigation Bank	Southern Illinoian Till Plain eco-region	None at surface.	Inceptisol (Belknap silt loam), and alfisol (Hurst silt loam, Colp silt loam)	0-5% both sides of stream.	Bounded on the west by a mixed Oak-Hickory and the east by active corn and soy farm.

Table 6.2 Overall comparison of impact and mitigation bank site geology and climate. Eco-region data collected source: Woods et al. (2000). Soil and slope data from Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm; Last accessed June 2, 2016).

Figure 6.1 Impact site #1. Left image: looking southwest towards impact site 1 in the right image. Right image: Looking northeast toward the left image.

Figure 6.2 Impact Site #2: The channel sits at the base of the hill centered in this photo.

Figure 6.3 Impact Site #3. Left image: downstream of culvert. Right image: Looking northwest towards impact site #3 (the clearing of trees below the transmission line).

Figure 6.4 Impact Site #4: looking upstream at culvert.

Figure 6.5 Mitigation banking site. Left image: Young trees planted for riparian corridor. Right image: Mature trees within channel banks that are considered in threat of being eroded by the channel.

6.3 Methods

The geomorphic and water quality characteristics of instream conditions at the impact sites and at the compensatory mitigation banking site are assessed through comparisons of: a) channel dimensions, b) channel bed sediment texture, c) water temperature, specific conductivity, and pH, and d) upstream watershed area. This chapter also examines water level variability over a period of four months at the mitigation banking site. All analysis is conducted using a space-for-time substitution approach (Roni and Beechie 2012). Space-for-time substitution is appropriate when assessing the effects of changes, but no data were collected prior to changes (Roni and Beechie 2012). The method assumes that stream conditions upstream and downstream of impacted locations along a stream are representative of conditions at the impacted locations prior to the impacts.

Channel Dimension Analysis: The longitudinal profile (i.e. thalweg) and cross-sectional profiles were measured using a Leica TCR303 Total Station. Thalweg measurements consist of measurements of the deepest point in the channel at ~2 meter intervals through the extent of the study reach. Measurement of the thalweg at 2-meter intervals is sufficient spacing to ensure statistical robustness and closeness of spacing to discern topographic variation (Bartley and Rutherford 2005). The line that connects the depth point measurements constitutes the thalweg, and the vertical variation of this line is the thalweg variability.

Cross sections were measured perpendicular to the channel direction. Cross sections were measured approximately every five to seven bankfull channel widths. Due to accessibility constraints (e.g. water was not always wadeable, thick vegetation), not all sites had equal coverage (Table 6.3). Cross section endpoints were marked with wooden stakes and a survey tape was stretched tightly from endpoint to endpoint. Cross section elevations were surveyed along each cross section at a maximum spacing of 1 m. Additional points were added to capture local changes in slope along the cross-section profile. Total station measurements were referenced to a local arbitrary datum at each site to produce elevations.

Bankfull width and average channel depth values were extracted from cross-sectional elevation measurements (see figure 6.6). Bankfull level was identified using both abrupt transitions from channel to floodplain and vegetation changes. Vegetation indicators used include transition from the un-vegetated stream channel to either grasses, shrubs, or trees. Bankfull levels were measured on both sides of the cross-section when possible. The distance of this line (i.e. the difference of the distance coordinates of the endpoints) constitutes the bankfull width.

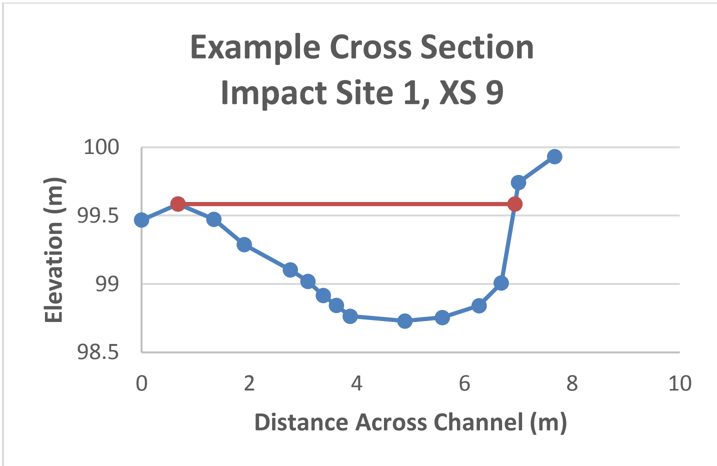

Figure 6.6 Example cross section survey. Red line is bankfull width level. Blue line is cross-section elevation measurements. In this case, the left bank peak is the bankfull level elevation.

Average depth was calculated by dividing the bankfull channel area by the bankfull channel width. Bankfull channel area was calculated using the mid-section method (Turnipseed and Sauer 2010) (see Figure 6.7).

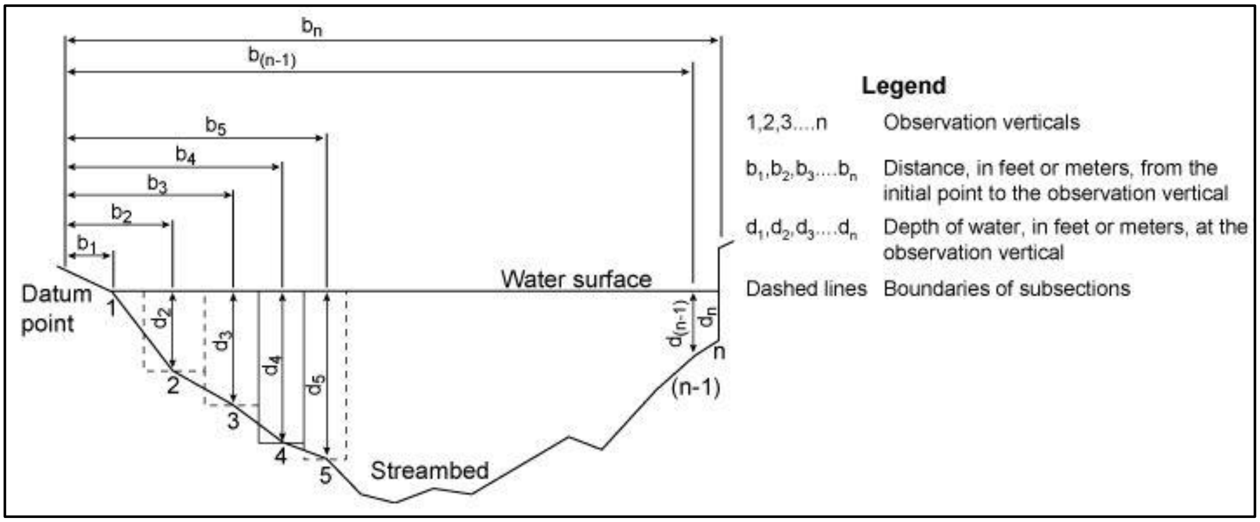

Figure 6.7 Definition of the midsection method. Source: http://gallatin.humboldt.edu/~brad/nws/lesson5.html. Last accessed June 10, 2016**.**

In the mid-section method, cross-section area is calculated by first calculating the area of individual subsections. The total area is then calculated by summing the area of each individual subsection. For example, the formula to calculate the area of subsection three in Figure 6.7 would be:

$$A_3 = d_3 * (\frac{b_4 - b_2}{2})$$

where A_3 = Area of subsection three

d_3 = depth of channel measured at observation point three

b_4 = distance of observation point four from starting point

b_2 = distance of observation point two from starting point

Channel Sediment Size Analysis: Sediment samples were collected from the bed of the channel upstream and downstream of impacts in both pools and riffles. Pools, or deep and gradually sloped portions, typically collect the finest sediments in a stream under low flow conditions. Riffles, or shallow and steeper portions, typically contain the coarsest sediments in a stream under low flow conditions. Together, sampling the pools and riffles captures the probable range of sediment sizes in each stream. The two dominant impact activities are culverts and channel bank vegetation clearance. In the case of culverts, sediment samples were collected upstream and downstream of culverts. In the case of vegetation clearance, sediment samples were collected upstream of vegetation clearance, through the reach of cleared vegetation, and downstream of the cleared vegetation. Sediment samples were collected using a hand-held Soft Bottom Modified Petersen Grab sampler. Samples were collected at varying bed depths; no sample was less than 15 cm deep. Bottom sampling was restricted to sites 2 (6 samples), 3 (4 samples), 4 (6 samples), and the mitigation bank (4 samples). Site 1 was too coarse to sample using bottom sampling methods. Some samples in sites 2, 3, and 4 included gravel. To collect this coarse sediment, sediment was excavated into a pile using the grab sampler and then scooped using the grab sampler. Larger volumes of sediment were collected at sampling locations with coarser material. Samples were dried, split, sieved, and weighed in the Geomorphology Soils Lab of University of Illinois, Champaign-Urbana campus to determine particle size distributions.

Water quality analysis: Water quality measurements were obtained using a YSI Professional ProPlus meter and hydro probes. Measurements of temperature (°C), pH, and specific conductivity (μS/cm) provided information on chemical and thermal properties of stream water. Specific conductivity and pH probes were calibrated within 24 hours prior to data collection. The YSI ProPlus meter automatically corrected both specific conductivity and pH for temperature with the Automatic Temperature Correction (ATC) feature. Measurements were taken at the midsection of each cross section used for channel dimension analysis and at the mouth of incoming tributaries when possible. A different protocol was used at the mitigation banking site because the stream there has a much larger discharge than the impact streams. Water quality measurements were taken 5 kilometers upstream of the mitigation banking site, approximately one kilometer downstream of the mitigation banking site, and evenly spaced throughout the mitigation banking site reach. These measurements, in turn, are used to interpret the overall water quality characteristics of the stream reaches.

Watershed size delineation: Digital elevation models at a resolution of 10 m were obtained from the USGS National Map Viewer for each study site. Watersheds were delineated in ArcGIS using the Pour Point method. Pour points (the downstream outlet of a watershed) were selected at the downstream end of each study site.

Mitigation bank water level variation: Overbank flood variability was measured using HOBO water level recorder at the mitigation banking site. The water level recorder documented hydrologic variability for a 4-month (July 5- November 5, 2015) period at 15-minute intervals.

