State of Ohio
Environmental Protection Agency

Wetland Ecology Group
Division or Surface Water

An Inventory of Ohio Wetland Compensatory Mitigation

Final Report to U.S. EPA Grant No. CD97576201-0

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November 4, 2003

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Executive Summary

This report presents the baseline data on mitigation wetlands constructed from 1992-1999 in Ohio under §401 water quality certifications. It provides information on the compliance rates, amount of wetland impacts, the amount of wetland habitat created/restored, and basic habitat features (% emergent vegetation within the wetland basin, presence/absence of shallow littoral zones, presence of predatory fish, surrounding landscape context) of replacement wetlands.

The Ohio Environmental Protection Agency is in the process of creating a comprehensive database of past and present wetland impacts, and wetlands constructed to mitigate the impacts of wetland losses. Creating a database of wetland mitigation sites is an essential first step towards evaluating the success of the mitigation process in retaining wetland acreage, and replacing wetland functions lost due to impacts to natural wetlands. The findings from this study will serve as the initial information in that database.

A total of 76 projects (117 wetlands) satisfied our selection criteria. Wetlands constructed to fulfill certification conditions for these projects were visited during the years 2002 and 2003. Basic compliance rates are very high – no wetlands had been constructed or the attempts were complete failures in only 10.8% of all projects. A total of 387.5 acres were impacted, 629.3 acres were required as mitigation, and 417.7 acres were constructed. Only 66.3% of the required wetland replacement acreage was constructed resulting in a replacement ratio of **1: 1.08**. Multiplying the amount of acres required but not constructed, by $15,000 (an average price for an acre of wetland credit at wetland mitigation banks operating in Ohio), yields the incurred monetary shortfall of between **$2,676,000** and **$3,174,000**.

Over 88% of all wetlands were constructed as emergent marshes. 36% of these sites had more than 90% open water/aquatic bed/non-vegetated deep-water habitats and another 31.9% had less than 40% emergent vegetation cover. Predatory fish were present in 60.3% of the replacement wetlands greater than 1ha, and in 39.4% of the replacement wetlands smaller than 1ha. Overall, predatory fish were present in **52.4%** of replacement wetlands. Shallow littoral zones were present at 52.9% of the replacement wetlands greater than 1ha, and at 85.4% of the replacement wetlands less than 1ha. Overall, shallow littoral zones were completely absent from **42.7%** of the replacement wetlands.

Composition of the surrounding landscape around replacement wetlands may be a limiting factor in their ability to fully replace the functions of impacted sites. Landscape composition around replacement wetlands is especially important when mitigation is for the impacts to forested wetlands.

Major difficulties in determining project compliance with mitigation conditions were lack of information on impacted wetlands and pre-existing wetlands on mitigation sites, lack of follow-up by Ohio EPA staff within the five-year monitoring period, and dubious practices undertaken to satisfy enhancement or on-site preservation conditions.

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1. Introduction

Under §404 and §401 of the Federal Water Pollution Control Act amendments of 1972 and subsequent amendments (The Clean Water Act), the approval to fill, drain or otherwise degrade a wetland may be conditional on restoring, creating or enhancing wetlands to compensate for any unavoidable loss in wetland area and function (process called “wetland mitigation”). Until May 1998, all wetland impacts in Ohio had to be replaced at a ratio of no less than 1.5 acres of wetland restored or created for each acre of wetland impacted (1.5:1). In May 1998, Ohio EPA adopted wetland water quality standards (Ohio Administrative Code 3745-1-50 to 3745-1-54). This rule package separated wetlands into three antidegradation categories with varying wetland replacement ratios between 1.5:1 and 3:1. Larger mitigation ratios are required for impacts to higher quality wetlands and for mitigation projects located outside the watershed where the impacts occurred. The rules also require that replacement of lost wetlands shall be with in-kind wetlands of equal or higher quality. In-kind wetland replacement means forested for forested and non-forested for non-forested.

The Ohio Environmental Protection Agency is in the process of creating a comprehensive database of past and present wetland impacts, and wetlands constructed to mitigate the impacts of wetland losses. Creating a database of wetland mitigation sites is an essential first step towards evaluating the success of the mitigation process in retaining wetland acreage, and replacing wetland functions lost due to impacts to natural wetlands. This report presents the initial data, collected during the 2002 and 2003 field seasons, on mitigation wetlands constructed from 1992-1999 in Ohio. This report covers the compliance rates, amount of wetland impacts, and the amount of wetland habitat created or restored as part of the effort to mitigate wetland losses.

Replacement (mitigation) wetlands are built with the intent to replace all of the functions of lost wetlands, including storm water detention, water purification, nutrient cycling, ground water recharge and wildlife habitat (US Department of the Army and US Environmental Protection Agency 1990). A basic tenet of allowing wetland impacts is predicated by the assumption that the lost functions will be reestablished in replacement wetlands. In this report I present baseline data on some features of mitigation wetlands in Ohio (vegetation cover %, presence of predatory fish, landscape context). These data might provide a general indication of the quality of habitat established through the wetland mitigation process in Ohio, and its ability to replace lost wetland habitats. This topic is explored in great detail elsewhere (Porej 2003).

