An Evaluation of the Effectiveness of Mitigation Banking in Florida: Ecological Success and Compliance with Permit Criteria

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Kelly Chinners Reiss[1], Erica Hernandez[2], Mark T. Brown[1]

[1]Howard T. Odum Center for Wetlands
University of Florida
Gainesville, Florida 32611-6350

[2]Department of Environmental Protection
Kissimmee Prairie Preserve
Okeechobee, Florida 34972

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The primary purpose of this study was to determine the effectiveness of mitigation banking in Florida by determining compliance with permit success criteria, evaluating the ecological integrity of wetlands within wetland mitigation banks, and evaluating whether permit compliance reflects ecological integrity. Increasing the effectiveness of mitigation banking and improving wetland assessment methodologies should increase the capacity for long term protection and restoration of wetlands. The long term effects of this project will be to improve the ecological performance of mitigation banks, management of mitigation banks, and stewardship of wetland resources to better meet the goals of the Clean Water Act.

Specifically, this study used a collection of available wetland assessment methods combined with permit and document review to determine the condition of restored, enhanced, created, and preserved wetlands within wetland mitigation banks. Permit review involved determining stated permit success criteria and mitigation activities. Two rapid assessment methods, Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP), and two field intensive assessment methods, Hydrogeomorphic approach to assessing wetland function (HGM) and Florida Wetland Condition Index (FWCI), were applied to select wetland assessment areas. A fifth assessment method, the Landscape Development Intensity (LDI) index relies on geographic information systems (GIS) analysis.

Wetland assessment techniques employed varied by wetland type, but all generally relied upon a comparison of the current wetland condition to reference standard wetland condition. Reference standard condition was defined as the condition of wetlands surrounded by undeveloped landscapes and without apparent human induced alterations. By designating a measure of ecosystem condition we refer to what others have described as ecosystem integrity, defined by Karr and Dudley (1981) as “the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region” (p. 56).

As of November 2006, 45 wetland mitigation banks were permitted under Section 373.4135, F.S. in Florida. Twenty-nine of the permitted wetland mitigation banks were visited with functional assessments conducted at 58 wetland assessment areas within those banks between May 2005 and September 2006. The 58 wetland assessment areas were categorized based on the Florida Land Use, Cover and Forms Classification System (FLUCCS; FDOT 1999). Both permit review and application of functional assessment methods were used to determine the ecological integrity of wetland assessment areas within wetland mitigation banks. Permit reviews were conducted for all 29 wetland mitigation banks visited. In addition to permits, annual monitoring reports and other supporting documents were used when available. Credit release schedules and success criteria for each wetland mitigation bank were summarized.

The second part of this study involved application of five wetland assessment methods at 58 wetland assessment areas within 29 wetland mitigation banks. The wetland assessment methods were Uniform Mitigation Assessment Method (UMAM) (Ch. 62-345, F.A.C.), Wetland Rapid Assessment Procedure (WRAP) (Miller and Gunsalus 1999), hydrogeomorphic approach to assessing wetland function (HGM)(Noble et al. 2002; Noble et al. 2004), Florida Wetland Condition Index (FWCI) (Lane et al. 2003; Reiss and Brown 2005a; Reiss and Brown 2005b), and Landscape Development Intensity (LDI) index (Brown and Vivas 2005; Vivas 2007). UMAM, WRAP, and LDI index were completed at 58 wetland assessment areas. HGM (n=15) and FWCI (n=10) assessments were conducted when the type of wetland within the wetland assessment area matched the existing assessment methods.

UMAM (0.47-0.93), WRAP (0.48-0.99), and HGM (0.31-1.00) assessments showed a similar range of scores (on a scale of 0-1.00, where 1.00 represents the highest score attainable, a reflection of the reference standard condition). Macrophyte FWCI scores ranged from 0.21-0.88 (presented as proportion of reference standard condition). A strong positive correlation was found between UMAM and WRAP scores (Spearman rank correlation $r = 0.86$, $p < 0.001$). However for any given wetland, differences from -0.15 to 0.18 between UMAM and WRAP scores were detected with only a single wetland assessment area receiving the same UMAM and WRAP score. Across the board, neither UMAM nor WRAP provided consistently higher or lower scores and no trends were detected specific to wetland community type.

Approximately two-thirds of the wetland assessment areas (n = 38) had wetland scale LDI index scores less than 2.0 (where 0.0 represents no human development), with a mean wetland scale LDI index score of 3.21 ($\sigma = 4.87$), a median of 0.25, and a high score of 16.65. Wetland scale LDI index scores were calculated such that all lands within the 100 m zone surrounding a wetland assessment area designated as restoration, enhancement, creation, or preservation were assigned LDI index scores reflecting natural lands. In this application, the wetland scale LDI index score was considered a tool to predict the potential wetland condition based on the restored support landscape. Bank scale LDI index scores, based on land use within the 100 m zone surrounding a bank, were generally higher, with a mean bank scale LDI index score of 7.78 ($\sigma = 5.36$), a median of 6.53, and a range from 0.00-18.22

Overall, wetland assessment areas in banks that had achieved final permit success criteria did not receive the highest attainable scores for the functional assessment methods employed, suggesting full wetland function has not been achieved. Permit review found that determination of potential credits based on assessment methods (commonly using WRAP) generally assumed that mitigation would result in full wetland function through assigning the highest possible scores for with-mitigation scenarios.

Recommendations

As a result of permit review and associated assessments, eight recommendations for improving permits and/or restoration plans were developed:

1. Define natural communities and associated reference standard conditions;
2. Emphasize groundcover restoration;
3. Monitor plant and animal community structure, not just presence or cover of exotic or nuisance species;
4. Establish and implement fire management plans;

5. Identify sustainability of mitigation within the landscape;
6. Allocate a higher percent of credits for achieving success criteria and a lower percent of credits for task completion;
7. Encourage better coordination and standardization among state and federal agencies and between bank managers and agency personnel;
8. Increase compliance responsibilities of the regulatory agencies.

These suggestions are intended to facilitate improvement in the ecological condition of wetland and upland communities within wetland mitigation banks permitted in the future.

1. Define natural communities and associated reference standard conditions. Defining the target reference standard condition is imperative for successful restoration. In state permits, 13 bank permits described or referred to reference conditions either as a comparison to the literature or an actual field comparison. In contrast, 13 bank permits made no mention of reference conditions in state permits. A few of the bank permits recognized the inability to restore natural communities to reference condition and instead established anticipated ecological lift from pre-bank conditions. Language commonly encountered in permits suggested that the restoration areas would *resemble* a particular community type, but rarely were explanations given as to how this *resemblance* would be determined. Ruiz-Jaen and Aide (2005) noted that existing laws in the United Stated do not require restoration success as defined by comparison to reference standard ecosystems, and that given financial concerns (e.g., increased monitoring costs for monitoring reference sites as well as restoration sites) it is unlikely that such comparisons to reference sites will be required for future restoration efforts. While somewhat dated, the Florida Natural Areas Inventory (FNAI) Guide to the Natural Communities of Florida (1990) would be a useful classification guide in permit review, as it provides a detailed description of each of Florida's native communities.

2. Emphasize groundcover restoration. Restoration of different community types is dependent on more than replacement of canopy structure alone. Most bank permits had some basic requirement for percent cover of desirable, native species. Fourteen (of 29) bank permits included planting and/or seeding as a requirement for credit release (3-20%, typically 5-10%), though this has not been broken down by canopy or groundcover species. However, most of the planting and credit release criteria emphasized trees rather than groundcover species. While the canopy does influence a great deal about the community (i.e., microclimate, establishment of shade tolerant versus intolerant species, etc.), fire management, along with planting and/or seeding, is necessary in many community types to ensure establishment and maintenance of groundcover.

3. Monitor plant and animal community structure. Most permits required minimal cover by a suite of plant species, the percent cover of a desirable species to resemble that of a reference standard community, and/or the percent cover by exotic or nuisance species to be less than some target percentage. However, those criteria do not fully consider the target community structure for both flora and fauna. Ten years ago Mitsch and Wilson (1996) recognized the need for linking structural measures such as species diversity, productivity, or cover, with important ecosystem functions such as wildlife use, nutrient cycling, or organic matter accumulation. While many studies have noted the return of water storage or water quality functions at restoration sites, rarely do such wetlands provide comparable community structure or wildlife

habitat functions (e.g., Brown and Veneman 2001, McKenna 2003, Zampella and Laidig 2003). Mitigation plans should define the target natural community; recognize what physical, chemical, and biological characteristics characterize the target natural community; identify target species and/or community assemblages associated with the target natural community; ensure mitigation plans and subsequent mitigation goals actively meet the life history requirements of those target species and/or community assemblages, including needs such as connectivity, reproduction, food, cover, etc.; and monitor for the occurrence, reproductive success, and long-term maintenance of these target species and/or community assemblages to ensure mitigation goals have been met.

4. Establish and implement fire management plans. Fire management is crucial to successful maintenance of many of Florida's natural communities (for details see FNAI 1990). While 26 of the studied banks included some fire dependent communities, only eight banks had a credit release associated with conducting a prescribed fire, and a few more banks required prescribed fire as part of the final release criteria. While prescribed fire was indicated for achieving successful ecosystem restoration, many barriers arose to prevent implementation of prescribed fire management plans. At least seven banks included in this study reported that they were behind in accomplishing their prescribed burn plan for site specific condition, usually because the site was either too wet or too dry. Mitigation bank permits should require successful implementation of prescribed fire and community response to this management tool for credit release in fire-dependent communities.

5. Identify sustainability of mitigation within the landscape. Having realistic goals as to the potential function of a wetland mitigation bank should be a priority for assessing with mitigation bank scenarios. The landscape location of compensatory mitigation projects continues to be an important consideration. The landscape of Florida has been cross ditched and drained with human settlement, and as such, an ideal landscape setting probably does not exist within the state. Forman and Deblinger (2000) suggest that roadways and conservation areas should be separated, and yet many of the Florida wetland mitigation banks are bordered by busy roadways (e.g., Barberville Conservation Area bordered to the south SR-40; Everglades Mitigation Bank/Phase I (FPL) bordered to the east by Card Sound Rd. and the west by US-1) or bisected by busy roads (e.g., Tosohatchee bisected by the Beachline Expressway SR-528; Little Pine Island bisected by SR-78). Consideration of potential wetland functional lift should incorporate a landscape perspective. Wetland mitigation in general must be considered a trade-off between temporal and spatial ecosystem function, and the bottom line comes back to having a realistic expectation of attainable function in the calculated with mitigation bank scenario. That is, when a bank is adjacent to developed lands, the location and landscape functional component should never be expected to achieve a *perfect* score. Further, credits should reflect the landscape condition and be realistically based on limitations to water budget, water quality, connectivity for fauna populations, core to edge ratios for associated species, edge effects, etc. Such concerns will vary for every bank, being based on the community types involved, the associated fauna species, bank size, and surrounding land uses.

6. Allocate a higher percent of credits for achieving success criteria and a lower percent of credits for task completion. Incremental credit release based on completion of activities that do

not necessarily equate to demonstrated achievement of function should be avoided. Mitsch and Wilson (1996) argued a decade ago that efforts to determine wetland restoration or creation success were flawed due to a lack of application of sound wetland science and the weight of schedule-driven construction activities, and yet often credit release criteria in bank permits were based mainly on task completion. Activity-based credit releases averaged about 50% of the total potential credits and represented the preservation and completion of the mitigation "work" at the bank. Although it was recognized that the actual work was sometimes equated with ecological enhancements, mitigation success may be improved if credits releases were weighted more toward incremental improvement and community response to these treatments and actions, rather than simply completion of predetermined activities.

7. Encourage better coordination and standardization among the state and federal agencies and between bank managers and agency personnel. In a study of compensatory wetland mitigation across the United States, ELI (2002) suggested that the differences among permits and supporting documents make comparisons difficult. This study found that was true not only between federal and state documents, but also among documents from the four permitting agencies in Florida. In fact, simply tracking down documentation for each wetland mitigation bank proved difficult in many instances. Once fully on-line, the Regional Internet Bank Information Tracking System (RIBITS), a new internet-based tracking system for United States Army Corps of Engineer (USACE) districts to monitor wetland mitigation banks, should provide a warehouse for wetland mitigation bank documentation at the federal level. A similar electronic database for tracking and storing wetland mitigation bank permits at the state level would be useful. However, suggestions for centralized databases at the state level have been made in the past (e.g., Kentula et al. 1992) with little recent progress. All documentation leading up to permit implementation, permits themselves, permit modifications, credit ledgers, and other communications relating to monitoring and management should be centralized and available for review in a digital format. Further, mitigation banks should submit digital copies of reports and communications to be kept in a centralized file. Centralizing and tracking this documentation will make the review process more transparent and allow for better tracking of bank histories.

8. Increase compliance responsibilities of the regulatory agencies. While time and costs are no doubt limiting factors in the availability of agency personnel to conduct frequent and thorough site visits, increasing agency oversight and interactions with bank managers should enhance overall compliance and achievement of final success. Requiring frequent inspection should provide motivation for bank managers to maintain and improve ecosystem function between site visits. While no specific time schedule will meet the needs of all banks or regulators, maintaining regular communication with banks, even those not requesting a credit release, is encouraged. At a minimum, no agency should release credits without a bank inspection of sufficient detail to confirm that monitoring reports submitted by the banker correctly document site condition and that required release criteria were met.

Most of the wetland mitigation banks showed potential to provide increased wetland function following restoration, assuming completion of restoration activities. However, for many wetland banks, landscape position is the most limiting factor to attainment of full functional. Clearly defining reference standard conditions and having realistic expectations of the potential functional gain may lessen the potential of functional loss in wetland mitigation banks. Many of the findings for Florida mitigation banks corroborate recent findings in Massachusetts (Brown and Veneman 2001), California (Ambrose et al. 2006), and Ohio (Mack and Micacchion 2006), that while most wetland mitigation banks meet permit success criteria, this does not equate to the structure and function of natural wetland communities. Basic ecological principles can better dictate a more sensible way to plan, implement, and manage mitigation banks, with considerations including edge effects such as roads and towers, core to edge ratios for habitat, fragmentation and habitat loss in the landscape, and species interaction. If these basic principles are overlooked, then the assumption of achieving function has no validity. Mitigation banks must be assessed realistically for credit potential.

CHAPTER 1
INTRODUCTION

Wetland mitigation banking has grown steadily in the last decade since state law and rules on mitigation banks were adopted, with 45 wetland mitigation banks currently permitted in Florida. Additionally federal mitigation policy is trending toward a preference for mitigation banks, such as the 1998 Transportation Equity Act for the 21st Century "TEA-21 Restoration Act" (Public Law 105-178) and the recent proposed rule for Compensatory Mitigation for Losses of Aquatic Resources (2006). While there are several studies evaluating project-specific mitigation effectiveness (e.g. FDER 1991b; FDER 1992; Brown and Veneman 2000; Campbell et al. 2002; Morgan and Roberts 2003), few studies have been conducted on mitigation banks (though see Brown and Lant 1999; Ambrose et al. 2006; Mack and Micacchion 2006). The Florida Department of Environmental Protection (FDEP), in conjunction with the University of Florida's Howard T. Odum Center for Wetlands (UF-CFW) carried out this study to evaluate the ecological integrity of mitigation banks. This study also presents a comparison of different wetland assessment methodologies used to evaluate the ecological integrity of 29 banks. The study was funded through a grant from the United Stated Environmental Protection Agency (USEPA) Region IV.

Background

For over 20 years, the federal government, through the Clean Water Act, and the state of Florida, beginning with the Warren S. Henderson Wetlands Protection Act of 1984, have regulated wetland impacts. Wetland permitting programs are aimed at maintaining wetland functions and values through avoidance and minimization of wetland impacts and to compensate for unavoidable impacts through wetland mitigation. In 1991, the state conducted an audit of mitigation permitting operations (FDER 1991a) and a study that assessed compliance and effectiveness of a subset of permitted mitigation projects (FDER 1991b). Like other reports from around the country (e.g., Roberts 1993; Race and Fonseca 1996; Brown and Veneman 2000; Robb 2002; Morgan and Roberts 2003), these studies found significant problems with permit compliance, permit success criteria, and/or the potential for long-term viability of the mitigation area.

To address some of these issues, mitigation policies began to authorize and encourage more consolidated mitigation projects, such as mitigation banks and regional offsite mitigation areas. In Florida, that endorsement came with the passage of the Environmental Reorganization Act of 1993, specifically in Section 373.4135, Florida Statutes (*Mitigation banks and offsite regional mitigation*), which initially authorized the use of mitigation banks and offsite regional mitigation to offset impacts, and directed the development of mitigation bank rules. These rules were initially promulgated in 1994 and reflected in Section 373.4136, F.S. (*Establishment and operation of mitigation banks*) in 1996. Florida representatives worked closely with federal partners and contributed to the development of the *Federal Guidance for the Establishment, Use and Operation of Mitigation Banks*, published in the Federal Register in November, 1995, and the subsequent *Joint State/Federal Mitigation Bank Review Team Process* (the "Greenbook," cited as Story et al. 1998), which details how to integrate state and federal permitting for mitigation banks in Florida.

In 2001, the National Research Council conducted a review of the federal mitigation program (NRC 2001). Some of the common findings were:

- high rates of non-compliance;
- inadequate permit performance and success criteria;
- limited long term monitoring and management;
- sites located poorly in landscape;
- inadequate agency support in compliance monitoring, tracking, training, and research.

The report also emphasized the need to avoid and minimize wetland impacts in the first place. Only when impacts to wetlands cannot be avoided should mitigation be an option. Recommendations for advancing the mitigation program included improvements in technical information requirements, reference-based success criteria, long-term stewardship requirements (including conservation easements and financial responsibility), assessment methods based on function, and consideration for long-term viability within the watershed. It was thought that mitigation banks would offer advantages in addressing landscape planning, financial assurance, and long-term management and thus circumvent the problems that were plaguing compensatory mitigation. Additionally, compliance monitoring would be facilitated. Many of the recommendations were incorporated into the federal permitting process for mitigation banks today.

Mitigation Bank Regulations

In Florida, mitigation banks are regulated by both federal and state agencies. Because both sets of regulatory agencies cooperated during the development of the regulations, federal and state regulations are similar in principle components and integrally linked in others (i.e., federal agencies generally accept the state approved preservation and financial assurance instruments). For the purposes of this study, mitigation banks and regulations will be discussed within the context of state permits, with any significant federal differences noted. This state-centric approach is taken principally because more statewide data and documents were available than federal ones. Additionally, as will be detailed later, the state has permitted about a dozen more banks than have been federally authorized (generally due to permitting delays rather than fundamental differences in review).

The principle laws that regulate Florida's mitigation bank program are Florida Statute 373.4135 - *Mitigation banks and offsite regional mitigation*, and Florida Statutes 373.4136 - *Establishment and operation of mitigation banks*. Statute 373.4135 authorizes use of mitigation banks and recognizes the "improved likelihood of environmental success" associated with the establishment of mitigation banks, specifically favoring "the restoration and enhancement of degraded ecosystems and the preservation of uplands and wetlands as intact ecosystems . . . through restoration of ecological communities that were historically present."

The criteria for establishing mitigation banks in Section 373.4136, F.S. requires that they:

(a) improve ecological conditions of the regional watershed;
(b) provide viable and sustainable ecological and hydrological functions for the proposed mitigation service area;
(c) be effectively managed in perpetuity;

(d) prevent destruction of areas with high ecological value;
(e) achieve mitigation success;
(f) be located adjacent to lands that will not adversely affect the perpetual viability;
(g) meet all wetland permitting criteria;
(h) have sufficient legal or equitable interest in the property to ensure perpetual protection and management; and
(i) meet financial responsibility requirements.

Another important section in this statute defines credits as units of increased ecological value to be determined by a functional assessment method also used to determine ecological "debits" for wetland impacts. The statute lists factors to be considered when determining credits: the quantity and quality of the wetland and upland enhancement/restoration expected and the likelihood of achieving and maintaining the target condition; the degree that management activities such as prescribed fire promote natural ecological conditions; the location in the landscape relative to regionally significant and/or wildlife corridors; wetland and upland ecological and hydrological connections and listed species habitat; and the degree that the property is already protected by land use restrictions or the potential for adverse effects if the site is not preserved.

Further, this statute indicates that permits should include a schedule for release of credits based on the performance and criteria in the permit. Factors to be considered include the type of mitigation activities (whether solely preservation or other types of mitigation), time required for those activities to be successful, and ecological value associated with each mitigation activity. In practice, most banks receive 10-25% of their total potential credits upon preservation (usually through a recorded conservation easement) and the provision of the required financial assurance (usually performance bonds or letter of credit payable into a standby trust) for the implementation and long-term management of the plan. Additional credits are released for specific mitigation activities such as physical construction (e.g., ditch filling, road removal, etc.), exotic species removal, and/or planting. Further incremental credit release is based on regular monitoring and documentation of trending toward success culminating in a determination of final success.

Statute 373.4136 also establishes guidelines for the determination of the Mitigation Service Area (MSA) based on regional watersheds. Finally, it allows for the FDEP and state Water Management Districts (WMDs) to establish more specific rules, especially pertaining to preservation, financial assurance, and credit assessment methods. FDEP adopted and administers the mitigation bank rule, Chapter 62-342, Florida Administrative Code (F.A.C.), and three of the five WMDs (South Florida Water Management District, SFWMD; Southwest Florida Water Management District, SWFWMD; and St. Johns River Water Management District, SJRWMD) also adopted and administer similar rules within their jurisdiction. Which agency issues a state mitigation bank permit depends on the location and intended use of the bank, as determined through operating agreements between the agencies.

In addition to the statutory requirements, the mitigation banking rules provide increased guidance on intent, definitions, details on the required components of a permit, credit assessment and release, and specifics on the instruments for preservation and for financial assurance. However, the mitigation banking rules do not specify the functional assessment method to be used. As a result, mitigation banks have been assessed by several function and ratio-based methods. A standard, function-based method for debit and credit assessment for both mitigation banks and all other forms of compensatory mitigation, called the Uniform Mitigation Assessment Method (UMAM), went into effect in February 2004 under Rule 62-345, F.A.C. It is now used throughout the state on all projects requiring mitigation. Mitigation banks permitted prior to 2004 were grandfathered to continue to use their original assessment method, but a few have chosen to convert to UMAM.

Federal Coordination

The *Federal Guidance for the Establishment, Use and Operation of Mitigation Banks* (1995) was issued jointly by the United States Army Corps of Engineers (Corps), the United States Environmental Protection Agency (USEPA), the Fish and Wildlife Service (FWS), and, as programmatically appropriate, the Natural Resource Conservation Service (NRCS) and the National Marine Fisheries Service (NMFS). Evaluation of a proposed mitigation bank is undertaken by an interagency Mitigation Bank Review Team (MBRT) with federal authorization of a mitigation bank determined through a binding Mitigation Banking Instrument (MBI) that is signed by both the MBRT members and the banker. The MBI details the establishment, use and operational requirements of the mitigation bank, but dredge and fill operations associated with restoration activities, such as grading, ditch filling, installation of water control structures, etc., may require a separate 404 permit.

An important difference between state and federal permitting review is that once a formal permit application is received, the state is bound by statutory time clocks for review, information requests, and approval while the federal agencies are not. While the state and federal guidelines and goals are similar, programmatic and procedural differences can lead to disparate approvals. The development of the *Greenbook* (Story et al. 1998) was an attempt to minimize duplicate review. It provides for the state permit reviewer to co-chair the MBRT with the Corps. It establishes a pre-application protocol that involves a preliminary prospectus and determination of appropriateness. It stipulates a method of determining credits through ratios, Wetland Rapid Assessment Method (WRAP), or variations thereof. Additionally, it provides guidance indicating that the state permit application not be submitted until significant issues such as the mitigation plan, credit assessment, and MSA, have consensus agreement. However, the *Greenbook* is not binding on the state, the Corps, or the banker, so adherence to the provisions varies. Even when there is consensus on the major components, the final development of details and the permit under the state's time clock generally precedes that of the federal MBI. Therefore, differences in the final authorizations are common, but typically minor. This project has focused its review on state permits and requirements, but extends to federal requirements as well due to the similarities in state permits and federal MBIs.

Florida Wetland Mitigation Banks

The 45 state permitted wetland mitigation banks, which are in different stages of project development, served as the initial sample pool for this project (Figure 1-1). Table 1-1 lists the banks by name, permitting agency, permit number, permit issue date, bank size, potential credits, type of wetland credits available, and location (county(ies)). Two of the wetland mitigation

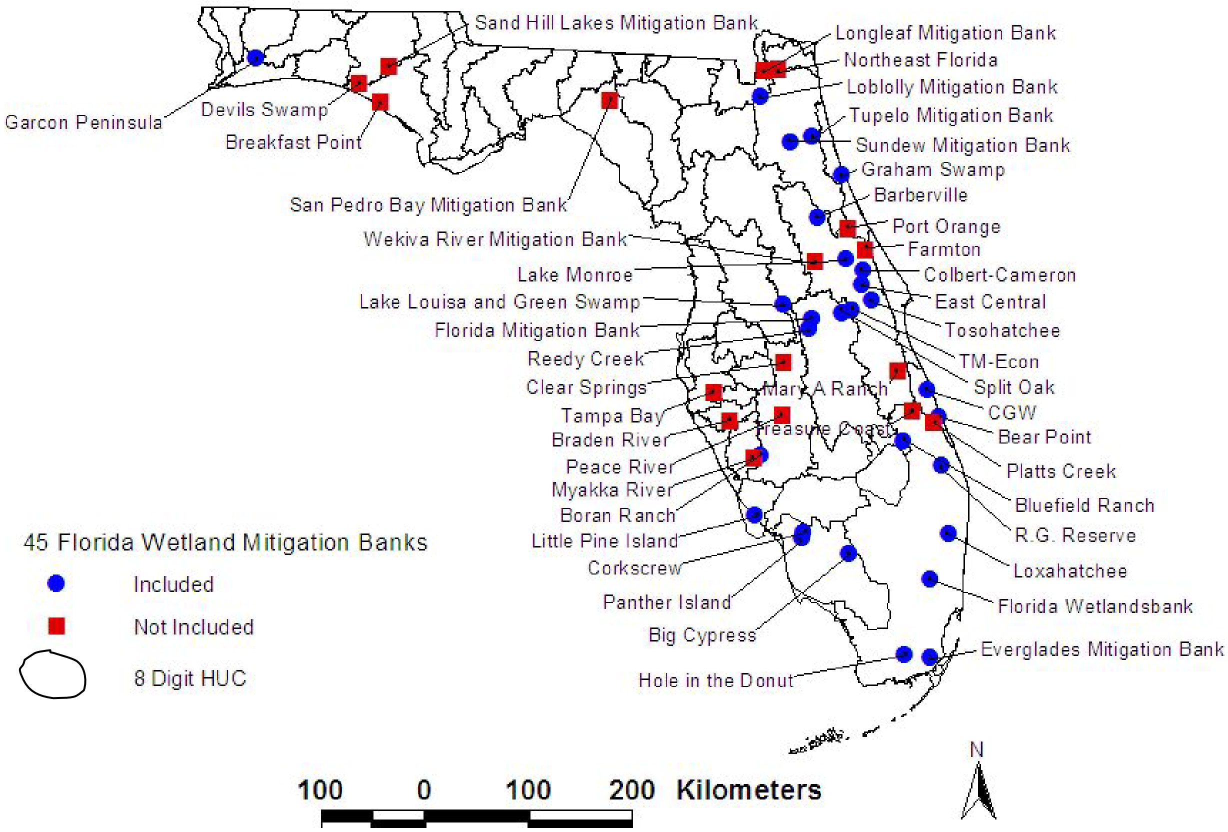


Figure 1-1. Location of 45 Florida wetland mitigation banks. Wetland mitigation banks included in this study represented by blue circles (●); wetland mitigation banks not included in this study represented by red squares (■). Background is 8-digit Hydrologic Cataloguing Units (HUC) of Florida from the Florida Department of Environmental Protection (available at http://www.fgdl.org, cover map WATERSHED).

banks have received permits for additional phases, Boran Ranch and Everglades Mitigation Bank (FPL), and as such, each phase (permit) is listed separately. Currently, SJRWMD has issued the most wetland mitigation bank permits with 16, followed closely by FDEP with 14 (Figure 1-2A). The remaining 15 mitigation banks were permitted through SFWMD (n = 9) and SWFWMD (n = 6). When considering land area covered by wetland mitigation, SJRWMD is responsible for 50% of total area in wetland mitigation banks with 23,654 ha (58,448 ac) (Figure 1-2B). FDEP is responsible for over one-third of the area with 17,832 ha (44,061 ac) permitted. SWFWMD (11%) and SFWMD (2%) are responsible for just 5,494 ha (13,576 ac) and 1,195 ha (2,952 ac) of wetland mitigation banks, respectively.

Definition of Success

This research has set out to determine the success of wetland mitigation banking through a review of permit compliance and an evaluation of the ecological integrity of wetlands using a variety of wetland assessment techniques. Permit assessment involved determining if stated permit success criteria and compliance with those standards would reflect ecological integrity.

Table 1-1. Details of the permitted wetland mitigation banks. Twenty-nine wetland mitigation banks were included in this study(*). Both Boran Ranch and Everglades Mitigation Bank (FPL) were permitted in two phases and thus both are listed twice (once for each permit).

Mitigation Bank	Public Land	State Agency	MBI+	Issue Date	Hectares	Acreage	Potential Credits	Released Credits	Used Credits	Released (%)
Barberville*	Y	SJRWMD	No	6/1/1996	148	366	84.30	54.20	35.10	64
Bear Point*	Y	FDEP	Yes	7/25/2003	128	317	49.80	25.00	3.70	50
Big Cypress*	N	SFWMD	Yes	9/9/1999	518	1,280	1,001.78	559.20	246.23	56
Bluefield Ranch*	N	SFWMD	Yes	11/15/2001	1,091	2,695	1,240.00	558.14	135.62	45
Boran Ranch, Phase I*	N	SWFWMD	Yes	8/26/1997	96	237	108.59	100.78	98	92
Boran Ranch, Phase II	N	SWFWMD	Yes	Unknown	69	170	102.53	16.99	5.20	17
Braden River	N	SWFWMD	No	Unknown	141	349	71.69	0.00	0.00	0
Breakfast Point	N	FDEP	Yes	10/11/2004	1,877	4,637	1,051.66	76.29	21.36	7
CGW*	N	SJRWMD	Yes	6/10/1998	61	150	63.10	50.50	46.20	80
Clear Springs	N	SWFWMD	No	10/28/2003	473	1,168	438.00	0.00	0.00	0
Colbert-Cameron*	N	SJRWMD	Yes	10/28/1996	1,054	2,604	718.80	560.30	354.60	78
Corkscrew*	N	FDEP	Yes	6/4/2004	257	635	351.80	0.00	0.00	0
Devils Swamp	N	FDEP	Yes	10/11/2004	1,234	3,049	586.80	0.00	0.00	0
East Central*	N	SJRWMD	Yes	May-97	385	952	286.30	286.30	176.70	100
Everglades Mitigation Bank/Phase I*	N	FDEP	Yes	10/1/1996	1,669	4,125	424.50	382.00	290.69	90
Everglades Mitigation Bank/Phase II*	N	FDEP	unknown	10/16/2003	3,653	9,026	1,769.53	184.60	80.64	10
Farmton	N	SJRWMD	Yes	4/11/2000	9,681	23,922	4,585.20	664.50	588.40	14
Florida Mitigation Bank*	N	FDEP	Yes	5/28/1997	640	1,582	847.50	847.50	729.80	100
Florida Wetlandsbank*	Y	SFWMD	Yes	2/9/1995	170	420	370.00	367.37	367.37	99
Garcon Peninsula*	N	FDEP	Yes	4/12/2001	136	337	172.39	77.40	7.27	45
Graham Swamp*	N	FDEP	Yes	9/5/1996	27	66	32.50	29.25	5.50	90
Hole in the Donut*	Y	FDEP	**	2/15/1995	2,529	6,250	6,250.00	2,111.37	2,111.37	34
Lake Louisa and Green Swamp*	N	SJRWMD	Yes	10/10/1995	408	1,007	297.90	245.60	212.14	82
Lake Monroe*	Y	SJRWMD	Yes	9/12/1995	244	603	199.90	130.00	110.90	65
Little Pine Island*	Y	FDEP	Yes	2/6/1996	633	1,565	807.00	279.40	161.09	35
Loblolly Mitigation Bank*	N	SJRWMD	Yes	9/9/2003	2,528	6,247	2,034.00	508.58	315.52	25
Longleaf Mitigation Bank	N	SJRWMD	Yes	3/31/2004	1,223	3,021	813.80	105.54	20.34	13
Loxahatchee*	N	FDEP	Yes	2/18/2000	512	1,264	641.60	320.80	221.58	50
Mary A Ranch	N	SJRWMD	No	11/12/2002	837	2,069	1,252.80	302.90	154.47	24

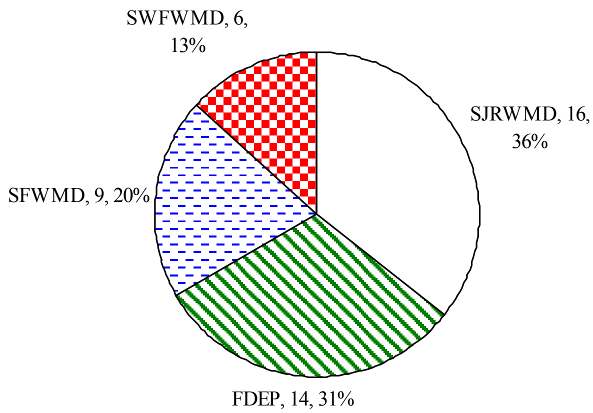
Table 1-1. Continued.

Mitigation Bank	Public Land	State Agency	MBI+	Issue Date	Hectares	Acreage	Potential Credits	Released Credits	Used Credits	Released (%)
Myakka River	N	SWFWMD	No	6/29/2004	154	380	224.60	38.20	9.09	17
Northeast Florida	N	SJRWMD	Yes	9/5/1997	315	779	407.30	400.00	375.00	98
Panther Island*	N	SFWMD	Yes	3/11/1999	1,128	2,788	934.64	799.24	588.72	86
Peace River	N	SWFWMD	No	Unknown	197	487	137.82	0.00	0.00	0
Platt's Creek	N	SFWMD	No	4/10/2003	33	82	69.51	0.00	0.00	0
Port Orange	N	SJRWMD	No	1/13/2004	2,314	5,719	1,176.30	237.90	73.00	20
R.G. Reserve*	N	SFWMD	No	1/9/2003	258	638	32.48	2.55	1.20	8
Reedy Creek*	N	SFWMD	Yes	2/13/1997	1,211	2,993	908.90	563.35	419.39	62
San Pedro Bay Mitigation Bank	N	FDEP	Yes	2/13/2002	2,731	6,748	1,083.00	170.80	6.02	16
Sand Hill Lakes Mitigation Bank	N	FDEP	Yes	8/5/2005	872	2,155	298.40	104.40	0.00	35
Split Oak*	Y	SFWMD	unknown	6/13/1996	425	1,049	206.50	88.80	88.80	43
Sundew Mitigation Bank*	N	SJRWMD	Yes	8/11/2001	853	2,107	698.30	194.20	101.54	28
Tampa Bay	N	SWFWMD	No	9/25/2002	65	161	111.55	0.00	0.00	0
TM-Econ*	N	SJRWMD	Yes	1/8/2003	2,104	5,199	1,568.60	227.97	150.31	15
Tosohatchee*	Y	SJRWMD	Yes	Unknown	531	1,312	185.00	185.00	152.90	100
Treasure Coast	N	SFWMD	No	3/9/2005	1,030	2,545	1,033.43	0.00	0.00	0
Tupelo Mitigation Bank*	N	SJRWMD	Yes	1/23/2004	617	1,525	459.70	144.85	144.52	32
Wekiva River Mitigation Bank	N	FDEP	No	6/1/2005	665	1,643	390.12	97.53	7.06	25

*Wetland mitigation bank included in this study
+ Federal Mitigation Banking Instrument (MBI)
** Has federal approval in the form of an “in lieu fee” type agreement; state permit also more closely resembles an in-lieu-fee arrangement
Information from: Florida Department of Environmental Protection, October 2006

(A)

Distribution of Wetland Mitigation Banks
by State Agency



(B)

Land Area in Wetland Mitigation Banks
by State Agency

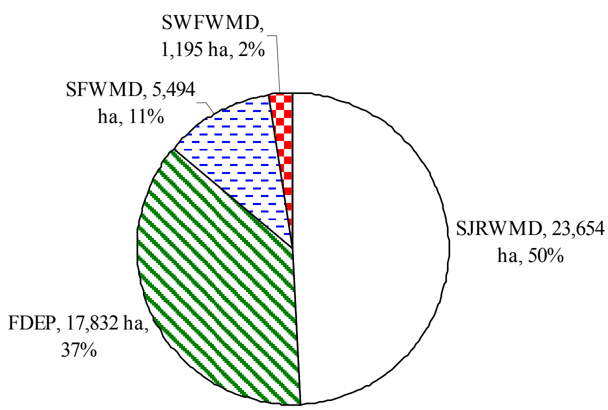


Figure 1-2. Florida state agency responsibility for wetland mitigation banks for A) currently permitted mitigation banks and B) land area of permitted wetland mitigation banks. State agencies are St. Johns River Water Management District (SJRWMD), Florida Department of Environmental Protection (FDEP), South Florida Water Management District (SFWMD), and Southwest Florida Water Management District (SWFWMD).

The wetland assessment techniques employed varied by wetland type, but all generally relied upon the comparison of the current wetland condition to wetland reference standard condition.

Because mitigation is meant to offset function lost from wetland impact activities, ideally mitigation bank *success* would be measured by a direct comparison of functions lost at impact sites to functions gained at the mitigation site. However, this was not feasible as part of this study, as the permitted impact sites no longer exist in their pre-impact condition and therefore could not be studied in the same way as the mitigation bank sites. Therefore, in this study, success was evaluated using the mitigation bank permits and mitigation bank study sites alone.

Permit success is defined by demonstration of achievement of permit success criteria. Within a given permit, achievement of specific performance standards or release criteria determines awarding of some proportion of total potential wetland credits. For instance, an initial credit release generally requires legal activities such as recording a conservation easement and assertion of financial assurance. Credit release criteria can also include physical activities such as earth moving, ditch plugging, and land grading, exotic or nuisance species removal, and planting desirable species. Interim and final success is often defined by achieving a specified percent cover of desired vegetation or resemblance of the mitigation wetland to a natural community.

The definition of success based on ecological integrity can be defined by achieving specific scores by various functional assessment methods. In this case, success is defined by the quantitative comparison of a mitigation wetland to a reference standard wetland. Only 14% of the banks studied included permit criteria based directly on the achievement of some functional assessment index score (e.g., a 1.00 Wetland Rapid Assessment Procedure (WRAP) score).

Merging these two definitions of success proves challenging as each is based on different assumptions. First, the definition of success for permitting relies on the assumption that completion of particular activities (e.g., ditch plugging, exotic species removal, etc.) in fulfilling permit compliance will result in functional gain and therefore provides successful mitigation. Complicating this assessment is the fact that the release of credits is generally incremental, based on activities such as site preservation, ditch fill, and cattle removal. On the other hand, the definition of success for ecological integrity is based on a comparison against the reference standard wetland condition.

Purpose of Study

The primary purpose of this study was to determine the effectiveness of mitigation banking in Florida by determining compliance with permit success criteria, evaluating the ecological integrity of wetlands within wetland mitigation banks, and evaluating whether permit compliance reflects ecological integrity. Increasing the effectiveness of mitigation banking and improving wetland assessment methodologies should increase the capacity for long term protection and restoration of wetlands. The long term effects of this project will be to improve the ecological performance of mitigation banks, management of mitigation banks, and stewardship of wetland resources to better meet the goals of the Clean Water Act.

Specifically, this study used a collection of available wetland assessment methods combined with permit and document review to determine the condition of restored, enhanced, created, and preserved wetlands within wetland mitigation banks. Two rapid assessment methods, Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP), and two field intensive assessment methods, Hydrogeomorphic approach to assessing wetland function (HGM) and Florida Wetland Condition Index (FWCI), were applied to select wetland assessment areas. A fifth assessment method, the Landscape Development Intensity (LDI) index relies on geographic information systems analysis.

This document is designed to present a summary of findings and synthesis of the permit and document review and field assessments. Chapter 2 Methods provides an overview of the location of Florida wetland mitigation banks, site visit protocol, procedures of permit and document review, and determination of reference standard condition. A detailed description of the field standard operating procedures can be found in Appendix A. Presentation of results from the permit and document review and field surveys are found in Chapter 3 Review of Permit Success Criteria and Credit Release and Chapter 4 Determination of Ecological Integrity, respectively. A presentation of field data sheets and a summary of permit review for each wetland mitigation bank can be found in Appendix B and Appendix C, respectively. Chapter 5 Permit Review and Ecological Integrity synthesizes findings from permit and document review and field assessments by presenting case studies of three wetland mitigation banks. Chapter 6 Discussion reviews major findings and recommendations and addresses the effectiveness of wetland mitigation banking in developing and maintaining wetlands with high ecological integrity.

CHAPTER 2
METHODS

The primary goal of this project was to determine the effectiveness of mitigation banking in Florida using permit and documentation review, field assessment, and geographic information systems (GIS). Twenty-nine wetland mitigation banks were included in this study, with quantitative, standardized assessment methods used to determine the ecological integrity of 58 smaller wetland assessment areas within the 29 banks. The availability of permits and other documents associated with wetland mitigation banks varied greatly. In general, supporting documentation gathered included permits, staff reports, monitoring reports, management plans, and/or site visit summaries, which were summarized to include credit potential, credit release schedules, and success criteria for each bank. Field assessments were conducted on select wetland assessment areas within the banks, but rarely covered the entire bank area. While some banks were relatively small in area and homogeneous in wetland community type, many covered large areas and contained a variety of wetland community types. The number of wetland assessment areas selected depended on a combination of site-specific conditions such as homogeneity of wetland community types, mitigation activities completed to date and progress towards success criteria, area of wetland, type of mitigation (i.e., restoration, creation, enhancement, or preservation), and general site conditions. Two rapid assessment methods, Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP), were used at all 58 wetland assessment areas, as was the Landscape Development Intensity (LDI) index, a GIS based assessment tool. When the wetland assessment area matched the communities with developed standard guidebooks for the Hydrogeomorphic wetland classification (HGM) and/or the Florida Wetland Condition Index (FWCI), these methods were also completed. This chapter presents background information on the assessment sites, permit and document review procedures, reference standard condition, and field site visits procedures.

Mitigation Bank Locations

Twenty-nine of the 45 permitted mitigation banks were included in this study. Banks were located throughout the four Florida wetland regions (Lane 2000), though only a single wetland mitigation bank, Garcon Peninsula, was located in the panhandle wetland region (Figure 2-1). Just over half of the study mitigation banks (n = 15) were within the central wetland region, with 10 in the south wetland region, and three in the north wetland region. Site selection criteria included length of time since permit issue, progress towards mitigation activities, and land owner or manager cooperation for site access. For the purposes of this study, the two phases of Everglades Mitigation Bank were considered as separate banks, as Phase I is nearing final credit release with 90% of credits awarded, and Phase II has limited credit release at 10%.

All of the wetland mitigation banks permitted before 2001 were visited, with the exception of two banks where field access was denied (Figure 2-2). In addition, banks permitted as recently at 2004 were also part of this study. The remaining mitigation banks either had no credits released to date and/or were lacking their federal MBIs. The four oldest banks included in this study were Florida Wetlandsbank (permit issue date February 9, 1995), Hole in the Donut (February 15, 1995), Lake Monroe (September 12, 1995), and Lake Louisa and Green Swamp

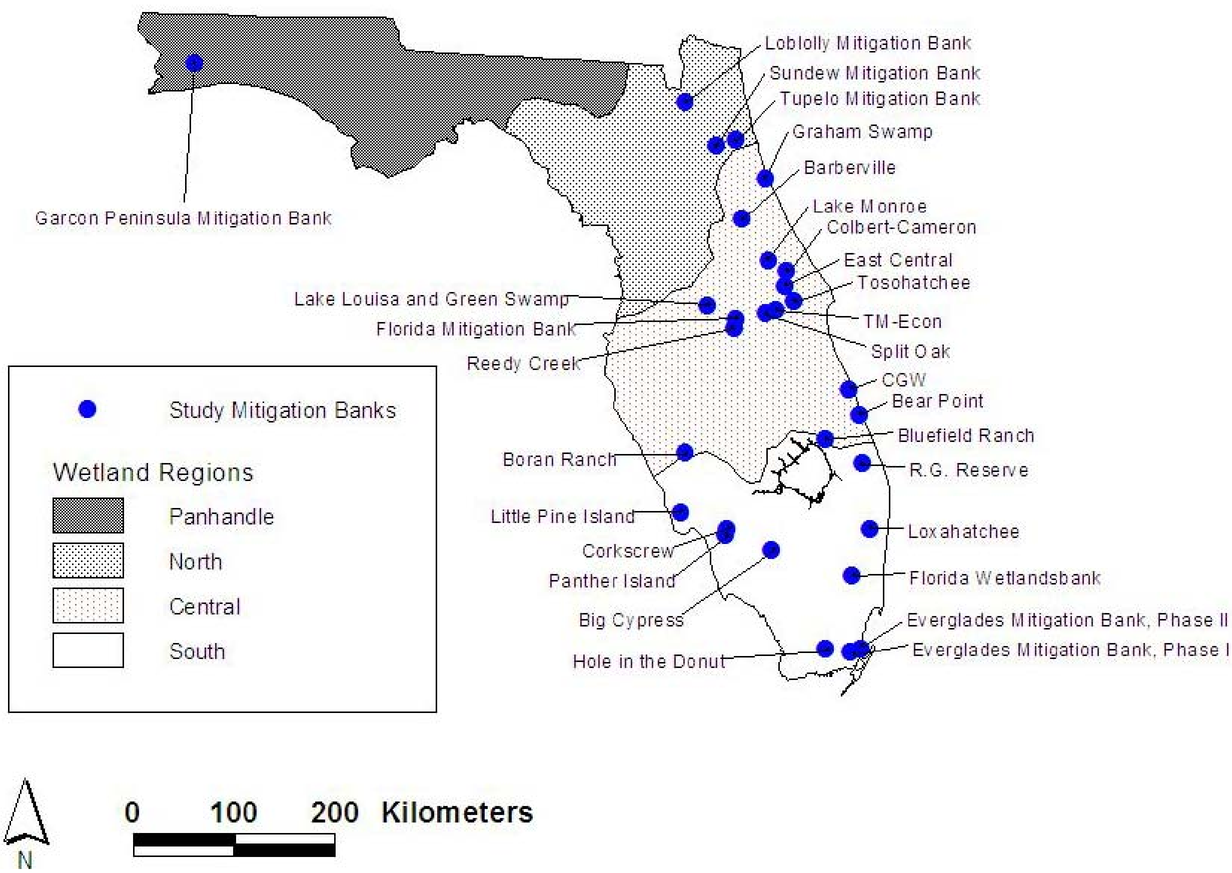


Figure 2-1. Location of 29 wetland mitigation banks included in this study. Wetland region boundaries according to Lane (2000).

(October 10, 1995). The two most recently permitted banks included Tupelo Mitigation Bank (January 23, 2004) and Corkscrew (June 4, 2004).

Mean bank size was 826 ha (2,040 ac) (σ = 887 ha; 2,192 ac), ranging from 27 ha (66 ac) at Graham Swamp to 3,653 ha (9,026 ac) at Everglades Mitigation Bank/Phase II. Twenty-seven of the 29 banks had freshwater wetlands. Three of these mitigation banks had both freshwater and saltwater wetlands, and the remaining two banks had salt marsh or/or mangrove wetlands. The range in potential credits was large, from 32.5 potential credits at Graham Swamp to 6,250 potential credits at Hole in the Donut. The median was 425 potential credits. It is important to mention that Hole in the Donut operates under a permit that more closely resembles an in-lieu-fee agreement. Funds for restoration activities are collected at the time of impact permit issuance until there is sufficient money to complete a portion of the required restoration. Thus, initially, impacts occur prior to mitigation. However, while there is a potential of 2,529 ha (6,250 ac) to restore at Hole in the Donut, work is being conducted incrementally, as financial resources allow, and is currently "ahead" in initial restoration area relative to impact area.