Statistical Analysis: A variety of statistical methods are available for the analysis of geomorphic variability (Bartley and Rutherford 2005; Laub et al. 2012). Bartley and Rutherford (2005) and Laub et al. (2012) each analyzed multiple metrics of geomorphic variability and associated statistical analyses of variability. The "degree of wiggliness" factor (w), or the degree of vertical variation of channel depth from the mean elevation, was used to analyze thalweg variability; where $w = \sqrt{n * \sum(\Delta\phi_i)^2}$, and n= the number of points collected, and $\Delta\phi_i$ is the vertical deviation of each point from the mean (Bartley and Rutherford 2005). Wiggliness has no units. The coefficient of variation (CV) was determined to analyze variability in channel width (bankfull width) and depth (average depth) of the cross-section profiles (Laub et al. 2012). CV is the ratio of the standard deviation and mean of a measurement. $\text{CV bankfull width and average depth} = (\frac{\sigma}{\mu})$, where σ is the standard deviation of cross-sectional bankfull width and average depth measures, and μ is the mean bankfull width and average depth of the cross-section. Sediment size variability was examined using the measurement of sediment sorting (Bartley and Rutherford 2005). Phi sorting is a measure of the standard deviation of the sediment size distribution about the mean sediment size, where $\text{Sort} = (\phi 84 - \phi 16)/2.$ $\phi 84$ is a grain size for which 84 percent of the sample distribution is finer, and $\phi 16$ is a grain size for which 16 percent of the sample distribution is finer. Planform variability was compared by calculating the sinuosity of all sites. A stream is considered "straight" if it has a sinuosity less than 1.2, and "meandering" if it has a sinuosity greater than 1.5 (Schumm 1963; Chang 1979).

6.4 Findings

6.4.1 Geomorphology: Channel Dimensions, Planform Variability, Sediment Variability, and Hydrology

The impact sites and mitigation banking site have considerably different cross-sectional shapes and variability. On the whole, the mitigation banking site is wider and deeper than the impact sites, and has less variability in bankfull width measures. The impact sites have similar variability in bankfull width and average channel depth variability (see table 6.3). These findings indicate that the impact sites and mitigation banking site perform different physical stream functions.

The average bankfull width of impact sites varied from 2.3 m (Site 2) to 6.2 m (Site 1). The coefficient of variability (CV) of bankfull width, a metric of variance, ranged from 0.22 (Site 3) to 0.50 (Site 2). The average depth across impact sites varied from 0.30 m (Site 2) to 0.88 m (Site 3). The average of the CV of depth of all cross-sections varied from 0.18 (Site 3) to 0.40 (Site 1). Based on the CV of cross-sectional dimensions, Site 1 has the greatest cross-sectional channel depth variability, while Site 2 has the greatest cross-sectional bankfull width variability. Site 1 is the widest channel, Site 2 is the narrowest and shallowest, and Site 3 is the deepest.

The banking site has a mean bankfull width of 18.3 m and an average channel depth of 2.6 m. Thus the banking site almost three times as wide as the widest impact site, and more than nine times the bankfull width of the narrowest impact site. The banking site is also almost three times as deep as the deepest impact site. Unlike the impact sites, the banking site has limited bankfull width variability (0.096) and limited average depth variability (0.086).

Site	No. of cross sections	Mean Bankfull Width (m)	Bankfull Width CV	Average Mean Depth (m)	Average Mean Depth CV
Impact 1	8	6.183	0.255643	0.400	0.403992
Impact 2	9	2.321	0.499827	0.300	0.325176
Impact 3	7	5.072	0.220863	0.880	0.177727
Impact 4	7	5.267	0.24869	0.569	0.225992
Bank	4	18.345	0.09572	2.590	0.086293

Table 6.3 Summary of cross-sectional measurements for all sites.

Longitudinal variability (i.e. ‘wiggliness’) and planform (sinuosity) measurements were taken at all sites. The impact sites have considerably different planform characteristics than the mitigation banking site. On the whole, the impact sites have greater longitudinal variability, but less planform variability. See figures A.1-A.5 in the appendix for thalweg data.

All four impact sites have a variable thalweg. The wiggliness values from 17.9 (Site 4) to 31.2 (Site 1). Despite that Site 2 has more than double the channel gradient than Site 3, the two have similar longitudinal variability (20.7 and 20.9, respectively). Impact site channel gradient ranges from 2.5 % (Site 2) to 0.6 % (Site 1). Impact site sinuosity varies from 1.10 (Site 3) to 1.39 (Site 4). Based on these measurements, impact site 1 has the greatest thalweg variability, but impact site 4 has the greatest planform variability (sinuosity) of the four impact sites.

The mitigation banking site has much lower thalweg variability than all of the impact sites. The mitigation banking site also has a much lower channel gradient than most impact sites. Compared with the steepest impact site (#2), the mitigation banking site has approximately $\frac{1}{15}$ the channel gradient. While the mitigation banking site lacks downstream depth variability, it has the most varied channel planform. The mitigation banking site has a sinuosity of 1.5, while the highest impact site sinuosity is 1.39 (Site 4).

Site	**Thalweg Wiggliness**	**No. of samples**	**Distance Sampled (m)**	**Channel Gradient (%)**	**Reach Sinuosity**
Impact 1	31.2303381	97	238.3	0.610	1.22
Impact 2	20.65481213	35	67.6	2.507	1.11
Impact 3	20.91432064	67	71.4	1.154	1.10
Impact 4	17.94311383	79	98.6	1.191	1.39
Bank	2.264463649	15	82.5	0.172	1.5

Table 6.4 Summary of downstream depth measurements and site slope of all sites.

Channel bed sediment was collected at Sites 2, 3, 4, and the mitigation banking site. Both sediment size variability and phi sort were calculated. Although each site has silt loam soils, there is a wide variability in the relative proportions of gravel, sand, and silt/clay at each site (Figure 6.13) Site 3 has the greatest sediment variability of the three impact sites sampled. Site 2 had an abundance of gravel, while sites 3 and 4 had more sand than any other size range.

Compared with the three impact sites measured, the mitigation banking site has less sediment variability. All impact site samples had gravel, sand, and silt/clay. No mitigation banking site sample contained gravel. Bed material at the mitigation banking site also has a narrower phi range than that at any impact site. The mitigation banking site phi range (0.75-0.95) reflects the dominance of silt/clay-sized particles in the mitigation banking site samples. By contrast, impact sites had phi ranges that varied by as much as 2 phi units (Site 3, 1.45-3.5), reflecting significant proportions of sand- and gravel-sized particles.

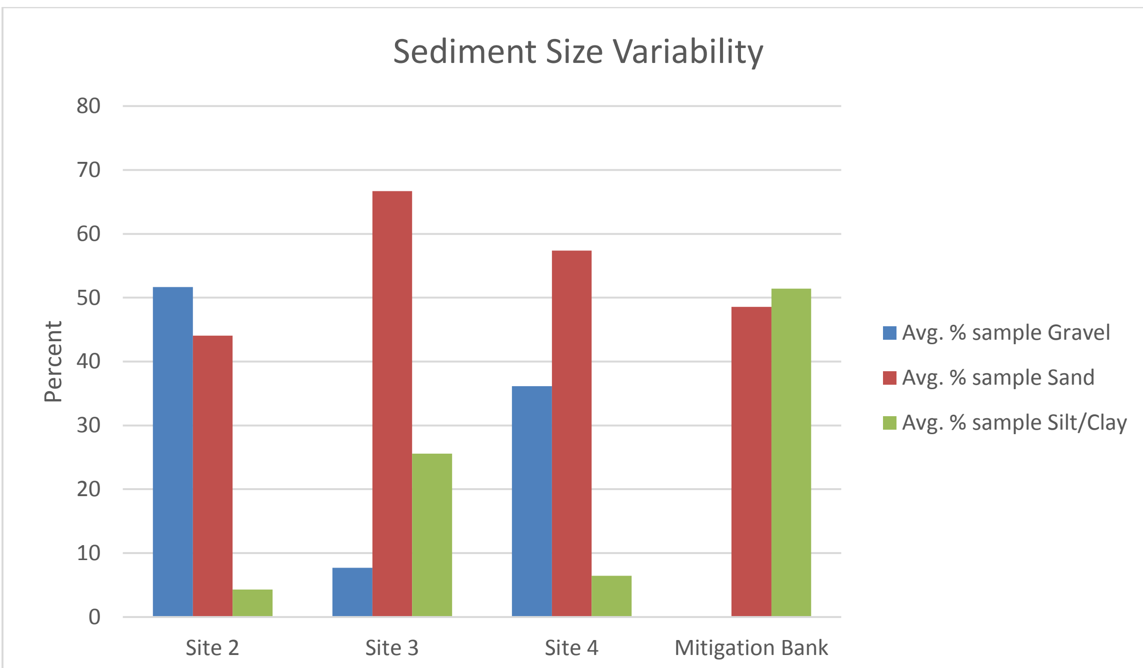

Figure 6.8 Sediment variability among all sites. Gravel = 31.5 mm to 2.0 mm diameter; Sand = 1.4 mm to 630 micrometers; Silt/Clay = < 630 µm.

The impact sites and mitigation banking site also have different hydrology. Two proxies were used to assess stream hydrology: watershed area and water-level stage of the mitigation banking site. The maximum stream discharge increases as watershed size increases (Knighton 1998). Based on this principle, it is possible to compare the relative hydrology between the impact sites and mitigation banking site based on watershed area alone. All impact sites have upstream drainage areas of less than 25.9 km^2. The mitigation banking site, by contrast, has an upstream drainage area of 450.7 km^2. Therefore, the mitigation banking site has a dominant stream discharge of at least an order of magnitude greater than the impact sites.

In a review of Illinois DOT wetland mitigation banking sites, Pociask and Matthews (2013) found that streams with smaller drainage areas had more frequent, but lower duration, over-bank flood events. Thus, in addition to differences in stream discharge, the impact sites and mitigation banking site most likely differ in the frequency and duration of overbank events. Because the connectivity of stream channels to the surrounding floodplain is critical for performing ecological functions (Ward et al. 1999; Freeman et al. 2007), differences in overbank events in turn has different impacts on ecological functions. The impact sites and mitigation banking site perform different ecological functions based on differences in stream hydrology and channel-riparian corridor connectivity.

The connectivity of the mitigation banking site and its floodplain was measured over a four-month period using a HOBO water level recorder (see figure 6.14). The mitigation banking site had one over-bank flow event between July 5 and November 5, 2015. This event lasted over 24 hours (approximately 28). June 2015 was one of the wettest months on record, and so it is likely that there were multiple other over-bank events in June too (http://mrcc.isws.illinois.edu/).

