INDIANA WETLAND COMPENSATORY MITIGATION: INVENTORY

Final Report

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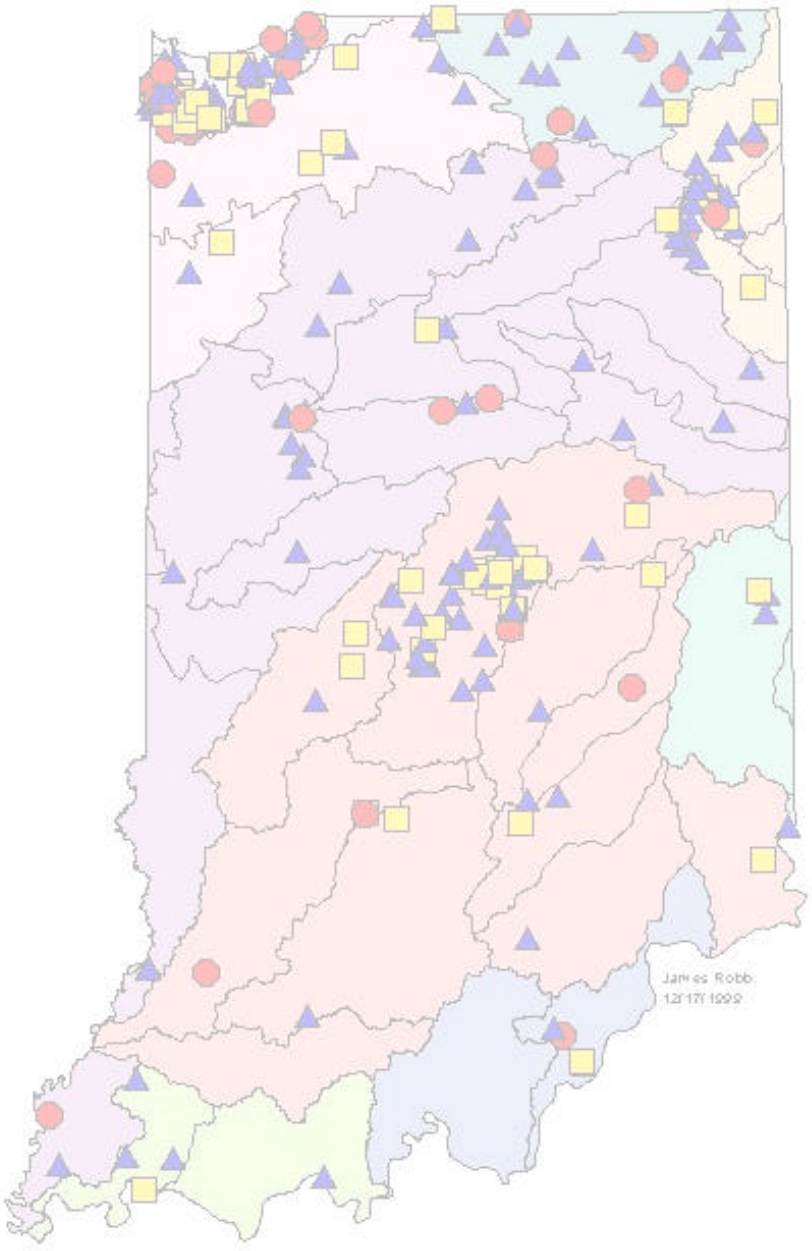

IDEM
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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Executive Summary

Amid questions about the efficacy of wetland compensatory mitigation, the Indiana Department of Environmental Management (IDEM) sponsored an effort to objectively study Indiana's mitigation sites. The first part of this program, the current study, sought to inventory Indiana's mitigation sites. Between 1986 and 1996 IDEM, through its Water Quality Certification program (Section 401 of the Clean Water Act), required 345 mitigation sites that met the criteria for inclusion in this study. The author visited each of these sites during 1998 and spring of 1999. Applicants had constructed 214 (62.03%) of the sites. Another 70 (20.29%) were incomplete. No attempt had been made to construct the mitigation on 49 (14.24%) of the sites. The author could not evaluate another 12 (3.48%) of the certifications due to a lack of information in the certification files. These sites were not distributed evenly across Indiana, but were in general clustered in the northern half of the state. The sites were especially dense around the Lake Michigan area, Fort Wayne and Indianapolis. Watersheds that feed Lake Erie and Lake Michigan contained 37% of the 345 sites. The watershed directly abutting Lake Michigan holds nearly 20% of the mitigation sites, raising cumulative impact concerns.

1 Introduction

Wetland scientists have questioned the very concept of wetland compensatory mitigation since its inception. From the beginning partial or total failures have been common (Kusler and Kentula 1989). Race found that few if any restoration sites in the San Francisco Bay area could be called successful or even complete and further disputed earlier published success claims as "premature or misleading" (Race 1985). Kentula et al documented a net loss of wetland area through mitigation requirements in Oregon and Washington (Kentula et al 1992). Even assuming that all of the mitigation had been constructed Sibbing found a net loss of more than 67 acres in Ohio (Sibbing 1997). Erwin found that only 4 of the 195 Florida mitigation sites he looked at met the specified success criteria, another 12 achieved partial success, but most striking was that only 40 of the mitigation sites had been attempted (Erwin 1991). Knowledge of where mitigation sites are and how many have been constructed is vital before we can further evaluate mitigation success, compliance, functionality, etc.