Progress towards mitigation success within a bank can be measured based on potential credits released. The wetland mitigation banks studied ranged from no credits released at Corkscrew to

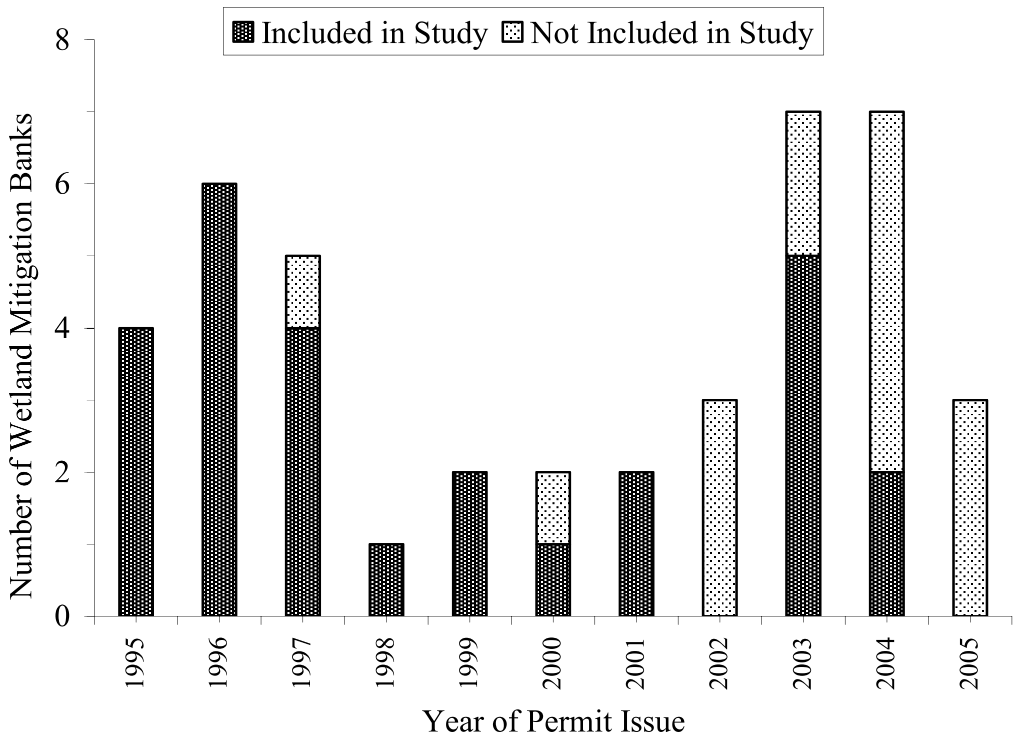


Figure 2-2. Florida wetland mitigation banks permitted by year.

100% of the potential credits released at three wetland mitigation banks: East Central, Florida Mitigation Bank, and Tosohatchee.

Permit Review Procedures

Permit review involved determining compliance with permit criteria. Acquisition of complete documentation for each wetland mitigation bank proved difficult. Many of the initial permits and technical reports were only available in draft forms, and few permit modifications were acquired. State permits were obtained for all 29 banks, with monitoring reports available for 18 banks. Details of permit compliance were based on phone interviews with appropriate personnel from Florida Department of Environmental Protection (FDEP), South Florida Water Management District (SFWMD), Southwest Florida Water Management District (SWFWMD), or St. Johns River Water Management District (SJRWMD). Differences in compliance tracking occurs among agencies, with FDEP and SJRWMD having the same individual following the initial permit process and implementation as well as keeping track of compliance. Conversely, SFWMD and SWFWMD have different individuals responsible for the compliance portion of wetland mitigation banks. If credit or permit modifications are needed, they refer back to the individual responsible for implementing the permit.

Reference Standard Condition

In order to complete field assessments, it was necessary to determine the reference standard condition of the wetland community type for each assessment area. Different information was available depending on the wetland community type. We used a database of depressional herbaceous (n=75; Lane et al. 2003), depressional forested (n=118; Reiss and Brown 2005a), and forested strand and floodplain wetlands (n=24; Reiss and Brown 2005b) to develop a baseline understanding of the condition of Florida wetlands. Species lists for diatom, macrophyte, and macroinvertebrate community assemblages, as well as physical and chemical soil and water parameters were available (Table 2-1).

Other sources of descriptive information were consulted to determine reference conditions (Tables 2-2, 2-3), particularly when detailed community data were not available from the studies listed above. While internet sources were consulted (Table 2-3), site content had been distributed by reputable sources such as the Cornell Lab of Ornithology, Florida Department of Environmental Protection, Florida Department of Natural Resources, Florida Fish and Wildlife Conservation Commission, Florida Natural Areas Inventory, United States Geological Survey, and University of Florida (Institute of Food and Agricultural Sciences).

Site Visits Procedure

Prior to a site visit, recent digital orthographic quarter quads were acquired from The Land Boundary Information System from FDEP (available at http://www.labins.org), and the statewide data layer showing boundaries of Florida wetland mitigation banks from the Florida Geographic Data Library (available at http://www.fgdl.org/) were overlain in ArcView GIS 3.2 (Environmental Systems Research Institute, Inc. 1999). Ecological communities within the wetland mitigation bank boundaries were identified and potential wetland assessment areas were documented. Background reference data were compiled for select ecological communities and Part 1 of UMAM Qualitative Description (Ch. 62-345, F.A.C) was initiated prior to site visits.

Most site visits began with a meeting with the land manager and/or bank owner followed by an overview tour of the site. However, each site visit was different based on the particular circumstances regarding each bank. Some of the meetings were conducted off-site and site visits were not always conducted with the land manager and/or owner present.

Once an overview of the wetland mitigation bank was provided, wetland assessment areas were selected based on the amount of mitigation work completed to date, current water level conditions, and accessibility. When practical, selection of wetland assessment areas targeted phases that already had credits released. Digital orthographic quarter quads or other map resources were used to determine the wetland boundary of each assessment area. The two to three member field crew proceeded to walk a portion of the wetland boundary and interior with sample effort regulated by homogeneity of site conditions, accessibility, and time and weather constraints. Miller and Gunsalus (1999) suggest that a minimum of 50% of the wetland boundary is traversed and 100% of the boundary is visually inspected when using WRAP; this guidance was also used for field assessments using UMAM. During the site visit, notes were

Table 2-1. Sample size of reference database for depressional herbaceous, depressional forested, and forested strand and floodplain wetlands. Data from Lane et al. (2003), Reiss and Brown (2005a), and Reiss and Brown (2005b), respectively.

	Depressional Herbaceous	Depressional Forested	Forested Strand and Floodplain
Diatom Community	70	50	x
Macrophyte Community	75	118	24
Macroinvertebrate Community	75	79	x
Soil Analysis	75	118	x
Water Analysis	75	75	x

Table 2-2. Sources of ecological information from print media used to establish the expected reference standard wetland condition.

Source	Description
Bardi, EB, MT Brown, KC Reiss, and MJ Cohen (2005) UMAM Training Manual: Web-based training manual for Chapter 62-345, FAC for wetlands permitting. Available at: http://www.dep.state.fl.us/labs/library/index.htm	Provides guidance on completing the Uniform Mitigation Assessment Method Part I and Part II forms, including Wetland Field Guides providing information on predominant vegetation and wildlife, landscape location, fire interval, hydrology, and functions for 23 wetland communities.
Mitsch, WJ and JG Gosselink. 1993. Wetlands, 2nd edition. John Wiley and Sons, Inc. New York, New York, USA.	Provides an overview of wetlands ecology with sections dedicated to individual wetland types describing wildlife, hydrology, plant composition, and fire frequency.
Myers, RL, and JJ Ewel, editors. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, USA.	Provides an overview of Florida's ecological communities. Includes information on upland and wetland communities.
Noble, CV, R Evans, M McGuire, K Trott, M Davis, and EJ Clairain, Jr. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of flats wetlands in the Everglades. Wetlands Research Program, Engineer Research and Development Center, US Army Corps of Engineers, Washington, D.C. ERDC/EL TR-02-19	Provides reference data for Everglades flats wetlands, including rocky flats, marl flats, and organic flats. Reference conditions provided for surface soil texture, soil thickness, microtopographic features, woody vegetation cover, periphyton cover, emergent macrophytic vegetation cover, plant species composition, native species richness, invasive vegetation cover, wetland tract area, interior core area, and habitat connections.
Noble, CV, R Evans, M McGuire, K Trott, M Davis, and EJ Clairain, Jr. 2004. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of depressional wetlands in peninsular Florida. Wetlands Research Program, Engineer Research and Development Center, US Army Corps of Engineers, Washington, D.C. ERDC/EL TR-04-3	Provides reference data for depressional wetlands including herbaceous marshes and cypress domes. Reference conditions provided for wetland volume, catchment size, upland land use, surface outlet, cypress canopy, subsurface outlet, surface soil texture, macrophytic vegetation cover, understory vegetation biomass, tree basal area, herbaceous plant species composition, number of wetland zones, wetland proximity, and tree species composition.
Soil Conservation Service. 1984. 26 Ecological Communities of Florida. United States Department of Agriculture, Washington, D.C., USA.	Provides descriptions of 26 ecological communities in Florida, including characteristic vegetation.

Table 2-3. Sources of ecological information from the internet used to establish the expected reference standard wetland condition.

Source	Description
Atlas of Florida Vascular Plants http://www.plantatlas.usf.edu/default.asp	Scientific and common name, exotic/native status, wetland status, and sometimes images of Florida plant species and range maps.
The Birds of North America Online http://bna.birds.cornell.edu/BNA/	Information on bird species, including range maps, distinguishing characteristics, distribution, habitat, food sources, behavior, breeding, demography and populations, conservation and management, appearance, and measurements.
Florida Delineation Program Field Guides http://www.dep.state.fl.us/water/wetlands/delineation/wetcomm/fieldguides.htm	Drawings of common species for algae and flowering plants, central Florida floodplain forests, north Florida floodplain forests, mangroves, north and central Florida salt marsh, and south and central Florida salt marsh.
Florida Delineation Program Vegetative Index (Plant List) from Chapter 62-340, F.A.C. (subsection 62-340.200(17), F.A.C.) http://www.dep.state.fl.us/water/wetlands/delineation/vegindex/vegindex.htm	Lists of native Florida plant species identified as facultative, facultative wet, and obligate species.
Florida Delineation Program Wetland Communities http://www.dep.state.fl.us/water/wetlands/delineation/wetcomm/wetcomm.htm	List and brief description of common plant communities for each of seven districts (NW, NE, central, SW, SE, S, and Florida Keys). More detailed descriptions and photos provided for some communities as well as common plant associates and community range.
End of the Road: The Adverse Ecological Impacts of Roads and Logging: A Compilation of Independently Reviewed Research http://www.nrdc.org/land/forests/roads/eotrinx.asp	Annotated bibliography of information pulled mainly from peer-reviewed journals pertaining to adverse impacts of roads on North American forests. Published by the Natural Resource Defense Council (1999).
Endangered Species in Florida http://www.endangeredspecie.com/states/fl.htm	State listed threatened and endangered plant and animal species for Florida.
Environmental Resource Analysis from the FDEP http://eraonline.dep.state.fl.us/ *NOTE* This website is scheduled to be retired be FDEP in the near future, and replaced by Water Data Central, available at: http://www.dep.state.fl.us/water/datacentral/	Interactive mapping interface providing geographical data and information relating to local roads, soils, Outstanding Florida Waters (aquatic preserves and special waters), conservation lands (federal, state, local, and private areas), city limits, and aerial photography. Also includes the ability to draw a 1 mile buffer around a given analysis point with summary information for permit application, jurisdictional boundaries, water resources, fish and wildlife resources, habitats, and mitigation and restoration opportunities.
Exotic Freshwater Fishes http://floridafisheries.com/fishes/non-native.html	Provides a description of 32 known introduced fish species currently reproducing in Florida waters. Includes common and scientific name, description, range, habitat, spawning habitat, feeding habitat, age and growth, sporting quality, edibility, state and world records, and drawing/sketch.

Table 2-3. Continued.

Source	Description
Florida Fish and Wildlife Conservation Commission. 2004. Florida's Imperiled Species. http://myfwc.com/imperiledspecies/	Lists Florida's imperiled species, including endangered species, threatened species, and species of special concern.
Florida Natural Areas Inventory and Department of Natural Resources. 1990. Guide to Natural Communities of Florida. http://www.fnai.org/PDF/Natural_Communities_Guide.pdf	Provides descriptions of natural ecological communities in Florida. Includes information on characteristic plant and animal species, hydrology, fire frequency, and associated communities.
Florida Wetland Restoration Information Center http://www.dep.state.fl.us/water/wetlands/fwric	Information on wetland and associated upland restoration; includes links to the Florida Ecological Restoration Inventory (descriptions of current and proposed restoration projects), restoration guidance (background on restoration with case studies), restoration library (links and bibliographies).
Frogs and Toads of Florida http://www.wec.ufl.edu/extension/wildlife_info/frogstoads/image_index.php *NOTE* This is not a permanent URL, search University of Florida	List and pictorial index of the 33 frogs and toads of Florida. A description of each species includes photos, distribution, habitat, size, reproduction, color, and call information. Many entries include an audio clip of the call.
Online Guide to the Snakes of Florida http://www.flmnh.ufl.edu/herpetology/FL-GUIDE/onlineguide.htm	Key to snake identification, list of Florida snakes, color patterns, and habitat descriptions. Provides photos, scientific name, description, sketches, range, and habitat information for each species as well as comments on behavior, location, food, reproduction, and a comparison with other species.
Plant Species Introduced in Florida http://www.flmnh.ufl.edu/herbarium/cat/imagesearch.asp?srchproject=IN	Scientific and common names for plant species as well as scanned herbarium specimen images from the University of Florida herbarium.
Tables of Florida Natural Communities Descriptions available for download http://www.dep.state.fl.us/water/wetlands/fwric/guidance.htm	Tabular information on dominant vegetative strata, ecosystem formation, typical vegetation, typical animals, soils, hydroperiod, fire regime, typical surrounding habitat, similar habitats, threats and importance.
Tadpoles of the Southeastern United States Coastal Plain from the USGS http://cars.er.usgs.gov/armi/Guide_to_Tadpoles/guide_to_tadpoles.html	Information useful for identification of tadpoles with photos of the adult and tadpoles plus information on habitat, breeding season, similar tadpoles, appearance, and approximate maximum size.
U.S. Fish and Wildlife Service – Species Accounts http://www.fws.gov/northflorida/Species-Accounts/SpeciesInfo.htm	List of federally listed endangered, threatened, and species of special concern by region for mammals, birds, reptiles, amphibians, fish, crustaceans, clams, arthropods, insects, and plants. Lists are also available by county. Links are available for further detailed information on family, status, description, range and population level, habitat, biological information, reason for current status, management and protection, and references.
What Bird: The Ultimate Bird Guide http://www.whatbird.com/	General species information as well as background on range and habitat with range maps. Shows images of species and often provides audio clips of bird calls.

taken on general site conditions including identified flora, observed wildlife (e.g., visual sightings, calls), evidence of wildlife (e.g., tracks, nests), and occurrence of listed species.

Once notes were completed for WRAP and UMAM rapid assessment methods, transects and/or quadrats were established for HGM and/or FWCI, depending on methods specific to those assessment techniques. While UMAM and WRAP were completed for each of the 58 wetland assessment areas, the more intensive sampling methods, HGM and FWCI, were only completed for Everglades flats (Noble et al. 2002) or depressional wetlands (Noble et al. 2004) for HGM and depressional herbaceous (Lane et al. 2003), depressional forested (Reiss and Brown 2005a), or forested strand and floodplain (Reiss and Brown 2005b) wetlands for FWCI. After returning from the field, a digital boundary of the wetland assessment area was drawn over the digital orthographic quarter quad and the wetland scale LDI index was calculated for each wetland assessment area using GIS. The bank scale LDI index value was also calculated around the boundary of the entire bank. A brief description of each field assessment method follows. Further details of methods for each assessment method including UMAM, WRAP, HGM, FWCI, and LDI, are available in Appendix A.

Uniform Mitigation Assessment Method (UMAM)

UMAM is defined in Rule Chapter 62-345, F.A.C. A complete UMAM survey includes Part I Qualitative Description and Part II Quantification of Assessment Area. Part I Qualitative Description establishes a reference baseline for expected site functions and considers connectivity, regional significance, and anticipated wildlife. Part II Quantification of Assessment Area requires completion at the field site with scoring assigned in each of the three indicators of wetland function: Location and Landscape Support, Water Environment, and Community Structure.

Part II Quantification of Assessment Area scores are based on evidence within the wetland community and the surrounding landscape, using reasonable scientific judgment. UMAM relies on an adequate understanding of the functions of and species found throughout Florida ecosystems to provide a score describing the functional capacity of a wetland. Within each of the three indicators of wetland function, the UMAM scale ranges from 0-10, with only whole numbers assigned. A score of 10 suggests the wetland assessment area reflects the expected wetland function at an optimal level. Alternatively, a score of zero means that no wetland function is being provided. Guidance is provided within the rule (Chapter 62-345, F.A.C.) for scores of 10, 7, 4, and 0. Once each of the three categories have been scored, the values are summed and divided by 30 to achieve a total UMAM score between 0.00-1.00, with 1.00 representing optimal wetland function. Assessments for this study were conducted as current condition scenarios. UMAM has additional application for scenarios with- and without-mitigation, time lag, and risk. A UMAM current condition assessment was conducted at all 58 wetland assessment areas within the 29 banks.

Wetland Rapid Assessment Procedure (WRAP)

WRAP methodologies are defined by Miller and Gunsalus (1999) for use in evaluation of restored, created, enhanced, and preserved wetland mitigation sites. WRAP was created for use in freshwater, non-tidal wetlands in South Florida, but is often applied statewide and has even been applied outside of Florida. WRAP includes six scoring categories: 1) Wildlife Utilization; 2) Overstory/Shrub Canopy; 3) Vegetative Ground Cover; 4) Adjacent Upland Support/Buffer; 5) Field Indicators of Wetland Hydrology; and 6) Water Quality Input and Treatment. Scores range from 0.0-3.0, in 0.5 increments. A score of 3.0 indicates an "intact" wetland, whereas a score of 0.0 indicates a wetland with a reduced functional capacity (Miller and Gunsalus 1999). Guidance is provided for scoring categories of 0.0, 1.0, 2.0, and 3.0. The final WRAP score is calculated by summing the scores for the scoring categories and dividing by the number of scoring categories used. For forested wetlands, six scoring categories are used; however, for herbaceous wetlands typically only five scoring categories are used as the Overstory/Shrub Canopy category is generally not applicable as it requires a minimum of 20% cover by woody species. The WRAP calculation results in a score between 0.00-1.00, with 1.00 representing an "intact" wetland. WRAP assessments were conducted at all 58 wetland assessment areas within the 29 banks.

Hydrogeomorphic wetland assessment (HGM)

Developed through the United States Army Corps of Engineers, HGM evaluates current wetland functions and can be used to predict prospective changes to a wetland's functions resulting from future activities (USEPA 1998). Two HGM regional guidebooks were applicable to this study, one for Everglades flats wetlands (Noble et al. 2002) and one for depressional wetlands in peninsular Florida (Noble et al. 2004). The HGM approach is based on an evaluation of a sample wetland attributes or variables compared to the reference standards provided by the guidebook (i.e., wetlands that are relatively unaltered); the index of ecological function is calculated from those variables. This approach focuses on five measures of wetland function: 1) Surface Water Storage; 2) Subsurface Water Storage; 3) Cycle Nutrients; 4) Characteristic Plant Community; and 5) Wildlife Habitat. For Everglades flats wetlands, wetland functions 1) Surface Water Storage and 2) Subsurface Water Storage are combined into one wetland function category called Surface and Subsurface Water Storage. Each wetland function has a calculated value based on equations with input variables from field measurements or GIS determinations. Each wetland function receives a score between 0.00-1.00, with 1.00 representing the reference standard condition. Each wetland assessment area receives four or five separate HGM scores for wetland function. HGM assessment was conducted at six Everglades flats and nine depressional wetlands.

Florida Wetland Condition Index (FWCI)

The FWCI is a wetland bioassessment method based on three separate indices of biological integrity: diatom, macrophyte, or macroinvertebrate community composition. The premise behind the FWCI is to detect differences in abundance, structure, and diversity of target species assemblages between the wetland being assessed and a reference standard wetland. Three variations of the FWCI have been developed for herbaceous depressional wetlands (Lane et al. 2003), forested depressional wetlands (Reiss and Brown 2005a), and forested strand and floodplain wetlands (Reiss and Brown 2005b). For a given species assemblage (i.e., diatom, macrophyte, or macroinvertebrate), presence/absence data are used to calculate metric values, which are then summed together to provide an overview score of wetland condition. This study used the macrophyte and macroinvertebrate FWCIs.

The macrophyte FWCI for all wetland types contains the following metrics: 1) Tolerant Species; 2) Sensitive Species; 3) Exotic Species; 4) Floristic Quality Assessment Index or mean Coefficient of Conservatism score; and 5) Annual or Perennial Species. The depressional forested wetland macrophyte FWCI also includes a metric for Wetland Status (based on obligate and facultative wetland species, as defined by Ch. 62-340.450, F.A.C. Metrics are scored from 0-10, with 10 representing the reference standard condition. Metric scores are summed and the resulting scale is from 0-50 for depressional herbaceous and forested strand and floodplain wetlands and 0-60 for depressional forested wetlands. The highest score represents reference standard condition (either 50 or 60, depending on wetland type). In this study, results are the presented as a percent of reference standard condition.

The macroinvertebrate FWCIs have different metrics for each wetland type. The depressional herbaceous wetland macroinvertebrate FWCI includes five metrics: 1) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 2) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 3) Percent of macroinvertebrates in the predator functional feeding group (Predators); 4) Percent of macroinvertebrates in the order Odonata that includes dragonflies and damselflies (Odonata); and 5) Percent of macroinvertebrates in the subfamily Orthocladinae, a subfamily in the family Chironomidae (Orthocladinae). Scoring for the depressional herbaceous wetland macroinvertebrate FWCI assigns scores of 0, 3, 7, or 10 to each of the five metrics with total FWCI scores ranging from 0-50, with 50 representing the reference standard condition. In this study, results are presented as a percent of reference standard condition.

The depressional forested wetland macroinvertebrate FWCI includes six metrics: 1) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 2) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 3) Calculated score from the Florida Index (Florida Index) (see Beck 1954, Barbour et al. 1996); 4) Percent of macroinvertebrates in the phylum Mollusca, including snails and bivalves (Mollusca); 5) Percent of macroinvertebrates in the family Noteridae, the burrowing water beetles (Noteridae); and 6) Percent of macroinvertebrates in the scraper functional feeding group (Scrapers). Metrics are scored on a continuous scale from 0-10, with 10 representing the reference standard condition. Metric scores are summed and the resulting scale is from 0-60, with 60 representing reference standard condition. In this study, results are presented as a percent of reference standard condition.

Macrophyte FWCI assessments were conducted at six depressional herbaceous wetlands, three depressional forested wetlands and one forested strand and floodplain wetland. Macroinvertebrate FWCI assessments were conducted at two depressional herbaceous wetlands and two depressional forested wetlands. Macroinvertebrate FWCI assessments were not conducted at the remaining five depressional wetlands, as those sites did not have the required minimum 10 cm of standing water covering a minimum of 50% of the wetland surface area, needed for macroinvertebrate sampling.

Landscape Development Intensity (LDI) index

The LDI index functions as an index of human activity based on a development intensity measure derived from nonrenewable energy use (e.g., fertilizer, fuel, electricity) in the surrounding landscape. The LDI index equation incorporates the amount of nonrenewable energy use (Table 2-4) weighted by area of land use within a 100 m radius of the property in question. Brown and Vivas (2005) present the basis for LDI index calculations, and Vivas (2007) presents a modified equation, which was used in this study. The LDI index scale runs from zero, representing high ecological integrity, to infinity, representing decreased ecological integrity, though in practice LDI index scores appear to be limited at around 35 (Vivas 2007; Reiss, unpublished data).

Two scales of the LDI index were calculated: wetland scale LDI index for each of the 58 wetland assessment areas and bank scale LDI index for 26 banks. To calculate the wetland scale LDI index, a 100 m zone was delineated around the edge of each wetland assessment area and land uses within the zone were identified based on 2004 digital orthographic quarter quads and field notes for current surrounding land use from site visits. Lands surrounding wetland assessment areas within the 100 m zone that were being restored, enhanced, created, or preserved within wetland mitigation bank boundaries were assigned the development intensity of "Natural Land," which suggests no use of nonrenewable energy. Clearly mitigation activities require nonrenewable energy use (e.g., earth moving activities, exotic plant removal or herbicide treatment). However, the calculated LDI index values for the wetland assessment areas were considered the "potential" LDI index for a wetland assessment area given the surrounding land uses, which should be an already restored, self-sustaining community. That is, given successful enhancement, restoration, creation, or preservation, the calculated LDI index value reflects the lowest potential LDI index score and in turn the highest potential ecological integrity possible for a wetland assessment area once mitigation is complete.

To calculate the bank scale LDI index, a 100 m zone was constructed around the bank boundary and land uses within the zone were identified using 2000 land use cover maps (LU00), available from the Florida Geographic Data Library (http://www.fgdl.org/). Only 26 of 29 bank scale LDI calculations were completed, as the mitigation bank outline was not available for Boran Ranch Phase I; Phases I and II of the Everglades Mitigation Bank were combined into one bank scale LDI index; and year 2000 land use was not available for Garcon Peninsula.

Table 2-4. Nonrenewable energy value for land use categories used to calculate the Landscape Development Intensity (LDI) index. The unit of nonrenewable energy (e.g., fertilizer, fuel, electricity) is empower density (sej/ha/yr). For a description of empower, see Odum (1996).

Land Use Category	Non-Renewable Empower Density (E14 sej/ha/yr)
Natural Land / Open Water	0.0
Recreational / Open Space - low intensity	2.8
Pine Plantation	5.1
Unimproved Pastureland (with livestock)	8.3
Improved Pasture (no livestock)	19.5
Low Intensity Pasture (with livestock)	36.9
High Intensity Pasture (with livestock)	51.5
Citrus	65.4
Recreational / Open Space - medium intensity	67.3
Row crops	117.1
High Intensity Agriculture (dairy farm)	201.0
Single Family Residential (Low-density)	1,077.0
Recreational / Open Space - high intensity	1,230.0
Single Family Residential (Med-density)	2,461.5
Low Intensity Transportation	3,080.0
Single Family Residential (High-density)	3,729.5
Low Intensity commercial (Comm Strip)	3,758.0
Institutional	4,042.2
Highway (4 lane)	5,020.0
Industrial	5,210.6
Multi-family residential (Low rise)	7,391.5
High intensity commercial (Mall)	12,661.0
Multi-family residential (High rise)	12,825.0
Central Business District (Avg 2 stories)	16,150.3
Central Business District (Avg 4 stories)	29,401.3

CHAPTER 3
REVIEW OF PERMIT SUCCESS CRITERIA AND CREDIT RELEASE

This study considers two kinds of success. First, ecological success was defined by restoring function to wetlands. Second, permit success was defined in regards to meeting criteria and conditions set forth in the mitigation bank permit. Ideally, the two categories of success would be integrally linked; however, in practice, permit conditions and criteria may not always equate to ecological success. This study looked to bridge the gap in achieving both ecological and permit success, so that improved permits result in ecologically successful wetland mitigation.

Documents reviewed for this study included state mitigation bank permits, permit modifications, federal Mitigation Banking Instruments (MBIs), and monitoring reports. Not all documents were obtained for all banks, but at a minimum state permits were acquired. State mitigation bank permits, whether issued by a water management district or the Florida Department of Environmental Protection (FDEP), generally consisted of two parts: 1) a staff review or agency intent to issue, which summarized the salient portions of the application file and documented the basis of the agency's authorization and 2) the legally binding permit and figures, which set forth the conditions of the authorization. Once issued, no changes can be made to the permit conditions without an official permit modification issued by the agency.

Appendix C lists the documents reviewed for each of the 29 banks included in this study, along with summary notes of these documents and final success criteria. The federal MBI was not consistently reviewed, but it was used when available. There was a great deal of variation between and among the mitigation bank permits and additional documentation, making generalizations difficult and statistics unrealistic. This chapter instead provides information on the range of differences of mitigation banks pertaining to their state permits and success criteria. Further, this chapter makes recommendations on how mitigation banks can improve permit criteria to better ensure achievement of ecological success.

Mitigation Goals and Success Criteria

Florida statutes and rules present guidance on ecological goals for mitigation in general and mitigation banks in particular. The statute establishing mitigation banking (Section 373.4135(1), F.S.) directs agencies to emphasize restoration and enhancement of degraded ecosystems and encourage restoration of communities that were historically present. Although state rules identify minimum requirements for success, it is up to the reviewing agency to state the success criteria in the permit and to ensure that specific conditions in the permit are met. Given its reference in statute and rule, it is surprising that more permits do not emphasize or require definitions for target natural ecological communities or reference wetlands that would include a suite of functional parameters.

Florida Statutes Rule 62-312.350, Florida Administrative Code (F.A.C.) states, "All mitigation bank permits include success criteria. These are indicators that long-term, self-sustaining ecological goals of the proposed enhancement or restoration will be met." The statute goes on to define the "minimum, necessary site characteristics to determine ecological success." These characteristics include but are not limited to delineation of the wetlands and other surface waters according to state rule (Ch. 62-340, F.A.C.); appropriate hydric soils; appropriate target vegetative community or early successional stages of said target community; appropriate size, topography, and configuration; hydrology to support target community; negligible exotic or nuisance species present; and meeting state water quality standards.

Many of the permits reviewed for this study did not explicitly describe the target wetland community or reference standard condition for the target wetland. When reference standard wetland conditions were addressed within a permit, these standards were often vaguely described and qualitative, using terms such as "based on a comparison" (TM-Econ and Colbert-Cameron), "within the range of similarity values" (Little Pine Island) or "resemble" those of a reference wetland (Boran Ranch, Phase I). Specific quantitative guidelines for addressing the similarity of the mitigation wetland with the reference standard wetland condition were routinely absent.

Approximately 50% (13) of the state mitigation bank permits reviewed in this study describe or refer to having reference conditions either as a comparison to the literature or an actual field comparison (Table 3-1). In contrast, 13 bank permits make no mention of reference conditions in state permits. A few bank permits recognize the inability to restore natural communities to reference condition due to site constraints and instead measure ecological lift from pre-bank conditions. For example, Bear Point has success criteria meant to increase function and improve water quality and fish and wildlife habitat, but will always be managed for mosquito control. As such, it can never represent the full function of reference conditions expected of saltwater marsh and mangrove communities. The most obvious limitation for banks to attain reference conditions are banks closest to urban development. Location and landscape support will always be a limiting factor in achieving full function when banks are situated in developed landscapes.

A standard should be developed for minimal criteria to describe target natural communities for restoration. The Florida Natural Areas Inventory *Guide to the Natural Communities of Florida* (FNAI 1990) document, while dated, would be a good resource to use in the initial development of a wetland mitigation bank. FNAI (1990) presents characteristic species, soils, hydrology, fire regime, and limitations to natural communities in detail. At a minimum, this would be a better starting place to frame specific restoration community goals, rather than vague references to pinelands or sawgrass marshes that lack a full appreciation of the complexity of natural communities.

Some banks defined target communities with the Florida Land Use, Cover and Forms Classification System (FLUCCS), which may not be at a fine enough scale for restoration goals. Communities defined as mixed forested wetland, wetland forested mixed, and freshwater marsh do not provide detailed information even though some of the characteristic dominant species are in the definitions of these categories. For example, the category of freshwater marsh (6410) includes prairie, depression marsh, basin marsh, flatwoods pond, and ephemeral pond. These wetlands occur throughout Florida and are composed of a variety of herbaceous species. These freshwater marshes vary widely in size, from less than an acre (e.g., depressional marshes) to thousands of acres (e.g., Everglades flats). In preference to FLUCCS, FNAI descriptions present baseline conditions and an initial starting point for a literature reference, describing community composition, structure, and ecosystem processes.

Table 3-1. Target community and reference condition information in mitigation bank permits.

	Target communities identified?	Target in success criteria?	Reference provided?	Reference in success criteria?
BARBERVILLE	3-4 communities named	no	no	no
BEAR POINT	1 type named	yes	no	no
BIG CYPRESS	4 communities named with required acreage	yes	literature reference for composition	no
BLUEFIELD	16 types named	yes	literature reference for composition	yes
BORAN RANCH I	3 named in map with required acreage	yes	onsite reference	demonstrate similarity
BORAN RANCH II	4 named in map with required acreage	yes	onsite reference	demonstrate similarity
CGW	not clear	no	no	no
COLBERT-CAMERON	preservation	no	no	no
CORKSCREW	4 communities named with required acreage	yes	must meet UMAM scores	must meet UMAM scores
EAST CENTRAL	existing communities	no	no	no
EVERGLADES I	3 types named with required acreage	no	must meet WATER scores	must meet WATER scores
EVERGLADES II	3 types named with required acreage	yes	must meet WATER scores	must meet WATER scores
FLORIDA MITIGATION BANK	3 types named with required acreage	some named	no	no
FLORIDA WETLANDS BANK	3-4 types named, map	no	no	no
GARCON PENINSULA	3 types named with required acreage	yes	literature reference for composition	must meet WRAP scores
GRAHAM SWAMP	existing communities	no	no	no
HOLE-IN-THE-DONUT	1 type named	inferred	yes onsite based on wetlands in Everglades National Park	Yes, statistical similarity required
LAKE LOUISA	4 types named	non-specific reference to composition	no	no
LAKE MONROE	14 named and mapped with FLUCCS	no	no	no
LITTLE PINE ISLAND	4 named with acreage	yes	yes, literature and reference wetlands	yes
LOBLOLLY	2-3 named communities	no	MBI refers to literature but is vague	no
LOXAHATCHEE	5 named communities with required acreage	yes	criteria based on reference at adjacent Loxahatchee Preserve	wildlife has reference targets
PANTHER ISLAND	3-4 communities named and mapped	yes	criteria based on reference at adjacent preserve Corkscrew Sanctuary	no
REEDY CREEK	FLUCCS and mapped	no	no	no
RG RESERVE	existing communities	some named	no	no
SPLIT OAK	existing communities	unknown	no	unknown
SUNDEW	not clear, upland and wetland	no	MBI refers to literature but is vague	no
TM-ECON	4-5 existing communities mapped	no	relative to onsite preservation	based on enhancements over baseline
TOSOHATCHEE	existing communities in state park	no	no	no
TUPELO	not clear, upland and wetland	no	MBI refers to literature but is vague	no

Not all banks lacking a description of reference conditions in their permits appear to be limited in function or progress towards ecological improvement. Perhaps some banks that lacked documentation for reference conditions utilized the professional experience of the land manager to restore the natural communities. Some of the banks that were having difficulty restoring some community types did not always have a clear goal defining the target natural community. Simply referring to the natural community and its dominant species composition is not enough to restore the function of the community. Measurable parameters should be clear and succinct when referring to desirable reference conditions. Qualitative "resemblance" without quantitative correlations is not enough to determine restored structure and function.

Perfunctory comparisons to reference wetland types based on plant descriptions can limit determination of full wetland function if composition of flora and fauna, physical characteristics, and structure are also not defined. Basing success only on attaining similarity of the plant community to reference standard conditions may not restore total function and other parameters pertaining to water chemistry, soils, macro and micro fauna, and ecological processes, all of which are an important part of defining reference standard conditions. Nine wetland mitigation banks make no mention of fauna in their state permits or technical reports. Ten banks make reference to wildlife utilization in the final success criteria. Twelve banks have some form of qualitative wildlife monitoring in their banking program, and seven banks implemented quantitative monitoring. Of the seven banks with quantitative monitoring, two require monitoring for listed wildlife species that occur on the bank (Table 3-2).

While application of wetland assessment methods, which are used to determine potential credits, requires the assessor to research associated wildlife and basic life history traits, it was not apparent that this baseline information was always being sought for fauna on the banks. Ch. 62-345, F.A.C., is the required assessment method for calculating credits for wetland mitigation banks, effective February 2004. UMAM 62-345.400 Part I Qualitative Characterization clearly requires at a minimum identifying "anticipated wildlife utilization and type of use (i.e., feeding, breeding, nesting, resting, or denning) and applicable listing classifications (i.e., threatened, endangered, or species of special concern as defined by Rules 68A-27.003, 68A-27.004, and 68A-27.005, F.A.C.)," which should increase assessor awareness of wildlife habitat and utilization. Basic ecological principles can be applied to determine the function of wildlife habitat and utilization. Fauna should be considered in the planning of the mitigation bank in the context of landscape fragmentation and habitat loss outside the bank and edge effects, connectivity and dispersal of expected fauna, core to edge ratios regarding habitat needs for foraging, cover and reproduction, species interaction, and monitoring should be conducted for fauna response to management activities. If it is outside of the ability of the regulating agencies and bank managers to apply these basic ecological principles to planning and management than more precaution should be taken when assuming potential gain in ecological function that would support the associated wildlife species.

Further, the scientific baseline that defines a natural community is ever evolving. It may take years to restore a community on a wetland mitigation bank, and in the mean time available scientific knowledge might evolve to further define appropriate fire return intervals or response to other disturbance phenomena like hurricanes. Without an appropriate understanding of the target natural community, and an adaptive management plan or experimental design, acceptable

Table 3-2. Successes criteria for native wildlife monitoring requirements in state permits.

Mitigation Bank	No detail on wildlife needs	Wildlife requirements in Success Criteria	Qualitative monitoring or observation requirements	Quantitative monitoring requirements
Barberville	✓			
Bear Point		✓		✓
Big Cypress		✓	✓	
Bluefield Ranch			✓	
Boran Ranch			✓	
CGW	✓			
Colbert-Cameron			✓	
Corkscrew		✓	✓	
East Central	✓			
Everglades Mitigation Bank		✓ (WATER requirements)	✓	
Florida Mitigation Bank		✓ (3 in MWRAP wildlife utilization)	✓	
Florida Wetlands Bank			✓	
Garcon Peninsula			✓	
Graham Swamp			✓	
Hole in the Donut		✓		✓
Lake Louisa and Green Swamp			✓	
Lake Monroe				✓ (FL scrub jays)
Little Pine Island		✓		✓
Loblolly Mitigation Bank	✓			
Loxahatchee		✓		✓
Panther Island		✓	✓	
Reedy Creek	✓			
R.G. Reserve	✓			
Split Oak		✓		✓
Sundew Mitigation Bank	✓			
TM-Econ				✓ (red cockaded woodpeckers)
Tosohatchee	✓			
Tupelo Mitigation Bank	✓			

variation in community structure and function based on response to disturbance would be unclear.

Credit Potential

Florida rules recognize that not all mitigation areas are expected to attain "reference condition." Chapter 62.312.350, F.A.C. states that "it is not the intent of the Department to require that the mitigation area exactly duplicate or replicate the reference water." Thus, an important concept in evaluating mitigation success is an understanding of how a mitigation site is assessed for credit. Mitigation projects are generally categorized along a continuum of regulatory categories including *creation* of wetlands from uplands, *restoration* of wetlands that had historically been converted to uplands or non-native land uses, *enhancement* of altered wetlands, and *preservation* of intact wetlands. A mitigation bank may have several of these different mitigation types in different locations or communities types within the bank, as well as upland preservation or enhancement to provide buffer, protection, habitat, and recharge function to the adjacent wetlands. Thus not all mitigation areas start at the same level of ecological function, nor do they all have the same anticipated outcome.

It is the improvement in ecological function, or ecological lift, that provides the mitigation value or credit to offset wetland impacts of functional loss. Potential credit and loss should be assessed by the same method. However, when evaluating mitigation banks, the future losses through impacts are not yet known, so a standard unit of lift or gain is needed to provide a currency for credit and debit. In Florida, a mitigation credit is defined as a "standard unit of measure which represents the increase in ecological value resulting from restoration, enhancement, preservation, or creation activities" (Section 373.403(20), F.S. and Chapter 62-342.200(5), F.A.C.). Typically, the mitigation area is divided into polygons or assessment areas of similar condition, treatment, community type, and anticipated results. Each area is assessed for its anticipated functional lift between its current or predicted "without bank" condition, compared to its anticipated outcome "with bank condition" (Story et al. 1998).

In February 2004, Florida adopted Uniform Mitigation Assessment Method (UMAM) in Chapter 62-345, F.A.C, thereby providing a standard methodology for all state wetland regulatory agencies to assess lift of mitigation and assess loss associated with impacts. Prior to that date, mitigation banks were assessed by a variety of other functional assessments and by acre to credit ratios. The 45 permitted mitigation banks total approximately 47,753 ha (118,000 ac) with a total of approximately 36,500 potential credits, which means, on average, about 1.4 ha (3.5 ac) of mitigation area is required to generate one credit (Figure 3-1).

In reviewing some of the permit files and attachments, it was clear that the "with bank" scenario was often scored very high, anticipating full function would return to a site once mitigation activities were completed. This was true even in cases where the surrounding landscape would have an impact on water quality or quantity or where wildlife support or movement was significantly curtailed. In fact, it often seemed that the assessment was focused only on the anticipated capacity to support vegetation rather than the full suite of integrated wetland functions of the community. This practice could lead to an over-estimation of ecological lift and mitigation credit.

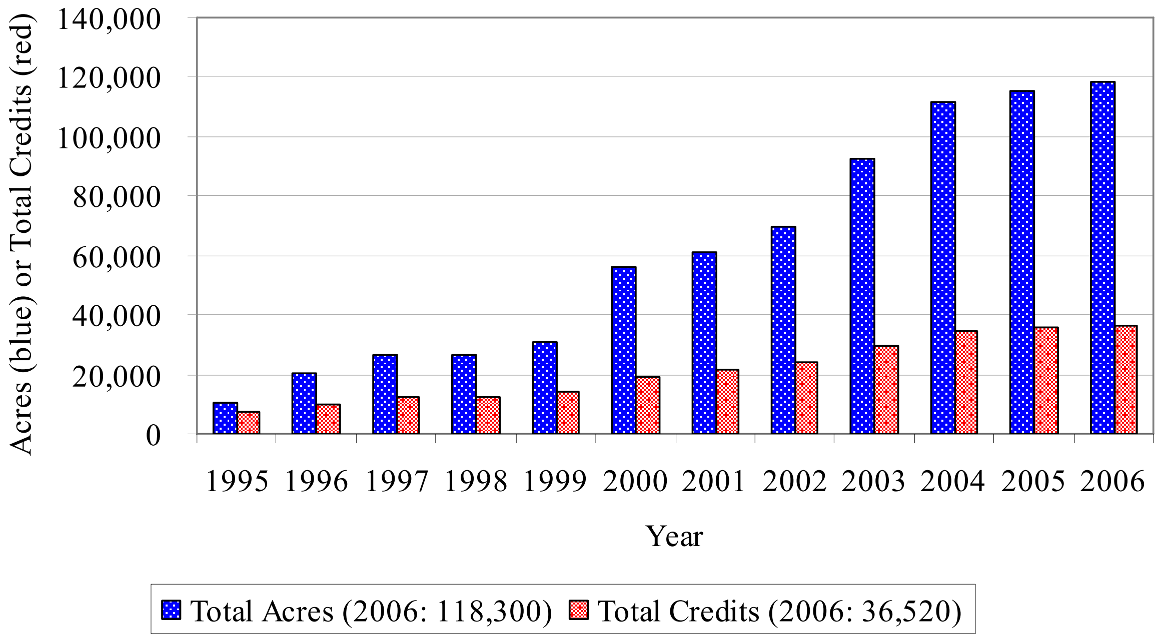


Figure 3-1. Total area (ac) of permitted mitigation banks (blue columns) in relation to total potential credits (red columns) (1995-2006).

Preservation

Historically, preservation of intact ecosystems through a conservation easement has been a form of mitigation that has been used to offset impacts in limited cases. Because, technically, no ecological function has been gained by the recording of a document, simple "preservation" was considered of restricted value in offsetting real losses. However, because of development pressures, relatively unregulated loss of supporting uplands, and the degradation of ecosystems by exotic or nuisance species, establishing non-degrading conservation easements is considered to be protection to losing function over time, and mitigation value is assessed by comparing the anticipated condition with-preservation to that without-preservation. By rule, no mitigation credit may be released until the mitigation bank, or phase thereof, has a recorded conservation easement and financial assurance for its implementation and long-term management (Ch. 62-342.470(3), F.A.C.) over the project area, regardless of its current condition. Therefore all mitigation credits represent some degree of protection from development and ecological degradation. However, there is wide variation among banks in the degree to which the preservation of intact ecosystems has in generating mitigation credit.

The mitigation bank permits reviewed did not consistently separate credit awarded for preservation in terms of preserving intact communities with a high degree of function versus filing a conservation easement over communities in pre-restored condition. About half of the studied banks have phases or polygons with intact wetlands or uplands where very little enhancement was required and management in perpetuity was assumed to maintain function.

Even these banks did not specifically separate the potential credit attributed to this preservation. It is unclear whether credits have been allocated as credits for conservation easements or as preservation credits based on the difference between the current condition and the assumed without mitigation scenario.

Credit Release

Florida statute recognizes that mitigation projects may take years to attain final success criteria, and provides for an incremental release of credits with a credit release schedule in the permit. Once the credits are released, they may be sold and used to offset impacts. Sec. 373.4136(5)(b), F.S. states "The number of credits and schedule for release shall be determined by the department or water management district based upon the performance criteria for the mitigation bank and the success criteria for each mitigation activity. The release schedule for a specific mitigation bank or phase thereof shall be related to the actions required to implement the bank, such as site protection, site preparation, earthwork, removal of wastes, planting, removal or control of nuisance and exotic species, installation of structures, and annual monitoring and management requirements for success."

Credit release schedules for mitigation banks included in this study are summarized in Table 3-3. Credit releases were separated into four broad categories: Legal Actions, Construction and Management Activities, Monitoring of Incremental Improvement and Final Success. Each category is discussed below in greater detail.

Legal Actions

In order to receive any credits to sell, a banker must record an agency reviewed conservation easement over the bank, or phase thereof, with the county in which it is located. The easement requires that the bank be maintained in its current or enhanced conditions and specifically lists activities which are forbidden, except as stipulated or required in the permit. The conservation easement is executed in favor of the department and/or the water management district. These easements are also required by federal agencies, but they do not accept the easement themselves. Prior to recording the easement, agencies review title information and required title insurance for the easement's value.

In addition to the conservation easement, the bank sponsor must provide financial assurance for both the implementation of the project and for its long-term management. Generally, the two assurances are in the form of a letter of credit (LOC) or performance bond, payable into a stand-by trust in favor of the agency. The amount of the implementation financial mechanism is based on a cost estimate of the money required to complete the mitigation plan and manage and monitor the land until it attains success. The banker must update the cost estimate every two years; the LOC or bond value may decrease when work is successfully completed or may increase to reflect higher anticipated costs. The amount for the long-term management trust is equal to the principle that will generate in interest (at 6%) the estimated annual management costs. When both the financial assurances and conservation easement documents are properly executed, the banker may request the initial credit release.