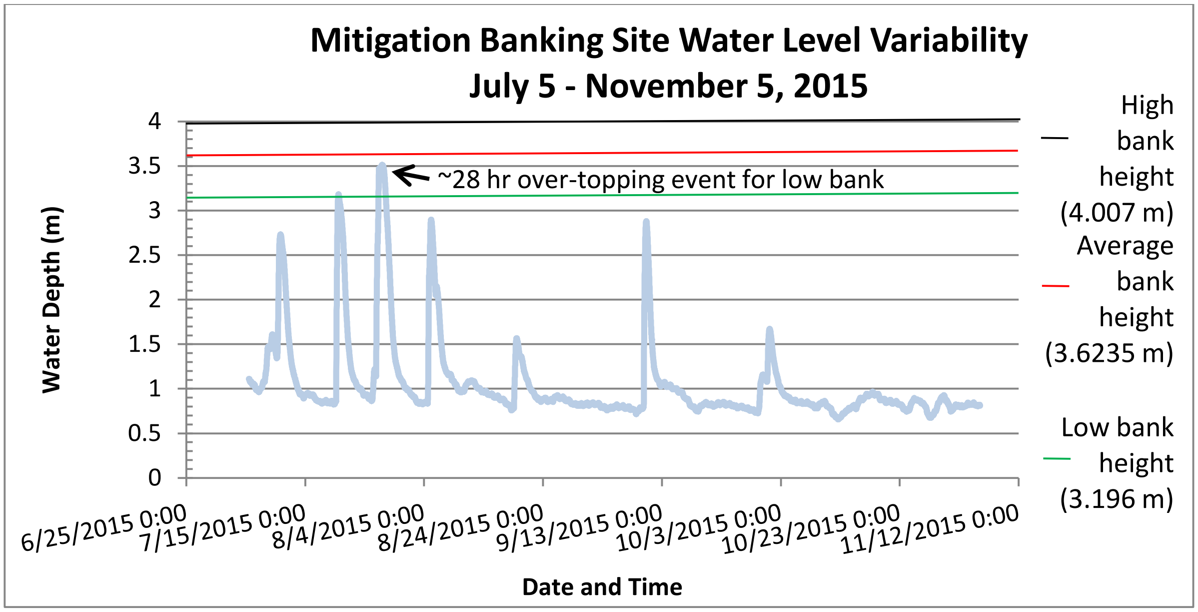

Figure 6.9 HOBO water level recorder data for stream mitigation banking site.

6.4.2 Water Quality

Water quality measurements are water-level dependent. Impact sites 2, 3, and 4 are ephemeral and intermittent streams that have limited water depth except during precipitation events. These sites had limited or insufficient water depth during multiple sampling periods. For these reasons, temperature, conductivity, and pH measurements were only taken at impact sites 1, 4, and the mitigation banking site (see table 6.5, Figures A.6-A.14 in Appendix A)

There are five main findings to emphasize. First, all pH measurements fall within the acceptable range established by the IEPA (IEPA 2004). Impact sites 1 and 4, and the mitigation banking site, are not likely impaired for uses (e.g. recreation, aquatic life) by pH. Second, the impact sites tend to have a wider temperature range than the mitigation banking site. Impact site 1 had a temperature range of 1.3°C and 3.3°C during the two sampling periods. The temperature range at impact site 4 is 6.2°C. By contrast, the temperature range at the mitigation banking site was only 0.4°C and 1.4°C during the two sampling periods. The mitigation banking site thus has a more stable temperature than the impact sites. This difference likely reflects the differences in discharge because shallow water heats and cools faster than deep water. During sampling, the water depths at the impact sites was much less than the depth at the mitigation banking site.

Third, impact site 1 and the mitigation banking site have similar pH and specific conductivity variability. The pH of the two sites varied less than 0.5 pH units, while the specific conductivity varied less than 40 µS/cm. This finding can be explained by the fact that flowing surface waters generally will not vary much in pH and conductivity unless non-point or point sources of dissolved minerals alter background values.

Fourth, except for one measurement upstream of the mitigation banking site, the mitigation banking site stream had lower pH values than all measurements taken at the impact sites. These differences cannot be explained by temperature differences. In general, as temperature increases, pH decreases (Girard 2005). However, in this case, the mitigation banking site also has lower overall temperatures than the impact sites. Other possible explanations for differences in pH include the geology of a site (e.g. clay soils decrease pH), photosynthesis (e.g. increased photosynthesis from algal growth results in increase in pH), and acid mine drainage (Girard 2005).

The mitigation banking site stream has been listed as impaired by the IEPA for manganese, sulfates, nitrogen, pH, siltation, low dissolved oxygen, total dissolved solids, habitat alterations, and total suspended solids (IEPA 2004). The mitigation banking site watershed has a history of coal mining. As of 2004 there was only one permitted, active coal mine in the mitigation banking site watershed; but this mine is downstream of the reach surveyed herein (IEPA 2004). The lower pH levels in the mitigation banking site thus likely reflects a combination of algal growth, differences in soil pH with the impact sites, and discharge from surrounding land uses (e.g. even historic mine tailings).

Fifth, values of specific conductivity are similar at all sites, but impact site 4 had the highest specific conductivity. Conductivity is a measure of the concentration of charged atoms present in a water body and can be indicative of the salinity or concentration of total dissolved solids (e.g., toxic metal, $H+$ cations, etc.) (Girard 2005). Conductivity is also affected by temperature; warmer water has a higher conductivity (Girard 2005). Water bodies have a range of conductivity that reflects the overall concentration of total dissolved solids for a given water temperature and volume (Girard 2005).

For comparison to nearby streams with similar drainage areas, Rayse Creek near Waltonville, IL (227.9 km^2 drainage area; a disturbed watershed with agriculture), has a conductivity ranging from 200 to 1400 µS/cm. Lusk Creek near Eddyville, IL (111.1 km^2 drainage area; an undisturbed watershed with forests) has a conductivity ranging from 40 to 170 µS/cm (Groschen and King 2005). Both of these creeks were measured between 2001 and 2003 by the IEPA and the USGS (Groschen and King 2005). The difference in conductivity of these two waterbodies reflects the differences in land use in these two watersheds (Groschen and King 2005). Undisturbed, forested watersheds in Illinois have lower conductivity values than disturbed, agricultural watersheds (Groschen and King 2005).

All measurements of specific conductivity (i.e. on both days) ranged between 508-555 µS/cm at site 1, 544-625 µS/cm at the mitigation banking site, and 459-839 µS/cm at site 4. Based on these findings, site 4 has a considerably higher concentration of total dissolved solids than site

1 and the mitigation banking site (e.g. 839 versus 553 μS/cm conductivity). Likewise, site 4 is likely more saline than site 1 and the mitigation banking site.

Site	Air temp (°C)	Avg. water temp (° C)	Temp range (° C)	Avg. pH	pH range	Average Sp.Cond. (μS/cm)	Sp.Cond. range (μS/cm)	pH within IEPA standard?
Site 1								
Day 1	29.4	21.08	20.8-22.1	8.149	8.103-8.191	539.79	508-544	Yes
Day 2	27.8	23.45	21.1-24.4	8.240	8.190-8.284	541.67	518-555	Yes
Site 4								
Day 1	26.7	25.53	23.2-29.4	8.060	7.624-8.639	717.5	459-839	Yes
Bank site								
Day 1	30.6	25.4	25.2-25.6	7.493	7.392-7.658	623.5	622-625	Yes
Day 2	23.9	20.53	19.7-21.1	7.386	7.333-7.406	563.43	544-583	Yes

Table 6.5 Summary of water quality measures across impact sites 1 and 4 and the mitigation banking site.

6.4.3 Riparian Vegetation

Section 404 permit documents provide a record of the total impact to streams, wetlands, and riparian corridors from the permitted activity. The permit documents also describe the compensation that was required for the permitted impacts. In this case the permit counted 3.24 hectares (8 acres) of cleared riparian corridor towards the impacted area in both Illinois and Missouri. The applicant needed to offset the Illinois' portion of this impact by providing 3.20 hectares (7.91) acres of "functioning riparian corridor." Legally, the riparian corridor counts as all trees both within 7.62 m (25 feet) of each stream bank as well as all trees within the 45.72 m (150 feet) right of way corridor. It is not clear how the permittee or regulator actually measured the impacts to determine that 8 acres were affected.

Using Google Earth ™, I measured approximately 20.23 hectares (50 acres) of forest cover—including both riparian and non-riparian—that was cleared in total for this permitted activity. Therefore, the compensatory mitigation work provided at the mitigation banking site did not replace the total acreage lost to the permitted activity. This difference is because the applicant was not required to compensate for impacts beyond the riparian corridor zone. Areas outside of the riparian corridor zone are external to Section 404 regulatory jurisdiction.

6.5 Discussion

Prior to 2008, Section 404 mitigation credits for stream impacts were primarily determined using length and area measurements. The Corps therefore achieved compensatory mitigation by replacing an impacted stream segment with a stream segment of equal or greater length. However, because length and area measurements do not ensure *functional* replacement of resources, the Corps and EPA revised Section 404 regulations and guidelines. These new guidelines, encapsulated in the 2008 Rule, require each Corps district to develop function-based stream assessment protocols for the standard and consistent measurement of stream credits.

As chapter 3 demonstrates, the Illinois and Missouri SAT have not developed functional assessment methods because the St. Louis Corps and other Corps districts have emphasized practical concerns of method use and whether or not the method results in "no net loss" in terms of stream credits for Section 404 stream compensation. The resulting Illinois and Missouri stream mitigation methods do not require collection and analysis of field data. Instead, commensuration for no net loss of stream functions is based on two core assumptions: 1) that physical stream conditions determine the overall biological productivity of a stream, and 2) that each activity has a distinct physical (and therefore biological) impact on stream functions.

The focus that the St. Louis Corps places on commensurating the value of impact and mitigation activities means that different kinds of work can be done to compensate for impacts. As this chapter indicated in the introduction, out-of-kind compensation is the norm for compensatory stream mitigation banking in Illinois. Impacted streams are affected by both riparian corridor and in-channel activities. Sites used for compensatory mitigation banking, by contrast, currently are only improved using riparian corridor activities. As a result, compensatory stream mitigation banking Illinois is out-of-kind, and thus likely not achieving no net loss goals for these reasons.

However, as this chapter demonstrates, there are also unlikely to be significant non-compensatory mitigation benefits provided by this stream mitigation banking site. Rather than focusing on impact and mitigation activities per se, this case study has analyzed the streams themselves. These geomorphic measurements indicate that the impact sites and mitigation banking site have different geomorphic characteristics. Geomorphic processes are predominantly controlled by the interaction among channel morphology, sediment variability, and hydrologic variability (Montgomery 1999; Doyle et al. 2005). As these variables change, so do the ways that stream channels evolve in their shape, ability to transport material, and position on the landscape (Montgomery 1999; Poole 2002; Doyle et al. 2005). It is exactly these changes—in channel shape, sediment and material transportation potential, and location/position—that alters the ability of stream channels to perform critical ecological functions (e.g. denitrification, habitat) (Doyle et al. 2005).

As such, differences in channel size, sediment type, gradient, hydrology/discharge, and planform are all indications that the impact streams and the mitigation banking stream perform different ecological functions. Sediment variability, and the replenishment of variable sediment patches, is critical for sustaining in-channel habitat (Poole 2002; Doyle et al. 2005). A major driver for these differences is often specific discharges that occur concurrently with seasonal biological patterns (Doyle et al. 2005). Discharge, along with geology, is a controlling variable of stream size and dimension. Because stream size and gradient are significantly correlated with the type and quality of fish assemblages common to a stream (D'Ambrosio et al. 2009), differences in stream size and gradient can result in differences in stream ecology. Thus, based on the differences between the channel size and variability in the impact sites and the mitigation banking site, the impact sites presumably provide *different* habitat type and quality than the mitigation banking site. Furthermore, based on water quality data, the mitigation banking site stream does not necessarily provide higher-quality water for in-stream habitat.

