State of Ohio **Wetland Ecology Group**
Environmental Protection Agency **Division of Surface Water**

An Inventory of Ohio Wetland Compensatory Mitigation
Part 2

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

Chad Kettlewell
The Ohio State University
Environmental Science Graduate Program
365 Kottman Hall
2021 Coffey Road
Columbus, Ohio 43210

March 31, 2005

Bob Taft, Governor
State of Ohio

Joseph P. Koncelik, Director
Environmental Protection Agency

P.O. Box 1049, Lazarus Government Center, 122 S. Front Street, Columbus, Ohio 43216-1049

Executive Summary

This report is the second document designed to present data about mitigation wetlands constructed in Ohio under §401 water quality certifications. The initial report by Porej (2003) provided baseline data from 1992-1999 and was funded under the same grant. This report should be considered an addendum to the original manuscript by Porej (2003). The purpose of this report is to provide data on additional §401 certifications and also to summarize the findings of both studies. Due to the extensive amount of overlap in background information, methods, and data reporting, some of the text from Porej (2003) has been duplicated in this report.

Section 401 water quality certifications that were issued from 1992-1999 were discovered which were not visited by Porej (2003) and are described in this report along with other certifications that were issued later, primarily in the year 2000. Information regarding mitigation wetlands reflects that within Porej (2003) and consists of compliance rates, amount of wetland impacts, amount of wetland created or restored, and basic habitat features (% emergent vegetation within wetlands, presence/absence of shallow littoral zones, presence of predatory fish, and surrounding landscape context).

During 2004, 27 projects were visited and 62 wetlands were delineated. An additional twenty-seven wetlands that were constructed are described within this report but delineation was not feasible for them (a total of 89 wetlands were constructed). When possible, the areas of these wetlands were estimated with alternative methods for compliance calculations. Compliance rates for these projects were higher than those reported by Porej (2003). Overall, 44.8 acres of wetland impacts were permitted, 72.9 acres of wetland mitigation were required, and 79.1 wetlands were constructed. The result is a net gain of 34.5 acres of wetland and a replacement ratio of 1.77:1. The final compliance results from Porej (2003) had to be adjusted because one site visited for this report was constructed in addition to a site visited by Porej (2003) for the same project. Another project was re-visited and resulted in additional acreage. Between the two studies, 101 projects and 178 wetlands were monitored. For 425.3 acres of wetland impacts, 697.8 acres of wetland mitigation were required and 496.8 acres were constructed. These numbers demonstrate a net gain of 71.5 acres of wetland and a final replacement ratio of 1.17:1. Overall, 71.2% of the required wetland acreage was constructed.

Of the 85 mitigation wetlands that were delineated or estimated, 73% were emergent marshes and 27% were forested wetlands. On an area basis, 99% of the 85 wetlands were emergent marshes and 1% were forested. Of the emergent wetlands, 8% consisted of ≥90% open water/aquatic bed/non-vegetated deep-water habitats. Thirty-six percent of the emergent wetlands consisted of 10-40% emergent vegetation and the other 56% consisted of ≥40% emergent vegetation. Predatory fish were caught in 40% of emergent wetlands greater than 1ha and 26% of wetlands less than 1ha. Shallow littoral zones were present at 93% of emergent wetlands greater than 1ha and 79% of wetlands less than 1ha. Shallow littoral zones were absent from 18% of emergent wetlands.

As suggested by Porej (2003), there are some difficulties that arise when attempting to determine compliance with permit requirements. The presence of pre-existing wetlands on mitigation sites, deep open-water habitat, and the inability to collect GPS data under heavy forest canopy were the problems most commonly encountered during the 2004 field season.

1. Introduction

Under §404 and §401 of the Federal Water Pollution Control Act 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, enhancing, or preserving 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 forested wetlands, higher quality wetlands, and for mitigation projects located outside the watershed where the impacts occurred. Lower ratios result when impacts are partially mitigated through enhancement or preservation activities. In many cases a combination of mitigation methods are used and, as a result, several different replacement ratios may apply to one project. 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.

Within this report, only mitigation activities that resulted in additional wetland acreage were considered (creation or restoration of wetland area). Values regarding required mitigation acreage only reflect requirements for wetland creation or restoration and do not include any additional requirements for wetland enhancement or preservation. Section 401 certifications were assessed to determine compliance with permit requirements, net gain or loss of wetland area, and basic habitat structure (% emergent vegetation within wetlands, presence/absence of shallow littoral zones, presence of predatory fish, and surrounding landscape context). The results of this study will provide additional data for a wetland mitigation database, which has been designed to serve as a knowledge base regarding mitigation in Ohio (Porej 2003). This report provides information on §401 certifications that were issued between 1992 and 1999 and unintentionally omitted from the study by Porej (2003) and also additional certifications that were issued in the years 2000-2001. Data from the 2004 field season are presented individually and also combined with data from Porej (2003) for an overall summary.

2. Methods (Slightly modified from Porej (2003))

2.1. Site selection

Porej (2003) mentioned several factors which made it difficult to compile a complete list of issued permits for a certain time period. Record keeping within Ohio EPA has improved and these issues should become less of a problem in future studies. Section 401 certifications were selected for the assessment based upon the following criteria (permits were first located which were issued between 1992 and 1999 and were not included within Porej (2003)).

I. An individual §401 water quality certification was issued prior to Jan 1st 2002

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

III. Replacement wetlands were restored/created 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 July 1, 2004.

The following 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 the Trimble® GeoXT global positioning system. Data points were collected at least on each point where the boundary of the wetland appeared to turn 10° or more. This protocol is suggested in order to standardize the collection of GPS points for calculating wetland area. Differential correction of GPS data was conducted in the office using

data from a base station whose coverage included the mitigation site location. Additional data processing was occasionally necessary when several points were accidentally collected at one location, resulting in overlapping boundaries. When this occurred, the GPS data were imported into the ArcGIS (ESRI, Inc.) environment and edited. Digital photographs were taken at each site.

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; see Figure 1 *in* Porej (2003)).

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; see Figure 2 *in* Porej (2003)).

3.) High vegetation wetlands - Wetlands with scattered pools of open water interspersed within emergent vegetation or entirely vegetated (40-100% emergent vegetation cover; see Figure 3 *in* Porej (2003)).

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; Gallihugh 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 (ESRI, Inc.) applications. Different categories of land uses were collapsed into open water, wetland, forest, 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 mitigation was difficult to calculate (pre-existing wetlands or deep, open-water areas on-site). Porej (2003) described three special cases where on-site mitigation conditions made it difficult to calculate wetland area. I have added a fourth type that describes those projects where forest canopy created problems. For convenience, I have included all four of those cases below; however, Type B was not encountered during the 2004 field season.