2. Methods

2.1. Site selection

The main goal of this study was to follow up on all the individual §401 water quality certifications that required wetland mitigation and were issued by Ohio EPA up to Jan 1, 2000. Selection of a clearly defined group of sites was complicated by several factors:

I. Changes in the acreage of isolated wetland impacts that could be authorized under §401 and §404 nationwide permit #26 – some large impacts which would require an individual §401 certification today were covered by nationwide permit #26 in the past. Until 1992 up to 10 acres of wetland impacts could occur before an individual §404 permit was required. However, starting in 1992, an individual §401 water quality certification was required for isolated wetland impacts greater than 5 acres. From 1997 to 2002 up to 3 acres of isolated wetland could be impacted without requiring an individual §404 permit and an individual §401 certification was required for impacts greater than 1 acre.

II. A definite list of pre-2000 §401 water quality certifications issued by the Ohio EPA that includes amounts and types of wetland impacts and the corresponding required mitigation has never been developed.

III. Some of the §401 water quality certification records may have been lost. Files could not be found for several known projects involving wetland impacts that had received a Section 401 water quality certification.

The final list of study sites included sites that satisfied the following criteria:

I. An individual §401 water quality certification was issued prior to Jan 1st 2000

II. Wetland creation/restoration was required as mitigation for unavoidable wetland impacts

III. Replacement wetlands were restored/constructed before January 1, 2003

IV. Site documentation (permit, monitoring report or any other documentation helpful in locating the applicant, consultant, or the present landowner) was located before June 1, 2003.

The flowing project types were excluded from the study:

I. Wetland mitigation was achieved solely through preservation or enhancement of existing wetlands

II. Wetland mitigation was achieved through an in-lieu fee agreement

III. Wetland mitigation was achieved through purchase of wetland credits at a wetland mitigation bank

IV. Certifications were associated with ongoing mining operations

V. Certification extension was granted post Jan 1 2000.

2.2. Data collection protocols

2.2.1 Office data collection

Office preparation consisted of assembling individual permit information, contacting the applicant and the consulting company, finding the wetland mitigation plan (and sometimes monitoring reports), identifying precise site location, and obtaining site access permission from the current landowner. On numerous occasions the applicant's company and the consulting company no longer existed, and/or individuals involved in the process were no longer with their companies (including §401 Coordinators at Ohio EPA). The process of locating all necessary information, making contact with the applicant, consultant and property owner was time consuming and often required numerous contacts for each project.

2.2.2. Wetland delineation

Jurisdictional boundaries of mitigation wetlands were delineated using the Routine Determination Procedure outlined in the 1987 Wetland Delineation Manual (USACE 1987). Site boundaries were mapped using Trimble® GeoExplorer and Trimble® GeoXT global positioning system with real-time differential correction. In cases where real-time differential correction was not possible due to poor reception, post-processing of data was completed in the office. Using either of the two correction methods, individual points were recorded with sub-meter accuracy. Digital photographs were taken at each site, and pictures were later "stitched" to form a panoramic view of the entire site. Photos of individual sites are available at (www.epa.state.oh.us/dsw/programs/wetlandbioassesment)

2.2.3. Vegetation classification

The majority of study sites were constructed as emergent vegetation marshes. These wetlands were classified into three types based on the amount of emergent vegetation cover:

1.) Perimeter wetlands - wetlands with a central expanse of open water and scattered perimeter stands of emergent wetland vegetation less than 2m in average width (<10% emergent vegetation cover; Figure 1).

2.) Low vegetation wetlands - Wetlands with a central expanse of open water and a band of emergent vegetation wider than 2m on average (10-40% emergent vegetation cover, low-end hemi-marsh; Figure 2).

3.) High vegetation wetlands - Wetlands with scattered pools of open water interspersed within emergent vegetation (40-80% emergent vegetation cover; Figure 3).

2.2.4. Presence of a shallow littoral zone

Recent studies of replacement wetlands in the Midwest indicate that average bank slopes of replacement wetlands are significantly steeper compared to natural reference wetlands (Fenessy 1997; Gallinugh 1998). Bank slopes of replacement wetlands were calculated using elevation data collected along transects extending into the wetland and running parallel to the long and short axis of the wetland. Each transect was 15m long and divided into three 5m sections. “Shallow littoral zones” are defined as areas with bank slopes of less than 15:1 over each of the three 5m sections of the 15m transect and vegetation cover (excluding aquatic bed) of over 50%.