Based on the writings of these authors an inventory of Indiana's wetland mitigation sites appeared to be the most logical first step. This inventory was designed to yield useable data quickly (and cost effectively), and has done just that. Most importantly the inventory provided a starting place for future mitigation studies by recording where each site was and whether it was constructed or not.

2 Methods

2.1 Which Sites Were Included?

The author discovered a wide variety of mitigation types from in-lieu fee payments to combined, mitigation bank-like mitigation. There was even a dubious case of upland hydrologic enhancement. Many of these methods of compensation simply were not comparable to conventional restoration or creation type mitigation. Many, especially enhancement projects, were not verifiable. These unconventional strategies may have merit, but require different study parameters. For the purposes of this study, mitigation sites that meet the following criteria were considered in scope:

- **The Water Quality Certification file must have been found before July 1999.** The IDEM Water Quality Certification archives were in disarray at the onset of this study. Efforts to fix this problem resulted in the rediscovery of files. Unfortunately files continued to resurface even at the time this report was drafted.

- **The Department of Environmental Management (IDEM) granted, or waived with conditions, water quality certification on or before December 31, 1996.** The author visited several sites required through 1997 certifications, only a very few of these projects had begun to impact wetlands. Water quality certification waivers

present a special problem. At one time IDEM waived water quality certifications rather than granting with conditions. These sites have been included in this study. Unfortunately, IDEM does not have records for all unconditional waivers. Certifications waived without conditions were, therefore, excluded.

- **The certification required a specific acreage of wetland mitigation.** Occasionally a certification did not list an area for the required wetland mitigation: a littoral shelf or a vegetated ditch of unspecified dimensions, for example.

- **The certification required wetland restoration or wetland creation as compensatory mitigation.** This study does not include preservation and/or enhancement-based mitigation sites. The author could not verify enhancement without accurate baseline information, which was generally not available. In one case the certification required only preservation but the U.S. Army Corps of Engineers required enlargement of these preservation areas via creation. These sites were included.

- **The water quality certification required the applicant, or his subcontractors, to construct the required acreage of wetland mitigation.** The scope of this study excludes in-lieu payments or Adonations.@

- **The wetland impacts permitted by the water quality certification had begun by the time of the inventory inspections.** IDEM felt it unreasonable to expect mitigation completion if the wetland loss had not occurred.

- **Impacts were not a result of surface coal mining.** The Dept. of Natural Resources (IDNR), not IDEM, regulates surface coal mining. IDEM has few records of surface coal mining operations due to approval of nationwide 21 (33 CFR 330.1) which allows surface mining related wetland impacts.

- **Mitigation was not in the form of mine reclamation.** Surface mining often lasts for several years depending on the demand for the dredged material. Concurrent off-site mitigation or mitigation done concurrently on another part of the property was included, while mitigation sites which were to be constructed within the mined area, after the site had been mined, were excluded.

The author found 345 mitigation sites to meet these criteria. This study will need to be repeated in the future since more mitigation sites are required every month by IDEM, and old files are being rediscovered.

2.2 Procedures and Equipment

A location and photograph were recorded for each site. The photograph locations were recorded with either a Trimble GeoExplorer II or a Trimble ProXR global positioning system (GPS). Trimble reports the GeoExplorer II accuracy as between two and five

meters CEP[1] (Trimble 1996a). The accuracy of the ProXR was reported as 0.75 meters RMS[2] plus one part per million times the distance between the base and the rover (Trimble 1996b). Photographs were taken with an Olympus D-320L digital camera.

The author visited and categorized each mitigation site as constructed, incomplete or no attempt according to the criteria below. These criteria were designed to allow a single observer to inventory all of Indiana's mitigation sites in one year. In other words they were exceeding quick and superficial. Note that the term used here is *constructed* rather than *complete* which infers compliance. Classification as *constructed* does not mean the site is *complete* or *compliant* and certainly not *successful*. There were many constructed sites that were total failures. The goal here was simply to determine which sites were actually in the ground, nothing more.

2.3 Status Classes

Constructed: The study classified sites as *constructed* if the applicant had completed the earthwork as planned (if earthwork was required) and had planted the site (if planting was required). Earthwork included grading, breaking tiles, erecting berms, installing control structures, etc. in a manner similar to the plans. This criterion did not require the site to have exactly the same contours, size or shape, but sites which were obviously not built as planned were considered incomplete.

Sites with extreme planting failures complicated the planting determination. Interviews with applicants and receipts in IDEM files indicated that some sites had been planted but suffered extreme mortality. An interview with each of the applicants was not logistically feasible, nor would it necessarily provide reliable information. Instead the author chose a fairly liberal criteria for determining if planting had occurred: the presence of at least one species from the planting list other than cattail (*Typha spp*.), the presence of protective netting, lines made with a seed drill, broadcast seed laying at the surface, plastic or other indicators of tree or container plantings, or the remnants of mulch or straw. Sites with any one of these characteristics were considered planted.