A. **Open water bodies –** Many of the mitigation wetlands in Porej (2003) and also in this report contained areas of extensive, deep-water habitat (greater than 1.5m deep). It was often impossible to delineate the edge of the wetland and open water. In this case, other methods (visual estimates, aerial photographs, GIS) were used to approximate the area of the open water habitat so that it could be excluded from the wetland area delineated. These projects will be described in greater detail in future sections.
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 were developed within a pre-existing complex or enlargement of a pre-existing wetland of unknown size). Projects of this type that were visited in 2004 will be described in greater detail.
D. **Heavy forest canopy –** Wetland mitigation projects that consisted of wetlands with heavy forest canopy (either constructed wetlands or existing adjacent wetlands). For these projects, wetland delineations were not conducted because it was not possible to collect accurate GPS points under the heavy canopy. When possible, wetland areas were estimated using aerial photos, GIS, as-built surveys, and field estimates.

3. Results

3.1. Impacted, required and constructed wetland acreage

Overall, 27 mitigation projects were visited which consisted of 89 wetlands. Sixty-two of the 89 wetlands were fully delineated in the field. The sizes of 23 additional wetlands were estimated using GIS, as-built diagrams, aerial photos, and field estimations. The four remaining wetlands were not delineated in any fashion due to a variety of reasons that will be described later. Deep open water areas were subtracted from seven of the 62 delineated wetlands. These projects will be first described with respect to the different types described by Porej (2003) and then split into separate scenarios that were used for the calculation of total compliance rates and replacement ratios.

3.1.1. Special case types

Four projects fell into Type A (deep open water areas, Figure 1). These projects were ODOT Sta-30, ENZ coal, Four Seasons of Brecksville, and Kerruish Stormwater Expansion. These projects consisted of 11.3 acres of impacts, 20.4 acres of required mitigation, and 18.5 acres of delineated wetlands. A total of 4.0 acres of deep open water was estimated. Subtracting open water from the delineated acreage results in 14.5 acres of wetland mitigation.

Five projects fell into Type C (unclear boundaries). These projects were Conneaut Correctional Facility, Medina High School, Shelter Cove, Still Valley Lake, and Upper Sandusky Reservoir Expansion. Some of the wetlands were delineated for the latter two projects; however, one wetland for each project could not be delineated. Still Valley Lake and Conneaut Correctional Facility contained existing on-site wetlands that could not be differentiated from the mitigation. The mitigation for Shelter Cove was designed as an addition to the continuous fringe wetland around a small lake. As a result, it was impossible to determine how much mitigation was present. The mitigation wetlands associated with Medina High School could not be found. Upper Sandusky Reservoir Expansion contained wetlands that were created around the shelf of a reservoir. It was not possible to delineate the open-water/wetland edge without a boat and several days of work. These three projects resulted in 29.2 acres of wetland impacts and required 47.5 acres of wetland mitigation. No complete delineations were conducted for Conneaut Correctional Facility. Three wetlands were delineated for Still Valley Lake (1.11 acres) and 2 wetlands were delineated for Upper Sandusky Reservoir Expansion (16.25 acres). In total, five wetlands were delineated for these three projects (17.36 acres).

Two projects fell into Type D (heavy forest cover). These projects were Conneaut Correctional Facility and Geauga Lake Amusement Park. The primary difficulty for Conneaut Correctional Facility was the presence of existing on-site wetlands. Many of the adjacent wetlands were forested, causing further difficulty due to the inability to collect GPS data. Geauga Lake Amusement Park mitigation consisted of 25 wetlands, two of which were delineated. The other 23 wetlands were constructed as a vernal pool complex within a forested setting (Figure 2). An as-built survey was used along with GIS techniques to estimate the area of these vernal pools (0.74 acres, Figure 3). For this project, 2.4 acres were impacted and 3.9 acres of mitigation were required. The importance of upland habitat to vernal pool success has been considered for the review of this project. See Section 4 for a detailed discussion.

Four Seasons of Brecksville and Geauga Lake Amusement Park (Type A and Type D, respectively) also contained pre-existing wetlands on-site. For these two projects, the pre-existing wetlands obviously overlapped the delineated wetland mitigation. For both projects, wetland delineations of the existing wetlands were available. These delineations were used to estimate the area of pre-existing wetland located within the mitigation area. The pre-existing wetland area was subtracted from the delineated mitigation in order to acquire the final mitigation area (see discussion, Section 4).

3.1.2. Scenario 1

Scenario 1 includes only those projects for which all wetlands were fully delineated (no estimation of areas). For this scenario (16 projects), there were a total of 31.1 acres of wetland impacts, 48.6 acres of required mitigation, and 61.6 acres of wetlands constructed. Construction resulted in 13 more acres of wetland than were required. For this scenario, we see an overall replacement ratio of 2:1. Two projects (ODOT Lancaster Bypass and Ravenna Arsenal) constructed 15.2 acres in addition to the required amount. If these two projects are excluded, 19.2 acres of wetlands were impacted, 28.5 acres of mitigation were required, and 26.2 acres of wetland were constructed. As was the case in Porej (2003), a few projects were responsible for having a substantial effect upon replacement ratios. Exclusion of these two projects results in a replacement ratio of 1.4:1.

3.1.3. Scenario 2

Scenario 2 consists of all projects included in Scenario 1 and also Type A and Type D projects (21 projects which excludes Conneaut Correctional Facility because it also falls into Type C). For this scenario, open water estimations are omitted from wetland areas and the estimation for vernal pool wetlands associated with Geauga Lake Amusement Park are included. For these 21 projects, 44.8 acres of wetlands were impacted, 72.9 acres of mitigation were required, and 79.1 acres of wetlands were constructed. This results in a replacement ratio of 1.77:1. It should again be noted that these figures for mitigation acreage and replacement ratios are estimations due to uncertainties in the exact amounts of open water (non-wetland) areas, pre-existing wetlands within mitigation areas, and vernal pool size estimations. These are the best estimates that could be achieved given the amount of information available in an effort to describe actual mitigation acreages. Figure 4 shows the percent deviation from required mitigation acreage for these 21 projects.