2.2.5. Presence of predatory fish

Providing habitat for amphibians was an important function of many of the natural wetlands the constructed wetlands were built to replace. Several studies suggest that fish predation can impact the structure of amphibian communities and may exclude some species from otherwise suitable sites (Hecnar and M’Closkey 1997, Adams 1999, Smith et al. 1999). Presence or absence of predatory fish (centrarchids, eocids) was established by wading through the wetlands, and by deploying two baited minnow traps for no less than 1/2h. Traps were made of aluminum and fiberglass window screen with funnels at both ends that tapered from a 20 cm diameter to a 4 cm entrance hole. We followed Hecnar and M’Closkey’s (1997) classification of fish into predatory (centrarchids, eocids and salmonids) and non-predatory (cyprinids) categories.

2.2.6. Landscape composition

Data on the type of land uses surrounding replacement wetlands were obtained from the National Land Cover Database using ArcGIS applications. Different categories of land uses were collapsed into open water, wetland, urban, pasture/grassland, and row crop agriculture. Percent coverage of each class was calculated within a zone extending 200m from the wetland’s edge.

2.3. Assessing compliance

Required wetland mitigation acreage was compared to the acreage of created/restored mitigation wetlands present at the sites. Acreage of pre-existing wetlands at the mitigation site was deducted from the total mitigation acreage, but there were several cases where the exact acreage of pre-existing wetlands was not known (e.g., the §401 certification indicated that “several small, isolated wetlands existed on the site). Three special types of wetland mitigation sites provided a special challenge in determining whether they compiled with the certification in terms of the amount of wetland acreage developed:

A. **Open water bodies -** Wetland mitigation was attempted by constructing water bodies with >98% open water-aquatic bed habitat, and maximum depths greater than 1.5m (Figures 4a,b). Some of these water bodies are used as fishing ponds, one is a private water-skiing lake, and others include water-fountains or extensive rip-rap around the perimeter. In my professional opinion, none of these water bodies are jurisdictional wetlands because they do not meet the hydrophytic vegetation criterion.
B. **Unknown whether project is construction or enhancement -** Mitigation projects for which it is not certain whether the project was a wetland creation/restoration or just an enhancement, due to the lack of information on the quality and extent of pre-existing wetlands at the mitigation site.

C. **Unclear boundaries -** Wetland mitigation projects for which it was impossible to determine boundaries of the mitigation area (wetlands developed within a pre-existing complex, or enlargement of a pre-exiting wetland of unknown size).

3. Results

A total of 76 projects satisfied the above mentioned project-selection criteria. Access was denied to two projects located on private property (Borror Corporation and Ben Suarez), and no data was found for one project (Twin-value Stores, B 91-50-269). Of the remaining 73 projects, all but two (Ohio Turnpike, B 94-326-4; Holliday Harbor H 199600466-1) were visited during the project, for a total of 71 projects.

3.1. Total Non-Compliance

No attempt to construct replacement wetlands was documented for only 4 projects (5.2%), and one project was a complete failure (Figure 5). If the 3 projects where access was denied, or no information could be found are added to this group, the overall percentage of no attempts or complete failures increases to (10.8%). Distribution of wetland mitigation projects based on the % deviation from the required acreage is presented in Figure 6.

3.2. Impacted, required and constructed wetland acreage

Five projects fell into type A (open water bodies). These projects are City of Cambridge (H 91-37), Richard Lambert (B 92-496-2), Lombardo – L&M Properties (B 98-494-0055), Royalton Road Joint Venture (B 924942), and Avenbury Lakes (98-502-0016-2).

Three projects fell into type B (unknown whether the project is creation or enhancement). These projects are Silverlands (P 199700197), Lombardo – L&M Properties (B 98-494-0055), and Cedar Fair/East Harbor (95-475-15). Total impacts for these projects were 23.87 acres, and certifications required that 38.55 acres be created and 17.1 acres be enhanced as mitigation for the impacts.

Two projects fell into type C (unclear boundaries). These projects are Sunrise Land Company (B92-51-268) and City of Columbus Water Authority (H 94-55).

The following discussion (section 3.2.1.) on wetland impacts, mitigation acreage required and achieved is based on the remaining 62 projects (<u>Scenario 1</u>). A separate analysis of overall impacts if the projects that included wetlands in type A are included is presented in section 3.2.2 (<u>Scenario 2</u>).

3.2.1. Scenario 1

A total of 335.2 acres were impacted through 62 projects authorized under individual §401 water quality certifications. Required mitigation acreage was 566.1 acres, but only 387.7 acres were created/restored (68.5% of the required acreage). The achieved ratio of wetland impacts to wetland replacement is therefore **1: 1.16**.

One project (JMB) is a relative outlier, since 27.3 acres were impacted, 69.6 acres were required as mitigation, but only 8.51 were created. If this project is excluded, a total of 307.9 acres were impacted, 496.5 acres were required as mitigation, and 379.2 acres of replacement wetlands were created/restored (76.4% of the required acreage, at a replacement ratio of 1: 1.23).