Table 3-3. Percent of total potential credits released for each activity or release criteria (numbers are rounded).

	permit date	credit released to date	conservation easement	construction completion	exotic removal	tree removal	planting	prescribed fire	incremental	final	total	% potential credit which is activity based
BARBERVILLE	Jun-96	64%	40%			23%	yes		25%	12%	100%	63%
BEAR POINT	Jul-07	50%	10%	15%	15%				50%	10%	100%	40%
BIG CYPRESS	Sep-99	56%	10%	20%		yes	10%		48%	12%	100%	40%
BLUEFIELD	Nov-07	45%	10%	15%	10%		10%		45%	10%	100%	45%
BORAN RANCH I	Aug-97	93%	25%							75%	100%	25%
CGW	Jun-98	80%	28%	39%	13%				6%	14%	100%	80%
COLBERT CAMERON	Oct-96	78%	100%								100%	100%
CORKSCREW	Jun-07	0%	15%	20%	7%		yes	3%	30%	25%	100%	45%
EAST CENTRAL	May-97	100%	58%	30%				10%	2%		100%	100%
EVERGLADES I	Oct-96	90%	10%	10%	10%		yes		60%	10%	100%	30%
EVERGLADES II	Oct-03	11%	10%	20%	10%		3%	3%	34%	20%	100%	46%
FLORIDA MITIGATION BANK	May-97	100%	15%	20%	yes				50%	15%	100%	35%
FLORIDA WETLANDSBANK	Feb-95	99%	15%	40%	25%		10%		5%	5%	100%	90%
GARCON PENINSULA	Apr-01	45%	15%	15%	5%	yes	5%	5%	40%	15%	100%	45%
GRAHAM SWAMP	Sep-96	90%	60%	yes					25%	15%	100%	60%
HOLE-IN-THE-DONUT*	Feb-95	NA										
LAKE LOUISA	Oct-95	82%	15%	10%		10%	20%		25%	20%	100%	55%
LAKE MONROE	Sep-95	65%	15%	15%		yes	10%	15%	10%	35%	100%	55%
LITTLE PINE ISLAND	Feb-96	35%		10%	45%				30%	15%	100%	55%
LOBLOLLY	Sep-03	25%	25%	15%		5%	5%		30%	20%	100%	50%
LOXAHATCHEE	Feb-00	50%	15%	13%	13%				50%	10%	100%	40%
PANTHER ISLAND	Mar-99	86%	25%	15%	15%		10%	5%	20%	10%	100%	70%
REEDY CREEK	Feb-97	62%	30%	20%	5%		3%	2%	30%	10%	100%	60%
RG RESERVE	Jan-03	8%	40%		15%		8%	10%	20%	7%	100%	73%
SPLIT OAK**	Jun-96	43%	45%									
SUNDEW	Aug-01	10%	20%	20%		10%	5%		25%	20%	100%	55%
TM-ECON	Jan-03	15%	30%	15%					40%	15%	100%	45%
TOSOHATCHEE	Oct-95	100%		30%			20%			50%	100%	50%
TUPELO	Jan-04	32%	25%	15%		5%	5%		30%	20%	100%	50%

*On public land; In-lieu fee bank. Credits are not released incrementally; Acres restored incrementally as needed for mitigation.

** No more credits were sought; mitigation plan carried out through alternative agency agreements.

Initial credits releases are usually between 10%-25%; however there are exceptions (Table 3-3). Some conservation easement credit releases are awarded by phase (e.g., Panther Island, Reedy Creek – Table 3-3 reflects bank-wide average) and not for the entire property. On the high end, Colbert-Cameron, primarily a preservation bank, received 100% potential credits per phase after removing cattle and minor hydrological fixes one year after the conservation easement was filed. Similarly, Panther Island received 80-85% potential credit release for some of its phases in preservation areas. Most wetland mitigation banks are not preservation-only banks. Four banks received credit release based on conservation easements in addition to previously completed construction activities. For example, initial credit release at Graham Swamp of 60% was based not only on recording a conservation easement but also construction already completed and one year of monitoring. Split Oak had a similar requirement of active management plus conservation for their initial release. Three banks, Hole in the Donut, Little Pine Island and Tosohatchee, do not have conservation easements and did not receive credit for preservation because they occur on already protected public lands.

Typically, little information was provided as to how the amount of initial credit release was determined. Ideally, the initial credits generated by recording the conservation easement should reflect the preservation value of that property. SWFWMD has initiated a method whereby they conduct an initial assessment of a mitigation bank to determine potential credit based only on preservation. Assuming that the mitigation bank will be protected from future degradation, preservation credits are awarded based on current condition. Then a second assessment based on enhancement is completed to determine the lift associated with mitigation activities. Seemingly, this method would make awarding credit for preservation a more transparent process.

Construction and Management Activities

Generally, once a mitigation bank permit has been issued, work begins on the ground to commence enhancing and restoring the land as required. Some banks begin ground work in phases or polygons, sometimes with several activities occurring simultaneously. These activities usually include installing perimeter fencing, installing hydrologic enhancement or restoration mechanisms, earth moving, site clearing, and planting. Although there are no rules pertaining to monitoring and reporting requirements during the construction phase of the bank, all banks are required to give notice prior to construction initiation. FDEP requires status reports every six months, regardless of whether construction activities are in progress or not. Individuals at the permitting agencies commented that some banks did not submit reports or communicate with their regulating agency for some length of time because there was no activity on the bank during that time period. Perhaps standardization within the permit special conditions section that a status report is required every six months would help close the communication gap. An example of appropriate permit language for communication with state agencies is provided for Garcon Peninsula (Figure 3-2).

Once construction activities are complete, the bank is required to monitor. At this point, the bank should be able to demonstrate ecological incremental improvement over time. Some banks have interim criteria that must be met in order to demonstrate a trend towards success, while other banks must demonstrate an improvement over baseline conditions. Banks are required to submit a monitoring report at least annually to document the monitoring and provide the basis

30. Progress Reports. Beginning six months after permit issuance until final success determination, the permittee shall submit semi-annual progress reports containing the following information regarding the project:

a. Date permitted activities were begun or are anticipated to begin;
b. Brief description and extent of work completed since the previous report or since permit was issued;
c. Copies of permit drawings indicating areas where work has been completed;
d. A description of problems encountered and solutions undertaken;
e. A brief description of the work and/or site management the permittee anticipates commencing, continuing or completing in the next six months; and
f. Site management undertaken, including type of management and dates each type was undertaken.

Figure 3-2. Permit requirements from Garcon Peninsula Mitigation Bank (permit number 017-880-001).

for requesting credit release for that monitoring period. SWFWMD does not have interim or incremental criteria for Boran Ranch mitigation bank. At this bank, initial credit is released for recording a conservation easement and completing construction activities; only after final success criteria is met for a given wetland polygon is the remaining credit released. Two state agency regulators relayed that in the past, some early banks believed they were "owed" a credit release from the regulating agency for conducting monitoring, regardless of whether incremental ecological improvement was documented.

Hydrology

Most of the banks in this study have some hydrologic enhancement or restoration with associated credit releases for construction of these enhancements. Most enhancement practices have included removing roads or increasing connectivity under roads, removing or blocking ditches, and re-grading swales or other unnatural topographic features that inhibit the natural flow of water. Some banks are highly engineered. A few have heavily manipulated hydrology because of their placement in a regionally altered landscape (e.g., Floridawetlands Bank; Florida Mitigation bank). Two banks have constructed significant berms with control structures to increase water levels on site (i.e., Loxahatchee and Florida Mitigation Bank). Everglades Phase II and Bear Point have existing berms required for flood control or mosquito control; these banks have installed multiple controlled culverts through the berms to more closely mimic sheet-flow when allowable. Eight banks are known to have permanent water control structures as described in their state permits. In total, 19 banks describe some level of target hydrology listed in their success criteria. Other requirements hydrology requirement include that four banks must meet M-WRAP or other assessment criteria standards, and seven banks must meet a size requirement of jurisdictional wetlands as defined under Section 373.421, F. S. (a bank may have more than one of these requirements). Five banks do not specifically mention hydrology in their final success criteria, although some credit releases are tied to installation of hydrologic enhancements or monitoring of said enhancements.

Hydrologically based construction also occurred on the banks in terms of grading the existing lands to achieve a lower elevation to support target communities. Hole in the Donut requires grading all of the previously rock-plowed "soil" (approximately 0.3 m) down to the underlying limestone to prevent re-infestation of Brazilian pepper (*Schinus terebinthifolius*) and to promote the native marsh community. Likewise Florida Wetlandsbank, Panther Island, and Corkscrew have areas dominated by exotic species or pasture permitted to be graded to support a marsh community. Grading allowed for the appropriate target wetland species to become established and the community to more closely resemble the desired target community. However areas that have been rock plowed and graded lose the capacity for ground water storage in the areas that have been lowered.

The successful completion of construction activities typically result in the release of 10-20% of the potential credits, with a few exceptions for major construction projects: Tosohatchee and East Central at 30% and Florida Wetlandsbank at 40% (Table 3-3). Credit release is usually based on as-built information and/or other hydrologic data showing anticipated hydrologic enhancements or water levels were attained. Although surface water level changes tend to occur quickly after most hydrologic enhancement structures are in place, soil, plant, and animal community response to the enhanced hydrology may take several years or longer.

Although one of minimum requirements of success of Rule 62-312.350, F.A.C. state that water quality standards are met, very few banks monitor for water quality. Most banks do not specifically propose to improve water quality through wetlands mitigation, but this might be implied with restored function of those wetlands such as through nutrient cycling and improving fauna habitat. The state of Florida does not have water quality standards specific to wetlands, but general Class III water quality standards do apply (Ch. 62-302 Surface Water Quality Standards, F.A.C.). Some of the banks have written into their state permit that they must adhere to Best Management Practices during construction for minimizing turbidity and slope stabilization. Eight banks are required by their state permit to monitor water quality during that time. Only Bear Point, Florida Mitigation Bank, and Lake Louisa and Green Swamp have mitigation activities intended to specifically improve water quality.

Exotic and inappropriate species removal

Invasive exotic and nuisance species are a tremendous ecological and financial concern for land managers on conservation lands in Florida and elsewhere in the United States (e.g., Pimentel et al. 2000). Many contend that these species threaten biodiversity, ecosystem functioning, community health, or human economies (Myers et al. 2000; Diaz et al. 2003). Throughout Florida's history, some non-native species were deliberately planted as part of previous human land use activities like pasture, agriculture, and citrus, and as such are present on lands used for wetland mitigation banking. While some of these species are not considered an invasion threat (e.g., sweet orange or grapefruit, *Citrus* x *aurantium*), others can persist, reproduce, and spread (e.g., West Indian marsh grass, *Hymenachne amplexicaulis,* Diaz et al. 2003) and are thought to alter native community structure and function.

A disturbance or alteration in the landscape, often in the form of disruption of natural hydrology or a total change in the landscape from a natural land use to agriculture or pasture often increases the likely hood of occurrence of exotic species. Most of the banks in this study had enhancement activities relating to the eradication and continued treatment of exotic vegetation. Banks had varying degrees of exotic species. Little Pine Island (Figure 3-3), Hole in the Donut, and Florida Wetlansbank receive most of their credit from the removal of 80-100% cover of melaleuca (*Melaleuca quinquenervia*) or Brazilian pepper (*Schinus terebinthifolius*). Invasive tree species can have a significant impact to the hydrology, structure, and function of native communities when they invade open communities like marshes or flatwoods (EPPC 2003). Like wise, the exotic climbing fern (*Lygodium* spp.*)* can have significant impacts to function in forested communities (EPPC 2003). These exotics pose difficulties in restoring natural communities in several banks, including Bluefield, Corkscrew, Everglades Mitigation Bank, Garcon Peninsula, and Loxahatchee.

Figure 3-3. Dense cover by the invasive exotic species melaleuca or punktree (*Melaleuca quinquenervia*) prior to restoration activities at Little Pine Island.

Bahia grass (*Paspalum notatum)*, while not as invasive in intact natural areas, can be persistent and difficult to eradicate from pastures where it was introduced and is particularly difficult to treat in historically more xeric habitats. Other problematic exotic species which are extremely persistent and can dominate ground cover include torpedo grass (*Panicum repens)* and cogon grass (*Imperata cylindrical)*. Several earlier permits anticipated that with the restoration of appropriate hydrology and cessation of cattle or citrus management practices, the native vegetation would out-compete and dominate the pasture grasses or require only spot treatments of these species. This has not been borne out on some banks, and they continue to face an uphill battle with these invasive exotic species (e.g., Barberville, Big Cypress, Lake Louisa and Green Swamp, and Lake Monroe). Other banks have been very effective at removing pasture grasses and restoring back to a natural community (e.g., Reedy Creek, Bluefield) by implementing thorough site preparation, vigilant monitoring, re-treating exotics, and re-seeding deliberately to establish an intact native groundcover that can be more difficult for some exotics to invade.

Exotic species eradication is expensive and time consuming. Common control techniques included herbicides and mechanical removal with some banks utilizing hand pulling in more sensitive communities. Others experimented with manipulating hydrology and fire to remove exotics and keep them from returning. Because of their landscape location and proximity to non-conservation lands, many mitigation banks have a significant nearby constant exotic species seed source from adjacent properties. Most banks will perpetually have to manage for exotic species with the goal being to eradicate exotic species from the seed bank on site and treat new exotic species that are recruited to the site.

There was a wide variety of percent cover allowed for exotic vegetation in permit success criteria, ranging from 1% to 10%, and sometimes even higher for specific pasture grasses, such as bahia grass (*Paspalum notatum*) (Table 3-4). While this figure may be specifically related to individual conditions at the bank, it appeared that allowable coverage had a stronger relationship to the permitting agency (Figure 3-4). Additionally, some mitigation banks also recognized that a native species may be inappropriate for the target community such as woody species in an herbaceous dominated habitat (e.g., wax myrtle, *Myrica cerifera,* at Garcon Peninsula).

Another category of inappropriate species is found in historic wet prairie, flatwoods or mixed wetland forests of northern Florida that were converted to pine plantations. Several bank's mitigation plans involve the restoration of native communities from the planted pine areas (Barberville, Loblolly, Sundew and Tupelo, and to a lesser extreme TM-Econ and Garcon Peninsula). Similarly, two banks involved significant acreage of citrus tree removal and re-vegetation (Big Cypress, Lake Louisa). Eight mitigation banks have a potential credit release tied to removing silviculture or agriculture trees (Table 3-1). Garcon Peninsula and TM-Econ were the only banks of these eight that awarded potential credit based on the response of the native community to pine removal as opposed to potential credit awards for the physical act of removing the trees themselves.

Site preparation, planting, and seeding

With an emphasis on reference conditions for a target community, activities relating to site preparation, planting, seeding, and expected survivorship of plants should have measurable, expected densities. Most banks had some basic requirement for percent cover of desirable, native species (Table 3-5). Fourteen banks include planting and/or seeding as a requirement for credit release (3%-20%, typically 5%-10%) (Table 3-3). Site preparation is paramount to the survival of the desirable species as is the timing of planting and activities used to maintain the desired vegetation such as hydrologic regime and fire rotation. Vegetation planting may be necessary in mitigation areas that no longer have a viable native seedbank or nearby seed source

Table 3-4. Final success criteria for exotic and nuisance vegetative cover for state permits.

Mitigation Bank	Credit Type	County	Area (ha)	Exotic and nuisance cover
FDEP:				
Bear Point	Mangrove	St. Lucie	128	≤ 2% cover per acre exotic
Corkscrew	FW herb/for	Lee	257	< 2% exotic cover; < 5% nuisance; < 25% combined cover of *Myrica cerifera, Baccharis halimifolia* and *Salix caroliniana* per acre
Everglades Mitigation Bank, Phase I	Fresh/salt	Dade	1,669	≤ 1% aerial cover
Florida Mitigation Bank	FW herb/for	Osceola	640	≤ 1% total cover
Garcon Peninsula	FW herb/for	Santa Rosa	136	< 1% exotic; *Sapium sebiferum* ≤ 1%; Bahiagrass ≤ 10%, or if >10%, trend over 2+ years strongly indicating cover will decrease to < 10%; in cypress/hardwood swamp, nuisance species ≤ 5%
Graham Swamp	FW forest	Flagler	27	< 5%
Hole in the Donut	Everglades	Dade	2,529	≤ 5% total cover
Little Pine Island	Fresh/salt	Lee	512	< 1%
Loxahatchee	FW herb/for	Palm Beach	512	EPPC Category I^ exotic ≤ 1%; EPPC Category II^ exotic ≤ 3%
SFWMD:				
Big Cypress	FW herb/for	Collier	518	0 % total cover exotic; ≤ 3% total cover nuisance
Bluefield Ranch	FW herb/for	Martin & St. Lucie	1,091	≤ 10% exotic/nuisance cover; ≤15% in any ½ acre area at any time
Florida Wetlandsbank	Freshwater	Broward	170	≤ 5%
Panther Island	FW herb/for	Hendry	1,128	≤ 0 % exotic (exotics divided by total species rounded to nearest whole number); ≤ 3% nuisance
R.G. Reserve	FW herb/for	Martin	258	≤5% exotic; ≤10% nuisance ≤ 15% total cover any ½ acre area
Reedy Creek	FW herb/for	Osceola & Polk	1,211	< 10% exotic/nuisance; Uplands - mean % cover by nuisance tree species < 1%; mean % cover by nuisance shrub species < 5%; groundcover - bahiagrass and other nuisance species < 20 %
SJRWMD:				
Barberville	FW herb/for	Volusia	148	5% exotic; 10% nuisance
CGW	Saltwater	Indian River	61	≤ 1%
Colbert-Cameron	Freshwater	Volusia	1,054	< 10%
East Central	Freshwater	Orange	429	≤ 10%
Lake Louisa and Green Swamp	Freshwater	Lake	408	≤ 5% exotic; < 10% nuisance
Lake Monroe	FW herb/for	Volusia	244	< 5% exotic
Loblolly Mitigation Bank	Freshwater	Duval	2,528	State permit < 10%; MBI < 5%
Sundew Mitigation Bank	Freshwater	Clay	853	< 10%
TM-Econ	Freshwater	Orange	2,104	< 10%
Tosohatchee	DOT-used	Orange	531	< 10%
Tupelo Mitigation Bank	Freshwater	St. Johns	617	< 10%
SWFWMD:				
Boran Ranch Phase I	Freshwater	Desoto	96	< 1%

^ EEPC Category exotics from the Exotic Pest Plant Council (EPPC 2003).

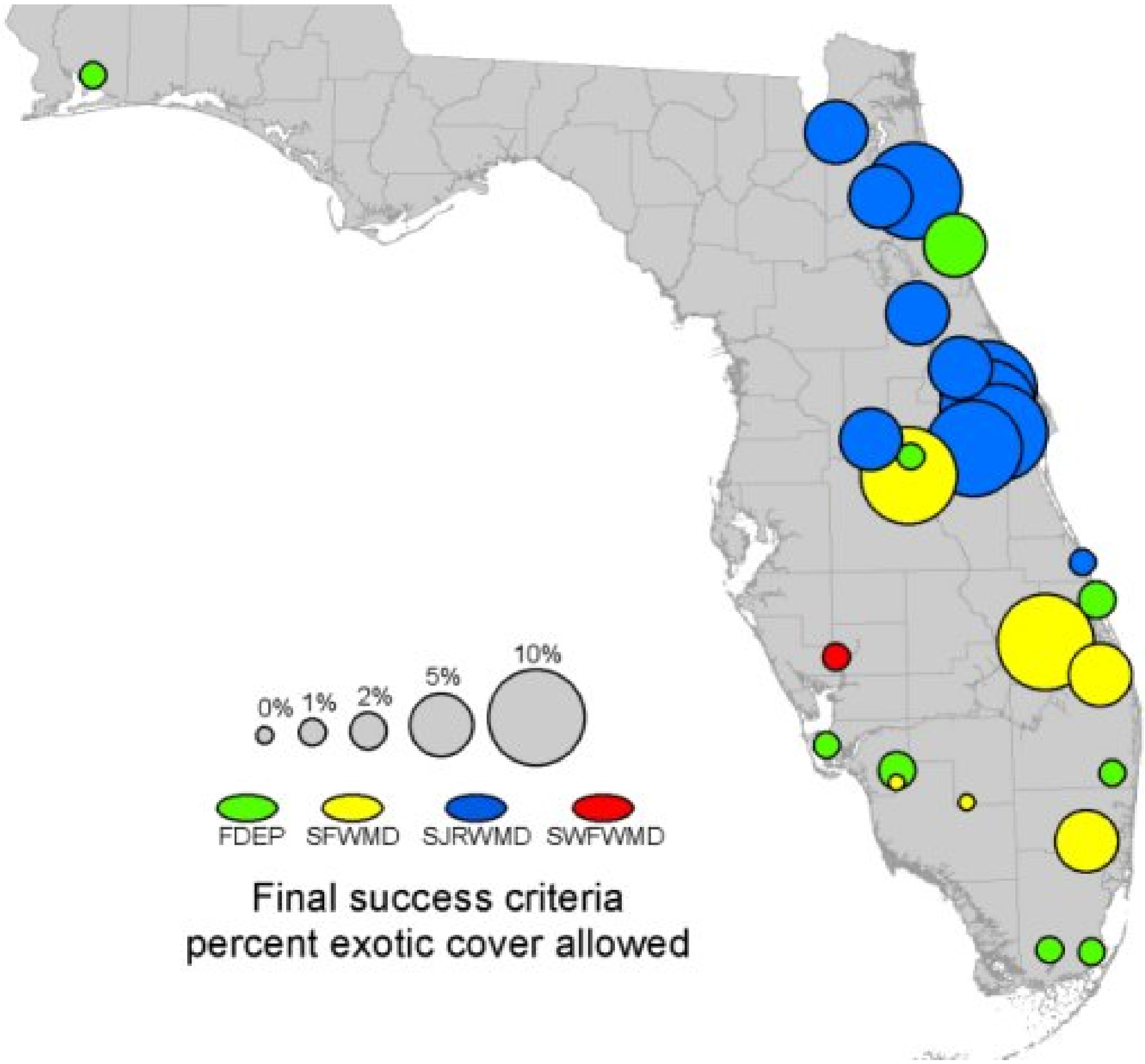


Figure 3-4. Final success criteria allowance for exotic vegetation percent cover by mitigation bank and regulating agency. Agencies include: FDEP - Florida Department of Environmental Protection; SFWMD – South Florida Water Management District; SJRWMD – St. Johns River Water Management District; SWFWMD – South West Florida Water Management District.

Table 3-5. Success criteria related to native vegetation cover and survivability of planted vegetation in state permits.

Bank Name	Dominant Habitat at Site Visit	Final Success Criteria - percent cover of native vegetation	Survivability of planted vegetation
Barberville	Flatwoods	Not specified	400 trees per acre
Bear Point	Mangrove swamp	> 50%	No planting in phase reviewed
Big Cypress	Flatwoods	Herbaceous: ≥ 80% cover native wetland spp. and ≥ 20 wetland herbaceous spp. The herbaceous vegetation shall cover ≥60 % with plant species listed FAC or wetter and be rooted for at least 12 months and be reproducing naturally Forested: ≥70% coverage by desirable ground cover plants, with ≥ 75% of spp. being listed FAC or wetter. Hydric pine flatwoods: diversity of ≥ 30 herbaceous spp. shall be present. For each 5 species over 30 a 1% credit bonus will be given for hydric pine flatwoods. Evidence of natural regeneration of planted species	≥ 80% survival of all planted trees and shrubs
Bluefield Ranch	Flatwoods	Flatwoods graminoid vegetation in groundcover strata ≥ 50% of total coverage ≥ 70% of total groundcover strata consists of wetland vegetation (hydric pine flatwoods only) ≥ 80% of total herbaceous groundcover strata FACW and/or OBL vegetation or OBL vegetation > upland vegetation	≥ 80% survival of planted trees
Boran Ranch	Flatwoods, marsh	85 to 90% cover for desirable vegetation depending on community type	No planting in phase I
CGW	High marsh, mangrove swamp	90%	No planting
Colbert-Cameron	Flatwoods, cypress domes	Percent cover not specified, bank is primarily preservation with some enhancement	No planting
Corkscrew Regional	Mixed forest, cypress domes, hydric flatwoods	Minimum percent cover of groundcover is 70% for hydric pines. Minimum percent cover of groundcover in cypress and mixed forest areas is 75% unless there is a lower percent because of open water or shading. Must show evidence of natural recruitment	No explicit numbers for survivorship in final success criteria.
East Central	Wetland forested mixed	Bank was monitoring for vegetative cover but this study did not acquire documentation that stated what that final success criteria was.	Unknown if there was a requirement for survivorship

Table 3-5. Continued.

Bank Name	Dominant Habitat at Site Visit	Final Success Criteria - percent cover of native vegetation	Survivability of planted vegetation
Everglades Mitigation Bank	Sawgrass marsh, tree islands	≥ 80% aerial coverage of vegetation including planted and naturally recruited vegetation	Survivorship not explicitly defined.
Florida Mitigation Bank	Freshwater marsh, bottomland hardwood	≥ 90% desirable vegetation groundcover and canopy	NA
Florida Wetlands Bank	Freshwater marsh	80%	planted species must have 80% cover
Garcon Peninsula	Wet prairie	Groundcover ≥ 75% Planted canopy must have at least 30% cover	> 90% survival
Graham Swamp	Bottomland hardwood forest	Vegetative cover must stay the same or increase over the baseline. Vegetation must demonstrate natural recruitment	No planting
Hole in the Donut	Freshwater marsh	The importance value, based on frequency and percent cover or density of desirable vegetation, for each restoration area shall fall within the range of Whittaker curves for the naturally occurring communities in this area of Everglades National Park	No planting
Lake Louisa and Green Swamp	Sandhill?	Unknown if there are requirements for percent cover, none were obtained by this study	Planted canopy 80% Planted groundcover 60%
Lake Monroe	Flatwoods	Unknown whether there is a target percent cover in the final success criteria but bank is tracking percent cover in the monitoring reports	Planted longleaf and cypress 50%
Little Pine Island	Mangrove swamp, salt marsh, mud flats, hydric flatwoods	Demonstrate > 60% cover and increase over time	NA
Loblolly Mitigation Bank	Hydric flatwoods, cypress domes	> 80% cover groundcover > 25% mast forming trees	100 trees per acre in forested wetlands 25 trees per acre in upland
Loxahatchee	Forested swamp and open marsh	80 - 90% ground cover in marsh and willow polygons except in mudflats with 25% woody species 50-90% canopy and ground cover for red maple, pond apple and cypress polygons 10-20% open water as meandering water courses and small depressions Permit also addresses appropriate number of species and densities	No planting

Table 3-5. Continued.

Bank Name	Dominant Habitat at Site Visit	Final Success Criteria - percent cover of native vegetation	Survivability of planted vegetation
Panther Island	Hydric flatwoods, cypress strands, cypress domes, freshwater marshes	70% average aerial cover by native wetland flora for transitional and emergent marshes Low pool marshes 60% cover Flatwoods 70% aerial cover by desirable ground cover and groundcover recruitment	Flatwoods minimum 90% survival planted canopy spp.; minimum 80% survival of planted sub-canopy spp.; minimum 80% average survival of planted ground cover spp.
Reedy Creek	Hydric flatwoods, freshwater marsh, wet prairie	flatwoods canopy cover ≤ 50%, shrub cover < 20% marshes 75% prairie ≥ 80%	Bank may have to do future plantings in marshes if percent cover by natural recruitment can not be met
R.G. Reserve	Bottomland hardwood forest, hydric flatwoods, swales	80% coverage of desirable wetland species Uplands mean % cover by indigenous ground species > 75% Ground strata dominated with indigenous grass species at > 50% of total ground strata: mean % cover by indigenous ground strata species is > 5% but < 30% Mean density of indigenous shrubs and semi-shrubs is > 180 and < 400/ac Shrub strata dominance < 75% by any 2 species Mean % cover by indigenous tree species is > 5% and < 25% Mean indigenous tree density is > 5 and < 50	Survivorship of planted vegetation not explicitly defined
Split Oak	Documentation did not include success criteria specific to native vegetation cover or survivability of planted vegetation.		
Sundew Mitigation Bank	Hydric flatwoods, cypress domes	No requirement for percent cover	100 trees per acre in forested wetlands
TM-Econ	Hydric flatwoods, forested slough	> 80 % aerial cover	trees ≥ 80%
Tosohatchee	Mixed wetland forested, fresh water marsh	> 80 % cover	> 80%
Tupelo Mitigation Bank	Hydric flatwoods, cypress domes	No requirement for percent cover	Minimum density of 100 surviving and growing trees/ac present in assemblages that reflects diversity in target vegetative community

for recruitment. Additionally, supplemental plantings may be required to increase diversity, provide structure, or stabilize areas where roads were removed, canals filled, or grading occurred. A practice commonly followed by several more recently permitted banks for flatwoods or wet prairie targets communities includes preparing large areas of bare ground by disking and/or herbicide treatments, then mulching with seed and other plant material directly from a harvested donor site.

Although most banks did list a desired percent cover for native vegetation, very seldom was there a reference in the permit for how percent cover would be defined or measured. Composition, dominance, structure, and other metrics that define a natural community say more about restored function than percent cover or survivorship of planted species alone. In addition, percent survivorship criteria often appeared to be based more on standard practice or previous permits, as opposed to expected vegetation density in the reference standard community. These arbitrary densities, especially for trees, should not be a standard, and plantings in specified target communities should be based on reference standards in the literature or a natural community.

Prescribed fire

A majority of the mitigation banks in this study include a diverse landscape mosaic of upland and wetland community types most of which are adapted to fire. Bear Point, CGW, and Graham Swamp represent three mitigation banks where prescribed fire would not be appropriate given that mangrove and hardwood wetland communities represent nearly 100% cover at these banks. However, historically fire would have played a significant role in maintaining the natural communities in the landscape surrounding these mangrove and bottomland hardwood swamps.

The FDEP mitigation rule requires mitigation bank permits to contain perpetual management plans (62-342.750(1)(h) F.A.C). Most of the banks acknowledge the role of prescribed fire in maintaining the natural communities on site. However, it was difficult to determine how detailed long term fire management plans were. Some banks also have (or intend to) utilized prescribed fire during enhancement and restoration activities in addition to using it for long term management of the natural communities.

Eight bank permits had a credit release associated with conducting a prescribed fire (Table 3-3). A few more permits required prescribed fire as part of the final release criteria. There is evidence that some banks are not as aggressive in the application of prescribed fire as they could be. At least two banks, Big Cypress and Barberville, cite being unable to apply prescribed fire until planted pine trees (*Pinus* spp.) in flatwoods communities are established for eight to ten years. Additionally, Barberville anticipates waiting 15 years to burn an area planted with cypress (*Taxodium* spp.). Documents for both banks do not adequately describe the natural community type, but suggest the overall reason for not applying prescribed fire is because of possible mortality to the planted trees. As well, both banks demonstrate a lack of diversity in the groundcover in what this study determined should be flatwoods communities. The emphasis to protect the planted trees appears misplaced when restoring the function for this community type. For example, in longleaf pine (*Pinus palustris*) communities, Kirkman and Mitchell (2006) propose that the age and diversity of groundcover and temporal extent of fire connections across the landscape may be more appropriate means of describing old-growth ecosystems as opposed to the age of trees, stressing the importance of appropriate groundcover and fire regime over tree structure. A low intensity prescribed fire during the growing season could benefit the groundcover and enhance species diversity. Primary concern for planting the pine trees first before restoring the groundcover may not have been the best approach to achieve success and restoring a functioning flatwoods community.

At least seven banks included in this study reported that they were behind in accomplishing their prescribed burn plan for site specific conditions, usually because the site was either too wet or too dry. Other limitations for some banks include their placement in populated areas where smoke control is more restricted (e.g., Everglades Mitigation Bank Phases I and II). In some circumstances (e.g., Garcon Peninsula), the inability to burn has set back the restoration progress because a primarily herbaceous ecosystem has been over taken by an overstory of shrubs and other woody structure. In this specific case, prescribed fire was tied to credit release and the state withheld future credit releases pending fire implementation.

As with all of the construction and management activities described in this chapter it would be worthwhile for regulators to consider tying credit release to the natural communities response to management decisions such as prescribed fire. Fire is an ecosystem process that can drastically alter a landscape, if applied appropriately it can be a tool for restoration and maintenance of a natural community. Monitoring should be conducted to determine flora and fauna response to the application of fire. Frequency and application techniques of prescribed fire should be based on reference documentation and literature.

Credit releases for construction and management activities described previously are based on documentation that the required action has occurred. In total, these activity-based releases at a typical bank averaged about 50% of the total potential credits (Table 3-3), and represent the preservation and completion of the mitigation "work" at the bank. Although it is recognized that the actual work does sometimes represent actual enhancements made, mitigation success may be improved if credits releases were weighted more toward incremental improvement and community response to these treatments and actions, rather than simply completion of predetermined activities. The remaining credits are typically based on achieving incremental or final performance goals.

Monitoring and Interim Release Criteria

Most mitigation banks are required to submit an annual monitoring report to document the level of success attainment. Monitoring plans, including both qualitative and quantitative parameters, are reviewed prior to permitting, and thus should be adequate to evaluate success criteria. Monitoring plans are generally referenced in permit criteria or attached to the permit. Some state permits specifically addressed what is expected in monitoring reports, others did not have specifications. The FDEP mitigation banking rule (Chapter 62-342, F.A.C.) requires that mitigation banks include a proposed monitoring plan to demonstrate success. Monitoring reports acquired in this study represented varying degrees of quality of data and quantity and completeness of information. For utility, monitoring reports should refer to success criteria, both interim and final, and specifically demonstrate incremental change from the baseline. If a bank is using reference wetlands for target restoration, then monitoring reports should reflect how the restored areas compare to reference conditions.

Some monitoring reports were mere plant lists, with minimal analyses and vague descriptions. It could be that some early permits did not specify enough detail as to what was required for monitoring, and bank are not offering more than these minimal requirement. While agency personnel do tend to visit banks either when new monitoring reports are submitted or following requests for credit release and regulators should be capable of verifying what is in the report, time and resources devoted to agency monitoring and analysis is limited. Efforts would be improved so that monitoring reports read easily for anyone unfamiliar with site history or permitting conditions of the bank. A monitoring report should summarize success criteria, history of the bank, activities completed, activities planned, and discuss how the bank is progressing in restoring and enhancing the natural target communities. Further, monitoring reports should clearly and unambiguously state if the mitigation bank is on target with interim or final success criteria and if the bank is trending towards success and describe the parameters it is meeting.

Compliance regulators reported that seven banks did not report on areas that were not demonstrating ecological improvement or did not submit a report because no activities were taking place. Sometimes if a bank falls behind in meeting their targets, the bank will not request additional credits release but will also not submit a monitoring report, as that would require admitting problems with attaining interim targets or monitoring. Some permits require a status report every six months, regardless of the degree of activity or monitoring results, which may be a good tool to track mitigation activities and progress.

After major mitigation construction activities but prior to final credit release, interim credits are typically awarded by year or phase of a mitigation bank. Potential credits awarded for reaching interim criteria vary, with mean awards of 5-8% of total potential credits per year. Total interim criteria varied around 30%-50% release of total potential credit (Table 3-3) over an average of four to five years. While there is an expectation that releasing interim criteria should implicate a "trending towards success," many times this was not reinforced by specific criteria that should demonstrate incremental ecological improvement. Out of twenty three mitigation banks that included an "interim" release, only thirteen had specific criteria tied to this annual or interim release.

It is important that permits clearly distinguish that the interim/annual credit releases are based upon the ecological functions gained since the last monitoring report, rather than on the submittal of the annual monitoring report itself. Compliance regulators reported some problems with expectations based on reports rather than success. Further, field work associated with this study revealed cases where credits were released when it appeared that interim criteria had not been achieved. Compliance regulators reported that monitoring reports can be misleading or report on improving areas rather than the whole site. A few mitigation banks have few or no credits released for interim success, either because credits are withheld until the bank or polygon attains full success (e.g., Boran Ranch) or because the activities represent the final or near final success (e.g., Colbert-Cameron, Florida Wetlandsbank). In addition, the number of years required for monitoring and meeting final success varies, with most anticipating a five year release schedule, some anticipating an accelerated schedule (e.g., Florida Wetlandsbank, Graham Swamp, Panther Island), and other banks have or are anticipated to take 10 or more years (e.g., Everglades Mitigation Bank, Florida Mitigation Bank, Garcon Peninsula, Hole in the Donut, Loxahatchee). In fact, even a 10 year time span may be too short to fully attain the natural variability and function for ecosystem development (Mitsch and Wilson 1996), even if permit success criteria are reached.

Final Success Determination and Release

Ideally, final success criteria should reflect the mitigation project's target community goals and anticipated functional gain, as determined by the potential credit assessment (i.e., its "with-bank" scenario). An early guidance document for Florida mitigation banking, *Joint State/Federal Mitigation Bank Review Team Process* (the "Greenbook," cited as Story et al. 1998), suggests that the risk inherent in wetland mitigation banking is managed through credit release schedules and that because most credits are not released until the success criteria have been met, risk has been minimized. Further, the "Greenbook" suggests that success criteria should be specific and quantifiable based on the field assessment used to determine appropriate awarding of credits (Story et al. 1998). Yet only five wetland mitigation banks reviewed included functional assessment scores, such as WATER, Wetland Rapid Assessment Procedure (WRAP, Miller and Gunsalus 1999), or Uniform Mitigation Assessment Method (UMAM, Chapter 62-345, F.A.C.), in the final success criteria.

For over a decade, wetland scientists have recognized that permit success criteria and achieving wetland function may not be equivalent (Mitsch and Wilson 1996), yet changes have not been made in the permitting process to require completion of functional assessments for attaining credit release. Functional assessment scores for WRAP or UMAM may not be included in permit language because of concerns about the inherent subjectivity in the methods. For example, an assessor could award a higher functional assessment score based on the incentive to attain functional success and not necessarily based on a wetland assessment area truly achieving the suggested function. This concern for subjectivity and evaluator bias does not speak well of the reliability of rapid assessment methodologies or the human involvement in wetland mitigation banking. Even in more calculation intensive methods such as the Hydrogeomorphic approach to assessing wetland function (HGM), it has been suggested that an assessor could "visualize" a higher percent cover of desirable species or "miss" an exotic species that occurred on a transect to improve the final score. Perhaps development of a more objective means of measuring ecological function is called for, and holding those involved in the process personally responsible for such evaluations would improve the situation. Despite these limitations, achieving a predetermined with-bank scenario score for a given functional assessment method could be used as a back up measure to withhold final credit release if the site did meet permit success criteria, but has been poorly monitored or is not functioning as anticipated.

Final release of potential credits for mitigation bank state permits have been organized in two ways: one includes final release of credits as an incremental installment of available credits after final monitoring for the entire mitigation bank, and the second separates out final credit release based on criteria specific to each community type or polygon. The typical range of potential credits for final credit releases is between 5-20% of total potential credits awarded (Table 3-3).

One obvious exception to the typical range is Lake Monroe, which has a potential final credit release of 35% total potential credits. To date, all potential credits have been released for Lake Monroe except for this final 35%, because it has not met its final success criteria. However, success criteria for this bank do not appear to encapsulate ecological function. There are incremental improvements, but the majority of credit is tied to the survival of a planted canopy instead of restored groundcover for a community that should have a species rich groundcover. There is also credit tied to the application of prescribed fire in the communities that are intact but are in need of enhancement. At this time the bank is behind schedule in implementing prescribed fire. Fortunately this final credit is being with held until improvements are made to the restored and enhanced areas. It is doubtful, under the current management strategy, that the pastures will ever be reclaimed and resemble any reference conditions, but this was never part of the success criteria goals. The primary with holding of final credit release appears to be tied to failures of control structures on hydrologic enhancement areas. Another exception to the average final success release is Boran Ranch, where the permit withholds 75% of credits until final success criteria are attained. However, this attainment is based on each polygon, rather than the whole bank, thus it becomes "successful" in pieces, which may mimic the incremental releases of other banks.

There are causes for concern if meeting final success criteria has a less significant credit release. This further illustrates the importance of the regulator's ability to determine that incremental credit releases are appropriate and determine a trending towards success. If banks are unable to meet final success criteria because they have failed to create conditions suitable for ecological trajectories, the final credits cannot be released.

Compliance with Permit Schedule of Activities and Success Criteria

State mitigation bank regulators were interviewed and asked to comment on the technical aspects of compliance for their respective mitigation banks. Their responses have been compiled and are listed in Table 3-6. In this section, success and trending towards success are defined in regards to permit criteria only. Three mitigation banks have reached final success criteria for the entire bank (East Central, Florida Mitigation Bank, Tosohatchee). Regulators believe that nine banks appear to be trending towards success and should be able to reach final success. Five banks are currently not trending towards success, at least in specific problem areas. Six banks were not far enough along for regulators to comment on whether or not they are trending towards success yet. Most banks are visited at least once, if not twice, a year by the regulatory agency; most visits are timed with monitoring reports and requests for credit release. This documentation is anecdotal, sometimes the regulator did not have all the institutional history on a bank if it was before their involvement and others expressed that some issues were one time incidents and not a continuous issue.

Summary

To insure that the credits released for use can indeed provide offsets to wetland functions, the following recommendations are necessary to the highest levels:

* Permits and attached or referenced documents should contain the detailed community goals and/or reference conditions the site is anticipated to attain. FNAI descriptions

could provide a valuable starting point to ensure that more than just vegetation is included. It is important to evaluate wildlife responses to mitigation activities.

* Final success criteria should be quantifiable reflections of these goals.
* Credit potential should be assessed with a reasonable evaluation of future condition given the expectations for surrounding landscape and water sources.
* Implementation of fire management plan, as appropriate, should be a permit requirement, rather than just referenced in mitigation plans.
* Regulatory agencies must endeavor to write permits that can be followed and enforced that use the best available technology or protocol for restoration, be vigilant in demanding accurate and representative monitoring reports, withhold credit for underachieving sites, and ensure frequent communication and inspection of the sites.
* The permit's credit release schedule should be commensurate with actual functional gain including the value of site preservation, with a higher focus on community response to mitigation activities, as opposed to the activity itself, and based on specific criteria.

Table 3-6. Summary of regulatory compliance for 28 wetland mitigation banks.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Barberville	Problems with planting pines, have had to replant several times but latest monitoring report reports good success with second planting which occurred in 2004. Bank has not had a permit modification yet but has planted cypress in areas that were more wet than anticipated, pine is not surviving. Bank did not request credit release when plantings were failing, now that they are finding better success they have asked for credit release.	Long ways off.	No problems.	Pretty good with communication, good about district visit.	New district staff has been out to the bank a couple of times, and going again now because of credit release request. If the bank is not improving, then the district will allow more time to meet criteria.
Bear Point	First release for exotic species control, preservation, and financial assurance.	Practically meeting success criteria after only 1-2 years.	Need reminders when submitting reports.	Needed help with process but good communicating.	1-2 times/yr - with every credit release.
Big Cypress	Time zero was reset because could not get ground cover to proper specifications. Recently bank submitted request for credit release, but the district only gave a partial release because the herbaceous level 1 criteria could not be met because torpedograss (*Panicum repens*) cover was greater than 10%. Bank has finished all planting.	Permit may have to be modified either in number of credits or type of credits because they may not be able to get the torpedograss within success criteria requirements. (this may not have ever been done before as far S.McCarthy knows) May experiment with different techniques to try and control the torpedograss.	Pretty good about submitting reports on time although did withhold a monitoring report for a while because they were trying to do better with the torpedograss, fell a little behind trying to get it under control.	Communicating pretty well. Usually on time except for what was previously mentioned.	Generally visit Big Cypress every time a request for credit release is submitted. Other than that, site visits may happen at the request of the permittee to address a specific issue (i.e., analyze methods to eradicate torpedograss). Site visit may be requested if there are any glaring non-compliance issues from the monitoring reports. District staff has visited the bank for training and educational type purposes for district staff in the past. The bank has always been very accommodating.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Bluefield Ranch	Credit for Phases 4 and 5 have been released post site inspection by district. Percent cover exceeds success criteria goals in the permit. Bank has met all requirements to date. Never denied a credit release.	Have met all requirements to date, very successful to date.	Reports are never late. Usually very lengthy with lots of documentation exceeding minimum requirements.	Very communicative and responsive, never late.	Agency staff only gets out once or twice a year. Try to time inspections following submittal of monitoring reports and prior to credit releases. Typically credit release inspections and general inspections are conducted together, limited staff and high work load being the factor.
Boran Ranch	There is not interim success criteria. Bank is laid out in polygons, there are no partial success or trending toward success credit releases. A polygon either has reached success or not. Credits released for Conservation Easement and construction and then for reaching success. Phase I is mostly released. Phase II - conservation easement and construction credits. Agency feels that the bank knows what the expectations are and what exactly it has to do. Myakka is set up the same way.	Final success is per polygon. A polygon might be the interior of a marsh and another polygon for the ecotone or transition area. The transition zone might be more difficult to achieve success because of pasture grasses and exotic species. Very cut and dry, either successful or not. If a polygon cannot reach success may have to do a credit modification and adjust success criteria and credits. Final success criteria is based on UMAM.	Annual reports are very good and on time.	Good communicating, bank keeps good track of credit withdrawals.	Site visits usually at least twice a year. Visits coincide with requests to release credit. Sometimes the bank might think they deserve credit release but the agency does not believe the polygon has met final criteria.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
CGW	No instance when credit was not released because of compliance issues.	Progressing well, currently in monitoring phase.	Sometimes needs to be reminded to keep on track. Asked for a credit release a year after monitoring report was due.	Not always communicating on the ground. Lately bank is better about communicating and is straightening up ledger issues.	District site visit are performance related. Site visit before credit is released when monitoring report is submitted and also to see how bank is progressing with interim criteria.
Colbert-Cameron	No problems with compliance, previous regulator said things were progressing well.	Looks good do not foresee any problems.	Submitting everything .	Good communication.	New district staff has been to the bank once, do not know history of previous district staff bank visits.
Corkscrew	Long delay with initiating work. Was not communicating that on the ground work had begun. Reevaluate different plan based on lack of earth work-construction changes. Permit modification made new plan less intrusive - but did not have big impact on success criteria or monitoring. Will not be as wet.	If they had scrapped the site like original intention the plan had more risk and might have been more difficult to hit final success. Hydrologic final success may be more difficult to reach now that they did not scrape.	Made a significant modification of the permit to do less earth work. On the ground less was done (less impact).	Not communicating at first what they were doing, doing their own thing. Better now. Work was good. They are responsive now.	Lots of field work in permitting - will be onsite for initial credit release December 2006.
East Central	Unknown if there is any history of not meeting interim criteria.	Sold out final success achieved.	Unknown.	Unknown.	Unknown.
Everglades Mitigation Bank	On the ground success looks good.	Phase I attained-conscientious management.	Tardy with annual monitoring report.	Not always on target.	~1/year - with credit release.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Florida Mitigation Bank	Hydrology poorly designed-ended up firing manager, got new manager, and everything improved, first year annual credit release was denied.	Do not have control of water input, but have relationship with Disney; official FDEP and MBRT success determination 2004.	Initial monitoring and management techniques poor; good after new consultant (~2000).	Initial reporting and modification very misleading; good after new consultant (~2000).	1-2 times/yr - with every credit release.
Florida Wetlandsbank	Regulator does not know previous compliance history but in last few years the transfer of the bank to the City of Pembroke Pines for perpetual maintenance was held up because the buffer between housing on west side of the bank had homeowners infringing into the conservation easement with exotic plantings, swing sets etc. Bank managers had to go to the homeowners and remove all infringements from the bank and then the bank was required to put up a fence on the bank boundary in that area before the SFWMD allowed the final transfer.	A final more recent phase has some time left in monitoring before the remaining credit (2.63) is released.	Very good about submitting reports on time, adequate detail and information.	No problems known.	Site visits every year not necessarily tied to credit release or a set time schedule, just worked out between bank, district, county, the Corp and the City of Pembroke Pines. Early stages did annual visit with the agencies. Towards the final stages the only bank activities were treating undesirable vegetation. The bank was well established so did not do as many site visits
Garcon Peninsula	Good start-initial credit release for fire and exotic eradication. Site got wetter than anticipated when ditches were plugged. Changed cover type. Management fell behind.	Needs a lot of work if they are going to try to hit final success. Back tracked some what because no burning, so will take longer than planned. Hydrologic success evident.	Was out of compliance because was not getting burning done and had aerial spraying of exotic species. Reports not sent because no work done	Not good - needs constant agency prodding.	Frequent early on, but 2+ years w/ no work, no request for credit release and no site visit; working to get back on track with frequent agency inspections and notices.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Graham Swamp	Monitoring is not often enough.	Did not attain final success - but 95% there.	Data are sometimes poor; because early permit not required to do long term management reports.	Not responsive about keeping ledger up to date.	1+/yr earlier, now every other year.
Hole in the Donut	Ahead in restoration by acre.	May never meet final success criteria, cover is not the same as reference conditions but function is believed to be met.	On time, scientific good annual monitoring, but deficient status/activity reporting relative to permit.	Miami Dade county not good about reporting permits and updating credits.	No "credit release" schedule per se, but inspections ~once/2 years reveal timely/appropriate management.
Lake Louisa and Green Swamp	Only SJRWMD bank that requested a credit release and the district said no. Having problems meeting interim success regarding groundcover and shrub layer in the planted areas. District asked for a plan for how bank will address these issues. The bank is in disagreement with the District's decision because of previous arrangements made with staff that is no longer with the District. There was never a permit modification for success criteria. Bank is not in compliance but believes that it is trending towards success.	Bank suffered from neglect, problems with bankruptcy. It is the District's opinion that the bank will have to change its management strategy if it will ever meet final success.	Have been submitting reports on time but they are not always accurate. Reports are misleading and only reporting on areas that are more successful not the areas that are not in compliance.	Monitoring report misleading, not on target.	New district staff visited the bank initially to become oriented and familiar with it. Since then there has been a site visit conducted because a monitoring report was submitted and a credit release requested.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Lake Monroe	Problems with ground cover, some plantings have failed, structure for hydrologic improvement has had some blow outs - District land managers may try to help with pasture grass issues because it is District property, ultimately when it is turned over then District will maintain, but they do not want it until FDOT has found success with restoration and enhancement measures and is up to date on prescribed fire.	Unknown.	No current monitoring report, new District staff plans on spending more time with this bank and addressing its issues.	Communicating pretty well.	New District staff has been out to look at the bank and has had discussions about some of the problems (hydrologic structures and pasture grasses). Bank is willing to redo that work but there is debate about culvert maintenance between district and FDOT land managers, may be an issue discussed with previous staff no longer with the district.
Little Pine Island	Good at hitting target.	Lots of phases are done; no final success determination requested yet.	Reporting/ communication good.	Mostly good, but some debit requests very late.	1-2 times/yr - with every credit release.
Loblolly Mitigation Bank	Request in right now for credit release, site visit is planned. Initially credit for conservation easement and clearing pines but have since done some plantings.	Very early stages of bank.	Had to be asked for report.	Not communicating so well, but is getting better. Does call a lot but has to be reminded for reports and more administrative type things. Bank does get in touch but might need more guidance and help in the process.	Visit planned to determine credit release.
Loxahatchee	Not getting credit released because so far mostly unsuccessful, may not be able to reach final criteria.	Hydrology success a problem in south parcel due to leaky underground conduits and canal level management out of control of bank - re-evaluation of criteria and credit likely.	Good monitoring and reporting - also addresses the problems responsively.	Very communicative and responsive.	1-2 times/yr - with every credit release.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Panther Island	A couple times there was a hold up on a release because WMD needed to go out and do a site visit, one phase okay but another was not, specifically there was an issue with the exotic species smut grass (*Sporobolus indicus*) and torpedograss (*Panicum repens*). Bank was required to do a re-treatment before full requested release. One phase had a design modified because a site was wetter then expected. With time the Bank seems to know when to wait to ask for certain releases because they know WMD will not approve it in its current standing.	Appears all phases trending towards meeting total success. Preservation areas doing very well, creation areas might take longer. As far as meeting criteria, Phase II might be too much cover- it exceeded percent cover requirement and went from supporting open water fauna such as ducks and white pelicans to supporting larger and more common egrets and herons, does not conflict with success criteria.	Bank reports are usually on time, or if not there is a particular reason that they have communicated to the WMD for example site was too wet to sample vegetation, or time zero report was delayed because planting issues with weather, lots of planning went into baseline and monitoring before anything was done on site.	Very communicative, good relationship.	WMD site visits tied to credit release most of the time. District staff has visited the bank to practice plant identification and train staff in the District. Site visits are conducted for final releases for particular phases.
R.G. Reserve	Bank has done minor enhancements, mostly credit for preservation. Credit might be denied sale because of withholding monitoring report (because the bank is waiting for a Corp permit).	If percent cover is not achieved the bank will have to do some vegetative planting.	Bank withheld monitoring reports because they did not have Corp permit yet, if the bank submits monitoring reports saying wetlands were restored, Corp would award less credit, Corp already has said that site is just preservation. Bank has modified its monitoring schedule.	All reports are up to date and submitted now. Very little credit release, two sold for owner's projects and one other private but only 2/10 of a credit.	Agency staff only gets out once or twice a year. Try to time inspections following submittal of monitoring reports and prior to credit releases. Typically credit release inspections and general inspections are conducted together, limited staff and high work load being the factor.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Reedy Creek	No record of having with held credit for not meeting interim goals.	Bank is fulfilling its requirements and submissions.	On time or ahead of schedule with improvements to get credit release. Quality of reports is exemplary.	Communication exemplary, bank and the agency audit each other, make sure both are on the same page- verify each others books are straight.	Credit release and monitoring reports simultaneously with conducting site visits.
Split Oak	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Sundew Mitigation Bank	Bank has only had an initial release for the conservation easement and has had some credits released for hydrologic enhancements, pine removal, and some plantings.	Very early stages of bank.	Had to be asked for report.	Not communicating so well, but is getting better. Does call a lot but has to be reminded for reports and more administrative type things. Bank does get in touch but might need more guidance and help in the process.	Bank has had a site visit because of request for credit release. Bank is in very early stages of work. Have done some planting, removed planted pine, and some hydrologic enhancement.
TM-Econ	No problems meeting interim criteria.	No foreseen problems meeting final criteria.	Always on time and responsive.	Very responsive, no complaints from District.	District site visit are performance related. Site visit before credit is released when monitoring report is submitted and also to see how bank is progressing with interim criteria.
Tosohatchee	Unknown if there is any history of not meeting interim criteria.	All credits released, applicant not asking for anything.	Unknown.	Unknown.	Previous regulator said bank was in good shape so it is not a current priority for follow-up to the new District staff.

