# AN EVALUATION OF WETLAND COMPENSATORY MITIGATION IN THE NEW YORK GREAT LAKES BASIN

by

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**ABSTRACT**

An ongoing priority for EPA's Wetlands Program is to determine the effectiveness of compensatory mitigation at offsetting impacts to wetlands and meeting the goal of 'no net loss' of wetland functions. The Army Corps of Engineers is also tasked to ensure that required compensatory mitigation actions are being taken for impacts to waters of the United States under the Clean Water Act-Section 404 permit program. The purpose of this study was to provide information about the success of compensatory creation and restoration mitigation efforts for permitted impacts in the New York Great Lakes region of the Buffalo Corps District. A review of the District's records was performed in order to identify where Section 404 wetland impacts have been occurring and to examine the extent to which wetland mitigation sites have been successful in terms of acreage achieved, established plant community type, and invasive species colonization. In addition, percent cover of invasive species at mitigation sites was examined against landscape setting to see whether this was related to success. A number of recommendations were made concerning possible improvements to permitting, data management, and mitigation project monitoring and reporting. At the onset of this study, data retrieval proved to be difficult because project files were often incomplete. At mitigation sites, a disproportionate amount of emergent and emergent/open water systems were proposed to replace scrub-shrub and forested communities. Thus, functional replacement may be unlikely in those cases. Percent cover of invasive species increased with urbanization, possibly reflecting effects of disturbance on fostering invasive plant species colonization. Success in obtaining no net wetland loss is reliant upon the ability to issue permits with conditions that ensure that functions are properly replaced, and also on continued follow up compliance monitoring of these mitigation projects.

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**List of Abbreviations**

| | |
|---|---|
| CWA | Clean Water Act |
| EPA | Environmental Protection Agency |
| GIS | Geographic Information Systems |
| GAO | Government Accountability Office |
| HUC | Hydrologic Unit Code |
| IP | Individual permit |
| MOA | Memorandum of Agreement |
| NHD | National Hydrography Dataset |
| NLCD | National Land Cover Dataset |
| NRC | National Research Council |
| NWI | National Wetlands Inventory |
| NWP | Nationwide permit |
| EM | Emergent |
| FO | Forested |
| OW | Open water |
| SS | Scrub-shrub |

# INTRODUCTION

Wetlands are valuable because of the various functions they can provide, including flood mitigation; water-quality improvement; groundwater recharge; nutrient removal and transformation; fish and shellfish breeding, nursery and habitat; and wildlife habitat. However, these functions are often lost with the alteration or destruction of the nation's wetlands (Mitsch and Gosselink 2000).

## Wetland Policy and Regulations

Section 404 of the 1972 Clean Water Act (CWA) requires authorization for dredging or filling of "waters of the United States," which are defined by the Army Corps of Engineers (hereafter "Corps") and the US Environmental Protection Agency (EPA) at 33 CFR §320. This includes most wetlands. The Corps, which administers the Section 404 permit program, is tasked to ensure that required compensatory mitigation actions are being taken for impacts to US waters. Under §404 regulations, compensatory mitigation may be required if wetland functions in the watershed are compromised. The concept of "no net loss," first presented in the 1988 National Wetland Policy Forum report (The Conservation Foundation 1988) and associated with the G.H.W. Bush administration, supported objectives set forth in the CWA. Following this, a national effort was launched to mitigate for wetland losses.

Subsequently, several guidance documents were released, reinforcing the federal government's commitment to protect wetlands, including a 1990 memorandum of agreement (MOA) between the US EPA and Corps (US EPA and US Army 1990), and a Corps-issued Regulatory Guidance Letter 02-2 (US ACE 2002). These documents restated the need to first avoid, and then minimize wetland impact prior to considering compensatory actions, and stated an objective of providing at a minimum one-to-one replacement for an impacted wetland, emphasizing replacement of wetland function over solely acreage totals. Furthermore, the guidance documents advised for on-site (areas adjacent or connected to the discharge site) and in-kind (replacement of a wetland area of the same physical and functional type) mitigation unless this was either not practical or would not provide greater ecological benefit.

**Historical Wetland Loss**

It was estimated that at the time of European settlement, the conterminous United States contained 221 million acres of wetlands (Dahl 1990). Over time, these wetlands have been drained, dredged, and filled. The U.S. Fish and Wildlife Service's *Status and Trends of Wetlands in the Conterminous United States: 1986-1997*, estimated that only 105.5 million acres of wetlands remained, representing a 52% loss by area. Despite the "no net loss" policy, between 1986 and 1997 the national annual loss rate was 58,500 acres (Dahl 2000). The most recent wetland status and trends report published in 2006 reported a net gain of 191,750 wetland acres nationwide between 1998 and 2004, an average annual net gain of 32,000 acres during this time. Ponds were included as freshwater wetlands in the study under the claim that this was consistent with the Cowardin *et al*. definition of 'open water' (Dahl 2006). However, the *1987 Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) does not consider non-vegetated open water to be wetlands as it does not fulfill all of the necessary criteria required of wetlands. Without the increased pond acreage of almost 700,000 acres, wetland gains would not have surpassed wetland losses during the period of the study (Dahl 2006).

For New York, wetland loss was estimated to be approximately 60%, or over 1.5 million acres between the 1780's and mid 1980's (Dahl 1990) and can be assumed to be greater given the nation's continued loss of wetlands after 1986.

**Wetland Habitat Types**

Cowardin and others (1979) characterized the various palustrine classes: forested (FO), scrub-shrub (SS), emergent (EM) and open water (OW), to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie found throughout the United States.

Forested wetlands, also known as swamps, hammocks, heads, and bottoms, are characterized by woody vegetation that is at least 6 meters tall. They are often described by the dominant tree species in that area (e.g. cypress swamps, black spruce bogs) (Cowardin et al. 1979). Forested wetlands can provide wildlife habitat for small mammals, deer, hawks, and owls. Canopy cover provides shelter and shading, which also affect the hydrologic cycle of the wetland.

Scrub-shrub wetlands are dominated by woody vegetation less than 6 meters tall, which can include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions (Cowardin et al. 1979). Scrub-shrub wetlands include shrub swamps, bogs, and pocosins and are used by a variety of avian fauna as nesting sites.

Emergent wetlands are characterized by herbaceous hydrophytes present for most of the growing season in most years. Common plants found in this habitat include cattails, bulrushes, sawgrass and other sedges, and true grasses. Emergent wetlands include freshwater marshes, wet prairies, sloughs, the shallow vegetated zones along rivers and lakes, prairie potholes, bogs, and fens (Cowardin et al. 1979). They can provide nesting and wading zones for waterfowl, feeding areas for migrating birds, and wildlife habitat for small mammals.

Open water, or aquatic bed habitat, is dominated by plants that grow mainly on or below the surface of the water for most of the growing season (Cowardin et al. 1979). Open water provides spawning areas and nursery for fish and shellfish.

Not all wetlands perform the same functions, even within the same wetland habitat type grouping. However, the more complex wetland types (e.g. SS and FO) are generally valued more for wildlife habitat and water quality improvement functions.

## Previous Studies

### *2001 NRC Report*

In June 2001, the National Academy of Sciences' National Research Council (NRC) issued a report on the effectiveness of wetland compensatory mitigation in the Corps' Regulatory

Program titled, "*Compensating for Wetland Losses under the Clean Water Act.*" (NRC 2001) This study yielded the following five conclusions:

1. The goal of 'no net loss' of wetlands could not be confirmed due to shortcomings of Corps data management, inadequate tracking of wetland functions, and projects out of compliance with permit requirements.
2. Permit decision-making would be improved by using a watershed approach, which would consider wetland needs in the watershed and consider surrounding landscape in mitigation site selection.
3. Section 404 permit compliance was often not being attained because of unclear performance expectations, inadequate compensation actions, and/or lack of long-term management.
4. There was not enough support/assistance for regulatory decision makers.
5. Third-party mitigation has its advantages and should be considered where appropriate.

The NRC report was thus significant in bringing attention to the weaknesses of the compensatory mitigation process and calling for an improvement in the CWA §404 program.

*Other studies in the Northeastern United States*

Other recent studies have evaluated the success of compensatory mitigation for Massachusetts (Brown and Veneman 2001), New Jersey (NJDEP 2002), Pennsylvania (Cole and Shafer 2002), and the overall New England region (Minkin and Ladd 2003) and support the NRC's conclusions of weaknesses in the Corps' Regulatory Program. All four of these region-specific studies noted a shift from the vegetation of natural wetlands dominated by woody species, especially forested wetlands, to emergent/open water or wet meadow systems. These changes probably led to net losses of vegetated wetlands and inadequate functional replacement. Net loss in wetland acreage ranged from 0.10 acres (New England) to 0.34 acres (Massachusetts) lost per acre of impact. Only the Pennsylvania study showed an apparent gain in wetland acreage. However, the authors relied solely on reported data in the permit files for mitigated acreage values, and cautioned that some gains may have been overstated. Common problems found by the studies included inadequate data management by the Corps, especially for older projects, mitigation wetlands that were never built, and constructed wetlands that did not have adequate hydrology or wetland plant coverage. The studies' independent yet comparable findings reveal problems with compensatory mitigation that transcend geographic boundaries.

A 2004 EPA-funded study (Taylor 2004) examined wetland habitat restoration strategies for specific sites in the New York portion of the Lake Ontario watershed, identified common mistakes in their creation/restoration, and made recommendations for improved success. Recommendations by Taylor (2004) included education of site managers on invasive species management, attention to microtopography and the effects of changes in topography on creation/restoration success, and increased monitoring and enforcement by regulatory agencies to decrease instances of permit non-compliance.

*2005 Government Accountability Office Report*

Tracking mitigation has historically been a "below the line" activity, meaning that it is not a top priority for the Corps (NRC 2001). In September 2005, the United States Government Accountability Office (GAO) published a study which reviewed §404 permits of seven Corps districts and found that they performed only limited oversight of compensatory mitigation, consistent with conclusions 1 and 3 of the 2001 NRC report described above. "Little evidence" was found that required monitoring reports were being submitted or that the Corps was consistently conducting compliance inspections. Instead, the Corps largely relied on the good faith of permittees to comply with permit conditions. Furthermore, guidance from the Corps was found to be "vague and inconsistent" with regard to the definitions of important terms, mitigation expectations, and consequences of non-compliance, which ultimately limited their own oversight abilities (GAO 2005).

**Purpose of Study**

An ongoing priority for EPA's Wetlands Program is to examine whether impacts to wetlands are being offset and the goal of 'no net loss' of wetland functions is being met.

However, in order to make changes in the Corps' Regulatory Program, there needs to be an evaluation of compensatory mitigation effectiveness. In the New York Great Lakes Basin, little information is known about the success of its mitigation projects as neither the NRC nor GAO study examined mitigation in this particular region. **The purpose of this study is to provide necessary information about compensatory mitigation (i.e., creation and restoration) for permitted impacts in the New York Great Lakes region.**

Through a partnership between Region II of the US EPA and the Army Corps of Engineers' Buffalo District, a review of the District's records for §404 permits issued between 1995 and 2005 was performed in order to identify the locations of wetland impacts and to examine the extent to which wetland mitigation has been successful in terms of acreage achieved, plant community type established, and sustainability of wetland communities based on invasive species colonization, as well as the Corps' role in supporting these objectives. In addition, invasive species colonization was examined against urban and agricultural land use to see whether these were related.

## DESCRIPTION OF STUDY AREA

The Corps districts of Buffalo and New York City have jurisdiction under §404 of the CWA over non-isolated New York wetlands. The Buffalo District's jurisdiction covers an area of approximately 98,000 $km^2$ south of the Great Lakes and extends from Toledo, Ohio to Massena, New York, thus encompassing the U.S. drainage basins for Lake Erie, Lake Ontario, and the St. Lawrence River. Within New York State, these drainage basins comprise 21 sub-basins totaling approximately 53,000 $km^2$ and extending into at least parts of 33 counties (Figure 1). Land cover for this region is approximately 3% open water, 3% urban, 35% agricultural, and 58% forested (NLCD 1992). Major urban areas in or bordering on the basins include the cities of Buffalo, Rochester, Syracuse, Ithaca, Utica-Rome and Elmira.


**Figure 1**. Map of the Lake Erie, Lake Ontario, and Saint Lawrence River watersheds within New York, including major urban areas in the region.

## METHODS

### Data Collection

A sample of nationwide, general, and individual permits issued by the Corps between 1995 and 2005 was selected based on file availability and supplemented with randomly-selected permits, each of which required some form of on-the-ground mitigation activity. Only permits involving the creation or restoration of wetlands were considered for analysis; mitigation projects dealing solely with enhancement or preservation were not included the study. Impacts that fell within Buffalo District jurisdiction, but outside of the study area were excluded, as were files missing significant information. Although roughly equal numbers of sites per permit year class were initially selected, data limitations led to a final sample of 83 project files. The distribution of these projects by year is shown in Table 1.

**Table 1**. Distribution of sampled project files by year

| *Permit Year* | *1995* | *1996* | *1997* | *1998* | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Count* | 1 | 6 | 10 | 10 | 4 | 6 | 7 | 7 | 16 | 13 | 3 |

For each of these sampled files, reviews of the District's regulatory files and microfilm records were performed. Follow-up questioning of Corps personnel and consultants was conducted to fill-in data gaps. Data were compiled into a database using information from Corps-issued permits, environmental assessments, wetland delineations, mitigation plans, consultants' monitoring reports, and Corps compliance inspection reports. Collected data included:

- Permit date of issuance
- Corps permit number
- Location of impact (i.e., geographic coordinates, county)
- Permit type (general, individual permit, or nationwide)
- 8-digit Hydrologic Unit Code (HUC)

- NWI wetland type impacted (emergent/scrub-shrub/forested/open-water)
- Acreage of wetland filled by wetland type
- Location of mitigation site: whether mitigation occurred on-site or off-site, geographic coordinates if off-site
- Type of mitigation permitted (i.e., creation or restoration)
- NWI wetland type proposed as mitigation (emergent/scrub-shrub/forested/open-water)
- Amount, in acres, of NWI wetland type proposed as mitigation
- Amount, in acres, of NWI wetland type actually completed
- Actual monitored parameters, if applicable
- Corrective measures needed, if any, for completed projects
- Length of post- construction monitoring required
- Performance standards required for success
- Presence/absence of invasive plant species, including percent cover estimates

**Data Analysis**

Locations of sampled impacts within the New York Great Lakes basin by county, sub-basin, and in proximity to urban areas were examined using tools in ArcGIS 9.1 (ESRI, Redlands, CA, USA). For impacts with coordinates that were difficult to obtain, sites were manually located using USGS quad maps included in permit application packages on file in conjunction with the web-based mapping service, TopoZone (www.TopoZone.com).