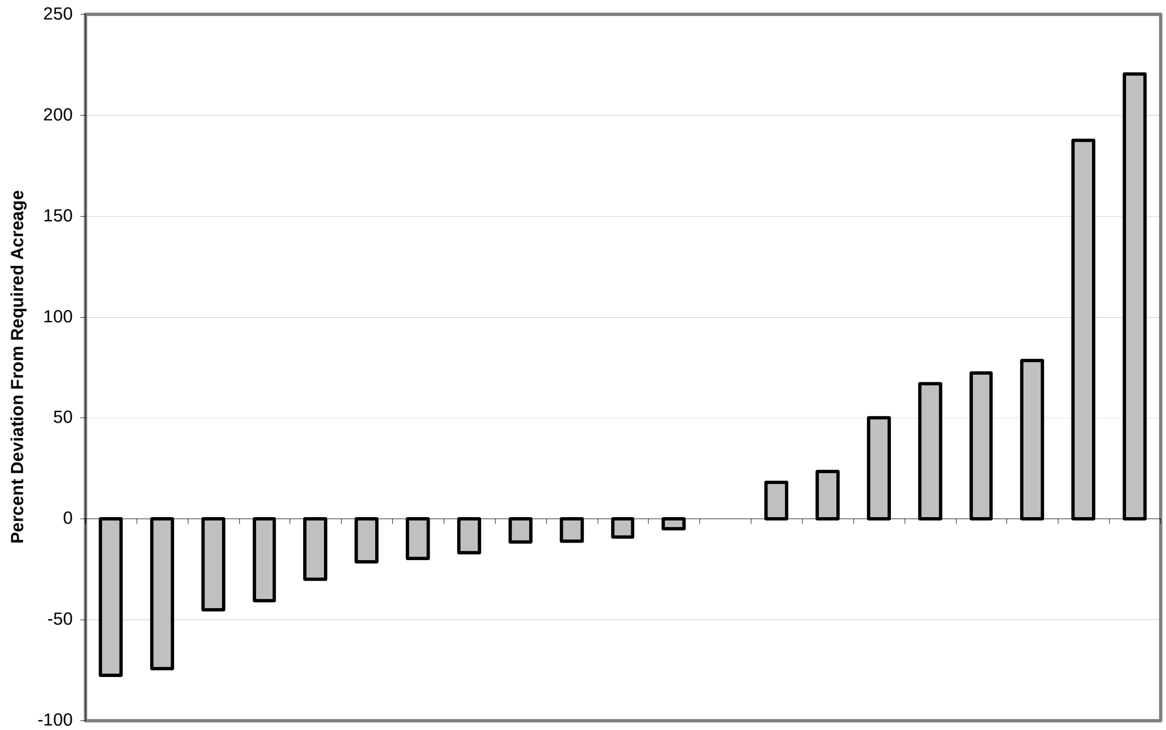

Figure 4. Distribution of projects visited in 2004 based on percent deviation from required mitigation area.

3.2. Habitat characteristics of wetland replacement sites

3.2.1 Vegetation patterns

The description of vegetation patterns and other habitat characteristics only includes replacement wetlands that were fully delineated (62 wetlands). All of these wetlands were constructed as emergent marshes. Twenty-three additional wetlands were constructed as small vernal pools within a forested setting (associated with the Geauga Lake Amusement Park project as described above) and four other wetlands were constructed with a forested component. Figure 5 describes the emergent marshes with respect to the amount of emergent vegetation versus the amount of open water/submergent vegetation area. Wetlands are split into those greater than 1ha and those less than 1ha as in Porej (2003).

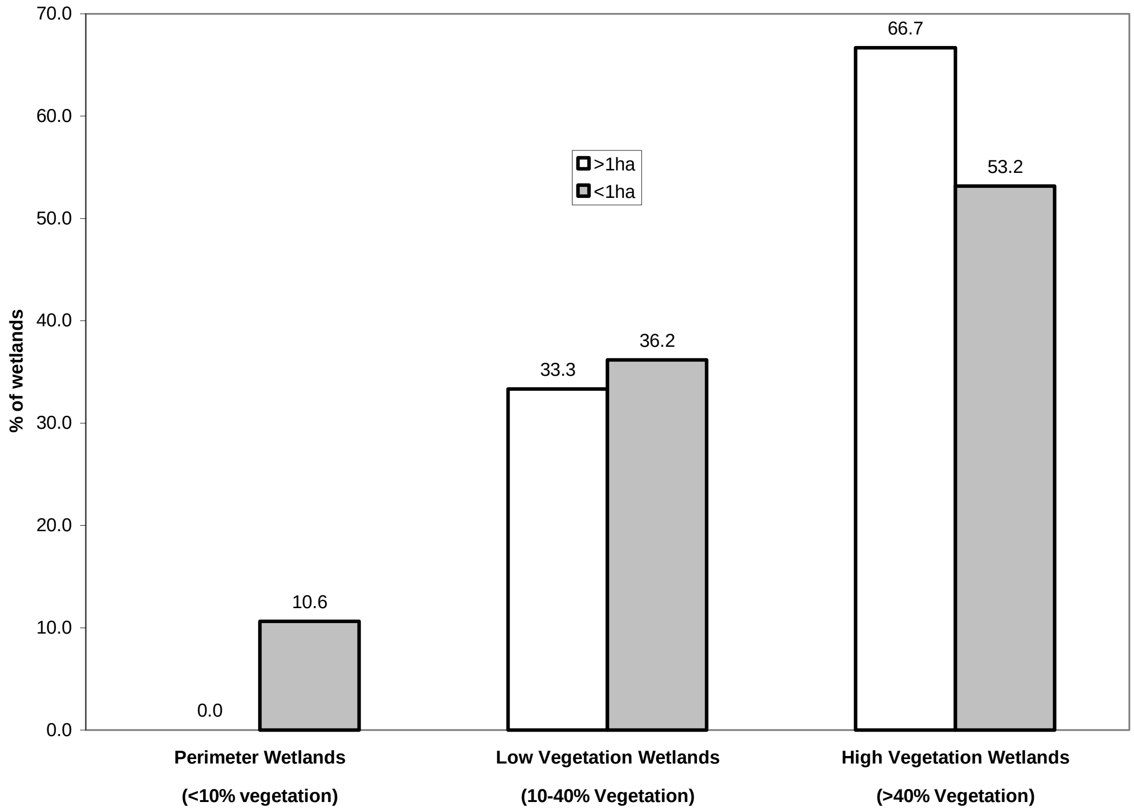

Figure 5. Distribution of replacement wetlands visited in 2004 based on amount of emergent vegetation

3.2.2 Shallow littoral zones and presence of predatory fish

Figure 6 presents data for the presence of vegetated shallow littoral zones and predatory fish within replacement wetlands. As with the vegetation patterns, only those wetlands that were fully delineated are described. Wetlands are divided into those that are greater than 1ha and those less than 1ha. Overall, shallow littoral zones were present in 82% of replacement wetlands and predatory fish were present in 29% of replacement wetlands. On an area basis, shallow littoral zones were present in 91% of wetlands and predatory fish were present in 50% of wetlands.