Table 3-6. Continued.

Bank	Interim Criteria	Final Success	Monitoring and Management Status Reports	Administrative Record Keeping -Ledger; Communication	Frequency of Compliance Inspections by Agency
Tupelo Mitigation Bank	Has had some credits released for hydrologic enhancements, clearing of pine, and some planting.	Very early stages of bank.	Had to be asked for report.	Not communicating so well, but is getting better. Does call a lot but has to be reminded for reports and more administrative type things. Bank does get in touch but might need more guidance and help in the process.	Bank has had a site visit because of request for credit release. Bank is in very early stages of work. Have done some planting, removed planted pine, Done with hydrologic enhancement. Tupelo has had the most work of the three banks including Sundew and Loblolly.

CHAPTER 4
DETERMINATION OF ECOLOGICAL INTEGRITY

In order to assess the current ecological integrity of the wetland communities in Florida wetland mitigation banks, five assessment methods were applied to select wetland assessment areas: Uniform Mitigation Assessment Method (UMAM), Wetland Rapid Assessment Procedure (WRAP), Hydrogeomorphic wetland assessment method (HGM), Florida Wetland Condition Index (FWCI), and Landscape Development Intensity (LDI) index. This chapter defines the term ecological integrity for the purpose of this study, followed by an overview of wetland assessment areas and a presentation of results from the five assessment methods. Comparisons among assessment methods are discussed.

Definition of Ecological Integrity

For this study, we adopt Karr and Dudley's (1981) definition of ecological integrity. They state that a system with high ecological integrity has the ability "to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats of the region" (pg. 56). In order to ascertain the degree of ecological integrity of the assessment sites in this study, we compared the sites to the appropriate reference standard condition for the region.

The term "reference standard wetland condition" has been defined (Smith 2001) as "the least altered wetlands in the least altered landscapes" (pg. 3), suggesting that those wetlands reflect the highest level of functioning for all of the functions expected of that type of wetland. Thus, the ecological integrity associated with these wetlands with no apparent anthropogenic alterations and surrounded by natural landscapes would be optimal.

All of the field assessment methods used in this study were developed with reference to minimally impacted ecological communities, and this comparison has been built into the scoring criteria for each assessment method. For example, UMAM includes a Part I Qualitative Description where the evaluator must determine the reference community type, hydrologic connectivity, and the expected functions and wildlife (both common and listed species) before the site visit and scoring occurs. Similarly, WRAP begins with an office evaluation that requires review of aerial photography, identification of adjacent land use, and identification of wetland area (Miller and Gunsalus 1999). Both HGM and FWCI were developed based on a comparison of reference standard wetland community condition, and scoring criteria were standardized against a set of reference wetlands.

Regional similarities and differences among wetland communities were considered when defining ecological integrity. WRAP was originally designed for use in certain types of south Florida wetlands, and has been applied state-wide to a variety of wetland types, whereas UMAM was intended to apply to all wetland community types statewide. The FWCIs for depressional forested wetlands and forested strands and floodplains are not limited geographically in the state. The Everglades flats HGM assessment method is applicable only to southern portions of the state (Figure 4-1), and both the depressional wetlands HGM assessment method and the depressional herbaceous FWCI were limited to the Florida peninsula (Figure 4-2).

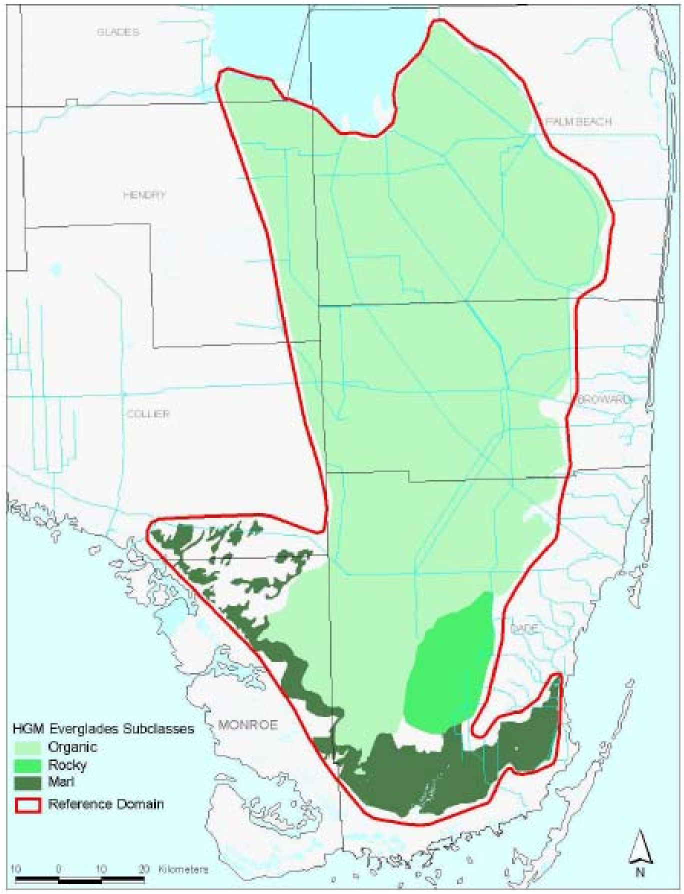


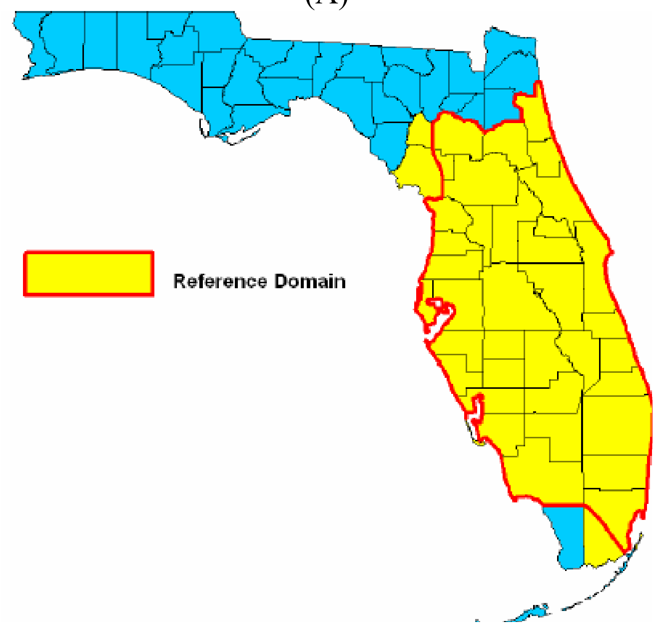
Figure 4-1. Applicable range of the Everglades flats Hydrogeomorphic wetland assessment method (HGM) in South Florida. Reprinted with permission from Noble et al. (2002).

Results of Assessment Methods

Site visits were completed at a total of 58 wetland assessment areas within 29 mitigation banks. Each wetland assessment area was assigned a unique code. The first set of characters were assigned as abbreviations of the mitigation bank name. For example, 'Barb' represents Barberville and 'Blue' represents Bluefield Ranch. The second set of characters were assigned as unique descriptions of a particular wetland type: BOT for Bottomland Hardwoods, FLA for Hydric Flatwoods, FOR for Mixed Forested, HAM for Cabbage Palm Hammock, PRA for Wet Prairie, SHR for Shrub, and SLT for Salt Marsh. When more than one wetland assessment area at a bank was the same wetland community type, a number was added to the code.

One to four wetland assessment areas were selected within each bank for field assessment, depending on a combination of site specific conditions such as homogeneity of the bank, mitigation activities completed to date and progress towards success criteria, area of wetland within the bank, types of mitigation (i.e., restoration, enhancement, creation, or preservation), and general site conditions. Priority was given to those areas representative of the bank and where mitigation work had been conducted.

(A)



(B)

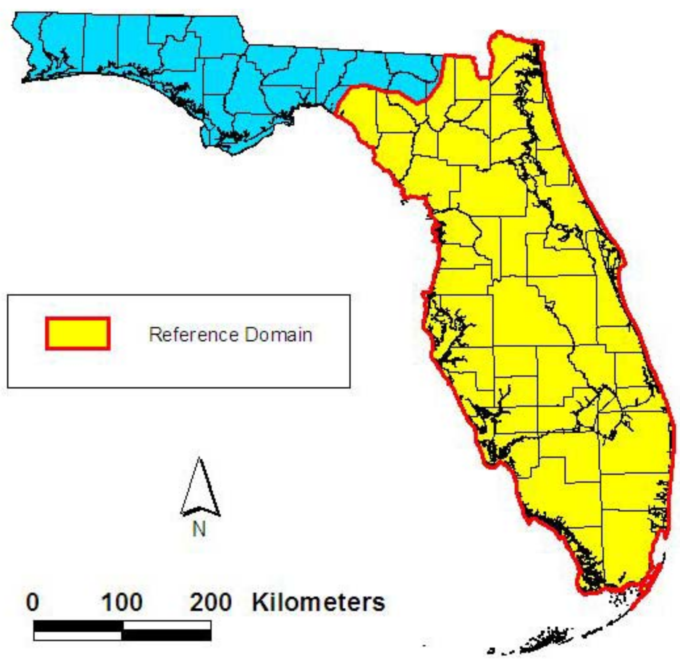


Figure 4-2. Applicable ranges (reference domain) of A) depressional wetlands Hydrogeomorphic wetland assessment method (HGM) and B) depressional herbaceous Florida Wetland Condition Index (FWCI) in peninsular Florida. HGM map reprinted with permission from Noble et al. (2004).

Generalized statistics regarding the size of banks as well as the wetland assessment areas sampled are telling of the vast differences among the banks (Table 4-1). For example, the mean bank area was 848 ha (σ = 894.5 ha) with a range from 27 ha at Graham Swamp to 3,653 ha at Everglades Mitigation Bank/Phase II. The size of the wetland assessment areas ranged from 0.2 ha at Lake Monroe to 282.2 ha at Loxahatchee, with a mean wetland assessment area of 20.3 ha (σ = 48.3 ha). The mean wetland assessment areas was 15.8% (σ = 30.8%) of the total bank area, with a range spanning from 0.1% at Loblolly Mitigation Bank and TM-Econ to 100% at Bear Point and Graham Swamp. Less than 1% of the bank area was included in the wetland assessment areas at 13 banks, while over 50% of the bank area was included in the wetland assessment areas at four banks.

Regardless of the size of the bank, which includes upland area as well as wetland area, the assessment areas were sampled to best reflect the scope of current conditions. For example, at Panther Island, four wetland assessment areas were selected due to the heterogeneity in wetland community and mitigation types. However, due to the large size of the bank (1,128.3 ha) and the small size of the wetland assessment areas (4.5 ha total); only 0.4% of the bank was included in the wetland assessment areas. Only a single wetland assessment area was selected at each of nine banks. At six of these banks, this was because the single wetland assessment area was representative of the dominant type of wetland community and mitigation activities. For example, an 8.1 ha wetland assessment area at Everglades Mitigation Bank/Phase II covered just 0.2% of the entire area of the wetland mitigation bank. In contrast, the 19.0 ha wetland assessment area at CGW covered 31.3% of the bank area. Due to vast differences in the size of the banks (60.7 ha at CGW and 3,652.7 ha at Everglades Mitigation Bank/Phase II), the percent of area covered is vastly different (31.3% compared to 0.2%). However, sampling efforts based on equal percentages of area of bank covered would not provide additional information regarding the ecological integrity of wetland communities within these banks. Furthermore, sampling an equal percent of wetland area at bank would have been time and resource inhibitive (e.g., sampling 31.3% of Everglades Mitigation Bank/Phase II would have required 1,143.3 ha of wetland assessment areas).

At each of the 58 wetland assessment areas, UMAM, WRAP, and LDI were used to determine ecological integrity (Table 4-2). At 16 of the wetland assessment areas, one or more additional assessment methods were completed (HGM n= 15; macrophyte FWCI n = 10; macroinvertebrate FWCI n = 4). HGM could only be applied to sites with a wetland community type with a regional HGM guidebook, which were limited to flats wetlands in the Everglades (Noble et al. 2002) and depressional wetlands in peninsular Florida (Noble et al. 2004). Similarly, the macrophyte FWCI could only be applied to depressional herbaceous wetlands in peninsular Florida (Lane et al. 2003), depressional forested wetlands (Reiss and Brown 2005a), and forested strand and floodplain wetlands (Reiss and Brown 2005b). Only a subset of those wetland assessment areas sampled for the macrophyte FWCI were appropriate for additional sampling using the macroinvertebrate FWCI (n = 4) as only four wetland assessment areas met the criteria of 10 cm of standing water covering a minimum of 50% of the surface area. A diatom FWCI is also available for depressional herbaceous wetlands (Lane et al. 2003) and depressional forested wetlands (Reiss and Brown 2005a). However, due to the small sample size (n = 4) and the time and expense associated with sample processing, a decision was made to eliminate diatom FWCI analysis. Indeed, a greater set of HGM and FWCI appropriate wetlands would be useful for

Table 4-1. Area of wetland mitigation banks and wetland assessment areas in the this study.

Bank Name & Site Code	Wetland Mitigation Bank (ha)	Wetland Assessment Area (ha)	% of Bank in Wetland Assessment Areas
Barberville	148.0		1.4
Barb_CYP		0.6	
Barb_MAR		1.4	
Bear Point	128.3		100
Bear_MAN		128.3	
Big Cypress	518.0		2.4
BigC_FLA		7.3	
BigC_MAR_1		2.4	
BigC_MAR_2		2.6	
Bluefield Ranch	1,090.6		2.9
Blue_BOT		26.0	
Blue_FLA		5.3	
Blue_MAR		0.5	
Boran Ranch, Phase I	95.8		23.1
Bora_MAR_1		1.1	
Bora_MAR_2		21.0	
CGW	60.7		31.3
CGW_MAN		19.0	
Colbert-Cameron	1,053.8		2.3
CoCa_CYP_1		5.2	
CoCa_CYP_2		5.7	
CoCa_FOR		13.0	
Corkscrew	257.0		2.2
Cork_FLA		5.7	
East Central	385.0		1.9
ECFl_FOR		0.9	
ECFl_HAM		6.4	
Everglades Mitigation Bank/Ph I	1,669.2		5.8
Glad_MAR_1		93.0	
Glad_MAR_2		2.2	
Glad_SHR		0.9	
Everglades Mitigation Bank/Ph II	3,652.7		0.2
Glad_MAR_3		8.1	
Florida Mitigation Bank	640.2		0.3
FLMB_FOR		1.8	
Florida Wetlandsbank	170.0		6.1
FLWt_MAR_1		9.1	
FLWt_MAR_2		1.2	
Garcon Peninsula	136.4		59.4
Garc_FLA		81.0	
Graham Swamp	26.7		100
Grhm_FOR		26.7	

Table 4.1. Continued.

Bank Name & Site Code	Wetland Mitigation Bank (ha)	Wetland Assessment Area (ha)	% of Bank in Wetland Assessment Areas
Hole in the Donut	2,529.3		7.6
HID_MAR_1		21.2	
HID_MAR_2		171.0	
Lake Louisa and Green Swamp	407.5		0.8
Loui_SHR		3.2	
Lake Monroe	244.0		0.3
Monr_CYP		0.6	
Monr_MAR		0.2	
Little Pine Island	511.5		7.8
LPI_MAR		6.0	
LPI_SLT_1		10.0	
LPI_SLT_2		24.0	
Loblolly Mitigation Bank	2,528.0		0.1
Lob_CYP_1		1.1	
Lob_CYP_2		0.7	
Loxahatchee	511.5		85.6
Lox_CYP		82.0	
Lox_FOR		282.0	
Lox_SHR		74.0	
Panther Island	1,128.3		0.4
Pant_CYP_1		0.4	
Pant_CYP_2		0.7	
Pant_CYP_3		2.5	
Pant_FOR		0.9	
Reedy Creek	1,211.2		0.2
Reed_BOT		1.3	
Reed_FOR		0.7	
R.G. Reserve	258.2		0.6
RG_MAR		1.6	
Split Oak	424.5		0.7
SplO_CYP		1.9	
SplO_MAR		1.2	
Sundew Mitigation Bank	852.7		0.5
Sun_FOR_1		3.3	
Sun_FOR_2		1.1	
TM-Econ	2,103.9		0.1
TMEc_CYP_1		1.0	
TMEc_CYP_2		1.5	
Tosohatchee	530.9		0.3
Toso_FOR		0.9	
Toso_MAR		0.3	
Toso_SHR		0.4	
Tupelo Mitigation Bank	617.1		0.6
Tup_FOR		0.7	
Tup_PRA		2.8	

Table 4-2. Overview of wetland assessment areas (n = 58) including Florida Land Use, Cover and Forms Classification System (FLUCCS Code), associated wetland community type, and wetland assessment methods applied: Uniform Mitigation Assessment Method (UMAM), Wetland Rapid Assessment Procedure (WRAP), Hydrogeomorphic wetland assessment method (HGM), Florida Wetland Condition Index (FWCI) for macrophytes and macroinvertebrates, and Landscape Development Intensity (LDI) index.

Bank Name	Site Code	FLUCCS Code	Wetland Community Type	UMAM	WRAP	HGM	Macrophyte FWCI	Macroinvertebrate FWCI	LDI
Barberville	Barb_CYP	6210	Cypress	✓	✓	✓	✓	✓	✓
	Barb_MAR	6410	Freshwater Marsh	✓	✓				✓
Bear Point	Bear_MAN	6120	Mangrove Swamps	✓	✓				✓
Big Cypress	BigC_FLA	6250	Hydric Pine Flatwoods	✓	✓				✓
	BigC_MAR_1	6410	Freshwater Marsh	✓	✓				✓
	BigC_MAR_2	6410	Freshwater Marsh	✓	✓				✓
Bluefield Ranch	Blue_BOT	6150	Stream and Lake Swamps (Bottomland)	✓	✓				✓
	Blue_FLA	6250	Hydric Pine Flatwoods	✓	✓				✓
	Blue_MAR	6410	Freshwater Marsh	✓	✓	✓	✓		✓
Boran Ranch, Phase I	Bora_MAR_1	6410	Freshwater Marsh	✓	✓	✓	✓	✓	✓
	Bora_MAR_2	6410	Freshwater Marsh	✓	✓				✓
CGW	CGW_MAN	6120	Mangrove Swamps	✓	✓				✓
Colbert-Cameron	CoCa_CYP_1	6210	Cypress	✓	✓				✓
	CoCa_CYP_2	6210	Cypress	✓	✓				✓
	CoCa_FOR	6170	Mixed Wetland Hardwood	✓	✓				✓
Corkscrew	Cork_FLA	6250	Hydric Pine Flatwoods	✓	✓				✓
East Central	ECFl_FOR	6300	Wetland Forested Mixed	✓	✓				✓
	ECFl_HAM	6181	Cabbage Palm Hammock	✓	✓				✓
Everglades Mitigation Bank/Phase I	Glad_MAR_1	6410	Freshwater Marsh	✓	✓	✓			✓
	Glad_MAR_2	6410	Freshwater Marsh	✓	✓				✓
	Glad_SHR	6172	Mixed Wetland Hardwoods - Shrubs	✓	✓				✓
Everglades Mitigation Bank/Phase II	Glad_MAR_3	6410	Freshwater Marsh	✓	✓	✓			✓

Table 4-2. Continued.

Bank Name	Site Code	FLUCCS Code	Wetland Community Type	UMAM	WRAP	HGM	Macrophyte FWCI	Macroinvertebrate FWCI	LDI
Florida Mitigation Bank	FLMB_FOR	6300	Wetland Forested Mixed	✓	✓				✓
Florida Wetlandsbank	FLWt_MAR_1	6410	Freshwater Marsh	✓	✓	✓			✓
	FLWt_MAR_2	6410	Freshwater Marsh	✓	✓	✓			✓
Garcon Peninsula	Garc_FLA	6250	Hydric Pine Flatwoods	✓	✓				✓
Graham Swamp	Grhm_FOR	6170	Mixed Wetland Hardwoods	✓	✓				✓
Hole in the Donut	HID_MAR_1	6410	Freshwater Marsh	✓	✓	✓			✓
	HID_MAR_2	6410	Freshwater Marsh	✓	✓	✓			✓
Lake Louisa and Green Swamp	Loui_SHR	6310	Mixed Scrub Shrub Wetland	✓	✓				✓
Lake Monroe	Monr_CYP	6210	Cypress	✓	✓	✓	✓		✓
	Monr_MAR	6410	Freshwater Marsh	✓	✓	✓	✓		✓
Little Pine Island	LPI_MAR	6410	Freshwater Marsh	✓	✓				✓
	LPI_SLT_1	6420	Saltwater Marshes	✓	✓				✓
	LPI_SLT_2	6420	Saltwater Marshes	✓	✓				✓
Loblolly Mitigation Bank	Lob_CYP_1	6210	Cypress	✓	✓				✓
	Lob_CYP_2	6210	Cypress	✓	✓				✓
Loxahatchee	Lox_CYP	6210	Cypress	✓	✓				✓
	Lox_FOR	6170	Mixed Wetland Hardwoods	✓	✓				✓
	Lox_SHR	6172	Mixed Wetland Hardwood- Shrubs	✓	✓				✓
Panther Island	Pant_CYP_1	6210	Cypress	✓	✓	✓	✓	✓	✓
	Pant_CYP_2	6210	Cypress	✓	✓				✓
	Pant_CYP_3	6210	Cypress	✓	✓				✓
	Pant_FOR	6300	Wetland Forested Mixed	✓	✓				✓
Reedy Creek	Reed_BOT	6150	Stream and Lake Swamps (Bottomland)	✓	✓				✓
	Reed_FOR	6170	Mixed Wetland Hardwood	✓	✓	✓	✓	✓	✓

Table 4-2. Continued.

Bank Name	Site Code	FLUCCS Code	Wetland Community Type	UMAM	WRAP	HGM	Macrophyte FWCI	Macroinvertebrate FWCI	LDI
R.G. Reserve	RG_MAR	6410	Freshwater Marsh	✓	✓	✓	✓		✓
Split Oak	SplO_CYP	6210	Cypress	✓	✓				✓
	SplO_MAR	6410	Freshwater Marsh	✓	✓	✓	✓		✓
Sundew Mitigation Bank	Sun_FOR_1	6300	Wetland Forested Mixed	✓	✓				✓
	Sun_FOR_2	6300	Wetland Forested Mixed	✓	✓				✓
TM-Econ	TMEc_CYP_1	6210	Cypress	✓	✓				✓
	TMEc_CYP_2	6210	Cypress	✓	✓		✓		✓
Tosohatchee	Toso_FOR	6170	Mixed Wetland Hardwood	✓	✓				✓
	Toso_MAR	6410	Freshwater Marsh	✓	✓				✓
	Toso_SHR	6460	Mixed Scrub Shrub	✓	✓				✓
Tupelo Mitigation Bank	Tup_FOR	6300	Wetland Forested Mixed	✓	✓				✓
	Tup_PRA	6430	Wet Prairie	✓	✓				✓

further consideration of ecological integrity of wetlands within banks; however, HGM and FWCI could not be applied to wetlands that did not fit the conditions for the reference wetlands used in developing these biological assessment tools.

Using the Florida Land Use, Cover and Forms Classification System (FLUCCS Code), 12 wetland community types were differentiated in the wetland assessment areas (Table 4-2). The most common wetland community types were 6410: Freshwater Marsh (n = 18) and 6210: Cypress (n = 13). In addition, 13 forested wetlands with mixed species composition were assessed, including five 6170: Mixed Wetland Hardwood, two 6172: Mixed Wetland Hardwoods – Shrubs, and six 6300: Wetland Forested Mixed community types.

Uniform Mitigation Assessment Method - UMAM

UMAM scores for the 58 wetland assessment areas ranged from a low of 0.47 at a hydric pine flatwoods at Big Cypress (BigC_FLA) to the high of 0.93 at five wetland assessment areas: two freshwater marshes at Boran Ranch, Phase I (Bora_MAR_1 and Bora_MAR_2), one freshwater marsh at Hole in the Donut (HID_MAR_1), a saltwater marsh at Little Pine Island (LPI_SLT_2), and a cypress wetland at Split Oak (SplO_CYP) (Table 4-3). Recall that the scale of UMAM ranges from 0.00-1.00, with 1.00 representing the optimal or reference standard condition. Half of the wetland assessment areas had UMAM scores greater than or equal to 0.75 (n = 29), suggesting that these wetland assessment areas provide 75% or more wetland function.

UMAM scores were based on an average of three categories representing indicators of wetland function: Location and Landscape Support, Water Environment, and Community Structure. These scores ranged from 4 to 9 for Location and Landscape Support, 5 to10 for Water Environment, and 4 to10 for Community Structure. While several wetland assessment areas scored 10 for both Water Environment (n = 7) and Community Structure (n = 2), no wetland assessment area scored 10 for the category of Location and Landscape Support.

As with the other assessment methods, UMAM was not meant to be used as a comparison among wetland community types. As such, UMAM scores have been summarized based on specific wetland community types using FLUCCS (Table 4-4). Averaging the UMAM scores by wetland community type shows that mean UMAM scores ranged from 0.53-0.80, though these averages have large standard deviations showing a great deal of variability in the function provided by the wetland assessment areas. The highest mean UMAM score for any wetland community type was 0.80 ($\sigma = 0.18$) for 6420 Saltwater Marsh. The large standard deviation is based on the wide variability in the scores for the two saltwater marshes at Little Pine Island, as one represented the pre-restored condition at LPI_SLT_1 (UMAM = 0.67) and one the post-restored condition at LPI_SLT_2 (UMAM = 0.93). Perhaps in this case, the difference between the two scores is more telling than the mean, as the numbers imply a functional lift of 0.26 may be attained by implementing the mitigation plan for Little Pine Island salt marshes. Similarly, at Everglades Mitigation Bank, freshwater marsh wetland assessment areas were sampled before (Phase II - Glad_MAR_3) and after (Phase I - Glad_MAR_1) mitigation activities were implemented. Again, the difference between the high UMAM score for the restored wetland assessment area of 0.83 and score of 0.60 at the pre-restoration wetland assessment area indicates the potential functional lift attainable from restoration activities.

Table 4-3. Uniform Mitigation Assessment Method (UMAM) scores for 58 wetland assessment areas at 29 wetland mitigation banks. In addition to total UMAM score, scores are presented for each of the three UMAM scoring categories: Location and Landscape Support, Water Environment, and Community Structure.

Bank Name	Site Code	Location and Landscape Support	Water Environment	Community Structure	UMAM
Barberville	Barb_CYP	8	7	8	0.77
	Barb_MAR	8	8	7	0.77
Bear Point	Bear_MAN	8	8	9	0.83
Big Cypress	BigC_FLA	5	5	4	0.47
	BigC_MAR_1	7	8	6	0.70
	BigC_MAR_2	7	8	7	0.73
Bluefield Ranch	Blue_BOT	7	8	6	0.70
	Blue_FLA	8	9	8	0.83
	Blue_MAR	8	7	7	0.73
Boran Ranch, Phase I	Bora_MAR_1	9	10	9	0.93
	Bora_MAR_2	9	10	9	0.93
CGW	CGW_MAN	4	7	8	0.63
Colbert-Cameron	CoCa_CYP_1	8	7	7	0.73
	CoCa_CYP_2	8	9	8	0.83
	CoCa_FOR	8	9	7	0.80
Corkscrew	Cork_FLA	5	5	5	0.50
East Central	ECFl_FOR	7	7	7	0.70
	ECFl_HAM	9	8	6	0.77
Everglades Mitigation Bank/Phase I	Glad_MAR_1	7	9	9	0.83
	Glad_MAR_2	8	8	9	0.83
	Glad_SHR	7	9	9	0.83
Everglades Mitigation Bank/Phase II	Glad_MAR_3	5	7	6	0.60
Florida Mitigation Bank	FLMB_FOR	8	7	5	0.67
Florida Wetlandsbank	FLWt_MAR_1	4	9	9	0.73
	FLWt_MAR_2	4	9	8	0.70
Garcon Peninsula	Garc_FLA	6	7	5	0.60
Graham Swamp	Grhm_FOR	4	7	7	0.60
Hole in the Donut	HID_MAR_1	9	9	10	0.93
	HID_MAR_2	8	9	8	0.83
Lake Louisa and Green Swamp	Loui_SHR	8	6	5	0.63
Lake Monroe	Monr_CYP	9	9	9	0.90
	Monr_MAR	7	10	7	0.80
Little Pine Island	LPI_MAR	8	10	8	0.87
	LPI_SLT_1	8	7	5	0.67
	LPI_SLT_2	8	10	10	0.93
Loblolly Mitigation Bank	Lob_CYP_1	6	8	6	0.67
	Lob_CYP_2	8	9	9	0.87

Table 4-3. Continued.

Bank Name	Site Code	Location and Landscape Support	Water Environment	Community Structure	UMAM
Loxahatchee	Lox_CYP	5	7	5	0.57
	Lox_FOR	6	9	5	0.67
	Lox_SHR	6	7	7	0.67
Panther Island	Pant_CYP_1	7	8	6	0.70
	Pant_CYP_2	8	9	8	0.83
	Pant_CYP_3	8	9	6	0.77
	Pant_FOR	9	10	8	0.90
Reedy Creek	Reed_BOT	6	5	6	0.57
	Reed_FOR	7	9	7	0.77
R.G. Reserve	RG_MAR	7	7	6	0.67
Split Oak	SplO_CYP	9	10	9	0.93
	SplO_MAR	8	6	7	0.70
Sundew Mitigation Bank	Sun_FOR_1	6	8	6	0.67
	Sun_FOR_2	7	9	7	0.77
TM-Econ	TMEc_CYP_1	9	7	6	0.73
	TMEc_CYP_2	9	8	9	0.87
Tosohatchee	Toso_FOR	8	9	9	0.87
	Toso_MAR	9	9	9	0.90
	Toso_SHR	8	9	8	0.83
Tupelo Mitigation Bank	Tup_FOR	7	6	6	0.63
	Tup_PRA	6	5	5	0.53

Table 4-4. Uniform Mitigation Assessment (UMAM) scores categorized by Florida Land Use, Cover and Forms Classification System (FLUCCS) wetland community type. In addition to total UMAM score, mean ($\bar{x}$) scores and standard deviation (σ) are presented for each of the three UMAM indicators: Location and Landscape Support, Water Environment, and Community Structure.

UMAM Category		**6181: Cabbage Palm Hammock**	**6210: Cypress**	**6410: Freshwater Marsh**	**6250: Hydric Pine Flatwoods**	**6120: Mangrove Swamps**	**6310 & 6460: Mixed Scrub Shrub Wetland**	**6170: Mixed Wetland Hardwood**	**6172: Mixed Wetland Hardwoods - Mixed Shrubs**	**6420: Saltwater Marshes**	**6150: Stream and Lake Swamps (Bottomland)**	**6430: Wet Prairie**	**6300: Wetland Forested Mixed**
Sample size	n	1	13	18	4	2	2	5	2	2	2	1	6
Location and Landscape Support	$\bar{x}$	9.0	7.8	7.3	6.0	6.0	8.0	6.6	6.5	8.0	6.5	6.0	7.3
	σ	na	1.2	1.6	1.4	2.8	0.0	1.7	0.7	0.0	0.7	na	1.0
Water Environment	$\bar{x}$	8.0	8.2	8.5	6.5	7.5	7.5	8.6	8.0	8.5	6.5	5.0	7.8
	σ	na	1.0	1.2	1.9	0.7	2.1	0.9	1.4	2.1	2.1	na	1.5
Community Structure	$\bar{x}$	6.0	7.4	7.8	5.5	8.5	6.5	7.0	8.0	7.5	6.0	5.0	6.5
	σ	na	1.4	1.2	1.7	0.7	2.1	1.4	1.4	3.5	0.0	na	1.0
UMAM	$\bar{x}$	0.77	0.78	0.79	0.60	0.73	0.73	0.74	0.75	0.80	0.64	0.53	0.72
	σ	na	0.10	0.10	0.16	0.14	0.14	0.11	0.11	0.18	0.09	na	0.10

UMAM scores reflect current condition of the assessment areas and do not indicate the beginning condition of the assessment area, nor the anticipated amount of ecological lift attributed to the mitigation plan, nor the overall status of the bank in accordance with the permitted plan. The degree of ecological improvement, or lift, in a bank determines the number of potential credits awarded and integrates changes from the beginning condition and the anticipated condition of the bank. Lift has been defined as the number of potential credits awarded per acre. Mean lift was 0.38 ($\sigma = 0.20$), with a range from 0.05 (at R.G. Reserve, which had minor enhancement) to 0.88 (at Florida Wetlands Bank, with mostly restoration). When Hole-in-the-Donut was included, the mean lift was slightly higher at 0.40 ($\sigma = 0.23$), as Hole-in-the-Donut more closely resembles an in-lieu-fee bank, and has been awarded 1 credit per acre of restoration. Each data point on Figure 4-3 represents a wetland assessment area, with the UMAM score for the wetland assessment area on the y-axis (vertical) and lift or potential credits released for the entire mitigation bank on the x-axis (horizontal). No correlation was found between UMAM scores, lift, or potential credits released (Figure 4-3).

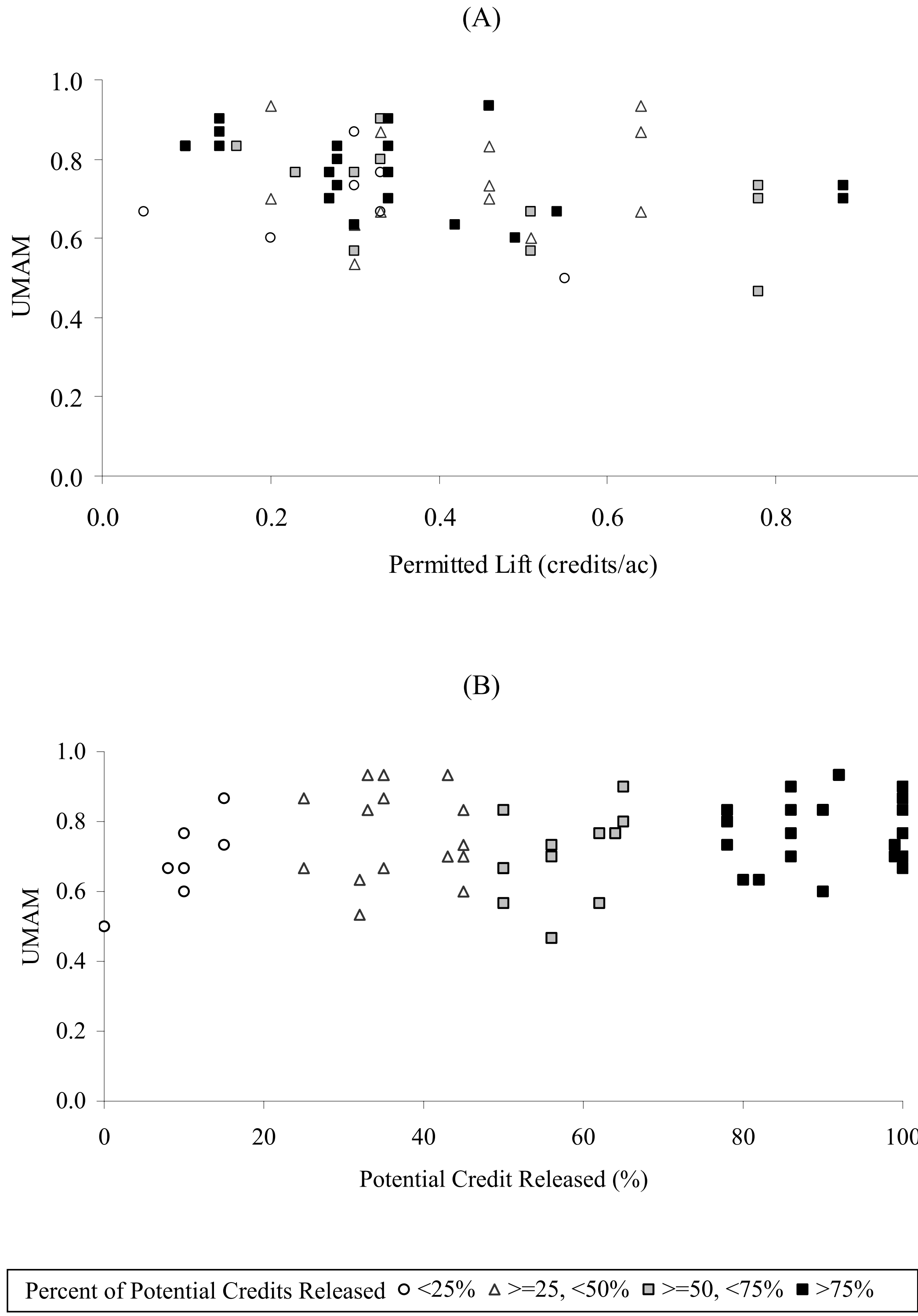


Figure 4-3. Uniform Mitigation Assessment Method (UMAM) scores for the 58 assessment areas in relation to A) permitted lift (credits/ac) in respective bank and B) potential credits released (%) at respective bank.

WRAP: Wetland Rapid Assessment Procedure

The WRAP scale ranges from 0.00-1.00, with 1.00 representing the reference standard condition. WRAP has six scoring categories, each with scores ranging from 0.0-3.0, in 0.5 increments, and a score of 3.0 represents an "intact" wetland. For herbaceous wetland systems, the category of Wetland Canopy (O/S) is generally not scored; however, if the wetland assessment area had 20% or greater overstory and/or shrub canopy, a score was assigned (Miller and Gunsalus 1999). This was the case at three of 18 wetland assessment areas with a wetland community type of 6410: Freshwater Marsh.

A freshwater marsh at Boran Ranch, Phase I (Bora_MAR_1) received a 0.99, the highest WRAP score (Table 4-5). This wetland assessment area also received the highest UMAM score of 0.93. At the other extreme, a hydric pine flatwoods at Corkscrew (Cork_FLA) received the lowest WRAP score of 0.47 (Table 4-5). No wetland assessment area received a 0.0 score in any of the six scoring categories. However, nine scores of 0.5 were assigned for the categories of Wetland Canopy (O/S) (n = 2), Wetland Ground Cover (GC) (n = 3), Habitat Support/Buffer (n = 3), and Water Quality Input & Treatment (WQ) (n = 1).

Thirty-two wetland assessment areas had WRAP scores greater than or equal to 0.75. Comparison of mean WRAP scores within FLUCCS wetland community types shows a wide variability in scores ranging from $\bar{x} = 0.57$ ($\sigma = 0.18$) for 6250 Hydric Pine Flatwoods (n = 4) to $\bar{x} = 0.82$ ($\sigma = 0.13$) for 6210 Cypress (n = 13) (Table 4-6). The highest variability of WRAP scores within a wetland community type was for 6420 Saltwater Marshes for two wetland assessment areas within Little Pine Island mitigation bank; the same wetland assessment areas discussed earlier for UMAM. The scores ranged from 0.49 at the pre-restoration saltwater marsh (LPI_SLT_1) to 0.92 at the restored saltwater marsh (LPI_SLT_2). At the other extreme, the wetland community type with the smallest variability in WRAP scores was 6120 Mangrove Swamps ($\bar{x} = 0.74$, $\sigma = 0.02$). Both of the 6120 Mangrove Swamps assessment areas at Bear Point (Bear_MAN) and CGW (CGW_MAN) scored 3.0 in the category of Wetland Canopy (O/S). However, total WRAP scores were lower than the optimal 1.00 score at these sites due to the influence of adjacent development, which generally provided poor habitat support and buffers, limited wildlife utilization, and adversely influenced wetland hydrology. As noted in the UMAM section above, assessment area scores reflect current condition at the time of site visits. No correlation was found between WRAP scores, lift, or potential credits released (Figure 4-4).

Table 4-5. Wetland Rapid Assessment Procedure (WRAP) scores for 58 wetland assessment areas. In addition to total WRAP score, scores are presented for each of the six WRAP scoring categories: Wildlife Utilization, Wetland Canopy, Wetland Ground Cover, Habitat Support/Buffer, Field Hydrology, and Water Quality Input & Treatment.

Bank Name	Site Code	Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)	Habitat Support/Buffer	Field Hydrology (HYD)	WQ Input & Treatment (WQ)	WRAP
Barberville	Barb_CYP	2.5	2.5	2.5	2.5	2.5	2.8	0.85
	Barb_MAR	2.5	na	2.0	2.5	2.5	2.5	0.80
Bear Point	Bear_MAN	2.5	3.0	na	2.5	2.0	1.3	0.75
Big Cypress	BigC_FLA	1.5	1.0	0.5	1.4	2.0	2.5	0.49
	BigC_MAR_1	2.0	2.0	2.0	2.4	3.0	3.0	0.80
	BigC_MAR_2	2.0	2.5	2.0	2.1	2.5	3.0	0.78
Bluefield Ranch	Blue_BOT	2.0	1.5	2.0	2.3	2.5	1.7	0.67
	Blue_FLA	2.5	2.5	3.0	2.4	3.0	1.6	0.83
	Blue_MAR	2.0	na	2.0	2.5	2.5	3.0	0.80
Boran Ranch, Phase I	Bora_MAR_1	3.0	na	3.0	3.0	3.0	2.9	0.99
	Bora_MAR_2	3.0	na	2.5	2.5	3.0	2.9	0.93
CGW	CGW_MAN	2.0	3.0	3.0	1.5	2.0	1.5	0.72
Colbert-Cameron	CoCa_FOR	2.5	2.0	2.5	2.5	3.0	3.0	0.86
	CoCa_CYP_1	2.0	2.0	3.0	2.5	2.0	3.0	0.81
	CoCa_CYP_2	2.5	2.5	2.5	2.5	3.0	3.0	0.89
Corkscrew	Cork_FLA	1.5	na	0.5	1.6	2.0	1.5	0.47
East Central	ECFl_FOR	2.0	2.0	0.5	2.0	2.0	3.0	0.64
	ECFl_HAM	2.0	2.0	2.5	2.0	2.5	3.0	0.78
Everglades Mitigation Bank/Phase I	Glad_MAR_1	2.5	na	3.0	1.6	2.5	2.1	0.78
	Glad_MAR_2	2.5	3.0	2.5	2.0	2.0	2.4	0.80
	Glad_SHR	3.0	2.5	3.0	2.5	2.5	3.0	0.92
Everglades Mitigation Bank/Phase II	Glad_MAR_3	1.5	na	2.0	1.5	2.0	2.8	0.65
Florida Mitigation Bank	FLMB_FOR	2.5	1.5	2.0	1.8	2.0	0.9	0.59
Florida Wetlandsbank	FLWt_MAR_1	1.5	na	2.0	0.5	2.5	1.8	0.55
	FLWt_MAR_2	1.5	na	1.5	0.5	2.5	1.8	0.52
Garcon Peninsula	Garc_FLA	1.5	0.5	1.0	1.9	2.0	1.8	0.48
Graham Swamp	Grhm_FOR	2.5	2.5	2.0	1.3	2.0	1.9	0.68
Hole in the Donut	HID_MAR_1	3.0	na	3.0	2.6	3.0	2.5	0.94
	HID_MAR_2	3.0	na	2.5	2.0	2.0	2.0	0.77
Lake Louisa and Green Swamp	Loui_SHR	2.0	1.0	2.0	2.0	1.0	2.8	0.60
Lake Monroe	Monr_CYP	3.0	2.0	3.0	2.5	2.0	3.0	0.86
	Monr_MAR	2.0	na	2.0	2.0	3.0	2.5	0.77
Little Pine Island	LPI_MAR	2.5	na	2.5	3.0	3.0	3.0	0.93
	LPI_SLT_1	2.0	0.5	1.0	1.5	1.5	2.4	0.49
	LPI_SLT_2	2.5	3.0	3.0	2.5	3.0	2.5	0.92

Table 4-5. Continued.