Impacted and proposed mitigation wetlands were compared according to NWI habitat type and acreage. For constructed and monitored projects, as-built information was also compared with proposed specifications. The accuracy of these data relied upon documents assembled by the Corps, permittees, and consultants.

*Land cover assessment*

Using ArcGIS 9.1, a land cover assessment was performed on the landscape surrounding completed and monitored mitigation projects. Land cover was defined according to the most recent available National Land Cover Dataset (NLCD) GIS layer (U.S. Geological Survey 1992). Forested land cover was used to represent a reference standard or “natural” condition while agriculture and urban areas represented departures from this condition. Urban land cover consisted of low-intensity residential, high-intensity residential, and commercial/industrial areas;

agricultural land cover consisted of pasture/hay, row crops, and other grasses; and forested/natural land cover consisted of evergreen, deciduous, and mixed forests, woody and emergent wetlands, and open water. Natural, agricultural, and urban land cover percentages were calculated within a 1-km radius at each project site for which data was available (Figure 2).

Percent cover of invasive and nuisance species was extracted from monitoring reports and then averaged for mitigation sites with the available information. Invasive/nuisance species coverage values were plotted against the ratios of urban:natural and agricultural:natural land cover at each mitigation site.

## RESULTS AND DISCUSSION

### Sampled Impacts

Difficulties in obtaining complete information for impact sites and their corresponding mitigation were encountered early in this study. Recent efforts taken by the Buffalo District to track mitigation has improved data reporting and accessibility as all permits issued after 2002 are currently required to be entered into a database for tracking mitigation. However, many of the older projects were missing mitigation plans or monitoring reports. Because the assessment of mitigation was not a priority for the Corps, some of these older projects were never tracked. **If the Corps intends to track mitigation, it is recommended that files be complete and organized so that data are easily accessible and wetlands that adequately replace lost functions can be proposed and created.**

The size of wetland fill for the 83 §404 case studies ranged from 0.02 to 7.59 acres with a mean of 1.35 acres impacted, while corresponding proposed mitigation projects ranged from 0.06 to 22.14 acres with a mean of 2.73 acres. A total of 227.12 acres was proposed as mitigation for 112.23 acres of filled wetlands, a proposed compensation ratio of 2:1. However, information on how many acres of wetlands were actually constructed is unknown for many of these projects.

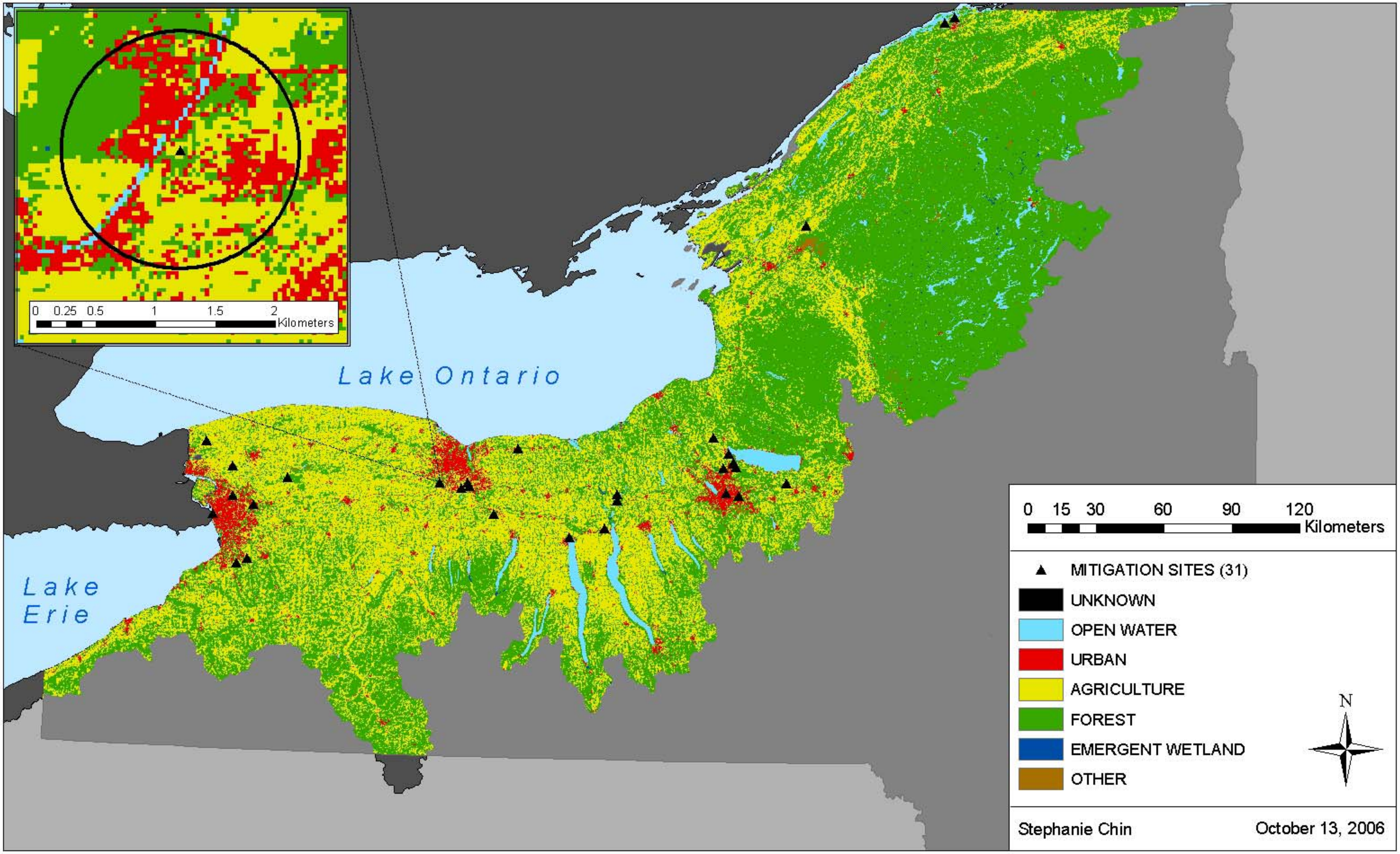


**Figure 2**. Determination of surrounding land cover for mitigation sites using GIS. Land cover percentages were calculated using a 1-km radius circle surrounding the mitigation site.

*Location of Impacts by Hydrologic Unit Code Boundaries*

Approximately 78% of the region's sampled impacts occurred in the Lake Ontario basin, 14% in the Lake Erie basin, and 7% in the St. Lawrence River basin. When the distribution of impacts is broken down by sub-basin, or 8-digit HUC boundaries (Table 2, Figure 3), the highest proportion of impacts based on incidence occurs in the Niagara sub-basin followed by the Oneida, Seneca, and the Buffalo-Eighteenmile sub-basins. The Niagara and Buffalo-Eighteenmile sub-basins encompass the city of Buffalo-Niagara Falls while the Oneida and Seneca sub-basins are part of the Finger Lakes region of New York.

**Table 2**. Distribution of sampled wetland impacts by sub-basin

| *8-Digit HUC* | *Sub-basin* | *Basin* | *Number of Impacts* | *Percent of Total Impacts* |
|---|---|---|---|---|
| 04120104 | Niagara | Ontario | 18 | 21.69 |
| 04140202 | Oneida | Ontario | 14 | 16.87 |
| 04140201 | Seneca | Ontario | 13 | 15.66 |
| 04120103 | Buffalo-Eighteenmile | Erie | 11 | 13.25 |
| 04140101 | Irondequoit-Ninemile | Ontario | 7 | 8.43 |
| 04130003 | Lower Genesee | Ontario | 6 | 7.23 |
| 04130001 | Oak Orchard-Twelvemile | Ontario | 3 | 3.61 |
| 04140102 | Salmon-Sandy | Ontario | 2 | 2.41 |
| 04150301 | Upper St. Lawrence | St. Lawrence | 2 | 2.41 |
| 04150303 | Indian | St. Lawrence | 2 | 2.41 |
| 04120102 | Cattaraugus | Erie | 1 | 1.20 |
| 04140203 | Oswego | Ontario | 1 | 1.20 |
| 04150102 | Chaumont-Perch | Ontario | 1 | 1.20 |
| 04150302 | Oswegatchie | St. Lawrence | 1 | 1.20 |
| 04150306 | St. Regis | St. Lawrence | 1 | 1.20 |
| 04120101 | Chautauqua-Conneaut | Erie | 0 | 0 |
| 04130002 | Upper Genesee | Ontario | 0 | 0 |
| 04150101 | Black | Ontario | 0 | 0 |
| 04150304 | Grass | St. Lawrence | 0 | 0 |
| 04150305 | Raquette | St. Lawrence | 0 | 0 |
| 04150307 | English-Salmon | St. Lawrence | 0 | 0 |
| Total | | | 83 | 100 |

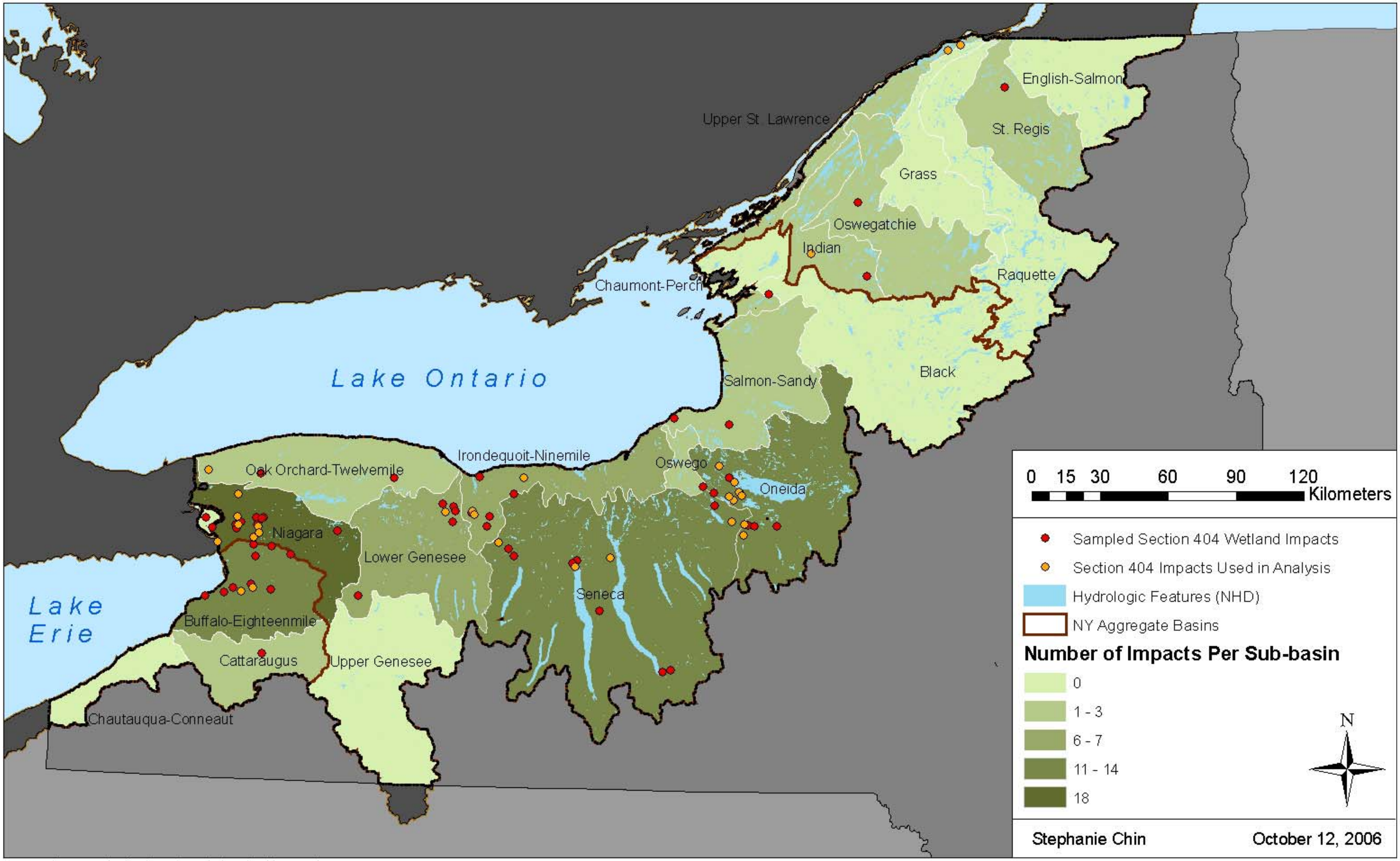


**Figure 3**. Distribution of sampled wetland impacts by sub-basin.

*Locations of Impacts by County*

One-third of the total sampled case studies were located in Erie County, and another third in Onondaga and Monroe Counties combined (Table 3, Figure 4). These three counties contain Buffalo, Syracuse, and Rochester, the three largest urban centers in the NY Great Lakes basin.