Incomplete: The study classified a site as incomplete if the mitigation had begun but had not been completed as of the observation date. Sites that had been graded but showed no signs of planting occurred most frequently. A few sites that had obviously not been constructed as planned also fell within this category. Site number 1995054M01 (Photo 4), which has a berm separating it from its planned water source, was an example of this type of incomplete. This category included sites that truly appeared to be in the process of construction as well as those that had obviously been abandoned.

No Attempt: Sites that exhibited no signs of mitigation construction activity fell into this category (Photo 6).

[1] CEP stands for Circular Error Probable and means that 50% of the positions collected fall within a circle with a radius equal to the specified error, between two and five meters in this case (Trimble 1996a).
[2] RMS or Root Mean Square means that 68% of the positions fall within a circle of the specified radius, 0.75 meters in this case (Trimble 1996b).

The photographs in Appendix A illustrate the sometimes subtle differences between these categories. Photographs one and two depict constructed mitigation sites with no apparent problems. Photograph three was also categorized as constructed but looked very similar to both photographs four and five, all of which resembled ponds rather than wetland mitigation.

This study did not measure slopes, grading depths, size, or the myriad of other details one must look at to determine true compliance. The purpose of this study was simply to determine if the site had been built or not. Many sites were poorly planned or poorly constructed but more or less built as planned (Photo 3). These sites were called constructed, even though planting failures, steep slopes, and excessive/inadequate hydrology made them nearly indistinguishable from incomplete sites (Photo 5). There were, however, instances when the mitigation was obviously not constructed as planned. The plan for the site in photograph four, for example, called for the mitigation site to extend an existing wetland along a stream. Rather than receiving floodwater from the stream and the existing wetland, the applicant built a berm around the mitigation site, installed a pipe from the development and used the mitigation site for a detention pond. The site was constructed in the correct location, was approximately the correct size, and hydrophytic vegetation had established around the edges of the pond. The author, however, could not call this site Aconstructed@ when it was obviously constructed incorrectly to the point of performing entirely different functions from the planned site.

3 Results

3.1 How Many Sites Were Done?

The study found that 214 of the 345 mitigation sites had been constructed, 70 more were incomplete, and 49 were not attempted (Figure 1). Another 12 certifications had too little information to evaluate. In most of these "info needed" cases IDEM issued a certification without a mitigation plan, stipulating that they receive the plan within a specified number of months. IDEM has no record that it ever received the required plans. In other cases the planned mitigation site's location was not adequately documented.

Figure 1: Mitigation Site Status

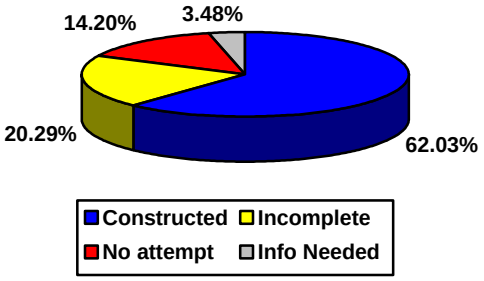


Figure 2 illustrates the increase in mitigation activity from 1986 to 1996. The slight dip in 1996 sites may be somewhat misleading. Many of the 1996 sites were excluded because the applicant had not started the permitted wetland loss.

3.2 Mitigation Site Distribution

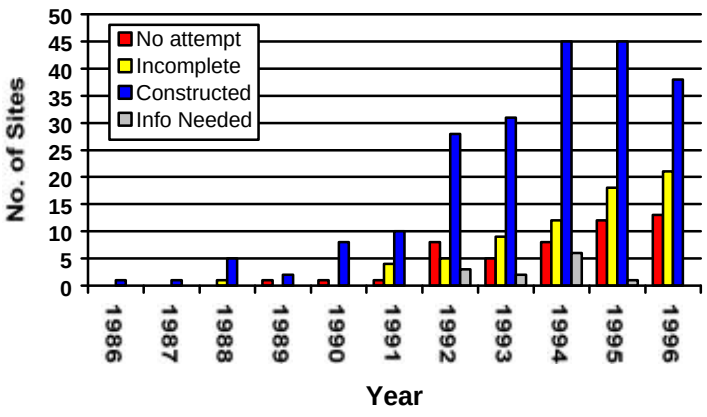
The mitigation sites were concentrated in the northern portion of the state, especially around Indiana's growth centers: Indianapolis, Fort Wayne, and the Lake Michigan area (Figure 3). The watersheds that feed Lake Michigan and Lake Erie contained nearly 37% (127) of Indiana's mitigation. Exactly 20% (69) of the mitigation sites sat within the watershed directly adjacent to Lake Michigan (Figure 4).