6.6 Conclusion

The goal of the Clean Water Act is to maintain no net loss of stream function nationally. Ideally, no net loss goals would be met using functional-assessment methods that compare functions damaged at impact sites to functions generated at compensation sites. However, in the St. Louis Corps district, no net loss compensation is assessed based on the value of stream credits associated with impact and mitigation activities. The actual functions that result from these activities, and the stream settings in which they occur, are unexamined. Thus, according to the St. Louis Corps's, "in-kind" compensation means to replace one activity with a similar activity.

Nevertheless, compensatory mitigation banking sites in the St. Louis Corps district generate stream credits exclusively through the use of riparian corridor tree plantings. Impact sites, by contrast, include activities that affect both riparian corridors and in-stream conditions. Compensatory stream mitigation banks in the St. Louis district thus provide compensation using out-of-kind activities.

Assessing compensation by activity is at best an inexact measure of stream functions. For one, by focusing on the activity alone, regulators tend to under-emphasize the characteristics of the streams themselves that are being impacted and compensation. This chapter has provided evidence that the St. Louis Corps's compensatory stream mitigation banking program is not only out-of-kind because it compensates for in-stream impacts with floodplain mitigation activities. The St. Louis Corps's compensatory stream mitigation banking program also is not likely providing non-compensatory mitigation benefits. Impacted streams and mitigation site streams have dissimilar biophysical characteristics, and thus presumably provide different aquatic functions. Moreover, the water quality measurements taken at the mitigation banking site stream do not demonstrate clear improvement of water quality due to compensatory mitigation banking activities.

The differences between the watershed area of the impact sites and the mitigation banking site implies that the impact streams have much lower stream discharge than the mitigation banking site stream. Since channel discharge is a "master variable" for stream ecology (cf. Doyle et al. 2005), channels with discharge differences over many orders of magnitude perform markedly different ecological functions (cf. Poole 2002; Doyle et al. 2005). Therefore, this chapter provides two tentative conclusions. First, findings in this chapter indicate that the impact sites in this study are out-of-kind with the mitigation banking site stream. Second, findings in this chapter indicate that the mitigation site stream is not likely providing non-compensatory mitigation benefits.

CHAPTER 7

CONCLUSIONS

7.1 Summary of Findings

The primary goal of this dissertation is to shed light on the translational process through which the St. Louis Army Corps of Engineers District *commensurates* streams for no net loss of function, and the biophysical outcomes of this process. Through an extended case study of the St. Louis Corps during the implementation of Section 404 policy in Illinois and Missouri, as well as a biophysical comparison of impact and mitigation sites, this research provides insights into the regulatory politics of compensatory stream mitigation. The research identifies the logics of why and how Section 404 regulators, actors invited to provide input during stream mitigation method development, and mitigation bankers implement Section 404 compensatory stream mitigation banking in Illinois and Missouri. This work also demonstrates the applicability of the sociology of translation to the implementation of federal guidelines.

This dissertation investigated four moments in the process of *translation*: the establishment of a standard method and measure for evaluating stream functions by a lead agency across a diverse social network. The first focused on how the St. Louis Corps creates state-specific stream mitigation methods in Illinois and Missouri. St. Louis navigates this process by attempting to enroll actors who share the regulatory burden of issuing Section 404 permits in a timely manner. The second moment focuses on how St. Louis regulators govern the Section 404 permit review process. This study followed a St. Louis regulator using the Illinois stream mitigation method (whose development was the focus of the first study) to issue a Section 404 stream permit. The third moment investigates how St. Louis regulators attempt to steer the development of compensatory stream mitigation banks. It also discusses how mitigation bankers' environmental values shape the development of compensatory stream mitigation banks. The fourth moment assesses non-compensatory mitigation outcomes by comparing the in-channel geomorphology and water quality of four impact sites and the stream mitigation bank that supposedly compensates for the functional losses at the impact sites.

The conclusions of these four studies show that the commensuration of stream functions is largely shaped by St. Louis's prioritization of timely permit issuance over all other factors. This over-riding priority tempers how St. Louis develops state-specific stream mitigation methods, reviews and issues of Section 404 permits, works with compensatory mitigation bankers, and approves out-of-kind stream mitigation. As a result, St. Louis has developed a program that evaluates no net loss using metrics of stream credit that are not based on measurements of stream functions. In this case, streams are commensurate not because they perform similar stream functions, but because they are considered to be of similar value of stream credits.

The research design was guided by key questions and objectives that are outlined in Chapter 1. The questions are restated here for clarity, and a summary of the main findings related to each question are given below.

1) *What practical, scientific, and political factors inform the creation of a standardized, state-specific stream mitigation method?*

The St. Louis Corps organized two groups ("Stream Assessment Teams") to create state-specific stream mitigation methods in Illinois and Missouri. The primary factor that informed the creation of stream mitigation methods in Illinois and Missouri was whether or not the method could be used by both experts and non-experts in a timely manner. St. Louis was interested in creating a regulatory setting whereby Section 404 permits could be issued in a timely manner, and thus wanted to ensure that the method is useful across a wide range of potential users with varying levels of expertise. For these reasons, St. Louis discouraged suggested method changes from any group member that required any kind of data collection and analysis.

St. Louis's differences in the level (or "uneven success") of success at developing state-specific stream mitigation methods in Illinois and Missouri reveals the social factors necessary for a method or protocol to become standardized. In Missouri, the SAT more or less fully agreed with St. Louis's problematization of the stream mitigation method as a visual-assessment method that does not need to assess compensatory mitigation using direct measurements of impacts or mitigation activities. All Corps districts and the Missouri DNR had a joint planning agreement to streamline Section 404 permit review—including both review of individual permits and the development of mitigation method guidelines. The agreement held others accountable (in the protocol's implementation) for not participating as planned. All SAT members accepted the use both versions of the Missouri method.

In Illinois, by contrast, the Illinois stream mitigation method is not widely accepted. There, not all Corps districts are willing to adopt multiple methods for standardizing stream credits. For example, the Louisville district opposed elements of the Illinois method on the grounds that the method did not accommodate permitting needs in the rest of the Louisville district (e.g. coal mining projects in Indiana and Kentucky). The Illinois stream method is also not completely embraced by the Illinois EPA. The Illinois EPA agrees that an Illinois method is needed, but does not agree on the components of the current draft. From the Illinois EPA's perspective, unless the method includes the legal requirements necessary for a Section 401 water quality review, it will not be sufficient for assessing stream damages and benefits statewide. Protocols only become standard when all of the designers and users agree on the scope, applicability, and elements included in the protocol.

2) *What is the translational process through which Section 404 actors determine what counts as an impact and what counts as sufficient mitigation to fulfill no net loss goals?*

Question 2 was answered in two separate analyses (Chapters 4 and 5). Chapter 4 evaluated the process through which a St. Louis regulator reviews a Section 404 permit and determines mitigation necessary to off-set stream impacts. Chapter 5 evaluated the process through which St. Louis regulators work with compensatory stream mitigation bankers to design and plan compensatory stream mitigation banks in Illinois.

The main conclusion that can be drawn from both chapters 4 and 5 is that both during the permit review process and the mitigation review process the Corps's duty of ensuring "sustainable development" (i.e. issuing permits in a timely manner) trumped the Corps's duty of ensuring environmental protection. Environmental protection (i.e. meeting no net loss goals) took the form of a practical trade-off that the Corps considers necessary to accomplish timely permit review. The Corps are constrained by a need to avoid slowing the permit process. For example, during the permit review process, the applicants studied would have been allowed to compensate for impacts by purchasing credits from a mitigation bank had there been credits available—irrespective of the kind of mitigation. The only factor impeding this type of action by the Corps was a lack of available credits.

Three primary conclusions can be drawn from the analysis in Chapter 4. First, Corps regulators coach the Section 404 applicant to streamline the permitting process. At the same time, each Corps regulator has his/her own way of ensuring that permits sufficiently meet mitigation requirements in a timely manner. Corps regulators take it upon themselves to communicate state and federal guidelines so that the applicant can make an informed decision as quickly as possible. Second, the Illinois and Missouri stream mitigation methods are not prescriptive; the data used to meet classification criteria vary by method user. The implication here is that most method users err on the side of simplicity and base assessments off of visual, activity-based information rather than using complex, function-based data. Third, since Corps regulators consider no net loss as a numerical problem of balancing stream credits, regulators ultimately deem impacts and compensation to be commensurate by the metric of stream credits. In practice this translates to a game of balancing credits. Once an impact assessment is complete and the total number of stream credits required for compensation is determined, applicants can mix-and-match mitigation techniques to meet the minimum credit requirement. While this approach is certainly flexible, it in no way guarantees that the mitigation required to compensate for impacts will be of similar functional quality.

Chapter 5 evaluated the process through which St. Louis regulators work with compensatory stream mitigation bankers to design and plan compensatory stream mitigation banks in Illinois. Similar to Chapter 4, Chapter 5 demonstrates the variability of ecological types that are deemed commensurate using the metric of stream credits. One conclusion that can be drawn from Chapter 5 is that, since compensatory mitigation banking is framed as an incentive-based program, Corps regulators lack the oversight and control necessary to require that compensatory mitigation banks are in-kind. Corps regulators lack sufficient regulatory authority to require compensatory stream mitigation banks to use in-channel methods. Ultimately, Corps regulators are required by law to issue Section 404 permits. When practicable, Corps regulators are encouraged to replace the functions lost to an impact activity.

Two conclusions can be drawn from this study regarding mitigation banker activities and motivation. First, mitigation bankers are reluctant to do in-channel work because of a fear that in-channel work will not be successful and will be costly. Thus while some economic incentives work (e.g. riparian corridor tree plantings) while others have thus far failed in Illinois (e.g. in-channel stream credits). Mitigation banker doubt that in-channel work will be successful, a lack of trust in in-channel methods by both bankers and Corps regulators, and a lack of experience developing in-channel sites by mitigation bankers all work to counter the economic incentive provided by the mitigation methods.

Second, mitigation bankers and Corps regulators do not only consider in-channel work as necessary to doing "stream" mitigation. Mitigation bankers view non-channel mitigation work as valuable because it replaces riparian farmland with historic bottomland forests and wetlands. Both mitigation bankers and Corps regulators cite the connectivity of floodplain corridors with stream channels as reasons for why riparian corridor work counts as "stream" work.

3) *Does the mitigation banking site provide non-compensatory mitigation benefits to the in-channel area?*

The primary conclusions of Chapter 6 are that Section 404 compensatory stream mitigation banking in Illinois both does not achieve no net loss of stream function goals and also does not likely provide non-compensatory mitigation benefits. This conclusion can be explained by three different factors.

First, while impact sites include both in-channel and riparian corridor impacts, stream mitigation banks lack any in-channel replacement or enhancement. Even if the mitigation site functions according to its goals (e.g. denitrification, dampen flood waves, store sediment), these functions will not necessarily replace the functions lost or damaged at the impact sites.