**Table 3**. County distribution of sampled Section 404 wetland impacts. Identification numbers are county federal information processing standards (FIPS) codes.

| *FIPS ID* | *County* | *Number of Impacts* | *Percent of Total Impacts* |
|---|---|---|---|
| 29 | Erie | 28 | 33.73 |
| 67 | Onondaga | 14 | 16.87 |
| 55 | Monroe | 11 | 13.25 |
| 69 | Ontario | 7 | 8.43 |
| 75 | Oswego | 4 | 4.82 |
| 89 | St. Lawrence | 4 | 4.82 |
| 63 | Niagara | 3 | 3.61 |
| 45 | Jefferson | 2 | 2.41 |
| 99 | Seneca | 2 | 2.41 |
| 109 | Tompkins | 2 | 2.41 |
| 117 | Wayne | 2 | 2.41 |
| 37 | Genesee | 1 | 1.20 |
| 49 | Lewis | 1 | 1.20 |
| 53 | Madison | 1 | 1.20 |
| 121 | Wyoming | 1 | 1.20 |
| 3 | Allegany | 0 | 0 |
| 9 | Cattaraugus | 0 | 0 |
| 11 | Cayuga | 0 | 0 |
| 13 | Chautauqua | 0 | 0 |
| 15 | Chemung | 0 | 0 |
| 19 | Clinton | 0 | 0 |
| 23 | Cortland | 0 | 0 |
| 31 | Essex | 0 | 0 |
| 33 | Franklin | 0 | 0 |
| 41 | Hamilton | 0 | 0 |
| 43 | Herkimer | 0 | 0 |
| 51 | Livingston | 0 | 0 |
| 65 | Oneida | 0 | 0 |
| 73 | Orleans | 0 | 0 |
| 97 | Schuyler | 0 | 0 |
| 101 | Steuben | 0 | 0 |
| 107 | Tioga | 0 | 0 |
| 123 | Yates | 0 | 0 |
| Total | | 83 | 100 |

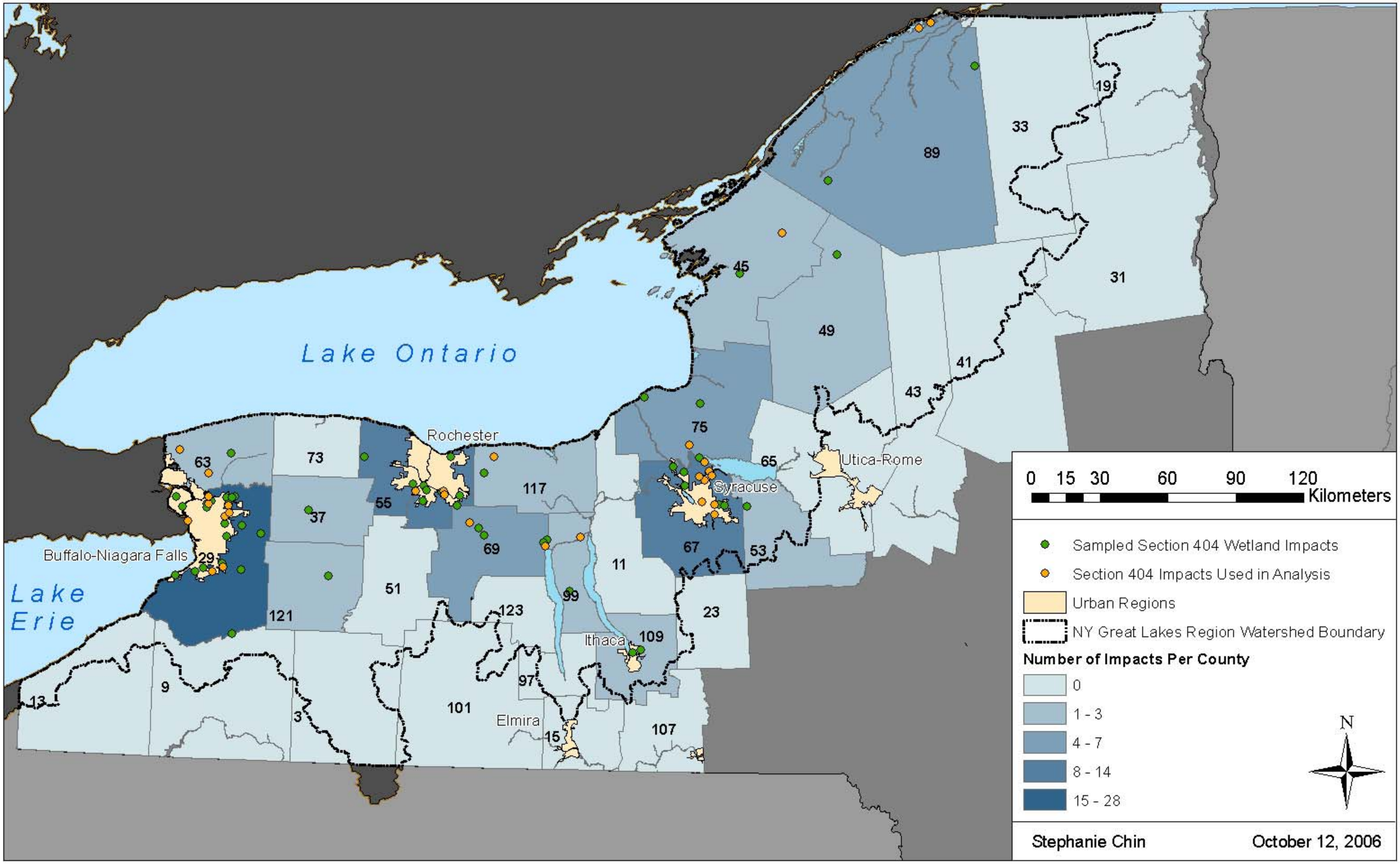


**Figure 4**. Distribution of sampled wetland impacts by county. Identification numbers are county federal information processing standards (FIPS) codes.

*Proximity of Impacts to Urban Areas*

About 71% (59/83) of the impacts from sampled cases were located within 10 km of one of the six major urban areas in the basin. When evaluated by year, 51% of the impacts permitted between 1995 and 2000 fell outside of an urban area compared to 61% of those permitted between 2001 and 2005. Impacts resulted mainly from residential, commercial, or road development. The locations of these impacts at the fringes of the urban areas (Figure 5) and their suggested 'outward' movement suggest impacts associated with suburban sprawl.

*On-site vs. off-site mitigation*

Approximately 77% of the mitigation projects for the sampled cases were done entirely on-site, 18% were done off-site, and 5% included both onsite and off-site components. The reason most commonly cited for off-site mitigation was lack of on-site space.

On-site mitigation can help to maintain the size and integrity of an affected wetland by directly linking the mitigation to the larger wetland ecosystem, thus providing a greater chance that lost functions are replaced. While on-site mitigation is generally suggested, off-site mitigation is acceptable under certain circumstances such as lack of space or site contamination. However, the benefits being provided by some wetland functions are site-dependent (i.e., flood control) and those mitigation projects constructed off-site would not be able to compensate for these functions (NYDEC 1993).

*Comparison of Impacted and Proposed Mitigation Acreage by Wetland Habitat Type*

Wetland habitat types (NWI) from sampled cases included emergent (EM), scrub-shrub (SS), forested (FO), and open water (OW). A review of permits and mitigation plans revealed that these were often not specified, or that mitigation which included more than one wetland type did not specify the proposed amount of each wetland type. **The Corps should make every effort possible to include this information to allow for better tracking of wetland habitat type replacement.**

Based on evaluations of permit impacts to wetland type, forested wetlands had the greatest impacted area (22.50 acres) followed by emergent wetlands (15.93 acres) and scrub-

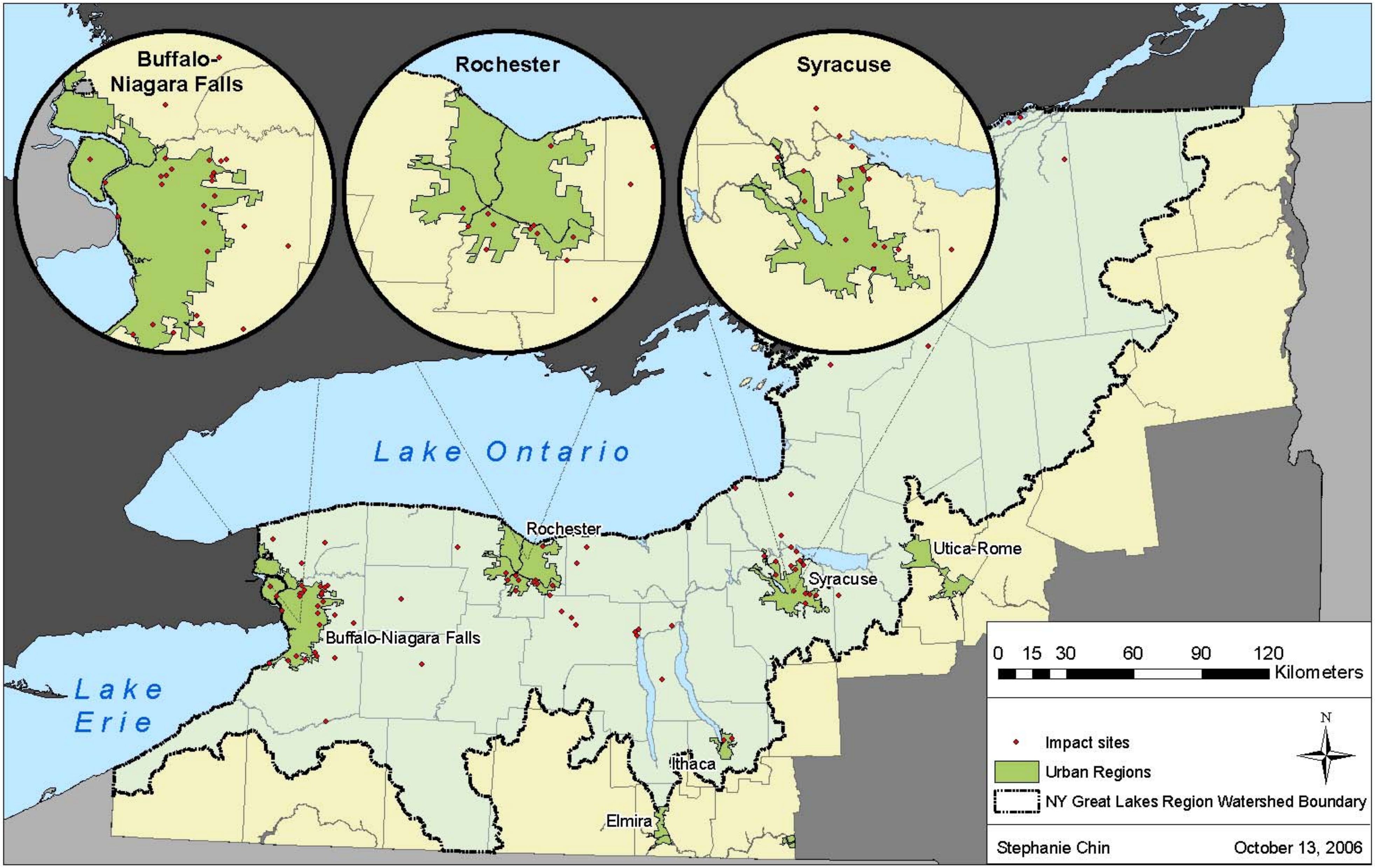


**Figure 5**. Locations of wetland impacts relative to urban areas. Section 404 permitted impacts tended to occur on the fringes of the urban regions

shrub wetlands (12.67 acres). However, emergent wetlands were most often proposed as compensatory mitigation (102 acres), followed by emergent/open water wetlands (44 acres). When combined, the emergent and open water types made up approximately 66% of the proposed mitigation acreage, compared to just 14% of the impacted acreage total, and proposed a net gain of 130 acres of these wetland types. The result was a proposed 12-acre net loss of forested wetlands. Despite the uncertainty associated with mixed and unknown wetland types, there appears to be a net gain in emergent and open water acreage and a loss of forested acreage for the Great Lakes region (Figure 6). However, even with adequate acreage compensation, functional replacement cannot be assumed.

*Comparison of Impacted and Proposed Mitigation Projects by Wetland Habitat Type*

A comparison of impacted vs. proposed-as-mitigation wetland types by project rather than acreage totals reveal a similar trend. Of the 83 sites studied, 40 scrub-shrub and 40 forested wetlands were impacted; however, only 28 scrub-shrub and 14 forested wetlands were proposed as mitigation. By comparison, 39 emergent wetlands were impacted with 71 proposed as mitigation, nearly doubling the incidence of emergent wetland habitat. Furthermore, although only three open water wetlands were impacted, 26 were proposed as mitigation (Figure 7). Thirty of the 63 created mitigation projects with known wetland types (47.6%) were the same wetland type as some portion of the impacted wetlands.

As a result of lack of data, the status of mitigation proposed for 24% of the projects was unknown. There was nearly an equal percentage (19-20%) of out-of-kind as in-kind mitigation (Figure 8). A little over one-third of the projects were partially in-kind mitigation; for example, if an emergent wetland was proposed to mitigate for an impacted emergent-scrub-shrub wetland.