Bank Name	Site Code	Wildlife Utilization (WU)	Wetland Canopy (O/S)	Wetland Ground Cover (GC)	Habitat Support/Buffer	Field Hydrology (HYD)	WQ Input & Treatment (WQ)	WRAP
Loblolly Mitigation Bank	Lob_CYP_1	2.0	2.0	2.0	2.5	2.0	1.0	0.64
	Lob_CYP_2	2.5	3.0	2.5	2.5	2.5	3.0	0.89
Loxahatchee	Lox_ CYP	1.5	1.5	1.0	1.5	1.5	1.9	0.49
	Lox_ FOR	1.5	2.0	2.0	0.5	2.0	1.3	0.52
	Lox_SHR	1.5	2.5	2.5	1.0	2.0	1.4	0.60
Panther Island	Pant_CYP_1	3.0	3.0	1.5	2.5	2.5	2.8	0.85
	Pant_CYP_2	2.5	3.0	2.5	2.5	3.0	3.0	0.92
	Pant_CYP_3	2.5	3.0	1.5	2.5	2.5	2.8	0.82
	Pant_FOR	3.0	3.0	2.0	2.5	3.0	2.0	0.86
Reedy Creek	Reed_BOT	2.0	1.5	1.5	2.1	2.0	2.2	0.63
	Reed_FOR	2.0	2.0	2.0	1.5	3.0	0.5	0.61
R.G. Reserve	RG_MAR	2.0	na	2.0	1.8	2.0	2.8	0.71
Split Oak	SplO_CYP	3.0	3.0	2.5	3.0	3.0	3.0	0.97
	SplO_MAR	2.0	na	2.0	2.4	1.5	3.0	0.73
Sundew Mitigation Bank	Sun_FOR_1	2.0	2.0	1.5	2.0	2.5	1.6	0.65
	Sun_FOR_2	2.0	2.0	3.0	2.0	2.5	1.6	0.73
TM-Econ	TMEc_CYP_1	2.5	1.5	1.5	2.8	2.0	2.7	0.72
	TMEc_CYP_2	3.0	3.0	2.5	3.0	2.5	2.9	0.93
Tosohatchee	Toso_FOR	2.5	3.0	2.0	2.5	2.5	2.8	0.85
	Toso_MAR	3.0	na	3.0	2.0	3.0	3.0	0.93
	Toso_SHR	2.5	3.0	2.0	2.5	3.0	3.0	0.89
Tupelo Mitigation Bank	Tup_FOR	2.5	2.0	2.5	2.3	1.5	2.1	0.70
	Tup_PRA	1.5	1.5	1.5	2.2	1.5	2.5	0.59

Table 4-6. Wetland Rapid Assessment Procedure (WRAP) scores categorized by Florida Land Use, Cover and Forms Classification System (FLUCCS) wetland community type. Values for each wetland community type include mean ($\bar{x}$) and standard deviation (σ).

WRAP Category		**6181: Cabbage Palm Hammock**	**6210: Cypress**	**6410: Freshwater Marsh**	**6250: Hydric Pine Flatwoods**	**6120: Mangrove Swamps**	**6310 & 6460: Mixed Scrub Shrub Wetland**	**6170: Mixed Wetland Hardwood**	**6172: Mixed Wetland Hardwoods - Mixed Shrubs**	**6420: Saltwater Marshes**	**6150: Stream and Lake Swamps (Bottomland)**	**6430: Wet Prairie**	**6300: Wetland Forested Mixed**
Sample size	n	1	13	18	4	2	2	5	2	2	2	1	6
Wildlife Utilization (WU)	$\bar{x}$	2.0	2.5	2.3	1.8	2.3	2.3	2.2	2.3	2.3	2.0	1.5	2.3
	σ	na	0.5	0.5	0.5	0.4	0.4	0.4	1.1	0.4	0.0	na	0.4
Wetland Canopy (O/S)	$\bar{x}$	2.0	2.5	2.5	1.3	3.0	2.0	2.3	2.5	1.8	1.5	1.5	2.1
	σ	na	0.6	0.5	1.0	0.0	1.4	0.4	0.0	1.8	0.0	na	0.5
Wetland Ground Cover (GC)	$\bar{x}$	2.5	2.2	2.3	1.3	3.0	2.0	2.1	2.8	2.0	1.8	1.5	1.9
	σ	na	0.6	0.5	1.2	na	0.0	0.2	0.4	1.4	0.4	na	0.9
Habitat Support/Buffer	$\bar{x}$	2.0	2.5	2.1	1.8	2.0	2.3	1.7	1.8	2.0	2.2	2.2	2.1
	σ	na	0.4	0.7	0.4	0.7	0.4	0.9	1.1	0.7	0.1	na	0.3
Field Hydrology (HYD)	$\bar{x}$	2.5	2.4	2.5	2.3	2.0	2.0	2.5	2.3	2.3	2.3	1.5	2.3
	σ	na	0.5	0.5	0.5	0.0	1.4	0.5	0.4	1.1	0.4	na	0.5
WQ Input & Treatment (WQ)	$\bar{x}$	3.0	2.7	2.6	1.9	1.4	2.9	1.9	2.2	2.5	2.0	2.5	1.9
	σ	na	0.6	0.4	0.5	0.1	0.1	1.0	1.1	0.1	0.4	na	0.7
WRAP	$\bar{x}$	0.78	0.82	0.79	0.57	0.74	0.75	0.70	0.76	0.71	0.65	0.59	0.70
	σ	na	0.13	0.13	0.18	0.02	0.21	0.15	0.23	0.30	0.03	na	0.09

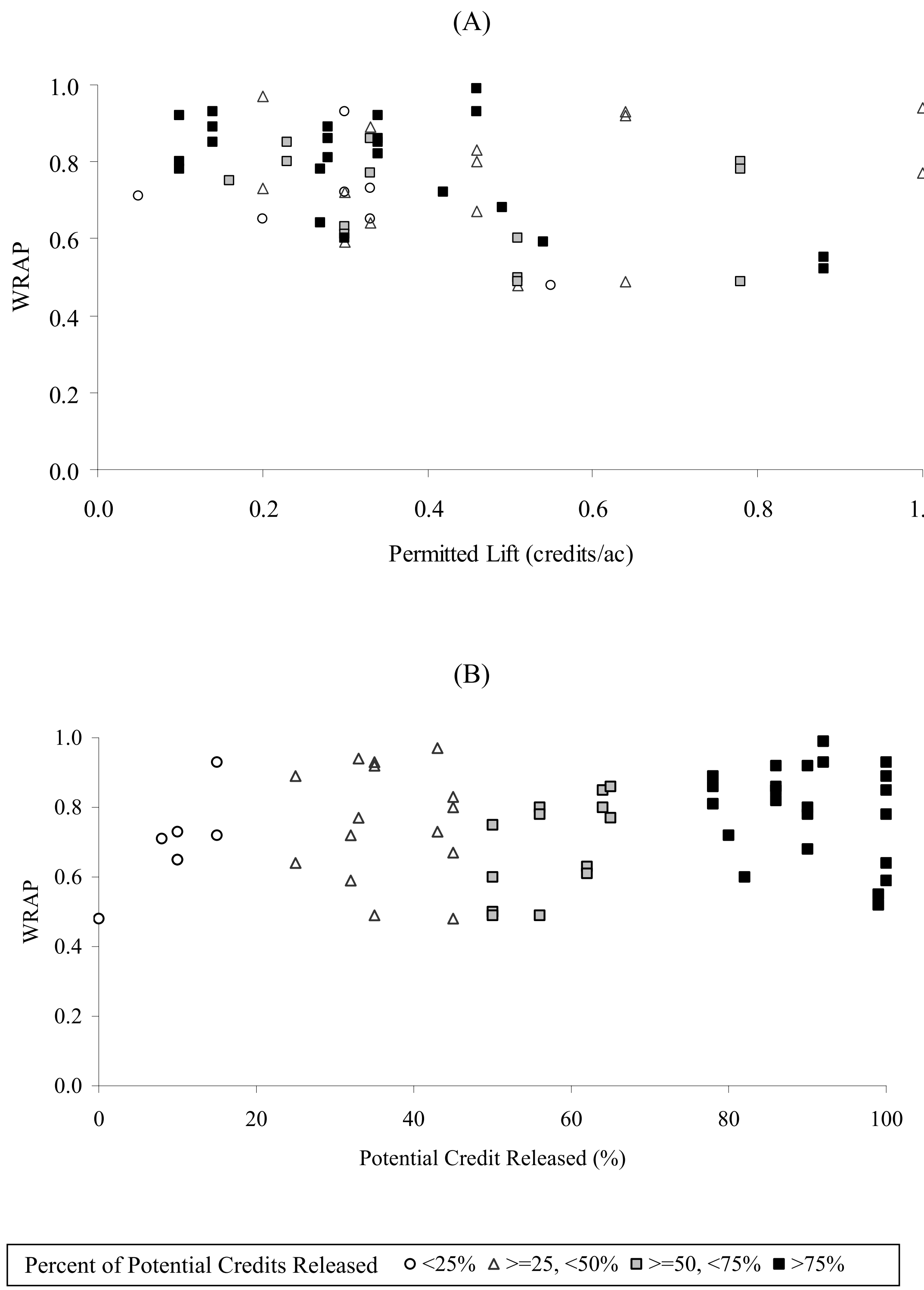


Figure 4-4. Wetland Rapid Assessment Procedure (WRAP) scores for the 58 assessment areas in relation to A) permitted lift (credits/ac) in respective bank and B) potential credits released (%) at respective bank.

HGM: Hydrogeomorphic Wetland Assessment Method

The Hydrogeomorphic wetland assessment method (HGM) was conducted at six flats wetlands in the Everglades and nine depressional wetlands in peninsular Florida.

Flats wetlands in the Everglades

HGM assessment for flats wetlands in the Everglades was divided into three subclasses of flats wetlands: marl, organic, and rocky flats. These wetland subclasses were distinguished based on geology, geomorphic setting, climate, soils, water source, hydrodynamics, and biota. A spatial distribution of flats wetlands in the Everglades was presented by Noble et al. (2002, see Figure 2, page 14). While the three subclasses were distinguished primarily on soil differences and hydrology, they share similarities in wetland functions including unidirectional surface water flow, poorly drained soils, flat terrain, and surficial aquifer interactions (Noble et al. 2002). An overview of the variables used in HGM functional capacity index calculations and the functional capacity index scores for all three subclasses of flats wetlands in the Everglades is presented in Tables 4-7 and 4-8, respectively. Of the 12 variables described for functional capacity index calculations in flats wetlands in the Everglades, 10, 9, and 11 variables were used for marl, organic, and rocky flats wetlands, respectively (Table 4-7).

The two marl flats wetlands sampled were located in Everglades Mitigation Bank: Glad_MAR_1 in Phase I, where mitigation activities had been completed at the time of the site visit, and Glad_MAR_3 in Phase II, where no mitigation activities had been completed at the time of the site visit. For the marl flats wetlands in the restored wetland tract (Glad_MAR_1), 9 of the 10 variables achieved a perfect score of 1.00, where 1.00 reflects the reference standard condition. The only variable not receiving a perfect 1.00 was Emergent Macrophytic Vegetation Cover (MAC), with a score of 0.68. The marl flats wetland in the non-restored wetland tract (Glad_MAR_3) also received high variable scores, with 8 of 10 variables receiving 1.00. This wetland also received lower scores for MAC (0.40) and for Habitat Connections (CONNECT) (0.85).

The two organic flats wetlands were both located within Florida Wetlandsbank. The variable scores for these wetlands were lower, with FLWt_MAR_1 receiving 3 (of 9) scores of 1.00 and FLWt_MAR_2 receiving 4 (of 9) scores of 1.00, where 1.00 reflects the reference standard condition. Both wetlands received scores of 0.00 for the variable Microtopographic Features (MICRO), as these wetlands had previously been rock plowed for farming and then were re-graded as part of the restoration plan to match the modeled hydrology. These wetlands also received scores less than 1.00 for Plant Species Composition (COMP), Habitat Connections (CONNECT), Interior Core Area (CORE), and Wetland Tract Area (TRACT), as Florida Wetlandsbank was located in urban Broward County with predominantly residential and transportation land uses in the supporting landscape. FLWt_MAR_1 also received a 0.90 score for Cover of Woody Vegetation (WOODY).

The two rocky flats wetlands within Hole in the Donut included the wetland re-graded in 1989 (HID_MAR_1) receiving 7 (of 11) scores of 1.00 and the wetland re-graded in 2001 receiving 8 (of 11) scores of 1.00, where 1.00 reflects the reference standard condition. The younger

Table 4-7. Hydrogeomorphic wetland assessment method (HGM) variable for flats wetlands in the Everglades. Combinations of these 12 variables were used to calculate wetland function scores in Table 4-8 according to equations from Noble et al. (2002).

		MARL FLATS:		**ORGANIC FLATS:**		**ROCKY FLATS:**	
		Everglades Mitigation Bank		**Florida Wetlandsbank**		**Hole in the Donut**	
		Phase I	**Phase II**				
Variable	**Code**	**Glad_MAR_1**	**Glad_MAR_3**	**FLWt_MAR_1**	**FLWt_MAR_2**	**HID_MAR_1**	**HID_MAR_2**
Plant Species Composition	COMP	1.00	1.00	0.76	0.55	na	na
Habitat Connections	CONNECT	1.00	0.85	0.10	0.10	1.00	1.00
Interior Core Area	CORE	1.00	1.00	0.38	0.38	1.00	1.00
Invasive Vegetation	INVASIVE	1.00	1.00	1.00	1.00	1.00	1.00
Emergent Macrophytic Vegetation Cover	MAC	0.68	0.40	1.00	1.00	0.65	1.00
Microtopographic Features	MICRO	1.00	1.00	0.00	0.00	0.00	0.00
Number of Native Wetland Species	NATIVE	na	na	na	na	1.00	1.00
Periphyton Cover	PERI	1.00	1.00	na	na	0.73	1.00
Soil Thickness	SOILTHICK	na	na	na	na	0.70	0.20
Surface Soil Texture	SURTEX	1.00	1.00	1.00	1.00	1.00	0.70
Wetland Tract Area	TRACT	1.00	1.00	0.03	0.03	1.00	1.00
Cover of Woody Vegetation	WOODY	1.00	1.00	0.90	1.00	1.00	1.00

Table 4-8. Hydrogeomorphic wetland assessment method (HGM) functional capacity index scores (Function) for six flats wetlands in the Everglades. Variables in Table 4-7 were used to calculate functional capacity index scores according to equations from Noble et al. (2002).

	MARL FLATS:		**ORGANIC FLATS:**		**ROCKY FLATS:**	
	Everglades Mitigation Bank		**Florida Wetlands Bank**		**Hole in the Donut**	
	Phase I	**Phase II**				
Function	**Glad_MAR_1**	**Glad_MAR_3**	**FLWt_MAR_1**	**FLWt_MAR_2**	**HID_MAR_1**	**HID_MAR_2**
Surface and Subsurface Water Storage	1.00	1.00	0.63	0.67	0.64	0.48
Cycle Nutrients	0.95	0.90	0.69	0.64	0.65	0.68
Characteristic Plant Community	0.98	0.96	0.66	0.62	0.72	0.59
Wildlife Habitat	0.96	0.90	0.56	0.53	0.81	0.81

wetland (HID_MAR_2), re-graded in 2001, received scores less than 1.00 for MICRO, Soil Thickness (SOILTHICK), and Soil Surface Texture (SURTEX). Whereas, the older rocky flats wetland (HID_MAR_1), re-graded in 1989, received scores less than 1.00 for MICRO, MAC, SOILTHICK, and Periphyton Cover (PERI).

When the variables presented in Table 4-7 were used to calculate the functional capacity index scores for the flats wetlands (Table 4-8), two wetlands, both at Everglades Mitigation Bank, received the highest score of 1.00 for the Surface and Subsurface Water Storage function at Phase I (Glad_MAR_1) and Phase II (Glad_MAR_3) wetlands. The remainder of the functional capacity index scores between 0.48 and 0.98.

While HGM is not designed to provide one single overall score of wetland function, Story et al. (1998) suggest several ways HGM could be used while establishing a single value of function. For example, averaging the four functional capacity index scores would result in a range of scores from 0.62 at Florida Wetlandsbank (FLWt_MAR_2) to 0.97 at Everglades Mitigation Bank Phase I (Glad_MAR_1).

Depressional wetlands in peninsular Florida

Nine wetlands belonging to both subclasses of depressional wetlands in peninsular Florida were sampled (n = 6 herbaceous marsh depressional wetlands, n = 3 cypress domes). Noble et al. (2004) described the differences in these two subclasses mainly on visual distinction based on woody vegetation and a longer hydroperiod for cypress domes. The depressional wetlands HGM model had 10 variables for herbaceous marsh depressional wetlands and 12 variables for cypress domes.

All nine depressional wetlands received the maximum score of 1.00 for the variable Upland Land Use (UPUSE) (Table 4-9). Further, eight of nine depressional wetlands received 1.00 scores for Surface Outlet (SUROUT) and Wetland Volume (WETVOL), as most of these wetlands had little to no excavation or disturbance in their interior. The exceptions were the herbaceous marsh depressional wetlands at Split Oak (SplO_MAR, SUROUT = 0.78) and Barberville (Barb_MAR, WTEVOL = 0.92), respectively.

Among the herbaceous marsh depressional wetlands, the wetland assessment area at Lake Monroe (Monr_MAR) received a 1.00 score for 9 (of 10) variables and received a 0.98 score for the tenth variable (MAC). Similarly, the cypress dome at Lake Monroe received the highest number of 1.00 variable scores for 9 (of 12) variables. The remainder of the wetland assessment areas received between three to seven scores of 1.00 for HGM variables. The herbaceous marsh depressional wetland at Split Oak (SplO_MAR) received the lowest number of 1.00 scores for variables with 3 (of 10).

When the variables were used to calculate functional capacity index scores for herbaceous marsh depressional wetland functions, scores ranged from 0.53 for Characteristic Plant Community at Split Oak (SplO_MAR) to 1.00 for Surface Water Storage at three wetland assessment areas including Bluefield Ranch (Blue_MAR), Lake Monroe (Monr_MAR), and R.G. Reserve (RG_MAR), and Subsurface Water Storage at one wetland at Lake Monroe (Monr_MAR) (Table 4-10). When attempting to compress HGM functional capacity indices into a single value for

Table 4-9. Hydrogeomorphic wetland assessment method (HGM) variable for depressional wetlands in peninsular Florida. Combinations of these 14 variables were used to calculate wetland function scores in Table 4-10 according to equations from Noble et al. (2004).

		Herbaceous Marsh Depressional Wetlands						Cypress Domes		
		Barberville	Bluefield Ranch	Boran Ranch, Phase I	Lake Monroe	R.G. Reserve	Split Oak	Lake Monroe	Panther Island	Reedy Creek
Variable	**Code**	**Barb_MAR**	**Blue_MAR**	**Bora_MAR_1**	**Monr_MAR**	**RG_MAR**	**SplO_MAR**	**Monr_CYP**	**Pant_CYP_1**	**Reed_FOR**
Cypress Canopy	CANOPY	na	na	na	na	na	na	1.00	1.00	0.40
Change in Catchment Size	CATCH	0.75	1.00	0.93	1.00	1.00	0.85	0.50	0.12	1.00
Herbaceous Plant Species Composition	HCOMP	0.50	0.33	0.50	1.00	0.67	0.25	na	na	na
Macrophytic Vegetation Cover	MAC	0.95	1.00	0.95	0.98	0.50	0.87	na	na	na
Understory Vegetation Biomass	SSD	na	na	na	na	na	na	0.88	0.90	0.08
Subsurface Outlet	SUBOUT	1.00	1.00	1.00	1.00	0.15	0.00	1.00	1.00	1.00
Surface Outlet	SUROUT	1.00	1.00	1.00	1.00	1.00	0.78	1.00	1.00	1.00
Surface Soil Texture	SURTEX	1.00	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.70
Tree Basal Area	TBA	na	na	na	na	na	na	0.20	0.37	1.00
Tree Species Composition	TCOMP	na	na	na	na	na	na	1.00	0.90	0.20
Upland Land Use	UPUSE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wetland Proximity	WETPROX	0.99	0.70	1.00	1.00	1.00	0.10	1.00	0.10	0.82
Wetland Volume	WETVOL	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Change in the Number of Wetland Zones	ZONES	0.50	0.25	0.50	1.00	0.25	0.50	1.00	1.00	0.50

Table 4-10. Hydrogeomorphic wetland assessment method (HGM) functional capacity index scores (Function) for nine depressional wetlands in peninsular Florida. Variables in Table 4-9 were used to calculate functional capacity index scores according to equations from Noble et al. (2004).

	Herbaceous Marsh Depressional Wetlands						Cypress Domes		
	Barberville	Bluefield Ranch	Boran Ranch, Phase I	Lake Monroe	R.G. Reserve	Split Oak	Lake Monroe	Panther Island	Reedy Creek
Function	**Barb_MAR**	**Blue_MAR**	**Bora_MAR_1**	**Monr_MAR**	**RG_MAR**	**SplO_MAR**	**Monr_CYP**	**Pant_CYP_1**	**Reed_FOR**
Surface Water Storage	0.93	1.00	0.99	1.00	1.00	0.92	0.94	0.88	0.92
Subsurface Water Storage	0.94	0.98	0.98	1.00	0.79	0.71	0.88	0.78	0.93
Cycle Nutrients	0.96	0.97	0.98	0.99	0.83	0.92	0.79	0.78	0.75
Characteristic Plant Community	0.85	0.79	0.85	0.99	0.58	0.53	0.88	0.88	0.31
Wildlife Habitat	0.87	0.76	0.87	0.99	0.69	0.56	0.93	0.82	0.61

herbaceous marsh depressional wetland functions there was a large range when considering the mean (0.73-0.99), the maximum (0.92-1.00), or the minimum (0.53-0.99). Selection of any of these methods has strong impact on the overall assessment of wetland condition.

In general, cypress dome wetland assessment areas scored lower than the marsh assessment areas with an overall range from 0.31 for Characteristic Plant Community at Reedy Creek (Reed_FOR) to 0.94 for Surface Water Storage at Lake Monroe (Monr_CYP) (Table 4-10). Scores for the functional capacity index category of Cycle Nutrients had a narrow range for all three cypress domes, with scores of 0.75, 0.78, and 0.79, at Reedy Creek (Reed_FOR), Panther Island (Pant_CYP_1), and Lake Monroe (MONR_CYP), respectively. Once more, for cypress domes, selecting a single value to describe HGM would present a large range in scores for wetland mean ($\bar{x}$ = 0.70-0.88), maximum (max = 0.88-0.94), or minimum (min = 0.31-0.79) functional capacity index scores.

FWCI: Florida Wetland Condition Index

The Florida Wetland Condition Index (FWCI) is an index of biological integrity with similar community-specific metrics for depressional herbaceous wetlands (Lane et al. 2003), depressional forested wetlands (Reiss and Brown 2005a), and forested strand and floodplain wetlands (Reiss and Brown 2005b). All three wetland classes have a FWCI developed for the macrophyte assemblage. In addition, an FWCI for diatom and macroinvertebrate assemblages has been developed for depressional herbaceous and depressional forested wetlands. This study includes macrophyte FWCI assessments for six depressional herbaceous wetlands, three depressional forested wetlands, and one forested strand wetland. As well, macroinvertebrate FWCI assessments were completed at two depressional herbaceous wetlands and two depressional forested wetlands. Macroinvertebrate samples were not collected at the remaining six depressional wetlands, as these wetland assessment areas did not have a minimum of 10 cm of standing water throughout a minimum of half the wetland area, which is the minimum requirement for application of the macroinvertebrate FWCI.

Macrophyte FWCI

The depressional herbaceous wetland macrophyte FWCI included five metrics: 1) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 2) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 3) Percent of species exotic to the state of Florida (Exotic); 4) Ratio of annual to perennial species (A:P Ratio); and 5) Mean Coefficient of Conservation score based on the Floristic Quality Assessment Index (Average CC; Cohen et al. 2004). Each metric was assigned a score of 0, 3, 7, or 10 with total possible FWCI scores ranging from 0-50, with 50 representing the reference standard condition. Metric scores included two 0 scores for the Sensitive metric at Boran Ranch, Phase I (Bora_MAR_1) and for the A:P Ratio metric at Lake Monroe (Monr_MAR) (Table 4-11). The most common metric score was 3 (n = 14), followed by 7 (n = 9). Five metric scores of 10 were assigned for Sensitive and for A:P Ratio at Barberville (Barb_MAR) and for Sensitive, Exotic, and Average CC at R.G. Reserve (RG_MAR). Total FWCI scores ranged from 12 (of 50) at Boran Ranch, Phase I (Bora_MAR_1) to 41 (of 50) at Barberville (Barb_MAR) with a mean of 26 (σ = 12), translating into 24-82% of reference standard condition ($\bar{x}$ = 52%, σ = 24%).

Table 4-11. Macrophyte Florida Wetland Condition Index (FWCI) metric scores, total FWCI scores, and percent of reference condition for six depressional herbaceous wetlands. Wetland region from Lane (2000).

Bank Name	**Barberville**	**Bluefield Ranch**	**Boran Ranch, Phase I**	**Lake Monroe**	**R.G. Reserve**	**Split Oak**
Site Code	**Barb_MAR**	**Blue_MAR**	**Bora_MAR_1**	**Monr_MAR**	**RG_MAR**	**SplO_MAR**
Region	Central	Central	Central	Central	South	Central
Sensitive	10	7	0	7	10	7
Tolerant	7	3	3	3	7	3
Exotic	7	3	3	3	10	7
A:P Ratio	10	7	3	0	3	3
Average CC	7	3	3	3	10	3
FWCI	41	23	12	16	40	23
out of	50	50	50	50	50	50
% of Reference Condition	82%	46%	24%	32%	80%	46%

The depressional forested wetland FWCI included six metrics: 1) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 2) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 3) Percent of species exotic to the state of Florida (Exotic); 4) Floristic Quality Assessment Index score (FQAI Score); 5) Percent of species that are both native and perennial (Native Perennial); and 5) Percent of species that are either facultative wetland or obligate species (Wetland Status). For the depressional forested wetlands scoring for individual FWCI metrics was on a continuous scale from 0.0-10.0, with 10.0 representing the reference standard condition. FWCI metric scores had a mean of 5.5 (σ = 3.2) with scores assigned at both extremes, with a 0.0 for the Sensitive metric at Panther Island (Pant_CYP_1) and a 10.0 for the Tolerant metric at Lake Monroe (Monr_CYP) (Table 4-12). Total FWCI scores ranged from 12.8 (of 60) at Panther Island to 48.3 (of 60) at Lake Monroe ($\bar{x}$ = 33.2, σ = 18.3), translating into 21-81% of the reference standard condition ($\bar{x}$ = 55%, σ = 31%).

Five metrics were included in the forested strand and floodplain FWCI: 1)Proportion of tolerant indicator species (Tolerant); 2) Proportion of sensitive indicator species (Sensitive); 3) Floristic Quality Assessment Index score (FQAI Score); 4) Proportion of species exotic to Florida (Exotic); and 5) Proportion of species that are both native and perennial (Native Perennial). Scoring for each metric was based on a continuous scale from 0.0-10.0, with 10.0 representing the reference standard condition. Only the wetland assessment area at TM-Econ (TMEc_CYP_2) was included in the forested strand and floodplain FWCI calculations, with a range of metric scores from 7.5 for the FQAI Score metric to 9.1 for the Sensitive metric ($\bar{x}$ = 8.3, σ = 0.7) (Table 4-13). The total FWCI for the wetland assessment area (TMEc_CYP_2) was 41.7 (of 50), translating into 83% of the reference standard condition.

Table 4-12. Macrophyte Florida Wetland Condition Index (FWCI) metric scores, total FWCI scores, and percent of reference condition for three depressional forested wetlands. Wetland region from Lane (2000).

Bank Name **Site Code**	**Lake Monroe** **Monr_CYP**	**Panther Island** **Pant_CYP_1**	**Reedy Creek** **Reed_FOR**
Region	Central	South	Central
Tolerant	10.0	3.5	9.8
Sensitive	6.6	0.0	1.5
Exotic	8.1	2.3	6.3
FQAI Score	8.9	0.5	4.6
Native Perennial	8.0	2.3	8.1
Wetland Status	6.7	4.3	8.2
FWCI	48.3	12.8	38.5
out of	60	60	60
% of Reference Condition	81%	21%	64%

Table 4-13. Macrophyte Florida Wetland Condition Index (FWCI) metric scores, total FWCI score, and percent of reference condition for a forested strand wetland within TM-Econ Mitigation Bank. Wetland region from Lane (2000).

Bank Name **Site Code**	**TM-Econ** **TMEc_CYP_1**
Region	Central
Tolerant	7.9
Sensitive	9.1
FQAI Score	7.5
Exotic	8.2
Native Perennial	9.0
FWCI	41.7
out of	50
% of Reference Condition	83%

Macroinvertebrate FWCI

The depressional herbaceous wetland macroinvertebrate FWCI included five metrics: 1) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 2) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 3) Percent of macroinvertebrates in the predator functional feeding group (Predators); 4) Percent of macroinvertebrates in the order Odonata, which includes dragonflies and damselflies (Odonata); and 5) Percent of macroinvertebrates in the subfamily Orthocladinae, a subfamily in the family Chironomidae (Orthocladinae). Scoring for the depressional herbaceous wetland macroinvertebrate FWCI assigned scores of 0, 3, 7, or 10 to each of the five metrics with total possible FWCI scores ranging from 0-50, with 50 representing the reference standard condition. Only two wetland assessment areas were sampled, with a majority of the metric scores (6 of 10) assigned scores of 10 (Table 4-14). One metric was scored a 0 for the Odonata metric at Boran Ranch, Phase I (Bora_MAR_1). The remaining three metric scores were 7 for the Tolerant metric at Barberville (Barb_MAR) and the Sensitive and Predators metrics at Boran Ranch, Phase I (Bora_MAR_1). Total FWCI scores were 34 (of 50) at Boran Ranch, Phase I (Bora_MAR_1) and 47 (of 50) at Barberville (Barb_MAR), reflecting 68% and 94% of reference standard condition, respectively.

Six metrics were included in the depressional forested wetland macroinvertebrate FWCI: 1) Percent of sensitive indicator species as determined from a reference dataset (Sensitive); 2) Percent of tolerant indicator species as determined from a reference dataset (Tolerant); 3) Calculated score from the Florida Index (Florida Index; see Beck 1954, Barbour et al. 1996); 4) Percent of macroinvertebrates in the phylum Mollusca, including snails and bivalves (Mollusca) 5) Percent of macroinvertebrates in the family Noteridae, the burrowing water beetles (Noteridae); and 6) Percent of macroinvertebrates in the scraper functional feeding group (Scrapers). Each metric was scored between 0-10, with 10 representing the reference standard condition. Metric scores were summed for a final index ranging from 0-60, with 60 representing the reference standard condition. Two wetland assessment areas were assessed using the depressional forested wetland macroinvertebrate FWCI (Table 4-15). The lowest metric score was 0.0 for the Scrapers metric for the wetland assessment area at Panther Island (Pant_CYP_1). This wetland assessment area also received a score of 0.1 for the Florida Index metric. Four of the metrics scored above 5.0, the midpoint of the scale, including the Tolerant metric (6.1) for the wetland assessment area at Panther Island (Pant_CYP_1) and the Tolerant (7.1), Florida Index (6.5), and Mollusca (5.2) metrics for the wetland assessment area at Reedy Creek (Reed_FOR). Total FWCI scores reflected less than 50% of the reference standard condition, with a 15.3 (of 60) at Panther Island (Pant_CYP_1) and 27.1 (of 60) at Reedy Creek.

Table 4-14. Macroinvertebrate Florida Wetland Condition Index (FWCI) metric scores, total FWCI scores, and percent of reference condition for two depressional herbaceous wetlands. Wetland region from Lane (2000).

Bank Name Site Code	Barberville Barb_MAR	Boran Ranch, Phase I Bora_MAR_1
Region (Lane 2000)	Central	Central
Sensitive	10	7
Tolerant	7	10
Predators	10	7
Odonata	10	0
Orthocladinae	10	10
FWCI	47	34
out of	50	50
% of Reference Condition	94%	68%

Table 4-15. Macroinvertebrate Florida Wetland Condition Index (FWCI) metric scores, total FWCI scores, and percent of reference condition for two depressional forested wetlands. Wetland region from Lane (2000).

Bank Name Site Code	Panther Island Pant_CYP_1	Reedy Creek Reed_FOR
Region	South	Central
Sensitive	2.7	3.5
Tolerant	6.1	7.1
Florida Index	0.1	6.5
Mollusca	3.8	5.2
Noteridae	2.6	1.9
Scrapers	0.0	2.9
FWCI	15.3	27.1
out of	60	60
% of Reference Condition	26%	45%

LDI: Landscape Development Intensity Index

Wetland scale LDI index scores were calculated for each of the 58 wetland assessment areas. The mean wetland scale LDI index score was 3.17 ($\sigma = 4.89$) with a median of 0.26 and a range from 0.00-16.65 (Table 4-16). The distribution of LDI index scores was non-normal (Shapiro-Wilk $W = 0.7029$, $p < 0.01$), with 16 wetland assessment areas with wetland scale LDI index scores of 0.00 and an additional 19 wetland scale LDI index scores less than 1.00. Nine wetland scale LDI index scores were greater than 10.00. Recall that the wetland scale LDI index was calculated as a "potential" score, as the surrounding landscapes within the wetland mitigation bank may not yet be fully enhanced, restored, or created, although it is assumed that they will as a result of the permitted mitigation activities and after final success criteria have been met, and were accordingly assigned scores for natural lands.

Bank scale LDI index scores were higher, with a mean bank scale LDI index score of 7.78 ($\sigma = 5.36$), a median of 6.54, and a range from 0.00-18.22 (Table 4-16). Only Little Pine Island had a bank scale LDI index score of 0.00, with two additional mitigation banks (East Central and Graham Swamp) having bank scale LDI index scores less than 1.00. The wetland assessment areas at East Central (ECFl_HAM and ECFl_FOR) had wetland scale LDI index scores of 0.00 (compared to bank scale LDI index score of 0.32); whereas, Graham Swamp had a difference of 11.43 between the higher wetland scale LDI index (11.91) and lower bank scale LDI index (0.48), an indication that the scale of delineation of land uses within the GIS interface has important implications for LDI calculations (i.e., bank scale LDIs were calculated based on the WMD 2000 land use cover (LU00) where land use was delineated at a scale of 1:12,000; whereas wetland scale LDIs were calculated at a much finer grain, based on hand delineation of land uses around the wetland assessment areas digitally drawn on the digital orthopohoto quarter quads updated during the 2005 field visit). Eight banks had bank scale LDI index scores greater than 10.00, with Florida Wetlandsbank having the highest bank scale LDI index score of 18.22.

A weak correlation was found between wetland scale LDI index and bank scale LDI index scores ($r = 0.27$, $p < 0.05$) (Figure 4-5). A large number of wetland assessment areas had wetland scale LDI scores of 0.00 ($n = 16$). These sites were typically located in the interior portion of the wetland mitigation bank, or at least 100 m from the surrounding properties and therefore were buffered from surrounding land use activities by other areas within the mitigation bank boundaries. Consideration of potential wetland functional lift should incorporate both the wetland scale and bank scale LDI index, reflecting both the local and broad scale landscape support.

Table 4-16. Landscape Development Intensity (LDI) index scores. Wetland scale LDI index scores were based on hand delineation of land uses around the wetland assessment areas digitally drawn on the digital orthopohoto quarter quads updated during the 2005 field visit. Bank scale LDI index scores were based on delineation of land use within a 100 m zone around the wetland mitigation bank boundary using 2000 land use cover maps from the WMD (LU00). The mitigation bank outline was not available for Boran Ranch Phase I (only Boran Ranch Phase II). Everglades Mitigation Bank has one bank scale LDI index, as the outline available was combined for Phases I and II. Year 2000 land use was not available for Garcon Peninsula.

Bank Name	Site Code	Wetland Scale LDI Index	Bank Scale LDI Index
Barberville	Barb_ CYP	0.10	9.39
	Barb_ MAR	0.04	9.39
Bear Point	Bear_MAN	6.92	6.59
Big Cypress	BigC_FLA	1.74	4.63
	BigC_MAR_1	5.87	4.63
	BigC_MAR_2	0.00	4.63
Bluefield Ranch	Blue_BOT	0.29	3.74
	Blue_FLA	1.55	3.74
	Blue_MAR	0.00	3.74
Boran Ranch, Phase I	Bora_MAR_1	0.00	NC
	Bora_MAR_2	4.42	NC
CGW	CGW_MAN	0.16	9.85
Colbert-Cameron	CoCa_ CYP_1	5.18	4.81
	CoCa_CYP_2	0.00	4.81
	CoCa_ FOR	0.00	4.81
Corkscrew	Cork_FLA	0.00	6.01
East Central	ECFl_HAM	0.00	0.32
	ECFl_FOR	0.00	0.32
Everglades Mitigation Bank Phase I	Glad_MAR_1	13.69	11.58
	Glad_MAR_2	8.30	11.58
	Glad_SHR	0.00	11.58
Everglades Mitigation Bank Phase II	Glad_MAR_3	6.51	11.58
Florida Mitigation Bank	FLMB_FOR	0.80	10.65
Florida Wetlandsbank	FLWt_MAR_1	16.65	18.22
	FLWt_MAR_2	13.00	18.22
Garcon Peninsula	Garc_FLA	12.55	NC
Graham Swamp	Grhm_FOR	11.91	0.48
Hole in the Donut	HID_MAR_1	7.45	3.70
	HID_MAR_2	13.10	3.70
Lake Louisa and Green Swamp	Loui_SHR	0.00	2.87

Table 4-16. Continued.

Bank Name	Site Code	Wetland Scale LDI Index	Bank Scale LDI Index
Lake Monroe	Monr_CYP	0.05	10.46
	Monr_MAR	0.01	10.46
Little Pine Island	LPI_MAR	0.00	0.00
	LPI_SLT_1	2.01	0.00
	LPI_SLT_2	10.77	0.00
Loblolly Mitigation Bank	Lob_CYP_1	1.00	10.86
	Lob_CYP_2	0.28	10.86
Loxahatchee	Lox_ CYP	15.72	17.03
	Lox_ FOR	10.93	17.03
	Lox_SHR	6.51	17.03
Panther Island	Pant_CYP_1	0.22	9.90
	Pant_CYP_2	0.02	9.90
	Pant_CYP_3	0.01	9.90
	Pant_FOR	0.00	9.90
Reedy Creek	Reed_BOT	2.28	8.12
	Reed_FOR	0.00	8.12
R.G. Reserve	RG_MAR	0.01	6.48
Split Oak	SplO_CYP	0.03	1.25
	SplO_MAR	0.80	1.25
Sundew Mitigation Bank	Sun_FOR_1	0.59	16.04
	Sun_FOR_2	0.23	16.04
TM-Econ	TMEc_CYP_1	1.26	17.84
	TMEc_CYP_2	0.02	17.84
Tosohatchee	Toso_FOR	0.00	5.43
	Toso_ MAR	0.00	5.43
	Toso_ SHR	0.00	5.43
Tupelo Mitigation Bank	Tup_FOR	0.52	5.91
	Tup_PRA	0.14	5.91

NC – none calculated

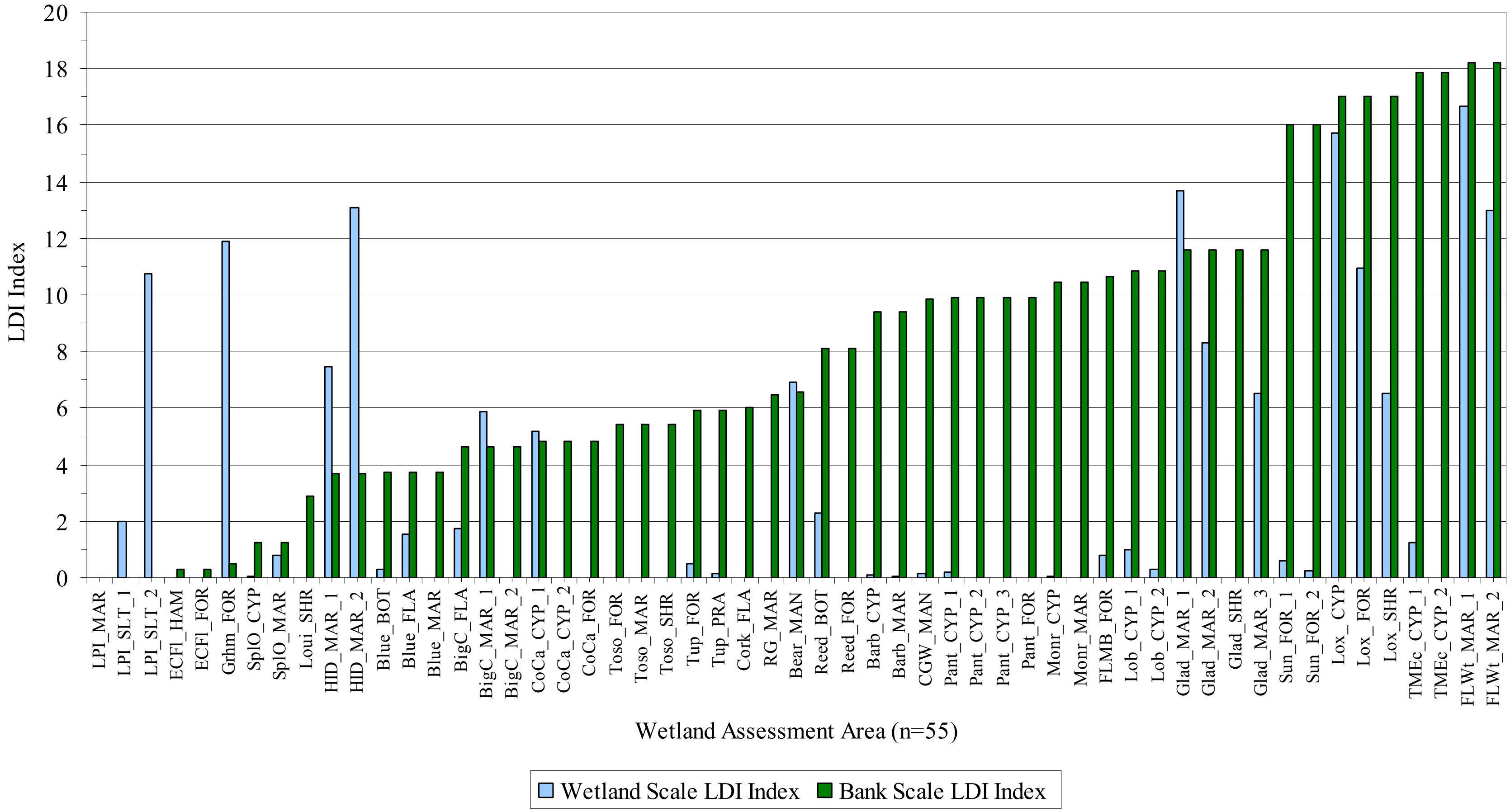


Figure 4-5. Wetland scale (light blue bars) and bank scale (dark green bars) Landscape Development Intensity (LDI) index scores for 55 wetland assessment areas (identified by site code).

Comparison of Assessment Methods

Comparisons were made between the five assessment methods used (UMAM, WRAP, HGM, FWCI, and LDI). Each assessment method was based on wetland condition using field observations, field sampling and measurements, laboratory taxonomic identification, and/or GIS. General comparison among UMAM, WRAP, and LDI were most robust, with a sample size of 58 wetland assessment areas, while comparisons of HGM or FWCI (macrophyte and macroinvertebrate) with other assessment methods were more limited due to much smaller sample sizes (15, 10, and 4, respectively). Statistical analyses were performed using Analyse-It Software, Ltd., version 1.67 (1997-2003).

UMAM and WRAP

Half (n = 29) of the wetland assessment areas had UMAM scores greater than 0.75 (Table 4-3). Results were similar for WRAP assessments, as 31 of the wetland assessment areas (53%) had scores greater than 0.75 (Table 4-5). WRAP and UMAM scores for the 58 wetland assessment areas showed a strong positive correlation (Spearman rank correlation $r = 0.87$, $p < 0.01$) (Figure 4-6). While it is not considered appropriate to compare scores for different wetland community types, UMAM and WRAP scores for each assessment area should be comparable to each other as a set, due to similarity in assessment method design and intent. Given the similar scoring criteria and scale, a wetland assessment area may be expected to achieve equal UMAM and WRAP scores.

Comparison between UMAM and WRAP scores for the various wetland community types shows that there was no significant difference based on community types regarding whether the UMAM or WRAP score was higher (Figure 4-6). The difference between UMAM and WRAP scores at each wetland assessment area ranged from -0.15 to 0.18 (Figure 4-7), with two wetland assessment areas, a hydric pine flatwoods wetland assessment area at Bluefield Ranch (Blue_FLA; UMAM, WRAP = 0.83) and a freshwater marsh at Boran Ranch, Phase I (BORA_MAR_2; UMAM, WRAP = 0.93), having no difference between UMAM and WRAP scores. Two freshwater marsh organic flats wetland assessment areas at Florida Wetlandsbank (FLWt_MAR_1 and FLWt_MAR_2) and a saltwater marsh wetland assessment area at Little Pine Island (LPI_SLT_1) had the largest difference between UMAM and WRAP scores of 0.18 (FLWt_MAR_1 UMAM = 0.73, WRAP = 0.55; FLWt_MAR_2 UMAM = 0.70, WRAP 0.52; LPI_SLT_1 UMAM = 0.67, WRAP = 0.49). However, the mean difference between UMAM and WRAP scores was 0.00 ($\sigma = 0.08$), suggesting that as a group, UMAM and WRAP scores were similar.

A simple linear regression analysis performed between UMAM and WRAP scores for the 58 wetland assessment areas showed a positive correlation ($R^2 = 0.72$, $p < 0.01$, fitted regression line shown), a narrow 95% confidence interval (middle dashed lines), and a wide prediction interval band (bold outer lines), suggesting the fitted regression line was not a good fit and that accurate or useful prediction of future UMAM scores are not possible based on WRAP scores (Figure 4-8). Use of a linear regression was possible due to the normal distribution of the UMAM scores dataset (Shapiro-Wilk test) and apparent constant variance over the sampling range.