4 Discussion

4.1 Compliance is Deficient

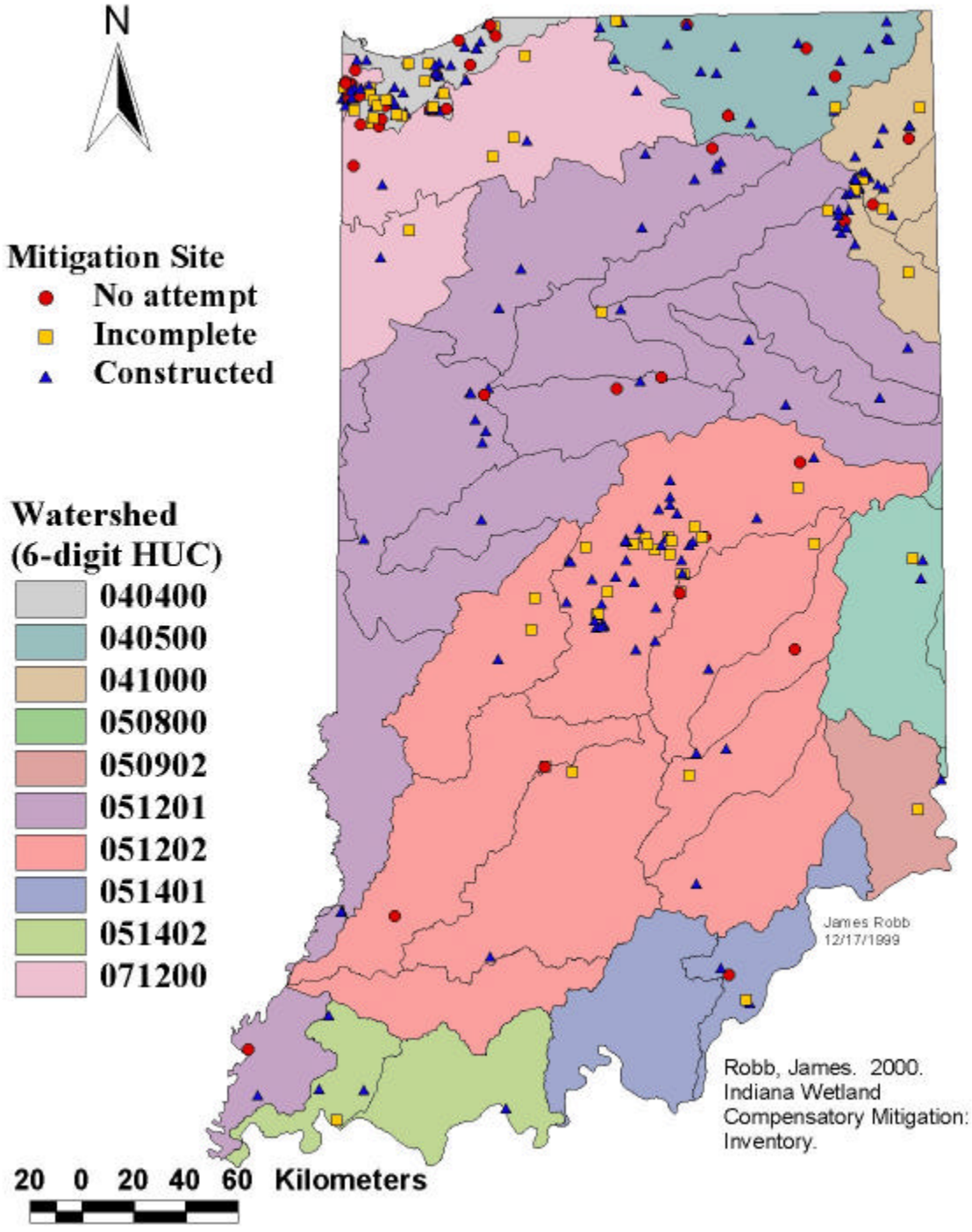
Nearly 35% of the mitigation sites were not constructed. Disturbingly large proportions of this these noncompliant applicants appear to be simply ignoring their requirement altogether. Many more have started construction but for one reason or another have not followed through. This study was meant only as an inventory to measure the most rudimentary forms of compliance. Some of the sites documented as constructed by this study may be total failures; many more may be only partially successful. The author's field notes indicate that many of these sites may have an inordinate amount of open water. More study will be needed to fully document both compliance and success.

Figure 2: Status by Application Year



Over the years IDEM has increasingly required mitigation to compensate for wetland loss (Figure 2). In 1992 IDEM denied certification of a number of U.S. Army Corps of Engineer's Nationwide Permits, including nationwide number 26. The graphic reflects this change with the substantial jump in mitigation required in 1992.