There was a net loss of forested and scrub-shrub wetland habitat based on acreage and number of projects and a disproportionate use of emergent or open water habitat as compensation. Emergent and open water habitat was proposed more often than other wetland types because they are less costly and easier to construct. However, this occurred at the expense of creating forested and scrub-shrub habitat. This apparent shift from impacted wetlands dominated by the woody species of scrub-shrub and forested wetland plant communities to the more open mitigated communities with emergent and open water components is consistent with

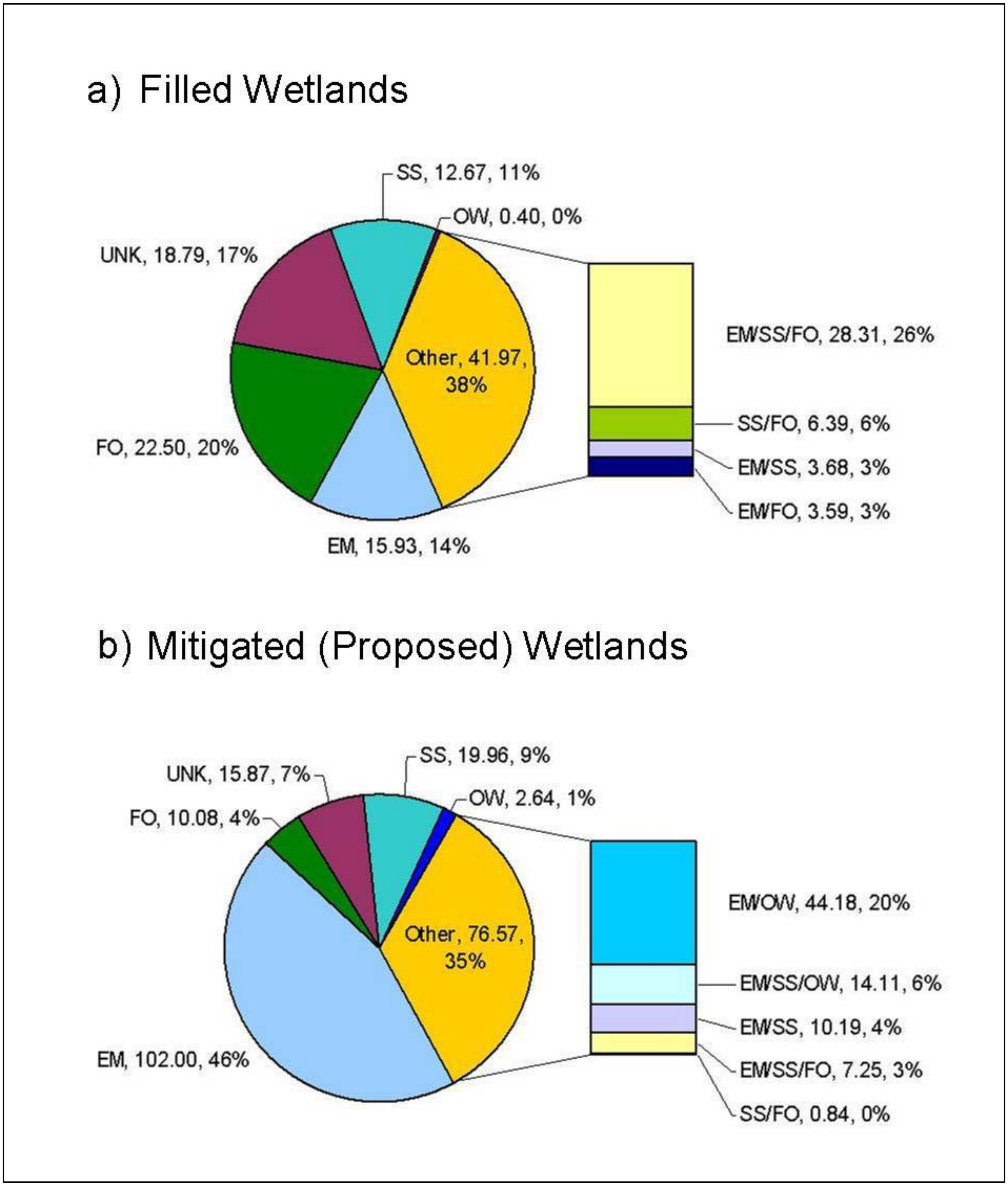


**Figure 6**. Breakdown of acreages by wetland habitat type for (a) wetlands filled and (b) proposed for mitigation indicating habitat type, acreage, and percentage of total area (n=83). FO=forested, SS=scrub shrub, EM=emergent, OW=open water, UNK=unknown]

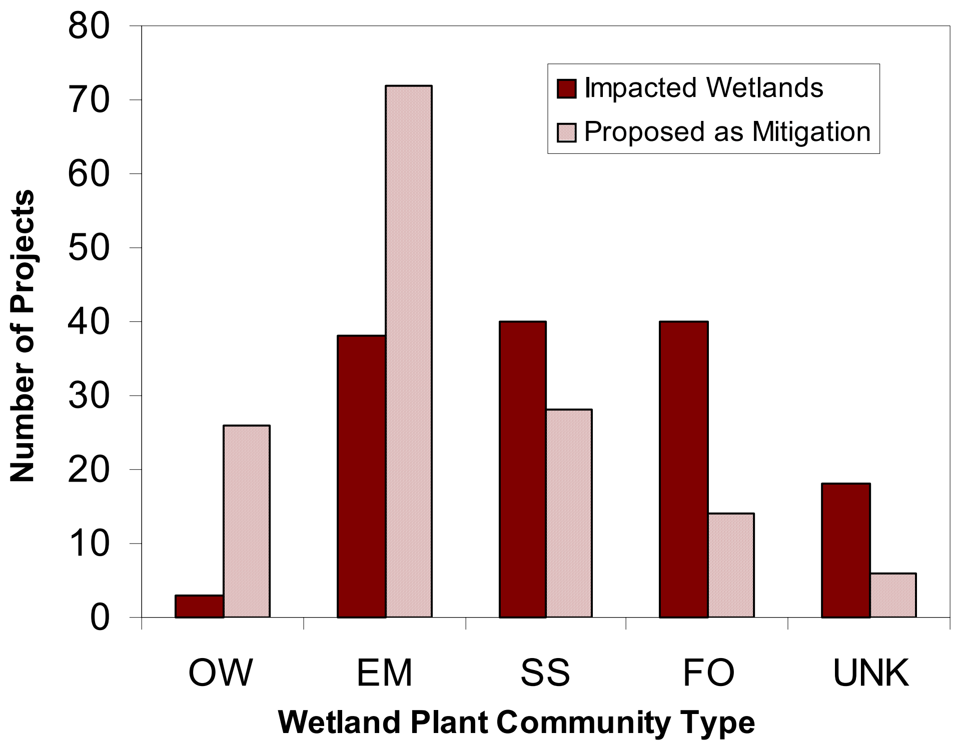


**Figure 7**. A comparison of wetland type impacted and wetland type proposed as mitigation by project (n=83). [FO=forested, SS=scrub shrub, EM=emergent, OW=open water, UNK=unknown]

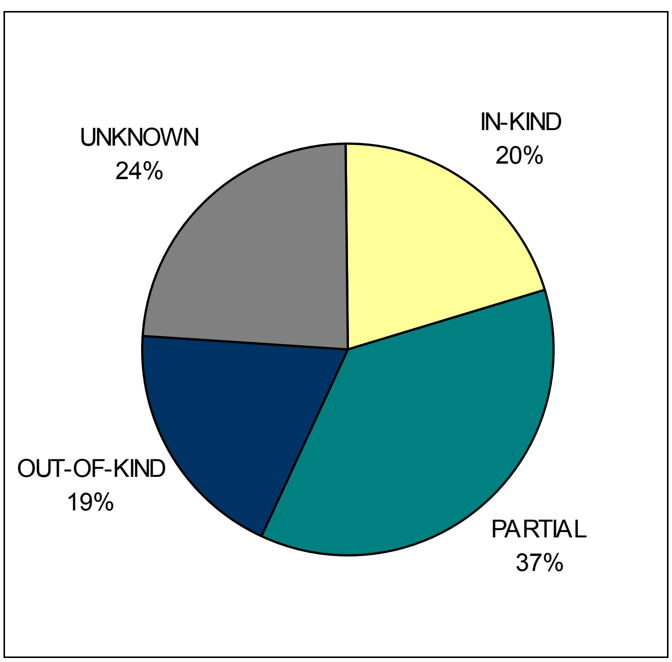


**Figure 8**. Proposed wetland mitigation type by project

trends observed in the Northeast (Brown and Veneman 2001, Cole and Shafer 2002, NJDEP 2002, Minkin and Ladd 2003) as well as nationwide (NRC 2001).

To ensure that this imbalance does not happen, **the Corps should more closely compare targeted to filled habitat type prior to permit issuance and stress in-kind mitigation when appropriate. Enforcement actions should be taken if the targeted wetland type differs from that which is achieved**. Under limited circumstances, out-of-kind replacement may be acceptable (i.e., replacement of a predominant wetland type with a more uncommon type to increase biological diversity). Nevertheless, **the reasons for choosing out-of-kind replacement should be documented as part of the permitting process** (NYDEC 1993).

*Project Success Criteria*

Success criteria for mitigation projects based on all available data were defined as presence and amount of herbaceous cover over time. The majority of the sampled permits required 80% areal cover of hydrophytic vegetation with no more than 50% of one species, or 85% areal cover of vegetation with FAC status or wetter to indicate vegetative success. However, even if these permit conditions are met, mitigation sites may not replace all lost wetland functions. The required monitoring period for this cover was generally for five years, with one consolidated mitigation project requiring a ten-year monitoring period.

## Monitored Mitigation Projects

Monitoring reports were readily available for at least one monitoring year for 31 mitigation sites, approximately one-third of the sampled files. These had permits ranging from 1995 to 2003. Permits are valid for five years; consequently, impacts for recently-issued permits may not have occurred or mitigation may not have been completed. For older cases, mitigation was often not tracked and monitoring reports were frequently not submitted. **Data management can be improved by better tracking of due dates for monitoring reports. Furthermore, proper enforcement by Corps personnel is needed to respond to those due dates.**

*Mitigation Acreage*

Of the 31 mitigation projects for which monitoring reports were submitted, one was a consolidated project that mitigated for three different permitted impacts. Two permitted impacts involved mitigation at more than one site. Thus, these 31 mitigation sites were created or restored to compensate for 31 impacts totaling 66.93 acres. Proposed mitigation for these impacts totaled 123.48 acres, a 1.84:1 compensation ratio. Completed mitigation projects totaled 117.17 acres, resulting in an actual compensation ratio of 1.75:1. However, the nearly 2:1 compensation ratio achieved with these projects could be a District-wide overestimation since mitigation projects not monitored may not have been constructed, or, if constructed, may not have resulted in wetland.

*Wetland Habitat Type*

A comparison of proposed and completed mitigation acreage by wetland habitat type (Figure 9) shows that construction of emergent and emergent open-water types resulted in more area than what was proposed while scrub-shrub wetland types resulted in less area than proposed. In this study, no forested wetlands were successfully created due to inadequate hydrology (either an overabundance or lack of water), which resulted in sapling mortality. A higher than expected water table was either a result of alterations in hydrologic regime due to construction activities or over-excavation. Taylor (2004) also observed that a common mistake in the Lake Ontario basin was over-excavation leading to the creation of open-water habitat over targeted wetland habitat types. In the present study, the acreage difference between what was proposed and what was actually built by habitat type further exacerbates the difference between emergent/open water and scrub-shrub/forested habitat types that were impacted and proposed as mitigation.

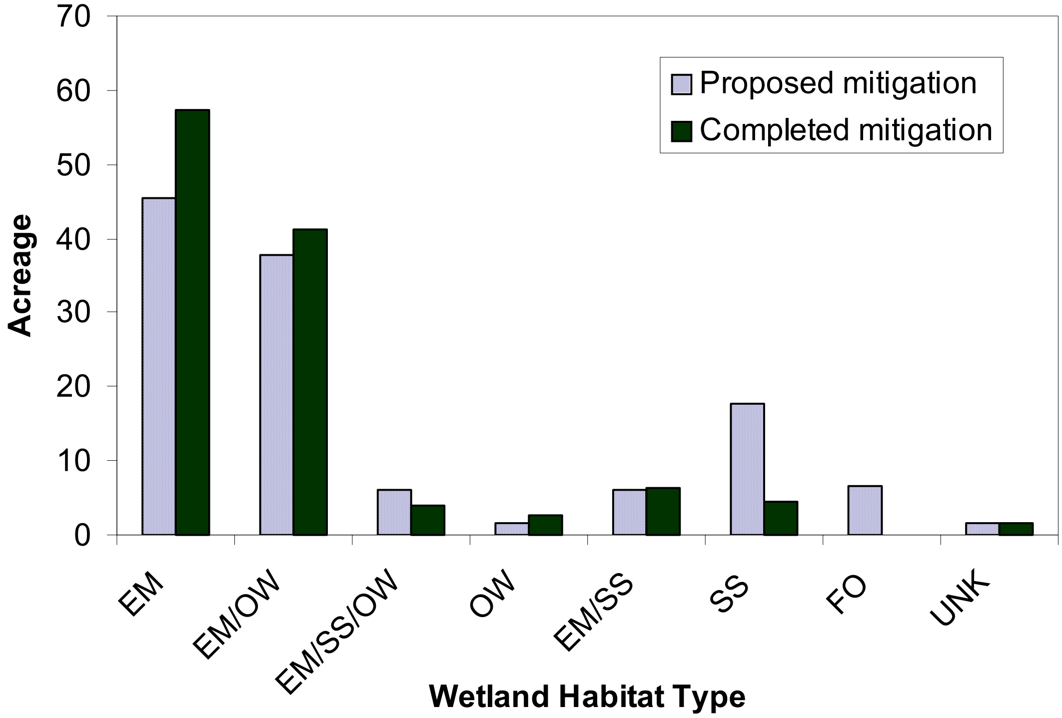


**Figure 9**. A comparison of proposed and completed mitigation acreage (n=31). [FO=forested, SS=scrub shrub, EM=emergent, OW=open water, UNK=unknown]

Impacts to forested wetland were not compensated with created or restored forested wetlands, although some sites may eventually develop into forested systems given enough time. Scrub-shrub wetlands were also inadequately replaced, though scrub-shrub habitat was created in some cases. The combination of overlooking scrub-shrub and forested habitat types in mitigation proposals and failure to follow-up with their creation suggests that many wetland impacts occurring in the New York Great Lakes region will not be replaced in-kind, at least in the short term. Thus, wetland functions would be expected to be affected and may not be adequately replaced at a 1:1 functional basis.

*Monitoring*

Monitored parameters were tallied from submitted reports from the 31 completed and monitored mitigation projects (Table 4). Vegetation was the most commonly measured parameter and was examined at all 31 sites. The second most commonly measured parameter was hydrology, followed by wildlife use of the site. Soils, one of the three factors necessary for a site to be considered a wetland by the Corps (Environmental Laboratory 1987) were examined at only six mitigation sites. Water quality and flood storage were not measured in any of the sites despite being considered two valuable functions of wetlands. These results are consistent with conclusions reached by the NRC committee stating that monitoring typically involved "only one or several easily measured parameters of a mitigation site", which in many cases, "do not reflect the overall viability of the mitigation site" (NRC 2001).

**Table 4**. Parameters measured at monitored wetland mitigation projects (n=31)

| *Parameter* | *Number of Sites Measured at* | *Percent of Sites* |
|---|---|---|
| *Vegetation* | 31 | 100 |
| *Hydrology* | 27 | 87.10 |
| *Wildlife* | 22 | 70.97 |
| *Soils* | 6 | 19.35 |
| *Invertebrates* | 2 | 6.45 |
| *Water Quality* | 0 | 0 |
| *Flood Storage* | 0 | 0 |

Furthermore, reporting styles between monitoring reports were inconsistent and ranged from only a general description of the dominant plants at a site to detailed data sheets with quantitative transect or sample plot data describing plant community type and percent cover. To increase consistency between reports and, more importantly, to ensure that all necessary and required data are included in them, **standardized monitoring forms should be developed to be used in addition to, or even in lieu of, the traditional monitoring report. Allowing for the electronic submission of these reports would increase efficiency by cutting down on paperwork that needs to be processed and filed.** This would also increase data availability by being able to place the information into a publicly-accessible database, thus increasing program transparency.