3.2.2. Scenario 2

Inclusion of projects that resulted in water bodies with little or no emergent vegetation, depths over 1.5m, and little to no aquatic bed vegetation (type A) in the calculations, changes achieved mitigation ratios significantly because these resulting constructed water bodies do not meet the wetland definition.

If water bodies of this type are not considered wetlands as dictated by the criteria in the 1987 Wetland Delineation Manual (USACE 1987), a total of 387.5 acres were impacted, 629.3 acres were required as mitigation, and 417.7 acres were created. In this case, only 66.3% of the required wetland replacement acreage was created, and the replacement ratio is **1: 1.08**.

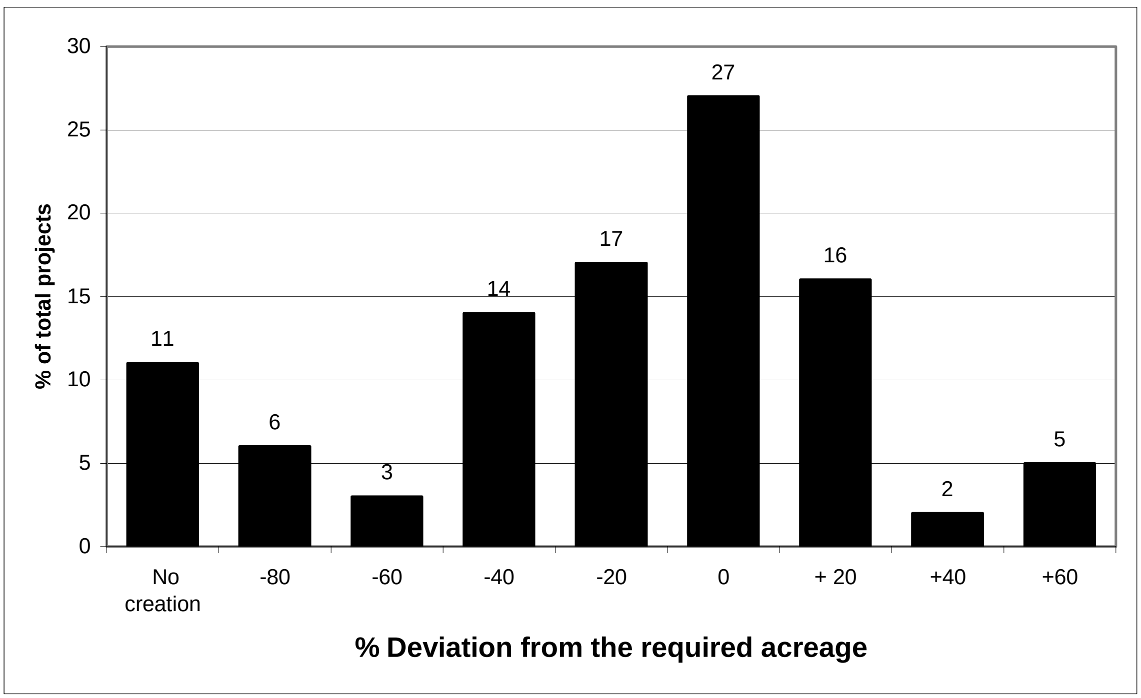

Figure 6. Distribution of wetland mitigation projects based on the % deviation form the required acreage under individual §401 permits in Ohio.

In 23% of the projects, several of them Ohio Department of Transportation projects, the permitee constructed up to 60% more wetland acreage than was required by their permits. The applicants for these projects deserve recognition for doing more than what was required. This extra acreage was an unexpected bonus and kept the overall survey acreage figures from resulting in a net loss of wetlands.

3.3. Economic considerations

Based on these results, between 178.4 and 211.6 acres of replacement wetlands that were required by the Ohio Environmental Protection Agency as wetland mitigation for unavoidable losses were not constructed (Scenario 1 and 2, respectively). An acre of wetland mitigation credits at wetland mitigation banks in Ohio cost between ($12,000-$18,000). If we consider $15,000 to be an average price, the monetary shortfall incurred is between **$2,676,000** and **$3,174,000**.

3.4. Habitat characteristics of wetland replacement sites

3.4.1 Vegetation patterns

A total of 104 replacement wetlands were classified as emergent marshes, and 13 were classified as forested wetlands. Nine small (<.2ha) forested wetlands were created as parts of three projects (Figure 7), and another four larger forested wetlands were created by expanding preexisting forested wetlands. This was achieved by increasing on-site hydrology through creation of berms, punching holes in dikes or blocking drainage tiles. Distribution of replacement wetlands classified as emergent marshes among different vegetation categories is presented in Figure 8 (excluding two sites with no standing water).