Second, Illinois Section 404 mitigation is based on activities rather than functions. As designed, the stream mitigation method assumes functions and benefits from impact and compensation activities. This assumption is a tenuous one; there is no guarantee that identical activities result in identical functional outcomes in different stream settings (cf. Doyle and Shields 2012). Rather than actually measuring the functional effect an activity has on a stream, it is assumed.

Third, impacts and mitigation occur in different geomorphic and ecological settings. While impacts are primarily to headwater streams with one set of geomorphic and ecological properties, mitigation is restricted to larger streams low in the watershed with a different set of geomorphic and ecological properties. Thus, regardless of the activities in the impact and mitigation sites, the streams themselves provide habitat and benefits for different plants and animals and therefore are not appropriate for replacing one another's functions (cf. Poole 2002; Doyle et al. 2005; Pociask and Matthews 2013).

7.2 Broader Significance and Future Work

This research has investigated the process and logics through which St. Louis Corps regulators organize the creation of standard stream mitigation methods in Illinois and Missouri, the interaction between Corps regulators and applicants during the permit application process, and the interaction between Corps regulators and stream mitigation bankers when providing compensatory stream mitigation banking. The findings indicate that Corps regulators prioritize "sustainable" development goals (i.e. issuing permits in a timely manner) over environmental protection goals. In the process, the goal of no net loss of stream function is not achieved. This research has implications for both practical and scholarly purposes.

The evaluation of St. Louis District's steering of the Illinois and Missouri SATs demonstrates how and why developing credit-based assessment methods is a socially contingent practice. As Chapter 3 revealed, decisions over what constitutes a sufficient measure of stream credits depends on who has say over method development, and the prioritization of stream credit assessment relative to other duties. The suggestions made by scientists and stream experts during method development to require field-based data collection were frequently disregarded and deemed either too complex, too time consuming, or both. These findings indicate that the rhetoric about credit-based environmental protection is cleaner and more certain than the actual application of credit-based environmental protection. Just because a credit value has been assigned to an environmental impact, it does not mean that the environmental impact has been replaced with similar functions.

These findings also call the no net loss goal into question. As this dissertation demonstrates, the term "no net loss" has no exact meaning. Instead, it can be molded to suit local policies, priorities, and willingness to hasten the permit process. The broader implication here is that just because environmental features are measured and compared does not mean that measurements are done in a way that addresses stream functions. Thus, there is no reason to be hopeful that credit-based assessment methods designed by the Corps will result in replacement of lost functions nationwide—even if the methods are "used as directed."

There remains a fundamental gap between the expectations of no net loss programs and the deliberations necessary to implemented such programs. No net loss policy is based on the premise that individual stream functions can be replaced by comparing functions using a single metric. To do so requires valuing stream functions relative to one another. However, establishing the value of one stream function over another is a subjective problem.

This presents an inherent contradiction. At one moment, no net loss intends to replace objectively measurable functions. At another moment, to do so requires subjective determination of the value of these different functions. This dilemma is captured in the concept of *commensuration* (Espeland and Stevens 1998). In order to compare apples and oranges, there needs to be a shared metric (or set of metrics) that apples and oranges share (cf. Espeland and Stevens 1998). Furthermore, there is no one "right" answer; it is up to those performing commensuration to decide what about apples and oranges (or different kinds of streams) is worth measuring and comparing (cf. Espeland and Stevens 1998). Therefore, rather than an innocuous moment of pure technical decision making, the commensuration of stream functions is a political moment. There is no objective explanation for why one function should be assigned a higher metric value than another. As this dissertation demonstrates, the political choice made by the St. Louis Corps in this case is to give the impression that no net loss is being met by ensuring that credits always balance.

This study also demonstrates the scholarly and practical applicability of using the framework of sociology of translation in two ways. First, it shows that the implementation of federal rules in a multi-agency setting can be viewed through the lens of translation. Federal regulations often specify the duties that agencies must conduct, however not necessarily the specific ways of carrying out duties. It is up to district regulators to interpret these federal guidelines, establish a problem scope, and assign duties for others to carry out in order to achieve the primary goal or duty. This translation process of federal regulations includes problematization, interessment/enrollment, and mobilization. Translation therefore can enrich our understanding of exactly how Corps regulators utilize interpretive flexibility when implementing guidelines.

Second, this study provides insight into the directionality of power and influence through a translation network. Callon (1984) originally emphasized the ability of a central authority to control others. The direction of influence in this regard was one way: from the individuals or group steering translation to those who were going to mobilize the method. However, in this dissertation, the Corps had sole authority in most decision making. To influence the Corps, other agencies took it upon themselves to persuade the Corps to adopt a different focus and goals. For example, in Illinois, the Illinois EPA urged the St. Louis Corps to provide chemical assessment methods so that the Illinois method can meet the needs of both the Section 404 permit and the Section 401 water quality certification. In Missouri, the US FWS, US EPA, and others, urged the St. Louis Corps to modify the Missouri method in a way that in-channel work would be valued more than riparian corridor work. Thus, rather than only uni-directional, translation is as much about lobbying the lead agencies as it is about the lead agency enrolling subordinate agencies (cf. Womble and Doyle 2012).

This dissertation also refines our understanding of how Section 404 regulators govern Section 404 impacts and work with mitigation bankers to create more ideal compensatory mitigation banking outcomes. While previous research emphasizes the role that economic incentives and spatial thresholds play in shaping impacts and compensation locations and qualities (cf. BenDor and Brozović 2007; Doyle and Yates 2010), this dissertation suggests other factors are equally important (cf. Robertson 2009; Doyle et al. 2015).

First, compensatory stream mitigation bankers are not motivated by economic incentives alone. Each banker has individual goals when designing mitigation banks. For example, despite the fact that there are economic incentives in place for mitigation bankers to conduct in-channel work, mitigation bankers instead opt for riparian corridor work.

Second, this dissertation shows the importance of applying a naturalization perspective when analyzing the governance of all manner of stream and watershed management (cf. Rhoads et al. 1999). Federal guidelines are written in a way to ensure that each Corps district can apply the 2008 Rule "to the extent practicable" (Womble and Doyle 2012; Bronner et al. 2013). As a result, depending on district priorities, state laws, and individual regulator perceptions, "mitigation" comes to embody different things. The replacement of in-channel impacts using riparian corridor tree plantings is a case in point. While federal guidelines define a "stream" as a channel that is bounded by an Ordinary High Water Mark (Corps and EPA 2008), as this research demonstrates, districts can count "stream credits" to be any activity perceived to benefit a stream. Therefore, "stream mitigation" is not merely the replacement of damaged in-channel habitat, but it is instead defined *as practiced in place*. Thus, stream mitigation is an exemplar case of *stream naturalization*: the criteria for determining what counts as natural, or at least natural enough, in a specific setting emerges out of social negotiation amongst multiple actors, institutions, and environmental types (cf. Rhoads et al. 1999).

Finally, this dissertation chronicles the *evolving* nature of Section 404 policy implementation in Illinois and Missouri. An important tenet is that the Illinois and Missouri mitigation methods are *living documents*: the criteria for defining stream credits will evolve with changes to state laws or policies, district policies or guidelines, or federal laws or guidelines. As in-channel mitigation becomes more common (or not!) in Illinois, and as federal guidelines re-define what counts as a "stream" (cf. Doyle and Bernhardt 2010; Acuña et al. 2014), the criteria necessary to mitigate a stream impact in Illinois are likely to change.

This work raises important questions that require future research: Will mitigation bankers begin to provide stream credits generated from in-channel work in Illinois, and other places in the Midwest? If mitigation bankers do switch to in-channel work, on what kinds of streams will banking sites be located, and how will the work be monitored to ensure that stream functions are improving due to compensation work? This research suggests that not all mitigation bankers will turn toward in-channel work. Only one of mitigation bankers interviewed in this study expressed explicit interest in adopting in-channel work. The lack of interest by the other mitigation banker is partly because, based on current regulations, riparian corridor work counts as stream credits. In addition, neither of the mitigation banking companies that sell stream credits in Illinois are explicitly trained in stream channel management. However, there are companies and contractors in southern Illinois that are trained in implementing in-channel work (e.g. engineering firms). Further research is needed to understand why these individuals (i.e. trained stream engineers) have not developed stream mitigation banks. Currently, the majority of Section 404 compensatory stream mitigation in Illinois occurs via Permittee-Responsible Mitigation (PRM). Furthermore, PRM work has readily provided in-channel compensatory mitigation. Nonetheless, Corps regulators prefer that mitigation occurs via mitigation banking. Thus there is a mismatch between how mitigation is provided and the kind of mitigation provided: those skilled at in-channel work are only providing PRM work, while those not explicitly trained in in-channel work are providing mitigation banks. Based on current monitoring standards of in-channel PRM work, mitigation bankers that provide in-channel work will not require complex performance standards. This is because current PRM in-channel work is monitored by visually assessing channel position and the overall physical condition of the channel. In particular, in-channel PRM work is currently monitored by looking for a) visual evidence of bank erosion, b) visual evidence of project movement, c) visual evidence of deposition. Thus, should mitigation bankers adopt in-channel work, it is unlikely that there will be a high hurdle of expertise required to monitor the work.

There are also questions pertaining to future changes to the mitigation methods: Will St. Louis eventually adopt functional-based assessments in Illinois and Missouri? At the district level, the transition to functional assessment techniques is unlikely in the near future. As this research demonstrates, there is still not a single method used statewide in Illinois. Furthermore, the primary Corps regulator in charge of the Illinois method suggests that the Illinois method may be revised considerably pending federal guideline changes to what constitutes "waters of the United States." The Corps regulator suggested that once new guidelines are established, he will likely copy and paste the language from the federal guideline directly into the Illinois method.

Nonetheless, there is indication from the Charleston Corps district that eventually districts will transition from "activity-based" assessments to "function-based" assessments. This dissertation suggests that should one Corps district begin to adopt a function-based assessment, other Corps districts will likely borrow the same method and test its application in a trial-and-error fashion. The method then may be tweaked and implemented given applicant and regulator feedback. However, this trial-and-error process occurs over long timescales and, given periodic changes to federal regulations, may never achieve its original goals. Although this dissertation focused specifically on mitigation banking, many of these questions also pertain to Permittee-Responsible Mitigation and In-Lieu Fee Mitigation. The overarching research question asks whether Section 404 compensatory stream mitigation banking is going to result in more in-kind compensation in the future.