The Buffalo Corps District recently developed a standardized compliance inspection form for Corps project managers to complete during or after compliance inspections of mitigation sites. **It is important that these standardized inspection forms are consistently filled out and then used to track the progress of mitigation projects, especially in cases where monitoring reports are delinquent.**

*Invasive Species Colonization of Mitigation Sites*

Monitoring reports for the mitigation sites were reviewed for the presence of purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*) and cattail (*Typha* spp.), the most common invasive wetland species in the region (Table 5). At some sites, site managers or consultants did not consider reed canary grass to be an invasive or noxious species, despite its identification as such (i.e., USDA and NRCS 2006, Uva et al. 1997). Other species considered invasive by the Corps in the Great Lakes basins including multiflora rose (*Rosa multiflora*) and buckthorn (*Rhamnus* spp.) were not specifically monitored as so. **Thus, the Corps should educate site managers on the identification, prevention, and removal of invasive species so that appropriate management actions can be taken.**

**Table 5**. Incidence of invasive or nuisance species at mitigation sites (n=31)

| *Common name* | *Scientific name* | *Percent of Projects* |
|---|---|---|
| Cattail | *Typha* spp. | 96.77 |
| Purple loosestrife | *Lythrum salicaria* | 67.74 |
| Reed canary grass | *Phalaris arundinacea* | 61.29 |
| Common reed | *Phragmites australis* | 35.48 |

All of the examined monitored projects had invasive or nuisance vegetation present, defined as having greater than 0% cover. *Typha* spp. included the native broad-leaved cattail (*T. latifolia*), introduced narrow-leaved cattail (*T. angustifolia*), and their hybrid, blue cattail (*T. x glauca*) (USDA and NRCS 2006). Cattail was found at all but one site. Although broad-leaved cattail and common reed are native, the Corps considers them to be nuisance species because of their ability and tendency to form dense, monotypic stands that displace native species and decrease biodiversity. Cattail species were often not specified in reports, but at least 48% of the examined projects contained either the introduced or hybrid varieties. To address minor problems with purple loosestrife or common reed, plants were often hand-pulled to prevent further spread of the species.

*Relationship of invasive plant species and surrounding land cover*

Not all 31 completed and monitored projects submitted monitoring reports with enough information from which percent cover of invasive species could be calculated. Furthermore, not all projects submitted reports for each of the five years either because required monitoring was not conducted, or because the Corps did not require a report for that year. As a result, sample sizes for each year after project completion were small.

Despite the sparse data, there appears to be a positive relationship between urban land cover and invasive species colonization for the years following wetland construction (Figure 10), a possible indication that disturbance caused by urbanization may be fostering the spread of these invasive/nuisance species. Land cover associated with residential, commercial, or industrial development comprised an average of 20.5% of the area within 1 km of the sites colonized by an invasive or nuisance species.

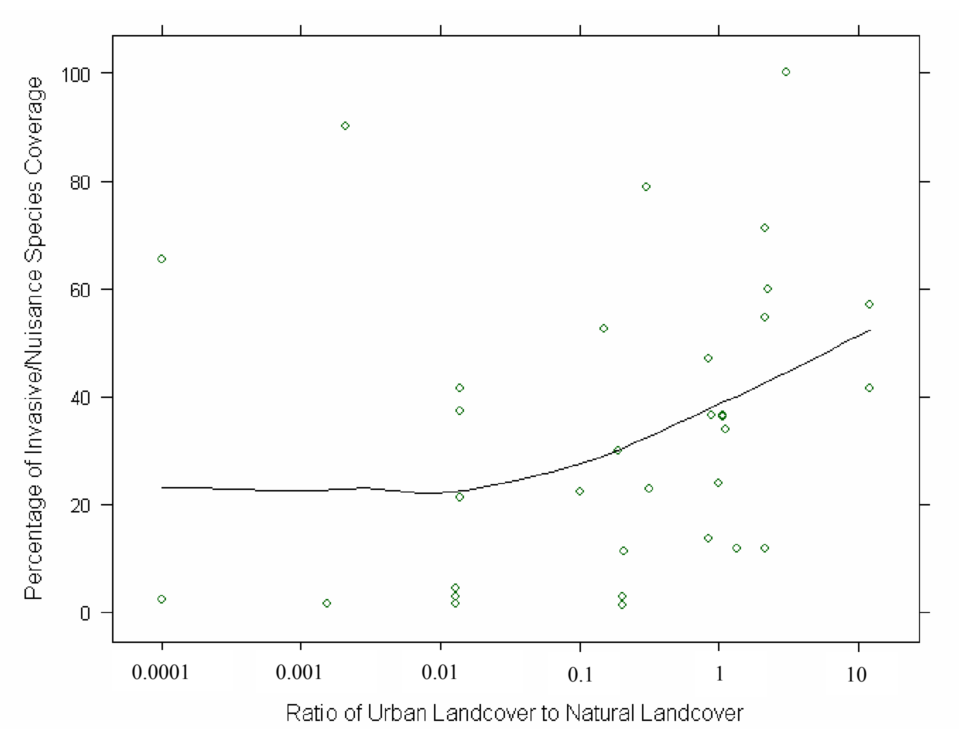


**Figure 10**. Percentage of invasive/nuisance vegetation coverage vs. ratio of urban to natural land cover (1-km radius) for completed mitigation projects

There was no apparent relationship between invasive/nuisance species colonization and surrounding agricultural land cover (data not shown). Agricultural land cover associated with pasture/hay, row crops, and other grasses formed an average of 45.4% of the area within 1km of the sites colonized by an invasive or nuisance species.

In the years following wetland construction, no increasing or decreasing trend in invasive/nuisance species cover was detected (Figure 11). The increase in variance of the data over the five monitoring years may indicate the role of disturbance, abiotic, or biotic factors in determining the distribution of species on the landscape. These additional stressors or effects were not obtained or measured in the field due to constraints in time and data availability.

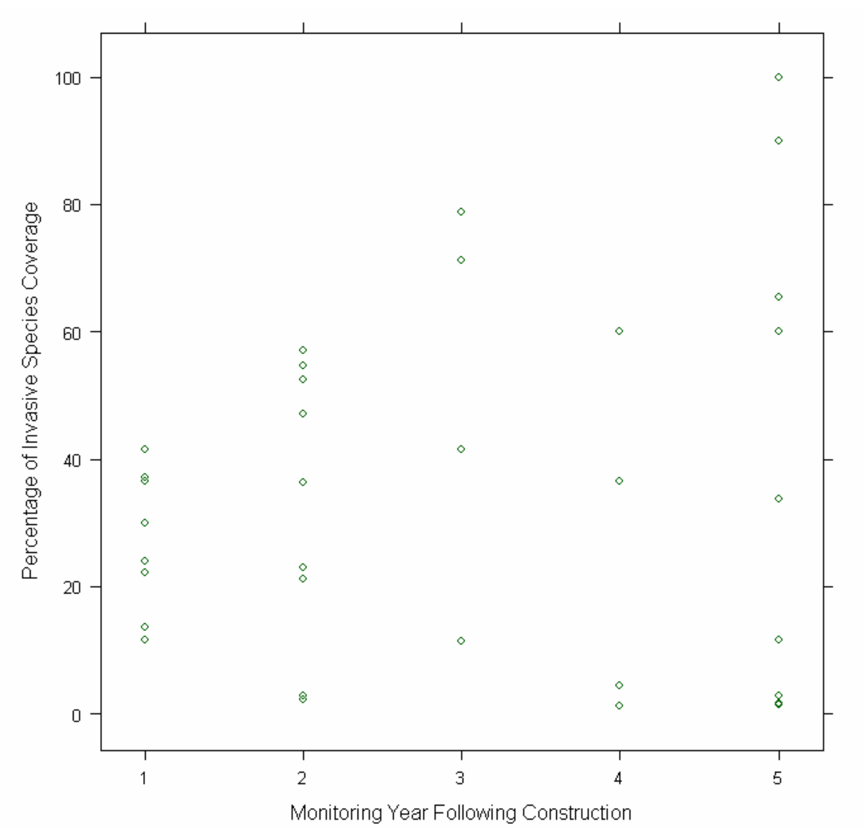


**Figure 11**. Percentage of invasive/nuisance vegetation coverage vs. monitoring year following completion of mitigation project

Temporary disturbance created at mitigation sites during construction activities can cause them to be more susceptible to invasive species, which can undermine mitigation efforts. Invasive species can out-compete native species because they are efficient colonizers and often lack natural controls (US EPA 2000). Although the introduction of invasive species onto a newly created mitigation site may be nearly unpreventable, precautions can be taken to minimize this risk. **Permit applications should include information on surrounding invasive species cover as well as land use. During the permitting process, the Corps should consider these prior to approving mitigation project sites, especially if invasive species are widespread in adjacent properties or if an area is highly disturbed.** This may reduce the number of site managers requesting to waive invasive species requirements for their sites because of problems at neighboring properties, as was the case at several sites. Moving a mitigation wetland off-site or utilizing a third-party project may offer more ecologically sound alternatives in these cases.

*Invasive species and wetland habitat type*

A notable study by Havens and others (2003) examined the spread of common reed at constructed wetland sites. The study found that at some sites, patches that were once common reed became predominately sapling/mid-story trees and shrub communities after several years. Hence, a decrease in common reed appeared to be correlated with an increase in scrub-shrub vegetation. The study recommended the planting of scrub-shrub species along a constructed wetland's perimeter as a method to reduce the likelihood of colonization. **Thus, ensuring the successful establishment of forested and scrub-shrub vegetation in the Great Lakes basin may limit encroachment nuisance species such as common reed.**

## CONCLUSION

Compensatory wetland mitigation in the New York portion of the Great Lakes region is not adequately meeting standards of the CWA Section 404 permitting program. However, results from this study are not specific to mitigation projects of the New York Great Lakes region. The insufficiency of monitoring report submissions and project tracking is consistent with the GAO 2005 study of seven other Corps districts, reflecting a nationwide trend of limited mitigation oversight. Monitoring that *was* performed did not always include parameters to ensure for the successful establishment of wetlands as defined by the Corps 1987 delineation manual (e.g. vegetation, soils, and hydrology), a conclusion also reached in the nationwide NRC (2001) study. Furthermore, the observed construction of emergent and open water habitat at the expense of scrub-shrub and forested habitat is consistent with the findings of other studies in the Northeast (Brown and Veneman 2001, Cole and Shafer 2002, NJDEP 2002, Minkin and Ladd 2003) as well as in other regions of the country (NRC 2001).

The Buffalo Corps District's openness and willingness to share their files for this study demonstrate their commitment to improving their Section 404 program to ensure for the adequate mitigation of permitted impacts. Project and file tracking have improved over the last few years; however, there is still a need for improvement. Success in obtaining no net wetland loss will be dependent upon the ability to issue permits with conditions that ensure that functions are properly replaced, and also on continued compliance monitoring of these mitigation projects.

## RECOMMENDATIONS

Recommendations based on the results of this study are as follows:

-The Buffalo Corps should place an increasing emphasis on the tracking, monitoring, and enforcement of mitigation projects and their requirements to improve data accessibility and program transparency.

-More effort should be put into replacing forested and scrub-shrub habitat types successfully, as fewer of these habitat types are proposed as mitigation, and creation/restoration attempts often result in failure.

-The failures to create/restore functioning wetlands indicate a problem in either the training of restoration practitioners in the district and/or a significant lack of Corps oversight. Adequate resources should be put into monitoring mitigation projects *during* construction as well as after. Using adaptive management may decrease the need for corrective measures later.

-Monitoring should include a variety of parameters to ensure that mitigation wetlands are successfully created or restored. This will also allow for adequate evaluation of functional replacement. The Buffalo Corps should develop its own functional assessment methodology to identify and measure levels of functions for mitigation wetlands within its jurisdiction.

-The Corps should require and enforce that monitoring reports be submitted each year of the monitoring period to better track mitigation progress. Longer monitoring periods should also be established to make certain that structural or functional goals achieved are not transitory.

-Site managers/consultants should be educated on the identification, prevention, and removal of invasive species so that appropriate management actions can be taken to create/restore successful wetlands.

-The development of standardized monitoring forms to be submitted in lieu of, or in addition to traditional reports would ensure that all required data are reported on, which would allow for early intervention if problems should arise. Form standardization would also improve the consistency of reported information, which would aid the Corps with tracking mitigation progress and replacement of habitat types.

-Electronic submissions of monitoring forms or reports should be encouraged to increase efficiency.

-Permit applications should include information on surrounding invasive species cover and land use, which the Corps should consider prior to approving mitigation projects. Special note should be taken if invasive species are widespread in adjacent properties or if an area is highly disturbed (ie, in a heavily urbanized region). When appropriate, off-site or third-party mitigation should be considered.