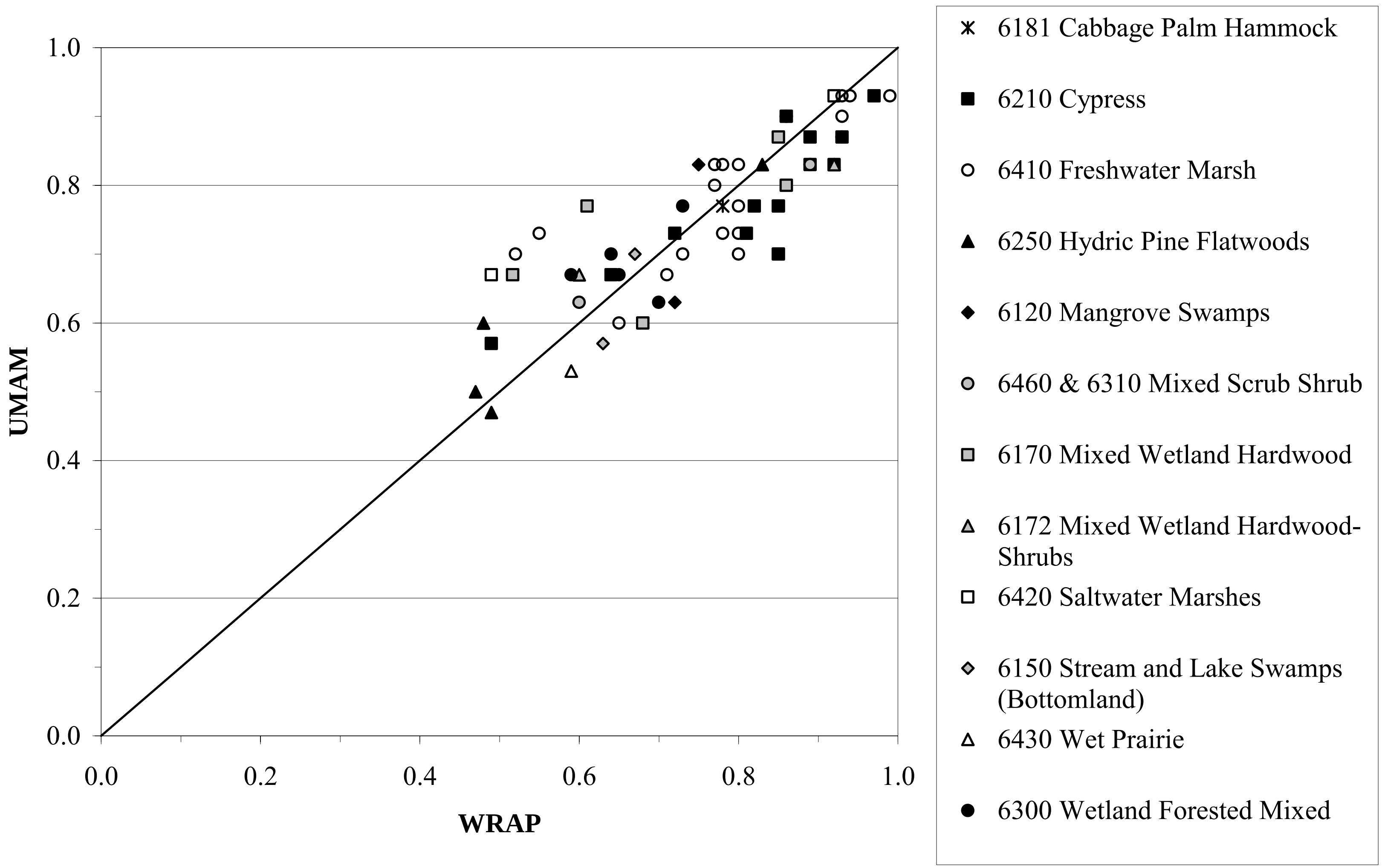


Figure 4-6. Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP) were positively correlated (Spearman rank correlation r = 0.87, p < 0.01). The line shown represents the 1:1 line.

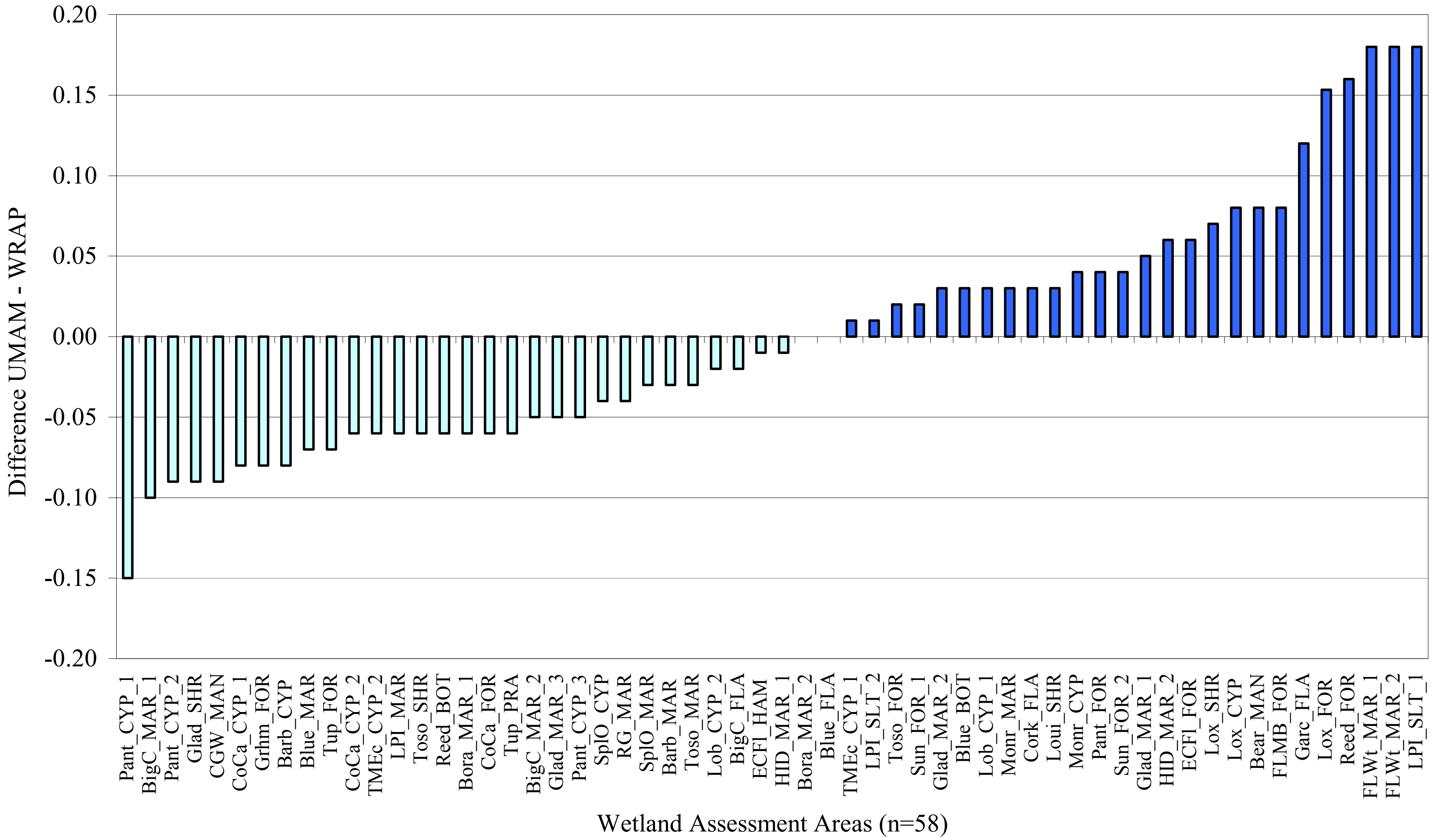


Figure 4-7. The difference between Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP) scores for 58 wetland assessment areas. Light colored bars (n = 30) show higher WRAP scores; dark colored bars (n = 26) show higher UMAM.

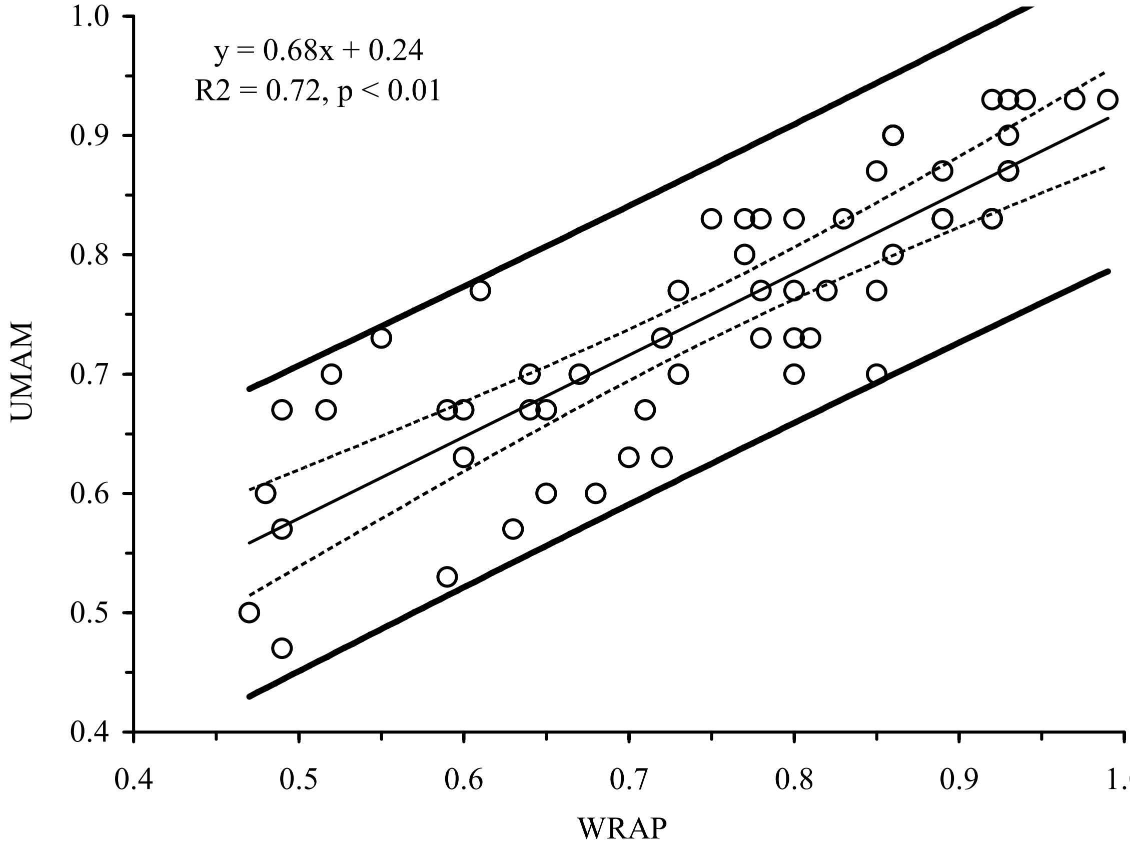


Figure 4-8. Linear regression between Uniform Mitigation Assessment Method (UMAM) and Wetland Rapid Assessment Procedure (WRAP) scores for 58 wetland assessment areas (R^2 = 0.72, $p < 0.01$, fitted regression line shown). Middle dashed lines are 95% confidence interval and bold outer lines are prediction interval band.

Given the similarities in the UMAM and WRAP scoring categories and application of the methods, correlations were expected among the many scoring categories for each method. In fact, of the 55 pair wise comparisons between UMAM and its three scoring categories (Location and Landscape Support, Water Environment, and Community Structure) and WRAP and its six scoring categories (Wildlife Utilization (WU), Wetland Canopy (O/S), Wetland Ground Cover (GC), Habitat Support/Buffer, Field Hydrology (HYD), WQ Input & Treatment (WQ)), 52 pair wise comparisons were statistically correlated (Spearman rank correlation $r > 0.25$, $p < 0.05$; Table 4-17). The three non-significant comparisons were for WRAP WQ Input & Treatment (WQ) with UMAM Water Environment, WRAP Wetland Canopy (O/S), and WRAP Wetland Ground Cover (GC).

UMAM, WRAP, and LDI

The distribution of scores for both wetland scale and bank scale LDI index were non-normal (Shapiro-Wilk $W = 0.69$; $W = 0.94$, respectively, $p < 0.01$), therefore the Spearman rank correlation was used for comparisons, as this correlation does not rely on the assumption of normal distributions and it does not anticipate a linear correlation among variables. Recall that the wetland scale LDI index was calculated as the "potential" for a wetland assessment area. That is, given successful restoration, creation, enhancement, or preservation in the adjacent landscape, the wetland scale LDI index value reflects the lowest potential wetland scale LDI index score and in turn the highest potential ecological integrity possible for a wetland assessment area once mitigation is complete and successful restoration of wetland function is achieved.

Overall UMAM scores were not significantly correlated with wetland scale or bank scale LDI index scores (Table 4-17). However the UMAM scoring category Location and Landscape Support was significantly correlated with both the wetland scale LDI index (Spearman rank correlation $r = -0.36$, $p < 0.01$) (Figure 4-9A) and bank scale LDI index ($r = -0.30$, $p < 0.05$) (Figure 4-9B). Bardi et al. (2005) suggested using a modified form of the LDI index scaled to match UMAM scoring, as a tool to assist in scoring UMAM. As the support landscape within mitigation banks undergoes further restoration and/or enhancement, the correlation between UMAM Location and Landscape Support and wetland scale LDI index may strengthen. UMAM Water Environment and UMAM Community Structure scoring categories were not statistically significant with either wetland scale or bank scale LDI index scores.

Overall WRAP scores were significantly correlated with wetland scale LDI index scores ($r = -0.36$, $p < 0.01$) (Figure 4-10A), though not with bank scale LDI index scores. In addition, wetland scale LDI index scores were significantly correlated with WRAP Habitat Support/Buffer ($r = -0.39$, $p < 0.01$) (Figure 4-10B), WRAP Field Hydrology (HYD) ($r = -0.27$, $p < 0.05$) (Figure 4-10C), and WRAP WQ Input & Treatment (WQ) ($r = -0.49$, $p < 0.01$) (Figure 4-10D). Bank scale LDI index scores were also correlated with WRAP WQ Input & Treatment (WQ) ($r = -0.37$, $p < 0.01$) (Figure 4-11).

HGM and FWCI

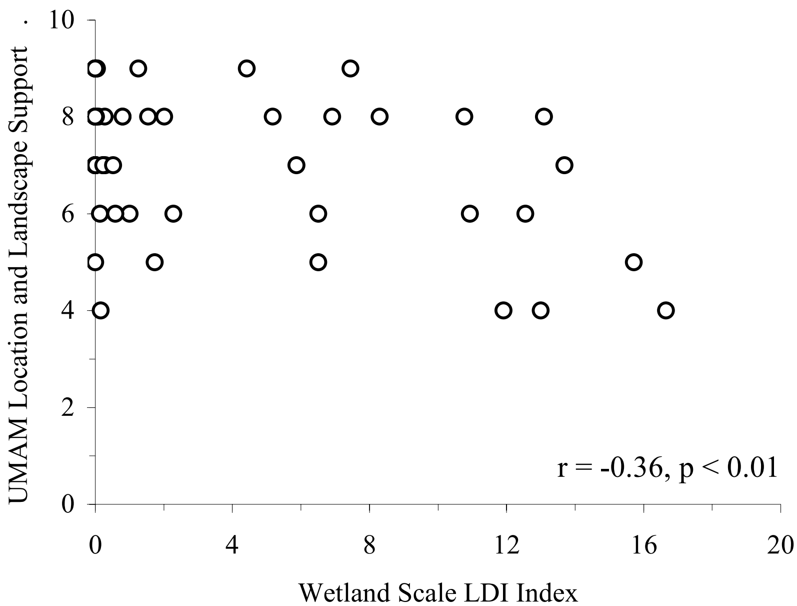
Comparisons between HGM and FWCI with the other three methods (UMAM, WRAP, and LDI) were limited due to the relatively small sample size of HGM assessments ($n = 15$), macrophyte FWCI assessments ($n = 10$), and macroinvertebrate FWCI assessments ($n = 4$), though some interesting trends were apparent with even this small dataset. One statistically significant correlation was found in the comparison of total WRAP score with HGM Wildlife Habitat (Spearman rank correlation $r = 0.55$, $p < 0.05$) (Table 4-18). This correlation used scores for all 15 HGM assessments, which included a mixture of flats wetlands in the Everglades and depressional wetlands in peninsular Florida. WRAP was originally designed for compliance assessment of wetlands in South Florida, including Everglades and depressional wetlands in the southern portion of the Florida peninsula. Two additional significant correlations were found between WRAP scoring categories and HGM functional capacity index scores: WRAP Field Hydrology (HYD) and HGM Subsurface Water Storage ($r = 0.75$, $p < 0.05$) and WRAP WQ

Table 4-17. Pair wise comparisons among scoring categories and total scores for the Uniform Mitigation Assessment Method (UMAM), Wetland Rapid Assessment Procedures (WRAP), wetland scale Landscape Development Intensity (LDI) index, and bank scale LDI index. All reported comparisons were significant ($p < 0.05$).

	UMAM	UMAM – Location and Landscape Support	UMAM – Water Environment	UMAM – Community Structure	WRAP	WRAP - Wildlife Utilization (WU)	WRAP - Wetland Canopy (O/S)	WRAP - Wetland Ground Cover (GC)	WRAP - Habitat Support/Buffer	WRAP - Field Hydrology (HYD)	WRAP - WQ Input & Treatment (WQ)	Wetland Scale LDI Index
UMAM – Location and Landscape Support	0.77	x										
UMAM – Water Environment	0.83	0.42	x									
UMAM – Community Structure	0.85	0.47	0.67	x								
WRAP	0.87	0.73	0.65	0.74	x							
WRAP - Wildlife Utilization (WU)	0.78	0.74	0.54	0.64	0.83	x						
WRAP - Wetland Canopy (O/S)	0.69	0.33	0.61	0.80	0.76	0.63	x					
WRAP - Wetland Ground Cover (GC)	0.66	0.46	0.49	0.71	0.68	0.55	0.48	x				
WRAP - Habitat Support/Buffer	0.66	0.72	0.38	0.45	0.8	0.69	0.49	0.35	x			
WRAP - Field Hydrology (HYD)	0.72	0.40	0.80	0.55	0.71	0.47	0.54	0.41	0.46	x		
WRAP - WQ Input & Treatment (WQ)	0.41	0.50	NS	0.27	0.63	0.35	NS	NS	0.54	0.31	x	
Wetland Scale LDI Index	NS	-0.36	NS	NS	-0.36	NS	NS	NS	-0.39	-0.27	-0.49	x
Bank Scale LDI Index	NS	-0.3	NS	NS	NS	NS	NS	NS	NS	NS	-0.37	0.27

Values reflect Spearman rank correlation coefficient (r value)
NS – Not significant

(A)



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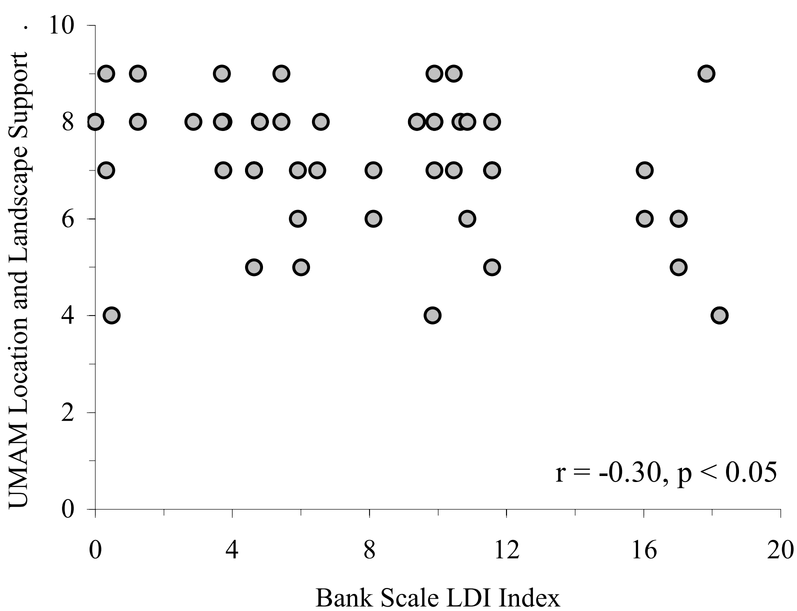


Figure 4-9. Correlations among Uniform Mitigation Assessment Method (UMAM) Location and Landscape Support scoring category with A) wetland scale Landscape Development Intensity (LDI) index scores and B) bank scale LDI index scores.

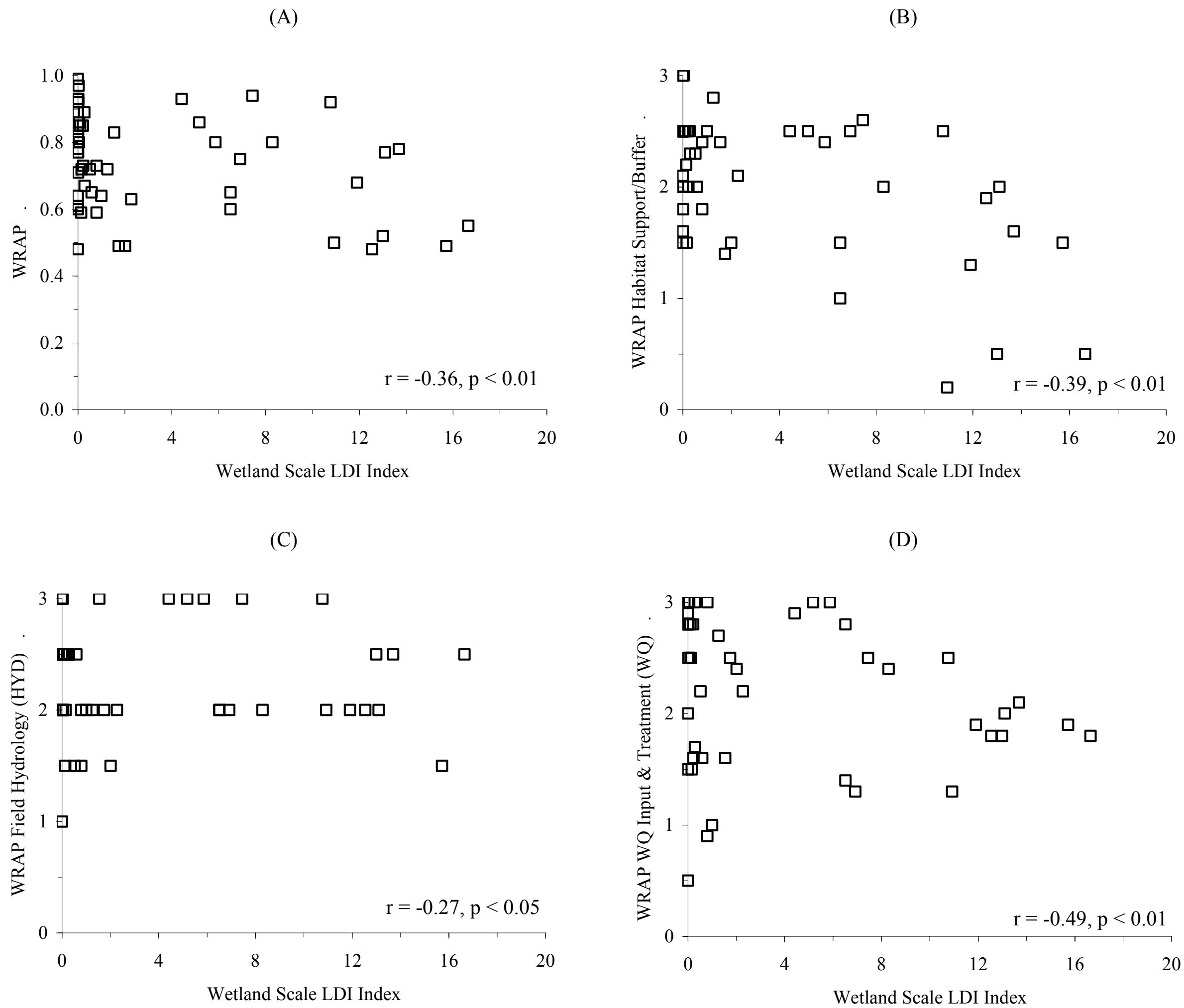


Figure 4-10. Wetland Rapid Assessment Procedure (WRAP) correlations with wetland scale Landscape Development Intensity (LDI) index: A) Overall WRAP scores ; B) WRAP Habitat Support/Buffer scores; C) WRAP Field Hydrology (HYD) scores; and D) WRAP WQ Input & Treatment (WQ) scores.

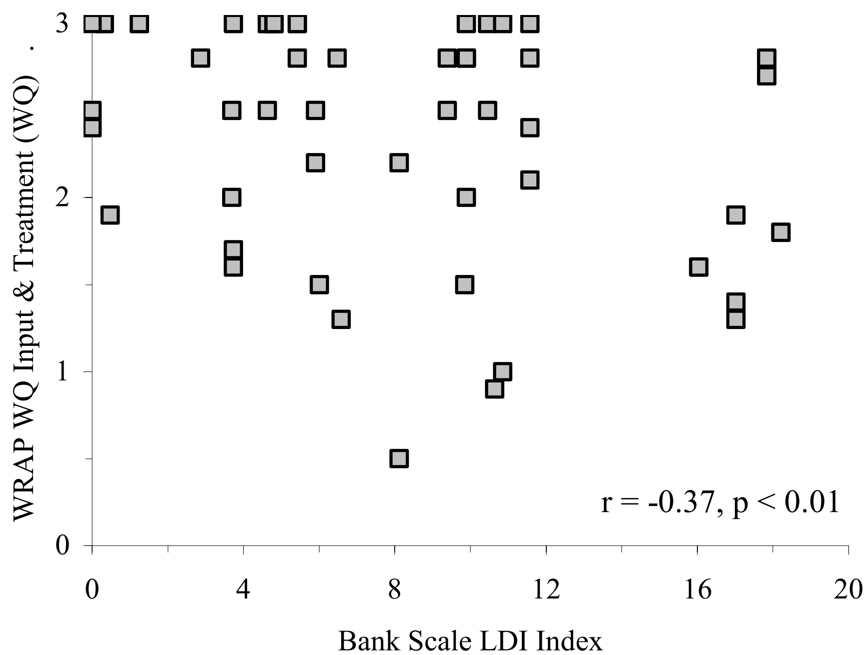


Figure 4-11. Bank scale Landscape Development Intensity (LDI) index score correlations: A) Wetland Rapid Assessment Procedure (WRAP) WQ Input & Treatment (WQ) scores; and B) wetland scale LDI index scores.

Table 4-18. Correlations among Uniform Mitigation Assessment Method (UMAM) and scoring categories, Wetland Rapid Assessment Procedure (WRAP) and scoring categories, wetland scale Landscape Development Intensity (LDI) index scores, bank scale LDI index scores, Hydrogeomorphic wetland assessment method (HGM) functional capacity index scores, macrophyte Florida Wetland Condition Index (FWCI) scores, and macroinvertebrate FWCI scores. Only significant correlations ($p < 0.05$) are shown.

	HGM Subsurface Water Storage	HGM Surface and Subsurface Water Storage	HGM Cycle Nutrients	HGM Characteristic Plant Community	HGM Wildlife Habitat
WRAP	NS	NS	NS	NS	0.55
WRAP - Field Hydrology (HYD)	0.75	NS	NS	NS	NS
WRAP - WQ Input & Treatment (WQ)	NS	NS	0.53	NS	NS
Wetland Scale LDI Index	-0.72	NS	-0.56	NS	NS
HGM Cycle Nutrients	0.71	NS	x	x	x
HGM Characteristic Plant Community	NS	0.81	NS	x	x
HGM Wildlife Habitat	NS	NS	0.56	0.88	x

Values reflect Spearman rank correlation coefficient (r value)
NS – Not significant

Input & Treatment (WQ) and HGM Cycle Nutrients ($r = 0.53$, $p < 0.05$). These same two HGM functional capacity index scores, HGM Subsurface Water Storage and HGM Cycle Nutrients were significantly correlated with wetland scale LDI index ($r = -0.72$, $p < 0.05$; $r = -0.56$, $p < 0.05$, respectively).

Comparisons among the HGM functional capacity index scores revealed four significant correlations within HGM: HGM Subsurface Water Storage and HGM Cycle Nutrients ($r = 0.71$, $p < 0.05$), HGM Surface and Subsurface Water Storage and HGM Characteristic Plant Community ($r = 0.81$, $p < 0.05$), and HGM Wildlife Habitat with both HGM Cycle Nutrients ($r = 0.56$, $p < 0.05$) and HGM Characteristic Plant Community ($r = 0.88$, $p < 0.01$).

Neither the macrophyte nor macroinvertebrate FWCI scores were significantly correlated with UMAM and UMAM scoring categories, WRAP and WRAP scoring categories, wetland scale or bank scale LDI scores, HGM functional capacity index scores, or one another. Further, UMAM, UMAM scoring categories, and bank scale LDI index were not significantly correlated with HGM functional capacity index scores.

Each of the five assessment methods measured wetland condition as compared to the reference standard condition. As such, comparisons have been made by scaling each assessment score to represent the percent of the reference standard condition. UMAM, WRAP, macrophyte FWCI, macroinvertebrate FWCI, and wetland scale LDI (Table 4-19) and HGM variables (Table 4-20) scores presented as percent of reference standard condition provide a complex picture of wetland assessment, as shown in three examples below.

The depressional forested wetland at Reedy Creek (Reed_FOR) scored 77% for UMAM, 61% for WRAP, 64% on macrophyte FWCI, and 45% on the macroinvertebrate FWCI (Table 4-19). This same wetland assessment area scored 31% of the reference standard condition for the HGM variable Characteristic Plant Community and 93% for the HGM variable Surface Water Storage variable (Table 4-20). The wetland scale LDI index was 0.00, suggesting that this wetland assessment area has the potential to provide full wetland function in the future, based on complete restoration of surrounding lands within the bank. However, the bank scale LDI for Reedy Creek was 8.12, as the land surrounding the bank hosts some human activities.

The depressional marsh at Barberville (Barb_MAR) reflected 85-96% of the reference wetland condition for all of the HGM functional capacity index scores. Scores for the remaining assessment methods were more variable, from 77% for UMAM, 80% for WRAP, 82% for macrophyte FWCI, and 94% for macroinvertebrate FWCI. Another interesting case was one of the organic flats marshes in Florida Wetlandsbank (FLWt_MAR_1), which received a wetland scale LDI index of 16.65, yet received higher percentages of reference standard condition according to UMAM (73%), WRAP (55%), and HGM functional capacity index scores from 56-69%. The variability in scoring percentages for this wetland assessment area was large, and it is unclear which, if any, assessment method provided a more accurate picture of current wetland condition. A simple average among the assessment methods ($\bar{x} = 0.64$, $\sigma = 0.07$) offers an incomplete description of the current wetland condition.

Table 4-19. Percent of reference standard conditions for Uniform Mitigation Assessment Method (UMAM), Wetland Rapid Assessment Procedure (WRAP), macrophyte Florida Wetland Condition Index (FWCI), and macroinvertebrate FWCI assessment methods for 16 wetland assessment areas.

Mitigation Bank	Site Code	Wetland Type	UMAM	WRAP	Macrophyte FWCI	Macroinvertebrate FWCI
Lake Monroe	Monr_CYP	Cypress	90%	86%	81%	na
Panther Island	Pant_CYP_1	Cypress	70%	85%	21%	26%
Reedy Creek	Reed_FOR	Cypress	77%	61%	64%	45%
TM-Econ	TMEc_CYP_1	Forested Strand	73%	72%	83%	na
Barberville	Barb_MAR	Marsh	77%	80%	82%	94%
Bluefield Ranch	Blue_MAR	Marsh	73%	80%	46%	na
Boran Ranch, Phase I	Bora_MAR_1	Marsh	93%	99%	24%	68%
Lake Monroe	Monr_MAR	Marsh	80%	77%	32%	na
R.G. Reserve	RG_MAR	Marsh	67%	71%	80%	na
Split Oak	SplO_MAR	Marsh	70%	73%	46%	na
Everglades Mitigation Bank Phase I	Glad_MAR_1	Marl Flats	83%	78%	na	na
Everglades Mitigation Bank Phase II	Glad_MAR_3	Marl Flats	60%	65%	na	na
Florida Wetlandsbank	FLWt_MAR_1	Organic Flats	73%	55%	na	na
Florida Wetlandsbank	FLWt_MAR_2	Organic Flats	70%	52%	na	na
Hole in the Donut	HID_MAR_1	Rocky Flats	93%	94%	na	na
Hole in the Donut	HID_MAR_2	Rocky Flats	83%	77%	na	na

Table 4-20. Percent of reference standard conditions for Hydrogeomorphic wetland assessment method (HGM) functional capacity index scores for 15 wetland assessment areas.

Mitigation Bank	Site Code	Wetland Type	HGM Surface Water Storage	HGM Subsurface Water Storage	HGM Surface and Subsurface Water Storage	HGM Cycle Nutrients	HGM Characteristic Plant Community	HGM Wildlife Habitat
Lake Monroe	Monr_CYP	Cypress	94%	88%	na	79%	88%	93%
Panther Island	Pant_CYP_1	Cypress	88%	78%	na	78%	88%	82%
Reedy Creek	Reed_FOR	Cypress	92%	93%	na	75%	31%	61%
Barberville	Barb_MAR	Marsh	93%	94%	na	96%	85%	87%
Bluefield Ranch	Blue_MAR	Marsh	100%	98%	na	97%	79%	76%
Boran Ranch, Phase I	Bora_MAR_1	Marsh	99%	98%	na	98%	85%	87%
Lake Monroe	Monr_MAR	Marsh	100%	100%	na	99%	99%	99%
R.G. Reserve	RG_MAR	Marsh	100%	79%	na	83%	58%	69%
Split Oak	SplO_MAR	Marsh	92%	71%	na	92%	53%	56%
Everglades Mitigation Bank Phase I	Glad_MAR_1	Marl Flats	na	na	100%	95%	98%	96%
Everglades Mitigation Bank Phase II	Glad_MAR_3	Marl Flats	na	na	100%	90%	96%	90%
Florida Wetlandsbank	FLWt_MAR_1	Organic Flats	na	na	63%	69%	66%	56%
Florida Wetlandsbank	FLWt_MAR_2	Organic Flats	na	na	67%	64%	62%	53%
Hole in the Donut	HID_MAR_1	Rocky Flats	na	na	64%	65%	72%	81%
Hole in the Donut	HID_MAR_2	Rocky Flats	na	na	48%	68%	59%	81%

Further sampling and analysis with the detailed biological assessments methods is suggested, as this would provide for more robust comparisons among methods. However, inspection of the percentage of reference standard condition reflected in the 16 wetland assessment areas with HGM and/or FWCI assessments shows that few if any of these wetlands are providing maximum function according to the comparison to the reference standard condition (Figures 4-12, 4-13, 4-14). There was a general (± 10-20%) agreement in the range of scores for the majority of these assessment methods at each site, though no clear trend was apparent based on higher or lower representation of reference standard condition by assessment method or by potential credits released. For the six Everglades flats wetlands there was no clear trend between which assessment method presented the highest percent of reference condition as measured by UMAM, WRAP, or HGM (Figure 4-12). Similarly, for the six depressional herbaceous wetlands, scores were variable, though scores for one of the HGM functional indices was often the highest assessment with the exception of the herbaceous marsh at Split Oak (SplO_MAR), where the WRAP score (0.97) was the highest measured assessment score (Figure 4-13). For the three forested depressional wetlands, HGM was also the highest assessment score, and for the forested strand wetland (where no HGM was conducted) the macrophyte FWCI was the highest assessment score (Figure 4-14).

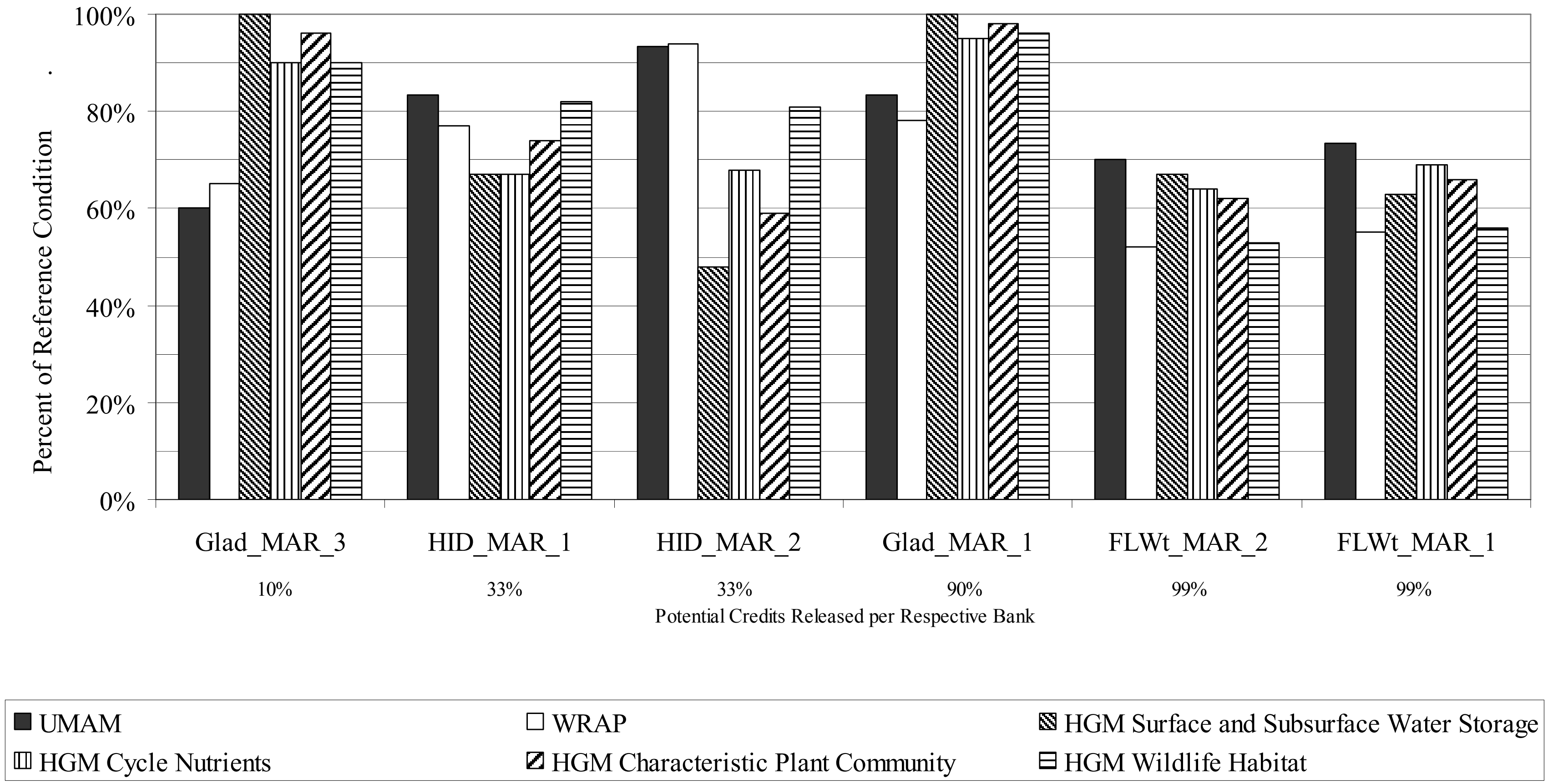


Figure 4-12. Comparison among six Everglades flats wetlands of UMAM (solid bars), WRAP (white bars), and HGM functional capacity indices (hatched bars).

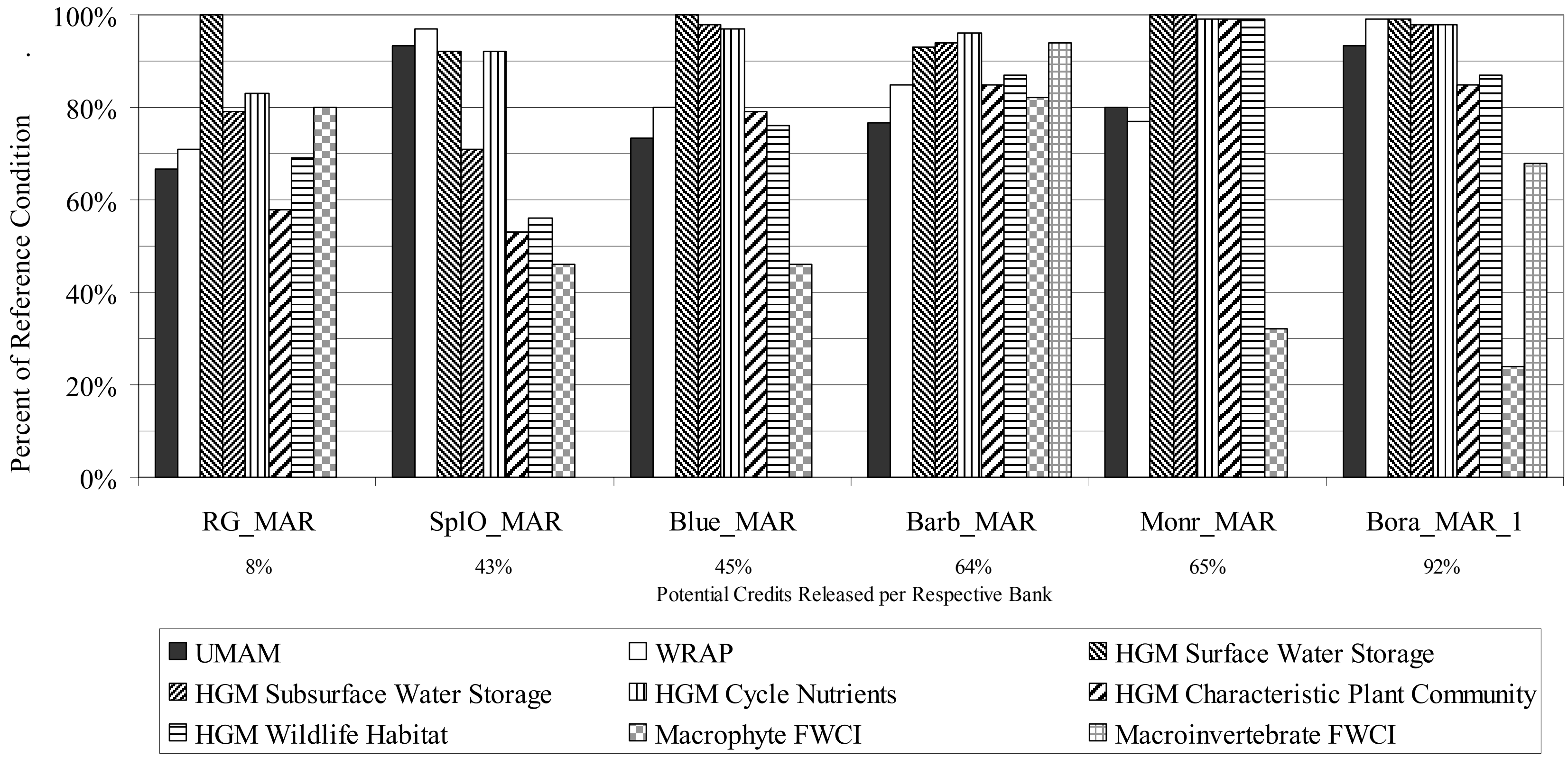


Figure 4-13. Comparison among six depressional herbaceous wetlands of UMAM (solid bars), WRAP (white bars), HGM functional capacity indices (hatched bars), macrophyte FWCI, and macroinvertebrate FWCI (checkered bars).

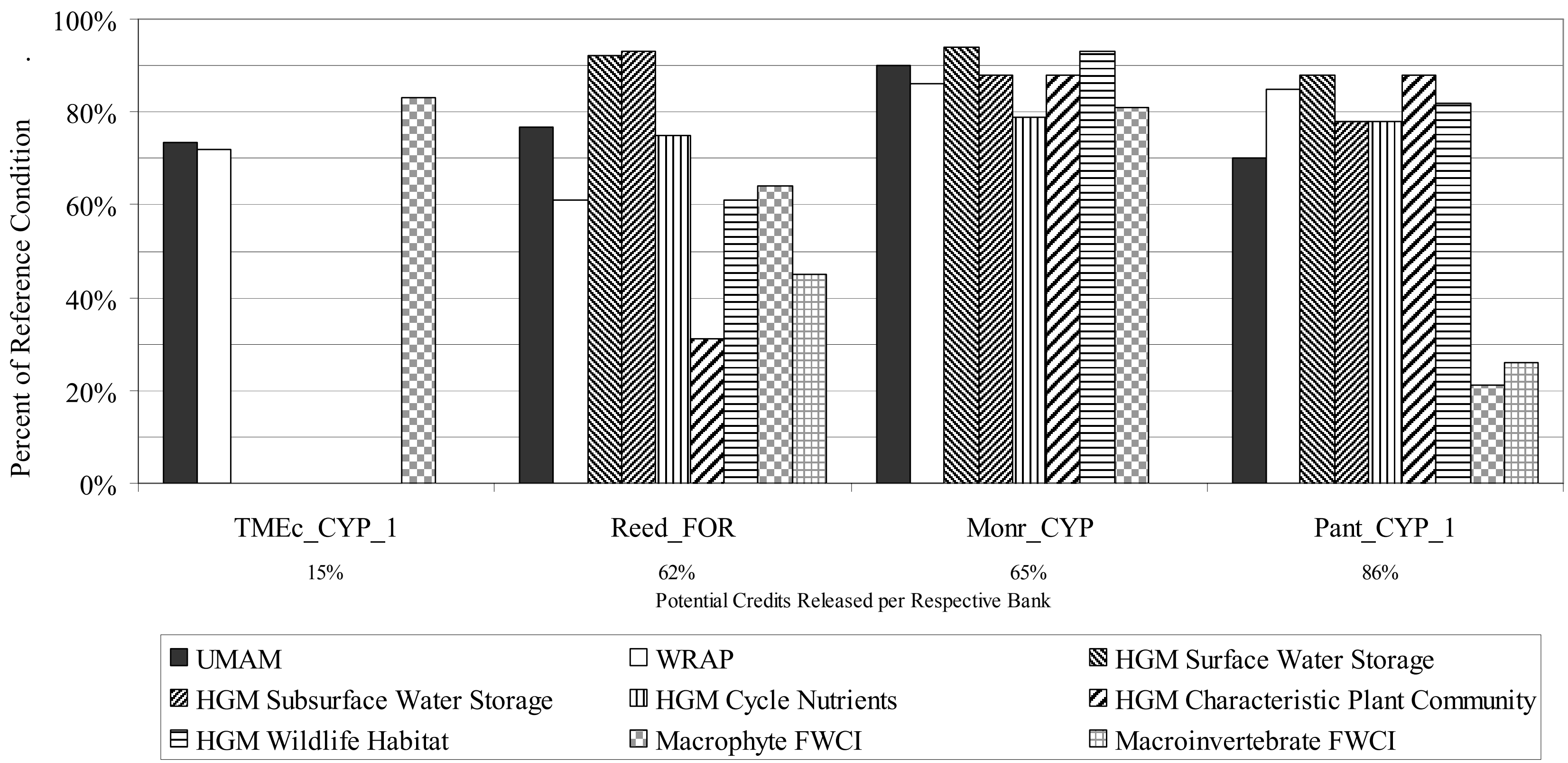


Figure 4-14. Comparison among four forested wetlands of UMAM (solid bars), WRAP (white bars), HGM functional capacity indices (hatched bars), macrophyte FWCI, and macroinvertebrate FWCI (checkered bars). HGM was not completed at TMEc_CYP_1, a forested strand wetland. The remaining three wetlands were depressional forested wetlands.