Figure 3: Mitigation Site Distribution

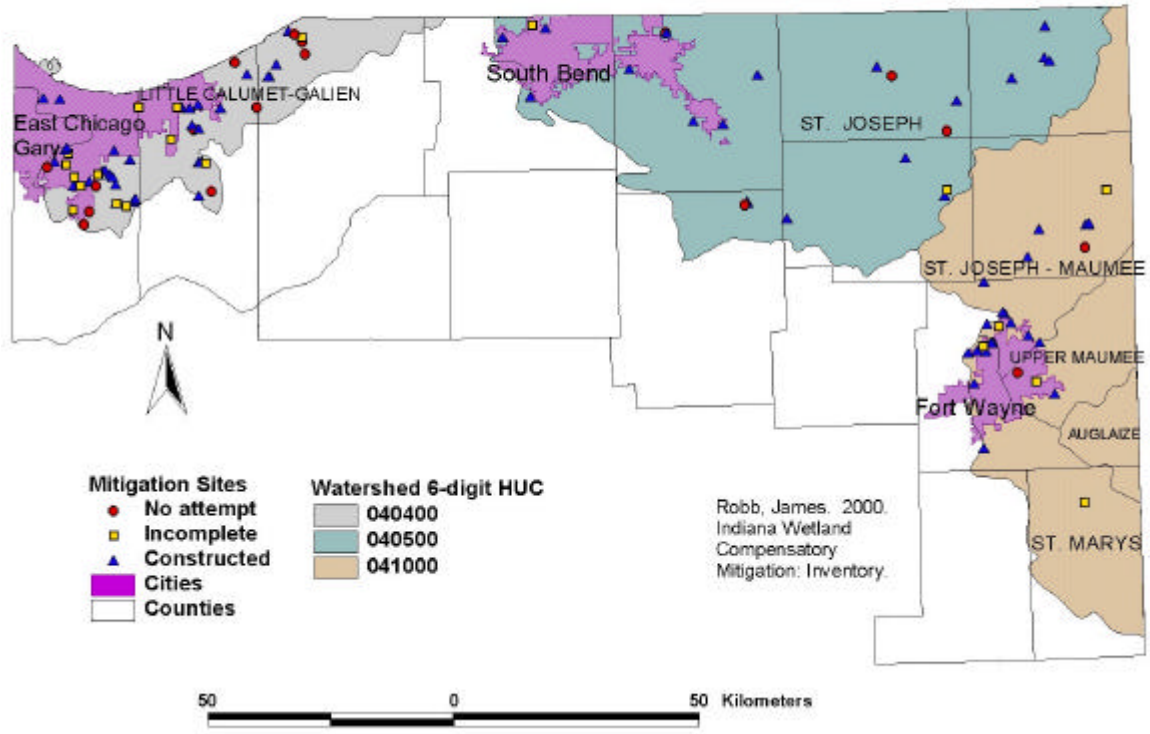


4.2 Success, Compliance and Function

This study did not address success, or function, and only addressed the most basic aspects of compliance. Success, while it sounds like a simple concept, is anything but. First one must settle on a definition of success, an ever-contentious issue. There is no denying that the purpose of *mitigation* is to replace the impact site with a new site. This may include replication of specific functions, a suite of functions, area, type, etc. The obvious problem with this approach is that the impact sites are gone.

From a legal or regulatory standpoint a mitigation site is successful if and when it meets the regulatory requirements specified for that site. From 1986 through 1996 the difficulty level of IDEM:s requirements has increased. In the 1980's few impacts required mitigation and those that did require mitigation had few stipulations. Any study with true compliance as the basis would likely reflect these regulatory inconsistencies and changes over time rather than the actual performance of the mitigation.

Figure 4: Great Lakes Mitigation Sites



In the beginning applicants had to do little more than establish a certain amount of wetland. Gradually the regulatory agencies began requiring in-kind mitigation and mitigation on-site, consequently increasing the level of difficulty. Planting requirements began to show up and increased over the years. Monitoring slowly emerged as a

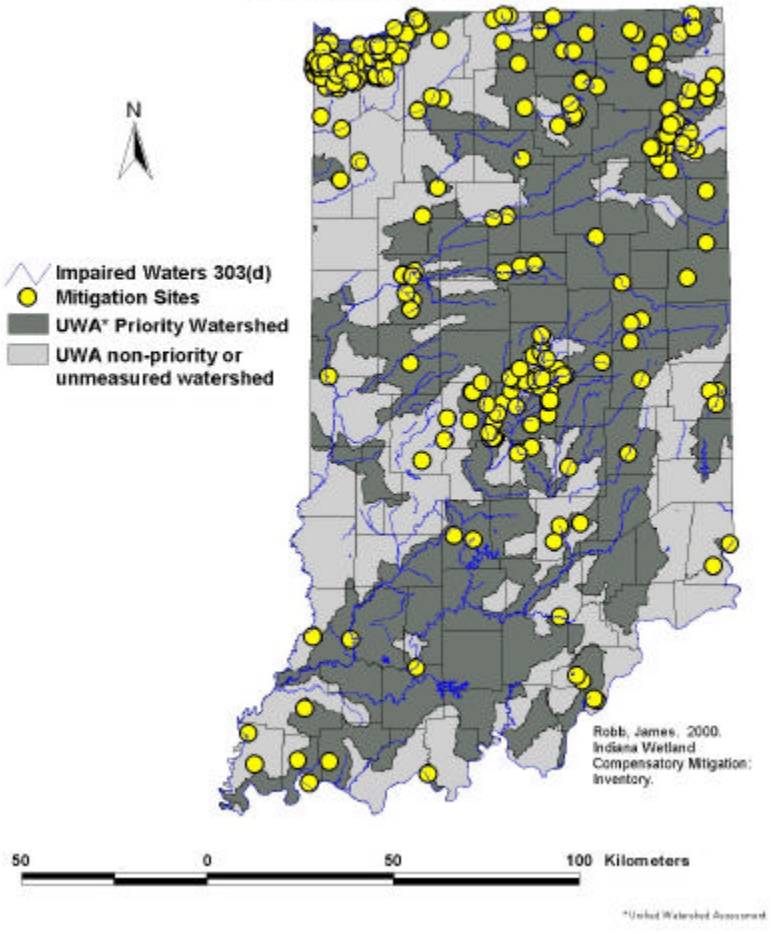
requirement on first the larger or more controversial sites but soon extended to most all sites. Performance standards began to emerge such as survival rates of vegetation or aerial coverage of vegetation. Unfortunately these requirements were inconsistently applied.