## ACKNOWLEDGEMENTS

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# APPENDIX

**Table A1**. Filled Acreage of 83 Sampled Projects

| *Permit Year* | *File ID* | *County* | *Latitude* | *Longitude* | *Permit* | *HUC* | *EM* | *FO* | *UNK* | *SS* | *OW* | *EM/SS/FO* | *SS/FO* | *EM/SS* | *EM/FO* | *Total Impacted Wetland Acreage* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ------------ *acres* ------------ | | | | | | | | | |
| 1995 | 009498577 | Monroe | 43.09000 | -77.53377 | IP | 04140101 | 1.20 | | | | | | | | | 1.20 |
| 1996 | 009198611 | Niagara | 43.21500 | -78.97000 | NWP26 | 04130001 | | 7.59 | | | | | | | | 7.59 |
| 1996 | 009497657 | Erie | 43.01370 | -78.68910 | | 04120104 | | 0.18 | | | | | | | | 0.18 |
| 1996 | 969880144 | Onondaga | 43.06100 | -76.06390 | NWP26 | 04140202 | 0.27 | 0.60 | | | | | | | | 0.87 |
| 1996 | 009599135 | Oswego | 43.47960 | -76.45380 | | 04140102 | | | 2.43 | | | | | | | 2.43 |
| 1996 | 095976173 | Erie | 42.98830 | -78.93780 | NWP | 04120104 | | | 0.51 | | | | | | | 0.51 |
| 1996 | 969920043 | Saint Lawrence | 44.80180 | -74.64520 | | 04150306 | | 1.20 | | | | | | | | 1.20 |
| 1997 | 979810001 | Jefferson | 43.97600 | -75.94310 | IP | 04150102 | | | 0.42 | | | | | | | 0.42 |
| 1997 | 969860055 | Niagara | 43.20932 | -78.68923 | IP | 04130001 | | 1.50 | | | | | | | | 1.50 |
| 1997 | 009498548 | Monroe | 43.07640 | -77.52450 | | 04140101 | 2.30 | | | | | | | | | 2.30 |
| 1997 | 979880025 | Onondaga | 43.15640 | -76.12070 | | 04140202 | 2.97 | 0.03 | | 0.30 | | | | | | 3.30 |
| 1997 | 979760084 | Erie | 43.00450 | -78.79860 | NWP26 | 04120104 | | | | | | | 0.50 | | | 0.50 |
| 1997 | 969760068 | Erie | 42.75680 | -78.70590 | NWP26 | 04120103 | | | | | | 5.00 | | | | 5.00 |
| 1997 | 969880115 | Onondaga | 43.17100 | -76.14640 | NWP26 | 04140202 | 0.54 | 0.08 | | 4.23 | | | | | | 4.85 |
| 1997 | 009499537 | Wayne | 43.23000 | -77.26320 | IP | 04140101 | 1.85 | 3.16 | | 1.19 | | | | | | 6.20 |
| 1997 | 979890007 | Ontario | 42.88167 | -76.97500 | IP | 04140201 | | | | | | 3.86 | | | | 3.86 |
| 1997 | 979890064 | Ontario | 43.03378 | -77.45456 | NWP26 | 04140101 | | | 0.90 | | | | | | | 0.90 |
| 1998 | 979850042 | Monroe | 43.08500 | -77.54220 | IP | 04140101 | | | 0.51 | | | | | | | 0.51 |
| 1998 | 009399513 | Wayne | 43.16440 | -77.31330 | NWP26 | 04140201 | | | 0.69 | | | | | | | 0.69 |
| 1998 | 989880031 | Onondaga | 43.05833 | -76.04167 | IP | 04140202 | | | 0.67 | | | | | | | 0.67 |
| 1998 | 989860006 | Niagara | 43.00000 | -78.69252 | NWP | 04120104 | | | | | | 2.05 | | | | 2.05 |
| 1998 | 989930013 | Seneca | 42.92170 | -76.78620 | NWP26 | 04140201 | 0.36 | 0.01 | | 1.87 | | | | | | 2.20 |
| 1998 | 979890020 | Ontario | 42.90660 | -76.96610 | NWP26 | 04140201 | | | 2.29 | | | | | | | 2.29 |
| 1998 | 989810008 | Jefferson | 44.13884 | -75.71245 | NWP26 | 04150303 | | | 0.91 | | | | | | | 0.91 |
| 1998 | 979880074 | Onondaga | 43.02010 | -76.06520 | IP | 04140202 | | | | | | | | | 2.90 | 2.90 |
| 1998 | 979760134 | Erie | 42.89450 | -78.51060 | NWP 26 | 04120104 | | | | 0.62 | | | | | | 0.62 |
| 1998 | 979850024 | Monroe | 43.10833 | -77.64000 | NWP26 | 04130003 | | | 0.60 | | | | | | | 0.60 |
| 1999 | 969890052 | Ontario | 42.94620 | -77.33470 | IP | 04140201 | | 0.42 | 1.04 | | | | | 0.94 | | 2.40 |
| 1999 | 199900030 | Erie | 42.95667 | -78.71000 | NWP26 | 04120104 | | 0.90 | | | | | | | | 0.90 |
| 1999 | 989760130 | Erie | 43.03417 | -78.80250 | IP | 04120104 | | 4.70 | | | | | | | | 4.70 |
| 1999 | 093976012 | Erie | 42.97333 | -78.68500 | NWP26 | 04120104 | | | | | | | 0.96 | | | 0.96 |
| 2000 | 199900871 | Seneca | 42.70690 | -76.83640 | NWP26&12 | 04140201 | | | 0.92 | | | | | | | 0.92 |
| 2000 | 199901712 | Monroe | 43.11540 | -77.69700 | UNK | 04130003 | | | 2.30 | | | | | | | 2.30 |
| 2000 | 199902976 | Erie | 42.73920 | -78.76520 | NWP26 | 04120103 | | 0.81 | | | | | | | | 0.81 |
| 2000 | 200000940 | Erie | 42.93160 | -78.90520 | NWP38 | UNK | | | 1.20 | | | | | | | 1.20 |
| 2000 | 200001040 | Onandaga | 43.18782 | -76.09128 | NWP26 | 04140202 | 0.67 | | | | | | | | | 0.67 |
| 2000 | 200001867 | Onondaga | 43.06986 | -76.13160 | NWP38 | 04140201 | | | | | | 7.40 | | | | 7.40 |
| 2001 | 200100543 | Tompkins | 42.47910 | -76.45090 | IP | 04140201 | 0.13 | 0.83 | | 0.52 | | | | | | 1.50 |

| Permit Year | File ID | County | Latitude | Longitude | Permit | HUC | EM | FO | UNK | SS | OW | EM/SS/FO | SS/FO | EM/SS | EM/FO | Total Impacted Wetland Acreage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | acres | | | | | | | | | |
| 2001 | 989890030 | Ontario | 42.91823 | -77.30650 | NWP32 | 04140201 | | | 1.25 | | | | | | | 1.25 |
| 2001 | 200100424 | Erie | 43.02630 | -78.97540 | IP | 04120104 | | | | 1.75 | | | | | | 1.75 |
| 2001 | 988720012 | St. Lawrence | 44.97093 | -74.89113 | IP | 04150301 | | | | | | | | 0.83 | | 0.83 |
| 2001 | 200002196 | St. Lawrence | 44.34578 | -75.45763 | NWP39 | 04150302 | | | | 0.20 | | | | | | 0.20 |
| 2001 | 200100486 | Niagara | 43.12441 | -78.80791 | IP | 04120104 | | | | | | | | 0.52 | | 0.52 |
| 2001 | 200001502 | Monroe | 43.08612 | -77.68341 | NWP32 | 04130003 | | | 1.06 | | | | | | | 1.06 |
| 2002 | 009399139 | Oswego | 43.29210 | -76.20390 | IP | 04140202 | 0.19 | | | | | | | | | 0.19 |
| 2002 | 000909888 | Onondaga | 43.19110 | -76.09480 | IP | 04140202 | 1.32 | | | | | | | | | 1.32 |
| 2002 | 200102561 | Onondaga | 43.17370 | -76.07840 | NWP39 | 04140202 | | | | | | | | | 0.45 | 0.45 |
| 2002 | 200200583 | Erie | 43.03432 | -78.70176 | IP | 04120104 | | | | | | | 0.29 | | | 0.29 |
| 2002 | 988720012 | St. Lawrence | 44.94930 | -74.95780 | IP | 04150301 | | | | | | | | 0.44 | | 0.44 |
| 2002 | 200002280 | Ontario | 42.96840 | -77.38720 | IP | 04140201 | 0.10 | | | 0.10 | | | | | 0.24 | 0.44 |
| 2002 | 200200834 | Monroe | 43.04667 | -77.64167 | NWP42 | 04130003 | | | 0.32 | | | | | | | 0.32 |
| 2003 | 200301793 | Erie | 42.75221 | -78.81406 | NWP39 | 04120103 | 0.22 | | | | | | | | | 0.22 |
| 2003 | 200201417 | Erie | 43.01556 | -78.78624 | NWP39 | 04120104 | | | | | | | 0.30 | | | 0.30 |
| 2003 | 200201266 | Onondaga | 43.22835 | -76.11972 | NWP39 | 04140202 | | | | | | 0.37 | | | | 0.37 |
| 2003 | 200202338 | UNK | 44.05353 | -75.40545 | NWP14 | 04150303 | | 0.13 | | | | | | | | 0.13 |
| 2003 | 200202200 | Tompkins | 42.47000 | -76.49301 | NWP39 | 04140201 | | | | | 0.13 | | | | | 0.13 |
| 2003 | 008698815 | Onondaga | 43.20833 | -76.29167 | NWP39 | 04140203 | | | | | | 0.19 | | | | 0.19 |
| 2003 | 200300767 | Onondaga | 43.18600 | -76.23007 | NWP13 | 04140202 | 0.25 | 0.07 | | 0.17 | 0.02 | | | | | 0.50 |
| 2003 | 200101381 | Onondaga | 43.05504 | -75.88675 | NWP39 | 04140202 | | | | | | | | 0.46 | | 0.46 |
| 2003 | 200101026 | Wyoming | 42.73942 | -78.13596 | IP | 04130003 | | | | 0.38 | | | | | | 0.38 |
| 2003 | 200002286 | Erie | 43.00261 | -78.81025 | NWP39 | 04120104 | | | | 0.19 | 0.25 | | | | | 0.44 |
| 2003 | 200201858 | Oswego | 43.45699 | -76.15091 | NWP14 | 04140102 | 0.49 | | | | | | | | | 0.49 |
| 2003 | 979910010 | Oswego | 43.24591 | -76.14862 | NWP39 | 04140202 | | | | 0.49 | | | | | | 0.49 |
| 2003 | 200300571 | Monroe | 43.09000 | -77.62653 | IP | 04130003 | | | | | | 1.11 | | | | 1.11 |
| 2003 | 200201252 | Monroe | 43.21474 | -77.96666 | NWP39 | 04130001 | 0.45 | | | | | | | | | 0.45 |
| 2003 | 200000325 | Erie | 42.88000 | -78.69667 | IP | 04120103 | | | | | | 7.54 | | | | 7.54 |
| 2003 | 200201777 | Erie | 42.77010 | -78.71343 | NWP39 | 04120103 | | | 0.36 | | | | | | | 0.36 |
| 2004 | 200302348 | Ontario | 42.89584 | -76.98648 | IP | 04140201 | 0.64 | | | | | | | | | 0.64 |
| 2004 | 200302013 | Onondaga | 43.13353 | -76.22641 | IP | 04040201 | | | | | | 0.60 | | | | 0.60 |
| 2004 | 200200754 | Monroe | 43.22667 | -77.50000 | IP | 04140101 | | | | 0.67 | | | | | | 0.67 |
| 2004 | 989760006 | Erie | 42.73389 | -78.85722 | IP | 04120103 | | | | | | | 1.20 | | | 1.20 |
| 2004 | 199901616 | Erie | 43.03750 | -78.66167 | NWP39 | 04120104 | | | | | | | 1.55 | | | 1.55 |
| 2004 | 200300556 | Erie | 42.49584 | -78.64100 | NWP14 | 04120102 | | | | | | 0.19 | | | | 0.19 |
| 2004 | 199900175 | Erie | 42.75028 | -78.60667 | NWP | 04120103 | 0.02 | | | | | | | | | 0.02 |
| 2004 | 200401591 | Erie | 42.98978 | -78.80862 | NWP39 | 04120104 | | | | | | | 0.49 | | | 0.49 |
| 2004 | 200401811 | Erie | 42.92440 | -78.61510 | NWP39 | 04120103 | | | 0.06 | | | | | | | 0.06 |
| 2004 | 200401219 | Erie | 43.00636 | -78.69372 | NWP39 | 04120104 | | 0.29 | | | | | | | | 0.29 |
| 2004 | 200301388 | Erie | 42.71668 | -78.95903 | NWP39 | 04120103 | | | | | | | | 0.49 | | 0.49 |

| Permit Year | File ID | County | Latitude | Longitude | Permit | HUC | EM | FO | UNK | SS | OW | EM/SS/FO | SS/FO | EM/SS | EM/FO | Total Impacted Wetland Acreage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | acres | | | | | | | | | |
| 2004 | 200400516 | Erie | 43.03280 | -78.67450 | NWP39 | 04120104 | | | | | | | 0.49 | | | 0.49 |
| 2004 | 200401145 | Monroe | 43.07306 | -77.44167 | NWP39 | 04140101 | 0.49 | | | | | | | | | 0.49 |
| 2005 | 092988906 | Onondaga | 43.05500 | -76.00830 | IP | 04140202 | 1.46 | | | | | | | | | 1.46 |
| 2005 | 009497630 | Erie | 42.92833 | -78.70833 | IP | 04120103 | | | | | | | 0.61 | | | 0.61 |
| 2005 | 979780005 | Genesee | 42.99608 | -78.26022 | NW 14-42 | 04120104 | | | 0.35 | | | | | | | 0.35 |
| TOTAL | | | | | | | 15.93 | 22.50 | 18.79 | 12.67 | 0.40 | 28.31 | 6.39 | 3.68 | 3.59 | 112.23 |