Suggestions for Assessment Methods

Our primary goal was to determine the current ecological integrity of the wetland resources within permitted wetland mitigation banks. While this research was not specifically designed to provide suggestions to further develop and refine the assessment methods, some comments and concerns have arisen after implementation of the different assessment methods.

In general, UMAM Location and Landscape Support could use further guidance regarding the spatial extent that should be identified and used in scoring this category. Questions that commonly arose in the field centered around the appropriate scale or extent to consider for wildlife conduits, downstream connectivity, and surrounding land uses. Some wetland assessment areas were situated in the interior of the wetland mitigation bank, while others were located adjacent to the boundary near roadways or other anthropogenic land uses. In the case of the former, consideration had to be given to the implications of developed lands outside of the mitigation bank boundaries and how these areas affected the connectivity of the wetland assessment area to areas appropriate to support expected wildlife species, provide water buffering (both quality and quantity), supply native and exotic seed sources, etc. In the case of the latter, consideration had to be given to immediately adjacent land uses as well as available habitat within the wetland mitigation bank. UMAM Location and Landscape Support scores could be highly variable depending on the spatial extent used.

Suggestions and concerns for WRAP have not been provided, as UMAM must now be used by state agencies for all regulatory decision making involving mitigation, including the determination of potential credits in mitigation banks in Florida.

Both the HGM flats wetlands in the Everglades and depressional wetlands of peninsular Florida guidebooks have had limited field testing and application within Florida. There are some areas where clarification would be appropriate for future HGM assessments as well as some minor errors that were detected within the guidebooks. Additional HGM guidebooks for more wetland community types would be beneficial. To ease the use of the guidebook, a reference sheet that explains what specific data need to be collected for each variable would be valuable. This study created its own reference sheet so that the guidebook did not need to go in the field and to ensure that important data were not accidentally overlooked and not collected. Field data sheets were inconsistently referred to within the text of the HGM guidebook for depressions making cross referencing confusing at times. Field data sheets could be reworked; it appears sometimes that they reflected data collection that may have been included earlier on in the development of the guidebook but not the final method. Specifically sometimes too much data collection was required that was not later used as part of the analysis. This was especially true for the variable of tree basal area (TBA) and macrophytic vegetation cover (MAC) in the depressional guidebook. Identification of a species and recording its species name was not part of the analysis and was unnecessary to that degree of detail. The field sheet could also be made more user friendly by providing more space for recording data. Often notes were taken elsewhere or in the margins and it would have been useful on the field sheet itself so that there was an obvious progression of data recorded and then final assessment. For example it would be appropriate for the COMP variable for vegetation dominance to have a space for recording what the species actually were along with the percent dominance.

Likewise, development and application of FWCI in Florida has been limited to three wetland community types, and expansion to include additional wetland types and regions would improve application. Clearly the diatom and macroinvertebrate FWCIs are limited by the need for a minimum of 10 cm of standing water. As these species assemblages depend on standing water for their existence, little could be done regarding the small sample size. Perhaps additional FWCIs for other community assemblages such as birds or herps could be developed to alleviate some of the need for a minimum level of standing water.

The application of LDI to mitigation sites presents many challenges. Primarily, there is concern over how to appropriately assign non-renewable empower density values to lands that in the past have been used for human activities but currently are being restored to a reference community type. As such, wetland scale LDI calculations used in this study have been considered "potential" LDI, suggesting the wetland condition attainable based on surrounding land use within the bank. Further, the differences between wetland scale and bank scale LDI scores raise a question as the most important or relevant scale to consider. In the end, perhaps an integration of both scales is the best indication of landscape support.

Overall each assessment method has multiple strengths and weaknesses. It was useful to use all five of the assessment methods to evaluate wetland condition within the wetland mitigation banks.

CHAPTER 5 - PERMIT REVIEW AND ECOLOGICAL INTEGRITY: CASE STUDIES

In an attempt to understand and evaluate the effectiveness of wetland mitigation banking in Florida, a review of permits and other relevant documents, site visits, and field assessments were conducted. The results indicated a disconnect between the determination of success or interim success criteria according to the permit and the site condition assessed according to five methods. Mitigation bank permits refer to "success" as meeting the minimal intended ecological condition and the specific criteria listed in the Mitigation Banking Instrument (MBI) or the permit as a result of the permitted restoration and enhancement activities (Story et al. 1998; Ch 62-342.750, F.A.C.). Permit "success" is not intended to indicate that the functional capacity of a particular area (whether wetland or upland, or whether restored, enhanced, created, or preserved) has been achieved. Therefore, it has been challenging to correlated "success" defined by permit review with field evaluations, which rely on a score of wetland function.

Permits may also refer to interim success, or milestones, for incremental credit releases. Permit credit release (also called interim success) criteria were often combinations of recording a conservation easement, removal of exotic species vegetation, earth moving and grading, hydrologic enhancement in the form of ditch plugging or canal filling, site preparation and planting, removal of undesirable tree canopy species or woody vegetation, successful completion of a prescribed burn, monitoring and accompanying reports, management, and preservation. While these are all worthy activities and necessary for restoration efforts, they do not in and of themselves equate to success defined as fully functioning wetland communities.

Due to the vast difference among permit success criteria, credit release requirements, and application of fields assessment methods (specific to particular wetland community types), across the board generalizations are difficult. Case studies for three wetland mitigation banks will be presented, highlighting differences of permit success, as measured by permit and document review and compliance interviews as presented in Chapter 3, and functional success, as measured by field assessment methods as presented in Chapter 4. Case studies for East Central, Florida Wetlandsbank, and Sundew Mitigation Bank provide an overview of permit and document review juxtaposed with field assessment results.

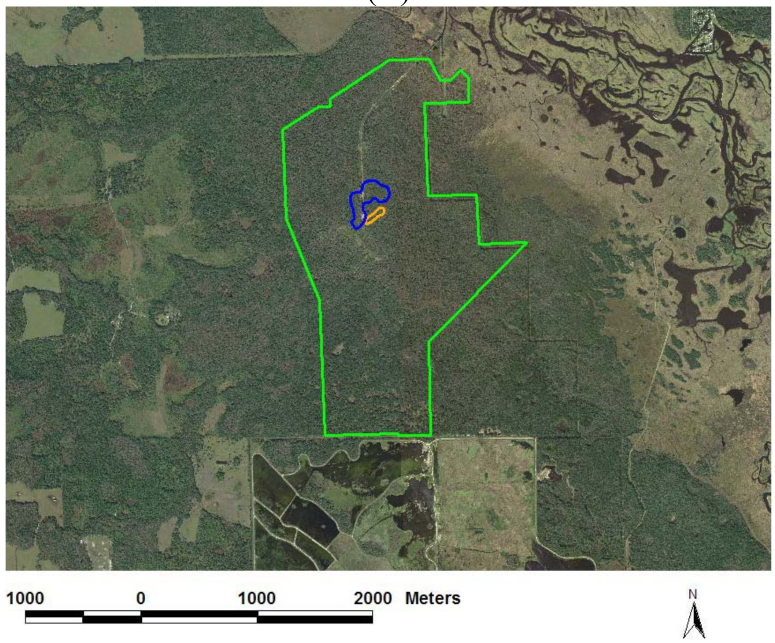
Case Study: East Central

East Central Florida Regional Mitigation Bank (East Central), a 385 ha (952 ac) wetland mitigation bank located in the northeast corner of Orange County in central Florida along the St. Johns River (S2-6, 8-11/T22S/R33E and S35/T21S/R33E) (Figure 5-1A), abuts approximately 23,472 ha (58,000 ac) of public lands and was reported to host seven state listed threatened or endangered plant species and six state and/or federally listed wildlife species. It was permitted by SJRWMD in May 1997. Approximately 75-80% of the bank consisted of hydric hammock and floodplain swamp wetland, with pine or mixed hardwood upland communities covering the remaining 20-25%. To date, all of the 286.3 potential credits have been released. Original credit allocation was 121.4 credits (42.4%) for forested upland enhancement and management, 96.2 credits (33.6%) for forested wetland restoration and enhancement, and 68.7 credits (24%) for forested wetland preservation. As of October 2006, a total of 176.1 credits (61.5%) have been sold.

The forested communities on this property were logged primarily for bald-cypress (*Taxodium distichum*), oak (*Quercus* spp.), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) in the 1940s, with additional logging activities in the past 60 yrs. In areas where the canopy has not recovered, the wetland community type was described as cabbage palm hammock. Cattle grazing was also historically prevalent on the property. The majority of credits (55.4%) were released for recording a conservation easement, removing cattle, and constructing a fence along the western boundary to prevent cattle access from adjoining properties (Table 5-1). Filling an existing canal system that impacted Christmas Creek and installing vegetation for stabilization accounted for 95.1 credits (33.2%). Additional ditch filling to improve the hydrology of seven impacted isolated wetlands was awarded 1.1 credits (0.38%). Canal filling used existing spoil berm materials on-site, with four areas of the canal filled to match the adjacent grade and others filled only to the extent possible given existing on-site material, leaving some deeper pools along the historic canal footprint (Figure 5-1B). Areas restored to matching grade were planted with herbaceous vegetation for stabilization. An additional 26.4 credits (9.22%) were allocated for a prescribed burn of designated upland area where fire suppression had led to encroachment by hardwood species in an otherwise pine (*Pinus* sp.) dominated area. Detailed success criteria were not found for the remaining 5.0 credits (1.7%) that were tied into *success* of planted areas, defined roughly with achieving and maintaining target hydrologic regimes based upon reversal of existing alterations and less than 10% cover by nuisance and exotic species of vegetation.

Potential credit determination was established through mitigation ratios by SJRWMD. The 121.4 forested upland enhancement and management credits were awarded based on a 2.1:1 credit ratio. Of the 96.2 credits for forested wetland restoration and enhancement, 50.9 credits were allocated for hydrologic enhancement within the primary and secondary zones along Christmas Creek canal and the isolated wetlands with credit ratios of 2.5:1, 5:1, and 6:1, respectively; 23.5 credits were allocated for enhancement of Christmas Creek with a credit ratio of 2.5:1; and 21.8 credits were allocated for wetland restoration using existing berms to fill canals to grade with a 1:1 credit ratio.

(A)



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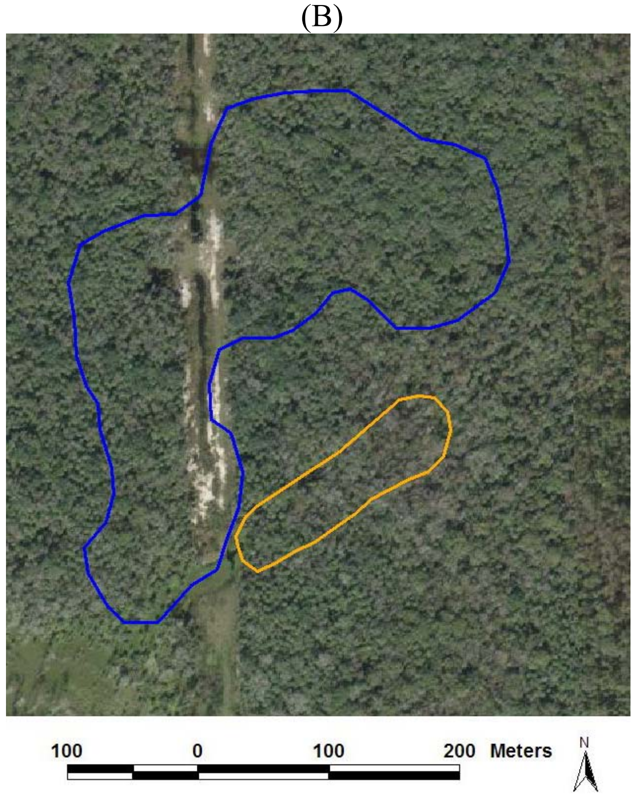


Figure 5-1. Landscape location of East Central (green line) in northeast Orange County: A) along the St. Johns River and surrounding land use in 2004 and B) close-up of wetland assessment areas for field assessment methods. Images are digital orthographic quarter quads. Green line is East Central bank boundary; blue (ECFl_HAM) and orange (ECFl_FOR) lines are wetland assessment areas for field assessment methods.

Table 5-1. Credit release schedule for East Central.

Activity	Credits	% Credits
Record conservation easement, remove cattle, construct fence along west boundary	158.7	55.4%
Complete canal filling and install plants for stabilization	95.1	33.2%
Perform restorative burn of designated upland area	26.4	9.2%
Meet success criteria for planted areas	5.0	1.7%
Complete ditch filling for seven "isolated" wetlands	1.1	0.4%
Total Credits	286.3	100%

Two wetland assessment areas were selected within East Central, ECFl_HAM a cabbage palm hammock (FLUCCS 6181 Cabbage Palm Hammock) and ECFl_FOR a mixed species forested wetland along a black water stream (FLUCCS 6300 Wetland Forested Mixed) (Figure 5-1B). ECFl_HAM surrounds a portion of the filled canal that has been planted with marsh vegetation for stabilization but will be allowed to naturally recruit shrub and tree species in the long term. The filled canal footprint was not included in the assessment area because it is not currently a recognized wetland community type. Historically the canal impacted the surficial aquifer in the forested areas and downstream wetlands within two zones according to the original permit, a primary impact zone within 76.2 m (250 ft) and a secondary impact zone within 152.4 m (500 ft). Both zones were included within the wetland assessment area of ECFl_HAM. Total UMAM (0.77) and WRAP (0.78) scores for ECFl_HAM were similar (Table 5-2). UMAM category scores ranged from 6 for Community Structure to 9 for Location and Landscape Support. The lower Community Structure score was assigned based on the altered canopy composition from logging activities and the presence of some exotic and nuisance species of vegetation. WRAP scoring categories ranged from 2.0 for Wildlife Utilization (WU), Wetland Canopy (O/S), and Habitat Support/Buffer to 3.0 for WQ Input & Treatment (WQ).

The second wetland assessment area, ECFl_FOR was located along the historic Christmas Creek floodplain in the forested wetland preservation area. Christmas Creek runs through the wetland mitigation bank in a southwest/northeast direction, though the creek signature is difficult to detect on the 2004 digital orthographic quarter quads (Figure 5-1). UMAM (0.70) and WRAP (0.64) scores were lower for ECFl_FOR (Table 5-2) mainly due to upstream disturbances, the constant input of the invasive exotic species common water-hyacinth (*Eichhornia crassipes*) from the connection with the St. Johns River, improper zonation in the wetland ground cover, and altered canopy. All three UMAM scoring categories were assigned scores of 7. WRAP scoring categories ranged from 0.5 for Wetland Ground Cover (GC) to 3.0 for WQ Input & Treatment (WQ), with the remaining four scoring categories assigned a 2.0.

While all of the potential credit has been released for East Central, it is clear from the wetland assessments conducted that full wetland function has not been achieved. It is unclear if the permitting process assumed full wetland function would be restored in determining mitigation

Table 5-2. Wetland assessment scores for two wetland assessment areas (ECFl_HAM and ECFl_FOR) at East Central. Assessment methods include Uniform Mitigation Assessment Method (UMAM), three UMAM scoring categories, Wetland Rapid Assessment Procedure (WRAP), and six WRAP scoring categories scores.

	ECFl_HAM	ECFl_FOR
UMAM	0.77	0.70
Location and Landscape Support	9	7
Water Environment	8	7
Community Structure	6	7
WRAP	0.78	0.64
Wildlife Utilization (WU)	2.0	2.0
Wetland Canopy (O/S)	2.0	2.0
Wetland Ground Cover (GC)	2.5	0.5
Habitat Support/Buffer	2.0	2.0
Field Hydrology (HYD)	2.5	2.0
WQ Input & Treatment (WQ)	3.0	3.0

ratios. If so, while success criteria designed for this project have been met, full wetland function has not been attained at this site as measured by these method. Of the entire credits allocated for East Central, only 1.7% (5.0 credits) were based on reaching success criteria for planted areas. A majority of credits, 89% (254.9 credits) were based on recording a conservation easement or construction activities (i.e., fence construction, canal filling, ditch filling). The remaining 8.8% (26.4 credits) were based on completion of a prescribed burn in the uplands and meeting success criteria. While these activities were assumed to enhance the condition of wetland and upland communities, there was little control over modification of credit release based on wetland function achieved from these activities.

Case Study: Florida Wetlandsbank

As the first wetland mitigation bank permitted in Florida in 1995 by SFWMD, Florida Wetlandsbank provided an example of a bank that has been deemed successful according to permit success criteria. Current conditions of two areas assessed in 2005, 10 yrs after the state permit was issued, suggested that full wetland function has not been restored to date.

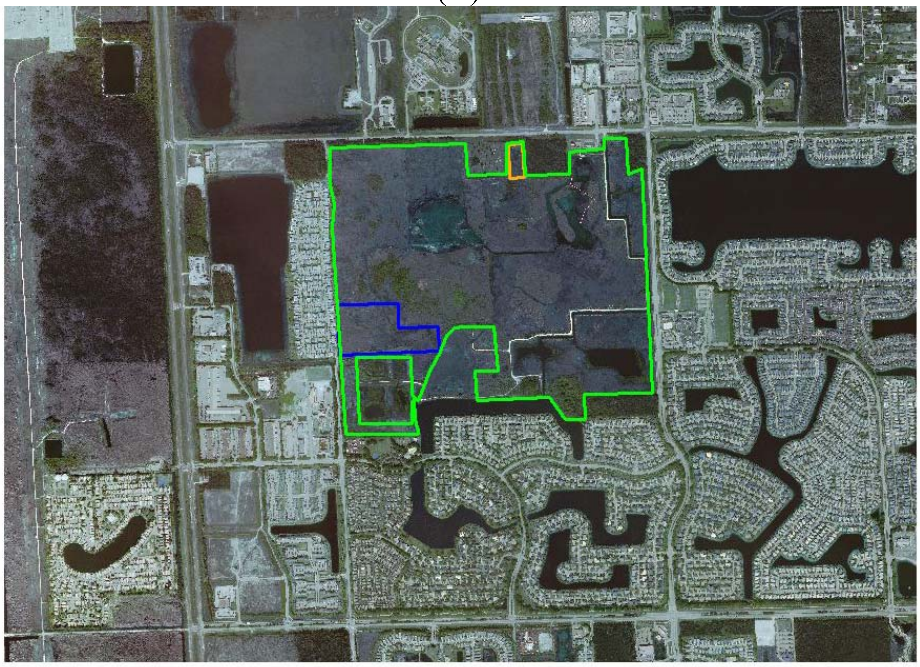
Florida Wetlandsbank was located in western Broward County (S11/T51S/R39E). Current land use surrounding the bank was predominantly residential with some light commercial development, roads, and small parcels of old-field non-restored lands (Figure 5-2A). Before becoming a mitigation bank, this 170 ha (420 ac) site was an old-field with a large population of the Florida Exotic Pest Plant Council Category I invasive exotic punktree (*Melaleuca quinquenervia*), a species documented as causing ecological damage through invading and disrupting native communities (EPPC 2003). The historic land use from a 1970s land use cover map (file USGSLU, available at: http://www.fgdl.org/) characterized the site as herbaceous rangeland (FLUCCS 3100). In addition, the site was hydrologically impacted by land drainage and canals, including a canal bisecting the property along a NE-SW line (Figure 5-2B).

The mitigation plan involved removing exotic species, scraping the site down to the limestone bedrock to facilitate wetland establishment, and installing water control structures. The site was graded to target elevations of community types present in the greater Everglades: cypress flats, open water, sawgrass marsh, wet prairie, tree islands and other native upland communities. Water levels were manipulated and controlled to keep the site hydrated for the extended 9-12 month annual period of inundation typical of natural organic flats wetlands in the Everglades (Noble et al. 2002). Berms surrounding the wetlands and dividing some of the phases were planted with native upland vegetation. The wetlands were also either planted and/or allowed to naturally recruit with native vegetation. Planting at the bank included 1,317,433 plants, and some areas had to be planted several times because of poor success in plant establishment. At least 129 native species were documented as recruiting naturally on the bank. In addition, the site has three known protected archaeological sites.

Success criteria for Florida Wetlandsbank included hydrology, exotic species cover, planted vegetation, and recruited vegetation (Table 5-3). For hydrologic restoration, the project goal was to maintain an average water level of 4.0 ft (± 0.25 ft) National Geodetic Vertical Datum (NGVD) to maintain the desired inundation conditions. The second success criteria was for 5% or less cover by exotic or undesirable species of vegetation throughout the bank, including both planted and non-planted areas. The remaining two success criteria concerned minimum survivorship and cover of desirable species throughout the bank.

The credit release schedule for this bank was 90% activity oriented credit: credit release awarded for recording the conservation easement (15%), punktree removal (25%), site grading (40%), and planting and mulching (10%). The final 10% of credits were scheduled for release after successful monitoring after the first (5%) and second (5%) year. To date, 367.37 of the potential 370 credits have been released and the bank has been sold out. The final 2.63 credits were being held by the SFWMD until monitoring for the last restored phase was complete.

(A)



(B)

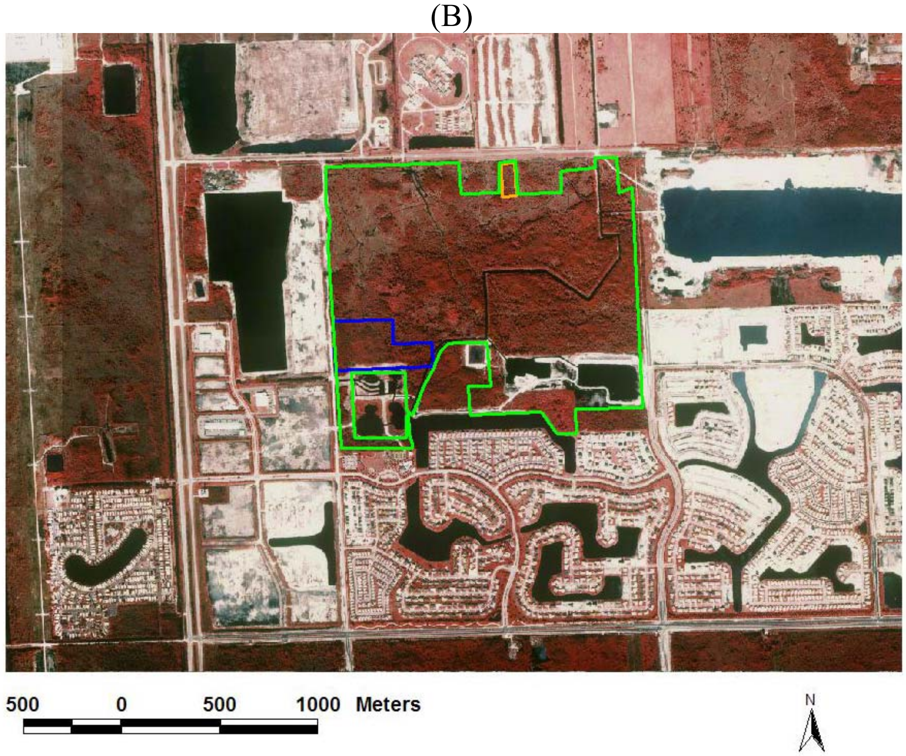


Figure 5-2. Landscape location of Florida Wetlandsbank (green line) in western Broward County and surrounding land use in A) 2004 and B) 1995. Images are digital orthographic quarter quads. Green lines are wetland mitigation bank boundaries with small county in-holding in southwest corner. Blue (FLWt_MAR_1) and orange (FLWt_MAR_2) lines are wetland assessment areas for field assessment methods.

Table 5-3. Success criteria for Florida Wetlandsbank.

Category	Criteria
Hydrology	Water levels demonstrate an average water elevation of 4.0 ft NGVD or within an acceptable deviation of 0.25 ft
Exotic cover	No more than 5% of both planted and unplanted areas will support exotic or undesirable plant species
Desirable vegetation, planted	80% survival of each planted species after 2 years with persistence of another 3 years after the date of time zero for each phase
Desirable vegetation, recruited	80% cover for volunteer vegetation areas without planting after 2 years persistence for another 3 years after the date of time zero for each phase

Information from Bank Permit Staff Report Monitoring Plan Exhibit 29 and Special Conditions.

Two years after the state permit was issued, Lew Lautin, Chief Executive Officer and Partner WetlandsbankTM, Inc., testified before the House of Representatives, Subcommittee on Water Resources and Environment Committee on Transportation and Infrastructure, that

> "*As of December 1, 1997, our Pembroke Pines mitigation bank has completely restored almost 350 acres to fully functioning wetlands that have been monitored and approved by federal, state and local regulatory agencies. In my written report, you will find information that supports this success through the elimination of exotic plants, the reestablishment of hydrology and the planting and growth of a variety of plants and trees that now thrive at the site and provide critical habitat for diverse wildlife species that now make their home in this mitigation bank within a mile of the historic Florida Everglades*" (pg. 3).

The permit and supporting documentation appear to assume full wetland function would be restored to this site once the success criteria have been met. However, according to the field UMAM, WRAP, and HGM assessment results from this study, this bank has achieved 52-73% of the reference wetland condition (Table 5-4). Assessment scores ranged between 0.52 (for WRAP at FLWt_MAR_2) to 0.73 (for UMAM at FLWt_MAR_1). The difference between the expected full return of wetland function following restoration and the measured level of wetland function was predominantly based on the suburban location and the effect of that location on wildlife, water, and related functions. It is not clear that the consideration of location was included in the original credit assessment. Thus, there is a potential for loss of wetland function for impact projects that relied on this bank as mitigation providing full function as defined by current assessment methods.

The wetland assessment area in Phase 1 (FLWt_MAR_1), which was restored approximately 3.5 yrs earlier than the wetland assessment area in Phase 29 (FLWt_MAR_2), had slightly higher scores for UMAM, WRAP, and HGM functional capacity index scores, except HGM Surface and Subsurface Water Storage (Table 5-4). Perhaps assessing the wetland function of similar wetland types restored over time using similar restoration techniques (i.e., a chronosequence design) would provide a reasonable estimate of time lag factors associated with restoration activities for specific wetland community types. However, finding a large enough sample size for any statistical vigor seems unlikely due to vast differences in site specific conditions.

Table 5-4. Wetland assessment scores for two wetland assessment areas (FLWt_MAR_1 and FLWt_MAR_2) at Florida Wetlandsbank. Assessment methods include Uniform Mitigation Assessment Method (UMAM), three UMAM scoring categories, Wetland Rapid Assessment Procedure (WRAP), six WRAP scoring categories, Hydrogeomorphic wetland assessment method (HGM), and four HGM functional capacity index scores.

	FLWt_MAR_1	FLWt_MAR_2
UMAM	0.73	0.70
Location and Landscape Support	4	4
Water Environment	9	9
Community Structure	9	8
WRAP	0.55	0.52
Wildlife Utilization (WU)	1.5	1.5
Wetland Canopy (O/S)*	na	na
Wetland Ground Cover (GC)	2.0	1.5
Habitat Support/Buffer	0.5	0.5
Field Hydrology (HYD)	2.5	2.5
WQ Input & Treatment (WQ)	1.8	1.8
HGM		
Surface and Subsurface Water Storage	0.63	0.67
Cycle Nutrients	0.69	0.64
Characteristic Plant Community	0.66	0.62
Wildlife Habitat	0.56	0.53

*WRAP Wetland Canopy (O/S) was not scored for these wetland assessment areas because they did meet the minimum requirement of 20% cover by overstory/shrub canopy (Miller and Gunsalus 1999).

In the case of Florida Wetlandsbank and other banks located in highly developed landscapes, the location and associated landscape support will always be a limiting factor in achieving full wetland function. For example, UMAM Location and Landscape Support score was 4 and WRAP Habitat Support/Buffer score was 0.5 for both wetland assessment areas indicating that habitats outside the wetland assessment area provide support for generalist species, but typically fail to provide support for many wetland specialists and wildlife species that have larger home ranges than the bank can provide or that need a mosaic of habitats to complete their life cycles. Both assessment areas had the same scores for HGM variables that defined accessibility to wildlife for dispersal and migration (TRACT; 0.03 out of 1.00), interior core habitat and vulnerability to fragmentation (CORE; 0.38 out of 1.00), and habitat connectivity (CONNECT; 0.10 out of 1.00). Reasons for low landscape and connectivity scores included: substantial barriers for terrestrial species to reach the greater Everglades system to the west from roadways, canals, and urban structures (Figure 5-3); nearby urban areas provided a constant seed source for exotic species of vegetation, including the invasive exotic punktree; and alteration of the hydrologic discharge from the property. Whereas, historically this area would have contributed to the regional water budget with sheet flow style drainage, now the downstream areas receive a point source outflow into a SFWMD canal, which drains to the east rather than into the greater Everglades system south and west. Florida Wetlandsbank was thought to act as a water purifier for the SFWMD canal water, a gain of local wetland function by treating urban run off, but that water is no longer part of the greater Everglades system, a loss of regional wetland function. The HGM assessment also gave all organic flats with rock plowing a 0.00 variable score (MICRO) because of the loss of water storage capacity. Even if restoration activities (i.e., grading) can account for recreating some microtopographic relief, the drop in elevation associated with scraping the site down to the bedrock can never regain the same storage capacity (Noble et al. 2002).

Lew Lautin, in his testimony before the House of Representatives, went on to state that ". . . when circumstances favor mitigation banking, it has proven to be a viable and successful alternative that ensures a true no net loss of wetland functional values" (pg. 4). It is true that the wetland resources at Florida Wetlandsbank are rare for urban Broward County and that the aesthetic and recreational resources provided are a positive contribution to the area. However, in regards to wetland function, there has been a net loss when assumptions of full functional restoration are perpetuated. For example, while local water treatment and nutrient cycling has been restored, contribution to the regional water cycle has not. In addition, wildlife species found within the wetland boundaries that can carryout their life cycles within narrow strips of upland or that can fly over urban development can succeed within the bank; however, ground limited species and those needing larger areas will not succeed. This is not to say that the wetland function has not been enhanced at the bank, but simply that it was not restored to full function.

Case Study: Sundew Mitigation Bank

Located in the southeastern corner of Clay County (S26,27,34,35/T7S/R26E), Sundew Mitigation Bank encompasses 851.7 ha (2,104.6 ac). Over half of the site (57%) was characterized as wetland (488.7 ha), with just under 6% of the wetland area (or 28.6 ha) considered largely unaltered by silvicultural activities. Only approximately 1.5 ha, less than 1% of the uplands, of "native-like forest (scrubby flatwoods) remains," according to the Individual Environmental Resource Permit Technical Staff Report (Staff Report) dated August 7, 2001.

This property was used for turpentine production in the early 1900s. By the 1940s, the entire property, including most interior wetlands, was clear cut, root raked, and bedded. A 1970s land use cover map (file USGSLU, available at: http://www.fgdl.org/) showed a majority of the property as FLUCCS code 4200 Upland Hardwood Forests with a strand of 6100 Wetland Hardwood Forests. The apparent shift from pine dominance (for turpentine and harvest) to hardwood species dominance was most likely a result of rapid hardwood re-growth following extensive pine harvest, suggesting the site was harvested again in the late 1960s or early 1970s. Silvicultural practices were active up until the property became a bank. Digital orthographic quarter quads from 1995 show that the middle section of the property had recently been harvested (Figure 5-3A), with the remaining areas harvested before the 1999 digital orthographic quarter quads were flown (Figure 5-3B). The Staff Report states that a majority of the upland areas host six-year-old slash pine (*Pinus elliottii*) planted on 0.9-1.5 m (3-5 ft) centers in 2001. The rows of young pine can be seen in the 2004 digital orthographic quarter quads (Figure 5-3C).

Mitigation activities at Sundew Mitigation Bank included ending silvicultural activities, eliminating most bedding, restoring water levels and patterns, enhancing native forest communities through planting, creating small herbaceous wetlands, and implementing prescribed fire. While the permit was issued August 7, 2001, little had been completed four years later. The only recent activity that was noted was some clear cutting. The ground was impacted with rutting by machinery and woody debris. Hydrologic alterations draining the site were still in place.

Sundew Mitigation Bank's permit allowed 698.3 potential credits, as stated in Exhibit 3 of the Staff Report (Table 5-5). As of October 2006, 194.2 credits had been released, representing just under 28% of the total potential credits. The federal Mitigation Banking Instrument (MBI) suggested 930.9 total credits were available. It was unclear from either the MBI or the state permit why the credit determination was different for the state and federal agencies. The credit release schedule in the SJRWMD permit was also set up somewhat differently than the federal MBI. The federal permit had more detail and different success criteria and credit release. Federal documents were not acquired for all banks, and the federal MBI success criteria for Sundew Mitigation Bank were included here as an example of the differences between state and federal requirements. Note that this was one example, and all state and federal permits do not share the same similarities and differences.

One of the primary differences between the state credit release schedule (Table 5-5) and the federal credit release schedule (Table 5-6) was the large difference between the percent of credits

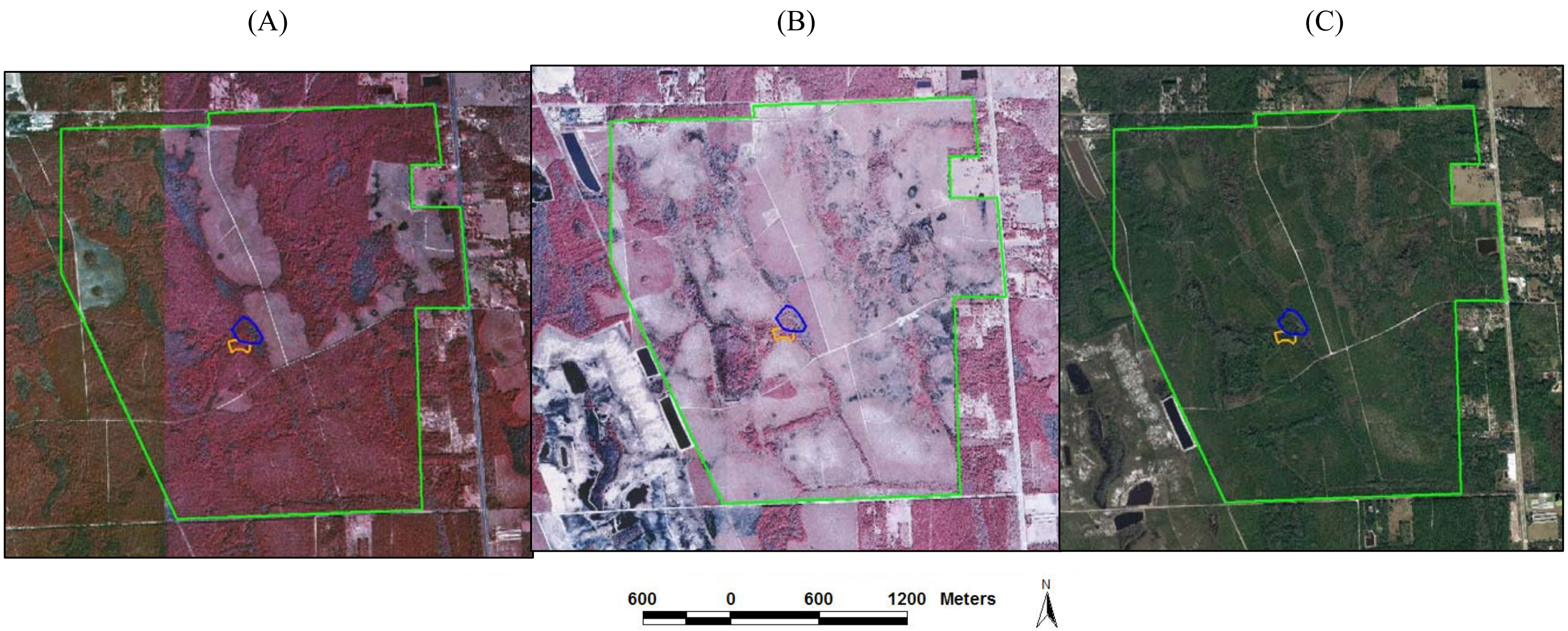


Figure 5-3. Landscape location of Sundew Mitigation Bank (green line) in Clay County and surrounding land use in A) 1995, B) 1999, and C) 2004. Images are digital orthographic quarter quads. Green line is wetland mitigation bank boundary; blue (Sun_FOR_1) and orange (Sun_FOR_2) lines are wetland assessment areas for field assessment methods.

Table 5-5. State permit credit release schedule for Sundew Mitigation Bank from SJRWMD technical report.

Activity	Credit Release	Percent Release
Conservation easement	139.66	20%
Cut planted pines	69.83	10%
Harrow the bedding	69.83	10%
Complete hydrologic enhancement construction	69.83	10%
Complete tree plantings	34.92	5%
Document hydrologic enhancement (with minimum 3 years monitoring)	34.92	5%
Document tree assemblage and densities met		
After 1 year monitoring indicates success	27.93	4%
After 2 year monitoring indicates success	27.93	4%
After 3 year monitoring indicates success	27.93	4%
After 4 year monitoring indicates success	27.93	4%
After 5 year monitoring indicates success	27.93	4%
Final success achieved with minimum 5 years monitoring*	139.66	20%
Total	698.30	100%

* 100% of *created* wetland credits will be released only after a minimum of 3 years of monitoring indicates successful establishment

awarded for mechanized or physical activities versus credits awarded for monitoring and demonstration of success. For example, 45% of the credits awarded through the state credit release schedule came from monitoring and documentation of meeting permit specified success criteria; whereas only 11% of the credits awarded through the federal credit release schedule came from monitoring and documentation of success. In fact, the state credit release schedule allocated 20% of the credits for reaching final success after a minimum 5 yr monitoring period. The federal credit release schedule, however, placed emphasis on construction based activities on the assumption that removing undesirable species (i.e., slash pine), removing silvicultural bedding, and removing unnatural drainage features would lead to full restoration of wetland function. The implementation of such activities resulting in restoration of full wetland function remains untested.

Two wetland assessment areas (Sun_FOR_1 and Sun_FOR_2) were selected for field assessments within Phase 1 at Sundew Mitigation Bank (Figure 5-3), both characterized as 6300 Wetland Forested Mixed wetland communities (SJRWMD 2000 land use cover map). The first wetland assessment area (Sun_FOR_1) included one area with a fairly closed canopy and one area with a more open canopy due to past harvesting with extensive evidence of recent hog rooting. Because these areas did not have distinct boundaries and they clearly comprised one contiguous wetland, these areas were scored as one wetland assessment area. The second assessment area (Sun_FOR_2) was characterized as floodplain forest, though the strip of remaining floodplain vegetation had been greatly reduced due to past silvicultural encroachment into the wetland. There were occasional cypress (*Taxodium* spp.) in the canopy with some large

Table 5-6. Federal permit credit release schedule from the Mitigation Bank Instrument for Sundew Mitigation Bank.

Activity	**Percent Release**
Place conservation easement	15%
Eliminate planted pines per plan	15%
Eliminate and Cross-cut bedding	
Year one	10%
Year two	5%
Year three	5%
Eliminate unnatural drainage structures and washouts	10%
Supplemental canopy tree planting	
Year one	6%
Year two	5%
Year three	5%
Year four	5%
Year five	8%
Demonstrate Improved Wetland Hydrology	
Year one	2%
Year two	2%
Year three	2%
Demonstrate <5% exotic nuisance plant cover	
Year one	1%
Year two	1%
Year three	1%
Year four	1%
Year five	1%
Completion and Success of Created Herbaceous Wetlands	100%

loblolly bay (*Gordonia lasianthus*) throughout, though much of the cypress had likely been harvested in the past. No evidence of cypress regeneration was found. Water flowed in a distinct channel through the center of this assessment area, directly connecting it to other wetlands throughout the bank and draining to the south.

Assessment score ranged from 0.65 to 0.77, with Sun_FOR_1 having UMAM and WRAP scores of 0.67 and 0.65 and Sun_FOR_2 having UMAM and WRAP scores of 0.77 and 0.73, respectively (Table 5-7). State credit allocation was based on mitigation ratios; however federal credit allocation was based on M-WRAP calculations with scoring worksheets available. All with-bank scenarios in the federal MBI for wetland polygons predicted a score of 3.0 for each M-WRAP scoring category and therefore an overall 1.00 M-WRAP score after restoration, enhancement, or creation activities were completed. M-WRAP scores for current (pre-bank) conditions from federal documentation at this bank ranged from 0.56-0.83, which encompassed the range of scores for the two wetland assessment areas in this study (Sun_FOR_1 and

Table 5-7. Wetland assessment scores for two wetland assessment areas (Sun_FOR_1 and Sun_FOR_2) at Sundew Mitigation Bank. Assessment methods include Uniform Mitigation Assessment Method (UMAM) with its three scoring categories and Wetland Rapid Assessment Procedure (WRAP) with its six scoring categories.

	Sun_FOR_1	Sun_FOR_2
UMAM	0.67	0.77
Location and Landscape Support	6	7
Water Environment	8	9
Community Structure	6	7
WRAP	0.65	0.73
Wildlife Utilization (WU)	2.0	2.0
Wetland Canopy (O/S)	2.0	2.0
Wetland Ground Cover (GC)	1.5	3.0
Habitat Support/Buffer	2.0	2.0
Field Hydrology (HYD)	2.5	2.5
WQ Input & Treatment (WQ)	1.6	1.6

Sun_FOR_2). While specific conditions within the wetlands can be expected to improve with the implementation of mitigation activities such as improved community structure and hydrologic conditions, it is uncertain that full function could ever be attained at this location. The disruption of neighboring lands to the southwest through mining activities (Figure 5-4B, C) will influence site hydrology, species exchange, and wildlife habitat support. Additionally, the proximity of US-17, a busy highway to the northeast, acts as a wildlife barrier between the bank and Bayard Conservation Area. As well, the occurrence of residential areas along the eastern boundary and the abundance of silvicultural activities in the vicinity suggest that the landscape will never provide all of the benefits and connections necessary for full wetland function.

Further, without-bank scenarios in the MBI used to calculate the delta for credit determination seemed overly depressed. For example, in one polygon (e.g., W-1) the Vegetation Overstory (an M-WRAP category analogous to WRAP Wetland Canopy) scored 0.0 under the assumption that all cypress would be harvested. Also, Adjacent Upland Buffer (analogous to WRAP Habitat Support/Buffer) received a score of 0.0. While it might be possible to completely eliminate both the vegetative structure of the wetland and the surrounding lands, current regulations regarding urban development would require some compensation for such loss, and these scores seem inappropriate for without-bank scenarios. Overall, the prospects of Sundew Mitigation Bank ever achieving full wetland function, documented through perfect WRAP or M-WRAP scores, seems unlikely, and a net loss of wetland function likely.

CHAPTER 6 - DISCUSSION

When this proposal was drafted in 2004, only 34 Florida wetland mitigation banks had been permitted. By October 2006, that number had increased to 45 permitted banks in Florida. As a result of this rapid increase in banking in Florida, this study had the opportunity to identify the current ecological function provided by permitted wetland mitigation banks across a broad spectrum of activity, from those sites where mitigation activities had not yet occurred to those banks deemed successful.

The following sections describe overall conclusions drawn from permit and documentation review and from field assessments. First, we present eight recommendations to improve permits and mitigation plans. Second, we discuss considerations for basing success criteria on indicators of ecological integrity. Third, we present a brief discussion on project limitations and future research direction, followed by concluding remarks.

Permit Review

Generalizations regarding permits were difficult considering the vast differences in wetland community types, regional variations in exotic and nuisance species of vegetation present, varied expectations of wildlife use, different anticipated fire regimes based on community type, assorted methods of potential credit determination, and differences among overseeing agencies (Florida Department of Environmental Protection, FDEP; South Florida Water Management District, SFWMD; Southwest Florida Water Management District, SWFWMD; or St Johns Water Management District, SJRWMD). All of these factors contributed to somewhat unique permit requirements for each wetland mitigation bank.

One consideration regarding wetland mitigation banks was the lack of any centralized oversight structure that followed the mitigation bank from initial permit application review through final credit release, combined state and federal regulations and oversight, and warehoused important documentation such as permits, credit release requests, monitoring reports, and any other additional correspondence and proceedings relating to banks. The management of banks by four separate agencies within the state and the time lag between state and federal processing appeared to confuse and delay the process of permitting Florida banks. In contrast, having multiple agencies responsible for permitting did not overload one single agency with all permit requests, though it did increase the differences among bank permits within the state. Sharing all documentation in a transparent, accessible, centralized, digital fashion from pre-permit through final success would facilitate compliance tracking and auditing.

Eight recommendations for improving permits and/or mitigation plans were developed from review of permits and documentation at 29 Florida mitigation banks. These included:

1. Define natural communities and associated reference standard conditions;
2. Emphasize groundcover restoration;
3. Monitor plant and animal community structure, not just presence or cover of exotic or nuisance species;
4. Establish and implement fire management plans;
5. Identify sustainability of mitigation within the landscape;

6. Allocate a higher percent of credits for achieving success criteria and a lower percent of credits for task completion;
7. Encourage better coordination and standardization among state and federal agencies and between bank managers and agency personnel; and,
8. Increase compliance responsibilities of the regulatory agencies.

These suggestions are intended to facilitate improvement in the ecological condition of wetland and upland communities within banks permitted in the future.

Natural Communities

Chapter 373.4135, F.S. states "Mitigation banks and offsite regional mitigation should emphasize the restoration and enhancement of degraded ecosystems and the preservation of uplands and wetlands as intact ecosystems rather than alteration of landscapes to create wetlands. This is best accomplished through restoration of ecological communities that were historically present." The Society for Ecological Restoration International (SER) defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER 2004, pg. 3). The Environmental Resource Permitting Basis of Review defines restoration as "converting back to a historic condition those wetlands, surface waters, or uplands which currently exist as a land form which differs from the historic condition" (SJRWMD BOR 2.0(vv)). Both the SER and SJRWMD definitions point to a need to understand the historic condition or a recovered condition of the intended community. Therefore, defining the targeted ecological community or reference standard condition is imperative in mitigation banks.

While some mitigation plans for banks clearly define the targeted natural community type and restoration goals, many more do not. Language commonly encountered in permits suggests that mitigation areas would "resemble" a particular community type, but rarely were explanations given as to how this "resemblance" would be determined. In fact, sometimes the "resemblance" would be based on similar percent cover by a single species. While ecological statistics can be quite complicated, some simpler functional assessment tools are available to provide a quantitative comparison of community structure, such as indices of biotic integrity (i.e., Florida Wetland Condition Index, FWCI), or functional assessment techniques (i.e., Hydrogeomorphic approach to assessing wetland function, HGM). Further, in a review of restoration projects described in the first 11 volumes of the journal Restoration Ecology, Ruiz-Jaen and Aide (2005) mention group comparisons (i.e., ANOVA, t-test), ordination (i.e., DCA), and linear comparisons as the three common statistical methods for evaluating restoration success. Surely some quantitative means of evaluating similarity to a reference standard community could be incorporated into permit success criteria.

Ecosystems are inherently variable as they organize around constant changes in driving energies (i.e., sunlight, rainfall, etc.) and natural disturbances (i.e., wind storms, hurricanes, fire, etc.). Defining the target reference standard condition and having a reference database and/or nearby field sites for comparison are crucial to understanding the expected range of variability for a community type. In many instances having both would be ideal, as a reference database provides representative conditions across the region or state and local field sites provide for an understanding of current local variation. Unfortunately, a state-wide reference database does not exist, though restoration planning, monitoring, and assessment would benefit from such a tool.

Florida banks are not alone in their lack of clearly defined target natural communities. In a nationwide study on wetland mitigation, the Environmental Law Institute (ELI 2002) found that a clear and uniform definition of wetland type was rarely included in bank permits and documents, despite indication within the documents suggesting a standard wetland classification systems would be used, typically that of Cowardin et al. (1979). Further, Ruiz-Jaen and Aide (2005) noted that existing laws in the United States do not require restoration success as defined by comparison to reference standard communities, and that given financial concerns, such as increased costs for monitoring reference sites as well as restoration sites, it is unlikely that such comparisons to reference sites will be required for future restoration efforts. While the Uniform Mitigation Assessment Method (UMAM), which is now the required assessment method for determining potential credits at wetland mitigation banks, does require the assessor to describe the wetland assessment area by FLUCCS code or other classification scheme, functions, and anticipated common and listed wildlife utilization, it does not require field comparison to a reference standard community. Perhaps the Florida Natural Areas Inventory (FNAI) Guide to the Natural Communities of Florida (1990) would be a more useful classification for managers planning restoration activities than FLUCCS codes, as FNAI provides a detailed description of each of Florida's native communities.