APPENDIX A

CHAPTER 6 THALWEG AND WATER QUALITY MEASUREMENTS

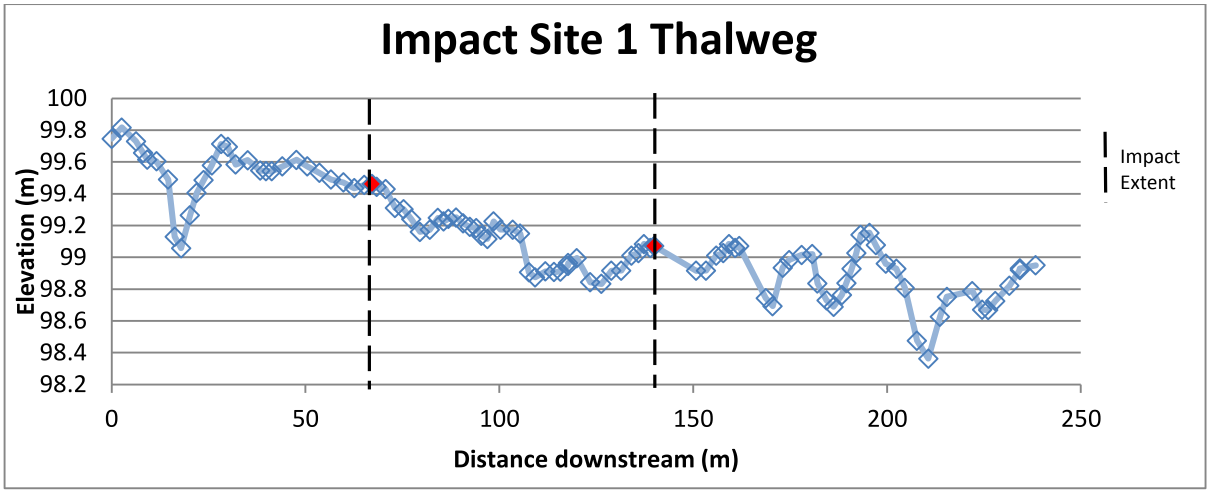

Figure A.1 Impact site 1 thalweg measurement.

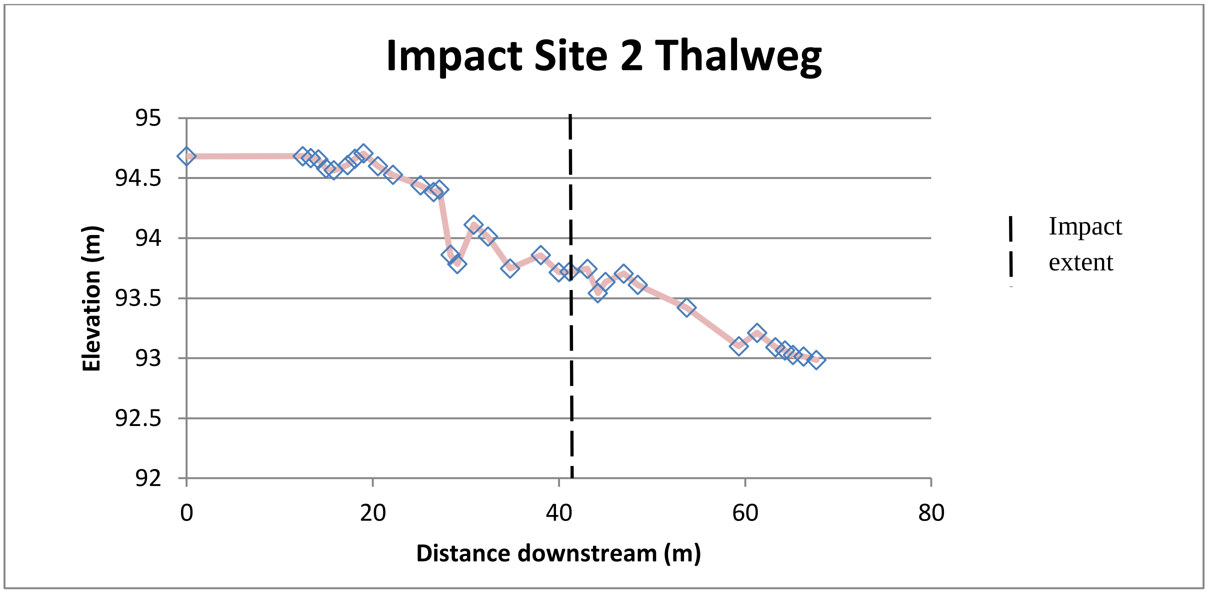

Figure A.2 Impact site 2 thalweg measurement.

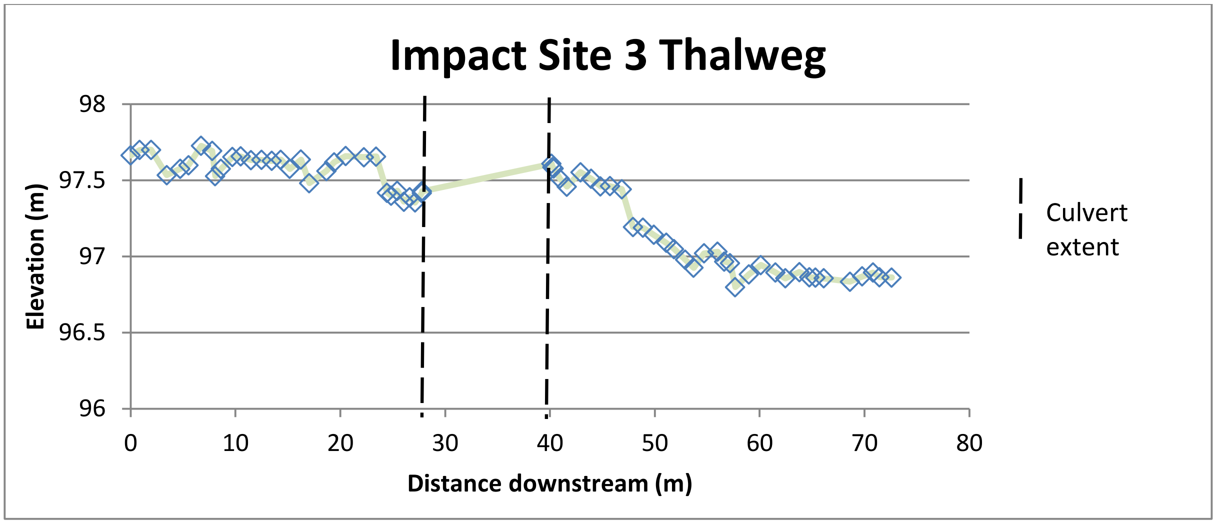

Figure A.3 Impact site 3 thalweg measurement.

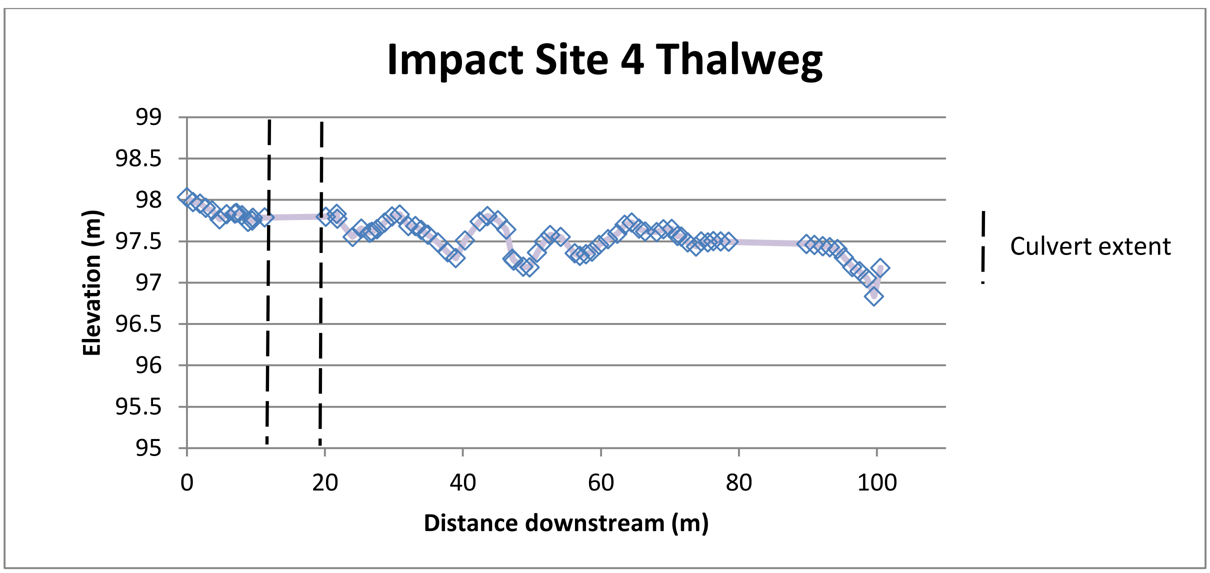

Figure A.4 Impact site 4 thalweg measurement.

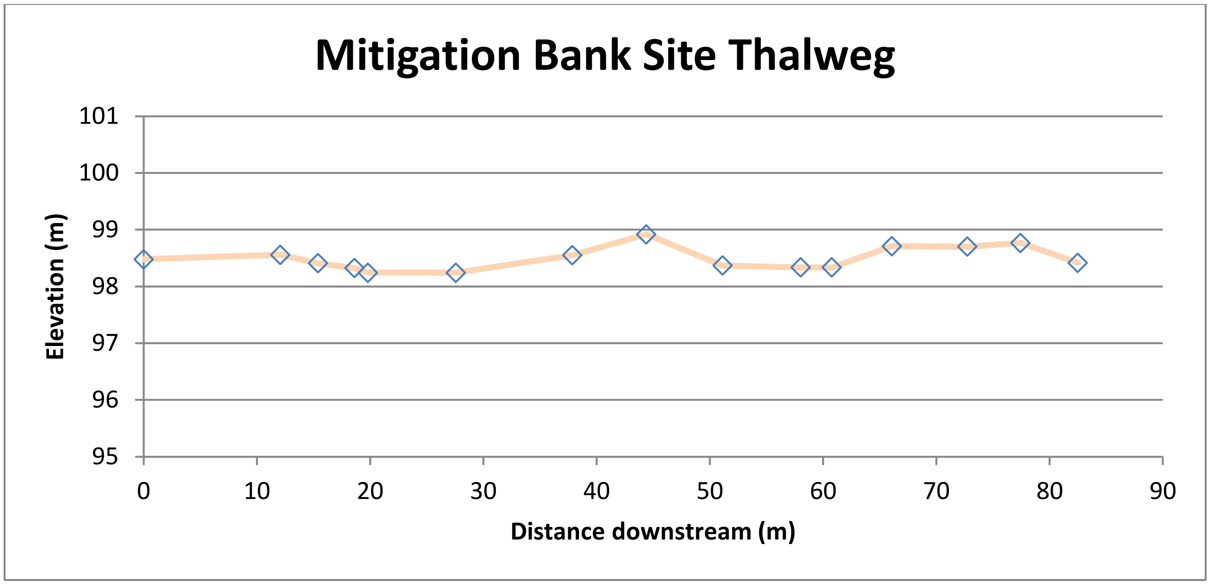

Figure A.5 Mitigation bank site thalweg measurement.