The resulting statistical *noise* would overwhelm a compliance study. A graphic depicting compliance over time such as Figure 2 would not be credible if we assume that compliance is inversely proportional to difficulty and that difficulty increased over that same time period. Certainly compliance on a site by site basis is relevant, but analysis of our entire mitigation population would give the illusion that our mitigation is worse now than it was five or ten years ago.
IDEM has recognized the problem of inconsistency and has made some significant strides towards fixing these disparities. This study was conceived as an effort to identify problems in the program and develop solutions to these problems. Two new rules are also underdevelopment: The Wetland Water Quality Standards, and 401 Implementation Rule. These rules cover the Water Quality Certification process from beginning to end. Once implemented these rules should eliminate many of these disparities.

4.3 Cumulative Impact Warning

The mitigation sites were clustered in especially high concentrations (nearly 37%) within Indiana watersheds that feed Lake Michigan and Lake Erie. The Little Calumet-Galien basin, which abuts Lake Michigan, contains nearly one-fifth of Indiana's mitigation sites, but covers only 1.5% of Indiana's surface area. Especially since Lake Michigan has been classified as an Outstanding State Resource Water (377 IAC 2-1.5-19(b)(2)) the cumulative impact of such intense dredge and fill activity in these watersheds needs to be evaluated.

Figure 5: Mitigation Site Proximity to Stressed Systems



There is some evidence that mitigation, and therefore associated wetland loss, occurs most frequently in stressed watersheds. Through the Unified Watershed Assessment, IDEM has identified several priority watersheds. These watersheds are of paramount concern due to their potential for non-point source pollution. Another segment of IDEM has identified impaired waterbodies. These have been listed on the Clean Water Act section 303(d) list of impaired waters. The clustering of mitigation sites within or near these waters and watersheds may cause additional stress upon already stressed systems. Priority watersheds contained over 67% of all Indiana mitigation sites. Over 21% of the mitigation sites occurred within 1000 meters of an impaired waterbody, and nearly 15% of the mitigation sites occurred both within 1000 meters of an impaired waterbody and within a priority watershed (Figure 5). The clustering of mitigation within these watersheds is not surprising given the extensive nature of Indiana's impaired waters and watersheds. Both the list of impaired waters and the UWA priority watersheds suffer from small sample size. In many ways the UWA reflects population density rather than being a real measure of non-point source pollution. More study is needed to address cumulative impact concerns.

4.4 How Can We Increase Compliance?

Over 34% of the mitigation sites were not constructed. Current efforts to formulate and enforce specific success criteria will be undermined if such a large portion of the projects do not comply with the most basic of requirements (Race and Fonseca 1996). There are a number of tools available to increase compliance: performance bonds, up-front mitigation, compliance inspections, and stiff penalties via enforcement action. The following discussion of these tools is meant to assist the user in making an informed decision. This is not an endorsement of any one tool; a combination of methods will likely yield the best results.

Up-front Mitigation: There is only one way to *guarantee* the construction and success of mitigation: complete and inspect the mitigation site before allowing the impacts to occur. Up-front mitigation is not a new idea, but it has often been termed unreasonable or impractical by those who do not wish to incur the added cost. Up-front mitigation is essentially a *cash-on-delivery* transaction. An applicant offers a completed and functioning wetland mitigation site in trade for a particular wetland impact. Regulators have both the proposed mitigation site and the proposed impact site to compare and determine if the mitigation compensates for what *will* be lost. The current system is equivalent to giving the applicant an unsecured loan with no collateral and little more than a promise to repay at a latter date. As with all loans, the lender, the regulatory agency in this case, incurs both risk and additional costs associated with collecting delinquent payment. In the case of mitigation, these "collection" costs come in the form of compliance inspections and enforcement actions. Up-front mitigation shifts both the procedural and financial burden of compliance from the agency (and taxpayers) to the individual applicants benefiting from wetland destruction.

There are equally compelling reasons for up-front mitigation from an ecological stand point. Erwin (1991) found only 4% of the 195 sites he looked at to be "successful."