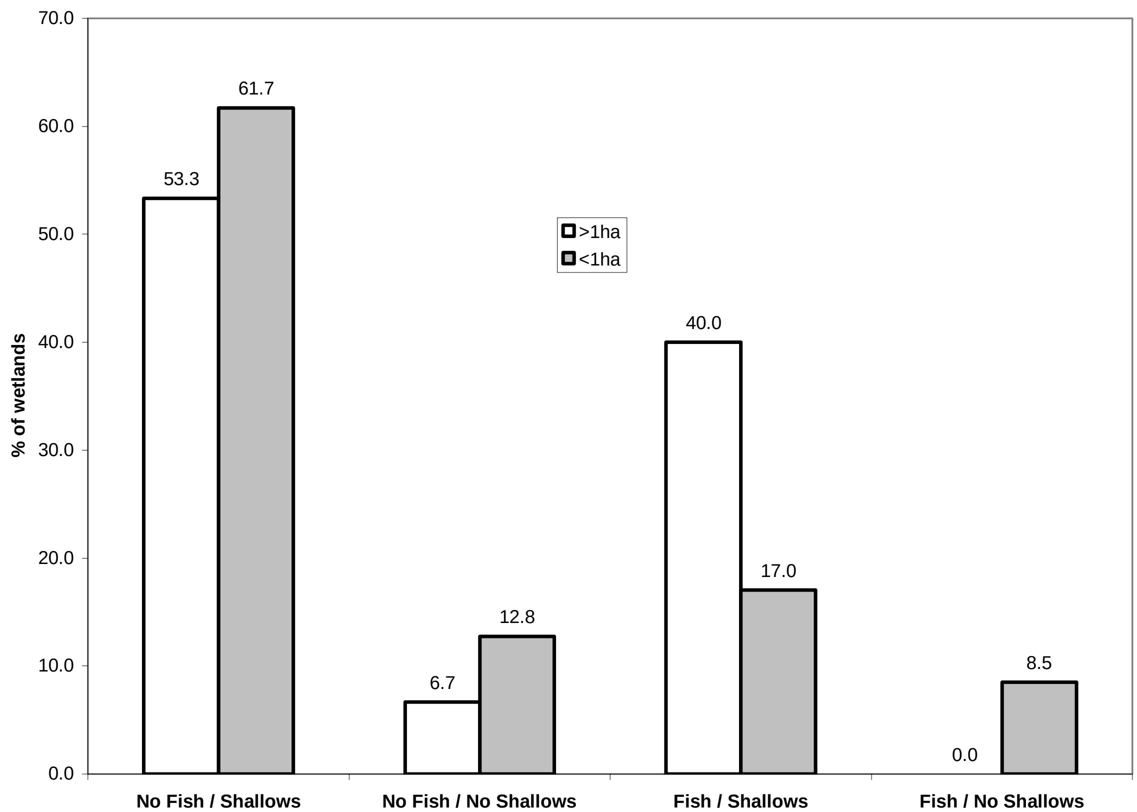

Figure 6. Distribution of replacement wetlands visited in 2004 based on the presence of predatory fish (Fish) and the presence of shallow littoral zones (Shallows).

3.2.3 Surrounding land uses

Forest and urban land uses were most common surrounding replacement wetlands followed by pasture and row crops. These land uses were derived from National Land Cover Data (NLCD) values which were collapsed into six land use categories as defined by Porej (2003). Table 1 describes the statistics for land uses surrounding those replacement wetlands visited during the 2004 field season.

	1st Quartile (25%)	Median	3rd Quartile (75%)	Maximum	Average
% Forest	27	37	52	79	41
% Urban	2	8	38	56	19
% Pasture	2	14	25	45	16
% Row Crops	7	16	23	37	16
% Wetland	0	4.9	9	48	8
% Open Water	0	0	0	9	1

Table 1. Land use statistics for a 200m buffer surrounding replacement wetlands visited in 2004.

3.3 Summary data

This section will combine the results of the two reports (Porej, 2003 and Kettlewell, 2005). These results are more influenced by data collected by Porej (2003) because of a longer monitoring period and therefore a larger project base. As mentioned earlier, the data for two projects included in Porej (2003) have been adjusted. Park Meadow Landfill Closing was re-visited in 2004 and a different acreage was found from when it was visited by Porej (2003). Porej (2003) only visited a portion of the mitigation constructed for Ohio Department of Transportation STA-30. The remaining mitigation wetlands for this project were visited in 2004 and added to data from Porej (2003).

Since both reports have split compliance results into two scenarios, the summary data will be described in the same way, by combining these scenarios. Scenario 1 was defined slightly differently within the two reports but essentially describes those projects that did not contain large areas of deep open water or un-definable boundaries. Scenario 2 describes all of the projects within Scenario 1 in addition to projects for which open water areas were subtracted or other estimates were required (as described above).

3.3.1 Scenario 1

A total of 78 projects fall into Scenario 1. There were 359.3 acres of authorized wetland impacts, 610.3 acres of mitigation required, and 449.2 acres of wetland were constructed. The result is a replacement ratio of 1.25:1 with 73.6% of the required wetland acreage being constructed.

3.3.2 Scenario 2

A total of 87 projects fall into Scenario 2. There were 425.3 acres of wetland impacts, 697.8 acres of mitigation required, and 497.6 acres of wetland constructed. This results in a replacement ratio of 1.17:1 with 71.3% of the required wetland acreage being constructed. Figure 7 shows the distribution of projects with respect to the percent deviation from required mitigation acreage.

3.3.3 Habitat characteristics

Vegetation patterns, shallow littoral zone presence, and predatory fish presence data were combined for the two studies. Of all wetlands studied, 25.6% were perimeter wetlands with less than 10% vegetation cover. Another 32.9% of the wetlands contained 10-40% vegetation and 41.5% of the wetlands had greater than 40% vegetation cover (Figure 8). Predatory fish were present in 43.8% of wetlands studied and shallow littoral zones were present in 67.9% of wetlands (Figure 9). These statistics are based upon the number of wetlands that were constructed. If habitat characteristics were compared on an area basis instead of wetland number, it is possible that results would be much different.