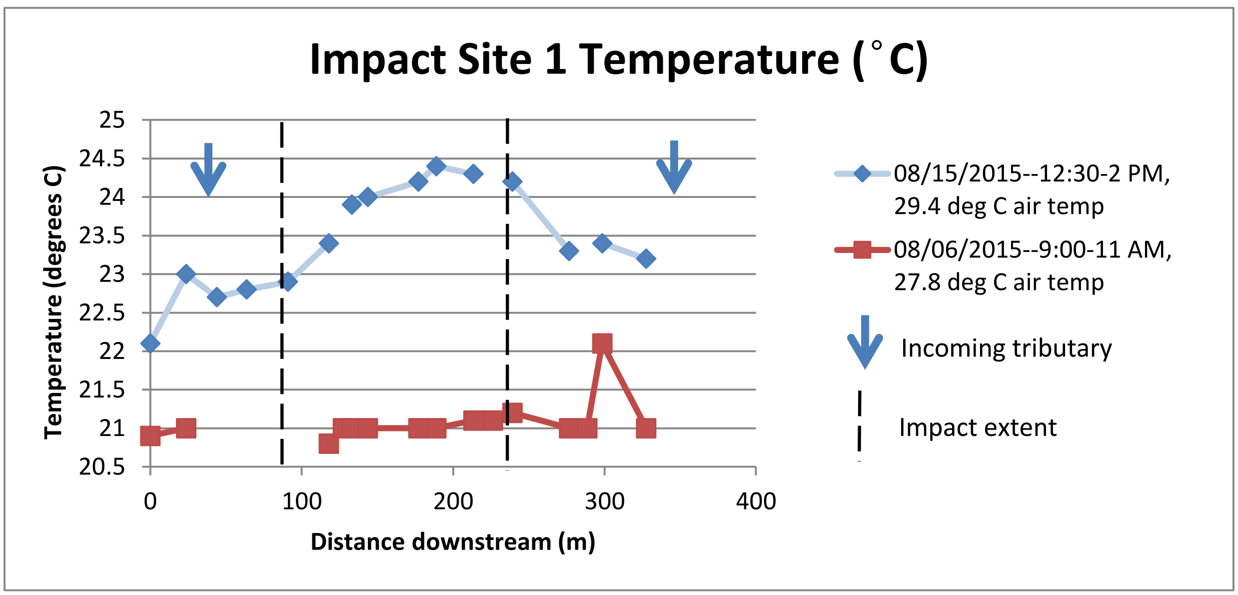

Figure A.6 Impact site 1 temperature measurements.

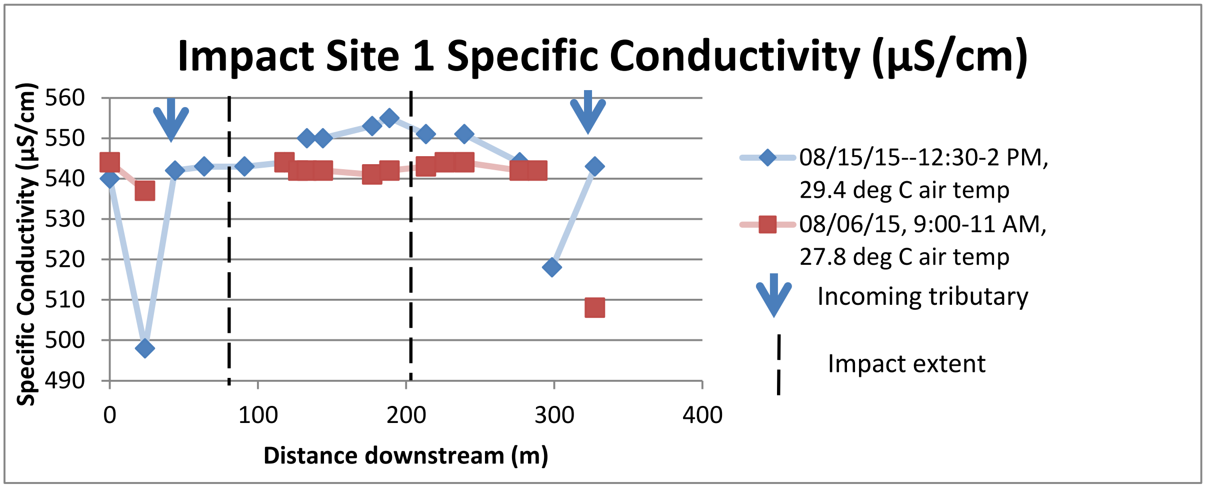

Figure A.7 Impact site 1 specific conductivity measurements.

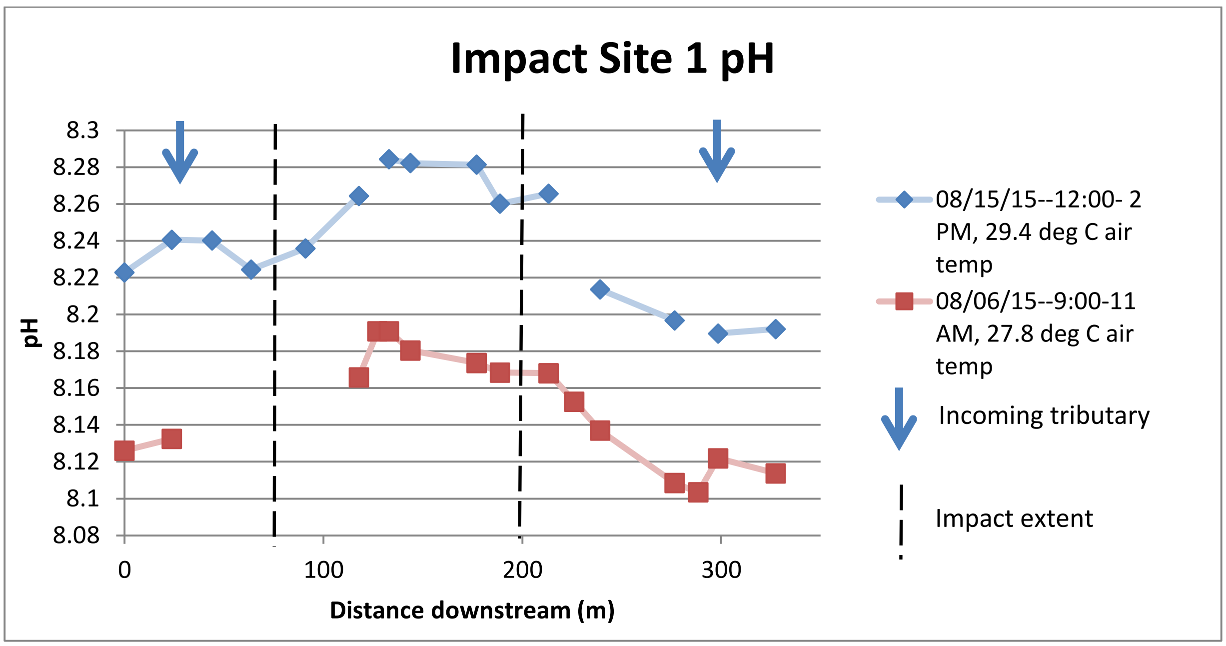

Figure A.8 Impact site 1 pH measurements.

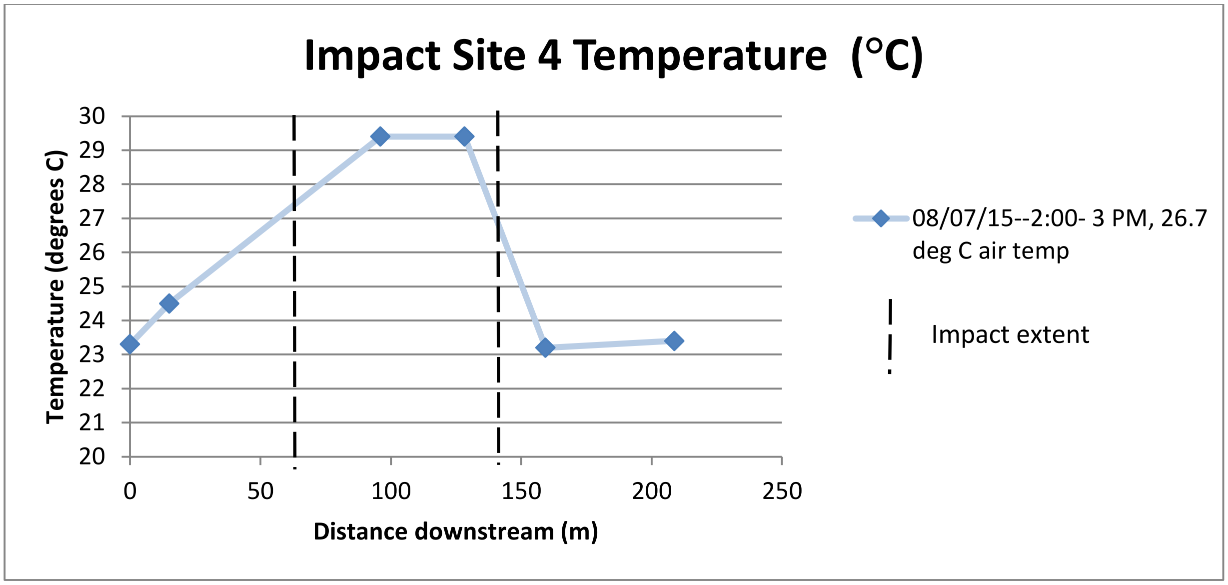

Figure A.9 Impact site 4 temperature measurements.

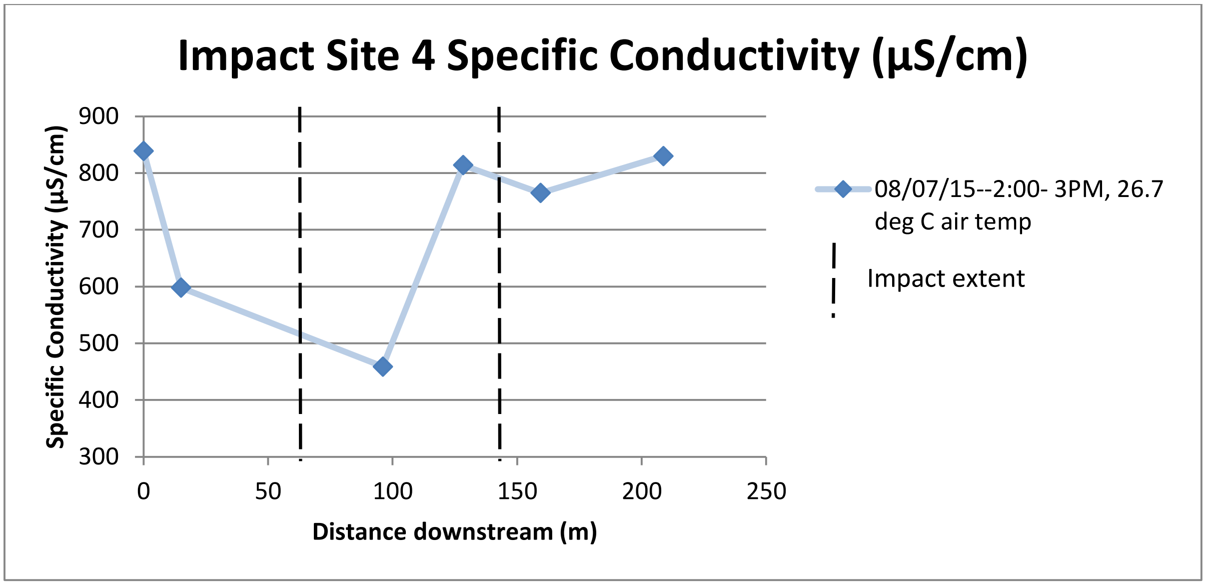

Figure A.10 Impact site 4 specific conductivity measurements.