Mockler et al. (1998) reported 21% of the 29 sites they reviewed were compliant, while only 3% (a single site) actually replaced the wetland functions lost at the impact site. The Ohio Environmental Protection Agency reported mixed results in its study of ten mitigation sites (Fennessy and Roehrs 1997). This Ohio study reported a net increase in wetland acreage while reporting that none of these ten sites were considered "functionally" successful (Fennessy and Roehrs 1997). In contrast, a previous study of 32 Ohio permits reported a net loss of 67.48 acres (Sibbing 1997), while an even earlier Ohio study found that four of the five sites examined were both in compliance and moderately to highly "ecologically successful" (Wilson and Mitsch 1996). A study of five New England mitigation sites found that two were "ineffective," two were "marginally successful," and one had not been constructed (Reimold and Cobler 1986). A recent study in Illinois by the U.S. Fish and Wildlife Service found that only 17% of the mitigation sites established the correct wetland community, and only 4% were in full compliance (Gallihugh 1998). Unfortunately these studies were not without flaws. Only one was published in a peer reviewed journal (Wilson and Mitsch 1996). Each study used different methods, and different definitions of success, functionality, compliance and even "mitigation." It is also unclear whether these sites were chosen as random samples, if they inspected the entire population, or if they were chosen as representative examples.

Lewis (1994) suggests that the time lag between initiating the mitigation site and it actually functioning necessitates up-front mitigation. There is no question that this method is most prudent and should be utilized when there are project "unknowns" (Kruczynski 1989), or a high risk of failure (Reimold and Cobler 1986, Kruczynski 1989). Although these previous studies indicate that mitigation in general is "risky," King and Bohlen (1994) make a compelling case that the poor success rates reported may be more a function of applicant motivation, and agencies' failure to enforce mitigation requirements, than the status of restoration science.

Follow Up and Enforcement: The high number of incomplete and unattempted mitigation sites documented in this study makes it clear that the limited enforcement action of the past was not effective. Because constructing mitigation properly is costly many applicants will not comply with their mitigation requirements unless there is a significant price for failure (Lewis 1992). Small, insignificant penalties, which are less than the cost of compliance, may encourage noncompliance (Erwin 1991, Race and Fonesca 1996). The current situation, in which enforcement is rare, encourages applicants to construct cheap mitigation rather than high quality restoration, if they mitigate at all (King and Bohlen 1994). Enforcement provides the tool to switch these incentives thereby promoting applicant interest in high quality wetland restoration over applicant desire for lower construction costs (King and Bohlen 1994).

The division of duties specified in the 19 January 1989 Memorandum of Agreement between the Army and the U.S. Environmental Protection Agency (EPA) makes the U.S. Army Crops of Engineers (COE) the lead federal agency for enforcing permit conditions issued under section 404 of the Clean Water Act. Section 404 permits incorporate conditions of the States' Water Quality Certifications including conditions requiring

mitigation. According to Gallihugh (1998), the U.S. Army Corps of Engineers' internal priorities prevent it from concentrating the necessary resources on compliance. The EPA may take action on a permit condition violation should the Corps choose not to (MOA 1989), but IDEM has no record that this has occurred on any of the mitigation sites reviewed for this study. This leaves the states with the awkward choice of ignoring the problem or shouldering both the financial and procedural burden of compliance and enforcement.

Performance Bonding: Requiring the applicant to guarantee construction of a mitigation site through a performance bond provides an economic incentive to finish the site; tying the release of the performance bond to a set of performance standards encourages the applicant to meet the stated goals (Erwin 1991). Releasing the bond contingent on the performance of the site shifts the applicant's priorities from low cost mitigation to site performance in an effort to achieve a release from the bond and its associated costs. Like enforcement, bonding will only produce the desired effect if the bond and its associated costs are large enough. When used correctly, bonding may reduce the need for enforcement and thereby reduce agency costs associated with pressing enforcement cases.

4.5 More Information Needed

Now that we know how many mitigation sites have been constructed, we need to know the area of wetland actually reestablished. None of the 345 mitigation sites evaluated had a jurisdictional determination as a monitoring requirement. Once we have area information we will need to know if the wetland types being lost are being replaced. Others have found that this shift from one wetland type to another or to an artificial functional class has been significant in other parts of the country (Bedford 1996, Gwin, Kentula, and Shaffer 1999). Cumulative impacts, functional equivalency, and vegetative quality are all topics that need to be addressed. Unfortunately little of this research is being performed in Indiana, and few, even those researching in Indiana, present their results here. Regulators, the regulated community, interested citizens and scientists need a forum to share this information and encourage its collection.

5 Conclusion

The study inventoried 345 mitigation sites required through IDEM's Water Quality Certification (401) program. Sites were classified as constructed (62.03%), incomplete (20.29%), and no attempt (14.24%). The author could not evaluate the remaining 3.48% of the sites due to a lack of information. The sites were clustered near the major metropolitan areas. Mitigation sites were especially dense in northern Indiana with 37% falling within watersheds feeding Lake Michigan and Lake Erie, and 20% falling within the watershed directly adjacent to Lake Michigan. Until compliance increases to reasonable levels there is little value in addressing success or functional equivalency. Increasing the compliance rate will take a combination of performance bonding, compliance inspections, enforcement, and up-front mitigation.