**Table A2**. Proposed Mitigation Acreage of 83 Sampled Projects

| Permit year | File ID | Mit Loc | County | Mit Latitude | Mit Longitude | In/Out of Kind | EM | FO | UNK | SS | OW | EM/OW | EM/SS/OW | EM/SS | EM/SS/FO | SS/FO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | acres | | | | | | | | | |
| 1995 | 009498577 | ON-SITE | Monroe | 43.09 | 77.53377 | IN | 1.50 | | | | | | | | | |
| 1996 | 009198611 | OFF-SITE | Niagara | | | OUT | | | | | | 10.00 | | | | |
| 1996 | 009497657 | ON-SITE | | | | IN | | 0.80 | | | | | | | | |
| 1996 | 969880144 | ON-SITE | Onondaga | | | PARTIAL | | 0.87 | | | | | | | | |
| 1996 | 009599135 | OFF-SITE | | | | UNK | | | | | | | | | 4.78 | |
| 1996 | 095976173 | | | | | UNK | 0.62 | 0.61 | | | | | | | | |
| 1996 | 969920043 | ON-SITE | | | | IN | | 1.20 | | | | | | | | |
| 1997 | 979810001 | OFF-SITE | Jefferson | | | UNK | | | 9.00 | | | | | | | |
| 1997 | 969860055 | ON-SITE | Niagara | 43.20932 | 78.68923 | OUT | 2.30 | | | | | | | | | |
| 1997 | 009498548 | OFF-SITE | Monroe | | | PARTIAL | | | | | | 3.00 | | | | |
| 1997 | 009498548 | ON-SITE | Monroe | | | PARTIAL | | | | | | 0.50 | | | | |
| 1997 | 979880025 | ON-SITE | Onondaga | | | UNK | 3.30 | | | | | | | | | |
| 1997 | 979760084 | ON-SITE | Erie | | | OUT | 0.70 | | | | | | | | | |
| 1997 | 969760068 | | | | | PARTIAL | | | | | | 8.36 | | | | |
| 1997 | 969880115 | ON-SITE | Onondaga | | | PARTIAL | 5.02 | | | 1.01 | | 0.59 | | | | |
| 1997 | 009499537 | | | | | PARTIAL | 10.71 | 5.64 | | 4.73 | 1.06 | | | | | |
| 1997 | 979890007 | ON-SITE | Ontario | 42.88167 | 76.975 | PARTIAL | 0.90 | | | | 0.60 | | | | | |
| 1997 | 979890007 | OFF-SITE | | | | UNK | | | | | | 10.00 | | | | |
| 1997 | 979890064 | ON-SITE | Ontario | 43.03378 | 77.45456 | UNK | | | | | | | | 3.95 | | |
| 1998 | 979850042 | UNK | | | | UNK | | | | | | | 3.50 | | | |
| 1998 | 009399513 | ON-SITE | Wayne | | | UNK | 1.26 | | | | | | | | | |
| 1998 | 989880031 | ON-SITE | Onondaga | 43.05833 | 76.04167 | UNK | | | | | | 2.82 | | | | |
| 1998 | 989860006 | OFF-SITE | Erie | 43.08615 | 78.5088 | PARTIAL | 11.5 | Consolidated project | | | | | | | | |
| 1998 | 989930013 | ON-SITE | Seneca | | | IN | 0.4 | 0.02 | | 2.8 | | | | | | |
| 1998 | 979890020 | ON-SITE | Ontario | | | UNK | | | 3.5 | | | | | | | |

| Permit year | File ID | Mit Loc | County | Mit Latitude | Mit Longitude | In/Out of Kind | EM | FO | UNK | SS | OW | EM/OW | EM/SS/OW | EM/SS | EM/SS/FO | SS/FO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ---------- acres ---------- | | | | | | | | | |
| 1998 | 989810008 | ON-SITE | Jefferson | | | UNK | | | 1.5 | | | | | | | |
| 1998 | 979880074 | OFF-SITE | Madison | | | PARTIAL | 5 | | 0 | | | | | | | |
| 1998 | 979760134 | OFF-SITE | Genesee | | | OUT | | | | | | 0.72 | | | | |
| 1998 | 979850024 | ON-SITE | Monroe | 43.10833 | 77.64 | UNK | 0.47 | | | | 0.08 | | | | | |
| 1998 | 979850024 | OFF-SITE | Monroe | 43.10833 | 77.64 | UNK | | | | | | 0.40 | | | | |
| 1999 | 969890052 | | | | | PARTIAL | 1.9 | | | | | | | | | |
| 1999 | 199900030 | OFF-SITE | Erie | 43.08615 | 78.5088 | OUT | 0 | Consolidated project | | | | | | | | |
| 1999 | 989760130 | OFF-SITE | Erie | 43.08615 | 78.5088 | OUT | 0 | Consolidated project | | | | | | | | |
| 1999 | 093976012 | ON-SITE | Erie | 42.97333 | 78.685 | PARTIAL | 0.36 | | | 0.23 | | | | | | |
| 2000 | 199900871 | ON-SITE | Seneca | | | UNK | 7 | | | | | | | | | |
| 2000 | 199901712 | ON-SITE | | | | UNK | 3.27 | 0.48 | | | 0.27 | | | | | |
| 2000 | 199902976 | ON-SITE | | | | OUT | 1.22 | | | | | | 0.58 | | | |
| 2000 | 200000940 | ON-SITE | Erie | UNK | UNK | UNK | | | | | | | 2.7 | | | |
| 2000 | 200001040 | ON-SITE | Onandaga | 43.18782 | 76.09128 | PARTIAL | 1.5 | | | | | | | | | |
| 2000 | 200001867 | ON-SITE | Onondaga | 43.06986 | 76.1316 | PARTIAL | | | | 9 | | | | | | |
| 2001 | 200100543 | ON-SITE | Tompkins | UNK | UNK | PARTIAL | 1.44 | | | 1.43 | 0.07 | | | | | |
| 2001 | 989890030 | ON-SITE | Ontario | | | UNK | 2 | | | | | | | | | |
| 2001 | 200100424 | ON-SITE | Erie | 43.0263 | 78.9754 | OUT | 4.6 | | | | | | | | | |
| 2001 | 988720012 | ON-SITE | St. Lawrence | 44.97093 | 74.89113 | PARTIAL | | | | | | | 2 | | | |
| 2001 | 200002196 | ON-SITE | St. Lawrence | 44.34578 | 75.45763 | IN | | | | | | | | 0.16 | | |
| 2001 | 200100486 | ON-SITE | Niagara | 43.12441 | 78.80791 | IN | | | | | | | | 1 | | |
| 2001 | 200001502 | ON-SITE | Monroe | 43.08612 | 77.68341 | UNK | | | | | | 5.3 | | | | |
| 2002 | 009399139 | ON-SITE | Oswego | UNK | UNK | IN | 0.38 | | | | | | | | | |
| 2002 | 000909888 | ON-SITE | Onondaga | UNK | UNK | IN | 2 | | | | | | | | | |
| 2002 | 200102561 | ON-SITE | Onondaga | UNK | UNK | PARTIAL | | | | | | | | 1.05 | | |
| 2002 | 200200583 | ON-SITE | Erie | 43.03432 | 78.70176 | OUT | | | | | | 0.5 | | | | |
| 2002 | 988720012 | ON-SITE | St. Lawrence | UNK | UNK | PARTIAL | | | | | | | 0.77 | | | |
| 2002 | 200002280 | ON-SITE | Ontario | 42.9684 | 77.3872 | PARTIAL | 0.98 | | | | | | | | | |
| 2002 | 200200834 | ON-SITE | Monroe | 43.04667 | 77.64167 | UNK | | | 0.97 | | | | | | | |
| 2003 | 200301793 | ON-SITE | Erie | 42.75221 | 78.81406 | IN | 0.33 | | | | | | | | | |
| 2003 | 200201417 | ON-SITE | Erie | 43.01556 | 78.78624 | OUT | 0.32 | | | | | | | | | |
| 2003 | 200201266 | ON-SITE | Onondaga | 43.22835 | 76.11972 | PARTIAL | | | | | | | | 0.75 | | |
| 2003 | 200202338 | ON-SITE | UNK | 44.05353 | 75.40545 | OUT | | | | | | | | 0.09 | | |
| 2003 | 200202200 | OFF-SITE | Cayuga | 42.66813 | 76.29573 | OUT | 0.4 | | | | | | | | | |
| 2003 | 008698815 | ON-SITE | Onondaga | 43.20833 | 76.29167 | PARTIAL | 0.4 | | | | | | | | | |

| Permit year | File ID | Mit Loc | County | Mit Latitude | Mit Longitude | In/Out of Kind | EM | FO | UNK | SS | OW | EM/OW | EM/SS/OW | EM/SS | EM/SS/FO | SS/FO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ---------- acres ---------- | | | | | | | | | |
| 2003 | 200300767 | ON-SITE | Onondaga | 43.186 | 76.23007 | IN | 0.25 | 0.15 | | 0.25 | 0.02 | | | | | |
| 2003 | 200101381 | ON-SITE | Madison | 43.05504 | 75.88675 | PARTIAL | 0.75 | | | | | | | | | |
| 2003 | 200101026 | ON-SITE | Wyoming | 42.73942 | 78.13596 | OUT | | | | | | 0.69 | | | | |
| 2003 | 200002286 | ON-SITE | Erie | 43.00261 | 78.81025 | PARTIAL | 0.38 | | | | 0.25 | | | | | |
| 2003 | 200201858 | ON-SITE | Oswego | 43.45699 | 76.15091 | IN | 0.5 | | | | | | | | | |
| 2003 | 979910010 | OFF-SITE | Oswego | 43.36314 | 76.1631 | PARTIAL | | | | | | | | 1.5 | | |
| 2003 | 200300571 | ON-SITE | Monroe | 43.09 | 77.62653 | PARTIAL | | | | | | | 1.5 | | | |
| 2003 | 200201252 | ON-SITE | Monroe | 43.21474 | 77.96666 | PARTIAL | 0.67 | 0.22 | | 0.51 | 0.29 | | | | | |
| 2003 | 200000325 | OFF-SITE | Erie | 42.89776 | 78.65229 | UNK | 7.14 | | | | | | | | | |
| 2003 | 200000325 | OFF-SITE | Genesee | 43.09598 | 78.44339 | UNK | 12 | | | | | | | | | |
| 2003 | 200201777 | ON-SITE | Erie | 42.7701 | 78.71343 | UNK | 0.53 | | | | | | | | | |
| 2003 | 200201777 | | Erie | 42.79851 | 78.72506 | UNK | 1.2 | | | | | | | | | |
| 2004 | 200302348 | ON-SITE | Ontario | 42.89584 | 76.98648 | IN | 1.5 | | | | | | | | | |
| 2004 | 200302013 | ON-SITE | Onondaga | 43.13353 | 76.22641 | PARTIAL | | | | | | | | 1.69 | | |
| 2004 | 200200754 | ON-SITE | Monroe | 43.22667 | 77.5 | PARTIAL | | | | | | | | | 1.21 | |
| 2004 | 989760006 | ON-SITE | Erie | 42.73389 | 78.85722 | OUT | 0.5 | | | | | | | | | |
| 2004 | 199901616 | OFF-SITE | Erie | | | OUT | | | | | | 1.3 | | | | |
| 2004 | 200300556 | ON-SITE | Erie | 42.49584 | 78.641 | IN | | | | | | | | | 1.26 | |
| 2004 | 199900175 | ON-SITE | Erie | 42.75028 | 78.60667 | IN | 0.06 | | | | | | | | | |
| 2004 | 200401591 | OFF-SITE | Erie | 43.0794 | 78.7145 | PARTIAL | | | | | | | 2.3 | | | |
| 2004 | 200401811 | ON-SITE | Erie | 42.9244 | 78.6151 | UNK | | | 0.4 | | | | | | | |
| 2004 | 200401219 | ON-SITE | Erie | 43.00636 | 78.69372 | IN | 0.51 | 0.09 | | | | | | | | |
| 2004 | 200301388 | ON-SITE | Erie | 42.71668 | 78.95903 | IN | | | | | | | 0.76 | | | |
| 2004 | 200400516 | ON-SITE | Erie | 43.0328 | 78.6745 | IN | | | | | | | | | | 0.84 |
| 2004 | 200401145 | OFF-SITE | Monroe | 43.0798 | 77.4339 | IN | 0.5 | | | | | | | | | |
| 2005 | 092988906 | OFF-SITE | Ontario | 43.09098 | 76.0504 | IN | 2.26 | | | | | | | | | |
| 2005 | 009497630 | ON-SITE | Erie | 42.92833 | 78.70833 | OUT | 1.47 | | | | | | | | | |
| 2005 | 979780005 | ON-SITE | Genesee | UNK | UNK | UNK | | | 0.5 | | | | | | | |
| | | | TOTAL | | | | 102 | 10.08 | 15.87 | 19.96 | 2.64 | 44.18 | 14.11 | 10.19 | 7.25 | 0.84 |

**Table A3**. Completed Acreage of 31 Available Monitored Mitigation Projects

| *Permit ID* | *EM* | *EM/OW* | *EM/SS/OW* | *OW* | *EM/SS* | *SS* | *FO* | *UNK* | *Completed Acreage* |
|---|---|---|---|---|---|---|---|---|---|
| | ------------ | ------------ | ------------ | *acres* | ------------ | ------------ | ------------ | ------------ | |
| 009498577 | 1.50 | | | | | | | | 1.50 |
| 009198611 | | 10.00 | | | | | | | 10.00 |
| 969880144 | | 0.87 | | | | | | | 0.87 |
| 009498548 | | 3.2 | | | | | | | 3.20 |
| 009498548 | | 0.5 | | | | | | | 0.50 |
| 979880025 | 3.32 | | | | | | | | 3.32 |
| 979760084 | 0.81 | | | | | | | | 0.81 |
| 969760068 | | 8.36 | | | | | | | 8.36 |
| 969880115 | 0.32 | 2.28 | | | | 0.91 | | | 3.51 |
| 009499537 | 15.71 | | | 1.38 | | | | | 17.09 |
| 979890007 | 0.90 | | | 0.60 | | | | | 1.50 |
| 979890007 | | 10.00 | | | | | | | 10.00 |
| 979890064 | | | | | 3.95 | | | | 3.95 |
| 989860006 | 11.5 | Consolidated project | | | | | | | 11.50 |
| 989930013 | 0.40 | | | | | 2.80 | 0.02 | | 3.22 |
| 989810008 | | | | | | | | 1.50 | 1.50 |
| 979880074 | 5.00 | | | | | | | | 5.00 |
| 199900030 | Consolidated project | | | | | | | | n/a |
| 989760130 | Consolidated project | | | | | | | | n/a |
| 093976012 | 0.66 | | | | | 0.19 | | | 0.85 |
| 199902976 | 1.22 | | 0.58 | | | | | | 1.80 |
| 200000940 | | | 2.74 | | | | | | 2.74 |
| 200001040 | 1.30 | | | | | | | | 1.30 |
| 200001867 | 9.00 | | | | | | | | 9.00 |
| 988720012 | 2.14 | | | 0.57 | | 0.49 | | | 3.20 |
| 200100486 | | | | | 1.00 | | | | 1.00 |
| 200001502 | | 5.30 | | | | | | | 5.30 |
| 009399139 | 0.43 | | | | | | | | 0.43 |
| 000909888 | 2.00 | | | | | | | | 2.00 |
| 200102561 | | | | | 1.31 | | | | 1.31 |
| 988720012 | | | 0.77 | | | | | | 0.77 |
| 200002280 | 1.04 | | | | | | | | 1.04 |
| 200201266 | | 0.60 | | | | | | | 0.60 |
| Total | **57.25** | **41.11** | **4.09** | **2.55** | **6.26** | **4.39** | **0.02** | **1.5** | **117.17** |