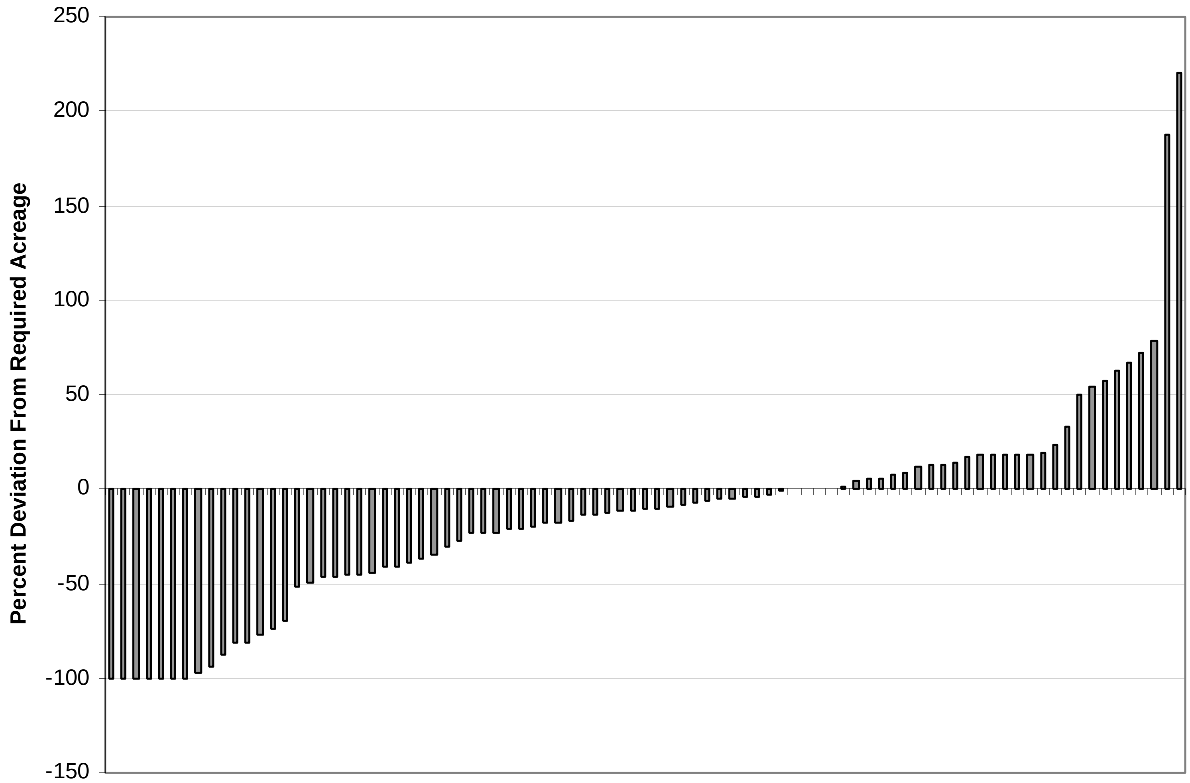

Figure 7. Distribution of all replacement wetlands based on percent deviation from required acreage.

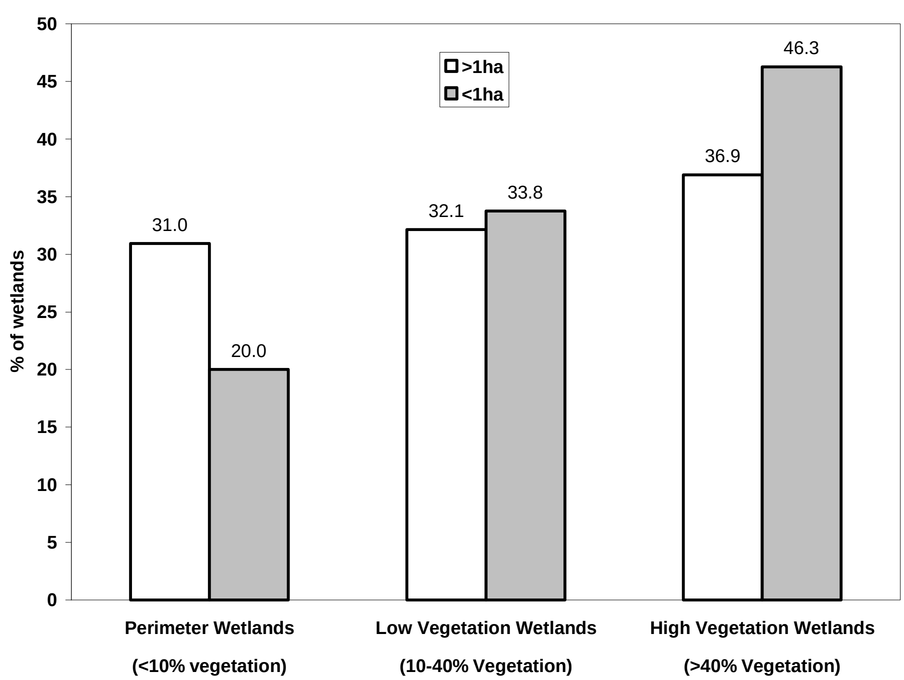

Figure 8. Distribution of all replacement wetlands based on amount of emergent vegetation.

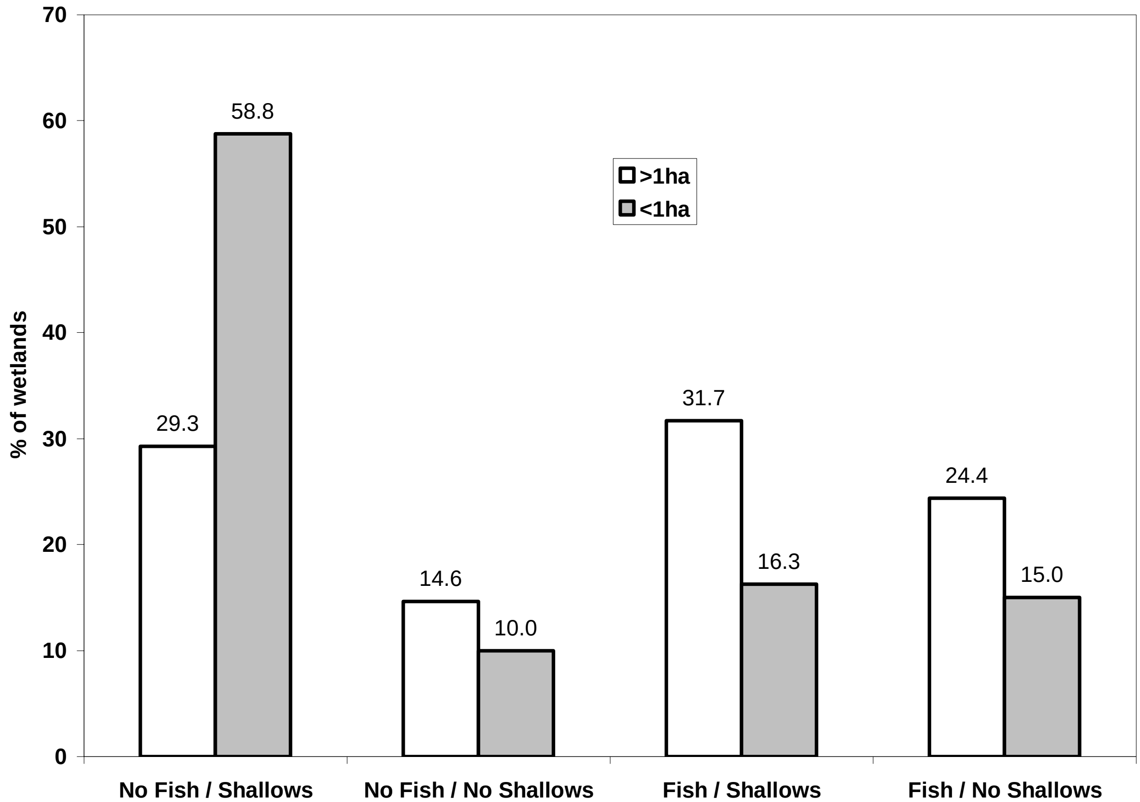

Figure 9. Distribution of all replacement wetlands based on the presence of predatory fish (Fish) and the presence of shallow littoral zones (Shallows).

3.3.4 Surrounding land use

Table 2 shows the statistics for surrounding land uses for the combined data. Forest and row crops were the two dominant land uses surrounding mitigation wetlands as demonstrated by Porej (2003).