In addition to defining a reference standard condition for a community type, baseline conditions should be established. Moore et al. (1999) state that the need for restoration activities and the evaluation of restoration success are based on differences between current and reference standard condition. While some permits did establish the current condition of the environmental resources for the determination of preservation credit release (credits available for preservation credit release can be calculated as the difference between the current condition scores minus the without bank scenario, Story et al. 1998), this depended on the method used to calculate potential credits. The baseline condition should be calculated for all communities within banks. This is particularly important if a bank falls out of compliance and the baseline wetland function has been diminished. Such was the case for at least one bank that stalled restoration activities, fell out of compliance, and thus had more work to attain permit success criteria due to the delayed activities and the growth of both exotic and nuisance species that expanded during an extended period of inactivity leading to a set back in restoration progress.

Groundcover Restoration

Restoration of different community types requires more than replacement of canopy structure alone. While the canopy no doubt influences a great deal about the community (e.g., microclimate, Breshears et al. 1998; air turbulence, Patton et al. 2003; etc.), there is more to restoring natural communities than simply planting or growing trees. However, most restoration plans rely on natural processes alone to establish non-canopy vegetation (Clewell 1999). In a study of Florida Everglades marsh restoration, Smith et al. (2002) support that active vegetation management must be used along with hydrologic restoration in order to restore the herbaceous vegetation to the target reference standard condition.

Beyond plantings, Mitsch and Wilson (1996) suggest that allowing nature to participate in the wetland community design through multiple-seeding, multiple-transplanting, and allowing genetic material to enter through hydrologically connected systems is an appropriate means of vegetative restoration. In a restoration site in south Florida, David (1999) suggested that colonization of a restored marsh by pickerelweed (*Pontederia cordata*) occurred due to the hydrologic connectivity of the restored site with a drainage ditch that hosted pickerelweed. For restoration at wetland mitigation banks, it may be important to include connectivity to off-site wetlands and uplands, not just for hydrologic restoration but to increase the inflow of genetic vegetation material as well.

In restoring flatwood ecosystems, many of the banks have success criteria tied to survivorship of planted pine trees, but relatively few include specific success criteria for groundcover composition in these areas. However, groundcover plays an important role in these communities, particularly for carrying fire and providing food and nesting materials for wildlife. When wet flatwoods have had groundcover or hydrologic disturbance, overall community recovery is poor (FNAI 1990), suggesting the importance of actively restoring the groundcover in such communities. An important part of achieving success in groundcover restoration includes adequate site preparation prior to planting, seeding or allowing natural regeneration to occur. Perhaps in such communities success criteria should be more closely tied to groundcover composition similarity to the target reference standard condition in addition to or instead of survivorship of planted tree species.

Community Structure

An apparent oversight in many mitigation plans is the lack of consideration of target community structure for both flora and fauna. Some permits require a minimum percent cover of a desirable species or percent plant cover that resembles a reference standard community and limit the percent cover by exotic and/or nuisance species. Ten of the 29 permits reviewed in this study had wildlife requirements for determination of success, and seven of these included qualitative wildlife monitoring. Restoration of wetland and upland communities should focus on the target wildlife community structure as well as the vegetative community structure. It is not enough to believe that if you create a similar vegetative structure, the wildlife will come back. Instead, attention should also be given to establishment and maintenance of desired wildlife communities.

Further, it is recognized that currently many available assessment methods clearly aim to measure community structure, with the assumption that restoring community structure will equate to returning community function. However, a simple list of species occurrence does not provide an adequate means of assessing ecosystem function (Mitsch and Wilson 1996). Ten years ago Mitsch and Wilson (1996) recognized the need for linking structural measures such as species diversity, productivity, or cover, with important ecosystem functions such as wildlife use, nutrient cycling, or organic matter accumulation. Studies have noted that the return of the water storage or water quality functions at restoration sites does not always equate to targeted community structure or wildlife habitat functions (e.g., Brown and Veneman 2003, McKenna 2003, Zampella and Laidig 2003) Further, McPherson and DeStefano (2003) suggest that a quantitative, objective description may be required to assess the effectiveness of management activities on community structure.

Establishing community structure targets through application of functional assessment tools that provide a quantitative comparison of community structure, such as indices of biotic integrity (i.e., Florida Wetland Condition Index, FWCI), or functional assessment techniques (i.e., Hydrogeomorphic approach to assessing wetland function, HGM), may improve the structural component of wetland mitigation banks. The underlying support for using biological indicators is that organisms have an intricate relationship with their environment, which reflects current and cumulative ecosystem conditions (Karr 1981). Biological indicators reflect chemical exposure and also integrate changes in the community composition of the ecosystem (from physical, chemical, and biological changes) (Adams 2002). Currently the FWCI is only available for three wetland community types (i.e., depressional herbaceous, depressional forested, and forested strand and floodplain wetlands) and three community assemblages (i.e., diatoms, macrophytes, and macroinvertebrates) for Florida wetlands. Similarly, indices of biotic integrity should be developed for other species assemblages, as has been the case in other states for fish (Schulz et al. 1999), birds (O'Connell et al. 1998), and amphibians (Micacchion 2002). Developing bioassessment tools based on additional community assemblages (e.g., bird, amphibians, etc.) and for additional wetland types (e.g., cabbage palm hammock, Everglades flats, etc.) for the state of Florida would help provide means to quantitatively compare community structure. In fact, biological assessment data for multiple community assemblages will provide a more complete picture of ecosystem condition (Reiss and Brown 2005a).

Application of the HGM approach is also limited by method development and field testing, as currently guidebooks are available for a limited set of wetland community types in Florida:

1. Flats wetlands in the Everglades (Noble et al. 2002);
2. Wet pine flats on mineral soils in the Atlantic and Gulf Coastal Plains (Reinhardt et al. 2002), which includes far northeastern Florida but excludes peninsular Florida, though the authors suggest the same model may be applicable to peninsular Florida with limited modification;
3. Low-gradient, blackwater riverine wetlands in peninsular Florida (Uranowski et al. 2003);
4. Depressional wetlands in peninsular Florida (Noble et al. 2004).

Increased field testing, developing guidebooks for other wetland community types, and expanding the geographic regions of Florida represented by HGM models would provide further tools for quantitative comparisons of community structure.

Fire Management

Fire management is crucial to successful maintenance of many of Florida's natural communities, ranging from high-frequency fires in prairies, flatwoods, and shallow marshes, to longer fire return interval in swamps and hardwood forests (FNAI 1990). Yet detailed fire management plans were often not included in permits and associated documentation. Even when prescribed fire was indicated for achieving successful ecosystem restoration, many barriers arose to prevent implementation of prescribed fire management plans. Management should be proactive and aggressive in conducting prescribed fires. While weather conditions are not always ideal for conducting prescribed fires, certainly some day within the appropriate fire season interval should become available within a reasonable time frame to keep fire management based mitigation activities on track. Managers should be ready to act when appropriate weather and field conditions arise.

Historic Florida fire regimes have been altered for over a hundred years, when human activities began to fragment the Florida landscape and promote activities to suppress and extinguish any natural fires that did occur. However, restoration of groundcover in many communities is dependent on frequent lightning season fires, and successful restoration may be unattainable without fire management that mimics the natural regime to the extent practical. Some banks suggest prescribed fire as a management tool only after the canopy species have become established (5-10 yrs after planting), yet prescribed fire should be considered as a restoration tool sooner to help promote the groundcover that can then support and sustain a fire. The early establishment of appropriate pyrophytic groundcover that includes fine fuels capable of carrying prescribed fire is an important consideration. Successful implementation of prescribed fire and community response to this management tool should be required by mitigation bank permits and linked to credit release in fire-dependent communities.

Sustainability and Landscape Position

The location of compensatory mitigation sites continues to be an important consideration. The state of Florida has been cross ditched and drained since human settlement began, and as such, an ideal landscape setting probably does not exist within the state. Having realistic goals as to the potential function of a wetland mitigation bank should be a priority for assessing with mitigation bank scenarios. A bank surrounded by human development land uses or in areas that are likely to support human development activities in the near future should not receive perfect landscape scores for with mitigation scenarios. Consideration of potential wetland functional lift should incorporate a landscape perspective, which could include application of available tools such as both the wetland scale and bank scale LDI index, reflecting both the local and broad scale landscape support. The relatively recently adopted UMAM does consider location and landscape support in its scoring.

Finding a significantly large tract of land on which to locate a bank in Florida, or the United States, may be impossible, as Forman (2000) suggests that approximately 20% of the land area within the United States has experienced direct ecological effects from the public road system. This 20% figure is expected to rise in the future, suggesting that roadways will continue to act as a major influence on the community structure and wildlife habitat suitability for Florida wetland mitigation banks. While the Criteria for Establishing a Mitigation Bank (62-342.400 (1) (f), F.A.C.) states that the wetland mitigation bank should "be adjacent to lands which will not adversely affect the perpetual viability of the Mitigation Bank due to unsuitable land uses or conditions" (pg. 538), this criteria may be overlooked when deciding to approve the location of a proposed wetland mitigation bank.

For example, mitigation banks adjacent to or bisected by highways is a concern, as highways act as significant barriers for wildlife. In a study on the mortality of amphibians, reptiles, and other wildlife along a two-lane paved causeway, Ashley and Robinson (1996) found over 32,000 individuals died in two two-year periods along the road. In another study from Boston, Massachusetts, researchers found the impacts of a major four-lane road extended at least 100 m and perhaps more than 1 km for some effects (Forman and Deblinger 2000). Further examples of the significant impacts roads play in disturbing wildlife include the mortality of herpetofauna along US-27 in Lake Jackson, Florida (Aresco 2005), which are a commonly overlooked though major biotic component of freshwater wetlands (Gibbons 2003). In addition, rarely have female Florida panthers (*Felis concolor coryi*) been found to cross major roads or use underpasses, so their habitat is still essentially fragmented by roads even where underpasses have been constructed (Maehr 1988, as cited by the Florida Fish and Wildlife Conservation Commission at http://myfwc.com/panther). These studies suggest that roadways and conservation areas should be well separated, and yet many of the Florida banks are bordered by busy roadways (e.g., Barberville is bordered to the south by SR-40; Everglades Mitigation Bank/Phase I is bordered to the east by Card Sound Rd. and the west by US-1; etc.) or bisected by busy roads (e.g., Tosohatchee is bisected by the Beach-Line Highway SR-528; Little Pine Island is bisected by SR-78; etc.). In addition, a recently permitted bank, Wekiva River, has been targeted as a potential area to be impacted by a future highway serving the Orlando area.

A further concern regarding landscape support is the presence of tall transmission towers on or near bank property that may occur within avian flight paths. A few banks (e.g., Panther Island) are situated adjacent to such towers, and species attracted to the mitigation site may be endangered by neighboring structures. For example, in a study on bird mortality in central Florida, Taylor (1973) found hundreds of black-throated blue and Cape May warblers were killed in a six week period in September and October at the WDBO-WFTV TV Tower, in the autumns of 1969-1972. In a more recent study by Crawford and Engstrom (2001), a total of 44,007 individuals of 186 species were collected at the WCTV television tower in north Florida, and over 94% of the total number of individuals were Neotropical migrants. The study spanned a 29-yr period, one of the longest of its kind. They found that towers approximately 94 m or lower may not pose as great a threat to avian mortality as caused by towers 200 m or greater. Clearly the position of banks in urban locations, near highways, or adjacent to transmission towers will have unintended consequences for mobile species.

Further, McAllister et al. (2000) suggest that the landscape location at a regional scale that would maximize the functional gain from wetland restoration is frequently ignored. While the primary focus of that study was the function of flood attenuation, certainly this is true of other functions. In the end, all restoration, mitigation, and conservation areas must contend with human development activities. Conversely, a recent study on the demographics of Florida banks suggested that the location of banks in more rural areas redistributes wetland resources and the associated ecosystem services away from urban areas and thus removes some of the services afforded by these systems (Ruhl and Salzman 2006). Locating banks within developed urban areas may improve the distribution of certain ecosystem services across the landscape (e.g., flood attenuation), but it will not improve the total potential function that could be attained on a site. Wetland mitigation in general must be considered a trade-off between temporal and spatial ecosystem function, and the bottom line comes back to a realistic expectation of attainable function in the calculated with mitigation bank scenario. That is, when a bank is adjacent to developed lands, the location and landscape functional component should never be expected to achieve a perfect score. Similarly, when a bank is located in an area spatially distant from the impact site, some local loss of wetland function should be anticipated and offset as appropriate through other components of wetland regulation, such as floodplain compensation and surface water treatment and attenuation. A national study by Brown and Lant (1999) found that the spatial location of banks was often in downstream or coastal locations, so that replacement may not be providing equal function as from the wetlands lost in the upper watershed. Significant loss in wetland function from moving mitigation wetlands towards the bottom of a watershed may be manifest in loss of flood control (Ogawa and Male 1986 as cited by Brown and Lant

1999) and change in water quality benefits (Peterjohn and Correll 1984), which should be taken into consideration when defining the mitigation bank service area.

Credits for Achieving Success Criteria

When reviewing bank permits and supporting documentation, it became clear that much of the credit release was tied directly into completion of specific tasks such as grading, ditch plugging, or canal filling. Because the concept behind compensatory mitigation is to prevent "no net loss" of wetland function and the function attributed to banks is meant to be in place prior to impacts (Federal Guidance for the Establishment, Use and Operation of Mitigation Banks 1995), more credits should be tied into demonstration of achieving function and less into task completion. Early credit release is probably necessary to maintain the economic incentive of establishing and operating a bank, and limited initial credit release based on acquisition of a conservation easement and demonstrating financial assurance seems justified. However, continued credit release based on completion of activities that do not necessarily equate to demonstrated improvement of function should be avoided. Credit release criteria should be explicit and measurable, and demonstration of trending towards success should be the most important factor in further credit release. Mitsch and Wilson (1996) argued a decade ago that efforts to determine wetland restoration or creation success are flawed due to a lack of application of sound wetland science and the weight of schedule-driven construction activities, and yet many of the success criteria of permits were focused on task completion.

Both the FDEP and WMD rules on mitigation banking state that a mitigation bank permit must include the success criteria by which the mitigation bank will be evaluated. (12.4.9(a)3, SJRWMD Applicants Handbook; Ch. 62-342.750(1)(c), F.A.C.) The FDEP rule goes on to state that ""Success" means when a Mitigation Bank meets the success criteria provided in Section 62-312.350, F.A.C., and in the Mitigation Bank Permit." Section 62-312.350, F.A.C. deems mitigation successful if three conditions are met:

1. All applicable water quality standards must be met. The state of Florida does not currently have water quality standards that specifically address wetland water quality, however the general state water quality standards established in Chapter 62-302 Surface Water Quality Standards, F.A.C. apply. Rarely did bank permits require water quality monitoring, and in the few permits that did mention water quality, generally it was in regard to monitoring turbidity during construction activities.
2. The mitigation project must have sufficient hydrology to sustain it. This was sometimes identified in permits as having a specified acreage of jurisdictional wetland, pursuant to Section 373.421, F.S. It seems intuitive that success of wetland restoration, enhancement, preservation, and particularly creation projects should be deemed successful only if they can be clearly identified as jurisdictional wetlands, though not all bank permits specified this condition. In a study of compensatory wetland mitigation throughout the United States, ELI (2002) found that nationwide just over half of wetland mitigation banks with explicit performance standards include hydrologic criteria.
3. For mitigation success, the project must meet permit specific success criteria. Generally this was the main condition identified to determine success for banks. As noted above, particularly in the discussions of natural communities, groundcover, and community

structure, many permits do not state the intended target community, establish a reference standard condition, or consider groundcover and other community components in the determination of success.

Another controversy surrounding the awarding of potential credits deals with the types of mitigation and the communities receiving credits including creation and preservation of wetlands and preservation of upland areas. Generally the greatest amount of potential credits is awarded for wetland creation as it represents the greatest potential lift, despite the low success rate of attaining wetland function with such endeavors (Stolt et al. 2000, ELI 2002). In addition, there is some loss of upland function in areas converted to wetland, and the redistribution of wetlands across the landscape should be considered. However, state rules require that "no credits awarded for freshwater wetland creation shall be *released* until the success criteria included in the mitigation bank permit are met" (12.4.5(c), SJRWMD Applicants Handbook; Ch. 62-342.470(3), FAC), thereby addressing the question of success rate for creation.

The Federal Guidance for the Establishment, Use and Operation of Mitigation Banks (1995) states that preservation should only be used under "exceptional circumstances," yet Section 373.4135, F.S. states that "Mitigation banks should emphasize the restoration and enhancement of degraded ecosystems and the preservation of uplands and wetlands as intact ecosystems." Preservation acreage made up a major component in some Florida banks.

A similar disconnect was found regarding awarding credits to upland areas. While many studies suggest the importance of uplands in buffering wetland and aquatic ecosystems, providing support habitat for valuable wildlife species, and protecting the functional integrity of these systems (i.e., Brown et al. 1990, JEA 1999), preservation or enhancement of upland ecosystems alone do not increase total acreage of wetland in the landscape. However, the state directs mitigation banks to include both uplands and wetlands in banks as intact ecosystems (Section 373.4135, F.S.).

Coordination and Standardization among Agencies

In a study of compensatory wetland mitigation across the United States, ELI (2002) suggested that differences among permits and supporting documents make comparisons difficult. This is true not only between federal and state documents, but also among documents from the four state agencies that permit Florida mitigation banks: FDEP, SFWMD, SWFWMD, and SJRWMD. In fact, simply tracking down documentation for each bank proved difficult in many instances. A new internet-based tracking system for United States Army Corps of Engineer (Corps) to monitor banks, called the Regional Internet Bank Information Tracking System (RIBITS), should provide a warehouse for bank documentation at the federal level. The RIBITS interface will allow Corps staff and the general public to track the status of banks, track credit release and credit debits, see compliance reports, and email information requests. A similar electronic database for tracking and storing bank permits at the state level would be useful. However, suggestions for centralized databases have been made in the past (e.g., Kentula et al. 1992) with little recent progress.

Similarly, having a standard format for permits issued by state agencies would enable quick and efficient comparison among the state banks. This would also ensure that important information has not been overlooked. While the Mitigation Bank Review Team (MBRT) established through the Joint State/Federal Mitigation Bank Review Team Process for Florida (Story et al. 1998) provides a forum for state and federal agencies to work together on bank reviews, the MBRT and recommended procedures are not binding on any of the agencies. In a few instances, the state and federal permits diverged in important points which leaves confusion over key issues, such as the number of potential credits.

Regulatory Agency Compliance Responsibilities

While time and costs are no doubt limiting factors in the availability of agency personnel to conduct frequent and thorough site visits, increasing agency oversight and interactions with bank managers should enhance overall compliance and achievement of final success. Frequent inspection should provide motivation for bank managers to maintain and improve ecosystem function between site visits. At a minimum, no agency should release credits without a bank inspection of sufficient detail to confirm that monitoring reports correctly document site condition and that required release criteria have been met.

Site visits are important to help understand the unique characteristics of each bank. In some instances, the quality and detail provided in a monitoring report does not reflect the quality of on the ground efforts. Wetland ecological condition and progress of restoration efforts are highly dependant on the knowledge and experience of the land manager and the interaction of the bank manager with the respective regulatory agency. FDEP, SJRWMD, SFWMD, and SWFWMD all operate somewhat differently regarding permit and compliance for banks. It appears that typically for FDEP the same individual is responsible for permit review and following up with compliance. However for SFWMD different individuals are responsible for each stage of the bank, so that once a permit has been approved the responsibility of compliance is shifted to someone who was not involved in the initial permit process. The benefit of this procedure is the additional oversight provided by a new individual. However, the down side is that the compliance office has no permit review experience with the bank manager, the mitigation plan, or the property.

Ecological Integrity

Before compensatory wetland mitigation is considered, state and federal regulations propose that first wetland impacts are avoided and second that unavoidable wetland impacts are minimized. Remaining wetland impacts are then mitigated with the intention of replacing lost wetland function and achieving the often proclaimed “no net loss” of wetland function. The impetus for wetland protection comes from protecting the physical, biological, and chemical integrity of our Nations waters, particularly in matters of human health and economic concerns (e.g., coastal fisheries, navigation). Defining ecological integrity of a delineated wetland or water body can be done in a number of different ways, each reaching a somewhat different conclusion depending on what was measured and how it was quantified. There is currently no single scientifically agreed upon best method to assess the ecological integrity of an ecosystem. However, developing a repeatable and objective measure of ecological integrity that is easy to implement and unambiguous would be ideal.

The variability in the wetland community types within the 29 banks included in this study plus the fact that anywhere from one single wetland community type to multiple different wetland community types existed at each bank made a simple calculation of ecological integrity impracticable. In fact, most assessment methods developed to measure ecological integrity are wetland community specific (e.g., HGM, FWCI) or are simply not meant to be used as a comparison against other wetland community types (e.g., WRAP, UMAM), in part due to the different ecosystem services and functions provided by each different wetland community type (Chapter 62-345.300, F.A.C.). Even if these issues could be overcome, one may expect many banks would achieve similar, average scores due to the dampening effect that would come into play when scores for different community types within a bank were averaged.

The number of potential mitigation credits is "relative to that [ecological value] obtained by successfully creating one acre of wetland" (Ch 62-342.470(2), F.S.). Wetland assessment areas in this study located in banks that had achieved final permit success criteria and had all potential credits released did not receive the highest possible scores for the field assessment methods, suggesting full wetland function had not been attained, as measured by these methods. Some banks near busy highways, receiving polluted water (e.g., receiving water from a canal that receives urban stormwater runoff), or adjacent to high intensity human development activities (e.g., high-density single family residential), were assumed to have the potential to provide full wetland function. However, the landscape of Florida has become more urban and Florida has one of the highest rates of conversion of rural to urban land use (Reynolds 2001). Realistic with-mitigation scenarios should be of primary importance for determining potential credits for a bank.

This draws into question whether the same wetland functions are being restored within banks as are being lost at impact sites. Unfortunately, this study was limited to wetland assessment areas within banks, and we cannot comment specifically on what functions have been lost due to permitted wetland impacts. We can, however, focus on our understanding of the differences between the community structure and functional assessment scores of wetland assessment areas within banks and reference wetlands. In a study of the effectiveness of compensatory wetland mitigation in Massachusetts, Brown and Veneman (2001) found that while all projects were in compliance, plant community structure at mitigation wetlands was not similar to the wetlands that had been impacted, leading to a loss of wildlife habitat and utilization functions. Even when water quality and sediment control functions were replaced, there was still a calculated net loss of wetland function (Brown and Veneman 2001).

Few studies have attempted to link community structure with function, though many assessment methods are based on the idea (e.g., VIBI, Mack et al. 2000; FWCI, Lane et al. 2003, Reiss and Brown 2005a). While community structure is considered relatively easy to measure, direct measures of wetland functions are either not available or are more difficult and more time intensive. Further, there is some concern that when restoring a single wetland function or a limited number of wetland functions, dissimilarities in community structure may still occur. A study in New York by McKenna (2003) found similar rates of production and respiration, which are wetland functions, at a restored wetland and reference wetland. However, the community structure was not similar between these wetlands, and McKenna (2000) suggested that different foodweb pathways resulted. This is an important consideration for any form of mitigation. For example, simply restoring or enhancing hydrologic connectivity or wetland volume for flood attenuation may never result in a fully functioning wetland considering all other potential wetland functions. Designing mitigation to address only a subset of all possible wetland functions provided by a certain wetland type could easily translate into a net loss of some wetland function if mitigation assumed equal improvement or replacement of all functions was attainable.

While methods are not currently available to answer the questions about how and which functions should be restored, there are methods available for determining ecological integrity. Perhaps HGM best addresses the various wetland functions by arriving at functional capacity index scores for each function separately. From an ecological perspective, separate accounting of each lost function may be the best means of accounting. However, from a regulatory perspective, accounting separately for each lost wetland function could further complicate the process. That does not mean this is not the best approach, but perhaps not the most realistic.

One of the driving principles of ecosystem restoration lies in the concept of determining a reference standard community type. This concept is similarly applied in the determination of ecological integrity, as community structure is compared to that of a reference standard community in order to assess ecological integrity. All of the field assessment methods used in this study were developed with regard to reference standard ecological communities. Some measures of wetland function can be calculated through rapid assessment methods and best professional judgment (e.g., WRAP, UMAM), measures of community structure (e.g., FWCI), or measures of community variables (e.g., HGM). Use of the more detailed assessment methods (e.g., FWCI, HGM) may provide a clearer picture of wetland function through measures of community structure and/or abiotic variables.

Limitations to Study

It is important to note that we are unable to comment specifically on the advantages of mitigation banking for maintaining "no net loss" of wetland function as compared to other methods of mitigation (e.g., on-site mitigation, in-lieu fee, etc.). In addition, we are unable to definitively suggest there is a calculated "no net loss" of wetland function, as we did not compare wetlands on impact sites to wetlands in banks. This is an important avenue to be explored. What we can say is that, when permits assume that the with-bank scenario attains full wetland function and success criteria are established based on assumed attainment of full wetland function, any wetland (or upland) community in a bank that falls short of full wetland function represents a potential "net loss" of wetland function.

Future Research Direction

Two primary avenues for future research have been identified through this study. First, further development of wetland assessment methods (e.g., FWCI, HGM) for additional Florida regions and wetland community types should be a priority in order to further accounting of wetland function. Second, further studies should focus on what wetland functions are being lost in wetland impact sites in relation to the mitigation provided.

When this project began, the FWCI was considered to be one of the primary detailed assessment methods that would be used to assess wetland assessment areas within banks. However, once site visits and field sampling began, it became apparent that the application of the FWCI would be limited by wetland community type, as the FWCI has only been developed for depressional herbaceous wetlands (Lane et al. 2003), depressional forested wetlands (Reiss and Brown 2005a), and forested strand and floodplain wetlands (Reiss and Brown 2005b). Further, while separate FWCIs have been developed for diatom, macrophyte, and macroinvertebrate assemblages, site conditions during the sampling period (May 2005-September 2006) prevented collection of diatom and macroinvertebrate samples at most sites.

The general lack of correlation among the rapid field assessment methods (e.g., WRAP, UMAM) with the more detailed field assessment methods (e.g., HGM, FWCI) may be attributable to the small sample size or the variability in wetland community type. It is unlikely that there was truly no correlation among these methods, as the reference database used to develop the FWCI showed significant correlations among LDI, WRAP, and FWCI (Reiss and Brown 2007, in press). Although HGM and FWCI methods were more time consuming and labor intensive, further development and testing of field based biological assessment methods and application of these tools for monitoring and assessment of restoration, creation, enhancement, and preservation effectiveness for wetlands within mitigation banks could strengthen the foundation for a basis of calculating wetland function.

In addition, undertaking a detailed study that measures the ecological integrity of wetlands lost from impacts compared to that gained from attainment of permit success criteria at banks should be considered. No true calculation of net wetland function can be considered after-the-fact at wetland impact sites. Such a study would require a long time frame, addressing initial wetland condition at the bank, wetland condition at the bank at the time of incremental credit releases, wetland condition at the bank following final release of credits after meeting permit success criteria, and assessments at each wetland impact project prior to impact that purchased credits from the bank, using the same assessment method or set of assessment methods throughout the study. While such a study may sound massive and unfeasible, it is seemingly the only way to truly account for functional gains or losses from compensatory mitigation and to calculate "net loss."

Conclusion

Return of full wetland function may be an impossible goal given current and future human development activities across the Florida landscape. A more realistic outlook on mitigation outcomes would probably reduce the amount of potential credits allocated for a particular site. Some may argue that this would reduce the economic incentive of mitigation banking. However, economic evaluation is beyond the scope of this study and existing state wetland regulatory rules.

One of the purported benefits of wetland mitigation banks is that mitigation is in place prior to wetland impacts, which is an improvement over on-site mitigation that allows for the impact of one wetland resource prior to the enhancement or creation of another. However, for mitigation banks, it is unclear how much wetland function is actually provided at the time of credit releases. Initial credit releases are based on recording of conservation easement, often with no additional mitigation activities or site improvements, such that there may be a temporary loss associated with this practice.

Overall, most of the wetland mitigation banks showed potential to provided increased wetland function following restoration. However, many wetland mitigation banks were limited by their position in the landscape, managed hydrologic regimes and altered benefits to downstream systems, water quality concerns, or other barriers to attaining full function. Having realistic expectations of the potential functional gain and clearly defining reference standard conditions may lessen the potential of "net loss" in wetland mitigation banks. As noted in compensatory mitigation studies in Massachusetts (Brown and Veneman 2001), California (Ambrose et al. 2006), and Ohio (Mack and Micacchion 2006), while most wetland mitigation banks may have the potential to meet permit success criteria, this does not necessarily equate to their achieving full wetland function. Basic ecological principles can better dictate a more sensible way to plan, implement, and manage mitigation banks, with considerations including edge effects such as roads and towers, core to edge ratios for habitat, fragmentation and habitat loss in the landscape, and species interaction. If these basic principles are overlooked, then the assumption of achieving function has no validity. Mitigation banks must be assessed realistically for credit potential.

REFERENCES

Adams, S.M. 2002. Biological indicators of aquatic ecosystem stress: introduction and overview. Pages 1-11 in S.M. Adams, editor. Biological indicators of aquatic ecosystem stress. American Fisheries Society. Bethesda, Maryland, USA.

Ambrose, R.F., J.C. Callaway, and F.F. Lee. 2006. An evaluation of compensatory mitigation projects permitted under Clean Water Act Section 401 by the California State Water Quality Control Board, 1991-2002. Final Report to the California Environmental Protection Agency, California State Water Resources Control Board, Los Angeles, California, USA. Contract number: 03-259-250-0.

Analyse-it Software, Ltd. 1997-2003. version 1.67. Leeds, England, United Kingdom.

Arcview GIS 3.2 Environmental Systems Research Institute, Inc. 1999. Neuron Data, Inc. 1991-1996. Portions copyright 1991-1995 Arthur D. Applegate. Redlands, California, USA.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549–560.

Ashley, E.P., and J.T. Robinson. 1996. Road mortality of amphibians, reptiles and other wildlife on the Long Point Causeway, Lake Erie, Ontario. Canadian Field Naturalist 110(3): 403-412.

Barbour, M.T., J. Gerritsen, and J.S. White. 1996. Development of the stream condition index (SCI) for Florida. A Report to the Florida Department of Environmental Protection, Stormwater and Nonpoint Source Management Section. Tetra Tech, Inc. Owing Mills, Maryland, USA.

Bardi, EB, MT Brown, KC Reiss, MJ Cohen (2005) UMAM Training manual: Web-based training manual for Chapter 62-345, FAC for wetlands permitting. Available at: http://www.dep.state.fl.us/labs/library/index.htm

Beck, W.M. 1954. Studies in stream pollution biology I: a simplified ecological classification of organisms. Quarterly Journal of the Florida Academy of Science 17(4): 211-227.

Breshears, D.D., J.W. Nyhan, C.E. Heil, and B.P. Wilcox. 1998. Effects of woody plants on microclimate in a semiarid woodland: soil temperature and evaporation in canopy and intercanopy patches. International Journal of Plant Sciences 159: 1010–1017.

Brown, M.T., J. Schaefer, and K. Brandt. 1990. Buffer zones for water, wetlands, and wildlife in East Central Florida. CFW Publication #89-07, Florida Agricultural Experiment Stations Journal Series No. T-00061.

Brown, M.T. and M.B. Vivas. 2005. A landscape development intensity index. Environmental Monitoring and Assessment 101: 289-309.

Brown, P., and Lant. 1999. The effect of wetland mitigation banking on the achievement of no-net-loss. Environmental Management 23(3): 333-345.

Brown, S.C. and P.L.M. Veneman. 2000. Effectiveness of compensatory wetland mitigation in Massachusetts, USA. Wetlands 21(4): 508-518.

Campbell, D.A., C.A. Cole, and R.P. Brooks. 2002. A comparison of created and natural wetlands in Pennsylvania, USA. Wetlands Ecology and Management 10: 41–49.

Clewell, A. 1999. Restoration of riverine forest at Hall Branch on phosphate-mined land, Florida. Restoration Ecology 7(1): 1-14.

Cohen, M.J., S.M. Carstenn, and C.R. Lane. 2004. Floristic quality indices for biotic assessment of depressional marsh condition in Florida. Ecological Applications 14(3): 784-794.

Cowardin, L.M., V. Carter, F.C. Goulet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. United States Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA.
Crawford, RL, and Engstrom, TR. 2001. Characteristics of avian mortality at a North Florida television tower: a 29-year study. Journal of Field Ornithology 72(3): 380–388.
David, P.G. 1999. Response of exotics to restored hydroperiod at Dupuis Preserve, Florida. Restoration Ecology 7(4): 407-410.
Dennison, M. S., and J. A. Schmid. 1996. Wetland mitigation: Mitigation banking and other strategies for development and compliance. Government Institutes, Rockville, Maryland.
Diaz, R., W.A. Overholt, and J.P. Cuda. 2003. Exotics in the wetlands: West Indian marsh grass. Document ENY-693, one of a series of the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Available at: http://edis.ifas.ufl.edu
ELI [Environmental Law Institute]. 2002. Banks and fees: the status of off-site wetland mitigation in the United States. Washington, DC. Available at: http://www.elistore.org/reports_detail.asp?ID=10695
EEPC [Exotic Pest Plant Council]. 2003. 2003 Invasive plant list. Available at: http://www.fleppc.org/ Accessed 2004-2006.
Estuarine wetland rapid assessment procedure for mitigation banks in Florida (E-WRAP). Date Unknown. Developed by the Mitigation Bank Review Team. Florida Department of Environmental Protection. Available at: http://www.saj.usace.army.mil/regulatory/assets/docs/mj/draft_E-WRAP.pdf
Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. 1995. Federal Register 60 (228): 58605-58614. Available at: http://www.epa.gov/owow/wetlands/guidance/mitbankn.html
Compensatory Mitigation for Losses of Aquatic Resources; Proposed Rule. 2006. Federal Register 71(59): 15519-15556.
FDEP [Florida Department of Environmental Protection]. 1994. The biological success of created marshes in central Florida. Biology Section, Division of Technical Services, Florida Department of Environmental Protection. April 1994.
FDEP [Florida Department of Environmental Protection]. 1996. A biological study of mitigation efforts at selected sites in north Florida. Biology Section, Division of Administrative and Technical Services, Florida Department of Environmental Protection. May 1996.
FDER [Florida Department of Environmental Regulation]. 1991a. Operational and compliance audit of mitigation in the wetland resource regulation permitting process. Report no. AR-249. Office of the Inspector General, Department of Environmental Regulation State of Florida. November 1, 1991.
FDER [Florida Department of Environmental Regulation]. 1991b. Report of the effectiveness of permitted mitigation. Florida Department of Environmental Regulation Pursuant to Section 403.918(2)(b), Florida Statutes, Department of Environmental Regulation, State of Florida. March 5, 1991.
FDER [Florida Department of Environmental Regulation]. 1992. The biological success of mitigation efforts at selected sites in central Florida. Biology Section, Division of Technical Services, Department of Environmental Regulation, State of Florida. September 1992.
FNAI [Florida Natural Areas Inventory]. 1990. Guide to the natural communities of Florida. Tallahassee, Florida. Available at: http://www.fnai.org/naturalcommguide.cfm

Forman, R.T.T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology 14(1): 31-35.
Forman, R.T.T., and R.D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (U.S.A.) suburban highway. Conservation Biology 14(1): 36-46.
Gibbons, J.W. 2003. Terrestrial habitat: a vital component for herpetofauna of isolated wetlands. Wetlands 23(3): 630-635.
Jones, Edmunds & Associates, Inc. (JEA), M. T. Brown, J. S. Wade, and R. Hamann. 1999. Background report in support of development of a wetland buffer zone ordinance. Project No. 19270-485-01. Jones, Edmunds & Associates, Inc. Gainesville, FL.
Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.
Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5: 55-68.
Kentula, M.E., J.C. Sifenos, J.W. Good, M. Rylko, and K. Kuntz. 1992. Trends and patterns in Section 404 permitting requiring mitigation in Oregon and Washington, USA. Environmental Management 16: 109-119.
Kirkman, K.L, and R.J. Mitchell 2006. Conservation management of *Pinus palustris* ecosystems from a landscape perspective. Applied Vegetation Science 9: 67-74.
Lane, C.R. 2000. Proposed ecological regions for freshwater wetlands of Florida. Masters Thesis, University of Florida, Gainesville, Florida, USA.
Lane, C.R., M.T. Brown, M. Murray-Hudson, and M.B. Vivas. 2003. The wetland condition index (WCI): biological indicators of wetland condition for isolated depressional herbaceous wetlands in Florida. H.T. Odum Center for Wetlands, University of Florida, final report to the Florida Department of Environmental Protection. Available at: http://www.dep.state.fl.us/labs/library/index.htm
Mack, J.J., M. Micacchion, L.D. Augusta, and G.R. Sablak. 2000. Vegetation indices of biotic integrity (VIBI) for wetlands and calibration of the Ohio rapid assessment method for wetlands v 5.0. Final Report to the United States Environmental Protection Agency Grant No. CD985276, Interim report Grant No. CD985875, Volume 1. Wetland Ecology Group, Division of Surface Water, Ohio Environmental Protection Agency, Columbus, Ohio, USA. Found at: http://www.epa.state.oh.us/dsw/wetlands/WetlandEcologySection_reports.html
Mack, J.J and M. Micacchion. 2006. An ecological assessment of Ohio mitigation banks: vegetation, amphibians, hydrology, and soils. Ohio EPA Technical Report WET/2006-1. Ohio Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, Columbus, Ohio, USA. Found at: http://www.epa.state.oh.us/dsw/wetlands/WetlandEcologySection_reports.html
Maehr, D.S. 1988. Florida panther movements, social organization, and habitat utilization. Annual Performance Report, 7/1/87-6/30/88, Study No. E-1-12 II-E-2 7502, Florida Game and Fresh Water Fish Commission.
McAllister, L.S., B.E. Peniston, S.G. Leibowitz, B. Abbruzzese, and J.B. Hyman. 2000. Synoptic assessment for prioritizing wetland restoration efforts to optimize flood attenuation. Wetlands 20(1): 70-83.
McKenna, Jr., J.E. 2003. Community metabolism during early development of a restored wetland. Wetlands 23(1): 35-50.
McPherson, G.R. and S. DeStefano (2003) Applied ecology and natural resource management, Cambridge University Press. New York, New York, USA.

Micacchion , M. 2002. Amphibian index of biotic integrity (AmphIBI) for wetlands. Final Report to the United States Environmental Protection Agency Grant No. CD985875-01 Testing Biological Metrics and Development of Wetland Assessment Techniques Using Reference Sites, Volume 3. Wetland Ecology Group, Division of Surface Water, Ohio Environmental Protection Agency, Columbus, Ohio, USA. Found at: http://chagrin.epa.state.oh.us/dsw/wetlands/2002_Amphibian_report_final_rev.pdf.

Miller, R.E., Jr. and B.E. Gunsalus. 1999. Wetland rapid assessment procedure. South Florida Water Management District, Technical Publication REG-001. West Palm Beach, Florida, USA.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands, 2nd edition. John Wiley and Sons, Inc. New York, New York, USA.

Mitsch, W.J., and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. Ecological Applications 6 (1): 77-83.

Moore, M.M, W.W. Covington, and P.Z. Fulé. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. Ecological Applications 9(4): 1266-1277.

Morgan, K.L., and T.H. Roberts. 2003. Characterization of wetland mitigation projects in Tennessee, USA. Wetlands 23(1): 65–69.

Myers, J.H., D. Simberloff, A.M. Kuris, and J.R. Carey. 2000. Eradication revisited: dealing with exotic species. TREE 15(8): 316-320.

Myers, R.L., and J.J. Ewel, editors. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida, USA.

Noble, C.V., R. Evans, M. McGuire, K. Trott, M. Davis, and E.J. Clairain, Jr. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of flats wetlands in the Everglades. Wetlands Research Program, Engineer Research and Development Center, US Army Corps of Engineers, Washington, D.C. ERDC/EL TR-02-19

Noble, C.V., R. Evans, M. McGuire, K. Trott, M. Davis, and E.J. Clairain, Jr. 2004. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of depressional wetlands in peninsular Florida. Wetlands Research Program, Engineer Research and Development Center, United States Army Corps of Engineers, Washington, D.C. ERDC/EL TR-04-3

NRC [Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, National Research Council]. 2001. Compensating for Wetland Losses Under the Clean Water Act. ISBN: 978-0-309-07432-2

O'Connell, T.J., L.E. Jackson, and R.P. Brooks. 1998. A bird community index of biotic integrity for the mid-Atlantic highlands. Environmental Monitoring and Assessment 51: 145-156.

Odum, H.T. 1996. Environmental accounting: Emergy and environmental decision making. John Wiley and Sons, New York, New York, USA.

Ogawa, H., and J.W. Male. 1986. Simulating the flood mitigation role of wetland. Journal of Water Resource Planning and Management 112:114-128.

Patton, E.G., P.P. Sullivan, and K.J. Davis. 2003. The influence of a forest canopy on top-down and bottom-up diffusion in the planetary boundary layer. Quarterly Journal of the Royal Meteorological Society 129: 1415–1434.

Peterjohn, W.T., and D.L. Correll. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest. Ecology 65:1466-1475.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. BioScience 50(1): 53-65.
Race, M.S., and M.S. Fonseca. 1996. Fixing compensatory mitigation: What will it take? Ecological Applications 6(1): 94-101.
Reiss, K.C. and M.T. Brown. 2005a. The Florida Wetland Condition Index (FWCI): developing biological indicators for isolated depressional forested wetlands. H.T. Odum Center for Wetlands, University of Florida, final report to the Florida Department of Environmental Protection. Available at: http://www.dep.state.fl.us/labs/library/index.htm
Reiss, K.C. and M.T. Brown. 2005b. Pilot study - The Florida Wetland Condition Index (FWCI): preliminary development of biological indicators for forested strand and floodplain wetlands. H.T. Odum Center for Wetlands, University of Florida, final report to the Florida Department of Environmental Protection. Available at: http://www.dep.state.fl.us/labs/library/index.htm
Reiss, K.C., and M.T. Brown. 2007, in press. An evaluation of Florida palustrine wetlands: application of USEPA levels 1, 2, and 3 assessment methods. EcoHealth.
Reynolds, J.E. 2001. Urbanization and land use change in Florida and the south. Current Issues Associated with Land Values and Land Use Planning, Proceedings of a Regional Workshop, SERA-IEG-30. Southern Rural Development Center, Mississippi State, Mississippi, USA. SRDC Series #220 Available at: http://srdc.msstate.edu/publications/220.htm
Rheinhardt, R. D., M. C. Rheinhardt, and M.M. Brinson. 2002. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of wet pine flats on mineral soils in the Atlantic and Gulf Coastal Plains. Wetlands Research Program, Engineer Research and Development Center, United States Army Corps of Engineers, Washington, D.C. ERDC/EL TR-02-9
Robb, J.T. 2002. Assessing wetland compensatory mitigation sites to aid in establishing mitigation ratios. Wetlands 22(2): 435–440.
Roberts, L. 2003. Wetlands trading is a loser's game, say ecologists. Science 260(5116): 1890-1892.
Ruhl, J.B., and J. Salzman. 2006. The effects of wetland mitigation banking on people. National Wetlands Newsletter 28(2): 1,9-14.
Ruiz-Jaen, M.C. and T.M. Aide. 2005. Restoration success: how is it being measured? Restoration Ecology 13(3): 569-577.
Schulz, E.J., M.V. Hoyer, and D.E. Canfield, Jr. 1999. An index of biotic integrity: a test with limnological and fish data from sixty Florida lakes. Transactions of the American Fisheries Society 128: 564-577.
SER [Society for Ecological Restoration International, Science & Policy Working Group]. 2004. The SER International primer on ecological restoration. www.ser.org & Tucson: Society for Ecological Restoration International. Available at: http://www.ser.org
Slocum, M.G., W.J. Platt, and H.C. Cooley. 2003. Effects of differences in prescribed fire regimes on patchiness and intensity of fires in subtropical savannas of Everglades National Park, Florida. Restoration Ecology 11(1): 91-102.
Smith, R.D. 2001. Hydrogeomorphic approach to assessing wetland functions: Guidelines for developing regional guidebooks, Chapter 3 Developing a reference wetland system. Wetlands Research Program, Engineer Research and Development Center, US Army Corps of Engineers, Washington, D.C. ERDC/EL TR-01-29

Smith, S.M., P.V. McCormick, J.A. Leeds, P.B. Garrett. 2002. Constraints of seed bank composition and water depth for restoring vegetation in the Florida Everglades, U.S.A. Restoration Ecology 10(1): 138-145.

Soil Conservation Service. 1984. 26 Ecological communities of Florida. United States Department of Agriculture, Washington, D.C., USA.

SFWMD [South Florida Water Management District]. 2000. Basis of review for environmental resource permit applications within the South Florida Water Management District. Rules of the South Florida Water Management District, West Palm Beach, Florida, USA. Available at: http://www.dep.state.fl.us/water/mines/docs/BOR_08_00.pdf

Story, G., A. Redmond, A. Ertman, D. Dale, H. Johnson, D. Hankla, D. Palmer, G. Carmody, B. Rieck, D. Ferrell, R. Moore, T. Gipe, and A. Bain. 1998. Joint State/Federal Mitigation Bank Review Team Process for Florida. United States Army Corps of Engineers, Jacksonville District. Available at: http://www.saj.usace.army.mil/regulatory/assets/docs/mj/jsfmbrtp/jointFED-State_bankReview.pdf

Taylor, WK. 1973. Black-throated blue and Cape May warblers killed in Central Florida. Bird Banding 44(4): 258-266

Tobe, J.D., K. Craddock Burks, R.W. Cantrell, M.A. Garland, M.E. Sweeley, D.W. Hall, P. Wallace, G. Anglin, G. Nelson, J.R. Cooper, D. Bickner, K. Gilbert, N. Aymond, K. Greenwood, and N. Raymond. 1998. Florida wetland plants: an identification manual. Florida Department of Environmental Protection, Tallahassee, Florida, USA.

Uranowski, C., Z. Lin, M. DelCharco, C. Huegel, J. Garcia, I. Bartsch, M.S. Flannery, S.J. Miller, J. Bacheler, and W. Ainslie. 2003. A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of low-gradient blackwater riverine wetlands in peninsular Florida. Wetlands Research Program, Engineer Research and Development Center, United States Army Corps of Engineers, Washington, D.C. ERDC/EL TR-03-3

USACE [United States Department of the Army, Corps of Engineers]; USEPA [United States Environmental Protection Agency]; USDI [United States Department of Interior]; and USDC [United States Department of Commerce]. 2000. Federal Guidance on the use of in-lieu-fee arrangements for compensatory mitigation under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Federal Register 65 (216): 66913-66917. Available at: http://www.usace.army.mil/cw/cecwo/reg/ILFFEDREG.pdf

USEPA [United States Environmental Protection Agency]. 1998. Lake and reservoir bioassessment and biocriteria: EPA 841-B-98-007 Technical Guidance Document. Washington, D.C., USA. Accessed 2002-2007. Available at: http://www.epa.gov/owow/monitoring/tech/lakes.html

USEPA [United States Environmental Protection Agency]. 2002. Elements of a wetland monitoring and assessment program. October 24, 2002, draft. Accessed August 2004. Available at: http://www.epa.gov/owow/wetlands/monitor/Wetlands_Elements_Checklist.pdf

Vivas, M.B. 2007. Effects of human development on the water quality of freshwater systems in Florida: a landscape analysis. Ph.D. Dissertation, University of Florida, Gainesville, Florida.

Vogel, R.J. 1973. Effects of fire on the plants and animals of a Florida wetland. American Midland Naturalist 89 (2): 334-347.

Zampella, R.A., and K.J. Laidig. 2003. Functional equivalency of natural and excavated coastal plain ponds. Wetlands 23(4): 860-876.