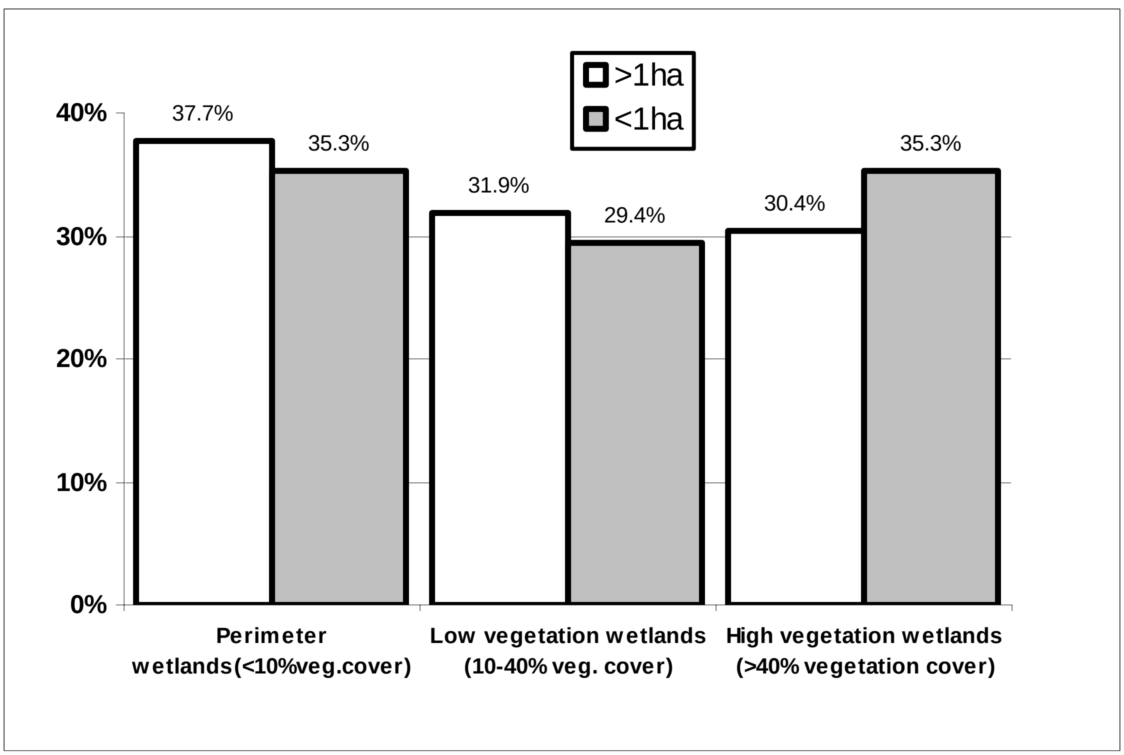

Figure 8. Distribution of replacement wetlands based on the amount of emergent vegetation cover.

3.4.2. Shallow littoral zones and presence of predatory fish

Predatory fish were present in 60.3% of the replacement wetlands greater than 1ha, and in 39.4% of the replacement wetlands smaller than 1ha (Figure 9). Overall, predatory fish were present in **52.4%** of replacement wetlands.

Shallow littoral zones were present at 52.9% of the replacement wetlands greater than 1ha, and at 85.4% of the replacement wetlands less than 1ha. Overall, shallow littoral zones were present in only **57.3%** of the replacement wetlands.