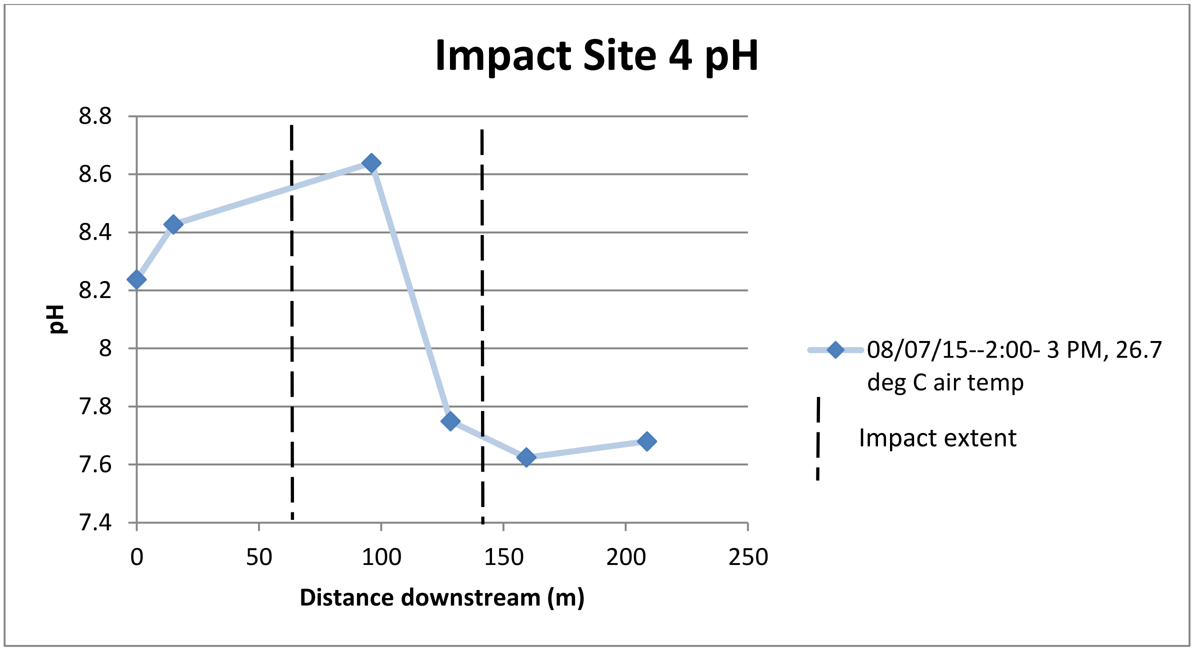

Figure A.11 Impact site 4 pH measurements.

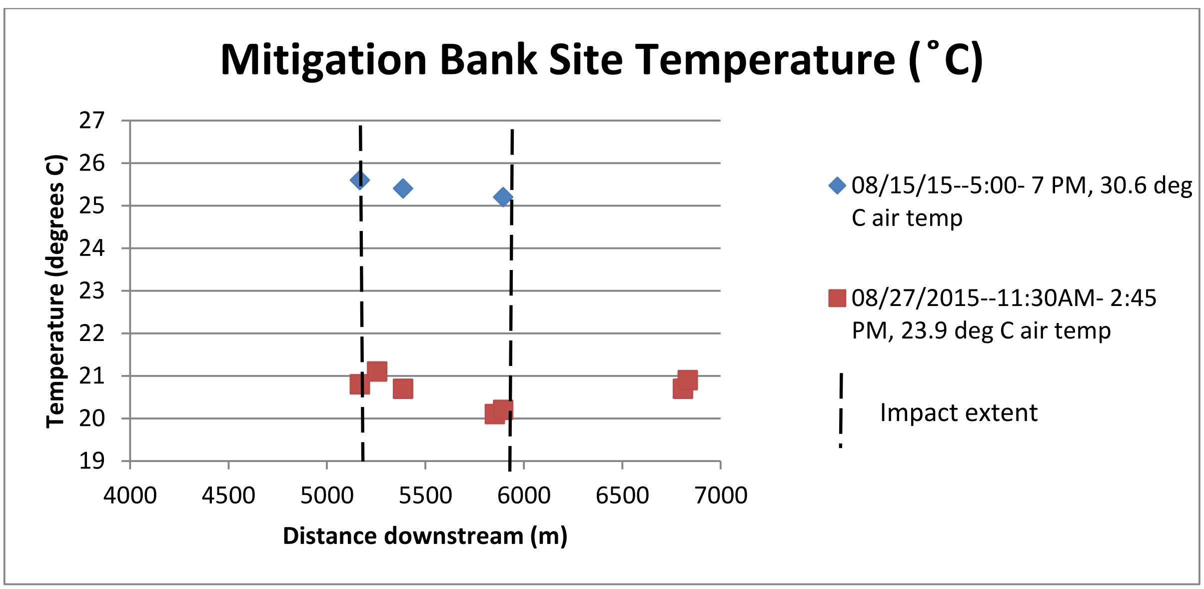

Figure A.12 Mitigation bank site temperature measurements.

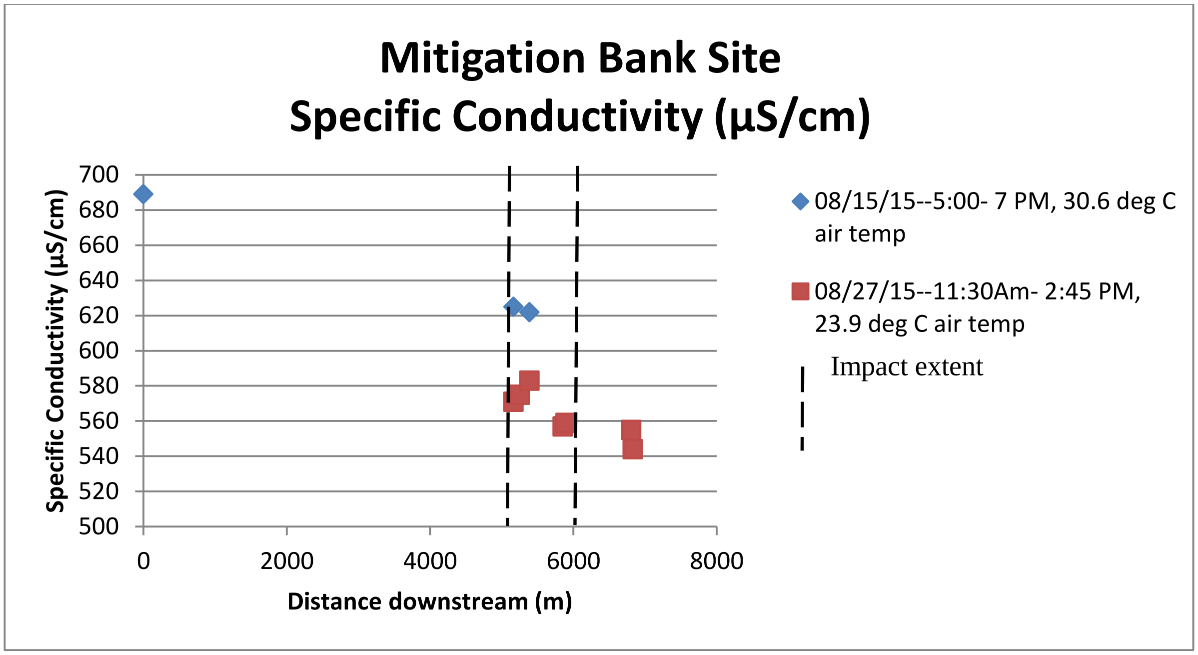

Figure A.13 Mitigation bank site specific conductivity measurements.

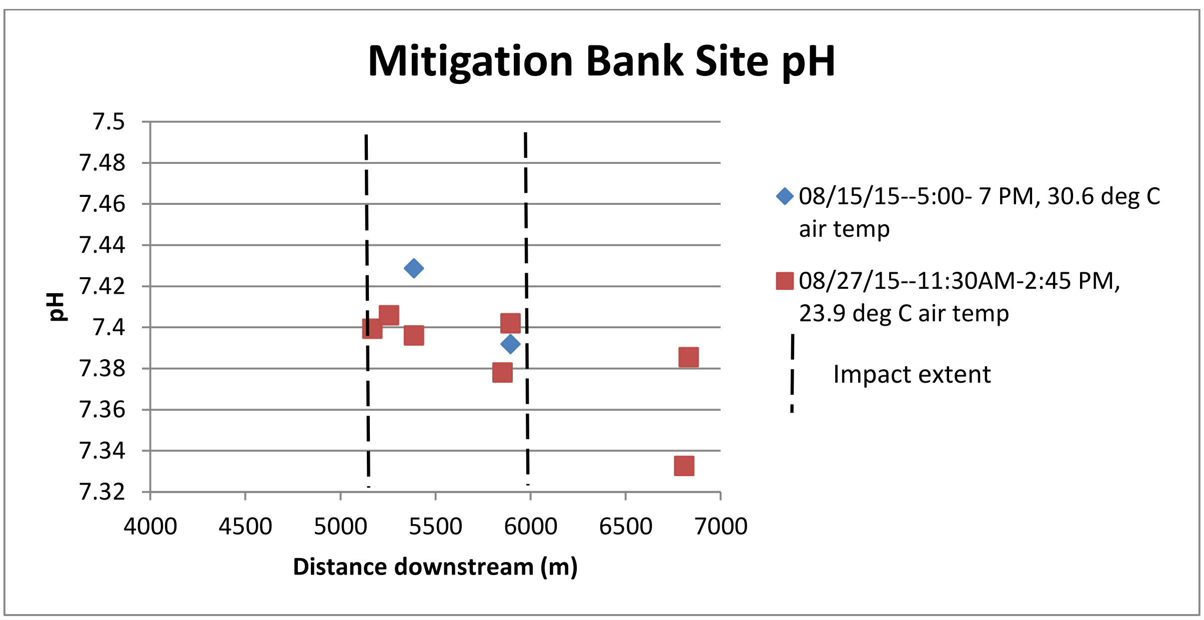

Figure A.14 Mitigation bank site pH measurements.

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