**Table A4**. Land Cover of Monitored Mitigation Projects

| Monitoring Year | Permit No. | Open Water ($m^2$) | Urban ($m^2$) | Ag ($m^2$) | Forested ($m^2$) | EM Wetland ($m^2$) | Other ($m^2$) | %Urban | %Agricultural | %Forested/Natural |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 979880025 | 48207.36 | 762197.37 | 2027314.72 | 300970.24 | 0.00 | 0.00 | 24.28 | 64.59 | 11.12 |
| 1 | 200001867 | 0.00 | 2612317.49 | 312696.36 | 216281.65 | 0.00 | 0.00 | 83.16 | 9.95 | 6.89 |
| 1 | 200100486 | 2605.80 | 2605.80 | 2947163.17 | 185012.01 | 0.00 | 0.00 | 0.08 | 93.94 | 5.98 |
| 1 | 200001502 | 63842.17 | 932877.47 | 1269026.05 | 871641.10 | 1302.90 | 0.00 | 29.72 | 40.43 | 29.85 |
| 1 | 009499537 | 6514.51 | 200646.83 | 945906.48 | 2001256.69 | 0.00 | 0.00 | 6.36 | 29.99 | 63.65 |
| 1 | 200001040 | 0.00 | 1007142.85 | 1197366.47 | 936786.17 | 0.00 | 0.00 | 32.06 | 38.12 | 29.82 |
| 1 | 200002280 | 0.00 | 171983.00 | 2071613.37 | 900304.93 | 0.00 | 0.00 | 5.47 | 65.89 | 28.64 |
| 1 | 000909888 | 0.00 | 859914.98 | 1270328.95 | 1009748.65 | 0.00 | 0.00 | 27.39 | 40.46 | 32.16 |
| 1 | 979890007 (off-site) | 22149.33 | 2605.80 | 1818850.48 | 961541.30 | 336148.58 | 0.00 | 0.08 | 57.90 | 42.02 |
| 1 | 988720012 | 1210395.48 | 13029.02 | 1368046.56 | 544612.82 | 0.00 | 0.00 | 0.42 | 43.62 | 55.96 |
| 1 | 199902976 | 1236453.51 | 1387590.09 | 169377.19 | 257974.50 | 0.00 | 0.00 | 45.47 | 5.55 | 48.98 |
| 2 | 009198611 | 5211.61 | 16937.72 | 1790186.65 | 1322445.01 | 6514.51 | 0.00 | 0.54 | 56.99 | 42.47 |
| 2 | 009399139 | 1302.90 | 0.00 | 2376492.32 | 767408.98 | 0.00 | 0.00 | 0.00 | 75.56 | 24.44 |
| 2 | 969760068 | 19543.52 | 585002.77 | 737442.24 | 1801912.76 | 0.00 | 0.00 | 18.61 | 23.46 | 57.94 |
| 2 | 979880025 | 48207.36 | 762197.37 | 2027314.72 | 300970.24 | 0.00 | 0.00 | 24.28 | 64.59 | 11.12 |
| 2 | 200100486 | 2605.80 | 2605.80 | 2947163.17 | 185012.01 | 0.00 | 0.00 | 0.08 | 93.94 | 5.98 |
| 2 | 200001040 | 0.00 | 1007142.85 | 1197366.47 | 936786.17 | 0.00 | 0.00 | 32.06 | 38.12 | 29.82 |
| 2 | 200001867 | 0.00 | 2612317.49 | 312696.36 | 216281.65 | 0.00 | 0.00 | 83.16 | 9.95 | 6.89 |
| 2 | 000909888 | 0.00 | 859914.98 | 1270328.95 | 1009748.65 | 0.00 | 0.00 | 27.39 | 40.46 | 32.16 |
| 2 | 200102561 | 2605.80 | 231916.47 | 1360229.15 | 1546544.07 | 1302.90 | 0.00 | 7.38 | 43.28 | 49.34 |
| 3 | 979880025 | 48207.36 | 762197.37 | 2027314.72 | 300970.24 | 0.00 | 0.00 | 24.28 | 64.59 | 11.12 |
| 3 | 199902976 | 0.00 | 222796.16 | 1851423.02 | 1061864.71 | 0.00 | 0.00 | 7.10 | 59.04 | 33.86 |
| 3 | 200100486 | 2605.80 | 2605.80 | 2947163.17 | 185012.01 | 0.00 | 0.00 | 0.08 | 93.94 | 5.98 |
| 3 | 988720012 | 1800609.86 | 75568.29 | 556338.94 | 612363.70 | 9120.31 | 16937.72 | 2.46 | 18.12 | 78.87 |
| 3 | 200201266 | 667085.56 | 622786.91 | 480770.65 | 1356320.45 | 13029.02 | 0.00 | 19.83 | 15.31 | 64.85 |
| 4 | 009198611 | 5211.61 | 16937.72 | 1790186.65 | 1322445.01 | 6514.51 | 0.00 | 0.54 | 56.99 | 42.47 |
| 4 | 989810008 | 0.00 | 161559.79 | 2186268.70 | 792164.11 | 0.00 | 0.00 | 5.15 | 69.63 | 25.23 |
| 4 | 969880115 | 0.00 | 723110.33 | 1598660.13 | 818222.14 | 0.00 | 0.00 | 23.03 | 50.91 | 26.06 |
| 4 | 979760084 | 46904.45 | 771317.68 | 2032526.32 | 290547.03 | 0.00 | 0.00 | 24.55 | 64.70 | 10.74 |
| 5 | 009198611 | 5211.61 | 16937.72 | 1790186.65 | 1322445.01 | 6514.51 | 0.00 | 0.54 | 56.99 | 42.47 |
| 5 | 979760084 | 46904.45 | 771317.68 | 2032526.32 | 290547.03 | 0.00 | 0.00 | 24.55 | 64.70 | 10.74 |
| 5 | 979890007 (on-site) | 0.00 | 1279449.26 | 725716.13 | 1128312.69 | 0.00 | 0.00 | 40.83 | 23.16 | 36.01 |
| 5 | 979890007 (off-site) | 22149.33 | 2605.80 | 1818850.48 | 961541.30 | 336148.58 | 0.00 | 0.08 | 57.90 | 42.02 |
| 5 | 989810008 | 0.00 | 161559.79 | 2186268.70 | 792164.11 | 0.00 | 0.00 | 5.15 | 69.63 | 25.23 |
| 5 | 979880074 | 0.00 | 0.00 | 1543938.26 | 1594751.42 | 0.00 | 0.00 | 0.00 | 49.19 | 50.81 |
| 5 | 989760130 | 13029.02 | 1302.90 | 2225355.74 | 884670.11 | 13029.02 | 0.00 | 0.04 | 70.93 | 29.03 |
| 5 | 093976012 | 2605.80 | 1504851.22 | 291849.93 | 1117889.48 | 0.00 | 225401.96 | 47.89 | 9.29 | 35.66 |
| 5 | 969880144 | 0.00 | 1996045.08 | 485982.26 | 634513.03 | 23452.23 | 0.00 | 63.57 | 15.48 | 20.95 |
| 5 | 979890064 | 166771.39 | 19543.52 | 2420790.97 | 527675.10 | 0.00 | 0.00 | 0.62 | 77.22 | 22.15 |
| 5 | 009498548 (off-site) | 0.00 | 217584.55 | 2238384.76 | 677508.77 | 5211.61 | 0.00 | 6.93 | 71.32 | 21.75 |
| 5 | 009498548 (on-site) | 0.00 | 1454038.06 | 1516577.33 | 165468.49 | 0.00 | 0.00 | 46.36 | 48.36 | 5.28 |
| 5 | 989930013 | 106837.92 | 703566.80 | 1413648.12 | 918545.55 | 0.00 | 0.00 | 22.39 | 44.98 | 32.63 |

**Table A5**. Invasive / Nuisance Species Cover of Monitored Mitigation Projects

| *Monitoring Year* | *Permit No.* | *% L. Salicaria* | *% P.Australis* | *% P.Arundinacea* | *% Typha spp.* | *% T.Latifolia* | *% T.Angustifolia* | *% T x Glauca* | *% Total* |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 979880025 | 0.00 | 0.00 | 1.50 | 10.19 | 9.19 | 1.00 | 0.00 | 11.69 |
| 1 | 200001867 | 9.50 | 24.50 | 0.00 | 7.50 | 7.50 | 0.00 | 0.00 | 41.50 |
| 1 | 200100486 | 0.00 | 0.00 | 17.86 | 19.29 | unknown | unknown | unknown | 37.15 |
| 1 | 200001502 | 0.00 | 0.00 | 0.12 | 23.75 | 18.81 | 0.00 | 4.94 | 23.87 |
| 1 | 009499537 | 1.11 | 0.00 | 1.31 | 19.81 | 9.81 | 10.00 | 0.00 | 22.23 |
| 1 | 200001040 | 8.18 | 0.00 | 0.00 | 28.25 | 28.25 | 0.00 | 0.00 | 36.43 |
| 1 | 200002280 | 0.00 | 0.00 | 0.00 | 30.00 | unknown | unknown | 0.00 | 30.00 |
| 1 | 000909888 | 6.00 | 0.00 | 0.00 | 7.50 | 0.00 | 7.50 | 0.00 | 13.50 |
| 1 | 979890007 (off-site) | >75% | present | 0.00 | present | unknown | unknown | unknown | unknown |
| 1 | 988720012 | present | 0.00 | present | present | present | 0.00 | 0.00 | unknown |
| 1 | 199902976 | 1-4% | present | 0.00 | present | present | 0.00 | 0.00 | unknown |
| 2 | 009198611 | 0.13 | 0.00 | 1.25 | 1.50 | 0.00 | 1.50 | 0.00 | 2.88 |
| 2 | 009399139 | 0.00 | 0.00 | 1.75 | 0.50 | 0.50 | 0.00 | 0.00 | 2.25 |
| 2 | 969760068 | 0.00 | 0.00 | 0.00 | 22.90 | 8.60 | 14.30 | 0.00 | 22.90 |
| 2 | 979880025 | 0.00 | 0.00 | 6.00 | 48.63 | 37.00 | 11.63 | 0.00 | 54.63 |
| 2 | 200100486 | 0.00 | 0.00 | 0.01 | 21.25 | 16.25 | 5.00 | 0.00 | 21.26 |
| 2 | 200001040 | 0.00 | 0.00 | 4.44 | 31.88 | 31.88 | 0.00 | 0.00 | 36.32 |
| 2 | 200001867 | 10.50 | 11.50 | 0.00 | 35.00 | 35.00 | 0.00 | 0.00 | 57.00 |
| 2 | 000909888 | 2.00 | 0.00 | 3.5 | 41.50 | 0.00 | 41.5 | 0.00 | 47.00 |
| 2 | 200102561 | 0.00 | 0.00 | 0.00 | 52.50 | 0.00 | 52.5 | 0.00 | 52.50 |
| 3 | 979880025 | 0.06 | 0.00 | 8.19 | 63.00 | 52.13 | 10.88 | 0.00 | 71.25 |
| 3 | 199902976 | 0.33 | 0.00 | 1.00 | 10.00 | 10.00 | 0.00 | 0.00 | 11.33 |
| 3 | 200100486 | 0.00 | 0.00 | 0.50 | 41.00 | 6.50 | 34.50 | 0.00 | 41.50 |
| 3 | 988720012 | present | present | 0.00 | dominant | unknown | unknown | unknown | unknown |
| 3 | 200201266 | 0.00 | 0.00 | 0.00 | 78.75 | 0.00 | 78.75 | 0.00 | 78.75 |
| 4 | 009198611 | 0.38 | 0.00 | 2.00 | 2.13 | 2.13 | 0.00 | 0.00 | 4.50 |
| 4 | 989810008 | 0.00 | 0.00 | 1.00 | 0.25 | 0.00 | 0.25 | 0.00 | 1.25 |
| 4 | 969880115 | 0.00 | 0.00 | 1.00 | 35.60 | 12.80 | 22.80 | 0.00 | 36.60 |
| 4 | 979760084 | 0.00 | 0.00 | 0.00 | 60.00 | 60.00 | 0.00 | 0.00 | 60.00 |
| 5 | 009198611 | 0.30 | 0.00 | 0.00 | 1.20 | 0.20 | 1.00 | 0.00 | 1.50 |
| 5 | 979760084 | 0.00 | 0.00 | 0.00 | 60.00 | 60.00 | 0.00 | 0.00 | 60.00 |
| 5 | 979890007 (on-site) | 0.10 | 0.10 | 2.80 | 30.73 | 1.56 | 29.17 | 0.00 | 33.73 |
| 5 | 979890007 (off-site) | 50.00 | 5.00 | 0.00 | 35.00 | unknown | unknown | unknown | 90.00 |
| 5 | 989810008 | 0.00 | 0.25 | 2.25 | 0.25 | 0.00 | 0.25 | 0.00 | 2.75 |
| 5 | 979880074 | 63.80 | | 0.83 | 0.83 | 0.83 | 0.00 | 0.00 | 65.46 |
| 5 | 989760130 | 0.70 | 0.00 | 0.30 | 0.60 | unknown | unknown | unknown | 1.60 |
| 5 | 093976012 | 8.33 | 0.00 | 0.00 | 3.33 | 0.00 | 3.33 | 0.00 | 11.66 |
| 5 | 969880144 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 5 | 979890064 | present | 30-50 | unknown | unknown | unknown | unknown | unknown | unknown |
| 5 | 009498548 (off-site) | 2.00 | unknown | unknown | 40.00 | 40.00 | 0.00 | 0.00 | unknown |
| 5 | 009498548 (on-site) | 2.00 | unknown | unknown | 60.00 | 60.00 | 0.00 | 0.00 | unknown |
| 5 | 989930013 | present | unknown | unknown | unknown | unknown | unknown | unknown | unknown |