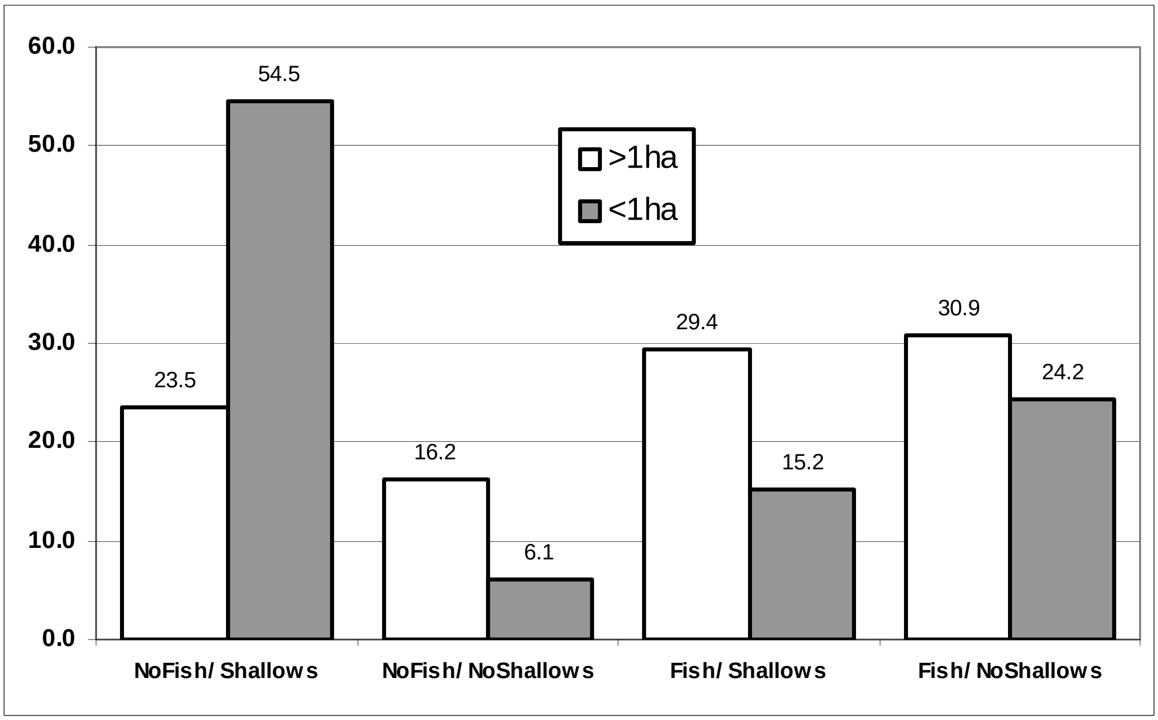

Figure 9. Distribution of replacement wetlands based on the presence of predatory fish (Fish) and the presence of a shallow littoral zone (Shallows).

3.4.3. Surrounding land use

Forest and row crops are the two dominant land uses surrounding the replacement wetlands (Table 1).

	1st quartile (25%)	Median	3rd quartile (75%)	Maximum	Average
% Forest	16	31	45	95	32
% Urban	0	1	15	80	11
% Pasture	6	14	23	61	16
% Row crops	18	30	48	90	35
% Wetland	0	0.5	4	37	4

Table 1. Composition of the 200m buffer zone surrounding wetland replacement sites.

4. Discussion

4.1. Regulatory issues

4.1.1 Lack of post-permit follow-up and enforcement

It is clear that most attention is given to wetland mitigation issues prior to the issuance of §401 water quality certifications. Due to the great volume of new applications, once a permit is approved, little time is allotted for follow-up to ensure compliance with water quality certification conditions. Agency priorities and outside pressures dictate that the limited personnel hours available go towards review of pending applications. And while it is the intention of Ohio EPA staff to follow up on monitoring requirements, there is little time available to devote to this task. Yearly monitoring reports are seldom read and almost none of the required three and five year site visits are made by Ohio EPA staff. Ohio EPA almost never formally acknowledges that a permittee has fully met its wetland mitigation obligations at the end of the monitoring period. While it is important for Ohio EPA to process permit applications with expedience, the resources of the agency need to be more focused on the follow-up process. Without close tracking to determine if wetland mitigation conditions are being met, Ohio EPA does not have a complete wetland program.

In order to assure continuity in the post-permit process (monitoring and enforcement), it is the recommendation of this report that at least one Ohio EPA full-time staff person be devoted entirely to this task. Critical functions to be performed by a person in this position should include:

a) Reviewing technical aspects of wetland mitigation plans
b) Assuring that Ohio EPA is receiving all required annual wetland monitoring reports for all projects
c) Managing and updating a centralized database of monitoring reports, requirements, time lines, etc.
d) Making site visits to assure wetlands are constructed as planned, and that permit requirements are met (habitat development, % cover of requires plant communities, vegetation IBI standards, etc.)

4.1.2 Lack of information on pre-existing wetlands on mitigation sites

Information on the quality, or even the extent, of pre-existing wetlands on the mitigation sites was often lacking or very vague. For example, this problem arose in situations where there was a “recent” tile failure in agricultural fields chosen as mitigation sites, or where a large forested wetland was developed by flooding a forest with “small, scattered” wetlands and pre-existing FAC or FACW trees and shrubs.

4.1.3. Dubious wetland “enhancement” and “on-site preservation” practices

New housing and development projects often retain some of the wetlands on the property for aesthetic, biological, or recreational purposes, while substantially modifying the surrounding terrestrial habitat ("on-site" wetland preservation; Figure 10). Since hydrology is retained, the functioning of these wetlands is often considered to be intact, but studies suggest that this may not always be the case. Porej et al. (2003) demonstrate the importance of upland habitat for maintaining local populations of amphibians. These findings should strengthen plans for "on-site" preservation (a provision to protect avoided wetlands is included in the rule package adopted in 1998). Wetlands whose terrestrial surroundings are significantly modified by construction of roads, clearing of forests or other activities should be considered "impacted" (Figure 11). These impacts can only be mitigated for by constructing replacement wetlands at a more suitable location.