	1st Quartile (25%)	Median	3rd Quartile (75%)	Maximum	Average
% Forest	18	32	47	96	35
% Urban	0	2	18	80	12
% Pasture	6	14	24	61	17
% Row Crops	11	23	41	90	29
% Wetland	0	0.7	6	48	5
% Open Water	0	0	2	50	3

Table 2. Land use statistics for a 200m buffer surrounding all replacement wetlands.

4. Discussion

4.1. Special projects

4.1.1 Projects where some wetland portion was not delineated

There were four wetlands that were not delineated or estimated in any fashion (associated with four different projects). The impacted, required, and constructed acreages for these projects were not included within final totals or replacement ratios within this report. Any wetlands that were completely delineated were, however, included within habitat characteristic analyses. Conneaut Correctional Facility contained substantial on-site, pre-existing wetlands as well as heavy forested canopy. These factors made it impossible to determine the wetland boundary within a reasonable amount of time. A rough estimate of the wetland area was acquired from the delineated portions of this large wetland complex. After consulting recent monitoring reports from the applicant, it appears as though this delineation was fairly accurate. The data within the monitoring report concludes that the applicant has created slightly more than the required acreage, which appears accurate based upon our estimates.

Still Valley Lake consisted of several wetlands, one of which was not completely delineated due to the presence of on-site, pre-existing wetlands. Using an estimate of the size of this wetland and delineations of the other wetlands, it appears as though there is insufficient wetland area present. Upper Sandusky Reservoir consisted of two wetlands that were delineated and also a fringe wetland that was created around the expanded reservoir (Figure 10). It was not feasible to delineate this wetland due to time and methodological constraints. Given the average width of the fringe wetland, we estimate that the applicant has created the desired acreage within the reservoir limits. The final project within this category, Golden Links, consisted of one wetland that was not delineated due to on-site, pre-existing wetlands. This wetland was constructed within a forested wetland complex, resulting in the presence of existing wetlands along approximately 75% of the mitigation wetland boundary.

4.1.2 Projects with known pre-existing wetland areas and vernal pools

Two projects contained on-site, pre-existing wetlands that coincided with mitigation wetland area where detailed project maps were available. For Four Seasons of Brecksville, 2.554 acres of wetland mitigation were originally delineated. Upon consulting the project map, subtracting open water estimates (1.025 acres) and pre-existing wetlands (0.395 acres), it was concluded that the applicant has constructed approximately 1.134 acres of mitigation (Figures 11-12). For Geauga Lake Amusement Park, 3.018 acres of wetland mitigation were originally delineated. Pre-existing, on-site wetlands (0.71 acres) were subtracted from this total. In addition, this project included the construction of a vernal pool complex. The areas of these pools were estimated using an as-built survey provided by the applicant (0.74 acres) and were added to the construction total (Figure 3). This results in a final estimation of 3.048 acres of wetland mitigation for this project. However, it is noted here that the vernal pool complex area was underestimated due to the fact that areas in between vernal pools were developing as wetlands nicely and were not included within the as-built survey. In addition, one of the

delineated wetlands contained an island of upland during the time of visit. The applicant was in the process of altering on-site hydrology in order to encourage the development of wetland in this area. Additional wetland area should be included within monitoring reports as it develops and will likely move this project into full compliance.

4.1.3 Additional Project Considerations

Admore Drive was the youngest wetland that was visited during the study. Additional time could be necessary in order for the wetland to develop the required area. Also, during the site visit, the applicant discussed plans to make alterations to hydrology, which could affect wetland area. Wilcox Commercial Center was assumed to have constructed exactly the amount of wetland area required even though additional wetland area was constructed. The applicant created additional wetlands with the intention of using extra area for future mitigation credits. As proposed by the applicant, only that wetland area set aside for this project was granted as mitigation credit. Ohio Department of Transportation (ODOT) Sta-30 fell slightly short of the required acreage due to the subtraction of estimated open water area. It should be noted here that ODOT has consistently created an excess of wetland area for mitigation projects which has boosted replacement ratios for the entire state (Porej 2003). Park Meadow Landfill was a project that was visited by Porej (2003) but was re-visited during the 2004 field season. Porej (2003) only delineated wetland area that had formed around the small retention pond created for mitigation. However, the §401 certifications only required the applicant to create a certain amount of retention pond with a wetland fringe present. As a result, the entire area of the retention basin was delineated and used for the calculation of mitigation compliance. It was noted that the wetland fringe area around the retention basin had increased considerably since visited by Porej (2003).

4.2 Comparisons with Porej (2003) data

The data provided within this report is best considered when combined with the data from Porej (2003) as in the summary section above. This is due to the fact that the projects selected for the two studies overlap both in time of permit issuance and in time of mitigation wetland construction. The number of projects studied for this report is also substantially smaller than the amount visited by Porej (2003) and so comparison between studies is cautioned against. As shown by the data, however, there are obvious differences between the two studies which can be at least be partially attributed to the fact that the majority of projects within this report are more recent than those in Porej (2003). As the science of wetland creation/restoration as well as policy has improved, we would hope to see an improvement in mitigation compliance. The projects within this report displayed higher replacement ratios for Scenario 1 and Scenario 2 than in Porej (2003) (2:1 vs 1.16:1 and 1.77:1 vs 1.08:1, respectively). Replacement wetlands visited in 2004 were favored by high vegetation (>40%) and low vegetation (10-40%) categories whereas those within Porej (2003) were nearly evenly distributed between all three categories. Shallow littoral zones were present more often in 2004 sites (82% vs 57%) and predatory fish were present less often (29% vs 52%). Although there was a change in the two dominant land uses surrounding replacement wetlands, the change was from forest and row crop dominance to forest and urban land dominance. This indicates that although within ecosystem characteristics

may have improved, the consideration of surrounding land uses has not. The characteristics of the landscape surrounding mitigation sites can be important for the maintenance of landscape connectivity (Amezaga et al. 2002), species recruitment (Kelly 2001), and the degree of human benefit from mitigation (Mitsch & Gosselink 2000). The surrounding land uses of mitigation wetlands are being further investigated for a subset of the projects included here (Kettlewell unpublished).

Both studies have shown that the majority of replacement wetlands are constructed as emergent marshes. The tendency for mitigation wetlands to be dominated by emergent and open water habitat has been reinforced in other studies of wetland mitigation (e.g. Brown & Veneman 2001, Cole & Shafer 2002, Gwin et al. 1999). Criteria for wetland establishment are based upon those provided by the Army Corps of Engineers Wetland Delineation Manual. In order to be considered jurisdictional wetland, an area must have adequate hydrology, hydric soil characteristics, and hydrophytic vegetation cover (USACE 1987). As alluded to in Porej (2003), it is easy to understand that the best way to achieve all three criteria is by creating a deep wetland with steep slopes. This generally ensures that there will be permanent standing water, a narrow fringe of emergent vegetation, and the development of hydric soil. This type of wetland dominated both studies although there was an increase in vegetation cover for 2004 projects. Improved quantitative wetland mitigation monitoring and performance standards and applicant education could help improve the diversity of wetlands constructed for mitigation. Looking at all projects that have been assessed, it is more common for an applicant to construct a wetland that falls short of required acreage than to construct a wetland that equals or exceeds requirements (Figure 7). Geauga Lake Amusement Park has succeeded in constructing many small vernal pools that are unlike most mitigation wetlands. As a result, some of the data within this report is skewed significantly by one project. Porej (2003) has provided additional discussion regarding the potential effects of mitigation wetland habitat characteristics, regulatory issues, and economic considerations.