6 Acknowledgements

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Literature Cited

Bedford, Barbara L. 1996. The Need to Define Hydrologic Equivalence at the Landscape Scale for Freshwater Wetland Mitigation. Ecological Applications, 6(1) pp.57-68.

Erwin, Kevin L. 1991. An Evaluation of Wetland Mitigation in the South Florida Water Management District. Vol. 1. Contract # C89-0082-A1.

Fennessy, Siobhan and Joanne Roehrs. 1997. A Functional Assessment of Mitigation Wetlands in Ohio: Comparisons with natural systems. Ohio EPA Final Report to the U.S. Environmental Protection Agency.

Gallihugh, Jeanette L. 1998. Wetland Mitigation and 404 Permit Compliance. Vol. 1 and 2. U.S. Fish and Wildlife Service. Chicago, IL. June 1998.

Gwin, Stephanie E., Mary E. Kentula, and Paul W. Shaffer. 1999. Evaluating the Effects of Wetland Regulation Through Hydrogeomorphic Classification and Landscape Profiles. Wetlands, 19(3) pp. 477-489.

Kentula, Mary E., Jean C. Sifneos, James W. Good, Michael Rylko, and Kathy Kunz. 1992. Trends and Patterns in Section 404 Permitting Requiring Compensatory Mitigation in Oregon and Washington, USA. Environmental Management, 16(1) pp. 109-119.

King, Dennis M. and Curtis C. Bohlen. 1994. Estimating the Costs of Restoration. National Wetlands Newsletter, 16(3) pp. 3-8.

Kusler, Jon A., and Mary E. Kentula. Eds. 1989. Wetland Creation and Restoration: The Status of the Science. Vol. 1 and 2. EPA/600/3-89/038.

Kruczynski, William L. 1989. Options To Be Considered in Preparation and Evaluation of Mitigation Plans. In *Wetland Creation and Restoration: The Status of the Science*. Jon A. Kusler and Mary E. Kentula. Eds. Vol. 2: Perspectives. EPA/600/3-89/038.

Lewis, Roy R. 1992. Why Florida Needs Mitigation Banking. National Wetlands Newsletter, 4 (1).

Lewis, Roy R. 1994. Enhancement, Restoration and Creation of Coastal Wetlands. In Donald M. Kent (ed.). *Applied Wetlands Science and Technology*. Lewis Publishers.

Memorandum of Agreement Between the Department of the Army and the Environmental Protection Agency Concerning Federal Enforcement For the Section 404 Program of the Clean Water Act. 19 January 1989.

Mockler, Anna, Laura Casey, Mason Bowles, Nick Gillen, and Jon Hansen. 1998. Results of Monitoring King County Wetland and Stream Mitigations. King County Department of Development and Environmental Services.

Race, Margaret S. 1985. Critique of Present Wetlands Mitigation Policies in the United States Based on an Analysis of Past Restoration Projects in San Francisco Bay. Environmental Management, 9(1) pp.71-82.

Race, Margaret S. and Mark S. Fonseca. 1996. Fixing Compensatory Mitigation: What Will It Take? Ecological Applications, 6(1) pp. 94-101.

Reimold, Robert J. and Sue A. Cobler. 1986. Wetland Mitigation Effectiveness. United States Environmental Protection Agency. Region I. USEPA contract no. 68-04-0015.

Sibbing, Julie M. 1997. Mitigation's Role in Wetland Loss. National Wetlands Newsletter, 19(1).

Trimble Navigation Limited. 1996a. GeoExplorer II. Operation Manual. Part Number 28801-00. Revision: B. Version 2.11. December 1996.

Trimble Navigation Limited. 1996b. ProXR Receiver manual. Part Number: 31172-00. Revision: A. October 1996.

Wilson, Renée F. and William J. Mitsch. 1996. Functional Assessment of Five Wetlands Constructed to Mitigate Wetland Loss in Ohio, USA. Wetlands, 16(4) pp. 436-451.

APPENDIX A:

PHOTOGRAPHS

Photo 1: Site # 1994029M01. Constructed with no apparent problems. Hydrophytes were well established with several macrophyte communities. 9/24/1998

Photo 2: Site # 1996089M01. Constructed with no apparent problems. Vegetation establishing well in this very young site. 9/15/1998.

Photo 3: Site # 1994012M01. Constructed but failing. Presence of Carex, and Scirpus evidence of planting. This site suffers from either poor planning, poor hydrological engineering or poor grading. The result is steep slopes, flashy hydrology, open water and a 2-foot wide band of vegetation.

Photo 4: Site # 1995054M01. Obviously constructed incorrectly. The mitigation plan for this site called for the expansion of an existing wetland. The adjacent creek was to supply water during flood events. Instead the site was surrounded by berms, thereby isolating it from the adjacent stream. Hydrology was piped in from the development.

Photo 5: Site # 1993011M01. Incomplete. Open water meets bare ground. What few hydrophytes may exist on the site have been mowed down. No sign of the species listed on the planting list.

Photo 6: Site # 1996071M01. No attempt. The area delineated by white stakes was to be graded to the elevation of the adjacent wetland.