Due to the general absence of enforcement of set mitigation goals with regard to habitat development in the post-construction period, "enhancement" is currently a dubious and unacceptable option for wetland mitigation in Ohio. In most cases, "enhancement" consisted of increasing the hydroperiod of the pre-existing wetlands (Figure 12), either by excavation or by creating berms. Adding water does not necessarily enhance the functions of the wetland system - in fact, it may substantially decrease its value as wildlife habitat if it results in the elimination of the shallow littoral zone and allows for persistence of predatory fish (Porej 2003). Functions to be enhanced and quantitative metrics to measure increases in function need to be clearly defined and enforced in order for enhancement to be a meaningful wetland mitigation strategy. Enhancement should also be limited to bringing back functions that were a natural part of the existing wetland at one time. As outlined in Ohio's rules, introduction of functions that a wetland never performed should not be authorized (Ohio Administrative Code 3745-1-50).

4.2. Habitat value of replacement wetlands

Different types of wetland designs may satisfy hydrological, soil and vegetation criteria required for demonstrating successful wetland replacement. In order to enhance the overall quality of wetland habitats, not merely retain the acreage, it is important to demonstrate which types of constructed wetland designs provide adequate habitat for different groups of wetland-dependent organisms. Failure to do so may result in habitats suitable for only a limited number of species. With historical wetland losses nearing 90% within the Midwestern states (Dahl 1990), attention needs to be focused on constructing wetland habitats that can contribute substantively to the preservation of diverse wetland-dependent fauna. However, replacement of wildlife habitat is usually not one of the functions monitored or regulated in replacement wetlands (National Research Council 1995, 2001), and Ohio is no exception to the rule.

Current criteria for successful wetland creation/restoration during the 5-year post-construction monitoring period are based on the 1987 Wetland Delineation Manual (USACE 1987). These criteria are: (a) sufficient periods of soil inundation or saturation (hydrology); (b) development of hydric soils; and (c) establishment of a plant community dominated by hydrophytic vegetation. Newly constructed wetlands with a permanent hydroperiod may have a higher probability of satisfying the hydrology and soil criteria than a newly constructed wetland with seasonal hydrology. Creation of pools with steep slopes maximizes the amount of wetland acres created per amount of land available and minimizes seasonal and year-to-year variations in the footprint of inundation (minimizing the risk of non-compliance due to insufficient acreage). Finally, the establishment of aquatic bed vegetation and a narrow fringe of emergent plants on steep banks slopes fulfill the hydrophytic vegetation cover criterion.

It is understandable then that we see an overrepresentation of open water (i.e. single, large pool), steep slopes and permanent hydroperiods in replacement wetlands. The practice of restricting water-level fluctuations used in many wetland management scenarios (the "misconception of stable water"; Frederickson and Reid 1990:79), and the general public's perception of the quality of wetland creation/restoration based on the size of permanent water bodies created (J. Watts of Columbus Metroparks, D. Petite of Cleveland Metroparks, personal communication) may have contributed to the construction of a significant number of replacement wetlands composed of a single, large, permanent pool on public lands in Ohio.

4.3.1. Emergent vegetation cover

I examined the associations between the amount of emergent macrophyte vegetation cover in replacement wetlands and wetland-dependent breeding bird species richness, breeding bird densities, and diversity of migrating wetland-dependent birds at 18 replacement wetlands (Porej 2003). Results indicate that creation of diverse wetland types is necessary for maintaining wetland dependent bird diversity, and that perimeter wetlands provide adequate habitat for a very limited subset of wetland-dependent bird species (e.g., pie billed grebes). In this study, I have documented that this type of wetland comprises over 36% of all replacement wetlands (see also Gallinugh 1998, Robb 2000). Similarly, recent studies of replacement wetlands in other states indicate that constructed wetlands tend to have longer, less variable hydroperiods than the impacted sites, and are often dominated by open-water/aquatic bed habitat (Illinois - Gallinugh 1998; Pennsylvania - Campbell 1996, Cole and Brooks 2000; Indiana - Robb 2000; New England - Minkin and Ladd 2003; Tennessee - Morgan and Roberts 2003).

4.3.2. Presence of shallow littoral zones and predatory fish

In this study, I documented that over 42% of all replacement wetlands in Ohio lack a shallow littoral zone, and 52% harbor predatory fish. In a separate study on a subset of these sites (Porej 2003), I demonstrated that local species richness of amphibians in replacement wetlands with shallows was 1.51 species higher on average than in wetlands without shallows (95% CI from 0.46 to 2.76). The presence of predatory fish was associated with an average reduction in species richness by an estimated 1.91 species (95% CI from 0.65 to 3.16). There was no significant association between local amphibian species richness and pool size or wetland age. Steep-sloped wetlands resemble gamefish ponds in design (Illinois Department of Conservation 1995), and are of little value in amphibian conservation (see also Lanoo 1996).Creation of a shallow littoral zone is a must, and efforts should be made to create more wetlands without predatory fish. Both of these objectives can be accomplished by encouraging the construction of wetlands with shallow slopes, and designing the hydrology so that the wetland will not hold water throughout the year (in most years).