4.3 Regulatory issues

4.3.1 Difficulty in assessing compliance

As stated earlier within this report and within Porej (2003), there are several factors that have hindered Ohio EPA's ability to monitor mitigation efforts and enforce regulations. Mitigation monitoring reports, although required for §401 certifications and §404 permits, are not always submitted. These reports are a necessary and important component of evaluating mitigation projects. Porej (2003) has pointed out the lack of permit follow-up in general and suggested the devotion of a full-time employee for mitigation monitoring and enforcement. This suggestion is re-enforced here and Ohio EPA has recently applied for grant monies that would fund such a position. Additionally, there has been even less follow-up with wetland mitigation efforts aimed at enhancing, preserving, and avoiding wetlands. Although the focus has been appropriately applied to creation and restoration of wetland habitat, enhancement credit is often awarded to permit applicants without much, if any follow up. Wetland preservation and/or avoidance requirements are also often included within §401 certifications and §404 permit conditions. The locations of these wetlands are most often stored away within a hard-copy file and seldom re-visited. Improved GIS resources and technology would allow permit coordinators

to have immediate visual access to the location of preserved and avoided wetlands, eliminating the possibility of allowing impacts to these areas which are often protected by preservation easements or trusts.

The presence of pre-existing wetlands on mitigation project sites has also created problems in assessing compliance. Pre-construction wetland delineations should always be required when a mitigation project is being considered. These delineations could also be incorporated into a GIS in order to aid in the subtraction of existing wetland area and also for wetland protection. Applicants should be well informed of jurisdictional wetland definitions and warned about the possibility of deep, open-water habitat being excluded from mitigation area. With increased knowledge of wetland restoration science, the presence of existing forest within and along mitigation areas is becoming more common. This creates a problem because often our current GPS equipment cannot reliably collect data points in these areas. New GPS technology consisting of a remote handheld unit and a stationary base unit would aid in the collection of GPS data in such situations.

5. Acknowledgements

I wish to thank Mick Micacchion and John Mack (The Ohio Environmental Protection Agency) for their guidance, support, and the opportunity to participate in this project. I also owe many thanks to Laura Fay for her administrative contributions, project knowledge, and willingness to help in all aspects of the project. I thank Randy Bournique, Jeff Boyles, Pete Clingan, Art Coleman, Brian Gara, Dan Osterfeld, Mike Smith, and Dave White (Ohio EPA) for their many and varied contributions. Kyle Snowdon was extremely beneficial to this project with his assistance in field and office work. My advisor, Dr. Virginie Bouchard provided endless support. Deni Porej has provided me with much opportunity, support, and friendship throughout the duration of this project. Finally, I wish to thank all of the permit applicants, environmental consultants, natural resource managers, and others involved in mitigation projects that were so willing to provide assistance.

6. References

Adams, M.J. 1999. Correlated factors in amphibian decline: exotic species and habitat change in western Washington. Journal of Wildlife Management 63:1162-1171.

Amezaga, J.M., L. Santamaria, and A.J. Green. 2002. Biotic wetland connectivity—supporting a new approach for wetland policy. Acta Oecologica 23:213-222.

Brown, S.C., and P.L.M. Veneman. 2001. Effectiveness of compensatory wetland mitigation in Massachusetts, USA. Wetlands 21:508-518.

Cole, C.A., and D. Shafer. 2002. Section 404 wetland mitigation and permit success criteria in Pennsylvania, USA, 1986-1999. Environmental Management 30:508-515.

Fennessy, S. 1997. A functional assessment of mitigation wetlands in Ohio: strategies and tools for conservation. Environmental Law Institute, Washington, D.C.

Gallihugh, J.L. 1998. Wetland mitigation and 404 permit compliance study (Volume I). Final Report, U.S Fish and Wildlife Service, Chicago Field Office, Barrington, IL.

Gwin, S.E., M.E. Kentula, and P.W. Shaffer. 1999. Evaluating the effects of wetland regulation through hydrogeomorphic classification and landscape profiles. Wetlands 19:477-489.

Hecnar, S.J., and R.T. M'Closkey. 1997. The effects of predatory fish on amphibian species richness and distribution. Biological Conservation 79:123-131.

Kelly, N.M. 2001. Changes to the landscape pattern of coastal North Carolina wetlands under the Clean Water Act, 1984-1992. Landscape Ecology 16:3-16.

Kettlewell, C.I. *Unpublished Data*. Master's thesis (in progress). The Ohio State University, Columbus, OH.

Mitsch, W.J., and J.G. Gosselink. 2000. The value of wetlands: importance of scale and landscape setting. Ecological Economics 35:25-33.

Porej, D. 2003. An inventory of Ohio wetland compensatory mitigation. Ohio Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, Final Report to U.S. EPA Grant No. CD97576201-0, Columbus, OH.

Smith, G.R., J.E. Rettig, G.G. Mittelbach, L.J. Valiulis, and S.R. Schaack. 1999. The effects of fish on assemblages of amphibians in ponds: a field experiment. Freshwater Biology 41:829-837.

U.S. Army Corps of Engineers. 1987. Corps of engineers wetlands delineation manual. U.S. Army Corps of Engineers, Waterways Experiment Station, Technical Report Y-87-1, Vicksburg, MS.

7. Additional Figures

Figure 1. An example of a mitigation wetland with extensive deep open-water habitat.

Figure 2. Geauga Lakes Amusement Park forested vernal pool.