4.3.3. Landscape context

The landscape of Ohio has been converted from nearly a continuous cover of mature, deciduous forest to a mosaic of agriculture, suburban/urban landuse and fragmented woodlands (Environmental Law Institute 1998). Around the turn of the 20th century, less than 10% forest remained in Ohio, mainly in the southeastern, unglaciated portion of the state. The overall forest cover in the state has now increased to around 30%, but the agricultural landscape of western Ohio still consists of less than 10% forest cover (Lafferty 1979), mainly in the form of isolated woodlots. Many of these woodlots contain wetlands, the presence of which may have discouraged their clearing for agriculture or other uses. As the land use changes, these woodlots are being lost at an increasing rate, and so are the forested wetlands.

Due to the lack of data on impacted wetlands, it is difficult quantify the overall amount of forested wetland impacts for the projects included in this study. However, a review of the types of wetlands whose losses are being mitigated for at three mitigation banks operating in central Ohio shows that 40-60% of all impacts are to forested wetlands (Porej 2003). On the other hand, a more detailed survey of replacement wetlands (Porej 2003) indicates that amphibians associated with forested wetlands are extremely rare or completely absent from replacement wetlands. It is therefore of paramount importance that we clearly define criteria and work within existing regulations to assure the terrestrial habitat around wetlands is replicated, especially for impacts to forested wetlands.

My study on the habitat associations of salamanders and wood frogs within the agricultural landscape of Ohio (Porej 2003) confirmed the strong association between the structure of surrounding upland areas and amphibian diversity in natural wetlands. Based on the species-specific models developed using data from natural wetlands (Micacchion 2002), the landscape context in which many replacement wetlands are constructed severely limits the likelihood that these wetlands will ever replace the functions of impacted sites. For example, we have not recorded spotted salamanders in any natural wetlands that had less than 37% forest cover within the 200m terrestrial buffer zone. The average amount of forest cover in this zone around replacement wetlands is 32%, and over 70% of replacement wetlands fall below the 37% forest cover threshold observed for spotted salamanders.

Past efforts show that forested wetlands are more difficult to construct then emergent wetlands and suitable locations that will maximize their functionality are hard to find. However, if impacts to forested wetlands in Ohio are to continue, better methods of replacing their functions must be developed. Some progress in improving forested wetland restoration and creation is occurring. Simple guidelines for constructing forested wetlands are now available (e.g., www.southernregion.fs.fed.us/boone/), and The Ohio Environmental Protection Agency, The Ohio Department of Transportation, and The Nature Conservancy are collaborating on a project to locate suitable sites in Ohio for future forested wetland restoration and creation.

5. Acknowledgements

I would like to thank Mick Micacchion and John Mack (The Ohio Environmental Protection Agency) for their friendship, support, guidance, and immense trust they had in me throughout the duration of this project. Many thanks go to the EPA Division of Surface Water §401 coordinators and supervisors, and The Army Corps of Engineers, Regulatory Branch staff from Huntington, Buffalo and Pittsburgh districts for their patience in enduring two years of an endless barrage of questions and requests, and yet always finding time to assist me. I owe my deepest gratitude to Chad Kettlewell for sharing all the good times and bad times with me in the field, for being a wonderful assistant and most important of all, a good friend. Finally, I wish to thank Dr. Thomas Hetherington for being a great advisor, Dr. Amon from The Wright State University, numerous private consultants, natural resource managers, Ohio Department of Transportation staff, and many others who helped me complete this project. I hope we will all benefit from the work you have helped me accomplish.

Appendix I

DEFINITIONS OF USED TECHNICAL TERMS

CONSTRUCTED WETLAND - includes both created and restored wetlands

CREATION - Establishment of a wetland where one did not formerly exist (non-hydric soils)

ENHANCEMENT - activities conducted in existing wetlands to improve or repair existing or natural wetland functions and values of that wetland

RESTORATION - re-establishment of a previously existing wetland at a site where it has ceased to exist (hydric soils)

MITIGATION - restoration, creation, enhancement or preservation of wetlands to compensate for adverse impacts to natural wetlands

PRESERVATION - protection of ecologically important wetlands in perpetuity. May include protection of adjacent upland areas as necessary to ensure protection of the wetland

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Figure 1. An example of a “perimeter wetland” (<10% emergent vegetation cover)

Figure 2. An example of low-vegetation wetland type (10-30 % emergent vegetation cover)

Figure 3. An example of a high-vegetation wetland (>40% emergent vegetation cover)

Figure 4a. An example of a category A replacement wetland (>98% open water/aquatic bed habitat). This “wetland” is 8 years old.

Figure 4b. An example of a category A replacement wetland (>98% open water/aquatic bed habitat). This “wetland” is 10 years old.

Figure 5. An example of a failed wetland restoration project

Figure 7. An example of a forested wetland replacement project

Figure 10. An example of on-site wetland preservation

Figure 11. Wetland impacts through severe surrounding landuse change

Figure 12. An example of on-site wetland “enhancement”