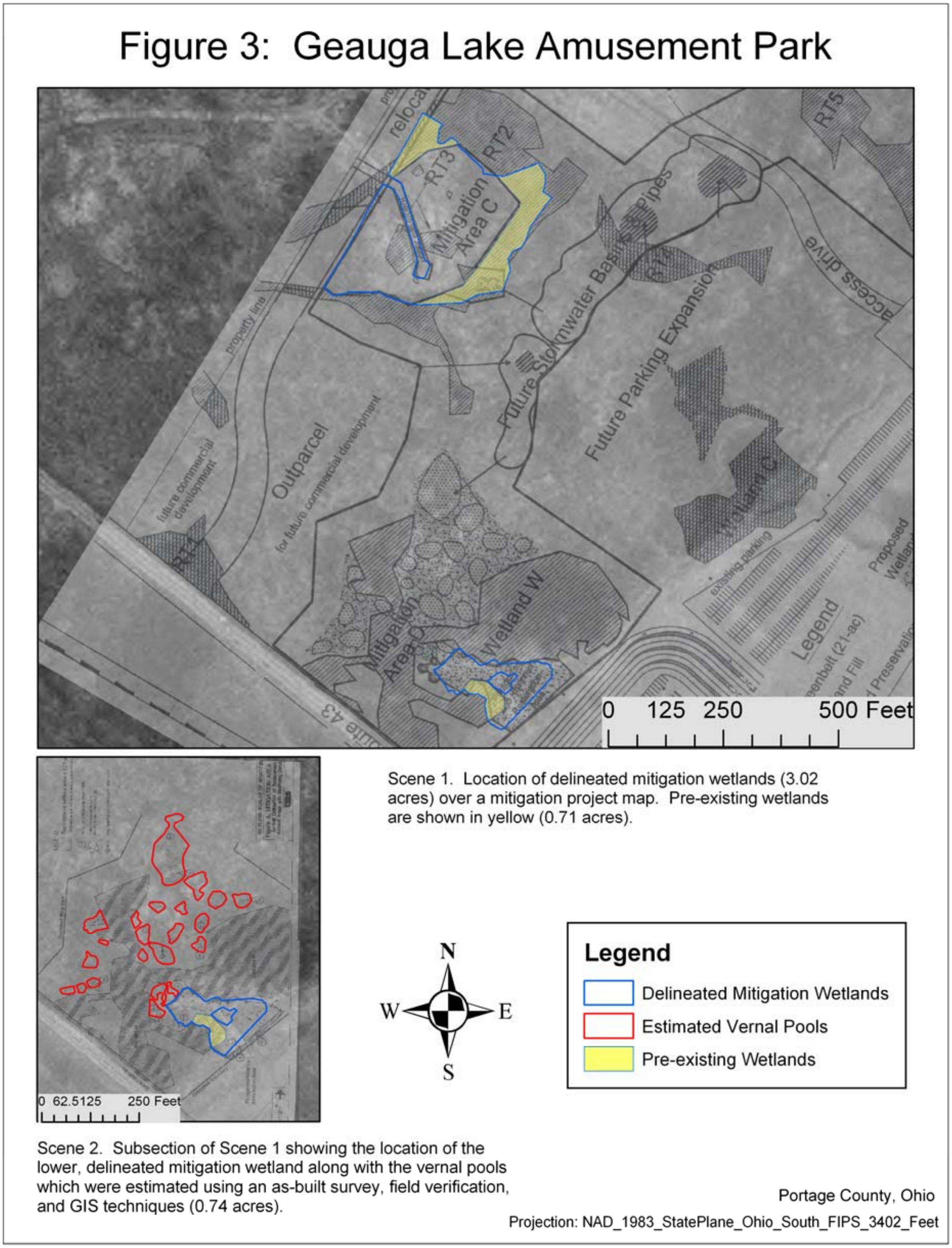

Figure 3. Geauga Lake Amusement Park Mitigation Map

Figure 10. Upper Sandusky Reservoir fringe wetland.

Figure 11. Four Seasons of Brecksville.

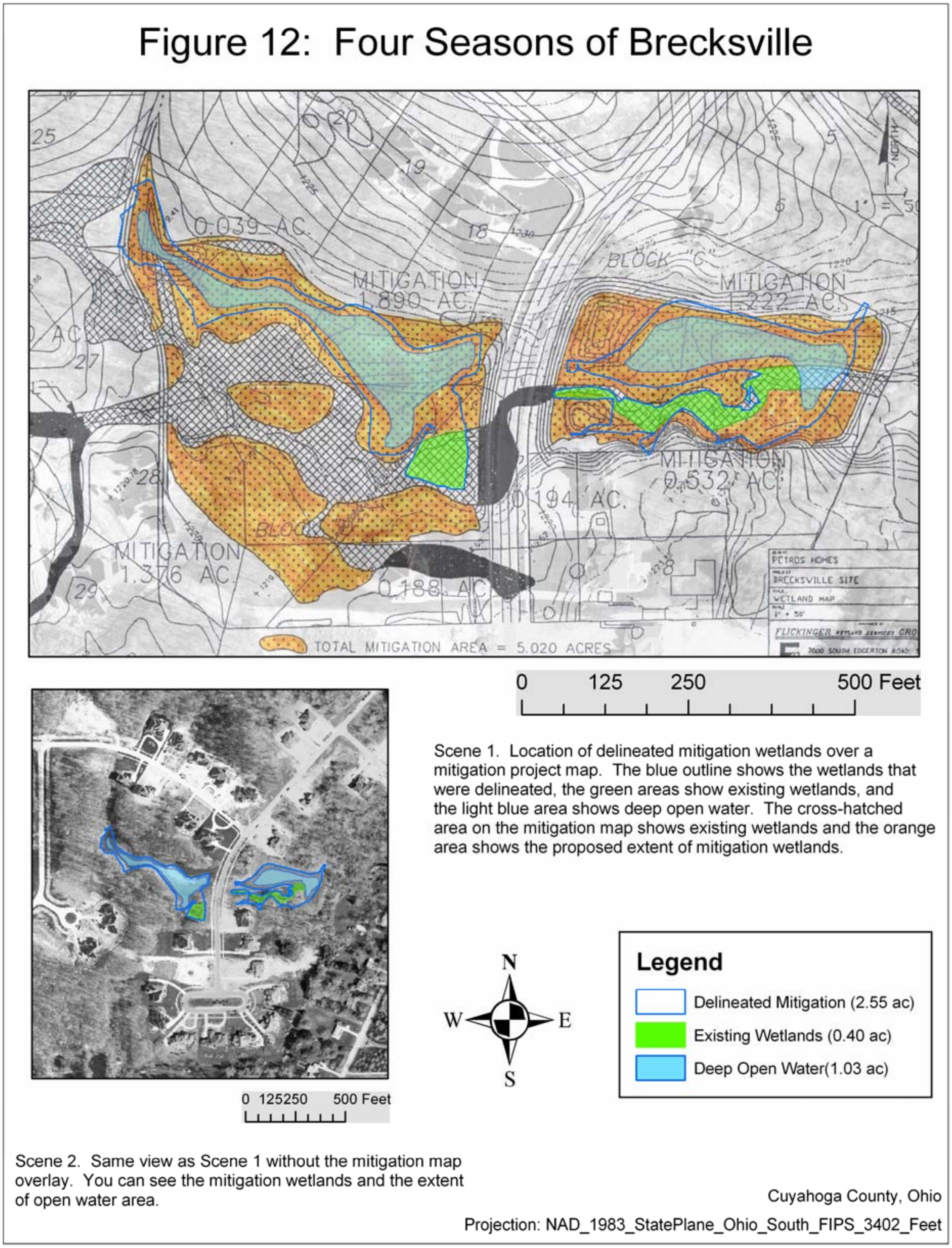

Figure 12. Four Seasons of Brecksville Mitigation Map